Research article

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Effectiveness of a training program on standard precautions in infection control for nurses based on the theory of planned behavior

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Abstract

Background: Standard precautions (SPs) are crucial measures to prevent nosocomial infections and protect healthcare workers. However, nurse compliance with SPs is often suboptimal, so effective interventions are needed to improve it.

Objective: Assess the results of the training program based on the Theory of Planned Behavior (TPB) model in improving nurses' knowledge, awareness, and compliance with SPs for nurses at three time points: pre-training, immediately post-training, and one month post-training.

Methods: A pretest-posttest one-group quasi-experimental study was conducted on 71 nurses at Gia Lai General Hospital from December 2020 to June 2021. The training program employed active teaching methods such as group discussions, videos, and multimedia presentations. Seven factors of the TPB model and the level of nurses' compliance with SPs were assessed using a 5-point Likert scale.

Results: SPs compliance score significantly increased immediately after the training (4.18 ± 0.47) compared to before training (3.20 ± 0.60, $p < 0.05$), with a large effect size (Cohen's d = 1.61), indicating a strong improvement. All seven factors of the TPB model also improved ($p < 0.05$). However, one month after training, SPs compliance score (3.92 ± 0.47) and SPs knowledge score decreased slightly ($p < 0.05$) but remained higher than before training.

Conclusion: The training program based on the Theory of Planned Behavior (TPB) model significantly improved nurses' knowledge, awareness, and compliance with SPs. However, to sustain the effectiveness, additional measures such as regular training and ongoing monitoring are needed.

Keywords: Standard precautions, nurses, the training program

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1. PROBLEM STATEMENT

Healthcare-associated infections (HAIs) are always a global medical challenge because they constitute an important cause of morbidity, mortality, prolonged stay, and economic burden to the patient [1]. In addition, agents that can be transmitted through blood, fluids, and air also increase the risk of exposure for Health care workers (HCWs). According to many studies in the world, HCWs are at risk of contracting tuberculosis and hepatitis B 3 to 5 times higher than the other population [2] [3]. Nearly 10% of AIDS among

HCWS is the result of occupational exposure [4]. In December 2019, the COVID-19 pandemic broke out and became very complicated. As of April 24, 2021, there were 146 million infections worldwide (14% of infections reported to WHO were HCWS) and more than 3 million deaths [5]. Therefore, the risk of cross-infection from patients to HCWS, from HCWS to HCWS in Medical facility (MF) is very high.

Standard Precautions (SPs) are fundamental measures of prevention and control of nosocomial infections. Compliance with SPs contributes significantly to reducing HAIS, limiting both disease transmission to patients and HCWS, as well as the spread of pathogens from patients to the environment to ensure safety and improve the quality of medical examination and treatment [6]. Currently, in the world and in Vietnam, there are many studies recording the suboptimal and inconsistent compliance of HCWS with SPs measures [7] [8] [9].

Among HCWS, nurses are the largest group and spend most of their time directly caring for patients. Failure to comply with SPs measures makes them susceptible to occupational exposure during MF and can cause infection to patients [10]. However, studies at Gia Lai Provincial General Hospital have demonstrated that the regular application of SPs measures by nurses can be influenced by factors designed based on the research model of The theory of planned behavior (TPB) including knowledge, attitude, exemplary behavior of colleagues, facilitating organization and organizational constraints [11]. Therefore, intervention strategies to improve SPs compliance are important. Several studies have documented improved SPs compliance following training programs that were designed based on behavior change theories and incorporated positive teaching strategies. [12] [13]. However, there is a lack of research on the application of TPB to the training program for nurses about SPs in Vietnam. Therefore, we conducted this research to evaluate the effectiveness of designing a training program based on the TPB model in improving compliance with SPs of nurse, thereby contributing to improving the quality of medical examination and treatment, ensuring safety for patients, HCWS and the community.

2. RESEARCH SUBJECT AND METHODOLOGY

2.1. Research subjects

Nurses work regularly and directly care for patients. Nurses include permanent staff, contract staff, and apprentices. Research period from December 2020 – June 2021.

Exclusion criteria: Nurses are in charge of administration, attending school, taking leave, maternity leave.

2.2. Research design:

The research used Pretest – Posttest one group quasi – experimental study.

2.3. Sample size and the sampling strategy:

The sample size was calculated using the formula for comparing two means in a pre- and post-intervention study design. The minimum required sample size in the study was 68 nurses. The study expect a sample loss rate of about 20%. Therefore, the sample size to be collected for the study is 82 nurses.

Sample representativeness was ensured through stratified random sampling, selecting 82 nurses from 219 nurses who meet the selection criteria across 8 clinical departments at Gia Lai General Hospital.

2.4. Survey instrument and research variables

The main variable used for the survey is a questionnaire with 51 questions including 2 parts:

The questionnaire to assess knowledge about SPs includes 15 questions. The questionnaire was built based on Decision

3671/QD-BYT on guidelines for SPs in medical examination and treatment facilities; Decision 468/QD-BYT on promulgating guidelines for prevention and control of acute respiratory infections caused by Corona Virus 2019 (COVID-19) in medical examination and treatment facilities and reviews from researches domestic and foreign.

Standard precautions questionnaire (SPQ) are developed by Michinov et al (2016) [14]. The questionnaire was translated into Vietnamese (local language) according to the guidelines of the WHO. A proposed questionnaire consists of 7 items with 35 self-sufficient questions. Inside, six items to assess factors influencing compliance with SPs that measured using a 5-point Likert scale, consists of: (1) attitude (6 questions), (2) Social influence (4 questions), (3) exemplary behavior of colleagues (7 questions), (4) facilitating organization (5 questions), (5) organizational constraints (5 questions), (6) Individual constraints (4 questions). And one item to assess compliance with SPs (4 questions measured using a 5-point Likert scale ranging from '1 = never' to '5 = always') based on self-reporting of nurses' compliance with SPs in the situations described in the questions.

The questionnaire was adapted by experts in infection control and nursing to ensure its suitability for the clinical context in Vietnam. The questionnaire achieved a Cronbach's Alpha coefficient ranging from 0.74 to 0.89 [11].

2.5. Data collection method

Researchers screened and recruited subjects. They explained the research purpose and provided the research participant consent form to the research subjects before proceeding.

A baseline survey using a self-administered questionnaire (30 minutes/nurse) took place before the training intervention.

The research team implemented the training program (90 minutes/session). The research effectiveness was based on the implementation of the training program on SPs that had been designed using TPB framework. Simultaneously, various active learning methodologies will be integrated, including lectures, group discussions, video presentations, and gamification. The lecture content was adapted from materials developed by Dr. Nguyen Thi Thanh Ha, guidelines from the Ministry of Health, and relevant studies [6] [15] [16] [17] [12]. Inside:

The PowerPoint presentation delivered comprehensive foundational knowledge on SPs, examined the critical role of SPs measures in infection control, and illustrated the consequences of non-compliance through clinically relevant scenarios and documented cases of severe occupational exposure.

Video presentations included content on the actual consequences of HAIs, the routes of disease transmission, hand hygiene, and an introduction to different types of sharps containers and their usage.

Small group discussions with 6 people per group with the following topics: Factors that facilitate the application of SPs or make it difficult to use SPs (Supervision / Availability of equipment / Being trained in using SPs / Increased workload…) ; Situations that hinder the application of SPs: (1) the patient is difficult/ (2) I'm pressed for time / (3) my hands are damaged or painful / (4) during an emergency situation And what methods did you use to deal with those situations? This discussion and experience sharing aimed to enable the nurses to have a clearer understanding of the impact of other HCWs on their own compliance with SPs and to have a clearer awareness that compliance with SPs brought more benefits to themselves compared to the difficulties they encountered in complying with SPs.

The second and third surveys using a self-administered questionnaire (30 minutes/nurse) took place at two time points: immediately after the training and one month after the training.

2.6. Methods of processing data

Data were entried, cleansed, processing and analyzed by using SPSS 20.0 software.

Quantitative variables with a normal distribution were presented as mean ± standard deviation. Quantitative variables without a normal distribution were presented as median (interquartile range). Qualitative variables were presented as frequency and percentage.

To compare the effectiveness of the training program between two time points: before training versus immediately after training, and between immediately after training versus one month after training, the Paired sample T-test was used to compare the mean scores of normally distributed variables. The Wilcoxon signed-rank test was used to compare the median scores of non-normally distributed variables. All statistical tests were considered significant at a p-value of < 0.05.

In addition, Cohen's d coefficient, which assesses the difference in mean values based on standard deviation, was also calculated using the formula:

$$Effect\ Size = \frac{[Mean_1 - Mean_2]}{Standard\ Deviation}.$$

Cohen's d measured the effect size, indicating the practical significance of the difference in mean between time points, with values of $d \geq 0.2$, 0.5, or 0.8 reflecting the practical significance of the SPs training program for nurses as small, medium, or large [18], [19].

2.7. Research ethical

This research is only carried out with the approval of the Ethics Council of Ho Chi Minh City University of Medicine and Pharmacy with a brief review process number 865/HDDD-DHYD, November 12, 2020.

3. RESULTS

Through training and surveys at three time points, which were before training, immediately after training, and one month after, 71 questionnaires of nurses at 8 clinical were completed and collected. After analyzing and processing the data, we got the following results:

Table 3. General characteristics of nurse (n=71)

Contents		Frequency (n)	Percent (%)
The mean age	(30.73±5.84)		
Gender	Male	4	5.6
	Female	67	94.4
Professional level	Intermediate	19	26.8
	College	28	39.4
	University	24	33.8
Total		71	100

The nurses in the study were predominantly female, accounting for 94.4%, with a mean age of 30.73 ± 5.84 years. Among them, the proportion of nurses with college and university degrees was high, representing nearly ¾ of the total (Table 3).

Intervention results

Table 4. Compare the mean scores of 7 factors according to the research model at the time of training (n=71)

Contents	Before training	P-values (Compare Mean before and the immediate moment after training)	The immediate moment after training	P-values (Compare Mean the immediate moment and one month after training)	One month after training
1. Knowledge (M±SD)	3.41 ± 0.52	< 0.001[a]	4.49 ± 0.33	< 0.001[a]	4.29 ± 0.34
2. Attitude (M±SD)	3.69 ± 0.39	< 0.001[a]	4.27 ± 0.33	0.436[a]	4.22 ± 0.43
3. Social influence – Mdn (IQR)	3.50 (0.75)	< 0.001[b]	4.0 (0.25)	0.304[b]	3.75 (0.50)
4. Exemplary behavior of colleagues – Mdn (IQR)	3.43 (0.57)	< 0.001[b]	3.71 (0.43)	0.172[b]	3.86 (0.57)
5. Facilitating organization (M±SD)	3.74 ± 0.56	< 0.001[a]	4.28 ± 0.44	0.966[a]	4.29 ± 0.41
6. Organizational constraints (M±SD)	3.34 ± 0.63	< 0.001[a]	2.963 ± 0.60	0.974[a]	2.960 ± 0.51
7. Individual constraints – Mdn (IQR)	3.25 (0.75)	0.012[b]	3.00 (0.75)	0.877[b]	2.75 (0.75)

[a] Paired t-test; [b] Wilcoxon Signed Ranks;

M: Mean; SD: standard deviation; Mdn: Median; IQR: interquartile range

At the immediate moment after training, among the 7 factors in Table 4, five factors achieved higher scores compared to before the training. Specifically, knowledge about SPs (4.49 ± 0.33) was higher compared to before training (3.41 ± 0.52); Attitude (4.27 ± 0.33) was higher compared to before training (3.69 ± 0.39); Social influence 4.0 (0.25) was higher than before training 3.50 (0.75); Exemplary behavior of colleagues 3.71 (0.43) was higher than before training 3.43 (0.57); and Facilitating organization (4.28 ± 0.44) was higher compared to before training (3.74 ± 0.56). Conversely, two factors at the immediately after training had lower mean compared to before training: Organizational constraints (2.963 ± 0.60) were lower compared to before training (3.34 ± 0.63); and Individual constraints 3.00 (0.75) were lower than before training 3.25 (0.75). All these differences were statistically significant with $p < 0.05$ (*Table 4*).

At one month after training, among the 7 factors in Table 4, only 1 factor showed a clear downward trend compared to immediately after training, which was knowledge about SP, with a mean score of 4.29 ± 0.34. This difference was statistically significant with $p < 0.05$. The remaining 6 factors had almost unchanged mean compared to immediately after training ($p > 0.05$).

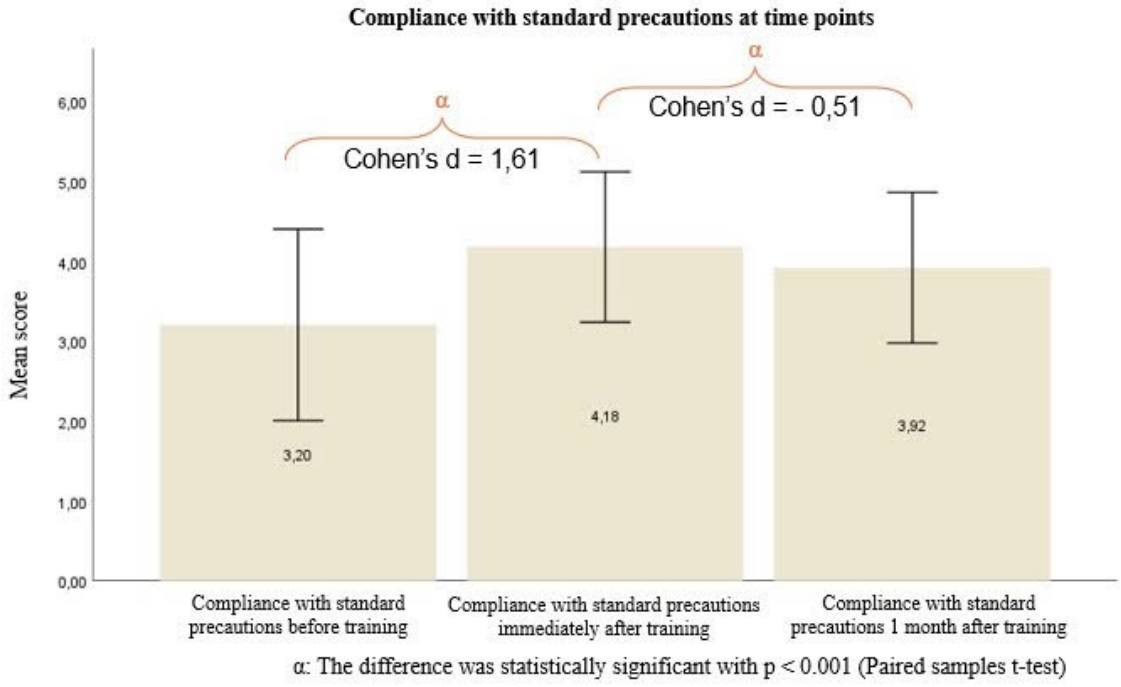

Figure 1. Mean scores for nurses' compliance with standard precautions at three measurement time points

The study results demonstrated that the training program on SPs for nurses had a significant impact on their adherence across the three study time points. Before training, SP's compliance for nurses score was 3.20 ± 0.60, reflecting the baseline level before any intervention. However, the immediate moment after training, SP's compliance score increased to 4.18 ± 0.47, indicating the immediate effectiveness of the program in improving nurses' compliance with SPs measures. The results of the paired t-test comparing compliance scores before and immediately after training revealed a statistically significant difference ($t = 13.58$, $p < 0.001$) and confirmed that the training program had a substantial effect on SP's compliance (Figure 1).

More special, the level of SP's compliance remained high one month after training, with mean score of 3.92 ± 0.47, although there was a slight decrease compared to the immediate moment after training. This indicated that the training program had a sustained impact, maintaining the improvement in the implementation of SPs measures, even though the effectiveness showed a partial decline over time. The results of the paired t-test comparing the compliance levels immediately after training and one month later revealed a statistically significant difference ($t = -4.34$, $p < 0.001$), reflecting a slight reduction in compliance levels after one month, but still maintaining a higher level compared to before training (Figure 1).

Cohen's d analysis revealed a large effect size of 1.61 for the difference in SPs compliance between the pre-training and immediate post-training periods, indicating a substantial improvement in compliance levels following the

intervention. In contrast, the effect size comparing compliance one month post-training to immediately after training was -0.515, reflecting a modest decline over time; however, this still represents a medium effect size, suggesting partial retention of training outcomes.

4. DISCUSSIONS

General characteristics of nurse

The average age of the nurses in the study was 30.73 ± 5.84 years. This age was consistent with the average age of nurses in several studies conducted in Vietnam but lower compared to studies internationally [20] [8] [12]. This difference could be attributed to variations in retirement ages and the aging population trends observed in other countries compared to Vietnam.

The cohort of nurses with college and university degrees in the study constituted the majority, accounting for nearly three-quarters of the nurses (73.1%). This aligns with the trend of standardizing the nursing workforce to have a minimum qualification of a college degree or higher, as stipulated by circular no. 26/2015/TTLT-BYT-BNV, which aimed to phase out intermediate-level nursing positions by January 1, 2025.

Effectiveness of standard precautions training intervention

This study designed a training program to enhance SPs compliance for nurses based on modifying seven factors influencing nurses' SPs compliance according to the TPB model.

Seven factors influencing nurses' SPs compliance according to the TPB model were achieved after the intervention

This study showed that immediately after the training program, nurses' knowledge demonstrated a significant improvement compared to before the training ($p<0.05$), but it was still approximately 10% - 14% lower than the studies by Sadeghi (2018) and Hassan (2018) [12] [21]. This discrepancy might be attributed to the fact that the training programs in those two studies had a considerably longer duration and their content included training on SPs practical skills. One month after training, the mean knowledge score was lower than immediately after the training but remained higher than the pre-training score ($p<0.05$). This indicates that the effectiveness of the intervention on knowledge persisted one month post-training, but with a tendency to decrease over time. Therefore, it is necessary to maintain the program's effectiveness through measures such as regular training sessions, online lecture videos and handouts for nurses for further reference.

The results of this study also showed that the training program could help nurses change the remaining six cognitive factors in a positive direction compared to the pre-training period ($p<0.05$). Encouragingly, unlike knowledge, the effectiveness of these six factors was maintained almost unchanged one month post-training ($p>0.05$). Sadeghi's study (2018) also demonstrated similar findings to ours, indicating that an educational program on SPs could reduce the perceived barriers (Organizational constraints and Individual constraints) to SPs compliance among nurses [12]. Perhaps enhancing the awareness of the importance of SP, combined with incorporating real-life scenarios about the severity of occupational exposure when

non-compliant with SPs and discussions during the training, deeply impressed the nurses, sustained their belief in the effectiveness of SPs compliance, and also increased their awareness of the control exerted by superiors in addressing violations. The content of the training program was partly designed with an analysis to help nurses recognize that SPs compliance would yield more benefits than the difficulties they face and to facilitate discussions on responding to emerging situations that negatively impact SPs compliance during patient care. Simultaneously, the enhanced content on knowledge and the belief in the benefits of SPs for limiting infection during patient care helped nurses become more confident in themselves, thereby potentially reducing obstacles arising from negative thoughts and harmful habits regarding SPs compliance of nurses during patient care.

Standard precaution compliance achieved after intervention

Immediately after the training, the mean score of SPs compliance showed a significant improvement compared to before the training ($p<0.05$). This indicates the effectiveness of the training program in enhancing SPs compliance among nurses in care immediately after the training. Several studies internationally and in Vietnam have shown similar results. Hassan's study (2018) demonstrated the effectiveness of an online training program on SPs in improving the mean of SPs compliance of nursing students from 37.22 ± 19.27 to 59.96 ± 11.42 [21]. The study by Do Thi Ha et al. (2019) also showed a significant improvement in routine hand hygiene compliance when applying a positive direct communication method integrated with training for nurses [13]. This study revealed a large effect size (Cohen's d = 1.61) between the level of SPs compliance immediately after training and before training, indicating a strong and practically significant impact from the training program. Specifically, this improvement was not only statistically significant but also reflected a clear change in the SPs compliance behavior of nurses. This result is consistent with previous studies on the effectiveness of training interventions. Notably, our study is one of the first in this field to specifically report Cohen's d as an indicator to measure effect size, providing an additional perspective on the practical impact of the training program.

However, the mean SPs compliance score of nurses one month post-training showed a tendency to gradually decrease compared to immediately after training, but it remained higher than the pre-training score ($p<0.05$). This could be because the training program primarily focused on improving knowledge and awareness regarding certain factors related to SPs compliance of nurses, rather than providing training on the practical application of SPs measures. Therefore, it limited the translation of techniques into clinical practice, which led to the observed decrease one month later. A study conducted at the Hospital in 2020 also indicated a difference in SPs compliance among different professional levels of nurses [11]. Nevertheless, the training program was not tailored to different professional levels. This could also affect the sustained effectiveness of

the training on the individual competence of each group with varying professional levels. Furthermore, this result aligns with the real-world context; without support and decisions from hospital leadership, it is challenging to secure sufficient budget to provide adequate essential resources for infection control and organize regular SPs training and monitoring sessions. Therefore, measures are needed to maintain the positive effects of the intervention program, such as strengthening communication, continuous training, and regular monitoring of SPs compliance for all healthcare workers (HCWs) in the hospital. Simultaneously, effective facilitating policies from hospital leadership are also necessary. Moreover, reasonable and consistent policies from the management organization regarding the establishment of a specific handling or reward system are also essential to sustain SPs compliance.

5. CONCLUSIONS

The results of our study showed that the effectiveness of designing a training program based on TPB model could enhance SPs compliance among nurses, improve knowledge, and positively change cognitive factors related to SPs compliance. Furthermore, one month following the training, the effectiveness of the training program on these factors persisted, but there was a tendency for SPs compliance and knowledge to decline.

6. RECOMMENDATIONS:

Future research should be conducted with a larger sample size and incorporate direct observational methods to more accurately assess compliance with SPs in real-world clinical settings. Additionally, evaluations of the training program's effectiveness should be extended to longer-term follow-up periods, such as three and six months post-intervention, to examine the sustainability of outcomes over time. The target population should also be broadened to include other HCWs within the hospital, as well as staff at other healthcare institutions. Furthermore, future training programs should integrate both theoretical instruction and hands-on practical components to enhance the translation of knowledge into clinical practice.

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