



Characteristics of Eye Movement and Clinical Judgment in Nurses and Nursing Students During the Sterile Glove Application

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Abstract. The purpose of this study is to elucidate differences between nursing students and nurses in obtaining visual information while performing sterile technique and thought processes when making judgments on sterility.

Study methods: The subjects were nine nursing students and eight nurses. Data collection was (1) View a video at sterile gloves, (2) Measure eye movement with eye camera, (3) Interview. The analysis calculated each time and number of times that they watched closely. The details of the interviews for each subject were recorded verbatim. The interview parts describing the observation details were extracted and analyzed qualitatively and inductively.

Result & Discussion: The analyzed target people are 7 Nursing students and 8 Nurse. Sight information was frequent in the domain indicating all seven action scenes [border part of cleanliness area and the pollution area]. For the talk of the sterilization gloves wearing action, [cleanliness area and boundary drawing] and [consciousness of the securing of cleanliness level] and three intentions of [confirmation of the wearing situation] were extracted.

Keywords: Eye movement · Clinical judgment · Nurse · Germfree operation

1 Introduction

Much of nursing care starts with observation, generally with the five senses. Visual data accounts for the largest proportion of the data obtained from the five senses, so it is possible to “overlook” any crucial point that nurses should pay careful attention to.

One illustration is aseptic technique, one of the nursing skills which prevents pathogenic microorganisms from entering patients’ body. Since pathogenic microorganisms are invisible to the naked eye, nurses are required to perform aseptic technique while visually confirming that sterility is maintained. When any crucial point is “overlooked,” it is impossible to confirm that a clean state is maintained, which is likely to increase the risks of infection. Therefore, it is important to use visual observation while employing this technique to confirm that sterility is being maintained properly.

Maintaining sterility requires nurses to be aware of the boundaries between clean and unclean areas. In spite of all the lectures and practice time for aseptic technique

provided for nursing students, they often find it difficult to understand and make correct judgments on the boundaries between the two areas.

In the clinical settings, one of the occasions where aseptic technique is required the most is in the operating room where nursing skills are necessary. Since the operating room requires particularly accurate judgment on clean and unclean areas, many institutions have adopted the system in which several nurses cross-check the sterility without relying on one nurse making the judgment alone. Even though the cross-checking system involves multiple nurses in the operating room, the fact that checking process relies on visual confirmation can make objective evaluations of the sterility difficult. What makes objective evaluations is using eye movement trackers. Previous studies conducted in the operating room using eye movement trackers include studies on surgeons' intraoperative gaze (Khan et al. 2012; Atkins et al. 2012) and nurses' gaze during surgery (Ranieri et al. 2011). These studies were conducted in the actual operating rooms. Thus, they did not focus exclusively on aseptic technique.

One of the common aseptic techniques, sterile glove application includes not only the simple act of putting on gloves, but also applying them while nurses are constantly conscious about sterile and non-sterile zones so as to maintain sterility. However, sterile gloves must be tightly fitted to the hands, which is rather difficult. Furthermore, nursing students cannot make judgment on what is clean and what is not easily by visual observation alone. Therefore, they often have great difficulty learning to apply sterile gloves using the correct techniques.

On the other hand, experienced nurses are able to apply sterile gloves quickly while maintaining sterility, which leads us to believe that nurses' visual information and abilities to judge sterility while performing aseptic technique vary depending on the nurse's experience level. Thus, the present study aims to elucidate differences between nursing students and nurses in visual observations during sterile glove application and thought processes when making judgments on sterility.

2 Purpose

The purpose of this study is to elucidate differences between nursing students and nurses in obtaining visual information while performing sterile technique and thought processes when making judgments on sterility.

3 Study Methods

3.1 Protocol

The subjects were nine nursing students and eight nurses with more than five years of experience. Data collection was conducted in the following three steps:

- Step 1: Subjects were asked to view a video on applying sterile gloves.
- Step 2: Subjects were asked to wear an eye camera (Talk-Eye2, Takei Scientific Instruments, Co., Ltd., Niigata, Japan), viewing 17 still images depicting sterile glove application for three seconds each.

Step 3: Subjects were shown the visual data obtained by the eye camera, and an interview was conducted.

In the interview the subjects were asked to describe what they were thinking while replaying the visual data on their tracked eye movements. The interviews were recorded with an IC recorder.

3.2 Methods of Analysis

For the eye movements, 12 of the 17 [A1] images, capturing the process from opening the wrap of the sterile gloves until putting on the gloves, were analyzed. An analysis area was determined for each image, and the total duration and number of gaze were counted. The analysis areas were established so as to include the [sterile zone] and [boundary between the sterile and non-sterile zones].

The 12 images were classified into seven sterile glove application steps: [inspecting the pack], [opening the outer wrap], [opening the sterile inner wrap], [unfolding the wrap], [pulling out a sterile glove and putting it on one hand], [putting on the other sterile glove], and [completing the sterile glove application].

The details of the interviews for each subject were recorded verbatim. The parts describing the observation details were extracted and analyzed qualitatively and inductively.

3.3 Ethical Considerations

The purpose and methods of the study, voluntary nature of participation, data management methods, and confidentiality were explained to the participants verbally and in writing, and their signatures were obtained on the consent forms.

This study was approved by the institutional review board of the Ishikawa Prefectural Nursing University (Nursing University approval No. 460) (Nursing University approval No. 871).

4 Results

Consent to participate was obtained from nine nursing students. Of these, two were excluded after the device stopped tracking their pupils halfway through the experiment. All eight nurses' data were included in the analysis.

We checked the gazed areas in the 12 images. There were no differences in the areas gazed by the nursing students and those gazed by the nurses.

In all seven steps, there was a high number of both nursing students and nurses who focused on the areas that included the [boundary between the sterile and non-sterile zones], and they observed them for long durations at high frequencies.

From the narratives describing the acts of sterile glove application, the following three intentions were identified: [delineating the sterile zone from the boundary], [awareness of securing the sterile zone], and [checking the application status].

For [delineating the sterile zone from the boundary], nursing students described that they were thinking “whether the boundaries between the sterile and non-sterile zones were being maintained” and “whether or not the boundary was contaminated.” Nurses described that they were thinking they “might cross the boundary into the contaminated zone” or that they “paid attention to the boundary.” However, there were some nurses who did not mention this at all.

In terms of [awareness of securing the sterile zone], nursing students explained that they were careful about “minimizing the contaminated zone” and “avoiding touching the clean part to prevent contamination while pulling on the fold.” Nurses described that they “opened the wrap so that it did not become unclean” or “did not perform any tasks above the sterile gloves.” There were also some nurses who did not mention this at all.

With regards to [checking the application status], nursing students described that they “checked to make sure that all fingers were inserted properly” and “made sure that the folded part was completely unfolded,” while nurses said that they “inspected for pinholes” or “made sure that the gloves were fitted tightly between the fingers.” Again, there were some nurses who did not mention this at all.

Regarding the seven steps in applying sterile gloves, nursing students tended to speak more about [delineating the sterile zone from the boundary] and [checking the application status].

For the preparatory steps such as [inspecting the pack], [opening the outer wrap], [opening the sterile inner wrap], and [unfolding the wrap], nursing students described that they “inspected whether the gloves had been sterilized,” “checked the expiration date,” “inspected for tears or contamination,” and “tried to minimize the contaminated zone.” Nurses said that they “checked the glove size” or “did not normally care about anything in particular.”

During the steps of [pulling out a sterile glove and putting it on one hand] and [putting on the other sterile glove], nursing students visualized the steps of sterile glove application to avoid contaminating the sterile gloves. There were some nursing students who spoke less on these two images compared to the other images. Similarly to the nursing students, some nurses said that they visualized the steps. However, they also gave details on their own tricks used when they were applying sterile gloves. Furthermore, the narratives from both nursing students and nurses indicated that they were thinking about what to do next. Nursing students’ narratives predicting what may happen next included abstract thoughts, such as “possibility to become contaminated,” while nurses described in detail how certain movements could cause contamination. Nurses’ narratives further indicated that they inspected from a wider perspective as seen in “observing the process as a whole” and “paying attention to their surroundings.” Their narratives also included a judgment aspect, such as “assuming that it was clean.” However, some nurses made almost no mention of [delineating the sterile zone from the boundary] or [awareness of securing the sterile zone].

Moreover, when viewing the videos and still images of sterile glove application that were presented to the nurses, some nurses commented, “This method is different from

mine, and it might cause uncleanness,” or “New nurses and nursing students are doing it slowly like this, but I don’t do it this way,” without reflecting upon their own glove application.

5 Discussion

5.1 Tendencies in Eye Movements During Aseptic Technique

No differences were observed between nursing students and nurses in terms of the number of subjects who looked at certain categories or the duration or number of their gaze. In particular, many subjects gazed at the [boundaries between the clean and unclean zones] for all 12 images, and they also gazed them for long durations at high frequencies. Textbooks on nursing skills state that “it is important to recognize the boundaries between clean and unclean zones” in performing aseptic technique. Furthermore, nurses are required to be conscious of these boundaries when performing the technique. Developing this awareness requires nurses to determine the clean and contaminated areas by actual visual observation. That is, the “boundaries between clean and unclean zones” are very important observation points in aseptic technique, and our results demonstrated that both nursing students and nurses were able to direct their gaze at these important observation points. The “boundaries between the clean and unclean zones” at which many nursing students and nurses looked are areas where visual verification is highly necessary during sterile glove application. Thus, this study clarified the zones where verification is highly necessary. Furthermore, an eye movement tracker can verify the presence or absence of gaze. This may increase the likelihood of making objective assessments and detecting “overlooking.” Also, objective assessments gained by this study method may help develop new teaching methods.

5.2 Thought Processes During Aseptic Techniques

Three intentions of [delineating the sterile zone from the boundary], [awareness of securing the sterile zone], and [checking the application status] were identified for aseptic technique.

Many narratives obtained from the interviews with nursing students included frequent use of technical terms, such as “clean,” “contamination,” and “boundaries, used in textbooks.” This demonstrated that they had a good understanding of specialized terms such as “clean” and “contamination” and that they were able to use the knowledge on aseptic technique that they learned from the textbooks.

Nursing students spoke about [delineating the sterile zone from the boundary] and [awareness of securing the sterile zone] in all steps of sterile glove application. This demonstrated that they were aware that [delineating the sterile zone from the boundary] and [awareness of securing the sterile zone] were very important details in performing aseptic technique.

Nurses also used technical terms, such as “clean,” “contamination,” and “boundaries” in their interviews. However, there were no verbal descriptions on [delineating the sterile from the boundary] or [awareness of securing the sterile zone], and some

nurses only nodded while watching the movements of the gaze. This is presumed to be due to the fact that nurses had much experience in applying sterile gloves and were checking the boundaries without being aware of making these observations.

In the subjects' narratives on [checking the application status], nursing students talked about "checking to make sure that all fingers were inserted properly," while nurses talked about checking on specific and predictable details such as "inspecting for pinholes." For the nursing students, the purpose of their observations was likely to be able to put on the sterile gloves properly, while the nurses' thought processes included predicting risks, as it was demonstrated by some subjects who discussed possible "contamination through pinholes" during the glove application. Nursing students also demonstrated predictive thought processes during sterile glove application by stating, "The fingers might touch it." However, their narratives likely reflected their practice experience on sterile glove application. Nurses' predictive thought processes involved foreseeing risks for contamination and choosing behaviors to avoid it, which included tricks they used during sterile glove application. Nurses have likely made mistakes and caused contamination in their career, enabling them to not only predict risks, but also develop tricks to avoid them and even think about measures taken in case of contamination. On the other hand, nursing students have had little experience in sterile glove application; thus, their thought processes did not go beyond predicting the risks for contamination.

There were many instances in which nurses were unable to describe their thought processes. This may be due to the fact that much of the nurses' knowledge became "tacit knowledge," that is, intentional or conscious thought processes became inexpressible or inexplicable after years of clinical experience.

Nursing students may perceive aseptic technique difficult. However, as observed in nurses, nursing students will be able to visualize clean and contaminated zones and their boundaries through experience. Although it is a skill that should be practiced carefully, it is a fundamental skill that does not apply to other tasks. Therefore, nurses have mastered this as a fundamental skill and are able to perform it unconsciously.


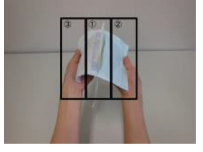
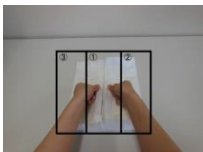
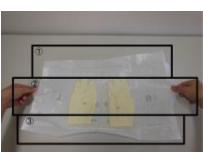

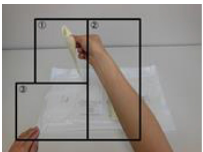
Among the nurses in this study, some viewed the videos and still images capturing the steps of sterile glove application not through a first-person perspective but through the perspective of somebody evaluating the steps. This requires a pre-determined set of points to check, as well as a set of criteria on which the actions are evaluated. Mastering the fundamental skill of aseptic technique through experience enables nurses to predict risks, which new nurses and nursing students are prone to having, and have a viewpoint that allows them to evaluate actual performance.

Going forward, we hope to apply this experience-based knowledge and evaluative perspective to educating nursing students and new nurses.

Appendix

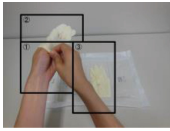
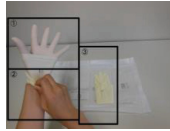
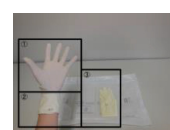
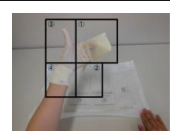
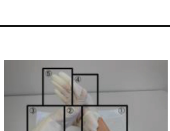
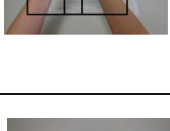
See Table 1.

Table 1. Nurse and nursing student gazing contents when wearing sterile gloves

Situation*1 · Images		A r e a	Nurse n=8, Student Nurse n=9					
			N (%)		Gaze time <i>M</i> ± <i>SD</i> (ms)		Number of gaze <i>M</i> ± <i>SD</i> (Times)	
			Nurse	St Nurse	Nurse	St Nurse	Nurse	St Nurse
No.1		①	8 (100)	9 (100)	1349.9 ±321.4	1118.5 ±200	9.3 ±5.3	7.4 ±3.4
No.2		①	8 (100)	9 (100)	1020.8 ±463.3	1066.6 ±324.3	7.8 ±3.4	7.2 ±2.3
		②	4 (50.0)	6 (66.6)	450.0 ±259.8	261.1 ±107.9	2.5 ±1.7	2.3 ±0.9
		③	4 (50.0)	6 (66.6)	583.3 ±177.7	205.6 ±91.2	3.5 ±0.5	2.0 ±1.0
No.3		①	3 (37.5)	2 (22.2)	222.2 ±62.9	50.0 ±16.7	1.7 ±0.5	1 ±0
		②	1 (12.5)	0 (0.0)	166.7	0	1	—
		③	3 (37.5)	6 (66.6)	288.9 ±103.0	300.0 ±214.2	3.3 ±1.2	3.7 ±2.6
No.3		①	8 (100)	8 (88.8)	970.8 ±359.2	716.6 ±511.5	6.9 ±1.9	5.4 ±3.2
		②	2 (25.0)	2 (22.2)	166.7 ±66.7	433.4 ±366.7	2.5 ±1.5	2.0 ±1.0
		③	6 (75.0)	7 (77.7)	472.2 ±245.2	780.9 ±639.9	5.2 ±3.3	5.3 ±2.5
No.4		①	8 (100)	8 (88.8)	1062.5 ±527.7	1091.6 ±571.2	8.9 ±2.9	8.0 ±3.4
		②	5 (62.5)	4 (44.4)	366.6 ±425.3	258.3 ±83.0	2.2 ±1.0	2.5 ±1.1
		③	7 (87.5)	8 (88.8)	728.5 ±474.5	658.3 ±433.9	6.9 ±3.4	5.0 ±2.8
No.4		①	8 (100)	5 (55.5)	566.6 ±290.5	526.6 ±226.5	4.8 ±4.3	3.4 ±1.6
		②	0 (0.0)	2 (22.2)	—	166.7 ±33.4	—	2.5 ±0.5
		③	8 (100)	6 (66.6)	520.8 ±393.7	733.2 ±626.1	4.9 ±2.9	5.3 ±3.6

(continued)

Table 1. (continued)

Situation*1 • Images		Nurse n=8 , Student Nurse n=9						
		A r e a		Gaze time (ms)		Number of gaze (Times)		
		N (%)		<i>M</i> ± <i>SD</i>		<i>M</i> ± <i>SD</i>		
		Nurse	St Nurse	Nurse	St Nurse	Nurse	St Nurse	
No.5		①	6 (75.0)	5 (55.5)	677.7 ±595.8	533.3 ±304.8	5.8 ±2.7	4.8 ±2.0
		②	5 (62.5)	4 (44.4)	173.3 ±106.2	208.4 ±95.4	1.4 ±0.5	1.8 ±0.4
		③	8 (100)	7 (77.7)	658.3 ±263.4	819.0 ±588.8	6.0 ±2.1	7.3 ±3.2
		①	7 (87.5)	6 (66.6)	550.4 ±258.7	472.2 ±386.1	4.6 ±2.6	2.8 ±1.3
		②	5 (62.5)	2 (22.2)	213.3 ±77.7	100.0 ±33.3	1.6 ±0.5	1 ±0.0
		③	6 (75.0)	9 (100)	788.8 ±536.6	592.5 ±486.3	6.2 ±2.9	5.3 ±2.7
		①	3 (37.5)	4 (44.4)	411.0 ±193.0	383.3 ±356.2	4.7 ±3.1	3.0 ±2.3
		②	4 (50.0)	6 (66.6)	325.0 ±266.0	177.8 ±125.7	3.0 ±1.9	2.0 ±1.4
		③	8 (100)	9 (100)	637.4 ±380.6	537.0 ±342.7	6.0 ±2.4	5.0 ±2.2
No.6		①	3 (37.5)	3 (33.3)	288.8 ±83.1	111.1 ±68.5	3.0 ±0.8	1 ±0.0
		②	2 (25.0)	1 (11.1)	283.3 ±183.3	300	1.8 ±0.5	2
		③	1 (12.5)	1 (11.1)	133.4	33.3	2	1
		④	6 (75.0)	6 (55.5)	827.7 ±243.7	485.7 ±259.3	7.8 ±3.3	3.6 ±1.6
		①	1 (12.5)	2 (22.2)	333.3	383.3 ±150.0	1	3.0 ±2
		②	1 (12.5)	0 (0.0)	100	—	1	—
		③	6 (75.0)	6 (66.6)	661.1 ±609.9	611.1 ±416.7	5.0 ±2.9	5.0 ±3.1
		④	3 (37.5)	4 (44.4)	200.0 ±0.05	166.7 ±74.5	3.0 ±0.8	2.0 ±1.0
	⑤	8 (100)	9 (100)	991.6 ±379.6	766.6 ±418.3	9.25 ±2.4	8.3 ±4.4	
No.7		①	2 (25.0)	2 (22.2)	116.6 ±50.0	49.5 ±16.7	3.0 ±1.0	1.5 ±0.5
		②	0	0	—	—	—	—

*1 Situation

No.1 [Inspecting the pack]

No.2 [Opening the outer wrap]

No.3 [Opening the sterile inner wrap]

No.4 [Unfolding the wrap]

No.5 [Pulling out a sterile glove and putting it on one hand]

No.6 [Putting on the other sterile glove]

No.7 [Completing the sterile glove application].

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