

ORIGINAL ARTICLE

Problem-solving training: effects on nursing students' adherence, confidence, and application of problem solving to deal with the barriers to adherence to routine infection control practices

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Abstract

**Background:** Adherence to routine practices (RP) in infection control can be influenced by a number of barriers, which can potentially be dealt with using problem solving (PS) as a new approach.

**Aim:** This study examined the effects of a problem-solving educational program (PSEDP) on nursing students' adherence, confidence, and application of PS to address the three identified common barriers to RP adherence.

**Method:** A controlled before and after study was conducted at two nursing schools in Eastern Canada. A total of 94 nursing students participated, with 62 students in the intervention group and 32 in the control group. Students in the intervention group received the PSEDP, while the control group received no intervention. Data from both groups were collected using a problem-solving questionnaire.

**Results:** Overall, no significant differences were found between the intervention and control groups in their adherence to RP ( $P = 0.580$ ), confidence in using PS ( $P = 0.602$ ), and application of PS (baseline  $P = 0.161$ , post-program  $P = 0.618$ ) to deal with the three identified barriers to RP adherence. However, we found significant differences in the subscale analysis of student confidence to deal with the barrier of high nursing workload ( $P = 0.032$ ) and student adherence to some of the RP components ( $P < 0.05$ ).

**Conclusion:** The educational program provided an opportunity for the students to learn about PS to address the three identified barriers. Some improvements were found but they were smaller than expected, possibly due to limited time for practice in the clinical setting following the intervention.

Keywords: *nursing student; problem solving; infection control; standard precautions; adherence; application; Canada*

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Healthcare-associated infections (HAIs) are prevalent in a number of Canadian healthcare facilities, with a prevalence rate estimated to be between 8 and 13%, and approximately 220,000 Canadians suffering from HAIs each year (1). Acquiring HAIs can 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 (2–4). To help 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. RP and SP include hand hygiene, use of personal protective equipment (PPE), sharps safety, and cleaning and disinfecting patient care equipment. Although the majority of HAIs can be

prevented through continuously adhering to RP and SP, adherence rates among nurses and nursing students were found to range from 55 to 78% (5–7). This suboptimal adherence has been attributed to a number of barriers. In this study, we focused on the top three commonly reported barriers to adherence to RP, which are high nursing workload, presence of negative role models, and inconvenient location of sinks and alcohol-based hand rub (ABHR) dispensers (8–12).

Addressing workload as a barrier to adherence to RP can be difficult under current healthcare system constraints such as lack of staffing and complexity of patient care, while interventions related to negative role models have focused on having students and nurses work with positive role models (13, 14). Because it may not always be possible to change the location of ABHR dispensers and hand wash sinks, therefore, nursing students need to be

prepared through specific strategies to deal with the influence of these barriers on their adherence to RP. Because 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), students need to use their problem-solving skills and try multiple solutions, and evaluate which strategies would help them to deal with specific barriers.

Problem solving (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” (15). PS can help nursing students to overcome complex problems that they may encounter during their clinical practice (16, 17). Moreover, PS skills have been shown to improve nursing students’ critical thinking, decision-making, and self-efficacy (18–20).

Multiple interventions, such as education, audits, and administrative support, have been implemented to improve adherence to RP (21–23). However, none of these interventions has specifically looked at the use of PS as an approach to address barriers to RP adherence. Despite the benefits of using PS as a strategy to enhance nursing students’ clinical practice, there have been no studies to date that have examined the effectiveness of using PS strategies to deal with the barriers to RP adherence. Therefore, the aim of this study was to evaluate the effect of a problem-solving educational program (PSEDP) on students’ adherence, confidence, and application of PS related to RP adherence.

## Methods

### Study design

A controlled before and after (CBA) study design was used.

### Study settings and participants

Second- and third-year nursing students were recruited from two nursing schools: Memorial University Faculty of Nursing (MUNFON) and Western Region School of Nursing (WRSON) in Eastern Canada. Participants were in Years 2 and 3 of the regular 4-year program and in Year 2 of the optional accelerated 3-year program. There was a total of 94 participants who were registered in the fall semester of 2019; 62 were in the intervention group at MUNFON, and 32 were in the control group at WRSON. Both schools share a curriculum and their regional health authorities follow similar policies and procedures.

### The education program

The PSEDP was developed based on gaps in the literature and the results of our recently conducted

cross-sectional study in the same settings, reported elsewhere (24). The PSEDP consisted of two parts: an educational part and an application part. In the educational part, the researchers discussed topics related to barriers to adherence, the definition of PS, and the steps of the social problem-solving model (25). The constructivist learning theory (CLT) informed the application part of the program. The CLT has a major focus on learning as an active process in which the learner is encouraged to construct new ideas and meanings based on their current or previous experience (26).

Based on the principles of the CLT, students were asked to discuss three case scenarios about the three barriers to RP adherence and construct some strategies that they can use to overcome these barriers. These three scenarios highlighted the three most common barriers to RP adherence that have been identified in the literature: high workload, presence of negative role models, and inconvenient location of ABHR. The questions related to each case scenario 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 (25). Students were divided into groups of three to eight students, and students in each group discussed the identified barrier using the questions on the discussion guide. Each group of students also had a facilitator to help them analyze the case using the discussion guides.

In CLT, the educator works as a facilitator of the learning process by developing educational materials and using techniques such as discussion, reflection, and concept mapping to guide the discussion throughout the learning process (27). In our study, the facilitators were three faculty members and two lab instructors, recruited and trained by the principal researcher on the use of the three discussion guides.

### Instrument for data collection

A *problem-solving questionnaire* was developed by the researchers based on the results of a cross-sectional study conducted by the researchers (24), a literature review, and the objectives of this study. The questionnaire comprised five sections. Section 1 consisted of six items to measure students’ self-report adherence to RP. The six items were scored on a 4-point Likert scale from 1 “rarely” to 4 “all of the time.” The total score ranged from 6 to 24. Section 2 consisted of three items to measure students’ confidence about applying PS to deal with the identified barriers to adherence to RP. The three items to measure students’ confidence were scored on a 4-point Likert scale from 1 “not at all confident” to 4 “confident.” The total score ranged from 3 to 12. In Section 3, we included one “select

all that apply” question to identify the commonly encountered barriers to adherence to RP. Section 4 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 if the answer to the questions was yes. The total score ranged from 0 to 3. The final section included a series of questions related to nursing students’ demographic characteristics such as year of study, gender, and age, and any previous training about RP and PS.

The study questionnaire was pilot tested on a group of faculty members and 16 nursing students who had just graduated; they had similar characteristics to the study group. Based on their feedback, minor changes were made to the questionnaire. The questionnaire was also tested for content validity through administration to five experts in adult learning and infection prevention and control (IPC) to determine whether questions measured the outcomes of interest; it had an acceptable content validity index of 0.80. The internal consistency of the two sections of the questionnaire that employed Likert scales (confidence of PS and adherence to RP) was assessed using Cronbach’s alpha. The confidence scale showed good reliability (Cronbach’s  $\alpha = 0.81$ ) whereas the adherence scale (Cronbach’s  $\alpha = 0.48$ ) was weaker, possibly due to the limited number of items.

#### Statistical analysis

Percentages and frequencies were used to describe the students’ demographic data (e.g. age, gender, year, stream of study), whether they were taught PS related to IPC practices previously, and barriers to RP adherence. The normality assumption of the outcome variables was tested using the Shapiro-Wilk *W* test for normal data. Based on this method, the Mann-Whitney *U* test was used to test for differences in the median scores for the adherence to RP and confidence about applying PS. In contrast, the paired *t*-test was used to compare the mean of students’ application of PS scores in baseline and post-program. For the subscale analysis, chi-square test was used to assess whether there were differences in the number of students whose answers reflected an improvement or not in their confidence in PS and in their adherence to RP (from baseline to follow-up) between those who received the PSEDP and those who did not. A two-sided  $P < 0.05$  was considered statistically significant. The data were analyzed with Stata statistical software (Stata Crop, 2015).

## Results

Baseline characteristics of the participants are presented in Table 1. Of the 94 students recruited for the study, the majority were female aged 18–24 years and in Year 2 of the regular stream. More students in the control group

(90.6%) compared to the intervention groups (54.8%) stated that they had been taught PS related to IPC practices. In comparison, more than 82% of the students in both groups stated that they had been taught PS related to areas other than IPC practices.

The results in Table 2 show that more than 90% of nursing students in the intervention group and all students in the control group reported that they have encountered a number of barriers that prevented them from adhering to RP. The commonly reported barriers by both groups were negative role models, high nursing workload, and forgetfulness. Less than 5% of students in both groups reported that other barriers influenced their adherence to RP.

Table 1. Characteristics of nursing students

Characteristics		Intervention (n = 62)	Control (n = 32)
		% (n)	% (n)
Year and stream of study	Year 2 accelerated	29.0 (18)	6.3 (2)
	Year 2 regular stream	48.4 (30)	65.6 (21)
	Year 3 regular stream	22.6 (14)	34.4 (11)
Age (years)	18–24	72.6 (45)	81.3 (26)
	25–34	22.6 (14)	15.6 (5)
	35–44	4.8 (3)	3.1 (1)
Gender	Female	88.7 (55)	96.9 (31)
	Male	11.3 (7)	3.1 (1)
Taught PS related to IPC practices	Yes	54.8 (34)	90.6 (29)
	No	45.2 (28)	9.4 (3)
Taught PS related to area other than IPC practices	Yes	82.3 (51)	87.5 (28)
	No	17.7 (11)	12.5 (4)

Table 2. Barriers preventing students from adhering to RP

Barriers to adherence to RP	Intervention (n = 62)	Control (n = 32)
	% (n) <sup>1</sup>	% (n) <sup>1</sup>
Negative role models	67.7 (42)	62.5 (20)
High nursing workload	56.5 (35)	50 (16)
Forgetfulness	50 (31)	28.1 (9)
Inconvenient location of ABHR	27.4 (17)	3.1 (1)
Other barriers	4.8 (3)	3.1 (1)
I did not encounter any of these barriers	1.6 (1)	0

Note: Numbers do not add up to 100% as students reported more than one barrier.

Table 3. Comparison of the median scores between two groups

Variables	Intervention (n = 60)	Control (n = 31)	z	P*
	Median score (IQR)	Median score (IQR)		
<b>Adherence to RP</b>				
Baseline	19.5 (18–21)	21.5 (19–24)	1.260	0.580
Post-program	22.5 (20–23)	22 (21.5–24)		
<b>Confidence to use PS</b>				
Baseline	9 (8–11)	9 (9–11)	1.582	0.602
Post-program	11 (9–12)	9 (9–11)		

\*P-value for the Mann-Whitney U test for the median differences between the intervention and control groups. The highest possible scores for adherence and confidence were 24 and 12, respectively.

Table 4. Comparison of the mean score of application of PS between two groups

	Intervention group (n = 62)	Control group (n = 32)	T	P*
	Mean ± SD	Mean ± SD		
<b>Application of PS</b>				
Baseline	1.17±1.04	1.47± 1.13	-1.410	0.161
Post-program	1.46±1.21	1.32± 1.24	0.500	0.618

\*P-value for the paired t-test of the mean scores of PS application between baseline and post-program for intervention and control groups.

Overall, as shown in Table 3, students in the intervention group had slightly higher median adherence and confidence scores compared to the control group. However, these differences were not statistically significant ( $z = 1.260$ ,  $P = 0.580$ ) and ( $z = 1.582$ ,  $P = 0.602$ ), respectively.

In the subscale analysis of the adherence to RP (not shown), 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 point of care risk assessment (PCRA) (intervention 15–41.7% vs. control 48.4–46.9%;  $P = 0.027$ ), cleaning and disinfecting all shared patient care equipment (intervention 37.1–41.7% vs. control 78.1–62.5%;  $P = 0.004$ ), and cleaning hands immediately after removal of gloves (intervention 63–66.7% vs. control 96.9–84.4%;  $P = 0.021$ ). 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.

In the subscale analysis of confidence to PS (not shown), we found 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 (intervention from 32.3% at baseline to 56.7% at follow-up vs. control 25.8–35.5%;  $P = 0.032$ ).

As shown in Table 4, paired *t*-test was used to compare the mean scores of students' application of PS in baseline and post-program. Students in the intervention group showed small improvements in their application of PS related to the barriers compared to the control group, but this difference was not statistically significant (baseline:  $P = 0.161$ ; post-program:  $P = 0.618$ ).

## Discussion

The aim of this study was to identify which barriers prevented nursing students from adhering to RP and to evaluate the effect of a PSEDP on students' adherence, confidence, and application of PS related to RP adherence.

In this study, we found that 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 frequency with which students encountered barriers to RP adherence indicates a need to help students learn to address them. The commonly encountered barriers by both groups were presence of negative role models, high nursing workload, forgetfulness, and inconvenient location of ABHR dispensers.

Our study result showed that 56.5 and 50% of the students in the intervention group and the control group, respectively, reported that high nursing workload negatively influenced their adhering to RP. This finding of this study was consistent with our recently conducted

cross-sectional study (24), as well as previous studies' findings (5, 10, 28). Our cross-sectional study with 557 students found similar results that high nursing workload (44.2%) was among the commonly reported barriers (24). In their cross-sectional survey studies, Cheung et al. (5) and Foote and El-Masri (10) found that 23–35% of nursing students reported that “busyness” influenced their adherence to SP.

We also found that 67.7% of the students in the intervention group and 62.5% in the control group reported that the presence of negative role models was one of the common barriers that prevented them from adhering to RP. Similar to our study, several studies identified the impact of role models on nursing students' adherence to SP. Dorgham and Obied (9) found that 38–40% of nursing students reported that they imitated their clinical instructors and nurses in their clinical areas. Similarly, Hinkin and Cutter (28) 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. Furthermore, two studies conducted in the United Kingdom (12) and Turkey (29) found that 38 and 91% of nursing students, respectively, self-reported that the presence of negative role models influenced their adherence to IPC practices.

In this study, we also found that 27.4% of nursing students in the intervention group 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 (10). Our recently conducted cross-sectional study (24) also found that 29.1% of students reported that inconvenient location of ABHR dispensers prevented them from adhering to RP. Moreover, Kirk et al. (11) surveyed 350 nurses and physicians from the United States and Canada about their knowledge, attitudes, and practices of hand hygiene. They found that over 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 (within one meter) compared to being further away.

In order for students to have better adherence to RP, they need to be confident in their application of PS to deal with the barriers they encounter. Overall, this study found that there were no significant differences between the intervention and control groups in their overall confidence to use PS to deal with the three barriers to adherence ( $P = 0.602$ ). However, when a sub analysis was conducted for each of the barriers, we found 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

( $P = 0.032$ ). There were no significant differences 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.

The study results revealed that both groups did not show statistically significant difference in their self-reported application of PS to deal with the three identified barriers to RP adherence (baseline:  $P = 0.161$ ; post-program:  $P = 0.618$ ). This lack of application of PS could be attributed to the limited time that students spent in clinical placements after the intervention session. During this study, students had spent only 5 clinical days following the intervention. 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. In order to improve students' 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 reinforcement of PS related to RP could take place and be an integral part of their regular clinical conference meetings.

Nursing administrators can also play an important role by providing their faculty members with training sessions about 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.

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. Although this research study confirmed that nursing students' adherence to RP is negatively impacted by the discussed three barriers, the PSEDP showed slight, but nonsignificant, overall improvement in their adherence to RP compared to the control groups ( $P < 0.05$ ). This could be attributed to the use of a self-report as students may have overestimated their adherence to RP, which was evident in their baseline scores. For instance, students' adherence scores were high at baseline in the intervention (mean = 19.5) and in the control group (mean = 21.5), so it is not surprising their improvements were small and not significant. However, we found significant differences in the subscale analysis of students' adherence to some of three of the RP components.



### 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. The study also applied CLT principles by using group discussion as a teaching method to enable students to engage in interactive discussions with their peers and to construct their own strategies that could be used to deal with barriers to RP.

As with any study, this study did have some limitations. The time allocated for the study was not long enough for the students to practice PS in clinical to obtain optimal results. In addition, the study intervention was delivered to the participants once, and the time allocated for the intervention was only 2 h due to the busy schedule for the students and the facilitators. 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 in real-life situations.

### Conclusion

In conclusion, in our study, 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. After PSEDP, more students in the intervention than in the control group showed slight improvement in their adherence to RP, confidence, and application of PS to deal with these three identified barriers. However, this improvement was not statistically significant, possibly due to limited time for practice. Further exploration of similar approaches is warranted for future studies.

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### Conflict of interest and funding

The authors declared no conflict of interest, and no funding was received to conduct this study.

### Ethical approval

This study was ethically approved by the Health Research Ethics Board and the Western Health Research Review Committee, and the two schools of nursing. The students were informed that completing and submitting the questionnaire indicated their consent to be in this study, and they did not need to sign a consent form.

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