Pharmacy Education (2022) 22(1) 492 - 497
https://doi.org/10.46542/pe.2022.221.492497

RESEARCH ARTICLE

Simulation of training solution for the prevention of medication errors in the emergency ward

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Keywords
Emergency ward
Medication error
Nurse
Simulation

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Abstract

Objectives: The purpose of the present study was to determine the effect of simulation training on nurses' drug errors in the hospital emergency ward in Iran. **Methods:** This quasi-experimental research was conducted over six months. The statistical population, who entered the study through a census, consisted of 52 nurses working in the emergency department of Imam Hossein Hospital. Data collection tools included a demographic questionnaire and Wakefield's drug error questionnaire. **Results:** The mean and standard deviation of the difference in medication errors before and after the intervention was 0.31. ± 0.55 for non-injectables and 0.18 ± 0.61 for injectable drugs. A yearly increase in nurse working experience was associated with a decrease in medication errors of -1.73. **Conclusion:** The present study results showed that simulation training using clinical scenarios for nurses is an efficacious step to prevent drug errors.

Introduction

Medication errors, one of the most common adverse effects of medical care, refer to inappropriate practices in prescriptions that might often occur in the course of care and treatment (Hajibeglou *et al.,* 2018). In a comprehensive report released by the National Academy of Medicine (NAM), about 5.1 million preventable medication errors occur annually in the United States (Harris *et al.,* 2014). Such errors are ranked as the eighth leading cause of death in the United States (Hajibeglou *et al.,* 2018). Besides, medication errors result in the death of 6.5% of hospitalised patients and an increase in the length of stay (LOS) by two days, while at least 3,800 adverse drug events (ADEs) are preventable (Khani-Jazani *et al.,* 2015). With reference to the National Report and Educational Services for England, 526,186 medication errors were reported in this country between 2005 and 2010 (Zarea *et al.,* 2018). Medication errors have given rise to health care spending of about 2 billion dollars per year (Mosakazemi *et al.,* 2019). It is also deemed that preventable medical errors might affect more than seven million people and might annually cost about 21 billion dollars in all healthcare sectors (da Silva & Krishnamurthy, 2016). Moreover, 158,520 children in the United States are referred to emergency departments each year due to ADEs (Niemann *et al.,* 2015). Such departments are thus the first place wherein the errors of look-alike/sound-alike (LASA) medication names might arise. Accordingly, the repeated error rates in emergency departments have been estimated at 14.4% and 39% in general and paediatric emergency departments, respectively (Mosakazemi *et al.,* 2019). Adverse drug reactions are also observed a million times in these wards annually (da Silva & Krishnamurthy, 2016). Medication errors can further occur in nearly all treatment team members, but nursing errors are the most common and frequent (Henriksen *et al.,* 2005). Since nurses spend 40% of their time in pharmacotherapy, they play a vital role in controlling medication errors (Miller, Haddad & Phillips, 2016). Hence, such professionals must strive to prevent these errors as much as possible (Harris *et al.,* 2014).

In Iran and other countries, medication errors are progressively increasing and have recently multiplied, thus requiring more attention (Zarea *et al.,* 2018) because many of them lead to referrals to emergency

departments and hospitalisations (Tenhunen, Smithers & Tucker, 2016). However, such events are only reported when patients are harmed or when someone detects the errors (Hirani & McFarlane, 2016). Therefore, it is of utmost importance to provide safe healthcare services and minimise medication errors.

For this purpose, training and professional development for efficient clinical nurses and simulation-based learning in healthcare ethics education have today become popular. In this sense, simulation is considered an educational model consisting of ethical and legal concepts. Simulation education is also likened to role-play, patient satisfaction, patient support, empathy, communication skills, and patient care in all health care dimensions (Thomas, McIntosh & Allen, 2014). The best type of training can thus occur through scientific experience and feedback from educators along with instructions and preparations. Training programmes can also be merged with clinical care services (Wong *et al.,* 2010). For example, the results of one study conducted on the effects of simulation-based learning on medication errors in critical patients (Ford *et al.,* 2010) had accordingly demonstrated that 70% of such errors in intensive care units had been reduced following simulations (Hardenberg, Rana & Tori, 2019). Given the researcher's working experience in emergency departments and the characteristics of this specific division, i.e. time constraints and overcrowding of patients with acute illnesses, the chance of making medication errors might double. Therefore, providing solutions to prevent and control such errors in this department is of great significance. Regarding insufficient evidence on the use of simulation in training about medication errors in Iran, the present study was to reflect on the effects of simulations on the incidence rate of medication errors among nurses involved in emergency departments.

Methods

In this intervention study with a pretest-posttest research design conducted in 2022, the effect of the independent variable (namely, training about medication use in emergency departments through simulation) on the dependent one (the incidence rate of medication errors) was investigated. The study population consisted of nurses working in the emergency department of Imam Hussein Hospital affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran. For this purpose, written consent forms were signed by the nurses who volunteered to participate in the study based on the following inclusion criteria: holding a bachelor's or higher degree in nursing, having a minimum of six months of clinical experience at the selected hospital, and working in rotating shifts. Exclusion criteria were moving to other departments during the study and being absent in workshops for one hour. The participants were also informed that the data would remain confidential and anonymous and that they could withdraw from the study whenever they desired. The total number of nurses who met the inclusion criteria in this emergency department was 52, three of whom were removed due to absenteeism from the workshop, and the study was consequently performed among 49 eligible nurses.

Then, the researcher referred to the emergency department affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran, and administered the demographic questionnaire and the Medication Administration Error Reporting Survey (MAERS) developed by Wakefield (2005). The latter consisted of three parts, namely, the rate of medication errors (two items), the type of medication errors, including errors associated with injectable and non-injectable medications (21 items) scored between zero and 100%, and the cause of medication errors (32 items) with a score range of 32 (minimum) and 160 (maximum), comprised of factors related to communication, packaging, transcription, working conditions, and pharmacy. The answers to the statements in this tool were rated on a 5-point Likert-type scale (from strongly agree=5 to strongly disagree=1). The questionnaire was also confirmed qualitatively for content validity by ten faculty members of the School of Nursing at Shahid Beheshti University of Medical Sciences, Tehran, IranReliability was assessed by 20 nurses working in the emergency department, and the recorded Cronbach's alpha values were 0.939 and 0.831 for error rate and error cause, respectively. Then, the nurses were allowed to complete the questionnaires in the presence of the researcher until their shifts finished. The researcher also allowed them to ask questions in case of any ambiguities.

After completing the questionnaires, the rate, the type, and causes of medication errors were determined using the SPSS Statistics software version 24. Based on the results, the training programme was consequently developed in the form of simulations in all areas using the clinical scenarios of medication errors. The place and the time of the workshops were also notified to the nurses under the coordination of the head nurse of the emergency department. Workshops were held for two hours in the emergency medicine classroom of this hospital. Based on the results of the questionnaires before the intervention and given the high incidence of slips in calculations, dosages, medication use speed, and lack of attention to drug interactions by the nurses, simulation-based education was provided using some clinical scenarios of medication errors in the form of

PowerPoint presentations. Errors were then discussed and examined into eight essentially correct medication use principles.

During the pretest, the content of the items on medication errors and calculations was also given to the participants. During this workshop, the researcher presented eight correct principles of medication use after providing educational materials on the prevalence of medication errors and the importance of patient safety, medication process, calculations, and a report on the results of the rates and causes of errors. Then, the scenarios were introduced according to the eight principles, and nurses were asked to propose their solutions to the errors arising in such cases. Educational brochures for calculations were further available to the participants. In the end, participants completed the posttest. The rate of medication errors was reviewed and compared for two months. During this period, the researcher mentioned the eight principles of correct medication use and proper calculations when visiting the department during different shifts. Moreover, the researcher had interviews and discussions with experienced nurses to provide adequate solutions for minimising medication errors. Educational posters on calculations were also displayed on the board at the nursing station to expose nurses and nursing students and consolidate what was taught during the workshop. A small brochure and a calculation formula were also provided for the nurses who had lost it. During the check-up process, medication use by nurses was monitored. Finally, the questionnaires completed by the nurses were analysed by the SPSS Statistics software version 24 through the Mann-Whitney U test, the Wilcoxon signed-rank test, Chi-square test, and t-test.

Results

The study results revealed that the mean age of the nurses was 33.43±6.66, their working experience was 8.16±6.04 years, and the number of patients per shift in the emergency department was 33.5±12 cases (Table I).

Table I: Demographics of nurses (N=49)

Characteristics		Values
Age (mean±SD; year)		33.43±6.66
Work experience (mean±SD; year)		8.16±6.04
Number of patients per shift (mean±SD; case)		33.5±12
Status of taking medication courses (n, %)	Yes	39 (79.60)
	No	10 (20.80)

It is noteworthy that the Kolmogorov-Smirnov test was implemented for data normalisation. Given the non-normality of the samples, non-parametric statistical tests, such as the Mann-Whitney U test, the Wilcoxon signed-rank test, Chi-square test, and t-test were used. The results showed an increase in each year of working experience among the nurses, and the medication errors had fallen to -1.731. Simulation training in the field of injectable and non-injectable medication errors based on the Wilcoxon signed-rank test results also demonstrated that the mean and standard deviation (SD) of the frequency of the non-injectable medication errors reduced from 2.75±2.0 to 2.44±1.51 and such errors with regard to injectable medications diminished from 2.03±2.77 to 2.59±1.42 (Table II).

According to the nurses working in the emergency department of the selected hospital, the most important causes of medication errors were inadequate staff (M=4.33), no round-the-clock presence of medication experts (M=3.95), LASA medication names (M=3.89), and frequent changes in doctors' orders (M=3.87) and the least important causes of such slips were limited knowledge of nurses about medications (M=2.46) and known allergic reactions (M=2.48), as well as poor professional relationships between nurses and doctors (M=2.59), non-English or non-Persian languages on medication packages (M=2.69), and flawed packages (M=2.63).

Discussion

This study aimed to determine the effect of simulation education on the incidence rate of medication errors among the nurses working in the emergency department of Imam Hussein Hospital affiliated with Shahid Beheshti University of Medical Sciences, Tehran, Iran, 2022. Based on the study results, the most common errors were slips in administration time and calculations prescribed for non-injectable medications and failure to pay attention to drug interactions, errors in injection speed, and calculations for injectable medications. A study had shown that the co-administration of multiple medications with no regard for their interactions was the most common error (Zarea *et al.,* 2018).

Table II: Mean and standard deviation of injectable and non-injectable drug errors studied before and after simulation training

Field of drug errors	Before Mean (SD)	After Mean (SD)	*p*-value
Non-injectable drugs			
Wrong method of drug administration	2.85 (2.15)	2.65 (1.63)	0.161
Error in the time of giving the drug	3.28 (2.22)	3.13 (1.85)	0.229
Wrong patient	2.45 (1.71)	2.17 (1.33)	0.08
Wrong drug	2.91 (2.10)	2.32 (1.21)	0.003*
Wrong drug amount	2.65 (2.11)	2.33 (1.29)	0.043*
wrong drug calculation	3.27 (2.13)	2.15 (1.31)	<0.001**
Giving medicine without a doctor's prescription	2.62 (2.38)	2.40 (1.99)	0.485
Giving medicine after stopping the doctor's order	2.40 (1.94)	2.53 (1.81)	0.797
Giving medicine to a patient with a history of allergies	2.37 (1.86)	2.28 (1.21)	0.335
Injectable drugs			
Wrong method of drug administration	2.32 (1.54)	2.23 (1.15)	0.257
Error in the time of giving the drug	2.77 (1.92)	2.45 (1.36)	0.032*
Wrong patient	2.64 (2.31)	2.02 (1.27)	0.006*
Wrong drug	2.66 (2.06)	2.17 (1.36)	0.001*
Wrong drug amount	2.65 (1.75)	2.02 (1.04)	0.001*
Wrong drug calculation	3.19 (2.27)	1.91 (0.89)	<0.001**
Giving medicine without a doctor's prescription	2.38 (1.99)	2.43 (1.92)	0.359
Giving medicine after stopping the doctor's order	2.27 (1.57)	2.36 (1.62)	0.079
Giving medicine to a patient with a history of allergies	2.80 (1.98)	2.54 (1. 61)	0.335
Use of unsuitable solution to dilute the drug	2.63 (2.21)	2.28 (1.70)	0.162
Wrong injection speed	3.22 (2.21)	2.30 (1.13)	<0.001**
Not paying attention to the drug interaction in the simultaneous administration	3.73 (2.62)	3.46 (2.06)	0.009*

*p-value <0.05, **p-value<0.001

Correspondingly, the study findings showed that the most common medication error was related to administration time, i.e. the medications had been used earlier or later than the due time. During the interviews and discussions with the nurses and based on the researcher's working experience, the causes of this error might be attributed to high workload, enhanced time efficiency to expedite patient care, and indirect nursing care affairs, including the electronic recording and reporting of laboratory tasks, medications, and radiology services.

Comparing the incidence rates of medication errors before and after the intervention among the nurses working in this emergency department showed that the frequency of medication errors for non-injectable medications decreased (p<0.001) in the following areas: wrong medications, dosages, calculations, administration times, patients, dosages, and injection speed, in addition to failure to pay attention to drug interactions during simultaneous administration. Education led to no significant differences in other areas. Therefore, it was concluded that training through simulation-based scenarios could reduce medication errors. These results were consistent with study findings where simulation has been employed to improve medication use skills among nursing students (Harris *et al.,* 2014). Another study established that the implementation of simulation-based education has promoted dosage calculation skills among nursing and pharmacy graduate students, respectively (Atayee *et al.,* 2016). According to our results and those of previous studies, simulation training could be efficacious at all nursing levels, namely nursing students, employed nurses, and those working in other fields (Harris *et al.,* 2014; Atayee *et al.,* 2016; Basak *et al.,* 2016).

Besides, the results in this study were in agreement with previous findings regarding the use of Pediatric Accurate Medication in Emergency Situations (PedAMINES) as a systematic guide for accurate treatment in children during emergencies to prepare medications required for continuous infusion, which could significantly contribute to minimising medication errors at the time of preparation and use (Siebert *et al.,* 2017). Moreover, the results in this study were in line with reports on the simulated resuscitation of children in an emergency department, wherein the golden time of medication use and the dosage decreased during this procedure (Moreira *et al.,* 2015). In this study, the rates of medication dosage errors also dropped, although the error of the golden time of giving medications during patient resuscitation was not investigated.

The results in this study also supported those of Hajibeglou and colleagues (2018), where patient safety

training programme for nurses was generally effective in reducing wrong dosage time and medication administration omission (p<0.001) because medication errors could be assumed as indicators of patient safety and the training programme could decrease such errors and increase patient safety. Moreover, the use of simulated training did not significantly reduce the errors associated with the administration time of injectable medications, the most common error among emergency department nurses. This finding conflicted with that of Hajibeglou and colleagues, who could highlight the positive effect of safety education on wrong medication use time. Such discrepancy might be attributed to the different teaching methods and the centrality of patient safety because the mentioned study specifically considered one aspect of the solution to patient safety, namely medication errors (Hajibeglou *et al.,* 2018).

It seems that the slight effect of simulated education on errors associated with medication administration time might be due to the high workload among nurses, particularly those working in emergency departments, the lack of specialist nurses in each department, particularly emergency wards, low working experience of nurses, the lack of supervision by head nurses or those in charge of shifts of patient medications and compliance, the lack of motivation in nurses, nursing shortages, patient overcrowding, the small number of simulated training sessions, and the insufficient cooperation of nurses to attend simulation workshops.

The results in this study also indicated that medication errors were due to inadequate staff, no round-the-clock presence of medication experts, LASA medication names, and frequent changes in doctors' orders, the most common being staff shortages, consistent with previous findings (Ehsani *et al.,* 2013).

Conclusion

This study examined the effect of simulation-based education on clinical scenarios to reduce medication errors by nurses and revealed that the frequency of injectable and non-injectable medication errors decreased. It could also identify the causes of medication errors by nurses working in emergency departments. These results could be used by the authorities and decision-makers to address the gaps, thereby increasing the number of nurses, motivating them toward medication safety, and improving their knowledge through simulation scenarios to minimise medication errors and enhance patient safety. In addition, it is of utmost importance to pay much more attention to patient care quality. It is also suggested to conduct further research using simulation-based training at different nursing levels in various hospital departments and then compare this approach with traditional and electronic programmes.

Acknowledgements

The authors express their gratitude to the Clinical Research Development Unit of Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran, for their support and cooperation during the study. The study protocol was approved by the Ethics Committee of the clinical development unit of Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran (IR.SBMU.RETECH.REC.1401.090; Research proposal cod: 32344).

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