

Validity testing of a tool for assessing nurse safety behaviour against blood borne infections

AUTHORS

HyunSoo Oh

PhD, RN
Professor, Department of Nursing, Inha University
Incheon, 402-751, Republic of Korea
hsoh@inha.ac.kr

WhaSook Seo

PhD, RN
Professor, Department of Nursing, Inha University
Incheon, 402-751, Republic of Korea
wschang@inha.ac.kr

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors

FUNDING

This work was supported by Inha University Research Grant.

KEY WORDS

Blood borne pathogens, factor analysis, health behaviour, reliability and validity

ABSTRACT

Objective

This study was conducted to develop and verify a tool for assessing nurse safety behaviour against blood borne infections.

Design

A cross-sectional correlation study design was used.

Setting and Subjects

Items were developed based on reviews of related literature, published guidelines regarding the prevention of blood borne infections, and existing tools designed to assess compliance with blood borne infection control precautions. Face and content validities of the tool was assessed by expert panels. Construct validity and reliability were examined on 320 staff and charge nurses whose duties involved direct contact with patients.

Results

A 12-item, 5-point Likert-type assessment tool of nurse safety behaviour against blood borne infections was devised. Construct validity, which was investigated by exploratory and confirmatory factor analysis, and reliability of the devised tool were well supported. The devised tool has a three-factor structure, 'use of personal protective equipment', 'hygiene', and 'compliance with precautions'. These factors were found to be interrelated, were not independent of each other, and their correlations and loading coefficients indicated good discriminant and convergent validities.

Conclusion

The devised 12-item assessment tool offers a clinically useful means of properly assessing safety related behaviours, and provides specific guidelines for preventive practices that should be followed by healthcare workers.

INTRODUCTION

Global risk of occupational exposure to blood borne pathogens among healthcare workers was reported to be 40% (Wilburn and Eijkemans, 2004). According to An et al (2010), 43% of sick leave taken by healthcare workers in Korea was due to blood borne infections and 75% of them were nurses. In clinical settings, the most frequent causes of blood borne infections are needle stick and sharps injuries (Kang 2011; Ayranci and Kosgeroglu 2004). Gabriel (2009) reported that there were approximately 180 sharps injuries per annum in a general 600-bed hospital in the United Kingdom (UK). Ko et al (2009) estimated an annual incidence rate of 1.3 needle stick and sharps injuries per person among healthcare workers in Taiwan.

The Center for Disease Control and Prevention (CDC) in the United States of America (USA) has issued standard precautions to provide specific guidelines for hand hygiene, the use of personal protective equipment, and the handling and disposal of clinical wastes and medical equipment (Siegel et al 2007). Although CDC standard precautions are most commonly recommended for preventing blood borne infections in healthcare settings, studies have shown low compliance rates among healthcare workers (Jeong et al 2008; Kim et al 2003), due to lack of knowledge, risk perception, time, personnel issues, uncomfortable personal protective equipment, inconvenience, or work stress (Kermode et al 2005).

Our literature review revealed that the majority of previous studies on blood borne infections have focused on epidemiology of blood borne infections, compliance with precautions regarding the prevention of blood borne infection, or the assessment of knowledge related to blood borne infections among healthcare workers (Kang 2011; An et al 2010; Cho and Choi 2010; Gabriel 2009; Ko et al 2009; Jeong et al 2008; Kermode et al 2005; Ayranci and Kosgeroglu 2004; Kim et al 2003). This literature revealed that most of the assessment tools used to evaluate compliance with precautions or preventive behaviours related to blood borne infections have been developed based on CDC general/standard precaution guidelines. Despite the reliability checks performed in previous studies, the processes used to develop and determine the reliabilities and validities of these assessment tools were not completed systematically. In particular, no previously described assessment tool has been subjected to validity testing. Because periodical assessments of adherence to safety precautions and preventive behaviours against blood borne infections should be conducted in clinical settings using adequate assessment tools, we recognised the need for a valid and reliable tool for assessing nurse safety behaviours against blood borne infections.

Therefore, the present study was conducted to develop and verify an assessment tool of nurse safety behaviour against blood borne infections. The specific aims of this study were: 1) to develop qualified items based on a review of; related literature, guidelines previously devised for preventing blood-borne infections, and of existing tools designed to assess compliance with blood borne infection control precautions or preventive behaviours, and 2) to determine the content and construct validities and reliability of the devised assessment tool.

METHODS

Item development

Because CDC standard precautions are considered to be the basis of good infection control practice, initially, we reviewed major principles and components of the CDC standard precautions. CDC standard precautions describe specific safety behaviours regarding: the safe handling and disposal of used needles, medical devices, and blood or body fluid samples; the cleaning and disinfecting of areas contaminated with blood or body fluids; hand hygiene; the use of personal protective equipment, such as, gloves, gowns, facemasks, or goggles; the management of biomedical wastes arising from and devices used for patient care; and rules and procedures regarding action taken after accidental exposure to blood borne pathogens. Those guidelines

result in specific tasks for individual healthcare workers (individual-level guidelines) and for institutions with respect to preparation and commitment (organisational-level guidelines). Because the present study aimed at developing a tool for assessing individual nurse safety behaviour against blood borne infections, assessment tool items were developed mainly based on individual-level precautions. A 17-item tool was initially developed, which contained four items on hygiene, seven items on personal protective equipment, and six items on compliance with precautions.

To determine whether additional items were needed, a review was performed of existing tools designed to assess compliance with precautions or preventive behaviours associated with blood borne infections (An et al 2010; Cho and Choi 2010; Choi and Kim 2009; Kermode et al 2005; Kim et al 2003). As a result of adopting this process, two additional items were identified as potentially useful, namely, 'used needles should not be removed from syringes by hand' and 'infectious equipment or waste containers should not be filled more than two-thirds', and these two were included to construct a provisional 19-item tool. Because Likert scales are widely used to measure attitude, belief, and behaviour, 5-point Likert-type response options, that is, always, often, sometimes, seldom, and never, were adopted.

Face and content validity tests on the items primarily included

Face validity of the 19-item provisional tool was assessed by an expert panel comprised of four infection control nurses employed at the two university hospitals in which data was collected. Discussions continued until an acceptable level of agreement was reached. The expert panel concluded most items appeared to be adequate and they were in-line with CDC standard precautions and institutional guidelines for preventing blood borne infections. However, three items were considered ambiguous and in need of modification. In addition, one item deemed to be irrelevant and two overlapping items were deleted. After these modifications and deletions, the assessment tool contained 16 items.

The content validity of the 16 items was assessed by a second expert panel comprised of three infection control nurses, who participated in the face validity testing, and four nursing professors with experience of developing assessment tools. Content validity testing was conducted to evaluate the correspondence between each item and the conceptual definition and attributes of nurse safety behaviours against blood borne infections using a 3-point scale: (1) invalid, (2) valid, and (3) highly valid. Content validity index (CVI) was computed as the number of items that the experts gave a rating of either (2) or (3) divided by the total number of items. In the present study, the CVIs of the 16 items ranged from 0.67-1.00, and the two items with a CVI of ≤ 0.90 were deleted (table 1).

Pre-test

Pre-testing of the then 14-item assessment tool was conducted using ten nurses to ensure that items were understandable and the time taken to complete the assessment was acceptable. Pre-testing indicated the devised tool was understandable, had no obvious problems, and it required only 1-3 minutes to complete.

Table 1: Exploratory factor analysis (n=120) and reliability testing (n=320)

Items	Factors		
	I	II	III
12. I wear a face shield (or mask) to protect my eyes if splashing of blood or body fluids is likely.	.83	-.01	-.02
11. I wear a gown or vinyl apron if splashing of blood or body fluids is likely.	.82	.09	.10
13. I wear mask to protect my mouth if splashing of blood or blood or body fluids is likely.	.77	.18	.07
14. I always wear gloves if I have a hand wound.	.71	.09	.32
10. I do not remove used needles from disposable syringes by hand.	.43	.37	.40
8. I wash my hands before and after handling blood and body fluids	.06	.80	.07
7. I treat instruments or devices contaminated with blood or body fluids as infectious.	.02	.79	.26
6. I wash my hands after removing gloves.	.06	.74	.24
9. I instantly clean and disinfect the area where blood or body fluids are splashed or spattered.	.34	.60	.13
3. I use special precautions when drawing blood samples from patients with infectious diseases.	.43	.09	.76
1. I do not fill containers of biomedical wastes or contaminated objects/device more than two-thirds full.	-.01	.17	.71
4. I use standard precautions when handling blood or body fluids.	.46	.16	.69
2. I always put potentially infectious objects or device in biohazard containers.	-.26	.35	.57
5. I do not recap used needles.	.23	.27	.42
Cumulated variance (%)	35.0	50.7	60.1
Kaiser-Meyer-Olkin	.81		
Bartlett Sphericity test (Chi-square/p-value)	820.06/<.001		

CONSTRUCT VALIDITY AND RELIABILITY TESTING OF THE DEVISED TOOL

Design

A cross-sectional correlation design was adopted to test construct validity and reliability of the devised 14-item, 5-point Likert-type assessment tool of nurse safety behaviour against blood borne infections.

Settings and participants

The study participants were 320 nurses that worked at two university hospitals located in Incheon and Kyungi province, South Korea. Only staff and charge nurses whose duties involved direct contact with patients were included in the present study.

Exploratory and confirmatory factor analyses were performed to determine the construct validities of the devised assessment tool, and therefore, sample sizes were separately computed for each analysis. Although sample sizes for testing validity of an assessment tool vary widely across studies, a minimum of five subjects per item is recommended in literature (Yu 2015; Tak 2007). Based on this recommendation, we considered 112 subjects were required for exploratory factor analysis (eight subjects per item for 14 items). In addition, a sample size of at least 200 subjects is recommended for stable and reliable statistical estimates of structural equation model analysis with confirmatory factor analysis. Accordingly, a total of 312 subjects appeared to be appropriate. Data was collected from 328 subjects based on expectations of missing or erratic responses. Of the 328 subjects, eight subjects were excluded because more than 20% of data was missing. Finally, 320 subjects were included in the analysis.

Data collection

The study was initiated after receiving an approval from the human research committee of the authors' affiliated university (IRB number: 11-0496) and permission from the two university hospitals involved. Data collection for the construct validity and reliability testing was performed on 320 nurses after the study purposes and procedures had been explained and informed consent obtained. All data collection was conducted by a previously trained research assistant (clinical nurse) in a quiet conference room in the hospitals.

Ethical considerations

It was made clear to all subjects they were free not to participate and could withdraw from the study at any time without prejudice. It was also explained information would be collected anonymously and that data would be presented as mean values (not as individual values). Study purposes and procedures in detail were explained and subjects were then allowed to decide upon participation. Written informed consent was obtained from all that agreed to participate.

Data analysis

Descriptive analyses of subject characteristics, item analysis, reliability testing, and construct validity testing were performed using SPSS ver. 21/PC (IBM, SPSS Korea, Seoul) and Lisrel 9.2 (Scientific Software International Inc., Illinois). Of the various types of validity tests, construct validity is particularly important when developing instruments for measuring psychosocial concepts. In the present study, factor analysis was used because it is the most frequently used method to examine construct validity (Park et al 2014). To elucidate the underlying factor structure of the devised assessment tool, we performed exploratory factor analysis using SPSS 21/PC. Confirmatory factor analysis was then conducted to validate the factor structure identified by exploratory factor analysis (Yong and Pearce 2013; Hurley et al 1997), using Lisrel 9.2. Internal consistency coefficients (Cronbach's alpha) were computed to evaluate the reliability of the devised 14-item tool.

FINDINGS

Descriptive analysis of subject general characteristics and major variables

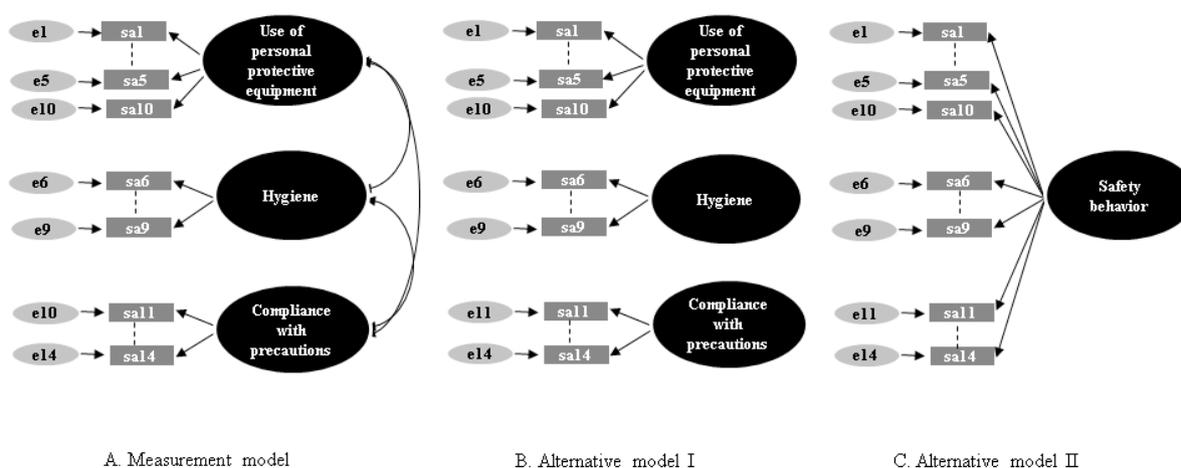
A total of 320 nurses were included in the study. Mean subject age was 30.10 (± 5.41) years. The majority of subjects were working in general medical/surgical units (68.4%). In terms of career years as a registered nurse, 159 subjects (49.7%) had worked for less than 5 years, 76 subjects (23.7%) for 5-10 years, and 85 subjects (26.6%) for more than 10 years. In addition, 284 subjects (88.8%) had previous experiences of skin contact with contaminated blood or body fluid ($n=206$, 64.4%) or with sharps or needles ($n=163$, 50.9%).

Construct validity: exploratory and confirmatory factor analyses

Exploratory factor analysis yielded three components with eigenvalues greater than one, that is, 'use of personal protective equipment' (component 1), 'hygiene' (component 2), and 'compliance with precautions' (component 3). Factor names were based on the characteristics of the items that had the highest factor loading scores. The total variance explained by these three components was 60.1%, that is, 60.1% of variance in nurse safety behaviour was explained by these three components. Because the communality value of the fraction of variance should be ≥ 0.60 (Kim 2005), our tool appeared to be acceptable in terms of its explanatory power. As presented in table 1, five of the 14 items loaded onto component 1 (35.0% variance), four onto component 2 (15.6% variance), and five onto component 3 (9.4% variance). All of the loadings were above the minimum recommended level of 0.40. The 10th item, "I do not remove used needles from disposable syringes by hand." was found to have similar loadings onto components 1 (0.43), 2 (0.37), and 3 (0.40). After careful consideration, this item was allocated to component 3 based on item attributes (table 1).

For confirmatory factor analysis, the measurement model was designed such that there were three factors (use of personal protective equipment, hygiene, and compliance with precautions), and these three were correlated with and were composed of items with high loadings as determined by exploratory factor analysis (figure 1). Model fit was examined using two alternative models and comparing fit indices to determine which model provided the better fit. The first alternative model was constructed using all three factors, but not correlated to each other. The second alternative model was a one-factor model in which all items were loaded on a single factor.

Figure 1: The measurement and alternative models



We found that the measurement model had a significant Chi-square value ($p > .001$), which indicated the model was unacceptable. The Chi-square statistic has been known to be highly sensitive to sample size, and hence virtually any model is likely to be rejected by the chi-square test when large samples are used (Bentler and Bonnet 1980). All other fit indices were satisfactory or acceptable [$\chi^2/df=2.14$ (optimal values: 1~3), RMSEA=0.07 (optimal values: $\leq .06 \sim .08$), NFI=.86 (optimal values: $\geq .90$), NNFI=.90 (optimal values: $\geq .90$), CFI=.92 (optimal values: $\geq .90$), GFI=.91 (optimal values: $\geq .90$), and AGFI=.87 (optimal values: $\geq .90$)] (table 2).

Table 2: Goodness of fit tests for measurement and alternative models (n=200)

χ^2/p	χ^2/df^*	RMSEA† (95% CI)	NFI‡	NNFI§	CFI	GFI**	AGFI††	BIC‡‡
<Original measurement model >								
158.68/<.001	2.14	0.07 (0.06~0.09)	.86	.90	.92	.91	.87	2502.67
<Modified measurement model>								
95.77/<.001	1.88	0.06 (0.04~0.08)	.91	.94	.96	.93	.90	2144.94
<Alternative model I >								
313.24/<.001	4.23	0.12 (0.10~0.13)	.73	.74	.78	.85	.80	2630.71
<Alternative model II>								
291.95/<.001	3.79	0.11 (0.10~0.13)	.75	.76	.80	.79	.71	2651.57

* $\chi^2/df \leq 3$ †Root mean square error of approximation ($\leq .06 \sim .08$) (95% confidence interval)

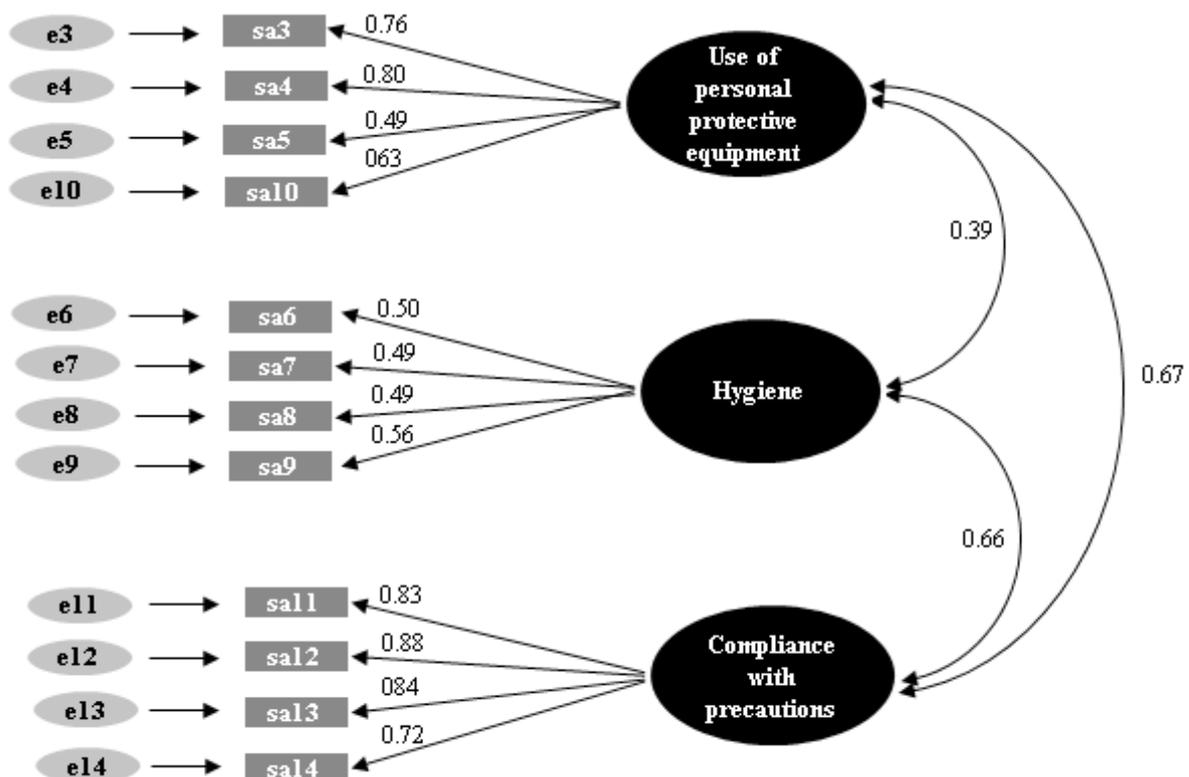
‡Normed fit index ($\geq .80 \sim .90$) §Non-normed fit index ($\geq .80 \sim .90$) ||Comparative fit index ($\geq .80 \sim .90$)

**Goodness of fit index ($\geq .80 \sim .90$) ††Adjusted goodness of fit index ($\geq .80 \sim .90$) ‡‡Bayesian information criteria

To improve model fit, standardised coefficients were then estimated. Standardised coefficients are considered sample specific, and need to be $\geq .40$ – $.50$ and $\leq .99$ for a sample size of >200 (Yu 2015; Hair et al 2010). In the present study, most items had acceptable standardised coefficients (range 0.49–0.88), except item 1 (0.27) and 2 (0.19). Accordingly, the model was modified by removing items 1 and 2, and model fit was re-examined. This 12-item model showed better goodness of fit indicators: $\chi^2/df=1.88$, RMSEA=0.06, NFI=.91, NNFI=.94, CFI=.96, GFI=.93, and AGFI=.90 (table 2).

This modified 12-item model was accepted as the final assessment tool and contained the following items: four items for ‘use of personal protective equipment’ (standardized coefficient: .72~.88), four items for ‘hygiene’ (standardised coefficient: .49~.53), and 4 items for ‘compliance with precautions’ (standardised coefficient: .49~.80). All of their standardised coefficients were statistically significant (table 3). Correlation coefficients were $r=.39$ between ‘use of personal protective equipment’ and ‘hygiene’, $r=.66$ between ‘compliance with precautions’, and $r=.67$ between ‘use of personal protective equipment’ and ‘compliance with precautions’ (figure 2).

Figure 2: Confirmatory factor analysis of the measurement model



Reliability testing

The internal consistency of the devised assessment tool was found to be well supported. Cronbach's alpha (reliability coefficient of internal consistency) for all three components was 0.88 (was 0.89 for ‘use of personal protective equipment’, 0.79 for ‘hygiene’, and 0.76 for ‘compliance with precautions’).

Table 3: Measured variables estimated of the confirmatory factor model (n=200)

Factors	Items	B*(SE) †	β‡	t(p)	alpha§
Use of personal protective equipment	12. I wear a face shield (or mask) to protect my eyes if splashing of blood or body fluids is likely.	1.00	.88		.89
	11. I wear a gown or vinyl apron if splashing of blood or body fluids is likely.	0.97 (.06)	.83	15.74 (<.01)	
	13. I wear mask to protect my mouth if splashing of blood or blood or body fluids is likely.	0.93 (.06)	.84	16.22 (<.01)	
	14. I always wear gloves if I have a hand wound.	0.77 (.06)	.72	12.65 (<.01)	
Hygiene	8. I wash my hands before and after handling blood and body fluids.	1.00	.49		.79
	6. I wash my hands after removing gloves.	1.12 (.28)	.50	3.98 (<.01)	
	7. I treat instruments or devices contaminated with blood or body fluids as infectious.	1.21 (.30)	.49	4.08 (<.01)	
	9. I instantly clean and disinfect the area where blood or body fluids are splashed or spattered.	1.39 (.33)	.53	4.28 (<.01)	
Compliance with precautions	3. I use special precautions when drawing blood samples from patients with infectious diseases.	1.00	.76		.76
	4. I use standard precautions when handling blood or body fluids.	1.01 (.09)	.80	11.14 (<.01)	
	5. I do not recap used needles.	0.57 (.08)	.49	6.90 (<.01)	
	10. I do not remove used needles from disposable syringes by hand.	0.79 (.09)	.62	8.83 (<.01)	

*Unstandardised beta †Standardised error ‡Standardised beta §Reliability test: Cronbach's alpha

DISCUSSION

Face and content validity tests indicated the devised items appeared to reflect important individual-level safety behaviours adequately in clinics and well corresponded with conceptual definitions and attributes of nurse safety behaviour against blood borne infections. The factor structure of the devised assessment tool was found to contain three factors, 'use of personal protective equipment', 'hygiene', and 'compliance with precautions', and the total variance explained by these three factors was acceptable. The 'use of personal protective equipment' yielded the highest explained variance of 35% and contained four subscale items that assessed the use of personal protective equipment, that is, gloves, face shield, mask, or gown.

It is well known that gloving provides an excellent means of preventing hand contamination while touching body fluid, blood, mucous membrane, or broken skin of patients with specific infections, and thus, routine gloving is required to protect healthcare workers and patients (Tenorio et al 2001). However, it has not been clarified how well gloving prevents against blood borne infections caused by needle or sharps injuries. Therefore, sharp instruments must always be handled carefully, even when wearing of gloves. The use of mask, face shield, and goggles also has been proposed to prevent contamination of eyes, nose, and mouth (CDC 2001).

Subscale items under the second factor 'hygiene' consisted of items relating to hand washing before and after handling blood or body fluids and after removing gloves. Empirical evidence demonstrates hand washing is the most important and effective intervention for preventing the spread of infectious diseases (CDC 2001), and is an essential part of CDC standard precautions (Siegel et al 2007). Items related to the management of devices and areas contaminated with blood or body fluids were also under the second factor 'hygiene'.

The third factor 'compliance with precautions' consisted of subscale items concerning compliance with procedures for the handling of blood, body fluids, or needles. It has been suggested healthcare worker safety regarding blood borne infections could be significantly improved by following existing protocols or guidelines, such as, those related to the use of protective equipment, routine sanitary inspection, preventive efforts to reduce percutaneous injuries from sharp devices or objects, and proper cleaning and disposal of used devices or instruments (Do et al 2003). The high incidence of needle stick injuries supports the need for such precautions (Gabriel 2009). Needle stick injuries commonly occur during needle recapping (Kim et al 2003), and an item was included to assess such risk behaviour in our tool.

Confirmatory factor analysis showed that the three factors, 'use of personal protective equipment', 'hygiene', and 'compliance with precautions', were interrelated, that is, they were not independent of each other. Correlation coefficients were of medium strength, which supported discriminant validity of the assessment tool (Yu 2015). In addition, all subscale items had loading coefficients of >0.49 , indicating excellent convergent validity.

Safety is an important issue for nurses, especially those who are clinically based. Close patient contact means nurses are at particularly high risk of exposure to blood borne pathogens. To develop a valid assessment tool of nurse safety behaviour against blood borne infections, 12 items were systematically devised based on a review of related literature, CDC standard precautions, and of existing tools designed to assess compliance with blood borne infection control precautions or preventive behaviours in the present study. We expect this assessment tool may be beneficial to help nurses understand safety issues, identify unsafe practice, and therefore promote their practice. However, its validity and reliability were tested with a sample of Korean nurses ($n=320$) recruited from two university hospitals, which limits the generalisability of the study findings to other populations. Accordingly, this tool still needs further verification and refinement with multi-centre multi-ethnic studies to be a standardised instrument for assessing nurse safety behaviour against blood borne infections.

CONCLUSION

The 12-item assessment tool produced, though concise, includes most of the essential components of the precautions that should be taken to prevent infection by blood borne pathogens, and offers a clinically useful means of properly assessing nurse safety related behaviours. In addition, we believe this tool could aid the identification and correction of problems associated with the adoption of safety behaviours and preventive practices related to blood borne infections, consequently reducing incidence of blood borne pathogen transmission. Furthermore, it provides specific information on safety precautions and on the preventive practices that should be followed by healthcare workers.

REFERENCES

- An, J.Y., Lee, Y.M. and Song, J.H. 2010. A Study on Performance Level for Universal Precautions on Blood-Borne Infections among Nurses in Hospitals. *Journal of Korean Academy of Society Nursing Education*, 16(1):92-100.
- Ayranci, U. and Kosgeroglu, N. 2004. Needlestick and sharps injuries among nurses in the healthcare sector in a city of western Turkey. *Journal of Hospital Infection*, 58:216-223.
- Bentler, P.M. and Bonnet, D.C. 1980. Significance Tests and Goodness of Fit in the Analysis of Covariance Structures. *Psychological Bulletin*, 88(3):588-606.
- Centers for Disease Control and Prevention. 2001. Updated U.S. Public Health Service guidelines for the management of occupational exposure to HBV, HCV, and HIV and recommendations for postexposure prophylaxis. *Morbidity and Mortality weekly Report*, 50(11):1-52.
- Cho, G.L. and Choi, J.S. 2010. Knowledge of and compliance with standard precautions by nurses in intensive care unit. *Journal of Korean Academy of Fundamental Nursing*, 17(1):73-81.
- Choi, J.S. and Kim, K.S. 2009. Application and evaluation of a web-based education program on blood-borne infection control for nurses. *Journal of Korean Academy of Nursing*, 39(2):298-309.

- Do, A.N., Ciesielski, C.A., Metler, R.P., Hammett, T.A., Li, J. and Fleming, P.L. 2003. Occupationally Acquired Human Immunodeficiency Virus (HIV) Infection: National Case Surveillance Data during 20 Years of the HIV Epidemic in the United States. *Infection Control and Hospital Epidemiology*, 24(2):86-96.
- Gabriel, J. 2009. Reducing needlestick and sharps injuries among healthcare workers. *Nursing Standard*, 23(22):41-44.
- Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. 2010. *Multivariate data analysis* (7th edn). Pearson Prentice Hall: New Jersey.
- Hurley, A.E., Scandura, T.A., Schriesheim, C.A., Brannick, M.T., Serrs, A., Vanderberg, R.J. and Williams, L.J. 1997. Exploratory and confirmatory factor analysis: guidelines, issues, and alternatives. *Journal of Organizational Behavior*, 18:667-683.
- Jeong, I., Cho, J. and Park, S. 2008. Compliance with standard precautions among operating room nurses in South Korea. *American Journal of Infection Control*, 36:739-742.
- Kang, J.O. 2011. Occupational infections of health care personnel in Korea, *Hanyang Medical Review*, 31(3):200-210.
- Kermode, M., Jolley, D., Langkham, B., Thomas, M. S., Holmes, W. and Gifford, S.M. 2005. Compliance with universal/standard precautions among health care workers in rural north India. *American Journal of Infection Control*, 33:27-33.
- Kim, G. S. (2005). *AMOS structural equation model analysis* (2nd edn). SPSS Academy: Seoul.
- Kim, M.J., Kim, J.S. and Eum, S.J. 2003. Knowledge, universal precaution practice, and hindrance factors of medical workers in a university hospital concerning bloodmediated diseases. *Clinical Nursing Research*, 9(1):41-54.
- Ko, N-Y., Yeh, S-H., Tsay, S-L., Pan, S-M., Feng, M-C., Ching, M-C., Lee, Y-W., Chang L-H. and Jang, J-F. 2009. Adherence to management after occupational exposure to bloodborne pathogen among health care workers in Taiwan. *American Journal of Infection Control*, 37(7):609-611.
- Park, I., Eom, N.Y. and Lee, G. 2014. Issues and concurrent solutions for the application of confirmatory factor analysis in physical education and exercise science research. *The Korean Journal of Measurement and Evaluation in Physical Education and Sport Science*, 16(1):1-22.
- Siegel, J.D., Rhinehart, E., Jackson, M. and Chiarello, L. 2007. Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. Retrieved from <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf>
- Tak J.K. 2007. *Psychological testing* (2nd edn). Hakjisa: Seoul.
- Tenorio, A.R., Badri, S.M., Sahgal, N.B., Hota, B., Matushek, M., Hayden, M.K., Trenholme, G.M. and Weinstein, R.A. 2001. Effectiveness of gloves in the prevention of hand carriage of vancomycin-resistant enterococcus species by health care workers after patient care. *Clinical Infectious Diseases*, 32(5):826-829.
- Wilburn, S.Q. and Eijkemans, G. 2004. Preventing needlestick injuries among healthcare workers: a WHO-ICN collaboration. *International Journal of Occupational Environmental Health*, 10:451-456.
- Yong, A.G. and Pearce, S. 2013. A beginner's guide to factor analysis: focusing on exploratory factor analysis. *Tutorials in Quantitative methods for Psychology*, 9(2):79-94.
- Yu, J.P. 2015. *Concepts and understanding of structural equation model*. Hannarae Academy: Seoul.