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Development and Effects of an Emergency Nursing Simulation-based Education Program for Hypoglycemia Patients

In-Hye Song[1] and Hyeon-Cheol Jeong[2*]

[1]*Dept. of Nursing, Graduate School, Sahmyook University*
[2]*Dept. of Nursing, Professor, Sahmyook University*
[1]*promise0407@naver.com,* [2*]*love2hc@syu.ac.kr*

Abstract

This study used a non-equivalent control group pre-test post-test design to develop an emergency nursing simulation-based education program for hypoglycemia patients, and examine the program's effects on nursing students' self-directed learning ability and confidence in performance of these said activities. Participants included sophomore nursing students from the Department of Nursing at S University in Seoul. Participants were divided in experimental (n=30) and control (n=30) groups. A 1-hour lecture on diabetes was administered to both groups. Subsequently, the experimental group was divided into teams and engaged in self-study for 1 week, after which time they participated in the simulation-based education program. Data were analyzed using SPSS, and the homogeneity of the dependent variables was verified using χ^2 tests and t-tests. Post-intervention between-group differences in self-directed learning ability and confidence in performance were analyzed using an ANCOVA. Study results showed that there was significant improvement in self-directed learning ability ($F=8.49$, $p=.005$) and confidence in performance ($F=13.88$, $p<.001$) for the experimental group. Therefore, this simulation-based program may be utilized as a useful educational method for enhancing nursing students' clinical performance abilities.

Keywords*: Hypoglycemia, Simulation, Self-directed learning ability, Confidence in performance*

1. Introduction

Since nursing science involves studying to increase clinical performance ability based on specialized knowledge, educational institutions should provide an opportunity for student clinical practice education so that they can properly assess patients and administer effective care [1]. However, there has been an increase in awareness of health care consumers' rights in recent years. Although in the past, nursing students could directly practice nursing techniques learned in college in the clinical field, contemporarily, patients only require interventions by skilled nurses rather than less experienced nursing students. Thus, there are only a few hospitals where students can directly practice nursing techniques [2].

Simulation-based nursing education has been introduced to counter these limitations of clinical practice education. Specifically, compared to traditional education, it has the advantages of eliminating potential harm to patients, providing students with the opportunity to safely practice patient care as they would in a clinical site, and allowing for repetitive practice of skills [3]. Therefore, it has been reported that learners not only become accustomed to nursing practice through simulation education carried out in an environment similar to clinical sites, but also improve confidence in their performance [4].

* Corresponding Author

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In previous domestic studies, simulation education has been applied to nursing education in various fields and has had positively impacted learners [5-8] in terms of self-directed learning ability, confidence in performance, learning satisfaction, clinical performance ability, and critical thinking ability. Thus, students' performance was found to be improved as their simulation performance was found to be improved, proving that simulation education is effective in promoting a variety of students' clinical competencies [9].

Diabetes is a disease that causes serious complications. Currently, in Korea, the prevalence of diabetes in the adult population has continually been increasing, with a prevalence of 8.6% in 2001, 9.8% in 2011, and 11.0% in 2013 [10]. Additionally, diabetes has a high mortality rate and, since 2008, has been ranked fifth out of the 10 most common causes of death in Korea [11]. If disease management is neglected and the severity of diabetes continues to increase, patients can experience a number of complications. Of these, hypoglycemia is a common and frequent complication experienced by diabetic patients treated with medication, and severe cases may lead to death [12,13]. Therefore, hypoglycemia should not simply be regarded as a lowering of blood sugar levels but, instead, as a diabetes-related complication that is important to manage. Thus, it should not easily be overlooked because it can be fully treated by fast and accurate emergency management from medical staff. Consequently, systematic and effective emergency nursing education about treatment is required [12]. The majority of recent domestic studies in the area of simulated education focus on newborn emergency care [6], neurological patient care [5], acute renal failure patient care [8], and heart failure patient care [7]. However, research on the development and application of simulation-based education related to hypoglycemia patient emergency care is minimal.

Thus, this study provides basic data for simulation practice education in diabetes management and emergency care. Specifically, we have developed a simulation-based education program for hypoglycemia patients' emergency nursing care and tested it among nursing students to verify its effectiveness.

1.1. Purposes

- To develop a simulation-based education program for hypoglycemia patients' emergency nursing care.
- To identify the effects of the simulation-based education program for hypoglycemia patients' emergency nursing care on nursing students' self-directed learning ability.
- To identify the effects of the simulation-based education program for hypoglycemia patients' emergency nursing care on nursing students' confidence in performance.

2. Methods

2.1. Study Design

This study uses a non-equivalent control group pre-post design to develop a simulation-based education program for hypoglycemia patients' emergency nursing care and identify the effects of the program on nursing students' self-directed learning ability and confidence in performance Figure 1.

Group	Pre-survey	Theory education	Post-survey	Intervention: Simulation-based nursing education	Post-survey
Control group	C_1	T_1	C_2		
Experimental group	E_1	T_1		T_2	E_2

T_1: Lecture education about diabetes (1 hour)

T_2: Simulation-based nursing education (1 week group self-study + total of 2 simulation education sessions + debriefing)

E_1 C_1: Research on general characteristics, self-directed learning ability, confidence in performance

E_2, C_2: Research on self-directed learning ability and confidence in performance

Figure 1. Study Design

2.2. Subjects

Subjects included sophomore nursing students without simulation practice experience from the Department of Nursing Science of S University, which is located in Seoul and offers a four-year nursing program. The necessary sample number was calculated using G*power 3.1.7, and the required number of subjects was calculated for a medium effect size of .5, level of significance of (α) .05, and test power (1-β) of .80. Results indicated that 27 participants should be selected for each group. However, a total of 60 participants (30 per group) were selected to account for potential attrition, although all participants completed the study. The selection criteria for subjects were as follows:

• Persons who can provide basic nursing as a result of completion of basic medical courses and basic nursing science-related subjects.

• Persons who can practice therapeutic communication as a result of completion of communication-related subjects.

• Persons who understood the described purpose of the study and verbally agreed to participate.

2.3. Development of the Simulation Education Program

2.3.1. Scenario Development Model: This study developed a simulation-based education program for hypoglycemia patients' emergency nursing care based on the Analysis, Design, Development, Implement, and Evaluation (ADDIE) model [14] Figure 2.

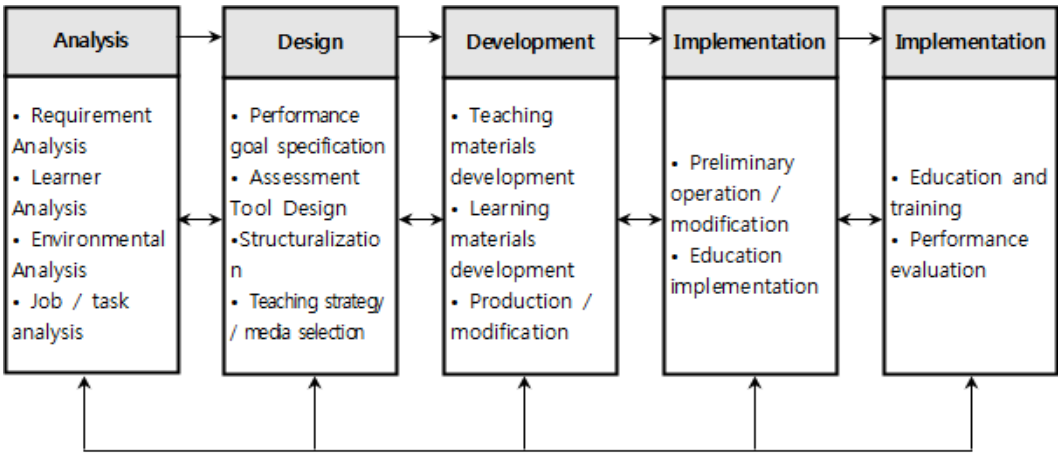

Figure 2. ADDIE Model

2.3.2. Setting Learning Objectives: In order to develop simulation training scenarios and determine learning objectives, learning objectives consistent with subjects' learning level were determined by referring to basic nursing science and adult nursing science learning objectives based on the sophomores' curriculum. These objectives were reviewed by 4 professors of nursing science and 1 emergency room (ER) chief nurse to ensure suitability. The selected learning objectives were as follows:

- Students will be able to explain the pathophysiology of diabetes.
- Students will be able to explain the symptoms and signs of hypoglycemia.
- Students will be able to assess subjects with hypoglycemia.
- Students will be able to explain drugs and actions of hypoglycemia.
- Students will be able to conduct grounds-based nursing interventions.
- Students will be able to provide

2.3.3. Scenario Development Process: We created a scenario including hypoglycemia-related symptoms and nursing issues based on existing literature [12, 15] and actual clinical cases. Additionally, the development was supervised by 4 professors of nursing science and a chief ER nurse's (from Seoul's K Hospital) advice to account for factors related to clinical experience. To achieve the learning objectives, a 15-minute simulation of a hypoglycemia patient emergency care scenario was developed based on the nursing process. Based on the developed simulation scenario, a Simulation Template including a SimMan® algorithm and debriefing plan was constructed.

The specific procedure for developing a simulation-based education program for hypoglycemia patient emergency nursing care followed the process presented in Figure 3.

Classification	Procedures	Activities	Main content
Development	Analysis	Learner analysis	• Recognizing nursing students' level of education : On-the-spot survey
		Task analysis	• Analysis of requirements for hypoglycemia emergency care : Literature review, On-the-spot survey • Key component of simulation learning : Literature review

		Environmental analysis	• Learning environment characteristics: On-the-spot survey
	Design	Materialization of learning objectives	• Selection of learning objectives
		Selection of educational methods	• Nursing process
		Selection of educational media	• Student self-learning materials and activity sheet • High reproducibility of simulator-related equipment
		Assessment tool design	• Evaluation tool selection and planning
	Development	Educational material development	• PPT educational materials • Simulation scenario • Development of evaluation tools
		Learning material development	• Prior learning materials for simulation education
Effect verification	Implementation	Preliminary operation	• Program modification and complement
		Main education implementation	• September 12–September 24, 2014
	Evaluation	Education evaluation	• Analysis of program learning effects

Figure 3. Procedure for Developing a Simulation-based Education Program

2.4. Research Tools

2.4.1. Self-directed Learning Ability

Self-directed learning ability was evaluated using a tool developed by Lee [16] for students and adults that measured self-directed learning ability as one of a number of general life abilities. This tool consisted of a total of 45 questions, and subscales were categorized as ‘learning plan’ (20 questions), ‘learning implementation’ (15 questions), and ‘learning evaluation’ (10 questions). Participants responded to each question on a 5-point Likert scale and higher scores mean higher self-directed learning ability.

Lee [16] attained a Cronbach’s αwas .93 at the time of development and the Cronbach’s α= .91 in this study.

2.4.2. Confidence in Performance

Participants’ degree of confidence about performing hypoglycemia patients’ emergency care was measured using a modified and complementary version of a tool developed by Yoo [6]. Based on algorithm contents and learning objectives, a hypoglycemia patient case simulation-based education program was modified to include essential practice items. The content validity of each item in the modified tool was evaluated by 4 professors of nursing science and 1 incumbent ER chief nurse with rich clinical experience. The Content Validity Index (CVI) was found to be 0.93. This measure includes a total of 15 questions evaluating ‘prepared knowledge’ (4 questions), ‘subject assessment’ (5 questions), and ‘nursing performance’ (6 questions). Each question is rated on a 5-point Likert scale, and higher scores mean higher confidence that a student can perform hypoglycemia

patient emergency care. When developed, Yoo [6] found a Cronbach's α= .96, and the Cronbach's α in this study was .93.

2.5. Procedures and Methods

This study was carried out from September 1, 2014 to September 26, 2014.

The researcher provided a 2-hour lecture about diabetes and nursing to participants. Subsequently, the next day, they were provided with learning materials pertaining to a simulation-based education program for hypoglycemic patient emergency nursing care for 1 week and asked to study these materials in teams. Participants were divided into 20 teams, with 3 people on each team. Subsequently, the 1st simulation education program provided a general overview of the scenario, the patient's body assessment, and differential diagnosis. The 2nd education program included the following themes: therapeutic communication, medication, nursing intervention, and patient education. This study used a high-fidelity simulator (SimMan 3G, Laerdal Medical, Norway). In the simulation education program, subjects worked in the 3 teams, and experienced a 10 minute simulation practice orientation, followed by team scenario operation and a 50 minute debriefing.

One day following simulation education completion, a trained research assistant administered the post-survey about self-directed learning ability and confidence in performance for hypoglycemic patient emergency care to both groups.

2.6. Data Analysis

Data were analyzed using SPSS version 21.0. Data were analyzed as follows:

• Subjects' general characteristics and homogeneity verification of dependent variables were analyzed using χ^2 tests and t-tests.

• An ANCOVA was used to analyze post-test differences in self-directed learning ability and confidence in performance between the experimental and control groups after controlling for pre-test scores.

3. Results

3.1. Verification of Subjects' Homogeneity

3.1.1. Homogeneity of General Characteristics: This study included a total of 60 subjects, and their general characteristics are presented in Table 1. Neither sex nor age differed significantly between the experimental and control groups. In terms of motivation for nursing department application, 'Selected on my own' was the highest for both groups, followed by 'Teacher recommendation'.

In the case of nursing department satisfaction, the experimental group obtained an average of 2.87 (SD=0.86) points out of 5 and the control group averaged 2.73 (SD=0.87). For average grades in the Department of Nursing Science prior to the previous semester, in the experimental group, 26.7% attained an 'A or higher' and 56.7% attained a 'B or higher'. In the control group, 20% received an 'A or higher' and 63.3% received a 'B or higher'. In addition, prior knowledge about diabetes and hypoglycemia interventions did not differ significantly between the groups. Therefore, there were no significant between-group differences and they were verified as homogeneous in Table 1.

Table 1. General Characteristics of Subjects

Characteristics	Classification	Experimental group (n=30)	Control group (n=30)	t or χ^2	*p*
		n(%) or M± SD	n(%) or M± SD		
Sex	Men	7(23.3)	2(6.7)	3.27	.071
	Women	23(76.7)	28(93.3)		
Age (years)		20.47± 0.97	20.00± 1.27	-1.58	.119
Motivation for nursing department application	Selected on my own	12(40.0)	17(56.7)	6.25*	.100
	Parent recommendation	13(43.3)	10(33.3)		
	Teacher recommendation	1(3.3)	3(10.0)		
	Other	4(13.3)	0(0.0)		
Satisfaction for department (points)		2.87± 0.86	2.73± 0.87	-0.60	.553
Grade Point Average (GPA)	≤A	8(26.7)	6(20.0)	0.40	.820
	≤B	17(56.7)	19(63.3)		
	≤C	5(16.7)	5(16.7)		
Degree of prior knowledge (points)		3.00± 0.64	3.30± 0.84	1.56	.125

3.1.2. Homogeneity Verification of Self-Directed Learning Ability and Confidence in Performance: Homogeneity verification of self-directed learning ability and confidence in performance of the experimental and control groups before conducting simulation-based education for hypoglycemic patient emergency nursing care is shown in Table 2. Prior to providing subjects with simulation education, pre-homogeneity of the dependent variables between the experimental and control groups was analyzed. Because there were no significant between-group differences, pre-homogeneity was established.

Table 2. Homogeneity of Dependent Variables between Experimental and Control Groups

Item	Experimental group (n=30)	Control group (n=30)	t	*p*
	M± SD	M± SD		
Self-directed learning ability	3.41± 0.39	3.33± 0.47	-0.83	.408
Learning plan	3.31± 0.46	3.18± 0.61	-1.01	.316
Learning implementation	3.40± 0.46	3.29± 0.43	-0.97	.338
Learning evaluation	3.63± 0.57	3.70± 0.54	0.09	.927
Confidence in performance	2.88± 0.64	2.81± 0.71	-0.75	.454
Prepared knowledge	2.28± 0.86	2.08± 0.68	-1.00	.323
Subject assessment	3.51± 0.64	3.50± 0.75	-0.07	.941
Nursing performance	2.75± 0.83	2.72± 0.91	-0.12	.902

3.2. Effect on Self-directed Learning Ability

The effect of the simulation-based education program for hypoglycemic patient emergency nursing care on the self-directed learning ability of nursing students was 3.55 points in the experimental group and 3.27 points in the control group. Additionally, the experimental group score was significantly higher than that of the control group (t=8.49, *p*=.005) Table 3.

Table 3. Self-directed Learning Ability between Experimental Group and Control Group

Item	Experimental group (n=30)	Control group (n=30)	t	*p*
	M± SD	M± SD		
Learning plan	3.49± 0.48	3.21± 0.59	4.18	.046
Learning implementation	3.56± 0.39	3.25± 0.49	7.19	.010
Learning evaluation	3.65± 0.45	3.44± 0.56	5.57	.022
Total	3.55± 0.38	3.27± 0.51	8.49	.005

3.3. Effect on Confidence in Performance

The experimental group obtained 3.69 points for confidence in performance, while the control group attained 3.69 points. The experimental group was significantly higher than that of the control group (t=13.88, *p*<.001) as presented in Table 4.

Table 4. Confidence in Performance between Experimental and Control Groups

Item	Experimental group (n=30)	Control group (n=30)	t	*p*
	M± SD	M± SD		
Learning plan	3.34± 0.65	2.87± 0.71	6.21	.016
Learning implementation	4.12± 0.56	3.56± 0.65	16.82	<.001
Learning evaluation	3.56± 0.69	3.06± 0.74	8.62	.005
Total	3.69± 0.52	3.17± 0.60	13.88	<.001

4. Discussion

First, the experimental group that received simulation-based hypoglycemic patient nursing education showed significantly higher self-directed learning ability scores than the control group. This result is consistent with those from a study by Lee Woo-Suk *et al.*, who determined that simulation practice education consisting of learning content including excretion and dosage, oxygenation, and stability of basic nursing improved nursing students' self-directed learning ability [2]. Additionally, our result is consistent with research reporting an increase in nursing students' self-directed learning ability among those who received simulation education about acute cerebrovascular disease management, normal newborn care, and prenatal care of mothers when a human patient simulator (HPS) [17].

This study examined why the self-directed learning ability of nursing students who received simulation-based hypoglycemic patient nursing education improved. We

believe this occurred because students in the experimental group had time in advance to prepare for appropriate nursing practice as a result of the scenario-related learning materials they received, as well as the opportunity for 1-week group self-study prior to simulation-based practice.

In contrast, Kim's study [18] of simulation-based critical patient nursing education including HPS [18] reported that simulation education did not positively affect or promote nursing students' self-directed learning ability. Additionally, simulation education was mandatory in this study and the learning period was limited to prior to the completion of the education-based course. The difference in these results and those in the current study may have occurred because it is desirable for learners to appropriately determine whether or not to participate in simulation-based education and when to engage in autonomous learning. This is necessary for efficient self-directed learning, to accurately identify students' needs and requirements, and to select the learning content required for self-directed learning [19].

Thus, in the current study, simulation-based education is regarded as an effective teaching method for improving nursing students' self-directed learning ability. Consequently, future studies that incorporate proper preliminary study time and explore different subjects that utilize simulation-based education programs in advance are necessary.

Second, this study showed that confidence in performance of the nursing students in the experimental group who received simulation-based hypoglycemic patient education was significantly higher than that of the control group. This result is similar to the results obtained in Yoo's study [6] analyzing the development and effects of a simulation-based newborn emergency care education program in that the experimental group scored significantly higher than the control group in confidence in performance. Our findings are also consistent with results from Chang's study [20], which reported that simulation education about difficult breathing was effective in improving nursing students' confidence in performance.

In this study, improvement in the confidence in performance among subjects who received a simulation-based education is thought to have occurred because they received repetitive education involving working with the same case twice as a result of group self-study.

Furthermore, subjects could increase their understanding of the scenario while examining their own appearance using video recordings of the practice process during debriefing. In addition, they could develop more effective nursing performance because there were enough opportunities to improve necessary areas by objectively reviewing their strengths and weaknesses. As a result, confidence in performance improved. However, Brannan's study [21] presented conflicting results. Specifically, the experimental group who received simulation education about myocardial infarction patient management did not differ significantly from the control group in confidence in performance. It was thought that this occurred because the experimental group was provided with insufficient education about the necessary practices, and confidence faded as the result of embarrassment experienced in an unfamiliar situation. Consequently, if students are not provided with sufficient information prior to the scenario situation, their confidence may decrease because of exposure to unexpected situations without adequate preparation, resulting in anxiety and embarrassment [22]. Therefore, the results of the study suggested that prior learning is required because students who have never participated in simulation-based education are unfamiliar with this type of learning [23].

Overall, the current study has contributed to improving nursing students' confidence in performance because simulation-based education using a model similar to practices applied with real patients enabled students to actively participate in patient care. Specifically, by providing a safe environment and reducing students'

psychological burden, they could directly apply their knowledge to practice in simulated clinical situations.

Based on our results, the simulation-based education programs for hypoglycemic patient emergency nursing care developed in this study is thought to narrow the differences between theory and practice among nursing students. Thus, it can be actively used as an educational method to facilitate sufficient clinical competence that enables students to perform complex and diverse nursing interventions required in actual clinical sites. As a result, this type of education program could be considered to be an effective alternative that can complement currently insufficient current clinical practice. To this end, it is believed that the effectiveness of this type of education should be verified through case development and application of this approach to diverse areas in the future.

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