Araştırma Makalesi
(Research Article)

EGEHFD, 2021, 37 (2): 121-129
Doi: 10.53490/egehemsire.873143

Detection of Drug Medication Errors of Nursing Students in Pediatric Patients Through a Hospital Simulation

Simüle Edilmiş Hastane Ortamında Hemşirelik Öğrencilerinin Çocuk Hastalarda İlaç Uygulama Hatalarının Belirlenmesi

Gönderilme Tarihi: 2 Şubat 2021 **Kabul Tarihi:** 08 Haziran 2021

Suat TUNCAY [1]
Orcid: 0000-0001-5493-6507

Ayşe ŞAHİN [2]
Orcid: 0000-0003-1240-0178

Kamile AKÇA[3]
Orcid: 0000-0002-2833-8754

Duygu ARIKAN[4]
Orcid: 0000-0001-9451-8799

[1] RN, M.Sc, Research Assistant, Bingöl University, Faculty of Health Sciences, Department of Pediatric Nursing, Bingöl, TURKEY

[2] RN, M.Sc, Lecturer, Amasya University, Sabuncuoğlu Şerefeddin Health Services Vocational School, Child Development, Amasya, TURKEY

[3] RN, M.Sc, Research Assistant, Gaziantep University, Faculty of Health Sciences, Department of Pediatric Nursing, Gaziantep, TURKEY,

[4] RN, M.Sc, Professor, Atatürk University, Nursing Faculty, Department of Pediatric Nursing, Erzurum, TURKEY

Sorumlu Yazar (Correspondence Author):

Suat Tuncay
suat.tuncay@gmail.com

Key Words:

Pediatrics; nursing student; drug medication errors; simulation.

Anahtar Sözcükler:

Çocuk; hemşirelik öğrencisi; ilaç uygulama hataları; simülasyon.

ABSTRACT

Objective: This study aimed to detect nursing students' drug medication errors in pediatric patients.

Methods: The study used a comparative descriptive and qualitative design and was carried out after the necessary ethical and official permissions had been obtained. The universe of the research consisted of the students of the Faculty of Nursing. The sample of the study included 94 students (third-year n=47 and fourth-year n=47). A laboratory of the Faculty of Nursing was simulated as a room where a nurse provides treatment. The students who participated in the study with the determined drug order were asked to prepare the drugs with the most appropriate technique, and they were observed by the researchers. Data were collected one by one by the researchers using a drug medication errors checklist prepared by the researchers.

Results: The third-year students did not consider dry powder dosage and obtained the lowest score ($\bar{X}$=0.68). The fourth-year students did not attach the right label on the drug taken and received the lowest score ($\bar{X}$=0.42). The third-year students were more successful in attaching the right label on the remaining drug (p=0.20) and the fourth-year students were more successful in observing aseptic rules (p=0.03). Students in both groups ignored the dry powder dosage of the drug in total and earned the lowest score from this practice ($\bar{X}$=0.64).

Conclusion: Drug medication errors committed by the students in both groups were high, and the students did not consider dry powder dosage when reconstituting the drug.

ÖZ

Amaç: Bu çalışmada hemşirelik öğrencilerinin çocuk hastalarda ilaç uygulama hatalarınının belirlenmesi amaçlanmıştır.

Yöntem: Araştırma karşılaştırmalı tanımlayıcı ve niteliksel türde tasarlanmış ve gerekli etik ve resmi izinler alındıktan sonra gerçekleştirilmiştir. Araştırmanın evrenini Hemşirelik Fakültesi öğrencileri oluşturmuştur. Örnekleme ise 94 öğrenci (üçüncü sınıf n=47 ve dördüncü sınıf n=47) dahil edilmiştir. Hemşirelik Fakültesi laboratuvarı, hemşirelik tedavi odası şeklinde simüle edilmiştir. Belirlenen ilaç sırası ile çalışmaya katılan öğrencilerden ilaçları en uygun teknikle hazırlamaları istenmiş ve araştırmacılar tarafından gözlemlenmiştir. Veriler, araştırmacılar tarafından hazırlanan ilaç uygulama hataları kontrol listesi kullanılarak tek tek toplanmıştır.

Bulgular: Üçüncü sınıf öğrencilerin ilaç kuru toz hacmini dikkate almadığı ve en düşük puanı aldıkları belirlendi ($\bar{X}$=0.68). Dördüncü sınıf öğrencilerinin kalan ilaca doğru etiketi yapıştırmadığı ve en düşük puanı aldıkları bulundu ($\bar{X}$=0.42). Üçüncü sınıf öğrencileri kalan ilaca doğru etiketi yapıştırmada daha başarılı (p=0.20) ve dördüncü sınıf öğrencileri aseptik kurallara uymada daha başarılı olduğu tespit edildi (p=0.03). Her iki gruptaki öğrencilerin ilaçların kuru toz hacmini göz ardı ettiği ve bu uygulamadan en düşük puanı aldıkları bulundu ($\bar{X}$=0.64).

Sonuç: Her iki gruptaki öğrencilerin yaptığı ilaç uygulama hatalarının yüksek olduğu ve öğrenciler ilacı sulandırırken kuru toz hacmini dikkate almadığı görüldü.

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Kaynak Gösterimi: Tuncay, S., Şahin, A., Akça, K., Arıkan, D. (2021). Simüle edilmiş hastane ortamında hemşirelik öğrencilerinin çocuk hastalarda ilaç uygulama hatalarının belirlenmesi. *EGEHFD,* 37(2), 121-129. Doi: 10.53490/egehemsire.873143
How to cite: Tuncay, S., Şahin, A., Akça, K., Arıkan, D. (2021). Detection of drug medication errors of nursing stodents in pediatric patients through a hospital simulation. *JEUNF,* 37(2), 121-129. Doi: 10.53490/egehemsire.873143

INTRODUCTION

The United States National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) defines medication errors as any preventable event that lead to inappropriate medication use or patient harm. Medication errors are among the most frequently encountered errors during the treatment of hospitalized patients (NCCMERP).

Children constitute a risky community for medication errors. Frequency of medication errors is higher in pediatric patients than in adults due to developmental characteristics of children, lack of many drugs for children, and administration of drugs through reconstitution (Al-Ramahi et al., 2017; Lalande et al., 2018). The effects of drug medication errors on infants and children can be very serious. A study examining medication errors reported that 55.2% of the errors reaching the child caused a harmful effect at a level that would not need follow-up, 12.1% had not harmed the child, and 27.2% were noticed before they had reached the child. In addition, 3.2% resulted in temporary damage and required intervention or long-term hospitalization, 0.3% of the children suffered from permanent damage but survived through intervention, 1.9% were noticed before almost reached the child, and 0.04% were errors that could be related to the child's death (Manias et al., 2014).

Nurses are the most important element in recognizing and preventing errors to reduce the risks in the process of drug administration to children (Sears et al., 2016). Nurses are responsible for having knowledge about the drugs they administer, their preparation, control, administration, and evaluation of the effectiveness of the treatment; therefore, they need to have continuous education throughout their professional life to minimize errors regarding drug applications (Di Muzio et al., 2017). One of the most important points in reducing and preventing drug medication errors is to allow nursing students, who are preparing for the profession, to exhibit their knowledge and experience about drug administration, enable them to review the drug administration education they received during their education, and detect the areas they think are insufficient (Grandell-Niemi et al., 2005). Many training methods and strategies are used to develop knowledge and skills in nursing education. One of the methods adopted for students to gain and improve their competence inpatient care management is simulations (Edeer & Sarikaya, 2015).

The World Health Organization (WHO) published gold standards in education for nurses and, accordingly, recommended using electronic learning and simulation methods in the programs of nursing schools for learning and teaching (WHO, 2009). The American Association of Colleges of Nursing (AACN) and the US National Council of State Boards of Nursing (NCSBN) reported that using simulation and online learning methods in nursing education was useful (AACN, 2005; NCSBN, 2005). In its report on the underlying proficiency of nurse educators, the US National League for Nursing (NLN) suggested using information technologies (computer programs, simulations, the internet, etc.) to facilitate students' learning and support their learning process (NLN, 2021).

When teaching drug application during professional nursing education, theoretical knowledge about drugs and applications is first given, and then this knowledge is reinforced through laboratory and clinical applications (Zaybak et al., 2017).

This study was conducted to determine drug medication errors of the nursing students who were taking or had taken Pediatric Nursing lesson in a simulated hospital environment before they administered drugs to children. Detecting drug medication errors committed by nursing students is necessary for the prevention of medical errors. The results of the study show that initiatives should be planned to minimize drug medication errors and eliminate their causes.

This study was planned to determine and compare the drug medication errors of the third and fourth-year nursing students who were taking or had taken Pediatric Nursing lesson in pediatric patients.

METHOD

Design

This research was designed with a comparative descriptive and qualitative feature.

This research was carried out at a school in eastern Turkey 4-year nursing education. The data were collected from the 3rd and 4th grade nursing students in the laboratory simulated in the pediatric clinic in the last week of May 2019.

Participants

The third-year and fourth-year students (n=263 and n=262, respectively) studying at a faculty of nursing and who were taking or had taken Pediatric Nursing lesson comprised the universe of the study. Using the known universe formula, 94 students were selected with a confidence interval of 90% and a margin of error of 7%. Totally, using the random sampling method, 94 students (third-year n=47 and fourth-year n=47) who were randomly selected and agreed to participate were included in the study.

Setting

The process of pediatrics nursing course

Pediatric Nursing is taught in the second semester of the third-year in the Faculty of Nursing. During the spring semester, students receive 12 hours of practice in the hospital in addition to weekly theoretical lessons at the faculty. Research nurses assigned by the Faculty of Nursing supervise clinical practice. Practice on pediatric patients is implemented individually and in a safely. Research nurses work with students 12 hours a week. Clinical nurses and research nurses cooperate. Accordingly, clinical nurses also direct students and participate in their education. Care and treatment are provided together.

Fourth-year students are intern students. They practice only with clinical nurses. They do not receive any theoretical lessons.

Creating the simulation room

The study was conducted in the laboratory of the Nursing Faculty. The laboratory is simulated as a pediatrics clinic with treatment and patient room. Necessary materials (serums, syringes, drugs, medical gloves, masks, medical waste boxes, labels, etc.) were provided by the researchers.

There was a nurse desk, various equipment cabinets, three intervention dummies, and venous access on the dummies in the laboratory.

The simulation was prepared by mimicking a hospital environment. A mini pediatric clinic was designed in the laboratory of the faculty within the context of the simulation. Medical gloves, injectors, masks, bonnets, waste boxes, a medicine cart, physician orders, labels, child dummies, and different types of drugs and reconstitution solutions were placed in the simulation environment.

Data collection tools

Drug application errors checklist

The Drug Application Errors Checklist was created based on the literature within the scope of the study. The order of action in the Drug Application Errors Checklist was prepared according to the specified literature (Bülbül et al., 2014; Kim & Lee, 2020; Musharyanti et al., 2019; Sears et al., 2016). After the "Checklist" was prepared, approval was obtained from two experts in the field of pediatric nursing.

Drug Application Errors Checklist consists of 17 techniques. The techniques in the checklist were created in a specific order. The students were given 5 points in the circumstance they applied the technique competently, and other scores were as follows: 4= Good, applied confidently, 3= Pass, applied confidently 2= Pass, did not apply confidently, 1= Bad, was not competent, 0= Did not apply. The maximum and minimum scores the students could obtain from the checklist were 85 and 0, respectively.

This checklist examines the following techniques; Ensuring hand hygiene, checking the physician's order, wearing medical gloves, checking medication time, reconstituting the drug with the correct solvent, observing aseptic rules when reconstituting the vial, considering the dry powder dosage when reconstituting the drug, taking the right dose, paying attention to no loss of dose, attaching the right label on the drug taken, attaching the right label on the remaining drug, checking the right room, confirming the right patient (wristband), confirming the route of administration, considering the speed of administration, recording the given medicine, disposing of the waste properly.

Data collection procedure

Data were collected using a "Drug Application Errors Checklist" prepared by the researchers in the last week of May 2019 and by checking the items on the form individually and sequentially.

Nobody, except the researchers and the student, was allowed into the simulation environment during the data collection process. The students were asked to prepare and administer the drugs according to the order specified in the laboratory that was simulated as a pediatrics clinic environment. The ordered drugs included vials with powder dosages. The student was not interfered during the preparation and administration of drugs; the student was just observed from afar. In the research, each student was observed by 3 specialist pediatric nurses of this research. Points were given by consensus according to the checklist.

After each student had conducted the last practice, he/she was told, "This is not an exam. We would like to get your opinions. Why did you follow these steps? Do you think you made an error? If you think you did, where did you make it? Could you please explain to us?" Then, the responses were evaluated.

Each meeting lasted approximately 20 minutes.

Data analysis

The data were analyzed electronically using the Kolmogorov Smirnov test, frequency, and mean. Independent groups were evaluated using the Student's t test.

Ethical considerations

For the study, ethical compliance approval from the University Ethics Committee (2019-2/16) were obtained. Written permission was obtained from the faculty to use the laboratory within the scope of the study. The students were interviewed individually and they were informed about the process of the study. The students who agreed to participate were included in the study.

RESULTS

The results of the study conducted to detect the errors committed by third and fourth-year nursing students who were taking or had taken the Pediatric Nursing lesson in drug administration practices in pediatric patients in a simulated environment are as follows:

In the study, it was determined that 76.6% (n = 36) of both 3rd and 4th grade students were female students and 23.4% (n = 11) were male students. The study also found that the mean age of 3rd grade students was 22 (SD =±1.2, range = 19-30), and the average age of 4th grade students was 22.4 (SD =±1.71, range = 21-32). It was determined that these two groups were homogeneous (p = 0.28).

The practices on which the third and fourth-year nursing students (n=94) received the lowest scores were "Considering the powder dosage when reconstituting the drug" ($\bar{X}$=0.64), "Attaching the right label on the drug taken" ($\bar{X}$=0.71), and "Attaching the right label on the remaining drug" ($\bar{X}$=0.87). The highest scores were obtained from the items "Checking the physician's order" ($\bar{X}$=4.21) and "Disposing the waste properly" (X=3.89) (Table 1).

The third-year students (n=47) scored the lowest on "Considering the powder dosage when reconstituting the drug" ($\bar{X}$=0.68). They obtained the highest score on "Disposing the waste properly" ($\bar{X}$=4.17) (Table 1).

In examining the errors made by the fourth-year students, they received the lowest scores on "Attaching the right label on the drug taken" ($\bar{X}$=0.42) and "Considering the powder dosage when reconstituting the drug" ($\bar{X}$=0.61). They obtained the highest score from "Checking the physician's order" ($\bar{X}$=4.36) (Table 1).

Table 1. Medical Error Practices of the Third and Fourth-year Nursing Students

		Third and Fourth-year Students (n=94)	**Third-year Students (n=47)**	**Fourth-year Students (n=47)**
		Mean (SD)	Mean (SD)	Mean (SD)
1.	Ensuring hand hygiene	0.8 (1.6)	1.00 (1.47)	0.78 (1.74)
2.	Checking the physician's order	4.21 (1.04)	4.06 (1.16)	4.36 (0.89)
3.	Wearing medical gloves	1.56 (2.15)	1.42 (1.89)	1.70 (2.39)
4.	Checking medication time	3.52 (1.68)	3.21 (1.70)	3.82 (1.61)
5.	Reconstituting the drug with the correct solvent	3.76 (1.85)	3.80 (1.84)	3.72 (1.88)
6.	Observing aseptic rules when reconstituting the vial	2.38 (1.20)	2.12 (1.24)	2.63 (1.11)
7.	Considering the dry powder dosage when reconstituting the drug	0.64 (1.04)	0.68 (0.91)	0.61 (1.17)
8.	Taking the right dose	1.78 (1.85)	1.48 (1.58)	2.08 (2.06)
9.	Paying attention to no loss of dose	1.31 (1.47)	1.59 (1.62)	1.04 (1.26)
10.	Attaching the right label on the drug taken	0.71 (1.24)	1.00 (1.31)	0.42 (1.11)
11.	Attaching the right label on the remaining drug	0.87 (1.46)	1.06 (1.48)	0.68 (1.43)
12.	Checking the right room	2.93 (2.29)	3.17 (2.19)	2.70 (2.38)
13.	Confirming the right patient (wristband)	1.87 (1.99)	1.65 (1.95)	2.08 (2.03)
14.	Confirming the route of administration	3.59 (1.84)	3.42 (1.95)	3.76 (1.73)
15.	Considering the speed of administration	2.68 (1.95)	2.95 (1.78)	2.40 (2.09)
16.	Recording the given medicine	2.25 (2.25)	2.23 (2.17)	2.27 (2.34)
17.	Disposing the waste properly	3.89 (1.99)	4.17 (1.67)	3.61 (2.26)

Note: For each practice, the maximum score is 5, the minimum score is 0.

The comparison of the medical error practices of the third and fourth-year nursing students showed a significant difference between the groups in the practices “Observing aseptic rules when reconstituting vial” (p=0.03) and "Attaching the right label on the drug taken” (p=0.02) (Table 2). In the practice of “Observing aseptic rules when reconstituting the vial,” the fourth-year students were more successful; however, the third-year students were more successful in the practice of “Attaching the right label on the drug taken” (Table 2).

The third and fourth-years students received 39.08 and 38.74, respectively, from the drug medication errors checklist out of 85, and the difference was not statistically significant (p=0.88) (Table 1, Table 2).

Table 2. Comparison of Medical Error Practices of the Third and Fourth-year Nursing Students

		t	p
1.	Ensuring hand hygiene	0.63	0.52
2.	Checking the physician’s order	1.38	0.16
3.	Wearing medical gloves	0.62	0.53
4.	Checking medication time	1.79	0.07
5.	Reconstituting the drug with the correct solvent	0.22	0.82
6.	Observing aseptic rules when reconstituting the vial	2.09	**0.03**
7.	Considering the dry powder dosage when reconstituting the drug	0.29	0.76
8.	Taking the right dose	1.57	0.12
9.	Paying attention to no loss of dose	1.84	0.06
10.	Attaching the right label on the drug taken	2.27	**0.02**
11.	Attaching the right label on the remaining drug	1.27	0.20
12.	Checking the right room	0.98	0.32
13.	Confirming the right patient (wristband)	1.03	0.30
14.	Confirming the route of administration	0.89	0.37
15.	Considering the speed of administration	1.38	0.17
16.	Recording the given medicine	0.09	0.92
17.	Disposing the waste properly	1.34	0.18

The responses of the students to the questions "Why did you follow these steps? Do you think you made an error? If you think you did, where did you make it?” are as Table 3.

Table 3. Students' Opinion on Medication Administration Errors

Of the students, 76.5% responded with the same or similar answers as:
“I did just the way clinical nurses do. Moreover, they are fast and practical. I think researcher nurses love details. That's why I believe that clinical nurses are doing more correct practices.”
Of the students, 19.2% gave the same or similar answers as:
“Theoretically I should have considered the powder dosage of the drugs, but I did not. I think I made an error there.”
Of the students, 4.3% gave the same or similar answers as:
“In the first year when drug administrations were taught in the lesson of principles of nursing, the issue of powder dosage was not taken into consideration. Therefore, I did not consider it, either. I guess I cannot change it because I learned it so at first.”

DISCUSSION

Simulation training is a way of providing learning using the desired professional knowledge and skills by preventing the patient from being harmed and offering unlimited repetition opportunities in special settings similar to the hospital environment. Also, the simulation environment; Using problem-based scenarios can be an alternative way to facilitate drug safety. Nursing schools and hospitals should consider integrating these teaching strategies for students and nurses to prevent medication errors (Kuo et al., 2020; Vural Doğru & Zengin Aydın, 2020). There are studies that examine the knowledge and skills of nurses students with a computer-based virtual reality simulation environment (Dubovi et al., 2017), or simulated the classroom environment and investigate medication errors (Kuo et al., 2020). In our study, the laboratory environment was simulated in the hospital environment. Rather than increasing the knowledge and skill level of the students, this study is to determine the medication errors and examine the reasons before the medication is administered to the patient.

The results of the study conducted to detect the errors committed by the third and fourth-year nursing students, who were taking or had taken Pediatric Nursing lesson, in drug administration practices in pediatric patients in a simulated environment are discussed and presented in the light of literature below.

Drug medication errors are one of the most common and patient safety threatening errors in hospitals, and its prevalence is reported to vary. Pharmaceutical management is among the basic steps of nursing practices as well as being the ethical and legal responsibility of the nurse (Al-Ramahi et al., 2017; Özyazıcıoğlu et al., 2018). The practices from which the third and fourth-year nursing students in the study obtained highest scores were "Checking the physician's order," "Checking medication time," and "Confirming the route of medication." A study investigating drug medication errors committed by nursing students reported that practices with the lowest error rate were drug administration without physician's order (6.7%), drug administration at the wrong time (5.0%), and drug administration using the wrong route (2.7%) (Ayık et al., 2010). This supports that the students were more sensitive about confirming the route of drug administration, checking the physician's order, and the drug administration time.

This study found that another practice on which the third and fourth-year students obtained highest scores was "Disposing the waste properly." (Table 1). A study conducted to determine the knowledge and attitudes of healthcare professionals about hospital waste reported that the majority of the professionals stated that cutting and piercing medical waste should be collected in separate boxes (İncesu & Evirgen, 2017). Based on this, nurses, who are the key members of healthcare workers, are thought to provide nursing students with the attitude of disposing medical waste properly by guiding them in clinical practices.

The item on which the nursing students received the lowest score was "Considering the powder dosage when reconstituting the drug" (Table 1). In a simulated scenario-based study, it was found that students in the control group failed to consider the drug powder volume (Kuo et al., 2020). Another study was conducted by Kim and Lee (2020). In this study, the students were included in the Medication Error Encouragement Training (MEET) program and their competencies were tested. As a result of the study, it was observed that the control group students were unsuccessful in drug preparation compared to the experimental group. Similarly, in another study, it was determined that 34% of the students calculated the pediatric drug dose incorrectly or underestimated (Özyazıcıoğlu et al., 2018).

This highlights the need to provide more information about considering the powder dosage when reconstituting drugs in Pediatric Nursing lesson and to improve students' drug dose calculation skills in clinical practice. Furthermore, students should be given opportunities to repeat until they have done the right thing during the learning process with simulation education. Therefore, the errors committed in the clinical environment can be reduced. Another reason why students calculate the wrong dose of medication is their lack of math skills. As a matter of fact, Özyazıcıoğlu et al. (2018) stated that students should acquire these skills during their school years.

In this study also; of the students, 19.2% gave the same or similar answers as: *"Theoretically I should have considered the powder dosage of the drugs, but I did not. I think I made an error there."* (Table 3). Based on these results, it is seen that the students made mistakes in calculating the drug dose but did not turn their thoughts into behavior.

Another practice on which the third and fourth-year students obtained low score was "Ensuring hand hygiene." The reasons for the low scores in the practice of ensuring hand hygiene could be related to the fact that there were not enough sinks in clinics, false confidence of using gloves, and solutions used for hand hygiene irritate hands.

Other practices in which the students scored low were "Attaching the right label on the drug taken," "Attaching the right label on the remaining drug," and "Taking the right dose." In a study conducted with nurses to determine the medication administration errors of nursing students, it was stated that the students did not pay enough

attention to labeling the remaining drugs. It was also stated in the study that the students only marked the patient's room number on the drugs to be administered (Musharyanti et al., 2019). These results may be related to the insufficient knowledge and skills of the students and their lack of awareness about patient care (Table 1).

In the study, it was observed that 4th grade students got higher scores on "Observing aseptic rules when reconstituting the vial". It can be deduced from this result that 4th grade students practice more and have more experience. Another result was that 3rd grade students got higher scores on “Attaching the right label on the drug taken”. This result makes us think the fact that 3rd grade students are inexperienced and sensitive about this issue and 4th grade students are more self-confident and neglect this (Table 2).

Both theoretical and practical training on “Ensuring hand hygiene”, “dry powder volume”, “Attaching the right label on the drug taken”, “Attaching the right label on the remaining drug”, and “checking the patient's wristband” are given to the students included in the study in the lessons. However, it was observed that students both the 3rd grade who were taking or 4th grade who had taken Pediatric Nursing lesson got similarly low scores. The students were asked if they made a medication mistake and, if so, where they did it. 76.5% of the students stated that the researcher nurses look at too much details. In addition, they stated that they took clinical nurses as an example and that they were both practical and more accurate. 19.2% of the students stated that they were aware that they made a mistake, and 4.3% of the students stated that they did not get information about the dry powder volume in the 1st grade and had difficulty in changing it (Table 3.).

Musharyanti et al. (2019), who investigated the reasons of nursing students' medication errors has stated that there are reasons such as "insufficient knowledge and skills", "lack of good role model", "incomplete supervision", "nurses are not interested in students due to their intense workload". Özyazıcıoğlu et al. (2018) argued that the analytical skills of nursing students are insufficient and that training should be given with reliable and sustainable learning methods. Kim and Lee (2020), who created the MEET program, also stated that students make similar mistakes and that this will be overcome with effective learning methods.

Strengths and limitations

The results of the study were obtained only from the students of a faculty of nursing, which was one of the limitations of the study. Another limitation was that the students thought they were in an exam, so they felt stressed. Some of the students may have made mistakes because they felt stressed.

CONCLUSION

The results of the study showed the practices on which the third and fourth-year nursing students received the lowest scores were “Considering the powder dosage when reconstituting the drug,” “Attaching the right label on the drug taken,” and “Attaching the right label on the remaining drug.” They received the highest scores from the practices "Checking the physician's order" and "Disposing the waste properly." In the practice of “Observing aseptic rules when reconstituting the vial,” the fourth-year students were more successful; however, the third-year students were more successful in the practice of “Attaching the right label on the drug taken.” It is important to identify the lowest and highest scores students obtain from drug application steps according to the results of the study.

- Detecting drug medication errors is essential for preventing medical errors. In addition, providing students with opportunities to benefit more from the laboratory environment and practice can help reduce medical errors.
- It is recommended that drug administration in children should be taught not only in pediatrics but also starting from the basics of nursing course.
- Pediatrics instructors are recommended to increase one-to-one practices with students and to be supervisory in correct practices.
- Misapplications of students from nurses working in pediatric clinics were observed. In a sensitive area such as pediatrics, nurses are advised to demonstrate and supervise correct practices through in-service training.

Author Contributions: Concept: S.T., Design: S.T., A.Ş., Data Collection and/or Processing: S.T., A.Ş., K.A., Analysis and/or Interpretation: S.T., A.Ş., K.A., Writing and Literature Review: S.T., A.Ş., K.A., Critical Review or Revision: S.T., A.Ş., K.A., D.A.

Conflict of Interest: There is no conflict of interest between the authors.

Funding

There is no financial support for this research.

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