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A STUDY OF A SIMULATED INFECTIOUS DISEASE ON HEALTHCARE WORKERS' REACTION, KNOWLEDGE, ATTITUDES, AND PERFORMANCE TOWARDS HAND HYGIENE

by

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ABSTRACT

A STUDY OF A SIMULATED INFECTIOUS DISEASE ON HEALTH CARE WORKERS' REACTION, KNOWLEDGE, ATTITUDES AND PERFORMANCE TOWARDS HAND HYGIENE

Lydia Wigglesworth-Ballard
Old Dominion University, 2015
Director: Dr. Holly D. Gaff

Problem Statement. The high rate of healthcare worker-patient contact provides many opportunities for exposure to pathogens, which creates challenges in assessing healthcare workers' success at preventing healthcare associated infections caused by these dangerous pathogens.

Methods. This study explored the effects of a simulated infectious disease on healthcare workers' hand hygiene knowledge, attitudes, performance, and reactions using Kirkpatrick's Four levels of Evaluation. The study utilized a mixed method pre-test – 2 post-test design. The dependent variables were hand hygiene knowledge, attitudes toward hand hygiene guidelines, hand hygiene performance, and reaction to the overall experience. Data was collected three times over a six-week study period. The simulation group completed a simulation experience using a clinical scenario with a simulated infectious disease, while the control group completed the same clinical scenario on paper during the same time period.

Results. Kirkpatrick Level I reaction findings revealed that all participants had a very positive reaction with the overall experience. Level II knowledge findings indicated, as expected, that using SID resulted in no new knowledge gain. Level II attitude findings revealed no significant changes in total attitude changes, but there was a

significant change for the attitude sub-scale relevance, and a near significant change for the attitude sub-scale motivation. Level III performance findings revealed no changes in self-reported hand hygiene performance, but the findings did suggest that participants showed an increase in personal intention to comply with hand hygiene guidelines and to sequence of care from clean to dirty. The qualitative data revealed healthcare workers' hand hygiene influences as scientific evidence and patient safety and it revealed hand hygiene barriers as supply accessibility and time constraints.

Conclusion. The simulation findings suggest that visualizing spread during clinical scenarios may have an immediate positive effect on attitudes and self-reported intentions to increase hand hygiene performance. Recommendations include utilizing SID with existing hand hygiene training protocols to demonstrate hand hygiene lapses during job and specialty appropriate hand hygiene and skills training.

This dissertation is dedicated to my children, Tyler, Andrew, and Alana. Their support and understanding have been tremendous during my doctoral journey. This dissertation is also dedicated to the memory of my mother, Florence Richter White, and grandmother, Florence Richter Woodhouse. Their constant encouragement, guidance, and love will be treasured forever.

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CHAPTER 1

INTRODUCTION

Healthcare associated infections places the lives of thousands of patients at risk in hospitals and other healthcare facilities. These infections cause dangerous complications that can cause morbidity and even death in patients who acquire them. Healthcare associated infections (HAIs) are infections that patients acquire in a healthcare setting while receiving care for another unrelated condition (United States Department of Health and Human Services, 2014; Klevens, 2007). Healthcare associated infections impact the patient's quality of life by creating financial, physical, and mental challenges with the burden of expensive treatments and longer lengths of stay in the hospital (Agency for Healthcare Research and Quality, 2009). Healthcare settings are complex environments where patients with weakened immune systems, constant patient contact, and invasive devices pose as an ideal place for pathogens to thrive and spread.

The routine treatment of antibiotics for patients with HAIs has become increasingly unsuccessful. Antibiotics is a class of drugs that become less effective with increased use and with its widespread overuse, antibiotics along with the emergence of multi-drug resistant organisms (MDROs) has played a role in the inability to control infectious pathogens (Centers for Disease Control and Prevention, 2013; Meade-Callahan, 2001). These MDROs, also referred to as "superbugs", have genes that make them resistant to one or more classes of antibiotics (Siegel et al., 2006). Presently, there are no new antibiotics available for use presenting an emergent need to increase hand hygiene vigilance.

The unsuccessful treatment of HAIs and their increasing resistance have been responsible for an estimated 90,000 deaths every year (AHRQ, 2009). The CDC has

reported that one out of twenty hospitalized patient will acquire an HAI, which will result in a total aggregate cost of 28 to 33 billion dollars in excess health care costs (Klevens, 2002; Scott, 2009). The individual cost can vary greatly depending on the patient's health status and type of infection from $600 for a urinary tract infection to $50,000 for prolonged bloodstream infection (Hassan et al., 2010).

Statement of the Problem

Healthcare associated infections present two unique challenges. First, the pathogens that cause these diseases can found everywhere, but are not visible to the naked eye. Theses pathogens can live and spread hospital surfaces, patients, visitors, and healthcare workers, all while remaining undetected. (Hota, 2004; Steinberg et al., 2013; Weber et al., 2013). The high rate of contact provides many opportunities for possible exposure to potentially dangerous pathogens. During these patient encounters hand hygiene practices are sometimes neglected, but these inactions in practicing basic and simple hand hygiene with just one patient could potentially lead to morbidity and death for the next patient.

Second, there is currently no universal standard for measuring compliance. Healthcare workers are in a dynamic line of work that requires constant patient contact in order to carry out their responsibilities in taking care of patients. The high rate of patient contact provides many opportunities for possible exposure to potentially dangerous pathogens. Even the most diligent healthcare worker has no means to assess his or her success at preventing spread. There have been advancements in the development of training resources to address the quality and safety concerns, but healthcare workers continue to fail to execute simple hand hygiene protocols at the appropriate times to prevent the spread of these dangerous pathogens. Hand hygiene rates among healthcare

workers has been documented as low as 40% and less (Longtin et al., 2011; Tiballs, 1996)

The previous work in hand hygiene during patient care has been focused on hand hygiene compliance which focuses on the process of just simply obeying the rules that pertain to one's job and nothing more, but without engagement compliance can be short-lived and easily overlooked. Commitment should be the ultimate goal, which is a process of wanting to do something by engaging oneself and is usually driven by motivational factors, as in doing what is best for the organization.

Background

The importance of infection control practices were recognized and studied in healthcare facilities as early as the 1840s. Dr. Ignaz Semmelweis, a practicing obstetrician at Vienna General Hospital, was one of the pioneers in infection control who studied the rate puerperal of fever, a bacterial infection contracted by women during childbirth in women giving birth. He observed that 20 % of women who gave birth at a hospital died from puerperal fever compared to only 1% of women who gave birth at home (Biddle, 2009; Cork et al., 2011). A case-control analysis conducted by Semmelweis enabled him to create a link between the hands of healthcare workers and the spread of pathogens to their patients. He implemented a hand-washing program that required healthcare workers to wash their hands in between patient care activities. The outcome of the hand-washing program resulted in a decreased puerperal fever rate among women giving birth in hospital to a rate comparable to women who gave birth at home (Biddle, 2009).

From the mid 1850's to 1860, Florence Nightingale emerged as a pioneer for modern nursing training (Reynolds-Finley Historical Library, 2014). She was recognized

for the care she provided wounded soldiers during the Crimean War and was a strong advocate towards improving sanitation and hygiene after she demonstrated how unsanitary environmental conditions were contributing to infections and increased death rates in hospitals (Newsom, 2003). Nightingale's "Notes on Nursing", published in the United States in 1860, covered basic guidelines on hygiene along with other valuable nursing information and became the introduction to modern nursing (Rosenberg, 1992). The efforts of Semmelweis, Nightingale, and others led the way for establishing measures to increase hand hygiene during patient care in order to reduce the spread of dangerous pathogens in healthcare settings.

In 1961, the U.S. Pubic Health Service produced the first training video that was used to demonstrate the proper hand hygiene techniques to healthcare workers. From the 1970s until now two global leaders in public health; the CDC, the World Health Organization (WHO), have increased their efforts to prevent and control infectious disease. These agencies have both stated that hand hygiene is the key method for reducing the spread of HAIs and have developed infection control guidelines for hospitals to use to increase their infection prevention efforts (Centers for Disease Control and Prevention, 2002; World Health Organization, 2002). Additionally, WHO developed the 5 Moments of Hand Hygiene to be used in conjunction with a hospital infection control programs (World Health Organization, 2009). The objective of the 5 Moments is to put the hand hygiene concept into simple, easy to learn pictorial descriptions demonstrating when to perform hand hygiene during patient care (Sax & Longtin, 2007).

The assembly of the Hospital Infection Control Practices Advisory Committee (HICPAC) helps to provide infection control advice, guidance, and strategies to the federal government and it's agencies. Healthy People 2020, managed by the U.S.

Department of Health and Human Services (U.S. Department of Health and Human Services, 2010), are a set of goals that was designed to serve as a guide for disease prevention and health improvement programs. Among the goals set for year 2020, measuring central line associated bloodstream infections (CLABSI) and methicillin-resistant staphylococcus aureus (MRSA) have been identified as priority (U.S. Department of Health and Human Services, 2010).

As a result of the high costs for treating patients with HAIs, the federal government has taken notice and policies have been put in place to hold hospitals accountable for the lapses rates of preventable infections. In October 2008, as a result of the Deficit Reduction Act of 2005 (U.S. Congress, 2005), the Department of Health and Human Service Services (CMS) submitted an accountability statement that stated payments will be withheld from hospitals for care associated with treating certain HAIs that are seen as highly preventable and were not present upon the patient's admission to the hospital (U.S. Government Accountability Office, 2008). Other insurance companies are following Medicare's lead and have begun to implement the same cost cutting measures.

The 2010 Affordable Care Act has established three policies addressing the need to reduce HAIs in hospitals: the Hospital Readmissions Program, Hospital-acquired Condition Reduction program, and the Hospital Value-based Purchasing program. The relationship between HAIs and hospital readmissions has gained much attention (Perencevich et al., 2003; Anderson et al., 2009; Jencks et al., 2009; Emerson et al., 2012) and has resulted in the fiscal year 2012 implementation of the Hospital Readmissions Program. The CMS has defined readmissions as being admitted to the same or another hospital within 30 days of discharge and as of fiscal year 2012;

healthcare facilities will face financial penalties and nonpayment for excessive and preventable patient readmissions (U.S. Congress, 2010).

The Hospital-acquired Condition Reduction program will begin implementation during fiscal year 2015 and will result in a 1% reduction in Medicare payments to hospitals that rank among the lowest 25% in regard to HAIs rates. The implementation of the hospital value-based purchasing program will begin fiscal year 2016. The hospital value-based purchasing program will adjust Medicare payments based on an identified set of quality measures to include central line associated bloodstream infections, catheter associated urinary tract infections, and surgical site infections.

Purpose of the Study

The purpose of this study is to examine the effects of using a simulated infectious disease (SID) on healthcare workers reaction, knowledge, attitudes and performance during a hand hygiene training review. This study aims to provide a novel visualization method to be used as a part of a hospital infection control training program to increase commitment to hand hygiene, this study also aims to improve patient safety, quality of care, and reduce unnecessary time and costs associated with the burden of deadly pathogens.

Significance of the Study

This study contributes to the body of knowledge in three ways. First, by providing insight into lapses in hand hygiene made by healthcare workers in a simulated scenario. Second, by contributing to the healthcare worker's understanding of how pathogens spread throughout a patient care setting by using SID to visually demonstrate the spread that can occur because of hand hygiene inactions. Third, by testing a potential training-based solution to hand hygiene commitment for healthcare workers that

addresses in part the federal governments' initiatives and calls to action for reducing the spread of HAIs.

Theoretical Rationale

Kirkpatrick's Levels of Evaluation model was used in this study. Donald Kirkpatrick published a series of articles in 1959, which introduced a four-stage model for evaluation of training programs (Kirkpatrick, 2006). This model has become well known in education and continues to be used today for adult training programs (Frash et al., 2008; Slater et al., 2012; Mollet & Ostergaard, 2014). In the healthcare industry, the Return on Investment (ROI) is usually the indicator of value when determining if a training program is successful. The ROI is defined as a measure of profitability or efficiency, which compares investment gains with costs (Business Encyclopedia, 2014). For example, investment gains that compare favorably with costs would result in a high ROI, which is an indication that an organization is efficiently using its resources. The Kirkpatrick model differs since it uses a concept of Return of Expectation (ROE) as the indicator of value. The ROE is what the organization determines is of value and how that value or expectation should look after the training. As in the case of this study case, the value would be defined as the reduction of HAIs.

Kirkpatrick identified four levels for evaluation of training programs (Figure 1). Level I is the reaction stage. This level measures the participant's reaction towards the program. This measurement determines if the participant liked the training, if the training was a positive experience, and if the training was motivational. This is accomplished through the use of what Kirkpatrick refers to as "smile" sheets, which are questionnaires asking participants how they felt about the training and if they like or enjoyed it. Level II is the learning stage. This level measures the increase in knowledge

or acquisition of knowledge of new skills. This level is where the training occurs and knowledge is measured by using a post-test with questions relating to the subject covered in the training. Level III is the transfer stage. This stage measures if the participant's new knowledge or acquired skills is being utilized in their work environment. Level IV is the result stage. This stage is measured at the organizational level and determines if the desired outcome of the training was achieved. In this case, the level would relate to factors such as patient outcomes, rates of infections, quality of care, and costs.

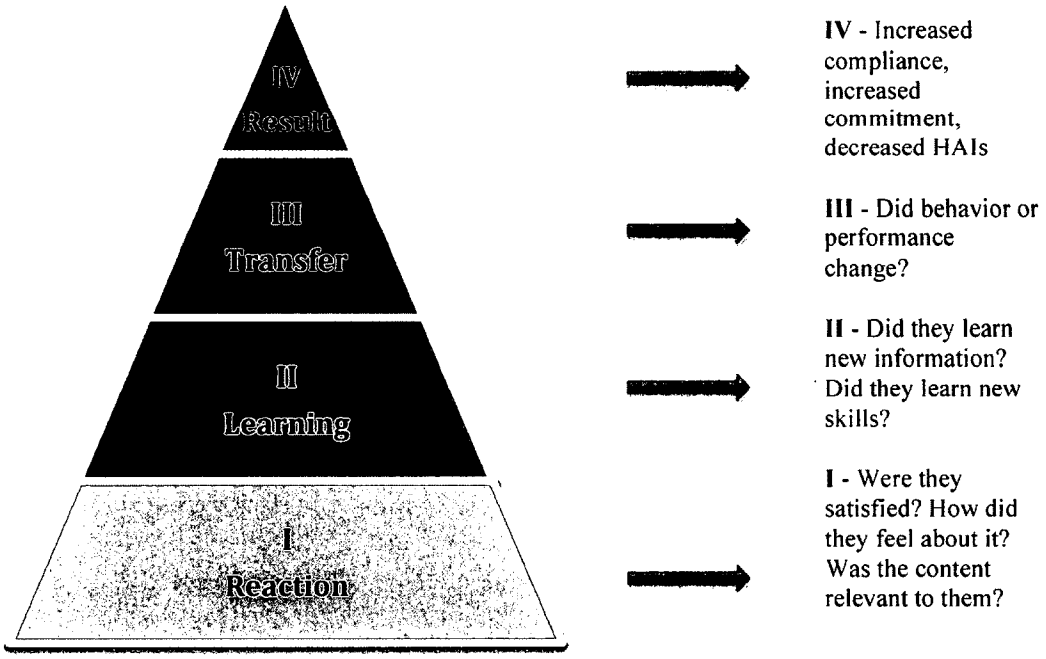


Figure 1. Graphical representation of Kirkpatrick's Four Levels of Evaluation

The key to successfully utilizing this model is to connect each of these levels to ultimately maximize ROE. Level IV is measured at the organizational level and requires an extensive amount of time and resources that cannot be afforded during this study.

Kirkpatrick's model is utilized in this study to provide a clearer understanding of the roles that the reaction, knowledge, attitude, and performance constructs have in determining whether or not a healthcare worker complies and commits to hand hygiene.. The literature has identified these constructs as barriers to healthcare worker's hand hygiene practices. In this study, Kirkpatrick's Level I will address the participants reaction to the study, Level II will address changes in knowledge, skills, or attitudes, and Level III will address changes in self-reported performance.

Research Questions

The following quantitative research questions were addressed:

1. What are the effects of a hand hygiene protocol review with and without SID on reaction to hand hygiene, infection control, and the overall study?
2. What are the effects of a hand hygiene protocol review with and without SID on knowledge regarding hand hygiene and infection control?
3. What are the effects of a hand hygiene protocol review with and without SID on attitude regarding hand hygiene and infection control?
4. What are the effects of a hand hygiene protocol review with and without SID on hand hygiene performance?

Assumptions

It was assumed that all healthcare personnel participating in this study could comprehend all written materials and the verbal instructions given. It is also assumed that all the participants would provide truthful answers to all questionnaires and interviews.

Definition of Key Terms

The following terms are defined to ensure clarity of their meaning as it pertains to this particular study. The researcher developed all definitions not accompanied by a citation.

Attitudes are defined as the participant's settled way of thinking or feeling toward hand hygiene practices, which is typically reflected in their hand hygiene performance.

Hand hygiene is the participant's act of removing visible soil or killing microorganisms with soap and water or alcohol based hand rub (Centers for Disease Control and Prevention, 2002).

Hand hygiene opportunity a given moment determined by set protocols or visible soil on hands that hand washing should be performed.

Hawthorne effect is the participant's alteration of behavior due to their awareness of being observed (Oxford Dictionaries, 2014).

Hospitalist is a physician who specializes in the care of hospitalized patients (Society of Hospital Medicine, 2009).

Infection control protocols are step-by-step procedures used by healthcare facilities during patient care or daily non-patient care activities to minimize the risk of spreading pathogens.

Knowledge is understanding and comprehension of information on common healthcare associated infections, hand hygiene and infection control protocols, and skills necessary to prevent or minimize the spread of pathogens that are acquired thought education, continuing education training, on the job training, and work experience.

Performance is the participant's execution of hand hygiene protocols (i.e. hand washing, use of alcohol based hand rub, donning of gloves and sterile technique) at every hand hygiene opportunity.

CHAPTER 2

LITERAURE REVIEW

This chapter provides a literature review, which is divided into three sections. The first section describes the chain of infection process in a healthcare setting. The second section describes how the core tenants of theoretical framework in examining healthcare workers perception of barriers to infection control, which includes attitudes, knowledge, and behavior towards infection control practices. The third and last section discusses use of traditional infection control training methods and simulation methods to teach and improve infection control practices. A comprehensive search of several large databases (MEDLINE, CINAHL Plus, Science Direct, Academic Search Complete and Health Source: Nursing / Academic Edition) was used to conduct the review of the literature.

Chain of Infection

A diagnosis of clinical disease is not solely based on a patient coming in contact with the pathogen, but occurs when a series of events take place in sequential order. This series of events is referred to as the Chain of Infection. The Chain of Infection involves six components, which are the infectious agent, reservoir, portal of exit model of transmission, portal of entry, and susceptible host (DeLaune & Ladner, 2006; CDC, 2004). The Chain of Infection in Figure 2 shows the key components of the chain and how they are linked together. The importance of each of these elements and the roles each plays in disease transmission have been well demonstrated and can be minimized with appropriate hand washing for each hand hygiene opportunity (Sax et al., 2007; Gawande, 2004; World Health Organization, 2009).

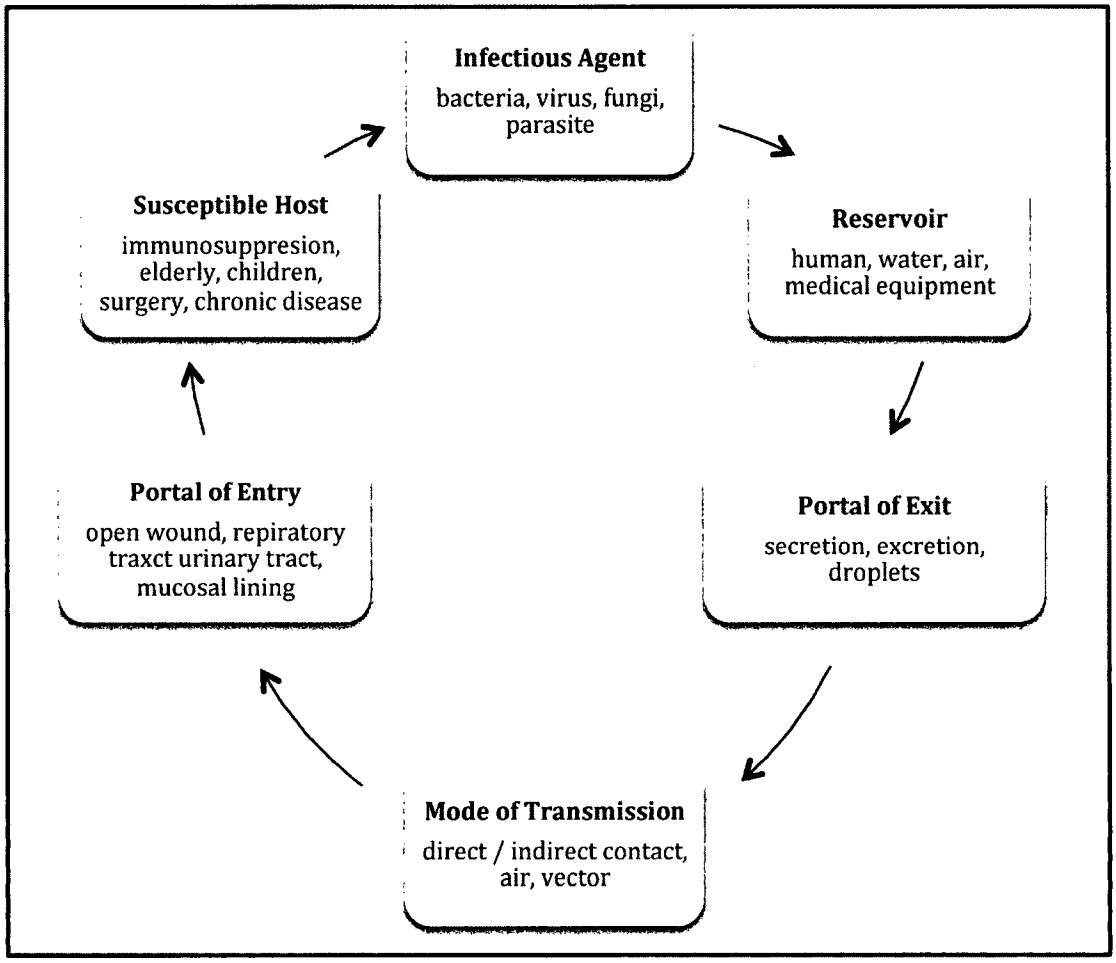


Figure 2. Schematic Drawing of the Infection Process.

Application of infection control practices at any of the links of the chain will break the cycle of transmission and infection. A combination of hand hygiene and personal protective equipment such as gloves, gowns, and masks, and proper disinfection procedures has the ability to stop harmful pathogens from spreading.

Infectious Agent

Microorganisms are too small to be seen with the naked eye, but are found virtually everywhere. Although many are beneficial and can live on and in the human body without causing harm, some microorganisms are infectious. These infectious

agents, commonly referred to as pathogens, are organisms that can cause a variety of host responses from no symptoms to the worse case scenario of death. The likelihood of disease development depends on three factors: virulence (the severity of the disease produced by the pathogen, pathogenicity (ability to enter the host and cause the disease), and amount of the infectious pathogen that inoculates the host (World Health Organization, 2002).

The HAIs are caused by a wide variety of common and unusual bacteria, fungi, and viruses. The conditions present in the healthcare environment make them a breeding ground for pathogens. The mix of patients with weakened immune systems, invasive devices, and open wounds create plenty of opportunities for pathogens to spread, grow, and thrive. Some of the more persistent and difficult to treat HAIs include Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant enterococcus (VRE), and *Clostridium difficile* (*C. difficile*).

Methicillin-resistant Staphylococcus aureus. Infections caused by MRSA have become more prevalent today than ever and has become one of the most frequent causes of skin and soft tissue infections in the United States (Dulworth, 2004). These infections are very difficult to treat and are the cause of respiratory tract infections, surgical site infections cardiovascular infections, and bacteremia (Klein et al., 2007). MRSA has been found to survive for eight days or more on plastic patient charts, cloth curtains, and laminate tabletops (Huang et al., 2006).

Clostridium difficile. *Clostridium difficile* are bacteria that cause mild to severe diarrhea, and in worst cases, the toxins from the bacteria can cause inflammation leading to life threatening perforations in the colon (Gould, 2010). This has become an increasing problem with the elderly population, especially in long-term facilities. Heavy

environmental contamination can occur due to the diarrhea, which is one of the major symptoms of this disease (Gould, 2010). *C. difficile* has been reported to occur on surfaces in close proximity to patients such as bedpans, blood pressure cuffs, stethoscopes, walls, and floors and remain viable for up to five months (Kim et al., 1981). In a study by Kim et al. (1981), cultures of an intensive care unit (ICU) were obtained after a *C. difficile* case was discovered in the unit. The results showed positive test results for presence of *C. difficile* in 48 of the 432 cultures taken on floors of patient rooms, bedpans, floors of utility rooms and toilet seats. Five of the patients in that particular ICU had later developed *C. difficile* associated diarrhea.

Vancomycin-resistant *Enterococcus* (VRE). VRE are bacteria that are normally found in the intestine and the female genital tract. A VRE infection is known to cause infections of the urinary tract, bloodstream, surgical site infections, and other wounds. The ability for VRE to survive and persist on hospital surfaces has been demonstrated in several studies (Noskin et al., 1995; Noskin et al., 2000; Neely & Maley, 2000; Hota, 2004). Noskin et al. (2000) were able to recover VRE from a fabric seat cushion one week after it was contaminated and demonstrated the ability of the transfer of VRE from a seat cushion to the hand of a healthcare worker.

Reservoir

A reservoir is any place where the pathogen can live, thrive, and reproduce (DeLaune & Ladner, 2006). In a healthcare setting, reservoirs may include the toilet, human feces, skin, counter tops, or any place where the pathogen can survive. The survival of pathogens has been well documented and studies confirm that many bacteria that cause HAIs can live on hospital surfaces for days, weeks, and sometimes months (Hota, 2004).

Portal of exit

The portal of exit is any location on the body where the pathogen exits or leaves such as the nose and mouth of the respiratory tract, the rectum of the intestinal tract, the urinary tract, or other body fluids such as blood (DeLaune & Ladner, 2006).

Mode of transmission

Transmission is when disease is transferred from one person to another. Patients can become infected through an endogenous infection or exogenous infections (DeLaune & Ladner, 2006). An endogenous infection comes from the normal flora of the patient and may present itself when the patient's immune system has been compromised. An exogenous infection comes from a pathogen that is transmitted from other patients and hospital staff. In the later case, these pathogens are transmitted through direct or indirect contact, droplets, or airborne transmission (DeLaune & Ladner, 2006).

Direct transmission occurs when one person who is the carrier of the disease passes the disease to another person via physical contact with blood or body fluids. To provide care, healthcare workers have to be in constant contact with patients (DeLaune & Ladner, 2006).

Indirect contact occurs when a susceptible person comes in contact with contaminated surfaces and objects and becomes infected without physical contact with the infected person. Surfaces may be contaminated with blood or other body fluids. Droplet transmission results from the inhalation of droplets that were dispersed into the air by the sneeze or cough of an infected person (DeLaune & Ladner, 2006). The droplets do not stay airborne and settle on the surfaces where they may potentially live for days, weeks, or even months in the right environmental conditions (Hota 2004).

Airborne transmission occurs from infectious pathogens that remain airborne (DeLaune & Ladner, 2006).

Role of healthcare workers in transmission. A healthcare worker's hands primarily cause the spread of infectious pathogens. The healthcare worker's hands becomes contaminated by a patient who is colonized and therefore becomes the mode of transmission for the pathogen to spread to the next patient if proper hand hygiene is not performed. There is also evidence that the pathogens can be carried on the healthcare workers clothing and personal equipment such as stethoscopes, mobile phones, and pens (Taconnelli, 2011).

Portal of entry

The portal of entry is the route by which a pathogen enters the body of a susceptible person (DeLaune & Ladner, 2006). This could be through open wounds, mucous membranes, or through any opening where invasive devices such as catheters or feeding tubes have been inserted.

Classification of healthcare-associated infections. The type of infection can vary depending upon the pathogen and the site of infection. The CDC has listed the five most common and costly types of infection include central line-associated bloodstream infections, surgical site infections, catheter-associated urinary tract infections, ventilator-associated pneumonias, and *Clostridium difficile*-associated disease.

Susceptible Host

A person who is at risk for developing an infection is known as a susceptible host (DeLaune & Ladner, 2006). A portion of the patient population may have one or more factors that make them more vulnerable to these types of infection. These factors include those patients who have less efficient immune systems such as the very young or elderly,

a chronic disease state such as diabetes and HIV, and other status such as post surgical, malnutrition, or treatment with immunosuppressive drugs.

Several studies have established a relationship between hospital readmissions and HAIs. Susceptible patients who have tested positive for HAIs have an even greater risk of hospital readmission (Anderson et al., 2009; Emerson et al., 2012; Jencks et al. , 2009). Emerson et al. (2012) conducted a study investigating the association between HAIs and time to hospital readmission. This retrospective study period covered 8 years of adult patients who were admitted to the University of Maryland Medical Center and had a positive clinical culture of MRSA, *C. difficile*, or VRE for more than 48 hours after hospital admission. The study sample consisted of 136,513 patients. The study discovered a significant association between hospital readmission and a positive culture of one of three HAIs patients were tested for. These patients who tested positive had a median time of 27 days to readmission compared to 59 days for those who did not test positive. The data in this study strongly supports the importance of reducing HAIs by demonstrating how increased time to readmission can lead to poor patient quality of care, poor patient outcomes, and increased healthcare costs.

Barriers to Hand Hygiene

Studies on lack of adherence to infection control practices among healthcare workers have shown that the actual and perceived barriers to these practices are multidimensional. Several studies have has identified knowledge (Boyce & Pittet, 2002; Rosenthal et al., 2005; Suchitra & Lakshmi, 2007), attitudes (Boyce & Pittet, 2002; Rosenthal et al., 2005; Wolk et al., 2008; Suchitra & Lakshmi, 2007), and performance (Boyce & Pittet, 2002; Suchitra & Lakshmi, 2007) as barriers to best infection control practices.

Reactions

There were no studies discovered in the literature that looked at healthcare workers' reactions or feelings toward hand hygiene protocol reviews in which no new content was provided. There were also no studies discovered that looked at healthcare workers' reaction to hand hygiene education or training, in which new information is provided to either broaden knowledge or skills.

The information received from evaluating participant reaction can be very valuable in assessing how to improve training programs. This information helps to identify learning needs or skills training that may have been overlooked and determine which educational or training methods are most likely to be received well by future participants (Salas et al., 2009; Weaver et al., 2011).

Hand Hygiene Knowledge

Lam et al. (2004) studied nurses' compliance with hand hygiene following a task-oriented hand hygiene education program. Nurses' hand hygiene practices were observed for one year to document factors that contributed to non-compliance and was followed by a hand hygiene educational program that was developed based on the non-compliance factors. A six-month post intervention observational assessment was conducted, which resulted in a decrease in infection rates and length of hospital stays from 11.3 days to 6.2 days per 1000 patient days. In Rosenthal et al. (2005) provided healthcare workers a comprehensive infection control manual in addition to the Associate for Professional in Infection Control (APIC) Hand Hygiene Guidelines educational tool, which resulted increased hand hygiene rates and reduction in HAI's by 42%. Suchitra and Lakshmi (2007) also assessed knowledge by giving healthcare workers a series of questionnaires at

three time periods after an educational module. The initial result was an increase in compliance; however, there was a decline in knowledge with the passage of time.

Hand Hygiene Attitudes

O'Boyle et al. (2001) studied nurses' motivation to wash their hands by looking at the internal and external motivational factors. The authors discovered that there are a variety of internal (attitude, perceived control and intention) and external (nursing unit activity and physical environment) factors that contribute a nurse's hand hygiene performance.

A nurse's perception regarding hand hygiene and infection control is shown to affect their behavior. The Nursing 2007 Infection Control Report explored nurses' perceptions of infection control guidelines in their respective facilities (Delahanty & Myers, 2007). Among the 3,278 nurses who participated in the survey, 76% believed that if the patient did not show signs of an infection while under their care, then they were convinced that they were doing a good job of preventing infection. This becomes a problem in infection control because most infections have an incubation period, so the nurse may never know of the infection after a patient has been discharged from the hospital (Delahanty & Myers, 2007).

Wolf et al. (2008) conducted a study designed to assess the nursing staffs' perceptions of MRSA in an Atlanta Veterans Affairs long-term facility. A total of 42 nursing staff participated in focus groups and given a questionnaire that measured their perception of threat and risk of MRSA. The authors reported that 59% of the nurses perceived MRSA as being a threat to the patients and perceived an even less risk to themselves. The results also showed that the nurses in this study tended to perceive that MRSA was more of a national problem than one within the Veterans Affairs facility.

Hand Hygiene Performance

Proper hand hygiene implementation protects the patient and the healthcare worker, but several studies have concluded that hand hygiene practiced by healthcare workers may be more for self-protection than for protection for the patient (Whitby et al., 2006; Bahal et al., 2007). Bahal et al. (2007) observed hand hygiene behaviors at the ICU and surgical ward of two different healthcare facilities. Patient pre-contact and post-contact hand hygiene behaviors of 141 doctors and nurses were documented. The authors determined from the data that the healthcare workers were consistently better at hand hygiene post-contact than pre-contact. It was concluded that these behaviors show that the hand hygiene behavior for some healthcare workers may be more for self-protection than for protection for the patient.

Understanding the importance of infection control practices in a healthcare setting does not always translate into practice. In a study conducted by Whitby et al. (2006) hand washing behavior may be based on perceived risk of infection. Nurses reported that an assessment of dirtiness and cleanliness was made by using factors such as a patient's diagnosis, physical appearance, and age to determine the need for hand washing.

Nurses have reported perceived barriers to infection control compliance to be long hours, high workload, understaffing, skin conditions that are irritated by frequent hand washing, lack of knowledge, inaccessible supplies, and use of gloves providing a false sense of comfort as replacement to proper hygiene (Pittett, 2001). The infection control nurse was cited as being the most influential factor in infection control practices for nurses and the charge nurse for nursing assistants (Wolfe et al., 2008).

Infection Control Simulation

Simulation training can be a useful tool for healthcare facilities to provide greater consistency among skills training, especially when accounting for the variety of educational backgrounds and learning experiences (Durham & Alden, 2008). More importantly, the use of simulation provides for a controlled environment where learners can practice skills, receive feedback, and have opportunities for corrective measures until proficiency is reached, while presenting no risk or harm to the patient.

The exploration of simulation use in healthcare began and has been advancing since that late 1800s and early 1900s (Nehring & Lashley, 2009). To date much of the literature on infection control simulation has focused on online infection control modules followed by a questionnaire to test knowledge (CDC, WHO) or presentation of clinical case that requires the participant to choose the next appropriate steps to take in care of the patient presented in the scenario (CDC, WHO).

In order to improve existing infection control and education, a study using a germ simulator as a possible method for teaching infection control was conducted. In a multidisciplinary pilot study in the virtual intensive care unit (VICU) at Old Dominion University, the investigators tested seven germ-simulation products currently available on the market to find one suitable for use with human simulator mannequins in a medical simulated environment. The product, GloGerm™ was determined to best meet the criteria for simulating the spread of MRSA within a patient care setting (Curry-Lourenco, et al., 2009) This simulation involved using techniques for visualization of spread through the use of GloGerm™ and feedback as a method for instruction. The two main issues that arose during the study was the substance's visibility under normal light and difficulty in washing the substance off the mannequins. The GloGerm™ in small

amounts could be seen slightly under normal light on the mannequins. This was not ideal because the sole purpose is for the substance to not be seen at all, just as there is the inability to see bacteria. In order to clean the GloGerm™ substance off of the surfaces the manufacturers recommendations were followed; however, some of the substance could not be properly removed under their guidelines making it less efficient for repeated use. The GloGerm™ study led to further exploration of germ-simulated substances that could be a more effective tool for teaching infection control which resulted in the development of the Simulated Infectious Disease (SID).

CHAPTER 3

METHODOLOGY

The methodology chapter will describe the research design and paradigm for the study. This study employs a mixed methods design utilizing both quantitative and qualitative components to address the research questions.

This chapter will be presented in three sections. The first section will include the research design, independent variables, and dependent variables. The second section will include the development and purpose of the infectious disease simulator. The third section will discuss the main study to include the setting, participants, and dependent measures, procedures, data collection, and data analysis.

Pilot Study

A pilot study, located in Appendix A, was conducted to provide a proof of concept for using a simulated infectious disease (SID) as a tool for assessing change in hand hygiene practices. The pilot study's first objective was to develop a simulated disease product that would be safe and effective to use repeatedly that would not damage delicate simulation equipment during training. The second objective was to assess nursing students' hand hygiene practices by measuring the amount and distance of SID spread and hand hygiene moments during a clinical scenario within a simulated healthcare setting. The pilot study was conducted with 4th year nursing students in a virtual intensive care unit. The results of the pilot study facilitated the design of the main study.

Study Design

This study utilized a quasi-experimental, mixed-method, non-equivalent control group pre-test -two post-test mixed methods design (Table 1).

Table 1

Experimental Design Diagram

Group	Pre-test	Treatment	Post-test 1	Post-test 2
Treatment (Simulation) Group	O	X	O	O
Control Group	O		O	O

The independent variables were study group (control vs. treatment) and profession (nurses vs. physicians). The control group completed the online hand hygiene review module and a paper-based patient-care scenario. The treatment group completed the online hand hygiene review module with a simulation patient-care scenario using SID. Participants were licensed nurses or physicians.

Dependent measures were pre-test, immediate post-test, and delayed post-test reaction, knowledge, attitudes, and self-reported hand hygiene performance scores collected over the six-week study period.

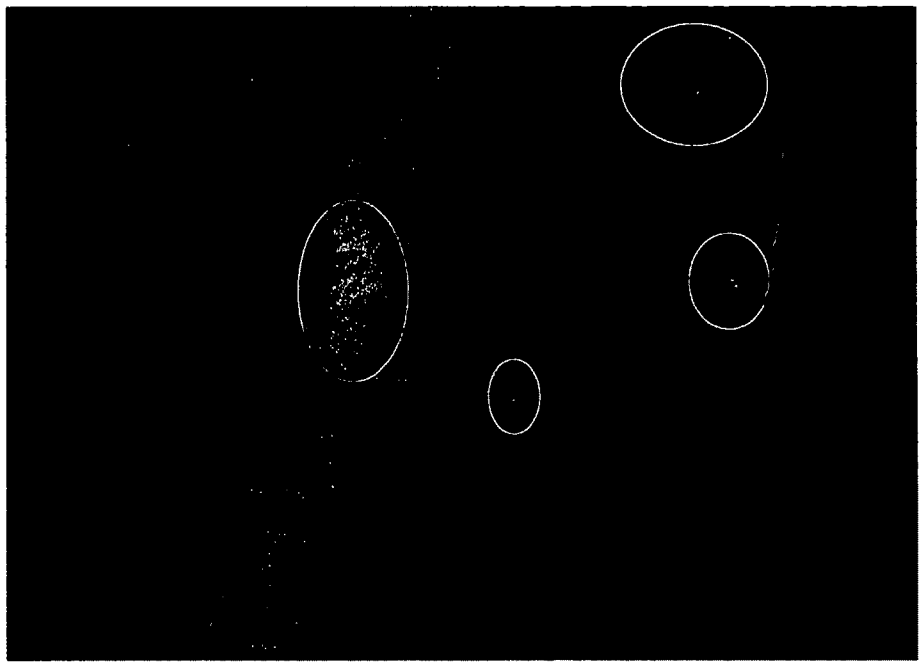
Qualitative data consisted of observations and semi-structured debriefing interview for participants in the simulation group and open-ended responses to two items on the Attitudes Toward Hand Hygiene Questionnaire for all participants. Qualitative data were analyzed using the phenomenology method.

Infectious Disease Simulator

For this study, a simulated infectious disease was used. This simulator was obtained from Cospheric, Inc. The researcher requested the development of custom microspheres for this project that met three criteria. The first criterion was for the microspheres to have the capability of blending into the skin color of the mannequin with minimal visibility with the naked eye. The second criterion was for the microspheres to spread by contact to other materials. The third criterion was for the microspheres to be

visible with an external stimulus such as ultraviolet light (UV). The final product met all three criteria and was delivered with instructions for application and clean up (Appendix B). The researcher named the microspheres "simulated infectious disease (SID)". When SID is placed applied to objects, as directed by the manufacturer, they are not visible under normal light, but are visible under a 365nm UV light, also known as black light. Figures 3a demonstrates a healthcare worker's hand that has come in contact with SID under normal light and Figures 3b demonstrates what the hand from Figure 3a looks like under UV light.

(a)



(b)

Figure 3. Photographs of hands "infected" with SID. (a) The top photograph is a healthcare worker's hand with SID under natural light. (b) The bottom photograph is a healthcare worker's same hand with SID under UV light. The SID dispersed on the hand and also found in clusters. The circles on the photograph note the clusters of SID.

These microspheres have many forms that have been used in cosmetics, medical devices for diagnostic purposes, and as a drug delivery method. The Food and Drug Administration has listed polyethylene as a safe ingredient for use in chewing gum and as an indirect food additive. The Cosmetic Ingredient Review Expert panel has deemed polyethylene safe for use in cosmetics. Simpler substances have been tested and presented logistical issues for complex training environments beyond simple hand washing (Curry-Lourenco et al., 2009). Simpler substances are not suitable for repeated tests, some are visible in daylight, and their consistencies (i.e. liquid makeup and mediums) may mechanically or cosmetically damage delicate medical equipment and mannequin simulators. SID is very safe and does not pose any potential danger to any trainee or the delicate equipment that is used for medical simulations.

The SID was used to simulate potentially infectious bacteria and was planted in areas on the patient mannequin and the bedside environment where colonization could potentially occur. The addition of SID to patient simulation scenarios allowed the participants to visualize the spread of infectious disease in a clinical setting and provide a visual impact of infection control lapses.

Sampling Procedure

The study population for this study consisted of healthcare workers employed at a teaching hospital having 1,432 physicians, fellows, and residents and 1,806 professional nurses as of the 2011 fiscal year. Infection prevention specialists identified five departments within the hospital that have a high population of patients who are at risk for acquiring HAIs. Participants were recruited from a total population of 220 hospital employees from the five departments by employing a criterion-sampling scheme. Participation was strictly voluntary. To qualify as a participant in the study, the employee had to be employed at the hospital as a physician (resident or hospitalist) or a nurse. Potential participants were recruited through hospital-supported email, which was sent to healthcare workers in the following departments: pediatrics, surgery, neurosurgery, bone marrow transplant unit, and the medical surgery oncology unit. Those who volunteered to participate were given an informed consent document and provided time to read and ask any questions prior to signing up. The healthcare workers were reassured that their decision to participate or not participate in the study would not jeopardize their employment. The participants were provided with a written description of the study and given the opportunity to ask any questions they may have. Participants were able to self-select which group to participate in: the online module only or the online module with simulation experience. Those who choose the online module only

became the control group and those who choose the online module with simulation experience became the treatment group.

It was preferred that staff complete the study during their off time; however, to increase participation, nurses were offered the option to participate in the study during their working shift if the nurse manager could easily cover them and patient care was not compromised. A point of contact for nurses was designated in each department to assist in answering questions and arranging the time for those who wanted to complete the study during their shift. Participants were presented with a five-dollar gift card to the hospital coffee shop at the completion of the study. Nurses who chose to complete the study during their work time were not eligible to receive the gift card. The physicians were able to complete the study before, after, or during a break in their shift when patient care was not compromised.

Power analysis

Cohen (1988) recommended a power analysis with effect size when determining the correct sample size to be able to generalize the data to the population. A power analysis to estimate sample size was not conducted because study measures were not collected during the pilot study. The pilot study focused on determining feasibility, time allotments, and recruitment rates, and recruitment rates in a clinical lab setting with practicing healthcare workers instead of students as in the initial pilot study.

Sample size

A total of 54 participants signed up for the study. One participant was disqualified for failing to meet criteria under the job description. Three participants were dropped for not following the protocol. Of the 54 who originally qualified for the study,

50 participants were included in all or some parts of the study. A complete description of enrollments is presented in Table 2.

Table 2

Description of Participation

	Nurses	Physicians
Number enrolled in study	19	35
Knowledge Questionnaire		
Participants completed	17	33
Failed to meet criteria	1	0
Disqualified - not following protocol	1	2
Attitude Questionnaire		
Participants completed	16	30
Disqualified - incomplete	1	3
Reaction & Satisfaction Survey		
Participants completed	14	23
Disqualified - incomplete	3	7
Simulation Experience		
Participants completed	9	13
Failed to meet criteria	1	0
Disqualified - not following protocol	1	0

Setting

The main study was conducted at a comprehensive academic medical center, which has over 700 beds. The medical center employs approximately 1,400 physicians and 1,800 nurses. The simulation portion of the study was conducted in a simulated center located within the facility. The simulated patient room was set up with a hospital bed, patient simulator mannequins, bedside equipment, and access to a sink. The room was equipped to simulate a realistic patient care environment in an acute care setting. The mannequins were set up to simulate a patient with a diabetic foot, a patient with an

abdominal wound, and a patient with a spinal wound. The mannequins also had an intravenous line for medication administration and a Foley catheter.

Human Subjects

This study was approved by the Institutional Review Boards (IRB) from Old Dominion University and the study facility where the data collection took place. Participants were informed of their right to withdraw at any time and that all their information would remain confidential.

Instruments and Measures

Data was collected using the following instruments: demographic questionnaire, hand hygiene knowledge questionnaire, attitudes toward hand hygiene guidelines, and reaction and satisfaction questionnaire. The demographic questionnaire was administered at pre-test only. The hand hygiene knowledge and attitudes toward hand hygiene questionnaires were administered at pre-test, immediate post-test, and delayed post-test, the reaction and satisfaction questionnaire was administered during delayed post-test only, and the hand hygiene performance data was collected at pre-test, immediate post-test, delayed post-test, and during the intervention.

Demographic Questionnaire

The demographic questionnaire was developed by the researcher to collect data on the characteristics of the study participants. This questionnaire contained six questions regarding the gender, age, highest degree obtained, type of profession, years in profession, and years employed at the hospital where the study was conducted.

Reaction and Satisfaction Survey

The Reaction and Satisfaction survey was a developed using tools from The Kirkpatrick Partners, which is the official online consulting website for Donald

Kirkpatrick that aims to improve training evaluation for businesses using the Kirkpatrick model (Kirkpatrick, 2008). This questionnaire contains 15 items measured on a 6-point Likert scale from "Strongly disagree" to "Strongly agree", which aimed to measure the participant's reaction and satisfaction with the overall study. The first 12 items was used for both the control (online only) group and simulation (online and simulation experience) group and items number 13 through 15 was used to measure the reaction of those who participated in the simulation group.

Participants responded with a rating of 1 for strongly disagree, 2 for somewhat disagree, 3 for disagree, 4 for somewhat agree, 5 for agree, and the highest possible score was a 6 for strongly agree. The Cronbach's Alpha reliability coefficient was calculated for the ten reaction and satisfaction items, resulting in a correlation coefficient of 0.89.

Hand Hygiene Knowledge Questionnaire

The questions for the Hand Hygiene Knowledge Questionnaire were taken from a modified version of the Institutes for Healthcare Improvement survey (Institutes for Healthcare Improvement, 2003). The original infection control knowledge questionnaire was used in the pilot study. The administration of the survey during the pilot study revealed some issues that presented problems in enabling proper measurement for this study. The survey was modified to make the questions more clear by making the alternatives to each question equal in length, using at least four alternatives for each item to lower the probability of getting the item correct by guessing, and using alternatives "none of the above" and "all of the above" sparingly. The changes were made based on the criteria used by the Center for Innovation in Teaching and Learning (2009) at the University of Illinois Urbana-Champaign.

The modified questionnaire was validated by administration to fourth year students from the Medical Technology program at Old Dominion University. The results shown that questions four and five needed further evaluation as shown in Figure 4.

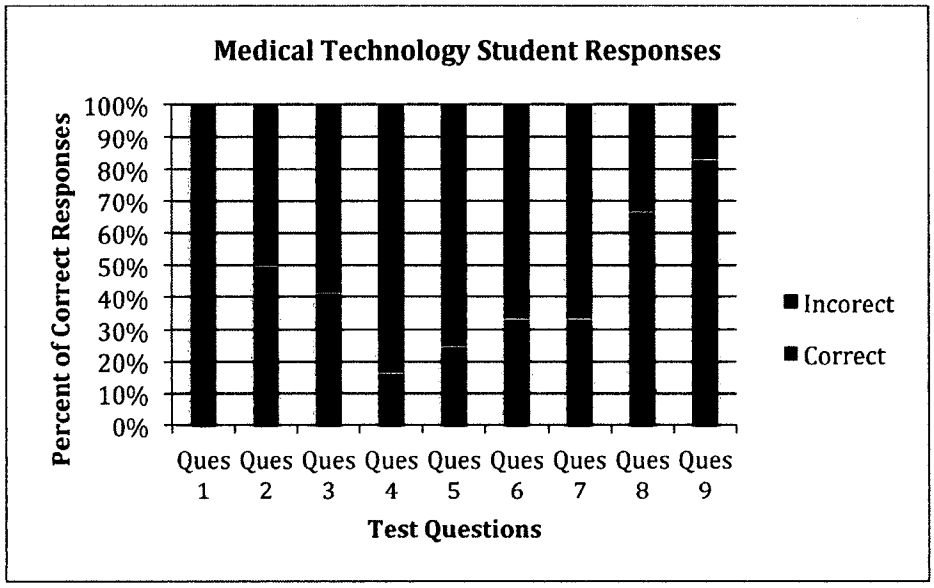


Figure 4. Medical Technology Student Responses to the Modified Hand Hygiene Knowledge Questionnaire.

It was finally determined that the modified hand hygiene knowledge questionnaire that was administered to the medical technology students was not a good fit for the participants for the main study. In order to properly align the questionnaire with the hand hygiene protocols at the main study site the instrument was reviewed for content and modified a third and final time with the assistance of an expert panel made up of a health educator, and three physicians; a hospital epidemiologist, a director of quality for hospitalists, and an educational director of quality and safety for residents. This final instrument was used for the main study. The revised questionnaire was administered before and after the online hand hygiene review module as a pre-test and immediate post-

test. This questionnaire was administered again as a delayed post-test approximately 30 days after the completion of the first post-test. The questionnaire contained eight multiple-choice items that assessed knowledge of healthcare associated infections and hand hygiene and infection control procedures. The test also contained three additional multiple choice items (questions nine, ten, and eleven) that were added to elicit how participants knew they were doing a good job of practicing hand hygiene, to self-rate their hand hygiene performance on a frequency scale from 0% to 100% in 25% increments, and to self-rate the hand hygiene practices of their colleagues on a frequency scale from 0% to 100% in 25% increments. Although these last three items were administered on the hand hygiene knowledge questionnaire, they will be analyzed with their appropriate constructs of attitude for question nine and performance for questions ten and eleven.

An item analysis was conducted using a Kuder-Richardson 20 ($K\text{-}R_{20}$) internal consistency estimate. All items were scored dichotomously as "0" for an incorrect response and "1" for a correct response. The $K\text{-}R_{20}$ yielded low values for internal consistency for the pre-test ($K\text{-}R_{20} = 0.41$), immediate post-test ($K\text{-}R_{20} = 0.45$), and delayed post-test ($K\text{-}R_{20} = 0.42$). These values may have been due to the few items on the questionnaire.

Attitudes Regarding Practice Guidelines Questionnaire

This modified questionnaire was developed by Elaine Larson, PhD to measure barriers to adherence to the CDC's Hand Hygiene Guidelines (Larson, 2004). Larson (2004) conducted preliminary testing on this instrument by administering this survey to 21 healthcare personnel. Larson concluded that in order to improve adherence and acceptance of guidelines, interventions might need to differ among staff depending on

whether they accept the guidelines or see them as unimportant. This instrument contained two parts. The first part assessed attitudes towards practice guidelines in general and the second part assessed attitudes specifically toward the CDC's practice guidelines. There was an overlap of questions between the two parts, so in order to stay with the time constraints given by the study facility, only part one was used. This questionnaire contains 18 items that are measured on a six-point Likert scale from "Strongly disagree" to "Strongly agree" and two fill in the blank questions that aimed to collect qualitative data on factors that influence hand hygiene practices and barriers to hand hygiene practices. This questionnaire is also listed, in The Joint Commissions' monograph titled Measuring Hand Hygiene Adherence: Overcoming the Challenges, as one of the examples for medical facilities to incorporate into their infection control training programs for hospital staff (The Joint Commission, 2009). This questionnaire was administered to the control and treatment groups during the pre-test, immediate post-test, and delayed post-test.

The subscales (Table 3) were obtained from Larson (2004), who performed a factor analysis using principal component analysis and varimax rotation with Kaiser normalization to examine underlying constructs. The items with correlation coefficients less than 0.3 were omitted. The final instrument consisted of 12 items assigned to one of three factors, which are relevance, motivation, and outcome expectancy.

Table 3

Attitude Sub-scale Factors

Question	Factor: Relevance
2	There are so many guidelines available that it is nearly impossible to keep up
4	I don't have time to stay informed about available guidelines
5	Guidelines are too "cookbook" and prescriptive
7	Generally, practice guidelines are cumbersome and inconvenient
8	Guidelines are difficult to apply and adapt to my specific practice
11	Generally, the costs of practice guidelines outweigh the benefits
12	Guidelines interfere with my professional autonomy
	Factor: Motivation
9	In this organization, practice guidelines are important
13	Generally, I would prefer to continue my routines and habits rather than to change based on practice guidelines
15	Publishing practice guidelines are important
	Factor: Outcome Expectancy
10	Guidelines improve patient outcomes
16	Guidelines help to standardize care and assure that patients are treated in a consistent way

For this study, the 12 items resulted in a Cronbach alpha of 0.79. The subscales are independent as they contribute to the overall attitude score, but do not correlate highly with one another. The correlation coefficients for the subscales for this study are listed in Table 4.

Table 4

Correlation Coefficients for Total and Sub-scale Scores for Attitude Questionnaire

	Relevance	Motivation	Outcome Expectancy	Overall Mean
Relevance		(Pre) $r = .52$ $r^2 = .27$ (IPost) $r = .68$ $r^2 = .46$ (DPost) $r = .61$ $r^2 = .37$	(Pre) $r = .26$ $r^2 = .07$ (IPost) $r = .56$ $r^2 = .31$ (DPost) $r = .66$ $r^2 = .44$	(Pre) $r = .89$ $r^2 = .79$ (IPost) $r = .93$ $r^2 = .86$ (DPost) $r = .92$ $r^2 = .85$
Motivation			(Pre) $r = .56$ $r^2 = .31$ (IPost) $r = .48$ $r^2 = .23$ (DPost) $r = .67$ $r^2 = .45$	(Pre) $r = .72$ $r^2 = .52$ (IPost) $r = .74$ $r^2 = .55$ (DPost) $r = .78$ $r^2 = .61$
Outcome Expectancy				(Pre) $r = .55$ $r^2 = .30$ (IPost) $r = .71$ $r^2 = .50$ (DPost) $r = .79$ $r^2 = .62$

Semi-structured debriefing interview questions

The interview collected data specifically regarding attitudes towards SID and the simulation experience. The interview consisted of eight questions that were asked immediately following the participant's simulation experience. The questions for the interview were selected based upon the Virtual Intensive Care Unit study (Curry-Lourenco et al., 2009) conducted at Old Dominion University. These specific set of questions were used to put more focus on gather feedback from the visualization of SID to distract from just focusing on the participants hand hygiene actions or inactions. This method was used to make the participant more confortable to speak about their own hand hygiene.

Procedures

The study was carried out using the hospital email as the point of communication for all the participants. All questionnaires and surveys were administered through the Qualtrix online survey website. The hand hygiene review module was accessed through a link provided in the hospital email. The study covered a 6-week period with weeks 1, 2, and 6 marked as actual data collection points in the study.

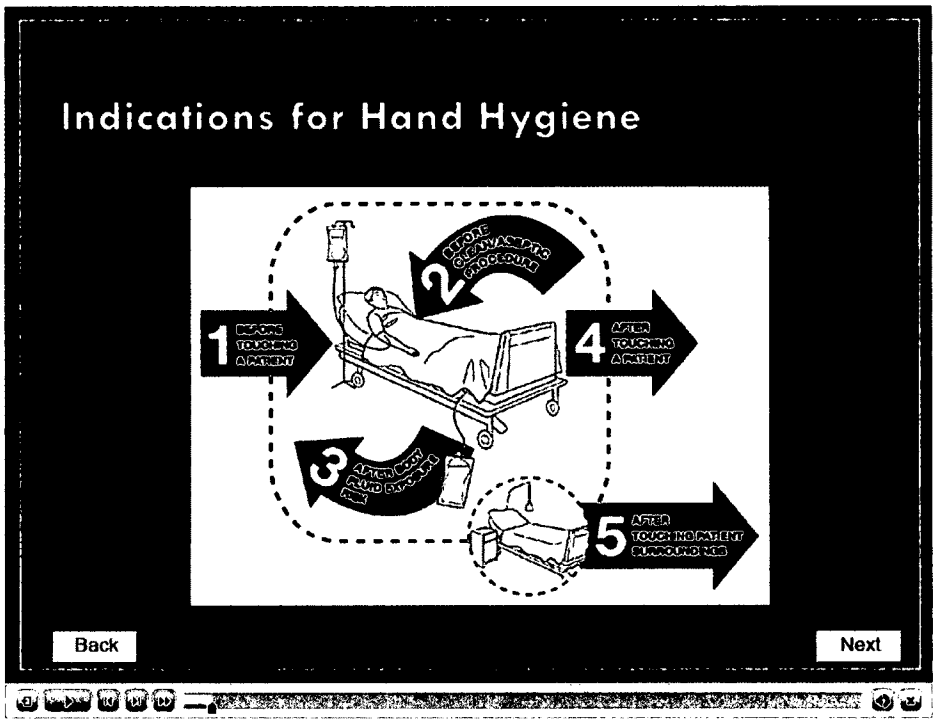
During week one of the study all participants (control and simulation groups) were sent an email, which contained a greeting along with an introduction and brief review of the information that was provided to them in the written description of the study during the sign-up process. The email also contained a link for the pre-test, online hand hygiene review module, and the immediate post-test. If they chose to continue with participation the study proceeded as follows in Table 5.

Table 5

Study Schema

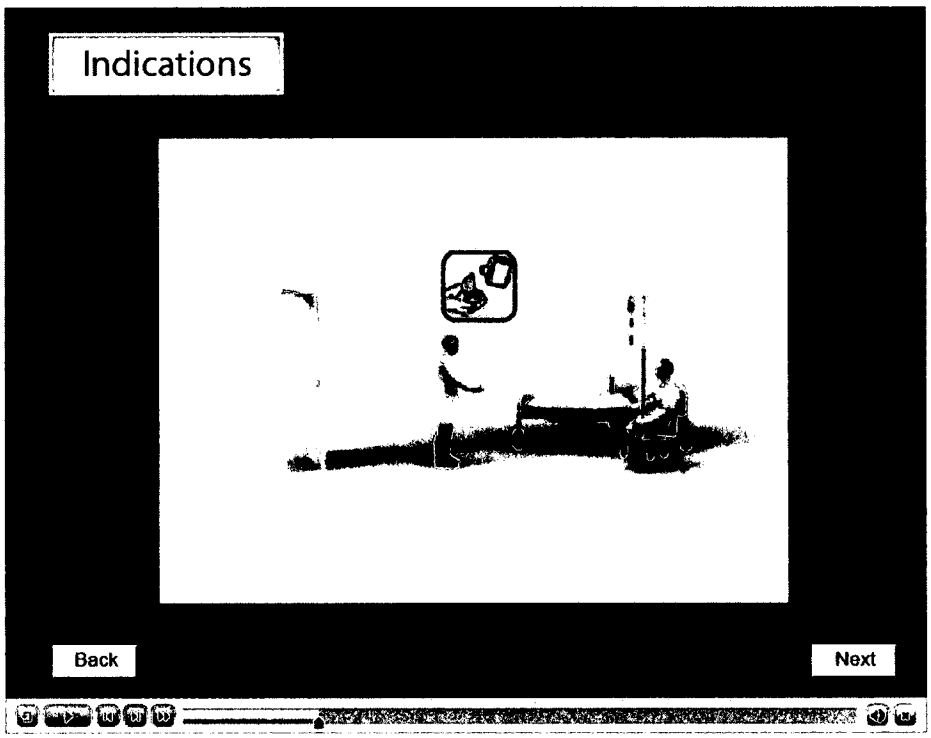
	Control Group tasks	**Simulation Group tasks**
Week 1	Email sent with three links: pretest, hand hygiene review video, and immediate post-test	
	1. Take pre-test online 2. Watch online 10 minute hand hygiene review module 3. Take immediate post-test online	1. Take pre-test online 2. Watch online 10 minute hand hygiene review module 3. Take immediate post-test online
Week 2	Email sent with control group scenario document attached	Email sent with appointment date and time to complete simulation experience
	Complete paper-based scenario and return via email or hospital mail	Complete simulation experience at the Nursing Education Center at appointed time
Week 6	Email sent with one link: delayed post test	
	1. Take the delayed post-test online 2. Complete the reaction and satisfaction survey	1. Take the delayed post-test online 2. Complete the reaction and satisfaction survey

The participants began the study by clicking on the link provided in the email to take them to the Qualtrics webpage for the pre-test. The pre-test assessed baseline knowledge of infection control protocols and hand hygiene, attitudes toward infection control protocols and hand hygiene, and self-assessment of hand hygiene performance. Once participants completed the pre-test, they were directed back to the email and were instructed to proceed to the second link to view the hand hygiene review module. The hand hygiene review module was developed by the hospital education staff and was approximately 10 minutes in duration. The module was a slide show with embedded videos demonstrating infection control and hand hygiene protocols based on the five moments of hand hygiene technique from WHO. The slide show included several formats as shown in Figure 5 that appeal to various preferences of receiving information.



(a)

(b)



(c)

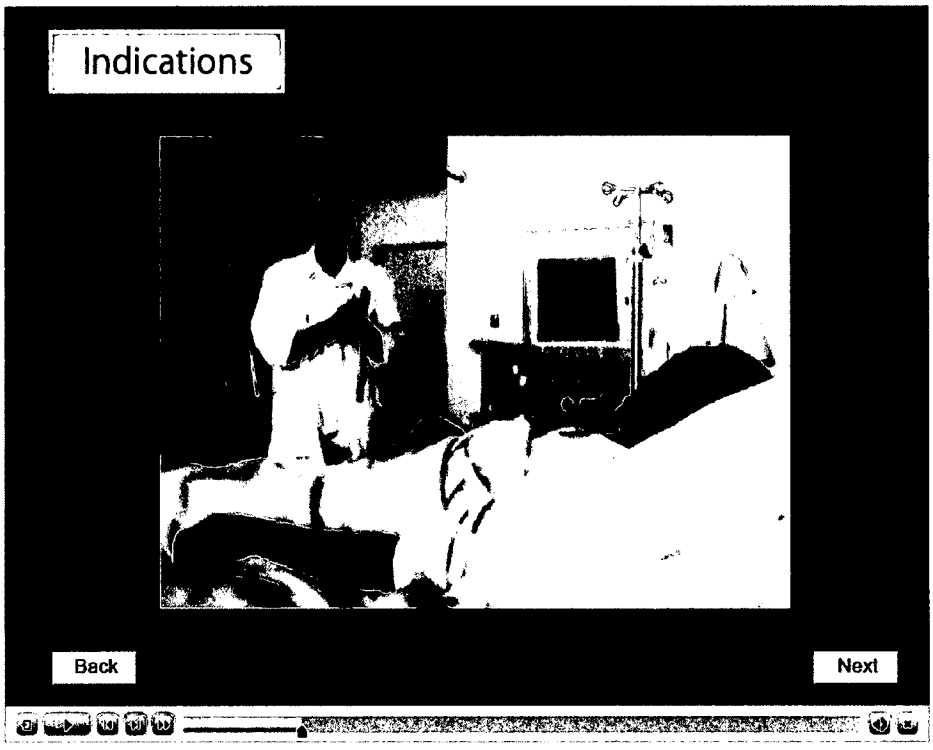


Figure 5. Screenshots of the online hand hygiene review: (a) a graphical depiction, (b) an animated demonstration, and (c) demonstration with live actors.

At the conclusion of the module, the participants were again directed back to the email and were instructed to click on the third link to take the immediate post-test questionnaire, which assessed any change in knowledge or attitudes toward infection control protocols and hand hygiene and changes in their assessment of their own hand hygiene practices and hand hygiene practices of their colleagues.

During week two of the study, the simulation group took part in the simulation experience in the nursing education center located within the hospital. Participants were scheduled individually by appointment. Appointments were available from 7:00 AM until 4:00 PM. Upon arrival, they were greeted, given a brief orientation of the room set up, and an overview of how the simulation was going to proceed. Participants were given time to read a simulated patient clinical case. The clinical cases were written specifically for each participant's specialty area. The specialty areas included pediatrics, general practice, surgery, and neurosurgery. The mannequin was outfitted with the appropriate wound site to reflect the participant's specialty. For example, general practice had a diabetic foot wound, pediatrics and surgery had an abdominal wound, and neurosurgery had a spinal wound. The simulated patient clinical case scenarios are located in Appendix I.

The participants were then instructed that they had ten minutes to complete the assessment and tasks list on the clinical scenario form. They were informed that they could begin whenever they were ready. The participants were then left alone in the room to demonstrate the appropriate clinical skills and hand hygiene for their given case. Figure 6 demonstrates some of the areas where SID was planted prior to the simulation.

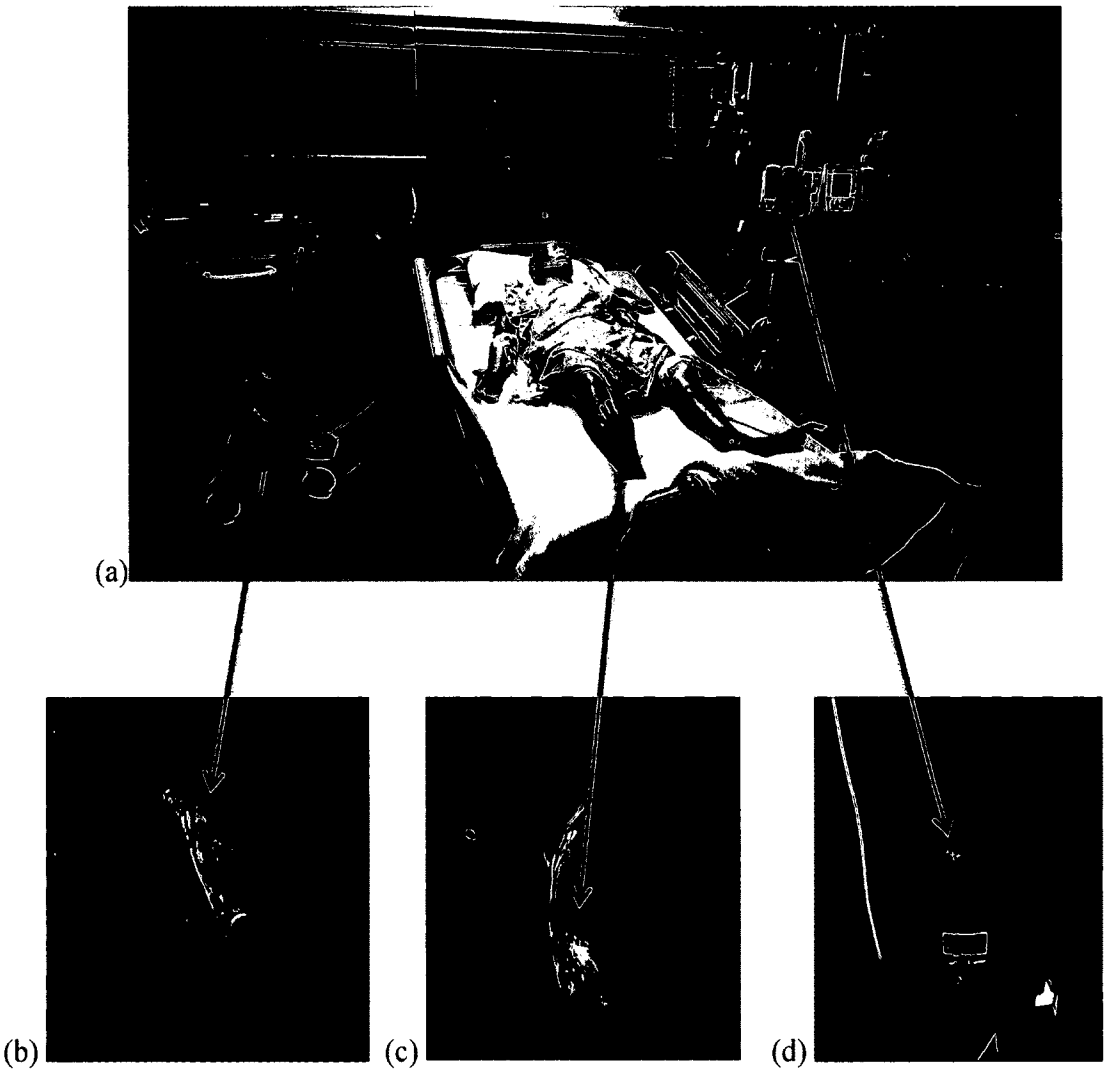


Figure 6. Photographs showing some of the locations where SID was planted in the simulation room. (a) The top photo is the simulation lab room under natural light. The bottom photos show the location of SID in the room under UV light. (b) The bottom left photo is the barcode scanner, which is used to scan the patient's identification band and medications that are prescribed for the patient. (c) The bottom center photo is the "infected" left diabetic foot. (d) The bottom right photo shows the SID on the IV pump.

The researcher monitored the participants from another room via video feed through a camera system built into the simulation room. The infection control team at the study site developed a checklist for the researcher to use to document observations of hand hygiene performance and sequence of care during the simulation experience. Once the participant completed the simulation training, the researcher entered the room, and the

participant was debriefed on the true nature of the study. The debriefing statement (Appendix J) was read verbatim to each participant. The debriefing also included a semi-structured interview (Appendix K), disclosing the presence of SID, showing the locations were the SID was planted, taking a walk through the space to highlight any contamination with the ultraviolet light, and highlighting any presence of SID on the participant. The participant was given the opportunity to ask any questions and have any concerns addressed. If any SID spread was discovered, as shown in Figure 7, it was documented by taking photographs or video recordings of the study area. Participants were provided with positive feedback on things that were executed well during the simulation, and they also received careful and focused feedback on missed hand hygiene opportunities and potential points of spread.

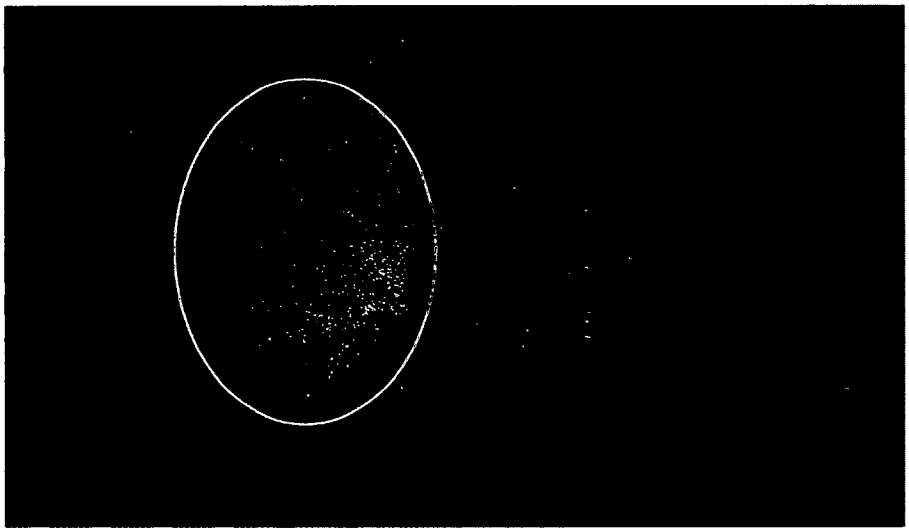


Figure 7. Photograph of SID spread on the back of participant's neck. This spread occurred during the simulation when the participant placed the stethoscope around their neck.

Also during week two, those in the control group were emailed a copy of the same clinical scenario (Appendix L) that the simulation group received and physically walked through in the simulation experience. The participants in the control group had the option of printing out the scenario or completing it online. The scenario could be returned through email or campus mail. They were asked to read the clinical scenario and complete the two written tasks. The first task consisted of numbering the list of clinical procedures in order beginning with which procedure they would do first to which they would do last. The second task was to circle all the procedures before which they would perform hand hygiene. Once completed the participants were asked to return the completed paper-based scenario via hospital mail or email.

During week 6 of the study, an email was sent to all participants informing them that this was the last portion of the study. The email contained a link to the delayed post-test. The delayed post-test accessed change in attitudes, knowledge, and self-reported performance. The reaction and satisfaction survey was also administered during this time at the end of the delayed post-test.

Data collection

All data collected remained confidential, and no personally identifiable information was used or collected on any of the questionnaires. A study identification number, known only by the participant, linked the pre-test, immediate post-test, and delayed post-test questionnaires. A hospital representative collected the informed consent documents and informed the researcher of the participant's choice for the group assignment (simulation group or control group). The group assignment data was collected to ensure proper email distribution and for simulation scheduling. The demographic questionnaire was used to collect demographic information that also

included information on the participant's job role. The hand hygiene knowledge questionnaire was used to gather information regarding the participants' knowledge of hand hygiene and infection control protocols and self-reported hand hygiene practices. The attitudes toward hand hygiene and infection control guidelines survey was used to collect the participant's attitudes towards hand hygiene and infection control and towards the hand hygiene guidelines that are set for the healthcare facility where this study was conducted. The reaction and satisfaction survey was used to collect information on the participant's reaction toward the entire study and their satisfaction with the way the study was carried out. The hand hygiene questionnaire, attitudes toward practice guidelines questionnaire, and the reaction and satisfaction survey were accessed through the Qualtrics online survey tool on the participants' personal electronic device or work computer. There was no supervision provided and the participants were allowed to complete the online portion of the study at a time convenient for them.

Photographs were taken with a Sony Cybershot Full HD 1080 camera with capabilities for taking photographs in the dark and under ultraviolet light. In the camera the photographs were stored on a SONY Memory Stick PRO-HG Duo before being transferred to a secure and encrypted external hard drive. There were no photos taken of identifying features, such as the face or name badge. The videos were recorded onto a write protected DVD using the hospitals built in camera and recording system. The video does capture some full facial features and due to the protection on the videos put in place by the hospital the researcher did not have the resources to block out the faces. The videos will be properly destroyed at the completion of this dissertation. The photographs and videos were used to document information regarding hand hygiene and infection performance during and after the completion of the scenarios and to record any evidence

of SID spread on the patient, in the area surrounding the patient, and on the participant. Qualitative data was collected during the debriefing to gain insight on how the participants felt about simulation experience and the presence of SID. The qualitative data was not recorded by video or audio, but was transcribed by hand verbatim during the interview.

Data Analysis

There were three types of data collected in this study: demographic, quantitative, and qualitative. Demographic data was summarized using measures of central tendency and frequency distributions. Quantitative data were analyzed using a t-test and two-way analysis of variance and a chi-square test. A p-value of 0.05 was considered as significant, and a p-value of 0.06 to 0.10 was considered near significant for all tests. The questions from each of the instruments will be analyzed with their corresponding constructs. Qualitative data were analyzed using the phenomenological method. The details of each analysis across the three levels of Kirkpatrick are provided below.

Reaction. The reaction construct was analyzed using a t-test to compare means between groups (nurses vs. physicians and control vs. simulation). This construct was measured at the delayed post-test only using responses to question one through ten and question fifteen. The instruments utilized to measure the reaction construct and the corresponding analyses are described in Figure 8.

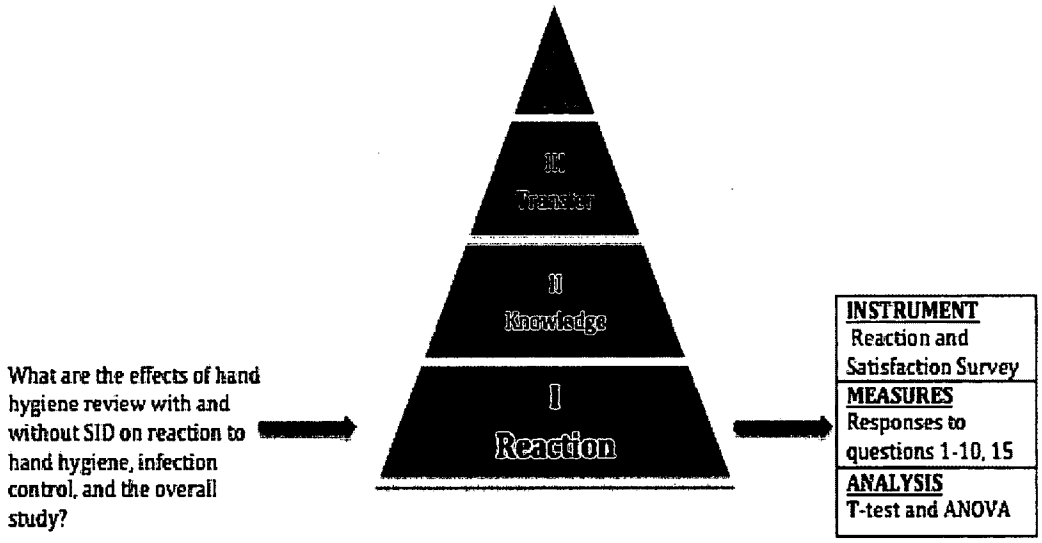


Figure 8. Kirkpatrick Model Level I: Reaction.

Knowledge. The knowledge construct was analyzed using responses to questions one through eight on the hand hygiene knowledge questionnaire. A two-way analysis of variance to compare knowledge gain scores between groups (control vs. simulation and physicians vs. nurses). This construct was measured at pre-test, immediate post-test, and delayed post-test. The instruments utilized to measure the knowledge construct and the corresponding analyses are described in Figure 9.

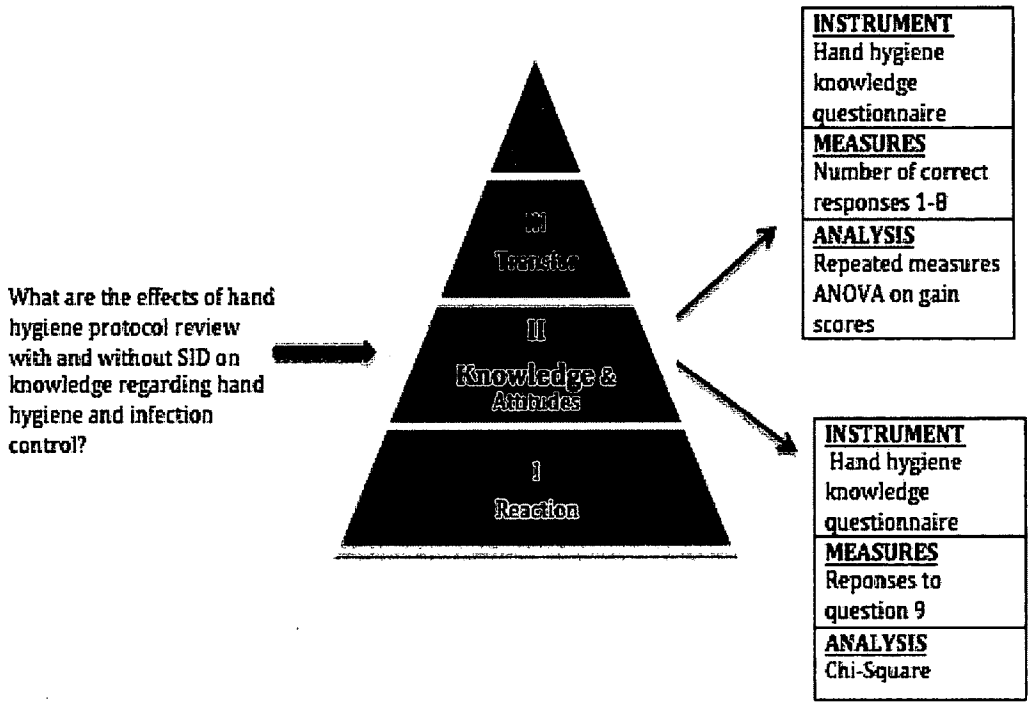


Figure 9. Kirkpatrick Model Level II: Knowledge.

Attitudes. The attitude construct was analyzed using responses to question 1-18 on the Attitudes Toward Hand Hygiene Guidelines Questionnaire. Pearson's product moment correlation was utilized to test any strength of associations between questions for the total and subscales. A two-way ANOVA was utilized to compare total attitude gain scores between groups (nurses vs. physicians and control vs. simulation) and subscale attitude gain scores between groups (nurses vs. physicians and control vs. simulation) on responses to questions 1-18. This construct was also analyzed using a chi-square test on the responses between groups (nurses vs. physicians and control vs. simulation) to the

hand hygiene question nine. This construct was measured at pre-test, immediate post-test, and delayed post-test. The instruments utilized to measure the attitude construct and the corresponding analyses are described in Figure 10.

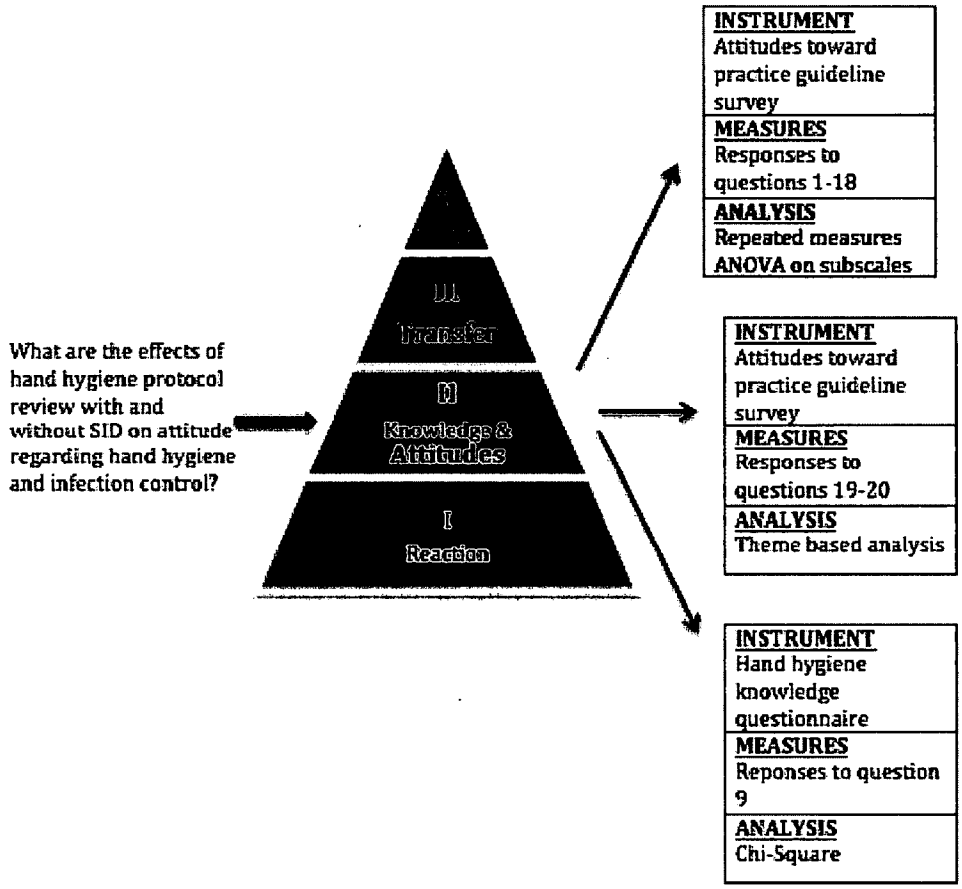


Figure 10. Kirkpatrick Model Level II: Attitudes

Performance. The performance construct was analyzed using a t-test to compare means between groups (nurses vs. physicians and control vs. simulation) on the Reaction and satisfaction questionnaire responses to questions elven through fourteen which was measured only at the delayed post-test. This construct was also analyzed utilizing a chi-

square test to compare responses between groups (nurses vs. physicians and control vs. simulation) to hand hygiene knowledge questions 10 and 11, which was measured at pre-test, immediate post-test, and delayed post-test. The instruments utilized to measure the performance construct and the corresponding analyses are described in Figure 11.

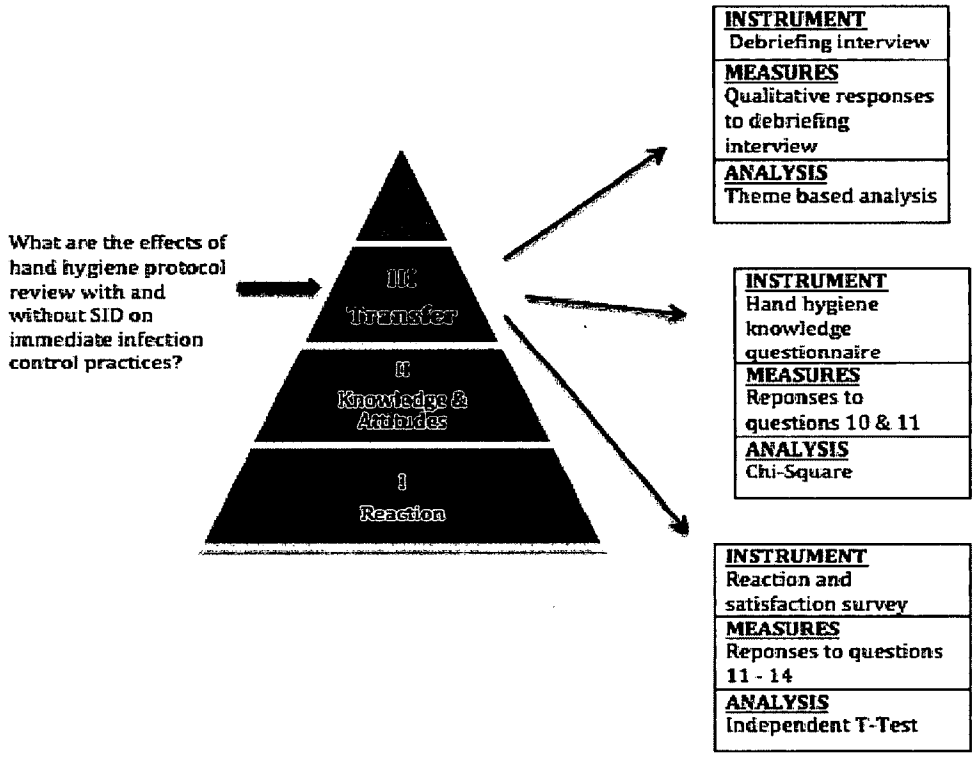


Figure 11. Kirkpatrick Model Level III: Performance

Qualitative data

The phenomenology method used in this study explored and described how healthcare workers experienced patient care situations involving hand hygiene. The phenomenological approach explores and describes healthcare workers' lived experiences

in patient care situations and is concerned with their personal perception of hand hygiene guidelines and how it affects their decision to perform hand hygiene.

Statements provided by the respondents that describe their experiences drove the phenomenological process. The statements were grouped into meaningful categories that were based on similarities. The conclusions of this study aim to integrate the quantitative and qualitative data to provide more meaning to this complex issue of hand hygiene.

Missing data

Missing data was addressed for each section of the questionnaires. All responses to the demographic section were retained.. The researcher set criteria for the participant's responses to be retained due to the low number of items on the questionnaires. For the reaction section, the participant had to answer at least 10 of the 12 items in that section. For a participant's responses to be retained in the knowledge section, the participant had to answer at least 6 of the 8 items in that section, and the missing response would be counted as incorrect. For the participant's responses to be retained in the attitude section, the participant had to answer at least 16 of the 18 items in that section.

In order to avoid using casewise deletion and lose data, mean substitution was also employed to account for missing responses for the attitude section in this study. Mean substitution is a process of replacing missing data with the mean for the group from which the data was missing.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter presents the results of the analysis of all valid responses to the instruments used in this study. The first section will present descriptive statistics for the demographic data. The second section will present the analysis for the responses to the reaction and satisfaction survey, which measures the participants' reaction to the study. The third section will present the analysis for responses to the questions measuring the hand hygiene knowledge construct. The fourth section will present the analysis for the responses to the question measuring the attitude construct. The fifth section will present the analysis for the responses to the questions measuring the performance construct. The sixth section will present the qualitative analysis and will include a theme-based analysis on the influences and barriers to hand hygiene and simulation group debriefing interview.

Demographics

The first six questions of the pre-test were used to collect demographic information from the participants. A total of 50 medical personnel participated in the hand hygiene study. Respondents included 17 nurses (34%) and 33 physicians (66%). There were an equal number (50%, n=25) of female and male participants. The ages ranged from 21-60 years with a mean age of 37.2 years (SD=10.82). The mean number of years the participants had been practicing in their respective professions overall was 10.5 years (SD=10.5) with a mean of 8.6 years (SD=8.7) at the medical facility. All participants had obtained an appropriate degree, which is a requirement to practice as a nurse or physician at the medical facility. One participant had an associate degree (2%), thirteen participants had a bachelor's degree (26%), six participants had a master's degree

(12%), and thirty participants had a medical degree (60%). A summary of the demographics is provided in Table 6.

Table 6

Sample Demographics (N=50)

	Mean	SD	Frequency	Percent %
Gender				
Female			25	50
Male			25	50
Age in years	37.2	10.8		
20-29			12	24
30-39			20	40
40-49			8	16
50-59			9	18
60-69			1	2
Education				
Associates degree			1	2
Bachelor degree			13	26
Master's degree			6	12
Medical degree			30	60
Time in profession	10.5	10.5		
Profession				
Nurse			17	34
Physician			33	66
Time at medical center	8.6	8.7		

Research Question 1: What are the effects of a hand hygiene protocol review with and without SID on reaction to hand hygiene, infection control, and the overall study?

The responses to the Reaction and Satisfaction Survey one through ten and the response to Reaction and Satisfaction Survey question fifteen will be used to address this construct. The data for this construct was only collected during the delayed post-test.

Reaction and Satisfaction Survey Questions One Through Ten. The mean total score for the scale measuring the participant's reaction and satisfaction to the study was 58.5 out of a possible 60 and the mean score was 4.95 on the 6-point Likert scale. A two-way ANOVA was utilized to compare reaction scores between groups (control vs. simulation and nurses vs. physicians). There was a near significant difference in reaction and satisfaction between the control (M=4.90, SD=0.53) and simulation (M=4.82, SD=0.51) groups toward hand hygiene protocol review and the overall study $F(1,37) = 3.025$, $p=0.09$. The control group had a higher somewhat agreeable reaction to the hand hygiene review and the overall study. No significant differences in reaction scores were found between nurses (M=4.89, SD=0.58) and physicians (M=4.85, SD=0.49), $F(1,37) = 0.941$, $p=0.34$. There was no interaction effect between group and profession scores $F(1,37) = 0.203$, $p=0.66$.

Reaction and Satisfaction Survey Question Fifteen. Question fifteen was given only to simulation participants; and therefore analyzed separately. This analysis for this section will analyze the responses to the question: The ability to visualize pathogen spread enhanced the overall training experience. The responses to this item were on a 6-point Likert scale. An independent t-test was conducted to compare mean reaction and satisfaction score between nurses and physicians. There were no significant differences in the reaction of the overall experience of being able to visualize pathogen spread between the nurses (M=5.56, SD = 0.53) and physicians (M=5.38, SD=0.77). Although not significant, the nurses did rate the overall simulation experience a slightly higher towards strongly agree than physicians.

Research Question 2: What are the effects of a hand hygiene protocol review with and without SID on knowledge regarding hand hygiene and infection control?

This question was addressed by analyzing the responses to multiple-choice questions one through eight from the hand hygiene knowledge questionnaire. An alpha value of 0.05 was used to determine the level for significance and alpha value from 0.06 to 0.10 was used to determine the level for near significant. The data for this construct was collected during the pre-test, immediate post-test, and delayed post-test. The ANOVA table is located in Appendix M.

Hand Hygiene Questionnaire Questions One Through Eight. A gain score was calculated from the pre-test to immediate post-test and from the immediate post-test to the delayed post-test for group (control vs. simulation) and profession (nurses vs. physicians). A general linear model two-way analysis of variance was employed to determine if there were any significant difference in knowledge gains score from pre-test to immediate post-test, which has been identified as the immediate gain score and from immediate post-test to the delayed post-test, which is identified as the delayed gain score between the control and simulation group and nurses and physicians.

Hand hygiene immediate gain score. There were no significant differences in immediate post hand hygiene knowledge gain scores between the control group and the simulation group scores $F(1,46) = 0.043$, $p = 0.84$, between physicians and nurses $F(1,46) = 0.753$, $p = 0.39$, or the interaction effect between group and profession scores $F(1,46) = 0.043$, $p = 0.84$. Overall the control group ($M = 0.19$, $SD = 0.86$) had a very small immediate post test gain over the simulation group ($M = 0.09$, $SD = 0.61$) on the knowledge test. When looking at profession, physicians ($M = 0.21$, $SD = 0.82$) had a very small immediate post test gain over the nurses ($M = 0.00$, $SD = 0.61$).

Hand hygiene delayed gain score. There were no significant differences in delayed post hand hygiene knowledge gain scores between the control group and the simulation group scores $F(1,46) = 0.043$, $p = 0.84$, between physicians and nurses $F(1,46) = 0.753$, $p = 0.39$, or the interaction effect between group and profession scores $F(1,46) = 0.043$, $p = 0.84$. There was a decrease in knowledge during the delayed posttest. Overall, the simulation group ($M = -0.27$, $SD = 0.98$) had a slightly greater decrease in knowledge over the control group ($M = -0.05$, $SD = 1.22$) and the nurses ($M = 0.36$, $SD = 1.22$) had a slightly greater decrease in knowledge over the physicians ($M = 0.07$, $SD = 1.04$).

Research Question 3: What are the effects of a hand hygiene protocol review with and without SID on attitude regarding hand hygiene and infection control?

This question was analyzed using the responses to attitude towards hand hygiene guidelines questions one through eighteen and questions nine on the hand hygiene knowledge questionnaire. This question was also analyzed qualitatively using the responses to questions nineteen and twenty on the attitude towards hand hygiene guidelines questionnaire. An alpha value of 0.05 was used to determine the level for significance and alpha value from 0.06 to 0.10 was used to determine the level for near significant. The data for this construct was collected during the pre-test, immediate post-test, and delayed post-test. The ANOVA table is located in Appendix M.

A two-way analysis of variance was performed to determine whether there were significant differences in attitude gain scores for between physicians and nurses and the control and simulation groups. The total mean gain attitude scores were calculated from pre-test to immediate post-test, which has been identified as the immediate gain score and from immediate post-test to the delayed post-test, which is identified as the delayed gain

score. The following analysis is presented for the attitude total gain score and for each of the three sub-scale scores.

Attitude total immediate gain scores. There were no significant differences in immediate post total attitudes toward hand hygiene guidelines gain scores between the control group and the simulation group scores F (1,42) = 0.055, p = 0.82, between physicians and nurses F (1,42) = 0.015, p = 0.90, or the interaction effect F(1,42) = 1.339, p = .254. The simulation group (M = 0.221, SD = 0.28) had a slightly higher immediate positive attitude gain score than control (M = 0.010, SD = 0.38) and the nurses (M = .022, SD = 0.29) had a slightly higher immediate positive attitude gain score than physicians (M = .012, SD = 0.33).

Attitude total delayed gain scores. There were no significant differences in the delayed post total attitude gain scores between the control group and the simulation group scores F (1,37) = 1.690, p = 0.20, between physicians and nurses F (1,37) = 0.017, p = 0.90, or the interaction effect F (1,37) = -3.836E-5, p = 0.99. The control group (M = 0.105, SD = 0.34) had a higher agreeable attitude toward the guideline, while the simulation group (M = 0.065, SD = 0.41) agreed less with the hand hygiene guidelines. Physicians (M = 0.017, SD = 0.31) agreed more than nurses (M = 0.007, SD = 0.51)

Attitude immediate subscale relevance gain scores. The subscale relevance resulted in seven items (Table 6). There were no significant differences in immediate post relevance gain scores between the control group and the simulation group scores F (1,42) = 0.133, p = 0.72, between physicians and nurses F (1,42) = 0 .061, p = 0.81, or the interaction effect F (1, 42) = 0.242, p = 0.63. The simulation group (M = 0.104, SD = 0.39) had a slightly higher agreeable attitude towards relevance than the control group (M

= 0.074, SD= 0.59) and physicians (M = 0.099, SD = 0.55) had a slightly higher agreeable score than nurses (M = 0.067, SD = 0.39).

Attitude delayed subscale relevance gain scores. There was a significant difference in the delayed post relevance gain scores between the control group (M = 0.154, SD = 0.37) and the simulation group (M = -0.305, SD = 0.72) scores, F (1,37) = 6.32, p = 0.02. The control group had a higher agreeable attitude toward relevance of the hand hygiene guidelines and the simulation group agreed less. There were no significant differences in delayed post relevance gain scores between physicians (M = -0.071, SD = 0.34) and nurses (M = -0.133, SD = 0.98), F (1,37) = 0.036, p = 0.85, or the interaction effect F (1, 37) = 0.475, p = 0.50. The nurses and physicians both agreed less on subscale relevance at the delayed post-test.

Attitude subscale motivation immediate gain scores. The subscale motivation resulted in three items (Table 7). There were no significant differences in immediate post motivation gain scores between the control group (M = -0.153, SD = 0.71) and the simulation group scores (M = 0.015, SD = 0.38), F (1,42) = 0.067, p = 0.80 and between physicians (M = -0.156, SD = 0.60) and nurses (M = 0.083, SD = 0.51), F (1,42) = 1.782, p = 0.19. The control group agreed less to being motivated for subscale motivation while the simulation group was more agreeable motivation. The nurses had an increase in motivation while the physicians had a decreased motivation. There was a near significant interaction effect between group and profession scores F (1,42) = 3.399, p = 0.07.

Attitude subscale motivation delayed gain scores. There were no significant differences in the delayed post motivation gain scores between the control group (M = .246, SD = 0.65) and the simulation group (M = 0.061, SD = 0.48) scores F (1,37) = 0.57, p = 0.46, between nurses (M = 0.095, SD = 0.33) and physicians (M = 0.173, SD = 0.66)

scores F (1,37) = 0.11, p = 0.74, or the interaction effect between group and profession scores F (1,37) = 0.20, p = 0.66. The control had a slightly higher agreement than the simulation group on the subscale motivation. Physicians had a slightly higher agreement than nurses on the subscale motivation.

Attitude subscale outcome expectancy immediate gain scores. The subscale outcome expectancy resulted in two items (Table 8). There were no significant differences in immediate post outcome expectancy gain scores between the control group (M = 0.042, SD = 0.57) and the simulation group (M = 0.042, SD = 0.46) scores, F (1,42) = 0.013, p = 0.91, between physicians (M = .031, SD = .58) and nurses (M = 0.063, SD = 0.36), F (1,42) = .362, p = 0.55, or the interaction effect between group and profession scores F (1,42) = 2.556, p = 0.12. The control group had less agreement for subscale outcome expectancy and the simulation group had more agreement for subscale outcome expectancy at the immediate post-test. The nurses had less agreement and physicians had more agreement for subscale outcome expectancy at the immediate post-test.

Attitude subscale outcome expectancy delayed gain scores. There were no significant differences in the delayed post outcome expectancy gain scores between the control group (M = 0.079, SD = 0.69) and the simulation (M = 0.091, SD = 0.40) group scores, F (1,37) = 0.029, p = 0.87, between physicians (M= 0.074, SD = 0.63) and nurses (M= 0.107, SD= 0.35), F (1,37) = 0.074, or the interaction effect between group and profession scores F (1,37) = 0.342, p = 0.56. The simulation group had a slightly higher agree score than the control group at the delayed post-test and the nurses had a slightly higher agree score than physicians.

Hand hygiene knowledge question nine. Participants were asked: How do you know you are doing a good job of preventing the spread of infections? There was no

right or wrong answer established for this question, so it was analyzed separately. The researcher felt that it was important to include this question to establish the factors that the participants used to determine their hand hygiene performance. Participants were given the following responses to choose from: "your patients aren't getting infections", "you consistently follow hand hygiene procedures and infection control precautions", "your supervisor has told you", "you have no way to determine this information", and "you feel confident". A chi-square table was utilized to determine what the most important factor were that the participants used to assess if they were doing a good job. Factors used by the participants to assess if they were doing a good job did not differ by group for pre-test, $x^2(2, N=50) = 1.75$, $p= .16$, immediate post-test $x^2(2, N=47) = 1.67$, $p = .29$, or delayed post-test $x^2(3, N=41) = 2.83$, $p = .42$. Factors used by the participants to assess if they were doing a good job also did not differ by profession for pre-test $x^2(2, N=50) = .61$, $p = .74$, immediate post-test $x^2(2, N=47) = 2.17$, $p = .34$, and delayed post-test $x^2(3, N=41) = 1.10$, $p = .78$. The most important factor for control and simulation groups and for nurses and physicians was the item "you consistently follow hand hygiene procedures and precautions".

What are the effects of a hand hygiene protocol review with and without SID on hand hygiene performance?

Participant responses to the Hand Hygiene Questionnaire questions ten and eleven and responses to the Reaction and Satisfaction survey question eleven through fourteen will be used to measure this construct.

Hand Hygiene Knowledge Questionnaire Question Ten. For question ten, participants were asked to rate how often they performed hand hygiene when indicated. Participants rated their hand hygiene performance on a frequency scale from 0% to 100%

in 25% increments. Self-reported hand hygiene rates did not differ by group at pre-test $x^2(1, N=50) = 2.92$, $p = 0.38$, immediate post-test $x^2(1, N=47) = 0.10$, $p = 0.75$, and delayed post-test $x^2(1, N=41) = .02$, $p = .88$. Self-reported hand hygiene rates also did no differ by profession at pre-test $x^2(1, N=50) = 1.41$, $p = 0.24$, immediate post-test $x^2(1, N=47) = 1.38$, $p = 0.24$, and delayed post-test $x^2(1, N=41) = 0.17$, $p = 0.69$. Table 7 shows the frequency of responses by group and Table 8 shows the frequency by profession.

Table 7

Frequency Table of Self-rated Hand Hygiene Performance by Group

	Pretest		I Posttest		D Posttest	
	Control	Simulation	Control	Simulation	Control	Simulation
0 to 25%	0	0	0	0	0	0
26% to 50%	0	0	0	0	0	0
51% to 75%	6	1	3	2	2	2
76% to 100%	22	21	22	20	17	20

Table 8

Frequency Table of Self-rate of Hand Hygiene Performance by Profession

	Pretest		I Posttest		D Posttest	
	Nurse	Physician	Nurse	Physician	Nurse	Physician
0 to 25%	0	0	0	0	0	0
26% to 50%	0	0	0	0	0	0
51% to 75%	1	6	3	2	1	3
76% to 100%	16	27	14	28	13	24

Hand Hygiene Knowledge Questionnaire Question Eleven. For question eleven, participants were asked to rate how often their colleagues performed hand hygiene when indicated. Colleague reported hand hygiene rates did not differ by group for pre-test $x^2(3, N=50) = 4.48$, $p = 0.21$, immediate post-test $x^2(2, N=47) = 0.90$, $p = 0.64$, and delayed post-test $x^2(3, N=41) = 2.68$, $p = 0.44$. Colleague reported hand hygiene rates also did not differ by profession at pre-test $x^2(3, N=50) = 5.70$, $p = 0.17$, immediate post-test $x^2(2, N=47) = 1.76$, $p = 0.42$, and delayed post-test $x^2(3, N=41) = 2.06$, $p = 0.56$. Participants rated their colleagues hand hygiene performance on a frequency scale from 0% to 100% in 25% increments. Table 9 shows the frequency of responses by profession and Table 10 shows the frequency by profession.

Table 9

Frequency Table of Hand Hygiene Performance Colleague Rating by Group

	Pretest		I Posttest		D Posttest	
	Control	Simulation	Control	Simulation	Control	Simulation
0 to 25%	0	0	0	0	0	0
26% to 50%	0	0	0	0	0	0
51% to 75%	6	1	3	2	2	2
76% to 100%	22	21	22	20	17	20

Table 10

Frequency Table of Hand Hygiene Performance Colleague Rating by Profession

	Pretest		I Posttest		D Posttest	
	Nurse	Physician	Nurse	Physician	Nurse	Physician
0 to 25%	0	1	0	1	0	1
26% to 50%	0	2	0	0	0	2
51% to 75%	4	16	6	15	5	11
76% to 100%	13	14	11	14	9	13

Reaction and Satisfaction Survey Question Eleven. There were no significant differences in likelihood to sequence care found between control and simulation, $F(1, 34) = 1.59$, $p = 0.22$, and nurses and physicians, $F(1, 34) = 1.52$, $p = 0.23$, to sequence care for patients from clean to dirty. Nurses ($M = 5.23$, $SD = 0.83$) reported that they agree they are more likely to sequence care, which is higher than physicians ($M = 4.88$, $SD = 0.88$) who somewhat agreed. The control group ($M = 5.24$, $SD = 0.56$) also reported they agree that they are more likely to sequence care then the treatment group ($M = 4.81$, $SD = 1.03$) who reported they somewhat agree.

Based on this training, I am more likely to comply with hand hygiene. For this question, participants were asked to respond to the statement: Based on this training, I am more likely to comply with hand hygiene guidelines. There was a near significant difference in likelihood to comply with hand hygiene guidelines between control and simulation groups, $F(1, 36) = 2.82$, $p = 0.10$, but no significant difference in nurses and physicians, $F(1, 36) = 1.07$, $p = 0.31$. Nurses ($M = 5.14$, $SD = 1.03$) reported their likelihood to sequence care as agree whereas physicians ($M = 5.0$, $SD = 0.72$) somewhat agreed. The treatment group ($M = 4.86$, $SD = 1.01$) somewhat agreed to their likelihood

to comply with hand hygiene guidelines, which is less likely than the control group (M = 5.21, SD = 0.54) who agreed with the likelihood to comply with hand hygiene guidelines.

The ability to visualize pathogen spread has impacted my commitment towards sequence of care. Question thirteen was given only to simulation participants; and therefore analyzed separately. This analysis for this section will analyze the responses to the statement: The ability to visualize pathogen spread has impacted my commitment towards sequence of care. The responses to this item were on a 6-point Likert scale. Participants responded with a rating of 1 for strongly disagree, 2 for somewhat disagree, 3 for disagree, 4 for somewhat agree, 5 for agree, and the highest possible score was a 6 for strongly agree. An independent T-test was conducted to compare mean reaction and satisfaction score between nurses and physicians. There were no significant differences on the impact of commitment towards sequence of care between the nurses (M = 5.33, SD = 1.12) and physicians (M = 5.00, SD = 0.91). Although not significant, the nurses and physicians both agree that the ability to visualize pathogen spread has impacted their commitment towards sequence of care.

The ability to visualize pathogen spread has impacted my commitment towards hand hygiene guidelines. This question was given only to simulation participants and therefore analyzed separately. The analysis for this section will analyze the responses to the statement: The ability to visualize pathogen spread has impacted my commitment towards hand hygiene guidelines. The responses to this item were on a 6-point Likert scale. Participants responded with a rating of 1 for strongly disagree, 2 for somewhat disagree, 3 for disagree, 4 for somewhat agree, 5 for agree, and the highest possible score was a 6 for strongly agree. An independent t-test was conducted to compare mean reaction and satisfaction score between nurses and physicians. There

were no significant differences in the commitment towards hand hygiene guidelines between the nurses (M = 5.33, SD = 1.12) and physicians (M = 4.92, SD = 1.12). Although not significant, the nurses did agree that the impact of visualizing pathogen spread has impacted their commitment towards hand hygiene guidelines, whereas the physicians somewhat agree.

Qualitative Results

This section presents the key findings obtained from questions nineteen and twenty on the Attitude towards hand hygiene guidelines survey and the simulation-debriefing interview. This study explored and described how healthcare workers experienced patient care situations involving hand hygiene. It was also concerned with their personal perception of hand hygiene guidelines and how it affects their decision to perform hand hygiene. Statements provided by the respondents that describe their experiences drove the phenomenology process. The statements were grouped into meaningful categories that were based on similarities.

Hand Hygiene Influences

This data was collected from question nineteen on the Attitudes Toward Hand Hygiene Questionnaire (Appendix G). The participants were asked to respond to the following statement: For me the most important factor that did or would influence me to implement the hand hygiene guidelines is. Four themes emerged from this statement: accessibility and availability of supplies, patient safety, reminders, and scientific evidence. Participants reported that not only having the needed supplies, but also having them in a convenient location during patient care influences them to perform hand hygiene at the right times. Nurses reported that the patients' safety was their main priority and that hand hygiene was their way of helping to provide the best care and

reduce the risk infections. Some participants reported that seeing printed reminders and graphical depiction of the five moment of hand hygiene influenced them to perform hand hygiene. Physicians reported that seeing the scientific evidence would influence them to perform hand hygiene. They felt that there should be more discussion within their organization to talk about data and determine what really works. They also want evidence that the guidelines are working in their department. The theme table for hand hygiene barriers is located in Appendix N.

Hand Hygiene Barriers

This data was collected from question twenty on the Attitudes Toward Hand Hygiene Survey (Appendix G). The participants were asked to respond to the following statement: For me the most important barrier to implementing hand hygiene is. The four themes that emerged from this statement were accessibility and placement of supplies, not enough time, skin discomfort, and impractical and unclear guidelines. Participants felt that the hand hygiene supplies are not readily available at the point of care and are sometimes difficult to get to due to the placement in the room or in their area of the hospital. Time was a key barrier for both physicians and nurses. They both stated that their busy schedules, heavy workloads, and emergent situations prevent them from performing hand hygiene as much as they should. Nurses reported skin dryness and irritation as a barrier. Physicians reported that the hand hygiene guidelines are confusing, unclear, and even impractical for their specific area. The presence of hand hygiene guidelines didn't seem to be the issue as much as having the appropriate set of guidelines. The theme table for hand hygiene barriers is located in Appendix N.

Simulation Debriefing Interview

The semi-structured interview was used to promote a conversation between the

participant and the researcher regarding the simulation and hand hygiene. This arm of the study included twenty-four participants of which nine were nurses and thirteen were physicians. The nine nurses had specialty areas in either the bone marrow transplant unit, medical oncology surgery unit, pediatrics, or neurosurgery. The physicians had specialty areas in either surgery, neurosurgery, infection prevention, general medicine or they were third year residents. Out of the twenty-four participants, eight of the nine nurses and four of the thirteen physicians responded "yes" to having participated in a study where the true nature of the study was not revealed. Ten of thirteen physicians reported that they had no idea what the researcher was looking for or that the researcher was looking for SID spread or anything related to infectious organisms. Seven of nine nurses reported that they did have an idea it was related to hand hygiene, but they weren't sure exactly what the researcher was looking for in relation to hand hygiene. Eight of the nine nurses and twelve of the thirteen physicians felt that the scenario was realistic. One nurse that disagreed with the scenario realism and stated that it did not apply to her specialty. The theme tables for the debriefing interview are found in Appendix O.

How did you feel during the simulation? Four themes emerged from this question: comfortable, uncomfortable, heightened awareness and engaging. The theme comfortable was derived from key terms such as realistic, natural, fine, and ok. One participant responded that it was like playing out his normal day. Another participant stated that she just had a patient with an identical case admitted just a few days prior to this simulation. The theme uncomfortable was derived from key term such as unsure, concerned, apprehensive, awkward, and weird.

I felt like I was a bad actress.

The theme, heightened awareness was derived from key terms such as conscious

and extra mindful. All participants knew they were being observed from another room via video feed and that the simulation session was being recorded.

I was conscious of being observed, but I was comfortable with what I was doing.

The theme engaging was derived from the key terms surprised, interesting challenging, and opportunity to learn. Although it was not asked for this question, one participant quickly indicated his awareness of mistakes that are made with his own hand hygiene practice.

Is there anything you would change in the scenario? The participants' responses did not answer this question directly, but seemed to be more suggestive toward changes for the setting instead of the scenario. Three themes emerged from this question: supplies, instructions, and staging.

The theme supplies was derived from the key terms placement and accessibility.

Gloves by the computer. I wish we had gloves by the computer. I don't change my gloves as often as I should because of accessibility.

The theme instructions emerged from the key terms specify, clearer, and explicit. Although the patient scenarios were presented in the same manner they would in a real setting, some participants had a difficult time with working in an environment where they could not get a response to their actions such as real vitals, response from the patient, and interaction with other staff to assess and treat the patient.

The theme, staging emerged from the key terms real patient, real setting, more patients, location of patient, white coats, and more scenarios.

You might want to have people wear their white coats. We don't wash our coats very often.

The remaining responses suggested no changes to the scenario or the setting and the key terms used to make this conclusion were appropriate, good, pretty realistic, and relevant.

During the course of the session, what if anything was going through your mind regarding infection control? Five themes emerged from this question: patient safety, personal safety, recall, heightened awareness, and supplies.

The theme patient safety emerged from key terms and phrases such as caring for patient, careful, type of infection, and hand hygiene.

The theme personal safety emerged from the key terms personal items, wondering what I am bringing home with me.

The theme recall emerged from the key terms and phrases hand hygiene guidelines, the five moments of hand hygiene, hand hygiene review video, clean to dirty.

I was constantly thinking about hand hygiene. I just saw the video, so I was making sure I did hand hygiene every time I was supposed to.

The theme heightened awareness was derived from the key terms and phrases conscious effort, being watched, paranoid, and thinking more.

We know if someone is watching us, we are more aware and we do it more often.

The theme supplies emerged from key terms and phrases sanitizer placement and knowing where the supplies are.

The one thing that bothers me is that it always feels like the hand sanitizer is in the most awkward places in the room.

Do you have any suggestion for us about what we might do for the future? Three themes emerged from this question: difficulty level, staging, and evidence. The theme difficulty level was derived from the key terms more involvement, detailed exams,

make mannequin talk, clean room to dirty room.

The theme staging were derived from the key terms and phrases SID placement, point out supplies, store supplies in cabinets, and nurse to help with set-up.

I think you should put SID in more places. It's reality.

The theme evidence was derived from key terms such as conscious and extra mindful. All participants knew they were being observed from another room via video feed and that the simulation session was being recorded.

I was conscious of being observed, but I was comfortable with what I was doing.

The remaining responses suggested no changes for future studies. The key terms and phrases used by the participants were comfortable and easy to do.

I thought it was a good simulation. I think it was good you didn't tell people until the end. It's more of the shock factor that will get people to do it.

How would you apply what you experienced today to the clinical experience?

Four themes emerged from this question: personal intentions, expectation of others, increased awareness, and organizational suggestions.

The theme personal intentions was derived from key terms and phrases more observant, more aware, change routines, touching anything matters, and do a better job cleaning.

I already wipe my stethoscope, but now I will be sure to wipe my other equipment, well, like my pens.

The theme expectation of others was derived from the key terms and phrases wash hands more uncomfortable from inactions of others, setting the example

I already wash my hands more than I need to. It makes me uncomfortable to not see other people wash their hands even if they don't touch the patient.

The theme increased awareness was derived from the key terms reinforcing, amazement, and reminder.

I think anyone who goes through an experience like this can certainly be helpful to know where this can spread. It's impressive for reinforcing the need for hand hygiene. I am glad you are doing this. This is very important stuff.

The theme organizational suggestions was derived from the key terms it's tough some days, surprised, interesting challenging, and opportunity to learn.

CHAPTER 5

CONCLUSIONS

This chapter includes a summary of the research results, a review of the measurements used, a summary of limitations on generalizability, and recommendations for future research. This chapter aims to integrate the quantitative and qualitative data to provide a deeper meaning to the complex issue of hand hygiene. Research findings are related to the original research questions and conclusions are drawn regarding the use of SID as a simulator in infection control review or training programs in the future.

The study explored the effects of a simulated infectious disease, referred to as SID, on healthcare workers' infection control knowledge, attitudes toward hand hygiene guidelines, self- reported hand hygiene performance, and reaction towards the overall review. This study utilized a non-randomized pre-test 2 post-test (immediate and delayed) design. The independent variables were group (control vs. simulation) and profession (nurses vs. physician). The dependent variables were reaction to hand hygiene review and the overall study, hand hygiene knowledge, attitudes toward hand hygiene guidelines, and hand hygiene performance. Pre-test, immediate post-test, and delayed post-test data was collected for the knowledge, attitude and performance constructs over a 6-week period. Reaction data was collected only at the delayed post-test. Control group scenario and simulation data was collected in between the immediate post-test and delayed post-test. There were 50 participants who qualified for the study, which included 17 nurses and 33 physicians.

During week 1, participants were asked to complete an online pre-test, hand hygiene review module, and immediate post-test. Demographic information was collected at the beginning of the pre-test. During week 2 participants in the control group

were asked to complete an online clinical scenario, with the option to print it out and complete on paper. During that same week the simulation group was asked to complete a 10-minute simulated clinical scenario in a simulation lab equipped with a mannequin. The mannequin and designated areas within the room had SID planted on them. During week 6 all participants were asked to complete the online delayed post-test.

The modified Hand Hygiene Knowledge Questionnaire (IHI, 2003) was used to measure hand hygiene knowledge and basic infection control protocols. The original Hand Hygiene Knowledge Questionnaire was not appropriate for this study and was modified to fit the specific population used in this study. The Attitudes Toward Hand Hygiene Guidelines Survey (Larson, 2004; Quiros et al., 2007) was used to measure participant attitudes toward the general hand hygiene guidelines. The Reaction and Satisfaction Survey was developed by the researcher with tools from Kirkpatrick (Kirkpatrick, 2013) and was used to measure the participants' reaction to the overall study and satisfaction with the way the study was implemented.

The specific research questions explored in this study were:

1. What are the effects of a hand hygiene protocol review with and without SID on reaction to hand hygiene, infection control, and the overall study?
2. What are the effects of a hand hygiene protocol review with and without SID on knowledge regarding hand hygiene and infection control?
3. What are the effects of a hand hygiene protocol review with and without SID on attitude regarding hand hygiene and infection control?
4. What are the effects of a hand hygiene protocol review with and without SID on performance immediate self-reported infection control practices?

Study findings did support a near significant effect on reaction for the independent variable groups (control vs. simulation), but not profession (nurse vs. physician). The simulation group control group had less of a positive reaction to the study than the control group. The study findings did not support any effects on reaction towards visualizing SID during the simulation on profession. Both nurses and physicians had a positive reaction toward the simulation, with the nurses reporting a slightly more positive reaction.

The study findings did not support statistical evidence of SID having an effect on knowledge for either group or profession in this study.

The study findings did not support any effects of SID on total attitude. When assessing attitude sub-scale factors there was an effect of SID on the subscale Relevance and Motivation, but no effect on Outcome Expectancy. The simulation group agreed less with the relevance factors toward hand hygiene guidelines. All participants somewhat agreed in being motivated towards the hand hygiene guidelines, however, nurses had the most motivation. Both groups and profession agreed that complying the hand hygiene guidelines could improve patient outcomes and helps to standardize care for patients.

The control group agreed that due to the hand hygiene review they will be more likely to sequence care from clean to dirty and more likely to comply to the hand hygiene guidelines, whereas the simulation group only somewhat agreed. Nurses agreed that after their experience with the hand hygiene review they will be more likely to sequence care from clean to dirty and comply with hand hygiene guidelines, whereas physicians somewhat agreed. Nurses in the simulation agreed that visualizing pathogens affected their commitment to the guidelines and physicians somewhat agreed. Nurses highly agreed and physicians agreed that visualizing pathogen spread enhanced the overall hand

hygiene review.

The conclusion of this study aims to integrate the quantitative and qualitative data to provide more meaning to the complex issue of healthcare workers' hand hygiene actions or inactions.

Reaction

The healthcare workers' reaction and satisfaction was translated back on to the Likert scale as somewhat agreeable. Donald Kirkpatrick's theory states that the training is much more effective when it is received well by the audience (Kirkpatrick, 2006). This study utilized a review instead of training, in which no new information was provided. The review covered very basic hand hygiene protocols that all participants should have received in their formal education. The participants did agree that they understood all the objectives and have been able to apply on the job what they learned during this experience, however, they only somewhat agreed to feeling appropriately challenged by the material.

Qualitative considerations for reaction. The qualitative data revealed that participants wanted to be challenged more. Those who participated in the simulation wanted to see standardized patients instead of using mannequins, multiple patient rooms involved to observe SID transfer between rooms, and more challenging clinical cases. To improve the healthcare worker satisfaction with this type of training dealing with infection control protocols, it is recommended that SID be incorporated into a training module that appropriately challenges the healthcare worker.

Knowledge

This study was not intended to teach new hand hygiene knowledge or infection control protocols; rather the study sought to explore whether or not SID would have an

effect on existing knowledge. Prior studies (Chan et al., 2008, Stein et al., 2003) have focused on assessing hand hygiene knowledge without an education intervention and have concluded based on the assessments and observations that knowledge among healthcare workers still remains low. Other studies (Gould et al., 2010; Helder et al., 2010 & Backman et al., 2008) have reviewed hand hygiene research that have used various methods of educational campaigns, which have resulted in mixed results, such as effectiveness of the education decreasing over time and no control comparison group. As stated earlier, this study utilized hand hygiene and infection control review composed of information the healthcare worker should already have gained proficiency either through their formal education or as part of their continuing education. This step was measured by observing if there were any changes in their current knowledge based on the hand hygiene review. As expected, the results did not reach statistical significance for either group (control vs. simulation) or profession (physician vs. nurse). It was concluded that the participants already possessed the basic knowledge covered in the hand hygiene review and that SID did not have an effect on current hand hygiene and infection control knowledge. The questionnaire was general and did not measure knowledge specific to the simulation scenario. It is recommended that future research align more closely with the instrument with specific knowledge covered in the protocol. The questionnaires also need to incorporate higher level thinking, to help bridge the gap between knowledge and performance.

Qualitative considerations for knowledge. The participants reported learning new ways of looking at infection control by visualizing SID. Initially, the focus was on the impact of visualizing SID spread mainly from direct and indirect contact from the healthcare workers' hands to the patient and other surfaces. The participants reported

that the most impact came from seeing the SID spread onto themselves, their personal items such as stethoscopes, and the computer. They revealed that the idea of pathogen spread on their personal items was something they didn't think about. This may have facilitated learning in a new way that does not use the traditional educational modules that come with traditional training.

Attitudes

Attitude sub-scale relevance

The findings suggest that healthcare workers want their healthcare facility to provide more information on hospital infection rates for their units in order to make following hand hygiene guidelines become more relevant. Until then healthcare workers may develop their own understanding in determining if following hand hygiene guidelines are of value to them and their department. Grant and Hofman (2011) suggest that the most effective messages that can be conveyed to healthcare workers' about the importance of hand hygiene may be to stress the consequences for the patients and not focus on the healthcare worker. There is no statistical evidence that the use of SID alone will improve attitudes toward relevance. Healthcare workers will have to understand why specific guidelines are in place in order to become meaningful to them and be reminded that the patient's safety should make performing hand hygiene very relevant.

Qualitative consideration for subscale relevance. Only physicians; from both the control and simulation groups, reported wanting to know the evidence and scientific information that shows that following the hand hygiene guidelines are working. The responses from physicians were more analytical. Physicians' responses to qualitative questions mirrored the attitude relevance factor items of there being too many guidelines, not having time to stay informed of available guidelines, and that practice guidelines are

inconvenient. Physicians reported that they recognize that healthcare associated infections are a problem, but they want the "right" set of guidelines that do not interfere or delay patient care. One nurse and one physician both stated that they need know more specifically "why" they need to implement a specific set of the guidelines and that they can't be told to just adhere to them.

Attitude sub-scale motivation

O'Boyle et al. (2001) studied nurses' motivation to wash their hands by looking at the internal and external motivational factors. The authors discovered that there are a variety of internal (attitude, perceived control and intention) and external (nursing unit activity and physical environment) factors that contribute a nurse's hand hygiene performance. The results from Grant and Hofman (2011) suggest in order to increase motivation the most effective messages that can be conveyed to change attitudes in healthcare workers' about the importance of hand hygiene may be to stress the consequences for the patients and not focus on the healthcare worker. Although behavioral intentions do not necessarily translate into behavior changes (University of Iowa, 1985) changing the healthcare worker's perception of what is important may be a start. This is a very broad topic and is beyond the scope of this study, but should be studied further.

Qualitative consideration sub-scale motivation. Nurses' responses were mostly patient oriented for motivation. Nurses identified patient safety as a key influence to perform hand hygiene. Physicians identified being a role model and having guidelines that fit within their specialty as their key influence to perform hand hygiene.

Attitude sub-scale outcome expectancy

The study findings suggest that outcome expectancy is very high among most

healthcare workers. They believe that if guidelines are in place there will be good outcomes for the patients. It was also discovered that the physicians were driven by the knowledge that following the hand hygiene guidelines is working in their particular unit.

Qualitative considerations for subscale outcome expectancy. The qualitative responses revealed that regardless of group or profession, healthcare workers are very accepting of guidelines and feel that they are needed. The participants were very interested in wanting to know what they could do better, suggesting more discussion on how to fix the problem. The question is not if guidelines should be in place, but finding the best guidelines that fit into the dynamics of the healthcare workers' unit or department. One participant followed up with an email after the study and conveyed that she had specific concerns about spread of particular pathogens on the floor of her unit and was very interested in using SID to address those concerns.

Performance

Self-report assessments methods have been used to understand adherence to hand hygiene compliance among healthcare workers (Moret et al., 2004. The authors discovered that after observation of healthcare workers performing 8 specific patient care activities, physicians overestimated their hand hygiene performance and nurses underestimated hand hygiene performance. O'Boyle et al. (2001) sought to understand adherence, as well, in which the authors concluded that self-reported hand hygiene performance may be based on intentions, but actual hand hygiene performance may be based on the intensity of the workload on the nursing unit.

Qualitative considerations for performance. Nurses reported patient outcomes as the most important factor that influences their hand hygiene practices. The qualitative data suggests that nurses expressed an initial concern for the safety of their patients. This

was also observed during the simulation as the nurses displayed more interaction and hand hygiene moments per opportunities than physicians. Nurses reported accessibility and availability of supplies as the greatest barrier to hand hygiene performance. The qualitative data revealed that nurses feel they need a better placement of supplies within the room and within the unit. One nurse reported a low hand hygiene performance because of having to walk a far distance to get to a sink to wash her hands.

Physicians reported scientific evidence as the most important factor that influence their hand hygiene practices. They reported wanting to see more scientific data, as proof that following the guidelines resulting in less infections in their organization. One physician questioned if it would really make a difference if hand hygiene were implemented 100%. Nurses reported accessibility and availability of supplies as the greatest barrier to hand hygiene performance. Physicians reported time as the greatest barrier to hand hygiene performance.

The final thoughts will address when and how SID should and should not be used. The qualitative questions and interviews received very candid responses from the participants that should not be overlooked when planning future studies using SID. These statements have provided this study with information that can assist in determining how and when to use SID.

Policy Recommendations

What SID can't do.

If the barriers revealed in the qualitative portion of this study, and others, are true organizational and departmental barriers then SID cannot affect change. External factors such as the physical environment, the specific type of unit, and workload can't be resolved with education or training. In this case, new questions that were

conceived from the qualitative responses (Table 11) should be addressed at the organizational or departmental level and explored further.

Table 11

What SID Cannot Do: New Questions as a Result of True Barriers

Barriers	New Questions to Ask
Availability of supplies	1. Why are there no supplies? 2. Are there enough supplies stocked for regular daily use? 3. Are there enough supplies stocked for high volume use? 4. Which specific supplies are not available (i.e. gloves, hand hygiene agent, soap, etc.)
Accessibility of supplies	1. What is the reasonable distance for supplies from the point of care? 2. Do all supplies fall within the acceptable distance from the point of care?
Time	1. Is the nurse patient ratio acceptable? 2. Is the patient workload reasonable? 3. Are there plans in place when there are not enough nurses?
Lack of knowledge of infection rates	1. Are the hospital infection rates available and accessible to staff? 2. Are the department / unit infection rates available and accessible to staff? 3. What productive and effective way can infection rates and scientific evidence be provided to staff?

What SID can do

The Joint Commission (2009) developed hand hygiene improvement strategies that were based on cognitive, behavioral, social norm, marketing, and organization theoretical models. The exposure of SID was effective for grabbing the attention of the simulation participants. Although the study did not look at long-term effects, this may be an essential piece in creating healthcare workers' hand hygiene commitment by

highlighting the immediate consequences of pathogen spread. Table 12 describes how SID could be implemented into The Joint Commission's education component of the cognitive component of the behavioral theories.

Table 12

What SID can do: Suggestion for Using SID as a Part of The Joint Commission's Strategies to Improve Hand Hygiene

Strategy	When to Use	How to Use	What to Look For
Education	Use SID to ensure proper hand hygiene wash technique	Place SID on hands and have healthcare worker's wash hands as they normally would and then wash hands using recommended guidelines.	Are hands being washed thoroughly according to hand hygiene guidelines? Are hands being washed for at least the minimum amount of time based on the guidelines?
	Use SID to demonstrate how pathogens can spread from simple direct and indirect contact	Place SID in a simulated clinical situation using task trainer or mannequins and have them perform a specific skill (i.e. wound dressing change)	Are the steps being performed in the correct order according to the guidelines? Are the steps being executed correctly according to the guidelines?
	Use SID to demonstrate how pathogens can spread from missed hand hygiene opportunities during more complex situations.	Develop a training plan with a clinical case that involves performance of several clinical task on a mannequin	Are the tasks being performed in the correct order according to the guidelines (i.e. from clean to dirty)? Is hand hygiene being performed for every hand hygiene opportunity?

If these barriers are only perceived barriers, then visualizing SID may make the need to practice hand hygiene more relevant for the healthcare workers. If a concept becomes relevant then it is more meaningful and can increase motivation. For example,

if healthcare workers can visualize these pathogens then maybe the sink that didn't seem accessible to them before because it was 15 feet away, may now not seem so far. The outcome could be more motivation to walk the extra distance to wash their hands. In regards, to the guidelines, if the healthcare workers can visualize these pathogens then the outcome could begin a discussion on the issues that healthcare workers are concerned with in their departments, just as it did with the nurse who inquired about further information after this study. There could be more motivation to ask the nurse manager or infection control nurse why a particular set of guidelines are in place instead of just being told to comply with guidelines.

Policy Implications

The combined efforts of federally-funded agencies and its partnering programs have helped to increase attention given to HAIs through the development of protocols and prevention strategies. As a result of these efforts many states have seen a decline in HAIs, but the work in this area has been focused on hand hygiene compliance, which is a short-term solution in that it focuses on obeying the rules that pertain to the healthcare worker's job. Evidence from several studies (Lipsett & Swoboda, 2001; Pittet et al., 2001; Erasmus et al., 2009) and this study, point to the discrepancies in attitudes and hand hygiene performance between professions. Insufficient clinical training has been identified as a factor in several studies (Snow et al., 2006; van De Mortel et al., 2012; Mann & Wood, 2006) demonstrating the need for further evaluation of hand hygiene performance during clinical training. This study identified some of the factors that have been associated with noncompliance and has shown that current guidelines need to address specific specialties, levels of care, and levels of skill. Additionally, hand hygiene needs to be made more relevant to the healthcare worker to foster hand hygiene

commitment rather than compliance alone. This was demonstrated in those healthcare workers who participated in the simulation portion of this study. Simulation participants vocalized an increased desire to commit to hand hygiene when they saw the SID spread on themselves and the patient area. The use of SID provides a clear visualization of the consequences of inappropriate hand hygiene within existing training programs and can be tailored to fit the needs of multiple learning levels and a variety of specialty areas. Mandates requiring simulation based training with SID or similar substances would demonstrate the importance of hand hygiene practices beyond the computer based tutorials that are currently being used for some hand hygiene training programs.

Limitations of the study

Limitations for this study were identified as the sample characteristics, time constraints, data collection procedures, and data collection time.

The results of this study cannot be generalized to all hospitals because the convenience sample was taken from one hospital and consisted of 50 participants who were mostly healthcare workers who work with patients who have a higher risk of getting infections.

The time needed to fully cover all aspects of this study completely was not feasible. It would take a series of studies and more time to understand the role SID could potentially play in hospital training. A healthcare worker's time in a hospital setting is very limited and in some instances participants may have felt rushed to complete certain tasks due to their schedules and unknown factors that may have arisen during their participation.

Data was collected using online questionnaires that participants completed at a time convenient to them. It was possible that the participants testing conditions may have

played a role in how they responded to the questionnaire and surveys. The researcher was unaware of the participants testing time, testing location, and if the device used to complete the questionnaire was a work or personal computing device.

The study was conducted over a time period of six weeks. This study only covered the immediate effects and did not look at the long-term effects of using SID on hand hygiene. According to the Kirkpatrick Levels of Evaluation, long term is defined as greater than six months.

Recommendations for Future Studies

Hand hygiene in a healthcare setting is a complex issue that has no one solution. The researcher views this study as a series of pilot studies to find the best fit for SID as a visualization tool for healthcare settings. The long-term intention is to do the right thing, but the short term may result in what is convenient for the moment. As demonstrated in this study, hand hygiene inactions were reported as the result of several factors, more specifically: time, accessibility, and evidence that it is working. Something so basic as hand hygiene appears to be theoretically simple, but yet it is still difficult to obtain.

Population

Future studies should include all levels of nursing to include nursing assistants, and nursing care partners as all these levels within the nursing field have some patient contact. Future studies should also consider the use of SID for allied health professional in radiology, hospital laboratories, surgical technology, and cleaning and cooking personnel as these areas are commonly overlooked as possible vehicles for pathogen spread.

Simulator

Future studies should consider ways to fully utilize SID's capability. Developing

different colors of SID to represent specific bacteria that colonize certain areas on a person more than others. The colors could also represent bodily fluids such as urine, blood and pus drainage from a wound. This may allow for the training staff to determine more specifically which clinical procedures have the most hand hygiene lapses.

Setting

There was an attempt to create a patient room that would be very similar to what the participants are accustomed to. Resource constraints didn't allow for exact replications for each medical specialty area. Future studies should consider exploring different simulation room set-ups to obtain a better representation of the different levels of care (i.e. ICU, oncology units, etc.) within a healthcare facility.

Measures

Future studies should consider development of instruments that measure knowledge that can be used with SID as a visualization tool. The instrument should be focused on higher level thinking such as understanding and application rather than just recalling relevant knowledge and definitions.

Future studies should consider the development of standard measurements to assess different levels of spread. The optimal goal is to have no spread, however, in cases where this may be impossible it would be beneficial to look at ways to minimize spread.

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APPENDIX A

SID PILOT STUDY

Objective

The objective of the pilot study was to show physical proof of concept by incorporating the SID into clinical scenarios and will help to gather information on best camera and video angles. The pilot study also provided valuable information on how to best fit SID into a clinical situation. Although the Kirkpatrick Levels of Evaluation was used in the main study, they were not applied for the pilot study.

Sample

The convenience sample used for the pilot study was the NURS 451 – Clinical Management Adult Health Nursing III: Critical Care course in the Bachelor of Nursing program at Old Dominion University. This course has a required skilled lab component.

Students were told about study activities, which included completion of the informed consent process and a briefing on the clinical tasks to be completed on the simulated patients and stations in the VICU. They were informed that the simulation will last approximately two hours and a one-hour debriefing session will take place during the last hour of their final exam at the end of the semester.

A total of 32 students were enrolled in this course in the spring of 2011, of which there were 30 females and two males. The students were divided into two groups to rotate through the skills lab with half of the students in the lab in January and the other half in March. Participants were presented a description of the study and were asked to sign-up by putting their name on the sign-up sheet.

Measurement

An infection control knowledge questionnaire for this study was obtained from the Institute for Healthcare Improvement (IHI) titled "How-to Guide: Improving Hand Hygiene. A Guide for Improving Practices among Health Care Workers" (IHI). This questionnaire was developed by a collaborative group that consists of the CDC, The Association for Professionals in Infection Control and Epidemiology, and The Society of Healthcare Epidemiology of America (IHI, 2006). The participants were administered the IHI questionnaire at the beginning of the lab session.

The lab sessions were videotaped to document the students' hand protocols and performance. At the end of the lab session photographs were taken of the patient simulator mannequins and surrounding work area to document the distance and the magnitude of spread from its original location.

Procedure

January rotation. The nursing students were told that the purpose of this study was to test if the video camera equipment could be used for instructors to evaluate and grade students from outside of the skills lab. The skills lab consisted of several stations that the students had to rotate through in groups of two to three. Each station consisted of a clinical task using task trainers (i.e. a mannequin arm for intravenous line insertion) or full body mannequins (i.e. tracheostomy insertion) that each student in the group was required to perform. The SID was planted on the mannequin that required the students to perform a tracheostomy cleaning. The students from the January rotation were asked to perform a tracheotomy cleaning, wound dressing change, and vitals and were instructed to perform these clinical task while interacting with the patient, as they would in the real world. They were not informed of the presence of SID until after the lab session was

complete. Upon completion of the lab session the participants were debriefed on the deception that was employed during the study and were given an opportunity to view the location of SID on the mannequin and on their person.

March rotation. The nursing students were told that the purpose of this study was to test if the video camera equipment could be used for instructors to evaluate and grade students from outside of the skills lab. The skills lab consisted of several stations that the students had to rotate through in groups of two to three. Each station consisted of a clinical task using task trainers (i.e. a mannequin arm for intravenous line insertion) or full body mannequins (i.e. tracheostomy insertion). Students were required to stop at each station and perform the skill designated for that station. For this study, only two mannequin stations were used. The first mannequin had SID planted to represent an infected patient and the second mannequin had no SID representing an uninfected patient. The students from the March rotation were asked to perform a tracheotomy cleaning, wound dressing change, and vitals and were instructed to perform these clinical task while interacting with the patient, as they would in the real world. They were informed of the presence of SID, but they were not told of the exact location. Upon completion of the lab session the participants were debriefed and given an opportunity to view the location of SID on the mannequin and on their person.

Debriefing procedure. Both groups were provided with information on the safety of the polyethylene microspheres, and reminded of their rights to withdraw from the study at any time. The debriefing statement asked them to refrain from disclosing the deceptive purpose of this study or any specific information regarding this investigation to classmates, ODU faculty and staff, or affiliated individuals. It was stressed that doing so could jeopardize future research on this topic, using this or similar methods. After the

deception was disclosed and all questions from participants regarding the deception were answered, participants were asked several questions about their perceptions of the activities performed and how they felt about the study.

The January and March rotation participants also participated in a second debrief together at the end of the semester where they were able to discuss more in depth about how they felt about the study and concerns were addressed. The lab sessions were videotaped and photographs were taken of the patient simulator mannequins and surrounding work area to document the distance and the magnitude of spread from its original location.

Results

January rotation hand hygiene knowledge. Figure 4 shows the percentage of correct responses by item for the January rotation. The researcher used 30% as the percentage of correct responses needed to determine if the question was at an appropriate difficulty level. It was determined that questions seven and ten would need further attention to determine clarity of the question and if the level of difficulty was appropriate.

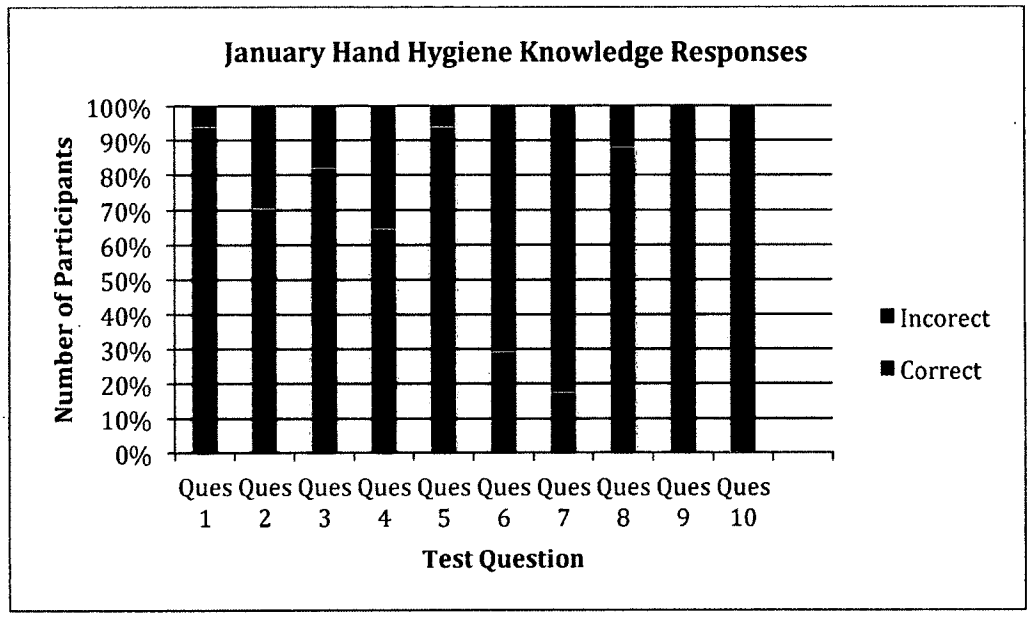


Figure 4. January rotation responses to the original hand hygiene knowledge questionnaire. Grey shaded area shows percentage of correct responses to each question. Black shaded area shows percentage of incorrect responses to each question.

January rotation simulation. The participants were observed having no interaction with the simulated patient mannequins while performing the clinical tasks, as instructed. Participants were also unexpectedly prompted and reminded about hand hygiene and infection control while performing the clinical tasks. The number of students who performed hand hygiene was zero. The distance and magnitude of spread were recorded and the SID spread was identified as direct and indirect contact spread by the students' hands.

March rotation hand hygiene knowledge. Figure 5 shows the percentage of correct responses by item for the March rotation. The researcher used 30% as the percentage of correct responses needed to determine if the question was an appropriate difficulty level. It was determined that questions six and seven would need further attention to determine clarity of the question and if the level of difficulty was appropriate.

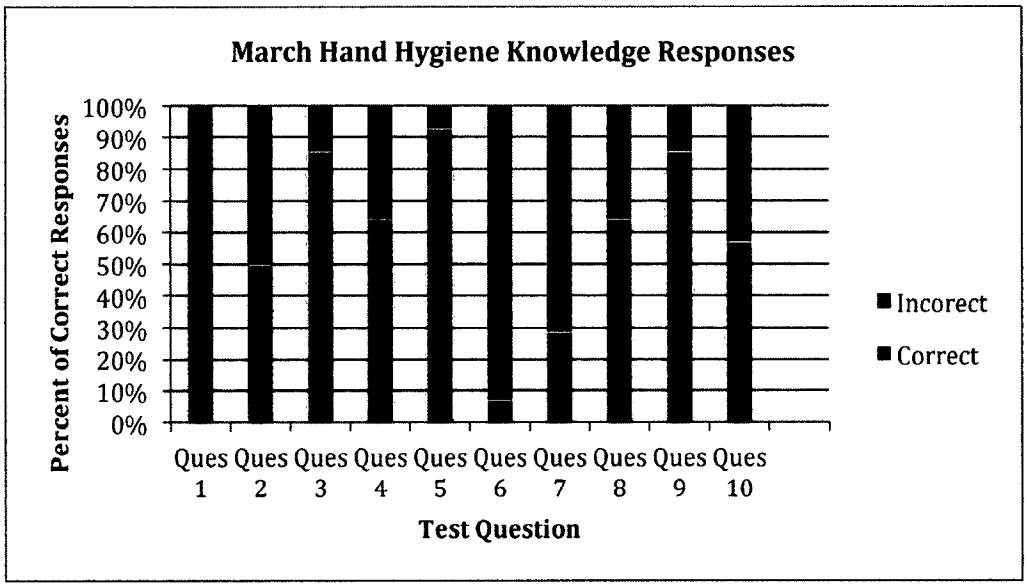


Figure 5. March rotation responses to the original hand hygiene knowledge questionnaire. Grey shaded area shows percentage of correct responses to each question. Black shaded area shows percentage of incorrect responses to each question.

March rotation simulation. Because of unforeseen circumstances the scenario for the March rotation changed immediately before the lab session. With this change in mannequins, the new mannequin was not set up for a tracheotomy cleaning, so an emergency resuscitation was performed instead. The organization of the lab was slightly different for the March group, which did not provide opportunities for each participant to take part in the simulation on the "infected" mannequin. Because these circumstances were beyond the researcher's control, there was difficultly in comparing the amount of spread between the two groups. The participants in the March group, who were informed of the presence of SID prior to the lab session, were observed to have higher vigilance of hand hygiene than the January group. Every student that participated washed his or her hands at the end of the lab session, but not during the scenario. The magnitude and distance of SID were recorded but were found to be consistently different based on the

type of clinical task performed. The spread from the resuscitation caused SID to disperse evenly around the patient contact area.

Group comparisons. Figure 6 displays the questionnaire results by item for both the January and March rotation. The January and March rotation scored low on questions six and seven, and the January rotation additionally scored low on question ten. It was determined that for the main study the hand hygiene questionnaire would need a careful review by experts in the field of infection control and clinical education to rewrite the questions for clarity and to ensure that the questions are written at the appropriate difficulty level.

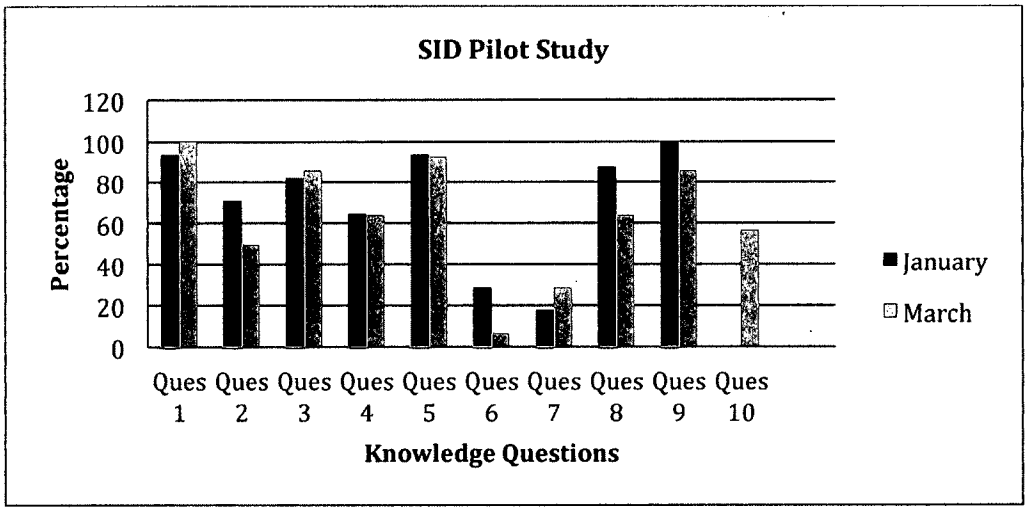


Figure 6. Comparison of the January and March rotation responses to the original hand hygiene knowledge questionnaire. Grey shaded area shows percentage of correct responses for the January rotation to each question. Black shaded area shows percentage of correct responses for the March rotation to each question.

Lessons Learned

The original study design sought to obtain some measurable data to determine if there was a difference in spread between the January rotation, who had their lab session

at the beginning of the semester course and was informed of SID after the lab session was complete, and the March rotation, whose lab session was later during the semester course and was informed of SID immediately before the lab session. Rather than a distinct set of measurable data, this pilot study provided lessons learned that has been very valuable in the design for the main study.

Lessons learned for setting. The lab session set up consisted of several clinical stations that each student was required to visit and demonstrate a specific clinical skill. The students did visit each station, however, there were some students who only watched the skill being demonstrated instead of performing the skill. There was nothing put in place to hold the student accountable for demonstrating the skill. A solution in the future may be to give each student a list to be signed off by the station monitor or lab assistant as they complete each station.

Lessons learned for scenarios. It was difficult for the participants to obtain a real world perspective with the faculty and assistants interacting with the students during the lab session. As mentioned earlier the participants were grouped three to each mannequin. This provided an environment for them to interact with each other and distracted them from interacting with the patient. This also made it difficult to determine which participant contributed to the spread. The main study will include a more structured environment and observation through video only and without faculty and assistants in the simulation area.

Lesson learned for measuring spread. During preliminary testing of SID, spread was defined as any relocation of SID from its original planted location to another location on the mannequin or surrounding clinical area, including the student. The results of the pilot study showed that the type of spread varied with the type of clinical

procedure. Data collected on actual distance and magnitude of spread will need to be compared to a baseline based on the type of clinical procedure.

APPENDIX B

SID APPLICATION INSTRUCTIONS

Cospheric
Innovations in Microtechnology
449 N. Hope Ave, Santa Barbara, CA 93110
Phone: (805) 687-3747 Fax: (866) 708-0375
info@cospheric.com http://www.cospheric-microspheres.com

Project: Custom Development of Fluorescing Microparticles (DO1189767)

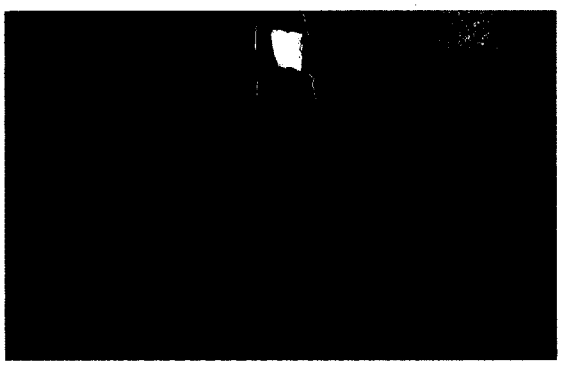
PROCEDURE FOR APPLICATION AND REMOVAL OF FLUORESCENT MICROSPHERES

Applying Microspheres:

Materials: Microspheres, Brush (provided)

Process:

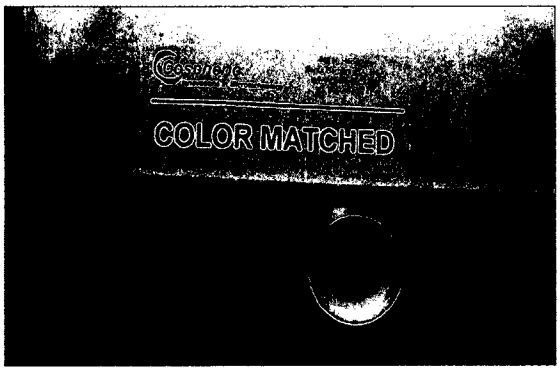
1. Gently dab a clean dry brush in the microsphere powder, making sure that only a small amount of microspheres is on a brush.



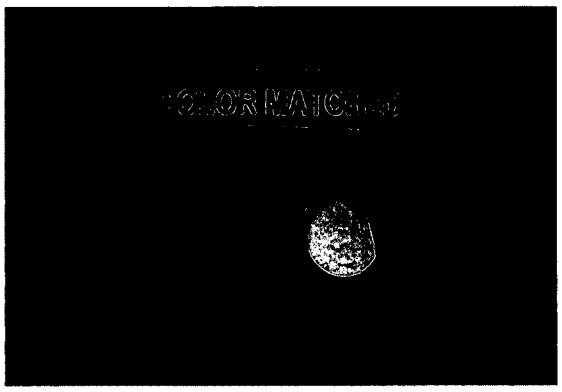
2. Gently brush the microspheres onto the skin, as if painting the skin with a brush.

Applying Microspheres (continued):

3. Continue spreading the microspheres with "painting" motion, until the layer is no longer visible to the naked eye. To apply a thicker layer or cover another area, repeat the process.



4. Turn room lights off and use a 365nm UV light to make sure that the layer of microspheres is thick enough to produce a strong fluorescent response.



5. If a stronger fluorescent response is required, add more microspheres a little at a time, each time spreading into a uniform layer.

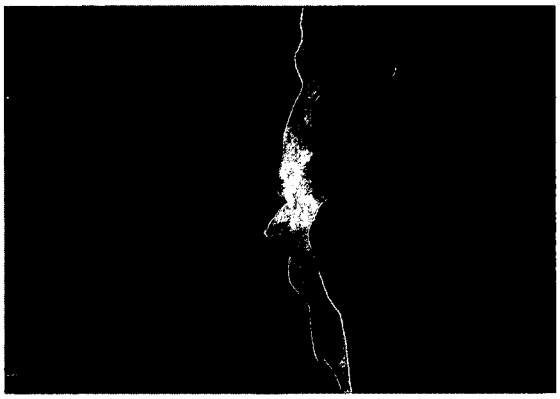
Removing Microspheres:

Materials: Wet cloth (wipe, sponge, towel or paper towel)

Process:

1. While applying gentle pressure, use wet cloth to wipe the microspheres off the surface of the skin.

2. Use 365nm UV light to make sure that the area is clean, i.e. does not have a fluorescent response.



3. Keep wiping until no microspheres are present.

APPENDIX C

RECRUITMENT FLYER

PROJECT TITLE:
Improving Healthcare Worker Training and Evaluation in a Simulated Hospital Environment

DESCRIPTION:
The study will examine using novel simulation methods in addition to traditional computer based education improve training techniques for healthcare personnel. Participants may choose online or online plus simulation. Limited spaces available for online plus simulation.

LOCATION:
The study will take place online and the [redacted] Nursing Simulation Center

PARTICIPANTS:
Must be employed at the [redacted] Medical Center
Must be one of the following:

1. Nurse, nurse assistant, nurse clerk, or environmental aide in the bone marrow transplant unit or medical surgical oncology unit
2. Resident
3. Hospitalist

APPROXIMATE TOTAL TIME REQUIREMENTS (During a 6 week period):
Online module only: 40 to 45 minutes
Online module plus simulation: 55 to 60 minutes

COMPENSATION:
Online only - $5 Gift card
Online plus Simulation - $10 Gift card

CONTACTS:
Bone marrow transplant unit – [redacted]
Medical surgical oncology unit – [redacted]
Residents – [redacted] or [redacted]
Hospitalists – [redacted] or [redacted]

APPENDIX D

INFORMED CONSENT DOCUMENT

Project Title: **Improving Healthcare Worker Infection Control Training and Evaluation in a Simulated Hospital Environment**

Principal Investigator: [redacted], Site PI
Lydia Wigglesworth, PI

Research Team Contact: [redacted]

This consent form describes the research study to help you decide if you want to participate. This form provides important information about what you will be asked to do during the study, about the risks and benefits of the study, and about your rights as a research subject.
If you have any questions about or do not understand something in this form, you should ask the research team for more information.

You should discuss your participation with anyone you choose such as family or friends. Do not agree to participate in this study unless the research team has answered your questions and you decide that you want to be part of this study.

WHAT IS THE PURPOSE OF THIS STUDY?
This is a research study. We are inviting you to participate in this research study because you work on 4JP, 7RCS or are an internal medicine resident or an internal medicine hospitalist.

The purpose of this research study is to compare two methods of training healthcare workers to hand hygiene when appropriate during the sequence of care.

HOW MANY PEOPLE WILL PARTICIPATE?
Approximately 220 people will take part in this study conducted by investigators at the [redacted].

HOW LONG WILL I BE IN THIS STUDY?
If you agree to take part in this study, your involvement will last for about 1 hour 10 min if you chose to participate in the online module only or about 1hr 35 minutes if you do the online module and the simulation. This time will be the total time spent over the 6 weeks of the study.

WHAT WILL HAPPEN DURING THIS STUDY?
[redacted] (7RCS), [redacted] (4JP), [redacted] (4JP), [redacted] (internal medicine hospitalists), and [redacted] (internal medicine residents) will describe the study and will give you a recruitment flyer, a consent document, and an envelope addressed to [redacted], which you can use to return your signed consent document if you decide to participate in the study. If you decide to participate in

the study and you want to do the simulation, [redacted] will email a list of possible times during which you could do the simulation.

Pre-test and surveys

- All participants will be given the web address for the pre-test, which is combined with two short associated surveys. They will access the website and do the pre-test and the surveys during the first week of the study. This task will take about 15 minutes.
- They will then access the website for the instructional Power Point slide show and go through the educational module. This task will take about 15 minutes.

Post-test 1

- Immediately after doing the educational module, participants will access the website for the first post-test. This test will take about 15 minutes to finish.

Written scenario (for the control group only)

- The participants in the control group will be asked to read a short clinical scenario and to answer one question pertaining to the scenario. This task will take about 5 minutes.

Simulation (for the intervention group only)

- For the simulation experience, a simulated patient room will be set up in the Nursing Education Center. The room will have a mannequin and medical supplies and equipment to mimic an acute care setting.
- You will be given a clinical case to read and then will be asked to demonstrate the appropriate clinical skills on a mannequin for the given case study.
- Ms. Wigglesworth will monitor participants during the simulation from another room via video feed through a camera system built into the simulation room. She will use a checklist to document your sequence of care performance
- Once you have completed the simulation training, Ms. Wigglesworth will enter the room and will debrief you, giving you feedback on your sequence of care.
- Ms. Wigglesworth will also ask you questions about your experience of doing the simulation.
- Ms. Wigglesworth will ask you if you have any questions of concerns. She will answer your questions and address any concerns that you have
- The simulation will take no more than 10 minutes and the debriefing will take 20 minutes.

Delayed post-test and surveys

- All participants will be given the web address for the delayed post-test that also includes two short associated surveys.
- You will access the website and do the delayed post-test and the surveys during the week six of the study. This task will take about 20 minutes.

Location for the study parts

- You can access the online training from any computer within the [redacted].

- You can access the pre-test, post-tests, and surveys from any computer with internet access.
- The simulation will take place in a private simulation room in the [redacted] Nursing Education Center on the 4th floor of General Hospital.

Do I have to answer all of the questions?

- You are free to skip any questions in the surveys, pre-test, and post-tests that you do not want to answer.

Audio Recording/Video Recording/Photographs

One aspect of this study involves making video recordings of you during the simulation (intervention group only). The video recording will be done so that Ms. Wigglesworth can review the sequence of care during your simulation. NOTE: This is for the simulation (intervention) group only.

WHAT ARE THE RISKS OF THIS STUDY?

You may experience one or more of the risks indicated below from being in this study. In addition to these, there may be other unknown risks, or risks that we did not anticipate, associated with being in this study.

- The primary risk is emotional or psychological distress among staff who participate in the simulation. They may feel that they failed if they miss hand hygiene opportunities. In addition, confidentiality could be compromised.
- The physical risks to participants in the simulation should not exceed the normal risks associated with healthcare clinical training and evaluations that normally take place within the medical center. Various potentially irritating or allergenic substances are always present in the hospital, so participants will be asked to inform researchers in advance if they have any specific allergies (for example, latex allergies).

WHAT ARE THE BENEFITS OF THIS STUDY?

We don't know if you will benefit from being in this study. However, participants in both arms of the study will learn about doing hand hygiene properly and, thus, should be more proficient in their jobs. Participants in the intervention group will be able to practice hand hygiene in a clinical simulation and get formative feedback. We hope that, in the future, other people might benefit from this study because these methods can be used to teach hand hygiene and the process of care to healthcare workers. If hand hygiene and the process of care improve, the risk of healthcare-associated infections among hospitalized patients could decrease.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

You will not have any **costs** for being in this research study.

WILL I BE PAID FOR PARTICIPATING?

You will receive a $5 gift card to the [redacted] if you complete the online only arm of the study. You will receive a $10 gift card to the [redacted] if you complete the online and simulation arm of the study.

WHO IS FUNDING THIS STUDY?
The University and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

WHAT IF I AM INJURED AS A RESULT OF THIS STUDY?
If you are injured or become ill from taking part in this study, medical treatment is available at the [redacted].

The University of Iowa does not plan to provide free medical care or payment for treatment of any illness or injury resulting from this study unless it is the direct result of proven negligence by a University employee.

If you experience a research-related illness or injury, you and/or your medical or hospital insurance carrier will be responsible for the cost of treatment.

WHAT ABOUT CONFIDENTIALITY?
We will keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people such as those indicated below may become aware of your participation in this study and may inspect and copy records pertaining to this research. Some of these records could contain information that personally identifies you.

- Federal government regulatory agencies,
- Auditing departments of the [redacted], and
- The [redacted] Institutional Review Board (a committee that reviews and approves research studies)

To help protect your confidentiality, you will create your own study ID, which will not be linked to your name or other identifiers. You will use the study ID on each of the tests so that we can track your progress without knowing who you are. We will use your study id for the simulation if you chose to do the simulation. If we write a report or article about this study or share the study data set with others, we will do so in such a way that you cannot be directly identified.

IS BEING IN THIS STUDY VOLUNTARY?
Taking part in this research study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may stop participating at any time. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

WHAT IF I DECIDE TO DROP OUT OF THE STUDY?
You may decide to drop out of the study at any point. There will be no adverse effects on your health or employment if you drop out.

WILL I RECEIVE NEW INFORMATION ABOUT THE STUDY WHILE PARTICIPATING?

If we obtain any new information during this study that might affect your willingness to continue participating in the study, we'll promptly provide you with that information.

CAN SOMEONE ELSE END MY PARTICIPATION IN THIS STUDY?

Under certain circumstances, the researchers might decide to end your participation in this research study earlier than planned. This might happen because we have enough study subjects.

WHAT IF I HAVE QUESTIONS?

We encourage you to ask questions. If you have any questions about the research study itself, please contact: [redacted] **or Lydia Wigglesworth** [redacted].

If you have questions, concerns, or complaints about your rights as a research subject or about research related injury, please contact the Human Subjects Office, [redacted]. General information about being a research subject can be found by clicking "Info for Public" on the Human Subjects Office web site, [redacted]. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

This Informed Consent Document is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You are not waiving any legal rights by signing this Informed Consent Document. Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Please check below to indicate if you would like to participate in the on line portion only or in the on line portion and the simulation

- o I will participate in the on line portion of the study only
- o I will participate in both the on line portion of the study and the simulation

If you agree to participate in the simulation, the researchers will need to videotape you while you are doing the simulation so that they can review the videotape to ensure that they did not miss anything as they observed you in real time. The videotape will be identified with your study ID and not with your name or other personal identifiers. The videotape will be erased once the researchers are sure that they observed your simulation correctly.

Please check the statement below to indicate whether the researchers can video tape your simulation. If you do not wish to be videotaped, you will not be able to participate in the simulation.

o I agree to be videotaped during the simulation.

Subject's Name (printed):

_____

Do not sign this form if today's date is on or after January 6, 2014

_____ _____

(Signature of Subject) (Date)

Statement of Person Who Obtained Consent

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative. It is my opinion that the subject understands the risks, benefits, and procedures involved with participation in this research study.

_____ _____

(Signature of Person who Obtained Consent) (Date)

APPENDIX E

DEMOGRAPHIC QUESTIONNAIRE

1. What is your gender?

   - o Female
   - o Male

2. Which is your age?

   _____ years

3. What is your highest level of education? (Check only one)

   - o Associates degree
   - o Bachelor degree
   - o Masters degree
   - o M.D. / PhD
   - o Other

4. Which below best describes your profession?

   - o Nurse
   - o Nursing Assistant
   - o Resident
   - o Hospitalist
   - o Nurse Clerk
   - o Environmental Aide

5. How long have you been working in the profession indicated above?

   _____ years

6. How long have you been working at [redacted]?

   _____ years

APPENDIX F

HAND HYGIENE KNOWLEDGE QUESTIONNAIRE

INSTRUCTIONS: Circle the letter corresponding to the single best answer.

1. In which of the following situations should hand hygiene be performed?

A. Before having direct contact with a patient
B. After removing gloves
C. When moving from a contaminated body site to a clean body site during an episode of patient care
D. After having direct contact with a patient or with items in the immediate vicinity of the patient
E. All of the above

2. If hands are not visibly soiled, which of the following regimens is the most effective for reducing the number of pathogenic bacteria on the hands of personnel?

A. Washing hands with plain soap and water
B. Washing hands with an antimicrobial soap and water
C. Applying 1.5ml to 3ml of alcohol-based hand rub to the hands and rubbing hands together until they feel dry
D. All of the above have the same effectiveness
E. It has not been proven that one is better than the other

3. How are antibiotic-resistant pathogens most frequently spread from one patient to another in health care settings?

A. Airborne spread resulting from patients coughing or sneezing
B. From one patient to another via contaminated hands of clinical staff
C. Patients coming in contact with contaminated equipment
D. Poor environmental maintenance
E. All of the above are methods by which resistant organisms are spread

4. Which of the following statements is true?

A. Many organisms that cause infections can be transmitted to patients on healthcare workers' hands
B. Most organisms that cause infections cannot survive on environmental surfaces
C. Alcohol hand rubs kill all organisms that cause infections
D. Alcohol hand rubs do not need to dry to kill bacteria and virues
E. All of the above are true

5. Which of the following bacteria are not readily killed by alcohol-based hand hygiene products?

A. Methicillin-resistant *Staphylococcus aureus*
B. *Escherichia coli*
C. *Pseudomonas aeruginosa*
D. Vancomycin-resistant enterococci
E. *Clostridium difficile spores*

6. Which of the following statements about alcohol-based hand hygiene products is false?

A. They dry the skin less than repeated hand washing with soap and water
B. They cause fewer allergies and skin irritation than chlorhexidine products
C. If the skin is irritated, they will not cause stinging of the hands
D. They are not effective when the hands are visibly soiled
E. They kill bacteria more rapidly than chlorhexidine and other antiseptic containing soaps

7. Which of the following statements about handwashing is false?

A. Handwashing should be performed prior to eating
B. Handwashing should be performed after using the restroom
C. After applying the product, all surfaces of the hands and fingers need to be rubbed vigorously
D. Handwashing with bland soap is the preferred hand hygiene method before placing or caring for a central line
E. After washing your hands, you should dry them with a disposable towel and use the towel to shut off the water

8. While you are in Ms. Johnson's room you talk with her and you silence an IV pump alarm. You then leave the room. Which is of the following statements is TRUE?

A. You do not need to do hand hygiene because you did not do any real work.
B. You do not need to do hand hygiene because you are going to do documentation in Epic and you won't be doing patient care.
C. You do not need to do hand hygiene because you did not touch the patient.
D. You do not need to do hand hygiene because you touched an environmental surface for less than 10 seconds.
E. None of the above.

9. How do you know you are doing a good job of preventing the spread of infections?

A. Your patients aren't getting infections
B. You consistently follow hand hygiene procedures and infection control precautions
C. Your supervisor has told you
D. You have no way to determine this information
E. You feel confident

10. How often do you do hand hygiene when it is indicated?

A. Less than 25% of the time
B. 25% to 50% of the time
C. 51% to 75% of the time
D. 76% to 100% of the time

11. How often do your co-workers do hand hygiene when it is indicated?

A. Less than 25% of the time
B. 25% to 50% of the time
C. 51% to 75% of the time
D. 76% to 100% of the time

APPENDIX G

ATTITUDES TOWARD HAND HYGIENE GUIDELINES QUESTIONNAIRE

1. I am familiar with the hand hygiene guidelines in my field

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

2. There are so many guidelines available that it is nearly impossible to keep up

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

3. In my field, I find practice guidelines readily available

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

4. I don't have time to stay informed about available guidelines

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

5. Guidelines are too "cookbook" and prescriptive

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

6. Practice guidelines are practical to use

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

7. Generally, practice guidelines are cumbersome and inconvenient

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

8. Guidelines are difficult to apply and adapt to my specific practice

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

9. In this organization, practice guidelines are important

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

10. Guidelines improve patient outcomes

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

11. Generally, the cost of practice guidelines outweigh the benefits

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

12. Guidelines interfere with my professional autonomy

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

13. Generally, I would prefer to continue my routines and habits than to change based on practice guidelines

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

14. I am not really expected to use guidelines in my practice setting

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

15. Publishing practice guidelines increases the risk of malpractice liability

5	4	3	2	1	0
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

16. Guidelines help to standardize care and ensure that patients are treated in a consistent way

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

I7. In my practice setting, there is sufficient administrative support and resources to allow the implementation of practice guidelines

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

18. Patients are generally aware of practice guidelines related to their condition

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

19. For me, the most important factor that did or would influence me to implement hand hygiene guidelines is:

Please write your answer in the space provided:

20. For me, the most important barrier to implementing hand hygiene guidelines is:

Please write your answer in the space provided:

APPENDIX H

REACTION AND SATISFACTION SURVEY

1. I understood the learning objectives

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

2. **I was appropriately challenged by the material**

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

3. I found the online materials easy to navigate

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

4. I feel the course material will be essential for my success

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

5. I was comfortable with the pace of the training

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

6. I was comfortable with the duration of the training

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

7. I will be able to apply what I learned during this training experience on the job

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

8. I do not anticipate any barriers to applying what I learned

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

9. I anticipate that I will eventually see positive results as a result of my efforts

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

10. I was satisfied with the overall training

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

11. After this training, I am more likely to sequence my care for a patient from clean to dirty

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

12. Based on this training, I am more likely to comply with hand hygiene guidelines

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

ANSWER QUUESTIONS 13, 14, AND 15 ONLY IF YOU PARTICIPATED IN THE SIMULATION

13. The ability to visualize pathogen spread has affected my commitment to sequence care for a patient from clean to dirty

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

14. The ability to visualize pathogen spread has affected my commitment to applying hand hygiene guidelines

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

15. The ability to visualize pathogen spread enhanced the overall training experience

0	1	2	3	4	5
Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree

APPENDIX I

SIMULATION GROUP CLINICAL SCENARIOS

General Medical Nurse Role

Setting: Inpatient General Medicine Ward

Patient: Mr. Jones is a 72 y.o. man with a diabetic foot ulcer complicated by cellulitis and osteomyelitis who was recently discharged home from the hospital with a PICC line for home intravenous antibiotics for his osteomyelitis. He is being readmitted from home for fevers and increasing foot pain and confusion.

Your role: You are the nurse on the team that will be taking care of Mr. Jones. You are called by the unit clerk who tells you that Mr. Jones has arrived in his room and he is complaining of foot pain and of being cold. Unfortunately Mr. Jones is not able to give a good history because he is confused. Your job is to obtain his vital signs, check the level of the urine in his Foley bag, and examine his PICC line site and anything else you would do to evaluate him for his fever, foot pain, and confusion.

The physician ordered intravenous vancomycin, which you must also administer to Mr. Jones via his PICC line.

You have 10 minutes to complete your evaluation and administer the medication.

Pediatric Nurse Role

Setting: Inpatient Pediatric Ward

Patient: Ronald Jones is a 15 y.o. boy who had an abdominal operation yesterday (postop day 1). The wound was left open and packed. He has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse on the team taking care of Ronald. You enter his room to complete your AM assessment, check his vital signs, and administer his AM antibiotics. When you ask Ronald how he is doing, he tells you that his abdominal dressing has come loose and that he thinks something wet is seeping out from under the dressing.

Your job is to obtain his vital signs, check his Foley/Foley bag to ensure that they are positioned properly, assess his urine output, and examine his PICC line exit site. You also need to check his abdominal dressing and redress/repack it and you must administer his IV antibiotics via his PICC line.

You have 10 minutes to complete your evaluation, care for the patient, and administer the medication.

Surgical Nurse Role

Setting: Inpatient Ward

Patient: Ronda Jones is a 65 y.o. woman who previously underwent a debulking operation for ovarian cancer. She was readmitted with fever, abdominal pain, and purulent drainage from her wound. She underwent a reoperation and was found to have a small perforation in her colon. The perforation was closed, the abdomen irrigated copiously, and the wound was packed open, and dressed. The wound was left open and packed. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse taking care of Ms. Jones. You enter her room to complete your AM assessment, check her vital signs, and administer her AM antibiotics. When you ask Ms. Jones how she is doing, she tells you that her abdominal dressing has come loose and that she thinks something wet is seeping out from under the dressing.

Your job is to obtain her vital signs, check her Foley/Foley bag to ensure that they are positioned properly, assess her urine output, and examine her PICC line exit site. You also need to check her abdominal dressing and redress/repack it and you must administer her IV antibiotics via her PICC line.

You have 10 minutes to complete your evaluation, care for the patient, and administer the medication.

Neurosurgical Nurse Role

Setting: Inpatient Surgical Ward

Patient: Ronda Jones is a 65 y.o. woman who underwent a spine fusion 17days ago. She was readmitted with purulent drainage from her wound. She underwent a reoperation and was found to have an epidural abscess. The abscess was drained, the wound was closed, and a drain was placed through a stab wound. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse taking care of Ms. Jones. You enter her room to complete your AM assessment, check her vital signs, and administer her AM antibiotics. You notice that Ms. Jones dressing is saturated with serosanguineous drainage. You need to obtain vital signs, check her Foley/Foley bag to ensure that they are positioned properly, assess her urine output, and examine her PICC line exit site. You also need to check her surgical dressing and the drain. You will need to redress the wound and administer IV antibiotics via her PICC line.

Your job is to obtain her vital signs, check her Foley/Foley bag to ensure that they are

positioned properly, assess her urine output, and examine her PICC line exit site. You also need to check her surgical dressing and redress it and you must administer her IV antibiotics via her PICC line.

You have 10 minutes to complete your evaluation, care for the patient, and administer the medication.

General Medical Physician Role

Setting: Inpatient General Medicine Ward

Patient: Mr. Jones is a 72 y.o. man with a diabetic foot ulcer complicated by cellulitis and osteomyelitis who was recently discharged home from the hospital with a PICC line for home intravenous antibiotics (ertapenem) for his osteomyelitis. He is being readmitted from home for fevers, increasing foot pain, and confusion.

Your role: You are the physician on the team who will be taking care of Mr. Jones. You are called by the nurse to evaluate him as he is spiking a fever and complaining of foot pain. Unfortunately Mr. Jones is not able to give a good history because he is confused. Your job is to perform a focused exam on Mr. Jones to evaluate potential causes for his fever, foot pain, and confusion. You decide to give him a dose of intravenous vancomycin and will need to order this in EPIC as well as enter any other orders you think you need to take care of Mr. Jones.

You have 10 minutes to complete your evaluation and enter orders.

Pediatric Physician Role

Setting: Inpatient Pediatrics Ward

Patient: Ronald Jones is a 15 y.o. boy who had an abdominal operation yesterday (postop day 1). The wound was left open and packed. He has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ronald and you are called by the nurse to evaluate him because he is spiking a fever and complaining of pain and drainage at his surgical site. Your job is to perform a focused exam on Ronald to evaluate potential causes for his fever, abdominal pain, and wound drainage. You decide to give him I.V. antibiotics and will need to order these in EPIC as well as enter any other orders you think you are necessary to identify the source of his fever and for Ronald' care in general.

You have 10 minutes to complete your evaluation and enter orders.

Surgical Physician Role

Setting: Inpatient Ward

Patient: Ronda Jones is a 65 y.o. woman who previously underwent a debulking operation for ovarian cancer. She was readmitted with fever, abdominal pain, and purulent drainage from her wound. She underwent a reoperation and was found to have a small perforation in her colon. The perforation was closed, the abdomen irrigated copiously, and the wound was packed open, and dressed. She was admitted to your unit. Today is postop day 1. The wound was left open and packed. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ms. Jones and you are called by the nurse to evaluate her because she is spiking a fever and complaining of pain and drainage at her surgical site. Your job is to perform a focused exam on Ms. Jones to evaluate potential causes for her fever, abdominal pain, and wound drainage. You decide to give her Piperacilin Tazobactam I.V. and will need to place orders in EPIC for this agent and for any tests you think are necessary to identify the source of her fever .

You have 10 minutes to complete your evaluation and enter orders.

Neurosurgical Physician Role

Setting: Inpatient Surgical Ward

Patient: Ronda Jones is a 65 y.o. woman who underwent a spine fusion 17days ago. She was readmitted with purulent drainage from her wound. She underwent a reoperation and was found to have an epidural abscess. The abscess was drained, the wound was closed, and a drain was placed through a stab wound. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ms. Jones and you are called by the nurse to evaluate her because she has a fever and is complaining of pain and drainage at her surgical site.

Your job is to perform a focused exam on Ms. Jones to evaluate potential causes for her fever, incisional pain, and wound drainage. You decide to give her Piperacillin Tazobactam and vancomycin I.V. You will need to order these antimicrobial agents in EPIC as well as enter any other orders you think are necessary to identify the source of her fever and for Ms. Jones' care in general.

You have 10 minutes to complete your evaluation and enter orders.

APPENDIX J

DEBRIEFING STATEMENT

Initially, you were told that the purpose of this study was to improve sequence of care by using computer module training and simulation based training. While we are interested in this, the primary purpose of this research was to investigate the spread of infectious disease in a simulated clinical setting. In order to do this, we used a simulated infectious disease product we call SID to mimic healthcare-associated infections colonized on patients in a clinical setting. This substance is not visible under natural light but appears under a specialized light source. This product is marketed for drug delivery, for use in make up, and teaching hand washing, isolation techniques, aseptic techniques, and general infection control. It is considered a safe product and has been used in makeup, chewing gun, and for drug delivery. It is easily removed with soap and water.

If you have any concerns about your exposure to this product, please let me know and I can provide you with a Materials Safety Data Sheet (MSDS). If you feel you have experienced any reaction to this product, please let me know so that appropriate action can be taken right away.

Also, remember that we do not collect any data directly about you or your specific involvement in the spread or containment of SID during these sessions. The primary data collected for analysis during these sessions is actually taken after you have left the simulation center.

Please be reminded that you have the rights to withdraw from this study at anytime.

Because we plan to conduct other studies of this nature in the future, it is critical that future participants not learn the purpose of this study. Therefore, we ask that you refrain from discussing the primary purpose of this study with other healthcare staff, University of Iowa faculty and staff, and affiliated individuals. We cannot stress enough that sharing this information could jeopardize future research on this topic.

If you have further questions regarding the purpose of this research that we were not able to answer at this time, you may contact [redacted] or Lydia Wigglesworth [redacted].

APPENDIX K

SEMI-STRUCTURED DEBRIEFING INTERVIEW

The following set of interview questions are not to be read word-for-word to the study participants; rather they are meant provide a general set of questions that will be asked about participants' perceptions regarding study scenarios and their attitudes toward the use of SID to evaluation and training of infection control procedures.

Thank you for volunteering to participate in the study today. We would now like to get some feedback from you on your experience today. First of all, do you have any questions or comments that you'd like to make regarding your experience in this study?

If there are no (other) questions, we'd like to begin by asking you a few questions:

- Have you have ever participated in another study where the true nature of the study was not revealed to the participants?
- How did you feel during the simulation?
- How realistic were the scenarios?
- Is there anything you would change in the scenarios?
- During the course of the session, what, if anything, was going through your mind regarding infection control
- Did you have any idea that we were looking at infectious disease spread?
- Do you have any suggestions for us about what we might change for the future?
- How would you apply what you experienced today to the clinical setting?

Do you have any additional questions or comments before we conclude?

Be sure that you have your copy of the informed consent document. Feel free to contact [redacted], [redacted], [redacted], or Lydia Wigglesworth, if you have additional questions or concerns about the study.

Again, we want to thank you for participating in this study. Unless you have additional questions, the simulation portion of this study is complete. You will receive notification in approximately 30 days reminding you to complete the delayed post-test which will also be administered online. Once you have completed all required portions of this study you will receive your gift card, as promised.

APPENDIX L

CONTROL GROUP SCENARIOS

Patient Care Simulation: General Medical Nurse Role

Please read the following patient care scenario.

Setting: Inpatient General Medicine Ward

Patient: Mr. Jones is a 72 y.o. man with a diabetic foot ulcer complicated by cellulitis and osteomyelitis who was recently discharged home from the hospital with a PICC line for home intravenous antibiotics for his osteomyelitis. He is being readmitted from home for fevers and increasing foot pain and confusion. He apparently has a foot ulcer on his left heel that is bandaged. He has a Foley catheter in.

Your role: You are the nurse on the team who will be taking care of Mr. Jones and you are called by the unit clerk who tells you that Mr. Jones has arrived in his room and he is complaining of foot pain and being cold. Unfortunately Mr. Jones is not able to give a good history because he is confused. Your job is to obtain his vital signs, check his Foley/Foley bag for urine, and examine his PICC line site and anything else you would do to evaluate him for his fever, foot pain, and confusion. The physician ordered intravenous vancomycin, which you must also administer to Mr. Jones via his PICC line.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 8).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Inspect PICC site

_____ Take vitals

_____ Check the Foley/Foley bag for urine/urine level

_____ Lower bedrail

_____ Evaluate foot pain

_____ Evaluate for fever, and fever

_____ Administer Vancomycin ordered by the physician

_____ Record vital signs in Epic

Patient Care Scenario: Pediatric Nurse Role

Please read the following patient care scenario.

Setting: Inpatient Pediatrics Ward

Patient: Ronald Jones is a 15 y.o. boy who had an abdominal operation yesterday (postop day 1). The wound was left open and packed. He has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse on the team taking care of Ronald. You enter his room to complete your AM assessment, check his vital signs, and administer his AM antibiotics. When you ask Ronald how he is doing, he tells you that his abdominal dressing has come loose and that he thinks something wet is seeping out from under the dressing. Your job is to obtain his vital signs, check his Foley/Foley bag to ensure that they are positioned properly, assess his urine output, and examine his PICC line exit site. You also need to check his abdominal dressing and redress/repack it and you must administer his IV antibiotics via his PICC line.

For the scenario below please number the tasks described below in the order you would do them if you actually cared for this patient (use numbers 1 through 9). Then CIRCLE the tasks that you would do immediately AFTER doing hand hygiene.

_____ Examine abdominal dressing

_____ Inspect PICC site

_____ Scan the barcode on the IV antibiotic bag

_____ Check the Foley/Foley bag for urine/urine level

_____ Re-pack and re-dress the wound

_____ Administer the AM antibiotics

_____ Scan the barcode on the patient's wristband

_____ Take vitals

_____ Record vital signs in Epic

Patient Care Scenario: Surgical Nurse Role

Please read the following patient care scenario.

Setting: Inpatient Ward

Patient: Ronda Jones is a 65 y.o. woman who underwent a debulking operation for ovarian cancer. She was readmitted with fever, abdominal pain, and purulent drainage from her wound. She underwent a reoperation and was found to have a small perforation of her colon. The perforation was closed, the abdomen irrigated copiously, and the wound was packed open, and dressed. The wound was left open and packed. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse taking care of Ms. Jones. You enter her room to complete your AM assessment, check her vital signs, and administer her AM antibiotics. Ms. Jones tells you that her abdominal dressing has come loose and that she thinks something wet is seeping out from under the dressing. You need to obtain vital signs, check her Foley/Foley bag to ensure that they are positioned properly, assess her urine output, and examine her PICC line exit site. You also need to check her abdominal dressing and redress/repack it and administer IV antibiotics via her PICC line.

For the scenario below please number the tasks described below in the order you would do them if you actually cared for this patient (use numbers 1 through 9). Then CIRCLE the tasks that you would do immediately AFTER doing hand hygiene.

_____ Examine abdominal wound and surgical dressing/packing

_____ Inspect PICC site

_____ Scan the barcode on the IV antibiotic bag

_____ Check the Foley/Foley bag for urine/urine level

_____ Re-pack and re-dress the wound

_____ Administer the AM antibiotics

_____ Scan the barcode on the patient's wristband

_____ Take vitals

_____ Record vital signs in Epic

Patient Care Scenario: Neurosurgical Nurse Role

Please read the following patient care scenario.

Setting: Inpatient Surgical Ward

Patient: Ronda Jones is a 65 y.o. woman who underwent a spine fusion 17days ago. She was readmitted with purulent drainage from her wound. She underwent a reoperation and was found to have an epidural abscess. The abscess was drained, the wound was closed, and a drain was placed through a stab wound. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the nurse taking care of Ms. Jones. You enter her room to complete your AM assessment, check her vital signs, and administer her AM antibiotics. You notice that Ms. Jones dressing is saturated with serosanguineous drainage. You need to obtain vital signs, check her Foley/Foley bag to ensure that they are positioned properly, assess her urine output, and examine her PICC line exit site. You also need to check her surgical dressing and the drain. You will need to redress the wound and administer IV antibiotics via her PICC line.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 10).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Examine her surgical wound

_____ Inspect PICC site

_____ Scan the barcode on the IV antibiotic bag

_____ Check the Foley/Foley bag for urine/urine level

_____ Re-dress the wound

_____ Administer the AM antibiotics

_____ Scan the barcode on the patient's wristband

_____ Take vitals

_____ Sign into Epic and open the MAR

_____ Record vital signs in Epic

Patient Care Simulation: General Medical Physician Role

Please read the following patient care scenario.

Setting: Inpatient General Medicine Ward

Patient: Mr. Jones is a 72 y.o. man with a diabetic foot ulcer complicated by cellulitis and osteomyelitis that was recently discharged home from the hospital with a PICC line for home intravenous antibiotics (ertapenem) for his osteomyelitis. He is being readmitted from home for fevers, increasing foot pain, and confusion. He apparently has a foot ulcer on his left heel that is bandaged. He has a Foley catheter in.

Your role: You are the physician on the team who will be taking care of Mr. Jones and you are called by the nurse to evaluate him as he is spiking a fever and complaining of foot pain. Unfortunately Mr. Jones is not able to give a good history because he is confused.

Your job is to perform a focused exam on Mr. Jones to evaluate potential causes for his fever, foot pain, and confusion. You decide to give him a dose of I.V. Vancomycin and will need to order this in EPIC as well as enter any other orders you think you need to take care of Mr. Jones.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 5).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Inspect PICC site

_____ Order medication in Epic

_____ Lower bedrail

_____ Examine heel ulcer and evaluate foot pain

_____ Evaluate patient for fever and confusion

Patient Care Scenario: Pediatric Physician Role

Please read the following patient care scenario

Setting: Inpatient Pediatrics Ward

Patient: Ronald Jones is a 15 y.o. boy who had an abdominal operation yesterday (postop day 1). The wound was left open and packed. He has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ronald and you are called by the nurse to evaluate him because he is spiking a fever and complaining of pain and drainage at his surgical site.

Your job is to perform a focused exam on Ronald to evaluate potential causes for his fever, abdominal pain, and wound drainage. You decide to give him I.V. antibiotics and will need to order them in EPIC as well as enter any other orders you think necessary to identify the source of his fever and for Ronald's care in general.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 5).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Examine the patient to identify possible sources of fever

_____ Inspect PICC exit site/palpate the PICC exit site

_____ Order medications and lab tests in Epic

_____ Examine foley catheter/reposition the tubing to ensure it is draining/evaluate the color and amount of urine in the bag

_____ Examine the surgical wound

Patient Care Simulation: Surgical Physician Role

Please read the following patient care scenario

Setting: Inpatient Surgical Ward

Patient: Ronda Jones is a 65 y.o. woman who previously underwent a debulking operation for ovarian cancer. She was readmitted with fever, abdominal pain, and purulent drainage from her wound. She underwent a reoperation and was found to have a small perforation in her colon. The perforation was closed and the abdomen irrigated copiously; the wound was packed open and dressed. She was admitted to your unit. Today is postop day 1. The wound was left open and packed. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ms. Jones and you are called by the nurse to evaluate her because she is spiking a fever and complaining of pain and drainage at her surgical site. Your job is to perform a focused exam on Ms. Jones to evaluate potential causes for her fever, abdominal pain, and wound drainage. You decide to give her Piperacillin Tazobactam I.V. You will need to order this antimicrobial agent in EPIC as well as enter any other orders you think are necessary to identify the source of her fever and for Ms. Jones' care in general.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 5).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Inspect PICC exit site, including palpating the exit site

_____ Order medication and diagnostic tests in Epic

_____ Lower bedrail

_____ Examine the surgical wound

_____ Examine the patient to identify possible sources of fever

Patient Care Scenario: Neurosurgical Physician Role

Please read the following patient care scenario

Setting: Inpatient Surgical Ward

Patient: Ronda Jones is a 65 y.o. woman who underwent a spine fusion 17 days ago. She was readmitted with purulent drainage from her wound. She underwent a reoperation and was found to have an epidural abscess. The abscess was drained, the wound was closed, and a drain was placed through a stab wound. Today is postop day 1. She has a PICC line for intravenous antibiotics and a Foley catheter.

Your role: You are the physician on the team who will be taking care of Ms. Jones and you are called by the nurse to evaluate her because she has a fever and is complaining of pain and drainage at her surgical site. Your job is to perform a focused exam on Ms. Jones to evaluate potential causes for her fever, incisional pain, and wound drainage. You decide to give her Piperacillin Tazobactam and vancomycin I.V. You will need to order these antimicrobial agents in EPIC as well as enter any other orders you think are necessary to identify the source of her fever and for Ms. Jones' care in general.

Please number the tasks described in the scenario (see list below) in the order you would do them if you actually cared for this patient (use numbers 1 through 5).

Next indicate when you would do hand hygiene in this sequence of care by CIRCLING the tasks BEFORE which you would do hand hygiene.

_____ Inspect PICC site

_____ Order medication and diagnostic tests in Epic

_____ Lower bedrail

_____ Examine the surgical wound

_____ Examine the patient to identify possible sources of fever

APPENDIX M

ANALYSIS TABLE FOR DEPENDENT VARIABLES

Table

Two-way ANOVA for Dependent Variables

Source	*SS*	*df*	*MS*	*F*	*p*
Knowledge: Immediate post-test gain					
Group	.025	1	.025	.043	.837
Profession	.449	1	.449	.753	.390
Group x Profession	.025	1	.025	.043	.837
Within (Error)	27.442	46	.597		
Total	28.020	49			
Knowledge: Delayed post-test gain					
Group	.685	1	.685	.550	.463
Profession	.361	1	.361	.290	.594
Group x Profession	.659	1	.659	.529	.472
Within (Error)	46.074	37	1.245		
Total	47.805	40			
Total attitudes: Immediate post-gain					
Group	.006	1	.006	.055	.815
Profession	.001	1	.001	.015	.904
Group x Profession	.135	1	.135	1.339	.254
Within (Error)	4.240	42	.101		
Total	4.377	45			

Note. * = $p \leq .05$, ** = $p \leq .1$

(continued)

Source	*SS*	*df*	*MS*	*F*	*p*
Total attitudes: Delayed post-gain					
Group	.259	1	.259	1.690	.202
Profession	.003	1	.003	.017	.898
Group x Profession	.000	1	.000	.000	.987
Within (Error)	5.661	37	.153		
Total	28.020	40			
Subscale relevance: Immediate post-gain					
Group	.035	1	.035	.133	.717
Profession	.016	1	.016	.061	.806
Group x Profession	.063	1	.063	.242	.625
Within (Error)	10.972	42	.261		
Total	11.060	45			
Subscale relevance: Delayed post-gain					
Group	2.272	1	2.272	6.324	.016*
Profession	.013	1	.013	.036	.850
Group x Profession	.171	1	.171	.475	.495
Within (Error)	13.292	37	.359		
Total	15.615	40			
Subscale motivation: Immediate post-gain					
Group	.021	1	.021	.067	.797
Profession	.551	1	.551	1.782	.189
Group x Profession	1.051	1	1.051	3.399	.072*
Within (Error)	12.995	42	.309		
Total	14.870	45			

Note. * = $p \leq .05$, ** = $p \leq .1$

(continued)

Source	*SS*	*df*	*MS*	*F*	*P*
Subscale motivation: Delayed post-gain					
Group	.188	1	.188	.565	.457
Profession	.037	1	.037	.110	.742
Group x Profession	.067	1	.067	.201	.657
Within (Error)	12.296	37	.332		
Total	12.733	40			
Subscale outcome expectancy: Immediate post-gain					
Group	.003	1	.003	.013	.911
Profession	.095	1	.095	.362	.550
Group x Profession	.673	1	.673	2.556	.117
Within (Error)	11.056	42	.263		
Total	11.922	45			
Subscale outcome expectancy: Delayed post-gain					
Group	.009	1	.009	.029	.867
Profession	.024	1	.024	.074	.787
Group x Profession	.109	1	.109	.342	.562
Within (Error)	11.831	37	.320		
Total	11.951	40			
Performance: more likely to sequence care for a patient from clean to dirty					
Group	1.104	1	1.104	1.589	.216
Profession	1.054	1	1.054	1.518	.226
Group x Profession	.948	1	.948	1.365	.251
Within (Error)	23.613	34	.695		
Total	28.000	37			

Note. * = $p \leq .05$, ** = $p \leq .1$

(continued)

Source	*SS*	*df*	*MS*	*F*	*p*
Performance: *more likely to comply with hand hygiene guidelines*					
Group	1.934	1	1.934	2.821	.102*
Profession	.732	1	.732	1.068	.308
Group x Profession	.480	1	.480	.700	.408
Within (Error)	24.684	36	.686		
Total	26.975	39			

Note. * = $p \leq .05$, ** = $p \leq .1$

APPENDIX N

ATTITUDES TOWARD HAND HYGIENE GUIDELINES THEME TABLE

Table

Theme table for Attitudes toward hand hygiene guidelines question nineteen

Category	Key Terms	Significant Responses
Q19. For me the most important factor that did or would influence me to implement the hand hygiene guidelines is:		
Supplies	Accessibility Availability Placement Convenience Ease Set-up	"Convenience of hand hygiene product to point of care"
Patient Safety	Concern Caring Safe Reduce risk Prevention	"Patient care prevention of infection to my patients and myself"
Reminders	Triggers Graphical depiction of 5 moments	"Presence of a real time monitor on the unit until guidelines firmly adhered to"
Scientific evidence	Data Discussions Effectiveness Patient outcomes	"Scientific evidence of the utility of different methods in different settings"
Q20. For me the most important barrier to implementing hand hygiene guidelines is:		
Supplies	Accessibility Placement Convenience Difficult	"A few places it is difficult to get to the hand hygiene"
Time	Multi-tasking Emergent situation Busy schedule Work load	"Time (to do it correctly)"

(continued)

Thematic Category	Key Terms	Significant Responses
Skin discomfort	Dry Irritation	"My skin gets so dry and I get rashes when washing using Avagard all the time. It's painful to use it when my skin integrity is impaired"
Guidelines	Changing Confusion Unclear Impractical	"There has been constant change of guidelines without documentation that the changes are working or have worked" "Following/ understanding the correct sequence of care and when to perform hand hygiene"

APPENDIX O

SIMULATION GROUP DEBRIEFING THEME TABLE

Table V

Theme table for debriefing interview

Category	Key Terms	Significant Responses
Q2. How did you feel during the simulation		
Comfortable	Realistic Natural Fine Comfortable Ok	"I felt like I was playing out my normal day" "Do this 10,000 times. We tend to forget about the sequence. We are so focused on the patient and we are focused on coming in and out the room and tend to forget about the bedside."
Uncomfortable	Unsure Concerned Apprehensive Awkward Uncomfortable Weird	"I felt like a bad actress. I didn't know how in depth to go"
Heightened awareness	Conscious Extra mindful	"I was conscious of being observed, but I was comfortable with what I was doing"
Engaged	Interesting Challenging Opportunity to learn	"Challenging and interesting"
Q4. Is there anything you would change in the scenario?		
Supplies	Placement Accessibility	"Gloves by the computer. I wish we had gloves by the computer. I don't change my gloves as often as I should because of accessibility"
Instructions	Specify Explicit Clearer	"More explicit set of instruction. I wasn't quite sure what you were looking for"
Staging	Real patient Real setting More patients White coat More scenarios	"You might want to have people wear their white coat. We don't wash our coats very often" "May want to make two scenarios; one for ICU and one for general ward"

(continued)

Category	Key Terms	Significant Responses
Satisfaction	Appropriate Good Relevant	"Nothing I can think of. Pretty realistic."

Q5. During the course of the session, what if anything was going through your mind regarding infection control?

Patient Safety	Caring for patient Careful Type of infection Hand hygiene	"To be honest, I was thinking about the patient and caring for him."
Personal safety	Personal items	"I'm wondering what I am bringing home with me on my keys, beeper, and phone."
Recall	Guidelines 5 moments Hand hygiene video Clean to dirty	"I was constantly thinking about hand hygiene. I just saw the video, so I was making sure I did hand hygiene every time I was suppose to."
Heightened awareness	Conscious effort Being watched Paranoid Thinking more	"We know if someone is watching us, we are more aware and we do it more often." "It's very different being watched. It's not my normal setting."
Supplies	Sanitizer placement	"The one thing that bothers me is that it always feels like the hand sanitizer is in the most awkward places in the room."

Q7. Do you have any suggestions for us about what we might do for the future?

Difficulty level	More involvement Detailed exams Mannequin talk Clean room to dirty room	"I think seeing it would be helpful. Have a more detailed exam for patient."
Staging	SID placement Point out supplies Store supplies in cabinets Nurse help with set-up	"I think you should put SID in more places. It's reality." "Placement of room items."

(continued)

Category	Key Terms	Significant Responses
Evidence	Does it make a difference	"Maybe we haven't studied if everyone did 100% hand hygiene; would it make a difference. I would like to know if it really does make a difference."
Q8. How would you apply what you experienced today to the clinical experience?		
Personal Intentions	More observant More aware Change routines Touching anything matters Do a better job cleaning	"We try to make a point to disinfect. It's not a priority of mine, but it should be more of a priority." "Bedside hand hygiene moment I tend to forget. I am comfortable doing entry and exit, but not doing bedside so well." "I already wipe my stethoscope, but now I will be sure to wipe my other equipment; well, like my pens."
Expectation of others	Wash hands more Uncomfortable from inactions of others Setting the example	"I already wash my hands more that I need to. It makes me uncomfortable to not see other people wash their hands even if they don't touch the patient." I'm not sure I would change very much because I try to model what I do when I do hand hygiene. That's what I expect from my team."
Increased awareness	Reinforcing Amazement Reminder	"I think anyone who goes through an experience like this can certainly be helpful to know where this can spread. It's impressive for reinforcing the need for hand hygiene. I am glad you are doing this. This is very important stuff." "The stethoscope was definitely an eye opener."
No specific intentions	No Nothing Not necessarily	"Not necessarily. I have my own idea of what I experienced and I know what I am supposed to do." "I don't know. I think anyway about what I've touched and where it can go."
Organization suggestions	Enhance understanding Make it easier	"We can't fix something, if we don't know. Just telling us, won't fix it." "It's really tough some days. In a lot of situations you should have a little bottle on you instead of running 10 ft to get to hand sanitizer."

VITA

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1997 M.S, Biology, Virginia State University, Petersburg, VA
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2010 Research Internship
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CONFERENCE PRESENTATIONS

2015 Wigglesworth-Ballard, "Hand Hygiene Simulation", Infection Prevention Seminar, Des, Moines, IA

2010 Wigglesworth, L.E. "The use of polyethylene microspheres to simulate hospital acquired infections: A teaching strategy for healthcare students and workers," 2010 Student Capstone Conference, Suffolk, Virginia

2010 Wigglesworth, L.E., "The use of polyethylene microspheres to simulate hospital acquired infections: A teaching strategy for healthcare students and workers", *Modeling For Public Health Action 2010: From Epidemiology to Operations*, Atlanta, Georgia

2011 Wigglesworth, L.E., "Improving Nursing Infection Control Practice in a Virtual Intensive Care Unit," 2011 MODSIM World Conference and Exposition, Virginia Beach, Virginia

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