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Physicians' Perceptions and Practice Regarding the Prevention of Catheter-Associated Urinary Tract Infections in the ICU

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Abstract

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MD Candidate, Windsor University School of Medicine, 2016

BSIT, Clayton State University, 2008

Dissertation Submitted in Partial Fulfillment

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Abstract

Catheter associated urinary tract infection (CAUTI) incidence continue to rise despite all prevention efforts. The state of Georgia incidence of CAUTI between 2012 and 2013 showed an increase by 350 cases. The challenge is translating CAUTI prevention knowledge into practice by all physicians. The purpose of this correlational study was to improve the epidemiological understanding of CAUTI. Looking at physicians' perception and practice of CAUTI preventions was necessary. A total of 336 physicians from the state of Georgia completed a 26-item survey. Additionally, a pilot study was conducted on a small sample of participants. The result of the Cronbach alpha for the pilot study analysis of the 26-item survey instrument indicated excellent reliability. The analysis revealed that participants' frequency of training on proper catheterization and their perception of CAUTI risk factors and effective implementation of CAUTI prevention bundle elements, varied significantly. It also resulted that many of the participants were not knowledgeable of certain important CAUTI prevention elements. Only a few made changes in their practice despite knowledge of the Center for Medicare and Medicaid Services reimbursement policy. Results of the Pearson's chi-square test for independence indicated a significant correlation ($p < .05$) between physicians' perception and practice of CAUTI prevention elements and CAUTI incidence. The results of this study suggest that current CAUTI prevention practice may be inefficient without the effective implementation of proven bundled element. Improved understanding of CAUTI and its relation to effective implementation of bundled prevention elements may result in improved prevention efforts, decreased morbidity, mortality, and overall healthcare cost.

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Dedication

I dedicate my dissertation to my entire family. A special sentiment of gratitude to my beloved parents, Mr. & Mrs. Feh Henry Baaboh, Esq. and Ms. Immaculate N. Ntinglet-Mbi whose continuous financial and moral support and words of encouragement to always shoot for the "star" keeps resonating in my ears. My other dad, Mr. Sonny Mbi who agreed to support me when I decided to pursue my doctoral degree, I thank you for everything dad. My brother Conrad Feh and his wife Christy who have always been there for me and never stopped believing in me. My sisters, Ashley, Yasmine, Betina, Camilla, Vanessa and Maheva are my motivation. My beautiful nieces Theresia, Amyrah and Cailah are very special to me; they give me the reason to not give up.

I also dedicate this dissertation to my grandparents, Mr. Christopher and Mrs. Regina Musongong who contributed enormously in making me to be the woman that I am today. My aunty Dr. Emelda S. Ntinglet who is my role model and my other many aunties and uncles who are like parents to me and whose continuous support aided me to get to this point. To all my cousins who have continuously given me words of encouragement, I appreciate you all.

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Chapter 1: Introduction to the Study

Introduction

Hospital acquired infections (HAI) can lead to longer stays in the intensive care unit (ICU), extended morbidity, mortality, and an increase of overall cost of treatment and are therefore an important marker of quality of care (Becerra et al., 2010; Yuceer & Demir, 2009). Nearly 2 million individuals are affected by HAIs, also known as nosocomial infections, with patients in the ICU being at greater risk primarily due to device–associated (central venous catheter, urinary catheter, ventilator utilization) infections (Center for Disease Control and Prevention [CDC], 2000). These infections are caused by opportunistic organisms such as Gram positive *Staphylococcus aureus* and other Gram negative organisms such as *Klebsiella pneumonia*, *Escherichia coli*, *Pseudomona aeroginosa*, and *Acinebacgter species* (Katherason, Naing, Jaalam, & Ismail, 2007). These nosocomial infections cost an estimated 28.4 to 33.8 billion dollars in the United States (Scott, 2009).

A urinary tract infection (UTI) is an inflammatory reaction to a colonized urinary tract. It is termed CAUTI once a patient with an indwelling Foley catheter develops two or more signs or symptoms of UTI such as fever, hematuria, flank pain or suprapubic pain, altered mental status, and change in urine quality (Parida & Mishra, 2013). Of the nosocomial infections reported annually, CAUTI is the most common in the United States, comprising 36% of the 1.7 million reported cases of nosocomial infections (Barnes & Mahabir, 2013; Vacca & Angelos, 2013). The microorganisms

commonly found in the catheters and the hospital environment that are responsible for CAUTI are bacterias such as *Escherichia coli* (*E.coli*), *Klebsiella oxytoca*, *Klepsiella pneumoniae, Staphylococcus aureus* and *Pseudomonas aeruginosa* (He et al., 2012; Pavlovic et al., 2011; Stahlhut, Struve, Krogfelt, & Reisner, 2012). Infections with these microorganisms can result in complications such as gram-negative bacteremia, cystitis, prostatitis, pyelonephritis, and orchitis in males, epididymitis, and less commonly, endocartidis, septic arthritis, endophthalmitis, vertebral osteomyelitis, and meningitis in all patients. These complications can cause patient discomfort, increase costs, morbidity, and mortality. According to a study by Saint, Meddings, Calfee, Kowalski, and Krein (2009), each incident of CAUTI and urinary tract-related bacteremia cost $600 and $2800 respectively. It costs an estimated $500 million per annum to treat and is responsible for 13,000 deaths annually in the United States (Association for Professionals in Infection Control [APIC], 2012; Barnes & Mahabir, 2013; Vacca & Angelos, 2013). The consequence of this is the Center for Medicare & Medicaid services (CMS) decision to hold hospitals financially liable by refusing to compensate for the treatments of CAUTI due to its frequency, cost, and most importantly because it is believed to be practically preventable (Meddings et al., 2012; Morse, Boland, Blackhurst, & Roettger, 2010; Palmer, Lee, Dutta-Linn, Wroe & Hartmann, 2013; Saint et al., 2009).

The decision made by CMS lead Morse et al. (2010) to perform a “retrospective review of inpatient charts and the Greenville Hospital System electronic coding database” in an effort to evaluate the incidence and rate of CMS “never event” (HAI

deemed preventable by CMS) in patients aged 65 to 79 years (n = 118) and 80 years or above (n = 33) undergoing bowel surgery. The researchers' results focused on duration of stay, incidence of "never event," discharge status, and mean hospital cost. Patients 80 years or older had statistically elevated incidence of CAUTI and vascular catheter infections as compared to those 65 to 79 years of age, (36% vs. 12%) and (15% vs. 4%) respectively (p. 841). Further, the median hospital cost as well as hospital length of stay was observed to be higher in the former group as contrasted with the latter, (11 days vs. 6 days) and ($28,300 vs. $15,300) respectively. The researchers failed to clarify if the "never events" resulted in the higher cost or due to patients being prone to more illness; however, it was clear that hospitals will have to assume responsibility for the cost of treating patients who incur a "never event" (Morse et al., 2010). Saint et al. (2009) found that effective application of evidence-based guidelines by all clinicians and healthcare administrators can result in preventing the incidence of CAUTI thus reducing the hospitals financial burden, discomfort to the patient, morbidity, and mortality.

Background

Initially, an open bucket was used to drain catheters; however, this method ended four decades later when the closed drainage system method was introduced in the 1960s, resulting in a significantly decreased incidence of UTIs in the hospitals (Desautels, Walter, Graves & Harrison, 1962; Kunin, & McCormack, 1966). Since then, it has been the focus of the infection control team in hospitals to prevent the incidence UTIs acquired in hospitals; however, a significant decrease is yet to be seen (van den Broek et al., 2011).

According to the 2012 surveillance record, 4.5 nosocomial infections occur per 100 hospitalizations and 32% are catheter related UTIs. In fact, 59% to 86% of nosocomial UTIs are catheter related (Meddings et al., 2012). Two years prior, Hooton et al. (2010) reported on a 38 month prospective observational study in a spinal injury referral hospital, involving 128 acutely injured patients. The results showed rates of catheter associated bacteriuria and CAUTI incidences to be 2.72 and 0.68 cases per 100 catheter days respectively.

A recent prospective study showed the most important risk factors of CAUTI to be extended period of catheterization, unsuitable condition for the duration of catheterization, and preoperative antibiotic usage (Boybeyi, Karnak, Ciftci, Tanyel, & Senocak, 2013). Elpern et al. (2009) conducted a prospective study on 337 patients in a medical ICU having a sum of 1432 days of urinary catheterization. Within a 6-month intervention period, these researchers implemented suggestions of ongoing urinary catheterization with indwelling catheters created by unit clinicians. They then contrasted the amount of days indwelling catheters where used and the rates of CAUTI throughout the intervention phase with records from the previous 11 months. Results show a decrease in duration of use of indwelling catheters from 311.7 d/month to a mean value of 238.6 d/month. The incidence of CAUTI significantly decreased from 4.7/month prior to the study period to zero during the study period. Thus, judging the appropriate length of use of indwelling catheters can drastically reduce the rate of infections by pathogens causing CAUTI (Elpern et al., 2009).

Some studies have also considered fomites (pens, keyboards, stethoscopes, electronic devices, and doorknobs etc.) to be potential carriers of infectious pathogens when used during point of care without disinfecting. A prospective comparative study carried out in the emergency department of one hospital contrasted the value of using standard manual and self-cleaning units for the decontamination of small instruments (SUDS) in decontaminating 91 nonshared medical and electronic equipment (keyboards, phones, sphygnometers, intravenous poles, EKG leads and cables, pulse oximeter, blood pressure cables, etc.) during patient care. It resulted that 25% (23/91) of the manually decontaminated equipment were positively cultured for clinically significant pathogens, 15% showing multiple pathogens; however, after using SUDS, the colonization rate dropped to 0%. It was noted that the colonization rate remained 0% after 48 hours of SUDS treatment and re-introducing the equipment into the clinical setting (Obasi et al., 2009).

Despite all the studies in the literature that has established the positive effect of hand hygiene in decreasing the incidence of HAI, compliance continues to be a concern by all health care professionals (Alex-Hart & Opara, 2011; Hussein, Khakoo & Hobbs, 2007; Katherason et al., 2010; Mathai, George & Abraham, 2011; Rosner, 2007; Siegel & Korniewicz, 2007;). In an effort to improve compliance, Cheng et al. (2011) conducted a study in a Hong Kong hospital's neurosurgical ICU, which involved health care workers wearing an electronic hand hygiene compliance monitoring system called MedSence in a form of a name badge to identify hand hygiene opportunities and compliance before and after seeing a patient. Compliance established by the system as

well as infection control nurse was evaluated. In totality, 13,694 hand hygiene opportunities were identified by the system during the evaluation phase; however, only 35.1% compliance was noted. Compliance increased to 88.9% and 95.5% after a four 20-minute session when hand hygiene was screened in tandem by the system and infection control nurse respectively. The benefit of using an electronic monitoring system such as MedSense by the infection control team to obtain an objective measure of hand hygiene compliance was thus established.

The use of prophylactic systemic antimicrobials has been shown to decrease the risk of CAUTI especially in patients catheterized for 3-14 days; however, this can result in organism becoming resistant because most hospitalized patients are already receiving antibiotics for other causes (Medscape, 2012). An antimicrobial that has been proven to be effective is Trimethoprim-sulfamethoxazole (TMP-SMX) when administered prior to removal of urinary catheter. Researchers evaluated the effectiveness of administering TMP-SMX in 3 doses prior to removal of urinary catheters (Pfefferkorn et al., 2009). A total of 239 patients suffering from major abdominal surgery who were catheterized preoperatively were included in the prospective randomized trial. Urine cultures obtained prior and 3 days after removal of bladder catheters showed a considerable decrease in the incidence of symptomatic UTI in patients who were administered TMP–SMX or before catheter removal (4.9%) as compared to the control (21.6%) (Pfefferkorn et al., 2009). Zacharias, Dwarakanath, Agarwal, and Sharma (2009) reported on a prospective randomized control study conducted at the All Indian Institute to evaluate the effectiveness of using amikacin sulfate bladder wash on catheterized

patients. It resulted that none of the patients who were given amikacin sulfate bladder wash developed CAUTI while 40% of the patients who did not receive the bladder wash developed CAUTI.

Pickard et al., (2012) reported on a study where they compare silver alloy and nitrofural (also called nitrofurazone) impregnated catheter versus the standard polytetrafluoroethylene (PTFE) catheterization as the control in a multicenter randomized control trial in 24 hospitals in UK to ascertain whether interim use of antimicrobials would reduce the risk of CAUTI. It resulted that 263 (12.5%) out of 2097 of the silver alloy group and 228 (10.6%) out of 2153 of the nitrofural group had primary outcome when contrasted with 271 (12.6%) out of 2144 participants of the control group. The authors noted the nitrofural group to have demonstrated higher rate of catheter related discomfort when compared with the other groups. They also saw no significant advantage in the interim use of silver alloy or nitrofural impregnated catheters in reducing symptomatic CAUTI (Pickard et al., 2012). Although research have demonstrated some benefits of using antiseptic agents such as nitrofurazone and silver alloy impregnated catheters as well as some catheters impregnated with antibiotics in decreasing asymptomatic CAUTI, a significant decrease in symptomatic CAUTI incidence was not seen (Pickard et al., 2012). Pickard et al. (2012) supported the guidelines by CDC and IDSA which warned against routine use of antimicrobial or antibiotic impregnated catheters (Gould et al., 2010; Hooton et al., 2010).

An internet survey was sent to Minnesota physicians by Drekonja, Kuskowski, and Johnson (2010) to ascertain their knowledge and practice with regards to catheter

placement, CAUTI prevention interventions, as well as their thoughts on the policy change. Physicians who responded to the survey where acquainted with the utilization of Foley catheter and majority of them were aware of the altered repayment policy on CAUTI. Although the respondents had catheter-related knowledge, it was not being used in good practice to prevent CAUTI.

This cross-sectional study provided a better understanding of the perception and practice of evidence-based guidelines by an under researched population. In clinical practice, nurses receive orders (orders for catheter placement or removal, or administration of medications) from physicians. However, researchers have focused mainly on nurses' rather than physicians' practice on preventing the incidence of CAUTI . In this study, I focused on the state of Georgia physicians' perception of and practice with evidence-based elements to decrease the incidence of CAUTI. More studies on physicians are needed because establishment of evidence-based practice by all health care professionals can drastically decrease the prevalence of indwelling catheterization in addition to the incidence of CAUTI (Parida & Mishra, 2013). In the remainder of this chapter, I present major sections such as the Purpose of the Study as well as its significance. In Chapter 2, I present a Review of Literature with evidence of the crisis related to CAUTI, its evidence based prevention elements, as well as the limited study on physicians' perception and practice.

Statement of the Problem

Of the 1.7 million cases of nosocomial infections reported annually, CAUTI makes about 36% thus making it the most common of all the nosocomial infections

(Barnes & Mahabir, 2013; Vacca & Angelos, 2013). Despite infection prevention strategies offered by CDC, CAUTI incidences continue to rise (CDC, 2015). Researchers have also discussed the need for an active infection control program throughout all hospitals (Vacca & Angelos, 2013). The CMS considers CAUTI to be preventable and therefore, will not pay hospitals for claims related to hospital-acquired UTI with the intention to persuade hospitals to enhance patient safety as well as decrease medicare costs (Meddings et al., 2012; Palmer, Lee, Dutta-Linn, Wroe, & Hartmann, 2013). With the CMS decision in place, individual hospitals as well as the healthcare system as a whole must deal with the financial burden caused by the rising incidence and prevalence of CAUTI (Parida & Mishra, 2013).

The problem is the lack of translation of CAUTI prevention knowledge into clinical practice by physicians. Several researchers have focused on nurses' knowledge and practice on CAUTI prevention however; little attention has been place on physicians practice. Catheter placement is frequently carried out by nurses and physicians may be uninformed of whether their patients have indwelling catheters (Drekonja et al., 2010). It is possible that hospitals that frequently educate their physicians on proper catheterization and CAUTI risks will experience a decrease in the incidence of CAUTI. It is also possible that physicians who translate their knowledge of CAUTI prevention into practice will also help in decreasing the incidence of CAUTI. In this research I studied the relationship between the recently reported annual incidences of CAUTI in Georgia as the dependent variable and nine independent variables: (a) constant education of physicians on proper catheterization, (b) physicians awareness of

CAUTI risk factors, (c) physicians perception and practice on effective implementation of prevention bundle elements, (d) early catheter removal, (e) regular disinfecting fomites (f) use of electronic monitoring system to improve hand hygiene, (g) effective use of TMP-SMX as prophylaxis, (h) effective use of amikacin sulfate bladder wash as prophylaxis, (i) physicians' compliance with CDC and IDSA guidelines to avoid habitual use of antimicrobials, and (j) physicians' awareness of CMS reimbursement policy on CAUTI claims. In an effort to steer clear of bias on CAUTI incidence and reporting, the cohort of physicians that were included in this study must be employed by hospitals that are part of the National Health Safety Network (NHSN) thus maximizing quality of data collected.

Purpose of the Study

The purpose of this research was to improve the epidemiological understanding of CAUTI by quantitatively investigate whether physicians' perception and practice on CAUTI prevention bundle elements either in part or in full are associated with reported CAUTI incidence. Understanding the brunt that physicians' perception and practice have on CAUTI incidence may present new and vital considerations for healthcare professionals, infectious disease control directors, lawmakers and other public health organizations and CAUTI researchers. Healthcare professionals (especially physicians) may be interested because understanding how their practice can influence prevention progress may result in a self evaluation with a resultant change in attitude with regards to their prevention practice method. Infectious disease control directors, lawmakers and other public health organizations may be interested because of the recent CMS decision

of not reimbursing claims related to hospital acquired CAUTI hoping that it may encourage hospitals to improve patient safety (APIC, 2012). Researchers may be interested because a translation of CAUTI prevention knowledge into practice and its effect on CAUTI incidence has been understudied (Drekonja et al., 2010).

Research Question and Hypothesis

For the purpose of this research, five questions were assessed, part of which are bundle elements verified by the review of literature to be effective in preventing CAUTI incidence. The subsequent study questions and hypothesis were obtained from the assessment of accessible literature in the area of CAUTI risk, guidelines for prevention of CAUTI and physicians' perception and practice in preventing CAUTI.

Research Question 1: Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia?

$H_0$1: There is no relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

H_a1: There is significant relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

Research Question 2: Is there a relationship between physician's awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

$H_0$2: There is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

H_a2: There is significant relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

Research Question 3: Is there a relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

H_03: There is no relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a3: There is significant relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Research Question 4: Is there a relationship between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

H_04: There is no relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a4: There is significant relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Research Question 5: Is there a relationship between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI?

$H_0$5: There is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a5: There is significant relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Theoretical Framework for the Study

The theoretical framework for this study was Kaipayil's (2009) theory of relationalism which refers to the theory of realism that construes the existence, significance and temperament of things with regards to their relationality; it is a theory of the one (CAUTI incidence as the dependent variable) and the many (perception and practice of CAUTI prevention elements as the independent variable). It is a philosophical theory of reality which suggests that there is an interrelation between things and events (Kaipayil, 2009), i.e. there is relationship between the certain risk factors (e.g. duration of catheterization) and the frequency of CAUTI.

The incidence of CAUTI is the amount of new cases of CAUTI that occurred in a population of catheterized patient in a specified time period and the attributable risk is the amount of CAUTI incidence that can be attributed to certain specific risk factors (CDC, 2012). For example, assume a population of 1000 catheterized patients, 500

exposed tested positive for CAUTI while 500 unexposed tested negative. Of those who tested positive, 300 were false positive and of those who tested negative, 25 actually were false negatives. The attributable risk will look at the difference in the incidence of CAUTI between the exposed (patients with extended catheter days) and the unexposed (patients with decreased catheter days). In this example, if 500 catheterized patients were in the exposed of which 200 developed symptomatic CAUTI and 500 catheterized patients where in the unexposed of which 25 developed symptomatic CAUTI, then the attributable risk will be (200/500) minus (25/500) which equals 175/500. Therefore the incidence of CAUTI attributed to extended catheter days is 175/500. The attributable risk is usually determined if the incidence is known and it helps in developing an approach for disease prevention (CDC, 2012). Looking at the lack of transferring CAUTI risk and modes of prevention knowledge into practice in relation to the incidence of CAUTI is the theoretical foundation using physicians' current perceptions and practices as variables in connection with CAUTI incidence.

Frequent education of Physicians on Proper Catheterization as an Independent Variable

One estimate of risk in this study was based on how often physicians are trained on infection control programs. Theoretically, frequent education on CAUTI prevention elements and placing emphasis on transferring the education into practice should result in an observed decreased in CAUTI incidence (Drekonja et al., 2010). In this research, the use of frequency of physicians' education as a variable in relation to the recently reported incidence of CAUTI will be analyzed.

Physicians Awareness of Risk Factors as an Independent Variable

The most important direct risk factors attributed to CAUTI incidence are extended period of catheterization, unsuitable conditions under catheterization and preoperative antibiotic usage (Boybeyi, Karnak, Ciftci, Tanyel, & Senocak, 2013). Elpem et al. (2009) confirmed a significant decrease in CAUTI incidence from 4.7/month to zero when suggestions to reduce indwelling catheter days was implemented by unit clinicians. Catheter placement is usually administered by nurse; however, in theory, if physicians are aware of the risk related to prolonged indwelling catheters, they can protect their patients by making sure that nurses don't live catheters in-situ for prolonged period of time.

Physicians Perceptions and Practices on Effective Implementation of Bundle Elements both In Part and In Full as an Independent Variable

Early catheter removal. Extended period of catheterization is one of the highest risk factor of CAUTI incidence amongst others (Talaat et al., 2010). The result of a systemic review and meta-analysis of 14 interventional studies that used a reminder system to remind clinicians that a urinary catheter was in use or stop orders that prompt catheter removal showed significant results. There was a reported decrease in CAUTI incidence by 52% when a reminder or stop order was implemented. There was also a 37% decrease in the mean length of catheterization, ensuing in a 2.61 less days of catheterization (Meddings et al., 2010). Theoretically, if physicians' are aware of the benefits of the reminders and stop orders and they practically implement it in their

practice, this will prevent inappropriate or extended catheterization resulting in a decreased incidence of CAUTI.

Constant disinfecting fomites. Fomites (pens, electronic devices, stethoscopes, etc.) have been known to be potential carriers of infectious pathogens and it poses potential risk when used during point of care (Das, Kansal, Asthana, Pandey, & Madan, 2011). The results of a prospective study showed a decrease in colonization from 15% to zero after standard manual and self-cleaning units for the decontamination of small instruments (SUDS) was used to disinfect fomites prior to use during point of care (Obasi et al., 2009). Hypothetically, if physicians' know that their fomites are potential carriers of pathogens and they are proactive in disinfecting them with disinfectants such as SUDS prior to seeing their patients, this can result in a decrease in transmission of infectious pathogens causing CAUTI.

Use of an electronic monitoring system to detect hand hygiene compliance. Hand hygiene compliance continues to be a concern by all healthcare professionals despite its benefits in decreasing the incidence of HAI (Alex-Hart & Opara, 2011). The results of a study demonstrated an increase in hand hygiene compliance when MedSense, an electronic monitoring system in the form of a name badge was implemented (Cheng et al., 2011). Apparently, if physicians do find the use of an electronic monitoring system to monitor hand hygiene as an indication to improving hand hygiene then its practice could relate to a decrease in the incidence of CAUTI.

Effective use of TMP-SMX or Amikacin Sulfate bladder wash as prophylaxis. Even though systemic antimicrobials has been proven to be successful in reducing the

risk of CAUTI especially for patients with prolonged catheterizations, resistance of organisms has been an issue mostly for patients already on antibiotic treatments (Medscape, 2012). However, result of a study that evaluated the administration of TMP-SMX in 3 doses prior to removal of urinary catheter showed a significant decrease in the incidence of symptomatic UTI (Pfefferkorn et al., 2009). Also, the effective use of amikacin sulfate bladder wash on catheterized patients was assessed by Zacharias, Dwarakanath, Agarwal, & Sharma, (2009) and it resulted that none of the patients who received the bladder wash developed CAUTI. If amikacin sulfate bladder wash is used effectively, it can ameliorate the issue of resistance by decreasing systemic antibiotic usage (Zacharias et al., 2009). Theoretically, if physicians find TMP-SMX or amikacin sulfate bladder wash as prophylaxis on catheterized patients to be indicated in relation to preventing CAUTI, then it should show in the recently reported incidence record.

Physicians Compliance with CDC and IDSA Guidelines as an Independent Variable

Another risk that was assessed is the habitual use of antimicrobial coated catheters. Some studies have shown silver alloy and nitrofurazone coated catheters to be effective however, when re-evaluated, both agents were not found to be significantly effective in decreasing the incidence of symptomatic CAUTI (Pickard et al., 2012). This supports guidelines provided by CDC and IDSA which warns against habitual use of antimicrobials or antibiotic impregnated catheters (Gould et al., 2010; Hooton et al.,

2010; Pickard et al., 2012). In theory, if physicians are compliant with the above mentioned compliance, it should contribute in the decrease in the incidence of CAUTI.

Physicians Awareness of CMS No Reimbursement Policy on CAUTI Claims

The frequency and high cost in treating CAUTI, which is deemed to be preventable, resulting is CMS decision to refuse compensating for its treatments (Palmer et al., 2013). Hypothetically, if physicians are aware and do understand the financial burden that this poses on the healthcare system, it encourage hospitals to improve patient safety. This could in-turn result in a decrease in CAUTI incidence

Further, this study was a correlational research and the use of the theory of relationalism was beneficial since it aided in evaluating quantitative data (Rudestam & Newton, 2007, p. 31). Rationalism is advantageous for this study also because of its capacity to furnish a combined perception on certainty by "accounting for the unity and the plurality that we experience" (Kaipayil, 2009, pg. 11) not only in public health but in the world at large. The literature linked to the variables contained in this study is further discussed in much detail in chapter 2. The subsequent section presents the nature of the study.

Nature of Study

A cross-sectional design that is descriptive in nature was used in this study. Using a cross-sectional design allowed for the assessment of the relationship between CAUTI incidence (as the dependent variable) and the independent variables of interest; (i.e. physicians' perceptions and practices on CAUTI prevention elements) within a

short time frame. This design was practical in providing a snapshot of the frequency of CAUTI, assess the burden of the disease in the population and also useful in informing physicians and other healthcare officials of the benefit of translating knowledge into practice.

A descriptive survey as well as recently reported frequency of CAUTI was used in this study. The dependent variable was the incidence of CAUTI between 2012 and 2013. The independent variables are: (a) constant education of physicians on proper catheterization, (b) physicians awareness of CAUTI risk factors, (c) physicians perception and practice on effective implementation of prevention bundle elements (early catheter removal; regular disinfecting fomites; use of electronic monitoring system to improve hand hygiene; effective use of TMP-SMX as prophylaxis; Effective use of amikacin sulfate bladder wash as prophylaxis); (d) physicians' compliance with CDC and IDSA guidelines to avoid habitual use of antimicrobials and (e) physicians' awareness of CMS no reimbursement policy on CAUTI claims.

The method for this study was quantitative. The prospective subjects were physicians in the State of Georgia who care for patient with indwelling catheter. In order to reach this population, email addresses of all licensed physicians as of January 2011 was obtained from the Medical Association of Georgia. An email was sent to these physicians inviting them to take part in a study on CAUTI prevention. The inclusion criteria were any doctor who treats catheterized patients in the ICU. This was stated on the invitation. The eligible physicians were then directed to a link to the survey instrument. The survey respondents were anonymous. Respondents who work at

more than one site were asked to respond only about their principal place of employment. A hospital is considered teaching if it has a residency program present. Only data from respondents who work for hospitals that are part of the National Health Safety Network (NHSN) was analyzed. The statistical tool that was employed for analysis will be SPSS. The frequency and percentage analysis was used to measure scores between responds. The Pearson's chi-square test for independence used to test the hypothesis. The next section will provide definitions of possible uncommon terms that were used throughout the rest of the chapters.

Definition of Terms

The subsequent terms and phrases are defined as used in this research.

Nosocomial infection (hospital-acquired infections): It is defined by the National Nosocomial Infection Surveillance systems (NNIS) as a systemic infection that is a consequence of an adverse reaction to the presence of an infectious agent(s) or its toxins and that was not there or incubating at the time of admission to the hospital. These infections usually become manifest about 48 hours or more after admission to the hospital (Inweregbu, Dave, & Pittard, 2013).

Catheter associated urinary tract infection (CAUTI): It's an infection that occurs in a patient whose urinary tract is presently being catheterized or was catheterized within the preceding 48 hours (Hooton et al., 2010).

Urinary tract infections (UTI): It refers to considerable bacteriuria in a patient who has signs or symptoms attributable to the urinary tract only (Hooton et al., 2010).

Fomites: These are nosocomial environmental surfaces such as writing pens, keyboards, stethoscopes, telephones, doorknobs, uniforms, said to be potential carriers of pathogens that cause healthcare-associated infections (Halton et al., 2011; British Medical Association, 2007).

Urinary catheter: This is a tube inserted in the urinary tract to empty urine from the bladder (Resnick, 2011).

Indwelling urethral catheters aka Foley catheter: For the purpose of this study, this is a catheter than has been left in the bladder for multiple days (Resnick, 2011).

Intensive care unit (ICU): It is a ward in the hospital that provides intensive care or critical care treatment to patients that are critically ill or in very unstable or life threatening conditions (National Health Services [NHS], 2012).

Infectious disease society of America (IDSA): This is a medical society that represents physicians, scientists and other health care professionals whose specialty is infectious diseases. In 2009, this organization published a guideline warning clinicians against habitually adding antiseptics or antimicrobials to the drainage bags of patients who are already catheterized in an effort to reduce to risk of nosocomial CAUTI or bacteriuria (Hooton et al, 2010).

Center for disease control and prevention (CDC): This is the national public health institute of the United States. In order to avoid resistance, CDC published a guideline in 2009 which recommended clinicians to avoid habitual use of systemic antimicrobials to avert CAUTI in patients needing either long or short-term catheterization (Gould et al., 2010).

Self-cleaning unit for the decontamination of small instruments (SUDS): According research, this is an easy to use, automated instrument that a group of experts developed to use for decontamination in the clinical setting. A study by Obasi and colleagues (2009) affirmed zero colonization rate 48 hours after using SUDS to decontaminate fomites in the clinical setting (Obasi et al., 2009) .

MedSense: According to Cheng et al. (2011), this is an electronic hand-hygiene monitoring method in a form of a name badge that presents Infection control specialists with constant access to hand-hygiene compliance information by monitoring moments 1 and 4 of the World Health Organization (WHO) "My 5 Moments of Hand Hygiene" guidelines. The result of a study done by these researchers showed an increase in compliance when MedSense was implemented to monitor hand hygiene compliance (Cheng et al., 2011).

Trimethoprim-Sulfamethoxazole (*TMP-SMX):* This a combination sulfa drug antibiotic used to eliminate bacteria that cause various infections including urinary tract infections etc. A study by Pfefferkorn et al. (2009) showed TMP-SMX to be significantly beneficial in preventing CAUTI incidence when used as prophylactic in 3 doses prior to removal of urinary catheter.

Amikacin sulfate: This antibiotic has been demonstrated to be valuable in preventing CAUTI when used as a bladder wash on catheterized patients. It also prevents the emergence of antibiotic resistance (Zacharias, Dwarakanath, Agarwal & Sharma, 2009).

Silver alloy coated catheter: Studies in the past have confirmed silver alloy coated catheters to be useful in preventing the incidence of CAUTI; however, a recent study by Pickard et al. (2012) saw no significant advantage when silver-alloy coated catheter was used short term.

Nitrofural coated catheter: Studies in the past have confirmed Nitrofural coated catheters to be effective in preventing the incidence of CAUTI; however, a recent study by Pickard et al. (2012) saw no significant advantage when silver-alloy coated catheter was used short term.

Assumptions and Limitations

Assumptions

This study assumed that certain recognized risk factor such as female gender and patients' age above 40 years is not significantly different between hospitals nationally. However, it does assume prior catheterization in the same hospital setting and extended period of catheterization to be a very significant risk factor. The study also assumed that the participants may or may not be aware of these risk factors.

Essential policies for the prevention of CAUTI such as indication for indwelling catheter placement, proper catheter insertion and maintenance as well as quality improvement programs have been proposed by the Center for Disease Control (CDC, 2009). This research assumed that hospitals are following these guidelines but what is unknown is how often quality improvement programs are implemented in hospitals. It is assumed that the frequency at which quality improvement programs are implemented will reflect on the rates of CAUTI. It is also assumed that the most recently reported

CAUTI incidence rates will show a decrease from previous reported rates if prevention bundle elements are implemented in full.

Also, in collaboration with CDC, the NHSN supplies healthcare facilities with data needed to recognize problem areas and assess progress of their prevention efforts with the ultimate goal of eliminated nosocomial infections (CDC, 2013c). This study assumed that facilities whose CAUTI incidence rates were assessed are part of the NHSN. The study also assumed that the physicians that participated in the survey are primarily employed by such facilities and their survey responses will be based on their practice in their primary place of employment. This important assumption minimized the possibility that certain healthcare facilities' infection control programs vary, however what is unknown is the practice of these programs among hospitals.

It is also presumed that the compliance of the participants to take part in the survey would not bias the study. It was also assumed that the participants would complete the survey truthfully based on their perception and practice. Finally, the study further assumed that the instrument that was be used for the research would be appropriate in measuring the selected variables.

Scope & Delimitations

This study focused on physicians in the state of Georgia who treat catheterized patients in the ICU and whose primary employer is a member of the NHSN. The reason for focusing on this group was because members of the NHSN are required to report every incidence of CAUTI to the NHSN, thus addressing the likelihood of sampling bias against internal validity. The objective was to assess whether physicians knowledge

on CAUTI prevention strategies is being translated into practice thus assessing the effectiveness of hospitals prevention efforts.

This study was limited to a cohort of physicians practicing in the state of Georgia. It is known that despite the high level if internal validity, this cohort may not precisely represent the physicians in the whole United States. Also, the hospitals in the State of Georgia that are part of the NHSN may also not accurately represent the hospitals in the United State. However, their willingness to be members of the NHSN may indicate their commitment to nosocomial infection prevention thus making them unique. The resultant delimitation is the decreased ability to generalize the result across all healthcare facilities in the United States.

Limitations

This was a cross-sectional study that's correlational in nature focusing on the relationship between CAUTI incidence and physicians' perception and practice on preventive measure. Because of this, causality was not able to be assessed thus weakening internal validity. Some of the selected respondents did not respond to the request to participate in the survey thus limiting the study. This may result in bias of measuring the outcome since the characteristics of responder may differ from non-responders. For the purpose of this research study, the limitations were identified as unavoidable but essential. An extended discussion of the thread to validity of the study will be addressed in chapter 3.

Significance of the Research

This proposed research was incomparable and appropriate given that it focused on a population that has been under-researched while trying to gain insight on an essential problem. The result of this study addressed a gap in the literature by providing a much desired insight on physicians' perception of the current theory as well as their current practice of effective administration of evidence-based elements both in part or in full for the purpose of preventing nosocomial CAUTI. By conveying together what is acknowledged about nosocomial CAUTI incidence risk and evidence-based prevention strategies with new understanding of physicians' perception on constant education on CAUTI prevention strategies and their perception and practice on disinfecting fomites, the use of electronic monitoring system for hand hygiene improvement and their practice on the effective use of TMP-SMX and amikacin sulfate bladder wash as prophylaxis to prevent CAUTI incidence, their compliance on guidelines from CDC and IDSA and their attitude on the recently CMS no reimbursement policy, a better appreciation for CAUTI epidemiology will be attained. By instituting an association between nosocomial CAUTI incidence and variables related to physicians' perception and practice, this study presented a more inclusive research design for research studies related to nosocomial CAUTI incidence and prevention strategies.

Another significant outcome from this study was improvement in translating CAUTI prevention knowledge into practice by all clinicians' thus decreasing risk and improving patient safety. Such an outcome would result in enhanced appreciation of the

epidemiology of CAUTI incidence. A comprehensive epidemiologic account of any disease allows for enhanced prevention and control strategies.

The positive social change expected to follow will be a decrease in CAUTI incidence, morbidity, mortality and overall healthcare cost. Saints et al. (2009) showed that each CAUTI event adds about $600 to $2800 to a patients cost of care. Other researchers showed that CAUTI incidence cost an estimated $500 million per annum to treat and its responsible for about 13,000 deaths annually (APIC, 2012; Barnes & Mahabir, 2013; Vacca & Angelos, 2013). By improving the understanding of application of prevention elements and CAUTI incidence, physicians and healthcare facilities may be offered improved guidance to transfer their knowledge into effective practice on CAUTI prevention on each catheterized patient. Assuming that improved knowledge leads to effective practice; hospitals may begin to experience lesser incidences of CAUTI, as well as decreased morbidity, mortality and healthcare cost related to CAUTI.

Summary

Catheter associated urinary tract infection (CAUTI) is the mostly reported of all the HAI comprising 36% of the 1.7 million reported cases. An estimated $500 million is spent annually to treat CAUTI cases and about 13,000 deaths related to CAUTI have been reported annually in the United States alone. Because of its frequency, cost and most important because it's believed to be highly preventable, the CMS has decided to not compensate hospitals for the treatment of any HAI case. Current literature supports the hypothesis that effective translation of perception or knowledge of CAUTI

prevention elements into practice by physicians will result in a decrease in the frequency of CAUTI incidence. The difference among hospitals in terms of how CAUTI prevention practice is performed and which elements are used may affect the incidence of CAUTI. If the current physicians' perception and practice have an impact on CAUTI incidence, then the epidemiology of CAUTI may be somewhat misconstrued. This research examined the relationship between five independent variables: (a) frequency of educating physicians on proper catheterization; (b) physicians' awareness of CAUTI risk factors; (c) physicians perception and practice on implementing CAUTI prevention bundle element (early catheter removal, disinfecting fomites, their use of electronic monitoring system called MedSense to improve hand hygiene, their effective use of TMP-SMX as prophylaxis, their effective use of amikacin sulfate bladder wash as prophylaxis); (d) physicians compliance with CDC and IDSA guidelines to avoid habitual use of antimicrobials and (e) physicians attitude on the CMS no reimbursement policy and the incidence of CAUTI in a population of hospitals that are members of the National Health Safety Network (NHSN).

In the next two chapters, the literature review and the research methods will be described. The literature review chapter, Chapter 2, critically discussed past research intended to notify readers about CAUTI and evidence based prevention elements as well as laid emphasis some gaps contained in past researches. The gaps in the past researches were discussed in the context of the study variables. The methodology chapter, Chapter 3, will present a detailed sketch of how the research was undertaken. Chapter 3 offers a more detailed explanation of the research design as well as the

sample, the instrument that was used, the data collection process and analysis. The references are appendices are in the final pages of this research.

Chapter 2: Literature Review

Introduction

This review of literatures instituted the call for further research pertaining to the effective prevention of nosocomial CAUTI in ICUs resulting in decreased incidence, morbidity, mortality and overall healthcare cost. Exploring the relationship between the adoption of effective preventive measures by all physicians and the reduction of hospital acquired infection (HAI) rates is fairly new in infectious disease research. For example, an internet based survey was sent to 7528 email addresses belonging to licensed physicians in the state of Minnesota by Drekonja, Kuskowski, and Johnson (2010) to establish physicians' awareness and stance as regards Foley catheters placement, effective interventions to prevent CAUTI and their response to the recent reimbursement policy change. Only 635 of the 7528 physicians responded to the survey. Amongst the 635 respondents were 201 (32%) who reported to not caring for inpatients. The remaining 434 respondents who cared for inpatient with catheters in-situ completed the entire 23 question survey. Using both the Mann-Whitney U test and the Kruskal-Wallis test, the researchers where able to compare score between group responses (primary care physicians vs. surgeons, physicians with more than 20 years of experience vs. those with less than 20 years of practicing medicine, physician in teaching hospitals vs. physicians in non-teaching hospitals and physicians working in hospitals that have guidelines on catheter insertion and monitoring vs. physicians in hospitals with no set guidelines). The Fisher's exact test was used to contrast frequencies. According to these researchers, the respondents where acquainted with the

use of Foley catheter and most were familiar with the altered reimbursement policy on CAUTI claims. It was noted that though Minnesota physicians had catheter-related knowledge, it was not being used in good practice to prevent CAUTI.

An inspiration for this study with a focus on assessing physicians in another setting came from the above mentioned study by Drekonja and colleague. Recent studies have examined and reported on different policies of preventing CAUTI; however, none have been done that compared the implementation of bundle elements in whole and or in part by physicians in the state of Georgia with the incidence rate. It is clear that putting these bundle policies in place does not assure that it will be executed effectively at the bedside (Furuya et al., 2011). This review of literature would lead to a better understanding that effective adoption of bundle elements not only at a departmental level but also at an individual level is very crucial if positive result is to be expected.

Theoretical Foundation

The theoretical framework for this dissertation was Kaipayil's (2009) theory of relationalism which refers to the theory of realism that construes the existence, significance and temperament of things with regards to their relationality. It is a philosophical theory of reality which suggests that there is an interrelation between things and events (Kaipayil, 2009). This study was a correlational research and the use of the theory of relationalism was of benefit since it aided in evaluating quantitative data (Rudestam & Newton, 2007, p. 31). Relationalism was advantageous for this study also because of its capacity to furnish a combined perception on certainty by

"accounting for the unity and the plurality that we experience" not only in public health but in the world at large (Kaipayil, 2009, pg. 11).

Literature Search Strategies

Pragmatic research in the subject of infectious disease prevention was seen not only in peer reviewed journals with a special focus on nosocomial infections, but also in venerable medical periodicals. A research of literature was performed digitally throughout multidisciplinary databases such as CINAHL, Academic Search Complete/Premier, MEDLINE, and NHS Economic Evaluation Database as well as the Gwinnett County public library database. The list of search phrases utilized to perform the literature search comprised of nosocomial infections, hospital acquired infections, catheter associated urinary tract infections, infection control, prevention, intensive care unit, device associated infections, physicians practice, and nurses' practice. This search resulted in over 400 peer reviewed articles. After several months of reviewing these literatures, about 76 of them met the inclusion criteria for this study which focuses on the prevention of CAUTI. The sources of articles achieved and assessed for this research were acquired electronically as well as traditionally via accessible print forms of professional periodicals. Some books that presented summaries of decades of infectious disease control research were also secured.

This chapter presents a review of the incidence of CAUTI as well as discussions of preventive measures, in particular evidence based guidelines that have been approved by CDC and the importance of adopting these guidelines by all healthcare professionals. Additionally, CAUTI control research involving the question in this study was

incorporated for examination. Research that investigates the risk factors, the role of fomites, hand-hygiene compliance, prophylaxis, antiseptics, and prevention bundle as well as physician practice to prevent the incidence of CAUTI was integrated in this section. In order to achieve an objective discussion of the literature, a dialogue of studies that objects to some of the conclusions of researches in these areas was discussed. This chapter concludes by justifying how previous studies have persuaded this study.

Incidence of CAUTI

An incidence of CAUTI is deemed nosocomial if it occurred around 48 hours following admissions in the hospital (Pavlovic et al., 2011). This is termed hospital acquired because the patient diagnosed did not show any signs or symptoms of infection upon admission (Pavlovic et al., 2011). According to IDSA, about 900,000 incidences of HAI are diagnosed yearly and 40 percent of these are CAUTI (Hooton et al., 2010), thus making it the most widely recognized HAI in the United States (Hanchett, 2012; Lo et al., 2008).

The reported incidence rates of HAI among hospitals in the United States vary greatly. A good example of this was found within the newly reported summary of HAI rates (from January through December 2010) amassed by hospitals that participate in the National Healthcare Safety Network (NHSN) and reported to the CDC. A segment of this report summarized by Dudeck et al. (2011) is found on table 1 which shows the number of CAUTI, urinary catheter day and the pooled mean in critical care units across the United States (see Table 1). From Table 1, one can see a significant

difference in the HA-CAUTI rates, urinary catheter days and the pooled mean between the different critical care units. For example, six pediatric medical locations reported a total of 6 incidence rates of CAUTI and 1,527 urinary catheter days in addition to a pooled mean rate of 3.9/1000 catheter days. Further, ninety eight medical/surgical units in major teaching hospital reported a total of 587 CAUTI rates and 268,186 urinary catheter days with a pooled mean rate of 2.2/1000 catheter days. Also, twenty three burn units reported a total of 115 CAUTI rates and 24,324 urinary catheter days with a pooled mean rate of 4.7/1000 catheter days. Significant difference in rates can also be seen in the non-teaching medical/surgical units with varying number of beds as well as the other critical care units.

Table 1

The 2010 Pooled Mean of the Distribution of CAUTI Rates by Type of Location.

Type of location	No. of locations	No. of CAUTI	Urinary catheter-days	Pooled mean
Critical care units				
Burn	23	115	24,324	4.7
Medical-Major teaching	67	470	192,002	2.4
Medical-All other	110 (107)	436	232,454	1.9
Medical cardiac	139	414	213,535	1.9
Medical/surgical-Major teaching	98	587	263,186	2.2
Medical/surgical-All other, <=15 beds	397 (376)	555	434,729	1.3
Medical/surgical-All other, >=15 beds	201 (200)	770	596,233	1.3
Neurologic	12	84	27,681	3.0
Neurosurgical	45	446	110,797	4.0
Pediatric cardiothoracic	10 (8)	21	8,988	2.3
Pediatric medical	6	6	1,527	3.9
Pediatric medical/surgical	78 (72)	127	57,420	2.2
Surgical-Major teaching	59	471	157,384	3.0
Surgical-All other	53	182	118,919	1.5
Surgical cardiothoracic	124	371	239,246	1.6
Trauma	51	488	151,217	3.2

Note. Adapted from "National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module" by Dudeck et al., 2011, *American Journal of Infection Control,* 39(10), p 803

[a] (Number of CAUTI / Number of urinary catheter days) * 1000 = mean incidence rate per 1000 catheter days = pooled mean. [b]The number in parentheses is the number of locations meeting minimum requirement for percentile distribution (% distribution not added on table)

A recent study in a spinal injury unit of a referral hospital accessed the incidence of CAUTI. This 38 month prospective interventional study of 128 acute care patients

showed incidence rates of catheter associated bacteriuria and CAUTI to be 2.72 and 0.68 per 100 catheter days respectively (Hooton et al., 2010). Another prospective active surveillance study of 757 patients (239 with existing indwelling catheters and 518 with catheters inserted after admission) was conducted in a big university hospital in Egypt by Talaat et al. (2010). The results confirmed a total of 161 diagnosed cases of CAUTI with a total rate of 15.7 CAUTIs per 1000 catheter days (Talaat et al., 2010). This overall summary of incidence rates by Dudeck et al. (2011) as well as the surveillance studies by Hooton et al. (2010) and Talaat et al. (2010) supported the problem statement of this research as well as the alternative hypothesis that affective administration of all evidenced based bundle elements by all physicians will result in a considerable reduction of the incidence rates of CAUTI. An important feature of applying best practices in preventing CAUTI incidence rates involves understanding the most important preventable risk associated with this nosocomial infection.

Risk of CAUTI

Observed risks associated with CAUTI according to Talaat and colleagues are female gender, prior catheterization in the same hospital admission, patients in cardiac unit, patients over 40 years of age, extended period of catheterization and extended hospital and ICU stay having the highest risk (Talaat et al., 2010). This is in accord with other research findings by other researchers (Hanchett, 2012; Hooton et al., 2010; Boybeyi, Karnak, Ciftci, Tanyel & Senocak, 2013; Van der Kooi et al., 2007). However, it was noted that instrumentation of the urinary tract (using Foley catheters or indwelling urethral catheters) is the most associated risk factor for acquiring CAUTI

during hospital stay accounting for 80% of cases (Hanchett, 2012; Hooton et al., 2010; IHI, 2013).

Although the risk of using Foley or indwelling urethral catheters is well known, its use is inevitable. This can be noted in a segment of the summary of the NHSN reported device associated module for the year 2010 summarized by Dudeck et al. (2011) found in Table 2. The reported numbers of instrumentation days among hospitals across the United States vary significantly. For example, it can be noted from Table 2 that 23 burn units reported having a total of 24,324 catheter-days, 98 medical/surgical-major teaching hospitals reported having a total of 263,186 catheter-days, 201 medical/surgical hospitals having more than 15 beds reported a total of 596,233 catheter days and 51 trauma hospitals reported having a total of 151,217 catheter days. Also, if the number of catheter days is divided by the number of locations, the figure provides an average of the number of catheter days per location in a given unit, thus showing the varying difference in the number of days catheters are used in different hospitals (see Table 2). For example, using the above mentioned division, one can see that the medical/surgical-major teaching hospitals reported an average of 2,686 catheter days while the medical/surgical all other hospitals with more than 15 beds reported an average of 2,966 catheter days; a difference of 280 catheter days (see Table 2) (Dudeck et al., 2011). The data from Table 2 supported the alternative hypothesis for this research that the expected constant education of clinicians on proper catheterization in teaching hospitals will result in a drop of the number of days catheters are used

compared with non-teaching hospitals; the outcome of this decrease in instrumentation will be a decrease in the incidence rates of CAUTI according to other researchers.

Table 2

The 2010 Pooled Mean of the Distribution of Urinary Catheter Utilization Ratio by Type of Location

Type of location	No. of locations	No. of catheter-days	Urinary Patient-days	Pooled mean
Critical care units				
Burn	23	24,324	47,388	0.51
Medical-Major teaching	67	192,002	261,834	0.73
Medical-All other	110	232,454	355,856	0.65
Medical cardiac	139	213,535	431,323	0.50
Medical/surgical-Major teaching	98	263,186	361,301	0.73
Medical/surgical-All other, <=15 beds	397 (390)	434,729	695,150	0.63
Medical/surgical-All other, >=15 beds	201 (200)	596,233	843,654	0.71
Neurologic	12	27,681	33,829	0.82
Neurosurgical	45	110,797	150,613	0.74
Pediatric cardiothoracic	10	8,988	45,106	0.20
Pediatric medical	6	1,527	9,843	0.16
Pediatric medical/surgical	78 (77)	57,420	223,652	0.26
Surgical-Major teaching	59	157,384	205,973	0.76
Surgical-All other	53	118,919	152,651	0.78
Surgical cardiothoracic	124	239,246	345,376	0.69
Trauma	51	151,217	188,295	0.80

Note. Adapted from "National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module" by Dudeck et al., 2011, *American Journal of Infection Control,* 39(10), p 804

[a] (Number of catheter days/ Number of patient days) = mean catheter days per patient days = pooled mean. [b]The number in parentheses is the number of locations meeting minimum requirement for percentile distribution (% distribution not added on table)

Referring back to Table 1, the medical/surgical-major teaching hospitals reported an average of 6 cases of CAUTI as compared to the medical/surgical hospitals

with more than 15 beds who reported an average of 4 cases of CAUTI even though they reported more catheter days than the former. This is opposite to the formerly stated alternative hypothesis. A likely clarification of the teaching hospitals accounted incidence could lie within their perception of other risk factors associated with CAUTI and their practice in preventing it. These other risk factors include "lack of systemic antimicrobial therapy, positive culture of urethral meatus, female sex, colonization of the drainage bag, catheter placement outside of the operation room, violation of catheter care, old age, critical underlying illness, diabetes mellitus and high serum creatinine at the time of catheterization" (Hooton et al., 2010, p. 632). The above mentioned risk prompted some researchers to conduct studies on the appropriate use of catheters and its effect in reducing CAUTI.

Catheter Use Studies

Recent studies related to the use of catheters by clinicians have capitulated diverse results. A randomized trial was carried out in three tertiary-care hospitals in Canada by Loeb et al. (2008) to evaluate whether implementing stop order for indwelling urinary catheters would decrease the extent of unsuitable urinary catheterization as well as the rate of CAUTI incidence. In that study, prewritten orders to remove urinary catheters in patients who did not meet specific criterion were implemented and compared to the usual care group. The result showed a decrease in length of unsuitable urinary catheterization but no considerable reduction in the CAUTI incidence (19.0% of the stop-order group and 20.2% of the usual care group). Other studies however, have demonstrated considerable benefits. For example, Meddings,

Rogers, Macy, and Saint (2010) conducted a systemic review and meta-analysis of 14 interventional studies that used a reminder system to remind physicians and nurses that a urinary catheter was in use or a stop order to prompt catheter removal in hospitalized patients. The researchers reported a reduction in CAUTI rates by 52% when a reminder or stop order was implemented. There was a decrease in the mean duration of catheterization by 37%, ensuing in a 2.61 fewer days of catheterization per patient in the intervention versus control group. The researchers reported a pooled standardized mean difference (SMD) in the duration of catheterization to be -1.11 overall. Studies that used a stop order recorded a statistically significant decrease in CAUTI rates (SMD, -30; p=.001) as compared to those that utilized reminder (SMD, -1.54; P=.071). The researchers reported similarities in recatheterization rates in the intervention as well as control group. A reduction in CAUTI rates was expected when a reminder and a stop order was implemented; thus should be stoutly considered in order to improve the safety of hospitalized adult (Meddings et al., 2010).

Similarly, a prospective intervention study carried out on 337 patients in a medical ICU having a sum of 1432 days of urinary catheterization showed a drastically reduced rate of infections by pathogens causing CAUTI when length of use of indwelling catheters was judged appropriately (Elpern et al., 2009). To achieve the above mentioned results, the researchers implemented suggestions of ongoing urinary catheterization with indwelling catheters developed by unit clinicians during the 6 months intervention period. They then contrasted the amount of days indwelling catheters where used and the rates of CAUTI throughout the intervention period with

the prior 11 months records. There was a reduction in duration of use of indwelling catheters from 311.7 d/month to a mean value of 238.6 d/month. The incidence of CAUTI significantly decreased from 4.7/month prior to the study to zero during the study period. The study by Elpern et al. (2009) was probably prompted from Saints et al. (2008) randomized survey of 50 non-federal U.S. hospitals and 119 Veterans Affairs hospitals which showed that majority of hospitals didn't have policies (e.g. system that monitors patients with catheter placement, catheter duration, consistently using of antimicrobial urinary catheters, portable bladder scanner, condom catheters and catheter reminders) put in place to prevent CAUTI. The researchers found it quite surprising that only less than 10% of hospitals in the United States use the reminders or stop orders (Saints et al., 2008). The conflicting result of the study by Loeb et al. (2008) when compared with that of Saint et al. (2008), Elpern et al. (2009) and Meddings at al. (2010) gives additional evidence of the problem with regards to physicians practice in effective catheter use in relation to the incidence rates of CAUTI.

Further researches on Foley catheter use by providers shows that without proper supervision, they are not prone to following directions with regards to proper instrumentation. One of the studies is by Apisarnthanarak, Suwannakin, Maungboon, Warren, and Fraser (2008) which showed an increase in the use of Foley catheters when discussions between investigators and providers stopped; however, when the discussion recommenced, a decrease in use was observed. This goes in line with a comprehensive quality improvement project conducted by Knoll et al. (2011) with the aim of reducing avoidable Foley catheter use and augmenting order documentation in a Minneapolis

Veterans Affairs Medical Centers. The project included various forms of education, revamping the system, incentives, feedbacks and an involvement of a devoted Foley catheter nurse. Result from the project showed a decrease in the daily ratio of non-ordered and non-indicated Foley catheters from 17% to 5.1% and from 15% to 1.2% correspondingly. It was therefore concluded by Knoll and colleague that with the direct involvement of a dedicated Foley catheter nurse, hospitals can experience a significant reduction in total and inappropriate Foley catheter use as well as improvement in documenting Foley catheter orders (Knoll et al., 2011). The positive result seen when a dedicated nurse is present proved ineffective according to a study by Saints and colleague and reported by Knoll et al. (2011), which showed that providers wouldn't respond to written nurse reminders but will take action only after they have been encouraged to do so via email by the Medical Director of Infection Control. The study by Saints and colleagues prompted them to recommend clinicians and other healthcare workers involved in a placement of Foley catheter to be instructed on the suitable indications for catheter use and also be advised on the benefits of early catheter removal (Saints et al., 2009). Along with these studies and recommendations are guidelines provided by CDC and IDSA on catheter use in preventing CAUTI.

Guidelines for Catheter Use in Preventing CAUTI

It is established that the inevitable use of indwelling catheters has been recognized to be one of the causes of urinary tract infections (UTI) in the hospitals; the most frequent nosocomial infections (Lo et al., 2008). This can be prevented if best practice is followed by all healthcare professionals. The reason for indwelling catheters

use must be warranted by healthcare providers prior to insertion according to the 2009 CDC guidelines for preventing CAUTI, taking into consideration individuals that are vulnerable to UTI such as immunocompromised patients, women and the elderly (Gould, Umscheid, Agarwal, Kuntz, & Pegues, 2010). If catheter use is highly necessary, it should be left in place only as long as required. For example, postoperative prompt removal of indwelling catheters is necessary for patients needing catheter placement prior to undergoing surgery (Gould et al., 2010). In addition, instructions from the 2009 IDSA affirms that an indwelling catheter might be used only when other advancements to manage incontinence have been fruitless and at the request of patient in special cases (Hooton et al., 2010). The price to pay for long standing catheterization is increased mechanical complications even though it increases patients' satisfaction. In an effort to reduce these complications, the 2009 IDSA instructions urges that indwelling catheters that were in-situ for more than two weeks at the inception of CAUTI and remains indicated, should be changed in order to improve symptoms as well as reduce future catheter related infections (Hooton et al., 2010). Institutions are further advices to use aseptic techniques as well as sterile equipments when inserting indwelling urethral catheters. The IDSA also advices on the use of catheters that are coated with antimicrobials in patients with short-term indwelling catheters so as to lessen or delay the onset of catheter associated bacteriuria (Hooton et al., 2010). These efforts to manage CAUTI were approved by the 2012 National Patient Safety Goal ("Without Identity", 2011). In accord with the above mentioned guidelines are studies

on fomites, hand hygiene, prophylaxis, aseptic agents, clinician practices and their rule in CAUTI incidences.

Fomites Studies

In the 19th century, Gerken, Cavanagh and Winner (1972) introduced the word 'fomites', with its origin stemming from the Latin word '*fomes*' to signify items such as utensils, furniture and clothes that have the probability of hosting infectious agents. Prior to this inception, Louis Pasteur noted in 1873 that even after effectively sanitizing his hands, he still dreaded germs surrounding patients' beds (Birch & Birmingham, 1996). To review, fomites are things such as keyboards, pens, stethoscopes, white-coats, mobile phones, pagers and other clinical equipments that can be handled for a long time devoid of sanitizing, making them possible hosts of infectious pathogens in the hospital (British Medical Association [BMA], 2007; Gerken et al., 1972; Halton et al., 2011). In fact, recent studies have confirmed the above statement. One such study was carried out in India to access the role of keyboards and mouse as reservoirs for pathogens causing nosocomial infections. This hospital based bacteriological surveillance study of 120 computer keyboards and mouse showed 105 (88%) yielding to different pathogens such as Bacillus species, Corynebacterium species, Staphylococcus species (Das, Kansal, Asthana, Pandey, & Madan, 2011). Also, a prospective study was conducted on 23 pens used by patients (10 in the trial group and 13 were controls) in order to compare the effect of using an alcohol-based sanitizing agent to clean the pens after each use versus not cleaning the pens. The researchers found bacterial colonization on 12 of the 13 pen in the control group while only 4 of the 10 pens in the trial group

where colonized (Halton et al., 2011). The study did reveal the colonized bacterial to be *Staphylococcus spp*. and *Enterococcus spp.*

Further, another recent prospective review of 92 stethoscopes in a district hospital conducted by Rehman, Razzaq, and Owais (2011) was designed to establish the prevalence of bacterial colonization and the effect of staff education in reducing these colonizations. Results showed that of the 47 stethoscope swabbed in the first week, 44 were positive for *Staphylococcus aureus*. After staff awareness and education on sanitizing the stethoscope after each use, a decrease in colonization was observed in week two (38 of the 45 swabbed has positive cultures) (Rehman et al., 2011). Another study was conducted by Whittington, Whitlow, Hewson, Thomas, and Brett (2009) to assess colonization levels of stethoscopes by pathogenic bacteria and the frequency of disinfecting stethoscopes in the intensive care unit (ICU) by healthcare professionals. The result showed that two diaphragms and five earpieces of the 24 ICU bedside stethoscopes where colonized with pathogenic bacteria and all the 32 nurses who were questioned disinfected their stethoscopes daily while only 3 of the 22 physicians who did the questionnaire agreed to cleaning their stethoscopes often (Whittington et al., 2009).

Although no gram negative bacilli for instance, *Pseudomonas spp*. or *E. coli* commonly colonized in CAUTI was recognized in the above mentioned studies by Das et al., (2011), Halton et al., (2011) and Rehman et al., (2011) and even though the observed decrease in colonization was not very significant in the study by Rehman et al. (2011), they do support the problem statement in this research. Further, the study by

Whittington et al. (2009) also supports the study by Rehman et al. (2011) which showed that constant education on effective septic techniques administration during point of care will result in a reduction in pathogenic colonization of fomites.

Additionally, an increase in using portable electronic devices (smartphones, pagers, personal digital assistants) by physicians during point of care has amplified the intricacy of this problem (Singh, Acharya, Bhat, Rao, & Pentapati, 2010). This can be seen in a recent cross-sectional study conducted by Singh et al. (2010) in India to assess mobile phone utilization by physicians during point of care, establish the level of bacterial contamination of mobile devices and verify the efficacy of using isopropyl alcohol to disinfect these devices. The study results showed that physicians use their phone while attending to patients and also to check time (18% and 64% respectively). This same study also reported that 64% of the physicians who participated don't clean their phone. The researchers further reported that microorganisms were cultured in fifty mobile phones, 98% being culture-positive and 34% having potential pathogenic bacteria. They also reported a considerable decrease in colonization after 79 percent isopropyl alcohol was used to decontaminate the phones (Singh et al., 2010).

The above mentioned study by Singh et al. (2010) validated studies done by Brady, Verran, Demani, and Gibb (2009), Davidson and Malkary (2008), and Ulger, Esen, Dilek, Yanik, Gunaydin, and Leblebicioglu, (2009) with regards to clinical pathogens on mobile devices and its risk in the hospital setting. The study by Davidson and Malkary (2008) was a market research with findings showing that 65% of United States doctors acknowledge that portable devices pose a considerable threat in

spreading pathogenic bacteria in hospitalized patients. This acknowledgement was confirmed by Brady et al. (2009) in their review of recent studies of bacterial contamination of mobile devices. The review confirmed that 9-25% of portable phones are polluted with pathogenic bacteria. Also in another study done on the same year, the hands as well as mobile phones of 200 healthcare workers were sampled to assess contamination rate. Overall, 94.5% of phones confirmed facts of pathogenic contamination with various kinds of bacteria some of which where nosocomially important pathogens (Ulger, et al., 2009).

Further, it has been confirmed by Singh et al. (2010) study mentioned above that disinfecting the hospital environment/equipments thus removes pathogenic bacteria with resultant benefit to the patient. Another of such affirmation is seen in a prospective comparative study carried out in the emergency department of one hospital (Obasi et al., 2009). That study contrasted the value of using standard manual and self-cleaning units for the decontamination of small instruments (SUDS) in decontaminating 91 non-shared medical and electronic equipment (keyboards, phones, intravenous poles, sphygnometers, blood pressure cables, EKG leads and cables, pulse oximeter, etc.) in patient care. It resulted that 25% (23/91) of the manually decontaminated equipment were positively cultured for clinically significant pathogens, 15% showing multiple pathogens; however, after using SUDS, the colonization rate dropped to 0%. It was noted that the colonization rate remained 0% 48 hours post SUDS treatment and re-introducing the equipment into the clinical setting (Obasi et al., 2009). Without making applications in disinfecting fomites as well as emphasize on the benefits of hand-

hygiene by all healthcare professionals (Pavlovic et al., 2011), it would be impossible to really observe a decline in infections often acquired in the hospitals.

Hand Hygiene Compliance Studies

Studies have clearly established the positive effect of hand hygiene and proper hand hygiene technique in decreasing the incidence HAIs (Garcia-Vazquez, Murcia-Paya, Canteras, & Gomez, 2011; Gould & Drey, 2008;). However, the issue that continues to be a cause of concern with regards to this practice is compliance by all health care professionals (Alex-Hart & Opara, 2011; Hussein, Khakoo & Hobbs, 2007; Katherason et al., 2010; Mathai, George & Abraham, 2011; Rosner, 2007; Siegel & Korniewicz, 2007). For example, Katherason et al. (2010) performed an observational study on hand hygiene practice by nurses and doctors in an ICU in Malaysia. It resulted that compliance on hand hygiene was only 70%. Moreover, staffs didn't adhere to hand hygiene steps entirely (duration of hand washing, rubbing palm over the dorsum, rubbing fingers intertwined and rubbing of thumbs revolvingly) (Katherason et al., 2010).

Before the study by Katherason et al. (2010) was undertaken, a qualitative study with an ethnographic approach was conducted in 2008 by Salazar-Mayar, Guarin-Berrio, Arroyave-Cadavid, Ochoa-Acosta, and Galeano-Ochoa (2008) in order to understand the importance and priority assigned to hand hygiene by the health team of an ICU in a university hospital. After a participatory observation and interviews of the participants (doctors, nurses and auxiliary nurses), it resulted that hand hygiene was viewed as a sporadic, transitory, and a contextualized practice with limitations and

strains. The type of patient, procedure and setting was used to determine the magnitude assigned on hand hygiene by the participants.

Extensive research on the effects of hand-hygiene in decreasing incidence rates of HAI has established that continuous educational programs as well as behavioral modification is paramount if adherence to effective hand hygiene is to be improved (Asare, Enweronu-Laryea, & Newman, 2009; Farrell, Savage, & O'leary, 2008; Katherason et al., 2010; Suchitra & Devi, 2007). Few studies have confirmed this assertion. One of them is a before and after prospective, observational intervention conducted by Mathai et al. (2011) in a mixed medical-surgical ICU of a tertiary level hospital to examine compliance rate of hand hygiene by healthcare professionals in the ICU, evaluate basis for non-compliance and study the effectiveness of a multimodal intervention approach which integrated education, verbal reminders, posters and easy accessibility of materials, at improving compliance. In that study, the hand hygiene compliance of all healthcare workers who came in contact with patients in the ICU was monitored before and after the above mentioned multimodal intervention strategy. In addition, the perception with regards to compliance was also evaluated via a self-reporting questionnaire. It resulted that 26% of the healthcare workers in the ICU complied before the multimodal intervention and after the intervention, the compliance improved with 57.36%. Based on the questionnaire, 37% of the participants stated their reason for non-compliance to be lack of time (Mathai et al., 2011).

Prior to the above mentioned study carried out by Mathai and colleagues, a quasi-experimental study in a neonatal ICU of a Thailand teaching hospital was carried

out by Picheansathian, Pearson and Suchaxaya (2008) in order to recognize the impact of a hand hygiene practice campaign and its effect on HAI rates. The result of the study showed a considerable increase in hand hygiene practice by the participants (26 nurses) from 6.3% prior to the program to 81.2% after the program. The researchers reported no significant decrease in incidence rate of HAI during the study period possibly due to the multiple factors related to infections as a whole. However, the participants did agree with certainty that the promotion program did motivate them to be more effective in their hand hygiene practice.

Another study explored the role of introducing an electronic screening system and compliance of hand hygiene. Cheng et al. (2011) conducted this study in a Hong Kong hospital's neurosurgical ICU, which involved health care workers wearing an electronic hand hygiene compliance screening system called MedSence in a form of a name badge to spot hand hygiene opportunities and compliance before and after seeing a patient. Compliance established by the system as well as infection control nurse was evaluated. A sum of 13,694 hand hygiene opportunities were identified by the system during the evaluation phase however, only 35.1% compliance was noted. Compliance increased to 88.9% and 95.5% after a four 20-minute session when hand hygiene was screened in tandem by the system and infection control nurse respectively. The benefit of using an electronic monitoring system such as MedSense by the infection control team to obtain an objective measure of hand hygiene compliance was thus established.

Further, the cost effectiveness of compliance with hand hygiene protocols has also been established. For example, a quasi-experimental surveillance and case-control

research was carried out to measure the cost effectiveness of hand hygiene programs (HHP) in a teaching hospital in Taiwan having 2,200 beds (Chen et al., 2011). The researchers laid emphasis on compliance of using alcohol-based hand rub, its effect in reducing hospital acquired infections and its economic impact. The result showed an improvement in compliance in using alcohol-based hand rub from 43.3% in the beginning of the study to 95.6% at the end of the study. An 8.9% reduction in HAIs as well as a drastic decrease in the incidence of ICU infections was observed. Also noted was a net benefit of hand hygiene promotion of $5,289,364.00 (Chen et al., 2011).

Despite all the education and training on effective hand hygiene in preventing the spread of infections in the hospital setting, compliance continues to be low (Wilson, Jacob & Powell, 2011). This has prompted a recent literature review in order to identity alternative interventions that can persuade continues effective hand-hygiene compliance in the hospital. Results from the review confirmed that interventions that focus on social pressure showed unreliable influence on behavior change while interventions that focused on organizational culture showed affirmative results (Wilson et al., 2011).

Prophylaxis Studies

In addition to effective sanitizing fomites and hands, prophylactic therapy has been shown to be effective at preventing nocosomial CAUTI. This is seen in a study conducted to assess the efficacy of prophylactic antibiotics therapy before ejection of urinary catheters. The study evaluated the effectiveness of administering Trimethoprim-sulfamethoxazole (TMP-SMX) in 3 doses before ejection of urinary catheters. A total of 239 preoperative catheterized patients undergoing major abdominal surgery were

included in the prospective randomized trial. Urine cultures collected prior and 3 days after removal of catheters showed considerable decrease in the incidence of symptomatic UTI in patients who were administered TMP–SMX or before catheter removal (4.9%) as compared to the control (21.6%). This implies that pithy antibiotic prophylaxis when removing short-term bladder catheters may possibly be helpful in preventing symptomatic as well as asymptomatic UTI (Pfefferkorn et al., 2009).

Additionally, the use of systemic antimicrobials has frequently been shown to lessen the risk of CAUTI especially in patients who are catheterized for 3-14 days. This however can result in organism becoming resistant since most hospitalized patients are already receiving antibiotics for other causes (Medscape, 2012). To avoid resistance, the 2009 CDC guidelines recommended clinicians to avoid habitual use of systemic antimicrobials to avert CAUTI in patients needing either long or short-term catheterization (Gould et al., 2010). The IDSA further warned clinicians in their 2009 guidelines against habitual addition of antiseptics or antimicrobials in the drainage bags of patients who are already catheterized in an effort to decrease the risk of nosocomial CAUTI or bacteriuria (Hooton et al, 2010). Prior to the dissemination of the above mentioned guideline by CDC and IDSA, a few studies were conducted comparing certain antiseptic impregnated catheters and their effect in reducing the incidence of nosocomial CAUTI. The next section will explore those studies and how they can be implemented while still adhering to the above mentioned guidelines.

Aseptic studies

There are grounds to believe that the use of effective aseptic agents coated on catheter and antibiotics can result in decreasing the incidences of CAUTI (Drekonja et al., 2008). This can be seen in a randomized double-blinded controlled trial conducted by Stensballe et al. (2007) on 212 trauma patients to compared CAUTI incidences in patients with silicone impregnated urinary catheters and patients with nitrofurazone impregnated catheters. The result showed fewer funguria and bacteriuria linked with the use of nitrofurazone impregnated catheters (9.1%) as compared to that of silicone urinary catheters (24.7%). The study was limited since the clinical significance of asymptomatic funguria and bacteriuria was not clear; however, the benefit of using nitrofurazone impregnated catheters over that of silicone prior to insertion of the catheter was well noted (Stensballe et al., 2007).

Furthermore in 2008, Schumm and Lam (2008) reviewed and reported on twenty three randomized control trials comparing the efficacy of antiseptic catheters impregnated with silver oxide or silver alloy in hospitalized patients with short-term catheters. The result showed a considerable decrease in asymptomatic bacteriuria incidence in patients with silver alloy impregnated catheters for less than a week as compared to silver oxide impregnated catheters. It was also noted that patients with catheters impregnated with silver alloy for more than a week also showed reduced risk of bacteriuria (Schumm & Lam, 2008). In the same review of literature, Schumm and Lam also mentioned another research that recommended catheter-impregnated with antibiotics to be effective in reducing symptomatic UTI. This particular study assessed

catheters impregnated with minocycline, rifampin and nitrofurazone versus standard catheters in a randomized controlled trial of 124 adult male patients. The researchers found lower rates of asymptomatic bacteriuria in the antibiotic group at less than a week of catheterization for minocycline and rifampin equally (RR 0.36, 95% CI 0.18 to 0.73), and nitrofurazone (RR 0.52, 95% CI 0.34 to 0.78). Yet, symptomatic UTI was reported in one out of 56 patients with antibiotic impregnated indwelling catheters for more than a week as compared with 6 out of 68 patients with standard catheters (RR 0.20, 95% CI 0.03 to 1.63) thus showing lack of statistical significance (Schumm & Lam, 2008). Existing evidence such as the above mentioned was evaluated and summarized and areas of uncertainty was addressed in a systemic review by Drekonja et al.(2008). Reliable but patchy evidence was established showing that antimicrobial-coated catheters did prevent CAUTI, though this was evident during short term catheterization mostly. The review however did not address any benefit clinically (Drekonja et al., 2008)

Four year later, Pickard et al. (2012) reported on a study where they compare silver alloy and nitrofural (also called nitrofurazone) impregnated catheter (which showed some benefits in reducing CAUTI incidence in the 2007 and 2008 studies by Stensballe and colleague and Schumm and colleague respectively) versus the standard polytetrafluoroethylene (PTFE) catheterization as the control in a multicenter randomized control trial in 24 hospitals in UK to ascertain whether short-term use of antimicrobials would reduce the risk of CAUTI. It resulted that 263 (12.5%) out of 2,097 of the silver alloy group and 228 (10.6%) out of 2,153 of the nitrofural group had

primary outcome when contrasted with 271 (12.6%) out of 2,144 participants of the control. The authors noted the nitrofural group to have demonstrated higher rate of catheter related discomfort when compared with the other groups. They also saw no significant advantage in the short-term use of silver alloy or nitrofural impregnated catheters in reducing symptomatic CAUTI (Pickard et al., 2012). In essence, even though research has demonstrated some benefits of using antiseptic agents such as nitrofurazone and silver alloy impregnated catheters as well as some catheters impregnated with antibiotics in decreasing asymptomatic CAUTI, a significant decrease in symptomatic CAUTI incidence was not seen. Pickard and colleagues study thus supported the guidelines by CDC and IDSA which warned against routine use of antimicrobial or antibiotic impregnated catheters (Gould et al., 2010; Hooton et al., 2010; Pickard et al., 2012).

Further, a study conducted from June to December of 2006 by researchers at the All Indian Institute of Medical Science not only also supports the guidelines by CDC and IDSA; it also sheds some insight on how CAUTI incidence can be prevented. That study was a prospective, randomized control trial of 60 neurosurgical ICU catheterized patients done to measure the effect of amikacin sulfate bladder wash on CAUTI as well as study the organisms that cause CAUTI. It resulted that not any of the patients who were administered amikacin sulfate bladder wash acquired CAUTI while 40% of patients who were not administered the bladder wash acquired CAUTI. They also found *Pseudomonas aeruginosa* to be the commonest pathogen. The authors thus concluded that performing a bladder wash using amikacin sulfate was effective at preventing

CAUTI thus decreasing antibiotic usage and resistance. (Zacharias, Dwarakanath, Agarwal, & Sharma, 2009)

Prevention Bundle & Physician Practice Studies

Per the review of literature, only a couple of bundle elements studies have recently been conducted which focused on hospitals' compliance or execution of preventive elements that have been approved by CDC and the IDSA. One such study is a survey that was conducted by Conway, Pogorzelska, Larson and Stone in 2008 but published in 2012. In that study, two hundred and fifty out of 441 hospitals that are part of the National Health Safety Network (NHSN) responded to the survey in an effort to ascertain whether CAUTI prevention guidelines were implemented in ICUs, to classify any distinctions in guidelines with regards to organizational attributes as well as establish if there is an association amid prevention guidelines and CAUTI incidence rate. It resulted that of the 250 hospitals, 106 had policies that support bladder ultrasound, 82 hospitals supported condom catheterization, 51 hospitals supported catheter removal reminders and 39 hospitals supported nurse-initiated catheter discontinuation. In addition, unlike smaller hospitals, ICUs in hospitals with more than or equal to 500 beds were likely to adopt at least one CAUTI prevention guideline or policy. It was also noted by the researchers that infection control directors who networked with important decision makers had a higher chance of adopt policies when compared with those who didn't network with important decision makers (Conway, Pogorzelska, Larson, and Stone, 2012).

Further, in 2012, Titsworth and colleagues reported on a 30 month prospective study that they conducted in a single neurological ICU in an effort to examine the execution of a UTI prevention bundle which integrated averting of catheter insertion, continuance of sterility, product standardization and early removal of catheter (Titsworth et al., 2012). The result demonstrated a considerable reduction in urinary catheter utilization rate (from 100% to 73.3%) and decreased CAUTI rates (from 13.3 to 4.0 infections per 100 catheter days) was noted as well as a linear association amid CAUTI and catheter utilization rate (Titsworth et al., 2012). The reduction in incidence rate seen in Titsworth and colleagues study is significant; however, an even greater significance could be seen if more elements were added in bundle.

The most recent study to examine physicians' knowledge and practice with regards to prevention of CAUTI was conducted by Drekonja, Kuskowski and Johnson (2010). The researchers aimed at ascertaining physicians in Minnesota's knowledge and practice with regards to catheter placement, CAUTI prevention interventions as well as their thoughts on the policy change. Physicians who responded to the survey where acquainted with the use of Foley catheter and most knew of the altered repayment policy on CAUTI. It was noted that though the respondents had catheter-related knowledge, it was not being used in good practice to prevent CAUTI.

Summary

Besides providing a support for the problem statement and the theoretical basis for the hypothesis, the literature reviewed in this chapter illustrated sufficient data that shows that the reported incidence of HAI varied greatly and CAUTI incidence surpasses

that of other nosocomial infections significantly thus posing a serious concern. The literature reviewed also provided evidence of well known risk factors such as extended period of catheterization and prolonged hospital and ICU stay, which explains CAUTI risk at the hospital level. In fact, it was noted by several studies that prolonged instrumentation of the urinary tract using Foley catheters or indwelling urinary catheters, as the most associated risk factor for acquiring CAUTI during hospital stay accounting for 80% of cases (Hanchett, 2012; Hooton et al., 2010; IHI, 2013) . This was supported by the 2010 device associated module reported by NHSN and summarized by Dudeck et al. (2011). The report showed varying instrumentation days at the national level linking to the rise in incidence rates of CAUTI. Unfortunately, no study was found which investigated the correlation between constant education of physicians on proper catheterization and CAUTI rates between teaching and non-teaching hospitals in the State of Georgia. Other risk factors found in the review of literature that is worth mentioning are prior catheterization in the same hospital admission, patients in cardiac units, lack of systemic antimicrobial therapy, positive culture of the urethral meatus, catheter insertion outside of the operation room, colonization of the drainage bag, violation of catheter care, elevated serum creatinine level at time of catheterization, fatal illness (i.e. Diabetes mellitus) and female gender (Hooton et al., 2010; Talaat et al., 2010). No study was found which investigated physicians perception on the risk factors related to CAUTI incidence in the State of Georgia thus making it worthy of exploring.

Most reviewed studies correlating catheterization and CAUTI incidence used different designs and where done at the hospital level with the exception of a

prospective intervention done at the patient level by Elpem and colleagues. Elpem et al. (2009) found that patients had decreased level of infections by pathogens causing CAUTI when length of use of indwelling catheters was appropriately judged. Findings of a multi-site randomized trial and a systemic review and meta-analysis of several studies correlated the use of reminders and stop order with a decrease in the incidence rate of CAUTI. However, Saints et al. (2008) asserted that most hospitals do not have policies put in place to prevent CAUTI. In fact, only 10% of hospitals in the United States are implementing the reminders or stop order. This can be improved if a dedicated Foley catheter nurse is on site daily to constantly remind and emphasize on the decrease of catheter use (Knoll et al., 2011). Of all the catheter use studies identified and reviewed, only 1 used a single site observational design with providers as the participants. This study showed that without proper supervision, physicians are not prone to following directions with regards to proper use of Foley catheter. Another researcher attested that providers will not respond to nurse reminders but will do so only when prompted by the Medical Director of Infection Control. The addressed concerns with regards to catheterization and CAUTI incidence rates prompted CDC in collaboration with IDSA in 2009 to develop guidelines for catheter use in preventing CAUTI which was subsequently approved in 2012 by National Patient Safety Goal. However, to date, no study has assessed physicians' perception with regards to the catheter use guideline provided by CDC and IDSA thus worth examining as well.

Other researchers linked the use of pathogenic fomites to the increase in incidence of HAI. Of the 7 relevant fomites studies reviewed, four were prospective in

nature while the rest used different designs. All of the researches examined cultured fomites used by healthcare providers with the exception of one by Halton et al. (2011) which examined pens used by patients. The entire reviewed researches confirmed the presence of pathogenic bacterial colonization in all fomites used in the hospital. Moreover, with regards to providers practice in controlling fomites colonization, the prospective study by Whittington et al. (2009) affirmed that only very few physicians sanitize their stethoscope often Further, the benefits of awareness and education on the sanitization of stethoscopes and other fomites during point of care were established in the literatures reviewed. One of the researches that was found to be intriguing showed a decrease of colonization to zero after self-cleaning units for the decontamination of small instruments (SUDS) was employed and the contamination rate remained at 0% after 48 hours of the SUDS treatment (Obasi et al., 2009). Unfortunately, no research was found in the literatures reviewed which assessed physicians' in the State of Georgia's perception or practice with regards to disinfecting fomites in connection with decreasing the incidence of CAUTI.

Additionally, of the seven pertinent researches reviewed which correlated hand hygiene compliance by healthcare professional and incidence rates of HAI, three were observational in nature, two used quasi experimental design and the remaining two were exploratory and a meta analysis respectively. The 3 observational studies reviewed examined compliance rate which showed it as being sporadic and it was interesting to note that the reason for lack of compliance to hand hygiene was either because of lack of time in a busy ICU setting or type of patient and procedure being performed. Further,

the 2 quasi-experimental researches reviewed showed an increase in hand hygiene compliance after an intervention was conducted. However, one reported no significant decrease in HAI rates during the study period while the other reported an 8.9% reduction in HAI incidence rates in the ICU and a net benefit of hand hygiene promotion of $5,289,364.00 thus making hand hygiene compliance worth adhering to. Cheng et al., (2011) introduced an electronic monitoring system called MedSence which proved effective in monitoring hang hygiene compliance level. However, the use of an electronic monitoring system will prove effective only in a department that focuses on organizational culture and not social pressure. Conversely, no study was found which assessed physicians' perception with regards to using an electronic monitoring system in connection with hand hygiene improvement and the decrease in incidence of CAUTI, thus worth exploring.

Other studies reviewed examined effective prophylactic as well as antiseptic practices all of which were randomized in nature. A study that examined the use of Trimethoprim-sulfamethoxazole (TMP-SMX) as prophylaxis proved beneficial in preventing both symptomatic and asymptomatic CAUTI when used prior to catheter removal for short term catheterization. Additionally, other reviewed studies which examined the use of antimicrobial impregnated catheters with aseptic agents such as nitrofurazone and silver alloy or using antibiotics such as minocycline, rifampin or nitrofurazone yielded reliable evidence in preventing CAUTI especially during short term catheterization. The use of systemic antimicrobial was also proven in the review of literature to be effective in decreasing CAUTI in long term catheterized patients.

However, due to issues with resistance, CDC and IDSA have advised clinicians to avoid habitual use of systemic antimicrobials to prevent CAUTI incidence in patients needing both short and long-term catheterization. Additionally, to avoid antibiotic resistance and also decrease CAUTI incidence, a reviewed study concluded with certainty that using Amikacin sulfate bladder wash on catheterized patients twice daily was effective. Although the effective use of TMP-SMX as well as other antimicrobials in preventing CAUTI is well established in the literature, what is yet to be ascertained is physicians in the state of Georgia's practice with regards to the use of TMP-SMX and or amikacin sulfate bladder wash and compliance with the guidelines from CDC and IDSA with regards to avoidance of habitual use of antimicrobials or antibiotics to prevent resistance.

In addition to all the CAUTI prevention studies reviewed, only three where bundle element studies. Two of the three were surveys of infection control directors in several hospitals in the United States and survey of physicians in the state of Minnesota respectively with the third being prospective in nature in a single neurological ICU. These literatures asserted that only a few hospitals in the United States support bladder ultrasound, condom catheterization, catheter removal reminder and nurse initiated catheter discontinuation. It was also affirmed that physicians know of the altered repayment policy and also acquainted with Foley catheter use however, it was not being used in good practice. The rational for studying a cohort of physicians who take care of inpatients (medical-surgical ICU, Neuro-surgical ICU, etc.) with Foley catheter in the

State of Georgia is centered on the results of the literature reviewed in this section. A detailed description of the sample population can be found in chapter three.

In summary, all facets of the research hypotheses were founded on facts established in a full review of literature linked to nosocomial CAUTI along with its prevention practice. The literature reviewed presented reason to analyze the following null hypotheses an explore associations between physicians in the State of Georgia's perception and practice with regards to preventing the incidence of CAUTI and reported CAUTI incidence.

Hypothesis 1

$H_0$1: There is no relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

H_a1: There is significant relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

Hypothesis 2

$H_0$2: There is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

H_a2: There is significant relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

Hypothesis 3

$H_0$3: There is no relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a3: There is significant relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Hypothesis 4

$H_0$4: There is no relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a4: There is significant relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Hypothesis 5

$H_0$5: There is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a5: There is significant relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

A detailed description of the design for this study can be found in chapter 3. The above mentioned variables are further discussed in the framework of data collection and association. The succeeding methods chapter starts by briefly introducing the chapter then proceeds with the study design and rational before fully describing all the components of the methodology (population, sampling and procedures, instrumentation, analysis, etc.) that will be employed in carrying out the research as well as ethical considerations.

Chapter 3: Research Method

Introduction

The purpose of this study was to improve the epidemiological understanding of CAUTI by quantitatively look at whether physicians' perception and practice on CAUTI prevention bundle elements either in part or in full are associated with reported CAUTI incidence. This chapter consists of a description of the design, population, sampling, procedures, instrumentation, analysis, as well as ethical considerations of this study. An overview of the design incorporates a rational explaining the reasons for deciding on this particular research. The sample characteristics and size is addressed in addition to a sketch of the instrumentation.

Design and Rational

The aim of the study was to better appreciate how frequent education and effective application of evidence based CAUTI prevention elements by physicians might reduce its incidence. This study used a correlational approach that tried to examine the degree to which current differences in physicians practice in preventing CAUTI corresponds with the different rates of recently reported incidences of CAUTI. In particular, it studied the relationship between frequent education of physicians, physicians awareness of CAUTI risk factors, physicians perception and practice on disinfecting fomites, physicians perception and practice on the use of electronic monitoring system called MedSense to improve hand hygiene, physicians perception and practice on the use of TMP-SMX and amikacin sulfate bladder wash as prophylaxis, physicians compliance with CDC and IDSA guidelines to avoid habitual

use of antimicrobials and last but not least, physicians awareness of CMS's repayment policy as the independent variables and recently reported incidences of CAUTI by a cohort of hospitals in the State of Georgia.

The correlational approach was suitable for this study since the participants were retrospectively reporting their perception and current practice with regards to preventing CAUTI incidence. The study employed a cross-sectional design that was descriptive in nature and this design was chosen because of the timing of the study. Recently, CMS decided to stop reimbursing hospitals for claims related to CAUTI and other nosocomial infections with the hope of encouraging hospitals to improve patient safety (APIC, 2012). With new evidence-based practice on CAUTI prevention currently reported in the literature, a prospective study was less enviable since the availability of these practices might influence some physicians to change their practice method during the study period. So the cross-sectional design was chosen in an effort to evade issues of data discrepancy coupled with the fact that it allowed for the assessment of the variables over a short period of time.

A cross-sectional design using a survey was chosen over observational, experimental or quasi-experimental designs owing to the originality of the hypothesized associations between the variables. An association between CAUTI incidence and the independent variables was yet to be documented in literature; thus making it logical to begin this inquiry with a cross-sectional survey. The study's results may suggest an observational or experimental design as the reasonable subsequent step. The benefit for using a cross-sectional survey design is that the hypothetical basis for the study can be

assessed in less time and at a lower cost compared to a more demanding experimental design. Cross-sectional designs are uncomplicated and allowed for the collection of retrospective survey data which normally requires less resources and time.

The limitation of using a cross-sectional survey design for this study was the difficulty to determine whether the current reported incidence resulted from the survey outcome making it difficult to interpret identified associations. Another limitation with this design is that incidence cannot be measured however, to overcome this; an already measured incidence was retrieved from the NHSN database. In addition, this design choice was vulnerable to bias due to low response by the possible participants. Regardless of these identified limitations, a cross-sectional survey was still best for this study with the rational that the research represents a unique hypothesis that may not yet merit a large amount of resources necessary to execute an experimental design with a cohort of physicians in specific hospitals.

Methodology

Population

The participants or population for this study were physicians in the State of Georgia with variable experiences who care of patients with indwelling catheters in the ICU. In order to reach this population, email addresses of licensed physicians as of January 2011 in the state of Georgia was obtained from the Medical Association of Georgia (MAG). The MAG is the State of Georgia's leading physicians' advocate with an emphasis on legislative, legal and issues related to third party payers (MAG, 2014). The organization's mission to "enhance patient care and the health of the public by

advancing the art and science of medicine and by representing physicians and patients in the policy making process" spearheaded the researchers reason for choosing its members as participants for this study (MAG, 2014, para. 2). The organization "have nearly 7500 members, including physicians that represent every specialty in every practice setting" (MAG, 2014, "About Us," para. 3). These participants were selected for the following reasons: (a) they have not been studied before in the state of Georgia; (b) they are reachable; (c) they are able to give informed consent; (d) they are believed to have had some experience in treating catheterized patients in the ICU; (e) the MAG members are physicians from a diverse ethnic, cultural and age background. The estimated target population size will be 4000 physicians from all the qualified hospitals in Georgia.

The qualification criterion was physicians whose primary place of employment is hospitals that are members of the National Health Safety Network (NHSN). The NHSN is a nationally used HAI tracking system. It supplies "facilities, states, regions and the nation with data needed to determine problematic areas, measure advancement of prevention efforts" and eventually eliminates HAI (CDC, 2013, "About NHSN," para. 1). Medical facilities that are members of the NHSN are required to report incidences of all HAI. Currently, over 12,000 medical facilities are being serviced by the NHSN nationwide, with hospitals and dialysis centers making up most of facilities reporting data (CDC, 2013). For the purpose of this study, the NHSN will provide access to recently reported incidences of CAUTI within the past two consecutive years (2012, 2013 data), which will be secondary data.

Sampling and Procedures

The unit of interest in this study was physicians with a focus on those who care for patients with indwelling catheter in the ICU as the population. The phenomenon of interest was this population's perception and practice on preventing CAUTI. This study employed probability sampling since it aided in making statistical inference, a representative sample was achieved and sampling bias was minimized. The sample technique to be exact was stratified random sampling since the study was interested in particular groups, (e.g.: physicians in different specialties who are for patients with indwelling Foley catheter in the ICU). The representative sample was randomly selected for generalization purposes thus representing the total population. The sampling frame was physicians that are members of the MAG. These physicians were randomly generated from the member list. The inclusion criterion was specialties with high probability of caring for patients with Foley catheter (surgeons, cardiologist, internist, internist subspecialty, family practice, urologist, gastroenterologist, obstetric, and gynecologist, etc.). The exclusion criterion was specialties that have the least probability of caring for patients with indwelling Foley catheter (dermatologist, radiologist, etc.).

For the purpose of estimating the least amount of participants needed to assertively accept the result of the analysis, a power analysis table provided in the dissertation course as well as power analysis by Cohen (1988) was used to determine how many respondents would be needed to yield a power value of 0.8. Power values are very important in research since they interpret the probability of accurately rejecting the

null hypothesis. So having a power of 0.80 means that the possibility of accurately rejecting the null hypothesis is 0.80 (Katz, 2006).

So for a two tailed test with an alpha level of .05, a large effect size of 0.2 and a power of 0.80, the study needed a sample of at least 345 participants (n) to respond to the survey. In the study of physicians conducted by Drekonja et al. (2010), the population size (N) was 7528 (i.e. the amount of prospective participants survey was emailed to); however, only 635 responded, reflecting a response rate of 0.0844 or 8% , 201 of them reported to not care for hospitalized patients while 434(n) of the respondents cared for hospitalized patients. Further, the typical response rate of an external survey is 10% to 15% (surveygizmo.com, 2014). So with that in mind, the anticipated response rate for this study was 400 to 600. However, in order to achieve statistical power, this study will need at least 345 (n) respondents who care for patients with indwelling Foley catheter from the sample size of 4000 (N) prospective participants.

Procedures for Recruitment

In order to obtain the list of physicians, an email correspondence was sent to the membership department of MAG and an approval to use the member list was made via email. The email correspondence approving to supply the member list with a fee can be seen in appendix A. A total of 4000 MAG members was randomly generated from the MAG physicians member list. An email was sent to all the 4000 physicians introducing the study and inviting them to participate. The researcher re-sent the email invitation after a week to those physicians who never responded to the initial invitation. The

inclusion criteria were physicians who care for patients with indwelling catheter. This was stated in the invitation. The invitation also included an informed consent. The informed consent included a brief background information on the study, the procedures for participation, a discussion of confidentiality, the voluntary nature of the study and ethical concerns. A copy of the invitation and informed consent can be found in Appendix D. A second informed consent form is included for participants who were interested in taking part in the test/retest reliability of the 26-item survey of physician instrument. A copy of this informed consent can be seen in Appendix E. The physicians who consent to take part in the study were directed to a link to the survey instrument. The survey respondents were anonymous. Respondents who work at multiple sites were required to respond only about their principal place of employment. Only data from respondents who currently work for hospitals that are part of the NHSN and have been employed at their current place of establishment for 3 or more years were received and analyzed using SPSS.

Procedures for Getting Archived Data

The secondary data that was used for this study is CAUTI incidences that were reported during the 2012 and 2013 fiscal year by all hospitals in the state of Georgia that are members of the NHSN. In brief, the NHSN is a nationally used internet based surveillance system for tracking hospital acquired infections. It is maintained and supported by CDC's Division of Healthcare Quality Promotion (DHQP). Participation in NHSN is a state authorized requirement for healthcare facilities in the State of Georgia as well as a great number of states in the United States. Catheter associated

urinary tract infections (CAUTI) is one of the 8 HAI that must be reported to the NHSN. To ensure the quality of all reported CAUTI data, the infection control departments in all facilities have been property trained by CDC on effective reporting thus ensuring the validity and accuracy of CAUTI data reporting.

To gain access to the data, a phone call was initially made by the researcher to NHSN requesting access to CAUTI incidence data for 2012 and 2013. The researcher was provided access to a link on CDC website which took the researcher to the national and state specific progress report for HAI for 2012 and 2013. The 2012 report was organized by Dudeck et al. (2013) while the 2013 reported data available for access at the NHSN national surveillance reports on CDC website was organized by several CDC and the Georgia department of public health staff. The researcher will access these data and analyze the reported CAUTI incidence specific for the state of Georgia and also compare it with the national records during the analysis phase of the study.

Instrumentation

This study employed a 26-item Likert type scale internet based survey instrument. It is based on an effective 23- item Likert type scale survey instrument with seven main subjections. This 23-item instrument was used by Drekonja et al. (2010) in two separate studies to assess nurses and physicians' knowledge and attitude regarding catheters use in the State of Minnesota. This 23-item instrument specifically assessed Minnesota physicians' knowledge concerning indications for placing catheters and measures for preventing CAUTI, their stances with regards to who is responsible for

determining the need for placing catheters, knowledge as regards to the changed CMS repayment policy as well as any practice changes ensuing from the policy change.

The reliability of a study instrument indicates that a researcher will get similar results if the questionnaire is repeated soon after, using the same respondents, i.e. the test/retest reliability; the questionnaire also has to be consistent (At Work, 2007). The 23-item instrument according to Drekonja was "developed for exploratory purposes" and so certain "performance characteristics have not been established" (Drekonja et al., 2010, p. 695). It makes sense why a published reliability value for the 23-item instrument was not seen after intense search. This research endeavored to establish the reliability of the 26-item instrument by performing a test/retest with a sample willing participants. A one week interval was used to perform the retest of the instrument and the test and retest scores of the participants were assessed for association.

The construct validity of the 23-item instrument was established in Drekonja et al., (2010) work. Construct validity refers to the capability of translating any construct into an operationalization or the extent to which scores on an instrument test the theoretical construct that the instrument is professing to evaluate (Trochim, 2000; *At Work*, 2007). For instance, in Drekonja and colleagues (2010) work, the measures of the CAUTI prevention construct was consistent with experts opinions as well as clinical trials in that the most favorable "rated CAUTI prevention measure was early catheter removal with a mean effective score of 3.8, followed by automated discontinuation reminders with a mean score of 3.0" (Drekonja et al., 2010, p. 696). The relatedness of this construct established the construct validity of the 23-item instrument. In addition,

the questions in the 23-item instrument were suitably phrased as well as the options for responding thus establishing the face validity. Also, those who responded to the 23-item instruments in Drekonja et al. (2010) work were physicians who are familiar with treating patients with indwelling Foley catheter. The items included in the instrument are supposed to be known to these participants thus establishing the content validity of the 23-item instrument. The constructs in the instrument used for this study is similar to that used by Drekonja et al. with just a slight alteration thus still sustaining its validity.

A copy of this previously used survey was available after directly contacting Dr. Drekonja via email by the researcher to inquire of its availability for use in another setting. An email correspondence permitting the use of this instrument as well as to alter it if need be to reflect the current study can be found in Appendix B. A copy of the 23-item instrument can also be found in Appendix C. Minimal alteration were done on the 23-item instrument to reflect the current study thus increasing the items in the instrument from 23 to 26 while still reflecting its' effectiveness of use since the measurements are still the same. For the purpose of specificity, minor alterations done on the 23-item scale are described next.

The first section of the 23-item scale was left unchanged. In the second section of the scale, another facility specific question: Does your primary facility provide physicians with training on proper catheterization? (a) Yes, (b) No, (c) Unsure; If Yes, how often? (a) Weekly, (b) biweekly, (c) monthly, (d) quarterly, (e) yearly) was added because it is pertinent to this study. The third section of the 23-item scale, a responsibility question pertaining to who should make decisions regarding a patient's

Foley catheter was replaced in the third section of the 26-item scale with a question pertaining to physicians' perception on CAUTI risk factors. This was done because the former was not analyzed in this study while the latter was. The same measurement that was used by Drekonja and colleague for the forth section on the 23-item scale was used in the third section in the 26th item scale. However, the items in the forth section of the 23-item scale which pertains to indication for Foley catheter use was not added to the 26-item scale because the specific items being measured was not required to answer any of the research questions in this study. The fifth section of the 23-item scale pertaining to physicians methods for preventing catheter-related infections was included in the 4th section of the 26-item scale, however a couple of the items (using condom catheter instead of Foley catheter and using intermittent catheterization instead of Foley catheter) was replaced with items pertinent for this study (constant disinfection of fomites during point of care, hospital use of electronic monitoring system to monitor hand hygiene, effective use of TMP-SMX as prophylaxis prior to catheter removal, effective use of amikacin sulfate bladder wash as prophylaxis prior to catheter removal). Again, the same measurement was used during the analysis phase of the study. The remainder of the sections in the 23-item scale which includes the respondents' demographics and question pertaining to the CMS's no reimbursement policy is in the 26-item scale with no alterations.

This 26-item Likert type scale survey instrument was divided into 6 main sections and was used to obtain the measures for the independent variables. The main domains to measure included respondents demographics, perception of risk factors

related to CAUTI, current practice method in preventing CAUTI, knowledge related to the changed CMS repayment policy and any practice change ensuing from the current policy change. These comprised of 5 measurements all of which are independent variables which was correlated with the dependent variable (recently reported CAUTI incidences in the state of Georgia). The 26-item survey of physicians scale is described in detail next and a copy of it can be seen in Appendix F

Section 1 of the survey asks if respondent care for inpatients in the ICU with indwelling Foley catheter, with a "yes" or "no" answer choice. If respondent answer "no" then their survey terminates whereas if they answer "yes", then they are asked to continue with the survey. Section 2 contains four items related to the hospital or facility that the respondent spends the most time. Item 1 asks if respondents' primary place of employment is a teaching hospital or not. The choices are (1 = Yes teaching; 2 = No, not teaching; 3 = Unsure). Item 2 of section 2 asks if respondents' primary facility has a system for guidance on when to insert or remove catheter or a method of monitoring which patients have indwelling catheter. The choices are (1 = Yes; 2 = No; 3 = Unsure). Item 3 of section 2 ask if respondents' primary facility provides physicians with training on proper catheterization. The choices are (1 = Yes; 2 = No; 3 = Unsure). If respondent answers "Yes" then he/she is asked the 4th item which is "How often". The choices are (1= Weekly; 2 = Biweekly; 3 = Monthly; 4 = Quarterly; 5 = Yearly). In section 3, respondents knowledge regarding indications for CAUTI risk is assessed by asking 8 scenarios to be rated on a 6 point scale (1= Almost always indicated; 2 = Usually indicated; 3 = Indicated about ½ of the time; 4 = Rarely indicated; 5 = Almost never

indicated; 6 = Unknown/unsure). The 8 scenarios are: extended period of catheterization, unsuitable condition during catheterization, preoperative antibiotic use, female gender, prior catheterization in the same hospital admission, patients in cardiac unit, age over 40 and increased hospital and ICU stay. In section 4, respondents current practice regarding prevention of CAUTI is assessed by asking respondents to rate 7 interventions on a 5-point scale (1 = Large effect; 2 = Moderate effect; 3 = Slight effect; 4 = No effect; 5 = Unknown). The prevention measures to assess are: removing catheters are early as possible, constant disinfection of fomites during point of care, hospital use of electronic monitoring system to monitor hand hygiene compliance, effective use of TMP-SMX as prophylaxis prior to catheter removal, effective use of amikacin sulfate bladder wash as prophylaxis prior to catheter removal, constant use of catheter coated antimicrobials and having automated reminders to discontinue/renew the order for catheter. The respondents' demographics questionnaire is presented in Section 5 of the instrument. It assesses how many years since respondent graduated from medical school and his/her current medical specialty. In section 6, respondents' current knowledge and practice regarding CMS reimbursement policy is assessed. Respondent is asked if he/she knows that CAUTI is 1 of 8 HAI for which CMS will not offer repayment anymore. Two options are given (a ="yes"; b= "no"). If respondent answers "no" then they are directed to the final section which thanks them for taking the survey. If respondent answers "Yes", then he/she is asked the final item which assesses any practice changes resulting from this policy. In this item 3 scenarios are rated on a 3 point scale (1 = Yes; 2 = No; 3 = Unsure). The scenarios are: prompted you to order

fewer catheters, affected how often you order a urinary catheter or urine culture to be collected from catheterized patients and prompted you to remove catheters as soon as possible. The respondent was then thanked for taking the survey. This instrument located in Appendix E., is sufficient in obtaining the independent variables for this study. As stated earlier, this research endeavored to establish the reliability of the instrument by performing a test/retest with a sample willing participants. A one week interval was used to perform the retest of the instrument and participants test and retest scores were assessed for association. With regards to validity, the face and content validity of the 26-item survey of physicians instrument is already established. The questions as well as options for responds are phrased appropriately coupled with the fact that the questionnaire includes items about CAUTI prevention methods that's established in literature. The evidence of construct validity of this instrument was established when the test measured the intended construct.

The dependent variable, CAUTI incidence rates, was derive from CDC's NHSN record of the recent two years (2012 and 2013) reported cases of CAUTI incidences in the State of Georgia. Overall Incidence from the 2 reported years will be compared. A correlation between the dependent variable the independent variables from the survey result was made.

Data Analysis Plan

This study used statistical package for the social science (SPSS) version 21 for data analysis. The responses from the surveys was populated automatically to an excel spreadsheet using a system provided by surveymonkey.com. After mining the data, to

prepare the data set for analysis, it was screened for accuracy and cleaned using the SPSS. Cleaning of the data was needed for this study since without performing it, the final statistical result may be impacted. To clean the data, first the data was screened for consistency as well as any missing data item responses were verified.

Checking the consistency aided in identifying any data that's out of range, reasonably inconsistent or had excessive values. To analyze the data for consistency, the data view tab on SPSS was used and descriptive statistics was ran under the analyze option. The minimum and maximum values were then be checked to make sure they are within the values on the instrument scale. If there were any values that are out of range, it was be resolved by deleting them.

Some participants might have either intentionally or mistakenly skipped an item while doing the survey and this might have resulted in missing data. Any missing responses would create a dilemma if there was a significant proportion to the total. So any missing responses were resolved by using SPSS to assign suitable values. To check for missing data, the data set was reviewed for any missing data points and a frequency was ran on the data using the analyze tab. Any missing data was resolved by using the "replaced missing value" function under the "transform" option tab on SPSS. The normality of the data was also be checked by running the mean and standard deviation.

The instrument that was used for measuring the variables in this study allows for the data to be analyzed using non-parametric testing thus avoiding the assumption of normality. The dependent variable, comparing CAUTI incidence rates for 2012 and 2013 was analyzed descriptively. The independent variable was measured descriptively

using frequencies and percentages; the mean and standard deviation (SD) was also assessed to check for normality. The Pearson's chi-square test of independence was used to test all five null hypotheses thus testing the significance of the probability that the dependent and independent variables are related. With the knowledge of the chi-square value, the degree of freedom and the significance level or probability value of 0.05, the chi-square distribution table (see Appendix G) was employed to test the hypothesis and establish the answer of the research questions listed below.

Research Question 1: Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia?

$H_0$1: There is no relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

H_a1: There is significant relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

Research Question 2: Is there a relationship between physician's awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

$H_0$2: There is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

H_a2: There is significant relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

Research Question 3: Is there a relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

$H_0$3: There is no relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a3: There is significant relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Research Question 4: Is there a relationship between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

$H_0$4: There is no relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a4: There is significant relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Research Question 5: Is there a relationship between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI?

$H_0$5: There is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

H_a5: There is significant relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

The data from the respondents were exported to an excel spreadsheet using a surveymonkey.com tool and SPSS version 21 was used for data analysis. The CAUTI incidence rates were manually entered into a spreadsheet. The first step in the data analysis was to analyze all the variables one at a time using univariate statistics. Then a univariate analysis to score the number of total respondents (*n*), number of respondents in teaching and non-teaching facilities, number of respondents in different specialties, number of respondents in years of practice was performed. These was reported in number of responses and percentage (%) (see Table 3). The number of years in practice was treated as possible confounders and was included in regression model. The next step was to analyze the incidence of CAUTI in the state of Georgia. The overall incidence of CAUTI in 2012 will be compared with that of 2013 using univariate analysis and it will be presented descriptively using frequency tables (see Table 5). The p-value was used to determine significance. Another descriptive analysis of the incidence of CAUTI observed in the ICU for 2012 and 2013 in the state of Georgia was also presented (see Table 6). This study assumed that incidence rates (dependent variable) will be affected (increase or decrease) depending on physicians perception and

most importantly, practice (independent variables) with regards to preventing CAUTI. A bivariate analysis was done between the dependent and the independent variables separately to determine correlation. The Pearson's chi-square test of independence as employed to test the hypothesis. The p-value was used to determine significance of association.

Before the correlation between dependent and independent variables is done to test the hypotheses, a descriptive analysis was done in order to score the independent variables of respondents. The respondents' frequency and perception of CAUTI risk was measured using descriptive statistics and the mean and standard deviation was scored to test for normality. The same test was ran to measure Foley catheter related infection prevention measures and the frequency of training on catheter placement. The knowledge and responses to CMS reimbursement policies was scored descriptively as well to measure the frequency and percentage of respondents who are aware of the policy and respondents' reaction to the policy change will be scored and presented in percentage. The mean and standard deviation was measured to test for normality.

A descriptive statistics was scored and presented in the form of tables to describe the relationship between the items in each independent variable. To be specific, descriptive statistics related to constant education of physicians reported the mean number of participants who respondent "yes", "no" or "unsure" on a table. The descriptive analysis of education/training was presented as well in the form of frequency and percentage. Descriptive statistics in the form of table related to indications of CAUTI risk factors reported the mean number of participants who

responded “almost always indicated”, “usually indicated”, “indicated about ½ of the time”, “rarely indicated”, “almost never indicated”, “unknown” to all the items related to the risk factors variable. Another descriptive statistics in form of table related to effect of CAUTI prevention measures also reported the mean number of participants who responded “large effect”, “moderate effect”, “slight effect”, “and no effect ”,“ unknown” to all the items related to the CAUTI prevention measures variable. Descriptive statistics was presented in the form of table to illustrate the frequency and percentage of respondents who responded most favorably between the independent variables. As can be seen above, frequency, percentage, mean and standard deviation was used to present the results.

Test/Retest Reliability

The test/retest reliability was performed prior to conducting the study. To perform this, 100 participants were randomly pulled from the main sample of 4000 participants. An invitation was sent to these 100 physicians requesting that they participate in a survey related to CAUTI prevention for the purpose of testing the reliability of the instrument. An informed consent (See Appendix E) along with a brief description of the study accompanied the invitation. Those who consent to do the study were directed to a link on surveymonkey.com to take the survey. A week after the respondents did the survey, another email was sent to those who did the survey initially, thanking them for taking the survey one week prior and request that they take the survey again as they did before for the purpose of testing the reliability of the instrument. In order to correlate the test/retest scores for the same respondents, a

coding system was created to identify the respondents. To analyze the test/retest reliability section of this study, the Cronbach alpha (α) was used. With the use of SPSS, a Cronbach alpha coefficient was done between the results obtained from the same respondents on the first and second administration of the 26-item scale. A Cronbach alpha coefficient that is greater than or equal to α =.70 is necessitated for the procedure to be judged as reliable (Bland & Altman, 1997).

Threats to Validity

In this study, there was possible threats to external, internal, construct validity and response bias which was addressed. External validity entails the degree to which the results of this study can be generalized to the population. To ensure the generalizability in this study, the sample was drawn from the target population and not from an accessible population thus avoiding this threat. Also, there was a possibility of Hawthorne effect in which the participants would respond favorably to the survey because they know they are being studied thus jeopardizing external validity. So to overcome this, the reason for the study was clearly communicated to the participants thus stressing the importance of them being as truthful and honest as possible.

Internal validity refers to whether it can be conclusively stated that the independent variables is the cause of the observed differences in the study. An example of internal validity that might pose a threat in this study is statistical regression effect which is common when assessing the test/retest reliability of the study. In regression effect, the test/retest scores may drift to the mean systematically instead of remaining stable or become disproportionate. To avoid this regression threat, the researcher made

sure that the sample for the initial measure of the test/retest reliability segment of the study was not too different from the actual population.

Construct validity in this study refers to the extent to which the researcher can justifiably make conclusions based on the operationalizations in the study to the theoretical construct on which the operationalizations were based. A threat to the validity of construct was avoided by adequately explaining the construct of the study.

This study was also implicated by the issue of response bias which is prevalent is surveys (Furnham, 1986). This could be seen if only those physicians who apply CAUTI prevention measure respond to the survey. This threat was minimized by stipulating in the consent form that all responses will be anonymous, the estimated completion time is only 5-10 minutes and most importantly, the results of the study may present new and vital consideration for healthcare professionals, administrators, lawmakers and researchers. This ought to have motivated most physicians who met the criterion to respond regardless of their current practice with regards to CAUTI prevention.

Ethical Procedures

To gain access to the participants, an email was sent to the MAG membership department explaining the purpose of the study and a request of participants from their membership list. An email approving to provide a random list of physicians for a fee was sent to the researcher. A copy of the email correspondence can be found in Appendix A.

The temperament of the study was contemplated and its potential effect on the participants. An email which includes the informed consent (one for the main study (Appendix D) and another for the test/retest reliability segment of the study (Appendix E)) which discusses the background of the study, the procedures of the study, issues related to confidentiality, the voluntary nature of the study, the risk and benefits of being part of the study, in addition to a way to contact the researcher, was sent to the potential participants. The potential participants were required to sign the informed consent electronically which shows that they understood and agreed to be part of the study.

The informed consent form clearly stated that participants and their responses will be kept anonymous and the data would not be used for any other purpose outside of the study. It was also stated in the consent form that after key variables are grouped, any information that may be linked to the participants would permanently be taken out of the data set thus making the data set unidentifiable at both the hospital and physician level. Further, the participants were free to change their mind or withdraw from the study if any component of the study made them feel uncomfortable. They were able to omit or skip any questions that they felt uncomfortable to respond. Participants were asked to sign the consent form electronically before being directed to the survey. To ensure that the data files from the survey are properly stored, it was password protected. This ensured that the files are not manipulated by others. The data files would be stored for 5 years after the dissertation process was completed and approved, after which it will be discarded.

Summary

This cross-sectional, correlational study examined and analyzed the degree to which current differences in physicians practice in preventing CAUTI corresponds with the different rates of recently reported incidences of CAUTI. Data related to the 2012 and 2013 fiscal years reported incidence of CAUTI by hospitals in the State of Georgia to the NHSN were available for comparison and analysis. Data related to the current perception and practice of CAUTI prevention elements by physicians in the State of Georgia were collected electronically using an online survey.

The independent variables were collected and analyzed descriptively and presented using frequencies and percentages in the form of tables. The data that was collected was arranged in a way that permitted the null hypotheses to be tested using the Pearson's chi-square test of independence. Specifically, Multiple bivariate analyses was done using the Pearson's chi-square test of independence to test the original hypotheses and determine whether or not the independent variables (constant education of physicians on proper catheterization, physicians' awareness of CAUTI risk factors, physicians' perception and practice on CAUTI prevention bundle elements, physicians compliance with CDC and IDSA guidelines to avoid habitual use of antimicrobials, physicians awareness of CMS reimbursement policy) are associated with the recently reported incidence rates of CAUTI among hospitals in Georgia. A comprehensive description of the actual analysis is presented in chapter 4.

Chapter 4: Results

Introduction

The methodology described in Chapter 3 was intended to facilitate a study to improve the epidemiological understanding of CAUTI by quantitatively investigate whether physicians' perception and practice on CAUTI prevention bundle elements either in part or in full are associated with recently reported CAUTI incidence. Hence, the data collected on the occurrence of CAUTI incidences in the State of Georgia and survey responses by physicians enabled the testing of the hypotheses and answering the research questions.

This chapter will present the results of the data collection and the descriptive hypotheses testing presented above keeping in mind the assumptions of the study stated in Chapter 1. This chapter was organized in the following 4 sections: Pilot study results, primary study data collection, results of descriptive analysis and summary. The pilot study result section describes the result of the pilot study that was conducted prior to carrying out the main study for the purpose of testing the 26-item survey of physician instrument of physicians' perception and practice on CAUTI prevention. The main study data collection section describes the time it took for both secondary and primary data to be collected as well as response rate for primary data collection. Because the main sample potential participants list was lower than anticipated, a brief discussion of an adjustment to sample size are included in the main study data collection section. A baseline descriptive and demographic characteristic of the sample for the primary data was also reported. Additionally, the result of the descriptive analysis section describes

the study sample in terms of independent and dependent variables. This is followed by the hypothesis testing of the five research questions. Further, a summary that ties the analysis results back together is discussed followed by an introduction of the next chapter.

Pilot Study Result

Prior to conducting the primary study, a pilot test of the 26-item survey of physician perceptions and practice instrument was conducted using a randomly selected sample of 100 potential participants from a list of 4000 physicians in the State of Georgia. Of the 100 email invitation that was sent out using surveymoney.com, a sample of 64 physicians agreed to take part in the pilot study by electronically signing the informed consent and completed the survey. In order to assess the internal consistency of the measures, Cronbach's alpha (α) was conducted on survey items. Results of the pilot test indicated excellent reliability (α = .905). As such, no modifications to the survey were made, and the instrument was deployed for the full list of potential participants.

Main Study Data Collection

Upon IRB approval, the data for this study was collected as described in chapter 3 within a 4 week period between December of 2014 and January of 2015. The secondary data, recently reported CAUTI incidence of the year 2012 in the State of Georgia, was retrieved for analysis on December 27th 2014 from this link, http://www.cdc.gov/nhsn/dataStat.html and the year 2013 CAUTI incidence report in the State of Georgia was retrieved on February 20th 2015 from this link,

http://www.cdc.gov/hai/progress-report/index.html on CDC website. The 2012 report was prepared by Dudeck and colleagues and published in the year 2013 while the 2013 report was prepared by several CDC staff members and published in January of 2015. The CAUTI data relevant to this study was extracted from the above mentioned reports (see Table 4, Table 5 and Table 6). The results of the State of Georgia's 2012 vs. 2013 CAUTI data report is presented in the result of descriptive analysis section of this chapter.

The initial list of randomly selected prospective participants purchased from the MAG member list was 4000 physicians practicing in the State of Georgia. After populating this list, 688 of the list showed up as either bounced or opted out from a previous survey sent out by another researcher using the surveymonkey.com system. This reduced the potential participant list from 4000 to 3312. An online survey was then sent to the 3312 list of potential participants. The researcher received 105 emails from physicians who stated that they had retired from clinical practice and will not be taking part in the survey. Three weeks after the main survey was sent out, the resulted survey data were downloaded from Surveymonkey.com, organized and assessed. A total of 371 participants began the survey for a response rate of 11.2%; however, 19 (5.12%) of those opted not to consent and/or participate in the study. Another 15 (4.04%) participants were removed for indicating that they do not care for patients with indwelling catheters. Lastly, one participant (0.3%) was removed due to incomplete data, resulting in a final sample size of 336 ($N = 336$) physicians for a final response rate of 10.2% which is typical for external survey (surveygizmo.com, 2014). Though

lower than initially proposed in chapter 3, the final response rate based on the adjusted participants list was appropriate for this study. The fact that some respondents did not complete the survey may indicate that they either didn't want to disclose their current practice on CAUTI prevention or they just didn't know what was indicated or not and thus decided to skip some of the items. This explanation is speculative and will be addressed further in the discussions for further research.

Sample Characteristics

A summary of the sample descriptive are outlined in Table 3. As shown, the greatest percentage of participants had been in practice for more than 20 years (38.6%), followed by those who have been in practice for 6–10 years (22.3%), 16–20 years (18.7%), 11–15 years (12.0%), and 1–5 years (8.4%). Participants represented a wide range of specialties, including, but not limited to, family practice (19.3%), internal medicine (24.1%), obstetrics/gynecology (19.6%), surgery (14.8%), and urology (1.8%). More participants reported working at non-teaching hospitals (59%) compared to those working at teaching hospitals (41.0%).

Table 3

Frequencies and Percentages for Categorical Demographic Variables

	n	%
Years in Practice		
1–5 Years	29	8.4
6–10 Years	75	22.3
11–15 Years	41	12.0
16–20 Years	63	18.7
More Than 20 Years	128	38.6
Medical Specialty		
Family Practice	65	19.3
Geriatrics	2	.6
Internal Medicine	81	24.1
Internal Medicine Sub-Specialty	17	4.8
Neurology	1	.3
Obstetrics/Gynecology	66	19.6
Surgery	49	14.8
Urology	6	1.8
Surgery Sub-Specialty Not Otherwise Listed	16	4.8
Other	33	9.9
Teaching Hospital		
Teaching Hospital	138	41.0
Non-Teaching Hospital	198	59.0

A summary of the characteristics of facilities that reported CAUTI incidences in 2012 and 2013 are outlined in Table 4. As shown, of the 166 facilities in the State of Georgia, 107 reported CAUTI incidence to the NHSN in 2012 while 106 reported in 2013. More facility locations reported CAUTI incidences in 2013 compared to 2012 (315 vs. 274). However, fewer ICU locations reported CAUTI incidences in 2013

compared to 2012 (176 vs. 182) while the number of wards locations increased in 2013 compared to 2012 (139 vs. 92).

Table 4

State of Georgia's 2012 vs. 2013 Characteristics of Facilities Reporting CAUTI to the NHSN

		2012 NHSN Reporting In State				2013 NHSN Reporting In State			
State	Number of Facilities in State[3]	Number of Facilities Reporting	Locations (n)[2] Total	ICU	Wards[2]	Number of Facilities Reporting	Locations (n)[2] Total	ICU	Wards[2]
Georgia	166	107	274	182	92	106	315	176	139

Note. CAUTI = Catheter Associated Urinary Tract Infections; ICU = Intensive Care Unit; NHSN = National Healthcare Safety Network. Adapted from "National Healthcare Safety Network (NHSN) Annual Report: data summary for 2012, Device-associated Model," by Dudeck et al., 2013, *American Journal of Infection Control*, 41(12), p. 1148-1166. Retrieved from http://www.cdc.gov/nhsn/dataStat.html and "Centers for Disease Control and Prevention. 2013 National and State Healthcare-Associated Infections Progress Report," by CDC., 2015, *National and State Healthcare-Associated Infections Progress Report.* Retrieved from http://www.cdc.gov/hai/progress-report/index.htm

Results of Descriptive Analysis

Research Questions

There were five research questions that were posed in this study. Answers to these questions are provided bases on the following steps. First, a summary of the descriptive analysis of the dependent variable, comparing the rate of CAUTI incidence between 2012 and 2013 was done. Then, using the primary data, the five independent variables were analyzed descriptively using frequencies and percentages; the mean and

standard deviation (SD) was also assessed to check for normality (see descriptive summaries of the independent variables below). Finally, to check the probability that the dependent and independent variables are related as well as assess the significance of the relationship, the Pearson's chi-square test for independence was used to test all five null hypotheses. With the knowledge of the chi-square value, the degree of freedom and the significance level or probability value of 0.05, the chi-square distribution table (see Appendix G) was employed to determine the answer of the research questions. Before testing the five null hypotheses, the dependent variable, recently reported CAUTI incidence in the State of Georgia was analyzed descriptively.

The tables below carry a descriptive statistics of the true report of the State level data on the rates of CAUTI as well as the standardized infection ratio (SIR) in the years of 2012 and 2013 (see Table 5 and Table 6).

Table 5

State of Georgia 2012 vs. 2013 CAUTI and SIR Reporting to NHSN, All Locations

		No. of CAUTI			95% CI for SIR			Δ in SIR	
Year	Number of Facilities Reporting	Observed	Predicted	SIR	Lower	Upper	% of Change	Direction of Change	P-Value
2012	107	938	930.446	1.008	0.945	1.075	32%	Increased	0.0000
2013	106	1,288	947.983	1.359	1.286	1.434			

Note. CAUTI = Catheter Associated Urinary Tract Infections; SIR = Standardized Infection Ratio; NHSN = National Healthcare Safety Network; CI = Confidence Interval. Adapted from "National Healthcare Safety Network (NHSN) Annual Report: data summary for 2012, Device-associated Model," by Dudeck et al., 2013, *American Journal of Infection Control*, 41(12), p. 1148-1166. Retrieved from http://www.cdc.gov/nhsn/dataStat.html and "Centers for Disease Control and Prevention. 2013 National and State Healthcare-Associated Infections Progress Report," by CDC. 2015, *National and State Healthcare-Associated Infections Progress Report.* Retrieved from http://www.cdc.gov/hai/progress-report/index.htm
[a]The standardized infection ratio (SIR) is a summary statistics that can be used to track HAI prevention progress over time; lower SIRs are better.

As shown in Table 5 above, between the years of 2012 and 2013, reported rates of CAUTI incidence increased significantly in the State of Georgia. A total of 938 CAUTI rates were observed in 2012 while 1,288 CAUTI rates was observed in 2013, which are both higher than the predicted rates of 930.4 and 947.9 respectively. An increase in the standardized infection ratio (SIR) was reported in 2013 compared to 2012 (1.359 vs. 1.008) showing a 32% increase and a 95% CI of 0.945 – 1.075 in 2012 vs. 1,286 – 1.434 in 2013 (P = 0.00) (see Table 5).

Table 6

State of Georgia 2012 vs. 2013 CAUTI and SIR Reporting to NHSN, ICU Only

Year	Number of Facilities Reporting	No. of CAUTI		SIR	95% CI for SIR	
		Observed	Predicted		Lower	Upper
2012	104	741	737.637	1.005	0.934	1.080
2013	99	997	720.628	1.384	1.300	1.471

Note. CAUTI = Catheter Associated Urinary Tract Infections; SIR = Standardized Infection Ratio; NHSN = National Healthcare Safety Network; ICU = Intensive Care Units; CI = Confidence Interval. Adapted from "National Healthcare Safety Network (NHSN) Annual Report: data summary for 2012, Device-associated Model," by Dudeck et al., 2013, *American Journal of Infection Control*, 41(12), p. 1148-1166. Retrieved from http://www.cdc.gov/nhsn/dataStat.html and "Centers for Disease Control and Prevention. 2013 National and State Healthcare-Associated Infections Progress Report," by CDC. 2015, *National and State Healthcare-Associated Infections Progress Report.* Retrieved from http://www.cdc.gov/hai/progress-report/index.htm

[a]The standardized infection ratio (SIR) is a summary statistics that can be used to track HAI prevention progress over time; lower SIRs are better

Furthermore, between 2012 and 2013, there were differences in the predicted and observed number of CAUTI incidences in the ICU. The reported data shows that of the 107 facilities that reported in 2012 (see Table 5), 104 were ICU facilities (see Table 6). These 104 ICU facilities observed 741 CAUTI incidences as opposed to the 737.6 cases that were predicted in 2012. This gave a SIR of 1.005 (95% CI: 0.934 - 1.080). On the other hand, of the 106 facilities that reported in 2013 (see table 5), 99 were ICU facilities (see Table 6). These 99 facilities observed 997 CAUTI incidences as opposed to the 720.6 cases that were predicted in 2013. This gave a SIR of 1.384 (95% CI: 1.300-1.471). Thus, the report shows that there was a marked increase in the difference

between the observed and predicted number of CAUTI incidences in both 2012 and 2013. Most importantly, a significant increase in CAUTI incidence in the ICU was observed in 2013 compared to 2012 (997 in 2013 vs. 741 in 2012) (see Table 6). The above descriptive data of CAUTI incidence (dependent variable) along with the data from the survey of physicians (independent variables) was used to test and answer the 5 sub-questions of this study.

Research Question 1: Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia?

To answer the question of whether or not there is a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the state of Georgia, the physicians responses on the formalized system for guidance on when to insert or remove catheters or a method for monitoring patients with indwelling catheter as well as the provision of physicians with training on proper catheterization were analyzed descriptively and the responses are found on Table 7 below. A further analysis on the frequency of physicians training on proper catheterization was done and the summary can be found on Table 8 below.

Table 7

Frequencies and Percentages of Physician Education

		Yes	No	Unsure	Total	Mean	SD
Does your primary facility have a formalized system for guidance on when to insert or remove a catheter, or a method for monitoring which patients have indwelling catheter?	Freq.	251	49	36	336	1.36	0.67
	Percent	74.7	14.6	10.7	100		
Does your primary facility provide physicians with training on proper catheterization?	Freq.	64	232	40	336	1.93	0.55
	Percent	19.1	69.0	11.9	100		

First, Table 7 indicates that of the 336 physicians that responded to the questionnaire, 251(74.7%) acknowledged that their facility had a formalized system for guidance on when to insert or remove a catheter, or a method for monitoring patients with indwelling catheter. 49 (14.6%) of these physicians had a negative impression about their facility having a formalized system for guidance on when to insert or remove catheter; while 36 (10.7%) physicians were unsure whether their facilities had this system or not. A mean of 1.36 and a standard deviation of 0.67 indicate a positive trend of their responses towards the first question. This means a majority of the physicians (74.7%) are in facilities with formalized systems for guidance on when to insert or remove a catheter or a method for monitoring patients with indwelling catheter.

Second, 232 (69.0%) of the 336 physicians who took part in this study indicated that their primary facility does not provide physicians with training on proper

catheterization. This is opposed to the 64 (19.1%) who agreed that their primary facility thus provide such training (see Table 7). A summary of the frequency of physicians training on proper catheterization is depicted in Table 8.

Table 8

Frequency of Training

	n	%
If "Yes" how often		
Bi-Weekly	6	9.5
Monthly	6	9.5
Quarterly	20	31.7
Yearly	32	49.3

It resulted that about half of the 64 physicians, 32 (49.3%) who agreed to receiving training on proper catheterization indicated that their training was offered yearly. Further, 20 (31.7%) physicians indicated that they received training quarterly while 6 (9.5%) received training monthly. Interesting, it was noted that the remaining 6 (9.5%) of physicians who receive training on proper catheterization indicated to receiving their training by-weekly (see Table 8). Furthermore, the responses were analyzed using the Pearson's chi square test for independence in order check the probability that frequent education of physicians' on proper catheterization(as determined by the 26-item survey of physicians) is related to CAUTI incidence as well as assess its significance thus testing the null hypothesis 1 and the findings are presented as follows:

$H_0$1: There is no relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

The result of the analysis (see Table 9) demonstrates sufficient evidence to reject the null hypothesis (Ho1) and consider that a relationship may exist between the frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia.

Table 9

Pearson Chi-square Table to Show the Correlation Between Frequent Education of Physicians on Proper Catheterization and CAUTI Incidence in the State of Georgia

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	230.13	2	.000*
Likelihood Ratio	186.68	2	.000
Linear-by-Linear Association	55.632	1	.000
N of Valid Cases	336		

Note: * $p < 0.05$

The calculation in Table 9 carries the result of the chi square analysis for hypothesis and it demonstrates sufficient evidence to reject the null hypothesis (Ho1) and consider that a relationship may exist between frequent education of physicians and CAUTI incidence in the State of Georgia. Here, the calculated chi square value (230.13) is far greater than the chi square critical value of 05.99 with 2 degree of freedom and at the 0.05 level of significance. And following the chi square decision rule, the null hypothesis is rejected and the alternative confirmed. Hence, one can say that there is a

correlation between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia.

Research Question 2: Is there a relationship between physicians' awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

Research Question 2 was posed in order to verify whether there is any relationship between physicians' awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia. The responses of these physicians are summarized in the following table (see Table 10).

Table 10

An Assessment of Physicians' Awareness of CAUTI Risk Factors as Determined by the 26-item Survey of Physicians

		Always indicate	Usu. Ind	Indicated ½ of time	Rarely Indicated	ANI	Unk.	Total	Mean	SD
Extended period of Catheterization	Freq.	230	42	18	10	05	31	336	1.84	1.57
	Percent	68.5	12.5	5.4	3.0	1.5	9.2	100		
Unsuitable condition during catheterization	Freq.	128	78	43	26	10	51	336	2.60	1.78
	Percent	38.1	23.2	12.8	7.7	3.0	15.2	100		
Preoperative antibiotic use	Freq.	49	24	34	113	47	69	336	3.87	1.63
	Percent	14.6	7.1	10.1	33.6	14.0	20.5	100		
Female gender	Freq.	58	91	62	35	21	69	336	3.23	1.77
	Percent	17.3	27.1	18.5	10.4	6.3	25.0	100		
Prior catheterization in same hospital admission	Freq.	71	88	98	31	00	48	336	2.84	1.57
	Percent	21.1	26.2	29.2	09.2	00	14.3	100		
Patients in Cardiac Units	Freq.	37	62	33	81	00	123	336	3.93	1.85
	Percent	11.0	18.5	9.8	24.1	00	36.6	100		
Age Over 40	Freq.	57	100	51	30	36	62	336	3.22	1.77
	Percent	17.0	29.8	15.2	8.9	10.7	18.5	100		
Increase hospital and ICU stay	Freq.	188	75	18	06	00	49	336	2.11	1.74
	Percent	56.0	22.3	5.4	1.8	00	14.6	100		

Note. Key: ANI =Always Never Indicated; Unk =Unknown; SD = Standard Deviation

This table (see Table 10) indicates that a majority (81%) of physicians who took part in this study always indicated (230 [68.5%]) or usually indicated (42 [12.5%])

extended period of catheterization as a risk factor for CAUTI incidence (mean = 1.84; *SD* = 1.57). A total of 206 (61.3%) physicians considered unsuitable conditions during catheterization to be indicated always (128 [38.1%]) or usually (78 [23.2%]) as risk factor for CAUTI incidence (mean= 2.60; *SD* = 1.78). It also resulted that 64.2% of the physicians considered preoperative antibiotic use to be rarely indicated (113 [33.6%]), indicated half of the time (34 [10.1%]), or unknown (69 [20.5%]) as a risk factor for CAUTI incidence (mean = 3.87; *SD* = 1.63). Also, 62.9% of the physicians in this study noted female gender to be always indicated (58 [17.3%]), usually indicated (91 [27.1%]) or indicated about half of the time (62 [18.5%]) as a risk factor for CAUTI incidence (mean = 3.23; *SD* = 1.77). Additionally, 76.5% of the physicians in this study noted prior catheterization in the same hospital admission to be always indicated (71 [21.1%]), usually indicated (88 [26.2%]) or indicated about of the time (98 [29.2%]) as a risk factor for CAUTI incidence (mean = 2.84; *SD* = 1.57). It was further noted that 83.7% of the physicians in this study acknowledged increase hospital and ICU stay to be indicated always (188 [56%]), usually (75 [22.3%]) or half of the time (18 [5.4%]) as a risk factor for CAUTI incidence (mean = 2.11; *SD* = 1.74).

Further, the null hypothesis derived from the second research question was tested using the Pearson's chi-square tests for independence in order to check the probability that physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) is related to CAUTI incidence as well as assess its significance. The findings are indicated in the next table.

Ho2: There is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

Table 11

Chi Square Table on the Relationship Between Physicians' Awareness of CAUTI Risk Factors and the CAUTI Incidence in Georgia

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	367.891	7	.000*
Likelihood Ratio	48.126	7	.000
Linear-by-Linear Association	55.896	1	.000
N of Valid Cases	336		

Note: * $p < 0.05$

Results of the analysis (see Table 11) demonstrate sufficient evidence to reject the null hypothesis (Ho2) and consider that a relationship may exist between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia. Here, the calculated chi square value (367.891) is greater than the chi square critical value of 14.067 at the 0.05 level of significance. And following the chi square decision rule, the null hypothesis is rejected and the alternative confirmed. Hence, one can say that there is an apparent relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

Research Question 3: Is there a relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

The third research question was aimed at finding out whether there exist any relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia. To answer this question, the researcher went on to analyze the responses of the physicians on their knowledge of the CAUTI prevention bundle in part and in full. Frequencies and percentages of responses were computed (see Table 12). The table below summarizes these responses:

Table 12

An Assessment of Physicians Perception and Practice on CAUTI Prevention Bundle Elements in Part or in Full as Determined by the 26-item Survey of Physicians

		L E	M E	S E	N E	Unk.	Total	Mean	SD
Removing catheters as early as possible	Freq.	305	18	00	00	12	336	1.20	0.77
	Percent	91.1	5.4	00	00	3.6	100		
Constant disinfection of fomites during point of care	Freq.	84	104	93	42	13	336	2.39	1.11
	Percent	25.0	31.0	27.7	12.5	3.9	100		
Hospital use of electronic monitoring system to monitor hand hygiene	Freq.	41	91	103	38	63	336	2.97	1.28
	Percent	12.2	27.1	30.7	11.3	18.8	100		
Effective use of TMP-SMX as prophylaxis prior to catheter removal	Freq.	06	27	110	127	66	336	3.65	0.94
	Percent	1.8	8.0	32.7	37.8	19.6	100		
Effective use of amikacin sulfate bladder wash as prophylaxis prior to catheter removal	Freq.	16	10	105	100	105	336	3.80	1.07
	Percent	4.8	3.0	31.3	29.8	31.3	100		
Having automated reminders to discontinue/renew the order for catheter	Freq.	207	102	11	04	12	336	1.55	0.90
	Percent	61.6	30.4	3.3	1.2	3.6	100		

Note. Key: LE= Large Effect; ME = Moderate Effect; SE = Slight Effect; NE = No Effect; Unk = Unknown

As shown in Table 12, majority of the physicians who responded on their current practice method of preventing CAUTI 305 (91.1%), noted removing catheters as early as possible to be large effect while 18(5.4%) noted that this prevention method had a moderate effect on preventing CAUTI (mean = 1.20; *SD* = 0.77). It also resulted that 84 (25%) of the sample considered constant disinfection of fomites during point of care to have a large effect, while 104 (31.0%) considered this prevention method to

have a moderate effect and 93 (27.7%) deemed this method to have a slight effect on preventing CAUTI (mean = 2.39; *SD* = 1.11). A majority of the sampled physicians, 103 (30.7%) noted that hospitals use of electronic monitoring system to monitor hand hygiene had a slight effect on preventing CAUTI incidence while 41 (12.2%) and 91 (27.1%) noted this prevention method to have a large effect and moderate effect respectively (mean = 2.97; *SD* = 1.28). It also resulted that 127 (37.8%) of the sampled physicians believed that the effective use of TMP-SMX as prophylaxis prior to catheter removal has no effect in preventing CAUTI while 110 (32.7%) believed this method to have a slight effect on preventing CAUTI incidence; interestingly, only 6 (1.8%) and 27 (8.0%) of the sample believed this method to have a large and moderate effect respectively in preventing CAUTI incidence (mean = 3.65; *SD* = 1.07). Further, it resulted that only 16 (4.8%) and 10 (3%) of the sample physicians considered the effective use of amikacin sulfate bladder wash as prophylaxis prior to catheter removal to have a large effect and moderate effect respectively in preventing CAUTI incidences while 105(31.3%) and 100 (29.8%) considered this method to have a slight effect and no effect respectively in preventing CAUTI (mean = 3.80; *SD* = 1.07). In addition, majority of the participants, 207 (61.6%) believed that having automated reminders to discontinue/renew the order for catheter to have a large effect in preventing CAUTI while 102 (30.4%), 11 (3.3%) considered this method to have a moderate and slight effect respectively in preventing CAUTI incidence (mean = 1.55; *SD* = 0.90).

The null hypothesis derived from this research question was also analyzed using the Pearson's chi-square test for independence in order to check the probability that

physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) is related to CAUTI incidence as well as assess its significance as indicated in Table 13 below. This aided in answering the third research question.

Ho3: There is no relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia

Table 13

Pearson Chi Square Calculation Table on the Correlation Between Physicians' Perception and Practice on CAUTI Prevention Bundle Elements Both in Part or in Full and the CAUTI Incidence in Georgia

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	359.265	7	.000*
Likelihood Ratio	51.568	7	.000
Linear-by-Linear Association	45.895	1	.000
N of Valid Cases	336		

Note: * $p < 0.05$

The result of the analysis (see Table 13) demonstrated sufficient evidence to reject the null hypothesis (Ho3). The chi square test indicated that the calculated value of 359.265 is greater than the chi square table or critical value of 14.067 at a 0.05 level of significance with 7 degree of freedom. According to the decision rule, the null hypothesis is rejected and the alternate confirmed. This means that there is a significant

relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Research Question 4: Is there a relationship between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

The fourth research question aimed at verifying the link between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia. The goal here was to assess whether the physicians' respect or lack of respect of the antimicrobial guidelines of the CDC and IDSA as determined by the 26-item survey of physicians had any impact on the rate of CAUTI incidences in the State of Georgia. These physicians were asked to assess the effect of the constant use of antimicrobial coated catheter on the prevention of CAUTI. The frequencies and percentage of their responses were computed and are summarized in the table below.

Table 14

An Assessment of Physicians' Compliance with CDC and IDSA Antimicrobial Guidelines as Determined by the 26-item Survey of Physicians

		L E	M E	S E	N E	Unk	Total	Mean	SD
Constant use of antimicrobial coated catheters	Freq.	21	55	78	67	115	336	3.60	1.28
	Percent	6.3	16.4	23.2	19.9	34.2	100		

Note. LE = Large Effect; ME = Moderate Effect; SE = Slight Effect; NE = No Effect; Unk = Unknown

From the table, it is realized that 21 (6.3%) of the physicians who took part in the study indicated that the constant use of antimicrobial coated catheters had a large effect in preventing CAUTI. 55 (16.4%) of the 336 physicians who responded said the use of antimicrobial coated catheters had a moderated effect in preventing CAUTI. 78 (23.2%) talked of antimicrobial coated catheters having a slight effect in preventing CAUTI. There were 67 (19.9%) who stated that the use of antimicrobial coated catheters had no effect in preventing CAUTI; while the remaining 115 (34.2%) did not know what effect constant use of antimicrobial coated catheters had on CAUTI incidences. It was then noted that a majority, 145 (43.1%) of the sample physicians who took part in this study were of the impression that the constant use of antimicrobial coated catheter had a slight or no effect on preventing CAUTI (mean = 3.60; *SD* = 1.28) (see Table 14). Furthermore, the responses were analyzed using Pearson's chi square test for independence in order to check the probability that physicians' compliance with the guidelines from CDC and IDSA to avoid constant use of antimicrobial coated catheters (as determined by the 26-item survey of physicians) is related to CAUTI incidence as well as assess its significance. This aided in testing the fourth null hypothesis as well as provided answer to the fourth research question as depicted below.

Ho4: There is no relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobial coated catheters (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Table 15

Pearson's Chi Square Calculation Table on the Correlation Between Physicians' Compliance with the Guidelines from CDC and IDSA to Avoid Habitual use of Antimicrobial and the CAUTI Incidence in Georgia

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	69.714	4	.000*
Likelihood Ratio	21.568	4	.000
Linear-by-Linear Association	25.895	1	.000
N of Valid Cases	336		

Note: * $p < 0.05$

The chi square calculation for the fourth hypothesis resulted in a value of 69.714 which is greater than the critical value of 9.488 at the 0.05 level of significance with 4 degree of freedom. According to the decision rule, the null hypothesis is rejected and the alternate confirmed. This means that there is relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia (see Table 15).

Research Question 5: Is there a relationship between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI?

Research question 5 was aimed at verifying the relationship that exists between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-items survey of physicians and the current incidence of CAUTI. Here the researcher

started with a question to the physicians on whether they know that catheter-associated UTI is one of eight hospital-acquired conditions for which the Centre for Medicare/Medicaid Services will no longer offer reimbursement. The frequency and percentage of their responses were analyzed and presented in the next table (see Table 16).

Table 16

Physicians' Response on Knowledge of the Non-Reimbursement of Catheter-Associated UTI Claims

	Frequency	Percent	Mean	Standard Deviation
Yes	306	91.1		
No	30	8.9	1.09	0.29
Total	336	100.0		

As shown, majority of the sample physicians, 306 (91.1%) know that CAUTI is one of the eight hospital-acquired infections (HAI) for which the Center for Medicare/Medicaid Services (CMS) will no longer offer reimbursement. The rest of the sampled physicians, 30 (8.9%) were not aware of the CMS non-reimbursement policy. The fact that 91.1 percent of the sample physicians acknowledged that CAUTI is one of the eight HAI for which the CMS will no longer offer re-imbursements, shows a high degree of awareness as far as catheter related issues are concerned. The researcher went on to verify the effect of this legislation on catheter-related practices of these physicians (see Table 17).

Table 17

The Effect of Legislation on Catheter on Related Practices by Physicians

		Yes	No	Unsure	Total	Mean	SD
Prompted you to order fewer catheters	Freq.	145	185	06	336	1.64	0.50
	Percent	43.1	55.1	1.8	100		
Affected how often you ordered a urinalysis	Freq.	120	198	18	336	1.76	0.52
	Percent	35.7	58.9	5.4	100		
Prompted you to remove catheters sooner	Freq.	230	99	07	336	1.37	0.51
	Percent	68.4	29.5	2.1	100		

Note. Key: SD = Standard Deviation

As shown, 145 (43.1%) of the physicians involved in the study were prompted by the legislation to order fewer catheters while 185 (55.1%) of them were not prompted to do so (mean = 1.64; *SD* = 0.50). The legislation also affected the rate at which 120 (35.7%) of these physicians ordered urinalysis however, 198 (58.9%) of these physicians indicated that they were not affected (mean = 1.76; *SD* = 0.52). Finally, the legislation on catheter prompted 230 (68.4%) of the physicians to remove catheters sooner but 99 (29.5%) were not pushed by the legislation to remove catheters early (mean = 1.37; *SD* = 0.51).

The Pearson's chi-square test for independence was then carried out to assess the probability that physicians' knowledge of the legislation on catheter has an effect on CAUTI incidence in the State of Georgia as well as assess its significance. This aided in

testing the fifth null hypothesis as well as provided answer to the fifth research question as depicted below.

Ho5: There is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

Table 18

Pearson Chi Square Calculations Table on the Relationship Between Physicians Awareness of the CMS no Reimbursement Policy on all HAI and CAUTI Incidence in the State of Georgia.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	255.063	3	.000*
Likelihood Ratio	193.817	3	.000
Linear-by-Linear Association	85.895	1	.000
N of Valid Cases	336		

Note: * $p < 0.05$

The result of the test analysis provides sufficient evidence to reject the null hypothesis and accept the alternative hypothesis. The calculated chi square value (255.063) here is greater than the critical or table value of 7.815 within 3 degree of freedom and at 0.05 level of significance. Hence, the alternate hypothesis is validated and it can be said here that there exist a correlation between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI.

Summary

The result of the analysis shows an increase in the reporting of CAUTI incidences in 2013 compared to 2012. It also implies that the State of Georgia physicians' perception and practice of CAUTI prevention methods do differ and that prevention related variables are useful in decreasing the incidence levels of CAUTI. The result of descriptive analysis found that sample physicians did differ significantly in terms of their training on proper catheterization, their perception of CAUTI risk factors, their effective practice of CAUTI prevention measures, their implementation of guidelines to prevent CAUTI and their view on the CMS reimbursement policy.

Pearson's chi-square test for independence analyses were used to test the following null hypotheses:

$H_0$1: There is no relationship between frequent education of physicians' on proper catheterization and CAUTI incidence in the State of Georgia.

$H_0$2: There is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence in the State of Georgia.

$H_0$3: There is no relationship between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

$H_0$4: There is no relationship between physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

$H_0$5: There is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia.

All five null hypotheses were rejected following Pearson's chi-square test for independence which showed that a significant correlation exist between CAUTI incidence and frequent education of physicians on proper catheterization, physicians awareness of CAUTI risk factors, physicians' perception and practice on CAUTI prevention bundle elements both in part or in full, physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials and physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians.

The pilot study portion of this study which tested the internal consistency of the measures showed excellent reliability of the 26-item survey of physician instrument. The next chapter will conclude the study by interpreting the findings. It will also provide the limitations of the study, the social change implications as well as the recommendations for future research in this area.

Chapter 5: Discussion

Introduction

The purpose of this study was to improve the epidemiological understanding of CAUTI by quantitatively investigate whether physicians' perception and practice on CAUTI prevention bundle elements either in part or in full are associated with recently reported CAUTI incidence. With prevention efforts in place, CAUTI is still the most frequently reported HAI in the United States leading to increased cost to treat, patient discomfort, morbidity and most importantly mortality. It seems reasonable then that healthcare professionals' perception and practice method on CAUTI prevention could provide some insight as to the reason for the increase in CAUTI frequency. This study was conducted because several studies have been done on nurses' practice on CAUTI prevention but very few have been done with the focus on physicians. With only one study done in Minnesota focusing on physicians, the researcher thought it necessary to carry out another study with the focus on physicians in the State of Georgia in association with recently reported frequency of CAUTI. Additionally, this study sought to confirm the reliability and validity of the 26-item survey of physician instrument.

With IRB approval, randomly selected lists of physicians in the State of Georgia were invited via email to participate in a survey on CAUTI prevention by completing a consent form electronically and short survey. The survey asked participants questions regarding their current perception and practice on CAUTI prevention (see Appendix F). Recently reported CAUTI incidence for the years 2012 and 2013 were obtained from CDC'S NHSN. The report contained number of facilities that reported CAUTI, its

frequency and SIR for 2012 and 2013 in both ICU and wards. Data collected from the survey and from the CAUTI frequency data set were organized and manipulated to create independent and dependent variables. Statistical analysis was performed using SPSS version 21.

The main research question addressed by this study was: Are physicians' perception and practice regarding the prevention of CAUTI in the ICU associated with CAUTI incidence rates in the State of Georgia? The main question is addressed by answering the following five sub-questions:

1. Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia?
2. Is there a relationship between physician's awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?
3. Is there a relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?
4. Is there a relationship between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

5. Is there a relationship between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI?

After analyzing the CAUTI data set, it was confirmed that overall, the frequency of CAUTI in the State of Georgia did increase significantly between 2012 and 2013 and most of the incidence occurred in the ICU. Also, after descriptively analyzing the survey data using frequencies and percentages, a positive trend was observed in the responses indicating that a relationship might exist between physicians' perception and practice on CAUTI prevention elements and its incidence in the ICU. The five sub-questions were then transformed into null hypothesis and tested using Pearson's chi-square test of independence in order to test the probability of the relationship as well as assess its significance.

Analysis found that a significant correlation does exist between CAUTI incidence and frequent education of physicians on proper catheterization. It was also found that physicians awareness of CAUTI risk factors as well as their perception and practice on CAUTI prevention bundle elements both in part or in full as determined by the 26-item survey of physicians is significantly associated with CAUTI incidence. Further analysis showed that physicians' compliance with the guidelines from CDC and IDSA to avoid habitual use of antimicrobials and physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians is related to CAUTI incidence.

Interpretation of Findings

Drekonja et al. (2010) asserted that several studies have focused on nurses' knowledge and practice on CAUTI prevention however; little attention has been placed on physicians practice with regards to CAUTI prevention. It seems logical why this is so since catheter placement is frequently carried out by nurses; majority of the times, physicians are even uninformed of whether or not their patients have indwelling catheters (Drekonja et al., 2010). Drekonja et al., revealed there was a lack of translation of catheter related knowledge into practice by physicians. In the current study, in a manner similar to Drekonja and colleagues' survey of physicians in Minnesota, a random selection of physicians in the state of Georgia responded to a survey which focused on their perception and practice on evidence-based bundle elements said to decrease the incidence of CAUTI. The recently reported incidence of CAUTI between the year 2012 and 2013 was also assessed to see if there has been any improvement. It was expected that a decrease in the incidence of CAUTI between 2012 and 2013 in the State of Georgia will be observed if majority of the participants reported that they receive constant training on proper catheterization and also if their knowledge of CAUTI prevention elements is being translated into practice.

This section is organized around the main research question and the five sub-questions. The sub-questions are answered after a discussion of the survey and sampling results as well as the recently reported CAUTI frequency in the State of Georgia. This section concludes with a short discussion on the main research questions.

Sampling and Survey Results

The potential participants list was adjusted from 4000 to 3312 because some in the list had bounced or opted out of the surveys sent via surveymoney.com. Approximately 10% of the randomly selected participants that where invited via email to take part in this study agreed to participate and completed the survey. One participant started the survey but decided to skip some of the questions probably because they did not want to disclose their current practice method on CAUTI prevention or they just didn't know what was indicated or not with regards to CAUTI prevention. A few in the list could not take the survey because they were either retired (105) or they do not care for catheterized patients (15). It could be speculated that the majority in the list were very busy and did not have time to take the survey. Though lower than expected, the sampling result rate was expected for an external survey thus making it appropriate for this study. Sampling results revealed that 59% of the participants worked at non-teaching hospitals while the rest worked at teaching hospitals. It also revealed that the physicians varied with regards to their years of practice with majority having been in practice for more than 20 years. They also represented a wide range of specialties including but not limited to family practice, internal medicine, obstetrics/gynecology, surgery and urology.

Sampling and surveys also found that most of the participants' primary facilities have a formalized system for guidance on proper catheterization. However, data showed that 10% of the samples were unsure if their primary facility provided such guidance or not while fourteen percent reported that their primary facility does not provide such

guidance. It is difficult to conclude whether or not the description of the research sample participants' primary facility is similar to facilities in other states in the United States. Presently, there is little published record of this nature to compare to.

Evaluation of the survey results also revealed some noteworthy findings. One of the findings was that physician's perception and practice with regards to catheter prevention varied significantly. Even though a higher percentage of the participants responded positively to most of the elements, it was interesting to note that some did not know if the elements in the 26-item survey of physicians were associated with CAUTI incidence. This finding raises a new question related to CAUTI prevention: What is the prevalence of physicians who are familiar with the methods that have been proven to be clinically effective in preventing CAUTI?

CAUTI Incidence in the State of Georgia

The CAUTI incidence report from the NHSN showed that although more facilities reported CAUTI incidence in 2012 compared to 2013, the number of facility locations that reported in 2013 exceeded that of 2012 significantly. It also showed that the number of wards locations that reported CAUTI incidence was more than ICU locations in 2013 compared to 2012. The frequency of CAUTI increased in the state of Georgia significantly in 2013 compared to 2012. The observed CAUTI incidence for year 2013 was 1,288; this exceeds the reported incidence rate for the year 2012 by 350 cases. With such an increase, it is not surprising to note that the standardized infection ratio (SIR) for 2013 (1.359) was also higher that the SIR for 2012 (1.008), showing a 32% increase in the state SIR. To note, the SIR is a summary statistics that is used to

track HAI prevention progress over time, thus meaning that the lower the SIR the better (CDC, 2015). Based on the CAUTI incidence and the SIR reported in the State of Georgia, it is reason to suspect that not enough effort is being applied by all healthcare professionals to prevent the incidence of CAUTI.

Interpretation of Research Questions

Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia?

There is little, if any guide for researching the relationship between frequent education of physicians on proper catheterization and CAUTI incidence observed in the field. There are, however some studies related to catheter use and its effect on CAUTI incidence. These studies were appraised in Chapter 2 and generally recommend that effective catheterization has a positive impact on CAUTI prevention.

New Data from a systemic review and meta-analysis of several studies by Meddings, Rogers, Macy and Saint (2010) showed a decrease in the mean duration of catheterization when a reminder system to remind physicians and nurses that a urinary catheter was in use or a stop order to prompt catheter removal in hospitalized patients was implemented. These researchers reported that studies that used a stop order recorded statistically significant decrease in CAUTI rates compared to those that used reminders. They concluded with a firm statement that a reduction in CAUTI rates was expected when a reminder and a stop order was implemented; thus should be stoutly considered in order to improve the safety of hospitalized adults. Data from Elpern et al. (2009) showed a drastically reduced rate of infections by pathogens causing CAUTI

when length of use of indwelling catheter was judged appropriately. This study was probably prompted by data from Saints, Kowalsky, Kaufman, Hofer, Kauffman & Olmsted et al., (2008) study which showed that majority of hospitals do not have policies (e.g. system that monitors patients with catheter placement, catheter duration, consistently using of antimicrobial urinary catheters, portable bladder scanner, condom catheters and catheter reminders) put in place to prevent CAUTI. The study also showed that less than 10% of hospitals in the whole United States use the reminder or stop orders method.

Further, data from Apisarnthanarak, Suwannakin, Maungboon, Warren and Fraser (2008) showed that without proper supervision, providers are not prone to following directions with regards to proper instrumentation. It basically showed an increase in the use of Foley catheters when discussions between investigators and providers stopped; however, when the discussion recommenced, a decrease in use was observed. Additionally, a quality improvement project by Knoll et al. (2011) which included various forms of education, revamping the system, incentives, feedbacks and an involvement of a devoted Foley catheter nurse showed a decrease in the daily ratio of non-ordered and non-indicated Foley catheters from 17% to 5.1% and from 15% to 1.2% correspondingly. These researchers concluded that with the direct involvement of a dedicated Foley catheter nurse, hospitals can experience a significant reduction in total and inappropriate Foley catheter use as well as improvement in documenting Foley catheter orders.

The positive result seen when a dedicated nurse is present proved ineffective according to a study by Saints and colleague and reported by Knoll et al. (2011), which showed that providers wouldn't respond to written nurse reminders but will take action only after they have been encouraged to do so via email by the Medical Director of Infection Control. The data from Saints and colleagues (2009) suggested that clinicians and other healthcare workers involved in a placement of Foley catheters be educated on the suitable indications for catheter use and also be advised on the benefits of early catheter removal. Literature related to proper catheterization suggests that a relationship between reported CAUTI incidence and the frequency of educating physicians on proper catheterization is possible.

In Chapter 1, the principle of the frequency of educating physicians on infection control programs as an attributable risk, in relation to CAUTI incidence was presented as part of the theoretical foundation for this research. The following example is intended to strengthen this principle and help answer the question: Is there a relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia? For example; if the Medical Directors of Infection Control at hospitals in the State of Georgia implements a quarterly training program similar to the comprehensive improvement project conducted by Knoll et al. (2011) which showed a decrease in the daily ratio of non-ordered and non-indicated Foley catheters from 17% to 5.1% and from 15% to 1.2% correspondingly, hospitals will experience a decrease in CAUTI incidence. In addition, if regular training programs are conducted (preferably quarterly with monthly or bi-weekly reminders) related to

CAUTI prevention which is guided by a dedicated Foley catheter nurse under the direction of the Medical Director of Infection Control, revamping the current system, implementation of a reminder system to remind physicians and other healthcare workers involved in Foley catheter placement that a urinary catheter is in use and stop order to prompt catheter removal, a decrease in the incidence of CAUTI in the State of Georgia will be observed. However if hospitals do not have a regular training program for physicians and other healthcare workers involved in Foley catheter placement or a policy put in place to prevent CAUTI as Saints et al. (2008) found, then hospitals will continue to experience an increase in the incidence of CAUTI year after year. The principle of the frequency of educating physicians on infection control programs as an attributable risk, in relation to CAUTI incidence suggest that a relationship between the reported CAUTI incidence and the frequency of educating clinicians on proper catheterization is possible.

Consistent with the literature presented in Chapter 2 and the principle of the frequency of educating physicians on infection control programs as an attributable risk in relation to CAUTI incidence presented in Chapter 1, this study found sufficient evidence to reject the null hypothesis that there is no relationship between frequent education of physicians on proper catheterization and CAUTI incidence in the State of Georgia. Even though a majority of the participants in this study acknowledged that their facility had a formalized system for guidance on when to insert or remove a catheter, or a method for monitoring patients with indwelling catheter, a great number of the participants also indicated that their primary facility does not provide physicians

with training on proper catheterization (see Table 7). In fact, of the 64 participants who acknowledge to receiving training, close of half (49.3%) indicated that their facility offered yearly training on proper catheterization. The reported incidence of CAUTI in 2013 exceeded that which was reported in 2012 by 350 cases in the state of Georgia. The 2013 SIR for CAUTI in the state of Georgia exceeded that of 2012 by 32%, showing a lack of progress with regards to prevention efforts (see Table 4 and Table 5). This shows that a relationship definitely exist between frequent education of physicians on proper catheterization and the incidence of CAUTI. The Pearson's chi-square analysis shows a chi-square value of 230.13 which is far greater than the critical value of 05.99 with 2 degree of freedom and at a 0.05 level of significance thus showing the significance of the correlation between frequent education of physician on proper catheterization and CAUTI incidence. The findings of this study is consistent with the literature on instrumentation and the principle of frequent education of physician on proper catheterization which suggest that frequent education on CAUTI prevention elements and placing emphasis on transferring the education into practice should result in an observed decrease in CAUTI incidence. Since there is scant literature on the relationship between the frequency of educating clinicians on proper catheterization and CAUTI incidence, it seems relevant that research continues to explore this topic in other settings.

Is there a relationship between physician's awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

There were limited studies found in the field that assessed clinicians' awareness of CAUTI risk factor in relation to its incidence, during the review of literature. However, Chapter 2 reported of certain observed risk factors according to Talaat et al. (2010) and several other researchers (Hanchett, 2012; Hooton et al., 2010; Boybeyi, Karnak, Ciftci, Tanyel & Senocak, 2013; Van der Kooi et al., 2007), that are found to be attributed to CAUTI incidence. The observed attributed risk factors are extended period of catheterization, unsuitable condition during catheterization, pre-op antibiotic use, female gender, prior catheterization in the same hospital admission, patients in cardiac unit, patients over 40 years of age and increased hospital and ICU stay. However, it was reported by Hanchett (2012), Hooton et al. (2010) and IHI (2013) that instrumentation of the urinary tract (using Foley catheters or indwelling urethral catheters) is the most associated risk factor for acquiring CAUTI during hospital stay accounting for 80% of cases. Majority of the participants in this study reported favorably to be aware of the risk of instrumentation with Foley catheter; however its use is inevitable. Even so, some studies have shown without a doubt that CAUTI rates can still be minimized if length of instrumentation is judged appropriately. In the review of literature, a prospective intervention study performed by Elpern and colleagues (2009) showed significant decrease in CAUTI rates from 4.7/month to zero in a medical ICU

when suggestions to reduce indwelling catheter days was implemented by unit clinicians.

In Chapter 1, the principle of physicians' awareness of CAUTI's attributable risk factors in relation to CAUTI incidence was presented as part of the theoretical foundation for this research. The following example is intended to strengthen this principle and help answer the question: Is there a relationship between physician's awareness of CAUTI risk factors as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia? Theoretically, if physicians are aware of all the attributable risk factor related to CAUTI, they can translate that knowledge into practice by implementing an intervention program similar to what Elpern and colleague (2009) did which resulted very favorably. Basically, Elpern and colleague implemented suggestions of ongoing urinary catheterization with indwelling catheters developed by unit clinicians during a 6 months intervention period. They then contrasted the amount of days indwelling catheters where used and the rates of CAUTI throughout the intervention period with the prior 11 months records. There was a reduction in duration of use of indwelling catheters from 311.7 d/month to a mean value of 238.6 d/month. The incidence of CAUTI significantly decreased from 4.7/month prior to the study to zero during the study period. Since instrumentation of the urinary tract accounts for 80% of CAUTI rates according to Hanchett (2012) and other researchers and majority of clinicians acknowledged that instrumentation is the most important risk factor, then it's reasonable to suggest that if that knowledge is not translated into practice as did Elpern and colleagues (2009), then hospitals will continue

to observe increase rates of CAUTI. Catheter placement is usually administered by nurses however, in theory, if physicians are aware of the risk related to prolonged indwelling catheters, they can protect their patients by making sure that nurses do not live catheters in-situ for prolonged period of time. The principle of physicians' awareness of CAUTI attributable risk factors in relation to CAUTI incidence suggests that a relationship between reported CAUTI rates and physicians awareness of CAUTI risk factors is possible.

Consistent with the limited literature presented in Chapter 2 and the attributable risk theory presented in chapter 1 as part of the main theory of relationalism, this study found sufficient evidence to reject the null hypothesis that there is no relationship between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians instrument) and CAUTI incidence in the State of Georgia. The frequency and percentage analysis in this study found that majority of the participants (81%) indicated extended period of catheterization as a risk factor for CAUTI incidence. A high percentage (61.3%) of the participants also indicated unsuitable conditions during catheterization to be a risk factor. The analysis shows that the participants' knowledge of the other risk factors varied greatly (see Table 10). Even though majority of the participants are aware of the most important risk factor, record of the recently reported incidence shows that this knowledge is not being translated into practice. As stated earlier, the reported incidence of CAUTI in 2013 exceeded that which was reported in 2012 by 350 cases in the state of Georgia. The 2013 SIR for CAUTI in the state of Georgia exceeded that of 2012 by 32%, showing a lack of

progress with regards to prevention efforts (see Table 4 and Table 5). This shows that a relationship definitely exist between physicians' awareness of CAUTI risk factors (as determined by the 26-item survey of physicians) and CAUTI incidence. The Pearson's chi-square analysis shows a chi-square value of 367.891 which is far greater than the critical value of 14.067 with 7 degree of freedom and at a 0.05 level of significance thus showing the significance of the correlation between physicians' awareness of CAUTI risk factors and the incidence of CAUTI. The findings in this study confirm what Drekonja et al. (2010) concluded that physicians may be aware of CAUTI risk factors but that knowledge is still not being translated into practice. Since the data in this study is limited to the State of Georgia, its result cannot be generalized to the whole United State. Further research of this nature is warranted in other States in order to assess their prevention progress. Also further onsite intervention programs that focus on judging the length of instrumentation and its effect on CAUTI rates is needed so that clinicians can really see its benefit.

Is there a relationship between physicians' perceptions and practices on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

The prevention bundle elements reviewed in this study are early catheter removal, constant disinfection of fomites, use of electronic monitoring system to monitor hand hygiene, effective use of TMP-SMX as prophylaxis, effective use of amikacin sulfate bladder wash as prophylaxis and having an automated reminder to discontinue or renew the order of catheter. In Chapter 2, a study conducted by Titsworth

et al. (2012) was reviewed in order to highlight the benefits of implementing certain bundle elements. A more detailed review of the same study also offers some evidence of a relationship between effectively implementing prevention bundle elements and the incidence of CAUTI. This was a 30 month prospective study that Titsworth et al. (2012) conducted in a single neurological ICU in an effort to examine the execution of a UTI prevention bundle which integrated averting of catheter insertion, continuance of sterility, product standardization and early removal of catheter). The result demonstrated a considerable reduction in urinary catheter utilization rate (from 100% to 73.3%) and decreased CAUTI rates (from 13.3 to 4.0 infections per 100 catheter days) as well as a linear association amid CAUTI and catheter utilization rate. The reduction in incidence rate seen in Titsworth and colleagues study is significant; however, according to other studies reviewed in Chapter 2, an even greater significance could be possible if more elements such as those analyzed in this study, were added in their bundle of elements.

The benefit of one of the prevention elements that were reviewed in Chapter 2 is early catheter removal. Meddings et al. (2010) systemic review of 14 interventional studies reported a 52% decrease in CAUTI rates when a reminder system to remind clinicians that a urinary catheter was in use or a stop order to prompt catheter removal in hospitalized patients was implemented. Other studies reviewed in Chapter 2 showed significant results when catheter use was judged appropriately (Elpern et al., 2009). The above mentioned studies suggest that a relationship between early catheter removal and CAUTI incidence is possible.

Theoretically, if physicians perceive that reminders and stop orders are beneficial with regards to preventing CAUTI and they practically implement it in their practice, this will result in avoiding inappropriate or extended periods of catheterization and reduce the incidence of CAUTI. Majority of the participants in this current study (91.1%) did acknowledge that removing catheters as early as possible is indicated as a preventive measure for CAUTI incidence. Thus meaning per this study, that majority of physicians in the state of Georgia do give orders for catheters to be removed as early as possible. However, according to the results in Meddings et al. (2010) systemic review, only a percentage in the reduction of CAUTI incidence should be expected with the implementation of early catheter removal alone. Thus meaning that, if hospitals are to experience a significant improvement with regards to CAUTI, more prevention elements will have to be implemented in addition to early catheter removal.

The second prevention element that was reviewed in Chapter 2 is the constant disinfection of fomites such as stethoscopes, pens, mobile phones, keyboards, and white-coats etc. which are confirmed to be hosts of clinically infectious pathogens in the hospital according to the results of 9 reviewed studies. One of the researchers reviewed in Chapter 2, Whittington et al (2009) conducted their study in a medical ICU to assess colonization rate of stethoscopes as well as assess the frequency of disinfecting these stethoscopes by healthcare professionals. The researchers concluded that not only were the stethoscopes host of clinically pathogenic bacteria such as *Staphylococcus aureus,* but also that all the 32 nurses who were questioned disinfected their stethoscopes daily while only 3 of the 22 physicians who did the questionnaire agreed to cleaning their

stethoscopes often. Also, data from Singh et al. (2010) showed that majority of physicians who use their mobile phones during point of care do not clean their phones. The same study also showed a considerable decrease in colonization after 79 percent isopropyl alcohol was used to decontaminate the phones. An even better decontamination result was seen in Obasi et al., (2009) study which resulted in a 0% of colonization when self-cleaning units for the decontamination of small instruments (SUDS) was used to disinfect 91 non-shared medical and electronic equipment (keyboards, phones, intravenous poles, sphygnometers, blood pressure cables, EKG leads and cables, pulse oximeter and many others) in patient care instead of manually decontaminating the equipments. Obasi and colleagues (2009) also noted that the colonization rate remained 0% 48 hours post SUDS treatment and re-introducing the equipment into the clinical setting. Literature related to fomites suggests that a relation between constant disinfection of fomites and CAUTI incidence is possible.

In theory, if physicians recognize that their fomites (potable mobile devices, stethoscopes, pens etc) are potential carriers for pathogens and they are proactive in disinfecting them with disinfectants such as the SUDS used by Obasi and colleagues (2009) prior to seeing their patients, this will result in decreasing the transmission of infectious pathogens causing HAIs including CAUTI. In this current study, only 25% of the participants considered the constant disinfection of fomites to having a large effect in preventing CAUTI incidence while 27.7% deemed this method to have only a slight effect. It can thus be said that majority of physicians in the state of Georgia do not disinfect their fomites during point of care which also confirms Whittington et al.'s

(2009) study. If hospitals in the state of Georgia expect to see a decrease in the transmission of infectious pathogens leading to a decrease in CAUTI incidence, all physicians and nurses must implement the disinfection of their fomites during point of care. However, more prevention methods are needed since fomites are not the only host for pathogens as per the review of literature.

The third prevention element that was reviewed in Chapter 2 is hand hygiene compliance. The benefit of effective hand hygiene in relation to preventing HAIs has been established in the field. The issue that was reviewed and presented in Chapter 2 is the lack of compliance by all healthcare professionals and the positive outcome if compliance is monitored. One of the study reviewed is by Katherason and colleagues (2010) which showed that not only was compliance only 70%, the healthcare professionals did not adhere to hand hygiene steps entirely (duration of hand washing, rubbing palm over the dorsum, rubbing fingers intertwined and rubbing of thumbs revolvingly). Other reviewed studies suggested reasons for non-compliance to be lack of time and hand hygiene is viewed as a sporadic, transitory and contextualized practice with limitations and strains and so healthcare workers have to determine the magnitude assigned to hand hygiene based on patient type, procedure and setting. Data from Mathai and colleague (2011) showed an improvement in compliance from 26% to 57.36% after a multimodal intervention which included education, verbal reminders, posters and easy accessibility of materials was implemented to improve compliance of hand hygiene. Cheng et al. (2011) study presented in Chapter 2 showed an even better improvement in compliance by the participants. In that study, health care workers wore

an electronic hand hygiene compliance screening system called MedSence in a form of a name badge to spot hand hygiene opportunities and compliance before and after seeing a patient. The study showed an increase in compliance from 35.1% to 88.9% and 95.5% when hand hygiene was screened in tandem by the system and infection control nurse respectively. Another study by Chen et al. (2011) resulted in not only an increase in compliance from 43.3% to 95.6% when alcohol-based hand rub was used but they also saw an 8.9% decrease in HAIs as well as a drastic decrease in the incidence of ICU infections. Literature related to improving hand hygiene compliance suggests that a relationship between monitoring hand hygiene with an electronic monitoring system and HAI incidence which includes CAUTI is possible.

Theoretically, hospitals will experience an improvement in hand hygiene compliance and a decrease in incidence of ICU infections if they implement the same hand hygiene electronic monitoring system used in Cheng et al.'s (2011) study along with the alcohol based hand-rub used in Chen et al.'s (2011) study. The results of this current study show that only 12.2% of the participants acknowledge the use of an electronic monitoring system to monitor hand hygiene to be indicated in preventing CAUTI. From this result, it could be assumed that those participants who didn't find the use of a hand-hygiene monitoring system to be effective in preventing CAUTI are among the once that are usually non-compliant with regards to effective hand hygiene, thus supporting the results of Katherason et al., (2010) study. The importance of hand-hygiene in the hospital setting is well known and an improvement in compliance from

all clinicians is warranted if the hospitals expect to see an improvement with regards to prevention efforts.

The fourth prevention element that was reviewed in Chapter 2 is the effective use of Trimethoprim-sulfamethoxazole (TMP-SMX) as prophylaxis for CAUTI. Clinical trials have confirmed the efficacy of TMP-SMX in treating urinary tract infections. A study reviewed in Chapter 2 also found it effective in preventing CAUTI if administered in 3 doses prior to ejecting a urinary catheter from a catheterized patient. This study by Pfefferkorn et al., (2009) showed a considerable decrease in the incidence of symptomatic UTI in patients who were administered TMP–SMX before catheter removal (4.9%) as compared to the control (21.6%). Even though a very small percentage of patients who received TMP-SMX as prophylaxis still experienced symptomatic UTI, the experienced decrease in incidence is still significant; thus, Pfefferkorn et al.'s (2009) study definitely suggests that TMP-SMX is effective in decreasing CAUTI incidence if used effectively by clinicians and other healthcare workers.

In theory, if physicians that care for catheterized patients find TMP-SMX to be indicated as prophylaxis for CAUTI and they order its effective administration on their patients prior to catheter removal just like Pfefferkorn et al. (2009) did in their study, an improvement in reducing CAUTI incidence should be expected. In this current study, only 1.8% of the participants acknowledged that TMP-SMX has a large effect in preventing CAUTI incidence. Thus meaning per this study, that majority of physicians

in the state of Georgia are not implementing this element of CAUTI prevention in their practice.

The fifth prevention element that was reviewed in Chapter 2 is the effective use of amikacin sulfate bladder wash as prophylaxis for CAUTI. Clinical trials have also found amikacin sulfate to be very effective in treating several infections including serious complicated and recurrent urinary tract infections. It was also seen to be significantly effective in preventing CAUTI in a study reviewed in Chapter 2. The study by Zacharias et al. (2009) showed amikacin sulfate bladder wash to be effective in preventing CAUTI incidence when used twice daily under strict aseptic precautions on catheterized patients. None of the patients in the bladder wash group developed CAUTI while 40% in the control group were diagnosed with CAUTI. The Zacharias et al.'s (2009) study suggested with certainty that a relationship between effective use of amikacin sulfate bladder wash and CAUTI incidence is promising.

Theoretically, if physicians order a twice daily amikacin sulfate bladder wash on their catheterized patients, they will not developed CAUTI. The result in this current study shows that only 4.8% of the participants recognized this prevention element to having a large effect in preventing CAUTI. Thus meaning per this study, that majority of physicians in the state of Georgia are not implementing this element of CAUTI prevention in their practice.

The sixth and final prevention element that was reviewed in Chapter 2 is having an automated reminder to discontinue or renew the order for catheter. Past interventional studies related to CAUTI prevention has shown significant benefits when

a reminder system was used to remind clinicians that a catheter was in use (Meddings et al. 2010). So theoretically if an automated system is put in place that reminds physicians of how long their patients have been catheterized, these physicians can order the catheters to be stopped or renewed resulting in a decrease in the length of catheterization and ultimately decrease in CAUTI incidence rates. More than half of the participants (61.6%) in this current study acknowledged this prevention element to having a large effect in preventing CAUTI. Though this is to be commended, it would be best if all physicians that care for catheterized patients acknowledged the benefit of the automated reminder system and actually implement it in their practice.

The theory of relationalism presented in Chapter 1 suggests that there is an interrelation between things and events, i.e. there is a relationship between CAUTI prevention elements and its frequency. This theory and applicable literature related to the individual prevention elements has been addressed previous in an attempt to answer the third research question and will not be re-iterated at this point. Theoretically, implementing these prevention elements as a bundle will result in a much significant decrease and possible eradication of CAUTI incidence compared to if they are implemented in part. Thus, the answer to the question of whether or not there is a relationship between physicians' perception and practice on CAUTI prevention bundle elements in part or in full as determined by the 26-item survey of physicians and the incidence of CAUTI in the state of Georgia is yes.

The results of this study provided sufficient evidence to reject the null hypothesis that there is no relationship between physicians' perceptions and practice on

CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia. The frequency and percentage analysis of the individual prevention variable of this study (see Table 12) have been previously addressed and so will not be re-iterated here. However, it is important to note that the participants' perception and practice of the tested prevention elements varied significantly. Although a majority of the participants considered early catheter removal and a reminder to discontinue or renew the order of catheter to be indicated, only a few found the other very important prevention elements (constant disinfection of fomites, use of an electronic monitoring system to monitor hand hygiene, effective use of TMP-SMX and Amikacin sulfate bladder wash as prophylaxis) to be indicated in preventing the incidence of CAUTI. It is not surprising then why progress in the prevention efforts is not being reflected in the recently reported CAUTI incidence (see Table 4 and Table 5). This shows that a relationship exist between physicians' perceptions and practice on CAUTI prevention bundle elements both in part or in full (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia. The Pearson's chi-square analysis (see Table 13) shows a chi-square value of 359.265 which is far greater than the critical value of 14.067 with 7 degree of freedom and at a 0.05 level of significance thus showing the significance of the correlation. The findings in this study not only confirms what Drekonja et al. (2010) concluded that physicians are not translating their knowledge of CAUTI prevention knowledge into practice, it also extends knowledge in the discipline that some physicians are not aware of some of the very important prevention elements. Since the

data in this study is limited to the State of Georgia, its result cannot be generalized to the whole United State. Further research of this nature is warranted in other States in order to assess their prevention progress. In addition, further onsite intervention programs that focus on implementing all the bundle elements tested in this study and their effect on CAUTI rates is required in order to add more weight to its benefit thus extending the knowledge in the discipline.

Is there a relationship between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia?

Literature reviewed in Chapter 2 highlights a guideline from CDC and IDSA to avoid habitual use of antimicrobials or antibiotic impregnated catheters (Gould et al., 2010; Hooton et al., 2010; Pickard et al., 2012). Pickard et al study confirmed the importance of this guideline which showed silver alloy and nitrofurazone coated catheter to be effective but when re-evaluated, both agents were not found to be significantly effective in decreasing the incidence of symptomatic CAUTI (Pickard et al., 2012).

So theoretically, if physicians are compliant with the above mentioned compliance, it should contribute in the decrease in the incidence of CAUTI. This thus suggest that a relationship between physicians compliance with the CDC an IDSA antimicrobial guidelines and CAUTI incidence is possible.

The results of this study provided sufficient evidence to reject the null hypothesis that there is no relationship between physicians' compliance with the

guidelines from CDC and IDSA to avoid habitual use of antimicrobials (as determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia. The frequency and percentage analysis (see Table 14) shows that only 19.9% of the participants stated that the constant use of antimicrobial coated catheters had no effect in preventing CAUTI; thus reflecting a lack of compliance by the majority. The reported increase in the incidence of CAUTI in the state of Georgia (see Table 4 and Table 5) is not surprising. This shows that a relationship does exist between physicians' compliance with CDC and IDSA antimicrobial guideline as determined by the 26-item survey of physicians and the incidence of CAUTI in the State of Georgia. The Pearson's chi-square analysis (see Table 15) shows a chi-square value of 69.714 which is far greater than the critical value of 9.488 with 4 degree of freedom and at a 0.05 level of significance thus showing the significance of the correlation. The findings in this study extends knowledge in the discipline that while some physicians that care for catheterized patients are not in tuned with the effect that habitually using antimicrobials has on CAUTI incidence, other are not even aware of the guidelines to avoid this practice. The results of this study cannot be generalized to the whole United States since the data is limited to the state of Georgia, so further research of this nature is needed in other states in order to assess their physicians' level of compliance.

Is there a relationship between physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI?

In Chapter 2, an article by Palmer et al. (2013) was reviewed which highlights CMS decision to refuse compensating hospitals for the treatment of CAUTI and other HAI because they are deemed preventable. Theoretically, if physicians are aware of this decision and do understand the financial burden that this poses on the healthcare system; it should encourage them and other healthcare professionals to make the extra effort at improving patient safety thus reducing the incidence of CAUTI as well as other HAI that are deemed preventable.

The results of this study presented satisfactory evidence to reject the null hypothesis that there is no relationship between physicians awareness of the CMS no reimbursement policy on all HAI (determined by the 26-item survey of physicians) and the CAUTI incidence in the State of Georgia. The frequency and percentage analysis (see Table 16 and Table 17) shows that although majority of the participants (91.1%) are aware of the CMS no-reimbursement policy, a significant percentage (55.1%) are not prompted to reduce their order of catheter. Further, though a good percentage of the participants (68.4%) are prompted to remove catheter sooner because of the legislation, other (29.5%) are not. It is again not surprising why the incidence of CAUTI in the state of Georgia continues to increase each year (see Table 4 and Table 5). Since there is an awareness of the CMS policy but only some physicians have been prompted to make some changes in their practice, it can thus be said that a relationship exist between

physicians' awareness of the CMS reimbursement policy on HAI as determined by the 26-item survey of physicians and the current incidence of CAUTI. The Pearson's chi-square analysis (see Table 18) shows a chi-square value of 255.063which is far greater than the critical value of 7.815 with 3 degree of freedom and at a 0.05 level of significance thus showing the significance of the relationship. The findings in this study confirms what Drekonja et al. (2010) concluded that although physicians are aware of the altered re-imbursement policy, that knowledge is not being used in good practice to prevent CAUTI. Further research is needed in other states in order to ascertain their physicians' awareness of the CMS policy and what effect it has on their incidence of CAUTI.

Are physicians' perception and practice regarding the prevention of CAUTI in the ICU associated with CAUTI incidence rates in the State of Georgia?

In general, the findings of this study were somewhat expected based on the epidemiological philosophy and sufficient studies showing relative performance of different CAUTI prevention methods. Though not astonishing, the results are finally pragmatic in practice and no longer speculative. This study offered evidence that the lack of translating CAUTI prevention knowledge into practice by all healthcare professionals that care for catheterized patients may cause an increase in the observed incidence of CAUTI. In theory, if clinicians and other healthcare professionals in the state of Georgia continue with their current method of practice, an improvement in the CAUTI prevention efforts will not be observed. However, if they are constantly trained on CAUTI risk factors and prevention methods that have been proven effective in peer-

reviewed literature and they are encouraged to translate that knowledge into clinical practice with the use of a hospital initiated intervention program, hospitals should see some improvement in their efforts in decreasing and possibly eradiating the incidence of CAUTI. Although the findings of this study are actionable, it is vital to acknowledge that the findings are not to be generalized to all physicians in the whole United States. This study found that physicians' perception and practice regarding the prevention of CAUTI in the ICU is associated with CAUTI incidence rates in the State of Georgia.

Test-Retest Reliability

The 26-Item Survey of Physicians instrument is a new instrument that was created by the researcher and has been used only in this study. This instrument is an update of the 23-Item Survey of Physicians instrument that was created by Drekonja and colleagues in and used in two studies. Upon receiving permission from Dr. Drekonja, the researcher made some changes to the 23-Item Survey of Physician instrument by deleting some items that were not pertinent to this study and adding items that are related to this study. In order to assess the reliability and validity of the 26-Item Survey of Physician instrument, a pilot test was conducted using a randomly selected sample of 100 potential participants from a list of 4000 physicians in the State of Georgia. 64% of the randomly selected participants agreed who received an email invitation to take part in the pilot study, agreed by signing a consent form electronically and took the survey. A one-week span of time separated the first administration of the 26-Item Survey of Physicians instrument and the second. In order to assess the

internal consistency of the measures, Cronbach's alpha (α) was conducted on survey items. Results of the pilot test indicated excellent reliability (α = .905). This implies that the 26-Item Survey of Physicians instrument yields consistent scores over separate administration in this timeframe. While reliability does not assure validity, in order for an instrument to be valid, it ought to be reliable. Because of the short time period between administrations of the 26-Item Survey of Physicians instrument in this study, future test of reliability with longer time period between test-retest administrations is warranted.

Limitation and Recommendations for Further Study

This was a cross-sectional study that's correlational in nature and the study's results are bound to claims of association within a cohort of physicians in the state of Georgia whose primary place of employment are hospitals that are part of CDC'S NHSN, a healthcare-associated infection tracking system. Therefore neither claims of cause and effect nor generalizability to a larger population such as the entire United States can be made from this study because of these limitations and delimitations, both of which were presented in chapter one. Another limitation of this study that was presented in chapter one is the participants' response rate. Even though the rate of respondents for this study is expected for electronic surveys, the characteristics of responders may differ from non-responders. Regardless of these limitations, the research should be deemed original and reminiscent of the need for more related studies. Given the limitations and results of this research, future studies should take a couple of routes. One of the routes should address the delimitation stated in chapter one

by conducting similar study in other states in order to assess the progression of their prevention efforts along with the expected limitation of low participation associated with survey response. The other route should address the limitation related to the nature of the study by conducting a well-controlled, experimental study within a single site.

Conducting a series of well-designed experimental studies within a single site is necessary in order to strengthen the evidence that variables of CAUTI prevention bundle elements are related to the increase or decrease in the incidence of CAUTI. This type of experimental design will address the limitation observed in this study. The series of experiments would need to occur in hospitals that are part of CDC's National Healthcare Safety Network in order to ensure proper tracking of CAUTI and infection control adherence rate. Also, to avoid the limitation of inter-rater reliability, the ideal site would need to have an internally consistent case definition for CAUTI. The following trials would have to be performed at sites with these characteristics in the absence of an epidemic of CAUTI:

1. Compare the effects of a bi-weekly, monthly, quarterly and yearly training of clinicians on CAUTI risk factors and proper catheterization between 4 different sites in relation to CAUTI incidence.
2. Compare two onsite intervention programs: site A implements a CAUTI prevention bundle elements in part by unit clinicians compared to site B that implements a CAUTI prevention bundle elements in full by unit clinicians in relation to CAUTI incidence.

3. Compare two intervention groups of patients: group A constantly receives antimicrobial coated catheters while group B does not in relation to CAUTI incidence.

The above trials would be reasonable next steps towards ascertaining causality. Regrettably, the recommended trials are difficult to generalize to all hospital so trials at hospital levels must still be carried on. Doing so will result in identifying problem areas, measure the progress of prevention efforts and hopefully eradicate CAUTI.

Recommendations for Action

The findings of this study are significant for at least five stakeholders: healthcare professionals that care for catheterized patients (especially physicians), infection control directors, lawmakers, the CDC and other public health organization, and CAUTI researchers. Healthcare professionals that treat catheterized patients especially physicians are the first group of stakeholders for whom the result of this study present reason for some action. Physicians were the target of the survey used to collect data for the prevention variables of this study. It was interesting to find in this study that some physicians appear to be unknowledgeable regarding certain very important CAUTI prevention elements. Based on that finding and the finding that CAUTI prevention elements may be associated with CAUTI rates, it is recommended that all physicians that care for catheterized patients be well-informed of all the possible prevention elements that have been proven effective in preventing the incidence of CAUTI. Based on the results of this study, it is suggested that physicians translate their CAUTI prevention knowledge into practice thus ensuring the safety of their patients.

Principally, physicians are recommended to abstain from ordering catheter placement unless really necessary. To avoid extended periods of catheterization, it is recommended that they order early catheter removal or renewal thus preventing the colonization of pathogenic bacteria known to cause CAUTI. Physicians are urged to also order for the effective administration of TMP-SMX and Amikacin sulfate bladder wash as prophylaxis which should result in eliminating CAUTI incidence according to research. Physicians are also proposed to avoid the habitual use of antimicrobial coated catheters such as silver alloy or nitrofurazone coated catheters especially on patients that require extended periods of catheterization since both agents were not found to be significantly effective in decreasing the incidence of symptomatic CAUTI. Additionally, physicians are advised to adjust their attitude on hand hygiene and disinfection of their fomites by making sure they effectively sanitize their hands and tools especially during point of care thus preventing transmission of pathogenic bacteria. Understanding the brunt that CAUTI incidence has on their patients and the financial impact it has on the healthcare system as a whole should motivate physicians to do their best in implementing their CAUTI prevention knowledge in their practice.

The second group of stakeholders for whom the result of this study presents reason for some action is the infection control directors. Keeping in mind CMS's reason for not reimbursing claims related to all HAI's including CAUTI should motivate infection control directors to ensure that an effective prevention control system is in place and everyone is playing their part effectively in preventing CAUTI incidence as well as other HAIs. Infection control directors are recommended to continue monitoring

the CAUTI incidence rate at their facility and hold monthly interactive meetings or training programs in which CAUTI prevention progress are discussed. If the facility is not experiencing any progress in decreasing CAUTI rates, then it is advised that a comprehensive quality improvement program be initiated which includes first of all educating providers and other healthcare professional that care for catheterized patients of the prevention elements that have been proven to be significantly effective in decreasing CAUTI (for example: instruct them on the suitable indications for catheter use, advice on the benefits of early catheter removal, advice on the effective use of certain antimicrobials as prophylaxis for CAUTI such as TMP-SMX and Amikacin sulfate bladder wash, effective and continuous sanitation of hand and fomites). Secondly, the researcher proposes that the current system that has not proven effective be re-evaluated and revamped if need be in order to attain the CAUTI prevention goal of the organizational. Infection control directors are also urged to establish an organizational culture in which all clinicians and nurses are encouraged to continuously sanitize their fomites and hand during point of care. In order to ensure continuous and effective hand hygiene, it is recommended that a hand hygiene monitoring system in the form of a name badge such as MedSense be implemented thus addressing the issue of compliance. It is also recommended to ensure that a dedicated Foley catheter nurse is placed in each unit with the responsibility of ensuring the avoidance of inappropriate Foley catheter use and ensure proper Foley catheter documentation. Further, infection control directors are urged to encourage their organization to provide monthly incentives to physicians who have not experienced a CAUTI incidence in any of their

patients thus encouraging their effective translation of prevention knowledge into practice. Additionally, as per the results of Conway et al. (2012) study, all infection control directors are advised to network with important decision or lawmakers so as to have a high chance of adopting policies related to CAUTI and other HAI prevention.

Lawmakers, the CDC and its NHSN along with other public health organizations and CAUTI researchers represent the third, fourth and fifth group of stakeholders that are urged to act upon this research. Lawmakers are recommended to continue to enforce and support policies that will improve patient safety. This research also offers valuable information on physicians practice on CAUTI prevention to agencies such as CDC and its NHSN and other health organizations such as the World Health Organization (WHO) and the National Institute of Health (NIH). These agencies are commended for continuing to support and provide funding for different epidemiological studies related to CAUTI prevention. Researchers are encouraged to continue to expand on the epidemiological understanding of CAUTI by carrying out the above mentioned recommendations for future studies.

Implication for Social Change

This study's results present a comprehensive understanding of the epidemiology of CAUTI. Improved understanding leads to novel avenue of inquiry and enhanced study designs. New study leads to new findings related to the prevention of CAUTI which will ultimately result in saving and improving the lives of thousands of patients yearly.

Specifically, this study may influence physicians to be more proactive with regards to preventing the incidence of CAUTI. Having an improved understanding of the effect that their current practice or lack of has on CAUTI incidence may likely result in an interest in examining their current method of CAUTI prevention and evaluate areas for improvement. There is a potential of reducing the incidence of CAUTI, maximize patient safety and minimize cause if all physicians and other healthcare professionals who care for catheterized patients understand the significance of effectively administering CAUTI prevention bundle elements. This is even so important since the CMS is currently holding hospitals liable for the observed rates of eight different hospital acquired infections.

At the level of the infection control directors, understanding that some physicians may not be knowledgeable of some important CAUTI prevention elements might likely result in an interest in examining how often CAUTI prevention meetings or trainings is implemented. Infection control directors may be interested in improving the hospitals CAUTI prevention program, especially if their reported rates of CAUTI continue to rise with resultant increased patients' length of stay and cost of treatment. This study results can influence hospital leaders to evaluate and improve their CAUTI prevention method. Consequently, many hospitals are likely to find a chance to improve patient safety, decrease morbidity and mortality and healthcare cost.

This study also has the potential to influence the improvement of CAUTI prevention policies and research. As mentioned earlier, lawmakers and other public health organizations such as CDC, IDSA etc could be influenced by the research to now

see the importance of enforcing the implementation of CAUTI prevention bundle elements in all healthcare organizations. By so doing, these important stakeholders could validate this study on a larger scale and influence new research and understanding related to the epidemiology of CAUTI. These stakeholders might also be influenced by this study to begin comparing CAUTI prevention methods within different hospitals in relation to their reported CAUTI incidence rates. This may generate interest in developing an improved policy for CAUTI prevention. Better policies for CAUTI prevention would result in fewer and possibly eradicating the incidence of CAUTI. It would also result in decrease morbidity, mortality and overall healthcare cost related to CAUTI. Further into the future and after the results of the inquiry have standardized physicians practice methods with regards to CAUTI prevention, risk factors for CAUTI are re-examined now with prevention variables controlled and new innovations are made taking the place of things we thought we knew and again the society is impacted as the epidemiology of CAUTI is better understood and new interventions are organized.

Conclusion

It is well understood in clinical practice that physicians are responsible for giving orders with regards to catheter placement and the administration of treatment in the hospital setting. This study found that physicians' perception and practice with regards to CAUTI prevention elements (i.e. understanding risk factors, early catheter removal, administering prophylaxis such as TMP-SMX and Amikacin sulfate bladder wash, disinfecting fomites and hand hygiene monitoring and avoiding habitual use of

antimicrobials) vary greatly thus explaining the continuous observed increase in CAUTI incidence in the state of Georgia. Latest analysis comparing CAUTI prevention elements and the basic epidemiological principles of disease prevention suggest that the most reasonable interpretation of this study is that lack of effectively implementing all prevention bundle elements in full may result in the continuous increase in CAUTI incidence rates.

Having an understanding of the reported incidence of nosocomial CAUTI in the state of Georgia in the context of prevention elements is a clear message for all physicians and other healthcare professionals. The results of this study suggest for the first time that current CAUTI prevention practice by physicians may be inefficient without the effective implementation of proven bundled element not in part but in full. Without these findings, it is probable that the healthcare system as a whole would continue to misconstrue the reasons for the lack of progress in preventing CAUTI. This new information also invites physicians and hospitals in general to assess and optimize their current prevention practice and strategies respectively in order to see a decrease in their observed CAUTI incidence rates resulting in decrease morbidity, mortality and cost associated with treating preventable nosocomial CAUTI infections.

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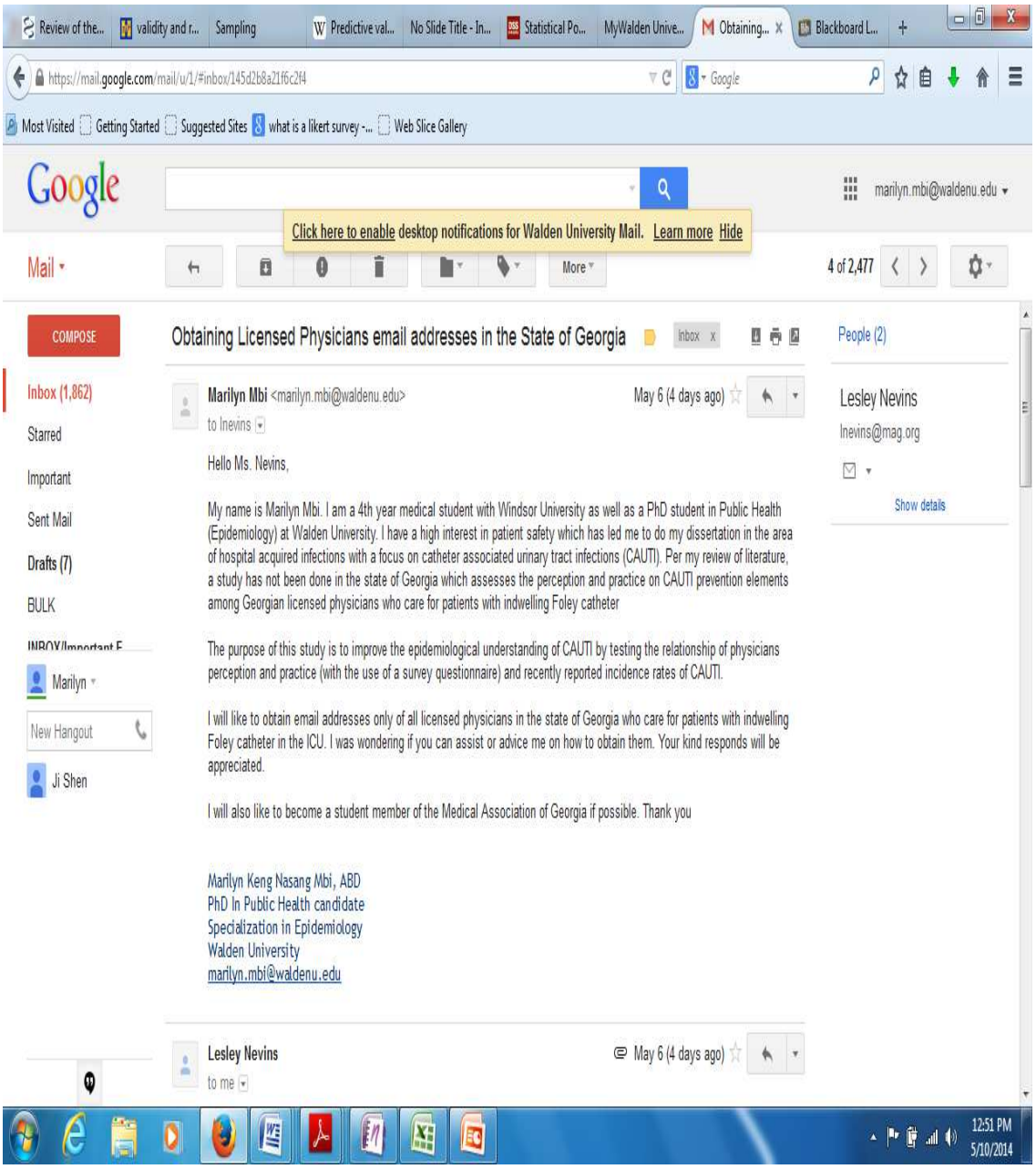
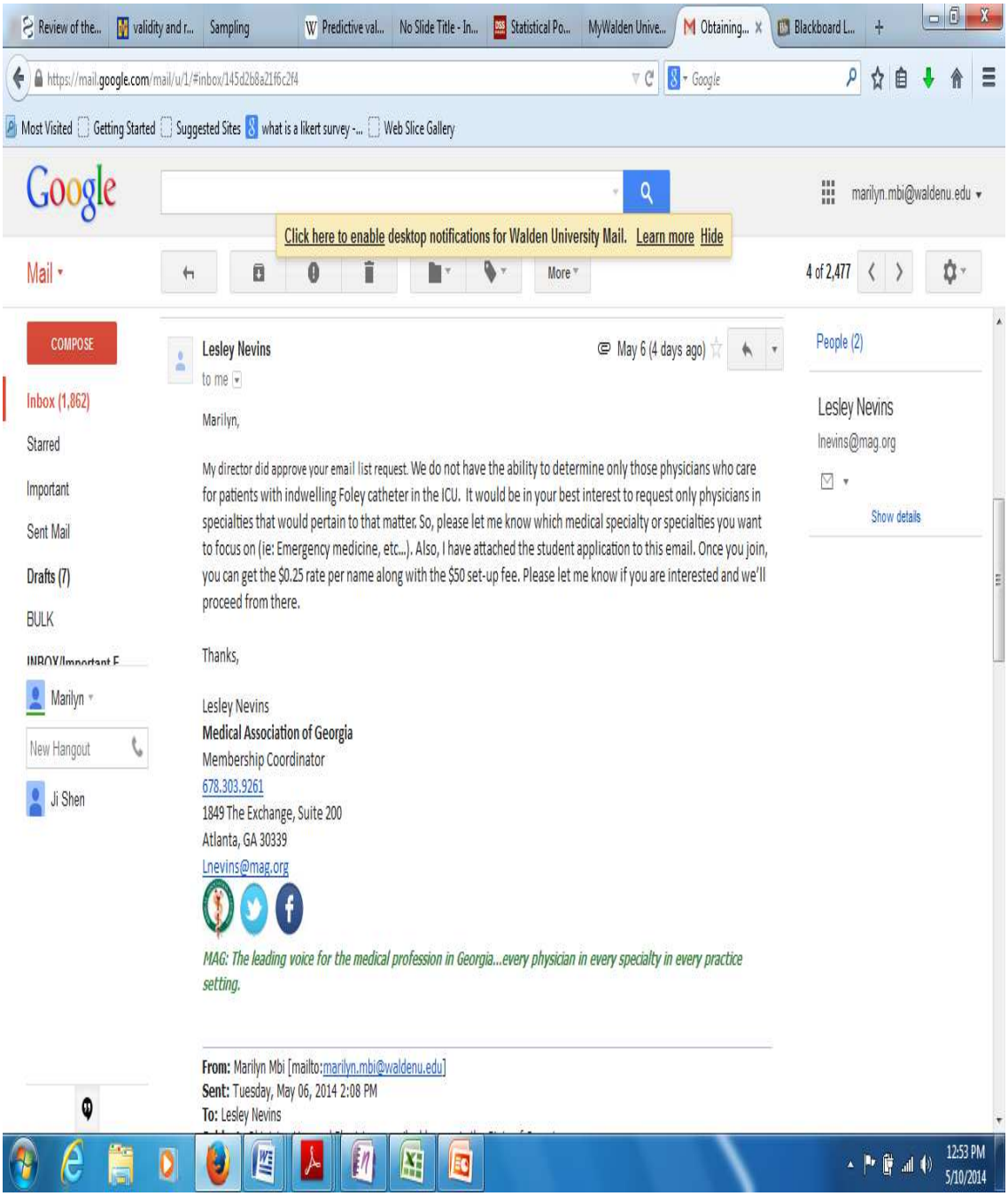
Appendix A: Email Correspondence from MAG

Email Correspondence between MAG membership coordinator and Marilyn Mbi approving to provide member list




Review of the...
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No Slide Title - In...
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MyWalden Unive...
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https://mail.google.com/mail/u/1/#inbox/145d2b8a21f6c2f4
Most Visited
Getting Started
Suggested Sites
what is a likert survey -...
Web Slice Gallery
Google
marilyn.mbi@waldenu.edu
Click here to enable desktop notifications for Walden University Mail. Learn more Hide
Mail
More
4 of 2,477
COMPOSE
Inbox (1,862)
Starred
Important
Sent Mail
Drafts (7)
BULK
Marilyn
New Hangout
Ji Shen
Lesley Nevins
to me
May 6 (4 days ago)
Marilyn,
My director did approve your email list request. We do not have the ability to determine only those physicians who care for patients with indwelling Foley catheter in the ICU. It would be in your best interest to request only physicians in specialties that would pertain to that matter. So, please let me know which medical specialty or specialties you want to focus on (ie: Emergency medicine, etc...). Also, I have attached the student application to this email. Once you join, you can get the $0.25 rate per name along with the $50 set-up fee. Please let me know if you are interested and we'll proceed from there.
Thanks,
Lesley Nevins
Medical Association of Georgia
Membership Coordinator
678.303.9261
1849 The Exchange, Suite 200
Atlanta, GA 30339
Lnevins@mag.org
MAG: The leading voice for the medical profession in Georgia...every physician in every specialty in every practice setting.
From: Marilyn Mbi [mailto:marilyn.mbi@waldenu.edu]
Sent: Tuesday, May 06, 2014 2:08 PM
To: Lesley Nevins
People (2)
Lesley Nevins
lnevins@mag.org
Show details
12:53 PM
5/10/2014

Appendix B: Email Correspondence from Dr. Drekonja

Email Correspondence between Dr. Drekonja and Marilyn K. Mbi Regarding the use of Survey/Questionnaire

Subject : **Request for the Instrument used is your research entitled "Foley catheter practices and knowledge among Minnesota physicians".**
Date : Thu, Sep 19, 2013 02:14 AM CDT
From : **"Marilyn Mbi" <marilyn.mbi@waldenu.edu>**
To : drek0002@umn.edu

Hello Dr. Drekonja,

My name is Marilyn K. Mbi and I am a PhD student in Public health (Epidemiology) at Walden University. I have a bachelors of Science degree in Information Technology. I am also in my 4th year of medical school currently doing my medical rotations with Windsor University School of Medicine. Even though my initial background is in IT, I have a passion for healthcare and the public health system. My interest in patient care and safety led me to further my dissertation in this area. I am currently doing my dissertation in the area of hospital acquired infections with Catheter Associated Urinary Tract Infections (CAUTI) as my focus. I have been searching for an instrument that would explore physicians practice regarding the prevention of CAUTI in the ICU and current incidence rate. I was elated when I read the study conducted by you along with Kuskowski and Johnson (2010) on Foley catheter practices and knowledge among Minnesota physician in PubMed. as well as in the American Journal of Infection Control. Per my review of literature, a study of this magnitude has not been done in the state of Georgia. Since the published article didn't have the actual survey/questionnaire, I was wondering if the instrument is available for use. With your permission, I can make some changes to your survey/questionnaire so that it reflects practice of prevention techniques and bundle elements with regards to CAUTI by physicians in hospital ICUs. I will also appreciate your advice on the best way to reach out to the Physicians. I really do appreciate your assistance in this matter as well as any directions or advice you might offer. Please feel free to contact me atMarilyn.mbi@waldenu.edu .

Sincerely,

Marilyn Keng Nasang Mbi
PhD In Public Health
Specialization in Epidemiology
marilyn.mbi@waldenu.edu

Subject : **Re: Request for the Instrument used is your research entitled "Foley catheter practices and knowledge among Minnesota physicians".**
Date : Thu, Sep 19, 2013 05:13 PM CDT

From : drek0002@umn.edu

To : Marilyn Mbi <marilyn.mbi@waldenu.edu>

Attachment : Survey_instument.physician.pdf

Hello Marilyn-- the survey instrument is attached, I hope you find it helpful. Feel free to use or modify it as you see fit. Kind regards, -dd

Appendix C: 23-Item Survey Instrument

Survey Instruments of Physicians Used Previously by Dr Drekonja and colleague

1. Foley catheter use in Minnesota (page 1/9)

Hello-

-Thank you for taking this survey for a research study about short-term indwelling urinary catheter (Foley catheter) use at your institution.

-There are 12 questions; completion should take 5-10 minutes.

-This survey is for any physician who cares for inpatients (hospital or long-term care facility) with a Foley catheter, even if this is rare in your day-to-day work.

-If you do not care for patients with Foley catheters, please indicate this by answering question 1 (immediately below) with "No," which will end the survey.

-The responses to this survey are anonymous, the authors cannot link responses to any individual email address.

-The study uses the commercial website surveymonkey.com, which can and will be configured so that no IP addresses or other identifying data are stored.

-There is no material benefit we can offer for participation in this survey.

-Your response will help define the current state of knowledge, attitudes, and practices regarding inpatient Foley catheter use among Minnesota physicians.

Do you care for inpatients (hospital or long-term care facility) with Foley catheters?

◯ Yes (Continue on to survey)

◯ No (This will end the survey)

2. Facility questions (page 2/8)

These questions pertain to the hospital or long-term care facility at which you spend the most time.

Is your primary facility a teaching facility? (defined here as being affiliated with a resident physician training program)

- ◯ Yes, teaching facility
- ◯ No, not a teaching facility
- ◯ Unsure

Does your primary facility have any formalized system for guidance on when to insert or remove a catheter, or a method for monitoring which patients have indwelling catheters? (Examples include: standardized order sets, requiring an indication to be listed with the order to place a catheter, automatic discontinuation of catheters after a certain time, etc)

- ◯ Yes
- ◯ No
- ◉ Unsure

Comments or questions? (Optional)

3. Responsibility questions (page 3/8)

These questions pertain to who should make decisions regarding a patient's Foley catheter.

Choose the option that best reflects your agreement with the following statements:

"A patient's physician should be responsible for deciding on the need for placing a Foley catheter"

◯ Agree strongly ◯ Somewhat agree ◯ Unsure/neutral ◯ Somewhat disagree ◯ Disagree strongly

"A patient's nurse should be responsible for deciding on the need for placing a Foley catheter"

◯ Agree strongly ◯ Somewhat agree ◯ Unsure/neutral ◯ Somewhat disagree ◯ Disagree strongly

How frequently is input from nursing staff included in the decision to place a catheter?

◯ Almost all the time

◯ Most of the time

◯ About 1/2 the time

◯ Infrequently

◯ Almost never

Comments or questions? (Optional)

4. Indications for Foley catheter use (page 4/8)

In answering the following question, assume that NO complicating factors are present. (For instance, regarding incontinence, assume there is no skin breakdown)

Choose the option that best reflects whether a Foley catheter is indicated for each scenario:

	Almost always indicated	Usually indicated	Indicated about 1/2 the time	Rarely indicated	Almost never indicated	Unknown/unsure
Critical illness and tenuous volume status?	○	○	○	○	○	○
Post-bladder urinary obstruction?	○	○	○	○	○	○
Urinary incontinence?	○	○	○	○	○	○
Unable to stand to void?	○	○	○	○	○	○
New or increased dose of furosemide (Lasix) or another diuretic?	○	○	○	○	○	○

Comments or questions? (Optional)

5. Methods to prevent catheter-related infections (page 5/8)

How large an effect do you think each of the listed interventions has in preventing catheter-associated urinary tract infections?

	Large effect	Moderate effect	Slight effect	No effect	Unknown
Removing catheters as early as possible	○	○	○	○	○
Using a condom catheter instead of a Foley catheter (if possible)	○	○	○	○	○
Using intermittent catheterization instead of a Foley catheter	○	○	○	○	○
Using catheters coated with antimicrobial substances	○	○	○	○	○
Using antimicrobial agents in the drainage bag	○	○	○	○	○
Having automated reminders to discontinue/renew the order for a catheter	○	○	○	○	○

Comments or questions? (Optional)

6. Demographic questions (page 6/8)

How many years ago did you graduate from medical school?

- [ ] 1-5 years
- [ ] 6-10 years
- [ ] 11-15 years
- [ ] 16-20 years
- [ ] more than 20 years

What is your medical specialty?

- ◯ Anesthesiology
- ◯ Family Practice
- ◯ Geriatrics
- ◯ Internal medicine
- ◯ Internal medicine sub-specialty
- ◯ Neurology
- ◯ Obstetrics/Gynecology
- ◯ Orthopedic surgery
- ◯ Pediatrics
- ◯ Physical Medicine and Rehabilitation
- ◯ Psychiatry
- ◯ Surgery
- ◯ Urology
- ◯ Surgery sub-specialty not otherwise listed

Other (please specify)

Comments or questions? (Optional)

7. Medical practice questions (page 7/8)

Did you know that catheter-associated UTI is 1 of 8 hospital-acquired conditions for which the Center for Medicare/Medicaid Services will no longer offer reimbursement?

◯ Yes

◯ No (skip to last page)

Has this legislation:

	Yes	No	Unsure
Prompted you to order fewer indwelling catheters?	◯	◯	◯
Affected how often you order a urinalysis or urine culture to be collected from a catheterized patient?	◯	◯	◯
Prompted you to remove catheters sooner than previously?	◯	◯	◯

Comments or questions? (Optional)

8. Thank you (page 8/8)

Thank you for taking the time to take this survey

If you have any comments, concerns, or other feedback regarding this survey (or catheter use in general), please enter them here.

Appendix D: Study Consent Form

Physicians Perception and Practice on Preventing CAUTI
Consent Form

Dear Doctor,

Thank you for your consideration to participate in a study that will further our epidemiological perception of catheter associated urinary tract infection (CAUTI) prevention practices. My name is Marilyn K. Mbi and I am a 4th year medical student with Windsor University. I am also PhD in public health candidate at Walden University and I am collecting data to complete my dissertation. With the support of the Medical Association of Georgia (MAG), this research intends to measure the variability in current physicians' perception and practice on preventing CAUTI and how that impacts the rates of CAUTI. You where selected for this study because you are a member of MAG whose mission is to "enhance patient care and the health of the public by advancing the art and science of medicine and by representing physicians and patients in the policy making process" (MAG, 2014). Please take a second to read the informed consent below. If you agree to participate, you will be asked to answer 11 short questions about indwelling Foley catheter at your establishment.

Informed Consent

You are invited to participate in a research study of physicians' perception and practice on preventing catheter associated urinary tract infection (CAUTI). You were chosen for this study because you are a physician in the state of Georgia and/or a member of the Medical Association of Georgia (MAG) whose mission is to "enhance patient care and the health of the public by advancing the art and science of medicine and by representing physicians and patients in the policy making process" (MAG, 2014). This form is part of a process called "informed consent" which allows you to understand the study before deciding to whether to participate in it.

This study is being conducted by a researcher named Marilyn K. Mbi who is a 4th year medical student and a PhD in public health (epidemiology) candidate at Walden University. As a PhD candidate, Ms Marilyn Mbi is completing her dissertation study on the impact of physicians' current perception and practice on nosocomial catheter associate urinary tract infections rates in the ICU. This study is very important because its results may present new and vital consideration for healthcare professionals, administrators, lawmakers and researchers. Though highly needed and appreciated, it is important that you understand that your participation is totally voluntary. Whereas there

is a lot to be shared and learned from this project, there is nothing else to be gained or lost as a member of the Medical Association of Georgia.

Background of Study
The purpose of this study is to improve the epidemiological understanding of CAUTI by assessing the relationship between physicians' current perception and practice on CAUTI prevention bundle elements both in part or in full and current CAUTI incidence rates.

Procedures for Participation
If you agree to be part of this study, you will be asked to complete this 26 item survey divided into 6 main questions related to your current perception and practice on CAUTI prevention. The survey is estimated to require between 5 to 10 minutes of your time.

Confidentiality
Your responses to the survey will be kept anonymous and the researcher will not use your responses or any other information for any purposes outside of this research project. Also, the researcher will not use your name or anything that could identify you in any report of the study. During the early stages of data collection, incidence of CAUTI in ICUs in the state of Georgia that are reported to CDC's National Health Safety Network (NHSN) will be collected and the result from the survey will be exported from surveymoney.com After key variable are grouped, all information that maybe link to you will be removed permanently from the limited data set, depicting the data de-identifiable at both hospital and physician level.

Voluntary Nature of Study
Your participating in this study is highly voluntary. The researcher will respect your decision of whether or not you want to be in the study. If you decide to be part of the study now, you can still change your mind during the study. If you feel anxious while taking the survey, you can stop at any time. You can omit any questions that you believe to be too personal.

Risk and Benefits of Being in the Study
There are no risks of participating in this study because the data being used will be permanently de-identified and presented in aggregate format. The benefit in your participating in this study is that you will be helping to improve the epidemiological understanding of CAUTI as well as improve the understanding of nosocomial CAUTI so that hospitals can benefit from future policy changes that will improve hospital operations and patient safety.

Compensation
There is no direct compensation being offered for participating in the study. Nevertheless, please be mindful of the fact that this study will shed some light on the

difference between physicians' perception and practice on preventing nosocomial CAUTI and also show any association between current practices and reported incidences of nocosomial CAUTI. This will help healthcare administrators and professionals to improve patient safety and decrease cost related to nosocomial CAUTI.

Contacts and Questions
The researcher conducting this study is Marilyn K. Mbi. She can be reached at 786-368-5168 or Marilyn.mbi@waldenu.edu. The researchers chair for this study is Dr. Ji Shen who can also be reached at ji.shen@waldenu.edu.

◯ Click here to print or save a copy of the informed consent

Statement of Consent
I have read the above information and I believe I understand the study well enough to make a decision about my involvement. By clicking here I am agreeing to the terms described above.

Print Name of Participant _____

Date of Consent _____

Participant's Written or Electronic Signature _____

Researcher's Written or Electronic Signature _____

Electronic signatures are regulated by the Uniform Electronic Transaction Act. Legally, an "electronic signature can be the person's typed name their email address or any other identifying marker. An electronic signature is just as valid as a written signature as long as both parties have agreed to conduct the transaction electronically.

Appendix E: Test/Retest Consent Form

Informed Consent for Test/Retest Reliability Study for the 26 Item Physicians Survey Instrument

Informed Consent

This study is being conducted by a researcher named Marilyn K. Mbi who is a 4th year medical student and a PhD in public health (epidemiology) candidate at Walden University. As a PhD candidate, Ms Marilyn Mbi is completing her dissertation study on the impact of physicians' current perception and practice on nosocomial catheter associate urinary tract infections rates in the ICU. This study is very important because its results may present new and vital consideration for healthcare professionals, administrators, lawmakers and researchers. Though highly needed and appreciated, it is important that you understand that your participation is totally voluntary. Whereas there is a lot to be shared and learned from this project, there is nothing else to be gained or lost as a member of the Medical Association of Georgia.

Background Information

The purpose of this study is to determine the test/retest reliability of the 26-item questionnaire of physician's perception and practice on CAUTI prevention survey after separate interval administrations

Procedure for Participation

If you agree to be part of this study, you will be asked to complete this 26 item survey divided into 6 main questions related to your current perception and practice on CAUTI prevention. You will be asked to please answer the question the same way that you did before. The survey is estimated to require between 5 to 10 minutes of your time.

Confidentiality

Your responses to the survey will be kept anonymous and the researcher will not use your responses or any other information for any purposes outside of this research project. Also, the researcher will not use your name or anything that could identify you in any report of the study. After key variable are grouped, all information that maybe link to you will be removed permanently from the limited data set, depicting the data de-identifiable at both hospital and physician level.

Voluntary Nature of the Study

Your participating in this study is highly voluntary. The researcher will respect your decision of whether or not you want to be in the study. If you decide to be part of the study now, you can still change your mind during the study. If you feel anxious while

taking the survey, you can stop at any time. You can omit any questions that you believe to be too personal.

Risk and Benefits of Being in the Study
There are no risks of participating in this study because the data being used will be permanently de-identified and presented in aggregate format. The benefit in your participating in this study is that you will be helping to improve the epidemiological understanding of CAUTI as well as improve the understanding of nosocomial CAUTI so that hospitals can benefit from future policy changes that will improve hospital operations and patient safety.

Compensation
There is no direct compensation being offered for participating in the study. Nevertheless, please be mindful of the fact that this study will shed some light on the difference between physicians' perception and practice on preventing nosocomial CAUTI and also show any association between current practices and reported incidences of nocosomial CAUTI. This will help healthcare administrators and professionals to improve patient safety and decrease cost related to nosocomial CAUTI.

Contacts and Questions
The researcher conducting this study is Marilyn K. Mbi. She can be reached at 786-368-5168 or Marilyn.mbi@waldenu.edu. The researchers chair for this study is Dr. Ji Shen who can also be reached at ji.shen@waldenu.edu.

◯ Click here to print or save a copy of the informed consent

Statement of Consent
I have read the above information and I believe I understand the study well enough to make a decision about my involvement. By clicking here I am agreeing to the terms described above.

Print Name of Participant _____

Date of Consent _____

Participant's Written or Electronic Signature _____

Researcher's Written or Electronic Signature _____

Appendix F: 26-Item Survey of Physicians Instrument

Physician's Perception and Practice of CAUTI prevention in Georgia Questionnaire

Hello Doctor,

Thank you very much for taking this survey for a dissertation research about indwelling catheter (Foley catheter) at your establishment.

There are 11 questions; completion should take 5-10 minutes

This survey is for physicians who care of inpatients in the ICU/critical care units with Foley catheter, even if this is rare in your day –to-day work.

If you don't care for patients with Foley catheter in the ICU/critical care units, please indicate this by answering question 1 (immediately below) with "NO" which will end the survey.

The responses to this survey are anonymous; the author/researcher cannot link responses to individual email address.

The study uses the commercial website survey monkey.com, which can and will configure so that no IP addresses or other identifying data are stored.

There is no material benefit that can be offered for participating in this survey

Your response will help define the current state of knowledge and practice regarding inpatient Foley catheter use in the ICU among Georgia hospitals as well as increase the epidemiological knowledge of CAUTI.

1) Do you care of inpatients in the ICU with indwelling Foley catheters?

1 Yes (Please continue with the survey)
2 No (This will end the survey)

2) This questions pertain to the hospital or facility at which you spend the most time

A. Is your primary facility a teaching hospital? (defined here as being affiliated with a resident physician training program)
    1. Yes, teaching hospitals
    2. No, not teaching hospital
    3. Unsure

B. Does your primary facility have a formalized system for guidance on when to insert or remove a catheter, or a method for monitoring which patients have indwelling catheters? (Example include: standardized order sets, requiring an indication to be listed with the order to place catheter, automatic discontinuation of catheters after a certain time, etc)
    1. Yes
    2. No
    3. Unsure

C. Does your primary facility provide physicians with training on proper catheterization?
    1. Yes
    2. No
    3. Unsure

D. If "Yes", how often

1	2	3	4	5
Weekly	biweekly	monthly	quarterly	yearly

3) These questions pertain to your perception of CAUTI risk factors

Choose the best option that best reflect whether CAUTI is indicated as risk factors

	Almost always indicated	Usually indicated	Indicated about ½ of the time	Rarely indicated	Almost never indicated	Unknown/ unsure
A) Extended period of Catheterization	1	2	3	4	5	6
B) Unsuitable condition during catheterization	1	2	3	4	5	6
C) Preoperative antibiotic use	1	2	3	4	5	6
D) Female gender	1	2	3	4	5	6
E) Prior catheterization in same hospital admission	1	2	3	4	5	6
F) Patients in Cardiac Units	1	2	3	4	5	6
G) Age over 40	1	2	3	4	5	6
H) Increase hospital and ICU stay	1	2	3	4	5	6

Comments or questions? (Optional)

4) This questions pertains to your current practice methods to prevent Foley catheter-related infections

How large an effect do you think each of the listed interventions has in preventing CAUTI?

Note: Fomites are instruments used during point of care such as stethoscopes, portable electronic devices, pens etc

	Large effect	Moderate effect	Slight effect	No effect	Unknown
A) Removing catheters as early as possible	1	2	3	4	5
B) Constant disinfection of fomites during point of care	1	2	3	4	5
C) Hospital use of electronic monitoring system to monitor hand hygiene	1	2	3	4	5
D) Effective use of TMP-SMX as prophylaxis prior to catheter removal	1	2	3	4	5
E) Effective use of amikacin sulfate bladder wash as prophylaxis prior to catheter removal	1	2	3	4	5
F) Constant use of	1	2	3	4	5

antimicrbial coated antimicrobials					
G) Having automated reminders to discontinue/renew the order for catheter	1	2	3	4	5

Comments or questions? (Optional)

5) Medical Practice Questions

Do you know that Catheter-associated UTI is 1 of 8 hospital-acquired conditions for which the Center for Medicare/Medicaid Services will no longer offer reimbursement?

a. Yes
b. No (skip to next question)

If "Yes" has this legislation

	Yes	No	Unsure
A) Prompted you to order fewer catheters?	1	2	3
B) Affected how often you order a urinalysis or urine culture to be collected from catheterized patients?	1	2	3
C) Prompted	1	2	3

you to remove catheters sooner than previously			

Comments or questions? (Optional)

6) Demographic questions

A) How many years have you been in your practice?
   a. 1-5 years ago
   b. 6-10 years ago
   c. 11-15 years ago
   d. 16-20 years ago
   e. More than 20 years ago

B) What is your medical specialty
   a. Anesthesiology
   b. Family practice
   c. Geriatrics
   d. Internal Medicine
   e. Internal Medicine sub-specialty
   f. Neurology
   g. Obstetrics/Gynecology
   h. Orthopedic surgery
   i. Pediatrics
   j. Physical Medicine and Rehabilitation
   k. Psychiatry
   l. Surgery
   m. Urology
   n. Surgery sub-specialty not otherwise listed
   o. Other (Please specify)

Comments or questions? (Optional)

7) Thank you

Thank you very much for taking the time to do this survey

If you have any comments, concerns, or other feedbacks regarding this survey (or catheter use in general), kindly enter them here

Appendix G: Chi-Square Distribution Table

Chi-Squared Distribution Table

df	0.995	0.99	0.975	0.95	0.9	0.1	0.05	0.025	0.01	0.005
1	0	0	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.01	0.02	0.051	0.103	0.211	4.605	5.991	7.378	9.21	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.86
5	0.412	0.554	0.831	1.145	1.61	9.236	11.07	12.833	15.086	16.75
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.69	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.18	2.733	3.49	13.362	15.507	17.535	20.09	21.955
9	1.735	2.088	2.7	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.94	4.865	15.989	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.92	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.3
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.66	5.629	6.571	7.79	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.39	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.26	9.591	10.851	12.443	28.412	31.41	34.17	37.566	39.997
21	8.034	8.897	10.283	11.591	13.24	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.041	30.813	33.924	36.781	40.289	42.796
23	9.26	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.98	45.559
25	10.52	11.524	13.12	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.16	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.29
27	11.80	12.87	14.57	16.15	18.11	36.741	40.113	43.195	46.963	49.645

	8	9	3	1	4					
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.256	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.953	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.169	67.505	71.42	76.154	79.49
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.192	53.54	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.294
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169