

Effectiveness of Structured Infection Prevention and Control Training on Improving Knowledge, Perception, and Confidence in Performance of Undergraduate Nursing Students in a University Hospital: A Quasi-experimental Study

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ABSTRACT

Background

Healthcare-associated infections remain a significant global patient-safety concern. Effective implementation of infection prevention and control (IPC) measures can prevent these infections. Nurses play a key role in implementing infection prevention and control measures because of their continuous patient contact and involvement in clinical procedures.

Objective

To assess the effectiveness of a structured infection prevention and control training program on improving knowledge, perception, and confidence among nursing students in a university hospital.

Method

A quasi-experimental pre-test and post-test study was conducted at the Kathmandu University School of Medical Sciences, Nepal, from August 2025 to January 2026 among nursing students. Baseline score on participants' knowledge, perceptions, and self-reported confidence were compared with post scores following infection prevention and control trainings immediately and after three weeks.

Result

A total of 143 nursing students participated in the study. The baseline scores for knowledge, perception, and self-reported confidence improved from 26.64, 194.62, and 191.03, respectively to 29.38, 203.20 and 199.57 immediately to 29.38 ± 3.04, 203.20 ± 13.11 and 199.57 ± 8.97 respectively after three weeks, following the infection prevention and control training. Perception score demonstrated a significant improvement immediately after the training but did not show a further significant increase at the three-week follow-up.

Conclusion

The structured infection prevention and control training was effective in improving nursing students' knowledge and self-confidence regarding infection prevention and control practices, indicating a positive retention of learning. It can play an important role in strengthening students' preparedness for safe clinical practice, though additional strategies may be needed to sustain long-term changes in perception.

KEY WORDS

Confidence, Infection prevention and control, Knowledge, Nursing Students, Perception

INTRODUCTION

Healthcare-associated infections (HAIs) are infections that occur 48 hours or more after hospital admission and were not present or incubating at the time of admission.¹ Common HAIs include catheter-associated urinary tract infections, central line-associated bloodstream infections, ventilator-associated pneumonia, and surgical site infections.² HAIs remain a significant global patient-safety concern as they contribute to increased morbidity, mortality, prolonged hospital stay, and higher healthcare costs.³ On any given day, about one in 31 hospital patients has at least one healthcare-associated infection. Infection prevention and control (IPC) practices such as proper hand hygiene, use of personal protective equipment, and adherence to standard precautions are essential strategies to reduce infection transmission and improve patient outcomes.⁴

Nurses play a key role in implementing IPC measures because of their continuous patient contact and involvement in clinical procedures. Although nursing students are expected to have adequate knowledge, appropriate perceptions, and confidence to apply IPC practices during clinical training, studies have shown that they often demonstrate only moderate knowledge and inconsistent adherence to IPC guidelines in clinical practice.⁵⁻⁷ Similar findings have also been reported in study conducted in Nepal, highlighting gaps in nursing students' knowledge on IPC practices.⁸ In many nursing curricula, IPC teaching is fragmented and largely theoretical, with limited opportunities for structured practical training. Moreover, evidence evaluating the impact of structured IPC training on nursing students' perception and confidence in performing infection prevention practices remains limited.^{9,10}

This study aimed to assess the effectiveness of a structured infection prevention and control training program on improving knowledge, perception, and confidence in performance among undergraduate nursing students in a university hospital. This may help the academicians to evaluate long term retention of IPC knowledge, translation into actual clinical care, and the effectiveness and sustainability of integrating in nursing curriculum.¹¹

METHODS

A quasi-experimental one-group pre-test and post-test study was conducted at Kathmandu University School of Medical Sciences (KUSMS), Nepal, from August 2025 to February 2026. Ethical approval was obtained from the Institutional Review Committee (IRC) of KUSMS (Ref. No. IRC 187/25). The study participants included third- and fourth-year nursing students enrolled in Bachelor in Nursing Science (BNS), Bachelor in Midwifery Sciences (B. Mid), and Bachelor of Science in Nursing (B.Sc. Nursing) programs at KUSMS who provided informed consent to participate. All

eligible nursing students were included in the study using a total enumeration (census) sampling method, resulting in a sample size of 143 students. First and second year undergraduate nursing students and master's level nursing students were excluded from the study.

Baseline data on knowledge, perception, and self-reported confidence in infection prevention and control (IPC) practices were collected using a self-structured questionnaire in English administered through Google forms as pre-test. The questionnaire was used from the study conducted by the same research team in 2023 to assess nursing students' knowledge, perception and confidence in performance on IPC measures.⁸ Following the pre-test, participants attended a two-day structured IPC training conducted by qualified trainers and nurses based on standard IPC protocols. Participants completed the same questionnaire immediately after the training (immediate post-test) and again three weeks after completion of the training (three-week post-test).

The questionnaire consisted of four parts. Part I included demographic characteristics. Part II assessed knowledge of IPC (40 items) covering general IPC principles (6 items), hand hygiene (6 items), use of personal protective equipment (PPE) (13 items), safe injection practices (9 items), aseptic technique (3 items), environmental sanitation (2 items), and waste management (1 item). Each correct response was scored as 1 and incorrect response as 0. Total knowledge scores were categorized as poor (< 50%), fair (50–79%), and good ($\geq$ 80%). Part III assessed perception toward IPC (42 items) and Part IV assessed confidence in performance of IPC practices (42 items) using a five-point Likert scale (1–5), where higher scores indicated greater perception and confidence. These sections covered hand hygiene, PPE use, respiratory etiquette, safe injection practices, environmental sanitation, isolation precautions, personal hygiene, and vaccination.

The Kuder-Richardson-20 (KR-20) reliability and Cronbach alpha coefficient were calculated to measure the reliability of the questionnaire items. As a result of the reliability verification, the KR-20 reliability of knowledge items was .570, and the Cronbach alpha coefficients of perception and confidence in performance items were .982 and .982, respectively.⁸

Data was retrieved from the Google form and checked for accuracy, utility and completeness. Data were exported to Statistical Package for Social Science (SPSS), version 25 for analysis. Descriptive statistics were presented as frequency, percentage, mean, and standard deviation. Inferential analysis was performed using analysis of variance (ANOVA) to compare mean scores across the three-time points. Benferroni correction/post hoc tests were used to identify significant pairwise differences. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 143 nursing students participated in the study. All the participants were undergraduate nursing students across various streams. All except one had prior clinical experience and all except three had prior IPC education exposure as shown in the table 1.

Table 1. Demographic Characteristics and IPC Background of the Participants (n=143)

Parameters	Frequency (n)	Percentage (%)
Level of Education		
Bachelor of science in Nursing (BScN)	63	44.06
Bachelor in Nursing Science (BNS)	63	44.06
Bachelor in Midwifery	17	11.88
Year of Education		
Third Year	78	54.55
Fourth Year	65	45.45
Clinical Practice Exposure		
Yes	142	99.30
No	1	0.70
Prior IPC Education		
Yes	140	97.90
No	3	2.10

Mean baseline knowledge, perception and confidence scores were 26.64, 194.62 and 191.03 respectively (Table 2). Post IPC training, the scores increased, reaching up to mean score of 29.38, 203.20 and 199.57 respectively (Table 3).

Table 2. Baseline Knowledge, Perception and Confidence Score of the Participants

Variable	Mean $\pm$ SD	Minimum	Maximum
Knowledge Score (0-40)	26.64 $\pm$ 3.02	18	35
Perception Score (42-210)	194.62 $\pm$ 12.80	97	210
Confidence Score (42-210)	191.03 $\pm$ 14.72	92	205

Table 3. Post IPC Training Knowledge, Perception and Confidence Score of the Participants

Variable	Mean $\pm$ SD	Minimum	Maximum
Immediately following IPC Training			
Knowledge Score (0-40)	28.14 $\pm$ 2.47	20	40
Perception Score (42-210)	208.47 $\pm$ 8.44	166	210
Confidence Score (42-210)	195.16 $\pm$ 6.34	163	200
Post three-week following IPC Training			
Knowledge Score (0-40)	29.38 $\pm$ 3.04	24	40
Perception Score (42-210)	203.20 $\pm$ 13.11	84	210
Confidence Score (42-210)	199.57 $\pm$ 8.97	144	205

A one-way repeated measures ANOVA was conducted to determine whether there were statistically significant differences in knowledge, perception and confidence scores over three-time points (baseline, immediate, and

three-week follow-up). There was a statistically significant main effect of IPC training on knowledge score [$F(2, 284) = 111.96, p < .001$]. Post-hoc analysis using the Bonferroni correction revealed that knowledge scores increased significantly from baseline to the immediate post-test [mean difference (MD) = 1.50, standard error (SE) = 0.16, $p < .001$], and continued to increase significantly from the immediate post-test to the three-week follow-up [MD = 1.24, $p < .001$]. Overall, knowledge scores at the three-week follow-up were significantly higher than at baseline [MD = 2.74, $p < .001$]. These results suggest that the intervention not only produced an immediate gain in knowledge but that scores continued to improve over the subsequent three weeks (Table 4). Similarly, there was a statistically significant effect of training on perception score [$F(1.20, 170.43) = 381.30, p < 0.001$]. These results indicate that perception scores changed significantly throughout the study. Post-hoc analysis revealed that perception scores increased significantly from baseline (Mean = 194.62) to the immediate post-test (Mean = 208.47, $p < 0.001$). However, these gains were not maintained; scores decreased significantly between the immediate post-test and the three-week follow-up (Mean = 195.16, $p < 0.001$). There was no statistically significant difference between baseline and the three-week follow-up ($p > .05$), suggesting that the intervention's effect on perception was temporary (Table 4).

Table 4. Changes in Knowledge, Perception and Confidence Scores across Three-time points (Repeated Measures ANOVA, n=143)

Variable	Sphericity Assumption	F value (2, 284)	p value	Longitudinal pattern
Knowledge	Met	111.96	< 0.001	Continuous growth
Perception	Violated	381.30	< 0.001	Temporary spike
Confidence	Violated	22.90	< 0.001	Continuous growth

There was statistically significant main effect of training on confidence score [$F(1.31, 186.02) = 22.90, p < 0.001$]. These results suggested that participants' confidence levels changed significantly across the three-time points. Post-hoc analysis revealed a continuous and significant improvement at every stage. Scores increased significantly from baseline to the immediate post-test (MD = 4.13, $p = 0.003$). Scores continued to rise significantly from the immediate post-test to the three-week follow-up (MD = 4.41, $p < 0.001$). The total improvement from baseline to the three-week follow-up was also highly significant (MD = 8.54, $p < 0.001$) (Table 4).

DISCUSSIONS

The baseline knowledge of the IPC was fair in our study. Our finding is consistent with the global findings.^{5,12} A similar finding was identified in the previous study by the

author, where 71% of student demonstrated adequate knowledge of IPC.^{8,13} We had previously observed a good theoretical understanding of principles, with relatively fair knowledge on environmental sanitation, safe injection and hand hygiene but poor knowledge regarding waste management.⁸ In a similar cohort of Indian practicing nurses, the level of knowledge and practice were modest (57.4% and 58.6%, respectively) although the adherence to practice was relatively low (45.5%).¹³ However, the variations in training duration, clinical exposure, curriculum, and prior clinical experience should be considered when comparing these findings. Differences in infrastructure, institutional support and infection control protocols across the local, regional and global settings may also influence the observed results.¹⁴

The effect of the training on IPC has been shown to improve significantly immediately and has shown to persist or increase even at the end of three weeks. Also, in the large-scale study conducted across 59 nursing institutes in France, the baseline knowledge of the nursing students, the knowledge score was moderate at the beginning, and improved slightly but significantly at the end of the semester.⁵ Similar study conducted at multiple Indian institutions found that pretest knowledge score (79.44 ± 17.50) was the lowest, which spiked immediately after the training (96.54 ± 25.42 , mean difference 17.10, $p < 0.000$) which slumped down yet still higher than the pretest level at the end of one month (84.49 ± 22.40 , mean difference 5.05, $p < 0.000$).⁹ The study evaluated the score at the one month while our study evaluated the score at three weeks. Although knowledge retention generally declines over time, the differences in IPC training curriculum, teaching methodology and approach, and the tools used for assessment may explain the contrast between the two studies.

The perception improved significantly after the training yet it returned to baseline at three weeks. This finding was similar to the finding of the Indian study, where the perception rose from baseline (42.69 ± 4.17) to immediate post training (44.33 ± 4.13 , $p < 0.00$) and dropped to (42.91 ± 5.21 , $p=0.99$) at the end of one month.¹³ The change in the attitude and perception can be attributed to the enhancement in the knowledge. An overwhelming change in the perception (96.10%) has been noted among dental students in a mixed model study in India, transitioning between pre-clinical and clinical posting.¹⁵ We found a significant improvement in the confidence of the students after the training which was persistent at the end of the three weeks. But, majority of the studies focused on the knowledge, attitude and performance.^{6,10,12-15} Limited studies discussed on the post training self-reported confidence of nursing students regarding the confidence. But the most plausible reason could be attributed to the enhanced knowledge. The trainings have been attributed to significantly improve the knowledge.^{5,6,9,13-16} However self-perceived skills and confidence in IPC often do not

accurately reflect the actual knowledge or performance has been demonstrated by Trifunovic-Koenig et al. and show that healthcare workers are overconfident compared to clinical assessment.¹⁷ They argue this mismatch arises from factors such as overconfidence effect, clinical tribalism and poor awareness of risks associated with noncompliance.¹⁷

The studies conducted on professional at different stages of careers have strongly highlighted and recommended the inclusion of IPC courses at all levels, reinforced with continued clinical education at different stages and certifications.¹³ Real life scenarios, simulations, peer review and mentoring should be added besides the theory to translate knowledge into practice.¹³ Mohammadi et al. recommended the incorporation of practice audits into IPC training program to improve outcomes.⁵ Lasting change can be achieved with continuous and accessible training program tailored to specific knowledge gaps and delivered through diverse educational methods.¹⁰ Similarly, a mixed model study on dental students have highlighted that the microbiological awareness in early education can be better applied clinically and helps bridge the gap at the beginning of their clinical journey.¹⁵ The increase in knowledge, perception, performance and confidence can improve the compliance with IPC protocol guidance, enhance professional foundation, and can make real impact in clinical application.¹⁵

In another quasi-experimental study conducted in the low resource setup of Gaza, among the hemodialysis nurses, there was a significant difference noted among the trained and untrained group at the end of one week, both in terms of knowledge and practice ($p=0.001$) demonstrating that structured IPC training is applicable not only in the university curriculum but also in real life clinical practice as continued medical education.¹⁸ Also another study from Pakistan among the active serving medical professionals, found that such IPC training is actually effective in enhancing the knowledge, skills and participants satisfaction using the Kirkpatrick Model of evaluation, at both the reaction and learning levels.¹⁶

Lee et al. have identified the gap in key areas of IPC in use of specific organisms, knowledge-practice gap in hand hygiene and transmission, legal reporting, pandemic preparedness and have highlighted the need for competency based and simulation-based training.¹⁰ They also recommended the systematic assessment of educational needs, incorporation of microbiology into decision making and focus on practical proficiency.¹⁰

Our study addresses a highly relevant topic central to patient safety and healthcare quality. The use of comprehensive and structured intervention to improve the competencies of future nurses, coupled with assessment and retention of knowledge at the end of three weeks provides a clear insight into the sustainability of changes in perception and confidence. Yet, the quasi-experimental design without any control group limits the internal

validity of the study. Concurrent inclusion of IPC content in the academia or concurrent clinical experience could have added or reinforced the knowledge besides the formal training program. Measure of confidence was self-reported and was not evaluated by independent assessor during the performance of any specific procedure.¹⁷ The reported confidence levels may reflect self-perception rather than true clinical competence. This also introduces social desirability bias and self-reported bias. Also, the self-validated questionnaire could have compromised the reliability of the tool used. The long-term follow-up is also limited as three-week retention of knowledge may not translate into clinical practice upon graduation.

CONCLUSION

IPC training among nursing students significantly improved knowledge and confidence immediately after the course, with gains sustained at three weeks follow-up. In contrast,

the increase in perception was more immediate and declined to near baseline at follow up. Further studies are recommended to evaluate long term retention of IPC knowledge, translation into actual clinical care, and the effectiveness and sustainability of integrating in nursing curriculum.

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