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Exploring Self-Perceived Hand Hygiene Practices among Undergraduate Nursing Students

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By

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Exploring Self-Perceived Hand Hygiene Practices among Undergraduate Nursing Students

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ABSTRACT

The consistent performance of hand hygiene by health care providers is the single most effective strategy to prevent the transmission of health care associated infections. An anonymous questionnaire to explore self-perceived hand hygiene compliance rates, predictors of compliance, and barriers to compliance was completed by 306 nursing students registered at the University of Windsor, in Ontario, Canada.

Overall, 74.8% of participants were considered to be hand hygiene compliant, indicating that their compliance was ≥ 90% both before and after having had direct patient contact. Logistic regression analysis suggested that seven variables were independent predictors of hand hygiene compliance: participants' concerns about receiving reprimand or discipline if hand hygiene guidelines were not followed; participants' motivation to protect the patient from infection; participants' number of clinical placements; busyness; forgetfulness; participants' perception that alcohol hand rub damages the skin; and participants' belief that their clinical nursing instructor consistently performed hand hygiene when necessary.

DEDICATION

I would like to dedicate this thesis to my family: My husband Ian and our beautiful daughters, Sarah and Claire. Without your support and sacrifices from start to finish, none of my success would have been possible. Also, to my father, John Fitzpatrick, you have been a role model for life-long learning. I share this accomplishment with them.

I would also like to dedicate this work to all the nursing students who participated in my research study, and to all of the students that I have had the pleasure of teaching. I thank you all so much.

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CHAPTER 1

INTRODUCTION

The World Health Organization (WHO) identifies the transfer of healthcare associated infections (HAIs) by healthcare providers (HCPs) to be a major concern for patient safety and recommends that surveillance and prevention of HAIs be a priority in healthcare settings worldwide (WHO, 2009). HAIs are defined as infections that occur as a result of health care interventions in any healthcare setting where care is delivered (Provincial Infectious Diseases Advisory Committee [PIDAC], 2011). These infections, their investigation and treatment have immense immediate and long-term implications for the individual, the healthcare system, and local, national and global communities (PIDAC, 2011; WHO, 2009).

In 2002, survey data from 25 acute care hospitals in eight Canadian provinces (N = 5750) reported the overall incidence of HAI in hospitalized adults to be 10.5% (Gravel et al., 2007). In a single-center study within a U.S. hospital, HAIs were reported to have contributed to 31% (55/179) of unexpected in-hospital patient deaths (Morgan, Lomotan, McGrail, Agnes, & Roghmann, 2010). Based on a systematic review of 30 studies, the proportion of potentially preventable HAIs was estimated to be at least 20% (Harbarth, Sax, & Gastmeier, 2003).

In Canada, there are no recent reported statistics that depict the current mortality rates of HAIs and no published total costs are available that demonstrate the accurate financial impact of HAIs (Public Health Agency of Canada, 2010). However, based on U.S. estimates of infection (Haley, Culver, White, Morgan, & Emori, 1985), and using the observed incidence of HAIs and the average number of hospital discharges, it has

been estimated by Zoutman et al. (2003) that 220,000 incidents of HAI occur each year in Canada, resulting in more than 8,000 deaths. In 2002, there were an estimated 1.7 million HAIs in U.S. hospitals, with 98, 987 associated deaths (Klevens et al., 2007). The estimated direct health care cost attributable to methicillin-resistant *Staphylococcus aureus* (MRSA) treatment alone has been estimated to range from $54 million to $110 million annually for Canadian hospitals in 2005 and were projected to reach $129 million in 2010 (Goetghebeur, Landry, Han, & Vicente, 2007). A recent analysis estimates that the overall direct medical cost of HAIs in U.S. hospitals ranges from $28 billion to $45 billion per year (Scott, 2009). Fear of acquiring an HAI can impact patient's and society's confidence in the safety of healthcare delivery in Canada (PIDAC, 2011).

Significance and Background of the Problem

Although many factors contribute to the development of HAIs, the performance of consistent hand hygiene (HH) by HCPs prior to physical contact with a patient or items in the patients' environment has been shown to be the single most effective strategy to prevent the transmission of HAIs (Boyce & Pittet, 2002; Larson, 1988; Mathai et al., 2010; Pittet et al., 2006; Sax, Allegranzi, et al., 2007). The hands of HCPs are the most common vehicle for the transmission of microorganisms. During daily practice, HCPs' hands typically touch a succession of surfaces and substances including inanimate objects, patients' intact or non-intact skin, mucous membranes, food, and body fluids. With each hand-to-surface exposure, a bidirectional exchange of micro-organisms occurs (Sax, Allegranzi et al., 2007).

Post graduate HH compliance rates. Despite overwhelming evidence demonstrating the negative impacts of HAIs and ongoing education emphasizing the

importance of performing HH, disappointing compliance rates among HCPs' continue to prevail. HCPs compliance with recommended HH guidelines has been reported with very variable figures, in some cases unacceptably poor, with mean baseline rates ranging from 5% to 89%, representing an overall average of 38.7% (Boyce & Pittet, 2002; Korniewicz & El-Masri, 2010; Pittet et al., 2006; WHO, 2009). A systematic review of HH compliance studies reports that nurses' averaged compliance rate was 46% prior to patient contact and 53% following patient contact (Erasmus et al., 2010). A study which observed HCPs' compliance with HH guidelines in 13 acute care hospitals in Ontario Canada, reported HCPs' overall HH compliance rate to be 31.2% during 9, 511 HH opportunities, nurses' HH compliance rates were reported to be 33% during 7, 497 observed opportunities (Mertz et al., 2011).

HH practices have been explored in pre and post graduate HCPs, and factors influencing compliance with guidelines have been identified. A review of this literature follows in Chapter 2. A brief summary of the influential factors follows.

Factors that Influence Compliance

There are indications in the literature that the motivation for HH practice is often one of self-protection. Research findings indicate that HCPs have higher HH compliance rates after performing patient care procedures than before performing care procedures (Korniewicz & El-Masri, 2010). This behaviour suggests that HCPs are more likely to perform HH out of fear for their own health, as opposed to concern of transmission of HAIs to patients. These findings are consistent with the understanding that motivating factors for HH practice are HCPs' evaluations of risk-to-self and concerns for self-protection (Erasmus et al., 2010; Jang et al., 2010; Korniewicz & El-Masri, 2010).

A systematic review of studies examining compliance with HH guidelines reported that varying compliance rates were found to be dependent on hospital department, HCPs' activity level/busyness, and HCP role (Erasmus et al., 2010). Findings from focus groups exploring HCPs' practices and compliance suggest that HCPs' are aware of co-workers HH practices and are influenced by their HH behaviour, attitudes, and practices (Jang et al., 2010; Pittet et al., 2004). The literature indicates that poor compliance has been associated with HCPs' lack of awareness of specific HH guidelines, skepticism of the value of HH, the absence of accountability, and the presence of institutional climates that do not encourage compliance (Bosek & Shaner-McRae, 2010; Calfee, 2012; Gilbert, Cheung, & Kerridge 2009; Magaldi & Molley, 2010; Pettit, 2004). Factors associated with sustained higher HH compliance have been identified as: use of performance feedback, type of task (clean vs. dirty), and the availability of alcohol based hand rub (Eramus et al., 2010).

Undergraduate student practices and compliance. At the University of Windsor, nursing students receive theoretical HH education beginning in the first semester of the undergraduate nursing program via lectures, online tutorials, skills practice, and self-directed learning. A review of the literature identifies limited research focused on the education of nursing students with regards to infection control (Ward, 2011a; Ward, 2011b) and HH predictors, practices and beliefs (Barrett & Randle, 2008; Çelik & Kocashi, 2008; Cole, 2009; Kelcikova, Skodova, & Straka, 2012; van de Mortel, Apostolopoulo, & Petrikkos, 2010; van de Mortel, Kermode, Progano, & Sansoni, 2012; Wu, Gardner, & Chang 2009).

Nursing students' perceptions of compliance with HH guidelines in clinical

settings has been qualitatively examined. Barrett and Randle (2008) reported students' perceived that their lack of compliance with HH guidelines was influenced by (a) lack of time and busyness, (b) the type of clinical procedure being completed, (c) concern over poor skin conditions, (d) lack of knowledge, (e) and the use of gloves. The authors also reported that nursing students perceived other HCPs to be an influencing factor in their own HH compliance as a result of their desire to 'fit in' with the rest of the team. Cassidy's (2006) and Lusardi's (2007) research supported the importance of role models influencing nursing students' HH practices and found that students identified their lack of compliance with guidelines was influenced by their observations of lack of compliance among staff members.

Cole (2009) explored self-reports of HH compliance among nursing students and reported students overestimated their HH knowledge, skills, and compliance. Students found it difficult to give an objective account of their performance, reporting improbable high levels of HH compliance. Cole concluded that flawed self-assessment was a barrier preventing students from seeing the need to improve their HH practices and recommended an increased emphasis on reflective practice and self-assessment in nursing undergraduate education.

Internationally, nursing students have been found to have low levels of infection control knowledge and poorly apply their knowledge to clinical practice (Wu et al., 2009). Recommendations for more HH education in basic nursing curriculum, as well as during practical training have been made (Çelik & Kocashi, 2008; Kelcikova et al., 2012; Ward, 2011b; Wu et al., 2009). A deficiency in knowledge, understanding, and skill concerning HH among students has the potential to negatively impact their HH

compliance during post-graduation professional practice (Kelcikova et al., 2012).

A lack of knowledge about the reasons and necessary occasions when HH must be performed during patient care, as well as a lack of awareness of the incidence rates of HAI, all contribute to poor HH compliance (Mathai et al., 2010; Sax, Allegranzi, et al., 2007). Although education alone is insufficient to effect sustained changes in practice, it remains an essential component of all HH programmes (WHO, 2009). Education must emphasize the morbidity, mortality, and costs associated with HAI, and should also emphasize the epidemiological evidence concerning the impact that improved HH compliance has on the reduction of HAI transmission rates (Pettit, 2004).

While each of the aforementioned studies provide some information on HH practices and compliance among healthcare students prior to entry into professional practice, it is difficult to make comparisons among them due to their limited number, scope, and varying designs and populations. The limited research literature in this area highlights the need for further research focusing on undergraduate HH education and application to practice.

Research Problem Statement

With evidence that HH compliance rates are unacceptably low among post graduate nurses and other HCPs, it is important to ascertain the predictors of HH compliance among undergraduate nursing students prior to their entry into professional practice. This is essential because undergraduate nursing students are the future workforce, and an evaluation of their perception of HH practice provides the opportunity to address potential factors that may lead to HH noncompliance. Although, a few studies have attempted to address this populations observed and/or perceived HH practices, there

remains a significant gap pertaining to the designs and scope of those studies. Most importantly, a literature review revealed that no research on this topic has been conducted within the context of a Canadian undergraduate nursing education.

Purpose of the Study

The primary purpose of this research was to explore the predictors of self-perceived proper HH practice among undergraduate nursing students prior to entry into professional practice. The secondary purposes included (1) description of self-perceived pre and post procedure HH compliance, and (2) description of the self-perceived barriers to HH compliance.

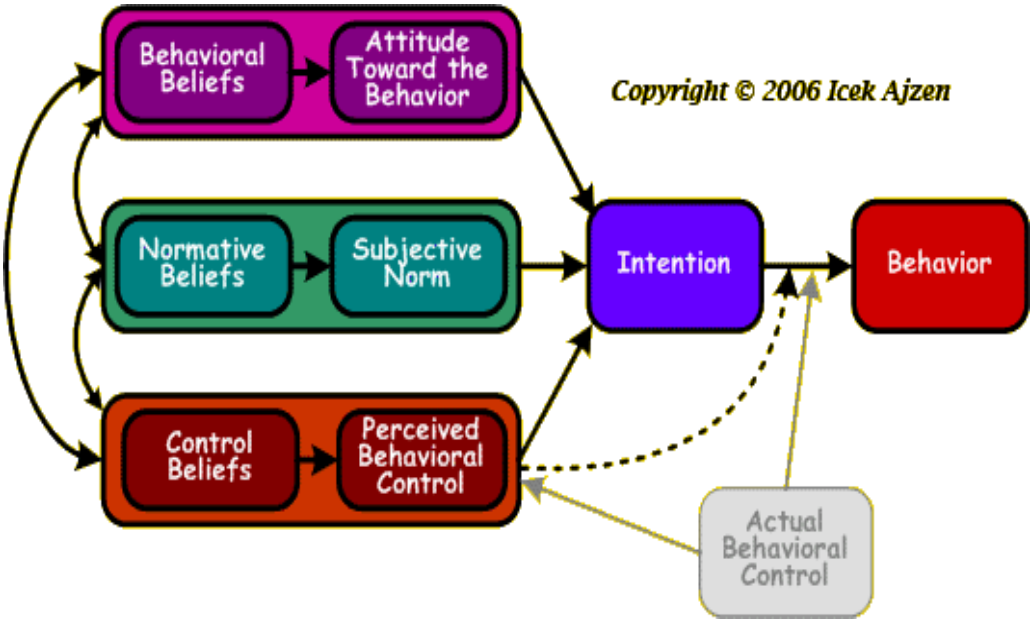
Research questions. This study answers the following research questions:

1) What is the frequency of self-perceived HH practices among undergraduate nursing students?
2) What are the predictors of self-perceived HH practices among undergraduate nursing students?
3) What are the self-perceived barriers to HH compliance among undergraduate nursing students?

Conceptual Framework

Lack of compliance with HH guidelines in health care settings is considered to be a preventable behaviour (Erasmus et al, 2010). The theory of planned behaviour (TPB) developed by Icek Ajzen has been selected as the conceptual framework for this study (Ajzen, 1985; Ajzen, 1988; Ajzen, 2006). Figure 1 depicts the TPB in the form of a structural diagram.

Figure 1 Theory of Planned Behaviour Model. Reproduced with permission.



The TPB explains how cognitive variables (attitude, subjective norms, perceived behaviour behavioural control, and intention) can predict behaviour and offers theoretical insights for the study of HH behaviour (Ajzen, 1985). The TPB is an extension of the theory of reasoned action (TRA) developed by Ajzen and Fishbein (1980). Questionnaires based on the TPB are used to investigate the attitudes and beliefs underlying health-related behaviour.

The TPB in the context of HH compliance. The performance of HH is not only a simple task; it is also a complex behaviour with multiple influences (Larson & Killien, 1982; Pittet, 2000; Pittet & Boyce, 2001). The inability over multiple years to motivate HCPs to achieve consistently high levels of HH compliance suggest that changing HH behaviour is a difficult task (Pittet, 2000; Whitby, McLaws, & Ross, 2006). An understanding of motivations to perform HH is essential in order to increase HH compliance rates (Pittet, 2004). The TPB has been successfully used as a theoretical

model for the identification of HCPs' intentions to comply with HH guidelines (Jenner, Watson, Miller, Jones & Scott, 2002; Nicol, Watkins, Donovan, Wynaden & Cadwallader, 2009; Pessoa-Silva et al., 2005; Tai, Mok, Ching, Set & Pittet, 2009; Whitby et al., 2006).

Explanation of TPB concepts. Intentions are assumed to capture the motivational factors that influence behaviour; they are indications of how hard an individual is willing to try, and of how much of an effort they are planning to exert in order to perform the behaviour. Intention is considered to be the immediate antecedent of the behavior. As a general rule, the stronger the intention to engage in behaviour, the more likely should be its performance (Ajzen, 1988; Ajzen, 2006; Montano & Kasprizyk, 2008). Intention to perform HH is directly predicted by three independent variables: (1) *Attitude toward the behaviour,* is the degree to which performance of the behaviour is positively or negatively valued (Ajzen, 2006). If the belief is performing HH has a desirable outcome, such as a decrease in HAIs or protection of self from infection, a positive attitude toward HH may result (Erasmus et al., 2009); (2) *Subjective norm,* which is the perception of social pressure to engage or not engage in a behaviour (Ajzen, 2006). For example, if a student believes that the clinical instructor and the nurses working on the unit expect HH guidelines to be followed, this perception may influence HH compliance (Sax, Uckay, Richet, Allegranzi, & Pittet, 2007); (3) *Perceived behavioural control,* is the perception of the ability to perform a given behaviour (Ajzen, 2006). A student may perceive that they have little control over external factors such as availability of sinks, time constraints, patient condition, or a heavy workload (Lankford et al., 2003) which may lead them to believe that they have little control over their HH practice.

These three factors are in turn, predicted by three antecedents: *Behavioural beliefs* are an individual's evaluation about the probability that the behaviour will produce a given outcome. *Normative beliefs*, are an individual's perception about the particular behaviour, which is influenced by the judgment of significant others (e.g., clinical instructor and registered nurses working on the unit); and *control beliefs,* an individual's perceptions about the factors that may facilitate or impede their performance of the behaviour (Ajzen, 2006). *Actual behavioural control* is the extent to which an individual has the necessary skills and resources needed to perform the behaviour (Ajzen, 2006).

Significance for Nursing

The consistent performance of HH is regarded as the most important measure to prevent HAIs (Larson, 1988; Mathai et al., 2010; Pittet et al., 2006), but HCPs' compliance remains unacceptably low (WHO, 2009)**.** In order to change poor compliance statistics, it is necessary to understand the factors that influence HH compliance in the undergraduate nursing student population. The results of this study can be used to inform curriculum development and design at the undergraduate level, and allow insights for improvement of HH practices in this population. The consistent and proper performance of HH during undergraduate education may lead to the formation of a habit, and habits can influence behaviour independently of cognitive factors (Ajzen, 2011; Pessoa-Silva et al., 2005). Improving nursing students' HH practices and increasing their compliance with HH guidelines prior to entry into professional practice has the potential to reduce the transmission of HAIs, resulting in decreased lengths of hospital stay, reduced health care costs and the HAI associated morbidity and mortality (van de Mortel et al., 2010; van de Mortel et al., 2012).

CHAPTER 2

REVIEW OF THE LITERATURE

The promotion of consistent HH practices has been a major priority in health care organizations for more than a decade (Sax, Allegranzi, et al., 2007). Regrettably however, HCPs' compliance rates to HH guidelines remain dismal, at an estimated average of 38.7% (WHO, 2009). Many interventions have been implemented in health care settings that have resulting in only transient increases in compliance, but successful, long term strategies to increase compliance have remained elusive (Aboelela, Stone, & Larson, 2007; Erasmus et al., 2010). Insight and appreciation of the factors that influence HCPs' HH behaviour is essential for the successful implementation of evidence informed strategies and interventions.

The objective of this chapter is to review the current research literature in order to gain an understanding of the factors that influence HCPs' HH compliance. This review has demonstrated that an abundance of research has been completed on the subject of HH compliance by HCPs, ranging from qualitative interviews, questionnaires, and interventions with observations of practice. This review highlights perceptions of HCPs, including the deterrents to HH which act as barriers and result in poor compliance, the factors that facilitate compliance, identifies gaps, inconsistencies and contradictions of research findings which pertain to HH compliance. An understanding of these influencing factors is needed in order to determine if change is necessary within the curriculum design and delivery of HH and infection control instruction provided to nursing students. Whenever possible, this review focused on nurses and nursing students in light of the outlined objective of this research project. Factors impacting HH performance have been

categorized in this literature review as demographics, behavioural factors, barriers, facilitators, and knowledge and education.

Search strategy

The following nursing electronic databases were systematically searched: Cumulative Index of Nursing and Allied Health Literature (CINAHL); Nursing and Allied Health Source (including Proquest and Evidence-Based Resources from the Joanna Briggs Institute); the Cochrane Database of Systematic Reviews. Online dissertations and theses were also searched. Keywords and subject terms used in a variety of combinations included: nurse, nursing student, healthcare provider, hand hygiene, hand washing, compliance and adherence. Additionally, selected journal bibliographies were reviewed for further sources.

Demographics

Professional Category. The professional category of a HCP has been determined to be a contributing factor in HH compliance. Research literature focused on HH compliance among different categories of HCPs' is diverse with differing methodology and study designs. While some studies have involved only nurses, others have included physicians, nurses and nursing assistants as well. Erasmus et al. (2010) conducted a systematic literature review of 96 studies which reported observed and self-assessed compliance rates with HH guidelines in hospital settings. The authors reported the overall median HH compliance rate for all HCPs' was a dismal 40%. The average compliance rate was 48% among nurses and 32% among physicians. A study of HH compliance by Pittet, Mourouga, and Perneger (1999), reported non-compliance with HH guidelines was higher among physicians (odds ratio [*OR*], 2.8 [95% *CI*, 1.9, 4.1]), nursing assistants

(*OR*, 1.3 [*CI*, 1.0, 1.6]), and other HCPs (*OR*, 2.1 [*CI*, 1.4, 3.2]) than among nurses.

The rationales for poor HH compliance within professional categories have been investigated qualitatively by Erasmus et al. (2009) with a study of 65 HCPs. Nurses in the study expressed the importance of performing HH to prevent cross-infection of their patients and themselves. Physicians mentioned the lack of evidence-based research to support the role of HH in the prevention of HAI as a barrier for compliance (Erasmus et al., 2009).

Comparing undergraduate nursing and medical students. Two cross-disciplinary studies have examined and compared nursing and medical students' HH knowledge, beliefs and practices with a questionnaire. Greek nursing students were more knowledgeable about HH guidelines ($p < .001$), had more positive beliefs ($p < .001$), and had higher self-reported compliance ($p = .034$), and considered HH more important in their curriculum than Greek medical students (van de Mortel et al., 2010). The same questionnaire was administered van de Mortel et al. (2012) to Italian nursing and medical students with similar findings. However, since there were no observations of the student HH practices in a clinical setting, it is not clear if these findings would result in actual differences in behaviour between the nursing and medical students. Van de Mortel et al. (2012) emphasized that the overall low scores on the knowledge items indicated that students require further education about HH.

Gender. Significantly different findings are present in the literature when the factor of gender is considered in HH compliance. Five studies were reviewed that assessed the relationship between gender and HH practices among HCPs providing patient care in hospital settings (Korniewicz & El-Masri, 2010; Laustsen, et al., 2009;

Mertz et al., 2010; Sax, Uckay, et al., 2007; van de Mortel et al., 2001). Findings reported by Korniewicz and El-Masri's (2010) observational study suggested female HCPs were less compliant with HH practices than their male counterparts (OR, 0.63 [95% CI, 0.47, 0.85]). In contrast, with an observational study conducted in Denmark, Laustsen et al. (2009) observed both male (n = 107) and female (n = 389) HCPs' rates of adherence to HH with the use of alcohol-based hand rub before and after the performance of clinical procedures. The rate of adherence was significantly higher for female HCPs than for male HCPs, both before performance (aOR, 1.51 [95% CI, 1.09, 2.10]) and after performance (aOR,1.73 [95% CI, 1.27, 2.36]) of clinical procedures. Sax, Uçkay, et al. (2007) used self-report questionnaires to assess predictors of HH adherence rates among medical and nursing staff. Female gender was identified as being an independently associated factor for good HH adherence (OR, 0.6 [95% CI, 0.4, 0.98]). An observational study by van de Mortel et al. (2001) assessed the gender differences in HH rates in a critical care unit. The authors reported there were no statistically significant differences in HH compliance rates among male and female nurses (p = .7588). Also, Mertz et al. (2010) reported no significant difference in either gender's HH compliance in an observational study.

Behavioural Factors

The attitudes and behaviours of HCPs' can significantly impact HH compliance. Understanding of the underlying reasons for HH beliefs and behaviours can provide understanding and help to structure interventions to motivate behavioural changes to bring about improvement (Mathai, 2010). An explanation follows of the behavioural factors that can influence HCPs' HH practices and compliance.

Self-protective HH behaviour. The perception of self-risk and self-protection against infection can be highly influential to HCPs' HH behaviour. In a study examining HCPs' compliance with HH guidelines in 13 acute care hospitals in Ontario, Canada, Mertz et al. (2011) reported that the presence of contact isolation precautions was the strongest predictor for HH compliance (*OR*, 2.64 [95% *CI*, 2.09, 3.33]).

A similar theme of self-protective HH behaviour was reported in a retrospective comparison of the risk of developing HAIs before and during the outbreak of the Severe Acute Respiratory Syndrome (SARS) in Ontario during the spring of 2003. During the SARS outbreak, hospitals imposed exceptionally strict enforcement of infection control guidelines. The reported rate of HAIs in the pre-SARS period was 14.5% as opposed to 9% during the SARS period. These findings suggest an independent association between the risk of developing HAIs and the time period (i.e., pre-SARS versus SARS) (El-Masri & Oldfield, 2012).

HCP's have higher HH compliance rates after performing patient procedures than before performing procedures which suggests that HCPs are more likely to perform HH out of fear for their own health than that of their patients (Korniewicz & El-Masri, 2010). These findings are consistent with the notion that a motivation for HH practice is a HCP's concerns for self-protection (Erasmus et al., 2010; Jang et al., 2010). A qualitative study of 46 HCPs by Nicol Watkins, Donovan, Wynaden, and Cadwallader (2009) revealed themes of the desensitisation to the risk of potential HAI transmission had affected HCPs' attitudes to HH compliance. Jang et al. (2010) qualitatively investigated Canadian HCPs' HH behaviours and revealed that HH was practiced for personal protection and anticipated risk to self and loved ones. The authors concluded that

subjective risk perception was a strong indicator of the performance of HH. Additional qualitative research has reported similar themes of self-protection, and appraisals of self-risk which then determine HH practices by nurses (Jenner et al., 2002; O'Boyle, Henly, & Duckett, 2001).

Inherent and elective HH. The self-protective mechanisms of HH are based on sensations that evoke feelings of unpleasantness, discomfort and/or disgust (Whitby et al., 2006). The mechanisms believed to influence HH behaviour have been explored by Whitby et al. (2006) and Whitby et al. (2007) who classified HH practices into 2 categories: Inherent and elective. Inherent HH practice is prompted when hands are visibly soiled, sticky or gritty, or with contact with 'emotionally dirty' areas such as the axilla, groin, or genitals. This inherent stimulus is persuasive, and HH will be performed regardless of inconvenience or time constraints. Also, it appears to require the individual to subsequently wash hands with soap and water. Elective contact does not trigger a compelling need to perform HH, contacts are not perceived to pose a risk for infection (i.e., measuring vital signs or touching objects in the patient's environment) (Whitby et al., 2006; Whitby et al., 2007).

Qualitative studies have explored HCPs' attitudes towards HH, revealing that HH compliance was influenced by assessments of the dirtiness of tasks performed (Erasmus et al., 2009; Whitby et al., 2006). A systematic review of HH compliance studies determined that the type of task (dirty vs. clean), the dirty task was consistently associated with higher compliance (Erasmus et al., 2010). These findings indicate that the motivation for performing HH may be influenced more by a desire to clean oneself for personal safety, rather than in an interest to protect the patient from HAI. Elective HH is

given a lower priority when HCPs' are busy, the failure to perform HH after elective contacts can results in the transmission of HAI (Sax, Allegranzi et al., 2007; Whitby et al., 2006; Whitby et al., 2007).

All HCP categories have lower rates of HH compliance prior to contact with a patient when compared to compliance rates after patient contact (Erasmus et al., 2010). The moment prior to touching a patient is an essential opportunity for a HCP to perform HH. Performing HH prior to contact with a patient or items in a patient's immediate surroundings protects the patient from pathogens carried on HCPs' hands. Not being cognizant of this HH opportunity has been identified as a barrier to HH compliance and can result in the transmission of a HAI (Sax, Allegranzi et al., 2007). A systematic review reported averaged HCPs' HH compliance rates to be 21% prior to patient contact and 47% after patient contact. The median compliance rates for nurses' were before (46%) and (53%) after patient contact (Erasmus et al. 2010). Thus, it is important to re-enforce understanding of the rationale for performing HH prior to patient contact or contact with objects in a patients' environment, in order to reduce transmission of HAI when planning initiatives for HCPs' education.

Flawed self-assessment. A questionnaire administered to 71 HCPs evaluated their self-reported HH practices, and then correlated findings with observations of their practice (Jenner et al., 2006). The authors reported that the self-reported HH behaviour had no relationship to actual observed behaviour and that actual practice could not be predicted by self-reports of practice. HH practices were poor despite the knowledge that they were being observed. The authors suggested that if HCPs' believe that their HH practice is much better than it actually is, they are likely to be oblivious to education

focused on changing attitudes and are likely to fail to change HH behaviour. Similar findings have been reported by O'Boyle, Henly, and Larson (2001) and Snow, White, Alder, and Stanford (2006). However, in contrast to these aforementioned studies, Moret, Tequi, and Lombrail (2004) found self-report rates of compliance and observed compliance rates correlated closely, averaging 74%. This finding should be interpreted with caution because the HCPs who completed the questionnaire (n = 1050) were not necessarily the same ones whose HH practices were observed (n = 205). In this study, self-reports of HH were not directly linked to the observed compliance rates. Also, the HCPs were aware that observations were occurring, which may have influenced results (Moret et al., 2004).

Nursing students' flawed self-assessment. Cole (2009) explored self-perceptions of HH practice in student nurses using a mixed methods study design (consisting of a quantitative questionnaire component [n = 147] and a qualitative component [n = 14]). Findings indicated that the students overestimated their knowledge, skills, and they had difficulty providing objective accounts of their HH performance. The students also reported improbable levels of compliance; however, no objective measure was used to determine actual HH compliance in this study. These findings raise concerns about the nursing students' abilities to objectively perform self-assessment. Flawed self-assessment may be a barrier to improving compliance if students perceive their HH practice to be better than it actually is (Cole, 2009). Emphasis was placed by the author on the fact that nursing curriculum needs to ensure that students are able to competently determine the occasions when HH is required, and the need to promote realistic and constructive self-assessment skills in nursing students (Cole, 2009).

Similar findings of overestimated HH compliance by self-assessment have been reported by Çelik and Kocashi (2008) with a survey of nursing students (N = 430).

Peer pressure and role models. Social pressures, the perceptions and the expectations of superiors, and the presence of others have been reported to both improve and decrease HH compliance. A survey of HCPs which evaluated the motivations of HH compliance was conducted by Sax, Uckay, et al. (2007). The authors reported that variables associated with a high self-reported rate of intention to comply with HH guidelines were influenced in part by peer pressure from colleagues who expected compliance (64.4%) and the perceptions that colleague HH was good (58.5%). Similar findings were reported by Pessoa-Silva et al. (2005) who found the perception of a positive opinion of superiors toward HH was independently associated with the intention to perform HH ($p = 0.035$). An observational study by Lankford et al. (2003) assessed HH group behaviour. The authors reported that when a senior ranking HCP did not perform HH, other HCPs in the room were less likely to do so. Similar themes of non-compliant role models which negatively influenced HH behaviour were reported in a qualitative study by Erasmus et al. (2009). Furthermore, Gilbert, Cheung, and Kerridge (2009) reported that persistent non-compliance of a few influential HCPs' can seriously undermine an infection-control program through negative role-modeling.

The influence of role models on undergraduate students. The influence of poor role modeling has been shown to negatively influence HH compliance among students (Barrett & Randle, 2008; Cassidy, 2006; Lusardi, 2007; Snow, White, Alder & Sanford, 2006). Barrett and Randle's (2008) qualitative study of nursing students ($N = 10$) found that students' HH compliance could be negatively influenced by the practices of other

HCPs. Students in this study identified that they copied the HH practices of their mentors to maintain a positive relationship and to be accepted as part of the nursing team. Students' identified that at times they chose to not perform HH as it was more important to appear busy and complete their patient care quickly (Barrett & Randle, 2008). Similar findings were reported in Cassidys' (2006) and Lusardis' (2007) qualitative studies of nursing students. A number of students suggested that their lack of compliance with HH guidelines was influenced by their observation of lack of compliance among staff members. Students also indicated that they were reluctant to challenge staff who did not perform HH when required (Cassidy, 2006; Lusardi, 2007). In a study using observations of practice, Snow et al. (2006), reported the effect of mentor's HH practices on students' HH compliance rates during clinical rotations. Mentor's HH practices were the strongest predictor of student's HH practices ($p < .01$).

The findings in the aforementioned studies suggest that HCPs' HH compliance can be both positively and negatively influenced by social pressure, particularly by senior HCPs' who act as role models. These findings indicate the need for conscious efforts by HCPs' with senior status, and those who act as role models to be aware of the importance of complying with HH guidelines.

Factors that act as Barriers to HH Compliance

Many studies have explored the external factors that have been associated with the lack of compliance with HH guidelines in post graduate HCPs'. The most frequently cited reasons were: time constraints, interruptions in patient care, skin irritation, and rationalization of poor HH practice. An in-depth exploration of these barriers follows.

Time constraints (busyness). A frequently cited reason by HCPs for the lack of

compliance with HH guidelines is time restrictions due to a heavy patient care workload. A landmark observational study conducted by Pittet et al. (1999) at the University of Geneva Hospitals indicated an independent predictor of HH non-compliance was increasing intensity of patient care workload, which was associated with lower compliance of HH by nurses. Noncompliance was higher when intensity of patient care was high (compared with ≤ 20 opportunities for HH per hour of care, 21 to 40 opportunities: *OR* 1.3 *CI* [1.0, 1.7]; 41 to 60 opportunities: *OR* 2.1 *CI* [1.5, 2.9]; and > 60 opportunities: *OR* 2.1 *CI* [1.3, 3.5]). Numerous studies have reported more frequent opportunities for HH correlate with decreased HH compliance (Griffiths, Renz, Hughes, & Rafferty, 2009; Nicol et al., 2009; Pittet & Boyce, 2001; Whitby et al., 2006). In an early attempt to determine the variables that influenced a HCP's decision to wash or not wash their hands, the highest ranking factor that prevented HH was identified as busyness (Larson & Killien, 1982).

Evidence also suggests that low nurse staffing and/or understaffing can contribute to an increased HAI risk in intensive care unit (ICU) settings. Hugonnet, Chevrolet, and Pittet (2007) estimated that 26.7% of all HAI's could be avoided with a higher level of nurse staffing; which would result in workload reduction and fewer opportunities for HH. Similar findings of an inverse relationship between HAIs and appropriate staffing levels were reported in a review of studies conducted by Griffiths et al. (2009).

Time constraints and the assessment of risk. It has been suggested in the literature that a self-developed assessment of risk is utilized by HCPs when they are faced with time constraints while providing patient care. Whitby et al. (2006) qualitatively explored nurses' HH behaviour. Nurses explained that when under time constraints, they

made an assessment of patients' personal hygiene and evaluated the type of care they were providing to determine the necessity of performing HH. The decision to comply with HH guidelines was based on evaluations of risk-to-self for infection and/or exposure to body fluids associated with a patient care activity. The result was an admitted lack of compliance with HH during periods of high patient care activity. Similar themes were reported by Nicol et al. (2009).

Interruptions in patient care and brief encounters. Research reported by Dedrick et al. (2007) determined HH compliance was strongly associated with length of the patient encounter; compliance was lowest after encounters lasting less than 1 minute. Compliance was highest after encounters lasting greater than 5 minutes. These results suggest that a significant proportion of HAI's are potentially transmitted during brief patient interactions. Similar themes were reported by Harbarth et al. (2001) identifying that HH compliance was lowest after interrupted patient-care activities. The authors hypothesized that the HCPs did not recognize that their hands could become contaminated with pathogens during activities such as telephone and computer use and medication preparation. A possible association between brief encounter duration and poor rates of HH compliance could indicate brief patient interactions signify an increased intensity of workload, which has also been negatively associated with HH compliance (Hugonnet, Chevrolet & Pittet, 2007; Pittet & Boyce, 2001; Pittet et al., 1999).

Nursing students' response to time constraints. Qualitative research examining nursing students' ($N = 10$) perceptions of barriers to HH compliance has revealed a perception of a lack of time and heavy workloads affected students' HH practice (Barrett & Randle, 2008). The students explained that less time was available to complete HH

when there were a higher number of tasks to complete. Similar themes of lack of time and heavy workload affecting students' HH compliance were reported by Lusardi (2007).

The aforementioned studies have provided insights into students' and practicing HCPs' perceptions of their lack of compliance with HH guidelines during periods of intense patient care activity. In some cases, when students' and HCPs' experience time constraints caused by high workloads they have used the excuse of busyness to justify their poor HH practices. When this excuse is considered with documented poor HH compliance rates, it suggests that inconsistent HH compliance may have become an accepted practice for some HCPs'.

Skin irritation from HH agents. Concerns about damaged skin conditions such as dryness and irritation on HCP's hands has frequently been cited as a barrier to HH compliance. The development of skin irritation and dryness on HCPs hands has been mistakenly attributed to the use of alcohol based HH products. The myth that frequent use of alcohol based hand sanitizers will lead to excessive skin dryness has persisted among HCP for years (Boyce, 2000; Larson, 1999). Using alcohol hand rub may cause a burning sensation when applied to pre-irritated skin. The burning sensation suggests that the skin barrier is already damaged. As a consequence, HCPs' may reduce the frequency of HH with alcohol based hand rub and compensate with increased soap and water hand washing, leading to increased skin barrier disruption. Frequent performance of HH with soap and water can increase the risk of skin irritation resulting from harsh detergents and hot water (Kampf & Loffler, 2003). It has been determined that HCPs often wash their hands with soap and water, when they should actually use an alcohol-based hand rub. This method of HH can potentially increase the risk of transmission of HAIs due to its

lower effectiveness when compared to HH performed with alcohol rubs (Kampf & Loffler, 2007; Winnefeld, Richard, Drancourt, & Grobb, 2000). Irritation is less likely to occur with the consistent use of alcohol hand rubs, especially those that have added emollients that minimize the potential drying effect of alcohol (Boyce, 2000; Chamorey et al., 2011; Kampf & Loffler, 2003, 2007; Pettit & Boyce, 2001).

The persistent incorrect beliefs held by HCPs' regarding the irritating or drying effects of alcohol hand rub, in addition to a lack of knowledge about the skin irritation that can result from repeated hand washing with detergent soaps and hot water is a significant barrier to compliance with HH guidelines (Boyce, 2000; Larson, 1999).

HH compliance and glove use. Wearing gloves during patient care has been shown to reduce the likelihood of bacterial contamination on HCP hands (Pittet, Dharan, Touveneau, Sauvan & Perneger, 1999). However, the failure to change or remove contaminated gloves, the incorrect belief that glove use negates the need for HH, and the failure of HCPs to perform HH before and after glove use are all factors affecting HH compliance that have been reported (Fuller et al., 2011; Harbarth et al., 2001; Pittet & Boyce, 2001; Pittet, Mourouga, & Perneger, 1999). Literature regarding the role that glove use plays in HCP compliance with HH is limited with conflicting findings.

An observational study of 120 HCPs revealed that the failure to change or remove contaminated gloves was a major factor resulting in poor HH compliance and high risk for microbial transmission (Girou et al., 2004). The authors reported overall HH compliance after the removal of gloves was 51.1% (95% CI, [50.6, 52.4%]). The continued use of gloves without removal after contact resulted in 64.4% (*CI,* [64.1, 65.1%]) of all contacts being performed without adequate HH. A microbe may colonize

one body site, and as a result of improper HH practices, become a pathogen at another body site (Kim et al., 2003). The practice of wearing gloves, but not changing them after contamination, increases the potential for cross-transmission of pathogens and increased risk of HAI (Pittet et al., 2006; Pittet, Dharan, et al. 1999). These findings demonstrate that failure to change or remove contaminated gloves is a major component of poor HH compliance. Wearing gloves can provide HCPs with a false sense of security; a qualitative study by Jang et al. (2010), revealed HCPs admitted to wearing the same pair of gloves for extended periods of time and for multiple activities. The failure of HCPs to perform HH before and after glove use and the failure to change gloves after contamination, suggest that they may not understand or recognize the risk for transmission of HAI when wearing gloves.

In contrast, additional research examining the impact of glove use on HH compliance has reported better rates of HH compliance with glove use. Kim et al. (2003) reported results indicating a positive association between glove use and subsequent HH (relative risk [*RR*], 3.9 [95% *CI*, 2.5, 6.0]). Similar findings suggesting HCPs who wore gloves were more likely to comply with HH then those who did not wear gloves have been reported (Langford et al., 2003; Snow et al, 2006; Thompson et al., 1997).

The effect of the location of sinks. Sinks cannot be installed in all locations most convenient for HCPs. A study conducted by Vernon, Trick, Welbel, Peterson, and Weinstein (2003) observed compliance with HH in 14 units at four hospital sites with varying sink-to-bed ratios (range 1:1 to 1:6). Compliance was less than 50% in all units and there was no significant trend showing improved HH with increased sink to-bed ratios. The availability of additional sinks did not improve rates of HH compliance.

Lankford et al. (2003) reported similar findings indicating that compliance did not improve with increased access to sinks.

Ethics, accountability and professionalism. The transmission of a HAI as a result of a lack of awareness and/or compliance with HH guidelines can also be viewed as an ethical issue concerning patient rights, the obligations of health care institutions, and the individual accountability of HCPs. Because the transmission of pathogens is subtle, it is difficult to attribute the occurrence of a HAI to an individual HCP. Because of this inability to attribute causality, it has been difficult to make HCPs accountable for their HH behaviour (Elliott, 2003; Gilbert et al., 2009; Jenner et al., 2002; Rickard, 2004). Unfortunately, there have been examples of HCPs who have consciously refused to follow HH guidelines, or mistakenly perceive their hands as clean because they are not visibly soiled (Bosek, Shaner-McRae, 2010; Calfee, 2012; Gilbert et al., 2009; Magaldi & Molley, 2010).

One qualitative study explored student nurses' ($N = 9$) experiences of HH practice in clinical areas in England. In this study, one student identified their sense of responsibility for the prevention of the spread of infection to patients, "I don't particularly want to feel responsible for passing somebody's infection onto somebody else" (Lusardi, 2007, p. 27).

The perception of the importance of HH compliance. A self-report survey assessed factors that influenced HH behaviours of 76 nurses and revealed that the nurses were more likely to perform HH if they perceived its importance ($p = 0.002$) (Hanna, Davies, & Dempster, 2009). An interview of HCPs' conducted by Nicol et al. (2009) revealed that a direct vivid experience, such as a personal exposure to an outbreak of

HAIs in a hospital, or affecting a patient under the HCPs' care, caused an emotional impact in the HCP. The experience permanently heightened the HCP's awareness and resulted in a sustained improvement in HH practice. It has been suggested that strategies need to be employed that enhance and maintain HCPs' sense of personal responsibility regarding their role in the prevention of HAIs, with appropriate HH practices (Jenner et al., 2002).

The rationalization of poor HH practices. The psychological issues concerning non-compliance with HH have been explored by Elliott (2003) who reported that HCPs' rationalise their unsafe HH practices by making excuses in order to reduce stress and anxiety resulting from not following standard HH guidelines. When HCPs' use the excuse of being too busy meeting their patient's needs, they do not realize, or they ignore the fact that disregarding HH guidelines in order to complete their workload could compromise patient safety through the transmission of HAIs. Some HCPs' have an unrealistic mindset and/or underestimate the health risks that they expose themselves and others to due to of their lack of compliance. In addition, the mistaken beliefs of 'if I cannot see it, then it does not exist' mindset regarding pathogen transfer, and the 'it will not happen to me' attitude toward the risk of self-infection have also been identified as psychological barriers to compliance (Elliott, 2003; Pettit, 2000).

HCPs have a moral, ethical, and professional responsibility to be aware of, and comply with, the evidence based guidelines for HH during the provision of patient care in order to protect patients from the preventable harm of a HAI (Gilbert et al., 2009). The lack of understanding of, or disregard for HH principles is a significant barrier to HH compliance by HCPs'. There was very limited research which focused on ethics,

accountability, and professionalism with HH practice in both pre-graduate and practicing HCPs, indicating a need for further research.

Factors that act as Facilitators for HH Compliance

Alcohol hand rubs. The introduction of conveniently available, alcohol based hand rub has been a factor that has positively influenced the performance of HH by HCPs' (Bischoff, Reynolds, Sessler, Edmond, & Wenzel, 2000). With a systematic review of HH compliance studies, Erasmus et al. (2010) concluded that the introduction of alcohol-based hand rub always resulted in higher HH compliance. Alcohol hand rub has excellent antimicrobial activity and achieves a greater reduction in bacterial count; it can also be utilized much quicker than traditional hand washing, due to the rapid drying effect of alcohol. The ability to conveniently locate dispensers in patient care areas makes it a cue to memory (Hugonnet, Perneger & Pittet, 2002; Whitby et al., 2006).

Feedback, rewards and sanctions. Mayer et al. (2011) conducted a study using a behavioural change approach which focused on positive reinforcement, frequent feedback and administrative support. Positive behaviour reinforcement was given to HCPs' who were 'caught in the act' of performing HH. Compliance rates with HH improved significantly after the intervention. Long term success with this intervention has been established, with mean compliance rates ranging from 19% to 41% at baseline, and remained improved with compliance rates of 59% to 81% during year six of the program.

A study by Chou, Kerridge, Kulkarni, Wickman, and Malow (2010), reported that a strongly worded violation letter, with re-enforcement provided by managers of noncompliant HCPs' appeared to be the major factor in raising the HH compliance rate from 34% to 90% in a 2-year period. With a systematic review of HH intervention

studies, it was reported that personalized and non-personalized performance feedback can improve the frequency of HH, but if feedback is not continued the effect may not be sustained (Nailkoba & Hayward, 2001).

Patient empowerment. The encouragement of patient participation has been recognized as a potential mechanism to improve HCPs' HH compliance. Patient empowerment is an essential part of the WHO (2009) HH multimodal strategy, and refers to a process that encourages patients to participate in their care (WHO, 2009). Research on the subject of empowering patients to ask their HCPs' to perform HH prior to providing care is limited to date and has evidence of both supports and limitations. Supporters of this concept explain that it is an opportunity to foster patient empowerment, increase HCP HH performance, improve patient safety, and reduce HAI (Longtin, Sax, Allegrannzi, Hugonnet, & Pittet, 2009; McGuckin, Storr, Longin, Allegranzi & Pittet, 2011; McGuckin, Taylor, Martin, Porten, & Salcido, 2004; McGuckin et al., 1999; McGuckin et al., 2001). Caution should be taken when interpreting and generalizing the results from this group of studies due to their small sample sizes, limited information provided regarding methods and a lack of long term follow-up.

In contrast to the previously cited literature, Lent et al. (2009) found that very few patients felt empowered to ask their HCPs to wash their hands. These findings indicated that patients were reluctant to step out of the traditional patient role and question HCP's about their actions regarding HH, even when they believed this questioning might be effective in protecting them from harm. Additionally, the necessity of having to remember to ask about HH puts inappropriate responsibility on an already vulnerable patient. Many healthcare organizations have not created an environment in which both

the patients and HCPs' feel that questioning about HH is welcomed and accepted. Patients may feel the risk of offending their HCP with such a question may outweigh the benefit of asking (Fletcher, 2009; Randle, Clarke, & Storr, 2006).

Some HCPs would feel ashamed if a patient asked whether they had cleaned their hands when they had not. "If a patient asks you, 'did you clean your hands' and you say no, you'll be washing your hand for the rest of the day because that's pretty humiliating" (Jang et al., 2010, p. 149). Criticisms of the strategy to empowering patients have been based on the belief that questioning a HCP can be perceived as a challenge or criticism of the clinical skills of the HCP, rather than a helpful request made in hopes of reducing the risk of acquiring a HAI.

The concept of empowering patients to ask HCPs' to perform HH requires further research. There is a lack of applicability of this tactic for patients' who are mechanically ventilated and /or critically ill (Whitby et al., 2007); patients who are confused or who have language barriers. Issues surrounding the ethics of patient dependency on their caregivers have not been thoroughly addressed. When hospitalized, patients are in vulnerable, often stressful situations; HCPs' must accept total responsibility for the prevention of harm to the patients' they care for; including the prevention of transmission of HAI. To place the onus on the patient to remind the HCP to perform HH may be an unreasonable request. No research literature was located that has examined the concept of having a patient ask a nursing student to perform HH, further research is necessary.

Knowledge and Education

Education has been determined to be an essential component of all strategies to improve compliance (Pittet, 2004; Sax et al., 2007; WHO, 2009b). Misconceptions about

HH, knowledge deficits regarding necessary occasions for the performance of HH during routine patient care, in addition to poor retention of the education provided to HCPs' are all barriers to compliance (Pittet, 2000; Sax, Allegranzi et al., 2007). One aspect of education that has not been addressed is an evaluation of the quality and content of the information and training given to HCPs for explanations of why, when and how to apply HH during routine care (Sax, Allegranzi et al., 2007). It is crucial to make certain that HCPs' have appropriate understanding of how the lack of compliance with HH transmits HAI in order to facilitate compliance with HH guidelines and increase self-efficacy for prevention (Mathai et al., 2010).

Unfortunately, studies have demonstrated that education alone is insufficient to ensure sustained changes in practice. Literature reviews indicate there is currently no clear evidence that education has a sustained positive effect on compliance with infection control precautions (Ward, 2011b). Jenner et al. (2002) explained "one possible reason for the failure of educational interventions may be explained by the tendency to assume a relationship between knowledge acquisition and subsequent behaviour change, when in fact this may not be the case" (p. 313).

Poor long term retention of information provided to HCPs' about infection control measures has been cited as a barrier to HH compliance (Gammon & Gould, 2005; Harne-Britner, Allen, & Fowler, 2011; Naikoba & Hayward, 2001; Trim, Adams, & Elliott, 2003). Ward (2011b) identified the role of education in the prevention and control of infection, and concluded that there was a lack of convincing evidence demonstrating that education improves compliance with infection control precautions or reduces HAI. Education increases knowledge, but increased knowledge does not necessarily improve

practice. While it is important to educate HCPs about the theoretical and practical aspects of HH, a lack of education is not the only barrier to compliance (Cole, 2006; Ward, 2011b). Individual motivations might not be influenced by traditional methods of education, so combinations of strategies and exploration of motivations for behaviour are necessary to address a lack of HH compliance (Cole, 2006).

Nursing students HH knowledge and education. The majority of research on HH education has involved post-graduation, practicing HCPs. Limited research has evaluated nursing students, their HH knowledge, and their application of theory to practice in the clinical setting. Nursing students receive theoretical instruction about HH and infection control during their undergraduate education. A review of the research literature on the role of education in infection prevention and control completed by Ward (2011b) identifies that there is a lack of research focused on the education of nursing students with regard to infection prevention and control. Nursing students' HH beliefs and practices have been explored qualitatively. A study examining ten nursing students' perceptions of their HH practices was reported by Barrett and Randle (2008). The reported findings revealed a lack of comprehension and/or understanding of the necessary occasions for HH. Additionally, students had the mistaken perception that gloves were an acceptable alternative to practicing HH.

Ward (2011a) reported a study of nursing students (n = 31) and mentors (n = 32) investigating perceptions of the infection control education needs and education beliefs of nursing students in the North of England. Several mentors identified that the students were lacking in theoretical knowledge about infection control and prevention. In contrast, the students concerns were focused more on deficits in their clinical skills and

the practical aspects of infection control, rather than on the deficits in their knowledge base. A survey of student nurses in Turkey ($N = 430$) evaluated knowledge and self-reported HH practices (Celik & Kocashi, 2008). The authors reported that not enough concern was given to HH by the nursing students and students inadequately used their theoretical knowledge of the subject in practice. Similar findings were reported by Wu, Gardner, and Chang (2009), who reported a survey of 175 student nurses in Taiwan, measuring knowledge of, and capacity to apply infection control precautions. The authors reported nursing students had low levels of infection control knowledge and poorly applied their knowledge to clinical practice. The relationship between effectiveness of nursing education and compliance with HH guidelines was explored with a questionnaire and observations of practice in Slovenia. Results indicated very low theoretical knowledge levels for HH standards among students, and supported observation findings which showed a significant lack of HH compliance. The authors acknowledge significant deficits in the quality of HH and infection control information provided in basic nursing educational programs in Slovenia (Kelcikova et al., 2012). These studies were carried out in countries other than Canada and may not be generalizable to nursing students in Canada.

This section of the review of literature has focused on nursing students' HH knowledge and education and has revealed that international nursing students' knowledge and compliance rates to HH guidelines are low. The lack of research available in this area makes it difficult to determine differences and/or similarities between education programs.

Identification of a research gap. A significant gap in the research has been

identified, with few existing studies that focus specifically on nursing students and their perceptions of their HH compliance, behaviour and practice. Existing studies have provided evidence of a lack of practical and theoretical knowledge among nursing students, which indicates nursing students could unknowingly be transmitting HAIs' while providing patient care during clinical training placements. The findings in the research literature raise concerns about nursing student knowledge levels, and students' subsequent lack of application of theory to practice when caring for patients during training.

Summary of the Literature Review

A review of the literature regarding barriers and facilitators of HH practice among HCPs has revealed that a great deal of research has been completed. Despite the overwhelming evidence that consistent HH practice is effective in preventing infection and reducing the spread of HAI, HH behaviour among HCPs remains far less than optimal (WHO, 2009). Examination of the demographics, motivators, deterrents and behaviours of HCPs' HH compliance illustrates that there are many explanations for why HH is not consistently performed. Non-compliance with HH guidelines continues to be an ongoing problem which compromises patient safety (WHO, 2009b). Many gaps in the literature exist, and strategies to promote lasting compliance with sustained behaviour change for the seemingly simple action of HH seems elusive (Erasmus et al., 2010; WHO, 2009b).

Consensus of factors affecting compliance. There appeared to be a consensus in the literature regarding barriers to HH compliance by HCPs. A frequently cited reason for the failure to perform HH has been identified by HCPs as time restrictions due to a heavy

patient care workload. Numerous studies have reported more frequent opportunities for HH correlate with decreased HH compliance (Nicol et al., 2009; Pittet & Boyce, 2001; Pittet et al., 1999; Whitby et al., 2006; WHO, 2009).

Self protective behaviour with appraisals of self-risk has been identified as a motivator for performing HH; the desire to clean oneself for personal safety, rather than patient protection (Erasmus et al., 2009; Jang et al., 2010; Jenner et al., 2006; Jenner et al., 2002; O'Boyle, Henly, & Duckett, 2001; Whitby et al., 2006). HH compliance can be both positively influenced (Pessoa-Silva et al., 2005; Sax, Uckay et al., 2007) and negatively influenced (Bartlett & Randle, 2008; Erasmus et al., 2009; Gilbert et al., 2009; Lankford et al., 2003) by the social pressures of role model expectations and peer pressure. Incorrect beliefs about the adverse effects of alcohol hand rub on skin condition persist (Boyce, 2000; Chamorey et al., 2011; Kampf & Loffler, 2003, 2007). The use of gloves has been reported to both positively influence compliance (Kim et al., 2003; Langford et al., 2003), and also negatively influence HH compliance (Fuller et al., 2010; Girou et al., 2004; Harbarth et al., 2001; Jang et al., 2010). Each of these findings indicates that significant limitations exist in regards to some HCPs comprehension of the basic principles of HH and necessary application of theory to practice.

A lack of knowledge and/or a disregard for the opportunities when HH was required was frequently cited as a barrier (Barrett & Randle, 2008; Dedrick et al., 2007; Sax et al., 2007; Whitby et al., 2006; Whitby et al., 2007). Flawed self-assessment of personal compliance to HH guidelines has been demonstrated in nursing students (Barrett & Randle, 2008; Celik & Kocashi, 2008; Cole, 2009). There is a lack of consensus within the literature about the most appropriate methods to educate HCPs and nursing students

about HH opportunities and compliance and a lack of evaluation of the long term retention of provided education (Gammon & Gould, 2005).

Limitations of current research methods. There has been a lack of rigorous evidence to link specific HH interventions with the prevention of HAI (Aboelela et al., 2007; Erasmus et al., 2010). The differing types of interventions and the various factors that are involved with transmission of HAI have made it difficult to determine the specific effect of individual HH interventions (Backman et al., 2008). Limitations include differing data collection methods, with some studies failing to report sample type, size, or reliability testing. (Eramus et al.). The methods for defining compliance (or non-compliance) and the methods for conducting observations have varied considerably in the research literature, and many studies have not included detailed information about the methods and criteria used (Erasmus et al.; WHO, 2009b). These limitations have made comparison and interpretation of research findings difficult and limit the generalizability of findings. Future research should incorporate standardized measures for monitoring and evaluation of interventions and outcomes (Erasmus et al.).

Limitations in research of nursing students. The subject of flawed self-assessment of HH performance by nursing students was examined by Celik and Kocashi (2008) and Cole (2009). Findings indicated that students overestimate their knowledge, skills, and compliance with HH and were also unable to objectively assess their HH performance. Nursing curriculum needs to ensure students are competent in HH practices and also encourage the promotion of realistic and constructive self-assessment in nursing students (Cole, 2009). The literature also suggested that student nurses had low levels of knowledge and poor levels of practice in relation to infection control (Ward, 2011a;

Ward, 2011b) and HH (Celik & Kocashi, 2008; Kelcíkova et al., 2012; Wu et al., 2009).

A large number of highly specific issues are covered in nursing school curricula and thus, it is possible that HH has received less emphasis. A lack of reinforcement of the significance of HH in pre-graduate education might result in insufficient knowledge and skills among students, and consequently lead to poor compliance by HCPs, contributing to a higher occurrence of HAIs in the clinical practice (Kelcíkova et al., 2012). An evaluation of the effectiveness of HH education therefore plays a key role in any strategy aimed at improving HH compliance among health care professionals.

There has been limited research conducted that specifically focuses on establishing the existence of a relationship between student nurse HH education, the retention of theory and HH compliance. The majority of HH behaviour and compliance investigation has been conducted on HCPs who have graduated from their education programs and are employed in professional roles in a hospital setting. Consequently, the findings may not be generalizable to pre-graduate nursing students. These limitations highlight the need to explore factors that may contribute to a lack of compliance with HH in nursing students. Research focusing on the predictors of self-perceived HH practices, nursing student perceptions of HH frequency, and self-perceived barriers to HH compliance will inform curriculum development and design at the undergraduate level, and allow insights for the improvement of HH practices in this population.

CHAPTER 3

METHODOLOGY

Research Design

A descriptive, cross-sectional study was conducted on a non-probability convenience sample of 307 consenting participants recruited from a pool of 578 undergraduate nursing students registered in years two, three, and four in the Faculty of Nursing at the University of Windsor, in Ontario, Canada. One participant completed only 52% (12/23) of the questions; therefore, this case was deleted from the study. A total of 306 completed questionnaires were retained in the dataset, demonstrating a 53% response rate. Students in year one of the program were excluded because some may not have had an opportunity to work with patients in a hospital or a long term care facility. Data were elicited using an anonymous self-administered HH questionnaire (HHQ) which explored undergraduate student nurses' self-perceptions of HH compliance during their hospital or nursing home clinical experiences. The HHQ items were specifically developed for this study. Given the descriptive nature of the questions, each item was treated as an independent unit of analysis.

The written self-report format of the HHQ provided a means of eliciting responses from students in an efficient manner during a regularly scheduled class. The study was communicated and promoted through email announcements and posters. Participants were eligible to enter a random draw for one of 10 gift cards worth $25 redeemable at a local shopping mall as a thank you gesture and to encourage study participation.

Data Collection Procedures

Approval from the University of Windsor's Research Ethics Board was obtained

prior to initiating the study. Upon receiving ethical clearance, the principal investigator (PI) and a research assistant made arrangements with faculty members to attend 15 minutes of each undergraduate nursing theory class in levels two, three, and four to administer the HHQ. All students in each level were given one opportunity to participate. In each class, the PI explained the purpose of the study and that participation in the study was voluntary. Participants were provided with a Letter of Information (Appendix A) detailing the purpose of the study, confidentiality and protection of the data, contact information for the PI, and assurances about the protection of the anonymity of responses. The PI explained to students that they could chose to only take part in the gift card raffle and not complete the HHQ, or decline from answering specific questions if they desired to do so. Students were given assurance that participation or non-participation in the study would in no way jeopardize their academic record or be used to penalize for past or current HH practices. Students were also informed that findings will be reported in the form of aggregate data and that feedback from the results of this study will be reported by the PI during a follow up visit to each class at the conclusion of the study. Study results will also be available on the Faculty of Nursing Research website. The procedure for the gift card raffle held immediately after completion of the questionnaire was also explained. A written informed consent was not sought. Instead, consent was inferred by those who chose to stay and complete the HHQ.

The PI and the faculty member then left the classroom and the research assistant stayed to administer the questionnaire and conduct the gift card raffle with the students who chose to participate. Each participant who remained in the classroom received an unmarked envelope which contained a written Letter of Information (Appendix A) and a

HHQ (Appendix B). The use of unmarked envelopes allowed participants to anonymously return completed HHQ to the research assistant. The completed questionnaires were stored in a locked cabinet in the Research Office at the University of Windsor, with access limited to the PI and faculty advisor. The HHQ will be destroyed after five years. The dataset is in a password protected electronic database which will be retained indefinitely by the PI.

Potential conflict of interest. The PI has been employed in the Faculty of Nursing at the University of Windsor since 2008, in the position of Clinical Nursing Instructor for years two and three in the undergraduate nursing program. There is a possibility that the PI may have previously instructed nursing students who participated in this study. To minimize the risk of social responder bias and the potential for coercion, the PI was not present while the HHQ was administered. Access to the HHQ responses was shared only with the research assistant and faculty advisor.

Sample size. Given the exploratory nature of the study, it was difficult to estimate the required sample size based on empirical estimates of the expected effect size. However, Stevens (1996) has suggested a rule of thumb suggesting that a minimum number of 15 participants are needed per each predictor variable. Given that the final model had seven independent predictors of HH compliance, the minimum required sample size was 105 participants. Thus, the acquired sample of 306 students was adequate for this analysis according to Stevens, assuming 80% power and using an alpha of .05. The choice to use this approach (i.e., rule of thumb) to estimate the sample size for the study is due to the fact that no prior effect size could be found on HH practices among nursing students and the exploratory nature of the study.

Instrumentation and Variable Definitions

There were no tools identified in the literature that have been used to measure specific predictors of HH compliance among undergraduate nursing students. Van de Mortel (2009) developed a questionnaire to assess HH knowledge, beliefs and practices among health care students, but this instrument included several additional concepts that are not relevant to this study. Sax, Uckay, et al. (2007) developed a questionnaire to quantify the different behavioral components of HCPs motivation to comply with HH, but this instrument was not available in English.

The HHQ. Items in the HHQ were developed by the PI specifically for the purpose of this study from current HH research literature, and included measures to capture concepts from the Theory of Planned Behaviour (Ajzen, 1985; Ajzen, 1988; Ajzen, 2006). No validity and reliability testing were performed on the HHQ because it was not intended to be treated as a psychometric measure of an overall concept. Instead, items in this questionnaire were treated as independent units of analysis. Prior to administering the HHQ, face validity was established with a pilot study conducted with ten nursing students. Students evaluated each question and provided feedback about clarity and understandability. However, testing for validity and reliability of the HHQ was beyond the scope of this study and each item was measured as a standalone variable.

The developed questionnaire consisted of two sections. Section A was comprised of four questions which elicited the participants' demographic variables of age, gender, nursing program year of program and number of clinical placements. Section B included 19 questions which elicited data about the participants' self-perceptions of their percentage of HH compliance, identification of the contributing barriers and motivating

factors impacting their HH compliance, and didactic HH education and opportunity for HH lab practice. In order to allow participants more choice when selecting responses, nine items in Section B were collected using a five point likert scale ranging from one (*strongly disagree*) to five (*strongly agree*). The last 2 points of the scale closest to the positive evaluation of the perspective in the item were considered positive responses; all other points were classified as negative responses. Data from these nine questions were recoded into a categorical reference of disagree and agree during the data analysis stage. The likert scale of strongly disagree, disagree, and unsure / neutral were all given the value of 0 (disagree). The likert scale of agree and strongly agree were recoded as 1 (agree). Recoding of likert data was necessary to meet the assumption for binary logistic regression analysis that variables be dichotomous or continuous allowing these variables to be entered into the regression model (Tabachnick & Fidel 2007).

Definition of HH compliance. In this study, HH was conceptually defined as the removal of visible soil and the removal or killing of transient microorganisms from the hands. It is accomplished using alcohol-based hand rub or soap and running water (Ontario Hospital Association, 2011). HH compliance was operationally defined as a participants' indication that they perceived they perform HH 90% of the time or greater during each of three moments: before, after, and both before and after having had direct patient contact during clinical placement experiences. Self-perceived HH compliance was measured by three HHQ items which asked participants to indicate the percentage of the time they performed HH in each of the three moments.

Of course, nursing students are expected to exercise 100% HH compliance while providing patient care during clinical placement experiences. However, in order to

account for the fact that students are still learning infection control concepts, the decision was made to make 90% the cut off point for this study population. The decision to use 90% as a cut-off criterion for compliance is slightly more restrictive than the 80% cut-off that is present in some existing literature (Budimir-Hussey et al., 2013; Sax, Uckay, et al., 2007), but more lenient than a strict 100% compliance level which has been suggested may be unrealistic (Voss & Widmer, 1997).

Motivating factors for HH compliance. One HHQ item instructed participants to select the one factor that motivates them the most to perform HH. Forty-six participants incorrectly interpreted the instructions for this item and selected all of the available options for this item. By selecting all the available options, these participants indicated that their greatest motivation to perform HH were all of the following factors: protection of the patients I care for; protection for self from infection; protection for both self and patient; and, concerns of reprimand/discipline if I do not follow hand hygiene guidelines. Due to concerns about statistical redundancy in this item, a decision was made to create three separate variables for this item. The new variables created to measure motivating factors were protection of patient from infection; protection of self from infection; and concerns about reprimand/discipline if guidelines are not followed. Each participant's response was reassigned based on original item responses.

Deleted questions. After the HHQ had been administered, two HHQ items were re-evaluated and were viewed as seeking redundant information. For this reason, the following items were excluded from the analysis: When I am busy, I can't always perform hand hygiene as required, and I perform hand hygiene less frequently when my hands are dry and/or irritated.

Data screening and analysis procedures. Data were analysed using Statistical Package for the Social Sciences (SPSS) software version 19.0. Prior to the actual analysis, the dataset was screened for missing data, outliers, and normality. Irregularities in the dataset were handled according to established guidelines (Field, 2005; Munro, 2005; Tabachnick & Fidel 2007). Data analysis procedures included basic descriptive statistics, univariate analysis (Chi-square, *t*-test), and multivariate binary logistic regression analysis.

Basic descriptive statistics summarized the characteristics of the sample, the general frequencies of the dichotomous and categorical variables as well as the mean and standard deviation (SD) of the one continuous variable, age. Univariate Chi-square comparisons were performed to compare the differences between participants who identified themselves as HH compliant versus participants who identified themselves as non-compliant at the predetermined 90% cut off point. One independent sample *t*-test was performed to compare age. A forward stepwise logistic regression approach was used to determine the independent predictors of HH compliance. Details of the data screening and preparation procedures are presented below.

Accuracy of input. Following initial data entry, the entire dataset was reviewed for accuracy of entry and out-of-range values for each variable were searched for. All errors of data entry were corrected. The dataset was again checked for accuracy to ensure it was free of errors.

Missing data. The complete dataset was screened for missingness. Of the 307 questionnaires submitted, one participant completed only 12 of 23 (52%) questions; therefore this case was deleted from the study. The total sample size was 306 cases.

Overall, only three variables had missing data points. The extent of the missing data on each variable were all < 5% of the total missing for each variable. Little`s MCAR Test was used to evaluate that the pattern of missingness $\chi^2 = 88.14$, ($p = .728$). The pattern of missingness was determined to be not significantly different from random missingness; therefore, the most frequent group response was used to replace the missing data points. One participant did not indicate their gender, this case was assigned most frequently occurring category of female 252/305 (82.6%). Four participants did not indicate their age; the group mean for age (23 years), was assigned to these four cases. Eight participants (all in year three of the program) did not indicate a value in number of clinical placements. The year three group mean value of six clinical placements were assigned to these cases. Table 1 provides an overview of the missing data and the associated handling procedures.

Table 1

Summary of Data Missingness and Treatment

	Frequency			Treatment
Variable	Valid	Missing	% Missing	Value
Gender	305	1	0.3	Most frequent response assigned
Age	302	4	1.3	Group mean assigned
Total number of clinical placements	298	8	2.6	Year 3 group mean assigned

Testing of Statistical Assumptions

Outliers. The data were tested for univariate outliers using Munro's (2005)

method for checking for outliers using a standardized *z*-score cut-off point of +/- 3.29 for each case on a continuous variable. Univariate outliers are values that are at the extremities of the range of data points, or are separated from the normal range of the data and may distort the mean and central tendency in addition to influencing statistical analysis and interpretation. The *z*-scores for the continuous variable of number of clinical placements ($M = 5.73$, $SD \pm 2.06$) were accepted as being normally distributed as all scores were within ± 3.29 indicating no outlier values within this variable. The continuous variable of age ($M = 23.06$, $SD \pm 4.47$), had five outliers with *z*-scores that exceeded ± 3.29. These outliers were treated by substituting the outlier data points with the *windsorized mean* (Munro, 2005). The five outlier data points in the raw data for age were replaced by the next to highest value for age in the dataset and then reassessed for outliers. This transformation resulted in four cases with *z* scores exceeded ± 3.29. The decision was made to recode the variable of age into a categorical variable of age ≤ 23 years and age >23 years.

In order to detect outlier cases that may be exerting influence on the final multivariate regression model, the values for Studentized residuals and Cook's distance were evaluated. The Studentized residuals all had acceptable values of less than ± 2, and Cooks distance for all cases had an acceptable value of less than one. (Field, 2005; Tabachnick & Fidell, 2007). Therefore, it was determined that no influential outlier cases were having an effect on the final model in this analysis.

Normality. The data in the continuous variable number of clinical placements were examined for normality by evaluating skewness and kurtosis values. Curran, West, and Finch (1996) suggest that normality can be assumed when the absolute skewness

value is ± 2 and absolute kurtosis value is ± 7. The variable number of clinical placements had a skewness statistic of .145 and a kurtosis statistic of -.605. Thus it met the criteria for normality proposed by Curren et al. (1996). Further, the histogram for this variable demonstrated a normal curve shape.

The preliminary univariate assessments of the independent variables determined statistically significant variables. Given the exploratory nature of this study, a forward stepwise logistic regression approach was performed to determine the independent predictors of HH compliance at a 90% cut off, and the odds ratio associated with each predictor variable. Logistic regression analysis describes the relationship between a dichotomous dependent variable and multiple independent variables with different levels of measurement. This analysis allowed for determination of the variables which affect the probability of a particular outcome by finding the best fitting model that describes the association between the outcome variable and a set of independent predictors (Munro, 2005). All variables having a p value of ≤ 0.25 in the univariate analysis were included in the logistic regression iteration process. The selection of a liberal p value of ≤ 0.25 was used to avoid deletion of potentially significant predictors from the final multivariate regression model (Hosmer & Lemeshow, 2000). A 95% confidence interval (*CI* 95) was the criteria used to determine whether a variable was an independent predictor. The final regression model was examined for appropriateness through goodness of fit statistics. Sensitivity, specificity, and positive/negative predictive values of the regression model were also examined (Hosmer & Lemeshow, 2000; Tabachnick & Fidel, 2007).

CHAPTER 4

FINDINGS

This chapter presents the results of the HHQ which explored participants' self-perceptions of HH compliance and barriers to performing HH. Descriptive statistics and univariate analyses (Chi-square, independent *t*-test) and logistic regression findings are presented in the following analysis.

Sample characteristics. A total of 306 completed questionnaires were retained in the dataset, demonstrating a 53.1% response rate. Of the 306 participants retained in the sample, 69% (69/100) of eligible second year students completed the questionnaire; 53% (164/308) of eligible third year students completed the HHQ; and 43% (73/170) of eligible fourth year students completed the HHQ. A total of 54% (253/469) of eligible female students registered in the surveyed years of the program completed the HHQ, and 49% (53/109) of eligible male students registered in the surveyed years of the program completed the HHQ. Overall, the sample was comprised of 83% (n = 253) female participants and 17% (n = 53) male participants. It is possible that not all eligible students were present in class when the HHQ was administered; potentially the response rate could have been greater. The mean age of participants was 23.2 years (*SD* ± 4.47) with an age range of 19 – 48 years. Participants' mean number of clinical placements was 5.73 (*SD* ± *2.06*), ranging from 2 - 11. The vast majority of participants indicated that they had received both didactic (classroom) 98% (n = 300) teaching, and clinical / lab 96% (n = 295) practice about proper HH procedures while in the nursing program.

Perceived HH compliance rates. The majority of participants indicated that they perceived their HH compliance to be 90% or greater during each of three moments:

before, after, and both before and after having had direct physical patient contact during their clinical placement experiences. The percentage of self-perceived HH compliance before having physical patient contact ranged from 15 – 100% (M = 92%), with 80% (n = 245) of participants indicating they were compliant with HH ≥ 90% of the time before having physical patient contact. The percentage of self-perceived HH compliance after having patient contact ranged from 50 – 100% (M = 96.4%), with 95% (n = 291) of participants indicating that they were compliant with HH ≥ 90% of the time after having had patient contact. Furthermore, 81% (n = 248) 25 – 100% (M = 92.8%) of participants indicated compliance with HH ≥ 90% of the time both before, and after having had direct patient contact.

Overall, 74.8% (n = 229) of participants were determined to have met the criteria to be considered HH compliant by indicating that their HH compliance was ≥ 90 % during each of the three moments: before, after, and both before and after having had direct patient contact.

Unadjusted Comparisons of HH Compliance and Potential Predictor Variables

Demographic characteristics. Table 2 shows the unadjusted Chi-square comparisons of HH compliant and HH non-compliant participants and the independent predictor variables. There was no suggestion of a significant difference between the HH compliant and non-compliant groups regarding the variables of age, gender, or participants' indication that they had received both didactic (classroom) teaching about HH and had clinical / lab practice on proper HH procedures while in the nursing program.

The results however, suggested a significant difference in HH compliance based on participants' year (level) of study (p = .012), whereby the percentage of compliant

participants in the second (79.7%) and third (78.7%) years of the program were greater than that of the fourth year (61.6%). Independent *t*-test was performed for the one continuous variable: number of clinical placements, with a significant result ($M \pm SD = 5.52 \pm 1.9$, $t = 3.08$, $p = .002$).

Compliance and perceived barriers. One HHQ item explored participants' perceptions of identified (listed) barriers to performing HH while performing direct patient care. The Chi-square comparisons suggested a significant difference in HH compliance in five specific barriers. Specifically, a greater percentage of non-compliant participants indicated that being too busy was a barrier to performing HH as compared to HH compliant participants (58.4% and 27.9% respectively, $p = < .001$). A greater percentage of non-compliant participants indicated that forgetfulness was a barrier to performing HH as compared to HH compliant participants (70.1% and 54.1% respectively, $p = .014$). As well, a greater percentage of non-compliant participants indicated that alcohol hand rub or a sink not being in a convenient location was a barrier to performing HH as compared to HH compliant participants (41.6% and 34.1% respectively, $p = .236$). Additionally, a greater percentage of non-compliant participants indicated that when the skin on hands was dry, cracked and /or irritated, this was a barrier to performing HH as compared to HH compliant participants (28.6% and 13.1% respectively, $p = .002$). Finally, a greater percentage of non-compliant participants indicated that they perceived alcohol hand rub damages their skin which was a barrier to performing HH as compared to HH compliant participants (23.4% and 7.4% respectively, $p = < .001$). There was no suggestion of a significant difference between the HH compliant and non-compliant groups regarding the variables of unsure of moments when

HH is necessary, and the perception that soap damages my skin.

There was a significant Chi-square difference between HH compliant participants and non-compliant participants with regards to the motivation variables of protection of patient from infection, and having concerns about reprimand/discipline if guidelines are not followed. Compliant participants were more likely than non-compliant participants to indicate that their greatest motivation for HH was protection of patient from infection (92.1% and 81.8% respectively, $p = .010$). Compliant participants were more likely to indicate that their HH compliance was based on concerns about reprimand/discipline if guidelines are not followed (17.5% and 7.8% respectively, $p = .040$). Interestingly, the motivation variable protection of self from infection was not statistically significant (93.9% and 97.8% respectively, $p = .374$).

Chi-square comparisons suggested no significant difference in compliant and non-compliant participants with regards to satisfaction with own HH practices (96.5% and 92.2% respectively, $p = .125$), believing a patient's rights are violated if a HCP did not follow HH guidelines and a HAI is transmitted (95.6% and 92.2% respectively, $p = .245$), when necessary, I remind other HCPs to perform HH when providing patient care (42.8% and 33.8% respectively, $p = .163$). However, there was significant difference, with a higher percentage of HH compliant participants agreeing that my clinical nursing instructor consistently performs HH when necessary (88.2% and 79.2% respectively, $p = .05$).

Table 2

Chi-Square Comparisons of Self-Perceived HH Compliance (≥ 90%) and Non Compliance (≤ 89%) and Beliefs

Variable	HH Compliance ≥ 90% (n [%])	HH Non-compliance ≤ 89% (n [%])	Total (N = 306) (n [%])	χ^2	*p*
Age					
≤ 23 years	162 (70.7)	59 (76.6)	221(72.2)	.993	.319
>23 years	67 (29.3)	18 (23.4)	85 (27.8)		
Nursing Program Level					
Level 2	55 (24.0)	14 (18.2)	69 (22.5)		
Level 3	129 (56.3)	35 (45.5)	164 (53.6)	8.889	.012*
Level 4	45 (19.7)	28 (36.4)	73 (23.9)		
Gender					
Male	39 (17.0)	14 (18.2)	53 (17.3)	.053	.817
Female	190 (83.1)	63 (81.8)	253 (82.7)		
Received didactic (i.e. class room) teaching on HH while in nursing program.					
Yes	225 (75.0)	75 (97.4)	300 (98)		
No	4 (1.7)	2 (2.6)	6 (2.0)	.217	.644
Received clinical/lab practice on proper HH procedures while in nursing program.					
Yes	225 (98.3)	75 (97.4)	300 (98)	.217	.644
No	4 (1.7)	2 (2.6)	6 (2.0)		
Barrier: Being too busy.					
Yes	64 (27.9)	45 (58.4)	109 (35.6)	23.366	< .001*
No	165 (72.1)	32 (41.6)	197 (64.4)		
Barrier: Forgetfulness.					
Yes	124 (54.1)	54 (70.1)	178 (58.2)	6.048	.014*
No	105 (45.9)	23 (29.9)	128 (41.8)		
Barrier: Unsure of moments when HH is necessary.					
Yes	16 (7.0)	8 (10.4)	24 (7.8)	.923	.337
No	213 (93.0)	69 (89.6)	282 (92.2)		
Barrier: Alcohol hand rub or sink is not in a convenient location.					
Yes	78 (34.1)	32 (41.6)	110 (35.9)	1.407	.236*
No	151 (65.9)	45 (58.4)	196 (64.1)		

Variable	HH Compliance ≥ 90% (n [%])	HH Non-compliance ≤ 89% (n [%])	Total (N = 306) (n [%])	χ^2	*p*
Barrier: Skin on hands is dry, cracked and/or irritated.					
Yes	30 (13.1)	22 (28.6)	52 (17.0)	9.778	.002*
No	199 (86.9)	55 (71.4)	254 (83.0)		
Barrier: Soap damages my skin.					
Yes	7 (3.1)	2 (2.6)	9 (2.9)	.043	1.0
No	222 (96.9)	75 (97.4)	297 (97.1)		
Barrier: Alcohol hand rub damages my skin.					
Yes	17 (7.4)	18 (23.4)	35 (11.4)	14.478	< .001*
No	212 (92.6)	59 (76.6)	271 (88.6)		
Other:					
I always do HH	12 (5.2)	—	12 (3.9)	—	—
No barriers indicated	217 (94.8)	77 (100)	294 (96.1)		
Motivation: Protection of patient from infection					
Yes	211 (92.1%)	63 (81.8%)	274 (89.5%)	6.556	.010*
No	18 (7.9%)	14 (18.2%)	32 (10.5%)		
Motivation: Protection of self from infection.					
Yes	215 (93.9%)	75 (97.4%)	290 (94.8%)	1.438	.374
No	14 (6.1%)	2 (2.6%)	16 (5.2%)		
Motivation: Concern about reprimand / discipline if guidelines are not followed.					
Yes	40 (17.5%)	6 (7.8%)	46 (15.0%)	4.223	.040*
No	189 (82.5%)	71 (92.2%)	260 (85.0%)		
I am generally satisfied with my own HH practices.					
Yes	221 (96.5)	71 (92.2)	292 (95.4)	2.439	.125*
No	8 (3.5)	6 (7.8)	14 (4.6)		
I feel confident in my knowledge of encounters that require HH during patient care.					
Yes	221 (96.5)	72 (93.5)	293 (95.8)	1.275	.325
No	8 (3.5)	5 (6.5)	13 (4.2)		
When hands are not visibly soiled, it is more effective to use alcohol based hand rub instead of soap and water.					
Yes	173 (75.5)	57 (74.0)	230 (75.2)	.071	.789
No	56 (24.5)	20 (26.0)	76 (24.8)		
I understand alcohol based hand rub and soap and water are equally effective for HH after direct care for a patient diagnosed with *Clostridium difficile* (C-diff).					
Yes	27 (11.8)	11 (14.3)	38 (12.4)	.330	.566
No	202 (88.2)	66 (85.7)	268 (87.6)		

Variable	HH Compliance ≥ 90% (n [%])	HH Non-compliance ≤ 89% (n [%])	Total (N = 306) (n [%])	χ^2	*p*
Patient's rights are violated if a HCP does not follow HH guidelines and a HAI is transmitted.					
Yes	219 (95.6)	71 (92.2)	290(94.8)	1.364	.245*
No	10 (4.4)	6 (7.8)	16 (5.2)		
When necessary, I remind other HCP's to perform HH when providing patient care.					
Yes	98 (42.8)	26 (33.8)	124 (40.5)	1.949	.163*
No	131 (57.2)	51 (66.2)	182 (59.5)		
Patients' have the right to ask nurses to perform HH prior to providing care.					
Yes	224 (97.8)	76 (98.7)	300 (98.0)	.235	1.0
No	5 (2.2)	1 (1.3)	6 (2.0)		
My clinical nursing instructor consistently performs HH when necessary.					
Yes	202 (88.2)	61 (79.2)	263 (85.9)	3.855	.05*
No	27 (11.8)	16 (20.8)	43 (14.1)		
Nurses I work with on the clinical unit consistently perform HH when necessary.					
Yes	133 (58.1)	40 (51.9)	173 (56.5)	.881	.348
No	96 (41.9)	37 (48.1)	133 (43.5)		
My patient's ask me about my HH.					
Yes	4 (1.7)	1 (1.3)	5 (1.6)	.072	1.0
No	225 (98.3)	76 (98.7)	301 (98.4)		

Note. * Indicates $p \leq .25$ and inclusion in multivariate analysis.

Logistic Regression Analysis

Thirteen variables were included in the regression model based on a liberal alpha level of .25 to maximize the parsimony of the regression model and avoid inclusion of statistically irrelevant variables (Hosmer & Lemeshow, 2000). The one categorical variable: nursing program level consisted of more than two groups. This variable was dummy coded to meet the assumptions of binary logistic regression analysis (Field, 2005). A limitation of stepwise logistic regression analysis is that inclusion and removal of predictor variables from the final model is based only on statistical criteria, not a theoretical basis (Tabachnick & Fidel 2007).

The results of the multivariate stepwise logistic regression analysis suggest that seven variables were independent predictors of self-perceived HH compliance in this study. The motivation: concern about reprimand/discipline if HH guidelines are not followed (odds ratio [*OR*], 4.324; 95% confidence interval [*CI*], 1.465 – 12.758); the motivation: protection of patient from infection (*OR,* 2.418; 95% *CI,* 1.001 – 5.838); participants' number of clinical placements (*OR,* .815; 95% *CI,* .702 – .947), the perceived barriers of: busyness (*OR,* .231; 95% *CI,* .126 – .423); forgetfulness (*OR,* .356; 95% *CI,* .186 – .678); alcohol hand rub damages skin (*OR,* .163; 95% *CI* .070 – .380), and finally, the variable: clinical nursing instructor consistently performs HH when necessary (*OR,* 2.227; 95% *CI* 1.009 – 4.915). Table 3 depicts the independent predictors of participants' HH compliance.

Table 3

Stepwise Logistic Regression Depicting the Independent Predictors of HH Compliance

Variable	*B*	*SE*	*OR*	95% *CI*	*p*
Motivation: Concern about discipline if HH guidelines are not followed.	1.464	.552	4.324	1.465 – 12.758	.008
Motivation: Protection of patient from infection.	.883	.450	2.418	1.001 – 5.838	.050
Number of clinical placements.	-.204	.076	.815	.702 – .947	.007
Barrier: Being too busy.	-1.466	.309	.231	.126 – .423	< .001
Barrier: Forgetfulness.	-1.034	.329	.356	.186 – .678	.002
Barrier: Alcohol hand rub damages skin.	-1.817	.433	.163	.070 – .380	< .001
Clinical nursing instructor performs HH when necessary.	.801	.404	2.227	1.009 – 4.915	.047

B = unstandardized coefficient; *SE* = standard error; *OR* = odds ratio; *p* = probability of accepting the null hypothesis at an alpha of 0.05

The omnibus tests of model coefficients result was significant ($p < .001$), indicating that the model was different from the constant only model. The Hosmer and Lemeshow goodness of fit test was non-significant χ^2 (6) = 4.977, $p = .177$) after seven iterations, suggesting that the model had a good fit with the data. The Cox & Snell R Square was .205 and the Nagelkerke R Square was .303, indicating that the seven predictor variables suggest a modest 20.5% to 30.3% of the total variance of HH compliance in this analysis.

Table 4 provides the classification of the observed and predicted values based on a cut-off point of 0.5. The model's specificity of 32.5% (TN/TN + FP) predicted the percentage of participants who were non-compliant and were correctly classified by the model as non-compliant. Alternately, the sensitivity of the model (TP/TP + FN) predicted those who are classified as complaint and are actually compliant. In this model, 93.9% who were classified as compliant by the model actually were compliant. The positive predictive value = 80.5% (TP/TP + FP) of the model determines if the student who is predicted to be compliant actually is compliant. The negative predictive value = 64% (TN/TN + FN) of the model is able to identify a non-compliant student as being non-compliant. The overall precision of the model, defined as the ability of the model to correctly classify a student as compliant or non-complaint was a modest 78.4%.

Table 4

Classification Table for Hand Hygiene Compliance Model

Observed	Predicted		
	No	Yes	% Correct
Non-Compliant (< 90%)	25 (TN)	52 (FP)	32.5
Compliant (> 90%)	14 (FN)	215 (TP)	93.9
Overall Precision			78.4

TN = true negative, FP = false positive, FN = false negative, TP = true positive

Multicollinearity assessment. Multicollinearity occurs when two or more predictors in a regression are highly related to one another and fail to provide unique and/or independent information to the regression. Multicollinearity in logistic regression analysis can be detected by examining the standard error values (*SE*) for the unstandardized coefficients (*B*). A standard error value larger than 2.0 indicates multicollinearity among the independent variables (Field, 2005). None of the independent variables in this analysis had a standard error larger than 2.0, therefore, no multicollinearily was evident.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The incidence of HAIs in healthcare settings is a major public health concern (WHO, 2009). Compliance with HH guidelines has been considered to be the most important strategy to reduce the transmission of HAIs in healthcare settings for many years (Pittet, 2000). Despite overwhelming evidence demonstrating the negative consequences of HAIs and ongoing education emphasizing the importance of performing HH, low HH compliance rates among all categories of HCPs continue to prevail.

This study was conducted on a sample of 306 participants who were registered in years two, three, and four of an undergraduate nursing program. These participants completed an anonymous HHQ that was developed for the purpose of this study with a response rate of 53%. The following discussion presents the study findings within the context of existing literature. Implications and recommendations for nursing education, research, and practice; and the study limitations are also discussed.

Self-Perceived HH Practices

Research Question 1: What is the frequency of self-perceived HH practices among undergraduate nursing students?

Overall, the majority of participants in this study indicated that their HH compliance was 90% or greater before, after, and both before and after having had direct physical patient contact during their clinical placement experiences. Eighty percent of participants indicated that they perceived they were compliant with HH ≥ 90% of the time before having physical contact with their patients. Ninety-five percent of participants indicated that they were compliant with HH ≥ 90% of the time after having

had contact with their patients. Further, 81% of participants in this study indicated that their compliance with HH was ≥ 90% in both of the moments before and after having had patient contact.

The finding of a greater HH compliance rate after patient contact when compared to HH compliance prior to patient contact suggested that participants in this study were more likely to be motivated to perform HH out of concerns for their own safety rather than concern for the safety of their patients. This finding is consistent with the results of a systematic review of 96 HH compliance studies which reported lower HCP HH compliance rates prior to patient contact when compared to HH compliance rates after patient contact (Erasmus et al., 2010). The higher compliance rate post patient contact indicates that participants in this study were similar to post graduate HCPs with the probable motivation for participants' greater HH rates after patient contact being related to their concern for self-protection (Erasmus et al., 2010; Jang et al., 2010; Korniewicz & El-Masri, 2010).

The aforementioned self-reported levels of HH compliance among participants in this study were surprisingly high when compared to the existing literature of observations of nurses' HH compliance levels, which range between 33 – 53% (Erasmus et al., 2010; Mertz et al., 2011). However, the high levels of HH compliance in this study were very similar to those reported by Cole (2009) and Celik and Kocashi (2008) who also found that nursing students reported surprisingly high levels of HH compliance. While it is possible that nursing students may have higher HH compliance than nurses, this finding may also suggest that participants have difficulty making objective self-assessments about their HH practices or, have poor insight into their actual HH behaviour.

Furthermore, in spite of the anonymous format of the HHQ, participants may have felt vulnerable and could have been subject to a social desirability bias making them hesitant to report their actual HH compliance rates. In fact, Ajzen (1988) has suggested that there is a tendency to over report behaviours that are deemed socially desirable, and to under-report socially undesirable behaviour. Jenner et al. (2006) has also suggested that HCPs actually perform HH much less frequently than they indicate on self-report studies and that HCPs' self-reported HH practices were not at all consistent with the actual observations of their HH practices.

The Predictors of HH Compliance

Research Question 2: What are the predictors of self-perceived HH practices among undergraduate nursing students?

In this study, the regression results suggested that seven variables were significant predictors of participants' self-perceived HH compliance. Two motivator variables were significant predictors: A participant's decision to perform HH as a result of concerns about reprimand/discipline if HH guidelines are not followed, and the motivation to perform HH in order to protect the patient. Also, participants' number of clinical placements, and a participant's perception that the clinical nursing instructor consistently performed HH were significant predictors of HH compliance. Further, the variables: being too busy, forgetfulness, and the perception that the use of alcohol hand rubs damages the skin were all significant predictors of HH compliance.

Concerns about reprimand or discipline. In this study, participants who indicated that they were motivated to perform HH by concerns about being reprimanded or disciplined if they did not follow HH guidelines were 4.3 times more likely to comply

with HH guidelines than participants who did not have concerns about being disciplined. Participants motivation to perform HH were driven by the perception that their HH behaviour was being observed and assessed by referent individuals (e.g. clinical nursing instructor, unit staff members) during their clinical placements, and if they failed to comply with HH guidelines they would be disciplined.

Unfortunately, what was not adequately explored in this study was how participants defined the experience of discipline or reprimand if they failed to do HH during their clinical experiences. For example, participants could misinterpret communication from a clinical instructor or staff member which was meant to alert them to a missed opportunity for HH and mistakenly perceive that as a reprimand or discipline. Participants might also envision the concept of discipline to be a maximum consequence such as receiving a failing grade, or receiving a documentation of disciplinary action onto their academic or clinical record.

Limited literature was found on the topic of the experience of negative feedback and HH compliance in post graduate HCPs, and there was no literature available that explored concerns about reprimand or discipline as a predictor for HH compliance in nursing students. However, Chou et al. (2010) reported that the introduction of a strongly worded violation letter given to non-compliant HCPs with re-enforcement by management appeared to be a major factor in increasing HH compliance from 34% to 90% over a 2-year period.

Protection of the patient. The findings of this research study suggested that participants who indicated that they were motivated to perform HH by the belief that HH protects the patient from infection were 2.4 times more likely to comply with HH

guidelines than those who did not hold this belief. In this study, 80% of participants indicated that they were compliant with HH guidelines ≥ 90% of the time prior to patient contact, but a greater number of participants (95%) indicated that they were complaint with HH guidelines ≥ 90% after patient contact.

The finding of greater HH compliance after patient contact seemed to contradict participants' self-reported motivation for HH compliance being protection of the patient from infection. HCP's appraisal of self-risk as a motivator for performing HH has been frequently reported in the literature; findings indicated the motivation to perform HH is based on personal safety, rather than patient protection (Jang et al., 2010; Jenner et al., 2006; Jenner et al., 2002; Novoa, Pi-Sunyer, Sala, Molins, & Castells, 2007; Whitby et al., 2006). Interestingly, the variable protection of self from infection was not statistically significant in the final logistic regression model, suggesting that the observed frequencies were a mere function of chance.

Number of clinical placements. The unadjusted and adjusted results suggested there was a significant difference in HH compliance across different levels (years) of study (p = .012). The percentage of compliant participants in the second (79.7%), and third (78.7%) years of the program was greater than that of the fourth year (61.6%) of study. The regression findings suggested that participants' number of clinical placements, which normally increases as the student advances in level, was an independent predictor of HH compliance. Specifically, participants who had a greater number of clinical experiences were 18.5 % less likely to be compliant with HH guidelines (*OR,* .815; 95% *CI,* .702 – .947). Unfortunately, there is very little literature concerning the relationship between HH compliance and experience as measured by number of clinical placements.

One possible explanation for this finding could be that greater HH compliance was the result of having recently received HH education, but participants' HH compliance decreased with the passage of time and lack of reinforcement of HH education.

Nursing instructor role modeling HH practices. Interestingly, 85.9% (n = 263) of all participants perceived that their clinical nursing instructors consistently performed HH when necessary. In fact, one of the most interesting findings of this study was the suggestion that if participants perceived that their clinical nursing instructor consistently performed HH when necessary; they were 2.2 times more likely to be compliant with HH guidelines than those who did not hold this perception. Similarly, Snow et al. (2006) reported that mentor's HH practices were the strongest predictor of students HH practices. Qualitative studies of nursing students have reported that students' HH compliance can be both positively and negatively influenced by other HCPs' HH behaviour (Barrett & Randle, 2008; Cassidy, 2006; Gould & Drey, 2013; Lusardi, 2007). These findings indicate the strong influence that role modeling proper HH behaviour can have on students' HH compliance.

The unadjusted results of this study indicated that 56.5% (n = 173) of participants perceived that the nurses they work with during their clinical experiences consistently performed HH when necessary, indicating that participants observed a relatively large percentage of poor role models for HH practice. Greater HH compliance by HCPs has been observed when role models comply with HH, and lower HH compliance when role models are not compliant (Erasmus et al., 2009; Lankford et al., 2003; Muto, Sistrom, & Farr, 2000; Pessoa-Silva et al. 2005; Sax, Uckay et al., 2007). These findings call attention to the fact that clinical nursing instructors and nurses need to be aware of their

influence, and understand the importance of role modeling excellent HH practices.

The Barriers to HH Compliance

Research Question 3: What are the self-perceived barriers to HH compliance among undergraduate nursing students?

Busyness. Participants in this study were 77% less likely to comply with HH guidelines if they perceived themselves to be busy when performing patient care than those who did not hold this belief. Similar findings of nursing students perceiving HH compliance was poor when they were busy were identified in two qualitative studies (Barrett & Randle, 2008; Lusardi, 2007). Numerous studies of post graduate HCP's HH compliance have reported busyness, with more frequent opportunities for HH correlating with decreased HH compliance (Erasmus et al., 2010; Griffiths et al., 2009; Nicol et al., 2009; Pittet & Boyce, 2001; Pittet et al., 1999). Nursing student education needs to reinforce that when busy, there is an increased risk of non-compliance and also encourage students to identify strategies that increase personal and team compliance (e.g. reminding busy colleagues if they forget to perform HH). It is also important to emphasize to nursing students and nurses in general that failure to comply with HH because of busyness contradicts HH guidelines and can result in the transmission of HAI.

Alcohol hand rub damages skin. Participants in this study were 84% less likely to comply with HH guidelines if they perceived that using alcohol hand rub for HH was damaging to their skin than those who did not hold this belief. The mistaken perception that the use of alcohol hand rubs causes damaged skin conditions such as dryness and irritation on hands has frequently been reported in the literature as a barrier to HH compliance by both nursing students (Barrett & Randle, 2008), and by HCPs' in general

(Boyce, 2000; Budimir-Hussey et al., 2013; Larson, 1999). Alcohol-based hand rubs are actually among the best tolerated HH agents, due to the addition of emollients (Chamorey et al., 2011; Kampf & Loffler, 2007), and therefore should not be a concern with regards to potentially causing skin damage. In fact, it has been recommended that when hands are not visibly soiled, the preferred agent for HH is alcohol based hand rub as it has the most rapid action of all antiseptics and excellent antimicrobial activity (Pittet, 2000). This evidence needs to be emphasized with nursing students to dispel this perception (myth).

Forgetfulness. The findings suggest that participants in this study were 64% less likely to comply with HH guidelines if they held the perception that forgetfulness was a barrier to their HH compliance than those who did not hold this perception. Similar findings have been reported by Budimir-Hussey et al. (2013) and Pittet (2000). Forgetfulness cannot be accepted as an excuse for lack of compliance with HH given the serious patient safety consequences of poor compliance. It is important to remember that education increases knowledge, but increased knowledge may not necessarily improve practice. Therefore, it is important that effective strategies to enforce HH compliance be implemented. A lack of compliance with HH due to forgetfulness can be countered by reminders such as posters and HH auditing with feedback and ongoing education.

Conceptual Discussion. Concepts from the TPB were used to inform the HHQ used in this study. The TPB proposes that attitudes, subjective norms, and perceived behavioural control are predictive factors of behavioural intention, and intention is considered to be the immediate antecedent of the behaviour (Ajzen, 2006). The findings of this study supported this proposition. Specifically, participants were motivated to perform HH because of the attitude or perception that HH protects patients from

infection. An individual's attitude toward the behaviour is the degree to which performance of the behaviour is positively or negatively valued (Ajzen, 2006).

The TPB further proposes that the subjective norm is the perception of social pressure to engage or not engage in behaviour and that an individual's perception about the behaviour is influenced by the judgment of significant others (Ajzen, 2006). In this study, a participant's perception of being observed impacted HH compliance based on an assessment of risk of reprimand/discipline. Additionally, the perception that a clinical nursing instructor consistently performed HH added support for the notion that social pressures influence HH behaviour.

The TPB defines perceived behavioural control as one's perception of the ability to perform behaviour (Ajzen, 2006). In this study, the perception of busyness, forgetfulness, and that use of alcohol hand rub was damaging to skin can be considered factors which could impact a participant's perception of having control over their performance of HH.

Although the variables of age and gender were theoretically validated variables, they were found to be non-significantly associated with HH compliance in this study. This could be due to the fact that the population which was sampled was homogenous in regards to age and gender. While the vast majority of participants were female, the mean age of study participants was 23 years ($SD \pm 4.47$).

Implications and Recommendations for Nursing Education and Practice

As described above, this study suggests that nursing instructors' HH compliance has a significant impact on nursing students' HH compliance. Students view their nursing instructors as role models for proper HH practice, and instructor's practices directly

influence students' HH compliance. This fact illustrates the need for nursing instructors to be aware of their own HH practices and strive to role model 100% HH compliance during student clinical experiences.

Participants in this study reported higher than expected rates of self-perceived HH compliance. It is therefore important that both students and nurse educators be knowledgeable about the often present discrepancy between self-reported HH compliance rates and actual observed HH compliance rates. A very concerning finding suggested decreased HH compliance correlating with greater numbers of clinical experiences. Including HH compliance learning activities into each level of the nursing program could make students more aware of their HH behaviour. A suggested strategy to increase nursing student's awareness of HH compliance involves training students to perform HH compliance audits of fellow students and staff members during their clinical experiences throughout the program. This is very important given that increasing student awareness of the importance of proper HH compliance has been shown to positively impact students' HH practices (Magaldi & Molloy, 2010; Salmon, Wang, Seetoh, Lee & Fisher, 2013; Waltman, Schenk, Martin, & Walker, 2011).

Implications for further research. The independent predictors in this study explained a relatively modest 20.5% to 30.3% of the total variance of undergraduate nursing student HH compliance. However, the high sensitivity result of this model (93.9%) suggests it was a good model for classifying those who comply with HH guidelines. However, the model's lower specificity result (32.5%) suggests that it is less accurate in classifying non-compliants. The overall precision of the model's ability to correctly classify a student as compliant or non-compliant was a modest 78.4%, which

indicates that future work is still needed to better understand the predictors of HH compliance among nursing students.

Future research in this population may also be needed to explore the students' perceptions of what constitutes reprimand/discipline and how this impacts HH practices. Also, the finding of decreased HH compliance in relation to more clinical experience suggests that further examination of this relationship is necessary.

Gender has not been extensively examined in the literature with regards to its impact on HH compliance. The few studies that examined the impact of gender on HH reported conflicting results (Korniewicz & El-Masri, 2010; Sax & Uçkay, 2007; van de Mortel et al., 2001). As more male students enter nursing programs, the impact that gender might have on HH compliance merits greater consideration for future research studies. What also remains unknown is the optimal level of HH compliance necessary to effect change in the rate of HAI. An additional challenge in the area of HH compliance research is the need for the development and validation of a HH compliance questionnaire specifically for nursing students.

Limitations. Like most self-report research studies, this study was not without limitations. The most important limitation of this study was that it did not measure participant's actual observed rates of HH compliance during their clinical experiences. Another factor to consider is that while completing the HHQ, participants may have experienced a recall and social desirability bias whereby they report higher levels of HH compliance than reality.

There may also have been a self-selection bias related to the fact that the PI in this study was nursing instructor at the University of Windsor. Participants may have

consciously or unconsciously taken this fact into consideration and may have indicated what they believed to be the most acceptable answer on the HHQ. To minimize the risk of these biases, the PI was not present in the classroom while the HHQ was administered or completed. Not adequately explored in this study was how participants conceptually defined busyness, forgetfulness, and the experience of discipline or reprimand in the occasion of failing to do HH. Participants could have perceived that the constructive feedback provided by their clinical instructor about a missed opportunity for HH was an experience of reprimand or discipline.

Conclusion

In conclusion, participants in this study had high rates of self-reported HH compliance when considered with reports of observations of nurses' HH compliance. It is possible that the self-reported HH compliance percentages were accurate, but these results may also indicate that participants may have difficulties with objective self-assessment as had been suggested by Cole (2009). Specific education to increase awareness of the tendency to overestimate personal HH compliance could make students more receptive to HH education.

An important finding was the positive influence that clinical nursing instructors' role modeling of proper HH practices can have on participants' HH compliance. Misconceptions surrounding the use of alcohol hand rub and skin damage need to be addressed with focused education. It is important to ensure that both nursing faculty and nursing students understand the relationship between HH agents and skin damage. The study findings of greater HH compliance after patient contact when compared with prior to patient contact suggested a need to provide specific education to students about the

need to perform HH prior to contact with patients in order to prevent the cross-transmission of pathogens. There is also a need for education about the specific barriers to HH compliance which can lead to poor compliance rates. Students need specific education about how they can be compliant with HH when faced with these barriers.

A decrease in HH compliance in relation to more clinical experience was an alarming finding, with the lowest HH compliance rate being in the fourth year of the nursing program. Declining compliance with more clinical experience may result from the formation of poor HH habits which have been role modeled by other HCPs' during clinical experiences, or the lack of reinforcement of HH concepts in successive years of the nursing program.

The findings of this study provide insights and understanding about participants' motivations to perform HH and the barriers that impact HH practices which are essential in order to increase HH compliance rates (Pittet, 2004). Additionally, a potential benefit for participants in this study was that it allowed for the opportunity to consider and reflect on HH practices and compliance when providing patient care.

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APPENDICES

Appendix A

Letter of Information for Consent To Participate In Research

Title of Study: Exploring Self-Perceived Hand Hygiene Practices among Undergraduate Nursing Students

You are asked to participate in a research study conducted by Anne Foote (Principle Investigator) Faculty of Nursing at the University of Windsor as part of the requirements for a Master's in Science (Nursing) thesis project.

If you have any questions or concerns about the research, please feel to contact:
Anne Foote, Principle Investigator: Telephone: 519-253-3000 ext. 2258; email afoote@uwindor.ca

Dr. M. El-Masri, Faculty Supervisor: Telephone: 519-253-3000 ext. 2400; email melmasri@uwindsor.ca

PURPOSE OF THE STUDY

Limited research examines the existence of a relationship between undergraduate nursing student hand hygiene education, retention of theory, or self-perceptions of hand hygiene practices. The primary purpose of this study is to explore the predictors of self-perceived hand hygiene practice in undergraduate nursing students prior to their entry into professional practice. Secondary purposes include investigation of the self-perceived facilitators and barriers of proper hand hygiene practice; and evaluation of self-perceived pre and post procedure hand hygiene compliance. The results of this study will inform curriculum development and design at the undergraduate level, allowing insights into the hand hygiene practices of undergraduate nursing students at the University of Windsor.

PROCEDURES

If you volunteer to participate in this study, you will be asked to complete a onetime anonymous questionnaire containing questions about your hand hygiene practices and beliefs. It is estimated that the questionnaire will take 15 minutes to complete. A plain beige envelope will be distributed to each student. Each envelope contains: A Letter of Information, a Hand Hygiene Questionnaire, and one half of a raffle ticket with a unique number on it.

POTENTIAL RISKS AND DISCOMFORTS

There are no foreseeable risks or discomforts to completing this anonymous questionnaire. Participants can decline from completing the questionnaire or answering specific questions if they so desire. Participation or non-participation in this study will in no way jeopardize academic record, grade, or be used to penalize for past or current hand hygiene practices.

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Your participation in this study will provide insights into your hand hygiene practices, and will allow an opportunity for reflection on your personal hand hygiene practices. It will also provide an opportunity to contribute to research that is relevant to nursing students, the nursing profession, and patient safety.

COMPENSATION FOR PARTICIPATION

As a thank you gesture, each student in this classroom will be eligible to enter and win a random draw for a $25.00 gift card for Devonshire Mall conducted with a raffle ticket draw today. Participants do not have to complete the questionnaire in order to enter and win the gift card raffle; participants do have to remain in the classroom until all of the questionnaire envelopes are collected. Participants will receive one half of a raffle ticket (tickets are in the questionnaire envelope) **Keep your raffle ticket!** The opposite half of the raffle ticket has been placed in a jar. After all questionnaire envelopes have been collected, the research assistant will randomly select the number of raffle tickets according to your class year and will immediately announce the winning raffle ticket numbers. Participants with a winning raffle ticket number can show their winning raffle ticket to the research assistant and will be immediately awarded the gift card by the research assistant. No names or identifying details of participants who win gift cards will be recorded or communicated to the Principle Investigator by the research assistant. Your likelihood of winning is based on the following information:

- Second year nursing class: 2 gift cards to be awarded,
- Third year nursing class: 5 gift cards to be awarded,
- Fourth year nursing class: 3 gift cards to be awarded.
- Your potential of winning a gift card is also dependent on the number of students who have attended class today.
- A total of ten $25.00 gift cards will be awarded in years 2, 3 and 4 of the nursing program, number of gift cards per year has been based on numbers of registered students in each year.

CONFIDENTIALITY OF DATA AND ANONYMITY OF PARTICIPANTS IS ENSURED

Participants are asked to remain in the classroom until all questionnaires have been completed and submitted to the research assistant. The research assistant will remain in the classroom until all questionnaires have been completed and collected into an unmarked envelope. All Faculty members will leave the classroom area while the questionnaire is being completed. The Principal Investigator will return to, and remain in the research office. The completed questionnaires will be returned to the Principle Investigator after all students have left the area. Completed questionnaires will be stored in a locked cabinet in the Research Office at the University of Windsor. Only the Principle Investigator and Faculty Supervisor will have access to the questionnaires. The questionnaires will be destroyed after 5 years. The password protected electronic database storing all collected data will be retained by the PI indefinitely. Study findings will be reported in a scholarly journal as aggregate data.

PARTICIPATION AND WITHDRAWAL

Participation in this study is completely voluntary. You may choose to withdraw from the study at any time prior to questionnaire submission with no consequence. There is no penalty for choosing: not to participate; to choose not answer specific questions, or not complete the questionnaire. If you choose not to participate, you may anonymously return the uncompleted

questionnaire envelope to the research assistant. You will continue to be eligible for the gift card draw. Due to the anonymous nature of the questionnaire, after a questionnaire is submitted, there will not be an opportunity to retrieve it, or withdraw from the study.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

Please contact Anne Foote (Principal Investigator) if you have any questions about hand hygiene, or would like to request more information about this study. Feedback from the results of this study will be reported by Anne Foote during follow up visits to each class at the conclusion of the study.

SUBSEQUENT USE OF DATA

Data may be used in subsequent studies in publications and presentations. Results will be reported as aggregate data.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, please contact: Research Ethics Coordinator, University of Windsor, Ontario N9B 3P4; Telephone: 519-253-3000, ext. 3948; email: ethics@uwindsor.ca

SIGNATURE OF INVESTIGATOR

These are the terms under which I will conduct research.

_____ _____

Signature of Investigator Date

Anne Foote RN, BScN, MSc(c)

Appendix B

Hand Hygiene Questionnaire

Hand hygiene refers to the removal of visible soil and the removal or killing of transient microorganisms from the hands. It is accomplished using alcohol-based hand rub or soap and running water (Ontario Hospital Association, 2011).

Section A

1) Gender: ____ 2) Age: ____ 3) Nursing Program Year of Study: □ 2nd □ 3rd □ 4th

4) Total number of clinical placements completed in hospital/long term care facility: ____

Section B

Please indicate what percentage of the time you perform hand hygiene during each of the following situations:

5) PRIOR to having direct contact with a patient (i.e. providing care); you perform hand hygiene approximately: _____ % of the time.

6) AFTER having direct contact with a patient (i.e. providing care); you perform hand hygiene approximately: _____ % of the time

7) You perform hand hygiene BEFORE and AFTER having direct contact (i.e. providing care); with your patients approximately: _____% of the time.

8) Have you received didactic (i.e., class room) teaching on hand hygiene while in the nursing program?
□ No □ Yes

9) Have you received clinical/lab practice on proper hand hygiene procedures while in the nursing program? □ No □ Yes

10) When you do not perform hand hygiene during direct patient care, it is because of the following factors: ***(Please check all that apply)***
□ Being too busy
□ Forgetfulness
□ Unsure of the moments when hand hygiene is necessary
□ Alcohol hand rub or sink is not in a convenient location
□ Skin on my hands is dry, cracked and/or irritated
□ Soap damages my skin
□ Alcohol hand rub damages my skin
□ Other, please specify: _____

11) What motivates you the most to perform hand hygiene?
(Please check only one)
□ Protection for the patients I care for
□ Protection for myself from infection
□ Protection of both my patient and myself
□ Concerns over reprimand/discipline if I do not follow hand hygiene guidelines
□ Other, please specify: _____

Please rate how strongly you agree or disagree with each of the following statements by selecting one of the five possible choices.

12) I am generally satisfied with my own hand hygiene practices.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

13) When I am busy, I can't always perform hand hygiene as required.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

14) I perform hand hygiene less frequently when my hands are dry and/or irritated.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

15) I feel confident in my knowledge of encounters that require hand hygiene during patient care.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

16) When hands are not visibly soiled, it is more effective to use alcohol based hand rub instead of soap and water.
□ Strongly disagree □ Disagree □ Unsure □ Agree □ Strongly agree

17) I understand that alcohol based hand rub and soap and water are equally effective when performing hand hygiene after direct care for a patient diagnosed with *Clostridium difficile* (C-diff).
□ Strongly disagree □ Disagree □ Unsure □ Agree □ Strongly agree

18) Patient's rights are violated if a health care provider does not follow hand hygiene guidelines and a healthcare associated infection is transmitted.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

19) When necessary, I remind other healthcare providers to perform hand hygiene when providing patient care.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

20) Patients have the right to ask nurses to perform hand hygiene prior to providing care.
□ Strongly disagree □ Disagree □ Neutral □ Agree □ Strongly agree

21) My clinical nursing instructor consistently performs hand hygiene when necessary.
□ Strongly disagree □ Disagree □ Unsure □ Agree □ Strongly agree

22) Nurses I work with on the clinical unit consistently perform hand hygiene when necessary.

□ Strongly disagree □ Disagree □ Unsure □ Agree □ Strongly agree

23) My patient's ask me about my about my hand hygiene.

□ Never □ Rarely □ Sometimes □ Often □ Always

Thank you for your participation in this study!

VITA AUCTORIS

NAME:	Anne Foote
PLACE OF BIRTH:	Windsor, Ontario, Canada
YEAR OF BIRTH:	1970
EDUCATION:	St. Clair College, Windsor, Ontario 1989 – 1992 Registered Nurse Diploma University of Windsor, Windsor, Ontario 1994 – 1999 BScN University of Windsor, Windsor, Ontario 2010 – 2013 MSc (c)