PROBLEM SOLVING AND THE BARRIERS TO ADHERENCE TO ROUTINE INFECTION CONTROL PRACTICES

By © Abubaker M. Hamed, A dissertation submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Nursing /Faculty of Nursing

Memorial University of Newfoundland

May 2021

St. John's Newfoundland and Labrador

Abstract

Background: Healthcare-associated infections can be prevented through adherence to Routine Practices (RP) for infection control. Problem solving (PS) is an approach that can potentially be used to promote adherence to RP, which is suboptimal. **Objectives**: 1) Understand nursing students' and instructors' PS related to RP and barriers to RP; 2) evaluate the effects of a Problem-Solving Routine Practices (PSRP) educational program; and 3) examine the issue of negative role models and strategies that can be used. **Methods:** The objectives were met using a cross-sectional study that surveyed nursing students and instructors, a controlled before and after (CBA) study that evaluated a PSRP educational program, and a discussion paper about role models and adherence to RP. **Results:** The vast majority (83.5% to 100%) of nursing students and instructors surveyed correctly answered most, but not all, of the questions related to RP and PS. Both groups identified high nursing workload, empty alcohol-based hand rub dispensers and presence of negative role models as the most common barriers, and identified specific strategies to address them. In the CBA, significantly higher proportions of students in the intervention group compared to the control group showed increased confidence about applying PS to deal with high nursing workload ($p = 0.032$), correctly identified the steps of PS ($p = 0.016$), and reported adherence to some of the RP components ($p < 0.05$). The discussion paper highlighted how role models influence adherence and strategies that can be used. **Conclusion:** Nursing students' and instructors' knowledge about some RP components and application of PS to deal with the barriers to RP adherence need to be strengthened. The effectiveness of the PSRP program was varied, but further exploration of this approach is warranted. Recommendations were made for infection control practitioners, educators, nursing administrators, and future research.

Keywords**:** *Infection control practice, nursing students, nursing instructors, problem solving, barriers, knowledge, confidence, and application, adherence to routine practices, role models, strategies*

Acknowledgments

I would like to express the gratitude I have for my supervisor Dr. Donna and for the members of my thesis committee, Dr. April and Dr. Vernon. Thank you, Dr. Donna, for encouraging me to embark on this journey in the first place and also for your continual support and patience throughout this process. Thank you for the time you spent guiding me through the writing process, you truly have inspired me to grow as a writer. Thank you for your endless time, energy and support you gave me without hesitation. You have inspired me to continue my journey in academia and I can only strive to be as great a professor as you are someday.

I would like also to express the gratitude I have for the members of my thesis committee, Dr. April and Dr. Vernon. Thank you both for your continuous and valuable feedback that have strengthened all the chapters of my dissertation.

To my family I would not have been able to complete this academic journey without you. To my wife Njlaa, thank you for the endless encouragement and understanding you have shown to me over these years. Thank you for your unwavering love and support. Thank you for all of your guidance and good energy you sent me over the years.

To my children Shahd, Akram, Anas, Aya, and Lena, I would not be the person I am today without all of you. Thank you for the love and kindness you have shown me over the years, it is what kept me going.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ABHR	Alcohol-based hand rub
ADDIE	Instructional System Design Model
BSI	Blood stream infections
CAUTI	Catheter-associated urinary tract infections
CBA	Controlled before and after study
CD	*Clostridium difficile*
CDC	Centers for Disease Control and Prevention
CDI	*Clostridium difficile* infections
CI	Confidence Interval
CLABSIs	Central line-associated bloodstream infections
CNISP	Canadian Nosocomial Infection Surveillance Program
CPSI	Canadian Patient Safety Institute
HADS	Hospital Anxiety and Depression Scale
HAIs	Healthcare-associated infections
HCWs	Healthcare workers
ICPs	Infection Control Practitioners
IPC	Infection prevention and control
JBI	The Joanna Briggs Institute
LOS	Length of hospital stay
MRSA	Methicillin-resistant *Staphylococcus aureus*
NL	Newfoundland and Labrador
OR	Odds Ratio

PCDs	Patient-care days
PCRA	Point of care risk assessment
PHAC	Public Health Agency of Canada
PPE	Personal Protective Equipment
PSRP	Problem-Solving Routine Practices educational program
PS	Problem solving
PSI	Problems Solving Inventory
RP	Routine practices for infection control
RCT	Randomized controlled trial
SP	Standard precautions
SPSI-R	Social Problem-Solving Inventory-Revised
SSIs	Surgical site infections
UCBA	Uncontrolled before and after
US	United States of America
UTI	Urinary tract infection
VAP	Ventilator-associated pneumonia
VRE	Vancomycin-resistant *Enterococcus*
WHO	World Health Organization

List of Appendices

Dissertation Overview

This dissertation consists of five chapters. **Chapter 1** provides a context for the study by summarizing and discussing the relevant literature and provides an overview of the methods for the two studies. **Chapter 2** discusses the first study (first manuscript), which was a cross-sectional survey to understand problem solving related to routine (infection control) practices (RP) among nursing students and instructors, and to identify the barriers to adherence to RP which they may encounter during their clinical practice. **Chapter 3** discusses the second study (second manuscript), which was a controlled before and after study to assess the effect of the Problem-Solving Routine Practices educational program on nursing students' and nursing instructors' knowledge, confidence, discussion, and application of problem solving related to RP. **Chapter 4** discusses the role of positive and negative role models on students' adherence to RP, the reasons that prevented them from dealing with the influence of negative role models, and the strategies that they can use, including problem solving as a potential strategy, to deal with negative role models (third manuscript). **Chapter 5** discusses the conclusion of the whole dissertation research and summarizes the key findings of the three manuscripts and the strengths and limitations of the two studies. In addition, it also presents the key recommendations for infection control practitioners, educators, nursing administrators, and future research.

Chapter 1: Literature Review and Overview of the Cross-sectional and Controlled Before and After Studies

Abubaker Hamed[1], Donna Moralejo [1], April Pike[1], Vernon Curran[2]

[1] *Faculty of Nursing, Memorial University of Newfoundland, Canada*

[2]*Faculty of Medicine, Memorial University of Newfoundland, Canada*

In chapter 1, a brief background of the study is provided, including a synthesis and discussion of the literature related to healthcare-associated infections (HAIs). HAIs are defined, followed by a discussion of the prevalence of HAIs, the major consequences of HAIs for patients, nurses, and the healthcare system, and how these negative consequences can be prevented. The chapter continues with a discussion of the literature related to adherence to routine infection control practices (RP), the common barriers to adherence to RP, and the multiple interventions that have been used to improve nurses' and nursing students' adherence to RP. Next is the summary of problem solving (PS), evidence of PS skills among nurses and nursing students, and the effectiveness of PS interventions. This chapter also present the research problem, the logic underpinning the research, the three frameworks that guided the controlled before and after study, the research questions, and the methods of the two studies. It also provides a brief description of the manuscripts that comprise this dissertation. This chapter, therefore, summarizes the evidence to support the need for a cross-sectional study to understand students' and instructors' knowledge, confidence, and application of PS related to RP (first study), and the need for a Problem-Solving Routine Practices (PSRP) educational program for nursing students to deal with the identified barriers to adherence to RP and its evaluation (second study).

AMH searched, reviewed, and critically appraised the available literature, wrote the literature review, and conceptualized the studies. DM contributed to synthesis of the literature. DM, AP, and VC contributed to the conceptualization of the studies. AP and VC contributed to the selection of the ADDIE Instructional System Design Model and the Constructivist Learning theory. In addition, DM, AP and VC also reviewed, suggested revisions to, and approved the manuscript.

Healthcare-associated infections (HAIs) have major impacts on patients, nurses, and the healthcare system, as they contribute to increased mortality rate, length of hospital stay, nursing workload, and financial burden on the healthcare system. The majority of HAIs can be prevented through adherence to routine infection control practices (RP) such as point of care risk assessment (PCRA), hand hygiene, use of personal protective equipment (PPE), sharps safety, and cleaning and disinfecting patient care equipment. Adherence of nurses and nursing students to RP has been found to be suboptimal due to a number of barriers such as the presence of negative role models, high nursing workload, and inconvenient location of alcohol-based hand rub (ABHR) dispensers. It is not always feasible to eliminate these barriers. Problem solving (PS) is a significant skill through which nurses and nursing students can manage problems that they may encounter during their clinical practice such as the barriers to RP adherence. Dealing with these barriers through the use of PS may improve adherence and could potentially reduce HAIs and their negative impacts.

To understand PS related to RP, two different but linked studies were conducted. The first study was a cross-sectional survey to understand nursing students' and nursing instructors' knowledge, confidence, application, and perception related to RP and PS, as well as to identify the barriers to RP adherence. The second study was a controlled before and after (CBA) study to evaluate the effect of a Problem-Solving Routine Practices (PSRP) educational program for nursing students to deal with the barriers to RP adherence. This educational program was informed by the results of the first study.

Literature Search Methods

A literature review was conducted to summarize and synthesize relevant published studies. CINAHL, PubMed, and Embase were used to search for the relevant literature in the last

10 years to understand the recent literature. The following keywords were used in the search: *healthcare-associated infections, infection control practice, nursing students, nursing instructors, problem solving, barriers, knowledge, confidence, application, adherence to routine practices, standard precautions, role models,* and *strategies.* Quantitative and qualitative research studies published in English only were included in this review. The quantitative research studies were critically appraised using the Public Health Agency of Canada (PHAC) Critical Appraisal Toolkit (PHAC, 2014). The qualitative research studies were critically appraised using the Joanna Briggs Institute (JBI) critical appraisal checklist for qualitative research (JBI, 2017).

Literature Review

This section provides an overview of the literature related to HAIs, their major consequences for patients, nurses, and the healthcare system, prevention of HAIs, the barriers to adherence to RP, and an overview of PS and PS-related interventions.

Healthcare-associated infections

HAIs are infections patients can acquire while receiving medical treatment in both acute and long-term care facilities (CDC, 2018; WHO, 2018). The most common types of HAIs are surgical site infections (SSIs), central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (CAUTI), and ventilator-associated pneumonia (VAP) (CDC, 2014; Khan et al., 2017; Russo et al., 2019). HAIs are caused by a wide range of microorganisms; however, *Staphylococcus aureus* is the most commonly reported microorganism that causes the four common types of HAIs (Haddadin & Regunath, 2017; Mundhada & Tenpe, 2015; Sandiumenge & Rello, 2012). Methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), and *Clostridium difficile* (CD) are

antibiotic-resistant microorganisms commonly found in Canadian hospitals (Provincial Infection Control Newfoundland and Labrador, 2015; Russo et al., 2019). MRSA and VRE can cause a variety of infections such as urinary tract infection (UTI), bloodstream infections (BSI), and SSI, while CD causes colitis.

Prevalence of HAIs

HAIs are serious health problems that affect millions of patients worldwide. The World Health Organization (WHO) estimates that 10% of patients in developing countries acquire an HAI, 7% of patients in developed countries acquire HAIs, and up to 30% of the patients admitted to intensive care units are affected by at least one HAI in developed countries (WHO, 2016). Recently, three prevalence studies on HAIs in a number of countries have reported the prevalence of HAIs ranged between 3.9% and 10.2% (Russo et al., 2019; Serrano et al., 2017; Suetens et al., 2018). For instance, Russo et al. (2019) conducted a prevalence study in 19 Australian hospitals and found that the prevalence of HAIs was 9.9%. Similarly, Serrano et al. (2017) conducted two prevalence studies in Italy between the years 2011- 2014 and found that the overall prevalence rate of HAIs was 10.2%. In comparison, Suetens et al. (2018) conducted point prevalence surveys in the European Union and European Economic Area from 2016 to 2017 to estimate the prevalence of HAIs. They found the prevalence rate of HAIs was lower, 3.9%.

HAIs are also prevalent in a number of Canadian healthcare facilities. The HAI prevalence rate is estimated to be between 8% and 13% (CNISP, 2015; Mitchell et al., 2019; Taylor et al., 2016). The Canadian Nosocomial Infection Surveillance Program (CNISP) estimated that 12% of adults and 10% of children admitted to a Canadian hospital will develop an HAI, and approximately 220,000 Canadians suffer from HAIs each year (CNISP, 2015). In

2009, Taylor et al. (2016) conducted a prevalence survey study in 50 Canadian hospitals from 10 provinces. The authors found that the prevalence of HAIs in the number of Canadian hospitals increased from 11% in 2002 to 13% in 2009. In 2017, Mitchell et al. (2019) conducted descriptive point-prevalence surveys to assess the burden of HAIs in 18 Canadian hospitals, and they found that the prevalence of HAIs was 8%. More recent Canadian prevalence data are not available.

SSI is one of the most common types of HAIs that may occur after surgery (Haque et al., 2018). The overall prevalence of SSI was estimated to be in the range of 17.4% to 24% (Magill et al., 2014; Mitchell et al., 2019; Taylor et al., 2016). Two point-prevalence surveys conducted in Canada and the United States (US) in 2009 and 2011 by Taylor et al. (2016) and Magill et al. (2014) respectively found that SSIs ranged from 17.4% to 24.3%. In the series of point-prevalence surveys by Mitchell et al. (2019) previously discussed, they found that the SSIs accounted for 19.4% of the total cases of HAIs. Furthermore, according to CPSI (2016), SSIs occur in 2% to 5% of all surgeries, and of the 1.3 million surgeries in Canada yearly, 26,000 to 65,000 patients acquire an SSI. Beside SSIs, other specific types of HAIs were also prevalent in the healthcare settings. In their previously discussed prevalence studies, Magill et al. (2014) and Taylor et al. (2016) found that CAUTIs ranged from 14.4% to 34.8%, CLABSIs ranged from 11.1% to 13.8%, and VAP ranged from 6.7% to 24.3 %. Similarly, Mitchell et al. (2019) found that CAUTIs accounted for 37.1% of all HAIs, CLABSIs for 21.2%, and VAP for 22.3%.

Specific HAI prevalence rates are not available for Newfoundland and Labrador (NL). However, a survey conducted in 2015 in NL showed that the incidence rate of C*lostridium difficile* infections (CDI) in acute care facilities increased from 1.4 per 10, 000 patient-care days (PCDs) in 2010 to 2.1 per 10, 000 PCDs in 2014, while the MRSA rate decreased from 6.2 per

10, 000 PCDs in 2010 to 3.3 per 10, 000 PCDs in 2014 (Provincial Infection Control Newfoundland and Labrador, 2015).

The Impacts of HAIs

HAIs are a problem because of their prevalence in all settings, with increases for some infections. They are also a problem because they have negative impacts on patients, nurses, and the healthcare system.

Mortality.

Annually a number of patients die as a result of HAIs. In the US it has been estimated that 99,000 die each year as a result of HAIs (CDC, 2018). In general, the mortality rate of HAIs in North America, Europe, and Sweden has been found to range between 1.2 % and 6.4% (Patel et al., 2017; Rahmqvist et al., 2016). In Canada, annually, an estimated 8,000 patients die because of HAIs (CNISP, 2015). The mortality rate of HAIs varies by the types of microorganisms. Olsen et al. (2015) conducted a retrospective cohort study between 2003 and 2009 to estimate the mortality rate among patients with CDI at one hospital in the US. The authors found that 26.8% of the patients with CDI died within 180 days of their discharge date. A recent prospective, sentinel surveillance study was conducted by CNISP (2020) between the years 2014 to 2018 in 70 Canadian hospitals to estimate the prevalence and mortality rate associated with CDI and found the mortality rate of CDI was 1.3%.

More recently, a number of studies have also reported the mortality rate of bloodstream *Staphylococcus aureus* (staph). In 2017, a surveillance study conducted in the US found that nearly 20,000 died from staph infections (Kourtis et al., 2019). Furthermore, a surveillance study conducted in Canadian acute care hospitals between 2008 and 2012 found that around 9% of patients with non-blood MRSA infection, and 25% of patients with an MRSA bloodstream

infection, died within 30 days after the diagnosis (CNISP, 2014). In the sentinel surveillance study previously discussed, CNISP (2020) found the mortality rate for MRSA infections was 18.8 deaths per 100 cases.

Length of Hospital Stay.

A number of studies have found that HAIs prolonged the length of hospital stay (LOS) by 2.6 to 21 days (Arefian et al., 2019; Jia et al., 2019; Zhou et al., 2019). For instance, Zhou et al. (2019) conducted a multi-state modeling study in China to estimate the LOS associated with HAIs. A total of 1709 patients with HAIs were included in the study. They found that the expected extra LOS attributable to HAIs was 2.56 days (95% confidence interval (CI), CI: 2.54–2.61). Similarly, in Germany, Arefian et al. (2019) conducted a prospective, single-center, uncontrolled before and after (UCBA) study with two surveillance periods before and after implementation of an infection prevention intervention program. They found that having HAIs increased the LOS by 8.4 days (95% CI: 6.8–10.0). Furthermore, Jia et al. (2019) conducted a case-control study in 68 hospitals in 7 major provinces in China to assess the impact of HAIs on the LOS. The authors found that there was a significant increase in the length of the hospital stay in the case group (21.3±1.9 days) compared to the control group (10.9±1.9 days).

The specific type of HAI can also lead to an increase in the LOS. For instance, Patel et al. (2017) conducted an extensive literature review that was specifically focused on the impact of SSI on patients with hip and knee surgeries. Eighty-one studies published between 2003 and 2013 in North America and Europe were included in this review. Of these 81 studies, 21 studies evaluated the impact of having SSI on the LOS. Based on the results of these 21 studies, patients with SSI had a median LOS of 18.9 days compared to 6 days for non-SSI patients. Similarly, Gili-Ortiz et al. (2015) conducted a retrospective cohort study in Spain to assess the impact of

SSI in 4377 patients who underwent radical cystectomy. They found that the mean LOS was 17.8 days longer among patients with SSI compared to non-SSI patients. CDIs were also found to increase the LOS, with increases ranging from 3-20 days (Provincial Infection Control Newfoundland and Labrador, 2015).

Psychological Impact.

HAIs can negatively impact patients' psychological conditions especially if the patients are under isolation precautions. Five studies were identified that evaluated the impact of isolation precautions on patients' psychological status (Day et al., 2011; Day et al., 2013; Guilley-Lerondeau et al., 2017; Lupión-Mendoza et al., 2015; Purssell et al., 2020). Of these five studies, three were cohort studies (Day et al., 2011; Day et al., 2013; Guilley-Lerondeau et al., 2017), one was a case-control study (Lupión-Mendoza et al., 2015), and one was a systematic review with meta-analysis (Purssell et al., 2020). Four of these five studies used the Hospital Anxiety and Depression Scale (HADS) as their measurement tool (Day et al., 2011; Day et al., 2013; Lupión-Mendoza et al., 2015; Purssell et al., 2020) and one study used the State-Anxiety Scale of Spielberger (Guilley-Lerondeau et al., 2017). Both scales were known to be valid and reliable.

All these five studies found that patients under isolation precautions were more likely to develop depression and anxiety. In their cohort study, Day (2011) found that 40% of the patients on isolation precautions were more likely to be diagnosed with depression compared to non-isolated patients. Similarly, in their systematic review and meta-analysis, Purssell et al. (2020) found that isolated patients were more likely than non-isolated patients to develop depression, with a difference in the mean score of 1.28 (95% CI, 0.47- 2.09). In their case-control study, Lupión-Mendoza et al. (2015) found that depression was associated with being under isolation precautions (adjusted odds ratio (OR), 4.56; 95% CI, 0.96-21.62; $p = 0.05$). Furthermore,

Guilley-Lerondeau et al. (2017) used the State-Anxiety Scale of Spielberger and found that patients under isolation precautions had significantly higher anxiety levels, with the median score of 52 (minimum and maximum scores 20-56) in those patients compared to a median score of 31 (minimum and maximum scores 23-73) in patients without isolation precautions ($p = 0.001$). Similarly, in the previously discussed meta-analysis by Purssell et al. (2020), isolated patients were more likely to develop anxiety, with a difference in the mean score of 1.45 (95% CI, 0.56 – 2.34; $p<0.0001$). In their cohort study, Day et al. (2013) also found that 4% of the patients under contact precautions were worried, 38% were sad, and 20% were angry.

Nurses' Workload.

Evidence has shown that HAIs can increase nursing workload particularly if nurses are caring for patients under isolation precautions (Barker et al., 2017; Kaba et al., 2017; Musau et al., 2015). For instance, Barker et al. (2017) conducted a prospective cohort study in New York, US, between the years 2012 and 2013. The authors found that nurses spent more time while caring for patients under isolation precautions, 7.14 minutes (95% CI, 6.08-8.21), compared to other patients, 5.08 minutes (95% CI, 4.48-5.69). According to the authors, this increase in time was due to actions needed to wear PPE (Barker et al., 2017). Similarly, a recent mixed-method study was conducted by Kaba et al. (2017) in five units at a community hospital system in Ontario, Canada, to assess the impact of infections that require isolation precautions on nurses' daily workload. In the qualitative phase of their study, nurses stated that caring for patients on isolation precautions added 20 minutes to two hours to their shifts. Moreover, Musau et al. (2015) conducted a retrospective exploratory case study in 2012 to assess the influence of HAI outbreaks on nurse workload at a large acute care hospital in Ontario, Canada. The researchers interviewed 21 bedside nurses and five nurse managers. Nurses stated that in every shift and

every time that they entered a room of an isolated patient, they needed 3-4 extra minutes to use infection prevention and control (IPC) practices, and they spent at least an hour in cleaning their hands and wearing PPE (Musau et al., 2015).

Costs.

HAIs place a significant economic burden on the healthcare system in a number of countries. For instance, the overall cost associated with HAIs in general was found to vary by country (Hessels & Larson, 2016; Zimlichman et al., 2013). In their cross-sectional study, Hessels and Larson (2016) reported that the annual attributable direct costs of HAI were estimated to be $9.8 billion in the USA and €7 billion in Europe. Similarly, a systematic review conducted between 2011 and 2013 showed that the total costs associated with specific types of HAIs were $9.8 billion (95% CI, $8.3-$11.5 billion) (Zimlichman et al., 2013).

Beside the overall cost, several studies have estimated the cost associated with a specific type of HAI such as CDIs, MRSA, SSI, Staphylococcal infections, CLABSIs, VAP, and CAUTIs (Keenan et al., 2014; PHAC, 2016; Schmidt et al., 2015; Schweizer et al., 2014; Thakore et al., 2015). In their retrospective database analysis conducted in France between the years 2009 and 2010, Schmidt et al. (2015) found that the direct cost associated with Staphylococcal infections after cardiothoracic and orthopedic operations was £35 million. Similarly, two retrospective cohort studies (Keenan et al., 2014; Schweizer et al., 2014) and one case-control study (Thakore et al., 2015) were conducted in the US to estimate the cost associated with having SSIs. These three studies found that patients with SSIs had a higher cost (adjusted mean $52, 620) compared to patients without SSIs (adjusted mean $31, 580) and the associated costs for the patients with SSI were 1.4 times higher compared to patients without SSI (95% CI, 1.34-1.52; difference, $11,876) (Schweizer et al., 2014). Furthermore, having an SSI

significantly increased hospital costs by 35.5% ($13, 253 vs. $9, 779) (Keenan et al., 2014), and the median cost associated with treatment and hospital readmission was significantly higher in patients with SSI ($108,782) compared to the patient without SSIs ($57,418) (Thakore et al., 2015).

It can be noted from the discussion above that HAIs have serious impacts on patients, nurses, and the healthcare system as they contribute to increased mortality rate, length of hospital stay, nursing workload, financial burden on the healthcare system, as well as psychological problems. These impacts can be prevented through adherence to RP. The majority of HAIs and their impacts can be prevented by interrupting the transfer of microorganisms from patient to patient or patient to nurse either directly or indirectly through healthcare workers (e.g., hands) or the environment (e.g., used equipment) (Adebayo et al., 2015; PHAC, 2016).

Prevention of HAIs with RP and SP

To help reduce the spread of microorganisms and prevent the majority of HAIs and their negative impacts in healthcare settings, Canada has implemented a system of basic infection control precautions called Routine Practices (RP), which is similar to the system of Standard Precautions (SP) used elsewhere (PHAC, 2016). RP and SP include hand hygiene, use of PPE, sharps safety, and cleaning and disinfecting patient care equipment. RP also specifies that, prior to each patient encounter, healthcare workers conduct a PCRA to identify potential risks of exposure to or transfer of microorganisms and then initiate appropriate actions, such as hand hygiene or cleaning equipment. RP and SP always apply to all patients in all settings, not just when patients are known or suspected to have an infection. In this dissertation, we will use the term SP when the study or studies being discussed investigated Standard Precautions, otherwise the term RP will be used. Although RP are used by other healthcare workers, the reason to target

the intervention nursing students is because, as future nurses, they will have the most interactions with patients.

Nursing Students' Adherence to SP

As previously described, the majority of HAIs and their related negative impacts can be prevented if nurses and nursing students are regularly adhering to RP (Adebayo et al., 2015; PHAC, 2016). However, multiple cross-sectional studies that used self-report and observations were conducted in different countries and found that nursing students' adherence to SP was suboptimal (Cheung et al., 2015; Colet et al., 2017; Cruz, 2019; Moon et al., 2019). All Canadian studies found reported on SP, not RP. Overall, nursing students' adherence rates to SP were found to range from 55% -78% (Cheung et al., 2015; Colet et al., 2017; Cruz, 2019; Moon et al., 2019). For example, Moon et al. (2019) found that only 55% of the 176 nursing students in their sample adhered to SP. Similarly, two cross-sectional studies conducted in Saudi Arabia found that nursing students' adherence rates to SP were 61.0% (Colet et al., 2017) and 61.8% (Cruz, 2019). In comparison, in their study of 632 nursing students, Cheung et al. (2015) found slightly higher adherence, but used a different measure than proportion who adhered; the mean score in their participants was 4.38 ± 0.40, with scores ranging from 3 (sometimes) to 5 (always).

Nursing students also showed low to moderate adherence to an individual item of SP such as hand hygiene. For instance, several cross-sectional studies found that nursing students' adherence to hand hygiene was also suboptimal (Al-Khawaldeh et al., 2015; AL-Rawajfah & Tubaishat, 2015; Colet et al., 2017; Foote & El-Masri, 2016). For instance, a Canadian study conducted among 306 nursing students found a relatively high adherence rate to hand hygiene (74.8%) (Foote & El-Masri, 2016). A number of studies focused on specific indications, known as moments, for hand hygiene. For example, Al-Khawaldeh et al. (2015) and AL-Rawajfah and

Tubaishat (2015) found that 54.9% of nursing students self-reported that they washed their hands after patient care, and only 47.3% washed their hands before patient care respectively. Colet et al. (2017) also assessed hand hygiene technique rather than hand hygiene moments and found 26.7% of the students reported that they used water only for hand washing, which is insufficient. Besides the suboptimal adherence to hand hygiene, the studies also showed that nursing students had low to moderate adherence to some of the components of RP such as waste disposal, glove use and sharps safety. For instance, Colet et al. (2017) found that only 48.3% of nursing students placed waste contaminated with blood, body fluids, secretions, and excretions in the recommended plastic bags. There were also several studies that examined adherence related to sharps safety, specifically recapping used needles. For instance, Colet et al. (2017) found that only 48.2% of nursing students did not recap used needles after administering an injection, i.e., the recommended practice, compared to 63% to 64% in the studies by Cruz (2019) and AL-Rawajfah and Tubaishat (2015) respectively. Therefore, one third to one half continued to recap used needles, which increases risk of a needle stick injury.

Nurses' Adherence to SP

Overall, nurses' adherence rates to SP have been similar to nursing students, ranging from 17% - 69% (Hessels & Larson, 2016; Pereira et al., 2015; Powers et al., 2016). For example, in their study in 11 units in 5 hospitals, Hessels and Larson (2016) found that nurses had an overall moderate adherence to SP (64%). Similarly, Pereira et al. (2015) compared the adherence rate between a sample of Hong Kong nurses and Brazilian nurses and found that the SP adherence rate of Brazilian nurses (mean: 69.4% ±13.57%) was significantly greater than that of Hong Kong nurses (mean: 57.4%18.62; $p<.001$). In contrast, in their study conducted in the

US, Powers et al. (2016) found that only 17.4% of nurses reported that they adhere to all SP items.

Nurses' adherence to individual SP items such as hand hygiene and gloves use was also found to be suboptimal (Deyneko et al., 2016; Hessels & Larson, 2016; Løyland et al., 2016). For instance, a Canadian study by Deyneko et al. (2016) found only 14.2% of the nurses performed hand hygiene after caring for patients with CDI. Similarly, in the US study by Loyland et al. (2016), only 61% of nurses performed hand hygiene after contact with body fluids; 27% before patient contact; 52% after patient contact; and 45% after touching a patient's surroundings. Hessels and Larson (2016) found that performing hand hygiene was missed by nurses more than half of the time indicated (58%), and that nurses did not use gloves in 43% of observed encounters.

Conclusion Regarding Suboptimal Adherence

Overall, the evidence for suboptimal adherence comes from 12 cross-sectional studies. Eight of these were rated as high quality (Al-Khawaldeh et al., 2015; AL-Rawajfah & Tubaishat, 2015; Cheung et al., 2015; Colet et al., 2017; Cruz, 2019; Deyneko et al., 2016; Hessels & Larson, 2016; Moon et al., 2019) using the PHAC critical appraisal tool (PHAC, 2014) and three as medium quality (Foote & El-Masri, 2016; Løyland et al., 2016; Powers et al., 2016). Although a cross-sectional design is weak in terms of testing a causal association, the results do indicate that components of SP and RP are frequently missed in practice. This lack of adherence could be attributed to a number of barriers that nurses and nursing students encounter during their clinical practice.

Barriers to Adherence to SP

Numerous cross-sectional studies that used self-report and observations were conducted in a number of countries to explore the barriers to adherence to SP among students (Cheung et al., 2015; Choi & Kim, 2018; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Wilson et al., 2017) and among nurses (Akagbo et al., 2017; Deyneko et al., 2016; Kirk et al., 2016; Quan et al., 2015; Rashmi & Kundapur, 2017; Zellmer et al., 2015).

According to these studies, nurses and nursing students reported that they encountered a number of barriers that prevented them from adhering to SP. These barriers included lack of knowledge and training, skin damage or dryness, forgetfulness, empty ABHR dispensers, unavailability of PPE, alteration of skills when wearing PPE, dealing with emergency situations, lack of hospital supporting policies, high nursing workload, presence of negative role models, and inconvenient location of ABHR dispensers.

In addition to these cross-sectional studies, a number of qualitative descriptive research studies were also conducted to explore the barriers to adherence to SP among nurses and nursing students (Atif et al.,2019; Barker et al., 2017; Kim & Oh, 2015; Travers et al., 2015; Ward, 2013). These qualitative research studies found similar results that nurses and nursing students encountered the same barriers identified in the cross-sectional studies.

Overall, the evidence for the barriers comes from 12 cross-sectional studies and five qualitative research. Using the PHAC critical appraisal tool, five of the cross-sectional studies were rated as high quality (Choi & Kim, 2018; Deyneko et al., 2016; Kirk et al., 2016; Quan et al., 2015; Rashmi & Kundapur, 2017) and seven as medium quality (Akagbo et al., 2017; Dombecki et al., 2015; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter,

2014; Wilson et al., 2017; Zellmer et al., 2015). Using the JBI appraisal checklist for qualitative research (JBI, 2017), the five qualitative research studies were deemed credible.

While conclusions that can be drawn from descriptive studies are limited, the evidence clearly shows that both nurses and nursing students encountered a number of barriers to SP adherence. However, in this dissertation research study, we focused on three encountered barriers, which are high nursing workload, presence of negative role models, and inconvenient location of sinks and ABHR dispensers. These three barriers were among the top three commonly reported barriers to adherence to RP in most of these studies. Therefore, in order to develop an appropriate intervention, it is paramount to understand these three barriers and discuss their impacts on nurses' and nursing students' adherence to RP.

High Nursing Workload.

High nursing workload was identified as one of the commonly encountered barriers to adherence to RP among both nursing students (Cheung et al., 2015; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014) and nurses (Akagbo et al., 2017; Quan et al., 2015; Rashmi & Kundapur, 2017). For instance, 23% to 35% of nursing students reported that "busyness" influenced their adherence to SP (Cheung et al., 2015; Foote & El-Masri, 2016), 24% viewed their adherence to SP as time-consuming (Dorgham & Obied, 2016), and 59.9% reported that high workload was one of the key factors that influenced their adherence to IPC practices (Hinkin & Cutter, 2014). Nurses' adherence to SP was also influenced by the high nursing workload (Akagbo et al., 2017; Rashmi & Kundapur, 2017; Quan et al., 2015). For instance, 44% (Akagbo et al., 2017) and 26 % (Rashmi & Kundapur, 2017) of nurses reported that they did not have enough time to adhere to SP. Furthermore, Quan et al. (2015) found a small but significant negative correlation (r= -0.118) between high workload and nurses' self-reported

adherence to SP. Similar results for both nurses and nursing students were also obtained by the five qualitative research studies previously described, in which lack of time, very busy schedules, and too many tasks and patients to care for were among the main barriers that prevented them from adhering to IPC practices (Barker et al., 2017; Atif et al., 2019; Kim & Oh, 2015; Travers et al., 2015; Ward, 2013).

Presence of Negative Role Models.

Another common barrier that influenced nursing students' and nurses' self-reported adherence was the presence of negative role models. For instance, Wilson et al. (2017) found that 38% of nursing students self-reported that the presence of negative role models affected their adherence to IPC practices. Recently, Choi and Kim (2018) found that the intention of nursing students to adhere to IPC practices was negatively influenced by the non-adherence of other nurses in their clinical settings ($r = - 0.469$). Moreover, Cheung et al. (2015) found that the second- and third-year nursing students' adherence to SP was significantly influenced by the adherence of other nurses in the unit ($p = 0.001$). Besides these cross-sectional studies, two qualitative research studies showed similar results in which nursing students stated that the presence of negative role models was one of the main factors that prevented them from adhering to SP (Kim & Oh, 2015; Ward, 2013). Nurses' adherence to RP can also be influenced by the presence of negative role models. Dombecki et al. (2015) observed hand hygiene practices of two groups of healthcare workers (HCWs) including nurses and they found the HCWs who worked with negative role models had significantly lower adherence to hand hygiene (29%) compared to those who worked with positive role models (71%, $p < 0.001$).

Inconvenient Location of Sinks and ABHR Dispensers.

The final barrier to be discussed is the inconvenient location of sinks and ABHR dispensers. The inconvenient location of ABHR dispensers was found to negatively impact nursing students' adherence to hand hygiene (Foote & El-Masri, 2016; Kirk et al., 2016) as well as the adherence of nurses and other HCWs (Deyneko et al., 2016; Zellmer et al., 2015). With regard to nursing students, the authors of the two Canadian studies explored the perceived predictors of hand hygiene and found that 36% of nursing students and 41% of nurses indicated that the inconvenient location of ABHR dispensers and hand wash sinks was one of the barriers that prevented them from adhering to hand hygiene (Foote & El-Masri, 2016; Kirk et al., 2016).

Besides the inconvenient location, visibility of ABHR dispensers and sinks can also influence adherence to hand hygiene. For instance, nurses and other HCWs were more likely to adhere to hand hygiene if ABHR dispensers and sinks were in a visible location (Deyneko et al., 2016; Zellmer et al., 2015). Moreover, nurses were significantly more likely to adhere to hand hygiene if hand wash sinks were in their direct vision (25.6 %) compared to those who did not visualize these sinks (8.5%) ($p = 0.001$) (Deyneko et al., 2016). Similarly, after two new sinks were placed in visible locations, hand hygiene adherence of nursing staff and other HCWs was significantly increased from 33.8% to 51.6% ($p = 0.03$), and the number of HCWs who did not clean their hands was significantly decreased from 54% to 37% ($p = 0.001$) (Zellmer et al., 2015). These results may indicate that the visibility of ABHR dispensers and hand wash sinks might be a factor for hand hygiene adherence.

In addition to the importance of ABHR dispensers' visibility, the distance of hand wash sinks from the patient zone was also an important factor for adherence (Deyneko et al., 2016; Kirk et al., 2016). For instance, when the distance between the patient zone and sink's location

increased, the nurses' adherence to hand hygiene decreased (adjusted OR, 0.90, 95 % CI, 0.84-0.97) (Deyneko et al., 2016). The authors also observed that nurses performed hand hygiene when the sink was located 7.6 meters from the patient zone and omitted hand hygiene when the sink was located 14.9 meters from the patient zone. Moreover, Kirk et al. (2016) surveyed 350 nurses and physicians from the United States and Canada about their knowledge, attitudes, and practices of hand hygiene. More than 50% of both groups agreed or strongly agreed that they were more likely to clean their hands if ABHR dispensers were located near the patient care zone. From these studies, we can conclude that if ABHR dispensers are not placed in a convenient location, nurses' adherence to hand hygiene will likely be negatively impacted.

In summary, descriptive research showed that nursing students and nurses are frequently encountering a number of barriers that prevented them from adhering to SP. These common barriers were high nursing workload, negative role models, and inconvenient location of ABHR dispensers. Addressing the workload can be difficult under current healthcare system constraints, while interventions related to negative role models have focused on having students and nurses work with positive role models (Dombecki et al., 2015; Huis et al., 2013; Schneider et al., 2009). In addition, it may not always possible to change the location of ABHR dispensers and hand wash sinks. Therefore, nurses and nursing students need to be prepared through specific strategies to deal with the influence of these barriers on their adherence to IPC practices. There is no single solution that students can use to deal with these barriers as each barrier could be dealt with using different strategies depending on the context (e.g., type of barriers, causes of barriers). Therefore, students need to use their cognitive skills and try multiple solutions, and evaluate which strategies would help them to deal with specific barriers. Multiple interventions, such as education, audits, and administrative support, have been evaluated with modest improvements in

adherence to hand hygiene recommendations (Gould et al., 2017), while education has been the main intervention for improving adherence to other aspects of RP, also with limited success (Moralejo et al., 2018). However, none of these interventions has specifically looked at the use of problem solving as a new approach to deal with the barriers to adherence to RP.

Problem Solving

Problem solving is defined as "the self-directed cognitive- behavioral process by which a person attempts to identify or discover effective or adaptive solutions for specific problems encountered in everyday living" (D'Zurilla & Nezu, 2010, p. 212). This definition was selected because it aligns with the objectives of this study as nursing students are expected to use their cognitive processes to find an effective solution for the barriers to RP adherence that they may encounter during their clinical practice. This problem-solving approach can help students to manage the complexity of today's nursing care (Vittrup & Davey, 2010).

An individual's problem-solving ability is commonly measured by the Problem-Solving Inventory (PSI). The PSI developed by Heppner and Petersen (1982) is a valid and reliable tool. The PSI is a 36-item questionnaire that uses a 6-point Likert scale. It has three dimensions, which are: problem-solving confidence (minimum and maximum score 11-66), approach-avoidance style (minimum and maximum score 16-96), and personal control (minimum and maximum score 5-30). A total score is calculated as the sum of these three subscales, which will show an individual's problem-solving ability. The overall score is a minimum of 32 and a maximum of 192. Lower scores indicate effective PS while higher scores indicate less effective PS (Heppner & Petersen, 1982); the midpoint is 112. The other but less commonly used scale was the Social Problem-Solving Inventory-Revised (SPSI-R). This scale consists of 52 questions in a 5-point Likert scale. The overall score is a minimum of 25 and a maximum of 125. Scores

from 25 to 50 indicate weak PS skills, from 50 to 75 indicate moderate PS skills, and more than 75 indicate strong PS skills. For the purpose of this literature review, scores around the midpoint using the PSI or categorized as moderate using the SPSI-R are labelled as medium in terms of problem-solving ability.

Problem-Solving Skills Among Nurses and Nursing Students

Problem solving is an important requisite skill that nurses and nursing students need to deliver effective and holistic nursing care (Lau, 2014). Three intervention studies (Ahmady & Shahbazi, 2020; Ancel, 2016; Yoo & Park, 2014) and two cross-sectional studies (Çinar et al., 2010; Erkuş & Bahçecik, 2015) have shown that nurse managers, nurses, and nursing students had medium problem-solving ability. The literature summary table found in Appendix A summarizes details of the five key studies related to problem solving discussed in this section of the literature review. These five studies were critically appraised using the PHAC critical appraisal tool (PHAC, 2014). The two cross-sectional studies were rated as high quality (Çinar et al., 2010; Erkuş &Bahçecik, 2015). Of the three intervention studies, two were rated as high quality (Ahmady & Shahbazi, 2020; Yoo & Park, 2014) and one was rated as medium quality due to inadequate control of confounding (Ancel, 2016).

The two cross-sectional studies and two of the intervention studies used the PSI developed by Heppner and Petersen (1982) (Ancel, 2016; Yoo & Park, 2014). However, the recent study by Ahmady and Shahbazi (2020) used a different scale, the SPSI-R. All these studies showed that the participating nurse managers, nurses, and nursing students had medium problem-solving ability (Ahmady & Shahbazi, 2020; Ancel, 2016; Çinar et al., 2010; Erkuş & Bahçecik, 2015; Yoo & Park, 2014). For instance, the two intervention studies that used PSI found that nurses and nursing students had medium problem-solving ability at the baseline

assessment, as scores, previously described, were 106 ± 24.06 (Yoo & Park, 2014) and 82 ± 12.9 (Ancel, 2016). Moreover, using SPSI-R, at baseline, the participants in the randomized controlled trial (RCT) study by Ahmady and Shahbazi (2020) had moderate PS (intervention 63.28 ± 3.08; control 64.57 ± 2.71). Similar results were also found by the two cross-sectional studies. For example, Erkuş and Bahçecik (2015) found that both nurse managers (102.6±12.8) and nurses (101.1±15.6) had medium problem-solving ability. In addition, Çinar et al. (2010) found that nursing students were rated less effective in problem-solving (86.85±18.55) compared to midwifery students (83.05±15.68).

Nursing students and nurses have been shown to have medium PS skills, which may affect their ability to deal with complex problems that they may encounter during their clinical practice. One of the problems is that they regularly encounter barriers to adherence to RP. Interventions are warranted to address PS ability.

Effectiveness of Problem-Solving Interventions

Three studies have evaluated the effect of PS training programs on improving PS ability among nurse managers, nursing students, and newly graduated nurses (Ahmady & Shahbazi, 2020; Ancel, 2016; Yoo & Park, 2014). One of these studies was an RCT (Ahmady & Shahbazi, 2020), one was a CBA study (Yoo & Park, 2014), and one was a UCBA study (Ancel, 2016). The intervention programs' durations, methods of delivery, and recruited participants varied in each study. For instance, the Iranian study used training programs that consisted of three hours of theoretical study and five hours of individual study (Ahmady & Shahbazi, 2020); the Turkish study used eight hours of theory, and 56 hours of practice given over seven weeks (Ancel, 2016). The intervention program by Yoo and Park (2014) consisted of three sessions, one session per week for three weeks, with each session lasting for 50 minutes. In each session, the students and

the facilitator discussed one of the three common problems encountered during their clinical practice. These studies aimed to examine the effect of PS training on the participants' PS skills.

All three of these studies found a significant improvement in PS after the participants received the problem-solving programs. For instance, Ancel (2016) used the PSI and found that the perceived problem-solving ability of nursing students improved after the intervention (82 ± 12.9) compared to the baseline (87.0 87.0 ± 16.7). As previously described, a lower score indicates more effective PS. Similarly, Yoo and Park (2014) also used the PSI and found that the graduate nurses who received the case-based learning had significantly better problem-solving confidence (95.53 ± 3.80) compared to those who received the lecture-based intervention (102.07 ± 2.93). Using the SPSI-R, Ahmady and Shahbazi (2020) found that the nurse managers who received the PSRP educational program had strong PS skills (109.12 ± 2.64), compared to the moderate skills in those in the control group (65.36 ± 2.03). The difference was statistically significant ($p<.0001$). Although these studies found a significant difference in the participants' PS skills as measured by the questionaries, none of them assessed the actual application of PS in clinical practice. A number of studies have also found that having PS skills has also been shown to improve nurses' and nursing students' critical thinking, decision making, and self-efficacy (Ahmady & Shahbazi, 2020; Çinar et al., 2010; Heidari & Shahbazi, 2014; Kanbay & Okanlı, 2017; Shahbazi et al., 2018).

In summary, PS is an important skill that both nurses and nursing students should have acquired during their nursing education and should be emphasized and reinforced during clinical practice. However, research showed nurse managers and nurses had medium problem-solving ability. PS interventions have been shown to strengthen PS skills related to areas other than infection prevention and control (Ahmady & Shahbazi, 2020; Ancel, 2016; Yoo & Park, 2014).

The intervention programs' durations, methods of delivery, and recruited participants varied in each study. All of the previously discussed interventions were focused on strengthening PS related to workplace issues such as a situation when there was a miscommunication between nurses and patients (Ahmady & Shahbazi, 2020; Ancel, 2016; Yoo & Park, 2014). For instance, some of these discussed situations were delayed laboratory tests, delayed discharge time, and unsatisfactory pain control. In addition, only one of these studies evaluated a PS intervention for nursing students. However, none of these interventions have used PS to address the barriers to adherence to RP. With such limited research, further research into effective strategies is warranted.

Strengthening IPC Practices in Nursing Students

The focus of this dissertation research study is on strengthening the PS skills of nursing students and their nursing instructors to address barriers to RP adherence. Nursing students will be the future nurses, nursing instructors, and nursing leaders. As such, if they are equipped with specific PS strategies to address concerns related to infection control, they can more readily translate this knowledge into practice as a registered nurse. Nursing students should therefore graduate with the knowledge, confidence, and ability to apply PS to deal with the barriers to adherence to RP. Nursing instructors have a significant role in teaching, discussing, and reinforcing RP. If nursing instructors have the knowledge, the confidence, and effective teaching strategies related to RP and PS, as well as tools to use to facilitate application, then they will be able to reinforce these processes while they are supervising students in clinical practice. As a result, nursing students will have the necessary knowledge and problem-solving skills, they will be capable of overcoming the barriers to RP, and they will have better adherence to RP.

There is limited research about the knowledge, skills and needs of nursing instructors related to infection prevention and control. However, one recent study conducted in Atlantic Canada showed that only 26.9% of nursing educators and 20.0% of nursing students reported feeling very confident in PS related to infection prevention and control, with 24.0% of nursing students reporting that they did not feel confident in this area (Chiasson, 2015). In addition, only 60.9% of nursing instructors felt adequately prepared for their role in teaching infection prevention and control material, and of those, only 42.9% had high knowledge scores related to infection prevention and control. Furthermore, 84.0% of instructors responded that they wanted to have more infection prevention and control education. Therefore, it is important to understand PS related to RP among nursing students and instructors and to identify strategies to strengthen their knowledge and skills.

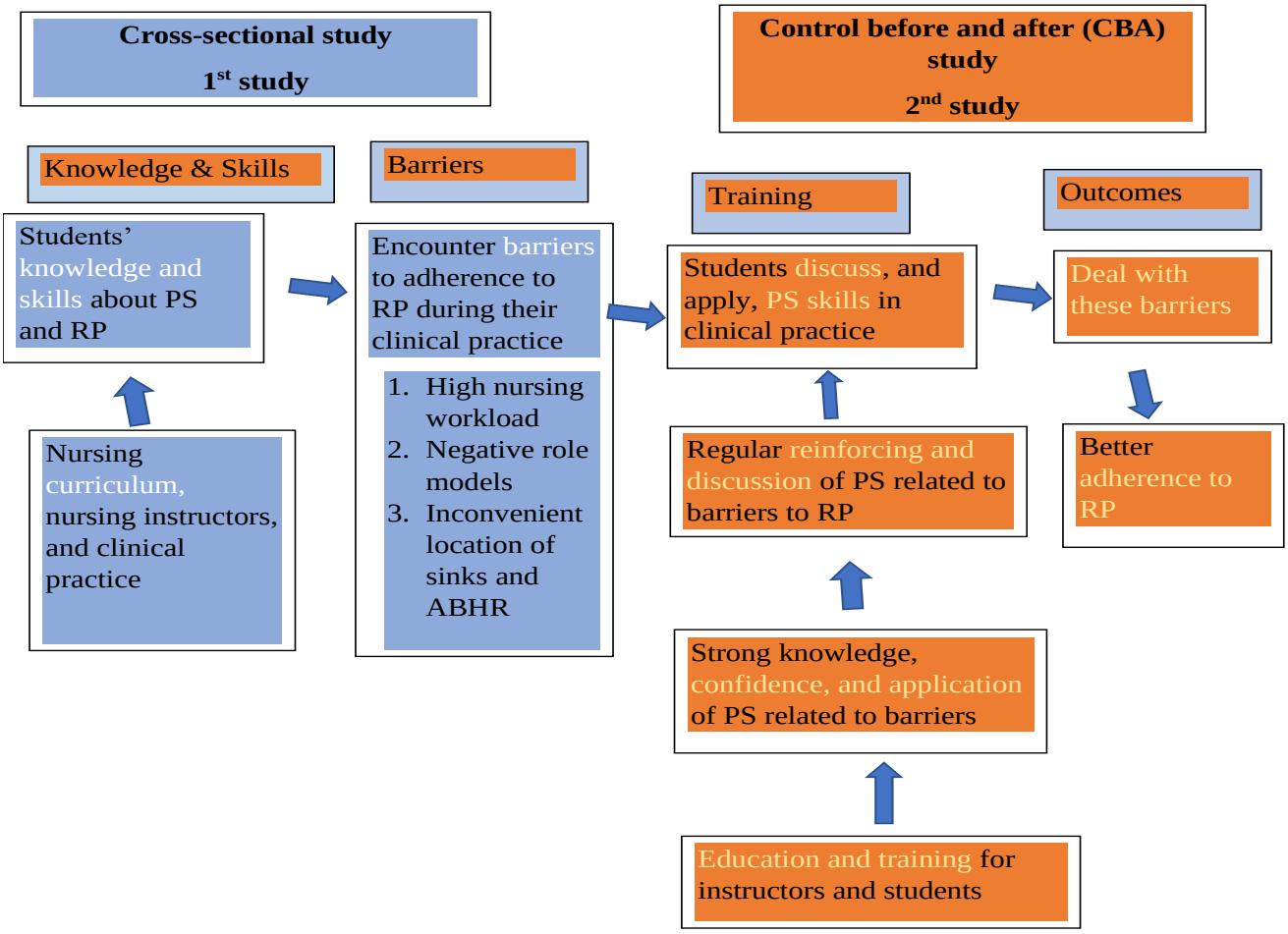
In the next section, we discuss the research problem, the logic underpinning the research, theoretical frameworks underpinning the design of an intervention related to PS, and the methods used for the two studies.

The Research Problem

Evidence has shown that HAIs are prevalent and have major consequences on patients, nurses, and the healthcare system. Fortunately, the majority of HAIs and their consequences can be prevented through adherence to RP. However, nurses and nursing students have shown suboptimal adherence to RP due to a number of barriers that they encounter during their clinical practices. The most common reported barriers are the presence of negative role models, high nursing workload, and inconvenient location of ABHR dispensers. A number of interventions have been implemented to improve nurses' and nursing students' adherence to RP with limited success; however, none of these interventions have focused on using PS as a new approach to

deal with these barriers. Because it is not always feasible to eliminate these barriers, PS can potentially help nursing students and others to deal with these barriers and have better adherence to RP. A PSRP educational program was developed and implemented as a new approach to promote nursing students' and instructors' adherence to RP. However, before we developed and implemented such an intervention program, it was crucial to understand PS and RP among nursing students and instructors.

Figure 1: *Logic Underpinning the Research*



Overview of the Studies

Two different but linked studies were conducted to address the research problem. The first study was a cross-sectional study, and the second study was a controlled before and after study. The logic underpinning the research is summarized in Figure 1. As can be seen, students acquire their knowledge and skills about RP from their nursing curriculum and from their clinical practice. During their clinical practice, nursing students may encounter a number of barriers to adherence to RP such as high nursing workload, presence of negative role models, and inconvenient location of hand wash sinks and ABHR dispensers. The cross-sectional study explored their knowledge about RP and PS, and the barriers that they encounter. A PS intervention was developed utilizing the results of the cross-sectional study and was tested in the CBA study. The underlying assumption is that if nursing students have better PS skills and their instructors have strong knowledge and skills about PS, and they are continuously reinforcing the use of PS during clinical practice, this may help students to manage these barriers and as a result demonstrate better adherence to RP. Each study had its own research questions and methods that are briefly described in this chapter with more details provided in Chapters 2 and 3. This was not a mixed methods study and there was no overarching research question.

Overview of the Cross-sectional Study

The first study was a cross-sectional survey conducted to assess nursing instructors' and nursing students' knowledge, confidence, application of both RP and PS related to RP, and strategies to teach PS related to RP and address barriers to adherence. The study was conducted with students and instructors in a baccalaureate program at three nursing Schools, A, B and C, in Atlantic Canada. The study proceeded only once ethical and other approvals were obtained. The approval letters can be found in Appendix B.

Research Questions

The research questions were:

1. How knowledgeable are nursing students and nursing instructors about PS and RP?
2. What barriers prevent nursing students and nursing instructors from adhering to RP?
3. What strategies have nursing students and nursing instructors used to deal with the barriers of adherence to RP?
4. How confident are nursing students and nursing instructors about performing RP?
5. How confident are nursing students and nursing instructors about applying PS to deal with barriers of adherence to RP?
6. What teaching methods do nursing students and instructors recommend as the best for use to teach PS related to RP?
7. What is the opinion of nursing students and instructors about the best time in the nursing program to learn about PS related to RP?

Recruitment and Data Collection

To recruit the study participants, permission was first obtained from the three nursing schools. Two information sheets, one to students and one to instructors, were sent to the offices of the Associate Dean or Associate Director at the three schools. The schools' administrators then distributed the information sheets and cover emails to all students and instructors at each site. The information sheets can be found in Appendix C and the cover emails can be found in Appendix D. The information sheets for instructors and students explained the purpose of the study, asked them to voluntarily participate in the survey, and provided them with contact information of the researchers. All nursing students (in all years) and instructors at the three

nursing schools were invited to participate in the study; 20 instructors and 577 nursing students were recruited in the study.

Data were collected using the *RP and Problem-Solving Questionnaire.* Nursing instructors and nursing students in Year 4 completed the survey online because they were not on campus at the time of the study. The survey was developed and administered using Qualtrics, the approved web-based survey platform for use at the University. Students in Years 1, 2, and 3, however, completed the questionnaire during the first 15 to 20 minutes of a class; the administrators identified which class to use and made arrangements.

Data Collection Instrument

The *RP and Problem-Solving Questionnaire* was developed by the researchers based on the literature, the objectives of this study, and infection control experts' feedback. This questionnaire consisted of short answer questions, true-false questions, and questions using different rating scales. It was designed to measure nursing instructors' and nursing students' knowledge, confidence, and application of both RP and PS related to RP, as well as their opinions as to when to learn and strategies to teach PS related to RP, and how to address barriers to adherence. Further details can be found in Chapter 2, and a copy of each version can be found in Appendix E.

Prior to use in the survey, feedback about the *RP and Problem-Solving Questionnaire* was obtained from a group of experts in infection prevention and control, and there were no recommended changes. A pilot test was then conducted with six students and two faculty members to check for completion time and ensure the ability of participants to understand the questions correctly. The researchers discussed their feedback and recommendations with pilot test participants. Based on their feedback, minor changes were made to the questionnaire.

Ethical Considerations

This research study was approved by the Health Research Ethics Board, and the appropriate regional research proposal approval committee. Individual approval from each school was also obtained. Ethical approval letters can be found in Appendix B. The study was initiated after all required ethical and school approvals were obtained. Loss of class time was minimal for students and the survey was conducted with the approval of the schools. Approximately 15 to 20 minutes were required from the participants to complete the paper questionnaire or the online questionnaire. Nursing instructors and nursing students had the right to refuse to participate without any impact on their employment or student status and had the right to decline to answer certain questions. To maintain participants' confidentiality and anonymity, no identifying information was collected from the participants as part of the survey. The completion of the questionnaire implied consent. Data collected from both nursing instructors and from Year 4 nursing students were stored electronically by the *Qualtrics* survey software and it is subject to their privacy policy. The paper questionnaires collected from students in Years 1, 2, and 3 were securely stored in a locked cabinet in the nursing program graduate office of Memorial University.

Data Analysis

Descriptive statistics were used to describe the course instructors' and nursing students' demographic characteristics such as age, sex, and years of experiences. In addition, frequencies and proportions were reported for each item in the questionnaire. The short answer knowledge questions were scored as correct or incorrect and compared in terms of proportions that answered the questions correctly. The data were analyzed with Stata statistical software version 14.0 (StataCorp. 2015).

The PSRP Intervention

Following the first study, a Problem-Solving Routine Practices (PSRP) educational program was developed so that it could be implemented for nursing students to be able to deal with the barriers to adherence to RP. This problem-solving educational program was informed by the results of the first study as well as the literature. The ADDIE Instructional System Design Model, Social Problem-Solving Model, and Constructivist Learning Theory were used to guide the PSRP intervention. For instance, the steps of the ADDIE model were followed to develop the PSRP educational program, and both the Social Problem-Solving Model and Constructivist Learning Theory were used to guide decisions about the content and delivery of the PSRP educational program. Each of these models/theories are described briefly below followed by the description of the PSRP educational program.

The ADDIE Instructional System Design Model

The ADDIE model is commonly used to assess, design, develop, implement and evaluate education programs (Kruse, 2002). According to the ADDIE model, the intervention should be learner-centered, goal-oriented, and focused on real-world performance (Gustafson & Branch, 2002). The ADDIE model consists of five phases: analysis, design, development, implementation, and evaluation.

In the analysis phase, the researchers should gather information to help clarify learning needs and should determine the objectives of the education program. For this study, a cross-sectional survey was conducted to gather information about the knowledge, confidence, and application of PS related to RP among nursing students and nursing instructors, as well as the barriers to adherence to RP that they encountered during their clinical practice. Based on the results of this cross-sectional study, objectives of this study, and the review of literature, three

main educational objectives were developed for the PSRP education program that was tested in the second study. The learner objectives were to: 1) explain the basic principles of RP, 2) explain PS and its steps, and 3) apply PS to the identified barriers to adherence to RP.

In the design phase, the researchers should determine the content related to the program, and how this content will be delivered to the participants. Based on the developed objectives of the PSRP educational program, topics were identified that needed to be covered such as review of specific points related to RP, steps of PS, and dealing with the barriers to adherence to RP. Moreover, based on the analysis phase of the model and the developed objectives of the program, we used the Constructivist Learning Theory (Aliakbari et al., 2015) to select a group case discussion as the most appropriate teaching method to deliver the content and to engage the participants in active learning and knowledge construction. Furthermore, we also used the Social Problem-Solving Model ((D'zurilla & Goldfried, 1971) steps to develop the discussion questions related to the three identified barriers.

In the development phase, the researchers should plan and provide appropriate details about the intervention program. Based on the analysis and design phases of the model, materials used in the PSRP education program were planned and developed with related instructions. These materials were the PowerPoint slides used for the education, and the mini cases for group discussion and their discussion related questions.

In the implementation phase, the researchers should deliver the education program to the selected participants. The researchers delivered the PSRP education program to nursing students in selected classes in Year 2 and Year 3 and to instructors at School A, in the fall semester of 2019. Students in Years 2 and 3 were selected because they were in clinical placements at the

time of the study, so that they could apply PS to deal with barriers. Instructors were selected so that they could discuss and reinforce students' application of PS in clinical.

In the evaluation phase, the researchers should obtain participants' feedback about the program. Based on the model, the researchers developed a feedback form to obtain the participants' opinions and evaluation for the PSRP educational program as well as any additional comments. Furthermore, the effects of the PSRP education program were evaluated in the CBA, discussed in the next section.

Social Problem-Solving Model

The Social Problem-Solving Model identifies six steps of PS: 1) general orientation about the problem; 2) defining and formulating the problem; 3) production of alternative solutions; 4) decision-making; 5) implementation of a solution, and 6) evaluation of the result (D'zurilla & Goldfried, 1971). According to the model, in the general orientation about the problem step, an individual identifies that there is a problem, acknowledges that the problem is changeable, and believes that he or she can solve the problem. In the defining and formulating the problem step, an individual collects the necessary information about the problem, analyzes the problem, and specifies the actual objectives to deal with the problem. In the production of alternative solutions step an individual determines multiple number of solutions that can be used to deal with the problem and weigh the pros and cons for each selected solution. In the decision-making step, an individual selects the best solution to solve the problem. In the implementation of a solution step, an individual implements the selected solution to solve the problem. In the last step (evaluation of the result), an individual observes and evaluates the result of implementing the selected solution (D'zurilla & Goldfried, 1971).

The application of this model was taught as part of the PSRP educational program to address problems related to adherence to RP. These six steps of the PS model were used by the researchers to develop three PS discussion guides for the three identified barriers to RP adherence (high nursing workload, inconvenient location of ABHR dispensers, and negative role models). The questions in each of these PS discussion guides were developed based on the six steps of the PS model. Students who participated in the PSRP educational program were divided by the researchers into three to four small groups. Each student in these groups was given a PS discussion guide, which includes questions based on the steps of the PS. Students in each group used these PS steps to identify: the barrier, why it is a problem, what are the possible solutions, what are the pros and cons of these selected solutions, what is the best solution that they can use to deal with the barrier, and how they would know if this solution was effective.

Constructivist Learning Theory

Constructivist Learning Theory emphasizes that acquired knowledge and skills should be constructed by the learner through authentic and applied experiences and encourages the active participation of the learners in group discussions related to certain problems with the presence of a facilitator (Aliakbari et al., 2015). The major focus of this theory is that learning is an active process in which the learner will construct and negotiate new ideas and meanings based on their current or previous experience and discussing, reflecting and sharing of meanings with peers (Hoover, 1996). For instance, rather than using an educator's knowledge to solve a problem, students construct and share their ideas based on specific learning needs. The educator works as a facilitator of the learning process by developing educational materials and using techniques such as problem solving, reflection, and concept mapping to guide the discussion throughout the learning process (Brandon & All, 2010). The students and the educator engage in discussion

about certain ideas, and the educator's role is to encourage the students to discover the principles or the solutions of a certain problem by themselves (Brandon & All, 2010).

The Constructivist Learning Theory approach was applied in the PSRP educational program by dividing the participants into small groups, then each group was given a case study related to the three commonly encountered barriers to adherence to RP. A group discussion was used to encourage the students to discuss these three identified barriers and construct strategies that they can use to deal with these barriers. The participants discussed the cases based on their current and previous knowledge and experiences. To help guide the education process, and based on the steps of the problem-solving model, the researchers created three discussion guides for each of the barriers. Each student in the group was given a PS discussion guides, and each group had their own facilitator to help guide the discussion and keep the students within the learning objectives. Students in each group were active learners because they followed the questions in each discussion guide to deal with each of the barriers. The facilitators and students engaged in a discussion about the selected solutions that were constructed by the students based on the participants' previous experience, as well as the current information that they received as part of the PSRP educational program. In addition, during the educational program, the researchers used the questions on the PS discussion guides and asked the students to go through each step of PS, and share their experiences in dealing with each of the barriers to RP adherence. To encourage discussion, we chose group discussion as a teaching method to deliver our intervention program because it aligns with the Constructivist Learning Theory approach by allowing the students to construct their own knowledge and solutions about a problem and become the leader of the learning process. In addition, group discussion was also found to create a positive learning

environment, allows for deep interaction and discussion, promotes reflection, and improves learning outcomes (Baghcheghi et al., 2010; Lin et al., 2013).

Overview of the CBA Study

A CBA study was conducted to examine the effect of the PSRP educational program on nursing students' knowledge, confidence, discussion, and application related to PS, as well as self-reported adherence to RP. The study also aimed to examine the effect of the program on instructors' knowledge and application of PS to help students. The study was conducted with students and instructors in the baccalaureate nursing program at Schools A and B. The study proceeded only once ethical and other approvals were obtained. The approval letters can be found in Appendix F.

Research Questions

The research questions were:

1. What is the effect of the PSRP educational program on nursing students':
    a) Knowledge about RP?
    b) Knowledge about PS?
    c) Self-reported discussion of PS to deal with identified barriers to adherence to RP?
    d) Self-reported application of PS to deal with identified barriers to adherence to RP?
    e) Confidence about applying PS to deal with identified barriers to adherence to RP?
    f) Self-reported adherence to RP?

2. What are the barriers to adherence to RP that students encounter in their clinical practice?
3. What is the effect of the PSRP educational program on nursing instructors' discussion, reinforcement, and application of PS related to RP?

Recruitment

To recruit the study participants, permission was first obtained from the two nursing schools. The cover emails and information sheets explaining the purpose of the study were sent by the researchers to the office of the Associate Dean or Associate Director, who then distributed the appropriate cover emails and information sheets to nursing students and nursing instructors at the two schools. The cover emails can be found in Appendix G and the information sheets can be found in Appendix H. The information sheets for instructors and students at School A (intervention group) asked them to voluntarily participate in a 2-hour training program related to PS and RP and complete the study questionnaires before the beginning of the intervention program (baseline) as well as 4 to 6 weeks later (follow-up), as part of a specific course. The information sheets for nursing students and instructors at School B (control group) asked them to complete the study questionnaires related to problem solving and RP as part of a specific course at baseline as well as 4 to 6 weeks later (follow-up). There was a total of 96 students recruited into the study, with 62 recruited into the intervention group at School A, and 34 recruited into the control group at School B. There was a total of nine instructors recruited into the study, with five recruited into the intervention group at School A, and four recruited into the control group at School B.

Data Collection Procedures

The data collection for students took place as part of specific courses that were identified by the school administrators. In the intervention group at School A, the PSRP educational program was given to each student in each of these specific courses. The researchers administered the study questionnaires to the participants before the beginning of the intervention program (baseline) and 4 to 6 weeks later (follow-up). In the control group at School B, a research assistant was hired to administer the study questionnaires to the participants at baseline and 4 to 6 weeks later (follow-up) during specific classes. The control group did not receive any intervention. The study questionnaires were mailed out to a research assistant at School B, who then sent them back by a courier after the data collection was completed. The instructors completed the data collection questionnaires at the same time as the students.

Data Collection Instruments

Problem-Solving Questionnaire.

The *Problem-Solving Questionnaire* was used to collect the data from study participants. The *Problem-Solving Questionnaire* was developed by the researchers based on the results of a recent cross-sectional study conducted by the researchers, a literature review, and the objectives of this study. This questionnaire was designed to measure nursing students' knowledge, confidence, discussion, and application related to PS and RP, as well as self-reported adherence to RP. Further details about this questionnaire can be found in Chapter 3. There were separate versions for the students and for the instructors with minor wording changes for the latter to reflect helping students rather than the instructors' behaviour. Copies of the questionnaire for both students and instructors can be found in Appendix I.

Validity and Piloting of the Questionnaires.

The study questionnaire was validated and piloted. The study questionnaire was tested for content validity through administration to a group of experts in adult learning and infection prevention and control to determine whether questions measured the outcomes of interest. Its content validity was evaluated by four experts in the field of nursing and infection prevention and control, with an acceptable content validity index of 0.80. The pilot test group consisted of a faculty member and 16 nursing students with similar characteristics to the study group. The researchers discussed their feedback and recommendations with them. Based on their feedback, minor changes were made on the questionnaire.

Feedback Form.

Based on the ADDIE model, the researchers developed a feedback form to obtain the participants' opinions and evaluation for the PSRP educational program as well as any additional comments. The feedback form was administered to the intervention group after they completed the intervention at baseline. Details can be found in Chapter 3 and the feedback form can be found in Appendix J.

Ethical Considerations

Ethical approval for this study was obtained from the Health Research Ethics Board, and the appropriate regional research proposal approval committee. Individual approval from each school was also obtained. Participation in the study was voluntary. To maintain participants' confidentiality and anonymity, no participants' information was collected (such as names or student numbers). Anonymity was ensured by coding the study questionnaire to ensure that pre-test and post-test questionnaires could be linked. The completion of the baseline and follow-up questionnaires implied consent. Only the research team could access the data, and computerized

files were password protected. Data collected from students and instructors were securely stored in a locked cabinet in the nursing program graduate office of Memorial University. In addition, data will be kept in a locked file cabinet for at least 5 years, as per Memorial University policy.

Data Analysis

Data analysis was conducted using Stata statistical software version 14.0 (StataCorp, 2015). Descriptive statistics were used to describe the students' and the instructors' demographic data. They were also used to describe participants' knowledge, confidence, and application of PS related to RP, the barriers to adherence to RP, and adherence to RP. Chi-square was used to test the differences in the proportions of the participants' knowledge, confidence, adherence, application, and discussion of PS related to RP between baseline and the follow-up for intervention and control groups; the independent t-test was used to test differences in mean scores. Regression had been planned but was not conducted because only very small differences were noted with bivariate analysis and the sample size was small. Details can be found in Chapter 3.

Conclusion

Nurses and nursing students regularly encounter a number of barriers that prevent them from adhering to RP. This dissertation research study focused on understanding students' and instructors' knowledge, confidence, and application of PS related to RP; implemented and evaluated a PS intervention to deal with the three common barriers to RP adherence; and examined role models and nursing students' adherence to RP. It can help improve our understanding of how to strengthen adherence to RP, which can then have a positive impact on the prevention of HAIs.

References

Adebayo, O., Labiran, A., & Imarhiagbe, L. (2015). Standard Precautions in clinical practices: A review. *Int. J. Health Sci. Res*, *5*, 521-528. Available at file:///C:/Users/user/Downloads/Standard_Precautions_in_Clinical_Practic.pdf.

Ahmady, S., & Shahbazi, S. (2020). Impact of social problem-solving training on critical thinking and decision making of nursing students. *BMC Nursing, 19*(1), 1-8. https://doi.org/10.1186/s12912-020-00487-x

Akagbo, S. E., Nortey, P., & Ackumey, M. M. (2017). Knowledge of standard precautions and barriers to compliance among healthcare workers in the Lower Manya Krobo District, Ghana. *BMC Research Notes*, *10*(1), 432. https://doi.org/10.1186/s13104-017-2748-9

Aliakbari, F., Parvin, N., Heidari, M., & Haghani, F. (2015). Learning theories application in nursing education. *Journal of Education and Health Promotion, 4*. https://doi.org/10.4103/2277-9531.151867

Al-Khawaldeh, O. A., Al-Hussami, M., & Darawad, M. (2015). Influence of nursing student's handwashing knowledge, beliefs, and attitudes on their handwashing compliance. *Health, 7*(05), 572. https://doi.org/10.4236/health.2015.75068

AL-Rawajfah, O. M., & Tubaishat, A. (2015). Nursing students' knowledge and practices of standard precautions: a Jordanian web-based survey. *Nurse Education Today*, *35*(12), 1175-1180. https://doi.org/10.1016/j.nedt.2015.05.011

Ancel, G. (2016). Problem-Solving Training: Effects on the Problem-Solving Skills and Self-Efficacy of Nursing Students. *Eurasian Journal of Educational Research, 16*(64). https://doi.org/10.14689/ejer.2016.64.13

Arefian, H., Hagel, S., Fischer, D., Scherag, A., Brunkhorst, F. M., Maschmann, J., & Hartmann, M. (2019). Estimating extra length of stay due to healthcare-associated infections before and after implementation of a hospital-wide infection control program. *PloS One, 14*(5), e0217159. https://doi.org/10.1371/journal.pone.0217159

Atif, S., Lorcy, A., & Dubé, E. (2019). Healthcare workers' attitudes toward hand hygiene practices: Results of a multicentre qualitative study in Quebec. *Canadian Journal of Infection Control, 34*(1). Available at https://ipac-canada.org/photos/custom/CJIC/CJIC_Spring2019_Atif.pdf.

Badia, J. M., Casey, A. L., Petrosillo, N., Hudson, P. M., Mitchell, S. A., & Crosby, C. (2017). Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *Journal of Hospital Infection*, *96*(1), 1-15. https://doi.org/10.1016/j.jhin.2017.03.004

Baghcheghi, N., Kouhestani, H., & Rezaei, K. (2010). Comparison of the Effect of Teaching through Lecture and Group Discussion on Nursing Students' Communication Skills with Patients. *Iranian Journal of Medical Education*, *10*(3). Available at http://ijme.mui.ac.ir/article-1-1307-en.html.

Barker, A. K., Brown, K., Siraj, D., Ahsan, M., Sengupta, S., & Safdar, N. (2017). Barriers and facilitators to infection control at a hospital in northern India: a qualitative study. *Antimicrobial Resistance & Infection Control*, *6*(1), 35. https://doi.org/10.1186/s13756-017-0189-9

Brandon, A. F., & All, A. C. (2010). Constructivism theory analysis and application to curricula. *Nursing Education Perspectives*, *31*(2), 89-92. Available at https://pubmed.ncbi.nlm.nih.gov/20455364/

Canadian Nosocomial Infection Surveillance Program. (CNISP). (CNISP, 2014). Methicillin-resistant *staphylococcus aureus* in Canadian acute-care hospitals. Available at https://www.ammi.ca/Guideline/25.ENG.pdf.

Canadian Nosocomial Infection Surveillance Program (CNISP). (CNISP, 2015). Healthcare-associated Infections Annual Report 2009-2014. Retrieved from https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2014.pdf.

Canadian Nosocomial Infection Surveillance Program (CNISP). (2020). Surveillance for Clostridioides *difficile* infection (CDI), CDI Surveillance Protocol. Available at https://ipaccanada.org/photos/custom/Members/CNISPpublications/CNISP%202020%20CDI%20Protocol_EN.pdf.

Canadian Patient Safety Institute (CPSI). (2016). Canadian Surgical Site Infection Prevention. Audit Month February 2016. Available at https://www.patientsafetyinstitute.ca/en/toolsResources/Documents/SSI%20Audit%202016_Recap%20Report%20EN.pdf.

Centers for Disease Control and Prevention (CDC). (2014). Types of healthcare-associated infections. Available at https://www.cdc.gov/hai/infectiontypes.html.

Centers for Disease Control and Prevention (CDC). (2018). Healthcare-associated infections. HAI Data and Statistics. Available at https://www.cdc.gov/hai/surveillance/index.html.

Cheung, K., Chan, C. K., Chang, M. Y., Chu, P. H., Fung, W. F., Kwan, K. C., ... & Mak, H. M. (2015). Predictors for compliance of standard precautions among nursing students. *American Journal of Infection Control*, *43*(7), 729-734. https://doi.org/10.1016/j.ajic.2015.03.007

Chiasson, M. (2015). *Exploring infection prevention and control education in Atlantic Canadian undergraduate nursing education programs* (Doctoral dissertation, Memorial University of Newfoundland). Available at https://research.library.mun.ca/8446/.

Choi, J. S., & Kim, K. M. (2018). Factors influencing nursing students' intention to comply with infection control practices. *American Journal of Infection Control*, *46*(6), 717-719. https://doi.org/10.1016/j.ajic.2017.12.010

Çinar, N., Sözeri, C., Şahin, S., Cevahir, R., & Say, M. (2010). Problem solving skills of the nursing and midwifery students and influential factors. *Rev Eletr Enf, 12*(4), 601-606. Retrieved from file:///C:/Users/user/Downloads/Problem_solving_skills_of_the_nursing_and_midwifer%20(2).pdf.

Colet, P. C., Cruz, J. P., Alotaibi, K. A., Colet, M. K., & Islam, S. M. (2017). Compliance with standard precautions among baccalaureate nursing students in a Saudi university: A self-report study. *Journal of Infection and Public Health*, *10*(4), 421-430. https://doi.org/10.1016/j.jiph.2016.06.005

Cruz, J. P. (2019). Infection prevention climate and its influence on nursing students' compliance with standard precautions. *Journal of Advanced Nursing*, *75*(5), 1042-1052. https://doi.org/10.1111/jan.13904

Day, H. R., Perencevich, E. N., Harris, A. D., & Gruber-Baldini, A. L., Himelhoch, S. S., Brown, C. H., & Morgan, D. J. (2013). Depression, anxiety, and moods of hospitalized patients under contact precautions. *Infection Control & Hospital Epidemiology*, *34*(3), 251-8. https://doi.org/10.1086/669526

Day, H. R., Perencevich, E. N., Harris, A. D., & Himelhoch, S. S., Brown, C. H., Gruber-Baldini, A. L., ... & Morgan, D. J. (2011). Do contact precautions cause depression? A two-year study at a tertiary care medical centre. *Journal of Hospital Infection, 79*(2), 103-107. https://doi.org/10.1016/j.jhin.2011.03.026

Deniz Kocoglu, R. N., Duygulu, S., Abaan, E. S., & Akin, B. (2016). Problem Solving Training for First Line Nurse Managers. *International Journal, 9*(3), 955. Retrieved from http://www.internationaljournalofcaringsciences.org/docs/24_kokoglu_originial_9_3.pdf.

Deyneko, A., Cordeiro, F., Berlin, L., Ben-David, D., Perna, S., & Longtin, Y. (2016). Impact of sink location on hand hygiene compliance after care of patients with Clostridium difficile infection: a cross-sectional study. *BMC Infectious Diseases*, *16*(1), 203. https://doi.org/10.1186/s12879-016-1535-x

Dombecki, C., Shah, M. M., Eke-Usim, A., Akkina, S. R., Ahrens, M., Sturm, L., ... & Foxman, B. (2015). The impact of role models on hand hygiene compliance. *Infection Control & Hospital Epidemiology*, *36*(5), 610-612. https://doi.org/10.1017/ice.2015.20

Dorgham, S. R., & Obied, H. K. (2016). Factors affecting nurse interns' compliance with standard precautions for preventing stick injury. *Journal of Nursing Education and Practice, 6*(12), 121–130. https://doi.org/10.5430/jnep.v6n12p121

D'zurilla, T. J., & Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of Abnormal Psychology*, *78*(1), 107. https://doi.org/10.1037/h0031360

D'Zurilla, T. J., & Nezu, A. M. (2010). Problem-solving therapy. *Handbook of cognitive-behavioral therapies*, *3*, 197-225.

Erkus, B., & Bahçecik, N. (2015). Level of critical thinking and problem-solving skills of administrator nurses and nurses who work at private hospitals. *Clinical and Experimental Health Sciences*, *5*(1), 1. https://doi.org/10.5455/musbed.20141106035312

Foote, A., & El-Masri, M. (2016). Self-perceived hand hygiene practices among undergraduate nursing students. *Journal of Research in Nursing*, *21*(1), 8-19. https://doi.org/10.1177/1744987115606959

Gili-Ortiz, E., González-Guerrero, R., Béjar-Prado, L., López-Méndez, J., & Ramírez-Ramírez, G. (2015). Surgical site infections in patients who undergo radical cystectomy: excess mortality, stay prolongation and hospital cost overruns. *Actas Urológicas Españolas (English Edition)*, *39*(4), 210-216. https://doi.org/10.1016/j.acuro.2014.11.004

Gould, D. J., Moralejo, D., Drey, N., Chudleigh, J. H., & Taljaard, M. (2017). Interventions to improve hand hygiene compliance in patient care. *Cochrane Database of Systematic Reviews*, (9). https://doi.org/10.1002/14651858.CD005186.pub3

Guilley-Lerondeau, B., Bourigault, C., des Buttes, A. C. G., Birgand, G., & Lepelletier, D. (2017). Adverse effects of isolation: a prospective matched cohort study including 90 direct interviews of hospitalized patients in a French University Hospital. *European Journal of Clinical Microbiology & Infectious Diseases*, *36*(1), 75-80. https://doi.org/10.1007/s10096-016-2772-z

Gustafson, K. L., & Branch, R. M. (2002). What is instructional design? *Trends and issues in instructional design and technology*, 16-25.

Haddadin, Y., & Regunath, H. (2019). Central line associated blood stream infections (CLABSI). In *StatPearls [Internet]*. StatPearls Publishing. Available at https://www.ncbi.nlm.nih.gov/books/NBK430891/.

Haque, M., Sartelli, M., McKimm, J., & Bakar, M. A. (2018). Health care-associated infections–an overview. *Infection and Drug Resistance*, *11*, 2321. https://doi.org/10.2147/IDR.S177247

Heppner, P. P., & Petersen, C. H. (1982). The development and implications of a personal problem-solving inventory. *Journal of Counseling Psychology*, *29*(1), 66. https://doi.org/10.1037/0022-0167.29.1.66

Hessels, A. J., & Larson, E. L. (2016). Relationship between patient safety climate and standard precaution adherence: a systematic review of the literature. *Journal of Hospital Infection*, *92*(4), 349-362. https://doi.org/10.1016/j.jhin.2015.08.023

Hinkin, J., & Cutter, J. (2014). How do university education and clinical experience influence pre-registration nursing students' infection control practice? A descriptive, cross sectional survey. *Nurse Education Today*, *34*(2), 196-201. https://doi.org/10.1016/j.nedt.2013.09.005

Hoover, A., Wesley. (1996). The practice implications of constructivism. Available at https://sedl.org/pubs/sedletter/v09n03/practice.html.

Huis, A., Schoonhoven, L., Grol, R., Donders, R., Hulscher, M., & van Achterberg, T. (2013). Impact of a team and leaders-directed strategy to improve nurses' adherence to hand hygiene guidelines: a cluster randomized trial. *International Journal of Nursing Studies*, *50*(4), 464-474. https://doi.org/10.1016/j.ijnurstu.2012.08.004

Jia, H., Li, L., Li, W., Hou, T., Ma, H., Yang, Y., ... & Luo, X. (2019). Impact of healthcare-associated infections on length of stay: a study in 68 hospitals in China. *BioMed Research International*. https://doi.org/10.1155/2019/2590563

Joanna Briggs Institute (JBI) Critical Appraisal tools. (2017). Retrieved from Qualitative Researchhttps://joannabriggs.org/sites/default/files/2019-05/JBI_Critical_Appraisal-Checklist_for_Qualitative_Research2017_0.pdf.

Kaba, A., Baumann, A., Kolotylo, C., & Akhtar-Danesh, N. (2017). A descriptive case study of the changing nature of nurses' work: The impact of managing infectious diseases requiring isolation. *American Journal of Infection Control*, *45*(2), 200-202. https://doi.org/10.1016/j.ajic.2016.06.036

Keenan, J. E., Speicher, P. J., Thacker, J. K., Walter, M., Kuchibhatla, M., & Mantyh, C. R. (2014). The preventive surgical site infection bundle in colorectal surgery: an effective approach to surgical site infection reduction and health care cost savings. *JAMA Surgery*, *149*(10), 1045-1052. https://doi.org/10.1001/jamasurg.2014.346

Khan, H. A., Baig, F. K., & Mehboob, R. (2017). Nosocomial infections: Epidemiology, prevention, control and surveillance. *Asian Pacific Journal of Tropical Biomedicine*, *7*(5), 478-482. https://doi.org/10.1016/j.apjtb.2017.01.019

Kim, K. M., & Oh, H. (2015). Clinical experiences as related to standard precautions compliance among nursing students: a focus group interview based on the theory of planned behavior. *Asian Nursing Research*, *9*(2), 109-114. https://doi.org/10.1016/j.anr.2015.01.002

Kim, H. R., Song, Y., Lindquist, R., & Kang, H. Y. (2016). Effects of team-based learning on problem-solving, knowledge and clinical performance of Korean nursing students. *Nurse Education Today*, *38*, 115-118. https://doi.org/10.1016/j.nedt.2015.12.003

Kirk, J., Kendall, A., Marx, J. F., Pincock, T., Young, E., Hughes, J. M., & Landers, T. (2016). Point of care hand hygiene—where's the rub? A survey of US and Canadian health care

workers' knowledge, attitudes, and practices. *American Journal of Infection Control*, *44*(10), 1095-1101. https://doi.org/10.1016/j.ajic.2016.03.005

Kourtis, A. P., Hatfield, K., Baggs, J., Mu, Y., See, I., Epson, E., ... & Ray, S. M. (2019). Vital signs: epidemiology and recent trends in methicillin-resistant and in methicillin-susceptible Staphylococcus aureus bloodstream infections—United States. *Morbidity and Mortality Weekly Report*, *68*(9), 214. https://doi.org/10.15585/mmwr.mm6809e1

Kruse, K. (2002). Introduction to instructional design and the ADDIE model. Retrieved from https://www.lib.purdue.edu/sites/default/files/directory/butler38/ADDIE.pdf.

Lau, Y. (2014). Factors affecting the social problem-solving ability of baccalaureate nursing students. *Nurse Education Today*, *34*(1), 121-126. https://doi.org/10.1016/j.nedt.2012.10.010

Lin, E. C. L., Chen, S. L., Chao, S. Y., & Chen, Y. C. (2013). Using standardized patient with immediate feedback and group discussion to teach interpersonal and communication skills to advanced practice nursing students. *Nurse Education Today*, *33*(6), 677-683. https://doi.org/10.1016/j.nedt.2012.07.002

Løyland, B., Wilmont, S., Cohen, B., & Larson, E. (2016). Hand-hygiene practices and observed barriers in pediatric long-term care facilities in the New York metropolitan area. *International Journal for Quality in Health Care*, *28*(1), 74-80. https://doi.org/10.1093/intqhc/mzv097

Lupión-Mendoza, C., Antúnez-Domínguez, M. J., González-Fernández, C., Romero-Brioso, C., & Rodriguez-Bano, J. (2015). Effects of isolation on patients and staff. *American Journal of Infection Control*, *43*(4), 397-399. https://doi.org/10.1016/j.ajic.2015.01.009

Magill, S. S., Edwards, J. R., Bamberg, W., Beldavs, Z. G., Dumyati, G., Kainer, M. A., ... & Ray, S. M. (2014). Multistate point-prevalence survey of health care–associated infections. *New England Journal of Medicine*, *370*(13), 1198-1208. https://doi.org/10.1056/NEJMoa1306801

Mitchell, R., Taylor, G., Rudnick, W., Alexandre, S., Bush, K., Forrester, L., ... & John, M. (2019). Trends in health care–associated infections in acute care hospitals in Canada: an analysis of repeated point-prevalence surveys. *CMAJ*, *191*(36), E981-E988. https://doi.org/10.1503/cmaj.190361

Moon, K. J., Hyeon, Y. H., & Lim, K. H. (2019). Factors associated with nursing students' compliance with standard precautions: a self-reported survey. *Int Journal of Infection Control*, *15*(3), 1-9. https://doi.org/10.3396/ijic.v15i3.19007

Moralejo, D., El Dib, R., Prata, R. A., Barretti, P., & Corrêa, I. (2018). Improving adherence to Standard Precautions for the control of health care-associated infections. *Cochrane Database of Systematic Reviews*, (2). https://doi.org/10.1002/14651858.CD010768.pub2

Mundhada, A. S., & Tenpe, S. (2015). A study of organisms causing surgical site infections and their antimicrobial susceptibility in a tertiary care government hospital. *Indian Journal of Pathology and Microbiology*, *58*(2), 195. https://doi.org/10.4103/0377-4929.155313

Musau, J., Baumann, A., Kolotylo, C., O'shea, T., & Bialachowski, A. (2015). Infectious disease outbreaks and increased complexity of care. *International Nursing Review*, *62*(3), 404-411. https://doi.org/10.1111/inr.12188

Olsen, M. A., Yan, Y., Reske, K. A., Zilberberg, M. D., & Dubberke, E. R. (2015). Recurrent Clostridium difficile infection is associated with increased mortality. *Clinical Microbiology and Infection*, *21*(2), 164-170. https://doi.org/10.1016/j.cmi.2014.08.017

Patel, H., Khoury, H., Girgenti, D., Welner, S., & Yu, H. (2017). Burden of surgical site infections associated with select spine operations and involvement of Staphylococcus aureus. *Surgical Infections*, *18*(4), 461-473. https://doi.org/10.1089/sur.2016.186

Pereira, F. M. V., Lam, S. C., Chan, J. H. M., Malaguti-Toffano, S. E., & Gir, E. (2015). Difference in compliance with Standard Precautions by nursing staff in Brazil versus Hong Kong. *American Journal of Infection Control*, *43*(7), 769-772. https://doi.org/10.1016/j.ajic.2015.03.021

Powers, D., Armellino, D., Dolansky, M., & Fitzpatrick, J. (2016). Factors influencing nurse compliance with Standard Precautions. *American Journal of Infection Control*, *44*(1), 4-7. https://doi.org/10.1016/j.ajic.2015.10.001

Provincial Infection Control Newfoundland and Labrador. (2015). Healthcare-associated Infections Annual Report 2009-2015. Retrieved from https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2015.pdf.

Public Health Agency of Canada (PHAC). (2014). Infection prevention and control guidelines critical appraisal tool kit. Available at http://publications.gc.ca/collections/collection_2014/aspc-phac/HP40-119-2014-eng.pdf.

Public Health Agency of Canada (PHAC). (2016). Routine practices and additional precautions for preventing the transmission of infection in healthcare settings. Available at https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/diseases-conditions/routine-practices-precautions-healthcare-associated-infections/routine-practices-precautions-healthcare-associated-infections-2016-FINAL-eng.pdf.

Purssell, E., Gould, D., & Chudleigh, J. (2020). Impact of isolation on hospitalized patients who are infectious: systematic review with meta-analysis. *BMJ Open, 10*(2). http://dx.doi.org/10.1136/bmjopen-2019-030371

Quan, M., Wang, X., Wu, H., Yuan, X., Lei, D., Jiang, Z., & Li, L. (2015). Influencing factors on use of standard precautions against occupational exposures to blood and body fluids among nurses in China. *International Journal of Clinical and Experimental Medicine*, *8*(12), 22450. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4730013/.

Rahmqvist, M., Samuelsson, A., Bastami, S., & Rutberg, H. (2016). Direct health care costs and length of hospital stay related to health care-acquired infections in adult patients based on point prevalence measurements. *American Journal of Infection Control*, *44*(5), 500-506. https://doi.org/10.1016/j.ajic.2016.01.035

Rashmi, A., & Kundapur, R. (2017). Factors influencing observation of standard precautions among nursing staff in tertiary care setting in Mangalore. *International Journal of Community Medicine and Public Health*, *5*(1), 377-381. http://dx.doi.org/10.18203/2394-6040.ijcmph20175817

Russo, P. L., Stewardson, A. J., Cheng, A. C., Bucknall, T., & Mitchell, B. G. (2019). The prevalence of healthcare associated infections among adult inpatients at nineteen large Australian acute-care public hospitals: a point prevalence survey. *Antimicrobial Resistance & Infection Control*, *8*(1), 114. https://doi.org/10.1186/s13756-019-0570-y

StataCorp. (2015). Statistical Software: Release 14. College Station, TX: StataCorp LP.

Sandiumenge, A., & Rello, J. (2012). Ventilator-associated pneumonia caused by ESKAPE organisms: cause, clinical features, and management. *Current Opinion in Pulmonary Medicine*, *18*(3), 187-193. https://doi.org/10.1097/MCP.0b013e328351f974

Schmidt, A., Bénard, S., & Cyr, S. (2015). Hospital cost of staphylococcal infection after cardiothoracic or orthopedic operations in France: a retrospective database analysis. *Surgical Infections*, *16*(4), 428-435. https://doi.org/10.1089/sur.2014.045

Schneider, J., Moromisato, D., Zemetra, B., Rizzi-Wagner, L., Rivero, N., Mason, W., ... & Ross, L. (2009). Hand hygiene adherence is influenced by the behavior of role models. *Pediatric Critical Care Medicine*, *10*(3), 360-363. https://doi.org/10.1097/PCC.0b013e3181a32f16

Schweizer, M. L., Cullen, J. J., Perencevich, E. N., & Sarrazin, M. S. V. (2014). Costs associated with surgical site infections in Veterans Affairs hospitals. *JAMA surgery*, *149*(6), 575-581. https://doi.org/10.1001/jamasurg.2013.4663

Serrano, M., Barcenilla, F., Limón, E., Pujol, M., & Gudiol, F. (2017). Prevalence of healthcare-associated infections in long-term care facilities in Catalonia. VINCat Program. *Enfermedades Infecciosas y Microbiologia Clinica (English ed.)*, *35*(8), 503-508. https://doi.org/10.1016/j.eimce.2017.08.004

Suetens, C., Latour, K., Kärki, T., Ricchizzi, E., Kinross, P., Moro, M. L., ... & Reilly, J. (2018). Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. *Eurosurveillance*, *23*(46), 1800516. https://doi.org/10.2807/1560-7917.ES.2018.23.46.1800516

Taylor, G., Gravel, D., Matlow, A., Embree, J., LeSaux, N., Johnston, L., ... & Roth, V. (2016). Assessing the magnitude and trends in hospital acquired infections in Canadian hospitals through sequential point prevalence surveys. *Antimicrobial Resistance & Infection Control*, *5*(1), 19. https://doi.org/10.1186/s13756-016-0118-3

Thakore, R. V., Greenberg, S. E., Shi, H., Foxx, A. M., Francois, E. L., Prablek, M. A., ... & Sethi, M. K. (2015). Surgical site infection in orthopedic trauma: A case–control study evaluating risk factors and cost. *Journal of Clinical Orthopedics and Trauma*, *6*(4), 220-226. https://doi.org/10.1016/j.jcot.2015.04.004

Travers, J., Herzig, C. T., Pogorzelska-Maziarz, M., Carter, E., Cohen, C. C., Semeraro, P. K., ... & Stone, P. W. (2015). Perceived barriers to infection prevention and control for nursing home certified nursing assistants: a qualitative study. *Geriatric Nursing*, *36*(5), 355-360. https://doi.org/10.1016/j.gerinurse.2015.05.001

Vittrup, A. C., & Davey, A. (2010). Problem based learning 'bringing everything together'–a strategy for graduate nurse programs. *Nurse Education in Practice*, *10*(2), 88-95. https://doi.org/10.1016/j.nepr.2009.03.019

Ward, D. J. (2013). The barriers and motivators to learning infection control in clinical placements: interviews with midwifery students. *Nurse Education Today*, *33*(5), 486-491. https://doi.org/10.1016/j.nedt.2012.05.024

Wilson, J., Bak, A., Whitfield, A., Dunnett, A., & Loveday, H. (2017). Public perceptions of the use of gloves by healthcare workers and comparison with perceptions of student nurses. *Journal of Infection Prevention*, *18*(3), 123-132. https://doi.org/10.1177/1757177416680442

World Health Organization (WHO). (2016). Health care-associated infections fact sheet. Retrieved from https://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf.

World Health Organization (WHO). (2018). The burden of healthcare associated infections worldwide. Retrieved from http://www.who.int/gpsc/country_work/burden_hcai/en.

Yoo, M. S., & Park, J. H. (2014). Effect of case-based learning on the development of graduate nurses' problem-solving ability. *Nurse Education Today*, *34*(1), 47-51. https://doi.org/10.1016/j.nedt.2013.02.014

Zellmer, C., Blakney, R., Van Hoof, S., & Safdar, N. (2015). Impact of sink location on hand hygiene compliance for Clostridium difficile infection. *American Journal of Infection Control*, *43*(4), 387-389. https://doi.org/10.1016/j.ajic.2014.12.016

Zhou, Q., Fan, L., Lai, X., Tan, L., & Zhang, X. (2019). Estimating extra length of stay and risk factors of mortality attributable to healthcare-associated infection at a Chinese university hospital: a multi-state model. *BMC Infectious Diseases*, *19*(1), 975. https://doi.org/10.1186/s12879-019-4474-5

Zimlichman, E., Henderson, D., Tamir, O., Franz, C., Song, P., Yamin, C. K., ... & Bates, D. W. (2013). Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. *JAMA Internal Medicine*, *173*(22), 2039-2046. https://doi.org/10.1001/jamainternmed.2013.9763

Chapter 2: Nursing Students' and Nursing Instructors' Knowledge, Confidence, and Application of Problem Solving Related to Routine Infection Control Practices: A Cross-Sectional Survey (First Study)

Abubaker Hamed[1], Donna Moralejo [1], April Pike[1], Vernon Curran[2]

[1] *Faculty of Nursing, Memorial University of Newfoundland, Canada*

[2]*Faculty of Medicine, Memorial University of Newfoundland, Canada*

In this chapter the first study is discussed, which was a cross-sectional study to understand problem solving related to routine infection control practices (RP) among nursing students and instructors, and to identify the barriers to adherence to RP that they may encounter during their clinical practice. This chapter includes a brief background of the literature, research questions, methods, results, and discussion of the study findings. The target audience for this manuscript is infection control practitioners.

AMH conceptualized the study, reviewed, and critically appraised the literature, developed the study questionnaire, collected and entered the data, conducted data analysis, interpreted the results, and wrote the manuscript. DM contributed to the synthesis of the literature, research design, sample size calculation, questionnaire development, statistical analysis and data interpretation, and reporting, and approved the manuscript. AP and VC contributed to the design and interpretation of results, and suggested revisions and approved the manuscript.

Abstract

Background: Adherence of nurses and nursing students to routine infection prevention and control practices (RP) has been found to be suboptimal due to a number of barriers. Problem solving (PS) is an approach that infection control practitioners (ICPs) can potentially use to promote adherence to RP. The aim of this study was to understand nursing students' and instructors' PS related to RP and barriers to RP. **Method:** A cross-sectional survey was conducted in 2019 in three nursing schools in eastern Canada. Participants were 577 nursing students and 20 instructors. Data were collected using the *Routine Practices Problem-Solving Questionnaire*. **Results:** The vast majority (83.5% to 100%) of nursing students and nursing instructors correctly answered most of the questions related to RP and PS. However, only 8.4% to 52.6% correctly identified the minimum time needed for alcohol-based hand rub (ABHR) to kill most germs on hands, explained the differences between RP and additional precautions (AP), and explained the point of care risk assessment. The three barriers most commonly identified by students and instructors, respectively were: high nursing workload (44.2% and 40%), empty ABHR dispensers (45.7% and 55%), and presence of negative role models (40.4 % and 25 %). Although they encountered these barriers, only 21.1 % to 30.2 % of students indicated that they used PS to deal with these barriers. Both groups also reported lack of training about RP and PS. **Conclusion:** Nursing students' and instructors' knowledge about some RP components and application of PS to deal with the barriers to RP adherence need to be strengthened. This information can be used to enable infection control practitioners to promote better infection and prevention control practices when they interact with nursing students and instructors on clinical units and in formal education sessions.

Keywords**:** *Infection control practice, nursing students, nursing instructors, problem solving, barriers, knowledge, confidence, and application*

Healthcare-associated infections (HAIs) are serious health problems that affect millions of patients worldwide. The Canadian Nosocomial Infection Surveillance Program (CNISP) estimated that 12% of adults and 10% of children admitted to a Canadian hospital will develop an HAI, and approximately 220,000 Canadians suffer from HAIs each year (CNISP, 2015). HAIs have major impacts on patients, nurses, and the healthcare system, as they contribute to increased mortality rate, length of hospital stay, nursing workload, and financial burden on the healthcare system (Badia et al., 2017; CNISP, 2015; Olsen et al., 2015; Provincial Infection Control Newfoundland and Labrador, 2015; Schmidt et al., 2015; Schweizer et al., 2014; Zimlichman et al., 2013). In Canada, annually, an estimated 8,000 patients die because of HAIs (CNISP, 2015). A number of studies have found that HAIs prolonged the length of hospital stay (LOS) by 2.6 to 21 days (Arefian et al., 2019; Jia et al., 2019; Zhou et al., 2019), and patients under isolation precautions were more likely to develop depression and anxiety (Day et al., 2011; Day et al., 2013; Guilley-Lerondeau et al., 2017; Lupión-Mendoza et al., 2015; Purssell et al., 2020). Furthermore, evidence has shown that HAIs can increase nursing workload, particularly if nurses are caring for patients under isolation precautions (Barker et al., 2017; Kaba et al., 2017; Musau et al., 2015). A literature review conducted between 2011 and 2013 showed that the total costs associated with specific types of HAIs were $9.8 billion (95% CI, $8.3-$11.5 billion) (Zimlichman et al., 2013).

Infection control practitioners (ICPs) function within, and promote, the Canadian system of basic infection control precautions called Routine Practices (RP), which is similar to the system of Standard Precautions (SP) used elsewhere (PHAC, 2014). RP and SP are used with all patients at all times and include hand hygiene, use of personal protective equipment (PPE), sharps safety, and cleaning and disinfecting patient care equipment. RP also specifies that, prior

to each patient encounter, healthcare workers conduct a point of care risk assessment (PCRA) to identify potential risks of exposure to or transfer of microorganisms and then initiate appropriate actions, such as hand hygiene or cleaning equipment. In this chapter we will use the term SP when the study or studies being discussed investigated Standard Precautions, otherwise the term RP will be used.

Adherence to SP and RP help reduce the spread of HAIs and their negative impacts in healthcare settings, however, nurses' and nursing students' adherence to SP and RP has been found to be suboptimal. For example, Moon et al. (2019) found that only 55% of the 176 nursing students in their sample adhered to SP. Similarly, the two cross-sectional studies conducted in Saudi Arabia found that nursing students' adherence rates to SP were 61.0% (Colet et al., 2017) and 61.8% (Cruz, 2019). Nurses' adherence was also found to be suboptimal. For instance, in their cross-sectional study in 11 units in 5 hospitals, Hessels and Larson (2016) found that nurses had an overall moderate adherence to SP (64%). Similarly, Pereira et al. (2015) compared the adherence rate between a sample of Hong Kong nurses and Brazilian nurses and found that the SP adherence rate of Brazilian nurses (mean: 69.4% ±13.57%) was significantly greater than that of Hong Kong nurses (mean: 57.4%18.62; $p<.001$). In contrast, in their study conducted in the US, Powers et al. (2016) found that only 17.4% of nurses reported that they adhered to all SP items.

This suboptimal adherence is related to a number of barriers such as presence of negative role models, high nursing workload, and inconvenient location of alcohol-based hand rub (ABHR). For instance, 23% to 35% of nursing students reported that "busyness" influenced their adherence to SP (Cheung et al., 2015; Foote & El-Masri, 2016), 24% viewed their adherence to SP as time-consuming (Dorgham & Obied, 2016), and 59.9% reported that high workload was

one of the factors that influenced their adherence to infection prevention and control (IPC) practices (Hinkin & Cutter, 2014). Wilson et al. (2017) found that 38% of nursing students self-reported that the presence of negative role models affected their adherence to IPC practices. Recently, Choi and Kim (2018) found that the intention of nursing students to adhere to IPC practices was negatively influenced by the non-adherence of other nurses in their clinical settings ($r = - 0.469$). The authors of the two Canadian studies explored the perceived predictors of hand hygiene and found that 36% of nursing students and 41% of nurses indicated that the inconvenient location of ABHR dispensers and hand wash sinks is one of the barriers that prevented them from adhering to hand hygiene (Foote & El-Masri, 2016; Kirk et al., 2016).

Because it is not always feasible to eliminate these barriers, problem solving (PS) strategies can potentially help nursing students and others deal with these barriers and be able to adhere to RP. PS is defined as "the self-directed cognitive-behavioral process by which a person attempts to identify or discover effective or adaptive solutions for specific problems encountered in everyday living" (D'Zurilla & Nezu, 2010, p. 212). This PS approach can help students to deal with the complexity of today's nursing care (Vittrup & Davey, 2010). Therefore, if nursing instructors have the knowledge and confidence related to RP and PS, and they facilitate and reinforce the application of PS related to the barriers to adherence, then one would expect that nursing students will gain the necessary knowledge and PS skills to address barriers to RP adherence and potentially help to reduce HAIs and their negative impacts. Therefore, it is important to understand nursing students' and instructors' knowledge, confidence, and application of PS related to RP, as well as to identify the barriers to adherence to RP that they may encounter during their clinical practice. Understanding these aspects about PS, RP, and the barriers to RP will allow us to provide evidence-based recommendations for infection control

practitioners (ICPs). These recommendations will enable ICPs to promote better infection and prevention control practices, and develop specific strategies and customized training programs to improve knowledge and confidence about PS related to RP.

Research Questions

This study aimed to assess PS, RP, and barriers to RP adherence among nursing students and nursing instructors.

The research questions were:

1. How knowledgeable are nursing students and nursing instructors about PS and RP?
2. How confident are nursing students and nursing instructors about performing RP?
3. What barriers prevent nursing students and nursing instructors from adhering to RP?
4. What strategies have nursing students and nursing instructors used to deal with the barriers of adherence to RP?
5. How confident are nursing students and nursing instructors about applying PS to deal with barriers of adherence to RP?
6. What teaching methods do nursing students and instructors recommend as the best for use to teach PS related to RP?
7. What is the opinion of nursing students and instructors about the best time in the nursing program to learn about PS related to RP?

Methods

Design

This was a descriptive, cross-sectional study.

Settings and Sample

The study was conducted at three nursing schools in Canada: Schools, A, B, and C. All nursing students and instructors at the three nursing schools were invited to participate in the study; however, 20 instructors and 577 nursing students were recruited in the study. The instructors were eligible if they: 1) worked as a full-time or a part-time instructor in any of the three schools, 2) taught clinical courses, theory courses, or both, 3) and agreed to participate in the study. Nursing students were eligible if they: 1) were registered in any year of either the regular four-year program or the 2-year accelerated program, and 2) agreed to participate in the study.

Sample Size

The final sample consisted of all instructors and nursing students at the three nursing schools who agreed to participate in the survey. To calculate the required sample size for both nursing instructors and nursing students, the following Cochran formula was used: $N= Z^2 * P (1-P)/ D^2$ (Cochran, 1977). Z is 1.96 for a 95% confidence interval and D is the level of acceptable error at 5% (Cochran, 1977). The value of P was taken from a previous study conducted in Atlantic Canada, in which 27% of nursing instructors and 20% of nursing students said they were very confident about PS related to RP (Chiasson, 2015). Based on these values, the sample size was estimated as 304 for nursing instructors and 247 for nursing students. However, there are only about 140 nursing instructors in the province; all were invited to participate.

A larger sample size of students was targeted. There were approximately 850 nursing students and we targeted them all for two reasons: 1) we wanted to do a subgroup analysis by year and therefore we wanted as large a sample as possible to allow such an analysis, and 2) we were unsure what the response rate would be and therefore we targeted the entire group to ensure at least the minimum number. Out of 850 nursing students and 140 nursing instructors in the three schools, a total number of 577 students and 20 instructors were recruited in the study, with the response rate of 67.9% and 14.3%, respectively.

Recruitment Procedures

The recruitment procedure was started after ethical approval was obtained from the Health Research Ethics Board and the appropriate regional research proposal approval committee. The approval letters can be found in Appendix B. Recruitment consisted of three steps: 1) obtaining permission from the three nursing schools to conduct the study; 2) recruiting nursing instructor participants; and 3) recruiting nursing student participants.

Recruitment of Nursing Schools.

Following ethics approval, the Dean at School A and the Directors at Schools B and C were contacted by the researchers to inform them about the survey, request permission to conduct the survey, and ask the schools to make first contact with the nursing instructors and nursing students at each site.

Recruitment of Nursing Instructors and Data Collection.

After permission was obtained from the schools, an information sheet explaining the purpose of the study was sent by the researchers to the office of the Associate Dean or Associate Director at the three schools. They then distributed the information sheet and a cover email to all instructors at each site. The information sheet can be found in Appendix C and the cover email

can be found in Appendix D. The information sheet for instructors asked them to voluntarily participate in the survey, provided them with the online link for the survey, and provided them with the contact information of the researchers. The instructors were asked to contact the researchers if they have any questions about the study. The instructors who agreed to participate completed the survey online using the *Qualtrics* survey software, which is the current approved survey platform for the University. The researchers considered completion of the online survey questionnaire as implied consent.

Recruitment of Nursing Students and Data Collection.

After permission was obtained from the schools, an information sheet explaining the purpose of the study was sent by the researchers to the office of the Associate Dean or Associate Director at the three schools. They then distributed the information sheet and a cover email to all nursing students at each site. The information sheet for students can be found in Appendix C and the students' cover email can be found in Appendix D. The information sheet for students asked them to voluntarily participate in the survey and provided them with contact information of the researchers. The students were asked to contact the researchers if they had any questions about the study. The office of the Associate Dean or Associate Director identified the appropriate class, one course per year, which was used for administration of the survey.

The nursing students in Years 1, 2, and 3 who were interested in participating completed the questionnaire during the first 15 to 20 minutes of the designated class. On the day of data collection, the researchers at Schools A and B and the research assistant at School C explained the purpose of the study and provided another opportunity to ask questions prior to administration of the survey. Students who chose not to complete the questionnaire remained in their classroom until data collection was completed. At Schools A and B, the researchers

administered and immediately collected the completed questionnaires, while at School C, a research assistant administered and immediately collected the completed questionnaires. The researchers considered completion of the survey questionnaire as implied consent. To accommodate class schedules, the questionnaire was administered to the students in Years 1, 2, and 3 on different days in the same week in October 2019. The students in Year 4 completed the same questionnaire online using the *Qualtrics* survey software because they were out in clinical placements at the time of data collection.

Data Collection Instrument: RP and Problem-Solving Questionnaire

The RP and Problem-Solving Questionnaire was developed by the researchers based on the literature, the objectives of this study, and infection control experts' feedback. This questionnaire was designed to measure nursing instructors' and nursing students' knowledge about RP, confidence about performing RP and application of PS to deal with the barriers. In addition, the questionnaire also asked participants to identify the barriers to adherence, the strategies that can be used to deal with these barriers, and the best teaching methods and best time in the nursing program to learn about PS related to RP.

The questionnaire consisted of seven sections. Sections 1 and 2 were knowledge sections to measure instructors' and nursing students' knowledge about PS and RP. ***Section 1*** consisted of nine questions in a "True" and "False" format. Eight of them were used to assess participants' knowledge about RP and one question was used to assess their knowledge about PS. A score of 1 was assigned if the answer was correct while a score of 0 was assigned if the answer was incorrect.

Section 2 consisted of four short answer questions. Three of them were used to assess participants' knowledge about RP and one question was used to assess knowledge about PS. The

researchers identified the correct answers for each of these four questions. Each participant's answers were then compared to these correct answers and a score was assigned accordingly. A score of 2 was assigned if the answer was correct, a score of 1 was assigned if the answer was partially correct, and a score of 0 was assigned if the answer was incorrect.

Section 3 consisted of one question to identify the barriers of adherence to RP. Participants were given a list of 11 barriers to adherence to RP, and they were asked to select from this list which barrier/s prevented them from adhering to RP. In addition, the participants were also given an option to add other barriers if they were not included in this list.

Section 4 consisted of three "Yes" and "No" questions to measure whether instructors and nursing students have used PS to deal with the barriers of adherence to RP. If they answered yes to a question, they were asked to give an example. No score was calculated for Sections 3 or 4.

Section 5 consisted of seven questions using a four-point Likert-type response scale. Of them, four questions were used to assess their confidence about some components of RP, and three questions were used to assess their confidence about applying PS to deal with the three common barriers (high nursing workload, negative role models, and inconvenient location of sinks and ABHR dispenses). The response set consisted of response choices, which was scored as follows: "very confident" (4 points), "confident" (3 points), "somewhat confident" (2 points), and "not at all confident" (1 point).

Section 6 consisted of three questions. Two were short answer questions and one was a multiple-choice question. Of the two short answer questions, one question asked the participants about when the best time was to learn about RP and PS. In the multiple-choice question, the

participants were given a list of six teaching methods, and they were asked to select which one/s are the best teaching methods to learn about PS related to RP.

Section 7 consisted of a number of questions about demographic data such as year of school, age, gender, school sites, any extra clinical experiences, any training about RP, and any previous training about PS related to RP. Different questions related to demographic data were asked of students compared to instructors.

This questionnaire had two versions, one for the students and one for the nursing instructors. All the questions on the two versions were similar except that the questions in sections 4 and 5 were phrased slightly differently in the two versions. In the version for the students, they were asked about their own experiences, while nursing instructors were asked about helping their students to deal with the barriers of adherence to RP. A copy of each version of the questionnaire can be found in Appendix E.

Validity and Pilot Test of the Questionnaire.

Prior to use in the survey, feedback about the *RP and Problem-Solving Questionnaire* was obtained from a group of experts in infection prevention and control, and there were no recommended changes. A pilot test was then conducted with six students and two instructors to check for completion time and ensure the ability of participants to understand the questions correctly. The researchers discussed their feedback and recommendations with pilot test participants. Based on their feedback, minor changes were made to the questionnaire.

Data Analysis

Descriptive statistics were used to describe the course instructors' and nursing students' demographic characteristics such as age, sex, and years of experiences. In addition, frequencies and proportions were reported for each item in the questionnaire. The short answer knowledge

questions were scored and compared using proportions. The data were analyzed with Stata statistical software version 14.0 (StataCorp. 2015).

Ethical Considerations

The research study, along with all necessary documentation, was submitted to the Health Research Ethics Board and the appropriate regional research proposal approval committee. Individual approval from each school was also obtained. The study was initiated after all required ethical and school approvals were obtained. Loss of class time was minimal for students and the survey was conducted with the approval of the schools. Approximately 15 to 20 minutes were required from the participants to complete the paper questionnaire or the online questionnaire.

There were no expected benefits or any expected potential risks for participating in this survey. Participation was voluntary. Nursing instructors and nursing students had the right to refuse to participate without any impact on their employment or student status and had the right to decline to answer certain questions. Students could choose not to complete the questionnaire but were asked to remain in the class during the data collection period. No one was identified as having chosen to participate or not unless they themselves told others. The researcher and the research assistant were not affiliated with any grading in the courses, so nursing students should not have felt they were under any pressure to participate. Return and completion of the questionnaire was taken as consent to participate.

To maintain participants' confidentiality and anonymity, no identifying information was collected from the participants as part of the survey; however, nursing instructors and Year 4 nursing students who chose to enter their email address in the draw for a $10 gift card were asked to click yes at the end of the survey. They were taken to another electronic page to enter

their email addresses, which were sent automatically to the researcher. They were informed that email addresses were not linked to the questionnaires. Nursing instructors and Year 4 nursing students who won the gift card were contacted via email. Gift cards were distributed by a member of the research team. Nursing students in Years 1, 2, and 3 were given the chance to choose an envelope on submission of the completed survey questionnaire. Each envelope contained a paper that said either “Win” or “No win”. Students who chose an envelope with a paper that read “Win” were given a $10 gift card. Only the email addresses of winning students were recorded. A coded list of recipients of the gift cards was kept for accounting purposes per Memorial University guidelines. They were informed that they could refuse to answer any questions or stop at any time. The researcher and research assistant had information about the University Counselling Centre to share with students if necessary; no adverse events were encountered.

Data collected from both nursing instructors and from Year 4 nursing students were stored electronically by the *Qualtrics* platform and were subject to their privacy policy. The *Qualtrics* survey software is the approved survey platform for the University. Only the research team could access the data, and computerized files were password protected. The paper questionnaires collected from students in Years 1, 2, and 3 were securely stored in a locked cabinet in the nursing program graduate office of Memorial University. In addition, data will be kept in a locked file cabinet for at least 5 years, as per Memorial University policy.

Results

As shown in Table 2.1, a total of 577 undergraduate nursing students participated in the study. Approximately half of students (49.2%) were from school B, which was expected because

this school has a larger number of students compared to Schools A and C. The majority (89.6%) were in the regular stream, which is the predominant stream.

Table 2.1

Characteristics of Nursing Students

Characteristics		**% (N)[1]**
School of nursing (**N[2] = 577**)	A	32.8 (189)
	B	49.2 (284)
	C	18 (104)
Year of study (**N[2] = 577**)	Year 1	35.9 (207)
	Year 2	40.2 (232)
	Year 3	20.4 (118)
	Year 4	3.5 (20)
Stream (**N[2] = 577**)	Regular	89.6 (517)
	Accelerated program	10.4 (60)
Age (**N[2]= 572**)	18-24	84.1 (481)
	25-34	14.5 (83)
	35-44	1.2 (7)
	> 45	0.2 (1)
Gender (**N[2] = 573**)	Female	87.1 (499)
	Male	12.9 (74)
Extra clinical experiences (**N[2] = 573**)	No	68.8 (394)
	Yes	31.2 (179)
Training about RP (**N[2] = 571**)	No	69.9 (399)
	Yes	30.1 (172)
Training about PS related to RP (**N[2] = 571**)	No	75.7 (432)
	Yes	24.3 (139)

% (N)[1]: the percentage of those who responded to the question and number of students with the identified characteristics.
(N)[2]: the number of students who answered the identified questions.
Abbreviations: PS = Problem Solving; RP = Routine Practices.

There was a representative sample from Years 1 to 3, and there were a few students in Year 4. Of 577 nursing students, 35.9% were in Year 1, 40.2 % were in Year 2, 20.4% were in Year 3, and only 3.5% were in Year 4. The majority of students were female (89.6%) and the age group of 18 to 24 years (84.1%). A large proportion of students (68.8% and 69.9 %) reported that they had no extra clinical experiences outside of nursing school and they did not receive extra training about RP, respectively. In addition, 75.7 % did not receive any training about PS related to RP.

Table 2.2

Characteristics of Nursing Instructors

Characteristics		**% (N)[1]**
Current employment status	Full time	100 (20)
	Part time	0 (0)
School of nursing	A	35 (7)
	B	40 (8)
	C	25 (5)
Year of experiences	Less than 5 years	30 (6)
	6 – 10 years	20 (4)
	11- 20 years	20 (4)
	More than 20 years	30 (6)
Clinical courses taught	Medical surgical	45 (9)
	Community	0 (0)
	Maternity or pediatrics	25 (5)
	Mental health	5 (1)
	Other	15 (3)
	Does not teach clinical	10 (2)
Gender	Female	90 (18)
	Male	10 (2)
Type of course taught	Theory	20 (4)
	Clinical	25 (5)
	Both	55 (11)
	No	70 (14)

Characteristics		% (N)[1]
Training about RP	Yes	30 (6)
Training about PS related to RP	No	100 (20)
	Yes	0 (0)

% (N)[1]: the percentage and number of instructors with the identified characteristics; there was a total of 20 instructors.
Abbreviations: PS = Problem Solving; RP = Routine Practices.

As shown in Table 2.2, a total of 20 nursing instructors participated in the study; the majority of them were female (90%). Nursing instructors reported a wide range of experience with 30% having less than 5 years of experience, and 30% having more than 20 years of experience. Out of the 20 clinical instructors, 45% stated that they taught medical-surgical courses and 55% stated that they taught both theory and clinical. The majority of the instructors (70%) reported that they did not have any training about RP, and none of them had received any training about PS related to RP.

Table 2.3

Participants who correctly answered the knowledge questions about RP and PS

True/false questions regarding knowledge	Year 1 N= 207	Year 2 N= 232	Year 3 N=118	Year 4 N=20	Total students (N= 577)	Instructors N= 20
	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]
The use of ABHR is recommended when hands are visibly soiled	94.2 (195)	96.5 (224)	95 (112)	100 (20)	95.5 (551)	75 (15)
If I do not clean my hands this will lead to spread of infections	99.5 (206)	99.6 (231)	99.2 (117)	100 (20)	99.5 (574)	100 (20)
Mask and eye protection should be worn when there is a	100 (207)	100 (232)	100 (118)	100 (20)	100 (577)	100 (20)

True/false questions regarding knowledge	Year 1 N= 207	Year 2 N= 232	Year 3 N=118	Year 4 N=20	Total students (N= 577)	Instructors N= 20
	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]	% (N)[1]
risk of splash or spray of blood or body fluids						
Gloves are recommended to be used if contact with mucous membranes or non-intact skin is expected	99.5 (206)	99.6 (231)	99.2 (117)	100 (20)	99.5 (574)	100 (20)
All shared patient care equipment (e.g., stethoscopes, blood pressure cuffs, and glucometers) should be cleaned with disinfectant wipes between each use	98.5 (204)	99.1 (230)	100 (118)	95 (19)	99 (571)	95 (19)
Gloves are a substitute for hand hygiene	100 (207)	99.6 (231)	100 (118)	100 (20)	99.8 (576)	100 (20)
It is acceptable to recap needles	87.9 (182)	79.3 (184)	85.6 (101)	75 (15)	83.5 (482)	95 (19)
Thirty seconds is the minimum time needed for ABHR to kill most germs on hands	15.5 (32)	11.2 (26)	28 (33)	10 (2)	16.1 (93)	15 (3)
Problem solving can help nurses to deal with barriers that prevent adherence to Routine Practices	94.2 (195)	95.7 (222)	92.4 (109)	90 (18)	94.3 (544)	100 (20)

% (N)[1]: the percentage and number of students and instructors who correctly answered the identified true and false knowledge questions as indicated.
Abbreviations: ABHR = Alcohol-Based Hand Rub.

As seen in Table 2.3, the vast majority (83.5% to 100%) of nursing students and nursing instructors correctly answered 7 out of 9 of the true/ false questions related to RP and PS. The other two questions were related to ABHR. Most of the students (95 %) answered correctly the question related to the use of ABHR, compared to only 75% of instructors. Only small proportions of clinical instructors (15%) and nursing students (16.1%) were correct about the minimum time needed for ABHR to kill most germs on hands. Interestingly, most of the nursing students (94.2%) and all nursing instructors (100%) correctly stated that PS can help them to deal with the barriers to adherence to RP. Knowledge related to RP and PS was similar across all years of nursing students.

Table 2.4

Participants' Knowledge about RP and PS

Short answer questions regarding knowledge	**Nursing students**			**Nursing instructors**		
	Correct	**Partially correct**	**Incorrect**	**Correct**	**Partially correct**	**Incorrect**
	% (N)[2]	**% (N)[2]**	**% (N)[2]**	**% (N)[2]**	**% (N)[2]**	**% (N)[2]**
1. What are the differences between Routine Practices and Additional Precautions? **(N[1] =574)**	15.3 (88)	22.5 (129)	62.2 (357)	30 (6)	45 (9)	25 (5)
2. What is a point of care risk assessment? Why is it done? Please give an example **(N[1] =572)**	8.4 (48)	17.8 (102)	73.8 (422)	52.6 (10)	10.5 (2)	36.8 (7)
3. Name the link of the chain of infection that is disrupted by gloves **(N[1] =571)**	33.6 (192)	N/A	66.4 (379)	64.7 (11)	N/A	35.3 (6)

Short answer questions regarding knowledge	Nursing students			Nursing instructors		
	Correct % (N)[2]	Partially correct % (N)[2]	Incorrect % (N)[2]	Correct % (N)[2]	Partially correct % (N)[2]	Incorrect % (N)[2]
4. Name the link of the chain of infection that is disrupted by vaccination **(N[1] =571)**	26.6 (152)	N/A	73.4 (419)	58.8 (10)	N/A	41.2 (7)
5. Name the link of the chain of infection that is disrupted by mask **(N[1] =571)**	25.4 (145)	N/A	74.6 (426)	58.8 (10)	N/A	41.2 (7)
6. What does problem solving mean to you with respect to infection prevention and control? **(N[1] =573)**	16.8 (96)	N/A	83.2 (477)	15 (3)	N/A	85 (17)

(N)[1]: the number of students who answered the identified confidence question.
% (N)[2]: the percentage and number of students and instructors who answered the identified question correctly or as otherwise noted; the number of students (see N[1]) and instructors in the denominator varied by question. There were 20 instructors who answered question 1 and 6; 19 answered question 2; and 17 instructors answered questions 3,4 and 5.

In contrast to the true and false questions, the majority of nursing students and nursing instructors were not able to correctly answer the short answer questions related to RP and PS. As shown in Table 2.4, only small percentages of nursing students (15.3 %) and nursing instructors (30%) correctly explained the differences between RP and additional precautions. In addition, 22.5% of nursing students and 45% of the instructors gave a partially correct answer. This result indicates that both students and instructors lacked the ability to correctly articulate the difference between RP and additional precautions. More than half (52.6%) of nursing instructors correctly explained PCRA, compared to only 8.4% of nursing students. Similarly, 58.8% to 64.7% of

nursing instructors correctly named the link in the chain of infection that is disrupted by gloves, mask, and vaccination, compared to 25.4% to 33.6% of nursing students. Only small proportions of both students (16.7%) and instructors (15%) were able to correctly explain what PS means with respect to infection prevention and control in terms of using a systematic approach to deal with any problem related to infection prevention and control. Overall, nursing instructors did better than nursing students in answering most of the questions.

Table 2.5

Nursing Students' Knowledge Regarding RP and PS

Short answer questions regarding knowledge	Year of study	Correct % (N)[1]	Partially correct % (N)[1]	Incorrect % (N)[1]
1. What are the differences between Routine Practices and Additional Precautions?	Year 1 Year 2 Year 3 Year 4	20.4 (42) 7.7 (18) 18.6 (22) 33.3 (6)	21.8 (45) 17.2 (40) 31.4 (37) 38.9 (7)	57.8 (119) 75 (174) 50 (59) 27.9 (5)
2. What is a point of care risk assessment? Why is it done? Please give an example	Year 1 Year 2 Year 3 Year 4	10.2 (21) 7.8 (18) 2.5 (3) 37.5 (6)	25.2 (52) 13.4 (31) 11.9 (14) 31.2 (5)	64.6 (133) 78.9 (183) 85.6 (101) 31.2 (5)
3. Name the link of the chain of infection that is disrupted by gloves	Year 1 Year 2 Year 3 Year 4	46.6 (96) 27.2 (63) 22.9 (27) 40 (6)	N/A	53.4 (110) 72.8 (169) 77.1 (91) 60 (9)
4. Name the link of the chain of infection that is disrupted by mask	Year 1 Year 2 Year 3 Year 4	29.6 (61) 25.4 (59) 16.1 (19) 40 (6)	N/A	70.4 (145) 74.6 (173) 83.9 (99) 60 (9)
5. Name the link of the chain of infection that is disrupted by vaccination	Year 1 Year 2 Year 3 Year 4	33.5 (69) 24.1 (56) 16.9 (20) 46.7 (7)	N/A	66.5 (137) 75.9 (176) 83 (98) 53.3 (8)

Short answer questions regarding knowledge	Year of study	Correct % (N)[1]	Partially correct % (N)[1]	Incorrect % (N)[1]
6. What does problem solving mean to you with respect to infection prevention and control?	Year 1 Year 2 Year 3 Year 4	19.9 (41) 12.9 (30) 15.2 (18) 41.2 (7)	N/A	80.1 (165) 87.1 (202) 84.7 (100) 58.8 (10)

% (N)[1]: the percentage and number of students who answered the identified question correctly or as otherwise noted; there were 206 students in Year 1 who answered all six questions; 232 in Year 2; and 118 students in Year 3. In Year 4: there were 18 students who answered question 1; 16 answered question 2; 15 answered questions 3,4, and 5; and 17 answered question 6.

As shown in Table 2.5, the proportion of students that correctly answered questions related to RP was quite variable, depending on the question and year. For example, only a small proportion (2.5% to 27.2%) of nursing students in Years 2 and 3, and only 10.2% to 46.7% of the students in Years 1 and 4 correctly answered all the questions related to RP. As can be seen, smaller proportions of nursing students in Years 2 and 3 gave correct answers about RP compared to Year 1 students. That may indicate the need for reinforcement of RP throughout the nursing curriculum. Similarly, only small percentages of nursing students (12.9% to 19.9%) in Years 1, 2, and 3, and 41.2% of students in Year 4 correctly explained what PS means with respect to infection prevention and control. In addition, 17.2% to 38.9% and 11.9% to 31.2 of nursing students in Years 1 to 4 were partially correct in their explanations of the difference between RP and additional precautions, and what is the PCRA, respectively. This may indicate that nursing students across all years do not clearly understand the difference between RP and additional precautions or the PCRA.

Table 2.6

Barriers to Adherence to RP Encountered by the Participants

Barriers to adherence to RP	**Year 1 N= 153** **% (N)[1]**	**Year 2 N= 211** **% (N)[1]**	**Year 3 N= 111** **% (N)[1]**	**Year 4 N= 20** **% (N)[1]**	**Total Students N= 495** **% (N)[1]**	**Instructors N= 20** **% (N)[1]**
Forgetfulness	54.2 (83)	46 (97)	53.2 (59)	10 (2)	48.7 (241)	25 (5)
Empty ABHR dispensers	41.8 (64)	46.4 (98)	48.6 (54)	50 (10)	45.7 (226)	55 (11)
High nursing workload	32.7 (50)	50.7 (107)	45 (50)	60 (12)	44.2 (219)	40 (8)
Presence of negative role models	22.9 (35)	48.3 (102)	47.7 (53)	50 (10)	40.4 (200)	25 (5)
Dealing with emergency situations	26.1 (40)	26.5 (56)	36.9 (41)	60 (12)	30.1 (149)	65 (13)
Inconvenient location of ABHR	20.3 (31)	32.2 (68)	36 (40)	25 (5)	29.1 (144)	40 (8)
Skin damage or dryness	24.2 (37)	27 (57)	26.1 (29)	45 (9)	26.7 (132)	20 (4)
Lack of knowledge and training	30.1 (46)	17.1 (36)	18 (20)	10 (2)	21 (104)	10 (2)
Unavailability of PPE	16.3 (25)	21.3 (45)	22.5 (25)	35 (7)	20.6 (102)	55 (11)
Alteration of skills when wearing PPE	8.5 (13)	19.9 (42)	26.1 (29)	40 (8)	18.6 (92)	25 (5)
Lack of hospital supporting policies	7.2 (11)	7.1 (15)	8.1 (9)	0 (0)	7.1 (35)	5 (1)
Other barriers	4.6 (7)	1.9 (4)	5.4 (6)	5 (1)	3.6 (18)	30 (5)

% (N)[1]: the percentage and number of students and instructors who answered the identified barriers to adherence questions as indicated.

Abbreviations: ABHR = Alcohol-Based Hand Rub; PPE = Personal Protective Equipment; RP = Routine Practices.

As can be seen in Table 2.6, there were multiple barriers reported by both nursing students and clinical instructors. Three of the most common barriers were almost the same in both groups of participants: high nursing workload (44.2% and 40%), empty ABHR dispenser (45.7% and 55%), and dealing with emergency situations (30.1% and 65%) for nursing students and instructors, respectively. The other common barriers identified by nursing students were forgetfulness (48.7%) and presence of negative role models (40.4%), while nursing instructors identified inconvenient location of ABHR (40%) and unavailability of PPE (55%). The same previously discussed barriers were also identified by students across the years. Nursing students were more likely to encounter these barriers as they progressed through in their program. For example, only 22.9% of students in Year 1 reported that they encountered negative role models compared to 60% in Year 4. Both nursing students and nursing instructors encountered a number of barriers that prevented them from adhering to RP.

Table 2.7

The Proportions of Participants that Identified Strategies to Deal with the Main three Barriers to Adherence to RP

Strategies to deal with the barriers	**Year 1 N= 193** **% (N)[1]**	**Year 2 N= 228** **% (N)[1]**	**Year 3 N= 116** **% (N)[1]**	**Year 4 N= 20** **% (N)[1]**	**Total Students N= 557** **% (N)[1]**	**Instructors N= 20** **% (N)[1]**
Inconvenient location of ABHR	20.2 (39)	34.2 (78)	36.2 (42)	45 (9)	30.2 (168)	30 (6)
High nursing workload	21.2 (41)	28.1 (64)	35.3 (41)	60 (12)	28.4 (158)	70 (14)

Presence of negative role models	15.5 (30)	21.1 (48)	30.2 (35)	20 (4)	21 (117)	75 (15)

% (N)[1]: the percentage and number of students and instructors who stated that they used some strategies to deal with the identified barriers.
Abbreviations: ABHR = Alcohol-Based Hand Rub.

Table 2.7 shows that nursing students were less likely to use strategies to deal with barriers to adherence compared to the instructors. Most nursing instructors (70 % and 75%) identified some strategies that can be used to deal with high nursing workload and presence of negative role models, respectively. Of 557 students, only 28.4% and 21% identified some strategies that can be used to deal with high nursing workload and presence of negative role models, respectively. Only small percentages of both nursing instructors (30%) and nursing students (30.2%) identified some strategies that can be used to deal with the inconvenient location of ABHR.

As nursing students progressed through the program, they were more likely to use strategies to deal with the barriers. For example, 20.2% and 21.2% of Year 1 students and 45% and 60% of Year 4 students identified some strategies to deal with inconvenient location of ABHR and with high nursing workload, respectively. However, only 15.5% to 21 % of nursing students across all years reported strategies to deal with presence of negative role models. Overall, relatively few nursing students and instructors reported some strategies to deal with the barriers to adherence to RP.

As shown in Table 2.8, both students and instructors identified a number of strategies that can be used to deal with these three identified barriers to adherence to RP. However, the most common identified strategies varied by barrier and between the students and their instructors. Both students and instructors identified “time management” (34% of the students and 9.1% of

the instructors) and “carry extra PPE and ABHR” (6.1% of the students and 9.1% of the instructors) as strategies that can be used to deal with high nursing workload. In addition to these two strategies, nursing students also identified “prioritizing” (21.8%), “ask for assistance” (9.1%), “delegation” (5.3%), “carry ABHR” (5.3%), and “cluster patient care” (4.5 %) as strategies that can be used to deal with high nursing workload.

Besides the two previously discussed strategies, 18.2% of the nursing instructors also identified “gather all needed supplies” as one of the strategies to deal with high nursing workload. Moreover, similar percentages (9.1%) of the instructors identified other strategies to deal with high nursing workload. These strategies were: “adjust the time for patient care”, “ask if questions and discussion”, “assess the individual and context”, “re-examine policies and procedures”, “discuss time management and cluster care”, “guidance on workload management”, and “clinical conferences discussion”.

In terms of strategies to deal with the inconvenient location of ABHR, more strategies were identified by students (12 strategies) compared to the instructors (3 strategies). Of these 15 identified strategies, both students (35.4%) and instructors (20%) identified “carry my own” as one of the common strategies that can be used to deal with the inconvenient location of ABHR dispensers. Moreover, of the 12 identified strategies by students, the most common ones were: “use water and soap” (25.7%), “look for near one” (22.9%), and “notify the staff” (4.9%). Besides “carry my own” strategy, instructors identified the following strategies: “students bring their own” (60%) and “students be familiar with the locations” (20%).

In terms of strategies to deal with negative role models, both students and instructors identified a number of strategies that can be used. The most common strategies identified by students were: “follow what I learned” (35.2%), “report to the instructor” (13%), “ignore the

negative role models" (11.1%), "work with a positive model" (7.4 %), "question the negative role models" (4.6%), "remind myself of expected standard" (4.6%), "communicate my concerns" (4.6%), and "approach the negative model" (4.6%).

Table 2.8

Strategies Identified by the Participants to Deal with the Three Identified Barriers to Adherence to RP

Participants	Strategies used to deal with high nursing workload %[1]	Strategies used to deal with inconvenient location of ABHR %[1]	Strategies used to deal with presence of negative role models %[1]
Nursing students	1. Time management (34%) 2. Prioritizing (21.8%) 3. ask for assistance (9%) 4. Carry extra PPE and ABHR (6.1%) 5. Delegation (5.3%) 6. Carried ABHR (5.3%) 7. Clustered patient care (4.5%) 8. Multitasking 9. Time management & prioritizing 10. Use agenda and go through a checklist 11. Let RN monitor me 12. communication 13. Think of what could happen to you 14. Critical thinking 15. Make RP as a habit 16. Take your time 17. Put RP as a highest priority 18. Gather all supplies needed	1. Carry my own (35.4%) 2. Use water and soap (25.7%) 3. Look for near one (22.9%) 4. Notify the staff (4.9%) 5. Be familiar with the locations 6. Give myself time 7. Move ABHR to an area has no one 8. Carry my own & notify the staff 9. Wear gloves instead 10. Gather my supply first 11. Notify the instructor	1. Follow what I learned (35.2%) 2. Report to instructor (13%) 3. Ignore the negative role models (11.1%) 4. Work with a positive model (7.4 %) 5. Question the negative role models (4.6%) 6. Remind myself of expected standard (4.6%) 7. Communicate my concerns (4.6%) 8. Approach the negative model (4.6%) 9. Avoid them 10. Speak to a unit supervisor 11. Tell them the correct way 12. Confrontation and education 13. I agree with them to avoid conflict 14. Make it a habit to wash my hand 15. Gather supplies beforehand

Participants	Strategies used to deal with high nursing workload	%[1]	Strategies used to deal with inconvenient location of ABHR	%[1]	Strategies used to deal with presence of negative role models	%[1]
Nursing instructors	1. Gather all needed supplies (18.2%) 2. Time management (9.1%) 3. Carry extra PPE and ABHR (9.1%) 4. Adjusting the time for patient care (9.1%) 5. Guidance on workload management (9.1%) 6. Ask if questions and discussion (9.1%) 7. Assess the individual and context (9.1%) 8. Clinical conferences discussion (9.1%) 9. Re-examine policies and procedures (9.1%) 10. Discuss time management and cluster care (9.1%)		1. Students bring their own (60%) 2. Carry my own (20%) 3. Be familiar with the locations (20%)		1. Engage in discussion with students (6.7%) 2. Advice on best practice (6.7%) 3. Discuss importance of adhering to PPE (13.3%) 4. Ask what if questions (6.7%) 5. Talk out the discrepancy with student (6.7%) 6. Debrief about what happening (6.7%) 7. Remind them about their own health (6.7%) 8. Review the policy (6.7%) 9. Remind and review RP with them (6.7%) 10. Review the implications of not properly adhering to RP (6.7%) 11. Provide education (6.7%) 12. Remind them that what they see done may not be correct (6.7%) 13. Respectful communication (6.7%)	

% [1]: is the proportion of participants who identified some strategies to deal with the three identified barriers. There were 133 students and 11 instructors who identified some strategies to deal with high nursing workload; there were 144 students and 5 instructors who identified some strategies to deal with inconvenient location of ABHR; and there were 108 students and 15 instructors who identified some strategies to deal with negative role models.
Note: proportions were only given for the identified strategies if 3% or more of the participants indicated that they used these strategies. The proportions do not add up to 100% as participants identified multiple strategies

Abbreviations: ABHR = Alcohol-Based Hand Rub; PPE = Personal Protective Equipment; RP = Routine Practices.

Table 2.8 shows that instructors identified different strategies than the students. For instance, the highest proportion of the instructors (13.3%) identified "discuss the importance of adhering to PPE" as one of the common strategies to deal with negative role models. In addition, similar percentages of the instructors (6.7%) also identified different strategies to deal with negative role models. These identified strategies were: "engage in discussion with students", "advice on best practice", "ask what-if questions", "talk out the discrepancy with students", "debrief about what happening", "remind them about their own health", "review the policy", "remind and review RP", "review the implications of not properly adhering to RP", "provide education", "remind them that what they see done may not be correct", and "respectful communication. As can be seen from these identified strategies, instructors were not in an agreement about the strategies to use to deal with negative role models. Interestingly, none of the students or instructors identified PS as a strategy that can be used to deal with these identified barriers.

Table 2.9

Participants' Confidence Related to RP and PS

Questions regarding confidence	**Nursing students**		**Nursing instructors**	
	Very confident or confident % (N)[2]	**Somewhat or not at all confident % (N)[2]**	**Very confident or confident % (N)[2]**	**Somewhat or not at all confident % (N)[2]**
Performing hand hygiene when indicated **(N[1]= 573)**	99 (567)	1 (6)	100 (20)	0 (0)
Discarding sharps needles in an appropriate sharp container **(N[1]= 572)**	93.9 (537)	6.1 (35)	100 (20)	0 (0)

Questions regarding confidence	Nursing students		Nursing instructors	
	Very confident or confident % (N)[2]	Somewhat or not at all confident % (N)[2]	Very confident or confident % (N)[2]	Somewhat or not at all confident % (N)[2]
Using PPE when indicated **(N[1]= 573)**	92.7 (531)	7.3 (42)	95 (19)	5 (1)
Doing point of care risk assessment before patient care **(N[1] = 567)**	47.4 (269)	52.6 (298)	65 (13)	35 (7)
Applying problem solving to deal with the influence of inconvenient location of ABHR on my adherence to Routine Practices **(N[1] = 567)**	70.2 (398)	29.8 (169)	70 (14)	30 (6)
Applying problem solving to deal with the influence of a negative role model on my adherence to Routine Practices **(N[1] = 567)**	54 (306)	46 (261)	80 (16)	20 (4)
Applying problem solving to deal with the influence of high nursing workload on my adherence to Routine Practices **(N[1] = 568)**	53.2 (302)	46.8 (266)	80 (16)	20 (4)

(N)[1]: the number of students who answered the identified confidence questions; there were always 20 instructors.
% (N)[2]: the percentage and number of students and instructors who reported the given confidence level for the identified confidence questions; the number of students in the denominator varied by question (see N[1]); there were always 20 instructors.
Abbreviations: ABHR = Alcohol-Based Hand Rub; PPE = Personal Protective Equipment.

As can be seen in Table 2.9, the majority (92.7% to 100%) of the nursing instructors and nursing students were very confident/confident about performing hand hygiene when indicated, using PPE when indicated, and discarding sharps needles in appropriate sharps container. More instructors were very confident/confident about explaining the PCRA (65%) compared to

nursing students (47.4 %). Similarly, more instructors (80% and 80%) reported that they were very confident/confident about applying PS to deal with the influence of high nursing workload and presence of a negative role on their adherence to RP, compared to nursing students (53.2% to and 54%), respectively. Both instructors (70%) and students (70.2%) showed a similar level of confidence in applying PS to deal with the influence of inconvenient location of ABHR on their adherence to RP.

Table 2.10

Confidence Related to RP and PS among Year 1, 2, 3, and 4 Nursing Students

Questions regarding confidence	**Year of study and number of students (N[1])**	**Very confident/ Confident % (N)[2]**	**Somewhat confident/ Not at all confident % (N)[2]**
Performing hand hygiene when indicated	Year 1 (N= 205) Year 2 (N=231) Year 3 (N=117) Year 4 (N=20)	98 (201) 99.1 (229) 100 (117) 100 (20)	2 (4) 0.9 (2) 0 (0) 0 (0)
Using PPE when indicated	Year 1 (N= 205) Year 2 (N=231) Year 3 (N=117) Year 4 (N=20)	93.7 (192) 91.3 (211) 94.9 (111) 85 (17)	6.3 (13) 8.7 (20) 5.1 (6) 15 (3)
Discarding sharps needles in an appropriate sharp container	Year 1 (N=204) Year 2 (N=231) Year 3 (N=117) Year 4 (N=20)	83.8 (171) 99.1 (229) 100 (117) 100 (20)	16.2 (33) 0.9 (2) 0 (0) 0 (0)
Doing point of care risk assessment before patient care	Year 1 (N=201) Year 2 (N=230) Year 3 (N=116) Year 4 (N=20)	45.8 (92) 51.7 (119) 40.5 (47) 80 (16)	54.2 (109) 48.3 (111) 59.5 (69) 20 (4)
Applying problem solving to deal with the influence of high nursing workload on my adherence to Routine Practices	Year 1 (N= 200) Year 2 (N=231) Year 3 (N=117) Year 4 (N=20)	49 (99) 58.9 (136) 51.3 (60) 35 (7)	51 (101) 41.1 (95) 48.7 (57) 65 (13)
	Year 1 (N=200)	53.5 (107)	46.5 (93)

Questions regarding confidence	Year of study and number of students (N[1])	Very confident/ Confident % (N)[2]	Somewhat confident/ Not at all confident % (N)[2]
Applying problem solving to deal with the influence of a negative role model on my adherence to Routine Practices	Year 2 (N=230) Year 3 (N=117) Year 4 (N=20)	59.1 (136) 47 (55) 40 (8)	40.9 (94) 53 (62) 60 (12)
Applying problem solving to deal with the influence of inconvenient location of ABHR on my adherence to Routine Practices	Year 1 (N=200) Year 2 (N=230) Year 3 (N=117) Year 4 (N=20)	62.5 (125) 76.6 (177) 69.2 (81) 75 (15)	37.5 (75) 23 (54) 30.8 (36) 25 (5)

(N)[1]: the number of students in each year who answered the identified questions about the confidence related to RP and PS.
% (N)[2]: the percentage and number of students who reported the given confidence level for the identified confidence questions; the number of students in the denominator varied by question and by year.
Abbreviations: ABHR = Alcohol-Based Hand Rub; PPE = Personal Protective Equipment.

As can be seen in Table 2.10, the majority of students (83.8% to 100%) in all years reported that they were very confident/confident about performing hand hygiene, using PPE, and sharps safety. A much higher proportion of Year 4 students (80%) were very confident/confident regarding PCRA compared to the other students (40.5% to 51.7%). For PS, smaller proportions of Year 4 students were very confident/confident about applying PS to deal with high nursing workload (35%) and negative role models (40%) than the other students (49% to 58.9% and 47% to 59.1%, respectively. For ABHR there was no clear trend by year, ranging from 62.5% to 75%.

As shown in Table 2.11, both students and instructors identified three teaching methods that can be used to teach PS related to RP. These three methods were: scenario-based simulation (71.3% and 90%), group discussion (63.2% and 85%), and video watching (57.2% and 75%), respectively. Most of the nursing instructors (95%) selected case studies, and a small percentage of nursing students (43.3%) selected the same method.

Table 2.11

Participants' Preferred Teaching Strategies to Teach PS Related to RP

Teaching strategies	**Year 1 N= 200** **% (N)[1]**	**Year 2 N= 230** **% (N)[1]**	**Year 3 N=118** **% (N)[1]**	**Year 4 N = 20** **% (N)[1]**	**Total students N = 568** **% (N)[1]**	**Instructors N = 20** **% (N)[1]**
Scenario-based simulation with instructor	70.5 (141)	68.3 (157)	78 (92)	75 (15)	71.3 (405)	90 (18)
Group discussion	64.5 (129)	65.7 (151)	60.2 (71)	40 (8)	63.2 (359)	85 (17)
Video watching	59.5 (119)	62.6 (144)	43.2 (51)	55 (11)	57.2 (325)	75 (15)
Lecture	52 (104)	45.2 (104)	30.5 (36)	30 (6)	44 (250)	45 (9)
Case studies	39 (78)	45.7 (105)	44.1 (52)	55 (11)	43.3 (246)	95 (19)
Role play	35.5 (71)	38.7 (89)	47.5 (56)	35 (7)	39.3 (223)	40 (8)
Other	1.5 (3)	2.2 (5)	4.2 (5)	5 (1)	2.5 (14)	10 (2)

% (N)[1]: the percentage and number of students who answered the identified preferred teaching methods.

As can be seen in Table 2.11, Only 44% and 45% of nursing students and nursing instructors, respectively, selected lecture as the best method to teach PS related to RP. Students also identified hands-on lab practice and clinical experience as other teaching methods that can be used to teach PS related to RP. When students were asked about the best time in the nursing program to learn about PS related to RP, 75.4% stated in Year 1, 61.4% identified the introduction to nursing course, and 23.3% stated before they start their clinical.

Discussion

Adherence to RP has been found to be suboptimal due to a number of barriers such as high nursing workload, inconvenient location of ABHR dispensers, and the presence of negative role models. Having the necessary knowledge and confidence about RP, as well as PS related to RP, can potentially help in addressing these barriers. Therefore, this study was conducted to understand nursing instructors' and nursing students' knowledge, confidence, and application of both RP and PS related to RP, as well as how they address barriers to RP adherence. Based on the findings of this study, there are clear implications for nursing school administrators, instructors, and curriculum development, but it is also important for infection control practitioners (ICPs) to know about these results so that they can understand the gaps in RP, PS, and barriers to RP. Understanding of these gaps will help with enhancing understanding of the topics that need to be addressed and reinforced when they are teaching or interacting with students and instructors about RP.

Knowledge and Confidence about RP

To identify the knowledge gaps about RP, we examined the students' and instructors' knowledge about RP using true/false and short answer questions. We found that the majority of students (83.5% to 100%) and instructors (75% to 100%) correctly answered 8 out of 9 of the true/false questions, although only a few of them (16.1 % and 15%, respectively) were able to correctly identify the minimum time needed for ABHR to kill most of the germs on hands. However, when participants' knowledge was assessed by using the short answer questions, we found that it was lower than when assessed with the true/false questions. For instance, only 15.3% of nursing students and 30% of nursing instructors correctly explained the differences

between RP and additional precautions, and 8.4% and 52.6% could explain about the PCRA, respectively. These results were also similar across all years of nursing students.

Not surprisingly, given their knowledge levels, we found that most of the students in all years (83.8% to 100%) and instructors (95% to 100%) reported that they were very confident/confident about performing hand hygiene when indicated, discarding needles in sharp containers, and using PPE when indicated. However, like their knowledge about PCRA, their confidence about PCRA was lower than their confidence about the other three RP items (performing hand hygiene when indicated, using PPE when indicated, and discarding sharps needles in an appropriate sharp container). For instance, only 65% of the instructors and 47.4% of the students reported that they were very confident/confident about doing the PCRA. Although more than half of the nursing instructors and almost half of the nursing students reported that they were confident about doing the PCRA, only 8.4% of the students and 52.6% of the instructors were able to explain the term and why it is done.

The results highlighted three important gaps: instructors' general knowledge of RP, students' and instructors' specific knowledge of PCRA, and the ability to articulate knowledge. As can be seen, instructors' knowledge about RP, including the difference between RP and AP and about the PCRA, was better than students' knowledge, but it was still low. Little research has been conducted related to instructors and RP, but these results are consistent with those by Chiasson (2015) who also found that nursing instructors stated that they need to know more than the students about all RP components, so that they can help their students to have a better understanding of RP and AP and their application. To strengthen instructors' knowledge and confidence about RP, the faculty of nursing administrators need to ensure that their faculty members receive the required training, and that their knowledge about RP remains up to date.

Lack of knowledge and confidence in PCRA, and difficulty explaining RP and PCRA, reflect areas that need further exploration. It is unclear why students lacked understanding of these terms as they are taught in the curriculum. For example, most of the students stated that RP was the routine care that can be done for every patient, such as vital signs, that AP was extra care needed based on patient-specific needs, and that PCRA was the assessment done to assess if the patient was at risk for a safety concern, such as a fall. Both groups of participants did not link their explanation to infection prevention and control practices. Because students prepare to write the National Council Licensure Examination (NCLEX) exams, which uses the American terminology related to SP, they may be more familiar with this terminology. PCRA is not included in SP but is a central component in RP. They may associate SP specifically with infection control whereas routine practices mean anything care done routinely, not specific to infection control. The terminology of RP and AP therefore needs to be emphasized in Canadian curricula and reinforced by ICPs in practice settings. Furthermore, the discrepancy in the knowledge scores for the true/false versus short answers could be attributed to the fact that students may be familiar with evaluation using fixed choice questions (e.g., multiple-choice) and thus recognition of correct answers, and they may not practice with short answer questions or having to articulate their rationales or understanding of terms. Therefore, they need more practice in clinical or labs or seminars articulating their understanding of RP.

While nursing schools have the primary responsibility for ensuring students graduate with a sound knowledge base of RP and AP, ICPs can help. Many ICPs are invited to give a class or to talk to students about RP and AP. They can expand their interactions with the schools and offer to share their expertise with curriculum committees to help them refine what students are taught and offer to give education sessions specifically for instructors. Such sessions could

focus not only on the concepts and practice of RP and AP but also on strategies for teaching and reinforcing RP and AP in classes, labs, and clinical practice (e.g., in clinical conferences). In addition, ICPs can and do have interactions with students and instructors when the students are in their clinical placements. ICPs who do not yet have established associations with nursing schools could seek to establish such associations.

Knowing the gaps in knowledge and confidence can help ICPs know what to address or reinforce. For example, ICPs can help emphasize the use of these previously identified terms by regularly discussing them with students and instructors while they are in their clinical practice, or when they are invited to give classes. They can also explain to the students and instructors why Canada has adopted the system of RP instead of SP, what are the components of RP, how these components are different from SP, what are the key differences between RP and AP, and how to apply a PCRA before interacting with each patient. In their discussions, ICPs can ask students and instructors to explain their rationales in their own words to ensure their understanding is correct. As can be seen from the results, however, students' and instructors' knowledge and confidence about RP were reasonably good except for a few gaps that need to be strengthened, so a more important issue to consider is that of the barriers to RP adherence.

Barriers to Adherence to RP

In this study, both groups of participants reported that they encountered a number of barriers that prevented them from adhering to RP. Three of the most common barriers were almost the same in both nursing students and clinical instructors: high nursing workload (44.2% and 40%), empty ABHR dispensers (45.7% and 55%), and dealing with emergency situations (30.1% and 65%). The other common barriers identified by nursing students were forgetfulness (48.7% and 25%), and the presence of negative role models (40.4% and 25%). These results are

consistent with previous study findings (Cheung et al., 2015; Choi & Kim, 2018; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Kirk et al., 2016; Wilson et al., 2017).

This study focused on workload, ABHR dispensers, and negative role models. These barriers need to be addressed because they can influence patient safety by impacting adherence to RP. ICPs can play a vital role in addressing these barriers at both individual and organizational levels. At the individual level, ICPs can use their communication skills to discuss the issue of negative role models with nurses and explain to them its negative impact on adherence to RP and reinforce best practices. At the organizational level, ICPs can use their knowledge and leadership skills to participate in designing and selecting convenient locations to place ABHR dispensers. They can also advocate for more staffing to address the issue of high nursing workload and its negative impact on adherence to RP. Because it is not always feasible to eliminate these barriers, other strategies are also needed to help nursing students and others to deal with these barriers.

Strategies and PS to Address the Barriers

Although a large proportion of both students and instructors reported that high nursing workload, negative role models, and inconvenient location of ABHR were among the most common barriers that prevented them from adhering to RP, the study results indicated that there was a lack of strategies used to deal with them. For instance, only 21% to 30.2% of the students, varying by year, identified some strategies that can be used to deal with these three barriers. However, as nursing students progressed through the program, they were more likely to use some strategies to deal with these three identified barriers. For instance, 21.1% and 20.2% of Year 1 and 60% and 45% of Year 4 students identified some strategies to deal with the inconvenient location of ABHR and high nursing workload, respectively. This could be

attributed to the fact that Year 4 students had spent more time in clinical compared to Year 1 students and thus would have had more encounters and opportunities to develop and use strategies to deal with barriers. Although more instructors (70% and 75%) than students (28.4% and 21%) identified some strategies to deal with high nursing workload and negative role models, respectively, only 30% of the instructors identified some strategies that can be used to deal with inconvenient location of ABHR dispensers.

To deal with the inconvenient location of ABHR dispensers, both groups identified "carry my own ABHR" as the most common strategy that can be used. In addition to this strategy, students also identified "use water and soap" and "look for the nearest location of ABHR dispensers", and instructors also identified "be familiar with the location of ABHR dispensers". To deal with high nursing workload, both students and instructors identified two common strategies: "time management" and "carry extra PPE and ABHR." In addition to these two strategies, students also identified "prioritizing", "ask for assistance", and "delegation", while instructors identified "gather all needed supplies". There was no literature found that described strategies used for addressing these common barriers. Future studies that aim to improve students' and nurses' adherence to SP could focus on strategies that address the barriers to adherence.

To deal with the presence of negative role models, both students and instructors identified different strategies. The most commonly identified strategies by the students were "follow what they learned in school" and "report the encounter of negative role models to their instructors"; the strategy most frequently identified by instructors was "discuss the importance of adhering to PPE with the students". Reporting to instructors as a strategy may indicate the vital role that instructors can play to help their students to deal with these barriers. However, if the instructors

are not able to guide them on how to deal with this barrier or the other barriers, their adherence to RP can be impacted. ICPs can help instructors develop knowledge related to addressing barriers, as discussed later. Instructors could also play an important role in helping students decrease their forgetfulness, but this barrier was not examined in this study.

PS is a potential strategy to use because it provides systematic steps that students can follow to address the barriers to RP adherence. However, before they can use PS, they need to know about it. Interestingly, although all of the nursing instructors (100%) and most of the nursing students (94.3%) stated that PS could help them to deal with these identified barriers, none of them identified PS as a strategy when asked about the strategies that they can use. This lack of using PS is probably affected by their lack of knowledge and training about PS. For instance, only 16.8% of the students and 15% of the instructors were able to correctly explain what PS means with respect to infection prevention and control. In addition, 75.7% of students and all of the instructors reported that they did not receive any training about PS related to RP.

Considering students and instructors did not have enough knowledge and training about PS, it is surprising that 70% to 80% of the instructors and 53.2% to 70.2% of students were very confident/confident about applying PS to deal with the inconvenient location of ABHR, negative role models, and high nursing workload, although more instructors had these levels of confidence. This contradicted the results of the study conducted in Atlantic Canada where Chiasson (2015) found that only 26.9% of nursing educators and 20.0% of nursing students reported feeling very confident in PS related to infection prevention and control. This contradiction could be because Chiasson assessed PS related to infection prevention and control in general, and we specifically assessed it related to the barriers.

To help strengthen instructors' and students' ability to use PS and other strategies to address the barriers to RP adherence, ICPs can coordinate with school of nursing administrators to offer their expertise to provide training sessions that focus on discussing the barriers to RP adherence and strategies to address these barriers, including PS. ICPs can help teach the steps of PS and help students practice its application with respect to RP in both formal educational sessions and in one-to-one or ICP-to-small-group encounters on clinical units. ICPs can review the steps of PS and explain how these steps can be used to address these barriers. For instance, students can follow these steps to identify the barrier, come up with the possible solutions, weigh the pros and cons of these solutions, choose, and implement the selected solution, and evaluate the effectiveness of the implemented solution. On the unit, ICPs can utilize the students' experiences in clinical practice as the basis of discussion about barriers and PS, as well as situation-specific issues and solutions. ICPs can help create a supportive environment that promotes and empowers students to come up with some strategies that they can use to deal with barriers to RP adherence.

The teaching and reinforcement of PS related to RP can be delivered to students by using specific teaching methods. In this study, large percentages of the students (71.3% and 63.2%) and the instructors (90% and 85%) identified scenario-based simulation and group discussion, respectively, as the best two teaching methods that can be used to teach PS related to RP. A short group discussion can be easily implemented on a clinical unit. In addition, ICPs can seek out interactions with students from all years of a program, not just those in first year, which is when they might most commonly be invited to talk to students. When students were asked about the best time in the nursing program to learn about PS related to RP, the majority of students stated in Year 1, in the *introduction to nursing* course, and before they start their clinical. However, the

results from this study indicated a need for reinforcement and clarification of practices in later years of the program as well.

Strengths and Limitations of the Study

This study has strengths and limitations. A key strength is that this was the first survey study of its kind to assess strategies used to address key barriers to RP adherence and PS related to RP among nursing instructors and nursing students. Furthermore, it is one of few studies to assess instructors' knowledge and confidence related to RP. The results therefore indicate some directions for strategies that might be used, such as PS as an approach as well as specific solutions relevant to each barrier, to help strengthen RP for infection prevention and control. Another strength of this study is that there was a good representative sample size of 557 students from Years 1 to 3 from three main nursing schools in Atlantic Canada, all of whom were exposed to the same infection prevention and control curriculum. The results therefore provide a good reflection of the knowledge and understanding of PS and RP in the target population. Results may be generalizable to other students in settings with similar characteristics and curricula.

However, this study has some limitations. First, there were only 20 nursing instructors from three nursing schools in the same province using the same curriculum that participated in this study; therefore, the results may not be generalizable to other instructors. Future research should both evaluate interventions that address instructors' knowledge and skills for promoting PS and RP and identify strategies for increasing their engagement in such research. A second limitation is that the sample of Year 4 students was small (n = 20) due to the fact that they were not on campus at the time of the study so they were not as easy to reach as other students; future research could explore their knowledge and experiences in more depth to better inform changes

in curricula related to RP and PS. A third limitation is that in this study we used a self-report questionnaire, therefore, we cannot exclude possible over or underestimation of participants' knowledge and confidence related to RP and PS. Future research should consider using an observation technique to observe the actual application of PS related to barriers to adherence. Finally, participants' knowledge about PS was measured by using only one short-answer (*what does PS mean to you with respect to infection prevention and control?*), which was not sufficient to draw a conclusion about their PS knowledge; therefore, this result should be interpreted with caution, and further exploration about what they know and do is warranted. There are no valid and reliable instruments that specifically measure knowledge and confidence about PS related to RP, therefore future research should focus on the development and validation of such an instrument. Even with the limitations of the current study, however, our results add to the literature and provide valuable information to inform interventions to strengthen nursing students' and instructors' knowledge and skills related to RP and PS and addressing barriers to RP adherence. The recommendations provided will be useful to ICPs and nursing curriculum committees.

Conclusion

The results of our study indicated that both nursing instructors and nursing students across all years showed good knowledge and confidence about most of the RP components, however, their knowledge and confidence about PCRA as well as about PS need to be strengthened. They also encountered a number of barriers that prevented them from adhering to RP. The most common ones were high nursing workload, inconvenient location of ABHR dispensers, and the presence of negative role models. Although they encountered these barriers, only a few of them identified some strategies that can be used to use to deal with them. These

identified strategies were varied between the participants. Both groups of participants also reported a lack of knowledge and training about PS; as a result, none of them identified PS as a potential strategy that can be used to address these barriers. Overall, this study has provided new insights that will help us to develop an evidence-informed PS educational program to strengthen students' knowledge, confidence, and application of PS to deal with three commonly identified barriers. Dealing with these barriers may lead to improve students' adherence and as result may also improve patient safety. Such a proposed PS program should use scenario-based simulation and group discussions as recommended by the nursing students.

Much of the onus for preparation of students related to RP rests with schools of nursing, their curricula, the instructors, and the students themselves. However, we have made a number of recommendations about how ICPs can contribute to students and instructors having the necessary knowledge and skills related to RP, so that they can deal effectively with the barriers to adherence. By sharing their expertise in both formal classes and informal on-unit encounters, ICPs can reinforce students' and instructors' understanding and application of RP and help them apply strategies to deal with common barriers. By knowing the gaps, as identified in this study, ICPs will also be better positioned to know what issues need to be addressed with new staff. This may also help them with orienting new graduates, and they may find it useful to focus on a problem-solving approach when reinforcing RP with all nurses.

References

Arefian, H., Hagel, S., Fischer, D., Scherag, A., Brunkhorst, F. M., Maschmann, J., & Hartmann, M. (2019). Estimating extra length of stay due to healthcare-associated infections before and after implementation of a hospital-wide infection control program. *PloS One, 14*(5), e0217159. https://doi.org/10.1371/journal.pone.0217159

Badia, J. M., Casey, A. L., Petrosillo, N., Hudson, P. M., Mitchell, S. A., & Crosby, C. (2017). Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *Journal of Hospital Infection, 96*(1), 1-15. https://doi.org/10.1016/j.jhin.2017.03.004

Barker, A. K., Brown, K., Siraj, D., Ahsan, M., Sengupta, S., & Safdar, N. (2017). Barriers and facilitators to infection control at a hospital in northern India: a qualitative study. *Antimicrobial Resistance & Infection Control, 6*(1), 35. https://doi.org/10.1186/s13756-017-0189-9

Canadian Nosocomial Infection Surveillance Program (CNISP). (CNISP, 2015). Healthcare-associated Infections Annual Report 2009-2014. Retrieved from: https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2014.pdf.

Cheung, K., Chan, C. K., Chang, M. Y., Chu, P. H., Fung, W. F., Kwan, K. C., ... & Mak, H. M. (2015). Predictors for compliance of standard precautions among nursing students. *American Journal of Infection Control, 43*(7), 729-734. https://doi.org/10.1016/j.ajic.2015.03.007

Chiasson, M. (2015). *Exploring infection prevention and control education in Atlantic Canadian undergraduate nursing education programs* (Doctoral dissertation, Memorial University of Newfoundland). Available at https://research.library.mun.ca/8446/.

Choi, J. S., & Kim, K. M. (2018). Factors influencing nursing students' intention to comply with infection control practices. *American Journal of Infection Control*, *46*(6), 717-719. https://doi.org/10.1016/j.ajic.2017.12.010

Cochran, W. G. (1977). Sampling techniques (3rd ed.). New York: John Wiley & Sons.

Colet, P. C., Cruz, J. P., Alotaibi, K. A., Colet, M. K., & Islam, S. M. (2017). Compliance with standard precautions among baccalaureate nursing students in a Saudi university: A self-report study. *Journal of Infection and Public Health*, *10*(4), 421-430. https://doi.org/10.1016/j.jiph.2016.06.005

Cruz, J. P. (2019). Infection prevention climate and its influence on nursing students' compliance with standard precautions. *Journal of Advanced Nursing*, *75*(5), 1042-1052. https://doi.org/10.1111/jan.13904

Day, H. R., Perencevich, E. N., Harris, A. D., Gruber-Baldini, A. L., Himelhoch, S. S., Brown, C. H., & Morgan, D. J. (2013). Depression, anxiety, and moods of hospitalized patients under contact precautions. *Infection Control & Hospital Epidemiology*, *34*(3), 251-8. https://doi.org/10.1086/669526

Day, H. R., Perencevich, E. N., Harris, A. D., Himelhoch, S. S., Brown, C. H., Gruber-Baldini, A. L., ... & Morgan, D. J. (2011). Do contact precautions cause depression? A two-year study at a tertiary care medical centre. *Journal of Hospital Infection*, *79*(2), 103-107. https://doi.org/10.1016/j.jhin.2011.03.026

Dorgham, S. R., & Obied, H. K. (2016). Factors affecting nurse interns' compliance with standard precautions for preventing stick injury. *Journal of Nursing Education and Practice, 6*(12), 121–130. https://doi.org/10.5430/jnep.v6n12p121

Foote, A., & El-Masri, M. (2016). Self-perceived hand hygiene practices among undergraduate nursing students. *Journal of Research in Nursing*, *21*(1), 8-19. https://doi.org/10.1177/1744987115606959

Guilley-Lerondeau, B., Bourigault, C., des Buttes, A. C. G., Birgand, G., & Lepelletier, D. (2017). Adverse effects of isolation: a prospective matched cohort study including 90 direct interviews of hospitalized patients in a French University Hospital. *European Journal of Clinical Microbiology & Infectious Diseases*, *36*(1), 75-80. https://doi.org/10.1007/s10096-016-2772-z

Hessels, A. J., & Larson, E. L. (2016). Relationship between patient safety climate and standard precaution adherence: a systematic review of the literature. *Journal of Hospital Infection*, *92*(4), 349-362. https://doi.org/10.1016/j.jhin.2015.08.023

Hinkin, J., & Cutter, J. (2014). How do university education and clinical experience influence pre-registration nursing students' infection control practice? A descriptive, cross sectional survey. *Nurse Education Today*, *34*(2), 196-201. https://doi.org/10.1016/j.nedt.2013.09.005

Jia, H., Li, L., Li, W., Hou, T., Ma, H., Yang, Y., ... & Luo, X. (2019). Impact of healthcare-associated infections on length of stay: a study in 68 hospitals in China. *BioMed Research International*. https://doi.org/10.1155/2019/2590563

Kaba, A., Baumann, A., Kolotylo, C., & Akhtar-Danesh, N. (2017). A descriptive case study of the changing nature of nurses' work: The impact of managing infectious diseases requiring isolation. *American Journal of Infection Control*, *45*(2), 200-202. https://doi.org/10.1016/j.ajic.2016.06.036

Kirk, J., Kendall, A., Marx, J. F., Pincock, T., Young, E., Hughes, J. M., & Landers, T. (2016). Point of care hand hygiene—where's the rub? A survey of US and Canadian health care workers' knowledge, attitudes, and practices. *American Journal of Infection Control*, *44*(10), 1095-1101. https://doi.org/10.1016/j.ajic.2016.03.005

Lupión-Mendoza, C., Antúnez-Domínguez, M. J., González-Fernández, C., Romero-Brioso, C., & Rodriguez-Bano, J. (2015). Effects of isolation on patients and staff. *American Journal of Infection Control*, *43*(4), 397-399. https://doi.org/10.1016/j.ajic.2015.01.009

Moon, K. J., Hyeon, Y. H., & Lim, K. H. (2019). Factors associated with nursing students' compliance with standard precautions: a self-reported survey. *Int J Infect Control*, *15*(3), 1-9. https://doi.org/10.3396/ijic.v15i3.19007

Musau, J., Baumann, A., Kolotylo, C., O'shea, T., & Bialachowski, A. (2015). Infectious disease outbreaks and increased complexity of care. *International Nursing Review*, *62*(3), 404-411. https://doi.org/10.1111/inr.12188

Olsen, M. A., Yan, Y., Reske, K. A., Zilberberg, M. D., & Dubberke, E. R. (2015). Recurrent Clostridium difficile infection is associated with increased mortality. *Clinical Microbiology and Infection*, *21*(2), 164-170. https://doi.org/10.1016/j.cmi.2014.08.017

Pereira, F. M. V., Lam, S. C., Chan, J. H. M., Malaguti-Toffano, S. E., & Gir, E. (2015). Difference in compliance with Standard Precautions by nursing staff in Brazil versus Hong Kong. *American Journal of Infection Control*, *43*(7), 769-772. https://doi.org/10.1016/j.ajic.2015.03.021

Provincial Infection Control Newfoundland and Labrador. (2015). Healthcare-associated Infections Annual Report 2009-2015. Retrieved from https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2015.pdf.

Public Health Agency of Canada (PHAC). (2014). Routine practices and additional precautions for preventing the transmission of infection in healthcare settings. Retrieved from https://www.canada.ca/en/public-health/services/infectious-diseases/nosocomial-occupational-infections/routine-practices-additional-precautions-preventing-transmission-infection-healthcare-settings.html.

Purssell, E., Gould, D., & Chudleigh, J. (2020). Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis. *BMJ Open*, *10*(2). http://dx.doi.org/10.1136/bmjopen-2019-030371

Schmidt, A., Bénard, S., & Cyr, S. (2015). Hospital cost of staphylococcal infection after cardiothoracic or orthopedic operations in France: a retrospective database analysis. *Surgical Infections*, *16*(4), 428-435. https://doi.org/10.1089/sur.2014.045

Schweizer, M. L., Cullen, J. J., Perencevich, E. N., & Sarrazin, M. S. V. (2014). Costs associated with surgical site infections in Veterans Affairs hospitals. *JAMA surgery*, *149*(6), 575-581. https://doi.org/10.1001/jamasurg.2013.4663

StataCorp. (2015). Statistical Software: Release 14. College Station, TX: StataCorp LP.

Taylor, G., Gravel, D., Matlow, A., Embree, J., LeSaux, N., Johnston, L., ... & Roth, V. (2016). Assessing the magnitude and trends in hospital acquired infections in Canadian hospitals through sequential point prevalence surveys. *Antimicrobial Resistance & Infection Control*, *5*(1), 19. https://doi.org/10.1186/s13756-016-0118-3

Vittrup, A. C., & Davey, A. (2010). Problem based learning 'bringing everything together'–a strategy for graduate nurse programs. *Nurse Education in Practice*, *10*(2), 88-95. https://doi.org/10.1016/j.nepr.2009.03.019

Wilson, J., Bak, A., Whitfield, A., Dunnett, A., & Loveday, H. (2017). Public perceptions of the use of gloves by healthcare workers and comparison with perceptions of student nurses. *Journal of Infection Prevention, 18*(3), 123-132. https://doi.org/10.1177/1757177416680442

Zhou, Q., Fan, L., Lai, X., Tan, L., & Zhang, X. (2019). Estimating extra length of stay and risk factors of mortality attributable to healthcare-associated infection at a Chinese university hospital: a multi-state model. *BMC Infectious Diseases*, *19*(1), 975. https://doi.org/10.1186/s12879-019-4474-5

Zimlichman, E., Henderson, D., Tamir, O., Franz, C., Song, P., Yamin, C. K., ... & Bates, D. W. (2013). Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. *JAMA Internal Medicine*, *173*(22), 2039-2046. https://doi.org/10.1001/jamainternmed.2013.9763

Chapter 3: Evaluation of a Problem-Solving Educational Program for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study (Second Study)

Abubaker Hamed[1], Donna Moralejo [1], April Pike[1], Vernon Curran[2]

[1] *Faculty of Nursing, Memorial University of Newfoundland, Canada*

[2]*Faculty of Medicine, Memorial University of Newfoundland, Canada*

This chapter discusses the second study, which was a controlled before and after study to assess the effect of the Problem-Solving Routine Practices (PSRP) educational program on nursing students' and instructors' knowledge, confidence, discussion, and application of problem solving related to routine infection control practices (RP), as well as students' self-reported adherence to RP. The PSRP educational program was developed by the researchers based on the results of the first study, a cross-sectional survey, and gaps in the literature. This chapter includes a brief background of the literature, research questions, methods used, results and discussion of the findings with recommendations for educators and future research.

AMH conceptualized and designed the study, reviewed and critically appraised the literature, developed the PSRP program and study questionnaire, collected and entered the data, conducted data analysis, interpreted the results, and wrote the manuscript. DM contributed to synthesis of the literature, research design, sample size calculation, questionnaire development, development of the PSRP program, and statistical analysis and data interpretation. AP and VC contributed to the research design, selection of the ADDIE Instructional System Design Model and the Constructivist Learning theory, development of the PSRP program, and interpretation of results. In addition, AP and VC also reviewed, suggested revisions to, and approved the manuscript.

Abstract

Background and Objectives: Adherence to routine infection control practices (RP) can be influenced by a number of barriers, which can potentially be dealt with using problem solving (PS) as a new approach. This study examined the effects of a Problem-Solving Routine Practices (PSRP) educational program on nursing students' and instructors' knowledge, confidence, and application of PS to the barriers to RP adherence. **Methods:** A controlled before and after study was conducted at two nursing schools. The intervention group consisted of 62 students and 5 instructors at School A who received the PSRP educational program, whereas the control group consisted of 34 students and 4 instructors at School B who received no intervention. The intervention involved education (PowerPoint presentation with interaction) and practice (group discussion of three identified common barriers). Data from both groups were collected at baseline and four to six weeks later using the *Problem-Solving Questionnaire*. **Results:** No significant differences were found between the intervention and control groups in terms of the change in the mean scores for adherence to RP ($p = 0.234$), confidence ($p = 0.182$) and application of PS ($p = 0.234$) to deal with the three identified barriers to RP adherence. However, there were significant differences in the proportions of the students in the intervention group compared to the control group who correctly identified the steps of PS ($p = 0.016$) and answered questions about doing a point of care risk assessment ($p = 0.027$), cleaning and disinfecting all shared patient care equipment ($p = 0.004$), and cleaning hands immediately after removal of gloves ($p = 0.021$). **Conclusion:** The effectiveness of the PSRP program was varied, but further exploration of this approach is warranted.

Keywords: *Adherence to Routine Practices, problem solving, confidence, application, barriers*

Healthcare-associated infections (HAIs) are infections patients can acquire while receiving medical treatment in both acute and long-term care facilities (CDC, 2018; WHO, 2018). Recently, three prevalence studies on HAIs in a number of countries have reported the prevalence of HAIs range from 3.9% to 10.2%. (Russo et al., 2019; Serrano et al., 2017; Suetens et al., 2018). HAIs are also prevalent in a number of Canadian healthcare facilities, where the prevalence rate is estimated to be between 8% and 13% (CNISP, 2015; Mitchell et al., 2019; Taylor et al., 2016). Approximately 220,000 Canadians suffer from HAIs each year (CNISP, 2015).

HAIs have major consequences on patients, nurses, and the healthcare system. For instance, annually a number of patients die as a result of HAIs. In general, the mortality rate of HAIs in North America and Europe has been found to range between 1.2 % and 6.4% (Patel et al., 2017; Rahmqvist et al., 2016). In the United States (US) it has been estimated that 99,000 die each year as a result of HAIs (CDC, 2018). In Canada, an estimated 8,000 patients die annually because of HAIs (CNISP, 2015). A number of studies have found that HAIs prolonged the length of hospital stay (LOS) by 2.6 to 21 days (Arefian et al., 2019; Jia et al., 2019; Zhou et al., 2019). Numerous studies have also found that patients under isolation precautions were more likely to develop depression and anxiety (Day et al., 2011; Day et al., 2013; Guilley-Lerondeau et al., 2017; Lupión-Mendoza et al., 2015; Purssell et al., 2020). Evidence has also shown that HAIs can increase nursing workload particularly if nurses are caring for patients under isolation precautions (Barker et al., 2017; Kaba et al., 2017; Musau et al., 2015). Moreover, the overall cost associated with HAIs in general was found to vary by country. In their cross-sectional study, Hessels and Larson (2016) reported that the annual attributable direct costs of HAI were estimated to be $9.8 billion in the US and €7 billion in Europe. In their retrospective database

analysis conducted in France between the years 2009 and 2010, Schmidt et al. (2015) found that the direct cost associated with Staphylococcal infections after cardiothoracic and orthopedic operations was £35 million.

To prevent and control the spread of HAIs and their negative consequences, Canada has implemented a system of basic infection control precautions called Routine Practices (RP), which is similar to the system of Standard Precautions (SP) used elsewhere (PHAC, 2016). RP and SP include hand hygiene, use of personal protective equipment (PPE), sharps safety, and cleaning and disinfecting patient care equipment. RP also specifies that, prior to each patient encounter, healthcare workers conduct a point of care risk assessment (PCRA) to identify potential risks of exposure to or transfer of microorganisms and then initiate appropriate actions, such as hand hygiene or cleaning equipment. RP and SP always apply to all patients in all settings, not just when patients are known or suspected to have an infection. In this chapter we will use the term SP when the study or studies being discussed investigated Standard Precautions, otherwise the term RP will be used.

Although the majority of HAIs can be prevented through adherence to RP and SP, nurses' and nursing students' adherence to SP has been found to be suboptimal. According to a number of studies, overall, nursing students' adherence rates to SP were found to range from 55% -78% (Cheung et al., 2015; Colet et al., 2017; Cruz, 2019; Moon et al., 2019). Overall, nurses' adherence rates to SP have been similar to nursing students, ranging from 17% - 69% (Hessels & Larson, 2016; Pereira et al., 2015; Powers et al., 2016). This suboptimal adherence is related a number of barriers such as lack of knowledge and training, skin damage or dryness, forgetfulness, empty alcohol-based hand rub (ABHR) dispensers, unavailability of PPE, alteration of skills when wearing PPE, dealing with emergency situations, lack of hospital

supporting policies, high nursing workload, presence of negative role models, and inconvenient location of ABHR dispensers (Akagbo et al., 2017; Atif et al., 2019; Barker et al., 2017; Cheung et al., 2015; Choi & Kim, 2018; Deyneko et al., 2016; Dombecki et al., 2015; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Kim & Oh, 2015; Kirk et al., 2016; Quan et al., 2015; Rashmi & Kundapur, 2017; Travers et al., 2015;Wilson et al., 2017; Zellmer et al., 2015). However, in this study, we focused on three commonly encountered barriers, which are high nursing workload, presence of negative role models, and inconvenient location of sinks and ABHR dispensers. These three barriers were among the top three commonly reported barriers to adherence to RP in most of these studies.

Addressing the barriers to adherence to RP such as workload can be difficult under current healthcare system constraints, while interventions related to negative role models have focused primarily on having them work with positive role models. Multiple interventions, such as education, audits, and administrative support, have been implemented to improve adherence to RP (Gould et al., 2017). However, none of these interventions has specifically looked at the use of problem solving as a new approach to address barriers to RP adherence. Problem solving is one of the significant skills through which nurses and nursing students can deal with complex problems that they may encounter during their clinical practice (Ancel, 2016; Deniz Kocoglu et al., 2016). Having PS skills has been shown to improve nurses' and nursing students' critical thinking, decision making, and self-efficacy (Ahmady & Shahbazi, 2020; Çinar et al., 2010; Heidari & Shahbazi, 2014; Kanbay & Okanlı, 2017; Shahbazi et al., 2018). PS is a potential strategy to use because it provides systematic steps that students can follow to address barriers to RP adherence. Therefore, the aim of this study was to evaluate the effect of a Problem-Solving Routine Practice (PSRP) educational program on nursing students' knowledge, confidence,

discussion, and application of PS related to RP, as well as students' self-reported adherence to RP. The role of nursing instructors was also examined.

Research Questions

1. What is the effect of the PSRP educational program on nursing students':
    a. Knowledge about RP?
    b. Knowledge about problem solving?
    c. Self-reported application of problem solving to deal with identified barriers to adherence to RP?
    d. Self-reported discussion of problem solving to deal with identified barriers to adherence to RP?
    e. Confidence about applying problem solving to deal with identified barriers to adherence to RP?
    f. Self-reported adherence to RP?
2. What are the barriers to adherence to RP that students encounter in their clinical practice?
3. What is the effect of the PSRP educational program on nursing instructors' discussion, reinforcement, and application of PS related to RP?

The PSRP Educational Program

The intervention consisted of a face-to-face workshop, which was administered to the students and nursing instructors as part of a specific university nursing degree course. The ADDIE Instructional System Design Model, Social Problem-Solving Model, and Constructivist Learning Theory were used to guide the study intervention. For instance, the steps of the ADDIE model were followed to develop the PSRP educational program. Both the Social Problem-

Solving Model and Constructivist Learning Theory were used to guide decisions about the content and delivery of the PSRP educational program. The PSRP educational program time was 2 hours in length, with half devoted to education about RP and problem solving and half devoted to the application of problem solving to the three identified barriers. Although additional common barriers identified by the participants in our cross-sectional study (e.g., forgetfulness and dealing with emergency situation), we focused on three common barriers that provided concrete examples for which they could apply and practice PS steps.

The PSRP educational program consisted of two parts: theoretical or educational part, and practical or application part. The educational portion ensured that both instructors and students were taught information to understand how to adhere to RP and engage in problem solving strategies to address common barriers (e.g., high workload, presence of negative role models, and inconvenient location of ABHR). In the educational part, the researchers discussed topics related to HAI prevalence, types, and consequences, barriers to adherence, chain of infection, RP components such as hand hygiene, use of PPE, sharps safety, PCRA, and cleaning patient equipment. The topics related to problem solving included the definition of problem solving, the Social Problem-Solving Model (D‘zurilla & Goldfried, 1971) and steps of problem solving, the importance of problem solving, and examples of application of problem-solving steps to the barrier of inconvenient location of ABHR. The educational part was presented by the researchers using PowerPoint slides, with interaction throughout the session.

In the practical part, applying constructivist learning principles, nursing students and instructors were asked to discuss three case scenarios related to barriers and devise appropriate strategies to use based on their previous experiences and suggested strategies. Constructivist Learning Theory emphasizes that acquired knowledge and skills should be constructed by the

learner through authentic and applied experiences, and encourages the active participation of the learners in group discussions related to certain problems with the presence of a facilitator (Aliakbari et al., 2015). The major focus of this theory is that learning is an active process in which the learner constructs and negotiates new ideas and meanings based on their current or previous experience and discussion and sharing of meanings with peers (Hoover, 1996). For instance, rather than using an educator's knowledge to solve a problem, students construct and share their ideas based on specific learning needs. The educator works as a facilitator of the learning process by developing educational materials and using techniques such as problem solving, reflection, and concept mapping to guide the discussion throughout the learning process (Brandon & All, 2010). The students and the educator engage in discussion about certain ideas, and the educator's role is to encourage the students to discover the principles or the solutions of a certain problem by themselves (Brandon & All, 2010).

The three scenarios of the case studies highlighted the three most common barriers to adherence: high workload, presence of negative role models, and inconvenient location of ABHR. The questions related to each case study were developed based on the six steps of the Social Problem-Solving Model, which are: 1) general orientation about the problem; 2) defining and formulating the problem; 3) production of alternative solutions; 4) decision-making; 5) implementation of a solution, and 6) evaluation of the result (D'zurilla & Goldfried, 1971). According to the model, in the general orientation about the problem step, an individual identifies that there is a problem, acknowledges that the problem is changeable, and believes that he or she can solve the problem. In the defining and formulating the problem step, an individual collects the necessary information about the problem, analyzes the problem, and specifies the actual objectives to deal with the problem. In the production of alternative solutions step, an

individual identifies multiple possible solutions that can be used to deal with the problem and weighs the pros and cons for each selected solution. In the decision-making step, an individual selects the best solution to solve the problem. In the implementation of a solution step, an individual implements the selected solution to solve the problem. In the last step (evaluation of the result), an individual observes and evaluates the result of implementing the selected solution (D'zurilla & Goldfried, 1971).

Participants were divided into groups of three to eight with students working with an instructor teaching in that course to discuss each case. Each student in the groups received a discussion guide which included questions based on the steps of the problem-solving model in order to discuss the three identified barriers. The researchers recruited three faculty members and two lab instructors to act as facilitators. They were trained in the use of the discussion guides prior to the intervention. Each group had a facilitator that helped them navigate the questions on the discussion guide, encouraged them to come up with some solutions for the identified barrier, assisted them to weigh the pros and cons of these solutions, and allowed them to select the best solution that they could use to deal with the identified barrier. Possible solutions for each of the barriers were suggested by the facilitators as needed, however the groups were encouraged to draw on their experiential knowledge to construct other solutions and to discuss the pros and cons of various approaches and issues. Students in each group discussed the identified barrier using the questions on the discussion guide based on the six steps of the problem-solving model. The case discussion was selected to encourage the nursing students and instructors to actively participate in constructing strategies that could be used during their clinical practice to deal with the identified barriers. The purpose of the case discussion was to help strengthen problem-

solving ability, confidence in problem solving, and application of principles of RP and problem solving by instructors and nursing students.

Methods

Design

A controlled before and after (CBA) study was conducted to examine the effects of the PSRP educational program. A CBA study is one in which groups rather than individuals are allocated to the intervention or control group, and there is no random assignment to the groups. Nursing students and nursing instructors at School A were recruited for the intervention group, while nursing students and instructors at School B were recruited for the control group.

Study Setting

The study was conducted in two nursing school settings in one province in eastern Canada, School A and School B. They share a curriculum and their regional health authorities follow similar policies and procedures.

Participants

There were two groups of participants: nursing students and nursing instructors. Convenience sampling was used to recruit the participants. The intervention group consisted of regular and accelerated program baccalaureate nursing students at School A, who registered in the fall semester of 2019 in specific courses in Years 2 and 3 of the curriculum, and instructors who taught in selected courses in Years 2 or 3. The control group consisted of regular and accelerated program students at School B who registered in the fall semester of 2019 in specific courses in Year 2 and 3 courses of the curriculum, and instructors who taught in selected courses in Years 2 or 3. Students from Years 2 and 3 were selected as they had previous clinical experience and were in clinical courses at the time of the study. The only exclusion criterion was

that nursing instructors who taught at both schools in the same semester were not eligible to participate.

Sample Size

A recent cross-sectional study conducted by the researchers in the same settings found that only 28% of Year 2 students and 35% of Year 3 students were able to identify strategies that could be used to deal with barriers to adherence to RP. The researchers considered the PSRP educational program effective if the proportion of students who were able to identify strategies increased to 65%. Using these differences for effect size, two-sided test, an alpha of .05, and a beta of .80, and using Stata statistical software (StataCorp, 2015), the total required sample sizes for Year 2 and Year 3 was calculated to be 118 participants. For Year 2, 28 participants were required per group for a total of 56 participants. For Year 3, 31 participants were required per group for a total of 62 participants. At the time of the study, in the selected courses, at School A (intervention group) there were a total of 87 nursing students and 11 nursing instructors and at School B (control group), there were 120 students and 14 instructors. However, a total of 96 students and nine instructors were recruited in the study. Of the 96 students, 62 were recruited in the intervention group with a response rate of 71%, and 34 were recruited in the control group with a response rate of 28%. Of the nine instructors, five participated in the intervention group with a 45% response rate and four participated in the control group with a 28% response rate.

Recruitment

In this study, the recruitment procedure began once ethical approval was received from the Health Research Ethics Board and the appropriate regional research proposal approval committee. Recruitment consisted of two steps: 1) obtaining the permission of the two nursing

schools to conduct the study; and 2) recruitment of nursing students and nursing instructors. The approval letters can be found in Appendix F.

Recruitment of Nursing Schools.

Following ethics approval, the researchers contacted the Dean at School A and the Director at School B to: 1) inform them about the study; 2) request permission to access appropriate students' classes, one course in Year 2 and one course in Year 3; 3) give permission to use part of these identified classes for the study; 4) send the information sheets about the study by email to Years 2 and 3 nursing students; and 5) send the information sheets about the study by email to nursing instructors teaching in Years 2 and 3.

Recruitment of Participants.

Once permission was obtained from the schools, cover emails and information sheets explaining the purpose of the study were sent by the researchers to the office of the Associate Dean or Associate Director, who then distributed the appropriate cover emails and information sheets to nursing students and nursing instructors at the two schools. The cover emails can be found in Appendix G.

The information sheet for instructors at School A asked them to voluntarily participate in a 2-hour training program related to problem solving and RP and complete the study questionnaires before the beginning of the intervention program (baseline) as well as 4 to 6 weeks later (follow-up). Students in Years 2 and 3 were practicing in medical surgical units under direct supervision of their clinical instructors. Students in both years had eight hours of clinical practice each day for a total of 40 hours in the five clinical practice days that occurred during the study period following the intervention.

The information sheet for students at School A informed them that they would receive a 2-hour training program related to problem solving and RP as part of a specific course. They were asked to voluntarily complete the study questionnaires before the beginning of the intervention program (baseline) as well as 4 to 6 weeks later (follow-up). The information sheet for nursing students and instructors at School B asked them to complete the study questionnaires related to problem solving and RP as part of a specific course at baseline as well as 4 to 6 weeks later (follow-up). At the start of the class, the researchers explained to the participants the purpose of the study and discussed any questions or concerns about the study. The information sheets can be found in Appendix H.

Data Collection Procedures

The PSRP educational program and data collection took place during sessions scheduled as part of specific courses. At School A, the researchers administered the study questionnaires to the participants before the beginning of the intervention program (baseline) as well as 4 to 6 weeks later (follow-up). Both instructors and students completed the relevant version of the *Problem-Solving Questionnaire.* At School B, a research assistant was hired to administer the study questionnaires to the participants at baseline as well as 4 to 6 weeks later (follow-up) during specific classes. The control group did not receive any intervention. The study questionnaires were mailed out to a research assistant, who then sent them back by courier after the data collection was completed.

Anonymity was ensured by coding the study questionnaire. The researchers gave out pre-coded questionnaires. Participants received both questionnaires at baseline with an envelope. They were asked to put the follow-up questionnaire in the envelope, write their name on the envelope, seal it, and return it to the researchers. Then at the follow-up, they received their own

envelope with the correctly coded questionnaire so the researchers could match the baseline and follow-up questionnaires. No record was kept of the names and matching codes.

Participants who agreed to participate in this study were entered into a draw to win a $10 Tim Horton's gift card. No identifying information was collected from participants as part of the study; however, after they completed the follow-up questionnaire, participants who chose to enter in the draw were asked to write their email address on a piece of paper and give it to one of the researchers. At the end of the data collection period, the participants who won the gift cards were contacted by the researchers to receive the gift cards. Email addresses were destroyed after the gift cards were awarded. The same methods were used for instructors for recruitment and data collection, using a slightly different version of the questionnaire and feedback.

Data Collection Instruments

The outcomes of interest were measured by the *Problem-Solving Questionnaire*. There was a version for students and a version for instructors, as well as a version for baseline and for follow up with minor variation in wording to reflect a point in time of data collection. The version for instructors had minor wording changes to reflect helping students rather than the instructors' behaviour.

Problem-Solving Questionnaire.

The *Problem-Solving Questionnaire* was developed by the researchers based on the results of a cross-sectional study conducted by the researchers, a literature review, and the objectives of this study. This questionnaire was designed to measure nursing students' or instructors' knowledge, confidence, discussion, application, and reinforcement related to problem solving and RP, as well as self-reported adherence to RP. In addition, it was also

designed to measure the commonly encountered barriers to adherence to RP. Student and instructor versions of the questionnaire were similar except for some phrasing.

This questionnaire consisted of six sections: ***Section 1*** consisted of six short-answer questions. Four questions were used to measure the participants' knowledge related to RP, and two questions to measure students' knowledge about problem solving. Responses for two of the questions on RP knowledge were rated as "correct" and "incorrect". A score of 1 was given for each correct answer and 0 for each incorrect answer. The responses for the other two questions were rated as "correct", "partially correct", and "incorrect". A score of 2 was given for each correct answer, 1 for each partially correct answer, and 0 for each incorrect answer. The total score ranged from 0-8; this was converted to a percentage and the highest possible score was 100%. To convert the scores to a percentage, the actual score was divided by the highest possible score and multiplied by 100.

Section 2 consisted of three questions. One question was about the most common barriers to adherence to RP that participants encounter during their clinical practice. The other two questions measured whether students discuss PS related to the barriers with their classmates and with their instructors**.** ***Section 3*** consisted of three "yes" or "no" questions to measure participants' application of PS to deal with the three identified barriers. Responses were "yes" or "no". A score of 1 was given for each correct answer. The total score ranged from 0-3. ***Section 4*** consisted of three questions to measure students' confidence about applying PS to deal with the identified barriers to adherence to RP. All three questions were scored on a 4-point Likert scale from 1 = "not at all confident" to 4 = "confident." The total score ranged from 3-12; it was converted to a percentage and the highest possible score was 100%. Instructors were asked about their confidence to help students apply PS.

Section 5 consisted of six questions to measure students' adherence to RP. All these six questions were scored on a 4-point Likert scale from 1 = "rarely" to 4 = "all of the time." The total score ranged from 6-24. Scores were converted to a percentage and the highest possible adherence score was 100%. ***Section 6*** included a series of questions related to nursing students' demographic characteristics such as year of study, gender, and age, or instructors' experience, as well as any previous training about RP and problem solving. The four versions (baseline and follow up for the students and baseline and follow-up for the instructors) of the study questionnaires can be found in Appendix I.

Feedback Form.

In keeping with the evaluative component of the ADDIE model, a feedback form was also given to the participants to rate their opinions about the PSRP educational program. This feedback form consisted of five Likert scale questions and four short answer questions. The five Likert scale questions were designed to examine if the educational program helped strengthen the participants' knowledge, confidence, and application of PS related to RP. All these five questions were scored on a 4-point Likert scale from 1 = "Strongly disagree" to 4 = "Strongly agree." The four short answer questions were designed to: 1) identify when the best time is to apply PS related to RP, 2) what do they like most about the program, 3) what do they like least about the program, 4) and if they had any other comments. While both instructors and students were asked to complete the form at the end of the intervention session, only nursing students completed the form. The version of the feedback form can be found in Appendix J.

Validity and Piloting of the Questionnaires.

The study questionnaire was piloted and validated. The pilot test group consisted of a faculty member and 16 nursing students who had just graduated; they had similar characteristics

to the study group. The researchers discussed their feedback and recommendations with them. Based on their feedback, minor changes were made on the questionnaire.

The study questionnaire was tested for content validity through administration to five experts in adult learning and infection prevention and control to determine whether questions measured the outcomes of interest, with an acceptable content validity index of 0.80. The internal consistency of the three parts of the questionnaire that employed Likert scales (confidence and application of PS, and adherence to routine practices) was assessed using Cronbach's alpha. The confidence scale showed a good reliability (Cronbach's $\alpha = 0.81$) whereas the application scale (Cronbach's $\alpha = 0.60$) and the adherence scale (Cronbach's $\alpha = 0.48$) were weaker possible due to the limited number of items.

Data Analysis

Percentages and frequencies were used to describe the participants' demographic data such as age, sex, years of experiences, nursing qualifications, whether they taught theory or practice, and whether they are full-time or part-time. They were also used to describe participants' knowledge, confidence, and application about RP and problem solving. In addition, the change in proportions who correctly answered questions at baseline and follow-up were calculated, for both intervention and control groups, with the changes reported as percentage points. Percentages and frequencies were also used to describe the reported barriers to adherence to RP. Mean scores and standard deviations were calculated for knowledge, confidence, and adherence to RP. An independent t-test was used to test the mean differences in the change of scores from baseline to follow-up between the participants who received the PSRP educational program and those who did not. The chi-square test was used to test whether there was a significant difference in the change of proportions of students who reported an improvement or

not in their adherence to RP (from baseline to follow-up) between those who received the PSRP educational program and those who did not. In addition, chi-square was used to test the differences in the change of proportions, from baseline to follow-up, related to the students' knowledge, confidence, adherence, application, and discussion of PS related to RP for intervention and control groups. Regression had been planned but was not conducted because only very small differences were noted with bivariate analysis and the sample size was small.

Ethical Considerations

This study was approved by the Health Research Ethics Board and the appropriate institutional research proposal approval committee. Individual approval was also obtained from each school of nursing. The students were informed by researchers about the nature of the study and were instructed that participation was voluntary. To maintain participants' confidentiality and anonymity, the researchers did not collect participants' information (such as names or student numbers). The intervention was implemented as part of the course and consent was required for participation in the evaluation. Nursing instructors and nursing students had the right to refuse to participate without any impact on their employment or student status. The data were entered into Stata statistical software program (StataCorp,2015). The laptop used for data entry was password-protected. The collected questionnaires and the laptop used for data entry were stored in a locked cabinet in the nursing program graduate office of Memorial University. Only the research team could access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy. Completing the study questionnaires indicated their consent to be in this study, and they did not need to sign a consent form.

Results

Table 3.1

Characteristics of Nursing Students

Characteristics		**Intervention %(N)[1]**	**Control %(N)[1]**	**Total % (N)[1]**
School of nursing	A	62	0	96
	B	0	34	
Year and stream of study	Year 2 accelerated program	29.0 (18)	5.9 (2)	20.8 (20)
	Year 2 regular stream	48.4 (30)	61.8 (21)	53.1 (51)
	Year 3 regular stream	22.6 (14)	32.4 (11)	26 (25)
Age	18-24	72.6 (45)	81.3 (26)	75.5 (71)
	25-34	22.6 (14)	15.6 (5)	20.2 (19)
	35-44	4.8 (3)	3.1 (1)	4.3 (4)
Gender	Female	88.7 (55)	96.9 (31)	91.5 (86)
	Male	11.3 (7)	3.1 (1)	8.5 (8)
Taught PS related to IPC	Yes	54.8 (34)	90.6 (29)	67 (63)
	No	45.2 (28)	9.4 (3)	33 (31)
Taught PS related to area other than IPC	Yes	82.3 (51)	87.5 (28)	84 (79)
	No	17.7 (11)	12.5 (4)	16 (15)

% (N)[1]: the percentage and number of students in each group with the identified characteristics; there were 62 in the intervention group and 34 in the control group, but only 32 in the control group and 94 in total answered the questions regarding age, gender and if they were taught problem solving.
Abbreviations: IPC = Infection Prevention and Control; PS = Problem Solving.

Table 3.1 shows the distribution of student characteristics of both groups. There were 96 students who participated in this study; 62 students were in the intervention group and 34 were in the control group. There was a representative sample from three different years: Year 2 accelerated program (*n* = 20; 20.8 %), Year 2 regular stream (*n* = 51; 53.1%), and Year 3 regular stream (*n* = 25; 26 %). Students in the intervention and control groups differed by year and

stream of study but differences were not statistically significant (p = 0.427). There were no other differences between the intervention and control groups at baseline regarding demographic characteristics. The majority of students were aged 18-24 (intervention 72.6 % vs. control 81.3%) and female (intervention 88.7 % vs. control 96.9 %). They were also similar in stating that they had been taught PS related to areas other than infection prevention and control (IPC) (intervention 82.3 % vs. control 87.5 %). However, the majority of the control group (90.6%) stated that they had been taught PS related to IPC compared to only half (54.8%) of the intervention group. The difference however was not statistically significant (p = .184).

The participants' knowledge was similar to that found in the cross-sectional study that was discussed in Chapter 2. While their knowledge could be strengthened, the focus of this chapter is on adherence and PS.

Table 3.2

Students' Adherence to RP

Adherence to RP	**Items**	**Intervention**		**Control**		**p-value** [2]
		Baseline % (N) [1]	**Follow-up % (N)** [1]	**Baseline % (N)** [1]	**Follow-up % (N)** [1]	
1. I did a point of care risk assessment before each patient encounter	All of the time	15 (9)	41.7 (25)	48.4 (15)	46.9 (15)	
	Most of the time	26.7 (16)	23.3 (14)	32.3 (10)	43.8 (14)	
	Some of the time	28.3 (17)	21.7 (13)	12.9 (4)	6.3 (2)	
	Rarely	30 (18)	13.3 (8)	6.5 (2)	3.1 (1)	
	Improved	---	53.3 (32)	---	29.0 (9)	0.027
2. I cleaned and disinfected all shared patient care equipment (e.g., blood pressure cuffs,	All of the time	37.1 (23)	41.7 (25)	78.1 (25)	62.5 (20)	
	Most of the time	33.9 (21)	33.3 (20)	15.6 (5)	18.8 (6)	
	Some of the time	24.2 (15)	21.7 (13)	3.1 (1)	18.8 (6)	

Adherence to RP	Items	Intervention		Control		p-value [2]
		Baseline % (N)[1]	Follow-up % (N) [1]	Baseline % (N) [1]	Follow-up % (N) [1]	
stethoscope, and glucometer)	Rarely	4.8 (3)	3.3 (2)	3.1 (1)	0	
	Improved	---	28.3 (17)	---	3.2 (1)	0.004
3.I cleaned my hands immediately after removal of gloves	All of the time	62.9 (39)	66.7 (40)	96.9 (31)	84.4 (27)	
	Most of the time	32.3 (20)	33.3 (20)	3.1 (1)	12.5 (4)	
	Some of the time	4.8 (3)	0	0	3.1 (1)	
	Rarely	0	0	0	0	
	Improved	---	21.7 (13)	---	3.1 (1)	0.021
5. I wore gloves when I was potentially exposed to body fluids, blood products, and any excretion of patients	All of the time	91.9 (57)	95 (57)	93.8 (30)	81.3 (26)	
	Most of the time	8.1 (5)	5 (3)	6.3 (2)	15.6 (5)	
	Some of the time	0	0	0	3.1 (1)	
	Rarely	0	0	0	0	
	Improved	---	5 (3)	---	6.5 (2)	0.773
6. I washed my hands with soap and water if they were visibly soiled	All of the time	98.4 (60)	98.3 (59)	96.7 (29)	87.1 (27)	
	Most of the time	1.6 (1)	1.7 (1)	3.3 (1)	9.7 (3)	
	Some of the time	0	0	0	3.2 (1)	
	Rarely	0	0	0	0	
	Improved	---	3.3 (2)	---	3.2 (1)	0.978
7. I put used needles into	All of the time	97.8 (44)	92.5 (49)	95.7 (22)	96.7 (29)	

Adherence to RP	Items	Intervention		Control		p-value [2]
		Baseline % (N)[1]	Follow-up % (N) [1]	Baseline % (N) [1]	Follow-up % (N) [1]	
sharps containers	Most of the time	2.22 (1)	1.9 (1)	4.3 (1)	3.3 (1)	
	Some of the time	0	5.7 (3)	0	0	
	Rarely	0	0	0	0	
	Improved	---	18.3 (11)	---	25.8 (8)	0.406

Adherence to RP mean scores	Intervention			Control			p-value[4]
	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	
	81.58 ± 1.14	87.63 ± 1.36	5.97 ± 1.24	88.41 ± 2.01	90.75 ± 2.00	3.22 ± 2.09	0.234

% (N)[1]: the percentage and number of students in each group who answered the identified adherence questions as indicated. Intervention group: at baseline 60 answered question 1, n = 62 answered questions 2, 3, and 4, 61 answered question 5, and 45 answered question 6; and at follow-up n = 60 answered the first five questions, and 53 answered question 6. Control group: at baseline 31 answered question 1, n = 32 answered questions 2, 3 and 4, 30 answered question 5, and 23 answered question 6; and at follow-up n= 32 answered the first four questions; 31 answered question 5 and 30 answered question 6.

[2] p-value: the p-value for the chi-square test used to assess whether there was a difference in the number of students whose answers reflected an improvement or not in their adherence to RP (from baseline to follow-up) between those who received the PSRP educational program and those who did not.

[3]change in the mean scores: the difference in the mean score, calculated as the follow-up score minus the baseline-score.

[4] p-value: the p-value for the independent t-test used to assess whether there was a difference in the change of scores (from baseline to follow-up) between the participants who received the PSRP educational program and those who did not.

Abbreviations: RP = Routine Practices; SD = Standard Deviation.

Table 3.2 summarizes students' adherence to RP. At baseline, of the six components of RP, students' adherence in both groups was similar for three of the RP components and was different for the other three components. However, as seen in the table, these differences were not statistically significant. In addition to considering the proportion of students with correct

responses, mean scores and standard deviations were calculated. Since the baseline scores were similar in the two groups, the change in the mean scores were compared. The results showed the change in the mean scores for adherence to RP in the intervention group (5.97 ± 1.24) was higher than that of the control group (3.22 ± 2.09), but this difference was not statistically significant ($p = 0.234$). Similarly, small proportions of the students in both groups showed non-significant improvement in their adherence to wearing gloves when they were potentially exposed to body fluids, blood products, and any excretion of patients ($p = 0.773$); washing their hands with soap and water if they were visibly soiled ($p = 0.978$), and putting used needles into sharps containers ($p = 0.406$). However, significant improvements were observed for three out of six RP components in the intervention group. For instance, the proportion of students reporting adherence all the time in the intervention group significantly increased from the baseline to follow-up compared to the control groups for doing the PCRA (intervention 15% to 41.7% vs. control 48.4% to 46.9%; $p = 0.027$), cleaning and disinfecting all shared patient care equipment (intervention 37.1% to 41.7% vs. control 78.1 % to 62.5 %; $p = 0.004$), and cleaning hands immediately after removal of gloves (intervention 63% to 66.7% vs. control 96.9% to 84.4%; $p = 0.021$). It should be noted that the baseline values were different between the two groups for some of the items so that even with the significant improvement found, their adherence at follow-up still needs to be strengthened.

At follow-up, in both groups, the proportion of students who reported that they adhered all the time remained low for doing a PCRA (intervention 41.7% and control 46.9%). However, more students in the control group compared to the intervention group reported that they adhered all the time to cleaning equipment (intervention 41.7% and control 62.5%) and to cleaning their hands after removal of gloves (intervention 66.7% and control 84.4%). The proportion of

students reporting adherence all the time to all other components was higher than 80% in both groups.

Table 3.3

Barriers Preventing Students from Adhering to RP

Barriers to adherence to RP	**Intervention**		**Control**	
	Baseline (n= 62) % (N) [1]	**Follow-up (n= 61) % (N)** [1]	**Baseline (n= 34) % (N)** [1]	**Follow-up (n= 31) % (N)** [1]
Negative role models	67.7 (42)	54.1 (33)	58.8 (20)	41.9 (13)
High nursing workload	56.5 (35)	52.5 (32)	47.1 (16)	41.9 (13)
Forgetfulness	50 (31)	42.6 (26)	26.5 (9)	35.5 (11)
Inconvenient location of ABHR	27.4 (17)	41(25)	2.9 (1)	16.1 (5)
I did not encounter any of these barriers	1.6 (1)	8.2 (5)	0	0
Other barriers	4.8 (3)	0	2.9 (1)	0

% (N)[1]: the percentage and number of students in each group who answered 'Yes" for the identified barriers to adherence to RP.
Note: Numbers do not add up to 100% as students reported more than one barrier.
Abbreviations: ABHR= Alcohol-Based Hand Rub; RP = Routine Practices.

The results in Table 3.3 show that more than 90% of nursing students in both groups reported that they have encountered a number of barriers that prevented them from adhering to RP, with only 1.1% at the baseline and 5.4% at the follow-up saying they did not encounter any of these barriers. The commonly reported barriers by both groups at baseline were negative role models (67.7%), high nursing workload (56.5%), forgetfulness (50%), and inconvenient location of ABHR (27.4%). In addition, the same barriers were encountered at the baseline and follow-up. Although proportions differed for each barrier, a higher proportion of students in the intervention group encountered each barrier at each time point.

Table 3.4

Students' Knowledge about Problem Solving

Short answer questions	Items	Intervention		Control		p-value [2]
		Baseline (n=62) % (N)[1]	Follow-up (n=61) % (N) [1]	Baseline (n=34) % (N) [1]	Follow-up (n=32) % (N) [1]	
What are the steps of PS?	Correct	14.5 (9)	36.1 (22)	8.8 (3)	6.3 (2)	
	Partially correct	37.1 (23)	23 (14)	8.8 (3)	9.4 (3)	
	Incorrect	48.4 (30)	41 (25)	82.4 (28)	84.4 (27)	
	Improved	---	36.1 (22)	---	12.5 (4)	0.016
What does PS mean to you with respect to IPC?	Correct	32.3 (20)	31.1 (19)	2.9 (1)	21.9 (7)	
	Incorrect	67.7 (42)	68. 9 (42)	97.1 (33)	78.1 (25)	
	Improved	---	14.8 (9)	---	18.8 (6)	0.619

% (N)[1]: the percentage and number of students in each group who answered the identified knowledge questions as indicated.
[2] p-value: the p-value for the chi-square test used to assess whether there was a difference in the number of students whose answers reflected an improvement or not in their knowledge of PS (from baseline to follow-up) between those who received the PSRP educational program and those who did not.
Abbreviations: IPC = Infection Prevention and Control; PS= Problem Solving.

Table 3.4 summarizes responses to the questions about knowledge of PS. At baseline and at follow-up, small percentages of students in both groups correctly identified the steps of PS (intervention at baseline 14.5% and at follow-up 36.1%; control at baseline 8.8% and at follow-up 6.3%) and explained what PS means with respect to IPC (intervention at baseline 32.3% and at follow-up 31.1%; control at baseline 2.9% and at follow-up 21.9%). When baseline and follow-up answers were compared, the proportions of the students who correctly identified the steps of PS increased significantly in the intervention group compared to the control group (intervention from 14.5 % at baseline to 36.1% at follow-up vs. control 8.8% to 6.3%; p = 0.016). It should be noted that the baseline values were different between the two groups for both

items so that even with the significant improvement found, their knowledge of PS at follow-up still needs to be strengthened.

Table 3.5

Students' Confidence to Apply PS to Deal with the Barriers

Confidence in application of PS		Intervention		Control		p-value [2]
		Baseline % (N)[1]	Follow-up % (N)[1]	Baseline % (N) [1]	Follow-up % (N) [1]	
1. Confidence in using PS to deal with high nursing workload	Confident	32.3 (20)	56.7 (34)	25.8 (8)	35.5 (11)	
	Somewhat confident	51.6 (32)	40.0 (24)	67.7(21)	64.5 (20)	
	Not very confident	16.1 (10)	3.3 (2)	03.2 (1)	0	
	Not at all confident	0	0	03.2 (1)	0	
	Improved	---	40 (24)	---	17.2 (5)	0.032
2. Confidence in using PS to deal with negative role models	Confident	31.2 (19)	43.3 (26)	21.9 (7)	32.3 (10)	
	Somewhat confident	41 (25)	43.3 (26)	56.3 (18)	61.3 (19)	
	Not very confident	27.9 (17)	13.3 (8)	18.8 (6)	6.5 (2)	
	Not at all confident	0	0	03.1 (1)	0	
	Improved	---	42.4 (25)	---	26.7 (8)	0.147
3. Confidence in using PS to deal with inconvenient location of ABHR	Confident	41.9 (26)	58.3 (35)	32.3 (10)	38.7 (12)	
	Somewhat confident	32.3 (20)	36.7 (22)	51.6 (16)	58.1 (18)	
	Not very confident	24.2 (15)	5 (3)	12.9 (4)	3.2 (1)	
	Not at all confident	1.6 (1)	0	03.2 (1)	0	
	Improved	---	38.3 (23)	---	27.6 (8)	0.319

Confidence to apply	Intervention			Control			p-value[4]
	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	

PS mean scores	77.59 ± 2.07	86.38 ± 1.70	9.03 ± 2.09	77.41 ± 2.81	83.06 ± 1.95	4.31 ± 2.63	0.182

% (N)[1]: the percentage and number of students in each group who answered the identified confidence questions as indicated. In the intervention group: at baseline 62 students answered questions 1 and 3, and 61 answered question 2; at follow-up 60 answered all three questions. In the control group: at baseline 32 students answered question 2 and 31 answered questions 1and 3; at follow-up, 31 students answered all three questions.
[2] p-value: the p-value for the chi-square test used to assess whether there was a difference in the number of students whose answers reflected an improvement or not in their confidence in PS (from baseline to follow-up) between those who received the PSRP educational program and those who did not.
[3]change in the mean scores: the change in the mean score was calculated as the follow-up score minus the baseline score.
[4] p-value: the p-value for the independent t-test used to assess whether there was a significant difference in the change of mean scores (from baseline to follow-up) between the participants who received the PSRP educational program and those who did not.
Abbreviations: ABHR= Alcohol-Based Hand Rub; PS = Problem Solving; SD = Standard Deviation.

Table 3.5 summarizes the responses about confidence in applying PS. At baseline and follow-up, small percentages of students in both groups were confident about applying PS to deal with high nursing workload (intervention 32.3% at baseline and 56.7% at follow up; control 25.8% at baseline and 35.5% at follow-up). Similarly, small proportions were confident about applying PS to deal with negative role models (intervention 31.2 % at baseline and 43.3 % at follow-up; control 21.9 % at baseline and 32.3% at follow-up); and deal with the inconvenient location of ABHR dispensers (intervention 41.9 % at baseline and 58.3 % at follow-up; control 32.3 % at baseline and 38.7 % at follow-up).

Mean scores and standard deviations were calculated for responses about the confidence questions. When baseline and follow-up answers were compared, the change in the mean scores for confidence about applying PS in the intervention group (9.03 ± 2.09) was higher than that of the control group (4.31 ± 2.63), but this difference was not statistically significant (p = 0.182). Both groups showed slight, but non-significant, improvement in their confidence about applying

PS to deal with negative role models (p = 0.147) and to deal with the inconvenient location of ABHR dispensers (p = 0.319). However, higher proportions of students in the intervention group compared to the control group showed a significantly increased confidence about applying PS to deal with high nursing workload (intervention from 32.3 % at baseline to 56.7 % at follow-up vs. control 25.8% to 35.5 %; p = 0.032).

Table 3.6

Students' Discussion and Application of PS related to RP

Discussion related to RP	**Intervention**		**Control**		
	Baseline % (N)[1]	**Follow-up % (N)[1]**	**Baseline % (N)[1]**	**Follow-up % (N)[1]**	**p-value [2]**
1. I discuss PS related to the barriers to adherence to RP with my classmates	24.2 (15)	34.4 (21)	32.4 (11)	33.3 (11)	
Improved	---	19.7 (12)	---	12.1 (4)	0.352
2. I discuss PS related to the barriers to adherence to RP with my instructors	35.5 (22)	28.3 (17)	44.1 (15)	42.4 (14)	
Improved	---	20 (12)	---	15.2 (5)	0.563
Application of PS related to RP					
3. I use PS to deal with high nursing workload	46.8 (29)	49.2 (30)	64.7 (22)	50 (16)	
Improved	---	19.7 (12)	---	12.5 (4)	0.384
4. I use PS to deal with negative role models	41.9 (26)	50 (30)	58.8 (20)	43.8 (14)	
Improved	---	21.7 (13)	---	9.4 (3)	0.138
5. I use PS to deal with inconvenient location of ABHR	29 (18)	48.3 (29)	23.5 (8)	35.5 (11)	

Discussion related to RP	Intervention		Control		
	Baseline % (N)[1]	Follow-up % (N)[1]	Baseline % (N)[1]	Follow-up % (N)[1]	p-value [2]
Improved	---	28.3 (17)	---	29.0 (9)	0.944

Application of PS mean scores	Intervention			Control			p-value[4]
	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	Baseline Mean SD	Follow-up Mean SD	Mean change[3]	
	81.58 ± 1.14	87.63 ± 1.36	2.5 ±1.40	88.41 ± 2.01	90.75 ± 2.00	-.80 ±2.09	0.183

% (N)[1]: the percentage and number of students in each group who answered the identified question as indicated. In the intervention group: at baseline 62 students answered all five questions; at follow-up 61 answered questions 1 and 3; and 60 answered questions 2, 4, and 5. In the control group: at baseline 34 students answered all five questions; at follow-up, 33 answered questions 1and 2; 32 answered questions 3 and 4, and 31 answered question 5.
[2] p-value: the p-value for the chi-square test used to assess whether there was a difference in the number of students whose answers reflected an improvement or not about application or discussion of PS to deal with the barriers (from baseline to follow-up) between those who received the PSRP educational program and those who did not.
[3]Change in the mean score: the difference in given score, calculated as the follow-up score minus the baseline-score.
[4] p-value: the p-value for the independent t-test used to test if there was a significant difference in the change of scores (from baseline to follow-up) between the participants who received the PSRP educational program and those who did not.
Abbreviations: ABHR= Alcohol-Based Hand Rub; PS = Problem Solving; RP = Routine Practices; SD = Standard Deviation.

As can be seen in Table 3.6, at baseline and follow-up, small percentages of students in both groups reported that they discussed PS related to barriers with their classmates (intervention 24.2% at baseline and 34.4 % at follow up; control 32.4% at baseline and 33.3% at follow-up) and with their instructors (intervention 35.5% at baseline and 28.3 % at follow up; control 44.1% at baseline and 42.4 % at follow-up). When baseline and follow-up answers were compared, students in both groups showed a slight, non-significant improvement in their discussion of PS related to the barriers with their classmates ($p = 0.352$) and with their instructors ($p = 0.563$).

When students in both groups were asked about the application of PS related to the barriers at baseline, only 29% of the students in the intervention and 23.5% in the control reported that they used PS to deal with the inconvenient location of ABHR dispensers. However, higher proportions of both groups at baseline and follow-up reported that they used PS to deal with high nursing workload (intervention 46.8 % at baseline and 49.2 % at follow up; 64.7% at baseline and 50 % at follow-up) and negative role models (intervention 41.9 % at baseline and 50 % at follow up; control 58.8% at baseline and 43.8 % at follow-up). Mean scores and standard deviations were calculated for the questions related to application of PS. When baseline and follow-up answers were compared, overall, there was a small non-significant improvement in the change of the mean scores for application of PS in the intervention group (2.5 ±1.40) compared to the control group (-.80 ± 2.09; $p = 0.183$). Similarly, students in both groups showed slight but non-significant improvement on their application of PS to deal with high nursing workload ($p = 0.384$), to deal with negative role models ($p = 0.138$), and to deal with the inconvenient location of ABHR dispensers ($p = 0.944$).

As seen in Table 3.7, the majority of students in the intervention group (95.7 %) and all students (100%) in the control group stated that they would recommend the application of problem-solving steps to deal with barriers to RP as a part of the infection prevention and control curriculum. However, only 47.5% and 53.1% stated that they have applied PS steps to areas other than IPC. The majority of the students (62.9%) in both groups stated that Year 1 was the best time to introduce PS related to the barriers to RP, and additional 18% recommended it be included in all four years.

Table 3.7

Recommendation and Application of PS and Time to Introduce PS

Characteristics		Intervention % (N)[1]	Control % (N)[1]	Total % (N)[1]
1. Recommend application of PS steps to deal with barriers to be part of IPC curriculum		93.4 (57)	100 (32)	95.7 (89)
2. Apply PS steps for problems other than IPC		47.5 (29)	53.1 (17)	49.5 (46)
3. Best time to introduce PS related to the barriers	Year 1	71.9 (41)	46.9(15)	62.9 (56)
	Year 2	10.5 (6)	9.4 (3)	10.1 (9)
	Year 3	3.5 (2)	6.3 (2)	4.5 (4)
	Years 1 & 2	1.8 (1)	03.1 (1)	2.3 (2)
	Year 1, 2, & 3	3.5 (2)	0	2.3 (2)
	Year 1, 2,3, &4	8.8(5)	34.4 (11)	18 (16)

% (N)[1]: the percentage and number of students in each group who answered identified question. In the intervention group, 61 students answered questions 1 and 2, and 57 answered question 3. In the control group, 32 students answered all three questions. In total, there were 93 students who answered questions 1 and 2 and 89 who students answered question 3.
Abbreviations: IPC = Infection Prevention and Control; PS = Problem Solving.

Nursing Instructors' Discussion, Reinforcement, and Application of PS related to RP

In this study, there were only five instructors in the intervention group and four in the control group. Overall, at baseline, only one in the intervention group and two in the control group correctly answered what PS means with respect to IPC and two in each group identified the PS steps. A few also stated that they helped their students to use PS to deal with the workload (intervention n = 3; control n = 2), negative role models (intervention n = 2; control n = 2), and inconvenient location of ABHR (intervention n = 1; control n = 1). Only one instructor in the intervention group and one in the control group reported that they were confident to help their students to apply PS to deal with inconvenient location of ABHR. Moreover, only one instructor

in the intervention group compared to two in the control group reported that they were confident to help their students to apply PS to deal with high nursing workload and negative role models. Two of the instructors in the intervention group compared to one in the control group also reported that they reinforce PS related to the barriers with their students, but none of the instructors in the intervention group and only one in the control group discussed PS with their students and taught PS related to IPC. At follow-up, both groups showed similar results. At follow-up, all instructors in both groups stated that they would recommend application of PS to deal with barriers to adherence to be part of the IPC curriculum.

Discussion

A Problem-Solving Routine Practices (PSRP) educational program was developed by the researchers based on the gaps in the literature and the results of a cross-sectional study. In this study, the researchers examined the effect of a PSRP educational program for nursing students and nursing instructors to manage barriers to adherence to RP that they may encounter during their clinical practice.

Students' Adherence to RP

A number of studies have shown that adherence to RP is essential to prevent the spread of HAIs and their associated negative consequences (Maroldi et al., 2017; WHO, 2016). Adherence to RP was assessed by using six questions that were developed by the researchers based on the literature review and the objectives of this study. The study results showed that the students' adherence at baseline and follow-up was very good for five out of the six components, with over 80% reporting adherence all or most of the time. Adherence was higher in the intervention group for three of the components: washing their hands with soap and water if they were visibly soiled, wearing gloves when they were potentially exposed to body fluids, and putting used needles into

sharps containers. The opposite was true for two components where the adherence was higher in the control group: cleaning and disinfecting all shared patient care equipment and cleaning hands immediately after removal of gloves. The results of our study are similar to the findings documented in a number of self-report cross-sectional studies where 84.3% to 96.0% of the students reported that used needles should be discarded in the special sharp containers (AL-Rawajfah & Tubaishat, 2015; Colet et al., 2017; Karadağ, 2010; Lam et al., 2010), 86.0% of students reported that most of the time they washed their hands immediately after removing medical gloves, and 78.5 % reported they cleaned contaminated patient equipment with disinfectants (AL-Rawajfah & Tubaishat, 2015). The results related to adherence may reflect the level of knowledge the students had regarding RP, but it may also be due to the fact that they may have overestimated their adherence, which is common with self-reports.

Adherence was lower for the sixth component; less than 50% of the students reported doing the PCRA before each patient encounter. This reduced adherence to PCRA could be attributed to the fact that a majority of students in both groups were unable to correctly articulate what PCRA means. In addition, although the term RP is a part of the infection control curriculum, it seems that many instructors and nurses in practice are still using the term SP instead of the term RP. There was no study in the literature with which to compare our results about PCRA and this could reflect that most of the studies in the literature have been assessing students' adherence to SP not to RP, and the PCRA is one of the main components of RP, but it is not part of the SP components.

We assessed the effect of the PSRP educational program on students' adherence to RP. Overall, students in the intervention group showed non-significant improvement in their adherence to RP compared to the control groups (change in mean scores for intervention 5.97 ±

1.24 vs. control 3.22 ± 2.0; p = 0.234). However, when we assessed the effect of the educational program on students' adherence to each of the six RP components, our study found that there was a significant increase in the intervention group compared to the control group in their adherence to doing the PCRA before each patient encounter (p = 0.027), cleaning and disinfecting all shared patient care equipment (p = 0.004), and cleaning hands immediately after removal of gloves (p = 0.021). Although the adherence of the students in the control group to some of the RP components was high at baseline, their adherence was decreased at follow-up. This could be attributed to the fact that they may have overestimated their adherence at baseline. However, there were no statistically significant differences for the other three components. This could be attributed to the insufficient time that had been given to the RP review as the main focus of the intervention was on PS not on RP training. Future interventions that focus only on RP training, or other changes in the curriculum to teach and reinforce RP, could have a better impact on students' adherence to RP. This adherence is also likely to be influenced by a number of barriers.

Barriers Preventing Students from Adhering to RP

A number of barriers have been shown to prevent nursing students from adhering to RP during their clinical practice. In this study, the majority of students (95%) reported that they encountered some of these barriers with only 1.1% at baseline and 5.4% at follow-up saying they did not encounter any of these barriers. The commonly encountered barriers by both groups at baseline were high nursing workload (53.1%), presence of negative role models (64.6%), forgetfulness (41.7%), and inconvenient location of ABHR dispensers (18.8%). The findings of this study were consistent with our cross-sectional study (Chapter 2), as well as previous studies' findings (Cheung et al., 2015; Foote & El-Masri, 2016; Hinkin & Cutter, 2014). Our cross-

sectional study with 557 students found similar results that the commonly reported barriers were high nursing workload (44.2%), forgetfulness (48.7%), negative role models (40.4 %), and inconvenient location of ABHR dispensers (29.1 %). Cheung et al. (2015) and Foote and El-Masri (2016) in their cross-sectional survey studies found that 23% to 35% of nursing students reported that "busyness" influenced their adherence to SP. In a separate cross-sectional study, 59.9% of the students reported that high workload was one of the factors that influenced their adherence to infection prevention and control (IPC) practices (Hinkin & Cutter, 2014).

Similar to our study, several studies identified the impact of role models on nursing students' adherence to SP. Dorgham and Obied (2016) found that 38% to 40% of nursing students reported that they imitated their clinical instructors and nurses in their clinical areas. Similarly, a cross-sectional study by Hinkin and Cutter (2014) conducted in the UK found that 98.5% and 95.6% of nursing students reported that their adherence to SP was more likely to be influenced by the adherence of their instructors and other nurses, respectively. Therefore, if nursing students observe that their instructors or nurses in the unit are not adhering to RP, students are likely to follow their example and not adhere to RP. Furthermore, in two studies conducted in the UK (Wilson et al., 2017) and Turkey (Alp et al., 2011), 38% and 91% of nursing students respectively self-reported that the presence of negative role models impacted their adherence to IPC practices. Recently, Choi and Kim (2018) found that the intention of nursing students to adhere to IPC practices was negatively influenced by the non-adherence of other nurses in their clinical settings ($r = - 0.469$).

Inconvenient location of ABHR can negatively influence nursing students' adherence to hand hygiene. This study found that 18.8% of nursing students reported that the inconvenient location of ABHR dispensers had prevented them from adhering to RP. Similar to our findings, a

Canadian cross-sectional study has shown that 36 % of nursing students indicated that inconvenient location of ABHR dispensers and hand wash sinks is one of the barriers that prevented them from adhering to hand hygiene (Foote & El-Masri, 2016). Our cross-sectional study also found that 29.1 % of students reported inconvenient location of ABHR dispensers prevented them from adhering to RP. Moreover, Kirk et al. (2016) surveyed 350 nurses and physicians from the United States and Canada about their knowledge, attitudes, and practices of hand hygiene. More than 50% of both groups agreed or strongly agreed that they were more likely to clean their hands if ABHR dispensers were located near to the patient care zone. In their cross-sectional observational study, Deyneko et al. (2016) found that nurses were more likely to adhere to hand hygiene if hand wash sinks were located in their direct vision (25.6 %) compared to those who did not visualize these sinks (8.5%).

As can be seen, the barriers to adherence to RP are a real and serious problem because students encounter them frequently, and, as a result, their adherence to RP was negatively impacted. Therefore, in order for students to have better adherence to RP, their knowledge about PS need to be strengthened so that they can address the barriers they encounter.

PS Intervention and Students' Knowledge about PS

Our study found that at baseline and follow-up, small percentages of students in both groups correctly identified the steps of PS and explained what PS means with respect to IPC. In this study, significantly more students in the intervention group were able to correctly identify the PS steps compared to the control group ($p = 0.016$). This significant improvement could be attributed to the fact that students in the intervention group practiced how to use PS steps as a guide for them to discuss the three common barriers to RP. Although the PSRP educational program helped improve students' knowledge of PS steps, this improvement was lower than

expected. Therefore, nursing administrators should consider strengthening students' knowledge about PS by making PS an important part of the infection prevention and control curriculum. If the students' knowledge about PS is strengthened, this could also improve their confidence to apply it to address the barriers to RP.

Students' Confidence to Apply PS to Deal with the Barriers

As previously discussed, students frequently encountered a number of barriers that prevented them from adhering to RP. In order for students to have better adherence to RP, they need to be confident in their application of PS to deal with these barriers. Our study found that at baseline and follow-up, small percentages of students in both groups were confident about applying PS to deal with high nursing workload, negative role models, and the inconvenient location of ABHR dispensers. When baseline and follow-up answers were compared, there was a significant increase in the proportion of students in the intervention group who were confident about applying PS to deal with high nursing workload compared to the control group ($p = 0.032$). However, both groups showed slight, but non-significant improvement in their confidence about applying PS to deal with negative role models ($p = 0.147$) and the inconvenient location of ABHR dispensers ($p = 0.319$). This lack of confidence could be attributed to the limited amount of clinical time they had post-intervention to practice, as discussed in the next section.

Students' Discussion and Application of PS Related to RP

As previously discussed, students frequently encountered a number of barriers that prevented them from adhering to RP. The PSRP educational program aimed to help students to discuss and use PS steps as a new approach to deal with these commonly encountered barriers. Our study results showed that at baseline and follow-up, small proportions of students in both groups reported that they discussed PS related to barriers with their classmates and with their

instructors. When baseline and follow-up answers were compared, students in both groups showed slight, but a non-significant improvement in their discussion of PS with their classmates ($p = 0.352$) and with their instructors ($p = 0.563$). Almost all of them did recommend that application of PS to address RP should be part of the curriculum.

We also assessed the students' application of PS to deal with the barriers. The application of PS to deal with the barriers varied between the groups. For instance, at baseline and follow-up, more students reported that they applied PS to deal with workload and role models, however, small proportions of them applied PS to deal with the inconvenient location of ABHR. Similarly, the results of the present study also showed that students in the intervention group were more likely than those in the control group to apply PS for all of the three barriers (workload, role models, and ABHR) but differences were not statistically significant ($p = 0.384$; 0.138; and 0.944), respectively. This lack of PS discussion and application could be attributed to the limited time that students spent in clinical placements after the intervention session. During this study, students had spent only five clinical days following the intervention; during these five clinical days, only small proportions of the students reported that they had applied PS to deal with these three identified barriers. In addition, there was also a lack of participation of nursing instructors in the intervention, which may have led to a lack of discussion and reinforcement of PS related to RP during students' clinical practice. This indicates the key role that clinical instructors can play to help their students to deal with these barriers.

Nursing Instructors' PS Discussion, Reinforcement, and Application of PS related to RP

In this study, out of 24 expected instructors, there were nine participants: five in the intervention group and four in the control group. Only a few of them in each group were able to correctly identify the steps of PS and self-reported confidence about helping students with PS

related to RP. These results were also supported by our cross-sectional study findings. For example, only 20% to 30% of the 20 instructors that participated in that study reported that they were confident about using PS to deal with these three identified barriers. Similarly, one study conducted in Atlantic Canada showed that only 26.9% of nursing educators reported feeling very confident in PS related to infection prevention and control (Chiasson, 2015). Our findings also found that both groups showed lack of discussion and reinforcement of PS related to the barriers with their students. This was consistent with the results from the students where only a small proportion of the students in both groups (intervention 32% and control 44%) reported that they discussed PS related to the barriers with their instructors.

We acknowledge that the instructors' results were based on a very small sample size, which has implications for future research. However, these results give us at least a sense about the PS related to barriers to RP adherence among nursing instructors. In this study, it was challenging to recruit the required number of instructors. This may be due to the lack of incentive, as per the University gift card policy, instructors are not allowed to receive any incentive if they have agreed to participate in a study. In addition, it could also be due to their workload and busy schedules; the researchers made multiple attempts to recruit them.

Strengths and Limitations

A key strength of this study is that it was the first study to assess the effect of the PS educational program on dealing with barriers to adherence to RP. It identifies areas for further exploration for both research and education. The study also applied the constructivist theory approach by using group discussion as a teaching method to allow the students to engage in an interactive discussion and to construct their own strategies that can be used to deal with barriers to RP. The benefit of this is to help the students to consider multiple perspectives on a given

situation and to develop flexibility in thinking by weighing the pros and cons of various strategies in order to deal with the encountered barriers.

However, a few limitations were identified in this study. The time allocated for the study was not long enough for the students to practice PS in clinical to obtain optimal results; they had five clinical days in which to practice which may not have been sufficient, especially without reinforcement. In addition, the study intervention was delivered to the participants once, and the time allocated for the intervention was only 2 hours due to the busy schedule for the students and the facilitators. The sample size was small, consisting of 62 students in the intervention and 34 students in the control, and the study was limited to the Years 2 and 3 students, which may limit the generalizability. In addition, the results of nursing instructors were also based on a very small sample size (intervention group n = 5 and control group n = 4). Therefore, their results should be interpreted with caution. Self-report was used to assess the study outcomes; the students may have over or underestimated their PS knowledge, discussion, and application, as well as their adherence to RP. Overall, however, we believe that the findings of the study can be of value in identifying the potential usefulness of a PS approach to addressing barriers to RP adherence. It can be used in many other similar settings.

Implications for Nursing Instructors and Nursing Administrators

There are several strategies that nursing instructors and nursing administrators can employ to contribute to HAI prevention and to improve adherence to RP. One of them is using PS as a strategy to deal with the barriers. In order to improve students' discussion and application of PS related to RP, nursing instructors need to discuss and reinforce the application of PS with their students to help them successfully overcome these barriers. This discussion and reinforcement of PS related to RP could take place and be an integral part of their regular clinical

conference meetings. It is also clear that barriers to adherence to RP are a real and serious problem because students encounter them frequently, and, as a result, their adherence to RP was negatively impacted. To enable students to report and discuss with their instructors any of the barriers that they may encounter, nursing instructors need to build a good relationship with their students, and encourage them to communicate any concerns such as these barriers.

In addition, nursing administrators can also play important role by providing their faculty members with training sessions about discussion and application of PS related to RP barriers so that they will have the necessary knowledge and skills to help their students to better understand and apply PS to deal with the barriers to adherence to RP as well as to other problems they encounter. These training sessions can also provide guidance on how and when to discuss and reinforce PS related to the barriers. They can also support simulation activities to strengthen communication and collaboration skills of students and application of RP and PS. In addition, it could be also an integral part of the nursing curriculum and simulation activities. For example, they can introduce it early in the nursing program such as in Year 1 and before students start their clinical rotation.

Recommendations for Future Research

Our intervention was based on PS as a new approach to deal with barriers to RP adherence and was informed by the literature and constructivist learning theory. Future studies could take a different lens by understanding the psychology behind these barriers, drawing on theories from organizational psychology and social psychology such as Bandura's social learning theory and Deci & Ryan's self-determination theory.

In this study, only a small number of instructors agreed to participate. Future studies with a large sample size and more effective recruitment strategies may provide results that can lead to

a better understanding of the impact of the PSRP on instructors' knowledge, confidence, discussion, reinforcement, and application of PS related to the barriers to RP adherence. In addition, future studies could also explore the reasons that prevent faculty members from participating in research studies.

In this study, students did not have many clinical days post-intervention, and their clinical instructors had limited involvement with the intervention, yet instructors can play an important role in reinforcing the application of PS in clinical. Therefore, it would be important to evaluate the impact of a longer follow-up period with more clinical days, where students had the opportunity to practice and discuss with instructors with real-life situations. It would be essential to involve instructors in the intervention, and provide them with strategies to use for reinforcement in clinical practice and discussion with students. A future qualitative descriptive study could also explore the role instructors play in helping students to apply PS to deal with the barriers to RP adherence and the issues they face.

In this study, both instructors and students identified a number of strategies that can be used to deal with these three identified barriers (high nursing workload, negative role models, and inconvenient location of ABHR dispensers). Future research could explore in depth how these strategies can be used, and what impacts these strategies may have on their adherence to RP. In this study, we developed our questionnaire based on the results of our cross-sectional survey, the gaps in the literature, and the objectives of this study. Future research could focus on developing a valid and reliable questionnaire to better capture these study outcomes. In addition, it should consider using an observation technique to observe their actual adherence and application of PS.

Conclusion

In conclusion, our study revealed that nursing students reported they encountered a number of barriers that prevented them from adhering to RP such as high nursing workload, negative role models, and inconvenient location of ABHR dispensers. They also reported limited knowledge about PS related to the barriers to adherence to RP. After the PSRP educational program more students in the intervention than in the control group showed significant improvement in their adherence to three out of six components of RP, and in their knowledge in identifying the steps of PS. However, there were slight, but not significant, improvements in their confidence and application of PS to deal with these three identified barriers. Due to the small sample size and limited time for practice, the effectiveness of the PSRP program was varied, but further exploration of this approach is warranted

References

Ahmady, S., & Shahbazi, S. (2020). Impact of social problem-solving training on critical thinking and decision making of nursing students. *BMC Nursing, 19*(1), 1-8. https://doi.org/10.1186/s12912-020-00487-x

Akagbo, S. E., Nortey, P., & Ackumey, M. M. (2017). Knowledge of standard precautions and barriers to compliance among healthcare workers in the Lower Manya Krobo District, Ghana. *BMC Research Notes, 10*(1), 432. https://doi.org/10.1186/s13104-017-2748-9

AL-Rawajfah, O. M., & Tubaishat, A. (2015). Nursing students' knowledge and practices of standard precautions: a Jordanian web-based survey. *Nurse Education Today, 35*(12), 1175-1180. https://doi.org/10.1016/j.nedt.2015.05.011

Aliakbari, F., Parvin, N., Heidari, M., & Haghani, F. (2015). Learning theories application in nursing education. *Journal of Education and Health Promotion,* 4.

Ancel, G. (2016). Problem-Solving Training: Effects on the Problem-Solving Skills and Self-Efficacy of Nursing Students. *Eurasian Journal of Educational Research, 16*(64). https://doi.org/10.14689/ejer.2016.64.13

Arefian, H., Hagel, S., Fischer, D., Scherag, A., Brunkhorst, F. M., Maschmann, J., & Hartmann, M. (2019). Estimating extra length of stay due to healthcare-associated infections before and after implementation of a hospital-wide infection control program. *PloS One, 14*(5), e0217159. https://doi.org/10.1371/journal.pone.0217159

Atif, S., Lorcy, A., & Dubé, E. (2019). Healthcare workers' attitudes toward hand hygiene practices: Results of a multicenter qualitative study in Quebec. *Canadian Journal of Infection Control, 34*(1). Available at https://ipac-canada.org/photos/custom/CJIC/CJIC_Spring2019_Atif.pdf.

Barker, A. K., Brown, K., Siraj, D., Ahsan, M., Sengupta, S., & Safdar, N. (2017). Barriers and facilitators to infection control at a hospital in northern India: a qualitative study. *Antimicrobial Resistance & Infection Control*, *6*(1), 35. https://doi.org/10.1186/s13756-017-0189-9

Brandon, A. F., & All, A. C. (2010). Constructivism theory analysis and application to curricula. *Nursing Education Perspectives*, *31*(2), 89-92. Available at https://pubmed.ncbi.nlm.nih.gov/20455364/

Canadian Nosocomial Infection Surveillance Program (CNISP). (CNISP, 2015). Healthcare-associated Infections Annual Report 2009-2014. Retrieved from: https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2014.pdf.

Centers for Disease Control and Prevention (CDC). (2018). Healthcare-associated Infections. HAI Data and Statistics. Available at https://www.cdc.gov/hai/surveillance/index.html.

Cheung, K., Chan, C. K., Chang, M. Y., Chu, P. H., Fung, W. F., Kwan, K. C., ... & Mak, H. M. (2015). Predictors for compliance of standard precautions among nursing students. *American Journal of Infection Control*, *43*(7), 729-734. https://doi.org/10.1016/j.ajic.2015.03.007

Chiasson, M. (2015). *Exploring infection prevention and control education in Atlantic Canadian undergraduate nursing education programs* (Doctoral dissertation, Memorial University of Newfoundland). Available at https://research.library.mun.ca/8446/.

Choi, J. S., & Kim, K. M. (2018). Factors influencing nursing students' intention to comply with infection control practices. *American Journal of Infection Control*, *46*(6), 717-719. https://doi.org/10.1016/j.ajic.2017.12.010

Çinar, N., Sözeri, C., Şahin, S., Cevahir, R., & Say, M. (2010). Problem solving skills of the nursing and midwifery students and influential factors. *Rev Eletr Enf, 12*(4), 601-606. Retrieved from file:///C:/Users/user/Downloads/Problem_solving_skills_of_the_nursing_and_midwifer%20(2).pdf.

Colet, P. C., Cruz, J. P., Alotaibi, K. A., Colet, M. K., & Islam, S. M. (2017). Compliance with standard precautions among baccalaureate nursing students in a Saudi university: A self-report study. *Journal of Infection and Public Health*, *10*(4), 421-430. https://doi.org/10.1016/j.jiph.2016.06.005

Cruz, J. P. (2019). Infection prevention climate and its influence on nursing students' compliance with standard precautions. *Journal of Advanced Nursing*, *75*(5), 1042-1052. https://doi.org/10.1111/jan.13904

Day, H. R., Perencevich, E. N., Harris, A. D., & Gruber-Baldini, A. L., Himelhoch, S. S., Brown, C. H., & Morgan, D. J. (2013). Depression, anxiety, and moods of hospitalized patients under contact precautions. *Infection Control & Hospital Epidemiology*, *34*(3), 251-8. https://doi.org/10.1086/669526

Day, H. R., Perencevich, E. N., Harris, A. D., & Himelhoch, S. S., Brown, C. H., Gruber-Baldini, A. L., ... & Morgan, D. J. (2011). Do contact precautions cause depression? A two-year study at a tertiary care medical centre. *Journal of Hospital Infection*, *79*(2), 103-107. https://doi.org/10.1016/j.jhin.2011.03.026

Deniz Kocoglu, R. N., Duygulu, S., Abaan, E. S., & Akin, B. (2016). Problem Solving Training for First Line Nurse Managers. *International Journal*, *9*(3), 955. Retrieved from http://www.internationaljournalofcaringsciences.org/docs/24_kokoglu_originial_9_3.pdf.

Deyneko, A., Cordeiro, F., Berlin, L., Ben-David, D., Perna, S., & Longtin, Y. (2016). Impact of sink location on hand hygiene compliance after care of patients with Clostridium difficile infection: a cross-sectional study. *BMC Infectious Diseases*, *16*(1), 203. https://doi.org/10.1186/s12879-016-1535-x

Dombecki, C., Shah, M. M., Eke-Usim, A., Akkina, S. R., Ahrens, M., Sturm, L., ... & Foxman, B. (2015). The impact of role models on hand hygiene compliance. *Infection Control & Hospital Epidemiology*, *36*(5), 610-612. https://doi.org/10.1017/ice.2015.20

Dorgham, S. R., & Obied, H. K. (2016). Factors affecting nurse interns' compliance with standard precautions for preventing stick injury. *Journal of Nursing Education and Practice*, *6*(12), 121–130. https://doi.org/10.5430/jnep.v6n12p121

D'zurilla, T. J., & Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of Abnormal Psychology*, *78*(1), 107. https://doi.org/10.1037/h0031360

Foote, A., & El-Masri, M. (2016). Self-perceived hand hygiene practices among undergraduate nursing students. *Journal of Research in Nursing*, *21*(1), 8-19. https://doi.org/10.1177/1744987115606959

Gould, D. J., Moralejo, D., Drey, N., Chudleigh, J. H., & Taljaard, M. (2017). Interventions to improve hand hygiene compliance in patient care. *Cochrane Database of Systematic Reviews*, (9). https://doi.org/10.1002/14651858.CD005186.pub3

Guilley-Lerondeau, B., Bourigault, C., des Buttes, A. C. G., Birgand, G., & Lepelletier, D. (2017). Adverse effects of isolation: a prospective matched cohort study including 90 direct interviews of hospitalized patients in a French University Hospital. *European Journal of Clinical Microbiology & Infectious Diseases*, *36*(1), 75-80. https://doi.org/10.1007/s10096-016-2772-z

Heidari, M., & Shahbazi, S. (2014). The effect of problem-solving training on decision making skill in nursing students. *International Journal of Nursing Education*, *6*(1), 15-18. https://doi.org/10.4103/2229-5151.195445

Hessels, A. J., & Larson, E. L. (2016). Relationship between patient safety climate and standard precaution adherence: a systematic review of the literature. *Journal of Hospital Infection*, *92*(4), 349-362. https://doi.org/10.1016/j.jhin.2015.08.023

Hinkin, J., & Cutter, J. (2014). How do university education and clinical experience influence pre-registration nursing students' infection control practice? A descriptive, cross sectional survey. *Nurse Education Today*, *34*(2), 196-201. https://doi.org/10.1016/j.nedt.2013.09.005

Jia, H., Li, L., Li, W., Hou, T., Ma, H., Yang, Y., ... & Luo, X. (2019). Impact of healthcare-associated infections on length of stay: a study in 68 hospitals in China. *BioMed Research International*. https://doi.org/10.1155/2019/2590563

Kaba, A., Baumann, A., Kolotylo, C., & Akhtar-Danesh, N. (2017). A descriptive case study of the changing nature of nurses' work: The impact of managing infectious diseases requiring isolation. *American Journal of Infection Control*, *45*(2), 200-202. https://doi.org/10.1016/j.ajic.2016.06.036

Kanbay, Y., & Okanlı, A. (2017). The effect of critical thinking education on nursing students' problem-solving skills. *Contemporary Nurse*, *53*(3), 313-321. https://doi.org/10.1080/10376178.2017.1339567

Karadağ, M. (2010). Occupational exposure to blood and body fluids among a group of Turkish nursing and midwifery students during clinical practice training: frequency of needlestick

and sharps injuries. *Japan Journal of Nursing Science*, *7*(2), 129-135. https://doi.org/10.1111/j.1742-7924.2010.00148.x

Kim, K. M., & Oh, H. (2015). Clinical Experiences as related to standard precautions compliance among nursing students: a focus group interview based on the theory of planned behavior. *Asian Nursing Research*, *9*(2), 109-114. https://doi.org/10.1016/j.nedt.2015.12.003

Kirk, J., Kendall, A., Marx, J. F., Pincock, T., Young, E., Hughes, J. M., & Landers, T. (2016). Point of care hand hygiene—where's the rub? A survey of US and Canadian health care workers' knowledge, attitudes, and practices. *American Journal of Infection Control*, *44*(10), 1095-1101. https://doi.org/10.1016/j.ajic.2016.03.005

Lam, S. C., Fung, E. S. S., Hon, L. K. Y., Ip, M. P. Y., & Chan, J. H. T. (2010). Nursing students' compliance with universal precautions in Hong Kong. *Journal of clinical nursing*, *19*(21-22), 3247-3250. https://doi.org/10.1111/j.1365-2702.2010.03419.x

Lupión-Mendoza, C., Antúnez-Domínguez, M. J., González-Fernández, C., Romero-Brioso, C., & Rodriguez-Bano, J. (2015). Effects of isolation on patients and staff. *American Journal of Infection Control*, *43*(4), 397-399. https://doi.org/10.1016/j.ajic.2015.01.009

Maroldi, M. A. C., da Silva Felix, A. M., Dias, A. A. L., Kawagoe, J. Y., Padoveze, M. C., Ferreira, S. A., ... & Figueiredo, R. M. (2017). Adherence to precautions for preventing the transmission of microorganisms in primary health care: a qualitative study. *BMC Nursing*, *16*(1), 1-8. https://doi.org/10.1186/s12912-017-0245-z

Mitchell, R., Taylor, G., Rudnick, W., Alexandre, S., Bush, K., Forrester, L., ... & John, M. (2019). Trends in health care–associated infections in acute care hospitals in Canada: an

analysis of repeated point-prevalence surveys. *CMAJ, 191*(36), E981-E988. https://doi.org/10.1503/cmaj.190361

Moon, K. J., Hyeon, Y. H., & Lim, K. H. (2019). Factors associated with nursing students' compliance with standard precautions: a self-reported survey. *Int J Infect Control, 15*(3), 1-9. https://doi.org/10.3396/ijic.v15i3.19007

Musau, J., Baumann, A., Kolotylo, C., O'shea, T., & Bialachowski, A. (2015). Infectious disease outbreaks and increased complexity of care. *International Nursing Review, 62*(3), 404-411. https://doi.org/10.1111/inr.12188

Patel, H., Khoury, H., Girgenti, D., Welner, S., & Yu, H. (2017). Burden of surgical site infections associated with select spine operations and involvement of Staphylococcus aureus. *Surgical Infections, 18*(4), 461-473. https://doi.org/10.1089/sur.2016.186

Pereira, F. M. V., Lam, S. C., Chan, J. H. M., Malaguti-Toffano, S. E., & Gir, E. (2015). Difference in compliance with Standard Precautions by nursing staff in Brazil versus Hong Kong. *American Journal of Infection Control, 43*(7), 769-772. https://doi.org/10.1016/j.ajic.2015.03.021

Powers, D., Armellino, D., Dolansky, M., & Fitzpatrick, J. (2016). Factors influencing nurse compliance with Standard Precautions. *American Journal of Infection Control, 44*(1), 4-7. https://doi.org/10.1016/j.ajic.2015.10.001

Public Health Agency of Canada (PHAC). (2016). Routine practices and additional precautions for preventing the transmission of infection in healthcare settings. Retrieved from https://www.canada.ca/en/public-health/services/infectious-diseases/nosocomial-occupational-infections/routine-practices-additional-precautions-preventing-transmission-infection-healthcare-settings.html.

Purssell, E., Gould, D., & Chudleigh, J. (2020). Impact of isolation on hospitalized patients who are infectious: systematic review with meta-analysis. *BMJ Open, 10*(2). http://dx.doi.org/10.1136/bmjopen-2019-030371

Quan, M., Wang, X., Wu, H., Yuan, X., Lei, D., Jiang, Z., & Li, L. (2015). Influencing factors on use of standard precautions against occupational exposures to blood and body fluids among nurses in China. *International Journal of Clinical and Experimental Medicine, 8* (12), 22450. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4730013/.

Rahmqvist, M., Samuelsson, A., Bastami, S., & Rutberg, H. (2016). Direct health care costs and length of hospital stay related to health care-acquired infections in adult patients based on point prevalence measurements. *American Journal of Infection Control*, *44*(5), 500-506. https://doi.org/10.1016/j.ajic.2016.01.035

Rashmi, A., & Kundapur, R. (2017). Factors influencing observation of standard precautions among nursing staff in tertiary care setting in Mangalore. *International Journal of Community Medicine and Public Health*, *5*(1), 377-381. http://dx.doi.org/10.18203/2394-6040.ijcmph20175817

Russo, P. L., Stewardson, A. J., Cheng, A. C., Bucknall, T., & Mitchell, B. G. (2019). The prevalence of healthcare associated infections among adult inpatients at nineteen large Australian acute-care public hospitals: a point prevalence survey. *Antimicrobial Resistance & Infection Control*, *8*(1), 114. https://doi.org/10.1186/s13756-019-0570-y

Serrano, M., Barcenilla, F., Limón, E., Pujol, M., & Gudiol, F. (2017). Prevalence of healthcare-associated infections in long-term care facilities in Catalonia. VINCat Program. *Enfermedades Infecciosas y Microbiologia Clinica (English ed.)*, *35*(8), 503-508. https://doi.org/10.1016/j.eimce.2017.08.004

Schmidt, A., Bénard, S., & Cyr, S. (2015). Hospital cost of staphylococcal infection after cardiothoracic or orthopedic operations in France: a retrospective database analysis. *Surgical Infections*, *16*(4), 428-435. https://doi.org/10.1089/sur.2014.045

Schweizer, M. L., Cullen, J. J., Perencevich, E. N., & Sarrazin, M. S. V. (2014). Costs associated with surgical site infections in Veterans Affairs hospitals. *JAMA surgery*, *149*(6), 575-581. https://doi.org/10.1001/jamasurg.2013.4663

Shahbazi, S., Heidari, M., Sureshjani, E. H., & Rezaei, P. (2018). Effects of problem-solving skill training on emotional intelligence of nursing students: An experimental study. *Journal of Education and Health Promotion*, *7*. https://doi.org/10.4103/jehp.jehp_50_18

StataCorp. (2015). Statistical Software: Release 14. College Station, TX: StataCorp LP.

Suetens, C., Latour, K., Kärki, T., Ricchizzi, E., Kinross, P., Moro, M. L., ... & Reilly, J. (2018). Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. *Eurosurveillance*, *23*(46), 1800516. https://doi.org/10.2807/1560-7917.ES.2018.23.46.1800516

Taylor, G., Gravel, D., Matlow, A., Embree, J., LeSaux, N., Johnston, L., ... & Roth, V. (2016). Assessing the magnitude and trends in hospital acquired infections in Canadian hospitals through sequential point prevalence surveys. *Antimicrobial Resistance & Infection Control*, *5*(1), 19. https://doi.org/10.1186/s13756-016-0118-3

Travers, J., Herzig, C. T., Pogorzelska-Maziarz, M., Carter, E., Cohen, C. C., Semeraro, P. K., ... & Stone, P. W. (2015). Perceived barriers to infection prevention and control for nursing

home certified nursing assistants: a qualitative study. *Geriatric Nursing*, *36*(5), 355-360. https://doi.org/10.1016/j.gerinurse.2015.05.001

Wilson, J., Bak, A., Whitfield, A., Dunnett, A., & Loveday, H. (2017). Public perceptions of the use of gloves by healthcare workers and comparison with perceptions of student nurses. *Journal of Infection Prevention, 18*(3), 123-132. https://doi.org/10.1177/1757177416680442

World health organization (WHO). (2016). Health care-associated infections fact sheet. Retrieved from https://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf.

World health organization (WHO). (2018). The burden of healthcare associated infections worldwide. Retrieved from http://www.who.int/gpsc/country_work/burden_hcai/en.

Zellmer, C., Blakney, R., Van Hoof, S., & Safdar, N. (2015). Impact of sink location on hand hygiene compliance for Clostridium difficile infection. *American Journal of Infection Control*, *43*(4), 387-389. https://doi.org/10.1016/j.ajic.2014.12.016

Zhou, Q., Fan, L., Lai, X., Tan, L., & Zhang, X. (2019). Estimating extra length of stay and risk factors of mortality attributable to healthcare-associated infection at a Chinese university hospital: a multi-state model. *BMC Infectious Diseases*, *19*(1), 975. https://doi.org/10.1186/s12879-019-4474-5

Chapter 4: Role Models and Nursing Students' Adherence to Routine Infection Control Practices

Abubaker Hamed[1], Donna Moralejo [1], April Pike[1], Vernon Curran[2]

[1] *Faculty of Nursing, Memorial University of Newfoundland, Canada*

[2]*Faculty of Medicine, Memorial University of Newfoundland, Canada*

In this paper, the role of positive and negative role models in affecting students' adherence to routine infection control practices, the reasons that prevented students from dealing with negative role models, the strategies that they can use to manage the influence, and the use of problem solving as a potential strategy to deal with negative role models are discussed. Based on this discussion, recommendations are made for nursing instructors to better address the issue of negative role models.

AMH conducted the literature review and wrote the manuscript. DM guided the discussion and writing and approved the manuscript. AP and VC reviewed the drafts, suggested revisions, and approved the manuscript.

Abstract

Background: A number of studies have identified negative role models as a barrier to adherence of healthcare workers to routine infection control practices (RP). However, no strategies have been reported to help students or nurses deal with this barrier. Therefore, the purpose of this paper is to discuss role models and students' adherence to RP, as well as strategies that can be used to deal with negative role models. **Discussion:** When students are in clinical practice, evidence indicates they encounter both negative and positive role models. Encountering positive role models who are continuously adhering to RP has been associated with better adherence. In contrast, the presence of a negative role model in clinical nursing practice has been identified as a significant barrier that adversely affects the adherence of nursing students to RP. The interventions that have been attempted to improve students' adherence to RP have focused primarily on education or having them work with positive role models. However, none of these strategies has specifically focused on helping students learn to deal with negative role models. Based on our previously conducted cross-sectional study, multiple strategies that can be used to deal with negative role models were identified and discussed. These strategies were classified under three themes: approved practice; communication and clarification; and help-seeking. **Conclusion:** This paper provides vital insights into understanding the effects of negative and positive role models on nursing students' adherence to RP as well as strategies to use to manage the influence of negative role models on their adherence. Nursing instructors play an important role in helping students choose appropriate strategies and apply effective strategies when they are in clinical settings.

Keywords: *Role models, adherence, strategies, problem solving, routine practices*

Healthcare-associated infections (HAIs) are a serious health problem that can cause unnecessary death, prolong patients' hospital stays, and increase costs of care to hospitals (Arefian et al., 2019; Kourtis et al., 2019; Keenan et al., 2014; Purssell et al., 2020; WHO, 2016). The World Health Organization (WHO) estimates that 10% of patients in developing countries acquire an HAI, 7% of patients in developed countries acquire HAIs, and up to 30% of the patients admitted to intensive care units are affected by at least one HAI in developed countries (WHO, 2016). Recently, three prevalence studies on HAIs in a number of countries have reported the prevalence of HAIs ranged between 3.9% and 10.2% (Russo et al., 2019; Serrano et al., 2017; Suetens et al., 2018). HAIs are also prevalent in a number of Canadian healthcare facilities. The HAI prevalence rate is estimated to be between 8% and 13% (CNISP, 2015; Mitchell et al., 2019; Taylor et al., 2016). HAIs and their negative consequences can be reduced by adhering to routine infection control practices (RP). RP is similar to the system of Standard Precautions (SP) used elsewhere, and include hand hygiene, use of personal protective equipment (PPE), sharps safety, cleaning and disinfecting patient care equipment, point of care risk assessment (PCRA) (PHAC, 2012). However, PCRA is part of RP, but it is not part of the SP. In this chapter we will use the term SP when the studies being discussed investigated Standard Precautions, otherwise the term RP will be used.

While RP can help reduce HAIs, nursing students' adherence to RP has been found to be suboptimal, with adherence rates ranging from 55% -78% (Cheung et al., 2015; Colet et al., 2017; Cruz, 2019; Moon et al., 2019). This suboptimal adherence could be attributed to a number of barriers. These barriers include lack of knowledge and training, skin damage or dryness, forgetfulness, empty alcohol-based hand rub (ABHR) dispensers, and unavailability of PPE, however, one of the most common is the presence of negative role models (Choi &Kim, 2018;

Cheung et al., 2015; Kim & Oh, 2015; Ward, 2013; Wilson et al., 2017). Encountering negative role models who are not continuously adhering to RP has been shown to negatively influence students' adherence to RP (Cheung et al., 2015; Erasmus et al., 2009; Hinkin & Cutter, 2014). Research has also shown that nursing students who work under the supervision of negative role models are more likely to adopt non-adherence behavior to SP (Barrett & Randle, 2008; Cheung et al., 2015; Erasmus et al., 2009; Foote & El-Masri, 2014; Kelcíkova et al., 2012; Kirk et al., 2016). Therefore, to have better adherence to RP, it is important for nursing students to be able to deal with negative role models while they maintain a professional relationship with nurses.

Despite the fact that a large body of literature has identified negative role models as a barrier to RP adherence, no strategies have been reported that can be used to help students or nurses deal with this barrier. Therefore, the purpose of this paper is to shed light on how role models influence nursing students' adherence to RP. This includes a discussion of the reasons that prevent students from overcoming the negative role models' behaviour and strategies that can be used to help the students be effective in dealing with it. In addition, we also draw on our experience of using problem solving (PS) as a potential strategy to deal with the influence of negative role model behaviour. Understanding these strategies can provide insight for nursing instructors on how to equip their students with strategies that can be used to manage encounters with negative role models during their clinical practice, as well as in their future careers as nurses.

Definition of a Role Model

A role model refers to "the observation of behaviors or attitudes of someone that one admires and the subsequent adopting of those behaviors or attitudes for oneself" (Baldwin et al., 2014, p. e18). While role modelling can be a deliberate educational strategy, in this paper we

focus on the negative role models' behaviour as it frequently and unconsciously occurs in the workplace. For the purpose of this discussion, a negative role model is defined as a nurse or other healthcare worker (HCW) who does not frequently or appropriately adhere to RP (e.g., the person who is doing the behaviour of non-adherence to RP). In contrast, a positive role model is defined as a nurse or other HCW who frequently and appropriately adheres to RP (e.g., the person who is doing the behaviour of adherence to RP). When students are in clinical practice, they may encounter both negative and positive role models. Encountering positive role models who consistently practice RP may help students increase their adherence to RP.

Positive Role Models and Adherence to SP

Positive role models have been shown to have a significant positive impact on nurses' and nursing students' adherence to SP including hand hygiene (Alp et al., 2011; Dorgham & Obied, 2016; Dombecki et al., 2015; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Huis et al., 2013; Schneider et al., 2009). For example, Huis et al. (2013) conducted a cluster randomized controlled trial (RCT) to examine the effect of two strategies on hand hygiene adherence among 67 wards in three hospitals in Netherlands. The intervention group consisted of 30 wards that received a leaders-directed strategy, while the control group consisted of 37 wards that received a state-of-the-art strategy. The state-of-the-art strategy consisted of education, reminders, feedback, and relevant products. The leaders-directed strategy consisted of all the strategies used in the state-of-the-art strategy plus setting norms and targets within the team, active involvement in the ward management, and modeling by informal leaders. The authors found that both groups showed improvement in their hand hygiene adherence. However, the nurses who received the leaders-directed strategy showed better improvement in their hand hygiene adherence (53.1%, $p < 0.001$) compared to the nurses who received the state-of-the-art strategy (45.9%). Moreover,

similar to Huis et al. (2013), Dombecki et al. (2015) observed hand hygiene practices of two groups of HCWs including nurses. One group worked with leaders that practiced hand hygiene; the other HCWs did not have a hand hygiene leader. They found that the HCWs who worked with a group with leaders had significantly higher adherence to hand hygiene (71%, $p < 0.001$) compared to those without leaders (29%). Similarly, Schneider et al. (2009) conducted a prospective observational study among two junior physicians and four junior nurses to assess if their hand hygiene adherence would be influenced by their supervisors (nurses, physicians, and other HCWs). They observed the participants' adherence to hand hygiene while they were working with their supervisor and then they put them with a supervisor who strictly adhered to hand hygiene (positive role model) and compared their adherence. The author found that as a result of role modeling, junior nurses who worked with a supervisor who strictly adhered to hand hygiene had a significantly better adherence rate (94%) compared to a supervisor who did not strictly adhere (20%; $p< 0.01$).

Multiple cross-sectional studies have also found similar results to the preceding studies. For example, nursing students' self-reported adherence to hand hygiene was higher (OR 2.23; 95% CI: 1.01-4.92) when they perceived their nursing instructors and nurses in their clinical areas were consistently adhering to infection prevention and control (IPC) practices (Foote & El-Masri, 2016). Alp et al. (2011) found similar results with nurses and nursing students (OR 2.30; 95% CI: 1.62-3.26). In a cross-sectional study by Dorgham and Obied (2016), 38% to 40% of nursing students said they imitated their clinical instructors and nurses in their clinical areas. In the cross-sectional study by Hinkin and Cutter (2014), 98.5% of nursing students were more likely to be influenced by the adherence of their mentors to IPC, 95.6% by other nurses, and 69.9% by the physician in their clinical placements.

Evidence suggests that students' adherence to SP is improved by the presence of positive role models, which means if nurses or nursing instructors were consistently adhering to RP, students are more likely to imitate them and adhere to RP as well. However, if the nurses or instructors decided not to adhere, they would then become a negative role model.

Negative Role Model and Students' Adherence to SP

According to a number of studies, nursing students reported that they witnessed negative role models in their clinical practice (Dorgham & Obied, 2016; Gould & Drey, 2013; Kim & Oh, 2015). Gould and Drey (2013) conducted a cross-sectional study with a sample of 488 nursing students in the UK to examine whether they encountered a negative role model in their clinical practice. Sixty-seven percent of the nursing students reported they observed nurses failing to clean their hands between patients; 59.3% failed to wear PPE, and 35.9% failed to wear gloves when they were in direct contact with patients' body fluids. In a similar study conducted in Egypt, 20% of nursing students reported that nurses and their clinical preceptors did not follow needle safety precautions (Dorgham & Obied, 2016). In a qualitative study, 38 nursing students from two universities in South Korea witnessed that nurses did not perform hand hygiene and did not use appropriate PPE when indicated (Kim & Oh, 2015).

Nursing students do not only encounter negative role models, but those negative role models have been shown to adversely influence their adherence to SP (Alp et al., 2011; Cheung et al., 2015; Choi & Kim, 2018; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Wilson et al., 2017). For instance, two studies, one conducted in the UK (Wilson et al., 2017) and one in Turkey (Alp et al., 2011), found that 38% and 91% of nursing students, respectively, self-reported that the presence of a negative role model impacted their adherence to SP. Recently, Choi and Kim (2018) found that the non-adherence of nurses negatively influenced

nursing students' intention to adhere to SP in their clinical settings (r = -0.469). Cheung et al. (2015) conducted a cross-sectional study with a sample of 632 nursing students and found that the perceived presence of negative role models was one of five significant predictors for adherence to SP. Similarly, in three qualitative research studies, nursing students who were interviewed stated that a negative role model was one of the main barriers that prevented them from adhering to SP and if the students observed their instructors not adhering to SP, they were more likely to do the same behavior (Efstathiou et al., 2011; Erasmus et al., 2009; Kim & Oh, 2015). When nursing students encounter negative role models during their clinical practice, they may not have the appropriate background training to manage negative role models' behaviour and they may not be able to deal with the influence of the negative role models due to a number of reasons.

Reasons That Prevented Students from Dealing with Negative Role Models

Nursing students do not always deal with the influence of a negative role model on their adherence to SP for multiple reasons. These reasons were identified through six qualitative research studies and can be classified into three themes (Barrett & Randle, 2008; Efstathiou et al., 2011; Erasmus et al., 2009; Jang et al., 2010; Kim & Oh, 2015; Ward, 2013). The first theme was "fitting in the unit norm." Nursing students stated that they feel pressure to model the behavior they witness in order to fit into the unit culture, and failure to follow SP norms of the unit or challenging SP practices was felt to put them in conflict with other nurses and not be accepted as a member of the team (Barrett & Randle, 2008; Erasmus et al., 2009). The second theme was "staff-related issues." Nursing students were cautious not to offend nursing staff and create an impression that they were more knowledgeable than those they were supposed to be learning from (Barrett & Randle, 2008).

The third theme was “nursing students’ related issues.” Nursing students said that they felt embarrassed to follow IPC practices if the nurses in the units did not, they were afraid to disagree with nursing staff, they felt pressured not to adhere, or they felt “weird” if they did adhere. They also said they worried they would be ridiculed by the staff, and they felt discouraged and frustrated (Efstathiou et al., 2011; Jang et al., 2010; Kim & Oh, 2015; Ward, 2013). These three themes were supported by a survey conducted by Dorgham and Obied (2016), who found that 74% of nursing students never advised their clinical instructors to adhere to safety precautions when they saw non-adherence. It’s unclear if students did not advise their instructors because they were concerned about a negative evaluation. Evidence points to the fact that nursing students need to learn some strategies to manage encounters with negative role models in order to ensure adherence to IPC.

Research on Strategies to Deal with Negative Role Models

Many of the interventions that have been attempted to improve the adherence of nursing students to SP have focused on education, audits, feedback, reminders, and administrative support (Al-Hussami & Darawad, 2013; Al-Momani & Al Momania, 2013; Hassan, 2018; Konicki & Miller, 2016; Moralejo et al., 2018; Salmon et al., 2013; Whitcomb, 2014; Xiong et al., 2016). However, none of the interventions reported in the literature have focused on developing strategies that can be used to manage experiences with negative role models. Therefore, we conducted two separate but linked studies; the first was a survey to identify what strategies nursing students can or do use to deal with the influence of negative role models related to their adherence to RP. In addition, in a controlled before and after (CBA) study, we also examined the effect of PS as a potential strategy that students could use to deal with negative role models. PS is an essential skill that nursing students should acquire to deal with the

complex problems they may encounter in their everyday practice (Ancel, 2016; Deniz Kocoglu et al., 2016). Having PS skills has been shown to improve nurses' and nursing students' critical thinking, decision making, and self-efficacy (Ahmady & Shahbazi, 2020; Çinar et al., 2010; Heidari & Shahbazi, 2014; Kanbay & Okanlı, 2017; Shahbazi et al., 2018).

Strategies Used by Students to Deal with Negative Role Models

In our cross-sectional study conducted in Canada, we surveyed 557 nursing students to understand what strategies they use to deal with the influence of negative role models on their adherence to RP. As shown in Table 4.1, students identified a number of strategies that can be used. However, in this paper, we discuss only the most common ones. Some of the strategies overlap with each other but were identified as distinct strategies. They are loosely categorized and discussed under three related themes: approved practice; communication and clarification; and help-seeking.

Table 4.1

Strategies Identified by Students to Deal with the Presence of Negative Role Models

Themes	**Strategies**	**%[1]**
Approved practice	Follow what I learned	35.2%
	Remind myself of expected standard	4.6%
	Ignore the negative role models	11.1%
Communication and clarification	Question the negative role models	4.6%
	Approach the negative model	4.6%
Help-seeking	Report to instructor	13%
	Communicate my concerns	4.6%
	Work with a positive model	7.4 %

Themes	Strategies	%[1]
Other strategies	Avoid them Speak to unit supervisor Tell them the correct way Confrontation and education I agree with them to avoid conflict Make it a habit to wash my hand Gather supplies beforehand	<3%

%[1]: is the proportion of 108 participants who identified some strategies to deal with the negative role models.
Note: proportions were only given for the identified strategies if 3% or more of the participants indicated that they used these strategies.

Approved Practice

The most commonly identified strategy was to "follow what they learned" (35.2%), which is the expectation in nursing practice. Students learn in their program that adherence to RP is required at all times for all patients, and it can play an important role in preventing the spread of HAIs and their related negative consequences. Nursing instructors, therefore, should continuously remind their students about the importance of adhering to RP and that they need to make it one of their top priorities when providing nursing care. In addition, they should also empower students to follow what they learn as approved practice and not be influenced by negative role models. It is equally important that they recognize the negative consequences that the negative role models may have on students' adherence to RP or other outcomes (e.g., self-esteem), and help the students be able to follow what they learned by employing strategies that allow them to do so. Nursing instructors also are in a better position than students to address negative role models because, as colleagues and experienced nurses, they can speak to nurses and managers about the lack of adherence and how the lack of adherence could negatively impact the students' adherence to RP, patient safety and staff safety. In addition, instructors can

engage with infection control practitioners (ICPs) to help them have the requisite knowledge and skills to help students and to address negative role models behavior of the unit.

A small proportion (4.6%) of the students identified "reminding themselves of the expected standard" as a strategy. This response indicates that the students understand and value the expectation that they provide a high standard of care, which might help them follow what they learned in their education about adherence to RP. Reminding oneself about the importance of adhering to RP as a strategy to reduce HAIs and their negative consequences can help reinforce appropriate practice. Students can also remind their colleagues about the expected standards of care if they observe them not adhering to RP. Instructors can play a vital role in reminding their students of the expected standards and discuss any lack of adherence during their clinical conference meetings. They should also emphasize the importance of patient safety and build a good relationship so that students can report to them any concerns.

Another strategy, "ignore the negative role models", was identified by 11.1% of the students. While ignoring the negative role models could mean that the nursing students would follow what they have learned in their nursing program, it was unclear from our study if that was the intent. The literature suggests that nurses ignore negative role models primarily to avoid conflict (Barrett & Randle, 2008). Studies have found that nursing students are afraid to challenge or disagree with the infection control practices of negative role models because this may result in a negative relationship between them and the nurses (Barrett & Randle, 2008; Efstathiou et al., 2011). Our study did not explore how students ignored the negative role models. For example, did they adhere to practices in the presence of the negative role model without saying anything, did they move out of their presence and adhere without allowing nurses to see them, or did they pretend that they did not see the negative role models and continue

adhering to RP? Further research is needed to have a fuller understanding of the underlying processes and effectiveness of ignoring or avoiding negative role models as a coping strategy.

Communication and Clarification

Small proportions of students identified "question the negative role models" (4.6%) and “approach the negative role model” (4.6%) as strategies that they can use to deal with the negative role models’ behaviour. Students stated that they could ask the nurses why they did not adhere to specific RP components, although it is not clear if they have done so in practice. We know from the literature that nursing students usually did not prefer to speak to the negative role models about their lack of adherence. For instance, in their Canadian cross-sectional study, Foote and El-Masri (2016) found only 40% out of 306 students recruited stated that they would remind nurses about their lack of adherence to hand hygiene. Similarly, Dorgham and Obied (2016) found that 73.6% of nurse interns reported that they had never talked to their preceptors about their lack of adherence to SP. These concerns about being afraid to disagree with negative role models may prevent them from questioning or approaching negative role models. Students do learn about conflict resolution and good communication skills, so it is important they learn how to discuss issues and reinforce adherence. For example, it would be helpful if they learn some phrases that they can use to question others, e.g., “I noticed you did not clean your hands yet; I’ll wait for you to do that” or reinforce RP, e.g., “I was taught to wear gloves if I’m going to touch a contaminated object such as the urine bag”. Students often say, “My instructors are expecting me to follow the protocols”; although this is not ideal in terms of confronting an underlying issue, it does allow them to address the immediate concern without antagonizing the negative role model. These phrases can be taught and discussed as part of their clinical conference meetings.

Help-seeking

Two of the identified strategies were related to help-seeking: 13% said they would "report to the instructor" and 4.6% said they would "communicate my concerns", although it was unclear with whom they would communicate. Nursing instructors are a key factor in any learning process (Dahlke et al., 2012). They are responsible for teaching, supervising, and evaluating students during their clinical practice and can play an essential role in teaching and guiding students to adhere to best practice, including adherence to RP. Because instructors spend so much time with the students in clinical practice, students usually turn to them if they encounter any problems. For instance, when students encounter negative role models, they will report them to their instructors and look for their instructors to guide them on how they could address the negative role models without compromising their adherence to RP.

Instructors must have the necessary skills and knowledge to be able to guide the students on how to deal with negative role models. They also need to establish a meaningful relationship with their students to allow them to express their concerns about the impact of negative role models on their adherence. Establishing such a relationship may enhance a collaboration between instructors and students. When students and instructors collaborate to address the influence of negative role models in the clinical setting, they are both equally involved in the decision-making process. This shared decision-making can be facilitated with open discussion and communication between students and their instructors. As such, establishing a culture of civility and trust can help the students to address any future problems, including encounters with negative role models (Milesky et al., 2015). Instructors can use their clinical conference meetings as an important learning opportunity to create a safe space for students to discuss and share their experiences about encountering and dealing with the negative role models, and discuss

appropriate strategies. Moreover, positive role modeling by instructors during clinical practice can encourage students to adopt positive adherence behaviors and help them ignore the negative role models.

The final identified strategy relates to help-seeking "work with a positive model" (7.4 %). This is a potentially effective strategy according to the literature, as a number of authors have assigned nurses to work with positive role models who continuously adhere to RP, such as hand hygiene. As previously discussed, the authors of these studies found that nurses who worked with positive role models had better adherence than those who did not (Huis et al., 2013; Dombecki et al., 2015; Schneider et al., 2009). However, this strategy is useful only if students are able to find positive role models in each nursing unit. Multiple studies have found that encountering negative role models was one of the most common barriers that the students identified during their clinical practice, whereas there was a lack of positive role models (Alp et al., 2011; Cheung et al., 2015; Choi & Kim, 2018; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Wilson et al., 2017). The students can try to work with positive role models, but if they cannot find one, they need to come up with other strategies that they can use to deal with negative role models, as previously discussed.

In summary, students identified multiple strategies they could use in clinical practice to deal with negative role models. Instructors should encourage students to try to use appropriate strategies when they encounter negative role models. PS would potentially be a useful strategy as it would help students identify the problem and implement appropriate solutions. Both students and instructors can then evaluate which solutions help the most in dealing with the influence of negative role models by discussing them with the students, so that they can be used in future

encounters and shared with other students and instructors. Furthermore, future research can be conducted to better understand these strategies and their effectiveness.

Problem Solving as a Strategy to Deal with Negative Role Models

Of all these previously discussed strategies, students did not identify problem solving as a strategy that can be used to deal with the influence of negative role models on RP adherence. There has been no research that has focused on teaching nursing students how to deal with the influence of negative role models on their adherence to RP. However, in our recent CBA study, we evaluated the effect of a PS educational program on improving nursing students' confidence and application of PS to deal with a number of barriers to adherence. The PS educational program consisted of a 2-hour face-to-face workshop, which was administered to students and nursing instructors as part of a specific course. Half of the workshop was devoted to education about RP and PS and half devoted to the application of PS to address the three identified barriers: negative role models, workload, and inconvenient location of alcohol-based hand rub (ABHR). In groups, students discussed one of the barriers and applied the steps of the Social Problem-Solving Model (D'zurilla & Goldfried, 1971). The steps of the model were used to help the students identify negative role models as a barrier, come up with solutions that they can use to deal with this barrier, weigh the pros and cons of each of the selected solutions, select and implement the best solution, and evaluate if the selected solution helps them to deal with negative role models. They were then instructed to apply the steps of PS when they returned to clinical practice. Assessments of RP and PS were done at baseline and at 4-6 weeks post-intervention. The control group completed the same questionnaires but did not have any intervention.

The results of this study showed that higher proportions of students in the intervention group compared to the control group showed a significantly increased confidence about applying PS to deal with high nursing workload ($p = 0.032$) and there were significant differences in the proportions of the students in the intervention group who correctly identified the steps of PS compared to the control group ($p = 0.016$). However, there was slight but non-significant improvement in the intervention group compared to the control group in terms of students' discussion of PS with instructors or classmates ($p = 0.352$), as well as in confidence in applying PS ($p = 0.182$), and application of PS to deal with negative role models ($p = 0.234$). This lack of improvement we attributed to a number of reasons. The first reason was the limited time that students spent, five clinical days, following the intervention session before completing the follow-up questionnaire. During these five clinical days, only 50% of them had applied PS to deal with the influence of negative role models on their adherence to RP compared to 42% at baseline. This short time may have limited their opportunities to practice applying PS in clinical.

The second reason was the lack of participation of nursing instructors in the intervention. In this study, out of 24 expected instructors, there were nine participants: five in the intervention group and four in the control group. The lack of instructor participation may have led to a lack of discussion and reinforcement of PS related to RP during students' clinical practice. For instance, our CBA study findings showed only 29% to 46.8% of students in the intervention group reported that they had applied PS to deal with the three identified barriers, and only 35.5% discussed PS related to the barriers with their instructors. The previous discussion has highlighted the important role instructors can play in reinforcing RP and helping students address negative role models or other barriers to adherence. Therefore, future interventions should be

implemented for a longer period of time and recruit more instructors to reinforce the application of PS to address the methodological limitations of our CBA study.

Recommendations for Nursing Instructors

This paper has identified numerous implications for clinical instructors on how they can help students strengthen their adherence to RP. They can, for example, regularly remind students about the importance of adherence to RP; ensure that they do not pay any attention to the behaviour of negative role models; and discuss with them how to respond to the negative role models so that they increase their adherence. To help students integrate what they learned about dealing with negative role models' behaviour into practice, instructors could make these strategies as part of the students' daily routine care, as well as part of their students' assessment and evaluation. In addition, instructors are also in a position to talk to the negative role models about their lack of adherence and its impact on students' adherence.

Talking to the instructors as a strategy may address the immediate problem but not the underlying problem of how nursing students can learn to communicate with negative role models to avoid conflict. It is therefore important to help the students learn strategies specifically that address the negative influence. One way would be to help students learn how to speak to others (e.g., if they're not adhering or if they are discouraging students from adhering), building on what they learn about communication and conflict resolution. For example, simulation activities that capture the experience of working with a negative role model would potentially be an effective learning strategy. Another way would be to integrate discussion of effective communication and conflict resolution strategies, as well as problem solving, into clinical courses. Instructors could use part of their clinical conferences to help students examine the strategies they are using or could use, and reinforce use of appropriate strategies. It is also

important for nursing instructors to role model adherence to RP, as students may also adhere through observational learning; studies have shown that being in clinical practice with a positive role model has a significant positive impact on students' adherence to SP. Learning to address negative role models could also be useful for a number of situations, not just IPC practices. Finally, nursing instructors can get involved in research studies to help assess interventions to help students address suboptimal adherence.

Conclusion

This paper provides vital insights into understanding the effects of negative and positive role models on nursing students' adherence to RP, as well as strategies to use to deal with influence of negative role models on their adherence. These identified strategies include following what they learned, reporting to instructors, ignoring the negative role models, and working with a positive model; these strategies have not been discussed before in the nursing literature. Considering that most students in our cross-sectional study identified these strategies that they can use to deal with negative role models, it is vital for nursing instructors to discuss them, help students identify barriers to their adherence, promote choice of appropriate strategies, and encourage students to apply effective strategies when they are in clinical settings. Providing nursing students with skills to deal with negative role models may help them to avoid the adverse effects of negative role models' influences that they may experience. Future research is recommended to evaluate the actual impact of these strategies and other strategies, such as PS, conflict management, and assertiveness, for both students and instructors on dealing with negative role models.

References

Ahmady, S., & Shahbazi, S. (2020). Impact of social problem-solving training on critical thinking and decision making of nursing students. *BMC Nursing, 19*(1), 1-8. https://doi.org/10.1186/s12912-020-00487-x

Al-Hussami, M., & Darawad, M. (2013). Compliance of nursing students with infection prevention precautions: effectiveness of a teaching program. *American Journal of Infection Control, 41*(4), 332-336. https://doi.org/10.1016/j.ajic.2012.03.029

Al-Momani, S. M., & Al Momania, W. (2013). Facilitating nursing students' compliance with standard precautions through their own reflection. *Asian Journal of Nursing Education and Research*, *3*(4), 248-253. Available at https://ajner.com/AbstractView.aspx?PID=2013-3-4-12.

Alp, E., Ozturk, A., Guven, M., Celik, I., Doganay, M., & Voss, A. (2011). Importance of structured training programs and good role models in hand hygiene in developing countries. *Journal of Infection and Public Health*, *4*(2), 80-90. https://doi.org/10.1016/j.jiph.2011.03.001

Ancel, G. (2016). Problem-solving training: effects on the problem-solving skills and self-efficacy of nursing students. *Eurasian Journal of Educational Research, 16*(64). https://doi.org/10.14689/ejer.2016.64.13

Arefian, H., Hagel, S., Fischer, D., Scherag, A., Brunkhorst, F. M., Maschmann, J., & Hartmann, M. (2019). Estimating extra length of stay due to healthcare-associated infections before and after implementation of a hospital-wide infection control program. *PloS One*, *14*(5), e0217159. https://doi.org/10.1371/journal.pone.0217159

Baldwin, A., Mills, J., Birks, M., & Budden, L. (2014). Role modeling in undergraduate nursing education: An integrative literature review. *Nurse Education Today, 34*(6), e18-e26. https://doi.org/10.1016/j.nedt.2013.12.007

Barrett, R., & Randle, J. (2008). Hand hygiene practices: nursing students' perceptions. *Journal of Clinical Nursing, 17*(14), 1851-1857. https://doi.org/10.1111/j.1365-2702.2007.02215.x

Canadian Nosocomial Infection Surveillance Program (CNISP). (CNISP, 2015). Healthcare-associated Infections Annual Report 2009-2014. Retrieved from https://www.health.gov.nl.ca/health/publichealth/cdc/hai/hai_2014.pdf.

Cheung, K., Chan, C. K., Chang, M. Y., Chu, P. H., Fung, W. F., Kwan, K. C., ... & Mak, H. M. (2015). Predictors for compliance of standard precautions among nursing students. *American Journal of Infection Control, 43*(7), 729-734. https://doi.org/10.1016/j.ajic.2015.03.007

Choi, J. S., & Kim, K. M. (2018). Factors influencing nursing students' intention to comply with infection control practices. *American Journal of Infection Control*, *46*(6), 717-719. https://doi.org/10.1016/j.ajic.2017.12.010

Çinar, N., Sözeri, C., Şahin, S., Cevahir, R., & Say, M. (2010). Problem solving skills of the nursing and midwifery students and influential factors. *Rev Eletr Enf, 12*(4), 601-606. Retrieved from file:///C:/Users/user/Downloads/Problem_solving_skills_of_the_nursing_and_midwifer%20(2).pdf

Colet, P. C., Cruz, J. P., Alotaibi, K. A., Colet, M. K., & Islam, S. M. (2017). Compliance with standard precautions among baccalaureate nursing students in a Saudi university: A self-

report study. *Journal of Infection and Public Health, 10*(4), 421-430. https://doi.org/10.1016/j.jiph.2016.06.005

Cruz, J. P. (2019). Infection prevention climate and its influence on nursing students' compliance with standard precautions. *Journal of Advanced Nursing, 75*(5), 1042-1052. https://doi.org/10.1111/jan.13904

Dahlke, S., Baumbusch, J., Affleck, F., & Kwon, J. Y. (2012). The clinical instructor role in nursing education: A structured literature review. *Journal of Nursing Education, 51*(12), 692-696. https://doi.org/10.3928/01484834-20121022-01

Deniz Kocoglu, R. N., Duygulu, S., Abaan, E. S., & Akin, B. (2016). Problem Solving Training for First Line Nurse Managers. *International Journal, 9*(3), 955. Retrieved from http://www.internationaljournalofcaringsciences.org/docs/24_kokoglu_originial_9_3.pdf.

Dombecki, C., Shah, M. M., Eke-Usim, A., Akkina, S. R., Ahrens, M., Sturm, L., ... & Foxman, B. (2015). The impact of role models on hand hygiene compliance. *Infection Control & Hospital Epidemiology, 36*(5), 610-612. https://doi.org/10.1017/ice.2015.20

Dorgham, S. R., & Obied, H. K. (2016). Factors affecting nurse interns' compliance with standard precautions for preventing stick injury. *Journal of Nursing Education and Practice, 6*(12), 121–130. https://doi.org/10.5430/jnep.v6n12p121

D'zurilla, T. J., & Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of abnormal psychology, 78*(1), 107. https://doi.org/10.1037/h0031360

Efstathiou, G., Papastavrou, E., Raftopoulos, V., & Merkouris, A. (2011). Factors influencing nurses' compliance with Standard Precautions in order to avoid occupational exposure to microorganisms: A focus group study. *BMC Nursing, 10*(1), 1. https://doi.org/10.1186/1472-6955-10-1

Erasmus, V., Brouwer, W., Van Beeck, E. F., Oenema, A., Daha, T. J., Richardus, J. H., ... & Brug, J. (2009). A qualitative exploration of reasons for poor hand hygiene among hospital workers: lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection. *Infection Control and Hospital Epidemiology*, *30*(5), 415. https://doi.org/10.1086/596773

Foote, A., & El-Masri, M. (2016). Self-perceived hand hygiene practices among undergraduate nursing students. *Journal of Research in Nursing, 21*(1), 8-19. https://doi.org/10.1177/1744987115606959

Gould, D., & Drey, N. (2013). Student nurses' experiences of infection prevention and control during clinical placements. *American Journal of Infection Control*, *41*(9), 760-763. https://doi.org/10.1016/j.ajic.2013.01.025

Jang, T. H., Wu, S., Kirzner, D., Moore, C., Youssef, G., Tong, A., ... & McGeer, A. (2010). Focus group study of hand hygiene practice among healthcare workers in a teaching hospital in Toronto, Canada. *Infection Control & Hospital Epidemiology*, *31*(2), 144-150.urse education. *Journal of Clinical Nursing, 26*(23-24), 4707-4715. https://doi.org/10.1086/649792

Hassan, Z. M. (2018). Improving knowledge and compliance with infection control standard precautions among undergraduate nursing students in Jordan. *American Journal of Infection Control*, *46*(3), 297-302. https://doi.org/10.1016/j.ajic.2017.09.010

Heidari, M., & Shahbazi, S. (2014). The effect of problem-solving training on decision making skill in nursing students. *International Journal of Nursing Education*, *6*(1), 15-18. https://doi.org/10.4103/2229-5151.195445

Hinkin, J., & Cutter, J. (2014). How do university education and clinical experience influence pre-registration nursing students' infection control practice? A descriptive, cross sectional survey. *Nurse Education Today, 34*(2), 196-201. https://doi.org/10.1016/j.nedt.2013.09.005

Huis, A., Schoonhoven, L., Grol, R., Donders, R., Hulscher, M., & van Achterberg, T. (2013). Impact of a team and leaders-directed strategy to improve nurses' adherence to hand hygiene guidelines: a cluster randomised trial. *International Journal of Nursing Studies*, *50*(4), 464-474. https://doi.org/10.1016/j.ijnurstu.2012.08.004

Kanbay, Y., & Okanlı, A. (2017). The effect of critical thinking education on nursing students' problem-solving skills. *Contemporary Nurse, 53*(3), 313-321. https://doi.org/10.1080/10376178.2017.1339567

Keenan, J. E., Speicher, P. J., Thacker, J. K., Walter, M., Kuchibhatla, M., & Mantyh, C. R. (2014). The preventive surgical site infection bundle in colorectal surgery: an effective approach to surgical site infection reduction and health care cost savings. *JAMA Surgery*, *149*(10), 1045-1052. https://doi.org/10.1001/jamasurg.2014.346

Kelcíkova, S., Skodova, Z., & Straka, S. (2012). Effectiveness of hand hygiene education in a basic nursing school curricula. *Public Health Nursing*, *29*(2), 152-159. https://doi.org/10.1111/j.1525-1446.2011.00985.x

Kim, K. M., & Oh, H. (2015). Clinical Experiences as related to standard precautions compliance among nursing students: a focus group interview based on the theory of planned behavior. *Asian Nursing Research, 9*(2), 109-114. https://doi.org/10.1016/j.nedt.2015.12.003

Kirk, J., Kendall, A., Marx, J. F., Pincock, T., Young, E., Hughes, J. M., & Landers, T. (2016). Point of care hand hygiene—where's the rub? A survey of US and Canadian health care workers' knowledge, attitudes, and practices. *American Journal of Infection Control*, *44*(10), 1095-1101. https://doi.org/10.1016/j.ajic.2016.03.005

Konicki, T., & Miller, E. (2016). Use of a simulation intervention to examine differences in nursing students' hand hygiene knowledge, beliefs, and behaviors. *Nurse Education Today*, *45*, 96-101. https://doi.org/10.1016/j.nedt.2016.06.022

Kourtis, A. P., Hatfield, K., Baggs, J., Mu, Y., See, I., Epson, E., ... & Ray, S. M. (2019). Vital signs: epidemiology and recent trends in methicillin-resistant and in methicillin-susceptible Staphylococcus aureus bloodstream infections—United States. *Morbidity and Mortality Weekly Report*, *68*(9), 214. https://doi.org/10.15585/mmwr.mm6809e1

Milesky, J. L., Baptiste, D. L., Foronda, C., Dupler, A. E., & Belcher, A. E. (2015). Promoting a culture of civility in nursing education and practice. *Journal of Nursing Education and Practice*, *5*(8), 90-94. https://doi.org/10.1111/nuf.12138

Mitchell, R., Taylor, G., Rudnick, W., Alexandre, S., Bush, K., Forrester, L., ... & John, M. (2019). Trends in health care–associated infections in acute care hospitals in Canada: an analysis of repeated point-prevalence surveys. *CMAJ*, *191*(36), E981-E988. https://doi.org/10.1503/cmaj.190361

Moon, K. J., Hyeon, Y. H., & Lim, K. H. (2019). Factors associated with nursing students' compliance with standard precautions: a self-reported survey. *Int J Infect Control*, *15*(3), 1-9. https://doi.org/10.3396/ijic.v15i3.19007

Moralejo, D., El Dib, R., Prata, R. A., Barretti, P., & Corrêa, I. (2018). Improving adherence to Standard Precautions for the control of health care-associated infections. *Cochrane Database of Systematic Reviews*, (2). https://doi.org/10.1002/14651858.CD010768.pub2

Public Health Agency of Canada (PHAC). (2016). Routine practices and additional precautions for preventing the transmission of infection in healthcare settings. Available at https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/diseases-conditions/routine-practices-precautions-healthcare-associated-infections/routine-practices-precautions-healthcare-associated-infections-2016-FINAL-eng.pdf.

Purssell, E., Gould, D., & Chudleigh, J. (2020). Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis. *BMJ Open*, *10*(2). http://dx.doi.org/10.1136/bmjopen-2019-030371

Russo, P. L., Stewardson, A. J., Cheng, A. C., Bucknall, T., & Mitchell, B. G. (2019). The prevalence of healthcare associated infections among adult inpatients at nineteen large Australian acute-care public hospitals: a point prevalence survey. *Antimicrobial Resistance & Infection Control*, *8*(1), 1-8. https://doi.org/10.1186/s13756-019-0570-y

Salmon, S., Wang, X. B., Seetoh, T., Lee, S. Y., & Fisher, D. A. (2013). A novel approach to improve hand hygiene compliance of student nurses. *Antimicrobial Resistance and Infection Control*, *2*(1), 16. https://doi.org/10.1186/2047-2994-2-16

Schneider, J., Moromisato, D., Zemetra, B., Rizzi-Wagner, L., Rivero, N., Mason, W., ... & Ross, L. (2009). Hand hygiene adherence is influenced by the behavior of role models. *Pediatric Critical Care Medicine*, *10*(3), 360-363. https://doi.org/10.1097/PCC.0b013e3181a32f16

Serrano, M., Barcenilla, F., Limón, E., Pujol, M., & Gudiol, F. (2017). Prevalence of healthcare-associated infections in long-term care facilities in Catalonia. VINCat Program. *Enfermedades Infecciosas y Microbiologia Clinica (English ed.)*, *35*(8), 503-508. https://doi.org/10.1016/j.eimce.2017.08.004

Shahbazi, S., Heidari, M., Sureshjani, E. H., & Rezaei, P. (2018). Effects of problem-solving skill training on emotional intelligence of nursing students: An experimental study. *Journal of Education and Health Promotion*, *7*. https://doi.org/10.4103/jehp.jehp_50_18

Suetens, C., Latour, K., Kärki, T., Ricchizzi, E., Kinross, P., Moro, M. L., ... & Reilly, J. (2018). Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. *Eurosurveillance*, *23*(46), 1800516. https://doi.org/10.2807/1560-7917.ES.2018.23.46.1800516

Taylor, G., Gravel, D., Matlow, A., Embree, J., LeSaux, N., Johnston, L., ... & Roth, V. (2016). Assessing the magnitude and trends in hospital acquired infections in Canadian hospitals through sequential point prevalence surveys. *Antimicrobial Resistance & Infection Control*, *5*(1), 19. https://doi.org/10.1186/s13756-016-0118-3

Ward, D. J. (2013). The barriers and motivators to learning infection control in clinical placements: interviews with midwifery students. *Nurse Education Today*, *33*(5), 486-491. https://doi.org/10.1016/j.nedt.2012.05.024

Whitcomb, K. S. (2014). Using a multidimensional approach to improve quality related to students' hand hygiene practice. *Nurse Educator*, *39*(6), 269-273. https://doi.org/10.1097/NNE.0000000000000070

Wilson, J., Bak, A., Whitfield, A., Dunnett, A., & Loveday, H. (2017). Public perceptions of the use of gloves by healthcare workers and comparison with perceptions of student nurses. *Journal of Infection Prevention, 18*(3), 123-132. https://doi.org/10.1177/1757177416680442

World Health Organization (WHO). (2016). Health care-associated infections fact sheet. Retrieved from https://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf.

Xiong, P., Zhang, J., Wang, X., Wu, T. L., & Hall, B. J. (2017). Effects of a mixed media education intervention program on increasing knowledge, attitude, and compliance with standard precautions among nursing students: A randomized controlled trial. *American Journal of Infection Control, 45*(4), 389-395. https://doi.org/10.1016/j.ajic.2016.11.006

Chapter 5: Conclusion of the Dissertation

Chapter 5 provides an overview of the three manuscripts which are: results of a cross-sectional survey (first manuscript), results of a controlled before and after study (second manuscript), and a discussion paper around role models and adherence to routine infection prevention and control practices (third manuscript). This chapter also summarizes the key findings of these three manuscripts and the strengths and limitations of the first and second studies. In addition, the key recommendations for infection control practitioners, educators, nursing administrators, and future research are presented.

This dissertation research consisted of two separate but linked studies and a discussion paper. The two studies are a cross-sectional survey (first study) and controlled before and after (CBA) study (second study). These two studies were conducted over a period of two years, from 2019 to 2020.

The aim of the cross-sectional survey was to understand problem solving (PS) related to routine infection control practices (RP) among nursing students and instructors, and identify the barriers to adherence to RP. This study was conducted at three nursing schools with a baccalaureate program (A, B, and C). All nursing students and instructors in these schools were invited to participate; 20 instructors and 577 nursing students agreed to participate in this study.

The aim of the CBA study was to evaluate the effect of a Problem-Solving Routine Practices (PSRP) educational program on nursing students' knowledge, confidence, discussion, application, and self-reported adherence to RP. The ADDIE Instructional System Design Model, Social Problem-Solving Model, and Constructivist Learning Theory were used to guide the PSRP intervention. For instance, the steps of the ADDIE model were followed to develop the PSRP educational program. Both the Social Problem-Solving Model and Constructivist Learning Theory were used to guide decisions about the content and delivery of the PSRP educational program. This program was also informed by the results of the cross-sectional survey. It consisted of a face-to-face workshop, which was administered to the students and nursing instructors as part of a specific course. The PSRP educational program time was 2 hours in length, with half devoted to education about RP and PS and half devoted to the application of PS to the three commonly identified barriers (high nursing workload, negative role models, and inconvenient location of alcohol-based hand rub (ABHR). The educational part was presented by the researchers using PowerPoint slides, with interactive discussion throughout the session. In

the practical part, applying constructivist learning principles, nursing students and instructors were asked to discuss three case scenarios related to barriers and devise appropriate strategies to use based on their previous experiences and suggested strategies. The questions related to each case study were developed based on the six steps of the Social Problem-Solving Model (D'zurilla & Goldfried, 1971). There were two groups of participants: nursing students and nursing instructors. A total of 96 students from Years 2 and 3, from the regular and accelerated program options, participated in this study. Of them, 62 participated in the intervention group (school A) and 34 participated in the control group (school B). There were only five instructors who participated in the intervention group and four who participated in the control group. Given the reduced participation by instructors, only limited results were reported about the impact of this intervention on their discussion, reinforcement, and application of PS related to RP.

In the discussion paper, we discussed the role of positive and negative role models on students' adherence to RP, the reasons that prevented them from dealing with negative role models, the strategies that they can use, and the use of PS as a potential strategy to deal with negative role models. Based on this discussion, recommendations were made for nursing instructors to better address the issue of negative role models.

Summary of the Cross-Sectional Survey (First Manuscript)

Key results for students and instructors as well as the strengths and limitations will be summarized.

Key Results for Students and Instructors

The results of this cross-sectional survey were described in detail in the first manuscript (Chapter 2) of this dissertation. The results of this study found that both groups of participants reported lack of training about PS related to RP. They were able to correctly answer questions

about most of the RP components; however, only a few of them were able to correctly identify the minimum time needed for ABHR to eliminate most of the germs on hands. Similarly, a few of them were able to correctly explain the differences between RP and Additional Precautions (AP). However, more than half of nursing instructors correctly explained the point of care risk assessment (PCRA), compared to only less than ten percent of nursing students. When they were asked about PS related to infection prevention and control, only small proportions of them were able to correctly explain it. Overall, nursing instructors did better than nursing students in answering most of the questions.

In this study, besides asking both groups about their knowledge about RP, we asked them about the barriers to adherence to RP that they encountered during their clinical practice. Both groups of participants reported that they encountered a number of barriers that prevented them from adhering to RP. The most commonly encountered barriers by students and instructors were forgetfulness, empty ABHR dispensers, high nursing workload, inconvenient location of ABHR dispensers, and the presence of negative role models.

Although they encountered these barriers, our study results indicated that there was a lack of strategies used to deal with specific barriers, and nursing students were less likely to use strategies to deal with barriers to adherence compared to the instructors. Almost one third of both students (30.2%) and instructors (28.6%) identified some strategies that can be used to deal with the inconvenient location of ABHR dispensers. However, more instructors (66.7% and 71.4%) than students (28.3% and 21.1%) identified some strategies that can be used to deal with high nursing workload and presence of negative role models, respectively. To deal with the inconvenient location of ABHR dispensers, both groups identified “carry my own ABHR” as the most common strategy that can be used. To deal with high nursing workload, both students and

instructors identified two common strategies: “time management” and “carry extra PPE and ABHR”. To deal with the presence of negative role models, both students and instructors identified different strategies. The most commonly identified strategies by the students were “follow what they learned in school” and “report the encounter of negative role models to their instructors”. As nursing students made progress through the program, they were more likely to use strategies to deal with the barriers. Overall, compared to instructors, nursing students reported a lack of strategies to deal with two of the barriers, which may have influenced their confidence to address these barriers to RP adherence.

In this study, we found that the majority of the nursing instructors and nursing students were very confident/confident about performing hand hygiene when indicated, using PPE when indicated, and discarding sharps needles in an appropriate sharp container. More instructors were very confident/confident about explaining the PCRA, and about applying PS to deal with the influence of high nursing workload and presence of a negative role on their adherence to RP, compared to nursing students. However, both instructors and students showed a similar level of confidence in applying PS to deal with the influence of inconvenient location of ABHR dispensers on their adherence to RP. As recommended by the study participants, educational programs aimed to strengthen their confidence about PS application related to RP barriers can be delivered by using scenario-based simulation, group discussion, and video watching. These programs can also be introduced in Year 1, in the *introduction to nursing* course, and before they start their clinical.

Strengths and Limitations

This study has strengths and limitations. A key strength is that this was the first study of its kind to assess strategies used to address key barriers to RP adherence and PS related to RP among nursing instructors and nursing students. Furthermore, it is one of few studies to assess

instructors' knowledge and confidence related to RP. Another strength of this study is that it had a large representative sample size of 577 students from Years 1 to 4 from three main nursing schools in Atlantic Canada, all of whom were exposed to the same infection prevention and control curriculum. The results therefore provide a good reflection of the knowledge and understanding of PS and RP in the target population. Results may be generalizable to other students in settings with similar characteristics and curricula.

However, this study has some limitations. First, there were only 20 nursing instructors from three nursing schools who participated in this study; therefore, the results may not be generalizable to other instructors. A second limitation is that in this study we used a self-report questionnaire, therefore, we cannot exclude possible over or underestimation of participants' knowledge and confidence related to RP and PS. Finally, participants' knowledge about PS was measured by using only one question, which was not sufficient to draw a conclusion about their PS knowledge; therefore, this result should be interpreted with caution. Even with the limitations of the current study, however, our results add to the literature and provide valuable information to inform interventions to strengthen nursing students' and instructors' knowledge and skills related to RP and PS and addressing barriers to RP adherence. The recommendations provided will be useful to Infection Control Practitioners (ICPs) and nursing curriculum committees. These recommendations will enable ICPs to promote for better infection and prevention control practices.

Summary of the Controlled Before and After Study (Second Manuscript)

Key results for students and instructors as well as the strengths and limitations will be summarized.

Key Results for Students

The results of this CBA study were described in detail in the second manuscript (Chapter 3) of this dissertation. Our study found that at baseline, of the six components of RP, students' adherence in both the intervention and control groups was similar for three of the RP components and was different for the other three components. However, these differences were not statistically significant. In addition to considering the proportion of students with correct responses, mean scores and standard deviations were calculated. When baseline and follow-up answers were compared, the change in the mean scores for adherence to RP in the intervention group was higher than that of the control group, but this difference was not statistically significant ($p = 0.234$). Similarly, small proportions of the students in both groups showed non-significant improvement in their adherence to wearing gloves when they were potentially exposed to body fluids, blood products, and any excretion of patients, washing their hands with soap and water if they were visibly soiled, and putting used needles into sharps containers. However, the proportion of students reporting adherence all the time in the intervention group significantly increased from the baseline to follow-up compared to the control groups for doing the PCRA ($p = 0.027$), cleaning and disinfecting all shared patient care equipment ($p = 0.004$), and cleaning hands immediately after removal of gloves ($p = 0.021$).

Similar to our cross-sectional study results, the results of the CBA showed that the commonly reported barriers by both groups, at both baseline and follow-up, were negative role models, high nursing workload, forgetfulness, and inconvenient location of ABHR. Although

proportions differed for each barrier, a higher proportion of students in the intervention group encountered each barrier at each time point. PS could be a potential strategy that they can use to deal with these barriers.

In this study, we evaluated the effect of the PSRP educational program on students' knowledge, confidence, discussion, application, and self-reported adherence to RP. Our study found that at baseline and follow-up, small percentages of students in both groups correctly identified the steps of PS and explained what PS means with respect to infection prevention and control (IPC). In this study, significantly more students in the intervention group were able to correctly identify the PS steps compared to the control group ($p = 0.016$). If they have good knowledge about PS, they may develop some confidence about applying it to deal with barriers to RP adherence.

Our study found that at baseline and follow-up, small percentages of students in both groups were confident about applying PS to deal with high nursing workload, negative role models, and the inconvenient location of ABHR dispensers. When baseline and follow-up answers were compared, there was a significant increase in the proportion of students in the intervention group who were confident about applying PS to deal with high nursing workload compared to the control group ($p = 0.032$). However, both groups showed slight, but non-significant improvement in their confidence about applying PS to deal with negative role models ($p = 0.147$) and the inconvenient location of ABHR dispensers ($p = 0.319$). If they were not confident about applying PS to deal with the barriers, they should discuss that with their classmates and with their instructors.

Our study results showed that at baseline and follow-up, small proportions of students in both groups reported that they discussed PS related to barriers with their classmates and with

their instructors. When baseline and follow-up answers were compared, students in both groups showed slight, but a non-significant improvement in their discussion of PS with their classmates ($p = 0.352$) and with their instructors ($p = 0.563$). Almost all of them did recommend that application of PS to address RP should be part of the curriculum.

We also assessed the students' application of PS to deal with the barriers. The application of PS to deal with the barriers was varied between the groups. For instance, at baseline and follow-up, more students reported that they applied PS to deal with workload and role models, compared to applying PS to deal with the inconvenient location of ABHR. Students in the intervention group were more likely than those in the control group to apply PS for all of the three barriers (workload, role models, and ABHR) but differences were not statistically significant ($p = 0.384$; 0.138; and 0.944), respectively. Instructors can play an important role in discussing and reinforcing the application of PS to deal with the barriers.

Key Results for Nursing Instructors

There were only five instructors in the intervention group and four in the control group who participated in this study. Our results found that only a few instructors in each group were able to correctly identify the steps of PS and were confident about helping students with PS related to RP. Our findings also found that both groups showed lack of discussion and reinforcement of PS related to the barriers with their students.

Strengths and Limitations

The strengths of this study are that it was the first study to assess the effect of the PSRP educational program on dealing with three of the most common barriers to RP adherence. The intervention also applied the constructivist learning theory approach in the design and delivery of the PSRP educational program by using group discussion as a teaching method to allow the students to engage in an interactive discussion and to construct their own strategies that can be

used to deal with barriers to RP. However, a few limitations were identified in this study. The time allocated for the study was not long enough for the students to practice PS in clinical to obtain optimal results; they had only five weeks post intervention to apply what they learned in practice. In addition, the study intervention was delivered to the participants only once, and the time allocated for the intervention was only 2 hours due to the busy schedule for the students and the facilitators. The sample size was small, consisting of 62 students in the intervention and 34 students in the control, and the study was limited to the Years 2 and 3 students, which may limit the generalizability. In addition, the results of nursing instructors were also based on a very small sample size (intervention group n = 5 and control group n = 4). Therefore, their results should be interpreted with caution. Self-report was used to assess the study outcomes; the students may have over or underestimated their PS knowledge, discussion, and application, as well as their adherence to RP. Overall, however, we believe that the findings of the study can be of value in identifying the potential usefulness of a PS approach to addressing barriers to RP adherence. Its use can be explored in many other similar settings and contexts other than infection prevention and control.

Summary of the Discussion Paper on Role Models (Third Manuscript)

This paper discussed the impact of role models on nursing students' adherence to RP and strategies that can be used to deal with negative role models. When students are in clinical practice, they may encounter both negative and positive role models. Encountering positive role models who are continuously adhering to RP may help students to better adhere to RP. For instance, being in clinical placements with a positive role model has been found to be associated with better adherence to hand hygiene. A number of studies have found that nursing students who worked with leaders who strictly adhere to hand hygiene have significantly better adherence

compared to students who work with leader who did not strictly adhere (Huis et al., 2013; Hinkin & Cutter, 2014; Schneider et al., 2009). In contrast, encountering negative role models who are not continuously adhering to RP may prevent students from adhering. For example, evidence has shown that the presence of a negative role model in clinical nursing practice is one of the significant barriers that adversely affects the adherence of nursing students to IPC practice (Alp et al., 2011; Cheung et al., 2015; Choi & Kim, 2018; Dorgham & Obied, 2016; Foote & El-Masri, 2016; Hinkin & Cutter, 2014; Wilson et al., 2017).

According to the literature, nursing students stated that they do not always deal with the influence of a negative role model on their adherence because they feel pressure to model the behavior they witness; they want to fit into the nursing team; they felt pressured not to adhere; and they felt "weird" if they did adhere. They also said they would not challenge the nursing staff because that may result in a negative relationship; they were worried they would not be accepted as part of the team; they felt that they might offend nursing staff if they adhered to IPC practices; and they worried that nurses in practice would think that the students know better than the staff. Furthermore, they felt embarrassed to follow IPC practices if the nurses in the units did not; they were afraid to disagree with nursing staff; they worried they would be ridiculed by the staff; and they felt discouraged and frustrated (Barrett & Randle, 2008; Efstathiou et al., 2011; Erasmus et al., 2009; Jang et al., 2010; Kim & Oh, 2015; Ward, 2013).

Therefore, nursing students need to learn some strategies that they can use to address the reasons that prevent them from dealing with negative role models. Many of the interventions that have been attempted to improve the adherence of nursing students to IPC practices have focused on education, audits, feedback, reminders, and administrative support (Al-Hussami & Darawad, 2013; Al-Momani & Al Momania, 2013; Hassan, 2018; Konicki & Miller, 2016; Moralejo et al.,

2018; Salmon et al., 2013; Whitcomb, 2014; Xiong et al., 2016). However, none of the interventions reported in the literature have focused on developing strategies that can be used to deal with negative role models. In our cross-sectional study, students identified a number of strategies that can be used. However, in this paper, we discuss only the most common ones. These common strategies were that they followed what they learned, reported to instructors, ignored the negative role models, worked with a positive model, questioned the negative role models, reminded themselves of expected standards, communicated their concerns, and approached the negative role models.

Although the students stated that they would recommend application of PS to deal with the barriers to RP adherence, none of them identified PS as a strategy that can be used to deal with negative role models. There has been no research that has focused on teaching nursing students how to deal with the influence of negative role models on their adherence to RP. However, the results of our CBA study evaluating the effects of the PSRP educational program showed slight but non-significant improvement in the intervention group compared to the control group in terms of students' discussion of PS with instructors or classmates ($p = 0.352$), confidence in applying PS ($p = 0.182$), and application of PS to deal with negative role models ($p = 0.234$). This lack of improvement we attributed to the fact that students had spent only five clinical days following the intervention and only five instructors agreed to participate in the PSRP educational program. This lack of participation of instructors and reduced clinical time may have led to a lack of discussion and reinforcement of PS related to RP during students' clinical practice. Therefore, to improve students' PS ability to deal with negative role models a number of recommendations have been made.

Recommendations from the Three Manuscripts

The recommendations reported in this chapter are based on the results of the cross-sectional survey and CBA studies, and the discussion paper. The key recommendations were for ICPs, educators, nursing administrators, and future research.

Infection Control Practitioners

To help strengthen students' and instructors' knowledge and skills related to RP, ICPs can share their expertise in both formal classes and informal on-unit encounters. In addition, ICPs can reinforce students' and instructors' understanding and application of RP and help them apply strategies to deal with common barriers. They can also expand their interactions with the schools and offer to share their expertise with curriculum committees to help them refine what students are taught and offer to give education sessions specifically for instructors. ICPs can help emphasize the use of the terms RP, AP, and PCRA by regularly discussing them with students and instructors while they are in their clinical practice, or when they are invited to give classes.

To help address the barriers to RP adherence, ICPs can play a vital role in addressing these barriers at both individual and organizational levels. At the individual level, ICPs can use their communication skills to discuss the issue of negative role models with nurses and explain to them its negative impact on adherence to RP and reinforce best practices. At the organizational level, ICPs can use their knowledge and leadership skills to participate in designing and selecting convenient locations to place ABHR dispensers. They can also advocate for more staffing to address the issue of high nursing workload and its negative impact on adherence to RP. ICPs can coordinate with school of nursing administrators to offer their expertise to provide training sessions that focus on discussing the barriers to RP adherence and strategies to address these

barriers. They can help create a supportive environment that promotes and empowers students to come up with some strategies that they can use to deal with barriers to RP adherence.

To help strengthen instructors' and students' ability to use PS and other strategies to address the barriers to RP adherence, ICPs can help teach the steps of PS and help students practice its application with respect to RP in both formal educational sessions and in one-to-one or ICP-to-small-group encounters on clinical units. ICPs can review the steps of PS and explain how these steps can be used to address these barriers. On the unit, ICPs can utilize the students' patients and experiences as the basis of discussion about barriers and PS, as well as situation-specific issues and solutions.

Nursing Instructors

In order to improve students' discussion and application of PS related to RP, nursing instructors need to know about RP and be able discuss and reinforce the application of PS with their students to help them successfully overcome these barriers. This discussion and reinforcement of PS related to RP could take place and be an integral part of their regular clinical conference meetings. In addition, nursing instructors also need to build a good relationship with their students, and encourage them to communicate any concerns such as these barriers.

To help students deal with the negative role models, instructors can help students examine the strategies they are using or could use, and reinforce use of appropriate strategies. They can help students learn how to speak to others, e.g., if they're not adhering or if they are discouraging students from adhering, building on what they learn about communication and conflict resolution. It is also important for nursing instructors to become positive role models and continuously adhere to RP as students may also adhere through observational learning.

Nursing Administrators

Nursing administrators can play an important role by ensuring that their faculty members receive the required training about PS and RP. This training can focus on strengthening their knowledge, confidence, discussion, and application of PS related to RP barriers, so that they will have the necessary knowledge and skills to help their students to better understand and apply PS to deal with the barriers to adherence to RP as well as to other problems they encounter. They can also support simulation activities to strengthen communication and collaboration skills of students and application of RP and PS. As ICPs can be an important resource in training students and instructors about RP, nursing administrators can help build organizational relationships with healthcare settings to facilitate collaboration with ICPs.

Future Research

The researchers identified a range of areas for attention in relation to RP, PS, barriers to RP adherence, and strategies to address these barriers. The following recommendations for research are based on the findings of the cross-sectional study, CBA study, and the discussion paper. Based on these findings, few instructors agreed to participate in the cross-sectional study (n = 20) and on the CBA study (n = 9). There is need for a qualitative descriptive study to explore the reasons preventing faculty members from participating in a research study and what strategies can be used to recruit them. Following the PSRP educational program, students did not have sufficient time to apply PS to deal with barriers as they only spent only five days in the clinical placements. Interventions to address the barriers to RP adherence should be implemented for a longer period of time to reinforce the application of PS and thus address this methodological limitation of our CBA study. Students also self-reported their application of PS

and their adherence to RP. Future interventions should consider using an observation technique to observe the actual application of PS and adherence to RP.

Both instructors and students identified a number of strategies that can be used to deal with these three identified barriers (high nursing workload, negative role models, and inconvenient location of ABHR dispensers). Future research could explore in depth how these strategies can be used, and what impacts these strategies may have on their adherence to RP. Future research is recommended to evaluate the actual impact of these strategies and other strategies, such as conflict management and assertiveness, for both students and instructors on dealing with negative role models. Future research should also explore strategies to address forgetfulness, which was not the focus of this study but was identified by almost half of the students.

Conclusion

In conclusion, this dissertation research provided understanding about nursing students' and instructors' knowledge, confidence, and application of the PS related to RP, as well as the barriers to adherence to RP and how they could apply PS as a new approach to deal with these barriers. It also helps draw attention to the impact of role models on nursing students' adherence to RP as well as strategies to use to deal with influence the of negative role models on their adherence. Based on the findings of this dissertation research, recommendations were made for ICPs, school administrators, nurse educators, and future research. If implemented, we can make progress in strengthening nursing students', and thus graduate nurses', adherence with both RP and PS.

References

Al-Hussami, M., & Darawad, M. (2013). Compliance of nursing students with infection prevention precautions: effectiveness of a teaching program. *American Journal of Infection Control*, *41*(4), 332-336. https://doi.org/10.1016/j.ajic.2012.03.029

Alp, E., Ozturk, A., Guven, M., Celik, I., Doganay, M., & Voss, A. (2011). Importance of structured training programs and good role models in hand hygiene in developing countries. *Journal of Infection and Public Health*, *4*(2), 80-90. https://doi.org/10.1016/j.jiph.2011.03.001

Al-Momani, S. M., & Al Momania, W. (2013). Facilitating nursing students' compliance with standard precautions through their own reflection. *Asian Journal of Nursing Education and Research*, *3*(4), 248-253. Available at https://ajner.com/AbstractView.aspx?PID=2013-3-4-12.

Barrett, R., & Randle, J. (2008). Hand hygiene practices: nursing students' perceptions. *Journal of Clinical Nursing*, *17*(14), 1851-1857. https://doi.org/10.1111/j.1365-2702.2007.02215.x

Cheung, K., Chan, C. K., Chang, M. Y., Chu, P. H., Fung, W. F., Kwan, K. C., ... & Mak, H. M. (2015). Predictors for compliance of standard precautions among nursing students. *American Journal of Infection Control*, *43*(7), 729-734. https://doi.org/10.1016/j.ajic.2015.03.007

Choi, J. S., & Kim, K. M. (2018). Factors influencing nursing students' intention to comply with infection control practices. *American Journal of Infection Control*, *46*(6), 717-719. https://doi.org/10.1016/j.ajic.2017.12.010

Dorgham, S. R., & Obied, H. K. (2016). Factors affecting nurse interns' compliance with standard precautions for preventing stick injury. *Journal of Nursing Education and Practice, 6*(12), 121–130. https://doi.org/10.5430/jnep.v6n12p121

D'zurilla, T. J., & Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of abnormal psychology*, *78*(1), 107. https://doi.org/10.1037/h0031360

Efstathiou, G., Papastavrou, E., Raftopoulos, V., & Merkouris, A. (2011). Factors influencing nurses' compliance with Standard Precautions in order to avoid occupational exposure to microorganisms: A focus group study. *BMC Nursing*, *10*(1), 1. https://doi.org/10.1186/1472-6955-10-1

Erasmus, V., Brouwer, W., Van Beeck, E. F., Oenema, A., Daha, T. J., Richardus, J. H., ... & Brug, J. (2009). A qualitative exploration of reasons for poor hand hygiene among hospital workers: lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection. *Infection Control and Hospital Epidemiology*, *30*(5), 415. https://doi.org/10.1086/596773

Foote, A., & El-Masri, M. (2016). Self-perceived hand hygiene practices among undergraduate nursing students. *Journal of Research in Nursing, 21*(1), 8-19. https://doi.org/10.1177/1744987115606959

Jang, T. H., Wu, S., Kirzner, D., Moore, C., Youssef, G., Tong, A., ... & McGeer, A. (2010). Focus group study of hand hygiene practice among healthcare workers in a teaching hospital in Toronto, Canada. *Infection Control & Hospital Epidemiology*, *31*(2), 144-150.urse education. *Journal of Clinical Nursing, 26*(23-24), 4707-4715. https://doi.org/10.1086/649792

Hassan, Z. M. (2018). Improving knowledge and compliance with infection control standard precautions among undergraduate nursing students in Jordan. *American journal of infection control*, *46*(3), 297-302. https://doi.org/10.1016/j.ajic.2017.09.010

Hinkin, J., & Cutter, J. (2014). How do university education and clinical experience influence pre-registration nursing students' infection control practice? A descriptive, cross sectional survey. *Nurse Education Today*, *34*(2), 196-201. https://doi.org/10.1016/j.nedt.2013.09.005

Huis, A., Schoonhoven, L., Grol, R., Donders, R., Hulscher, M., & van Achterberg, T. (2013). Impact of a team and leaders-directed strategy to improve nurses' adherence to hand hygiene guidelines: a cluster randomised trial. *International Journal of Nursing Studies*, *50*(4), 464-474. https://doi.org/10.1016/j.ijnurstu.2012.08.004

Kim, K. M., & Oh, H. (2015). Clinical Experiences as related to standard precautions compliance among nursing students: a focus group interview based on the theory of planned behavior. *Asian Nursing Research*, *9*(2), 109-114. https://doi.org/10.1016/j.anr.2015.01.002

Konicki, T., & Miller, E. (2016). Use of a simulation intervention to examine differences in nursing students' hand hygiene knowledge, beliefs, and behaviors. *Nurse Education Today*, *45*, 96-101. https://doi.org/10.1016/j.nedt.2016.06.022

Moralejo, D., El Dib, R., Prata, R. A., Barretti, P., & Corrêa, I. (2018). Improving adherence to Standard Precautions for the control of health care-associated infections. *Cochrane Database of Systematic Reviews*, (2). https://doi.org/10.1002/14651858.CD010768.pub2

Salmon, S., Wang, X. B., Seetoh, T., Lee, S. Y., & Fisher, D. A. (2013). A novel approach to improve hand hygiene compliance of student nurses. *Antimicrobial Resistance and Infection Control, 2*(1), 16. https://doi.org/10.1186/2047-2994-2-16

Schneider, J., Moromisato, D., Zemetra, B., Rizzi-Wagner, L., Rivero, N., Mason, W., ... & Ross, L. (2009). Hand hygiene adherence is influenced by the behavior of role models. *Pediatric Critical Care Medicine, 10*(3), 360-363. https://doi.org/10.1097/PCC.0b013e3181a32f16

Ward, D. J. (2013). The barriers and motivators to learning infection control in clinical placements: interviews with midwifery students. *Nurse Education Today, 33*(5), 486-491. https://doi.org/10.1016/j.nedt.2012.05.024

Whitcomb, K. S. (2014). Using a multidimensional approach to improve quality related to students' hand hygiene practice. *Nurse Educator*, *39*(6), 269-273. https://doi.org/10.1097/NNE.0000000000000070

Wilson, J., Bak, A., Whitfield, A., Dunnett, A., & Loveday, H. (2017). Public perceptions of the use of gloves by healthcare workers and comparison with perceptions of student nurses. *Journal of Infection Prevention, 18*(3), 123-132. https://doi.org/10.1177/1757177416680442

Xiong, P., Zhang, J., Wang, X., Wu, T. L., & Hall, B. J. (2017). Effects of a mixed media education intervention program on increasing knowledge, attitude, and compliance with standard precautions among nursing students: A randomized controlled trial. *American Journal of Infection Control, 45*(4), 389-395. https://doi.org/10.1016/j.ajic.2016.11.006

Appendices

Appendix A: The Literature Summary Table

Appendix B: Ethical Approval Letters (Cross-sectional Study)

- Approval Letter from Health Research Ethics Board
- Approval Letter from Regional Research Proposal Approval Committee

Appendix C: Information Sheets (Cross-sectional Study)

- Information Sheet (Nursing Instructors)
- Information Sheet (Years 1,2, and 3 Nursing Students)
- Information Sheet (Year 4 Nursing Students)

Appendix D: Survey cover emails (Cross-sectional Study)

- Survey Cover Email (Nursing Instructors)
- Survey Cover Email (Nursing Students)

Appendix E: Study questionnaire (Cross-sectional Study)

- Routine Practices and Problem-Solving Questionnaire (Nursing Instructors)
- Routine Practices and Problem-Solving Questionnaire (Nursing Students)

Appendix F: Ethical Approval Letters (CBA Study)

- Approval Letter from Health Research Ethics Board
- Approval Letter from Regional Research Proposal Approval Committee

Appendix G: Cover Emails (CBA Study)

- Cover Email for Nursing Students (Intervention Group)
- Cover Email for Nursing Instructors (Intervention Group)
- Cover Email for Nursing Students (Control Group)
- Cover Email for Nursing Instructors (Control Group)

Appendix H: Information Sheets (CBA Study)

- Information Sheet for Nursing Students (Intervention Group)
- Information Sheet for Nursing Instructors (Intervention Group)
- Information Sheet for Nursing Students (Control Group)
- Information Sheet for Nursing Instructors (Control Group)

Appendix I: Study Questionnaires (CBA Study)

- The Problem-Solving Questionnaire - Baseline (Nursing Students)
- The Problem-Solving Questionnaire - Baseline (Nursing Instructors)
- The Problem-Solving Questionnaire - Follow-up (Nursing Students)
- The Problem-Solving Questionnaire - Follow-up (Nursing Instructors)

Appendix J: Feedback Form (CBA Study)

- PSRP Educational Program Feedback Form (Participants)

Appendix A

Literature Summary Table for Problem Solving Studies

Study/Design	Methods	Key Results	Comments
Authors: Ahmady and Shahbazi (2020) Randomized controlled trial **Purpose:** Investigated the impact of social problem-solving training on nursing students' critical thinking and decision-making.	**Participants:** • 40 undergraduate/four-year students of nursing • Randomly allocated to group **Country/setting:** Iran **Intervention:** n = 20; received training program that consisted of three hours of theoretical study and five hours of individual study. **Control**: n = 20; received no intervention. **Data collection:** • The period of data collection was 4 months • The SPSI-R was given pre and a month after the intervention • Used the SPSI-R social problem-solving inventory-revised: o Valid and reliable o 52 questions in a 5-point Likert-type scale. o Overall score: 25-125 o Weak PS: 25-50 o Moderate: 50-75 o Strong PS: >75	**PS mean scores (SD)** • **Intervention group:** 109.12 (± 2.64) • **Control group:** 65.36 (± 2.03) • p <.0001	**Strength of Design:** Strong **Quality:** High Comments: • Appropriate randomization to the group. • Adequate retention and follow up for study participants. • Used appropriate statistics , but regression was not used to control for confounders • Baseline characteristics were the same between the groups
Authors: Ancel (2016) Uncontrolled before and after study.	**Participants:** • 26 nursing students **Country/setting:** Turkey	**Perceived PS ability mean scores (SD)** • **Pre-intervention:** 87.0 (± 16.7)	**Strength of design:** Weak **Quality:** Medium **Comments:**

Study/Design	Methods	Key Results	Comments
Purpose: To determine the effect of problem-solving training, through a management course, on nursing students perceived problem-solving skills.	• **Intervention: n =** 26; received case-based learning training program that consisted of 8 hours of theory and 56 hours of practice and it was given over a period of 7 weeks. • **There was no control group.** **Data collection:** • The PSI was given pre and 7 weeks after the intervention. • Used the PSI developed by Heppner and Petersen (1982). o Valid and reliable tool. o 32 questions in a 6-point Likert-type scale. o Overall score: 32-192. o Lower scores indicate effective problem solving o The midpoint is 112 o Higher scores indicate less effective problem solving.	• **Postintervention:** 82 (± 12.9) • P<0.05	• There was no control group • Inadequate power for some outcomes • Appropriate statistics tests were used, but no regression analysis was used • Used valid and reliable tool
Authors: Çinar et al. (2010) A cross-sectional study. **Purpose:**	**Participants:** • 154 nursing students • 98 midwifery students **Country/setting:** Turkey **Data collection:**	**PS mean scores (SD)** • Nursing students 86.85 (±18.55) • Midwifery students 83.05 (±15.68).	**Strength of design:** Weak **Quality:** High **Comments:** • No advanced statistical tests were used

Study/Design	Methods	Key Results	Comments
To determine and to compare the problem-solving skills of nursing and midwifery students during their education and to verify the factors that influence the problem-solving skills.	• Used the PSI developed by Heppner and Petersen (1982). o Known as valid and reliable tool. o 32 questions in a 6-point Likert-type scale. o Overall score: 32-192. o Lower scores indicate effective problem solving o The midpoint is 112 o Higher scores indicate less effective problem solving		
Authors: Erkus and Bahçecik (2015) A cross-sectional study. **Purpose:** To determine critical thinking level and problem-solving ability of nurse managers and nurses working at private hospitals.	**Participants** • 109 nurse managers • 1314 nurses **Country/setting:** Turkey **Data collection:** • Used the PSI developed by Heppner and Petersen (1982). o Known as valid and reliable tool. o 32 questions in a 6-point Likert-type scale. o Overall score: 32-192. o Lower scores indicate effective problem solving o The midpoint is 112 o Higher scores indicate less effective problem solving	**PS mean scores (SD)** • Nurse managers: 102.6 (±12.8) • Nurses: 101.1 (±15.6)	**Strength of Design:** Weak **Quality:** High **Comments:** • Representative sample of participants. • Valid and reliable tool

Study/Design	Methods	Key Results	Comments
Authors: Yoo and Park (2014) Controlled before and after study. **Purpose:** to investigate the effects of CBL on problem-solving ability of graduate nurses.	**Participants:** • 190 newly graduated nurses • No randomization **Country/setting:** Korea • **Intervention:** n = 94; received three sessions, one session per week for three weeks, with each session lasting for 50 minutes. In each session, the students and the facilitator discussed one of the three common problems encounter during their clinical practice. • **Control:** n = 96; received lecture learning for the same period. **Data collection:** • The PSI was given pre and 3 weeks after the intervention • Used the PSI developed by Heppner and Petersen (1982). o Known as valid and reliable tool. o 32 questions in a 6-point Likert-type scale. o Overall score: 32-192.	**PS confidence mean scores (SD)** • **Intervention group:** 95.53 (± 3.80) • **Control group:** 102.07 (± 2.93) • **P value** = 0.003	**Strength of Design:** Strong **Quality:** High **Comments:** • The two groups were comparable at baseline • Participation rates was more than 80% in each group. • Appropriate simple statistics, but weak control of confounders

Study/Design	Methods	Key Results	Comments
	○ Lower scores indicate effective problem solving ○ The midpoint is 112 ○ Higher scores indicate less effective problem solving		

Appendix B

Ethical Approval Letters (Cross-sectional Study)

Ethics Office

Suite 200, Eastern Trust Building 95 Bonaventure Avenue

St. John's,
NL A1B 2X5

November 06, 2018

7 Geoffrey Place
St John's, NL, A1B4P4

Dear Mr. Hamed:

Researcher Portal File # 20191869 Reference # 2018.223

RE: "Nursing Instructors' and Nursing Students' Knowledge, Confidence, Application, and Perception Related to Problem Solving and Routine Infection Control Practice: A Cross-Sectional Survey "

This will acknowledge receipt of your correspondence dated October 23, 2018.

Your application was reviewed by a sub-committee of the Health Research Ethics Board (HREB) via a delegated review process. Your revised application has been reviewed by the *Co-Chair under the direction of the HREB subcommittee*.

Ethics approval of this research study is granted for one-year effective November 5, 2018. This ethics approval will be reported to the HREB at the next scheduled meeting.

This is your ethics approval only. Organizational approval may also be required. It is your responsibility to seek the necessary organizational approval from the Regional Health

Authority (RHA) or other organization as appropriate. You can refer to the HREA website for further guidance on organizational approvals.

This is to confirm that the HREB reviewed and approved or acknowledged the following documents (as indicated):

- Application, approved
- Research proposal, approved
- Information SHEET, (Nursing Students), approved
- Information SHEET (Nursing Instructors), approved
- MUN Gift cards guidelines, acknowledged
- Budget, approved

This ethics approval will lapse on November 5, 2019. It is your responsibility to ensure that the Ethics Renewal form is submitted prior to the renewal date; you may not receive a reminder. The Ethics Renewal form can be found on the Researcher Portal as an Event Form.

If you do not submit the completed Ethics Renewal form prior to date of renewal:

- **You will no longer have ethics approval**
- You will be required to stop research activity immediately
- You may not be permitted to restart the study until you reapply for and receive approval to undertake the study again
- Lapse in ethics approval **may result in interruption or termination of funding**.

You are solely responsible for providing a copy of this letter, along with your approved HREB application form; to **Research Grant and Contract Services** should your research depend on funding administered through that office.

Modifications of the protocol/consent are not permitted without prior approval from the HREB. **Implementing changes in the protocol/consent without HREB approval may result in your ethics approval being revoked, meaning your research must stop.** Request for modification to the protocol/consent must be outlined on an amendment form available on the Researcher Portal website as an Event Form and submitted to the HREB for review. Please refer to the attached guidance document regarding on-going reporting requirements to the HREB.

The HREB operates according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2), the Health Research Ethics Authority Act (HREA

Act) and applicable laws and regulations.

You are responsible for the ethical conduct of this research, notwithstanding the approval of the HREB. We wish you every success with your study.

Sincerely,

Dr. Elizabeth Dicks (Co-Chair, Non-Clinical Trials Health Research Ethics Board)

CC: Dr. Donna Moralejo

You Have Received Ethics Approval, Now What?: HREB Reporting Requirements

Once a study has received ethics approval from the Health Research Ethics Board (HREB), there are still associated reporting requirements. In the conduct of approved research researchers are required to report to the HREB, in a timely manner, proposed changes from approved research that affect participants at any stage of the process. This includes, but is not limited to, changes to the consent form, changes to the tasks or interventions involved in the research, or changes to measures to protect privacy and confidentiality.

Any substantive change to the research should not be implemented prior to documented approval by the HREB, except when necessary to eliminate an immediate risk(s) to the participants. Below are examples of post approval documentation that must be submitted to the HREB:

Amendments

Any proposed change in the conduct of a study must be submitted to the HREB, and approved, before the change may be implemented. Such changes might include modification of recruitment procedures, inclusion or exclusion criteria, revised sample size, addition or deletion of study sites, changes to an intervention, consent forms, questionnaires or scripts, etc. If there are changes in project team members or changes to funding source(s)/sponsor(s), there are specific forms to complete to report this to the HREB.

Adverse Events

Serious and unanticipated adverse events that occur within Newfoundland and Labrador are required to be reported to the HREB. Such events may occur in both clinical trials and in other types of research, e.g. collapse during a rehabilitation program, emotional breakdown requiring follow up care during an interview, or breach of privacy during correspondence. Serious adverse events that are fatal or life- threatening are required to be reported to the HREB as soon as the research team is aware of the event.

Protocol Deviations

Deviations from an approved study protocol must be reported to the HREB. Changes that eliminate immediate hazards to participants do not require prior approval, but must be reported soon as reasonably possible.

Safety Reports

Safety reports providing information on all serious adverse events (SAEs) occurring in a clinical trial must be provided by the sponsor to the HREB, normally on a three or six monthly basis (i.e. in accordance with the specified reporting timelines that were outlined in the approved ethics application).

Investigator Brochure (IB) and Product Monograph (PM)

Throughout the course of a clinical trial, changes may be implemented to study documents. All revisions to

approved study documents must be submitted to the HREB to ensure the record is up to date. If the revisions include new risk or safety information there may be a requirement to notify research participants.

Ethics Renewal/Study Closure

Ethics approval lasts for one year. Ethics renewal is required annually, on the anniversary of the date of the HREB notification of approval. Once data collection is no longer ongoing, a study closure form is required to be submitted to the HREB for the study to remain active or to be closed in good standing.

December 6, 20 I 8

Mr. Abubaker Mohamed Hamed
School of Nursing
Memorial University St.
John's, NL

Re: Nursing Instructors' and Nursing Students' Knowledge, Confidence, Application, and Perception Related to Problem Solving and Routine Control Practice: A Cross-Sectional Survey (study ref. #2018.223)

Dear Mr. Hamed,

The Western Health Research Review Committee reviewed all documents related to the above study to assess resource implications and to determine whether it can be accommodated by or be of benefit to Western Health. I am pleased to advise you that this study has been approved.

If you have any questions or concerns, please contact Ms. Mariel Parcon, Regional Manager Research and Evaluation, at 709-784-6806 or marielparcon@westernhealth.nl.ca.

Sincerely,

rt/_ =-

Mariel Parcon
Regional Manager Research and Evaluation
On behalf of the
Western Health Research Review Committee

• Western Health Research Review Committee • I Brookfield Avenue • Corner Brook, NL • A2H 6J7 •
• Telephone: 709-784-6806 • Facsimile: 709-634-4591 •
• Web Site: www.westemhealth,nl,c.i •

Appendix C

Information Sheets (Cross-sectional Study)

Information Sheet for Nursing Students about Participating in this Research Study

TITLE: **Nursing Instructors' and Nursing Students' Knowledge, Confidence, and Application Related to Problem Solving and Routine Infection Control Practices: A Cross-Sectional Survey**

INVESTIGATORS:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca.
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your grades or your relations with your colleagues or instructors.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.

Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.

The researchers will:
- **discuss the study with you**
- **answer your questions**
- **keep confidential any information which could identify you personally**
- **be available during the study to deal with problems and answer questions**

1. Why is this research study important?

Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to recommended infection prevention and control routine practices (RP). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and nursing instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.

My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. I am conducting this survey as part of my doctoral research, under the supervision of Dr. Donna Moralejo.

2. What is the purpose of this research study?

The aim of this survey is to understand nursing students' and instructors' PS related to RP and barriers to RP. The results of this survey will be used to inform and develop an intervention program to help nursing instructors and nursing students to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?

Nursing students will be asked to complete a questionnaire during class time on a designated day in a course identified by the school of nursing administration and return the completed questionnaire to the researchers at that time. The questionnaires will take approximately 15-20 minutes to complete. There is no any known risk to participating or not participating in this survey; your decision will not have an impact on your grades or your relations with your colleagues or instructors. It is not known whether this study will benefit you. A separate survey will be conducted with nursing instructors.

4. Do I need to sign a consent form? What does consenting to participate mean?

Completing the study survey questionnaire is your consent to be in this study; you do not need to sign a form. Completion of the questionnaire tells us that you understand the information about the research study. Researchers or agencies involved in this research study still have their legal and professional responsibilities. **When you complete this survey, you give us permission to:**

- **Collect information from you**
- **Share information with the people conducting the study**
- **Share information with the people responsible for protecting your safety**

5. What about my privacy and confidentiality? Who can access my data?

Protecting your privacy is an important part of this study. All survey questionnaires are anonymous; no identifying information is being collected from nursing students as part of the survey. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.

Nursing students will be given the chance to choose an envelope on submission of the completed survey questionnaire. Each envelope will contain a paper that says either "Win" or "No win". Students who choose an envelope with a paper that reads "Win" will be given a $10 gift card. Names of winning students will not be recorded.

6. What information is being collected? Where will it be stored and for how long?

The research team will collect and use only the information they need for this research study.

- Year of study
- Program option
- Age
- Gender

- Extra clinical experiences outside nursing school
- Training about Routine Practices
- Your survey questionnaire answers

The collected data (completed questionnaires) will be securely stored in a locked cabinet in the nursing program graduate office in the education building (ED-5004). Only the research team can access the data. Computerized files will be password-protected and stored on secure computers in locked offices in ED-5004. In addition, data will be kept in a locked file cabinet for at least 5 years, as per Memorial University policy.

7. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation after submission of the questionnaire, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the questionnaire has been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.

Because no identifiers are collected, it will not be possible for you to access your survey questionnaire once it has been submitted.

8. Questions or problems:

If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974
Email at info@hrea.ca

This study has been reviewed and given ethics approval by the Newfoundland and Labrador Health Research Ethics Board.

Information sheet for (Nursing Instructors) about Participating in this Research Study

TITLE: Nursing Instructors' and Nursing Students' Knowledge, Confidence, and Application Related to Problem Solving and Routine Infection Control Practices: A Cross-Sectional Survey

INVESTIGATORS:

Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca.
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your employment status or your relations with your colleagues or instructors.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.
Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.
The researchers will:

- discuss the study with you
- answer your questions
- keep confidential any information which could identify you personally
- be available during the study to deal with problems and answer questions

1. Why is this research study important?

Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to recommended infection prevention and control routine practices (RP). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and nursing instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.
My name is Abubaker Hamed and I am a PhD student at the University, School of Nursing. I am conducting this survey as part of my doctoral research, under the supervision of Dr. Donna Moralejo.

2. What is the purpose of this research study?

The aim of this survey is to understand nursing students' and instructors' PS related to RP and barriers to RP. The results of this survey will be used to inform and develop an intervention program to help nursing instructors and nursing students to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?
Nursing instructors will be asked to complete an online survey questionnaire. The questionnaire will take approximately 15-20 minutes to complete. There is no any known risk to participating or not participating in this survey; your decision will not have an impact on your employment status or your relations with your colleagues. It is not known whether this study will benefit you. A separate survey will be conducted with nursing students.

4. Do I need to sign a consent form? What does consent to participate mean?
Completing the study survey questionnaire is your consent to be in this study; you do not need to sign a form. Completion of the questionnaire tells us that you understand the information about the research study. Researchers or agencies involved in this research study still have their legal and professional responsibilities. **When you complete this survey, you give us permission to:**

- **Collect information from you**
- **Share information with the people conducting the study**
- **Share information with the people responsible for protecting your safety**

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to research records (i.e., questionnaires). This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

All survey questionnaires are anonymous; no identifying information is being collected from nursing instructors as part of the survey. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study. However, nursing instructors who choose to enter their email address in the draw for a $10 gift card will click yes at the end of the survey. They will be taken to another electronic page to enter their email addresses, which will be sent automatically to the researcher. Nursing instructors will be contacted via email if they win the gift card. Gift cards will be distributed by a member of the research team. Only the researchers will have access to the instructors' email address for the purpose of the draw. Email addresses will be destroyed after the gift cards have been awarded. The email address is not linked to the questionnaire.

6. What about use of *Qualtrics* Survey Software and privacy?
Data collected from nursing instructors will be stored electronically by the *Qualtrics survey software* and it is subject to their privacy policy. The *Qualtrics survey software* was just approved by the University as an organizational resource. In addition, the Qulatric data are kept in Canada, and subject to Canadian law. If you have questions or concerns about how your data will be collected or stored, please contact the researcher and/or visit the provider's website for more information before participating. The privacy and security policy of the third-party hosting data collection and/or storing data can be found at: https://www.qualtrics.com/security-statement/.

7. What information is being collected? Where will it be stored and for how long?
The research team will collect and use only the information they need for this research study.

- Employment status
- Nursing school where are you currently working
- Number of years you have worked as an instructor or professor
- Gender
- Training about Routine Practices
- Types of courses (e.g., clinical, theory) you teach
- Area of clinical (e.g., community, med-surg) in which you teach
- Your survey questionnaire answers

All data will be collected in electronic format. Computerized files will be password-protected and stored on secure computers in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the questionnaire has been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study. Because no identifiers are collected, it will not be possible for you to access your survey once it has been submitted.

9. Questions or problems:
If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.
Or you can talk to someone who is not involved with the study at all but can advise you on your rights as a participant in a research study. This person can be reached through: Ethics Office at 709-777-6974, Email at info@hrea.ca

This study has been reviewed and given ethics approval by the Newfoundland and Labrador Health Research Ethics Board.

Information for (Year 4 Nursing Students) about Participating in this Research Study

TITLE: Nursing Instructors' and Nursing Students' Knowledge, Confidence, and Application Related to Problem Solving and Routine Infection Control Practices: A Cross-Sectional Survey

INVESTIGATORS:

Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca.
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your grades or your relations with your colleagues or instructors.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.
Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.
The researchers will:

- **discuss the study with you**
- **answer your questions**
- **keep confidential any information which could identify you personally**
- **be available during the study to deal with problems and answer questions**

1. Why is this research study important?

Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to recommended infection prevention and control routine practices (RP). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and nursing instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.
My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. I am conducting this survey as part of my doctoral research, under the supervision of Dr. Donna Moralejo
.

2. What is the purpose of this research study?

The aim of this survey is to understand nursing students' and instructors' PS related to RP and barriers to RP. The results of this survey will be used to inform and develop an intervention program to help nursing instructors and nursing students to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?
Nursing students will be asked to complete a questionnaire during class time on a designated day in a course identified by the school of nursing administration and return the completed questionnaire to the researchers at that time. The questionnaires will take approximately 15-20 minutes to complete. There is no any known risk to participating or not participating in this survey; your decision will not have an impact on your grades or your relations with your colleagues or instructors. It is not known whether this study will benefit you. A separate survey will be conducted with nursing instructors.

4. Do I need to sign a consent form? What does consenting to participate mean?
Completing the study survey questionnaire is your consent to be in this study; you do not need to sign a form. Completion of the questionnaire tells us that you understand the information about the research study. Researchers or agencies involved in this research study still have their legal and professional responsibilities. **When you complete this survey, you give us permission to:**

- **Collect information from you**
- **Share information with the people conducting the study**
- **Share information with the people responsible for protecting your safety**

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. All survey questionnaires are anonymous; no identifying information is being collected from nursing students as part of the survey. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.

All survey questionnaires are anonymous; no identifying information is being collected from Year 4 nursing students as part of the survey. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study. However, Year 4 nursing students who choose to enter their email address in the draw for a $10 gift card will click yes at the end of the survey. They will be taken to another electronic page to enter their email addresses, which will be sent automatically to the researcher. Year 4 nursing students will be contacted via email if they win the gift card. Gift cards will be distributed by a member of the research team. Only the researchers will have access to the instructors' email address for the purpose of the draw. Email addresses will be destroyed after the gift cards have been awarded. The email address is not linked to the questionnaire.

6. What about use of *Qualtrics* Survey Software and privacy?
Data collected from Year 4 nursing students will be stored electronically by the *Qualtrics survey software* and it is subject to their privacy policy. *The Qualtrics survey software* was just approved by the University as an organizational resource. In addition, the Qulatric data are kept

in Canada, and subject to Canadian law. If you have questions or concerns about how your data will be collected or stored, please contact the researcher and/or visit the provider's website for more information before participating. The privacy and security policy of the third-party hosting data collection and/or storing data can be found at: https://www.qualtrics.com/security-statement/.

7. What information is being collected? Where will it be stored and for how long?
The research team will collect and use only the information they need for this research study.

- Year of study
- Program option
- Age
- Gender
- Extra clinical experiences outside nursing school
- Training about Routine Practices
- Your survey questionnaire answers

All data will be collected in electronic format. Computerized files will be password-protected and stored on secure computers in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation after submission of the questionnaire, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the questionnaire has been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.
Because no identifiers are collected, it will not be possible for you to access your survey questionnaire once it has been submitted.

9. Questions or problems:
If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3390.
Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through: Ethics Office at 709-777-6974

Email at info@hrea.ca

Appendix D

Cover Emails (Cross-sectional Study)

Survey Cover Email for Nursing Students

Date
Dear Nursing Students,

My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. For my doctoral research, I am assessing nursing instructors' and nursing students' knowledge, confidence, and application of both Routine infection control Practices (RP) and problem solving related to RP. The results of this survey will be used to inform and develop an intervention program to help nursing instructors and nursing students to deal with barriers to adherence to RP.

Because you are registered in any year of either the regular stream or accelerated nursing programs in the province, I am inviting you to participate in this research study by completing a survey questionnaire. The questionnaire will require approximately 15- 20 minutes to be completed and will be administered during your NURS2002 and NURS3014 class on January 2019, as scheduled by your school administration.

Participation is voluntary and you may decline to participate or to answer specific questions. If you choose not to participate you will be asked to remain in the classroom during the data collection period. There is no any known risk to participating or not participating in this survey; your decision will not have an impact on your student status or grades. If you choose to participate in this survey, please answer all questions as honestly as possible. In order to ensure that all information will remain confidential, please do not include your name. Completion of the questionnaire will indicate your willingness to participate in this study.

Nursing students will be given the chance to choose an envelope on submission of the completed survey questionnaire. Each envelope will contain a paper that says either "Win" or "No win". Students who choose an envelope with a paper that reads "Win" will be given a $10 gift card. Names of winning students will not be recorded.

If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study. That person is: **Abubaker Hamed. (709-986-9410 or amh040@mun.ca). Or you can speak to my supervisor(s): Donna Moralejo, (moralejo@mun.ca**).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974

Email at info@hrea.ca

This study has been reviewed and given ethics approval by the Newfoundland and Labrador Health Research Ethics Board.

Survey Cover Email for Nursing Instructors

Date
Dear Nursing Instructors,

My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. For my doctoral research, I am assessing nursing instructors' and nursing students' knowledge, confidence, and application of both Routine infection control Practices (RP) and problem solving related to RP. The results of this survey will be used to inform and develop an intervention program to help nursing instructors and nursing students to deal with barriers to adherence to RP.

Because you work as a full-time or a part-time instructor in any of the three schools in the province, and teach clinical courses, theory courses, or both, I am inviting you to participate in this research study by completing the online survey found at the following link: https://mun.az1.qualtrics.com/jfe/form/SV_3VPDzTSpCCNCCW1.The questionnaire will require approximately 15- 20 minutes to be completed. Please complete the survey by **February 28, 2109**.

Participation is voluntary and you may decline to participate or to answer specific questions. There is no any known risk to participating or not participating in this survey; your decision will not have an impact on your employment status. If you choose to participate in this survey, please answer all questions as honestly as possible. In order to ensure that all information will remain confidential, please do not include your name. Completion of the questionnaire will indicate your willingness to participate in this study.

All survey questionnaires are anonymous; no identifying information is being collected from nursing instructors as part of the survey. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.

However, nursing instructors who choose to enter their email address in the draw for a $10 gift card will click yes at the end of the survey. They will be taken to another electronic page to enter their email addresses, which will be sent automatically to the researcher. Nursing instructors will be contacted via email if they win the gift card. Gift cards will be distributed by a member of the research team. Only the researchers will have access to the instructors' email address for the purpose of the draw. Email addresses will be destroyed after the gift cards have been awarded. The email address is not linked to the questionnaire.

If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study. That person is: **Abubaker Hamed. (709-986-9410 or amh040@mun.ca). Or you can speak to my supervisor(s): Donna Moralejo, (moralejo@mun.ca**).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974
Email at info@hrea.ca

This study has been reviewed and given ethics approval by the Newfoundland and Labrador Health Research Ethics Board.

Appendix E

Routine Practices and Problem-Solving Questionnaire (Students) (Cross-sectional Study)

Welcome
Thank you for participating in the study examining Nursing Instructors' and Nursing Students' Knowledge, Confidence, and Application Related to Problem Solving and Routine Infection Control Practices: A Cross-Sectional Survey. The questionnaire will take approximately 15-20 minutes to complete. You were sent an information sheet explaining the study. Key details are summarized here. Please read the information carefully, and check "I agree" to participate

Information for Nursing Students about Participating in this Research Study.

1. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study.
2. If you decide to take part, you can choose to stop at any time.
3. Any answers submitted up to that point will be used in the analysis.
4. Your decision will not have an impact on your grades or your relations with your colleagues or instructors.
5. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
6. All survey questionnaires are anonymous; no identifying information is being collected from nursing students as part of the survey.
7. The members of the research team will have access to study data but no one will know the participants' identities.
8. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.
9. Completion of the questionnaire implies consent to participate.

I understand and agree to participate

○ **Yes**

○ **No**

Section 1: Knowledge

Q1.1 Please select the appropriate box to indicate whether you believe the item is true or false or if you are unsure of the answer.

Knowledge questions			
1. The use of alcohol-based hand rub (ABHR) is recommended when hands are visibly soiled	○ True	○ False	○ Unsure
2. If I do not clean my hands this will lead to spread of infections	○ True	○ False	○ Unsure
3. Gloves are recommended to be used if contact with mucous membranes or non-intact skin is expected	○ True	○ False	○ Unsure
4. Gloves are a substitute for hand hygiene	○ True	○ False	○ Unsure
5. Mask and eye protection should be worn when there is a risk of splash or spray of blood or body fluids	○ True	○ False	○ Unsure
6. Thirty seconds is the minimum time needed for ABHR to kill most germs on hands	○ True	○ False	○ Unsure
7. All shared patient care equipment (e.g., stethoscopes, blood pressure cuffs, and glucometers) should be cleaned with disinfectant wipes between each use	○ True	○ False	○ Unsure
8. It is acceptable to recap needles	○ True	○ False	○ Unsure
9. Problem solving can help nurses to deal with barriers that prevent adherence to Routine Practices	○ True	○ False	○ Unsure

Section 2: Short answers

Instructions: Please write your short answers to the following questions.

Q2.1 **What are the differences between Routine Practices and Additional Precautions?**

Q2.2 **What does problem solving mean to you with respect to infection prevention and control?**

Q2.3 **What is a point-of-care risk assessment? Why is it done? Please give an example.**

Q2.4 **Name the link in the chain of infection that is disrupted by each of the following;**

- **Gloves** _____
- **Mask** _____
- **Vaccination** _____

Section 3: Barriers to adherence

Instruction: Please select all that apply.

Q3.1 Which of the following barriers has prevented you from adhering to Routine Practices? Please select all that apply.

- ☐ **High nursing workload**
- ☐ **Presence of negative role models**
- ☐ **Inconvenient location of ABHR**
- ☐ **Lack of knowledge and training**
- ☐ **Skin damage or dryness**
- ☐ **Forgetfulness**
- ☐ **Empty ABHR dispensers**
- ☐ **Unavailability of Personal Protective Equipment (PPE)**
- ☐ **Alteration of skills when wearing PPE**
- ☐ **Dealing with emergency situations**
- ☐ **Lack of hospital supporting policies**

Q3.2 **Please identify any additional barriers.**

Section 4: Strategies

Instructions: Please answer the following questions.

Q4.1 Have you ever used problem solving to deal with the influence of high nursing workload on your adherence to Routine Practices?

- ○ Yes
- ○ No

If yes, what strategies did you use?

Q4.2 Have you ever used problem solving to deal with the influence of inconvenient location of alcohol-based hand rub on your hand hygiene practice?

- ○ Yes
- ○ No

If yes, what strategies did you use?

Q4.3 Have you ever used problem solving to deal with the influence of a negative role model on your adherence to Routine Practices?

- ○ Yes
- ○ No

If yes, what strategies did you use?

Section 5: Confidence

Q5.1 Please indicate your level of confidence with each of these items (check your answer).

1. Performing hand hygiene when indicated	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
2. Using PPE when indicated	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
3. Discarding sharps needles in an appropriate sharp container	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
4. Doing point-of-care risk assessment before patient care	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
5. Applying problem solving to deal with the influence of high nursing workload on my adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
6. Applying problem solving to deal with the influence of a negative role model on my adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
7. Applying problem solving to deal with the influence of inconvenient location of ABHR on my adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident

Section 6: Teaching and Learning about Routine Practices

Please answer each of the following questions.

Q6.1 In your opinion, what is the best time in the nursing program to learn about problem solving related to Routine Practices, e.g., in what course or year, in theory, or clinical courses?

Q6.2 In your opinion, what are the best teaching methods that can be used to teach you problem solving related to Routine Practices? Select all that apply.

- ○ **Case studies**
- ○ **Group discussion**
- ○ **Lecture**
- ○ **Video watching**
- ○ **Role play**
- ○ **Scenario-based simulation with an instructor**
- ○ **Other, specify _____**

Q6.3 Any additional comments about teaching Routine Practices and problem solving?

Section 7: Demographic data

Q7.1 What year are you in?

- ○ First year
- ○ Second year
- ○ Third year
- ○ Fourth year

Q7.2 What stream are you in?

- ○ Regular stream
- ○ Accelerated program

Q7.3 What is your age?

- ○ 18-24 years old
- ○ 25-34 years old
- ○ 35-44 years old
- ○ Older than 45 years

Q7.4 What is your gender?

- ○ Male
- ○ Female
- ○ Others

Q7.5 Did you have any extra clinical experiences outside of nursing school (e.g., work as PCA)?

- ○ Yes
- ○ No

Q7.6 In the last two years, did you have any training about Routine Practices outside of nursing school?

- ○ Yes
- ○ No

Q7.7 In the last two years, did you have any training about problem solving related to Routine Practices?

- ○ Yes
- ○ No

Thank you for completing the questionnaire.

Routine Practices and Problem-Solving Questionnaire (Instructors)

Welcome to the online survey questionnaire for the study examining ***Nursing Instructors' and Nursing Students' Knowledge, Confidence, and Application Related to Problem Solving and Routine Infection Control Practices: A Cross-Sectional Survey.*** The questionnaire will take approximately 15-20 minutes to complete.

You were sent an information sheet explaining the study. Key details are summarized here. Please read the information carefully and click "I agree" to participate.

Information for Nursing Instructors about Participating in this Research Study

1. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you can choose to stop at any time.
2. Any answers submitted up to that point will be used in the analysis.
3. Your decision will not have an impact on your employment status or your relationships with your colleagues.
4. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
5. All survey questionnaires are anonymous; no identifying information is being collected from nursing instructors as part of the survey.
6. The members of the research team will have access to study data, but no one will know the participants' identities.
7. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.
8. Data collected from nursing instructors will be stored electronically by the *Qualtrics survey software* and is subject to their privacy policy.
9. The *Qualtrics survey software* is the approved survey tool for the University.
10. Completion of the questionnaire implies consent to participate.

I understand and agree to participate

- ○ Yes
- ○ No

Q 1.1 **Section 1: Knowledge**

Instructions: Select the appropriate box to indicate whether you believe the item is true or false or if you are unsure of the answer.

Knowledge Questions			
1. The use of alcohol-based hand rub (ABHR) is recommended when hands are visibly soiled	○ True	○ False	○ Unsure
2. If I do not clean my hands this will lead to spread of infections	○ True	○ False	○ Unsure
3. Gloves are recommended to be used if contact with mucous membranes or non-intact skin is expected	○ True	○ False	○ Unsure
4. Gloves are a substitute for hand hygiene	○ True	○ False	○ Unsure
5. Mask and eye protection should be worn when there is a risk of splash or spray of blood or body fluids	○ True	○ False	○ Unsure
6. Thirty seconds is the minimum time needed for ABHR to kill most germs on hands	○ True	○ False	○ Unsure
7. All shared patient care equipment (e.g., stethoscopes, blood pressure cuffs, and glucometers) should be cleaned with disinfectant wipes between each use	○ True	○ False	○ Unsure
8. It is acceptable to recap needles	○ True	○ False	○ Unsure
9. Problem solving can help nurses to deal with barriers that prevent adherence to Routine Practices	○ True	○ False	○ Unsure

Section 2: Short answers

Instructions: Please write your short answers to the following questions. If you do not know the answers to any of these questions, please write unsure or I don't know.

Q 2.1 **What are the differences between Routine Practices and Additional Precautions?**

Q 2.3 **What does problem solving mean to you with respect to infection prevention and control?**

Q 2.4 **What is a point-of-care risk assessment? Why is it done? Please give an example.**

Q 2.5 **Name the link in the chain of infection that is disrupted by each of the following:**

- ☐ Gloves
- ☐ Mask
- ☐ Vaccination

Section 3: Barriers to adherence

Instruction: Please select all that apply.

Q 3.1 **Which of the following barriers has prevented you from adhering to Routine Practices?** Please select all that apply.

- ☐ High nursing workload
- ☐ Presence of negative role models
- ☐ Inconvenient location of ABHR
- ☐ Lack of knowledge and training
- ☐ Skin damage or dryness

- [ ] Forgetfulness
- [ ] Empty ABHR dispensers
- [ ] Unavailability of PPE
- [ ] Alteration of skills when wearing PPE
- [ ] Dealing with emergency situations
- [ ] Lack of hospital supporting policies

Q 3.2 **Please identify any additional barriers**

Section 4: Strategies

Instructions: Please answer the following questions.

Q 4.1 **Have you ever used problem solving to help your students to deal with the influence of high nursing workload on their adherence to Routine Practices?**

- ○ Yes
- ○ No

What strategies did you use?

Q 4.2 **Have you ever used problem solving to help your students to deal with the influence of inconvenient location of alcohol-based hand rub on their hand hygiene practice?**

- ○ Yes
- ○ No

What strategies did you use?

Q 4.3 **Have you ever used problem solving to help your students to deal with the influence of a negative role model on their adherence to Routine Practices?**

- ○ Yes
- ○ No

What strategies did you use?

Section 5: Confidence

Q 5.1 ***Please indicate your level of confidence with each of these items (check your answer).***

Confidence questions				
1. Performing hand hygiene when indicated	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
2. Using PPE when indicated	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
3. Discarding sharps needles in an appropriate sharp container	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
4. Doing point-of-care risk assessment before patient care	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
5. Applying problem solving to deal with the influence of high nursing workload on my students' adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
6. Applying problem solving to deal with the influence of a negative role model on my students' adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident
7. Applying problem solving to deal with the influence of inconvenient location of ABHR on my students' adherence to Routine Practices	○ Very confident	○ Confident	○ Somewhat confident	○ Not at all confident

Section 6: Teaching and Learning about Routine Practices

Please answer each of the following questions.

Q 6.1 In your opinion, what is the best time in the nursing program to learn about problem solving related to Routine Practices, e.g., in what course or year, in theory, or clinical courses?

Q 6.2 **In your opinion, what are the best teaching methods that can be used to teach nursing students problem solving related to Routine Practices? Select all that apply.**

- ☐ Case studies
- ☐ Group discussion
- ☐ Lecture
- ☐ Video watching
- ☐ Role play
- ☐ Scenario-based simulation with an instructor
- ☐ Other, specify _____

Q 6.3 **Any additional comments about teaching Routine Practices and problem solving?**

Section 7: Demographic data

Q 7.1 **What is your current employment status with the school of nursing?**

- ○ Full time
- ○ Part time

Q 7.2 **What nursing school are you currently working with?**

- ○ School A
- ○ School B
- ○ School C

Q 7.3 **How many years have you worked as an instructor or professor?**

- ○ Less than 5 years
- ○ 6 - 10 years
- ○ 11 – 20 years
- ○ More than 20 years

Q 7.4 **What is your gender?**

- ○ Male
- ○ Female
- ○ Other

Q 7.5 **In the last two years, did you have any training about Routine Practices?**

- ○ Yes
- ○ No

Q 7.6 **In the last two years, did you have any training about problem solving related to Routine Practices?**

- ○ Yes
- ○ No

Q 7.7 **What type(s) of courses do you teach?**

- ○ Clinical
- ○ Theory
- ○ Both

Q 7.8 **What area of clinical do you teach?**

- ○ Medical surgical
- ○ Community
- ○ Maternity or pediatric
- ○ Mental health
- ○ Other _____
- ○ I don’t teach clinical

Thank you for participating in this study.

Appendix F

Ethical Approval Letters (CBA Study)

Research Ethics Office
Suite 200, Eastern Trust
Building 95 Bonaventure
Avenue
St.
John's,
NL A1B
2X5

August 05, 2019

7 Geoffrey Place,
St John's, NL, A1B4P4

Dear Mr Hamed:

Researcher Portal File # 20200603
Reference # 2019.166

RE: Evaluating a Problem-Solving Education Intervention for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study

Your application was reviewed by a subcommittee under the direction of the HREB and the following decision was rendered:

X	Approval
	Approval subject to changes
	Rejection

Ethics approval is granted for one-year effective August 2, 2019. This ethics approval will be reported to the board at the next scheduled HREB meeting.

This is to confirm that the HREB reviewed and approved or acknowledged the

following documents (as indicated):

- Application, approved
- Research proposal, approved
- Cover Letter for MUNFON Nursing Students, approved
- Feedback form, approved
- Time line form, approved
- Budget, approved
- Follow up, Instructors study questionnaire, approved
- Follow up, Students study questionnaire, approved

You Have Received Ethics Approval, Now What?: HREB Reporting Requirements

Once a study has received ethics approval from the Health Research Ethics Board (HREB), there are still associated reporting requirements. In the conduct of approved research researchers are required to report to the HREB, in a timely manner, proposed changes from approved research that affect participants at any stage of the process. This includes, but is not limited to, changes to the consent form, changes to the tasks or interventions involved in the research, or changes to measures to protect privacy and confidentiality.

Any substantive change to the research should not be implemented prior to documented approval by the HREB, except when necessary to eliminate an immediate risk(s) to the participants. Below are examples of post approval documentation that must be submitted to the HREB:

Amendments

Any proposed change in the conduct of a study must be submitted to the HREB, and approved, before the change may be implemented. Such changes might include modification of recruitment procedures, inclusion or exclusion criteria, revised sample size, addition or deletion of study sites, changes to an intervention, consent forms, questionnaires or scripts, etc. If there are changes in project team members or changes to funding source(s)/sponsor(s), there are specific forms to complete to report this to the HREB.

Adverse Events

Serious and unanticipated adverse events that occur within Newfoundland and Labrador are required to be reported to the HREB. Such events may occur in both clinical trials and in other types of research, e.g. collapse during a rehabilitation program, emotional breakdown requiring follow up care during an interview, or breach of privacy during correspondence. Serious adverse events that are fatal or life-threatening are required to be reported to the HREB as soon as the research team is aware of the event.

Protocol Deviations

Deviations from an approved study protocol must be reported to the HREB. Changes that eliminate immediate hazards to participants do not require prior approval, but must be reported soon as reasonably possible.

Safety Reports

Safety reports providing information on all serious adverse events (SAEs) occurring in a clinical trial must be provided by the sponsor to the HREB, normally on a three- or six-monthly basis (i.e., in accordance with the specified reporting timelines that were outlined in the approved ethics application).

Investigator Brochure (IB) and Product Monograph (PM)

Throughout the course of a clinical trial, changes may be implemented to study documents. All revisions to approved study documents must be submitted to the HREB to ensure the record is up to date. If the revisions include new risk or safety information there may be a requirement to notify research participants.

Ethics Renewal/Study Closure

Ethics approval lasts for one year. Ethics renewal is required annually, on the anniversary of the date of the HREB notification of approval. Once data collection is no longer ongoing, a study closure form is required to be submitted to the HREB for the study to remain active or to be closed in good standing.

September 12, 2019

Abubaker Hamed School
of Nursing Memorial
University St. John's, NL

Re: Evaluating a Problem-Solving Educational Intervention for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study (study ref. #2019.166)

Dear Hamed,

The Western Health Research Review Committee reviewed all documents related to the above study to assess resource implications and to determine whether it can be accommodated by or be of benefit to Western Health. I am pleased to advise you that this study has been approved.

If you have any questions or concerns, please contact Ms. Mariel Parcon, Regional Manager Research and Evaluation, at 709-784-6806 or marielparcon@westernhealth.nl.ca.

Sincerely,

Mariel Parcon
Regional Manager Research and Evaluation On
behalf of the
Western Health Research Review Committee

- Western Health Research Review Committee □ 1 Brookfield Avenue □ Corner Brook, NL □ A2H 6J7 □

□ Telephone: 709-784-6806 □ Facsimile: 709-634-4591 □
• Web Site: www.westernhealth.nl.ca □

Appendix G

Cover Emails(CBA Study)

Cover Emails for Nursing Students (Intervention Group)

Date
Dear Nursing students,

My name is Abubaker Hamed and I am a PhD student at Memorial University, Faculty of Nursing. For my doctoral research, I am conducting an interventional study to examine the effects of the problem-solving intervention for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to Routine infection control Practices (RP). This study was reviewed and given ethics approval by the Health Research Ethics Board (HREB) and the appropriate regional research proposal approval committee. Permission was also obtained from the dean of School A.

Because you are registered in a selected course in year 2 or 3 of either the regular stream or accelerated nursing programs at School A, you will receive a training program related to RP as part of a scheduled 2-hour session. The training program will last for 120 minutes, with 20 minutes allocated to completing the baseline questionnaire, 30 minutes for an interactive PowerPoint presentation, 60 minutes for small-group case discussion to apply problem solving to the identified barriers to adherence to RP, and 10 minutes for obtaining feedback. Nursing instructors will also participate with the students in small –group case discussion. Students who agree to participate in the study will be asked to complete the study questionnaires before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

Participation is voluntary and you may decline to participate or to answer specific questions. There is no known risk to participating or not participating in this intervention program; your decision will not have an impact on your student status or grades. In order to ensure that all information will remain confidential, please do not include your name in any of the questionnaires. It is not known whether this study will benefit you. Completing the study questionnaires is your consent to be in this study; you do not need to sign a consent form.

Students who agree to participate in this study will enter into a draw to win a $10 Tim Horton's gift cards. No identifying information is being collected from nursing students as part of the study; however, after they have completed the follow-up questionnaire, the students who won the $10 gift card will immediately receive the gift card, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

If you have any questions about taking part in this study, you can contact me, **Abubaker Hamed (709-986-9410 or amh040@mun.ca), or you can speak to my supervisor: Donna Moralejo, (moralejo@mun.ca**).

Or you can talk to someone who is not involved with the study at all but can advise you on your rights as a participant in a research study. This person can be reached through: **Ethics Office at 709-777-6974**

Email at info@hrea.ca

Thank you for agreeing to consider participating in this study.

Cover Emails for Nursing Instructors (Intervention Group)

Date

Dear Nursing Instructors,

My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. For my doctoral research, I am conducting an interventional study to examine the effects of the problems solving intervention for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to Routine infection control Practices (RP). This study was reviewed and given ethics approval by the Health Research Ethics Board (HREB) and the appropriate regional research proposal approval committee. Permission was also obtained from the dean of School A.

Because you work as a full time or a part-time instructor at (School A), who teach in a selected course in year 2 or 3 of either the regular stream or accelerated nursing programs who agreed to be part of the study will receive training program related to RP as part of a schedule classes. The training program will last for 120 minutes, with 20 minutes allocated to completing the baseline questionnaire, 30 minutes for an interactive PowerPoint presentation, 60 minutes for small-group case discussion to apply problem solving to the identified barriers to adherence to RP, and 10 minutes for obtaining feedback. Nursing students in the identified classes will also participate with the instructor in small–group case discussion. Nursing instructors who agree to participate in the study will be asked to complete the study questionnaire before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

Participation is voluntary and you may decline to participate or to answer specific questions. There is no known risk to participating or not participating in this intervention program; your decision will not have an impact on your employment status or your relations with your colleagues. In order to ensure that all information will remain confidential, please do not include your name in any of the questionnaires. It is not known whether this study will benefit you. Completing and retuning the questionnaires indicate your agreement to participate in the study. Completing the study questionnaires is your consent to be in this study; you do not need to sign a consent form.

Instructors who agree to participate in this study will enter into a draw to win $10 Tim Horton's gift card. No identifying information is being collected from nursing instructors as part of the study; however, the instructors who won the $10 gift card will receive the gift card, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

If you have any questions about taking part in this study, you can contact me, **Abubaker Hamed (709-986-9410 or amh040@mun.ca), or you can speak to my supervisor: Donna Moralejo, (moralejo@mun.ca**).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974
Email at info@hrea.ca

Thank you for agreeing to consider participating in this study.

Cover Emails for Nursing Students (Control Group)

Date

Dear Nursing students,

My name is Abubaker Hamed and I am a PhD student at Memorial University, Faculty of Nursing. For my doctoral research, I am conducting an interventional study to examine the effects of the problem-solving intervention for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to Routine infection control Practices (RP). This study was reviewed and given ethics approval by the Health Research Ethics Board (HREB) and the appropriate regional research proposal approval committee**.** Permission was also obtained from the dean of School A.

Because you are registered in a selected course in year 2 or 3 of either the regular stream or accelerated nursing programs at School B, you will be asked to complete the study questionnaire related to RP as part of a scheduled classes. Students who agree to participate in the study will be asked to complete the study questionnaires before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

Participation is voluntary and you may decline to participate or to answer specific questions. There is no known risk to participating or not participating in this control group; your decision will not have an impact on your student status or grades. In order to ensure that all information will remain confidential, please do not include your name in any of the questionnaires. It is not known whether this study will benefit you. Completing the study questionnaires is your consent to be in this study; you do not need to sign a consent form.

Students who agree to participate in this study will enter into a draw to win one of three $10 Tim Horton's gift cards. No identifying information is being collected from nursing students as part of the study; however, the students who won the $10 gift card will receive the gift card, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed after the gift cards have been awarded.

If you have any questions about taking part in this study, you can contact me, Abubaker Hamed (709-986-9410 or amh040@mun.ca), or you can speak to my supervisor: Donna Moralejo, (moralejo@mun.ca).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974
Email at info@hrea.ca

Thank you for agreeing to consider participating in this study.

Cover Emails for Nursing Instructors (Control Group)

Date
Dear Nursing Instructors,

My name is Abubaker Hamed and I am a PhD student at Memorial University, School of Nursing. For my doctoral research, I am conducting an interventional study to examine the effects of the problems solving intervention for nursing instructors and nursing students on their knowledge, confidence, and ability to deal with barriers to adherence to Routine infection control Practices (RP). This study was reviewed and given ethics approval by the Health Research Ethics Board (HREB) and the appropriate regional research proposal approval committee. Permission was also obtained from the dean of School A.

Because you work as a fulltime or a part-time nursing instructor at (School B), who teach in a selected course in year 2 or 3 of either the regular stream or accelerated program who agreed to be part of the study, you will be asked to complete the study questionnaire before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up) as part of a specific schedule course. The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

Participation is voluntary and you may decline to participate or to answer specific questions. There is no known risk to participating or not participating in this intervention program; your decision will not have an impact on your employment status or your relations with your colleagues. In order to ensure that all information will remain confidential, please do not include your name in any of the questionnaires. It is not known whether this study will benefit you. Completing the study questionnaires is your consent to be in this study; you do not need to sign a consent form

Instructors who agree to participate in this study will enter into a draw to win $10 Tim Horton's gift card. No identifying information is being collected from instructors as part of the study; however, the instructors who won the $10 gift card will receive the gift card, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

If you have any questions about taking part in this study, you can contact me, **Abubaker Hamed (709-986-9410 or amh040@mun.ca), or you can speak to my supervisor: Donna Moralejo, (moralejo@mun.ca**).

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:

Ethics Office at 709-777-6974
Email at info@hrea.ca

Thank you for agreeing to consider participating in this study.

Appendix H

Information Sheets (CBA Study)

Nursing Students' Information Sheet (Intervention Group)

TITLE: Evaluation of a Problem-Solving Educational Program for Nursing Students to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study

INVESTIGATORS:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca
Co-investigators:

- **Dr. Donna Moralejo (Supervisor) PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca.709-864-3390.**
- **Dr. April Pike, School of Nursing, aprilpike@mun.ca.**
- **Dr. Vernon Curran, PhD, Associate Dean of Educational Development, Faculty of Medicine, vcurran@mun.ca.**

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your student status or grades or your relationships with your colleagues or instructors.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.

Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.

The researchers will:

- discuss the study with you
- answer your questions
- keep confidential any information which could identify you personally
- be available during the study to deal with problems and answer questions

1. Why is this research study important?
Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to recommended infection prevention and control routine practices

(RP) such as hand hygiene and use of Personal Protective Equipment (PPE). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and clinical instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.

2. What is the purpose of this research study?
The aim of this study is to examine the effects of a Problem-Solving Routine Practices (PSRP) educational program for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?
Nursing students who registered in a selected course in year 2 or 3 of either the regular stream or accelerated nursing programs at School A will receive a training program related to RP as part of scheduled 2-hour classes. The training program will last for 120 minutes, with 20 minutes allocated to completing the baseline questionnaire, 30 minutes for an interactive PowerPoint presentation, 60 minutes for small-group case discussion to apply problem solving to the identified barriers to adherence to RP, and 10 minutes for obtaining feedback. Nursing instructors will also participate with the students in small –group case discussion. Students who agree to participate in the study will be asked to complete the study questionnaire before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

There is no known risk to participating or not participating in study intervention; your decision will not have an impact on your student status or grades. It is not known whether this study will benefit you.

4. Do I need to sign a consent form? What does consenting to participate mean?
Completing the study questionnaires is your consent to be in this study; you do not need to sign a form.

When you participate in the study, you give us permission to:

- Collect information from you
- Complete baseline and follow-up questionnaires
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to research records (i.e., questionnaires). This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

The study questionnaire is anonymous; no identifying information is being collected from you as part of this study. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.

Anonymity will be ensured by coding the study questionnaire. The researchers will give out pre-coded questionnaires. Students will get both questionnaires at baseline with an envelope. They will be asked to put the follow-up questionnaire in the envelope, write their name on the envelope, seal it and return it to the researchers. Then at the follow-up, they get their own envelope with the correctly coded questionnaire so the researchers can match the baseline and follow-up questionnaires. No record will be kept of the names and matching codes.

Students who agree to participate in this study will enter into a draw to win one of three $10 Tim Horton's gift cards. No identifying information is being collected from nursing students as part of the study; however, after they have completed the follow-up questionnaire, the students who won the $10 gift card will receive it, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

6. Where will data be stored and for how long?
The data will be entered into Stata statistical software program. The laptop used for data entry will be password-protected. The collected questionnaires and the laptop used for data entry will be stored in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

7. What information is being collected?
As the part of the study questionnaire, the research team will collect and use only the information they need for this research study.

- Year of study
- Program option
- Age
- Gender
- Extra clinical experiences outside nursing school
- Training about Routine Practices
- Your answers to the baseline and follow-up questionnaires

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the baseline and follow-up questionnaires have been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.

9. Questions or problems:
If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, 709-864-3603, moralejo@mun.ca.

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:
Ethics Office at 709-777-6974
Email at info@hrea.ca

Nursing Instructors' Information Sheet (Intervention Group)

TITLE: Evaluation of a Problem-Solving Educational Program for Nursing Students to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study

INVESTIGATORS:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca
Co-investigators:

- **Dr. Donna Moralejo (Supervisor) PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3603.**
- **Dr. April Pike, School of Nursing, aprilpike@mun.ca.**
- **Dr. Vernon Curran, PhD, associate dean of educational development, Faculty of Medicine, vcurran@mun.ca.**

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your employment status or your relations with your colleagues.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.

Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.
The researchers will:

- discuss the study with you
- answer your questions
- keep confidential any information which could identify you personally
- be available during the study to deal with problems and answer questions

1. Why is this research study important?
Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to Routine infection control Practices (RP) such as hand hygiene and use of personal protective equipment (PPE). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and clinical instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.

2. What is the purpose of this research study?

The aim of this study is to examine the effects of a Problem-Solving Routine Practices (PSRP) educational program for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to (RP).

3. What will happen during the study and how long the study will take?

A full time and part-time nursing instructors at School A who teach in a selected course in year 2 or 3 of either the regular stream or accelerated nursing programs who agreed to be part of the study will receive training program related to RP as part of a schedule classes. The training program will last for 120 minutes, with 20 minutes allocated to completing the baseline questionnaire, 30 minutes for an interactive PowerPoint presentation, 60 minutes for small-group case discussion to apply problem solving to the identified barriers to adherence to RP, and 10 minutes for obtaining feedback. Nursing students in the identified classes will also participate with the instructor in small–group case discussion. Nursing instructors who agree to participate in the study will be asked to complete the study questionnaire before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete. There is no any known risk to participating or not participating in study intervention; your decision will not have an impact on employment status or your relationships with your colleagues.

4. Do I need to sign this consent form? What does consenting to participate mean?
Completing the study questionnaires is your consent to be in this study; you do not need to sign a form.

When you participate in this study, you give us permission to:

- Collect information from you
- Complete baseline and follow-up questionnaires
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to research records (i.e., questionnaires). This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

The study questionnaire is anonymous; no identifying information is being collected from you as part of this study. The members of the research team will have access to study data, but no one

will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study.

Anonymity will be ensured by coding the study questionnaire. The researchers will give out pre-coded questionnaires. Students will get both questionnaires at baseline with an envelope. They will be asked to put the follow-up questionnaire in the envelope, write their name on the envelope, seal it and return it to the researchers. Then at the follow-up, they get their own envelope with the correctly coded questionnaire so the researchers can match the baseline and follow-up questionnaires. No record will be kept of the names and matching codes.

Instructors who agree to participate in this study will enter into a draw to win $10 Tim Horton's gift card. No identifying information is being collected from you as part of the study; however, after you have completed the follow-up questionnaire, instructors who choose to enter in the draw, and who won the gift cards, will receive it, and they will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

6. Where will data be stored and for how long?
The data will be entered into Stata statistical software program. The laptop used for data entry will be password-protected. The collected questionnaires and the laptop used for data entry will be stored in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

7. What information is being collected? Where will it be stored and for how long?
As the part of the study questionnaire, and before the beginning of the intervention program, the research team will collect and use only the information they need for this research study.

- Employment status
- Nursing school where are you currently working
- Number of years you have worked as an instructor or professor
- Gender
- Training about Routine Practices
- Types of courses (e.g., clinical, theory) you teach
- Area of clinical (e.g., community, med-surg) in which you teach
- Your answers to the baseline and follow-up questionnaires

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the baseline and follow-up questionnaires have been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.

If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:

Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3603.

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:
Ethics Office at 709-777-6974
Email at info@hrea.ca

Nursing Students' Information Sheet (Control Group)

TITLE: Evaluation of a Problem-Solving Educational Program for Nursing Students to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study

INVESTIGATORS:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca.
Co-investigators:

- **Dr. Donna Moralejo (Supervisor) PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca. 709-864-3603.**
- **Dr. April Pike, School of Nursing, aprilpike@mun.ca.**
- **Dr. Vernon Curran, PhD, Associate Dean of Educational Development, Faculty of Medicine, vcurran@mun.ca.**

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your student status or grades or your relations with your colleagues or instructors.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.

Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.
The researchers will:

- discuss the study with you
- answer your questions
- keep confidential any information which could identify you personally
- be available during the study to deal with problems and answer questions

1. Why is this research study important?

Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to recommended infection prevention and control routine practices (RP), hand hygiene and use of Personal Protective Equipment (PPE). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and clinical instructors to deal with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.

2. What is the purpose of this research study?
The aim of this study is to examine the effects of a Problem-Solving Routine Practices (PSRP) educational program for nursing students and nursing instructors on their knowledge, confidence, and ability to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?
Nursing students who registered in year 2 or 3 of either the regular stream or accelerated nursing programs at School B, you will be asked to complete the study questionnaire related to RP as part of a scheduled classes. Students who agree to participate in the study will be asked to complete the study questionnaire before the beginning of the intervention program (baseline) as well as a 4 to 6 weeks later (follow-up). The questionnaire will ask you about different aspects of RP and problem solving, including strategies used, confidence and self-reported adherence to RP. The questionnaire may take approximately 15-20 minutes to complete.

There is no known risk to participating or not participating in study intervention; your decision will not have an impact on your student status or grades. It is not known whether this study will benefit you.

4. Do I need to sign this consent form? What does consenting to participate mean?
Completing the study questionnaires is your consent to be in this study; you do not need to sign a consent form.

When you participate in the intervention program, you give us permission to:

- Collect information from you
- Complete baseline and follow-up questionnaires
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to research records (i.e., questionnaires). This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

The study questionnaire is anonymous; no identifying information is being collected from you as part of this study. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study. Anonymity will be ensured by coding the study questionnaire. The researchers will give out pre-coded questionnaires. Students will get both questionnaires at baseline with an envelope. They will be asked to put the follow-up questionnaire in the envelope, write their name on the envelope, seal it and return it to the researchers. Then at the follow-up, they get their own envelope with the correctly coded

questionnaire so the researchers can match the baseline and follow-up questionnaires. No record will be kept of the names and matching codes.

Students who agree to participate in this study will enter into a draw to win one of three $10 Tim Horton's gift cards. No identifying information is being collected from nursing students as part of the study; however, after they have completed the follow-up questionnaire, students who choose to enter in the draw, and who won the $10 gift cards will immediately receive it. The students will be asked to write their email address on a piece of paper and give it to one of the researchers. Email addresses will be destroyed as per Memorial University policy.

6. Where will data be stored and for how long?
The data will be entered into Stata statistical software program. The laptop used for data entry will be password-protected. The collected questionnaires and the laptop used for data entry will be stored in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

7. What information is being collected?
As the part of the study questionnaire, the research team will collect and use only the information they need for this research study.

- Year of study
- Program option
- Age
- Gender
- Extra clinical experiences outside nursing school
- Training about Routine Practices
- Your answers to the baseline and follow-up questionnaires

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the baseline and follow-up questionnaires have been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.

9. Questions or problems:
If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**
Dr. Donna Moralejo (**Supervisor),** PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3603.

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through:
Ethics Office at 709-777-6974
Email at info@hrea.ca

Nursing Instructors' Information Sheet (Control Group)

TITLE: **Evaluation of a Problem-Solving Educational Program for Nursing Students to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study**

INVESTIGATORS:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca
Co-investigators:

- **Dr. Donna Moralejo (Supervisor) PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3603.**
- **Dr. April Pike, School of Nursing, aprilpike@mun.ca.**
- **Dr. Vernon Curran, PhD, associate dean of educational development, Faculty of Medicine, vcurran@mun.ca.**

You have been invited to take part in a research study. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you are free to leave at any time. Your decision will not have an impact on your employment status or your relations with your colleagues.

Before you decide, you need to understand what the study is for, what risks you might take and what benefits you might receive. This information sheet explains the study.

Please read this carefully. Take as much time as you like. Please mark anything you do not understand or want explained better. After you have read it, please ask questions about anything that is not clear.
The researchers will:

- discuss the study with you
- answer your questions
- keep confidential any information which could identify you personally
- be available during the study to deal with problems and answer questions

1. Why is this research study important?

Healthcare-associated infections (HAIs) have negative consequences for patients, nurses, and the healthcare system. However, the majority of HAIs could be prevented through adherence of nurses and nursing students to Routine infection control Practices (RP) such as hand hygiene and use of personal protective equipment (PPE). A number of barriers have been shown to reduce adherence to RP. Because it is not always feasible to eliminate the barriers to adherence, problem-solving strategies can potentially help nursing students and clinical instructors to deal

with these barriers and promote adherence to RP. Using a problem-solving approach to strengthen RP however has not yet been researched.

2. What is the purpose of this research study?
The aim of this study is to examine the effects of a Problem-Solving Routine Practices (PSRP) educational program for nursing instructors and nursing students on their knowledge, confidence, and ability to deal with barriers to adherence to RP.

3. What will happen during the study and how long the study will take?
A fulltime and part-time nursing instructor at School B who agreed to be part of the study, and who agree to be part of the control group will be asked to complete the study at the bingeing of the study as well 6 to 8 week later. The instructors will complete the study questionnaire at a selected course. The questionnaires will ask you about different aspects of RP and problem solving, including strategies used, confidence and reinforcement of problem solving related to RP. The questionnaires may take approximately 15-20 minutes to complete. There is no any known risk to participating or not participating in study intervention; your decision will not have an impact on your employment status or your relations with your colleagues. It is not known whether this study will benefit you.

4. Do I need to sign this consent form? What does consenting to participate mean?
Completing the study questionnaires is your consent to be in this study; you do not need to sign a form.

When you participate in this study, you give us permission to:

- Collect information from you
- Complete baseline and follow-up questionnaires
- Share information with the people conducting the study
- Share information with the people responsible for protecting your safety

5. What about my privacy and confidentiality? Who can access my data?
Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to research records (i.e., questionnaires). This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

The study questionnaire is anonymous; no identifying information is being collected from you as part of this study. The members of the research team will have access to study data, but no one will know the participants' identities. Your name is not being recorded and therefore will not appear in any report or article published as a result of this study. Anonymity will be ensured by coding the study questionnaire. The researchers will give out pre-coded questionnaires. Students will get both questionnaires at baseline with an envelope. They will be asked to put the follow-up questionnaire in the envelope, write their name on the envelope, seal it and return it to the

researchers. Then at the follow-up, they get their own envelope with the correctly coded questionnaire so the researchers can match the baseline and follow-up questionnaires. No record will be kept of the names and matching codes.

Instructors who agree to participate in this study will enter into a draw to win **$**10 Tim Horton's gift card. No identifying information is being collected from you as part of the study; however, after you have completed the follow-up questionnaire, instructors who choose to enter in the draw will be asked to write their email address on a piece of paper and give it to one of the researchers. At the end of the data collection period, the instructors who won the $10 gift card will be contacted by the researchers to receive the gift card. Email addresses will be destroyed after the gift card have been awarded.

6. Where will data be stored and for how long?
The data will be entered into Stata statistical software program. The laptop used for data entry will be password-protected. The collected questionnaires and the laptop used for data entry will be stored in locked offices in the education building (ED-5004). Only the research team can access the data. In addition, data will be kept for at least 5 years, as per Memorial University policy.

7. What information is being collected? Where will it be stored and for how long?
The research team will collect and use only the information they need for this research study.

- Employment status
- Nursing school where are you currently working
- Number of years you have worked as an instructor or professor
- Gender
- Training about Routine Practices
- Types of courses (e.g., clinical, theory) you teach
- Area of clinical (e.g., community, med-surg) in which you teach
- Your answers to the baseline and follow-up questionnaires

8. What happens if I do not want to answer specific questions or want to stop my participation?
You can choose not to answer any question. If you decide to withdraw from the study and stop participation, the information collected up to that time will continue to be used by the research team. All data collected will be anonymous hence, once the baseline and follow-up questionnaires have been submitted, the research team will not be able to identify participants and thus data collected will not be able to be removed. The information collected will only be used for the purposes of this study.

If you have any questions about taking part in this study, you can contact the investigator who is in charge of the study:
Researcher: Abubaker Hamed, PhD (c), Principal Investigator, Memorial University School of Nursing, 709-986-9410, amh040@mun.ca**.**

Supervisor: Dr. Donna Moralejo PhD RN, Professor and Associate Dean (Graduate Programs), School of Nursing, moralejo@mun.ca, 709-864-3603.

Or you can talk to someone who is not involved with the study at all, but can advise you on your rights as a participant in a research study. This person can be reached through: Ethics Office at 709-777-6974

Appendix I

Problem-Solving Questionnaire (CBA Study)

The Problem-Solving Questionnaire - Baseline (Students) Code-------

Thank you for agreeing to participate in the study evaluating ***a Problem-Solving Educational Program for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study.***

The questionnaire may take approximately 10-15 minutes to complete.

You were sent some information explaining the study. Key details are summarized here. Please read the information carefully, and check "I agree" to participate.

1. Completing the study questionnaires indicates your consent to be in this study; you do not need to sign a consent form.
2. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you can choose to stop at any time.
3. Any answers submitted up to that point will be used in the analysis.
4. Your decision will not have an impact on your student status or your grades.
5. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
6. The study questionnaire is anonymous; no identifying information is being collected from you as part of this study.
7. You will be asked to complete the study questionnaires at baseline and 4 to 6 weeks later.

Please let us know if you have any questions.

I understand and agree to participate

- ○ Yes
- ○ No

Section One: Knowledge about Routine Practices, problem solving, and strategies

Please write your short answers to the following questions. If you don't know the answers to any of these questions, please write "unsure" or "I don't know".

Q1.1 What is the key difference between Routine Practices (RP) and Additional Precautions (AP)?

Q1.2 Name 2 components of Routine Practices (also known as Standard Precautions) other than hand hygiene.

- 1
- 2

Q1.3 Answer the following questions related to a point of care risk assessment.

- What is it?
- Why is it done?

Q1.4 Name the link in the chain of infection that is disrupted by each of the following:

- Gloves
- Mask
- Vaccination

Q1.5 What does problem solving mean to you with respect to infection prevention and control?

Q1.6 What are the steps of problem solving?

Section Two: Barriers to Adherence to RP

Please select all that apply.

Q2.1 In your last clinical course, which of the following barriers did you encounter? Please select all that apply.

- High nursing workload
- Negative role models
- Inconvenient location of alcohol-based hand rub (ABHR)

- ○ Forgetfulness
- ○ I did not encounter any of these barriers
- ○ Other, please specify_____

Q2.2 In your last clinical course, did you discuss with your classmates application of problem solving to deal with the barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how often?

Q2.3 In your last clinical course, did you discuss with your <u>instructors</u> application of problem solving to deal with the barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how often? Who initiated the discussion? You, instructors, or classmates?

<u>Section Three: Application of problem solving to deal with the identified barriers</u>
Please answer the following questions

Q 3.1 Did you use problem-solving steps to deal with the influence of a busy shift on your adherence to RP?

- Yes
- No

Q 3.2 Did you use problem-solving steps to deal with the influence of negative role models on your adherence to RP?

- Yes
- No

Q 3.3 Did you use PS solving steps to deal with the influence of inconvenient location of ABHR)?

- Yes
- No

Q 3.4 If you did use problem-solving steps to deal with a busy shift, negative role models, or high nursing workload, explain how you applied PS steps to deal with ONE of these barriers.

Q 3.5 Did it make a difference to your adherence to RP?

Section Four: Confidence about applying problem solving deal with the identified

In your last clinical course, please indicate your level of confidence with each of these items (check your answer).

Confidence questions	Confident	Somewhat confident	Not very confident	Not at all confident
Q 4.1 Applying problem-solving steps to deal with the influence of a busy shift on my adherence to Routine Practices	○	○	○	○
Q 4.2 Applying problem-solving steps to deal with the influence of a negative role model on my adherence to Routine Practices	○	○	○	○
Q 4.3 Applying problem-solving steps to deal with the influence of inconvenient location of ABHR on my adherence to Routine Practices	○	○	○	○

Section Five: Adherence to Routine Practices

In your last clinical course, please indicate how often you performed the following tasks (check your answer).

Adherence questions	All of the time	Most of the time	Some of the time	Rarely
Q5.1 I put used sharp needles into sharps containers. Check if not apply ☐	○	○	○	○
Q5.2 I cleaned my hands immediately after removal of gloves	○	○	○	○
Q5.3 I wore gloves when I am potentially exposed to body fluids, blood products, and any excretion of patients	○	○	○	○
Q5.5 I washed my hands with soap and water if they are visibly soiled	○	○	○	○
Q5.6 I cleaned and disinfect all shared patient care equipment (e.g., blood pressure cuffs, stethoscope, and glucometer)	○	○	○	○
Q5.7 I did a point of care risk assessment before each patient encounter	○	○	○	○

Section Six: Demographic Data

Q6.1 What year are you in?

- First year
- Second year
- Third year
- Fourth year

Q6.2 What nursing school are you in?

- School A
- School B

Q6.3 What stream are you in?

- Regular stream
- Accelerated program

Q6.4 What is your age?

- 18-24 years old
- 25-34 years old
- 35-44 years old
- Older than 45 years

Q6.5 What is your gender?

- Male
- Female
- Other

Q6.6 Have you been taught problem solving related to infection prevention and control?

- Yes
- No

Q6.6 Have you been taught problem solving for areas other than infection prevention and control?

- Yes
- No

Thank you for participating in the study

The Problem-Solving Questionnaire - Baseline (Instructors) Code_____

Thank you for agreeing to participate in the study evaluating ***a Problem-Solving Educational Program for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study.*** **The questionnaire may take approximately 10-15 minutes to complete.**

You were sent an information sheet explaining the study. Key details are summarized here. Please read the information carefully, and check "I agree" to participate.

1. Completing the study questionnaires indicate your consent to be in this study; you do not need to sign a consent form.
2. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you can choose to stop at any time.
3. Any answers submitted up to that point will be used in the analysis.
4. Your decision will not have an impact on your employment status or your relationships with your colleagues.
5. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
6. The study questionnaire is anonymous; no identifying information is being collected from you as part of this study.
7. You will be asked to complete the study questionnaires at the baseline and 6 to 8 weeks later.

Please let us know if you have any questions

I understand and agree to participate

- ○ Yes
- ○ No

Section One: Knowledge related to Routine Practices and Problem Solving

Please write your short answers to the following questions. If you don't know the answers to any of these questions, please write "unsure" or "I don't know".

Q1.1 What is the key difference between Routine Practices and Additional Precautions?

Q1.2 Name 2 components of Routine Practices other than Hand hygiene.

Q1.3 What is the minimum time needed for Alcohol Based Hand Rub (ABHR) to kill most germs on hands?

Q1.4 Answer the following questions related to a point of care risk assessment.

- ○ What is it?
- ○ Why is it done?

Q1.5 Name the link in the chain of infection that is disrupted by each of the following:

- ○ Gloves
- ○ Mask
- ○ Vaccination

Q1.6 What does problem solving mean to you with respect to infection prevention and control?

Q1.7 What are the steps of problem solving?

Section Two: Application of problem solving to deal with the identified barriers

Q2.1 In your last clinical course, did you use problem-solving steps to help your students to deal with the influence of a busy shift on their adherence to RP?

- ○ Yes
- ○ No

Q2.3 In your last clinical course, did you use problem-solving steps to help your students to deal with the influence of negative role models on their adherence to RP?

- ○ Yes
- ○ No

Q2.4 In your last clinical course, did you use PS solving steps to help your students to deal with the influence of inconvenient location of ABHR on your adherence to RP?

- Yes
- No

Q2.5 If you did use problem-solving steps to help your students with deal with a busy shift, negative role models, or high nursing workload, explain how you helped your students to apply PS steps to deal with ONE of these barriers.

Q3.6 Did it make a difference to your students' adherence to RP?

<u>Section Three: Confidence about applying problem solving deal with the identified</u>
In your last clinical course, please indicate your level of confidence with each of these items (check your answer).

Confidence questions	Confident	Somewhat confident	Not very confident	Not at all confident
Q3.1 I helped my students applying problem-solving steps to deal with the influence of a busy shift on their adherence to Routine Practices				
Q3.2 I helped my students applying problem-solving steps to deal with the influence of a negative role model on their adherence to Routine Practices				
Q3.3 I helped my students applying problem-solving steps to deal with the influence of the inconvenient location of ABHR on their adherence to Routine Practices				

Section Four: Reinforcement of Problem Solving

Please answer the following questions

Q4.1 In your last clinical course, did you reinforce with your students application of problem-solving steps to deal with barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how did you reinforce application of problem solving? And how often?

Q4.2 In your last clinical course, did you use part of the clinical conferences to discuss with your students application of problem-solving steps to deal with barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how often, and what did you discuss?

Section Five: Demographic Data

Q5.1 What is your current employment status with the school of nursing?

- ○ Full time
- ○ Part time

Q5.2 What nursing school are you currently working with?

- ○ School A
- ○ School B

Q5.3 How many years have you worked as an instructor or professor?

- ○ Less than 5 years
- ○ 6 - 10 years
- ○ 11 – 20 years
- ○ More than 20 years

Q5.4 What is your gender?

- ○ Male

- ○ Female
- ○ Other

Q5.5 What type(s) of courses do you teach?

- ○ Clinical
- ○ Theory
- ○ Both

Q5.6 What area of clinical do you teach?

- ○ Medical surgical
- ○ Community
- ○ Maternity or pediatric
- ○ Mental health
- ○ Other _____
- ○ I don't teach clinical

Q5.7 Have you taught problem solving related to infection prevention and control?

- ○ Yes
- ○ No

Thank you for participation

The Problem-Solving Questionnaire - Follow-up (Students) Code-------

Thank you for agreeing to participate in the study evaluating ***a Problem-Solving Educational Program for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study.*** **The questionnaire may take approximately 10-15 minutes to complete.**

You were sent some information explaining the study. Key details are summarized here. Please read the information carefully, and check "I agree" to participate.

8. Completing the study questionnaires indicates your consent to be in this study; you do not need to sign a consent form.
9. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you can choose to stop at any time.
10. Any answers submitted up to that point will be used in the analysis.
11. Your decision will not have an impact on your student status or your grades.
12. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
13. The study questionnaire is anonymous; no identifying information is being collected from you as part of this study.
14. You will be asked to complete the study questionnaires at baseline and 4 to 6 weeks later.

Please let us know if you have any questions.

I understand and agree to participate

- ○ Yes
- ○ No

Section One: Knowledge about Routine Practices, problem solving, and strategies

Please write your short answers to the following questions. If you don't know the answers to any of these questions, please write "unsure" or "I don't know".

Q1.1 What is the key difference between Routine Practices (RP) and Additional Precautions?

Q1.2 Name 2 components of Routine Practices (also known and Standard Precautions) other than hand hygiene.

- 1
- 2

Q1.3 Answer the following questions related to a point of care risk assessment;

- What is it?
- Why is it done?

Q1.4 Name the link in the chain of infection that is disrupted by each of the following:

- Gloves
- Mask
- Vaccination

Q1.5 What does problem solving mean to you with respect to infection prevention and control?

Q1.6 What are the steps of problem solving?

Section Two: Barriers to Adherence to RP

Please select all that apply.

In your last clinical course, which of the following barriers did you encounter? Please select all that apply.

- ○ High nursing workload
- ○ Negative role models
- ○ Inconvenient location of alcohol-based hand rub (ABHR)
- ○ Forgetfulness
- ○ I did not encounter any of these barriers

Other, please specify_____

Q2.2 In your last 4 to 6 weeks of your clinical course, did you discuss with your classmates application of problem solving to deal with the barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how often?

Q2.3 In your last 4 to 6 weeks of your clinical course, did you discuss with your <u>instructors</u>, application of problem solving to deal with the barriers to adherence to RP?

- ○ Yes
- ○ No

If yes, how often? Who initiated the discussion? You, instructors, or classmates?

<u>Section Three: Application of problem solving to deal with the identified barriers</u>
Please answer the following questions.

Q 3.1 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to deal with the influence of a busy shift on your adherence to RP?

- Yes
- No

Q 3.2 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to deal with the influence of negative role models on your adherence to RP?

- Yes
- No

Q 3.3 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to deal with the influence of inconvenient location ABHR?

- Yes
- No

Q 3.4 If you did use problem-solving steps to deal with a busy shift, negative role models, or high nursing workload, explain how you applied PS steps to deal with ONE of these barriers.

Q 2.7 Did it make a difference to your adherence to RP?

Section Four: Confidence about applying problem solving deal with the identified

In the last 4 to 6 weeks of your clinical course, please indicate your level of confidence with each of these items (check your answer).

Confidence questions	Confident	Somewhat confident	Not very confident	Not at all confident
Q 4.1 Applying problem-solving steps to deal with the influence of a busy shift on my adherence to Routine Practices	○	○	○	○
Q 4.2 Applying problem-solving steps to deal with the influence of a negative role model on my adherence to Routine Practices	○	○	○	○
Q 4.3 Applying problem-solving steps to deal with the influence of the inconvenient location of ABHR on my adherence to Routine Practices	○	○	○	○

Section Five: Adherence to Routine Practices

In the last 4 to 6 weeks of your clinical course, please indicate how often you performed the following tasks (check your answer).

Adherence questions	All of the time	Most of the time	Some of the time	Rarely
Q5.1 I put used sharp needles into sharps containers.	○	○	○	○
Q5.2 I cleaned my hands immediately after removal of gloves	○	○	○	○
Q5.3 I wore gloves when I am potentially exposed to body fluids, blood products, and any excretion of patients	○	○	○	○
Q5.5 I washed my hands with soap and water if they are visibly soiled	○	○	○	○
Q5.6 I cleaned and disinfect all shared patient care equipment (e.g., blood pressure cuffs, stethoscope, and glucometer)	○	○	○	○
Q5.7 I did a point of care risk assessment before each patient encounter	○	○	○	○

Section Six: Teaching and Learning about Problem Solving related to RP

Please answer the following questions.

Q6.1 Would you recommend this problem-solving intervention to be part of your curriculum related to Infection Prevention and Control?

- ○ Yes
- ○ No

If yes, when is the best time to introduce it? Please check that all apply.

- ○ Year 1
- ○ Year 2
- ○ Year 3
- ○ Year 4

Thank you for participating in the study

The Problem-Solving Questionnaire - Follow-up (Instructors) Code_____

Thank you for agreeing to participate in the study evaluating ***a Problem-Solving Educational Program for Nursing Students and Nursing Instructors to Deal with the Barriers to Adherence to Routine Infection Control Practices: A Controlled Before and After Study.*** **The questionnaire may take approximately 10-15 minutes to complete.**

You were sent an information sheet explaining the study. Key details are summarized here. Please read the information carefully, and check "I agree" to participate.

8. Completing the study questionnaires indicates your consent to be in this study; you do not need to sign a consent form.
9. Taking part in this study is voluntary. It is up to you to decide whether to be in the study or not. You can decide not to take part in the study. If you decide to take part, you can choose to stop at any time.
10. Any answers submitted up to that point will be used in the analysis.
11. Your decision will not have an impact on your employment status or your relationships with your colleagues.
12. Protecting your privacy is an important part of this study. Every effort to protect your privacy will be made.
13. The study questionnaire is anonymous; no identifying information is being collected from you as part of this study.
14. You will be asked to complete the study questionnaires at baseline and 4 to 6 weeks later.

Please let us know if you have any questions

I understand and agree to participate

- ○ Yes
- ○ No

Section One: Knowledge related to Routine Practices and Problem Solving

Please write your short answers to the following questions. If you don't know the answers to any of these questions, please write "unsure" or "I don't know".

Q1.1 What is the key difference between Routine Practices (RP) and Additional Precautions (AP)?

Q1.2 Name 2 components of Routine Practices (also known as Standard Precautions) other than Hand hygiene.

Q1.3 What is the minimum time needed for Alcohol Based Hand Rub (ABHR) to kill most germs on hands?

Q1.4 Answer the following questions related to a point of care risk assessment.

- What is it?
- Why is it done?

Q1.5 Name the link in the chain of infection that is disrupted by each of the following:

- Gloves
- Mask
- Vaccination

Q1.6 What does problem solving mean to you with respect to infection prevention and control?

Q1.7 What are the steps of problem solving?

Q1.8 In the last 4 to 6 weeks of your clinical course, did you discuss with any of your student application of problem-solving steps to deal with the barriers to adherence to RP?

- Yes
- No

Section Two: Application of problem solving to deal with the identified barriers

Q2.1 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to help your students to deal with the influence of a busy shift on their adherence to RP?

- Yes
- No

Q2.3 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to help your students to deal with the influence of negative role models on their adherence to RP?

- Yes
- No

Q2.4 In the last 4 to 6 weeks of your clinical course, did you use problem-solving steps to help your students to deal with the influence of inconvenient location of ABHR on your adherence to RP?

- Yes
- No

Q2.5 If you did use problem-solving steps to help your students with deal with a busy shift, negative role models, or high nursing workload, explain how you helped your students to apply problem-solving steps to deal with ONE of these barriers.

Q3.6 Did it make a difference to your students' adherence to RP?

Section Three: Confidence about applying problem solving deal with the identified
In the last 4 to 6 weeks of your clinical course, please indicate your level of confidence with each of these items (check your answer).

Confidence questions	Confident	Somewhat confident	Not very confident	Not at all confident
Q3.1 I helped my students applying problem-solving steps to deal with the influence of a busy shift on their adherence to Routine Practices	○	○	○	○
Q3.2 I helped my students applying problem-solving steps to deal with the influence of a negative role model on their adherence to Routine Practices	○	○	○	○
Q3.3 I helped my students applying problem-solving steps to deal with the influence of the inconvenient location of ABHR on their adherence to Routine Practices	○	○	○	○

Section Four: Reinforcement of Problem Solving related to RP

Please answer the following questions.
Q4.1 In the last 4 to 6 weeks of your clinical course, did you reinforce with your students application of problem solving steps to deal with barriers to adherence to RP?

○ Yes

○ No

If yes, how did you reinforce application of problem solving? And how often?

Q4.2 In the last 4 to 6 weeks of your clinical course, did you use part of the clinical conferences to discuss with your students application of problem-solving steps to deal with barriers to adherence to RP?

○ Yes

○ No

If yes, how often, and what did you discuss?

<u>Section Five: teaching and learning about problem solving related to RP</u>
Please answer the following questions.

Q5.1 would you recommend this problem-solving intervention to be part of your curriculum related to Infection Prevention and Control?

- ○ Yes
- ○ No

If yes, when is the best time to introduce it? Please check that all apply.

- ○ Year 1
- ○ Year 2
- ○ Year 3
- ○ Year 4

Thank you for participation

Appendix J

Feedback Form (CBA Study)

Problem solving intervention feedback form (Participants)

Instruction: Please indicate your agreement to the following statements.

Education program helped me to:	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
• Strengthen my knowledge about the key principles of RP				
• Strengthen my knowledge about the key principles of problem solving				
• Strengthen my knowledge about some of the strategies that can be used to deal with the barriers to adherence to RP				
• Enhance my ability to use problem solving steps to deal with the identified barriers to adherence to RP				
• Enhance my confidence in using problem solving steps to deal with the identified barriers to adherence to RP				

1. **Do you think you will be able to apply the problems-solving steps to deal with the barriers to adherence to Routine Practices (RP)?**

    A. Yes
    B. No

2. **If no, why not?**

3. **What did you like most about the program?**

4. **What did you like least about the program?**

5. **Any other comments?**

Thank you for your feedback