

Latent factors affecting safer injection practices that reduce infection and how education can improve them

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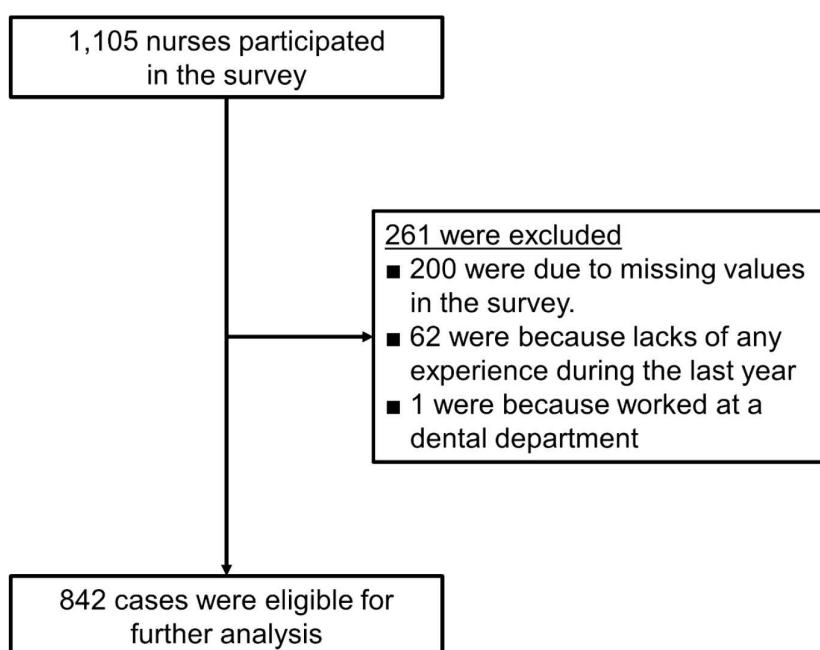
배경: The incidence of healthcare-associated infections, particularly injection-related infections, increases patient comorbidities even in countries with adequate medical resources. Although there are clear guidelines for injection practices to prevent infection, their application in clinical settings is insufficient. Therefore, we have identified factors that effectively affect the application of injection practices with reduced infection.

방법: Including all types of medical institutions from primary medical institutions to tertiary medical institutions. We developed a questionnaire related to safe injection for infection prevention and administered it to the medical staff in charge of injection practice. The survey questionnaires were classified into four factors through factor loading, and the factors affecting injection practice performance were analyzed using a multivariable robust regression test.

결과: In total, 842 questionnaires were analyzed. Each questionnaire was classified into four factors: “Reuse and contamination,” “Compliance with aseptic technique,” “Exchange of infusion set,” and “Use of multidose vials,” Nurses with higher careers showed more compliance; education within one year and awareness of each item of the questionnaire had positive associations with proper injection practice.

결론: The most important factor in the proper injection practice with reduced infection is education, and relevant knowledge through timely education positively affects the performance and compliance related to safe injection.

Keywords: Injection practices to prevent infection, Exploratory factor analysis, Latent variables



Supplemental Figure 1. Flow chart depicting an enrollment of the survey results

Table 1. Baseline characteristics of participants (N = 842)

List of survey items	N (%)
Hospital type	
Mid-tier hospitals or long-term care facilities	108 (12.8)
General hospitals	139 (16.5)
Tertiary general hospitals	595 (70.7)
Area	
Seoul metropolitan area	659 (78.3)
Other area	183 (21.7)
Hospital size, beds	
<500	123 (14.6)
500–999	303 (36.0)
≥1000	416 (49.4)
Department	
General ward	543 (64.5)
ICU, NICU, and ER	184 (21.9)
Other departments ^a	115 (13.7)
Grade	
General nurse	568 (67.5)
Middle-management (charged nurse)	101 (12.0)
Executive (headed nurse)	173 (20.5)
Age^b	33.5 ± 9.1 ^c
<30	386 (45.8)
30–39	226 (26.8)
≥40	230 (27.3)
Female	824 (97.9)
Have been educated within 1 year on injection-practice within a year, yes	676 (80.3)
Online	427 (63.2)
Offline	249 (36.8)
The presence of an administrative and educative department in the hospital, yes	809 (96.1)
Career	
<3 years	217 (25.8)
3–10 years	274 (32.5)
≥10 years	351 (41.7)

^a Other departments included operating rooms, outpatient clinics, endoscopy wards, anesthesia recovery wards, delivery rooms, intervention rooms, hemodialysis units, and outpatient injection units.

^b Two participants refused to answer their age.

^c Age was represented as mean ± standard deviation.

Abbreviations: ICU, intensive care unit; NICU, neonatal intensive care unit; ER, emergency room.

Table 2. Questionnaire Survey – Survey answer for Awareness and performance (N = 842)

Questionnaire	Performance ^a	Awareness ^b
Before handling intravenous injections, do hand hygiene before preparing injection drugs	4.5 ± 0.7	832 (98.8)
Follow sterilization in the preparation and administration of injection drugs.	4.6 ± 0.6	836 (99.3)
Do not use the opened syringe even if there is no visible contamination.	4.5 ± 1.1	820 (97.4)
When removing drugs using a syringe, the rubber stopper of the vial must be sterilized with a disinfectant such as alcohol.	4.8 ± 0.5	835 (99.2)
Before and after use, the injection port is thoroughly wiped with disinfectant for 3 to 15 seconds and dried	4.5 ± 0.7	806 (95.7)
Single-use vials are for one patient only, and the remaining medication is discarded.	4.9 ± 0.4	835 (99.2)
Do not reuse syringes or needles once connected to the infusion bag or infusion set.	4.9 ± 0.6	838 (99.5)
Do not use for flushing of multiple patients by drawing fluid from a sterile infusion bag or sterile infusion bottle.	4.7 ± 0.9	829 (98.5)
Do not transfer drugs from a syringe containing injection drugs to another syringe	4.7 ± 0.8	829 (98.5)
Do not collect the remaining injection drugs in a separate container after use on one patient	4.8 ± 0.7	840 (99.8)
Do not put the needle in the rubber stopper of the vial injection drug.	4.5 ± 0.9	807 (95.8)
Prepared injection drug is administered within 1 hour.	4.4 ± 0.8	805 (95.6)
Do not remove the rubber stopper to use the drug in the vial.	4.8 ± 0.7	836 (99.3)
Even if the needle is changed, the syringe is not reused.	4.8 ± 0.7	826 (98.1)
Sterilized syringes and needles are opened immediately before use.	4.7 ± 0.6	832 (98.8)
Injectable drugs that cannot be administered immediately should be labeled on the syringe with the ingredients, dosage, and date and time of preparation.	4.7 ± 0.7	832 (98.8)
If the package is opened or damaged, even an unused syringe is considered contaminated and discarded.	4.7 ± 0.6	832 (98.8)
The expiration date of the multi-dose vial is recorded when first opened.	4.9 ± 0.5	834 (99.0)
Opened multi-dose vials should be discarded within 28 days after opening unless the manufacturer has a specific expiration date.	4.8 ± 0.5	828 (98.3)
Wait for the disinfectant to dry out when disinfecting the skin before injection	4.4 ± 0.7	809 (96.1)
The TPN infusion set is exchanged every time a new fluid is connected or every 24 hours.	4.9 ± 0.5	834 (99.0)
The infusion set for injecting drugs intermittently is exchanged every injection or every 24 hours.	4.7 ± 0.7	810 (96.2)
The fluid set for injecting propofol is changed every injection or every 6 to 12 hours.	4.2 ± 1.4	772 (91.7)
The transfusion set and filters for injecting blood products should be changed every time the blood bag is changed or every 4 hours.	4.8 ± 0.7	827 (98.2)
If you must use a 3-way connector, attach a sterilization cap to the inlet to maintain a closed system.	4.9 ± 0.4	836 (99.3)
The 3-way connector must be exchanged together when changing the infusion set.	4.7 ± 0.7	822 (97.6)
Do not carry syringes and needles containing injections in uniform pockets.	4.9 ± 0.6	832 (98.8)

^a Mean ± standard deviation; ^b number (%)

Table 3. Questionnaire Survey - Survey Answers to Obstacles Factors (N = 842)

Questionnaire	Answer to yes ^a
There is not enough time to follow the injection practice guidelines for infection prevention, such as aseptic technique, hand hygiene, and disinfection.	466 (55.3)
It is difficult to comply with aseptic technique in all processes, such as preparation and administration of injectable drugs.	332 (39.4)
I think it's a waste to use only a portion of the injection and throw it away.	80 (9.5)
Insufficient supplies such as syringes, needles, and infusion set for safe use	179 (21.3)
The environment and facilities are not in place to safely comply with the injection practice guidelines for infection prevention.	186 (22.1)
There is no organizational culture that complies with the injection practice guidelines for infection prevention	101 (12.0)
It is difficult to understand the contents of the injection practice guidelines for infection prevention in working medical institutions	37 (4.4)
There are no practical guidelines for injections to prevent infection in the working medical institution	46 (5.5)
Lack of opportunities for training on injection practice for infection prevention	138 (16.4)
There is no penalty or penalty for non-compliance with the injection practice guidelines	227 (27)

^a number (%)

Table 4. Exploratory Factor analysis (EFA) – Knowledge and performance factors

Variables	Factor1	Factor2	Factor3	Factor4
Eigenvalue (SS loadings)	4.52	3.3	2.35	1.2
Proportion of variance	0.17	0.12	0.09	0.04
Cumulative variance	0.17	0.29	0.38	0.42
Reuse and contamination				
Do not collect the remaining injection drugs in a separate container after use on one patient	0.97			
Do not transfer drugs from a syringe containing injection drugs to another syringe	0.87			
Do not remove the rubber stopper to use the drug in the vial.	0.74			
Do not use for flushing of multiple patients by drawing fluid from a sterile infusion bag or sterile infusion bottle.	0.72			
Do not carry syringes and needles containing injections in uniform pockets.	0.71	-0.2	0.23	
Do not reuse syringes or needles once connected to the infusion bag or infusion set.	0.67			
Even if the needle is changed, the syringe is not reused.	0.65			
Do not put the needle in the rubber stopper of the vial injection drug.	0.52	0.42		
Compliance with aseptic technique				
Prepared injection drug is administered within one hour.		0.72		
Wait for the disinfectant to dry out when disinfecting the skin before injection.		0.64		
Before handling intravenous injections, do hand hygiene before preparing injection drugs.		0.6		
Sterilized syringes and needles are opened immediately before use.		0.58		-0.2
Follow sterilization in the preparation and administration of injection drugs.		0.57		
Before and after use, the injection port is thoroughly wiped with disinfectant for three to 15 seconds and dried.		0.54		
If the package is opened or damaged, even an unused syringe is considered contaminated and discarded.		0.51		
Injectable drugs that cannot be administered immediately should be labeled on the syringe with the ingredients, dosage, and date and time of preparation.		0.41		
Do not use the opened syringe even if there is no visible contamination.	0.22	0.37		
When removing drugs using a syringe, the rubber stopper of the vial must be sterilized with a disinfectant such as alcohol.		0.33		
Exchange of infusion set				
The TPN infusion set is exchanged every time a new fluid is connected or every 24 hours.			0.86	
The infusion set for injecting drugs intermittently is exchanged every injection or every 24 hours.			0.68	
If you must use a 3-way connector, attach a sterilization cap to the inlet to maintain a closed system.			0.65	0.22
The transfusion set and filters for injecting blood products should be changed every time the blood bag is changed or every 4 hours.			0.43	
The 3-way connector must be exchanged together when changing the infusion set.			0.38	
The fluid set for injecting propofol is changed every injection or every 6 to 12 hours.		0.22	0.31	
Single-use vials are for one patient only, and the remaining medication is discarded.			0.23	
Use of multi-dose vials				
The expiration date of the multi-dose vial is recorded when first opened.				0.73
Opened multi-dose vials should be discarded within 28 days after opening unless the manufacturer has a specific expiration date.			0.22	0.55

Table 5. Exploratory Factor analysis (EFA) – Obstacles factors

Variables	Factor1	Factor2
Eigenvalue (SS loadings)	3.53	2.46
Proportion of variance	0.35	0.25
Cumulative variance	0.35	0.6
External factors		
There are no practical guidelines for injections to prevent infection in the working medical institution	1.11	-0.23
Lack of opportunities for training on injection practice for infection prevention	0.91	
It is difficult to understand the contents of the injection practice guidelines for infection prevention in working medical institutions	0.75	
There is no penalty or penalty for non-compliance with the injection practice guidelines	0.65	
There is no organizational culture that complies with the injection practice guidelines for infection prevention	0.53	0.33
Internal factors		
There is not enough time to follow the injection practice guidelines for infection prevention, such as aseptic technique, hand hygiene, and disinfection.	-0.31	1.13
It is difficult to comply with aseptic technique in all processes, such as preparation and administration of injectable drugs.		0.82
I think it's a waste to use only a portion of the injection and throw it away.		0.44
The environment and facilities are not in place to safely comply with the injection practice guidelines for infection prevention.	0.36	0.43
Insufficient supplies such as syringes, needles, and infusion set for safe use	0.29	0.29

Table 6. Factors affecting the performance of proper injection practice

	Performance factors			
Variables	Reuse and contamination	Compliance with aseptic technique	Exchange of infusion set	Use of multi-dose vials
Area				
Seoul metropolitan area	Ref.	Ref.	Ref.	Ref.
Other area	-0.010	-0.004	-0.047	0.021
Hospital size, beds				
<500	Ref.	Ref.	Ref.	Ref.
500–999	0.038	0.200***	0.154	0.037
≥1000	-0.046	0.108	-0.228	0.053
Department				
General ward	Ref.	Ref.	Ref.	Ref.
ICU, NICU, and ER	0.049*	0.108**	0.165*	-0.058*
Other department ^a	0.040	0.092*	0.178*	-0.074**
Grade				
General nurse	Ref.	Ref.	Ref.	Ref.
Middle-management (charged nurse)	0.011	-0.012	0.044	-0.032
Executive (headed nurse)	0.022	0.031	0.081	-0.015
Career				
<3 years	Ref.	Ref.	Ref.	Ref.
3–10 years	0.051*	0.061	0.067	0.013
≥10 years	0.082***	0.091*	0.155	0.013
Have been educated within 1 year on injection-practice within a year^b				
No vs. Yes	0.014	0.040***	0.079***	0.022**
Online vs. Offline	0.007	0.004	-0.008	0.007
The presence of an administrative and educative department in the hospital, yes				
No	Ref.	Ref.	Ref.	Ref.
Yes	-0.050	-0.109	-0.012	0.040
Awareness factors^c				
Reuse and contamination	0.229***	0.056	0.189*	-0.015
Compliance with aseptic technique	0.022	0.307***	0.181***	-0.022
Exchange of infusion set	0.019	0.047	0.278***	0.073***
Use of multi-dose vials	0.020	0.040	0.078	1.019***
Obstacle factors^d				
External factors	-0.009	-0.010	0.037	-0.035***
Internal factors	-0.049***	-0.078***	-0.258***	-0.010

A multivariate robust regression test was performed. B-coefficient values are represented. P-values were calculated after Bonferroni correction.

^a Other departments included operating rooms, outpatient clinics, endoscopy wards, anesthesia recovery wards, delivery rooms, intervention rooms, hemodialysis units, and outpatient injection units.

^b Planned contrasts were used. At first, cases with education within a year were compared to cases without. Then, cases with online education were compared to cases with offline education.

^c Awareness factors were calculated as 1 point for answering yes to each questionnaire based on the knowledge and performance factor results (Table 2). Therefore, the maximum scores for “Reuse and contamination”, “Compliance with aseptic technique”, “Exchange of infusion set”, and “Use of multidose vials” were 8, 10, 7, and 2, respectively.

^d The value of the obstacle factor is the factor loading calculated based on the questionnaire (Table 3).

* P-value < 0.05; ** P-value < 0.01; P-value < 0.001.

Abbreviations: ICU, intensive care unit; NICU, neonatal intensive care unit; ER, emergency room.