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Exploring Knowledge, Attitudes and Practices of Registered Nurses Regarding the Spread of Nosocomial Infections

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EXPLORING KNOWLEDGE, ATTITUDES AND PRACTICES OF REGISTERED NURSES REGARDING THE SPREAD OF NOSOCOMIAL INFECTIONS

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Dedication

I dedicate my dissertation work to my family, friends, my study participants and mentors. I wish to first thank my parents - especially my dad Mr. Phillip Mwaura for raising me and providing me with as much education as he could against so many challenges. My sisters and brothers, thanks for being always there for me. My brother-in-law, Mr. Joseph Kamunge, it is your unselfish love and by picking up the burden of providing for the family that has gotten me this far. I thank my husband Mr. Mungai Kamunge for showing me how much I can accomplish in the face of adversity. You have inspired me in ways you might not know. Thanks for carrying us through the rough times throughout the years. My daughters: Winnie and Carol; you are my number one cheerleaders. Everything I do is for you. My son-in-law, Vincent, you added the cheers. I hope I have inspired you all as much as you have inspired me.

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Thank you!

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Abstract

EXPLORING KNOWLEDGE, ATTITUDES AND PRACTICES OF REGISTERED NURSES REGARDING THE SPREAD OF NOSOCOMIAL INFECTIONS

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Background and Purpose of the Study: Nosocomial infections (NIs) are new localized or systemic infections that develop in patients receiving medical care in a hospital or other healthcare facilities. The infections are not incubating or present during a patient's admission into the healthcare facility and are identified at least forty-eight to seventy-two hours following the patient's admission. Episodes of NIs are recognized in hospitalized patients world-wide and are prevalent in all age groups. They are caused by pathogens such as bacteria, viruses and parasites present in the air, surfaces or equipment and are often transmitted by indirect and direct contact. Some of the pathogens are resistant to antimicrobial agents. The burdens of NIs include prolonged duration of hospitalization for patients resulting in increased costs of healthcare and deaths. Implementation of safe patient care activities is the role of healthcare workers such as physicians, dental health care workers and nurses. Therefore these healthcare workers should be familiar with practices to prevent the occurrence and spread of NIs. It has been documented in the literature that at the time of their graduation from their professional education, healthcare professionals have sufficient knowledge to practice patient safety and infection control guidelines. However, the evidence suggests otherwise since healthcare workers including nurses are implicated in the

transmission of nosocomial infections. With nurses having the most contacts with patients; understanding of their knowledge, attitudes and practice patterns with regard to the spread of NIs may provide one approach by which this health care issue would be addressed.

Methods: This exploratory, cross-sectional and descriptive study was conducted using on-line survey responses from 352 registered nurses. Data was analyzed with descriptive and inferential non-parametric statistics.

Results: The participants demonstrated high levels of knowledge, adherence to recommended guidelines of infection control practices, and positive attitudes. These results, in addition to the observed significant associations between organizational support and registered nurses' knowledge, attitudes and practices, lend support to the recent CDC data on reduced incidence of NIs.

Conclusion: Findings in this study suggest that nursing education, concerted efforts of infection control, state mandates and organizational support play pivotal roles toward reducing the spread of NIs.

Chapter 1

INTRODUCTION

Background

Nosocomial Infection is a localized or systemic infection acquired in a hospital or any other health care facility by a patient admitted for a reason other than the pathology present during admission. It may also include an infection acquired in a healthcare facility that may manifest 48 hours after the patient's admission into the health care facility or discharge (WHO, 2002; Horan et al., 2008). Epidemiological studies report that nosocomial infections are caused by ubiquitous pathogens such as bacteria (Lepelletier et al., 2005), viruses (de-Oliveira et al., 2005) and fungi (Trick et al., 2002) present in air, surfaces or equipment. The pathogens are not present or incubating prior to the patient's admission into healthcare facility and are most likely transmitted by direct person-to-person contact during invasive medical procedures (Starfield, 2000). Some of the pathogens are highly resistant to antimicrobial agents, and this necessitates the prescription of more potent and costly antimicrobial agents (Boyce et al, 1994 and 1997; Lodise et al., 2002; Abbo et al., 2005; Haydent et al., 2006; Conly et al., 2004; Klein et al., 2007; Hildron et al., 2008; Mulvey et al., 2009; Anderson et al., 2010).

Nosocomial infections are prevalent nationally and internationally; and occur in patients of all age groups: neonates (Aly et al., 2005; Haque et al., 2004; Yogaraj et al., 2002; and Healy et al., 2004), immuno-compromised adults (de-Oliviera et al., 2005 and Lepelletier, D., 2005) and the elderly (Carusone, et al., 2006). The most frequent types of nosocomial infections are those

associated with the urinary tract, surgical wounds, respiratory tract and blood stream (WHO, 2002; Lo et al., 2008).

Statement of the Problem

Nosocomial infections have been recognized as a problem affecting the quality of health care and a principal source of adverse healthcare outcomes. It has been documented in the literature that within the realm of patient safety, these infections have serious impact. Increased hospital stay days, increased costs of healthcare, economic hardship to patients and their families and even deaths, are among the many negative outcomes (Emori et al., 1991; Starfield et al., 2000; Angus et al., 2001; Zhan & Miller, 2003; CDC, 2005; Engemann et al., 2005; Elward, et al., 2005: Klevens et al., 2007; Kaye et al., 2009; Edwards et al., 2009; Scott II, 2009). In the United States, recent data based on the Consumer Price Index in 2007 supports that the overall direct cost for in-patient hospital services related to nosocomial infections ranges from $35.7 billion to $45 billion yearly (Scott II, 2009). A systematic review of published literature on costs attributable to nosocomial infections among only 28 community hospitals in southeastern region of U.S. over a one-year period, revealed that the annual cost associated with nosocomial infections exceeded $26 million (Anderson et al., 2009). These findings are indicative of the enormous economic burden associated with nosocomial infections.

Epidemiological studies report that nosocomial infections are caused by ubiquitous pathogens transmitted, at least in part, by healthcare workers through direct and indirect contact. In 1938, Price established that microorganisms recovered from human body could be divided into two categories: the resident flora (microbiota), or transient flora (Price, 1938). The resident microbiota, also commonly referred to as normal flora consists of bacteria mostly found in the superficial cells of the skin and mucous membranes; and in linings of the orifices of digestive, respiratory and reproductive systems (Black, 2012). It has been demonstrated in several

immunological studies that resident microbiota exhibits protective functions against invasion, or outgrowth, of pathogenic microorganisms and its depletion or aberration may lead to opportunistic infections (Fujimura et al., 2010). However, these bacteria may cause infections in non-intact skin. The most dominant species of resident microbiota is *Staphylococcus epidermidis.*

Transient microbiota are microorganisms present, under certain conditions, in any of the locations where resident microbiota are found. Some of these microorganisms colonize the superficial layers of the skin. They are more amenable to removal by routine hand hygiene and such microorganisms are often acquired by healthcare workers during direct contact with patients or contaminated environmental surfaces, within the patient's surroundings. The most common types of transient bacteria are the *Staphylococcus aureus, Escherichia coli, βeta-hemolytic Streptococci, Serratia mercescens, Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterobacter species, Candida albicans and Clostridium difficile* (Black, 2012). These are the organisms frequently implicated in nosocomial infections (Monarca et al., 2000; CDC 2002; Lepelletier, 2005; Ribby et al., 2005 & Hayden et al., 2006) and some of the strains are resistant to antibiotics (Lodise et al., 2002; Conly et al., 2004; Abbo et al., 2005).

Epidemiological studies have demonstrated that transient bacteria are often acquired by healthcare workers during direct contact with patients, or contaminated environmental surfaces, within the patient's surroundings (Monarca et al., 2000; Lepelletier, 2005; Ribby et al., 2005 & Hayden et al., 2006). Epidemiological studies suggest that nosocomial infections can be transmitted through direct person-to- person contact between infected patient, healthcare workers, non-infected patients and by indirect contact through equipment, supplies, medical procedures, or air (CDC, 2000; WHO 2002). The affected body systems depend on the virulence of the pathogens, accessibility of the pathogen to the patient and susceptibility of the patient to the

pathogen (CDC, 2000). The most common types of nosocomial infections affect the urinary tract, surgical wounds, respiratory system and blood stream (WHO, 2002).

Studies that have examined the impact of nosocomial infections caused by antibiotic-resistant pathogens at a single center in United States and 281 laboratories that served 791 hospitals in Europe, showed that infections caused by antibiotic resistant pathogens were associated with increased mortality rates, increased lengths of hospital stay and higher healthcare costs compared to the nosocomial infections caused by pathogens susceptible to antibiotics (Boyce et al, 1994 and 1997; Lodise et al., 2002; Conly et al., 2004; Abbo et al., 2005; Haydent et al., 2006; Klein et al., 2007; Hildron et al., 2008; Mulvey et al., 2009; Mauldin et al., 2010 & de Kraker et al., 2011). These findings support the notion that nosocomial infections present enormous economic burden to the public and the healthcare system.

In response to the realization of the magnitude of the problem, various agencies including federal and state governments, and professional societies - both nationally and internationally, have devised measures aimed at reducing the occurrence of nosocomial infections. For example, Center for Infection Control and Epidemiology developed guidelines for hand-hygiene in healthcare settings and made recommendations for infection control practices which were based upon the available evidence surrounding the best practices for patient care (Boyce at al., 2002).

Additionally, the Centers for Disease Control and Prevention (CDC), in cooperation with government and non-government organizations throughout the world, has coordinated efforts and resources to help minimize the occurrence of nosocomial infections; and recommend activities that enhance quality of patient care. In this regard, healthcare workers have been encouraged to implement strategies that would emphasize measures aimed at prevention of the transmission of nosocomial infections. Accordingly, healthcare professionals have been encouraged to participate

in in-service continuing education on topics related to measures deemed necessary to reduce the transmission of nosocomial infections.

The World Health Organization (WHO), in conjunction with CDC, set prevention of nosocomial infections as priority by developing a practical guide (manual) for the prevention of nosocomial infections globally (WHO, 2002). Some recommended strategies included in the manual were: the use of hand decontamination, personal hygiene, utilization of masks and gloves; and proper methods of handling soiled clothing when healthcare workers perform patient care activities. The manual also recommends methods for preventing environmental transmission including cleaning the hospital environment, use of hot / superheated water, disinfection of patient equipment, sterilization, and prevention of transmission of pathogens (for example, *HIV, Hepatitis-B, Hepatitis-C* viruses, and *M. tuberculosis*) to staff. Above all, the manual recommends that hospitals provide sufficient resources by training staff in infection control programs such as appropriate patient isolation and sterilization techniques and yearly work-plans and manuals for infection control practices that are approved by infection control committees (WHO, 2002). Such initiatives by the CDC suggest the importance with which nosocomial infections should be addressed (http://www.cdc.gov/ncidod/hip/prevention). However, despite the development of the above policies and recommendations, the incidence of nosocomial infections and their impact on healthcare costs, morbidity and mortality remain unabated (Anderson et al., 2009 & Scott II, 2009) and healthcare workers are implicated in the transmission.

The centers for Medicare and Medicaid Services instituted a "*payment reform*" program where the prospective reimbursement system will not cover costs for preventable infections (nosocomial infections) acquired in the course of treatment (Johnson, 2009). Furthermore, the federal government requires that healthcare institutions' statistics on nosocomial infections be made available to the public and hospitals with highest rates of nosocomial infections will be

penalized (DHHS, 2009). Additionally, the Healthcare Reform Law has instituted measures that incentivize hospitals and other healthcare facilities to improve their programs for reducing nosocomial infections. For example, beginning October 2012, Medicare will assess the efficiency of healthcare facilities, patient satisfaction and quality of care; and in 2015, Medicare will cease to reimburse hospitals for readmissions related to nosocomial infections (DHHS, 2009; Palmore, 2010; Main & Starry, 2010). The potential for not receiving funds to cover additional days spent in the hospital or any other healthcare facility resulting from nosocomial infections will certainly motivate hospitals to devise more stringent measures to prevent nosocomial infections. Such measures will contribute in the reduction of the morbidity, mortality, and systemic costs associated with nosocomial infections. This might lead to enhanced quality care and improve patient care outcomes.

Findings from several epidemiological studies reveal that healthcare workers such as physicians, dentists and nurses are implicated in the transmission of nosocomial infections. It has also been reported that transmission frequently occurs during the performance of medical procedures, when these healthcare workers fail to follow aseptic precautions. Thus, non-compliance with recommended guidelines by healthcare workers expose patients to an abundance of pathogens (Monarca et al., 2000; Boyce et al., 2002; Cohen et al., 2003; Harrel et al., 2004; Pittet et al., 2004; Miner et al., 2004; Szymanska, 2004; de Oliveira et al., 2005; Lam et al., 2004; Kurita et al., 2006; Rautemaa et al., 2006; Racco et al., 2009; Eriksen et al., 2009 & Costello et al., 2010).

A study conducted by Casewell and Philips (1977) demonstrated that nurses could contaminate their hands with colonies of bacteria during clean patient care activities such as lifting patients, taking pulse, blood pressure, oral temperature or touching patients' hands, shoulder or groin (Casewell and Phillips, 1977). Stone (2001) documented that patient contacts result in

contamination of hands by pathogens and that washing hands significantly reduces hand contamination and infection rates (Mortimer et al., 1966; Stone, 2001). In a controlled trial study at a neonatal unit, Mortimer and colleagues (1966) found only 10 % acquisition rate of *Staphylococcus aureus* by babies where nurses washed their hands between patient contacts; and a 14% acquisition rate of the same pathogen by babies during the first 20 days when the nurses washed their hands between patient contacts. The rate increased to 43% when the nurses washed their hands only when they felt that the practice was clinically indicated (Mortimer et al., 1966). These findings affirmed the ease with which healthcare workers could transmit microorganisms and consequently, the spread of nosocomial infections.

Price (1938) and Lepelletier et al. (2005) observed that transient bacteria that colonize the superficial layers of the skin are easily acquired by healthcare workers during direct contact with patients or contaminated environmental surfaces (Price, 1938 & Lepelletier et al., 2005). Similarly, McBryde et al. (2004) and Michalopoulos et al. (2006), documented that healthcare workers contaminate their hands or gloves with various pathogens, including resistant strains, while performing procedures that involve touching hospitalized patients' intact skin or their immediate environment. Specifically, 17% of transmission of *Methicillin Resistant Staphylococcus aureus (MRSA)* to the healthcare workers' gloves occurred after contact with patients, patients' clothing or patients' bed (McBryde et al., 2004). Other studies that investigated the modes of transmission of nosocomial infections in neonatal intensive care units showed that each hospitalized neonate or its immediate environment was touched 78 times during a 12-hour shift. Specifically, more than half of the contacts were carried out by nurses (Cohen, et al., 2003). In the light of these statistics, it is incumbent upon healthcare workers to enhance their knowledge of options regarding the alleviation of the transmission of nosocomial infections.

It has been documented in the literature that at the time of their graduation from their professional education programs, nurses should have acquired sufficient knowledge to practice patient safety and infection control guidelines (Smith et al., 2007; Cronenwett et al., 2007). Furthermore, their expertise with regards to knowledge, attitudes and practice to control the spread of infection is also well evidenced by their success in licensure exams and other relevant assessments, which test their knowledge of infection control practices and the application of skilled safe patient care activities, over the course of their academic journey (Sherwood et al., 2007; Smith, 2007). Therefore, the continued presence of nosocomial infections raises an enigma which may only be explained by other factors. Interestingly, studies that investigated the role of institutional support and the spread of nosocomial infections showed that low staffing levels lead to high workload and increased healthcare workers' non-compliance with recommended hand hygiene practices (Huggonet et al., 2007). Additionally, existing studies show that the lack of proper equipment and surveillance systems for the monitoring of infections further increased the episodes of nosocomial infections (Monarca et al., 2000; Chen et al., 2003, Garretson et al., 2004; Lo et al., 2008 & Saint et al., 2008). Therefore, it is plausible that this paradox could be explained through a thorough examination of socio-cognitive perspectives with regards to knowledge; or behavioral aspects such as attitude that could affect the healthcare workers' on-the- job practice; or environmental factors that include organizational support or architectural design of healthcare facility.

Purpose of Study

Nurses, regardless of specialty, engage in the most direct contact with clients in healthcare settings. Additionally, existing literature has documented specific examples where nurses are implicated in the transmission of nosocomial infections (Casewell & Phillips, 1977; Ehrenkranz et al., 1991; Lucent et al., 2002; Waters et al., 2004; Lepelletier et al., 2005; de-Oliveira et al., 2005;

Pessoa-Silva et al., 2007). A review of literature has shown that nursing educational programs incorporate courses and instructional approaches that include methods aimed at preparing the nurse practitioner in protocols designed for infection control and as such the reduction and transmission of nosocomial infections. Furthermore, their expertise with regards to knowledge, attitudes and practice to control the spread of infections is well evidenced by their success in licensure exams and relevant assessments over the course of their academic journey (Sherwood et al., 2007; Smith, 2007). Paradoxically, the evidence highlights otherwise: that is, unabated levels of the spread of nosocomial infections (Anderson et al., 2009; Scott II, 2009) and the role of healthcare workers including nurses, in the transmission of nosocomial infections (Pittet et al., 2004; Miner et al., 2004; Eriksen et al., 2009; Racco et al., 2009; Costello et al., 2010).

Additionally, there is some evidence that suggests that the spread of nosocomial infections could be related to a breakdown in knowledge, attitude and practices among healthcare workers (Godin 1996; Pessoa-Silva et al., 2005; Pittet et al., 2006). What has not been established is if this breakdown is prevalent in novice registered nurses, suggesting the novice registered nurses' inability to apply their knowledge in a work setting, or that it is in the more experienced registered nurses, suggesting either a decrement of knowledge (Ribby et al., 2005; Lam et al., 2004; Pessoa-Silva et al., 2007; Suchitra et al., 2007; Sax et al., 2007) or a change in attitude and / or sloppy practices possibly associated with stressful behavioral interactions with colleagues, workload or other organizational factors (Godin, 1996; Larson et al., 2000; O'Boyle et al., 2001; Chenot & Daniel, 2010). With nurses having the most contacts with patients, understanding their knowledge, attitudes and practice patterns with regard to nosocomial infections may be an important mode by which this health care issue may be addressed.

The purpose of this study was four - fold: a) to investigate the level of knowledge, attitudes and practice of registered nurses with regards to the spread of nosocomial infections; b) to

compare the knowledge, attitudes and practice in novice and experienced registered nurses with regards to the spread of nosocomial infections; c) to investigate the level of organizational support as reported by the registered nurses; and d) to examine if a relationship exists between organizational factors or support and the level of registered nurses' knowledge, attitudes and practice with regards to the spread of nosocomial infections.

Significance of the Study

It has been documented in several epidemiological studies that healthcare workers such as physicians, dentists and nurses are implicated in the transmission of nosocomial infections. Literature that has explored the knowledge, attitudes and practices of nurses is limited. Therefore, it is important to further investigate the impact of knowledge, attitudes and practices of novice and experienced graduate nurses with regard to the degree of the spread of nosocomial infections. The findings from this study will add to the existing literature and may be used in developing interventions to reduce the spread of nosocomial infections.

Research Questions

There are five research questions for this study.

a) What is the overall level of Knowledge, Attitudes and Practice among registered nurses with regards to the spread of nosocomial infections?

b) Is there significant difference in the level of knowledge between novice and experienced registered nurses with regards to the spread of nosocomial infections?

c) Is there significant difference in attitude between novice and experienced registered nurses with regards to the spread of nosocomial infections?

d) Is there significant difference in practice of safe patient care between novice and experienced registered nurses with regards to the spread of nosocomial infections?

e) What is the level of organizational support as reported by registered nurses?

f) What is the relationship between organizational support and registered nurses' level of Knowledge, Attitude and Practice with regards to the spread of nosocomial infections?

Theoretical Framework

Existing social cognitive models suggest that determinants that shape human behavior are acquired through socialization and may be susceptible to change. When reviewing the literature, three theories were found to offer a strong theoretical framework for research in this area: the social cognitive theory (SCT), the Health Belief Model (HBM) and Theory of Reasoned Action / Theory of Planned Behavior (TRA/TPB) (Ajzen, 1980; Bandura,1989; Rosenstock et al. 1988).

The Social Cognitive Theory stems from the Social Learning Theory and was proposed by Alfred Bandura in 1986. This theory is based on the notion of a triad model that takes into account the interactions between three factors: environment, personal cognition and behavior. A central tenet of the Social Cognitive Theory asserts that behavior is uniquely determined by each of the three factors and that response consequences mediate behavior. Further, the theory asserts that people are most likely to learn and model behavior observed in persons with whom they identify through a phenomenon commonly referred to as "vicarious capacity". Vicarious capacity is defined as an observational learning mechanism governed by attention span, retention process, motor reproduction process and motivational processes (Bandura, 1991 and Glanz et al., 2002). Bandura asserted that people learn by modeling behaviors from significant others; and that behavior is determined by symbolizing capability, forethought, self-regulation, self-reflection, and vicarious capability. The theory also states that a bi-directional interaction occurs between the environment and personal characteristics and is thus central to the development of human expectations, beliefs, and cognitive competencies (Bandura, 1991 and Glanz et al., 2002). In the context of Bandura's Social-Cognitive theory, the healthcare facility would be the environment

where directional and personal interactions between the healthcare workers such as the experienced nurses would interact with the novice nurses. It is therefore possible to postulate that the nurses with less experience will model the behaviors of the more experienced nurses.

Some constructs of the Bandura's Social Cognitive Theory are applicable to the Health Belief Model (HBM) - a psychological model that explains and predicts health behaviors by focusing on the attitudes and beliefs of individuals (Glanz et al., 2002). Health Belief Model was first developed in the 1950s by social psychologists Hochbaum, Rosenstock and Kegels. The model uses constructs that represent perceived threats and net benefits such as perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy. The model asserts that these constructs account for a person's "readiness to act" (Rosenstock, 1988).

The literature reviewed suggests that it is possible to apply the constructs of the Health Belief Model to studies that explore health behaviors such as health prevention and promotion, and compliance with recommended guidelines for infection control. The behaviors of health care professionals, and in particular nurses, are also regulated by social and moral standards. Through foresight, the individual can think through the consequences of a behavior without actually performing the behavior oneself (Bandura, 1989). It is documented in some studies that positive health behaviors by healthcare workers may decrease the occurrence of the unabated nosocomial infections (Aly et al., 2005; Pittet et al., 2004). For example, if a nurse internalizes the notion that prevention of nosocomial infections is essential, he / she will take precautions in order to improve on the outcomes of the admitting disease or condition, and improve the delivery of quality standard of care. Furthermore, a study that examined compliance with hand-hygiene practices among medical staff showed that the frequency of healthcare workers' hand-hygiene was greatly influenced by role models (Lankford et al., 2001). In this observational study, the researcher noted that healthcare workers were less cornplaint with hand hygiene protocols when a high ranking

person such as physician or nurse did not carry out hand hygiene practices. This observation implied that the effect of role model is significant in negatively influencing healthcare workers' compliance with recommended guidelines.

Another theory with tenets applicable to this area of study is the Theory of Reasoned Action / Theory of Planned Behavior (TRA/TPB) developed by social psychologists Ajzen and Fishbein in 1967. This theory explains how attitude and motivation influences human behavior. The theory proposes that "*intent*" is the most important determinant of a person's "*behavior*"; and furthermore, that an individual's intention to perform a behavior is dependent upon the "*attitude*" toward the performance of the behavior. The theory also contends that behavioral beliefs and normative beliefs influence the individual's motivation to comply with performance of a certain behavior. According to Ajzen (1991), behavioral beliefs link the behavior to an expected outcome while normative beliefs are considered as the perceived behavioral expectations of individuals within a group. Altogether these referents lead to actual behavior beliefs control and may drive the individual's intention to perform the behavior (Ajzen, 2006). Another assumption of the TRA/TPB theory is that human beings are rational: they make systematic use of information available to them and consider the implications of their actions before they decide to engage or not engage in certain behaviors. They (human beings) have normative beliefs which arise from perceived behavioral expectations of individuals such as co-workers; for example, nurses. Therefore, the stronger a person's intention to perform a particular task (behavior) is, the more likely the person will perform the behavior (Ajzen, 2006).

In the context of this study, it is possible to speculate that registered nurses could be influenced by colleagues or friends and peers at the work settings. What is unclear is whether they are influenced in a positive or negative way. Additionally, it is possible to speculate that the healthcare workers would be influenced by cognitive factors such as decrement in knowledge. Any

decrement in knowledge might lead to healthcare workers' non- compliance with recommended guidelines and protocols while performing patient-care activities. What is also unclear from the literature is whether there is a decline in the knowledge and skills gained during their course of study or whether these workers become non-compliant over time due to modeling after other non-compliant colleagues during their performance of patient care activities. This non-compliance would lead to the spread of nosocomial infections.

Chapter II

LITERATURE REVIEW

Background

The World Health Organization (WHO) defines Nosocomial Infection as an infection acquired in hospital or other health care facility by a patient who was admitted for a reason other than the infection present during admission. This includes an infection acquired in the hospital, or other healthcare facility, but appearing after the patient's discharge (WHO, 2002). Epidemiological studies reveal that nosocomial infections occur worldwide and to patients of all age groups. In the United States, it was reported that more than 2 million of hospitalized patients contracted nosocomial infections in 1995 (CDC, 1996). Surveys on the prevalence of nosocomial infections conducted under the auspices of World Health Organization (WHO) showed that 5% - 10% of all hospitalized patients are affected by nosocomial infections, with a higher prevalence for patients in intensive care units (WHO, 2002). Furthermore, findings in epidemiological studies have shown the causative pathogens, the modes of transmission and that the most frequent types of nosocomial infections are associated with the respiratory tract, blood stream, surgical wounds and urinary tract (WHO, 2002; Lo et al., 2008).

Nosocomial infections take a major toll on society and the overall morbidity and mortality associated with these infections are enormous. Complications from nosocomial infections often result in extended lengths of stays in the hospital and increased cost of healthcare (Emori et al., 1991; Starfield et al., 2000; Angus et al., 2001; Zhan & Miller, 2003 and Engemann et al., 2005). In Europe, nosocomial infections represented 25 million extra hospital-stay days with a corresponding

healthcare costs of £24 billion and 153,000 deaths per year (WHO, 2005). In United States, the estimated cost associated with nosocomial infections, based on an incidence of 4.5 nosocomial infections for every 100-hospital admission, exceeded $4.5 billion in 1992 (Zhan & Miller, 2003). In 2002, a report issued by the Centers for Disease Control and Prevention (CDC) estimated an incidence of 1.7 million nosocomial infections and 99,000 deaths (Klevens et al., 2007). A systematic review of published literature on costs attributable to nosocomial infections among only 28 community hospitals in southeastern region of U.S., over a one-year period, revealed that the annual cost associated with nosocomial infections exceeded $26 million (Anderson et al., 2007). These findings suggest the enormous economic burden associated with nosocomial infections - given the large number of hospitals in the U.S. Moreover, data on annual aggregate direct cost for all nosocomial infections in U.S. hospitals in 2007 indicate that overall direct cost for in-patient hospital services, adjusted to 2007 dollars and based on Consumer Price Index, ranged from $35.7 billion to $45 billion (Scott II, 2009).

Existing literature suggests a strong association between poor compliance with the recommended infection control guidelines by health-care personnel and the transmission of pathogens. Transmission frequently occurs during the performance of medical procedures, when the health-care personnel fail to follow aseptic precautions. Poor compliance with recommended guidelines for controlling the spread of infections by healthcare workers expose the patients to an over abundance of pathogens (Boyce et al., 1997; de Oliveira et al., 2005; Lam et al., 2004). Some of the pathogens are resistant to antibiotics (Boyce et al., 1994 and 1997) and this necessitate the prescription of more potent and costly antimicrobial agents (Conly et al., 2002). Therefore, the best chance of controlling the transmission rests with a well-trained cadre of healthcare personnel. This section will review existing literature on epidemiology, impact and spread of nosocomial infections and explore the implications of knowledge, attitudes, and practices

and institutional support on healthcare workers' compliance with recommended guidelines for prevention of transmission of nosocomial infections.

Etiology of Nosocomial Infections

Numerous epidemiological studies have documented that nosocomial infections are commonly caused by pathogens such as bacteria, fungi, parasites and viruses transmitted from one patient to another through indirect or direct contact (Monarca et al., 2000; Yogaraj et al., 2002; Ribby et al., 2005 and Edwards et al., 2009). The most common pathogens are the bacteria. In 1938, Price established that bacteria recovered from the human body could be divided into two categories: the resident flora (microbiota), or transient flora (Price, 1938). The resident microbiota, also commonly referred to as normal flora consists of bacteria mostly found in the superficial cells of the skin and has protective functions. However, these bacteria may cause infections in non-intact skin. The most dominant species of resident microbiota is *Staphylococcus epidermidis*. Transient microbiota colonizes the superficial layers of the skin and is more amenable to removal by routine hand hygiene and such bacteria are often acquired by healthcare workers during direct contact with patients, or contaminated environmental surfaces, within the patient's surroundings (Monarca et al., 2000; Lepelletier, 2005; Ribby et al., 2005, & Hayden et al., 2006). The transmission of transient bacteria depends on the number of microorganisms on the surface, toxins produced during colonization, skin moisture, and the transmission of pathogens by healthcare workers (Price, 1938). The most common types of transient bacteria implicated in nosocomial infections are the *Staphylococcus aureus, Escherichia coli, βeta-hemolytic Streptococci, Serratia mercescens, Klebsiella pneumonia, Pseudomonas aeruginosa, Enterobacter species and Clostridium difficile*. The affected body systems depend on the virulence of the pathogens and the body system affected. Some of the bacteria become highly resistant to multiple classes of antimicrobial agents including antibiotics such as Methicillin and Vancomycin (Boyce et al, 1994

and 1997; Lodise et al., 2002; Abbo et al., 2005; & Haydent et al., 2006). The resistance of bacteria to antimicrobial agents requires prescription of more potent and expensive classes of antibiotics and they contribute to extended hospital stay days, and ultimate increased cost of healthcare (Engmann et al., 2005; Scott II, 2009).

Nosocomial infections are also caused by some parasites such as *Giardia lamblia, Candida albicans, Histoplasmas* and *Aspergillus species (*Rangel-Frausto et al., 1999). Pertinent literature indicates that populations at risk for acquiring nosocomial bloodstream fungal infections are the severely ill and immune-compromised patients (Trick et al., 2002). A prospective epidemiological study conducted by Rangel-Frausto and colleagues (1999) documented that *Candida* species were the fourth most frequent cause of nosocomial blood stream infections, and majority of the infections occurred in neonatal intensive care units (Rangel-Frausto et al., 1999). Trick and colleagues (2002) also conducted an epidemiological study that examined annual incidence of nosocomial infections caused by fungi among patients in US hospitals' intensive care units during a one year period (1998 – 1999). The analysis of this retrospective data showed that 2759 blood stream nosocomial infections were caused by Fungi. Among these, 2358 or 85% were caused by *Candida* species (Trick et al. 2002).

Viruses of different categories such as *Respiratory Syncytial* (RSV), and *Hepatitis- C (HCV)* are also involved in the etiology of nosocomial infections. The *RSV viruses* have been known to not only cause respiratory tract infections in adults with low immune defense mechanisms, they are also the leading cause of lower respiratory tract infections in infants and young children. In the United States, more than 125,000 children are hospitalized annually because of infections from RSV. These viruses also caused secondary respiratory tract infections in recipients of hematopoietic stem cell transplant (Nichols, 2001) and in patients who underwent chemotherapy (Annaise et al., 2004). Anaissie and colleagues (2004) conducted an observational

study that determined the incidence of RSV infections and the implications of associated infections among 190 patients (some of who had received transplants and some suffered from cancer). Thirty-seven % of patients developed severe respiratory complications from *RSV* (Anaissie et al., 2004). Another study by de-Oliveria and colleagues (2005) documented transmission of *Hepatitis-C virus* from one patient to 99 others who had received treatment at a Hematology / Oncology clinic in Nebraska (de-Oliveira et al., 2005).

The causative agents of nosocomial infections are commonly present in hospitals and other healthcare facilities and may be transmitted from one source to susceptible hosts by more than one route. For example, some of the pathogens are transmitted by "direct contact" between the healthcare workers and patients or by "indirect contact" with environmental surfaces and inanimate objects, or by air. The most common method of transmission of nosocomial infections from an infected patient to a susceptible patient, often via the contaminated hands of healthcare workers, is "direct contact".

Prevalence of Nosocomial Infections

There exists a plethora of literature on the prevalence, incidence, and risk factors associated with nosocomial infections, their transmission, and implications to society and health care costs (Stone at el., 2002; Zhan & Miller, 2003; Klevens et al., 2007). The overall morbidity, mortality and excess costs of healthcare associated with these infections continue to rise, regardless of a patient's age or diagnosis. (Scott II, 2009). Nosocomial infections are commonly found in hospitalized children and neonates who are admitted to intensive care units. Findings from a five-year epidemiology study conducted in 61 pediatric intensive care units in the US revealed that among 110,709 hospitalized children, approximately 6% were affected by nosocomial infections (Richards et al., 1999). Richards and colleagues (1999) documented that infants under two months old were more susceptible to nosocomial infections than older children, and blood

stream infections were the most common across the age categories (Richards et al., 1999). The frequency, causative pathogens, and modes of transmission were identical to those documented in other epidemiological studies (Heeg, 2006). Heeg documented that early onset sepsis was caused by pathogens from the maternal birth canal, transmitted to the neonates immediately prior to delivery and that most cases of late onset sepsis were associated with healthcare workers' utilization of intravascular catheters (Heeg, 2006). As noted by Richards and colleagues (1999), the premature and very low birth weight neonates are more vulnerable to nosocomial infections. Similar findings were noted by Haque et al. (2004) and Heeg (2006), where both reported that premature newborns required treatment and manipulative procedures that interrupted the integrity of their skin exposing them to abundant opportunistic microorganisms (Haque et al. 2004 & Heeg, 2006).

Similarly, Clark and colleagues (2004) documented the occurrence of nosocomial infections in neonates being as high as 33%. Clark et al. (2004) noted that gestational age contributed significantly to the vulnerability of hospitalized neonates to nosocomial infections. Premature neonates require treatment and procedures that interrupt the integrity of their skin, and thus allowing for ease of entry of opportunistic pathogens. Furthermore, the use of broad-spectrum antibiotics predisposed the neonates to opportunistic fungal infections (Clark et al., 2004).

The findings reported by Clark et al. (2004) and Haque et al. (2004) are consistent with those of Healy et al., (2004). Healy and colleagues (2004) investigated the incidence, clinical features and outcomes of invasive Staphylococcal disease in 191 neonates at an intensive care unit and found that 137 experienced episodes of nosocomial infections. These infections were attributed to the insertion of intravascular catheters (umbilical venous, central or peripherally inserted arterial or venous) and accounted for the higher morbidity and mortality rates in very low birth weight neonates (Healy et al., 2004). These findings strongly suggest that premature

neonates are susceptible to the nosocomial infections due to exposure to microorganisms during procedures conducted by healthcare personnel. Therefore, caution should be exercised during the performance of manipulative procedures.

The prevalence of nosocomial infections in adults has been well documented in epidemiological studies (Hernandez et al., 2005; Lepelletier et al., 2005; and Moro et al., 2005). The findings from these studies support the notion that patients who undergo surgical procedures have an increased likelihood of developing nosocomial infections as compared to patients who do not (Hernandez et al., 2005; Moro et al., 2005; and Lepelletier et al., 2005). Hernandez and colleagues (2005) conducted a longitudinal study that evaluated the incidence of surgical-site infections in 486 patients who underwent abdominal surgery in a Peruvian hospital, over a 5-month period. The patients were observed for 30 days after surgery. 125 patients developed surgical-site infections with the majority of infections occurring to those who underwent emergency surgery. The study revealed that the mean time for the development of a surgical site infection was approximately 6 days, and a higher rate of infections was found in patients who had in-dwelling drains, in place, for longer than 9 days. Additionally, patients who had multiple surgical procedures had an increased incidence of nosocomial infections. There was a strong correlation between the duration and depth of the surgical procedures, and the development of nosocomial infections. Based on their findings, the authors concluded that longer durations of surgical procedures and hospital-stay days resulted in a greater incidence of surgical site infections. This observation suggests that longer contact between health-care workers and patients or environment could have increased the chances of patients' exposure to pathogenic microorganisms and the likelihood for developing nosocomial infections. One may imply from these findings that the transmission of nosocomial infections could be attributed to medical staff's practices that exposed patients to the pathogens.

The findings of Hernandez and colleagues (2005), though focused on only one hospital, were similar to those indicated in a multisite study conducted in Italy by Moro et al., (2005). The study by Moro and colleagues quantified the occurrence of surgical-site infections among 6,167 procedures in patients admitted to 31 public hospitals over a one-month period. 95% of the patients were observed post-operatively for 30 days to up to one year after discharge. The researchers used a convenience sample based on 44 surgical procedures as classified by the National Nosocomial Infection Surveillance (NNIS) - an ongoing collaborative surveillance system sponsored by the Centers for Disease Control (CDC) to monitor the incidence of nosocomial infections, their associated risk factors and causative pathogens (Moro et al., 2005). Moro and colleagues (2005) documented an increased risk of nosocomial infections in operations lasting more than one hour and in invasive surgical procedures where open drainage lasted more than 5 days (Moro et al., 2005).

Epidemiological studies reveal that nosocomial infections are also common in the elderly. The elderly, particularly those under medical care, are highly vulnerable to nosocomial infections due to weakened host defenses that compromise their ability to ward off pathogens. The most frequent nosocomial infections in the elderly are those affecting the respiratory and genito-urinary systems (Bochicchio et al., 2002, Carusone et al., 2006 and Mukherjee et al., 2005). Regardless of the system affected or causative pathogens, nosocomial infections in the elderly population contribute significant to morbidity, mortality, extended stay days in long-term care facilities, and an increased consumption of health care resources.

Impact of Nosocomial Infections

Findings in several studies reveal three broad categories of burdens placed on our healthcare system by nosocomial infections: the cost of quality of healthcare, the unnecessary loss of human lives and the financial impact. Moreover, nosocomial infections impose many problems

for patient safety and the burden of extended hospital stay days, increased healthcare cost and deaths are much more severe for high-risk populations such as hospitalized neonates and immune-compromised adults. For example, after analyzing data on 24,179 cases of nosocomial bloodstream infections in critically ill patients, Pittet and colleagues (1994) documented that 16 to 40% of deaths in intensive care units were attributed to nosocomial infections and the related extended hospital stay days ranged from 7.5 to 25 days (Pittet et al., 1994).

Zhan and Miller (2003) conducted a study that assessed the length of stay, cost and deaths attributable to medical injuries during hospitalization (Zhan and Miller 2003). Their study used *Patient Safety Indicators* and administrative data on the healthcare cost for 2000 nationwide discharge records of 994 inpatients in acute-care hospitals. To ensure validity, the researchers considered type of diagnosis at admission, diagnosis related groups and diagnosis codes that followed the criteria established by the International Classification of Diseases - 9th edition, Clinical Modifications (ICD-9-CM). The study revealed that post-operative sepsis and wound dehiscence accounted for 9.42 extra days, over $40,000 for excess charges and a mortality rate of 9.64%. Miller and colleagues noted that nosocomial infections were among the Patient Safety Indicators noted at the provider level. Overall, the nosocomial infections accounted for 9.58 extra days of hospital stay, over $38,000 in excess charges and 4.31% mortality rate over a three-year period (Zhan & Miller, 2003). Study findings revealed that complications of nosocomial infections resulted in excess length of stay days, increased post-operative infections leading to excess mortality, and increased cost of healthcare. Specifically, the extended hospital stay days contributed to healthcare costs in excess of $8.73 billion and 9,500 deaths annually (Zhan & Miller, 2003). The findings in the study by Zhan and Miller are similar to those documented in the studies conducted by Engemann and colleagues in 2005. Engemann and colleagues (2005) conducted a retrospective study to evaluate the clinical outcomes and costs associated with nosocomial

infections related to *S. aureus* in 210 patients with chronic renal failure undergoing hemodialysis treatment at Duke University hospital (Engemann et al., 2005). 31% of patients developed complications related to infections caused by *S. aureus*. 27 of the 81 discharged patients developed recurrent infection from *S. aureus* within 12 weeks with a mortality rate of 19%. The mean cost for treatment of nosocomial infections caused by *S. aureus* was greater than for those patients without complications (Engemann et al., 2005). Analysis of data indicated that the mean cost for patients who acquired nosocomial infections was $14,000 higher than for patients without complications. These findings support the premise that increased costs of healthcare can be attributed to nosocomial infections.

In 2002, Klevens conducted a study that provided a national estimate of the number of nosocomial infections and deaths in the United States. The tabulated epidemiological data revealed that 1.7 million patients were affected in 2002 and about half a million or 470,274 infections affected newborns and children in intensive care units. Over 1.2 million (1,266,851) nosocomial infections affected patients in non-intensive care units. Altogether, about 100,000 deaths occurred and a significant number (35,967) resulted from nosocomial infections of the respiratory system; 30,665 from blood stream infections; while13,088 resulted from urinary tract infections; 8,205 from surgical site infections and 11,062 resulted from infections of other sites (Klevens et al., 2002).

Findings in a study conducted by Stone and colleagues (2008) also revealed an upward trend in the incidence in nosocomial infections and increased economic impact of these infections in the state of Massachusetts in 2005 (Stone, 2008) and a more recent CDC report, using Consumer Price Index for in-patient hospital services in US hospitals, estimated the annual medical costs of nosocomial infections to be between $28 and $45 billion (Scott II, 2009).

The burden of increased healthcare costs and deaths associated with nosocomial infections continues to increase unabated. Findings in epidemiological studies showed that nosocomial infections associated with bloodstream and ventilator-associated pneumonia had more severe impact on mortality, extra hospital stay days and costs. A more recent report of data on the incidence of nosocomial infections among 2,473 hospitals in 2010 indicated an increase in the numbers of infections associated with utilization of medical devices most of which occurred in medical/surgical units (Dudeck et al., 2011). These incidence rates translate to increased hospital stay days, increased associated cost of healthcare and unnecessary deaths.

The financial burden of antibiotic resistant microorganisms in hospitalized patients is also substantial. For instance, studies that examined the impact of antibiotic resistance bacterial strains on patient outcomes documented prolonged length of hospital stay days ranging from 2 to 18 days, increased healthcare costs due to additional prescriptions of antibiotics, and deaths. The organisms associated with antimicrobial resistance included strains of *Methicillin Resistant Staphylococcus aureus (MRSA), K. pneumoniae, P. aeruginosa* and various species of *Enterococci* (Cosgrove et al., 2003 and 2005; Engemann et al., 2003; Lodise et al., 2002). In the United States, cost estimates for managing antimicrobial resistance were approximately $10 billion per year (US Office of Technology, 1995) and in Canada, authorities documented that the costs for treating *MRSA* and *Enterococci* infections were in excess of $14,000 and $6700 per patient respectively in 2001. These incremental costs were due to excessive lengths of hospital stays (intensive care unit stays), private isolation rooms, need for expensive antibiotics, increased laboratory testing and added interventions for infection control – such as equipment, gloves, gowns and disinfectants (Conly et al., 2002).

A study by Klein and colleagues (2007) also examined the trend and impact of *MRSA* in hospitalized patients over a 7-year period. The data showed that infections related to *MRSA* –

related infections increased 54% (from 127,036 to 278,203) and *MRSA* – related deaths increased 18% (from 24,715 to 29,164) (Klein et al., 2007). Along the same lines, Anderson et al. (2009) conducted a study that examined the clinical and financial outcomes in 278 patients with surgical site infections due to *MRSA* in seven facilities. The study revealed that 150 or (54%) of all surgical site infections in the patients were due to *MRSA*. The researchers also confirmed that patients with surgical site infections inflicted by *MRSA* were 30 times more likely to be re-admitted in the hospital, 7 times more likely to die, had 16 more hospital stay days after surgery, and accrued more than $60,000 additional hospital charges than the uninfected patients. The patients with surgical site infections due to MRSA had a higher incidence of co-morbid illnesses than the uninfected patients. The excess healthcare cost due to the surgical site infections for patients who had contracted *MRSA* in the seven hospitals was approximately $17 million (Anderson et al., 2009). In addition, a more recent study that estimated annual hospital costs attributable to *MRSA* infections, based on a simulated model, showed that one episode of *MRSA* infection would result to an excess of $25,000; and that in a 200-bed hospital, the annual excess cost would be as high as $500,000 (Cummings et al., 2010). Even though these studies focused on only one strain of pathogens, the findings clearly indicate the impact of antibiotic resistant pathogens on healthcare cost and the unnecessary deaths given the variety of antibiotic resistant pathogens. Taken together, the upward spiral in incidence and costs associated with nosocomial infections suggests the need for a concerted effort in implementation of interventional strategies for reducing the spread of nosocomial infections.

Role of Healthcare Workers in the Transmission of Nosocomial Infections

It has been documented in several studies that healthcare workers could contaminate their hands or gloves with various microorganisms while performing procedures that involve touching the intact skin of patients. Existing literature suggests a strong association between poor

compliance with the recommended infection control guidelines by health-care workers on the one hand, and the transmission of pathogens some of which become resistant to antibiotics and other chemotherapeutic agents. The following sub-sections will address specific examples where healthcare workers were directly involved with the transmission of nosocomial infections.

Role of dental healthcare workers in transmission of nosocomial infections.

It has been established in the literature that several procedures in dentistry are associated with the release of pathogens and that dental procedures produce aerosols and droplets that are contaminated with pathogens. Furthermore, several studies have showed that transmission of the pathogens occurred as a result of contamination from splatters from dental procedures, dental instruments, air and equipment (Monarca et al., 2000; Harrel et al., 2004; Szymanska, 2004, Fulford et al., 2004, Rautemaa et al., 2006).

Monarca and colleagues (2000) conducted a study to evaluate environmental bacterial contamination and procedures used to control cross infection in dental surgeries. Microbial assays for the air, surfaces and water in the dental units revealed higher levels of microbial contamination than the safe or acceptable standards set by the American Dental Association (ADA) and Equivalent Units (EU). The acceptable bacterial counts under the American Dental Association is <200 colonies per milliliter at 37°C and < 10 colonies per milliliter Equivalent Units in water. Bacterial counts in air, water, and syringes yielded 2619 colony-forming units at 37°C and 2843 at 22°C. These bacterial counts exceeded the recommended guidelines for drinking water. Water is used frequently in dental facilities as the dental-care workers (including dentist, hygienists, and dental assistants) perform dental procedures.

The findings in the study by Monarca and colleagues revealed a high rate of infection with *Hepatitis-B Virus* among 13% of the dentists. The study also found that 6% of the nurses and 30% of all dental-care workers were not vaccinated against Hepatitis B virus. Furthermore, over 50% of

the dentists did not use correct decontamination procedures and only 39% had dedicated rooms for decontamination. Many of the clinics did not adhere to best practice guidelines on sterilization of instruments and some did not have sterilization equipment such as autoclaves. Healthcare workers failed to correctly follow the procedures aimed at controlling the transmission of nosocomial infections (Monarca et al., 2000). The lack of sterilization equipment and autoclaves in dental facilities, as documented by Monarca et al., (2000), could be attributed to lack of institutional support and thus lack of commitment to patient safety by the healthcare facilities. These findings further suggest that organizational support would play a significant role in the enhancement of measures deemed necessary for reducing the spread of nosocomial infections, and thus improve the patients' and healthcare workers' safety (Larson et al., 2000). Similarly, many epidemiological studies have documented that nosocomial infections could be transmitted via dental instruments including hand-pieces, air and water, syringes and splatter producing ultrasonic instruments and aerosols (Harrel et al., 2004; Fulford et al., 2004; Szymanska, 2004; Kurita et al., 2006; Rautemaa et al., 2006). Aerosol clouds of particulate matter and fluid contain combination of material and pathogens which originate from the treatment sites or dental unit waterlines (Harrel et al., 2004). Sirnilarly, other studies have documented that bacterial species such as *Legionella* are easily spread through aerosols (Szymanska, 2004); and a study conducted by Harrel documented the existence of *Mycobacterium* species in dental water-lines (Harrel, 2004). Kurita and colleagues (2006) also documented nosocomial transmission of *MRSA* strain in eight patients who received dental surgeries. *MRSA* was identified from post-surgery cultures of specimen collected from the surfaces of dental operation units, water syringes and reclining chairs, while the patients had no evidence of colonization by *MRSA* prior to admission into the dental surgical unit (Kurita et al., 2006). The evidence of MRSA after surgery was indicative of transmission by dental health workers via contaminated equipment in the patients' room or environment.

In 2006, Rautemaa and colleagues conducted a study that investigated bacterial aerosols in a specialist dental care unit. After analyzing the microbial results of the microbes cultured from air, environment and dental equipment (ultrasonic instruments, restorative dentistry fallouts, surfaces of dental chair and cabinets, keyboards and door knobs, and facial masks of dentists and dental nurses) within a two-meter radius, the results showed significant contamination at all distances. The bacterial species present were *S. aureus* and strains of *Streptococci.* There was a difference in contamination level between the rooms where high-speed instruments were used and the rooms where no instruments were used. Facial masks were also contaminated during the use of high-speed rotating instruments (Rautemaa et al., 2006). Another study that examined microbial contamination of dental surfaces, equipment and water systems in dental offices in England revealed that bacterial contamination was in excess of the amounts recommended by the American Dental Association (Fulford et al., 2004).

The findings from studies investigating the transmission of nosocomial infections in dentistry showed the presence of pathogens in aerosols and dental equipment and proved the notion that the pathogens may be easily transmitted during dental procedures. The direct contact between dental care workers, the equipment within patients' surroundings and the patients also increase the opportunities for transmission of nosocomial infections.

Role of physicians in transmission of nosocomial infections.

A plethora of literature suggests that physicians are also involved in the transmission of nosocomial infections; majority of which occurred in patients of all age groups and in different types of surgery: for example, abdominal surgeries, cardiac surgeries, orthopedic surgeries and cesarean section surgeries. Irrespective of age, affected patients or categories of surgical site infections, most patients who underwent surgical procedures were more likely to develop nosocomial infections. Such infections are broadly categorized as Surgical Site Infections (SSI)

and these infections could affect superficial or deep layers of the skin and underlying connective tissue (Smith et al., 2004; Miner et al., 2004; Michalopoulus et al, 2006; Olsen et al., 2008; Eriksen et al., 2009; Kaye et al., 2009; Costello et al., 2010). A study conducted by Miner and colleagues (2004) revealed nosocomial infections among outpatients who had operative procedures involving breast procedures and cesarean sections. For their study, Miner et al. (2004) confirmed infection rates of 2.8% and 3.1% respectively. Alarmingly, among the 104 breast procedures 37% contracted nosocomial surgical site infections and among 204 cesarean sections, 40% acquired nosocomial surgical site infections (Miner et al. 2004).

Other studies have also shown that deep tissue or organ surgical procedures such as those of the heart often create opportunities for development of nosocomial infections with fatal outcomes. Researchers in a prospective case-controlled epidemiological study that evaluated the frequency, characteristics, and predictors of nosocomial infections in 2122 patients after open heart surgery during a 16 month period documented that five % or 107 patients developed nosocomial infections. 45% of the infections affected the respiratory tract and 42% were associated with surgical site infections and central venous catheters. Microbiological assays revealed statistically significant association with post-operative infections. Out of the 107 patients, eighteen or 16.8% died from complications associated with nosocomial infections (Michalopoulos et al., 2006). The findings in the study conducted by Michalopouls and colleagues (2006) are echoed in a subsequent study that documented the impact of nosocomial infections in a retrospective study that examined the effect of surgery in 561 elderly patients (Kaye et al., 2009). In their study, Kaye and colleagues investigated the effect of surgical site infections on mortality, length of hospitalization and associated cost. After analyzing the data, the researchers concluded that surgical site infections were associated with an additional 15.7 post operative hospital stay days,

increase in associated hospital charges in excess of $43,000 and 161 patients died within 90 days post surgery (Kaye et al., 2009).

Epidemiological studies based upon retrospective review of patients' medical charts also revealed that women who underwent cesarean section contracted nosocomial surgical site infections after surgery (Olsen et al., 2008; Eriksen et al., 2009). Olsen and colleagues (2008) conducted a retrospective case-controlled study that identified the risk factors for surgical site infections after cesarean section procedures identified 81 surgical site infections among the 1605 women who underwent cesarean section. The researchers found that patients who had longer durations of surgery and where surgeons used staples to close incisions contracted more surgical site infections than those who had shorter operation time and the incision closures were not stapled. The authors also found that development of subcutaneous hematoma was the strongest independent risk factor for the development of post surgery infections suggesting that presence of hematomas may have provided ideal media for bacterial growth (Olsen et al., 2008).

Similarly to Olsen and colleagues (2008), Eriksen, Saether, Vangen, Hjetland, Lundmark and Aavitsland (2009) conducted a retrospective study that investigated the incidence of surgical site infections after cesarean sections, the risk factors for such infections and the proportion of hospital readmissions as a result of surgical site infections in Norwegian hospitals (Eriksen et al., 2009). Data was collected through self-reports of questionnaires mailed to 3491 women 30 days after surgery. Of the 3491 respondents, 290 or 8.3% experienced surgical site infections; majority of which occurred after hospital discharge. 54 women had deep wound infections, 20 were re-hospitalized and 11 were re-operated. The findings in the study by Eriksen et al. also identified the risk factors that predisposed the patients to surgical site infections to be the duration of the operation. Their findings were based on the fact that patients who developed surgical site

infections while they were in hospital had a longer post-operative hospital stay than those who did not develop surgical site infections (Eriksen et al., 2009).

Given the clearly established modes of transmission of pathogens, the findings in the studies by Olsen et al. (2008) and Eriksen et al. (2009) imply that the longer the operation time and the hospital stay, the more the opportunities to exposure of patients to the pathogens; and the more the contacts between the surgeons and patients, the higher the likelihood of cross-transmission of microorganisms to the patients; and thus, the occurrence of nosocomial infections. Additionally, the findings in the studies by Michalopoulos et al., 2006 and Kaye et al., 2009 affirmed that approaches to wound closure are also risk factors that predispose patients to the pathogens. The presence of hematomas at surgical sites provide ideal medium for the growth (colonization) of the pathogens leading to infections. Therefore, skilled procedures in surgery and wound management should be paramount in preventing occurrence of surgical site infections.

In 2009, Racco and Horn conducted a study that investigated the effect of multidisciplinary team effort in the reduction of nosocomial infections associated with central line catheters (Racco and Horn, 2009). Their study revealed that physicians were non-compliant with practices for infection control during insertion of central line catheters. Specifically, despite the recommended guidelines by CDC, none of the physicians wore a surgical cap during the insertion of the catheters. Racco and Horn (2009) also observed that the use of surgical caps and gowns was not consistent among the physicians. The baseline data showed that the physicians were not only resistant to wearing surgical caps during insertion of the catheters, they were also not convinced that surgical caps were necessary. Each participating physician was given a copy of the CDC's guidelines, which clearly recommended that surgical caps be worn. That initiative and continuous monitoring of the physicians by the units' clinical coordinator, collaboration among healthcare team, in-service education, institutional organizational support, reinforcement and reward led to an overall

increase in compliance from 40% to 80% and significant reduction (83%) of catheter associated nosocomial infections from 6 in 2005 to only 1 in 2006 (Racco & Horn, 2009). These findings support that continuing education and monitoring may provide reinforcement and improve on physicians' compliance with guidelines proven to reduce the transmission of nosocomial infections.

Role of nurses in transmission of nosocomial infections.

It has been documented in many studies that nurses could transmit nosocomial infections as they have the most opportunities for contact with patients. Casewell and Philips (1977) demonstrated that nurses could contaminate their hands with 100 to 1000 bacteria of the *Klebsiella* species during clean patient care activities such as lifting patients, taking pulse, blood pressure, oral temperature or touching patients' hands, shoulder or groin (Casewell et al., 1977). Ehrenkranz and colleagues (1991) also documented that nurses who touched patients' groins heavily contaminated their hands with 10 to 600 colonies per milliliter of bacteria (Ehrenkranz et al., 1991). Furthermore, Pittet and colleagues (1999) conducted a study that utilized microbiological assays to investigate the extent of contamination of healthcare worker's hands before and after direct contact with patients during patient care activities such as wound care, intravascular catheter care, respiratory tract care, and during handling of patients' secretions. The numbers of bacteria recovered from the nurses' fingertips were in excess of 300 per milliliter. These findings indicated that patient care activities that involved direct contact with a patient, particularly during provision of respiratory tract care, most likely contaminated the healthcare workers' hands. Furthermore, the duration of patient care activities was strongly associated with intensity of healthcare workers' contamination with bacteria (Pittet et al., 1999).

Additionally, it has been documented in several other studies that regardless of patient age or healthcare facility or unit nosocomial infections persist. Moreover, the findings in epidemiological studies also clearly suggest that hands are probably the most common mode by

which nosocomial infections are transmitted. It has also been documented in several other studies that healthcare workers could contaminate their hands or gloves with various microorganisms while performing procedures that involve touching hospitalized patients' intact skins. For example, McBryde and colleagues (2004) conducted a study that estimated the frequency of contamination of healthcare workers' gloves with *MRSA* after contact with colonized patient. Healthcare workers were intercepted after a patient-care episode and cultures obtained from their gloved hands before hand-washing occurred. In this study, 17% of transmission of *MRSA* to the healthcare workers' gloves occurred after contact with patients, patients' clothing or patients' bed (McBryde et al., 2004). Since nurses have the most contact with patients, and given the etiology and modes of transmission of nosocomial infections, it is possible to infer that these healthcare workers could play a significant role in the spread of pathogens.

Findings in two studies that investigated the modes of transmission of nosocomial infections in neonatal intensive care units showed that each hospitalized neonate or its immediate environment was touched 78 times during a 12-hour shift. More than half of the contacts were carried out by nurses (Cohen, et al., 2003). As noted by Lepelletier et al. (2005), transient bacteria, which is easily acquired by healthcare workers during direct contact with patients or contaminated environmental surfaces, colonizes superficial layers of the skin and is more amenable to removal by routine hand hygiene (Lepelletier et al., 2005). These findings are consistent with the findings reported by Waters and colleagues (2004) who documented that healthcare workers transmitted pathogens via hand contact in 42% of cases (Waters et al., 2004).

Lucet and colleagues (2002) have documented severe contamination of healthcare workers' hands after contact with patients and patients' body fluids or waste during routine patient care activities. Interestingly, a qualitative assessment revealed a 4.3% existence of pathogenic bacteria on healthcare workers' hands even after hand hygiene practices (Lucet et al., 2002).

Additionally, a study by Pessoa-Silva and colleagues (2007) showed that the use of gloves during nursing care activities reduced the numbers of bacteria on the healthcare workers' hands by half (Pessoa-Silva et al., 2007). Similarly, Hyden and colleagues (2008) conducted a study that investigated contamination of healthcare workers who cared for patients with *Vancomycin Resistant Enterococci (VRE).* The findings in this study revealed that 70% of healthcare workers contaminated their hands or gloves by touching the patients and objects in their environment (Hyden et al., 2008). Altogether, these findings suggest that in order to completely minimize the transmission of the pathogens, hand hygiene practices should be coupled with other protocols - such as the use of gloves, while patient care activities are being performed.

Aly et al., (2005) evaluated the role of aseptic precautions used for intravenous line management among 536 low birth weight infants at neonatal intensive care units. In their study 233 very low birth weight infants and 169 neonates were admitted before the implementation of aseptic precautions, and 367 were admitted after changes in procedural care for venous catheters and central line tubes were put in place. The results revealed a significant decrease in the incidence of blood stream infections among neonates when aseptic precautions were implemented. Therefore, it is possible to infer that adherence to and implementation of aseptic precautions by healthcare workers contributed largely to the reduction of nosocomial infections in the neonates Aly et al., (2005).

Along similar lines, de-Oliveira and colleagues (2005) conducted a study to determine the extent and mechanism of transmission of *Hepatitis C Virus (HCV)* among 842 patients who had received medical care at a Hematology / Oncology clinic during a nine-month period. This retrospective study used case findings and abstraction of data from medical records to identify all patients who had visited the clinic during the nine-month period and offered them free testing for the *HCV*. It was found that propagation of the virus was a result of reuse of disposable syringes

and contamination of shared saline bags. 99 patients who received care at the clinic contacted *HCV* and further investigation revealed that the outbreak originated from one patient with chronic *HCV* and had received saline flushes on a previous day. Interestingly, a single nurse was responsible for all catheter care, saline flushes, collection of blood specimen and infusion. The findings by de-Oliveira et al. (2005) showed a strong connection of healthcare workers with the propagation of nosocomial infections, and further suggest a strong association between poor compliance to recommended infection control practices and the transmission of the pathogens. The findings further showed that even one nurse can play a major role in the transmission of nosocomial infections.

The findings in the studies that linked healthcare workers with the propagation of nosocomial infections suggest that proper application of aseptic precautions by healthcare personnel could have an impact in the reduction of the spread of nosocomial infections. Furthermore, the findings in those studies also affirm that improvement in hand-hygiene compliance and incorporation of recommended practices into nursing care protocols are pivotal in reducing nosocomial infections. One wonders whether cognitive factors such as education, behavioral factors at the individual level, or organizational factors play a role in limiting healthcare workers' prudence in their performance of patient care activities.

Knowledge and Attitudes of Healthcare Workers

The importance of education as a measure to prevent nosocomial infections is implied in numerous studies. Studies exploring the knowledge, perceptions and attitudes of healthcare personnel towards the transmission of nosocomial infections in different patient groups suggest that education plays an important role in the prevention and spread nosocomial infections (Angelillo et al., 1999). Angelillo and colleagues (1999) launched a study to determine the disinfection and sterilization practices used in hospital operation units and at the same time evaluated the

knowledge and attitudes of 216 nurses from 16 hospitals over a three month period. The authors used a survey that included items related to knowledge and attitudes. The responses related to knowledge were evaluated on a five-point Likert scale and responses assessing the techniques for barriers were based on five-answer scale. Regression analysis was used to determine the association between the variables significantly associated with the model that included knowledge, disinfection and sterilization procedures, use of masks, and the use of barrier techniques.

A majority of the survey respondents learned about measures to prevent nosocomial infections from continuing education courses, colleagues and mass media. 95% of respondents indicated the desire to learn more about the transmission and prevention of nosocomial infections. Altogether, the findings in this study revealed that some nurses lacked broad knowledge about procedures regarding disinfection and sterilization of surgical instruments, and the precautions necessary to reduce nosocomial infections. These findings suggest that effective educational programs that target increasing the awareness of transmission, prevalence and protocols aimed at prevention of transmission of nosocomial infections by the healthcare workers could play a significant role in lowering the occurrence of these infections.

Along similar lines, Monarca and colleagues (2000) conducted a study to evaluate environmental bacterial contamination and procedures used to control cross infection in dental surgeries. They also assessed the knowledge, attitudes and behavior of 133 dental personnel toward infective practices. Their study revealed a high rate of infection with *Hepatitis-B Virus* among dental health workers. Furthermore, they also found that 13% of the dentists, 6% of the nurses and 30% of all dental-care workers were not vaccinated against *Hepatitis B virus* and over 50% of the dentists did not use correct decontamination procedures. Only 39% of clinics had dedicated rooms for decontamination and many of the clinics lacked regulations on sterilization of instruments. Worse still, some clinics lacked sterilization equipment such as autoclaves. In

summary, it appears that the administration did not provide the dental facilities with the equipment necessary to decontaminate their instruments, and healthcare workers failed to comply with the recommended guidelines, and to practice the procedures aimed at controlling the transmission of nosocomial infections (Monarca et al., 2000).

Findings from this study suggest that lack of protective procedures was strongly associated with the occurrence of nosocomial infections, and more importantly, the failure to follow aseptic precautions was attributed to a lack of educational knowledge about prevention and transmission of nosocomial infections. Based upon these findings, an educational program was developed. It targeted an increased awareness of infection control practices in dental units. The educational program also raised the awareness of nosocomial infections, their causes, modes of transmission and prevention. However, its effect was not assessed (Monarca et al., 2000).

Lam and colleagues et al. (2004) looked at healthcare workers' compliance with hand hygiene following interventions. Specifically, the interventions utilized by Lam and colleagues included protocols on problem-based and task-oriented hand hygiene education, handling and nursing care, clustering on nursing care, provision of alcohol-based antiseptics, regular hand hygiene audit, and implementation of health care-associated infection surveillance system for one year. A benchmark for which to evaluate and investigate factors for non-compliance was established and the health care workers received training on hand hygiene, protocols on minimal handling and provisions of ample alcohol-based hand antiseptics. A post-intervention observational assessment, repeated six months after the intervention, revealed that the nurses demonstrated increased compliance in hand hygiene before and after patient contact during high-risk procedures. There was a marked decrease in the rate of nosocomial infections and length of hospital stay days. Stay days decreased from 11.3 days to 6.2 per 1000 patient-days. These findings suggested that problem based and task-oriented educational programs used to increase

knowledge can improve hand hygiene compliance and consequently, the spread of nosocomial infections.

Similar to the study by Lam and colleagues (2004), Berhe et al., (2005) used self-reports to evaluate 324 healthcare workers' perceptions of adherence to infection control practices, motivational factors for compliance and their beliefs regarding the etiology and prevention of nosocomial infections. The categories of healthcare workers who participated in the study included attending physicians, registered nurses, practical nurses and patient care assistants. Berhe et al., (2005) found that over 65% of healthcare workers reported high self-compliance with infection control practices such as hand hygiene, contact isolation, and airborne isolation. However, registered nurses reported better compliance with contact isolation than other healthcare workers. For example, 77% of them reported greater than 80% compliance in performance of hand hygiene before and after patient contact. The key motivating factor for their compliance with hand hygiene was patient safety. The study also revealed poor healthcare workers' knowledge about the causes, spread and prevention of nosocomial infections. Fewer than 37% of them identified the etiology of nosocomial infections as cross-contamination, invasive procedures and co-morbidity. 83% felt that greater than 40% of nosocomial infections are preventable. These findings raise an enigma given the fact that at the time of their graduation, healthcare practitioners - such as registered nurses have acquired sufficient knowledge and skills to identify issues or conditions that would compromise the standard of care, and ultimately, patient safety (IOM Report, 2001; Tanner, 2006; & Cronenwett et al., 2007).

Pittet et al., (2004) explored the factors for non-adherence, beliefs and perceptions associated with hand hygiene among 163 physicians. The study used a self-reported questionnaire with categories that measured the individual's beliefs and perceptions. Adherence to proper hand hygiene and its lack thereof were measured through direct observations of physicians'

hand hygiene practices during routine patient care. The researchers found that adherence to hand hygiene varied across medical specialties and non-adherence to hand hygiene was also attributed to high workload and procedures used in surgery, anesthesiology, emergency and intensive care units (Pittet et al., 2004). It was observed that moderate adherence to hand hygiene (57%) was associated with physicians' awareness of being observed, beliefs of being positive role models for other colleagues, positive attitude toward hand hygiene after patient contact and availability of hand rubbing solutions (Pittet et al., 2004). However, direct observation of the physicians may have influenced adherence to hand hygiene and use of self – reports may have affected generalizability of the study results.

The findings in the study by Pittet and colleagues mirror the findings of an earlier study by Girou et al. (2002). Girou and colleagues (2002) conducted a prospective randomized blind study that evaluated the efficacy of hand rubbing with alcohol-based solution to standard hand washing with conventional antiseptic soap among 23 nurses who worked in three intensive care units over a 30-day period. The participants were previously instructed in the use of alcohol-based solution one year prior to the implementation of the study. Written protocols of hand hygiene practices were available in each unit. The researchers monitored the patient care activities that necessitated hand hygiene practices and the practice performed by the healthcare workers. Data was collected regarding patient care activities such as: use of gloves, opportunities for hand hygiene (based on established guidelines), number of actual hand hygiene procedures performed and duration of the use of antiseptic material. Whenever an opportunity for hand hygiene occurred, the researchers took imprints of fingertips and palms for the participants' dominant hands before, and one minute after the procedures and inoculated in agar plates. If the participants wore gloves during the procedure, the gloves were removed before collection of fingertip imprints. It was found that the causative pathogens were *S. aureus* (Girou et al., 2002). The results also revealed that hand

rubbing with an alcohol based solution was more efficient than hand-washing with conventional antiseptics soap in reducing bacterial contamination of healthcare workers' hands during routine patient care activities. Accordingly, it was suggested that the use of alcohol-based solutions may be included in educational techniques as a mechanism for reducing the spread and occurrence of nosocomial infections.

Studies have shown that education plays a pivotal role in reduction of transmission of nosocomial infections. For instance, Ribby et al. (2005) examined the patient care outcomes after implementation of nursing care activities, following an educational training program for nurses. Changes in policies and practice were integrated into the nursing orientation and additional skills checklists were updated. There was a marked improvement in compliance with nursing protocols after staff education. At the start, there was 4% compliance in one nursing unit and after one year, compliance with nursing protocols on insertion of Foley catheters ranged from 93% to 100% (Ribby et al., 2005). The findings in the study by Ribby and colleagues (2005) further confirms that education and staff development activities would improve the outcomes of nursing care by reducing the occurrence and spread of nosocomial infections.

Along similar lines, Suchitra et al. (2007) investigated the impact of education on knowledge, attitudes, and practices among various categories of health care workers regarding nosocomial infections. The researchers administered a questionnaire to the healthcare workers before and after an education module where they evaluated post-intervention at three time intervals: 6, 12 and 24 months. The study revealed an improvement in compliance immediately post education period; however, the compliance declined over time when educational reinforcement was not provided. The researchers also found that poor compliance with hand washing practices was largely attributed to lack of experience and knowledge of guidelines set by the institution, high work load, lack of role models among senior staff, and lack of rewards (Suchitra

et al., 2007). These findings suggest that continued education could have an impact on retention of knowledge, attitudes and practices in healthcare workers with regards to infection control compliance.

Interestingly, in spite of education and significant increase in post education scores, physicians were still the least compliant of all healthcare workers (Suchitra et al., 2007). The authors suggest that the need for effective and sustained educational programs is imperative in order to reduce the transmission of nosocomial infections. Thus, additional studies that examine different facets of knowledge, attitudes and practices of registered nurses and the role of organizational support towards transmission of nosocomial infections are important in developing interventions to reduce occurrence of these infections.

In 2001, a report on United States healthcare system issued by the Institute of Medicine (IOM) revealed many faulty areas in the system as a whole. The report identified some competencies that healthcare workers should possess in order to enhance quality of care. It also highlighted areas in the healthcare education where significant competencies were needed (IOM, 2001). One of the faulty areas identified was in nursing education. Since nurses have a critical role in the delivery of quality and safe patient care, this set the impetus for which the curriculum for nursing education should be structured or transformed.

Along the same lines, the curriculum for nursing education underwent a paradigm shift towards evidence based outcomes. A review of literature that examined clinical judgment in nursing using 200 studies showed that clinical judgment was affected by the knowledge nurses bring into the patient care situation, the context in which the situation occurs, and the culture of the nursing care unit (Tanner, 2006). Furthermore, the author noted that student nurses developed and expanded their clinical knowledge when subjected to nursing care activities that triggered events for reflection. It was observed in a study that examined the impact of reflection and

articulation in clinical setting that reflection and articulation improved judgment and clinical reasoning in the nursing students in clinical settings (Murphy, 2004).

Later on, Cronenwett et al. (2007) proposed a conceptual framework entitled Quality Safety Education for Nurses (QSEN) that comprised six core competencies for nursing education with a goal to improve outcomes of nursing practice and ultimately, patient care. According to the QSEN framework, pre-licensure nursing students must become proficient in six core competencies identified in the IOM report. These areas include patient-centered care, team work and collaboration, evidence-based practice, quality improvement, safety and informatics; along with basic knowledge, skills and attitudes required in each of the essential competencies (Cronenwett et al., 2007). Additionally, Cronenwett and colleagues (2007) suggested that nursing students should be able to understand both human and system factors that contribute to unsafe practices, analyze sources of errors, and adopt processes to prevent the incidence and adverse outcomes of patient care. Also, that the graduates should be able to examine system and human factors, basic safety design principles commonly used for safe nursing practices, participate in analyzing errors, value their own role in preventing the errors and promote patient safety (Cronenwett et al., 2007). MacIntyre et al. (2009) made recommendations on nursing education where clinical experiences required strengthening and they outlined specific areas where outcomes for education and practices were necessary. Other studies also indicated that nursing students would seek assistance from experienced nurses and may experience influence of peer pressure and role models during the clinical settings (Sherwood et al., 2007; Chenot & Daniel, 2010).

It appears that the core competencies are included in content domains for the nursing curriculum, and demonstration of their mastery is required for licensure and certification for all registered nurses (Tanner, 2003 & Smith, 2007). Therefore, it is possible to infer that since the nurse education curriculum and instructional design include implementation strategies whose

pedagogy focuses on didactic instruction and related clinical experiences; and mastery of these competencies is assessed at the time of their licensure, the graduate registered nurses are adept in protocols aimed at reduction of transmission of nosocomial infections and thereby patient safety. This inference creates an enigma as to whether these healthcare workers become non-compliant over time due to a decrement in knowledge and skills gained during their course of study or because of modeling after other non-compliant colleagues during their performance of patient care activities.

Behavioral Perspectives

One of the key components that limit the spread of nosocomial infections is the compliance with infection control practices by healthcare workers. Therefore, the social cognitive models can be applied to evaluate behavioral determinants of healthcare workers towards hand hygiene practices; and thus, the spread on nosocomial infections. Studies that investigated the association between cognitive factors and workload in a nursing unit and the nurses' compliance with hand hygiene practices showed that perceived behavioral control and intention were significant predictors of hand hygiene practices (O'Boyle et al., 2001). Additionally, findings from some studies suggest that motivating factors for compliance with hand hygiene practices among healthcare workers included perceived behavioral control and intention (Lankford et al., 2003; Pittet et al., 2004; Sax et al., 2004; Pessoa-Silva et al., 2007). For example, Lankford et al. (2003) conducted an observational study that examined the factors influencing adherence to hand hygiene practices among healthcare workers only to find that healthcare workers were significantly less likely to wash their hands if they were in a room with a peer or higher ranking person who did not perform hand hygiene (Lankford et al., 2003). Similarly to Lankford and colleagues (2003), studies conducted by Pittet and colleagues (2004) and Sax et al. (2007) showed that the key determinants for compliance with hand hygiene practices were behavior of other healthcare workers, normative

beliefs, control beliefs and attitudes (Pittet et al., 2004; Whitby et al., 2006 & Sax et al., 2007). The determinants construed as predictors for compliance with protocols for reduction of transmission of nosocomial infections included perception of being a role model, peer pressure (stemming from perceived expectation from colleagues), perceived positive opinion or pressure from superior or important referent - such as administration, perceived control over hand hygiene behavior, positive attitude towards hand hygiene after patient contact, perceived risk of infection during patient contact or perceived high public health threat and beliefs in benefits of performing hand hygiene and protection of healthcare workers from infection. The findings in these studies confirm that it is also possible to consider behavioral perspectives as essential contributors to healthcare workers' non-compliance with recommended protocols for safeguarding the spread of nosocomial infections. Therefore, such factors should be considered as relevant attributes during the planning and implementation of quality patient care.

Findings in the literature also suggest that lack of knowledge, experience and education, lack of rewards or encouragement, lack of role models from colleagues or superiors, lack of institutional priority for hand hygiene, lack of active participation in hand hygiene promotion at the individual and institutional level, and lack of institutional guidelines contribute significantly to low compliance with hand hygiene practices among healthcare workers (Larson et al, 2000; Pittet et al, 2000; Boyce & Pittet, 2002; Suchitra et al., 2007). Again, since nurses are among healthcare workers with the most contacts with patients, understanding how organizational support impacts on their knowledge, attitudes and practices regarding nosocomial infections might be the best line of approach in addressing the obvious gap in the literature regarding the spread of nosocomial infections.

Role of Organizational Support

One of the key components for limiting the spread of nosocomial infections is increased compliance with infection control practices by healthcare workers. However, findings from behavioral studies significantly link infection control practices and the spread of nosocomial infections with factors directly related to healthcare facilities' management or organizational support; such as, inadequate nurse staffing and inadequate supply of necessary medical equipment (Monarca et al., 2000; Aiken et al., 2004; Sochalski, 2004; Vahey et al., 2004, Huggonet et al. 2007; Hayden et al., 2006 & Pessoa-Silva et al., 2007; Saint et al., 2007; Cronin et al., 2008; Creedon et al., 2008; Glance et al., 2012; Cimiotti et al., 2012). Hugonnet and colleagues (2007) conducted a prospective cohort study that investigated the effect of workload on infection risk in critically ill patients at a single-center. All patients at risk for intensive care unit-acquired infections were followed daily, 5 days a week, by an infection control nurse until the patients' discharge. Since nosocomial infections manifest themselves after 48 hours, only the data on patients who stayed longer than 48 hours was used for analysis. Their findings revealed 686 infections in 415 patients. Furthermore, many patients developed at least one nosocomial infection while in critical care unit and analysis of data revealed an overall infection rate of 64.5 episodes per 1000 patient days, a mortality rate of 36.2 among the infected patients and a median length of hospital stay of 28 days (Hugonnet et al., 2007). In their cohort study, the researchers also found that one of the key determinants of occurrence of nosocomial infection was low staffing level (Hugonnet et al., 2007).

Along the same lines, findings in studies conducted by Aiken et al. (2002), Sochalski (2004), Cimiotti et al. (2012) and Glance et al. (2012) also showed that inadequate nurse staffing was associated with high workload and consequently contributed to nurse burnout and adverse patient outcomes; such as, increased occurrence of nosocomial infections and deaths.

Additionally, findings in a national study that investigated the practices for preventing urinary tract nosocomial infections in 719 intensive care units among federal and non-federal US hospitals showed inconsistencies in strategies used to reduce the occurrence of urinary tract infections (Saint et al., 2008). The findings in the study showed inconsistencies in: a) training programs, b) certification in infection control practitioners, c) urinary catheter teams, d) levels in registered nurses' staffing, e) uniform practices for monitoring placement of urinary catheters, and f) surveillance of incidence of urinary tract infections (Saint et al., 2008). The analysis of data also showed that residency training was significantly associated with the use of reminders for use of urinary catheters, and that the hospitals with infection control practitioners implemented measures for reducing occurrence of nosocomial infections, such (measures) as the use of antimicrobial urinary catheters and portable bladder ultrasound scanners. However, the hospitals without infection control practitioners did not implement such measures.

It has been documented in the literature that use of antimicrobial urinary catheters reduced the risk of urinary tract infections (Brosnahan et al., 2004) and that bladder ultrasound scanners are ideal non-invasive medical instruments used to detect urinary retention in patients. Urinary retention creates opportunities for bacterial colonization and the development of urinary tract infections, thus necessitating the need for catheterization (Saint et al., 2006). Furthermore, because bladder ultrasound scanners accurately measure the patient's urine volume; their use reduces the chances of intermittent catheterization - consequently reducing the risk of urinary tract infections (Sparks et al., 2004).

Epidemiological studies have established that urinary tract infections account for almost 40% of all nosocomial infections and the daily risk of acquisition of these infections ranged from 3% to 7% when indwelling urethral catheters remained in situ. Furthermore, it has been documented in the literature that minimization of catheter use is among the strategies to reduce catheter –

associated urinary tract infections (Lo et al., 2008). Yet, the study by Saint et al., (2008) found that only 44% of the participating hospitals had a system for monitoring which patients had urinary catheters place. About 70% to 75% of hospitals did not routinely monitor the duration and /or discontinuation of urinary catheters, and only 30% of the participating non-federal hospitals had established surveillance system for monitoring urinary tract infections. About 36% of the hospitals that participated in the study did not provide feedback on urinary tract infections to direct care providers and 99% did not have a urinary catheter team (Saint et al., 2008). These findings suggest that despite the well documented incidence, etiology, risk factors and impact of nosocomial infections of the urinary tract, many institutions have lax efforts in pivotal organizational measures deemed necessary for the reduction of nosocomial infections. For example, the survey respondents reported that participating hospitals had insufficient ultrasound bladder scanners, few infection control personnel, and that few hospitals implemented surveillance system to monitor urinary tract infections. These findings support the notion that the management of healthcare facilities and the provision of proper equipment and tools could positively impact healthcare worker's prudence in delivery of quality patient care; thus decreasing the spread of nosocomial infections.

Summary

The occurrence, undesirable complications, and overall impact of nosocomial infections have been well documented in the literature. These infections continue to pose major problems to healthcare nationally and internationally as they increase hospital stay days, contribute to deaths, increase costs of healthcare and pose economic hardship to patients and their family. The modes of transmission, prevalence and causative agents of nosocomial infections are also well understood. A plethora of literature clearly shows that healthcare workers are responsible for the transmission of nosocomial infections. Besides, studies that have investigated adherence to

infection control practices provide evidence that these infections can be reduced by concerted and targeted educational initiatives which emphasize adherence and implementation of infection control practices by healthcare workers.

Since it has been documented in the literature that nosocomial infections result from a high prevalence of pathogens, susceptible hosts and efficient mechanisms of transmission from patient to patient, the best chance of controlling the transmission rests with a well-trained cadre of healthcare workers. The curricula in allied health majors are based on the ideology that a person's behavioral interactions are influenced by one's thoughts, emotions and actions. Furthermore, it has been demonstrated in the literature that at the time of their graduation, nurses are adept in both knowledge and skills necessary to control the occurrence and propagation of nosocomial infections. Moreover, existing social cognitive theories show that intentions are determined by attitude towards behavior, and are determined by the individual's beliefs about the consequences of performing the behavior.

In addition, it has been demonstrated in the literature that not only does compliance with recommended guidelines for reducing transmission of nosocomial infections play a pivotal role in the prevention of the spread of infections but also contextual factors - such as inter-organizational collaboration, organizational innovativeness, money and workload influence nursing practices with regard to compliance. Given that nurses have greatest opportunity for contact with patients; it is important to investigate their knowledge, attitudes and practices towards the reduction of nosocomial infections. The findings from this study will add to existing literature and can be used to further develop interventions to reduce the incidence of nosocomial infections and alleviate the many undesirable effects and improve patient safety outcomes.

Chapter III

METHODOLOGY

Design

The design of this study was exploratory, cross-sectional and descriptive. The researcher did not attempt to control or manipulate the variables under study, but rather examined how the variables varied with respect to each other.

Participants

Participants were recruited from a target population that included healthcare workers under the category of registered nurses. The participants were men and women aged 20 years or older recruited from databases of registered nurses obtained from Essex County College. The database had more than 2000 members of alumni graduates from the nursing program. Because Essex County College offers an Associates in nursing with most of the graduates advancing their education and earning a Baccalaureate degree or Master's degree, it was speculated that some of the registered nurses would fall into any of the following educational categories: Associates in Nursing (AS), Bachelor's in Nursing (BSN), Masters in Nursing (MSN) or higher. In addition, the registered nurses in this data base were asked to forward the survey to other registered nurses using the snowball sampling technique in order to increase the diversity of the sample and its size. Recruitment flyers were also displayed on general information boards at Essex County College, calling for volunteer registered nurses to participate in the study.

Inclusion / Exclusion Criteria

Only healthcare workers categorized as Registered Nurses (RN) and holding an active RN license, irrespective of the job classification or work setting, were eligible to participate in this study. In order to earn the credentials of a registered nurse, the individual must have completed a nursing educational program and must have passed a licensing examination (NCLEX-RN) (http://www.nln.org). The participants were required to read English and be knowledgeable in the use of computers - including the use of electronic-communication (e-mails).

Registered Nurses work in different settings providing direct patient care to newborns, children and adolescents, adults or the elderly in critical healthcare settings. They also work in non-critical healthcare settings where they provide basic health care to patients in outpatient clinics, ambulatory care centers, schools, military, or correctional facilities. Furthermore, RNs work in other specialties that do not involve direct patient care such as forensics, education and informatics. Healthcare workers not categorized as registered nurses were excluded from the study. This study was approved by the Institutional Review Boards of Essex County College and Seton Hall University.

Sample Size

An a *priori* power analysis was used to determine the sample size appropriate to achieve adequate power using G*Power 3.1. A *p* level of 0.05 with a power of .95 and an effect size of 0.5 was used to calculate sample size. The minimum sample size required in this study was 248. This number was also based upon the number of variables studied.

Survey Instrument

A validated questionnaire that was developed by the principal investigator (Appendix C) was used as the survey tool in this study. The questionnaire was constructed from emergent themes reviewed in the literature (de-Oliveira et al., 2005; Edwards et al., 2009; Ribby et al., 2005;

Pittet et al., 2009; Pessoa-Silva et al., 2007; Sax et al., 2007) and items derived from established guidelines set by a task force committee on Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA (Boyce et al. 2002; WHO, 2002; McKibben et al., 2005). The information for completing each section and designation of the scale used were included at the beginning of each section. Demographic information and items regarding organizational support were included in section 1. Statements relating to the three domains: Knowledge, Attitudes and Practice were included in sections 2, 3 and 4 respectively (Appendix C).

After determining that the content validity of the questionnaire was good and internal consistency (item reliability) coefficients were acceptable (Nunnally, 1978; Robinson et al., 1991), the final questionnaire was ready for administration to the larger group of registered nurses.

Procedure

After IRB approval was obtained from both Seton Hall University (Appendix D) and Essex County College (Appendix E), the principal investigator posted recruitment flyers on bulletin boards at Essex County College (Appendix F). In addition, an e-mail invitation to registered nurses' in the alumni databases of Essex County College calling for participation by eligible nurses - as per set inclusion criteria. The e-mail also contained a link to the survey which was housed on Seton Hall University's website entitled "*Academic Survey System and Evaluation Tool (ASSET)*" for the participants who chose to participate (Appendix G). In addition to the snowball recruitment process, the e-mail also contained the following clause: " *....If you know anyone who is a registered nurse, please forward this e-mail to him / her.* To avoid duplication of surveys by participants who were involved in the development of the instrument, the invitation letter contained the following clause: " *....If you already have completed this survey please do not complete again....*"

Additionally, all participants were informed that they had the option to accept or decline to participate in the study as well as complete the online version or print it out and return the completed questionnaire. Participant's voluntary submission of the completed questionnaire was considered as their consent. Data was compiled and response items coded for analysis. Figure 1 provides a schematic flow of the procedure followed in the administration of the survey.

Figure 1

Schematic Flow of Procedure

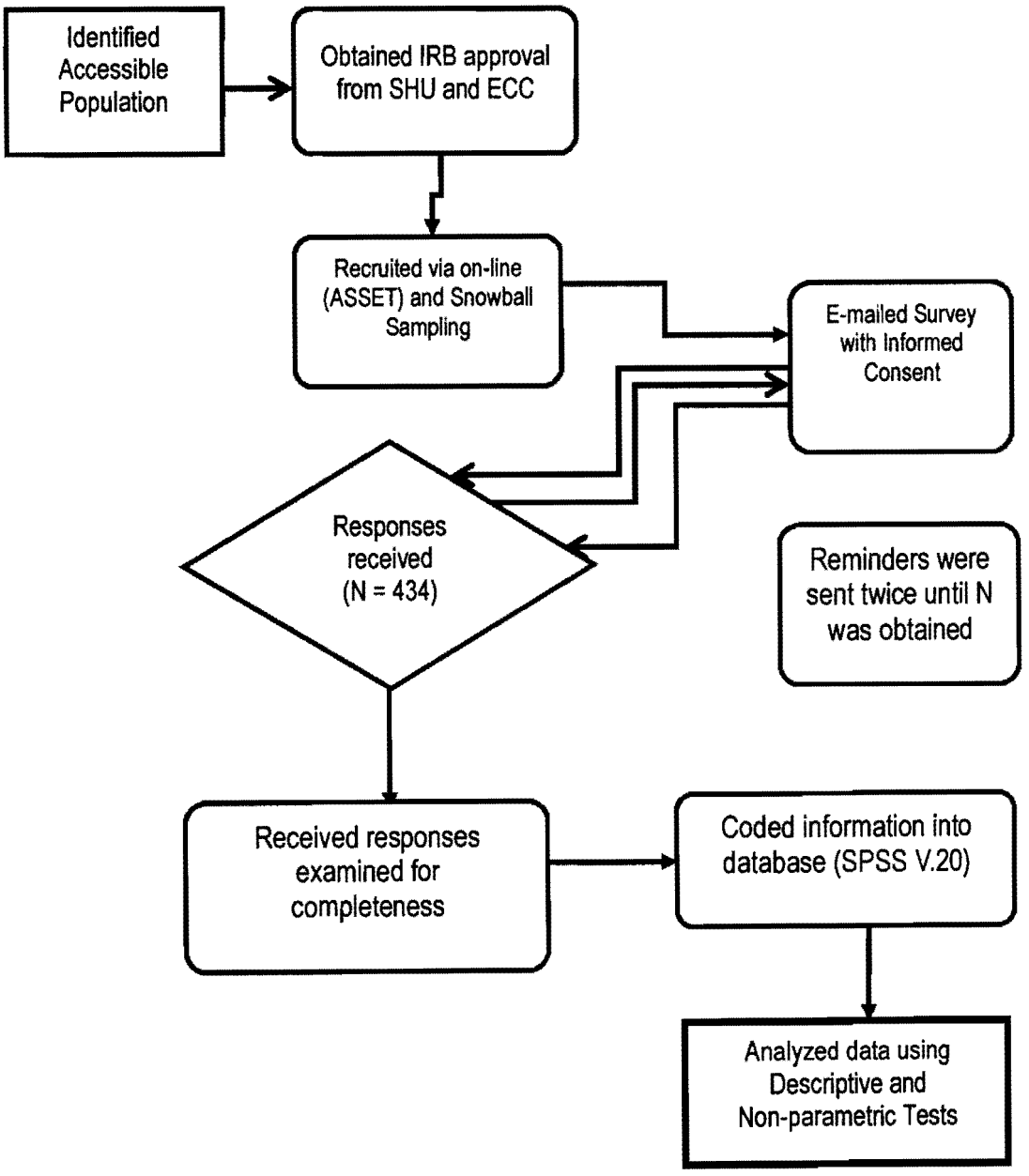
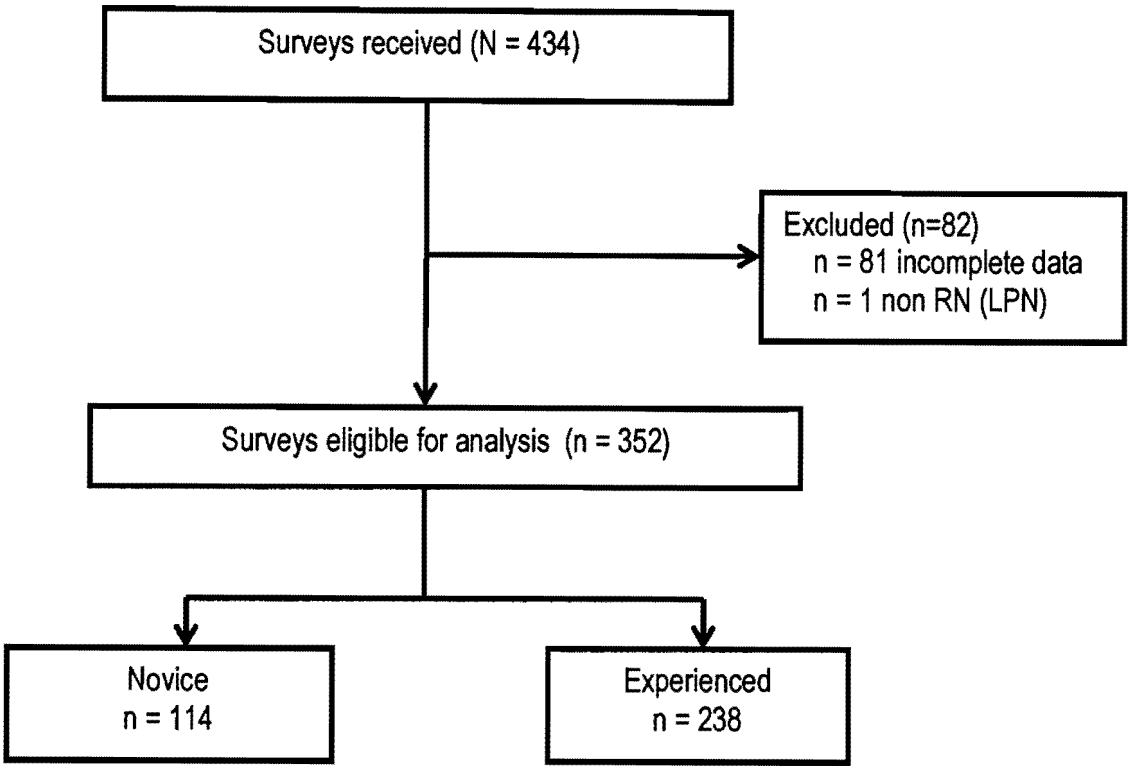


Figure 2 provides an illustration of the flow of data collection.

Figure 2

Schematic Flow of Data Collection



Data Analysis

Data was analyzed using both descriptive and inferential statistics using IBM SPSS Version 20.0. Demographic characteristics (Section 1) was presented in tabular form using descriptive statistics and reported as means, median, standard deviation, frequencies, percentages and presented as bar charts. The level of data for sections 2, 3 and 4 was ordinal scale. Therefore, inferential statistics – specifically for non-parametric statistics was used. For example, the Mann-Whitney U was used to test if differences between the two groups (novice and experienced registered nurses) existed. Spearman's rho was used to examine if a relationship existed between organizational factors and the nurses' level of knowledge, attitudes and practices with regard to the spread of nosocomial infections.

Chapter IV

RESULTS

Overview

This cross-sectional and descriptive study investigated the Knowledge, Attitudes and Practices of novice and experienced registered nurses with regard to the spread of nosocomial infections. It also examined if a predictive relationship exists between Organizational support and the level of nurses' knowledge, attitudes and practices. Data was collected in two ways: on-line survey, and mailed paper and pen / pencil survey format over a 6-month period. The survey was completed by registered nurses aged 20 years or older recruited from databases of alumni from the nursing program at Essex County College and by using a snowball sampling technique. A total of 434 responses were received. Of the 434 survey responses received, 81 (18.7%) were incomplete and 1 survey respondent did not meet the inclusion criteria thus leaving a total of 352 (81.1%) valid surveys for analysis with descriptive and inferential statistics using SPSS Version 20 (IBM Corporation, 2011).

This chapter presents the results of the analysis of all valid responses and is divided into six sections. The first section presents descriptive statistics for the demographics. The second section contains descriptive statistics on the participants' Knowledge, Attitudes and Practices with regard to the spread of nosocomial infections. The third section reports the results on comparison of Knowledge, Attitudes and Practices between novice and experienced registered nurses regarding the spread of nosocomial infections and compares the relationship between these variables. The fourth section reports the responses of registered nurses regarding organizational

support. The fifth section reports the results on relationship between organizational support and the registered nurses' Knowledge, Attitudes and Practices nurses with regards to spread of nosocomial infections. The last section offers a discussion of the study findings from the perspectives of the registered nurses' Knowledge, Attitudes and Practices; addresses the impetus behind the findings and relates the findings with recent data on Nosocomial Infections from the Centers for Disease and Control.

Section 1

Demographics

Table 1 presents the study participants' age. Table 11 (in the Appendices) presents additional demographic categories of the survey respondents. More than half of the participants were above the age of 45 years (n = 196, 56%). In terms of gender, about 30% (n=105, 29.8%) were males and 247 or 70.2% were females.

Table 1

Participants' Age: Means and Standard Deviations (n = 352)

Variable	Range	*M*	*SD*
Age	25 - 63	48.07	8.74

Note. M = Means SD = Standard Deviation

In terms of nursing education, more than half of the respondents (n=195, 55.4%) possessed bachelor's (BSN) degree compared to those with associate's degree (n=105, 29.8%). Respondents with master's (MSN / MA) degree were 38 (10.8%) and a small number of respondents held other degrees such as DNP or PhD (n=14, 4%). Also, many respondents (n

=283, 80.4%) had participated in in-service training within the last two years and 46% (n=162) had served as preceptors for at least six months.

In terms of their employment, about three-quarters of the respondents (n=267, 75.9%) worked in specialty departments within hospital settings. Majority of them worked in Medical / Surgical departments (n=157, 44.6%) and about a third (n=110, 31.3%) worked in emergency departments. Other respondents worked in specialties such as psychiatric units (n=38, 10.8%), maternal labor (delivery), pediatrics / neonatal (n=37, 10.5%). Other respondents worked in healthcare specialties such as Long Term Care Facilities (LTCF), and educational institutions as school nurses, or in physician's offices and department of corrections (n=10, 2.8%). Majority of the respondents (n=250, 71%) were employed on a full-time basis, while few (39, 11.1%) were employed on a part-time basis and17.9% (63) worked per-diem. 67.6% (n = 238) had more than 3 years of experience as registered nurses while 114 or 32.4% had less than 3 years of experience.

Section 2

RNs' Knowledge, Attitudes and Practices Regarding the Spread of Nosocomial Infections

The corresponding research question to this section was, "What is the overall level of Knowledge, Attitudes and Practices in registered nurses with regard to the spread of Nosocomial infections?" In order to address this research question, descriptive statistics, specifically percentages were used to calculate the overall score for each category and the corresponding categorical items respectively. The results are presented in table format and with figures embedded in each respective section.

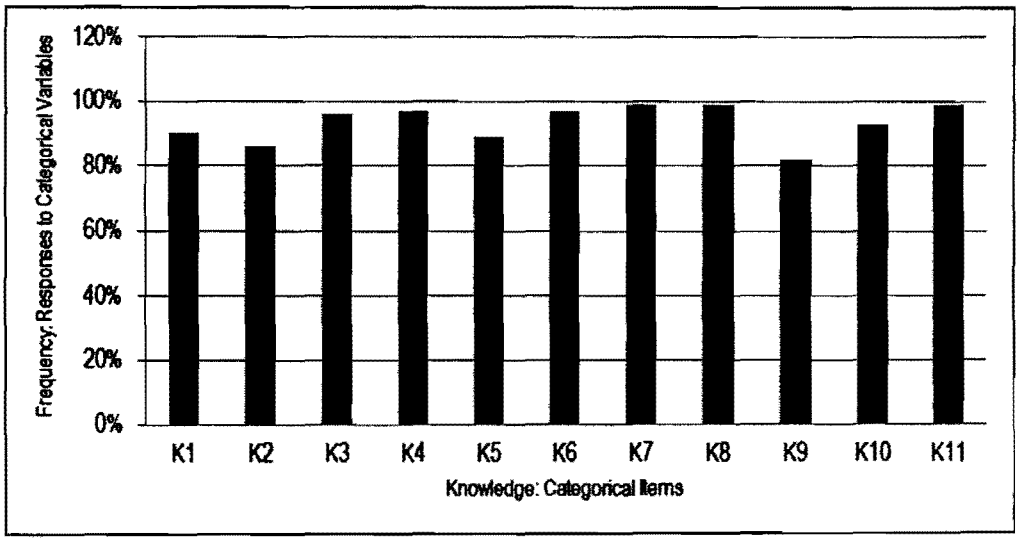
RNs' Knowledge regarding the Spread of Nosocomial Infections

The overall total score for Knowledge category was 93%. As reflected in figure 4, many respondents (n =337, 95.7%) were knowledgeable about etiology modes of transmission and risk factors of nosocomial infections (K3) and (n=318, 90.3%) stated that they were fully aware of the

hand-washing guidelines (K1). A very high number of respondents (n = 348, 98.9%) knew that Nosocomial Infections could be transmitted via fomites (K7) and a high number (n =328, 93.2%) indicated that they knew the opportunities for hand-hygiene (K10). A large number of respondents (n =340, 96.6%) were fully aware of safety precautions for the disposal of used medical equipment such as needles, syringes and catheters which are often associated with the spread of infections (K6). An overwhelming number of respondents (n=347, 98.6%) agreed with the statement that immune-compromised patients, for example; those with communicable diseases of the respiratory system or those patients with low levels of white blood cell counts should be cared for in private rooms (K8) and about the same number of respondents (n=347, 98.6%) indicated that they were knowledgeable in the use of alcohol-based formulations (K11). However, only 289 (82.1%) indicated having sufficient knowledge on the efficacy of alcohol based solutions in some microbes such as *C. difficile*. 60 or 18% of respondents indicated lack of knowledge on microbes not destroyed by Alcohol (K9). 86% (n = 303) indicated that they had been watched or supervised during a hand-washing activity (K2). Slightly over 97% (n =343) of respondents indicated that they knew how to use biohazard bags or containers (K4) and about 89% (n =312) knew where and how the biohazard contents are disposed (K5). Figure 3 provides a visual representation of the data. It depicts the proportional values of the responses for each item in the category of knowledge.

Figure 3

Registered Nurses' Knowledge regarding the Spread of Nosocomial Infections (N = 352)



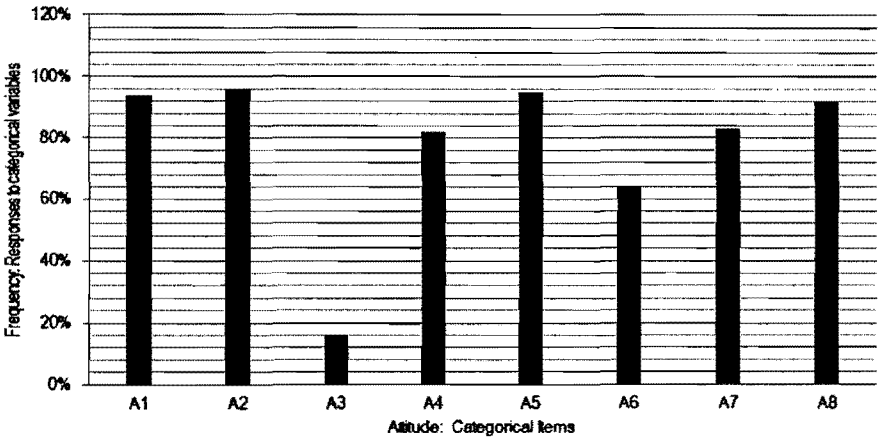
RNs' Attitudes Regarding the Spread of Nosocomial Infections

The overall score for the items under the category of Attitude was 79.66%. Figure 5 shows the opinions of the respondents with regard to attitudes to nosocomial infections. Many respondents (n= 330, 93.8%) were of the opinion that nosocomial infections pose serious patient outcomes (A1) and that healthcare workers could spread nosocomial infections (n=338, 96.0%) (A2). Over 95% (n=335) indicated that registered nurses served as role models in demonstrating adherence to recommended guidelines of infection control (A5). Also, many respondents (n =290, 82.4%) indicated that they were more compliant with hand-hygiene guidelines when training a new worker (A4) and 293 or 83.2% indicated that healthcare workers should be sanctioned if they were non-compliant with recommended guidelines for infection control (A7). A large number (n =319, 90.6%) were of the opinion that healthcare workers should be rewarded for compliance with infection control guidelines (A8). Comparatively fewer respondents (n =225, 63.9%) were of the opinion that it is unrealistic to expect healthcare workers to comply with recommended guidelines

for hand hygiene (A6). About 80% (n = 280) of respondents were of the opinion that other registered nurses do not respond negatively when a colleague is non-compliant with recommended guidelines for patient safety. Only a small number of respondents (n= 55, 15.6%) indicated that registered nurses respond negatively when a colleague is non-compliant with recommended guidelines for patient safety (A3). Figure 4 shows the respondents' responses regarding Attitudes toward the spread of nosocomial infections.

Figure 4

Registered Nurses' Attitudes with regard to the Spread of Nosocomial Infections (N = 352)



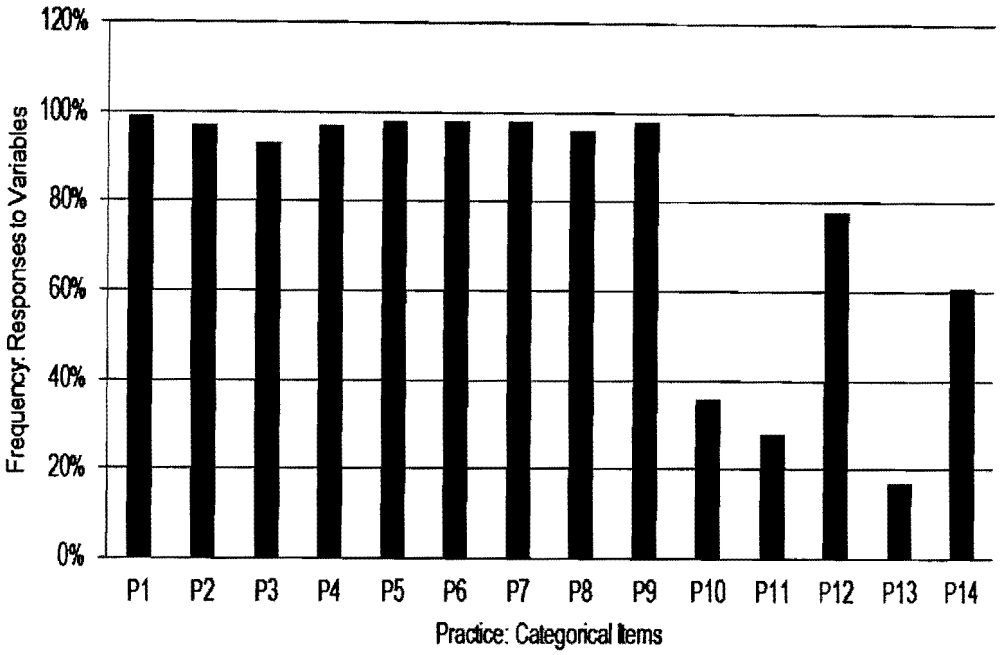
RNs' Practices with Regards to the Spread of Nosocomial Infections

The overall score for the items under the category of Practice was 78%. Figure 6 shows the responses regarding registered nurses practice. A large number of respondents indicated that they follow the recommended guidelines during patient care activities. Specifically, an overwhelming majority (n =347, 98.7%) indicated that they follow guidelines for use of alcohol based solutions before and after patient care activities (P1). Also, a significant number of respondents (n=341, 96.9%) indicated that they follow guidelines for use of alcohol-based solutions before opening vascular access equipment (P2). Over 90% of respondents indicated adherence to

recommended guidelines for reducing the spread of nosocomial infections. For example, 326 or 92.6% respondents indicated that they use alcohol based solutions or antiseptics between each patient contact (P3); after a nursing care activity such as bed bath and perineal care (n = 340, 96.6%) (P4); before and after direct contact with patients' intact skin (n = 345, 98%) (P7); moving from a contaminated body site to a clean body site (n = 345, 98%) (P9); before and after drawing or manipulating patient's body fluid samples (n = 345, 98%) (P6); before inserting indwelling urinary catheters (n = 339, 96.3%) (P8); after touching inanimate objects and equipment in the patients' room (n = 344, 97.7%) (P5); or touching surfaces in patients' surrounding (n = 275, 78.1%). Despite the hand-hygiene guidelines set forth by the CDC (2002), only 61% (n = 216) removed their rings or bracelet before hand-hygiene practice (P14) and only (n =214, 60.8%) indicated that they do not polish or wear artificial finger-nails. About one third of survey respondents (n =127, 36%) indicated that they occasionally polished their finger-nails or wore artificial ones (P10). A small percentage of registered nurses (n = 97, 28%) acknowledged that they were less compliant with recommended guidelines during episodes of increased work-load or emergency situations (P11) and 17% (n = 60) stated that they chart or use computer keyboards with when workload increased (P13). Figure 5 represents the responses on registered nurses' practice regarding the spread of nosocomial infections.

Figure 5

Registered Nurses' Practice (N = 352)



Summary

Overall, the findings in this study suggest that respondents were knowledgeable about etiology, modes of transmission and risk factors associated with the spread of nosocomial infections. Majority of the registered nurses, who participated in this study, followed the recommended guidelines for reducing the spread of nosocomial infections. Furthermore, the respondents had positive attitudes toward recommended guidelines for reducing the spread of nosocomial infections and they indicated good adherence to recommended practices for reducing the spread of nosocomial infections.

Section 3

Comparison of Registered Nurses' Knowledge, Attitudes and Practices

In order to address the question whether significant differences in Knowledge, Attitudes and Practices regarding the spread of nosocomial infections existed between the novice and

experienced registered nurses, participants were asked to rate their level of agreement with survey statements under each category. The corresponding research question for this section was: Is there significant difference in Knowledge, Attitudes and Practices in novice and experienced registered nurses with regard to spread of nosocomial infections? As mentioned earlier, of the 352 respondents, 114 had fewer than three years of experience as registered nurses and 238 had more than three years of experience and this reflects unequal sample size: in other words, two independent groups. Furthermore, there was no randomization and the scale used for Knowledge, Attitude and Practice categories was ordinal. Non-parametric tests were used to analyze the data. The assessment of this broad question was conducted in three subsections which evaluated Knowledge, Attitudes and Practices of registered nurses respectively.

Novice and Experienced RNs' Knowledge regarding the Spread of Nosocomial Infections

Research Question 2 sought to explore whether there exists a significant difference in the level of Knowledge between novice and experienced registered nurses with regards to the spread of nosocomial infections. In order to answer this question, the Means and Standard Deviations of the response scores under the category of Knowledge were computed and then analyzed using the Mann-Whitney U test. The findings are presented in Tables 2 and 3.

Table 2

Novice and Experienced Registered Nurses' Knowledge: Means and Standard Deviations

	Novice (n = 114)		*Experienced (n= 238)*	
Variable	*M*	*SD*	*M*	*SD*
Knowledge	71.59	4.11	72.04	4.75

Note. M = Means SD = Standard Deviation

Table 3

Comparison of Knowledge between Novice and Experienced Registered Nurses (n = 352)

Variable	*U*	*p*	*Sig*
Knowledge	11981.5	0.7	NS

Note. *NS* = Non-Significant $p < .05$ *U* = Mann-Whitney *U*

As seen in Table 2 and 3, there are no significant differences between the two groups. This supports the notion that registered nurses, whether novice or experienced, are equally knowledgeable about the spread of nosocomial infections.

Novice and Experienced RNs' Attitudes regarding the Spread of Nosocomial Infections

Research Question 3 sought to explore if there was a significant difference in the level of Attitude between novice and experienced registered nurses with regards to the spread of nosocomial infections. In order to answer this question, the Means and Standard Deviations of the response scores under the category of Attitude were computed and then analyzed using the Mann-Whitney U test as shown in Tables 4 and 5.

Table 4

Novice and Experienced Registered Nurses' Attitudes: Means and Standard Deviations

	Novice (n = 114)		*Experienced (n= 238)*	
Variable	*M*	*SD*	*M*	*SD*
Attitude	44.19	5.13	44.81	4.99

Note. M = Means SD = Standard Deviation

Table 5

Comparison of Attitudes between Novice and Experienced Registered Nurses (n = 352)

Variable	*U*	*p*	*Sig*
Attitude	12607.0	0.28	NS

Note. *NS* = Non-Significant, $p < .05$, *U* = Mann-Whitney *U*,

The results shown on tables 5 and 6 indicate that there is no statistically significant difference in Attitude between novice and experience registered nurses regarding nosocomial infections. This supports the notion that registered nurses, whether novice or experienced, have the same attitude towards reduction of the spread of nosocomial infections.

Novice and Experienced RNs' Practices

Research Question 4 sought to investigate if there was a significant difference in Practices of recommended guidelines between novice and experienced registered nurses. In order to answer this question, the Means and Standard Deviations of the response scores under the category of Practice were computed and then analyzed using the Mann-Whitney U test. The findings are presented in Tables 6 and 7.

Table 6

Novice and Experienced Registered Nurses' Practices: Means and Standard Deviations (N = 352)

	Novice (n = 114)		*Experienced (n= 238)*	
Variable	*M*	*SD*	*M*	*SD*
Practice	78.75	7.09	79.37	6.86

Note. M = Means SD = Standard Deviation

Table 7

Comparison of Practices of Novice and Experienced Registered Regarding the Spread of Nosocomial Infections

Nurses (n = 352)

Variable	*U*	*p*	*Sig*
Practice	12868.5	0.43	NS

Note. *NS* = Non-Significant, $p < .05$ *U* = Mann-Whitney *U*

The results of the analysis (U = 12868.5, p =.43) suggest that there is no statistically significant difference in novice and experienced registered nurses' practice of recommended guidelines (Table 6 & 7). Again, this again supports the notion that registered nurses, whether novice or experienced, practice the recommended guidelines of reducing the spread of nosocomial infections.

Relationship between Registered Nurses' Knowledge, Attitude and Practices

To further investigate whether a relationship existed between the registered nurses' level of Knowledge, Attitude and Practice with regard to the spread of nosocomial infections, a correlation test was used. As mentioned before, the data used for the categories of Knowledge, Attitude and Practice was ordinal and did not fit the assumptions of parametric tests. Therefore, Spearman's correlation (Spearman's rho) was identified as the most appropriate statistical measure to determine the relationship between the variables. The results indicate a significant but weak positive correlation between registered nurses' Knowledge and Practice $r_s(350) = .23$, p = .00). Also, there were significant but weak positive correlations between registered nurses' Practice and Attitude $r_s(350) = .33$, p = .00); and $r_s(350) = .14$, p = .01). Table 8 shows the correlation coefficients.

Table 8

Spearman's rho Correlation Coefficient for Study Variables

	Knowledge	Practice	Attitude
Knowledge			
Practice	.23**		
Attitude	.14**	.33**	

Note. *p<.05 level (2 tailed test) **.p<.01 level (2 tailed test)

Summary

The results of the analysis of the computed Means and Standard Deviations for the separate groups suggest that there were no significant differences in Knowledge, Attitudes and Practices between novices and experienced RNs. However, significant but weak associations were found between Knowledge, Attitudes and Practices of registered nurses.

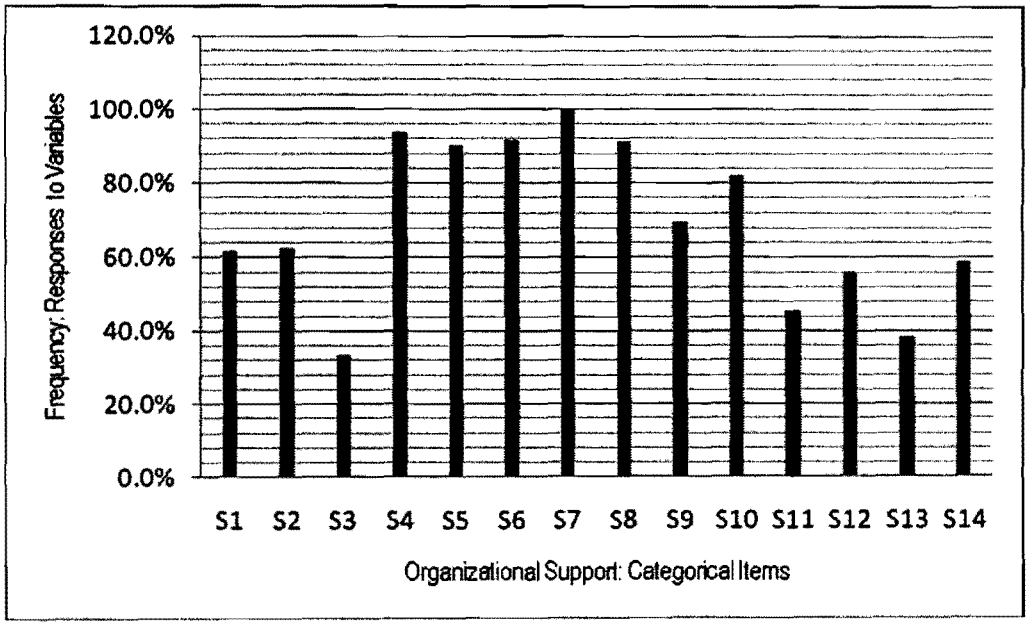
Section 4

Organizational Support

Research Question 5 sought to explore the level of organizational support as reported by registered nurses. It has been reported in the literature that organizational support plays a pivotal role in the reduction of the spread of nosocomial infections (Hugonnet et al., 2007; Saint et al., 2008). The scale of items that addressed registered nurses' responses regarding Organizational Support was nominal. Therefore, descriptive statistics was used to examine responses on overall organizational support as reported by the two groups. On average, about 70% of the respondents agreed with the statements related to organizational support. Figure 6 presents the responses regarding Organizational Support using a bar graph.

Figure 6

Responses regarding Organizational Support (N = 352)



Analysis of data through cross-tabulation indicated statistically significant values in RNs' responses regarding Organizational support and: a) where the healthcare worker knew the infection control practitioner X2 (352) = 3.82, $p < 0.05$ (S1); b) the infection control practitioner (ICP) was present during every shift $X^2(352) = 4.85$, $p < 0.03$ (S3); c) there was provision of hand disinfectants in patient's rooms as well as medication and utility rooms X^2 (352) = 7.26, $p < 0.01$ (S5); d) negative pressure rooms for patients with airborne and droplet infections were utilized X^2 (352) = 16.32, $p < 0.00$ (S10); e) disposable medical equipment were provided for use while nurses rendered nursing care to patients in contact isolation X^2 (352) = 4.07, $p < 0.04$ (S11), and f) where healthcare workers were given incentives to participate in seminars and workshops regarding nosocomial infections X^2 (352) = 8.27, $p < 0.00$ (S13). The results are presented in table 9.

Table 9

Crosstabulation of Organizational Support and Registered Nurses' Responses

Variable	Reponses		X^2	p
	Yes	No		
S1	215	137	3.82	.05
S2	220	132	2.91	.09
S3	117	235	4.85	.03
S4	330	22	.003	.95
S5	318	34	7.261	.01
S6	322	30	3.05	.08
S7	351	1	2.09	.15
S8	321	31	1.49	.22
S9	245	107	1.96	.16
S10	289	63	16.32	.00
S11	160	192	4.07	.04
S12	197	155	3.54	.06
S13	135	217	8.27	.00
S14	208	144	.10	.75

Note: $p \leq .05$ level (2 tailed test)

Relationship between Organizational Support RNs' Knowledge, Attitudes and Practices regarding the Spread of Nosocomial Infections

Correlation analysis was also conducted to examine the relationship between each item in the category of Organizational Support and participants' Knowledge, Attitudes and Practices

regarding the spread of nosocomial infections. Table 10 shows the results of the correlation which supports the notion that there is a relationship between the participants' reported Organizational support and the level of Knowledge, Attitudes and Practices among the registered nurses with regard to the spread of nosocomial infections.

Table 10

Spearman's rho Correlation Coefficients for Categorical Items in Organizational Support and Registered Nurses' Knowledge, Attitudes and Practices

Knows ICP (S1)	.16*	.33*	
HCF has ICP (S2)	.11*	.31*	.21*
ICP present every shift (S3)		.19*	
HCF has flyers/ posters regarding NIs (S9)	.27**	.32*	.15**
HCF provides disposable equipment (S11)	.11*	.28*	.12*
Patients question HCWs (S12)	.16**		.13*
Administration provides incentives (S13)		.14*	

Note. ICP = Infection Control Practitioner, HCF = Healthcare Facility, HCW = Healthcare Workers, NIs = Nosocomial Infections, *p <.05 level (2 tailed test), **p<.01 level (2 tailed test)

Organizational Support and RNs' Knowledge regarding the Spread of Nosocomial Infections

The results indicate a significant positive correlation between Organizational Support and respondents' Knowledge in cases: where the healthcare facility had an infection control team (r_s

[352] = .16, p <.00); where the respondents knew the infection control practitioners (r_s [352] = .11, p <.04); where the healthcare facility had conspicuous, written flyers / posters / reminders regarding the spread of nosocomial infections (r_s [352] = .27, p <00); where the healthcare facility provided medical equipment for healthcare workers' use while they (healthcare workers) performed patient care on patients in isolation (r_s [352] = .11, p < 0.04); and where patient's family members questioned healthcare workers if they (the family members) perceived that the healthcare workers intended to perform patient care activities without hand hygiene (r_s [352] = .16, p < 00).

Organizational Support and RNs' Attitudes

The results of Correlation coefficients indicate a weak but significant positive correlation between Organizational Support and respondents' Attitudes: where the healthcare facility had an infection control team(r_s [352] = .33, p <.00); where an infection control practitioner was physically present during all shifts (r_s [352] = .31, p < .00); where the facility had conspicuous written flyers / posters/ reminders regarding the spread on nosocomial infections (r_s [352] = .19, p <.00); where the healthcare facility provided medical equipment for healthcare workers' use while they (healthcare workers) performed patient care on patients in isolation (r_s [352] = .32, p <.00); and where the administration provided health workers with incentives to participate in workshops and seminars that address the spread of nosocomial infections (r_s [352] = .14, p <.01).

Organizational Support and RNs' Practices

As indicated in Table 10, Correlation coefficients indicate a weak but significant positive correlation between Organizational support and respondents' Practice: where the healthcare facility had an infection control team (r_s [352] = .21, p <.00); where facility had conspicuous written flyers / posters/ reminders regarding the spread on nosocomial infections (r_s [352] = .15, p <.01); where the healthcare facility provided medical equipment for healthcare workers' use while performing patient

care on patients in isolation (r_s [352] = .12, p <.02); and where family members question healthcare workers if they (family members) perceived that the healthcare workers intended to perform patient care activity without hand hygiene (r_s [352] = .13, p <.02).

Summary

The findings in this sub-section of this dissertation study support the notion that the administrations of healthcare facilities have been supportive in instituting measures deemed necessary in reducing the spread of nosocomial infections. Such measures included hiring infection control practitioners; setting aside isolation rooms for patients with communicable diseases; providing disposable medical equipment and disinfectants for healthcare workers' use; increasing the nursing staff in order to ensure a low nurse-to-patient ratio and encouraging healthcare workers to participate in seminars and workshops regarding the spread of nosocomial infections. The significant relationship between organizational support and registered nurses' knowledge where the facility had infection control practitioners, nurses knew their infection control practitioner, facilities provided suitable supplies and equipment, facilities had flyers and posters regarding nosocomial infections and family members questioned the healthcare workers if they determined non-compliance with hand hygiene guidelines by healthcare workers suggest that the role played by administration in healthcare institutions should not be ignored.

Chapter V

DISCUSSION

Overview

The purpose of this study was four-fold: a) to investigate the level of Knowledge, Attitudes and Practices of registered nurses with regards to the spread of nosocomial infections; b) to compare the Knowledge, Attitudes and Practices in novice and experienced registered nurses with regards to the spread of nosocomial infections; c) to investigate the level of organizational support as reported by the registered nurses; and d) to examine if a relationship exists between organizational factors or support and the level of registered nurses' Knowledge, Attitudes and Practice with regards to the spread of nosocomial infections.

Findings in several studies reveal three broad categories of burdens placed on our healthcare system by nosocomial infections and many problems for patient safety: the increased cost of healthcare services, the unnecessary loss of human lives and the financial impact on families (Wenzel & Edmond, 2001; Zhan & Miller, 2003; Klevens et al., 2007; Stone, 2008; Scott II, 2009). Many studies have shown the ease with which healthcare workers can spread nosocomial infections (Price, 1938; Lepelletier et al. 2005; McBryde et al. 2004; Michalopoulos et al. 2006). Furthermore, it has been documented in several epidemiological studies that healthcare workers particularly nurses are implicated in the transmission of nosocomial infections (Cohen et al. 2003, de-Oliveira et al, 2005).

Study Findings

The demographics of the participants in this study are similar, in many aspects, to that of the state of New Jersey and United States. Among the 352 registered nurses who participated in this study, majority were over 45 years of age with a mean age of 48.1 years (SD = 8.74). Similarly, the mean age among 21,553 registered nurses in the state of New Jersey who participated in a study conducted by Flynn (2007) was 51.3 years (SD = 11.1), with majority of the participants being between 45 and 60 years of age. Only a small number of the study participants were more than 60 years old (Flynn, 2007). Other findings from a 2008 National Survey of registered nurses showed that the median age of the registered nurse population was 46 years (DHHS, 2010).

In terms of gender, 70% of the participants in this study were females and about 30% were males. These findings are similar to those documented in the studies conducted by Flynn (2007) and the 2008 National Survey of Registered Nurses (DHHS, 2010), and affirm the notion that females comprise the majority of the registered nurse workforce. The percentage of males reported in this study is higher than that of the state of New Jersey and the US; however, a comparison of the percentage of registered nurses by gender in the 2008 National Survey of Registered Nurses indicated that the growth rate of male registered nurses' population was higher in 2008 than in 2000, and that a greater percentage of male registered nurses were employed in hospitals (DHHS, 2010). Over 97% of the participants in this study were employed in specialty units within hospital settings. The demographics of the 2008 National Survey of Registered Nurses' workforce indicated that over 80 % of men were employed in hospital and ambulatory care settings compared to 72% of female registered nurses. As mentioned earlier, majority of the respondents in this study were employed in hospitals; therefore, the enormity of the male registered nurses who participated in this study is acceptable.

The employment profile of participants in this study is also similar to that of the state of the New Jersey and the Nation. All study participants were employed as registered nurses and 70% were employed full-time while 11% worked part-time. Slightly over two-thirds (n = 238, 67.6%) of the study participants indicated that they had more than three years of experience and majority (n = 304, 86.4%) were employed in hospital specialties / units with most opportunities for patient contacts; for example medical surgical / critical care, emergency and telemetry, and maternal / neonatal / pediatrics units. Many respondents had worked in the same department longer than two years and over 70% were employed full time. Similarly, in the State of New Jersey, a large proportion of the registered nurses were employed in hospitals (Flynn, 2007).

An examination of the participants' educational preparedness showed that over 70% held bachelor's degrees or higher in nursing while about 30% had associates degree. Another important finding in this study was that four-fifths of the respondents had participated in in-service training or continuing education programs, in which they had learned about nosocomial infections. The *2008 National Sample Survey of Registered Nurses* showed a steady rise in the proportion of registered nurses with bachelor's degree in nursing and that 34% of the registered nurse population had bachelor's or higher degree level in nursing in 2008. However, the study also found that most registered nurses, with diplomas in nursing as their initial preparation, continued with their education to obtain baccalaureate or higher degrees (DHHS, 2010). In the State of New Jersey, Flynn and colleagues (2007) also documented that the most common route for initial nursing education was the diploma level. Similar to the findings in the *2008 National Sample Survey of Registered Nurses* (DHHS, 2010), Flynn (2007) also noted that registered nurses, with diploma in nursing as their initial education, continued their education to obtain the next highest college degree (Flynn, 2007).

The demand for increased knowledge in nursing education stems from the need to improve on faulty areas identified in a report that examined the status of the U.S. healthcare system (IOM, 2001). The report identified areas which, if improved upon, would lead to a safe and quality patient care. It also indicated the need for a well-educated healthcare workforce that was adept in knowledge to provide evidence-based practice necessary to attain quality patient care (IOM, 2001). The high number of survey respondents with bachelor's degrees in this study may be attributed to this call.

A study that investigated the association between nurses' level of education and patient outcomes by Aiken et al. (2003) showed that surgical patients had better outcomes when treated in hospitals with higher proportions of nurses, whose nursing education level was baccalaureate or higher. Aiken et al. (2003) found that a 10% increase in the proportion of nurses holding baccalaureate degrees decreased the risk of patient mortality by 5%. Similar findings were echoed in a study conducted by Estabrooks et al. (2005). A study by Tourangeau et al. (2007) also indicated that a 10% increase in the proportion of registered nurses with baccalaureate or higher degrees was associated with a 9% decrease in mortality rate (Tourangeau et al., 2007). Friese et al. (2008) found results which were similar to those of the studies by Aiken et al., (2003); Aiken et al., (2008) and Estabrooks et al., (2005). These results reinforce the notion that increased knowledge in nursing education plays a vital role in reducing the spread of nosocomial infections and associated death rates. Steering committees of nursing profession such as, the American Organization of Nurse Educators (AONE, 2005), American Association of Colleges of Nursing (AACN, 2010) consensus position made by the National Advisory Council on Nurse Education and Practice (NACNEP) and the Institute of Medicine (IOM, 2001) view these findings as strong foundation for concerted efforts to create a more highly qualified nursing workforce. All of these organizations urged that majority of the nursing workforce individuals hold baccalaureate or higher

degrees. More recently, the IOM report recommended that nursing education should serve as a platform for continued lifelong learning and acclaimed that the proportion of nurses with baccalaureate degrees be increased to 80% by 2020 (IOM, 2010).

The educational qualifications of the respondents in this study confirm the notion that the curriculum and educational experiences for registered nurses should prepare graduates to become competent, in terms of knowledge and clinical skills, which are required for practice of safe patient care and articulate the ability to comply with infection control guidelines. A recent study conducted by Sportsman (2010) showed that educational institutions have adopted nursing curricula with frameworks that encompass core practice competencies and that competencies are evaluated in both clinical judgment and non-clinical (didactic) settings. For instance, the Texas Board of Nursing developed competencies and required that schools of nursing integrate knowledge, judgment, skills and professional values expected of new graduates of nursing programs at the time of their graduation (Sportsman, 2010). In this study, no statistically significant difference was found between novices and experienced registered nurses regarding knowledge of infection control. Again, a large sample of the survey respondents in this study held bachelor's degrees or higher in nursing.

Another important issue regarding enhancement of knowledge in nurse practitioners arises from the concerted efforts and mandates made by state boards of nursing, national nursing certification organizations and employers. These efforts and mandates enforce demonstration of continuing competency in nurse practitioners. For instance, the Tri-Council for Nursing - a vast organization comprised of American Association of Colleges of Nursing (AACN), American Nurses Association (ANA), American Organization of Nurse Executives (AONE) and the National League for Nurses (NLN) issued a consensus statement calling for all registered nurses to enhance their competency in nursing and to advance their education (Burns, 2009). Specifically, all state Boards

of Nursing require that nurse practitioners demonstrate continuing education before their licenses are renewed. In 2006, the New Jersey Board of Nursing set forth a requirement that all registered professional or licensed practical nurses, who apply for license renewal, to attest to their completion of a minimum 30 hours of continuing education, within two years prior to renewing their license (N.J.A.C. 13:37-5.3). Such measures lend support to the notion that registered nurses, whether novice or experienced, would have sufficient knowledge regarding etiology, transmission and efficient methods of controlling the spread of nosocomial infections.

In terms of the registered nurses' attitudes, the overall score of the study participants was about 80%. Many respondents were of the opinion that nosocomial infections pose serious patient outcomes and indicated their role in reducing the spread of the infections. For example, over 95% of respondents viewed themselves as role models and were more compliant with the practice of evidence-based guidelines for reducing the spread of infections while training a new worker. Furthermore, a significant number (80%) of the survey respondents indicated that they did not respond negatively to colleagues who were non-compliant with recommended guidelines for patient safety. Only 64% of respondents were of the opinion that it is unrealistic to expect healthcare workers to comply with the recommended guidelines. It is possible to link this positive behavioral attribute to the high knowledge reported by the registered nurses who participated in this study.

As noted earlier, the overall score of the registered nurses' practice with regards to the spread of nosocomial infections was high across many categorical items. These findings support the notion that nursing education, in both didactic and clinical areas, provides the graduates with the competencies needed for the practice of safe patient care. Moreover, the recommendation made by the IOM (2001 and 2010) that nursing education should serve as a platform for advancement of knowledge has opened myriad of educational opportunities for advancement of

nursing competencies. The findings in this study support the notion that registered nurses have high knowledge, positive attitudes and good practices toward the reduction of nosocomial infections.

Lastly, findings in this study support that healthcare facilities have put in place measures necessary for reducing the spread of nosocomial infections. For example, the respondents reported that infection control practitioners were present, disposable medical equipment and disinfectants necessary for reducing the spread of nosocomial infections were available, education campaigns and posters regarding nosocomial infections were conspicuous and healthcare workers were encouraged to participate in educational activities. These findings are echoed in studies that investigated the impact of organizational support on healthcare workers' adherence to hand hygiene practices. For example, a study conducted by Monarca et al. (2000) revealed that lack of sterile equipment in dental offices contributed to the spread of nosocomial infections. Another study by Ribby and colleagues showed that utilization of posters and videos for nursing staff education, over a two year period, contributed to higher compliance with recommended guidelines for reducing the spread of infections (Ribby, 2005). These findings affirm that effective reinforcement of healthcare workers' knowledge of hand-hygiene practices and use of multimodal strategies combined with several elements, including administrative support, enhance an individual's compliance with infection control practices similarly noted in other studies (Lam et al., 2004; Pittet et al., 2006;Pessoa-Silva et al., 2007; Suchitra et al., 2007). Specifically, a study by Saint and colleagues (2008) showed that lack of uniform practices for monitoring safe patient care impacted on the healthcare workers' prudence in safe patient practices, and lead to increased incidences of nosocomial infections (Saint et al., 2008). Another important finding in this study was that about 80% of the participants had less than a 1:10 nurse to patient ratio. It has been demonstrated in the literature that low staffing negatively impacts on healthcare workers'

compliance with recommended guidelines. For instance, findings in the study by Brooten et al. (2006), Hugonnet et al. (2007) and Pessoa-Silva et al. (2007) showed that low staffing levels led to high workload and contributed to healthcare workers' non-compliance with hand-hygiene practices. A more recent study that examined whether nurse burnout was associated with infection rates also showed a significant association between patient to nurse ratio and the occurrence of urinary tract and surgical site infections. The study showed a significant reduction in the nosocomial infections when the workload was reduced (Cimiotti et al., 2012). In this dissertation study, about 33 % of the respondents indicated that they were less compliant with recommended guidelines when workload increased and 17 % indicated that they charted with their gloves on when workload increased.

While this study was not designed to validate behavioral theories, the findings shed some light into understanding some tenets of behavioral perspectives such as Bandura's Social Cognitive Theory and Health Belief Model. Bandura theorized that behavioral capability enables a person to achieve mastery learning through skills training (Bandura, 1989). Likewise, in the Health Belief Model, it is indicated that the constructs of perception are modified by variables such as education level, past experiences, skill and motivation. The theory also asserts that a person's behavior is influenced by the outcome expectancy and cues to action (Rosenstock, 1988).

The findings in this study support the notion that behavioral capability is based on the individual's knowledge and skill to perform a certain behavior. Over 82% of respondents indicated that they were more compliant with recommended guidelines for infection control when training a new worker and over 95% agreed with the statement that registered nurses served as role models in demonstrating adherence to the recommended guidelines for hand hygiene. According to Bandura's Social Cognitive Theory, people learn by modeling behaviors from persons with whom they identify, and that this bi-directional interaction helps in the development of cognitive competencies. Furthermore, the lack of or inadequate use of these cognitive competencies affects

the application knowledge and skills. Literature has shown that healthcare workers copy (mimic) behaviors of the more experienced colleagues (Lankford et al., 2001; Aly et al., 2005; Sax et al., 2007). Findings in these studies showed that when the experienced healthcare workers failed to apply cognitive competencies, the novice healthcare workers became non-compliant in proper application of knowledge and skills which they had acquired during their academic journey or during their continued education.

An observational study that investigated the impact of role models in healthcare workers' compliance with hand hygiene by Lankford et al. (2001) found that healthcare workers' compliance with hand hygiene was greatly influenced by role models. Furthermore, they found that healthcare workers were less compliant with hand hygiene guidelines when high ranking persons such as physicians or nurses did not practice hand hygiene during patient care activities (Lankford et al., 2001). Similarly, Aly and colleagues (2005) demonstrated that positive health behaviors by healthcare workers and peer pressure (Sax et al. 2007) played a significant role in reducing the spread of nosocomial infections. These findings suggest behavioral interactions play an important role in the application of knowledge. Likewise, in this study, it is possible to postulate that by modeling positive behaviors of the more experienced nurses, the novice nurses would tend to comply with the recommended guidelines for reducing the spread of nosocomial infections.

The findings in this study also suggest that behavior is influenced by the environmental or organizational support factors such as: the presence of infection control practitioners; provision of disinfectants inside and outside the patients' room; presence of conspicuous flyers; and reminders and posters regarding the spread of nosocomial infections, which offer constant reminders to the healthcare workers about the threats and impact or severity of nosocomial infections. In line with the Health Belief Model (Rosenstock, 1988), such motivational factors (posters, flyers and reminders) would prompt or enhance the nurses' "readiness to act'. Altogether, the positive

correlation between Organizational Support and registered nurses' Knowledge, Practices and Attitudes support the notion that these factors might have a role in healthcare workers' compliance with recommended guidelines, thus the reduction of the spread of nosocomial infections.

An examination of the trend of nosocomial infections reveals that collectively, the high levels of knowledge regarding the spread of nosocomial infections; positive attitudes and adherence to recommended guidelines of reducing the spread of nosocomial infections; along with organizational support have contributed to reduced spread of nosocomial infections. Findings from a comprehensive national survey of nosocomial infections by the National Healthcare Safety Network (NHSN), a surveillance system under the umbrella of the Centers for Disease Control and Prevention (CDC), revealed a decrease in the occurrence of nosocomial infections (CDC, 2012). The healthcare facilities in all 50 states in US, including Washington, D.C. and Puerto Rico, which participate in this surveillance network, are mandated to report the occurrence of nosocomial infections. Among the infections reported by the hospitals participating in the healthcare surveillance system include central line-associated blood stream infections (CLASBI), catheter-associated urinary tract infections (CAUTI) and surgical site infections (SSIs). The NHSN then uses the data of the observed (reported) nosocomial infections for national-level analysis to establish (define) a benchmark for inter-facility comparisons within a certain referent period. A Standardized Infection Ratio (SIR) is then obtained by calculating the observed number of nosocomial infections divided by the predicted number of nosocomial infections. A SIR of less than I means that there were fewer infections than with the predicted and a SIR above 1 means that there were more infections compared to the national average. The NHSN analyzed data on incidences of nosocomial infections associated with central line-associated blood stream (CLASBIs), surgical site infections (SSIs) and catheter-associated urinary tract infections (CAUTIs) reported by 50 states for the year 2010, and compared them to the findings in the year 2009.

According to the NHSN report, there has been a steady decrease in the rates nosocomial infections in all three categories since 2008. Specifically, in 2011, the reduction rate for the central line associated blood stream infections was 9% higher than it was in 2010. A 10 % reduction in surgical site infections was also reported. The data also showed no increase in catheter-associated urinary tract infections. However, there was a 7 % reduction in catheter-associated urinary tract infections in 2011 as compared to those reported in 2009.

Reduction in the rates of nosocomial infections has also been observed in the State of New Jersey. In 2009, the New Jersey legislature enacted the Patient Safety Act (P.L. 2009, C. 122). The policy requires all hospitals in New Jersey to report medical problems encountered by patients while receiving medical care in their healthcare facility. The data is then collected from the hospital discharge database and used for comparison of each hospital's performance in 12 Patient Safety Indicators (PSI). New Jersey reported fewer numbers of nosocomial infections in some categories including a) Surgical Site Infections, b) Central Line-Associated Bloodstream Infections, and c) Catheter-Associated Urinary Tract Infections. The report showed an overall 2% fewer surgical site infections than those observed nationally. In terms of Central Line-Associated Bloodstream Infections, the report showed that New Jersey had 20 % lower infections than the national. Similar to the national level, the SIR for the Catheter-Associated Urinary Tract Infections was 1 indicating that the numbers of observed CAUTIs were similar to those observed nationally for the same referent period. These findings indicate that the incidence of catheter-associated urinary tract infections did not increase (NJDHSS, 2011). These findings could be attributed to the concerted effort by the CDC and factors associated with organizational support along with increased knowledge, positive attitudes and practices of safe patient care by healthcare workers.

Chapter VI

CONCLUSION

Overview

This study addressed several gaps in the literature by investigating plausible reasons for the enigma behind the spread of nosocomial infections. Nosocomial infections have been recognized as a problem affecting the quality of health care and a principle source of adverse healthcare outcomes. Within the realm of patient safety, these infections have serious impacts as they increase hospital stay days, result in increased utilization of hospital resources and additional therapeutic interventions and thus increase healthcare costs. In the United States, data based on the Consumer Price Index in 2007 showed that the overall direct cost for in-patient hospital services related to nosocomial infections ranged from $35.7 billion to $45 billion yearly (Scott II, 2009). More importantly, these infections lead to unnecessary deaths (Klevens et al. 2007).

While the etiology of these infections is well understood, it has been extensively documented in the literature that healthcare workers are involved in the spread of nosocomial infections. Moreover, evidence suggests that the spread of nosocomial infections could be related to a breakdown in knowledge, attitude and practices among healthcare workers (Godin 1996; Pessoa-Silva et al., 2005; Pittet et al., 2006). However, what has not been established is if this breakdown is prevalent in novice registered nurses, suggesting the novice registered nurses' inability to apply learnt knowledge in a work setting, or in the more experienced registered nurses; suggesting either a decrement of knowledge or a change in attitude and / or sloppy practices

possibly associated with stressful behavioral interactions with colleagues, workload or other organizational factors.

Based on the data obtained from survey respondents, the results of analysis showed that registered nurses, whether novice or experienced, are knowledgeable about nosocomial infections: their etiology, risk factors for their transmission and the recommended guidelines for reducing their spread. These findings suggest that education has played a pivotal role in the implementation of strategies and protocols for reducing the spread of nosocomial infections. The high level of knowledge is attributable to the concerted efforts by nurse organizations. For example, strong curriculum for nurse education, uniform licensure requirements for new nurse graduates, the call for advancement in registered nurses' education and stringent mandates from state Boards of Nursing that nurse practitioners demonstrate continuing education before their renewal of licensure might have contributed to the improved strategies of reducing the spread of nosocomial infections. Finally, the observed significant associations between organizational support with registered nurses' Knowledge, Attitudes and Practices lend support to the reduced occurrence of nosocomial infections. These findings affirm that nursing education and organizational support play a pivotal role toward implementation of strategies known to reduce the spread of nosocomial infections.

Implications of the Study

The findings in this study suggest that the strong educational standards, set in place, should be continued and enforced. Additionally, monitoring of adherence to and compliance with established guidelines set by the Centers for Disease Control and Prevention (CDC) by healthcare workers should be sustained. Furthermore, the fundamental role of healthcare institutions to provide support in the form of adequate staffing and equipment should be intensified.

Limitations of the Study

As with many research projects, this study has several limitations. Firstly, the data in this study was captured using on-line survey procedures and snow-ball sampling method. Even though some of the advantages of online surveys are the instantaneous data collection and savings, in both time and money, the approach may lead to many limitations. One of the primary limitations is the generalizability of the results to all registered nurses. There was no randomization as survey was sent to only individuals in the database obtained from one source and through snow-ball sampling method. The next notable limitation is self-report bias. Cook and Campbell (1979) pointed out that people tend to report what they believe the researcher expects to read or report what reflects positively on their own abilities, knowledge, beliefs or opinions (Cook & Campbell, 1979). The questionnaire used in this study was constructed from emergent themes in the reviewed literature and established guidelines set by a task force committee on Infection Control Practices Advisory Comrnittee. The knowledge and skills items related to information the respondents ought to have mastered during their academic journey, or reinforced through work-related experiences and continuing education. The items might not have been broad enough to capture all pertinent concepts related to reduction of the spread of nosocomial infections.

Recommendations for Future Research

As it was noted in the methods section, the sample size in this exploratory study was small given the population of registered nurses in the state of New Jersey and nationally. The respondents were recruited from only one database and through a snowball sampling technique. Therefore, the study should be replicated using a larger sample size with a target population from a larger geographical area. Another recommendation would be to replicate the study with registered nurses working in target specialty units; for example, neonatal intensive care units, critical care units, operation rooms or medical / surgical units. Finally, a similar study should be conducted with

healthcare workers under other categories; for example, physicians, physician assistants, dentists, licensed practical nurses, or nurse aides.

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Appendix A

Tables

Table 11

Demographic Characteristics of Participants (n =352)

Categorical Variables	n	%
Gender		
Male	105	29.8
Female	247	70.2
Age		
21 – 30	64	18.2
31 – 40	92	26.1
41 – 50	106	30.1
>50	90	25.6
Nursing Education		
Associates degree	105	29.8
Bachelor's degree	195	55.4
Master's degree	38	10.8
Other (DNP, PhD)	14	4.0
Nursing Practice		
< 3 years (Novice)	114	32.4
> 3 years (Experienced)	238	67.6
Healthcare Facility		
Hospital	259	73.6
Long Term Care	83	23.6
Other (school nurse, physician's office, correctional facilities)	10	2.8
Specialty Department (Unit)		
Emergency and Telemetry	110	31.3
Medical Surgical and Critical care	157	44.6
Maternal and Pediatrics	37	10.5
Behavioral / Psychiatric	38	10.8
Others (school nurse, physician's office, correctional facilities)	10	2.8
Employment Status		
Full-Time	250	71.0
Part-Time	39	11.1
Per-Diem	63	17.9
Longevity at current department		
< 2 years	108	30.7
2 – 5 years	141	40.1
> 5 years	103	29.3
Units Nurse to Patient Ratio		
< 1:10	278	79.0

> 1:10	74	21.0
Other healthcare workers to help		
Yes	291	82.7
No	61	17.3
Participated in in-service training		
Yes	283	80.4
No	69	19.6

Table 12

RNs' Knowledge Regarding Nosocomial Infections n =352

	1	*2*	*3*	*sub-score (1-3)*	*4 Neutral (4)*	*5*	*6*	*7*	*Sub score (5-7)*
Item #	n (%)	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)	n (%)	n(%)
K1	8 (2.3)	1(.3)	19(5.4)	28 (8.0)	6(1.7)	20(5.7)	17(4.8)	281(79.8)	318 (90.3)
K2	31(8.8)	5(1.4)	6(1.7)	42(11.9)	7(2.0)	26(7.4)	37(10.5)	240(68.2)	303 (86.1)
K3	3(.9)	2(.6)	4(1.1)	9(2.5)	6(1.7)	41(11.6)	13(3.7)	283(80.4)	337(95.7)
K4	1(.3)	1(.3)	2(.6)	4(1.1)	5(1.4)	11(3.1)	15(4.3)	317(90.1)	343 (97.4)
K5	1(.3)	1(.3)	5(1.4)	7(2.0)	45(12.8)	15(4.3)	13(3.7)	284(80.7)	312 (88.6)
K6	5(1.4)	1(.3)	2(.6)	8(2.3)	4(1.1)	16(4.5)	14(4.0)	310(88.1)	340 (96.6)
K7	1(.3)	1(.3)	1(.3)	3(0.9)	1(.3)	12(3.4)	12(3.4)	324(92.0)	348 (98.9)
K8	1(.3)	1(.3)	2(.6)	4(1.1)	1(.3)	14(4.0)	14(4.0)	319(90.6)	347 (98.6)
K9	43(12.2)	15(4.3)	2(.6)	60(17.0)	3(.9)	12(3.4)	19(5.4)	258(73.3)	289 (82.1)
K10	1(.3)	2(.6)	1(.3)	4(1.1)	20(5.7)	38(10.8)	19(5.4)	271(77)	328 (93.2)
K11	2(.6)	1(.3)	1(.3)	4(1.1)	1(.3)	26(7.4)	23(6.5)	298(85.2)	347 (98.6)

Scale. 1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7 =Strongly Agree

K1. Fully aware of hand-washing guidelines

K2. Have been watched or supervised during hand-washing activity

K3. Knows that healthcare facility harbors variety of pathogens that could be transmitted byhcws

K4. Knows how to use the biohazard bag / container.

K5. Knows where and how biohazard contents are disposed.

K6. Knows safety precautions for disposal used medical supplies e.g. needles, syringes, catheters

K7. Knows that NIs can be transmitted via fomites e.g. needles, syringes, catheters, thermometers

K8. Knows isolation procedures for neutropenic patients or those with communicable diseases

K9. Knows microbes not eradicated by alcohol based solutions

K10. Knows opportunities for hand hygiene

K11. Knows recommended guidelines for hand hygiene with alcohol – based formulations.

Table 13

RNs' Attitudes Regarding the Spread of Nosocomial Infections n = 352

	1	*2*	*3*	*Sub- score*	*4*	*5*	*6*	*7*	*Sub-Score*
Item #	n (%)	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)	n (%)	n(%)
A1	1(.3)	2(.6)	6(1.7)	9(2.6)	13(3.7)	21(6)	11(3.1)	298(64.7)	330(93.8)
A2	2(.6)	2(.6)	5(1.4)	9(2.6)	5(1.4)	13(3.7)	65(18.5)	260(73.9)	338(96.0)
A3	136(38.6)	87(24.7)	57(16.2)	280(79.5)	17(4.8)	14(4)	17(4.8)	24(6.8)	55(15.6)
A4	29(8.2)	2(.6)	18(5.1)	49(13.9)	13(3.7)	32(9.1)	114(32.4)	144(40.9)	290(82.4)
A5	2(.6)	1(.3)	6(1.7)	9(2.6)	8(2.3)	31(8.8)	36(10.2)	268(76.1)	335(95.2)
A6	73(20.7)	30(8.5)	17(4.8)	120(34.1)	7(2)	16(4.5)	31(8.8)	178(50.6)	225(63.9)
A7	18(5.1)	14(4)	12(3.4)	44(12.5)	15(4.3)	36(10.2)	125(35.5)	132(37.5)	293(83.2)
A8	2(.6)	1(.3)	9(2.6)	12(3.4)	21(6)	42(11.9)	111(31.5)	166(47.2)	319(90.6)

Note: *RN's = Registered Nurses; NIs = Nosocomial Infections*

Scale. 1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7=Strongly Agree

A1. Opinion regarding outcomes of NIs

A2. Opinion about possibility of healthcare workers transmitting NIs

A3. Opinion about other healthcare workers response towards non-compliant colleagues

A4. Opinion on compliance when training a new worker

A5. Opinion whether RN serves as role model demonstrating adherence to hand hygiene

A6. Opinion if it is unrealistic to expect healthcare workers to comply with recommended guidelines for hand hygiene

A7. Opinion about sanctioning of non-compliant healthcare workers

A8. Opinion about reward for healthcare workers for compliance with recommended guidelines

Table 14

Registered Nurses' Practices Regarding the Spread of Nosocomial Infections (N=352)

	1	*2*	*3*	*Sub-total*	*4*	*5*	*6*	*7*	*Sub-total*
Item #s	n (%)	n (%)	n (%)	n(%)	n (%)	n (%)	n (%)	n (%)	n(%)
P1	2(.6)	1(.3)	1(.3)	4(1.1)	1(.3)	24(6.8)	23(6.5)	300(85.2)	347(98.6)
P2	1(.3)	3(.9)	2(.6)	6(1.7)	5(1.4)	28(8)	29(8.2)	284(80.7)	341(96.9)
P3	1(.3)	3(.9)	1(.3)	5(1.4)	21(6.0)	22(6.3)	77(21.9)	227(64.5)	326(92.6)
P4	3(.9)	3(.9)	1(.3)	7(2.0)	5(1.4)	32(9.1)	22(6.3)	286(81.3)	340(96.6)
P5	1(.3)	3(.9)	1(.3)	5(1.4)	3(.9)	16(4.5)	24(6.8)	304(86.4)	344(97.7)
P6	3(.9)	2(.6)	0	5(1.4)	2(.6)	26(7.4)	19(5.4)	300(85.2)	345(98.0)
P7	2(.6)	2(.6)	2(.6)	6(1.7)	1(.3)	11(3.1)	25(7.1)	309(87.8)	345(98.0)
P8	1(.3)	2(.6)	3(.9)	6(1.7)	7(2)	9(2.6)	30(8.5)	300(85.2)	339(96.3)
P9	2(.6)	2(.6)	2(.6)	6(1.7)	1(.3)	11(3.1)	29(8.2)	305(86.6)	345(98.0
P10	182(51.7)	21(6)	11(3.1)	214(60.8)	11(3.1)	16(4.5)	19(5.4)	92(26.1)	127(36.1)
P11	141(40.1)	64(18.2)	32(9.1)	237(67.3)	18(5.1)	26(7.4)	31(8.8)	40(11.4)	97(27.7)
P12	36(10.5)	17(4.8)	19(5.4)	72(20.5)	4(1.1)	22(6.3)	60(17.0)	193(54.8)	275(78.1)
P13	160(45.5)	102(29)	28(8)	290(82.4)	2(.6)	7(2.0)	22(6.3)	31(8.8)	60(17.0)
P14	58(16.5)	32(9.1)	15(4.3)	105(29.8)	31(8.8)	16(4.5)	28(8.0)	172(48.9)	216(61.4)

Scale. 1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7=Strongly Agree

P1. Follows guidelines for use of alcohol-based solutions before and after patient care activities

P2. Follows guidelines for use of alcohol-based solutions before opening vascular access equipment

P3. Uses alcohol based solutions or antiseptics between each patient contact

P4. Washes hands or use alcohol based solutions before and after providing nursing care activity e.g. bed bath, perineal care

P5. Wash hands or rub with alcohol after contact with equipment or objects likely to be contaminated

P6. Wash hands before and after drawing or manipulation patient's body fluids sample

P7. Always wash hands before and after direct contact with patient's intact skin

P8. Always wash hands before and after inserting indwelling urinary catheters

P9. Always wash hands when moving from a contaminated body site to a clean body site

P10. Occasionally polish finger nails or wear artificial nails

P11. Less compliant with recommended guidelines when workload increases

P12. Wash hands after touching surfaces and objects inpatient's surrounding

P13. Chart or use computer keyboard with gloves during busy patient care episode

P14. Remove rings, watch or bracelet before beginning hand-hygiene activity

Table 15

Organizational Support (N = 352)

Statement	*Yes*	*No*
	n(%)	*n(%)*
S1. I know my Infection Control Practitioner	215 (61.08)	137(38.92)
S2. My healthcare facility has Infection Control Practitioner	220 (62.50)	132(37.50)
S3. Infection Control Practitioner physically present every shift	117 (33.24)	235(66.76)
S4. Facility uses campaign ads for adherence to Hand Hygiene	330 (93.75)	22 (6.25)
S5. Facility provides disinfectants in patients' rooms	318(90.34)	34 (9.66)
S6. Facility provides disinfectants outside patients' rooms	322(91.48)	30 (8.52)
S7. Facility has no cloth towels of hanging / rolling type for staff use	351(99.72)	1 (0.28)
S8. Facility provides disposable paper towels for staff use	321(91.19)	31(8.81)
S9. Facility has conspicuous written flyers / posters on spread of NIs	245(69.60)	107(30.40)
S10. Facility ensures adherence to strict isolation procedures	289(82.10)	63(17.90)
S11. Facility provides disposable medical equipment for use with patients with communicable diseases	160(45.45)	192(54.55)
S12. Patients' family members question healthcare workers if they determined that healthcare workers intended to perform nursing care without hand-hygiene activity	197(55.97)	173(49.15)
S13. Facility provides healthcare workers with incentives to participate in seminars on NIs	135(38.35)	217(61.65)

S14. Administration mandates healthcare workers to participate in seminars regarding NIs	208(59.09)	144(40.91)

Appendix B

Pre-Study Survey Instrument Development

While previous studies evaluated knowledge, attitudes and practices among health care workers concerning the spread of nosocomial infections utilizing survey research, none of those studies reported data on validity and reliability of the used survey instrument (Pessoa-Silva et al., 2007; Suchitra et al., 2007 & Parmeggiani et al., 2010). Therefore, for this dissertation study a newly developed instrument was necessary. In developing a new survey the investigator's objective is create valid and reliable tests or measurement tools in order to enhance the accuracy of assessment and evaluations of the investigation. Validity refers to the extent to which a survey instrument measures what it is supposed to measure (Portney & Watkins, 2009). According to Portney & Watkins, an instrument's validity may be established as either content, criterion or construct. For this study, content validity was selected in order to determine that an overall sample of the content concerning the topic to be researched was represented in the questionnaire. Reliability refers to how consistently a measurement yields similar results under varying conditions. A variety of approaches are available to assess reliability such as test-retest, split halves, and, inter-observer ratings. The Cronbach alpha statistic may also be utilized to determine the internal consistency or average correlation of items in a survey instrument to gauge its reliability. For this study, the Chronbach's alpha statistic was utilized.

Methodology

The proposed questionnaire was constructed from emergent themes reviewed in the literature (Lam et al., 2004; Lepelletier et a., 2005; Conly, J.M. 2004; Cronin et al., 2008; de-Oliveira et al., 2005; De Wandel et al., 2010; Henderson et al., 2005; Helder et al., 2010;

Hugonnet et al., 2007; Edwards et al., 2009; Ribby et al., 2005; Pessoa-Silva et al., 2007; Sax et al., 2007; Friese et al., 2008; Godin & Kok, 1996) and items derived from established guidelines set by a task force committee on Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA (Boyce et al. 2002; WHO, 2002; McKibben et al., 2005). The information for completing each section and designation of the scale used were included at the beginning of each section. Demographic information and items regarding organizational support were included in section 1. Statements relating to the three domains: Knowledge, Practices and Attitudes were included in sections 2, 3 and 4 respectively.

To establish content validity of the questionnaire, a Delphi technique was utilized. This is a widely used and accepted method of gathering the opinions of experts in a particular specialization concerning the appropriateness of particular measures in the questionnaire. The technique involves several iterations of reviews with the aim of building a consensus (Hsu & Sandford, 2007). E-mail was utilized to transmit information to and from the experts. In each iteration, experts provided their opinions concerning the relevance and content of each proposed question (item). The researcher compiled the experts' opinions, utilizing a target of 80% agreement as the threshold for inclusion of an item in the questionnaire.

To establish the instrument's reliability, the investigator applied the Chronbach's alpha to test items under the categories of Knowledge, Attitude and Practice (Cronbach, 1951). The Cronbach's alpha quantifies the degree of internal consistency (item-reliability) of a set of items. It is affected by the instrument's length and dimensionality; and the test can also be used with items that are dichotomous or in cases where data is ordinal scale. If the items in the instrument are highly correlated to each other, the value of alpha is increased. If the items are not correlated, the

alpha is reduced (Portney & Watkins, 2009). Statistical analysis was accomplished using SPSS Version 20 (IBM SPSS® Statistics, 2011).

Since the development and validation of a study instrument is not considered as research with human subjects, the office of Institutional Review Board (IRB) of Seton Hall University advised the researcher that this pre-study activity did not fall under the purview of the IRB.

Procedure

Establishment of Content Validity of the Questionnaire

An expert panel including healthcare practitioners knowledgeable in infection control policies and procedures and in survey design and research methods was identified and participants recruited.

Inclusion / Exclusion criteria.

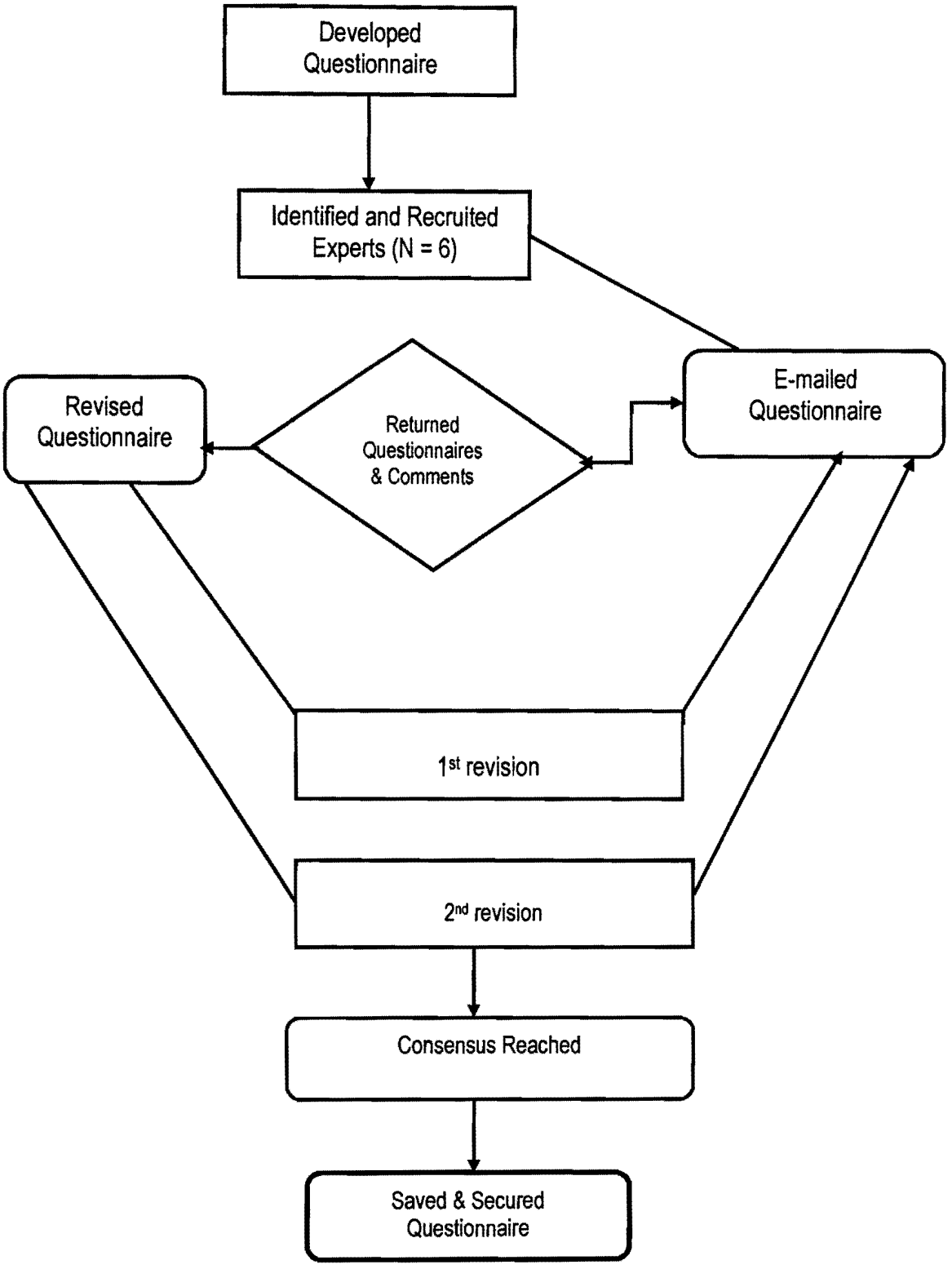
Healthcare workers knowledgeable in practices for infection control, as determined by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), were required for establishment of content validity of the questionnaire. According to the JCAHO, the minimum requirements for an infection control staff include basic qualifications in nursing, knowledge in epidemiology, and experience in infection control practices (www.hcpro.com). Therefore, healthcare workers in any of the following categories were recruited for the panel: registered nurse clinicians; nurse practitioners; nurse educators experienced in infection control practices; physicians or healthcare professional experienced in epidemiology, research methodology or questionnaire design. A panel of six content experts was formed. The panel included a physician (MD) and Professor of Research Methods, Epidemiology and Infectious Diseases courses at a

university medical school; two registered nurses (MSN) in the capacity of director of nursing from two different magnet hospitals; two registered nurses and infection control professionals (ICP) who worked in the capacity of charge nurse: one in a medical surgical unit, the other in an intensive care unit; and a registered nurse with Doctorate in Nurse Practitioner (DNP) and an adjunct professor of Research Methods in a nursing program at a university.

A Delphi technique was used to solicit the experts' opinions regarding proposed survey items (Hsu & Sandford, 2007). The process was iterated until a consensus was determined to have been reached. Two iterations were required to achieve the targeted agreement. Only the items with greater than 80% agreement were included in the final questionnaire. Figure 1 illustrates the validation process for achieving content validity.

Figure 1

Establishing Content Validity of the Questionnaire

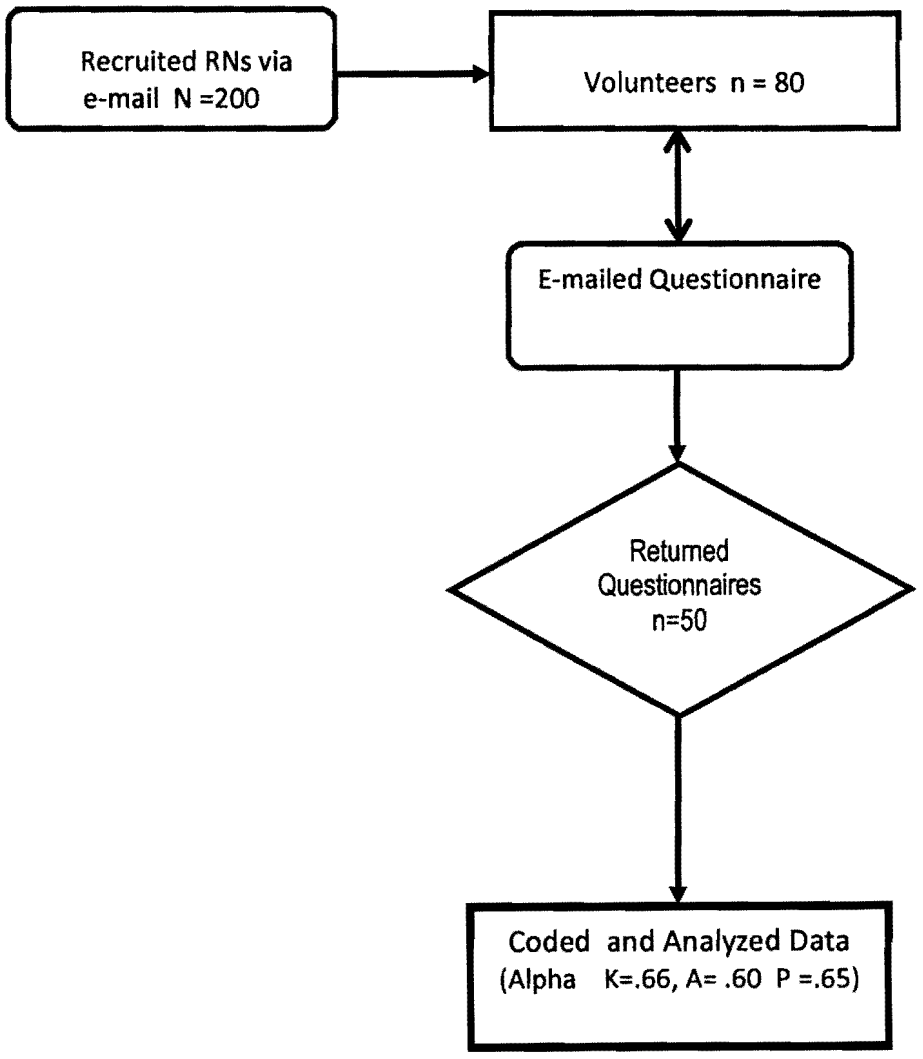


Establishing Internal Consistency of the Questionnaire

Following the validation of the proposed survey for content validity, the validation of item reliability (internal consistency) was accomplished utilizing Cronbach's alpha with a small group of registered nurses who volunteered to contribute to the development of the instrument. The volunteers were licensed as registered professional nurses, worked in a healthcare facility, demonstrated an ability to read and write in English, were knowledgeable in the use of electronic mailing (e-mail), and, expressed a willingness to participate in the reliability validation task. They were recruited via an email request sent to 200 registered nurses from a database of alumni of Essex County College. Additionally, recruitment flyers were placed on Essex County College bulletin boards seeking volunteers to participate in the validation of the questionnaire. 80 registered nurses expressed willingness to participate in this task. An e-mail, along with the proposed questionnaire as an attached Word® document was mailed to the 80 registered nurses and 50 responses were received. Figure 2 presents an illustration of the reliability validation process.

Figure 2

Validation of Questionnaire for Internal Consistency (Item Reliability)



Data *analysis*

Data on responses was coded and analyzed using SPSS Version 20 (IBM SPSS® Statistics). Cronbach's α (Reliability indices) were obtained.

Results

The Cronbach's α indices for Knowledge, Attitude and Practice were .66 .60, and .65 respectively. Table 1 shows the questionnaire's item distribution for three study variables (Knowledge, Attitude and Practice) and corresponding reliability indices (Cronbach's α).

Table 1

Internal Consistency of the Questionnaire: Cronbach's Alpha

Category	*Number of items*	*Cronbach's α*
Knowledge	13	.66
Attitude	8	.60
Practice	14	.65

Conclusion

As a rule of thumb, a Cronbach's alpha of at least .7 is the criterion used to establish an acceptable level of reliability. However, the recommended minimum Cronbach's alpha for exploratory studies is .6 (Nunnally, 1978). Therefore, the reliability for the proposed instrument was accepted based on these Cronbach's alpha results.

Following validation of the instrument's content validity and its internal consistency (item reliability), the final questionnaire was saved on a USB thumb drive, in anticipation of its use in the dissertation study.

Appendix C

QUESTIONNAIRE

Exploring Knowledge, Attitudes and Practices of Registered Nurses regarding Nosocomial Infections

Survey Objective:
This questionnaire is an essential part of a study that investigates Knowledge, Attitudes and Practices of registered nurses regarding nosocomial infections.

Instructions:
This survey collects data anonymously. Completion of this survey signifies your consent to participate in this study. Please check (√) in the box that corresponds to your response.

Section 1- Demographics:

1. Gender: ☐ Male ☐ Female

2. Age: ☐ < 20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ >50

3. What is your highest level of nursing education?
   - ☐ Associates degree
   - ☐ Bachelors (BSN-Accelerated)
   - ☐ Bachelors (BSN - Traditional)
   - ☐ Masters (MA / MSN)
   - ☐ Other (please specify) _____

4. How long have you worked (practiced) as a professional Registered Nurse?
   ☐ Less than 1 year ☐ 1-3 years ☐ more than 3 years

5. Your healthcare facility is classified as:
   - ☐ Hospital
   - ☐ Long Term Care
   - ☐ Other: (please specify)_____

6. Your **current** specialty unit / department is
   - ☐ Emergency Care
   - ☐ Telemetry/ Recovery
   - ☐ Medical –Surgical
   - ☐ Critical Care / Intensive Care /Acute Care
   - ☐ Oncology
   - ☐ Pediatric / Neonatal Unit
   - ☐ Maternal (Labor & Delivery, Post-natal)
   - ☐ Psychiatric / Behavioral
   - ☐ Ambulatory Care
   - ☐ Other (please specify) _____

7. Your employment status is ☐ Full –time ☐ Part-Time ☐ Per-diem
   ☐ Other (please specify)_____

8. How long have you worked in the current department?
   ☐ Less than 2 years ☐ 2-5 years ☐ more than 5 years

9. What is the **average** patient census in the unit? _____

10. What is your current shift? ☐ 8 Hrs ☐ 12 Hrs ☐ Day ☐ Night ☐ Week-end
☐ Other (please specify)_____

11. What is your unit's nurse to patient ratio? ___:___

12. Do you have other healthcare workers to help (e.g. RNs, LPNs)? ☐ Yes ☐ No

13. Have you ever participated in in-service education / workshops about "infection control"? ☐ Yes ☐ No

14. If Yes, how long ago? ☐ < 6 months ☐ 6 months to 1 year ☐ More than 1 year ago

15. Are you a preceptor? ☐ Yes ☐ No.

16. If Yes, how long have you been a preceptor? ☐ Less than 6 months
☐ 6 months to 1 year
☐ Longer than 1 year

To complete this section, please check (√) in the box that corresponds with how you agree with the given statement.

		1 = Yes	2 =No
17.	I know who my infection control practitioner is.	☐	☐
18.	My healthcare facility has an "infection control team".	☐	☐
19.	The infection control practitioner is physically present or on **call** during every shift in my unit or facility.	☐	☐
20.	My facility has made improved hand-hygiene adherence an institutional priority: for example, use of surveys and campaign ads.	☐	☐
21.	My facility provides suitable hand disinfectants in every patient's room, medication room, utility room, besides sink-water, soap and water	☐	☐
22.	My facility provides suitable hand disinfectants outside patients' rooms and in corridors.	☐	☐
23.	My facility has no multiple-use cloth towels of hanging or roll-type for staff use.	☐	☐
24.	My facility provides disposable paper towels for hand disinfection	☐	☐
25.	My facility has conspicuous written flyers / posters / reminders on transmission of nosocomial infections.	☐	☐
26.	My facility ensures that negative pressure rooms are used for patients with air borne and droplet infections	☐	☐

27.	My facility provides disposable stethoscopes, thermometers, BP cuffs for use while practicing patient care of patients in contact isolation	☐	☐
28.	Patients family members question health care workers if they determine that the healthcare worker intends to examined patient without hand washing.	☐	☐
29.	The administration provides workers with incentives to participate in workshops and seminars on transmission of nosocomial infections	☐	☐
30.	The administration in my facility mandates healthcare workers' participation in continuing education that addresses prevention of nosocomial infections	☐	☐

Section 2

Knowledge: To complete this section, please circle the number corresponds to how you agree with the given statement.

1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7=Strongly Agree

1.	I am fully aware of hand-washing guidelines	1	2	3	4	5	6	7
2.	I have been watched or supervised during hand-washing activity.	1	2	3	4	5	6	7
3.	Healthcare facilities harbor a variety of microorganisms that could be transmitted by healthcare workers.	1	2	3	4	5	6	7
4.	I know how to use the biohazard bag / container.	1	2	3	4	5	6	7
5.	I know where and how the contents in biohazard bags or containers are disposed.	1	2	3	4	5	6	7
6.	I know the safety precautions for disposal of needles, syringes, catheters etc and risk of transmission of nosocomial infections to healthcare workers.	1	2	3	4	5	6	7
7.	Nosocomial infections may be transmitted via medical equipment such as syringes, thermometers, needles, catheters, stethoscopes etc.	1	2	3	4	5	6	7
8.	Neutropenic patients or those with communicable diseases (e.g. diseases of the respiratory system) should be kept in private rooms.	1	2	3	4	5	6	7
9.	Some microorganisms such as *C. difficile* are not eradicated by alcohol based solutions.	1	2	3	4	5	6	7
10.	Hand hygiene should be performed after removing sterile or non-sterile gloves.	1	2	3	4	5	6	7
11.	I am aware of the recommended guidelines for hand hygiene							

with alcohol – based formulations. 1 2 3 4 5 6 7

Section 3

Practice: To complete this section, please circle the number corresponds to how you agree with the given statement.

1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7=Strongly Agree

1.	I follow recommended guidelines for use of alcohol based solutions or other antiseptics before and after helping a patient to move, or lifting / transferring the patient in and out of bed.	1	2	3	4	5	6	7
2.	I follow recommended guidelines for use of alcohol based solutions or other antiseptics before opening vascular access equipment.	1	2	3	4	5	6	7
3.	I use of alcohol based solutions or other antiseptics between each patient contact.	1	2	3	4	5	6	7
4.	I wash my hands or rub with alcohol based solution or other antiseptics **before** and **after** providing a nursing procedure: for example, bed bath, perineal care.	1	2	3	4	5	6	7
5.	I wash my hands or rub with alcohol based solution or other antiseptics after contact with equipment / objects likely to be contaminated followed by patient care activity e.g. taking vital signs.	1	2	3	4	5	6	7
6.	I wash hands **before** and **after** drawing and, or manipulating patient's body fluid sample.	1	2	3	4	5	6	7
7.	I always wash hands **before** and **after** having direct contact with patient's intact skin.	1	2	3	4	5	6	7
8.	I always wash my hands **before** and **after** inserting indwelling urinary catheters.	1	2	3	4	5	6	7
9.	I always wash my hands when moving from a contaminated body site to a clean-body site during patient care.	1	2	3	4	5	6	7
10.	I occasionally polish my fingernails or wear artificial nails.	1	2	3	4	5	6	7
11.	I am less compliant with recommended guidelines for reducing transmission of NI when workload increases or in emergencies.	1	2	3	4	5	6	7
12.	I wash my hands after touching inanimate surfaces and objects in patient's surroundings.	1	2	3	4	5	6	7
13.	During a busy patient care episode, I chart or use the computer keyboard with my gloves on.	1	2	3	4	5	6	7
14.	I remove my ring(s), watch or bracelet before beginning hand-hygiene.	1	2	3	4	5	6	7

Section 4

Attitude: To complete this section, please circle the number corresponds to how you agree with the given statement.

1=Strongly Disagree, 2=Slightly Disagree, 3=Disagree, 4 =Neutral, 5 = Agree, 6=Slightly Agree, 7=Strongly Agree

1.	In my opinion, nosocomial infections are pose a serious outcome (e.g. extended hospital stay days, mortality and increased cost of healthcare).	1	2	3	4	5	6	7
2.	In my opinion, I could transmit nosocomial infections.	1	2	3	4	5	6	7
3.	In my opinion, nurses respond negatively when a colleague (e.g. nurse or physician) is non-compliant with the recommended guidelines for patient safety.	1	2	3	4	5	6	7
4.	I am more compliant with the recommended guidelines for reducing the transmission of a nosocomial infection when training a new worker.	1	2	3	4	5	6	7
5.	I serve as a role model in demonstrating adherence to recommended practices for hand hygiene.	1	2	3	4	5	6	7
6.	It is unrealistic to expect healthcare workers to clean their hands after every contact with the patient.	1	2	3	4	5	6	7
7.	In my opinion, healthcare workers should be sanctioned for non-compliance with protocols for reducing transmission of nosocomial infections (for example, yearly assessment, denied promotion).	1	2	3	4	5	6	7
8.	In my opinion, healthcare workers should be rewarded (for example, given plaques, certificate) for compliance with protocols aimed at reducing transmission of nosocomial infections.	1	2	3	4	5	6	7

Thank you for completing this questionnaire.

Appendix D

IRB Approval – Seton Hall University

SETON HALL UNIVERSITY
1 8 5 6

February 28, 2012

Eunice W. Kamunge
64 Tottenham Court
Jersey City, NJ 07305

Dear Ms. Kamunge,

The Seton Hall University Institutional Review Board has reviewed the information you have submitted addressing the concerns for your proposal entitled "Exploring Knowledge, Attitudes and Practices of Registered Nurses Regarding Nosocomial Infections". Your research protocol is hereby approved as revised through expedited review. The IRB reserves the right to recall the proposal at any time for full review.

Enclosed for your records are the signed Request for Approval form and the stamped Recruitment Flyer. Make copies only of this stamped form.

The Institutional Review Board approval of your research is valid for a one-year period from the date of this letter. During this time, any changes to the research protocol must be reviewed and approved by the IRB prior to their implementation.

According to federal regulations, continuing review of already approved research is mandated to take place at least 12 months after this initial approval. You will receive communication from the IRB Office for this several months before the anniversary date of your initial approval.

Thank you for your cooperation.

In harmony with federal regulations, none of the investigators or research staff involved in the study took part in the final decision.

Sincerely,

Mary F. Ruzicka, Ph.D.

Mary F. Ruzicka, Ph.D.
Professor
Director, Institutional Review Board

cc: Dr. Raju Parasher

Please review Seton Hall University IRB's Policies and Procedures on website (http://www.provost.shu.edu/IRB) for more information. Please note the following requirements:

Adverse Reactions: If any untoward incidents or adverse reactions should develop as a result of this study, you are required to immediately notify in writing the Seton Hall University IRB Director, your sponsor and any federal regulatory institutions which may oversee this research, such as the OHRP or the FDA. If the problem is serious, approval may be withdrawn pending further review by the IRB.

Amendments: If you wish to change **any** aspect of this study, please communicate your request in writing (with revised copies of the protocol and/or informed consent where applicable and the Amendment Form) to the IRB Director. The new procedures cannot be initiated until you receive IRB approval.

Completion of Study: Please notify Seton Hall University's IRB Director in writing as soon as the research has been completed, along with any results obtained.

Non-Compliance: Any issue of non-compliance to regulations will be reported to Seton Hall University's IRB Director, your sponsor and any federal regulatory institutions which may oversee this research, such as the OHRP or the FDA. If the problem is serious, approval may be withdrawn pending further review by the IRB.

Renewal: It is the principal investigator's responsibility to maintain IRB approval. A Continuing Review Form will be mailed to you prior to your initial approval anniversary date. Note: No research may be conducted (except to prevent immediate hazards to subjects), no data collected, ~~nor any subjects enrolled after the expiration date.~~

REQUEST FOR APPROVAL OF RESEARCH, DEMONSTRATION OR RELATED ACTIVITIES INVOLVING HUMAN SUBJECTS

All material must be typed.

PROJECT TITLE: **Exploring Knowledge, Attitudes and Practices of Novice and Experienced Registered Nurses Regarding Nosocomial Infections.**

CERTIFICATION STATEMENT:

In making **this application**, I(we) certify that I(we) have read and understand the University's policies and procedures governing research, development, and related activities involving human subjects. I (we) shall comply with the letter and spirit of those policies. I(we) further acknowledge my(our) obligation to (1) obtain written approval of significant deviations from the originally-approved protocol BEFORE making those deviations, and (2) report immediately all adverse effects of the study on the subjects to the Director of the Institutional Review Board, Seton Hall University, South Orange, NJ 07079.

Eunice W. Kamunge Eunice Kamunge Dec. 8, 2011
RESEARCHER(S) OR PROJECT DIRECTOR(S) DATE

**Please print or type out names of all researchers below signature.
Use separate sheet of paper, if necessary.**

My signature indicates that I have reviewed the attached materials and consider them to meet IRB standards.

Raju K Parasher, PT, EdD Raju K Parasher. Dec 8 2011
RESEARCHER'S ADVISOR OR DEPARTMENTAL SUPERVISOR DATE

Please print or type out name below signature

The request for approval submitted by the above researcher(s) was considered by the IRB for Research Involving Human Subjects Research ~~at the~~ 1st Feb 2012 ~~meeting.~~

The application was approved ✓ not approved ___ by the Committee. Special conditions were ___ were not ✓ set by the IRB. (Any special conditions are described on the reverse side.)

Mary F. Ruzicka, Ph.D. 2/27/12
DIRECTOR, DATE
SETON HALL UNIVERSITY INSTITUTIONAL
REVIEW BOARD FOR HUMAN SUBJECTS RESEARCH

Appendix E

IRB Approval: Essex County College

ESSEX COUNTY COLLEGE
303 University Avenue, Newark, New Jersey 07102

(973) 877-3370

Office of Institutional Research

December 19, 2011

Eunice

Professor Eunice Kamunge
64 Tottenham Court
Jersey City, NJ 07305

Dear Professor Kamunge,

Thank you for your proposal regarding your research to examine registered nurses knowledge, attitudes and practices regarding the reduction of nosocomial infections.

All member of our Institutional Review Board reviewed your proposal and questionnaire and are pleased to approve your research efforts. Please see Ms. Rashidah Hasan to obtain a Hold Harmless Agreement after which you may begin your research efforts.

Good luck with your project.

Sincerely,

J. Scott Drakulich, Ed.D.
Associate Dean
Office of Planning, Research and Assessment

Drakulich, John

rom: Stein, Jill
Sent: Friday, December 16, 201 , 5:25 PM
To: Drakulich, John
Subject: Eunice Kamunge - PhD study

Dr. Drakulich,
I have read Professor Eunice Kamunge's doctoral proposal for Exploring Knowledge, Attitudes and Practices of Novice and Experienced Registered Nurses Regarding Nosocomial Infections. Her study is relevant and worthwhile. The questionnaire she will be using does not contain any personal identifying information, and is used strictly for research purposes. Taking all this into consideration, together with the fact that Ms. Kamunge has been a valued employee of Essex County College for many years, I recommend that she be given access to the database for ECC graduates of the Nursing program in order to be able to include them as participants in her study.

Jill C Stein, PhD
Dean of Liberal Arts and Sciences
Office of Academic Affairs
Essex County College
303 University Avenue
Newark, NJ 07102
973 877 3496 (Phone)
stein@essex.edu

Appendix F

Recruitment Flyer

Exploring Knowledge, Attitudes and Practices of Registered Nurses regarding Nosocomial Infections

Infections that develop during patients' stay in a hospital stay or health care facility lead to increased cost of healthcare, additional days of hospitalization and unnecessary deaths. So many factors and healthcare workers play a major role in the transmission of the infections from one patient to another.

Volunteers needed for a research study:

- Registered nurses
- Men and women 20 years or older
- Able to read English
- Familiar with the use of computers and e-mail

What is the study about?

- This study is designed to explore knowledge, attitude and practices of registered nurses regarding nosocomial infections.

Who is the Investigator?

- Eunice Kamunge.
  The investigator is a Doctoral candidate in the School of Health and Medical Sciences - Department of Graduate Programs in Health Sciences at Seton Hall University

Where is the study being conducted?

- The study will be conducted on-line.

If you are interested or know anyone who meets the above criteria, please forward this information along with the principal investigator's e-mail: **kamungeu@shu.edu** or **kamunge@essex.edu** to him or her.

This study has been reviewed and approved by Seton Hall University's Institutional Review Board, Office of the IRB, President's Hall – Room 325, Seton Hall University, 400 South Orange Avenue, South Orange, NJ 07079.

Seton Hall University
Institutional Review Board

FEB 27 2012

Approval Date

Expiration Date

FEB 27 2013

Appendix G

Solicitation Letter (electronic version)

Dear Registered Nurse:

My name is Eunice Kamunge - a student in the doctoral program at Seton Hall University, Department of Graduate Programs in Health Sciences, School of Health and Medical Sciences. Studies have shown that nosocomial infections pose a major burden to our society and literature suggests that healthcare workers play a significant role in their transmission. I am interested in examining the knowledge, attitudes, and practices of novice and experienced registered nurses regarding nosocomial infections.

You are being invited to participate in this study by completing an on-line survey that will be available by clicking the web-link. **You may use any name to log in**. The password for the survey is **password**. If you are interested, please click on this link: Exploring Knowledge, Attitudes and Practices of Registered Nurses regarding Nosocomial Infections to access the survey. The information that you enter will be directly imported into an ASSET survey, kept strictly confidential and not traceable to you. The survey is anonymous and you will not be identified by name or description in any reports or publications about this study.

There will be no monetary compensation or any kind of compensation for participating in this study. There are no foreseeable risks or direct benefits of the study to you. However, the information gathered will add to a body of knowledge regarding nosocomial infections. Your participation in the completion of the questionnaire is entirely voluntary. You may decide not to participate, or close the survey (browser) any time, before completion of the survey, without penalty.

If you prefer, you may print the survey, complete it in pen / pencil format and mail it to: Eunice Kamunge, C/O Dr. Raju Parasher, Associate Professor, Department of Graduate Programs in Health Sciences, School of Health and Medical Sciences, Seton Hall University, 400 South Orange Avenue, South Orange, NJ 07079.

The survey will take approximately 10 minutes to complete. If you have already completed this survey please do not complete it again. Furthermore, if you know any registered nurse who you think might be interested in participating in this survey, please feel free to forward this email to him or her.

If you have any questions, please feel free to contact the primary investigator, Eunice Kamunge through the office of Dr. Raju Parasher – Dissertation Chair, School of Health and Medical Sciences, Department of Graduate Programs in Health Sciences via parashra@shu.edu. The investigator's e-mail is kamungeu@shu.edu or kamunge@essex.edu.

This study has been reviewed and approved by Seton Hall University's Institutional Review Board, Office of the IRB, President's Hall – Room 325, Seton Hall University, 400 South Orange Avenue, South Orange, NJ 07079. The e-mail address is irb@shu.edu. Accessing and completing the survey conveys informed consent to participate in the study.

Thank you for your willingness to participate in this study.