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Major article

Predictors for compliance of standard precautions among nursing students

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Key Words:
Standard precautions
Biologic hazards
Nursing students
General linear model
Interaction effects

Background: We aimed to investigate the frequency of standard precautions (SPs) compliance and the factors affecting the compliance among nursing students (NSs).
Methods: A cross-sectional survey study guided by the health belief model was conducted in 2009. The study questionnaire is valid (content validity index, 0.81) and reliable (Cronbach α range, 0.65-0.94).
Results: There were 678 questionnaires analyzed, with a response rate of 68.9%. The mean frequency score of SPs compliance was 4.38 $\pm$ 0.40 out of 5. Tukey honest significant difference post hoc test indicated that year 2 and year 4 students had better SPs compliance than year 3 students. Further analysis using a univariate general linear model identified an interaction effect of perceived influence of nursing staff and year of study ($F_{1,593} = 3.72$; $P < .05$). The 5 following predictors for SPs compliance were identified: knowledge of SPs, perceived barriers, adequacy of training, management support, and influence of nursing staff.
Conclusion: Although the SPs compliance among NSs was high, the compliance varied by year of study and was affected by the nursing staff. Furthermore, SPs compliance among NSs can be enhanced by increasing SPs knowledge, providing more SPs training, promoting management support, reducing identified SPs barriers, and improving nursing staff compliance to SPs.

Nursing students (NSs) are at high risk of exposure to occupational biologic hazards because they are obligated to provide care to patients admitted with an unknown infection status.[1] Owing to the nature of the work, health care workers (HCWs) are 3 times and 5 times more likely to acquire tuberculosis[2] and hepatitis B (HB),[3] respectively, than the general population. Thirty-seven percent of HB and 10% of AIDS among HCWs are the result of occupational exposure.[4] In 2003, within 8 months of the outbreak of severe acute respiratory syndrome, it had spread rapidly to 30 countries, 8,096 people were infected, and 774 died from severe acute respiratory syndrome.[5] Among those infected, 21% (n = 1,706) were HCWs.[5] In the last 10 years, the reported cases of avian and swine influenza around the world, and lately the novel coronavirus in the United Kingdom (UK)[6] and avian influenza A,[7] signify the possibility of virus mutation and person-to-person transmission. These uncertainties on infectious diseases continue to pose a threat to the health of HCWs.[6]

Although HCWs face the challenge of emerging infectious diseases and pandemics, standard precautions (SPs) have been proven by evidence-based research as "the foundation for prevention transmission of infectious agents in all healthcare settings."[8] Hence, HCWs are required to treat patients as potentially infectious[9] and apply SPs routinely.[1] However, HCWs adopt SPs depending on their

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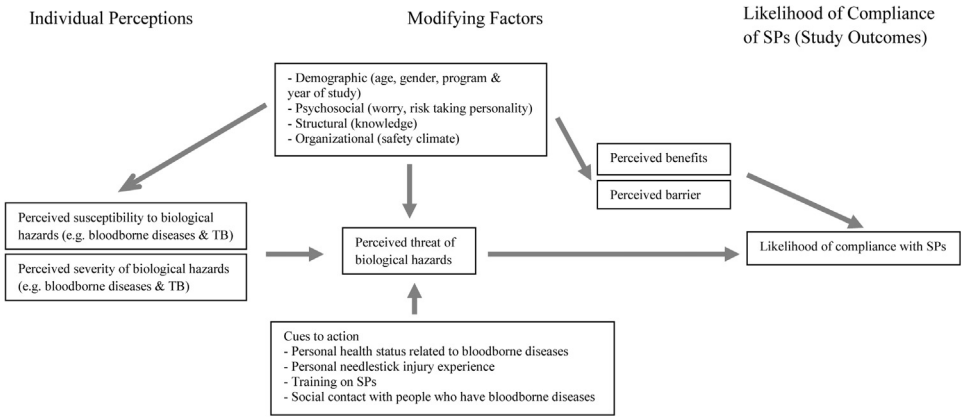

Fig 1. Conceptual framework to guide the study. *SP*, standard precautions; *TB*, tuberculosis.

own perception of risk of contracting the infectious disease in each clinical situation.[10] The compliance of SPs among HCWs is exceptionally low. For nurses, the compliance of SPs ranged from 9.1%-73%.[9,11] Factors affecting SPs compliance among registered nurses included individual factors (eg, age,[12] sex,[13] knowledge[14]), psychosocial factors (eg, risk-taking personality,[15] perceived susceptibility[16]), and organizational factors (eg, safety climate).[17] Still, limited studies have been conducted to investigate the compliance of and factors affecting SPs among NSs.[18] Worldwide, NSs in preregistration programs are required to provide nursing care in clinical practice.[19] In addition, their knowledge acquired and compliance of SPs during their nursing training years might affect their practice as they become registered nurses. A review of the literature found that only 2 studies, conducted in Italy and Brazil, have examined the compliance of some aspects of SPs in NSs[18,20]; and 4 studies examined knowledge of infection control preventive measures among NSs in France, Italy, Taiwan, and the United States.[20-23] However, no investigations to our knowledge have been carried out on the factors affecting the compliance of SPs among NSs. Theoretical frameworks have been used to guide studies on SPs among registered nurses,[12,24] but not in NSs. Furthermore, the sample size of those studies conducted among NSs was relatively small, ranging from 48-175 participants in 1 particular year of study.[18,20,21,23] It remains unclear whether NSs' compliance of SPs would be affected by registered nurses in the clinical settings.[18] Therefore, the aim of this study was to investigate the factors affecting the compliance of SPs among NSs.

METHODS

Design

This was a cross-sectional survey study. NSs who were studying in a full-time undergraduate program in 1 university in Hong Kong were invited to participate in the study. Ethical approval from the university was obtained.

Conceptual framework

The health belief model (HBM) is one of the most widely used models to explain and predict why an individual does or does not take preventive health measures.[25,26] The 3 key components are individual perceptions, modifying factors, and factors affecting the likelihood of taking preventive health measures.[26] Furthermore, the individual perception component has the 2 following dimensions: perceived susceptibility (eg, NSs' own subjective perception of the risk of contracting bloodborne diseases) and perceived severity (eg, NSs' own subjective perception of the consequential seriousness of contracting bloodborne diseases).[25] The combination of these 2 dimensions contributes to the perceived threat for acquiring bloodborne diseases.[24] The perceived threat provides the motivation to act.[25] The other key component, modifying factors, consists of demographic, sociopsychologic, structural, and cues to action factors, which influence NSs to take preventive measures.[26] The third component, the likelihood of taking preventive measures, also has 2 dimensions, which are perceived benefits (eg, NSs believe that SPs can effectively prevent them from contracting bloodborne diseases) and perceived barriers (eg, NSs believe that there are possible hindrances to engaging SPs).[26] If the perceived benefits are greater than the perceived barriers, it is more likely that the NSs would comply with the SPs or vice versa (Fig 1).[25]

Instrument

A questionnaire was developed based on a review of the literature.[15-17,27-30] Its content validity was evaluated by 4 experts in the field of nursing and infection control, with an acceptable content validity index of 0.81.[31] The 2-week test and retest reliability was conducted among 10 NSs, with an acceptable reliability of 0.99. Based on the study data (N = 678), Cronbach α of subscales were acceptable, ranging from 0.65-0.94.

The questionnaire consists of demographic information (eg, age, sex, program, year of study) and experience of needlestick injury and source of SPs information. The rest of the questionnaire has 12 subscales of which most are measured by a 4-point Likert scale (4 = strongly agree and 1 = strongly disagree): (1) risk-taking behaviors (2 items; $\alpha = 0.707$); (2) perceived susceptibility to disease (3 items; $\alpha = 0.741$); (3) perceived seriousness of disease (3 items; $\alpha = 0.728$); (4) perceived threat to disease (8 items; $\alpha = 0.896$); (5) perceived high-risk procedures (6 items; $\alpha = 0.820$); (6) knowledge of SPs (11 items; $\alpha = 0.937$; calculated in percentages); (7) compliance of SPs (20 items; $\alpha = 0.804$, with 5 = always and 1 = never); (8) perceived barriers (8 items; $\alpha = 0.837$); (9) perceived benefits (2 items; $\alpha = 0.653$); (10) management support from the school and clinical venues (2 items; $\alpha = 0.682$); (11) adequacy of training provided (3 items; $\alpha = 0.736$); and (12) nursing staff influence (1 item).

Data collection procedure

The questionnaires together with the information sheet were distributed to the target population in a classroom setting in

September 2009. Their consent to participate in the study would be implied by their willingness to fill in the questionnaire.

Statistical analysis

SPSS version 18 (SPSS, Chicago, IL) was used for the data analysis. Descriptive statistics, such as frequencies, means, and SDs, were used to assess the data. The data were assumed normally distributed because its sample size was >100.[32] The strength of associations between independent variables and the dependent variable, scores of SPs compliance, was analyzed using the following statistical tests[33,34]: (1) Pearson correlation to test the relationship between 2 variables (eg, age, compliance); (2) independent *t* test to test the difference between 2 dependent group means (eg, mean compliance scores between NSs perceived influence of nursing staff and those who did not perceive the influence); (3) 1-way analysis of variance to test the difference among the means of ≥3 independent groups (eg, mean compliance scores among NSs in first, second, third, and fourth year of study), and if there were significant differences, Tukey honest significant difference test for post hoc comparisons was performed; and (4) univariate general linear model to test the main effect and interaction effect of independent variables on compliance. Those independent variables which showed a significant relationship with the SPs compliance were checked for multicollinearity and were included in the multiple regression analysis to determine the predictors of compliance of the SPs.

RESULTS

A total of 984 questionnaires were distributed, and 698 questionnaires were returned. Of the returned questionnaires, 20 were invalid. Therefore, 678 questionnaires (response rate, 68.9%) were used in the final analysis.

Characteristics of NSs

NSs from 2 undergraduate programs with 1-4 years of study participated in the study. Their ages ranged from 18-29 years, with a mean age of 21.02 ± 1.46 years. The sex distribution of the study sample (female/male = 3:1) was similar to the sex ratio of students enrolled in the programs.[19] More than 70% (n = 486) of NSs had attended SPs training. Their sources of the SPs information mainly came from university teachers (n = 574, 84.7%), clinical staff (n = 310, 45.7%), television (n = 286, 42.2%), and newspapers (n = 239, 35.3%). Most of them (n = 635, 73.7%) did not have any bloodborne diseases, such as HB and hepatitis C. The study-period prevalence of needlestick injuries was 3.1% (n = 21), and the 12-month prevalence was 1.6% (n = 11). In their personal life, they have family members, relatives, friends, classmates, or coworkers who are homosexual (15.7%, n = 106), have HB or hepatitis C (12.6%, n = 85), are bisexual (8%, n = 54), are intravenous drug users (3.4%, n = 23), have AIDS (1.9%, n = 13), and are commercial sex workers (0.6%, n = 4) (Table 1).

Table 1
Characteristics of nursing students (N = 678)

Characteristics	Value
Sex	
Male	171 (25.4)
Female	506 (74.6)
Program of study	
BSN	514 (75.8)
HD	164 (24.2)
Year of study*	
1	143 (21.1)
2	277 (40.9)
3	94 (13.9)
4	164 (24.2)
Standard precaution training (n = 677)	
Yes	486 (71.8)
No	78 (11.5)
Not sure	113 (16.7)
Bloodborne disease (n = 673)	
Yes	9 (1.3)
No	635 (93.7)
Unknown	29 (4.3)
Social contact with persons with or high risk to have bloodborne diseases (n = 675)	
Yes	185 (27.4)
No	490 (72.6)
Needlestick injuries	
Yes	21 (3.1)
No	657 (96.9)
Age, y (n = 674)	21.02 ± 1.46 (18-29)

NOTE. Values are n (%) or mean ± SD (range).
BSN, Bachelor of Science in Nursing; *HD*, Higher Diploma in Nursing.
*Year 1: BSN year 1 and HD year 1; year 2 = BSN year 2 and HD year 2; year 3 = BSN year 3; year 4: BSN year 4 and HD year 3.

Compliance of SPs

Among 632 respondents, the mean frequency score of SPs compliance was 4.38 ± 0.40, with scores ranging from 3 (sometimes) to 5 (always). The mean frequency scores of nonsterile gloves, hand hygiene, handling and disposal of needle and sharp objects, gown, and eye protection compliance were 4.62 ± 0.49, 4.52 ± 0.49, 4.37 ± 0.58, 4.18 ± 0.87, and 3.87 ± 1.08, respectively. All NSs would perform hand hygiene after removing gloves. However, 19.1% (n = 122) of them often or always recapped needles contaminated with blood; 13.8% (n = 89) and 14.7% (n = 94) rarely or never wore eye protection equipment whenever there was a possibility of blood-body fluids or secretions-excretions splashing in their face, respectively. Furthermore, the results of 1-way analysis of variance indicated that the SPs compliance varied by year of study ($F_{3,628} = 4.09$; $P < .01$) (Table 2). The SP compliance for year 2 (mean, 4.41 ± 0.40) and year 4 (mean, 4.42 ± 0.38) students was significantly better than that of year 3 students (mean, 4.28 ± 0.37) as determined with the Tukey honest significant difference post hoc test.

Knowledge of SPs

Among the 678 respondents, the mean score of SPs knowledge was 78.02%, ranging from 0%-100%. Two NSs answered not sure for all the items, and hence they received zero percentage. On the other hand, 59 NSs (8.7%) achieved 100%, and 338 (49.8%) NSs obtained 81.82%-90.91%.

Interaction effects and factors associated with SPs compliance

Bivariate statistical analysis found 9 factors were associated with compliance of SPs among NSs (Table 2). Those 9 factors were perceived susceptibility, perceived seriousness, knowledge of SPs, perceived barriers, perceived benefits, perceived adequacy of training, perceived management support, perceived influence of nursing staff, and year of study. Further analysis using a univariate general linear model identified an interaction effect of perceived influence of nursing staff and year of study ($F_{1,593} = 3.27$; $P < .05$) (Table 3). Results showed that second ($t_{271} = 3.49$, $P = .001$) and third year ($t_{90} = 4.59$, $P < .001$) students were significantly affected by the nursing staff's compliance of SPs. However, there were no significant differences between perceived influence of nursing staff

Table 2
Relationship between demographics and study variables with compliance of standard precautions among nursing students (N = 678)

Items	Compliance of standard precautions	
	Pearson *r*	*P* value
Age	0.046	NS
Risk-taking behaviors	−0.065	NS
Perceived susceptibility	−0.09*	.023
Perceived seriousness	0.095*	.017
Perceived threats	0.049	NS
Knowledge of standard precautions	0.195†	>.001
Perceived barriers	−0.262†	>.001
Perceived benefits	0.162†	>.001
Perceived adequacy of training	0.207†	>.001
Perceived management support	0.175†	>.001
	Independent samples *t* test	
	t, df	*P* value
Sex	−1.50, 630	NS
Program of study	−1.72, 530	NS
Social contact with bloodborne diseases persons	−0.72, 627	NS
Needlestick injuries	1.29, 630	NS
Perceived influence of nursing staff	4.83, 618†	<.001
	One-way ANOVA	
	F, df (BG, WG)	*P* value
Year of study (1, 2, 3, 4)	4.09 (3, 628)‡	.007
Standard precautions training (yes, no, not sure)	1.99 (2, 628)	NS
Bloodborne diseases (yes, no, unknown)	0.17 (2, 624)	NS

ANOVA, analysis of variance; *NS*, nonsignificant; BG, between Group; WG, within Group.
*$P < .05$.
†$P < .001$.
‡$P < .01$.

Table 3
Analysis of variance for compliance of SPs as a function of perceived susceptibility, perceived seriousness, knowledge of SPs, perceived barriers, perceived benefits, perceived adequate of training, management support, perceived influence of nursing staff, and year of study using a univariate general linear model

Independent variables	df	Mean square	F	*P* value
Perceived susceptibility	1	0.003	0.023	NS
Perceived seriousness	1	0.127	0.932	NS
Knowledge of SPs	1	0.649	4.771*	.029
Perceived barriers	1	2.683	19.728†	<.001
Perceived benefits	1	0.085	0.625	NS
Perceived adequate of training	1	0.828	6.086*	.014
Perceived management support	1	0.69	5.073*	.025
Perceived influence of nursing staff	1	0.559	4.109*	.043
Year of study	3	4.998	4.998‡	.002
Perceived influence of nursing staff × year of study	3	3.267	3.267*	.021
Error	593			

NOTE. Adjusted $R^2 = 0.143$.
NS, nonsignificant; *SP*, standard precaution.
*$P < .05$.
†$P < .001$.
‡$P < .01$.

on compliance of SPs for first ($t_{94} = 0.53$, $P = .60$) and fourth year ($t_{157} = 1.04$, $P = .30$) NSs (Fig 2).

Predictors for compliance of SPs

Five predictors for compliance of SPs have been identified: knowledge of SPs, perceived barriers, perceived adequacy of training, perceived management support, and perceived influence of nursing staff ($F_{6,605} = 15.085$; $P < .001$) (Table 4). The adjusted R^2 value was 0.122. This indicates that 12.2% of the variance in

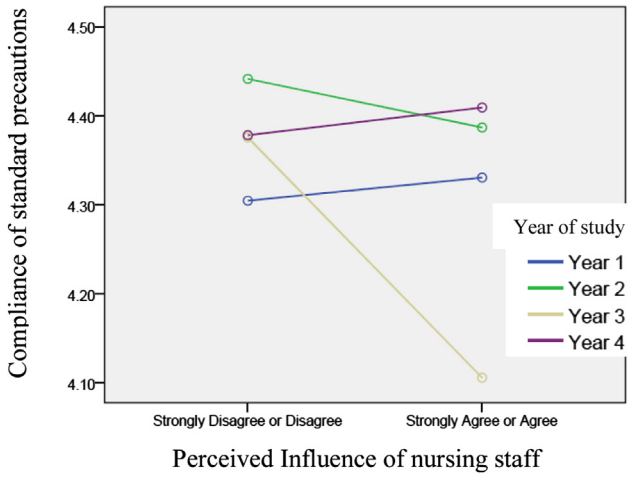

Fig 2. Interaction effect of perceived influence of nursing staff and year of study on compliance of standard precautions.

Table 4
Multiple regression analysis summary for knowledge of SPs, perceived barriers, perceived adequate of training, management support, influence of nursing staff, and year of study predicting compliance of SPs among nursing students (n = 612)

Independent variables	B	β	*P* value
Knowledge of SPs	0.003	0.105*	.009
Perceived barriers	−0.153	−0.191†	<.001
Perceived adequate of training	0.106	0.12*	.004
Perceived management support	0.069	0.092‡	.026
Perceived influence of nursing staff	−0.076	−0.09‡	.031
Year of study	0.000	0.001	NS
Constant	4.049		

NOTE. Adjusted $R^2 = 0.122$; $F_{6,605} = 15.085$; $P < .001$.
NS, nonsignificant; *SP*, standard precaution.
*$P < .01$.
†$P < .001$.
‡$P < .05$.

compliance of SPs was explained by the model. This small 12.2% variance indicated that the model explained only part, but not all, of the compliance of SPs among NSs. The perceived barriers included difficulty in performing procedures properly when wearing personal proactive equipment (39.3%, n = 247), offending patients when wearing personal proactive equipment to provide care (28.7%, n = 181), too busy to follow SPs (23.9%, n = 151), and offending nursing staff-ward practice if NSs followed proper SPs (22.7%, n = 143).

Power analysis

The results of the study found 5 predictors for compliance of SPs with an R^2 value of 12.2%. Power analysis was performed based on Cohen and Cohen.[35] The population effect size for the R^2 value of 0.12 was equaled to $R^2/1 - R^2$ (ie, $0.12/1 - 0.12 = 0.14$). With $\alpha = 0.05$ and a sample size of 678, the study's multiple regression model would have the power of >0.99 with independent variables <100.[35]

DISCUSSION

To our knowledge, this is the first study with a large sample size of 678 NSs participating in a study on SPs. The results of the study found that the compliance of SPs among NSs was high; this is consistent with findings in Italy[20] and Korea.[36] Furthermore, compared with self-reported results from registered nurses, it is

encouraging to know that NSs might comply with SPs more frequently than registered nurses.

Interaction effects

The findings of this study found that second- and third-year students' SPs compliance were significantly affected by the nursing staff's infection control practice in the wards. Furthermore, year 3 NSs had the lowest SPs compliance in the 4-year undergraduate program. A Bachelor of Science in Nursing is a 4-year program in Hong Kong. First- and second-year NSs are supervised by university clinical instructors, whereas second-year specialty and third- and fourth-year students were supervised by nursing staff in the clinical venue. It would be logical for the first year NSs to follow the SPs taught in the school because they were supervised by university clinical instructors. However, it is noteworthy that NSs were particularly affected by the nursing staff in the ward in their second and third year but not fourth year of clinical placement. Perhaps, the qualitative interview study results[37] conducted in the UK might provide some explanations. A Bachelor of Science in Nursing is a 3-year program in the UK, but only second- and third-year NSs were involved in the Ward study.[37] The study results found that poor practice by nursing staff observed by the NSs could have both negative and positive effects on their infection control practices. Some NSs would lower their infection control standards to fit in with the ward practice, whereas some would reflect on the poor practice observed and strive to maintain a high level of infection control practice. Furthermore, NSs' confidence on their infection control practice accumulated over their course of study, and this also increased their possibility of reporting poor infection control practice.[37] This might explain why fourth-year NSs were not as affected by nursing staff as much as those in their second and third years because they have the confidence to practice what they believe as the proper infection control practices.

Predictors for compliance of SPs

The results of this study found that knowledge, training, management support of SPs, barriers to SPs, and nursing staff influence were the predictors for NSs' SPs compliance. The purpose of the HBM is to identify the factors which can improve the likelihood of compliance to SPs among NSs. However, the underlying reasons why NSs might be affected by those factors might not be well explained by the HBM. Theory-in-use[38] might shine some light on the explanation of such findings in the present study. To apply the theory in the context of SPs compliance, theory-in-use is the performance of the behaviors related to the SPs compliance, whereas espoused theory is to explain or justify the behaviors related to the SPs compliance. Argyris and Schon[38] explained that theory-in-use (ie, actual practice and self-reported practice) of an individual worker is shaped by espoused theory, that is, his/her formal (eg, policies, guidelines) and informal (eg, observation, organizational culture) learning in the workplace. In terms of SPs compliance among NSs, increasing SPs knowledge, providing more SPs training, promoting a safety climate (management support), reducing identified SPs barriers, and improving nursing staff compliance to SPs would enhance NSs' SPs compliance.

Clinical implications

The results of the study indicated that more attention should be paid to NSs under the supervision of the clinical staff in the clinical venues, particularly in their junior-year period. Both qualitative studies in the UK[37,39] found that NSs intended to fit in with the clinical practices even though they knew the clinical staff did not comply with the SPs. In addition, NSs worried that their clinical performance evaluation would be negatively affected if they confronted the clinical staff about their improper infection control practices.[39] As a result, a comprehensive supporting program empowering students is recommended. Before clinical placement, assertiveness training[39] coupled with communication skills is suggested to empower NSs to handle challenges in the hierarchical clinical placement environment. Simultaneously, workshops for clinical mentors are recommended to inform them of the intended learning outcomes of the clinical placement and the expectations of the programs. The evidence-based effect of role modeling of clinical mentors to NSs would be emphasized in the workshops.

Limitation of the study

One of the limitations of this study is the sampling from 1 university, and hence the results might not be generalizable to NSs from other universities. Nonresponse bias and subjectivity of the self-report study are other limitations. Although many people's self-reported responses are based on their actual performance,[40] their recall might be questionable. Further studies using an observational design might be an alternative approach where NSs are observed objectively by an observer to determine their SPs compliance. In addition, further research should be conducted to explore the phenomena of the influence of nursing staff on NSs in the clinical settings. In addition, current studies seem to indicate that NSs have higher SPs compliance than nursing staff. After graduating from their university studies, at what point does compliance of SPs of junior nursing staff start to decline? Are they influenced by the existing senior nursing staff in the unit? What is the influence of the organizational culture? Answering these questions might shine light to establish appropriate strategies to improve the SPs compliance among nursing staff.

CONCLUSIONS

The result of the study indicates that NSs from various years of study have high compliance on SPs. Interaction effects were found: year 2 and year 3 NSs were significantly affected by the nursing staff's infection control practice in the units. Furthermore, knowledge, training, management support, barriers, and nursing staff influence were the predictors for compliance of SPs. Assertiveness training coupled with communication skills training should be implemented to empower NSs to handle the challenges in the hierarchical clinical placement environment. Future studies using an observational design on SPs compliance among NSs and studies to explore the influence of nursing staff to NSs and junior nursing staff are recommended.

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