

Original Article

Effect of Simulation and Pretest Application on Learning in Inhaler Drug Training of Nursing Student: Solomon Experimental Design

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Abstract

Background: Despite asthma management guidelines and newly developed effective medications, asthma is still a difficult-to-control disease because of the inability of nurses to use inhaler drugs effectively and properly.

Aim: This study aimed to determine the effect of simulation-based training and pretest application on the knowledge and performance scores with a Solomon four-group experimental design.

Methods: Group 1 underwent a pretest, training, and a posttest; group 2 a pretest and posttest; group 3 training and a posttest; and group 4 a posttest. Data were collected at the beginning and in the last stage (n = 120).

Results: Among groups without pretest the amount of increase in post-test knowledge score due to education in group 3 was higher compared to group 4. Post-test knowledge score average of group 2 was higher than group 4 (t = 3.30; p = .002). The average post-test knowledge score of group 1 was higher than group 3 (t = 7.35; p < .001). The pre-test affected the post-test knowledge score. Post-test mean score was higher than group 1 than group 2 (t = 2.92; p = .005). Posttest performance mean score of group 3 was higher than group 4 (t = 6.26; p < .001). Simulation training was effective in practice. Posttest performance mean score of group 2 was higher than group 4 (t = 4.27; p < .001).

Conclusion: Simulation training with standardized patients was effective in teaching how to use inhaler drugs.

Keywords: Learning, lecture, simulation, solomon experimental design, nursing

Introduction

Asthma and chronic obstructive pulmonary disease (COPD) cause serious mortality and morbidity in underdeveloped and developing countries (WHO, 2021).

In 2016, the World Health Organization reported more than 339 thousand patients with asthma and 251 million patients with COPD worldwide; in 2015, approximately 418 thousand deaths occurred due to asthma and 3.17 million due to COPD (WHO, 2021). Asthma and COPD are still difficult to manage despite effective treatments and evidence-based guidelines (Gregoriano et al., 2018). Inhaler drugs play an important role in asthma and COPD treatment (Usmani et al.,

2018). Metered-dose inhalers, dry powder inhalers, and nebulizers are used in treating these diseases (Dhand et al., 2018). The direct administration of these drugs to the respiratory system creates a high local concentration, but it leads to systemic side effects (Gregoriano et al., 2018). Certain steps should be followed while administering inhaler drugs to benefit from their advantages and avoid disadvantages. For inhaler drugs to be effective in patients, the drugs must be administered using correct application steps. False applications significantly reduce drug efficacy and safety (Padmanabhan et al., 2019). A previous study reported no improvement in the inhaler technique for the last 40 years (Sanchis et al., 2016). A system

compilation and meta-analysis study reported that the general and critical error rates of inhaler device application varied between 50%–100% and 14%–92%, respectively. In addition, the same study showed that an application checklist was needed to find out whether the inhaler drugs were being administered correctly (Chrystyn et al., 2017). A study reported that hospital admissions, emergency admissions, and use of oral steroids increased due to the misuse of inhaler drugs (Melani et al., 2011).

The important point in asthma and COPD control is to teach the patients the correct use of these drugs. Therefore, it is important for nurses to learn how to properly use and apply inhaler devices because each inhaler device requires a different technique and competence. A study reported that 15%–69% of healthcare professionals were able to use the correct inhaler technique (Price et al., 2013). However, another study found that the number of healthcare professionals who knew the right inhaler technique decreased from 20.5% to 10.8% in the last 20 years (WHO, 2021). Many studies showed that the training improved inhaler compliance and technique (Ahn et al., 2020; Pothirat et al., 2015).

Nurses are primarily responsible for inhaler training and adaptation of patients with asthma and COPD (Scullion, 2018). Nurses making mistakes within this role can cause patients to make mistakes in their disease management (Moroni-Zentgraf et al., 2018). Therefore, it was suggested that nurses should be trained about the correct use of inhaler devices so that they are able to apply them effectively to patients (Moroni-Zentgraf et al., 2018). Nurses who have important responsibilities in patient education should have acquired this competence before graduating (Ozel et al., 2018; Kim et al., 2020).

Thanks to innovative technologies, simulation is an educational method that enables students to gain cognitive, affective, and psychomotor skills in a safe learning environment (Yong-Shian et al., 2016). Simulation, virtual reality, low- and high-technology models, computer-aided simulators, standardized patients, and hybrid varieties help students acquire various skills (Sari & Erdem, 2017). A standardized patient (healthy or sick individual) is trained

to recreate a real-life story or their own illness (Jarosinski & Webster, 2016). Such patients create therapeutic communication to experience the real environment (Yong-Shian et al., 2016). Standardized patient training is used worldwide and in Turkey to teach various skills (Donovan & Mullen, 2019; Haskell & Thul, 2020). Students gain their knowledge and skills in a real setting with a standardized patient (Donovan & Mullen, 2019). In addition, the standardized patient evaluates performances by giving feedback according to certain checklists (Uslu & Van Giersbergen, 2019).

Thanks to the methodological approach of the Solomon four-group experimental research, it is now possible to show the effects of factors affecting learning. In education, it contributes to a student's level of readiness to learning, the contribution of sensitizing a student to learning by making a pretest, and evidence that enables the detection of learning differences by providing education without the need for a student to be sensitized.

This study with the Solomon experimental design was conducted to investigate the effects of simulation training using standardized patients on students' knowledge about inhaler device and their performance. It was novel in showing the effect of simulation training using standardized patients with the Solomon Experimental Design (SED).

Materials and Methods

Study design and sample: The study was conducted between February and March 2019.

Hypotheses:

H1: Training by simulation method affects inhaler learning (Groups 1 and 2)

H2: Pretest application affects inhaler learning (Groups 1 and 3; 2 and 4)

Population: The study population consisted of 155 fourth-year nursing students attending the undergraduate nursing program. Thirty-five students who did not want to participate in the study and did not meet the inclusion criteria were excluded. The sample consisted of 120 students. This study was designed according to the Solomon four-group model experimental design. The SED is one of the experimentations with the highest scientific

value. This design which includes several study groups with random method has experimental and control groups. The SED has experimental and control groups in which pretest is performed and also experimental and control groups in which pretest is not performed (Karasar, 2016). Experimental and control groups in which pretest is not performed are included in the design in order to remove most negative effects (such as carry-over effect) caused by pretest. The SED is a model making it possible to measure the carry-over effect and the experimental application effect synchronously (Gliner et al., 2011). It enables determining the effect of the method used in a study because it makes it possible to have a greater sample number and perform many different statistical analyses with the presence of experimental and control groups in which pretest is and is not performed (Karasar, 2016).

The random number table was used for assigning the students to groups 1, 2, 3, and 4. Group 1 underwent a pretest, training, and a posttest; group 2 a pretest and posttest; group 3 training and a posttest; and group 4 a posttest. The exclusion criteria were as follows: those stating that they had knowledge about asthma drugs, those actively working in chest polyclinics, those who administered these drugs while researching their patients, and those who did not want to participate. The inclusion criteria were as follows: being a volunteer and not having used this drug earlier.

Setting: Simulation design, implementation, and evaluation were based on the standards published by the International Nursing Association for Clinical Simulation and Learning Standards Committee. In the preparation phase of the study, the scenarios for the standardized patients were sent to them 1 week prior. The scenario used was similar to that for a patient who recently started using an inhaler. The patient was taught to use a metered-dose inhaler, a discus, a turbuhaler, an aerolizer, and a nebulizer. An education hall was used for this study. Demo inhaler drugs were employed for training. Prior to the training, a meeting was conducted with the standardized patients. In the meeting, information was provided about the scenario, roles, responsibilities, and tips. First, a pilot study was conducted.

Application: The study was carried out in four stages.

First stage-Pretest: Students in groups 1 and 2 underwent a pretest to evaluate their inhaler knowledge and skills. Pretest theoretical knowledge measurement: A test that measured their theoretical knowledge was applied to the students. It took 15 min. Pretest skill measurement: The students were asked to use the drugs on the demo inhaler, while the researchers evaluated them with a checklist. It continued for 1 day of internship (8 h).

Second stage-Theoretical Education: One day after the pretest, the researchers provided training on inhaler drugs and simulation method to groups 1 and 3. This training lasted for two lessons.

Third stage-Standardized Patient Application: Briefing session: The students were informed about standardized patients, setting, and demo inhaler drugs. Demonstration training with standardized patients: One day after the theoretical training, groups 1 and 3 and the standardized patients were gathered in the training hall. The researchers demonstrated the inhaler drug use with the standardized patients. The students were asked to work on the matter. Training application with standardized patients: Students in groups 1 and 3 individually experienced standardized patient simulations. The students were given 10 min to experience the scenario. Their performance was recorded by video. The students' performance was observed by the researchers. Debriefing session: In the scenario, the patient who just started to use inhaler medication was discussed. After the simulation, 4 separate informative sessions were held in groups of 15 people. The students' performances with the standardized patient were observed and discussed by the students and researchers. The analysis was done by the method of gathering, analyzing, and summarizing. The students' simulation experience, behaviors, and decisions were asked verbally. Positive and negative outcomes, experiences, opinions, and actions were summarized by the researchers. Also, feedback was received from the standardized patients.

Fourth stage-Posttest: A posttest was applied to the students in Groups 1, 2, 3, and 4 to evaluate their inhaler knowledge and skills. One week after the training, two

instructors evaluated the performance of the students in four days.

Measurements: Inhaler drug knowledge and skill evaluation form (pretest-posttest). The inhaler drug knowledge and skill evaluation form was created by the researchers, in line with the literature (Kilinc & Akgun, 2016). The first part was the knowledge form. This form was designed in consultation with two specialist physicians in the field of chest diseases (Kilinc & Akgun, 2016). The inhaler drug knowledge test form consisted of 26 questions: 8 regarding metered-dose inhalers, 6 regarding dry powder inhalers, and 12 regarding nebulizers. One point was given for each right answer. The highest score was 8 for the metered-dose inhaler, 6 for the dry powder inhaler, and 12 for the nebulizer. The highest total score to be obtained from the “Knowledge Test” was 26 and the lowest 0. The second part was the part where the application steps were evaluated. The application checklist was designed with nine steps for metered-dose inhaler, turbuhaler, discus, and aerolizer and with three steps for the nebulizer. The highest possible score for the metered-dose inhaler, turbuhaler, discus, and aerolizer was 9 and the lowest 0. The highest possible score for the nebulizer was 3 and the lowest 0. The total number of application steps for five inhalers was 39. Each correct application step was awarded 1 point. The total score to be obtained from the “Application Checklist” was 39 and the lowest 0.

Ethical considerations: The approval (No. 2019-01, dated 2 January, 2019) to conduct this study was obtained from XXX University, Health Sciences Research and Publication Committee Ethics Committee. Written and oral consent was received from the participants.

Data Analysis: The statistical analysis of the data was performed in the SPSS 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) statistical package program. The distribution of the data was tested using the Shapiro-Wilk test. The pre-test scores of Experimental Group I and Control Group I were analyzed using t-test for independent groups. The post-test and pre-test scores of Experimental Group I and Control Group I

were evaluated with dependent sample t-test. One-way analysis of variance (ANOVA) was used to determine whether there was a statistically significant difference between the post-test scores of the experimental and control groups. The statistical significance level was determined to be $p < .05$.

Results

The descriptive statistics of the distribution of the pretest-posttest Solomon Experimental Design scores of the students in groups 1, 2, 3, and 4 are given in Table 1.

The pretest-posttest scores of group 1 were significant at a 5% significance level, and the training increased the inhaler scores ($t = 4.960$; $P = .001$). No statistically significant difference was found between the pretest-posttest scores of the control group 1 ($P > 0.05$)(Table 2).

The pretest and training affected the posttest inhaler knowledge scores [$F(1;116) = 11.94$; $p = .001$]. As a result of simple main effects, the training did not affect the posttest scores in the groups that underwent a pretest (Groups 1 and 2) ($p > .05$). The training affected the score in group 3, which did not undergo a pretest; the score was higher than the score in group 4 ($P < .05$). The pretest affected the groups' scores ($p < .05$). The knowledge score in group 2 (15.50 ± 5.92) was higher than that in group 4 (10.90 ± 4.78) ($t = 3.30$; $p = .002$). The knowledge score of group 1 (18.50 ± 3.02) was higher than that in group 3 (16.90 ± 4.78) ($t = 7.35$; $p < .001$). The pretest and training did not affect the posttest inhaler application scores [$F(1;116) = 3.46$; $p = .065$]. As a result of simple main effects, the training affected the posttest performance scores in the groups ($p < .05$). The application score in group 1 (20.33 ± 6.73) was higher than that in group 2 (15.13 ± 7.04) ($t = 2.92$; $p = .005$). The application score in group 3 (17.90 ± 6.61) was higher than that in group 4 (8.33 ± 5.12) ($t = 6.26$; $p < .001$). The groups that underwent a pretest and training (Groups 1–3) were not affected in terms of performance scores ($p > .05$). The performance of those who did not undergo a pretest was affected ($p < .05$). The application score in group 2 (15.13 ± 7.04) was higher than that in group 4 (8.33 ± 5.12) ($t = 4.27$; $p < .001$)(Table 3).

Table 1. Solomon Design Descriptive Statistics.

Groups	Pretest score	Intervention		Posttest score	
		Mean \pm Std. Deviation	Mean \pm Std. Deviation		
Group 1	Knowledge score	12.03 \pm 3.42	Intervention	Knowledge score	16.86 \pm 5.51
	Practice score	11.23 \pm 7.24		Practice score	20.33 \pm 6.73
Group 2	Knowledge score	13.96 \pm 5.47	Intervention	Knowledge score	15.50 \pm 5.92
	Practice score	13.33 \pm 5.96		Practice score	15.13 \pm 7.04
Group 3	Intervention	Intervention	Intervention	Knowledge score	18.50 \pm 3.02
				Practice score	17.9 \pm 6.61
Group 4	Intervention	Intervention	Intervention	Knowledge score	10.09 \pm 4.78
				Practice score	8.33 \pm 5.12

Table 2. Pretest and Posttest Score Distribution of Groups I and II.

	Group 1				Group 2			
	Pretest	Posttest	<i>t</i>	<i>P</i> *	Pretest	Posttest	<i>t</i>	<i>P</i> *
	Mean \pm SD	Mean \pm SD			Mean \pm SD	Mean \pm SD		
Inhaler knowledge scores	12.03 \pm 3.42	16.86 \pm 5.51	4.960	<.001	13.96 \pm 5.47	15.50 \pm 5.92	1.285	.209
Inhaler practice scores	11.23 \pm 7.24	20.33 \pm 6.73	5.862	<.001	13.33 \pm 5.96	15.13 \pm 7.04	1.297	.205

* Dependent sample t test;	SD:standard deviation.
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Table 3. Posttest Score Distribution of Experimental and Control Groups.

Source of variance		df	MS	F	p*
Last knowledge score					
Pretest	1	603.00	24.70		<.000
Training	1	66.00	2.70		.103
Pretest*training	1	291.40	11.94		.001
Error		116			
Last total practice score					
Pretest	1	1635.40	39.626		<.000
Training	1	639.40	15.493		<.000
Pre-test*training	1	143.00	3.465		.065
Error		116			
p* One-Way ANOVA					

Discussion

This was the only study in the literature conducted to determine the effect of pretest and simulation-based training (SBT) with the Solomon four-group experimental design. It is the only study using the SED and simulation together.

SBT increased the inhaler knowledge and skills of students (Table 1). These findings were similar to the results of studies showing that the simulation-based teaching method positively affected the acquisition of knowledge and skills (Basak et al., 2019; Borgmeyer et al., 2017; Chee et al., 2019;

Crowe et al., 2018; Haskell & Thul; Kilinc & Akgun; Yilmazer et al., 2020). The results of the present study were supported by a previous study showing that actually experiencing physical and psychological pain by interacting with standardized patients was effective for students to gain skills (Tamaki et al., 2019). Informative sessions and standardized patient experience were important learning components in gaining knowledge and skills (Yilmazer et al., 2020). Other studies found that methods with active participation increased learning scores (Basak et al., 2019; Basheti et al., 2014; Chee et al., 2019), while participation with

passive teaching methods did not affect learning scores (Alismail et al., 2016). We believe that the physical and psychological interaction in the modern SBT method is important in providing effective learning. Feedback given to the students in this study was effective in the learning process by allowing the students to think and make judgments. Our interpretation was that the use of active learning methods in education increased learning outcomes.

Different studies found that pretest-supported trainings were effective in remembering, storing, and transferring information (Green et al., 2018), Latimier while others reported that these trainings did not affect (Latimier et al., 2019). The present study determined that the pretest did not affect the performance scores in the intervention groups. This implied that it was not necessary to apply a pretest to achieve the goal in SBT. It is possible to gain desired behavior in students using well-chosen and applied educational methods. We presume that the SBT without applying a pretest can be effective in learning by addressing students' cognitive, affective, and psychomotor domains.

Previous studies found that a pretest affected, motivated, and facilitated learning (Carpenter & Toftness, 2017; Sana et al., 2020). The present study found that the pretest increased the knowledge scores in the education groups and the knowledge and performance scores in the control groups; it also affected learning. It is thought that a pretest enables students to become aware of the situation and create sensitivity. Applying a pretest in sensitive students can affect learning positively. Achieving such results regarding the pretest application was possible, thanks to the study design.

The posttest inhaler knowledge and performance scores in the study groups increased with SBT and was higher compared with those in the training groups [Group 1 (pretest, SBT, and posttest) > Group 3 (SBT and posttest) > Group 2 (pretest and posttest) > Group 4 (posttest)]. This result showed that the intervention affected learning independently of the pretest (Table 3). We believe that SBT contributes to learning.

Limitations: The study demonstrates the outcomes of the students in only one

university, which limits the generalization of the findings.

Conclusion: In the present study, it was possible to show with the SED that SBT used in the education of inhaler drugs was effective in gaining knowledge and skills independently from the pretest and control groups. SBT is an effective teaching method for inhaler drug administration by addressing students' cognitive, affective, and psychomotor learning areas. The pretest was effective in gaining knowledge and skills in the control groups that did not receive training. We think that the use of the Solomon experimental design contributed to revealing the differences between the groups, and it showed how effective the educational interventions and pretest were using a posttest.

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