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COMMUNICATION

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Development of the neurological simulation program e-learning version (Neuro Sim-e)

Mitsumi Masuda[1,*], Fumino Sugiyama[2], Junko Shogaki[3], Kyoko Matsumoto[4], Machiko Saeki Yagi[5], Hidenori Oishi[6]

[1] Department of Critical Care Nursing, Graduate School of Nursing, Nagoya City University, Aichi, Japan;
[2] Department of Adult Nursing, School of Nursing, National College of Nursing, Tokyo, Japan;
[3] Graduate School of Health Science, University of Kobe, Hyogo, Japan;
[4] Nursing Division, Department of Neurosurgery, Kansai Rosai Hospital, Hyogo, Japan;
[5] SimTiki Simulation Center, University of Hawaii at Manoa, USA;
[6] Department of Neurosurgical, School of Medicine, Juntendo University, Tokyo, Japan.

Abstract: It is difficult to coordinate the working hours of busy clinical nurses and provide lectures, but e-learning can be used during their spare time. Therefore, this study aimed to share our experience in developing and implementing the neurology simulation program e-learning version (Neuro Sim-e). Needs analysis was conducted, and the Neuro Sim-e was developed. Four evaluation questionnaires: attention, relevance, confidence, and satisfaction (ARCS) etc., were examined. We developed the Neuro Sim-e, which consists of three scenarios. The subjects were 20 nurses. Regarding the "attention", "relevance", "reliability", and "satisfaction" of the Neuro Sim-e, 70.0%, 95.0%, 65.0%, and 90.0% of the respondents answered "rather agree" or higher, respectively. The Neuro Sim-e obtained positive feedback *via* ARCS evaluation and provided adequate results as an overall assessment. It is too early to conclude whether it is as effective as or better than a mannequin-based simulation, but this study provided learning materials that nurses could use in their spare time.

***Keywords*:** neurological nursing, simulation-based learning, e-learning

Introduction

Simulation training is rapidly being incorporated into health professional education and, recently, has ascertained efficacy as a way to foster clinical judgment capabilities (*1,2*). It is common for physicians and nurses in the field of neurology to encounter sudden change cases. A delay in response can directly lead to a life-threatening situation for the patient, so a prompt and accurate response is required. Therefore, education is required in neurology to learn various techniques, behavioral patterns, communication skills, and logical thinking in a real-world context. Conversely, in addition to the skill training, such as cardiopulmonary resuscitation, the Simulation-Based learning in the emergency field (*3,4*) and cardiovascular field (*5*), which often provide treatment for emergency changes and severe diseases, is applied sporadically. However, similarly, there is training specific to the neurology field, where the possibility of sudden patient changes is high.

It is also difficult to coordinate the working hours of busy clinical nurses and provide lectures simultaneously. Therefore, e-learning can be used "anytime and anywhere" during their spare time and can be applied when learners wish to learn. Moreover, in e-learning so far, the learning methods, such as the confirmation of knowledge, have been the mainstream, but are insufficient in improving the clinical practice ability. To compensate, Goal-Based Scenario (*6,7*) proposed by Schank is appropriate. Goal-Based Scenario (GBS) is the acquisition of necessary knowledge and skills while repeating training and error for the achievement of a given goal in the educational material using the experience of learning by failing a subject. Based on GBS, learners can learn how to make decisions by not only remembering knowledge they wish to acquire but also using that knowledge in practice.

Therefore, the aim of this short communication is to share our experience in developing and implementing a GBS-based the neurology simulation program-e-learning version (Neuro Sim-e).

Research design for developing the Neuro Sim-e

Flow of scenario creation

To develop the Neuro Sim-e, a semi-structured interview learning needs survey was administered to 10 second

year or older nurses in the neurology department of A University Hospital to determine their learning needs. The data collection period was from September 1, 2020 to March 31, 2021. The survey comprised of questions about frequent diseases and situations in clinical settings, learning needs, and barriers and needs in skill upgrading. The results of the interview survey were analysed qualitatively and inductively.

Based on need analyses, the diseases, situations, and learning components used in the case are considered among researchers. Next, seven components (mission, coverage story, roles, learning goals, scenario manipulation, feedback, and source) of GBS (*8*) are considered. The created content is set for online learning using Moodle, a learning management system. Then, researchers and three nurses with clinical experience in the neurology domain or intensive care unit confirmed content validity. Finally, a test run was performed to check whether the learning goal could be achieved and whether there was confusion or inadequacy.

The Neuro Sim-e evaluation

Subjects

The selection criteria for the study subjects were staff nurses who were assigned to the Department of Neurology at the University Hospital B in Japan and were in their second year or older who agreed to participate in this study. Exclusion criteria were qualified nurses such as certified nurse specialists.

Survey contents

The survey consisted of the attention, relevance, confidence, and satisfaction (ARCS) (9) evaluation questionnaire of Kirkpatrick's four-level training evaluation model (*10*). For level 1 response, four items were investigated. The answers were measured on a four-point Likert scale: 4 for "I think so" and 1 for "I do not think so".

Moreover, the Neuro Sim-e evaluation questionnaires consisting of five items (including one free-text), and learning time and rate of correct answers, as Kirkpatrick's four-level training evaluation model level 2 learning were investigated. The degree of difficulty, amount of questions, whether knowledge that can be used in practice was acquired, and whether they felt that they could use it in practice were asked in the Neuro Sim-e evaluation questionnaire. It also included an open-ended section for the user to express positive feedback and areas for improvement.

Survey method

The researcher asked all 25 candidates to participate in this study verbally and in writing. Consent to participate in this study was obtained by accessing the Neuro Sim-e on Moodle and responding to the presence or absence of consent. When accessing the Neuro Sim-e, the ID and password were prepared and shared with the subject.

Data analysis

The ARCS evaluation questionnaire and the Neuro Sim-e evaluation sheet were used to perform descriptive statistics. The Neuro Sim-e was used for learning analysis. Moreover, free description of the Neuro Sim-e evaluation sheet was analysed qualitatively and inductively.

Ethical considerations

This study was conducted with approval from the Research Ethics Committee of the Graduate School of Nursing, Nagoya City University (approval number: 18034). The subjects received verbal and written explanations about the purpose, methods, protecting personal information, e-learning, and responding to the questionnaire to ensure that individuals are not identified by their shared IDs and passwords.

Core elements of the Neuro Sim-e

The Neuro Sim-e development

As a result of the learning needs analysis, eight categories regarding the most frequent diseases and situations in clinical settings, and eight categories regarding barriers and necessities for skill upgrading were extracted (Table S1, *https://www.ghmopen.com/site/supplementaldata.html?ID=52*).

Based on the results, it was determined that the case needed to include the situations of "response to endovascular surgery" and "deterioration of condition after surgery", and was classified into three events: *i*) carotid artery stenting (CAS) in the posterior carotid sinus reflex, *ii*) CAS in posterior hypoperfusion syndrome, and *iii*) post-craniotomy cerebral infarction. The three situations were classified as observation, implementation of nursing care, and evaluation. Moreover, seven components of GBSs were considered. As an example, the GBS component of Case 1 is shown in Table S2 (*https://www.ghmopen.com/site/supplementaldata.html?ID=52*). The contents were set for online learning using Moodle, a learning management system.

Overview of study subjects

Requests were sent to 25 nurses, and 20 responses were obtained (80.0% response rate) from 18 women and 2 men in the neurology department at B University Hospital. The educational background of the subjects was as follows: junior college for 2 subjects, university for 16 subjects, and master's degree for 2 subjects. A total of 12 subjects had 3-5 years of nursing experience, 4 had 6-10 years, and 4 had ≥ 11 years. The Neuro

Table 1. ARCS evaluation questionnaire

Items	Four-level training evaluation				*n* = 20 Mean ± SD
	1 I do not think so *n* (%)	2 I somewhat do not think so *n* (%)	3 I somewhat think so *n* (%)	4 I think so *n* (%)	
Attention	1 (5.0)	5 (25.0)	12 (60.0)	2 (10.0)	2.75 ± 0.72
Relevance	0 (0.0)	1 (5.0)	17 (85.0)	2 (10.0)	3.05 ± 0.40
Confidence	1 (5.0)	6 (30.0)	0 (0.0)	13 (65.0)	2.60 ± 0.60
Satisfaction	0 (0.0)	2 (10.0)	15 (75.0)	3 (15.0)	3.05 ± 0.41

ARCS: attention, relevance, confidence, and satisfaction.

Sim-e and the ARCS evaluation questionnaire were administered to all 20 subjects who agreed to participate in the study.

The Neuro Sim-e evaluation

Kirkpatrick's four-level training evaluation model: Level 1 response

In terms of "Attention", "Relevance", "Confidence", and "Satisfaction" for the Neuro Sim-e the number of respondents that answered "I somewhat think so" or more, "Confidence" was slightly low (Table 1).

"Degree of difficulty", "Amount of questions" of five-item questions for the Neuro Sim-e evaluation were negatively answered. "Whether knowledge that can be used in practice was acquired" and "whether they felt that they could use it in practice" were positively answered (Table 2).

Free-text results were also summarized in 30 codes and 9 categories. Below, categories are indicated by the strongest quote. On the case used in the Neuro Sim-e, the opinion of "It was real cases and practice contents" was obtained. In addition, positive answers such as "I was able to deepen my knowledge", "I was able to learn how to report", "I want to put learning into practice", and "I learned how to deal with sudden changes" were reported. On the other hand, there were opinions on content and methods, such as "The descriptive test was difficult", "The number of free descriptions were many and it took a lot of time", "Difficult to see test", and "Difficult to perform with devices other than PC".

The ARCS evaluation for the Neuro Sim-e showed positive results. Therefore, it can be said that the learning motivation for the Neuro-Sim-e was effective. In a previous study on self-learning of neurological e-learning conducted in Korea (*11*), it was found that nurses' neurological assessment skills were improved. From this, it can be said that e-learning materials are an effective method for improving nurses' judgment and assessment skills. Moreover, the Neuro Sim-e is a GBS-based program, intended to not only remember the knowledge to be acquired but also to learn how to judge by utilizing that knowledge. From the result of this study, it was not only possible to deepen the knowledge but also to learn how to deal with and report the sudden change. It was evaluated that the learning which reflected the philosophy of GBS was possible and considered to be a great achievement.

Table 2. Neuro Sim-e evaluation questionnaire

Items	*n*	%	Mean ± SD
Degree of difficulty			1.85 ± 1.01
Difficulty	11	55.0	
A little difficulty	3	15.0	
Just right	4	20.0	
A little easy	2	10.0	
Easy	0	0.0	
Amount of questions			1.20 ± 0.41
Many	16	80.0	
A little more	4	20.0	
Just right	0	0.0	
A little few	0	0.0	
Few	0	0.0	
Whether knowledge that can be used in practice was acquired			3.10 ± 0.72
Acquired	6	30.0	
A little acquired	10	50.0	
Not acquired a little	0	0.0	
Not acquired	4	20.0	
Whether they felt that they could use it in practice			3.00 ± 0.46
I think so	2	10.0	
I somewhat think so	16	80.0	
I somewhat do not think so	2	10.0	
I do not think so	0	0.0	

However, it was suggested that the following points need to be improved. First, of the four items of the ARCS evaluation, "Confidence" was lower than the other three items, so further improvement is needed. High results are obtained for "Confidence" in Western studies (*12*), but "Confidence" tends to be low in previous studies in Japan (*13,14*). Therefore, it is considered that there is a Japanese cultural background of humility. Second, regarding the evaluation of the Neuro Sim-e, the difficulty level was high. This finding should be improved, and the high difficulty level may have influenced the inadequate "Confidence" of ARCS evaluation. Finally, participants also reported many questions and difficulty in inputting descriptive questions about reporting methods. As has been pointed

out, the circumstances used by learners have a major effect on e-learning; it will be improved by considering the ease of answering on various devices and asking multiple-choice questions. Particularly, the feature of this study is that busy clinical nurses can apply e-learning "anytime and anywhere" during their spare time and can obtain knowledge when they wish to. Therefore, it is important for it to be easily accessible on devices other than PCs.

Kirkpatrick's four-level training evaluation model: Level 2 learning

The correct answer rates for the total scores of cases 1 to 3 were 73.0%, 87.5%, and 80.4%, respectively, and Case 1 was slightly lower. The average response time (range) was 34.22 (9.12-120.55) min, 30.58 (6.30-60.85) min, and 30.35 (11.12-90.25) min, respectively.

Since this is a basic study prior to intervention research, and the goal was not to perform a pre-post comparative test of the mean points of each case, this result was an appropriate outcome as an overall overview. In Kirkpatrick's four-level training evaluation model, level 2 learning, is likely to exhibit an example of what has been experienced so far and the possibility of obtaining new findings and adapting the knowledge gained to practice. Merrill's first principle of instructional design states that "Learning is facilitated in situations where new knowledge can be used in practice" (*14*). In addition to learning content based on previous experiences, new findings and learning that can be used in actual clinical settings have been reflected in the total rating. Based on the above, the Neuro Sim-e had a certain effect on the improvement of knowledge and clinical judgment ability required for nursing in the neurology domain in Kirkpatrick's four-level training evaluation model level 1 response and level 2 learning.

Limitations

In this study, the pre- and post-comparison were insufficient, and levels 3 and 4 of Kirkpatrick's four-level training evaluation model were not evaluated. In the future, it will be necessary to add results, such as level 3 behavior and level 4 learner behavioral changes and clinical outcomes, to the evaluation items to conduct an effect confirmation study.

Conclusion

It is too early to conclude whether it is as effective as or better than a mannequin-based simulation because this is an exploratory study, but it provided learning materials that busy nurses could use in their spare time; thus, this study was meaningful.

As a result of levels 1 and 2 in Kirkpatrick's four-level training evaluation model, the effectiveness of the program could be confirmed. Conversely, from the evaluation of the Neuro Sim-e, it was suggested to refine the high degree of difficulty, quantity of questions, and convenience for use on various devices.

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Address correspondence to:
Mitsumi Masuda, Department of Critical Care Nursing, Graduate School of Nursing, Nagoya City University, 1 Kawasumi, Mizuo-cho, Mizuho-ku, Nagoya 467-0005, Japan.
E-mail: m.masuda@med-nagoya-cu.ac.jp