Original Article

The Impact of Simulation-Based Education on Students' Knowledge and Skills in Diabetic Foot Examination

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Abstract

Background: Simulation-based education is an interactive teaching method that offers a realistic learning environment to the students. The current literature emphasises that simulation supports the improvement of health professionals, and high-fidelity simulators enhance the coping skills of students, particularly in complicated clinical situations, thus increasing patient safety and decreasing the clinical complications.
Objective: The awareness and knowledge of and acquiring the necessary skills for diabetic foot are the challenging issues particularly for undergraduate nursing students.
Method: Forty-two fourth-year nursing students participated in this study with a pre-test–post-test design. The students were randomly assigned to two groups. One group practiced with high-fidelity simulators while the other group interacted with standardized patients. Before and after the simulation-based education, all students practiced diabetic foot examination on real patients.
Result: The between-group difference in the knowledge scores was similar before and after the education. High-fidelity simulator group, the scores increased significantly after the training in the SP group. The mean skill score of students after simulation assessment was significantly higher with real patients 2 than with real patients.
Conclusion: As a result, simulation-based education was effective teaching method for improving outcomes diabetic foot examination skills of nursing students.

Keywords*:* nursing education, diabetic foot examination, high fidelity simulator, standardized patient, real patient.

Introduction

There are globally more than 425 million patients with diabetes who experience various complications of the disease. Neuropathy is one such complication that causes long-term damage to various organs and tissues in patients with diabetes due to high blood glucose levels. Loss of sensation caused by neuropathy leads to diabetic foot. Every 30 seconds, a part of or the entire lower limb is lost to amputation somewhere in the world as a consequence of diabetes (IDF, 2017). The nurses attending to patients with diabetes are expected to be aware of the complications and be competent in providing care for, examining and consulting patients with complications.

Background

Many initiatives and educational bodies in the field of healthcare have organised educational activities and developed programs for nurses, nursing students and inter-professional teams for improving their knowledge and skills of and attitude toward diabetes and its complications.

All these efforts led to an improvement in the outcomes of these educational activities and improved patient outcomes as well (Brand, Musgrove, Jeffcoate, et al, 2016; Ogrin, Houghton, Thompson et al, 2013; Varaei Salsali, Cheraghi et al, 2013; Ching&Earle 2013). İn this context the awareness and knowledge of and acquiring the necessary skills for diabetic foot are the challenging issues particularly for undergraduate nursing students. It has become challenging to develop an effective teaching atmosphere in the classroom due to the lack of educational resources and instructors and excessive number of students (NACNE, 2010; Mcnett, 2012).

Novice learners with the fear of making mistakes and stress are negatively affected in the clinical settings where more interaction was needed (Elcigil & Sarı 2007; Moscaritolo 2009). However, nursing is a profession that requires the curriculum to be continuously improved with incorporation of new technologies. With the advancement of technology, it has become inevitable to use new teaching methods, particularly the interactive ones (e.g. simulation) in health sciences education (Hecimovich & Marin 2009).

Simulation-based education is an interactive teaching method that offers a realistic learning environment to the students (Barbosa & Marin 2009). It is an effective educational method that is increasingly being used in nursing education, particularly since the last ten years (Reed, 2012).

The current literature emphasises that simulation supports the improvement of health professionals, and high-fidelity simulators enhance the coping skills of students, particularly in complicated clinical situations, thus increasing patient safety and decreasing the clinical complications (Parkers & Myrick 2010; Purling &King 2012; Gum, Greenhill, Dix, 2011; Lewis, Strachan, Smith 2012). Diabetic foot is an important problem that nurses should be aware of, and its awareness can make a difference in patient outcomes with proper care.

Aims of the Study: Simulation studies for diabetic foot have not reported in the literature and Turkey, and thus, this study was planned. This study was planned to evaluate the knowledge and skills of students studying in the nursing department and to investigate the effect of use high-fidelity simulator and standard patient on their diabetic foot examination.

Methodology

Research Hypotheses: H1. There is a difference in the degree to which high-fidelity simulators and standardized patients improve nursing student's knowledge of diabetic foot examinations.

H2. There is a difference in the degree to which high-fidelity simulators and standardized patients improve nursing students' skills in conducting diabetic foot examinations.

In addition to the above mentioned hypotheses, the following study question is of interest: “How students' real patient experiences affected diabetic foot examinations?”

Study Design and Participants: Forty-two fourth-year nursing students of the University volunteered to participate in the study during their clinical practice in the Endocrine System which is as a part of the Internal Diseases Nursing Course. The students were randomly assigned to the following groups: One group (HFS) would learn with high-fidelity simulators while the other group (SP) with standardized patient. Both groups performed diabetic foot examination) before and after the simulation. After the simulation-based education focus, group interviews were conducted with the students.

Ethical Considerations: Social and Human Sciences Ethics Committee of the X University approved the study on December 9, 2015 (no: 191). The Nursing School permitted the participation of their students in the study. All the students and the patients signed the informed consent forms before participating in the study.

Measures: Diabetic Foot Examination Form: The authors developed a Diabetic Foot Examination Form based on the national and international guidelines http://care.diabetesjournals.org/content/diacare/suppl/2016/12/15/40.Supplement_1.DC1/DC_40_S1_final.pdf, https://www.idf.org/e-library/guidelines/119-idf-clinical-practice-recommendations-on-diabetic-foot-2017.html), on the examination and evaluation of diabetic. The form included 17 steps to be evaluated as ‘not done = 0’, ‘partially done = 1’ and ‘done =

2'. There were sub-steps under some of the steps. The maximum total score was 100.

Information Knowledge Test: The authors prepared a written 12-question multiple choice assessment of the knowledge on the evaluation, prevention and treatment of diabetic foot. The maximum total score was 100.

Debriefing Guide: The authors developed a guide for the debriefing sessions with the following probing questions: 'How did you feel during the simulation activity?', 'What would you do differently if you have another opportunity?', 'Did you achieve the knowledge and skills to perform it on your own?' and 'Do you believe you can perform this skill at the clinics?'.

Focus Group Interview Guide: The authors conducted the focus group interviews in a semi-structured way using the guide with the following questions: 'What did you like about the learning environment?', 'What do you think should be improved about the learning environment?', 'What was the impact of the lecture on your learning process?'

The forms were finalised by taking the opinion of five experts. To ensure the validity if the content of the these forms, two diabetes nurses, one endocrine doctor and two lecturers of the internal diseases nursing department of the nursing faculty provided feedback on the forms.

Implementation of the research:

This study was carried out in five steps.

1. Theoretical Training: The ongoing program for teaching diabetic foot examination was lecture-based and supported by clinical work on real patients. A 4-hour lecture for the theoretical background of diabetic foot was held, and a demonstration of diabetic foot examination during was performed the lecture.

2. Pre-test steps: As the first step of pre-test, all the students were instructed to complete the written test with 12 questions. All the students visited the clinicin small groups (5 students in each group) and performed diabetic foot examination on real patients (real patient 1). As the second step of pre-test, researchers used diabetic foot examination forms for observing the students.

3. Simulation-based education: The authors developed a simulation-based educational intervention to improve their program. They chose two modalities of simulation: High-fidelity simulators (HFSs) and standardized patients (SPs). They developed a common scenario for both groups keeping the case same but using different modalities portraying the patient. They randomly assigned the students into two groups.

3.a. Simulation HFS: The first group (n = 21) practiced with HFSs, and the students had 15 minutes for individual practice. Their performances during the scenarios were videotaped. A debriefing session was conducted with a group of 5–6 students after each group of simulations.

3.b. Simulation SP: The second group (n = 21) was practicing on SPs. The students had 15 minutes for individual practice. Their performances during the scenarios were videotaped. A debriefing session was conducted with a group of 5–6 students after each group of simulations.

4. Post-test steps: After the tests, all the students performed diabetic foot examination once more on the real patients at the clinic (Real patient 2). The students used diabetic foot examination forms in the second post-test step.

5. Focus group interview: Two focus group sessions were conducted, wherein each group comprised five student volunteers. These focus groups lasted 60–90 min.

Data Analysis: The authors used the Shapiro–Wilk test for analysing the distribution of the knowledge and skills scores in the study and expressed the scores using median values (minimum–maximum). The authors used the Mann–Whitney U test for the comparison of inter-group scores (HFS-SP) and Wilcoxon test for the comparison of intra-group knowledge and performances scores. The authors compared the differences between the pre-test–post-test scores using Mann–Whitney U test or t test among the two groups. The results were considered significantly different at $p < 0.05$.

Results

According to result, 37 (%) of students were women and 5 (%) were men. The age range of students was 19–21 years. The mean of the pre-test scores was 90.48±10.96, 89.29±10.91 , whereas the mean of the post-test scores was 92.46±6.40, 95.24±5.63 in the HFS Group and

SP Group (Table 1). The between-group difference in the knowledge scores was similar before and after the education (Z = 0.49 and Z = 1.445, respectively). In the HFS group, there were no statistically significant differences before and after the education in terms of the knowledge scores (p = 0.359), while in the SP group, the knowledge scores increased significantly after the education (p = 0.041).

Table 1. Distribution of information points in groups

	HFS Group (n=21)	**SP Group (n=21)**	**Z[1]**	**P[1]**
Knowledge Pretest Mean ± S	90.48±10.96	89.29±10.91	0.49	0.653
Knowledge Posttest Mean ± S	92.46±6.40	95.24±5.63	1.445	0.148
Z[2]	0.918	2.040		
P[2]	0.359	**0.041**		

[1] Mann Whitney U [2] Wilcoxon

Table 2. Distribution of skill points in groups

	HFS Group (n=21)	**SP Group (n=21)**	**Z[1]**	**P[1]**
Skill Pretest Mean ± S	16.67±8.74	15.41±11.23	0.456	0.648
Skill Posttest Mean ± S	82.07±12.27	85.85±6.87	0.508	0.611
X[2]	32.780	36.390		
P[2]	**<0.001**	**<0.001**		

[1] Mann Whitney U [2]Wilcoxon

The mean skill score at the pre-test level noted during the examination of the skill evaluation (real patient 1) was 16.67±8.74 in the high-fidelity simulator group and 15.41±11.23 in the SP group. The mean skill score at the post-test skill evaluation (real patient 2) was 82.07±12.27 in the high-fidelity simulator group and 85.85±6.87 in the SP group (Table 2). The post-test skill scores were significantly higher than the pre-test skill scores in both groups (X^2 = 32.780 and X^2 = 36.390, respectively; $p < 0.05$). However, the level of increase in the scores in each group was not statistically different from each other (Z = 0.456, Z = 0.508 p = 0.648, p = 0.611).

The students who practiced with HFS-SP group expressed their positive opinion about the methodology during the focus group interviews:

‘Simulation education was useful.’, ‘I would like to learn all the skills using these methods.’, ‘I learned about diabetic foot examination.’, ‘I felt more comfortable at the hospital while I was working with the real patient because I had practiced with the standardized patient.’ and ‘After this practice, I felt confident about diabetic foot examination.’

Discussion

Our primary aim in the current study was to evaluate the impact of simulation-based training

on nursing students' knowledge and skills in examining diabetic foot. The knowledge and skill of both student groups significantly improved in our study. The educational interventions with both high-fidelity simulators and standardized patients had a comparable positive impact on the development of nursing students. Educational activities are reportedly effective in improving the knowledge and skills of health professionals and lead to better patient outcomes and fewer diabetes-related complications. Even after a single educational session, the nurses showed a significant increase in the reported number of foot examinations, which translated into a significant improvement in the reported foot care behaviour (Brand, Musgrove, Jeffcoate, Lincoln 2016). Varaei et al. (2013) revealed that their study using evidence-based nursing education had an excellent impact on the knowledge, attitude and practice of nurses caring for patients with diabetic foot ulcer. Studies implementing inter-professional collaborative approaches to their course programs had similar participant and patient outcomes. Ogrin et al. (2013) designed inter-professional diabetes foot ulcer teams and involved them in the four 3-hour-long online sessions and six 2-hour-long face-to-face workshops. Their results demonstrated that their teams healed ulcers relatively quickly, amputations were fewer and minor and hospitalisation durations were short. Ching et al. (2013) implemented a diabetes-based inter-professional education program. The program had 10 sessions—one session a week over 10 weeks. Their results showed that the effects of the program were sustained beyond 2 years, and these changes were incorporated into practice. There was a change in participants' attitude and perception, and more importantly, the patient outcomes were improved.

The studies mentioned above used various educational methods and approaches: lectures, online sessions and workshops. Our study implemented simulation-based training to an ongoing lecture-based program. Our approach significantly improved the knowledge and skills of students who had already completed the lecture-based program. Our study had a similar positive impact as the previously reported studies on the overall outcome of educational activities. Moreover, our results revealed that the educational methodology we implemented was authentic, novel and more effective than the traditional ones.

We could not find a study that used simulation for educational purposes for health professionals related to diabetic foot or patients with diabetes. The only study in a related context was that of (Wilson et al. 2013), which involved 12 caregivers of patients with diabetes visiting endocrine outpatient clinics in a one-year-long diabetes technology simulation course. At the end of the year, the scores of caregivers on the follow-up of blood glucose and insulin were considerably improved (Wilson, Bailey Boyle et al. 2013).

Simulation-based education is shown to be an effective and efficient methodology for the achievement of knowledge and skills. The modalities of simulation, such as high-fidelity simulators and standardized patients, are preferred according to the content and context in various studies.

Unver et al. (2013) used standardized patient methodology with 85 students in the course of rational drug use and reported that the knowledge scores of the students increased considerably after the course. Several studies revealed that using standardized patient methodology in educational activities was effective in enhancing the knowledge of the students (Bornais, Raiger, Krahn,El Masrı, 2012; Yoo& Yoo 2012). Laschinger et al. (2008) reported similar results with high-fidelity simulators. They observed that the problem-solving skills, environment safety awareness and knowledge of the students improved after the education.

In a different study investigating the knowledge and skill scores of nursing students after cardiopulmonary resuscitation training, the experimental group that received the traditional plus high-fidelity simulator training presented statistically and significantly higher skill levels than the control group that received traditional training only (Ackermann, 2009).

The immersive involvement and interaction during the simulation practices, watching own performances and receiving and giving feedback in debriefing sessions play key roles in making simulation-based training effective, efficient and enjoyable. The students involved in the study of Becker et al. (2006) reported that standardized patient encounters were creative and pleasant.

The nursing students in our study expressed that simulation practices were useful, reinforced their learning process and made them feel comfortable in working with real patients.

The aim of our study was to compare the effectiveness of using high-fidelity simulators and standardized patients. Our results showed that practicing with standardized patients was more effective than with high-fidelity simulators in terms of knowledge gain. However, the difference in effectiveness of both modalities in achieving the skills was not statistically significant. The nursing students of the two groups involving practice with high-fidelity simulators and standardized patients showed increased skill. The results were exactly the same in our current study. (Becker et al. 2006, Bornais, Raiger, Krahn,El Masrı, 2012; Yoo&Yoo 2012; Unver, Basak, Iyigün, Tastan, Demiralp,.... Hatipoglu. 2013; Tuzer, Dinc, Elcin 2016, Basak, Acıksoz, Unver, Aslan 2018).

During the debriefing session we conducted in this study, the students expressed the effect of simulation application as follows: 'Simulation education was useful.' 'I would like to learn all the skills using these methods.' and 'I learned diabetic foot examination.' Debriefing is an important and inseparable element of learning through simulation, which is an innovative teaching method. Debriefing analysis reportedly enables students to discuss the scenarios where they practice, with a focus on learning, clinical reasoning, applying theory and better developing critical thinking (Chronister &Brown, 2012; Mariani, Cantrell, Meakim, Prieto ve Dreifuerst, 2013; Hall, Vet, Tae, 2017; Wrigth, Moss, Dennis, . Harrold, Levy, Furness, Reubenson, 2018). Our findings are consistent with the existing literature in this regard.

Limitations: Our study had the limitations of the number of students being limited and that it was a single-centre study, thus affecting the generalisability of the results.

Conclusion: Based on the results of current and previous studies, we concluded that using high-fidelity simulators and standardized patients for simulation-based education was very effective and efficient in improving the knowledge and skill levels of nursing students. The knowledge scores of the students who practiced with standardized patients increased significantly, while the knowledge scores of the students who practiced with high-fidelity simulators did not increase significantly. On comparing the skill scores of the students, both groups had significantly higher post-test scores; however, there was no statistically significant difference between the modalities. Further studies comparing the effectiveness of these simulation modalities with larger groups of participants and using more valid reliable assessment tools are needed.

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