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ORIGINAL ARTICLE / ÖZGÜN MAKALE

ASSESSMENT OF PHARMACY STUDENTS' KNOWLEDGE OF HANDLING HIGH ALERT MEDICATIONS

ECZACILIK ÖĞRENCİLERİNİN YÜKSEK RİSKLİ İLAÇLARIN KULLANIMI HAKKINDA BİLGİSİNİN DEĞERLENDİRİLMESİ

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ABSTRACT

Objective: *High alert medications (HAM) are medications commonly used in health care settings that are associated with significant harm when used in error. Improvement in the knowledge and practice of pharmacists is crucial to prevent and solve medication errors associated with HAM. This study aimed to assess the knowledge of pharmacy students about HAM.*

Material and Method: *A cross-sectional study was conducted among pharmacy students (3rd, 4th and 5th-year students) through an online survey in Ankara, Türkiye between 1 May 2021 and 31 October 2021. A Turkish translated and validated version of the High Alert Medications Knowledge Questionnaire was used. Only a correct answer was given score of 1 among the knowledge questions. The common resources for HAM use in the practice were assessed.*

Result and Discussion: *Among 124 students, 80.6% were female. The mean age (standard derivation ± SD) of the students was 23.3 ± 1.37 years. The percentages of the 3rd, 4th and 5th-year students were 51.6%, 16.1% and 32.3%, respectively. The mean ± SD score of the students was 6.8 ± 3.28 out of 20. The 5th-year students (8.00 ± 2.90) were more likely to get higher scores compared to 3rd-years (5.89 ± 3.15) (p = 0.003). RxMediaPharma® (local online drug information database) was the most (75.0%) commonly used resource by pharmacy students. The pharmacy students' knowledge about HAM was poor. Educational interventions are necessary early in the clinical pharmacy curriculum to improve pharmacy students' knowledge and preparedness to handle HAM.*

Keywords: *High alert medication, clinical pharmacy education, knowledge, questionnaire*

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ÖZ

Amaç: *Yüksek riskli ilaçlar (HAM), sağlık hizmeti sunulan ortamlarında yaygın olarak kullanılan ve yanlışlıkla kullanıldığında önemli zararlarla ilişkilendirilen ilaçlardır. Eczacıların bilgi ve uygulamalarındaki gelişme, HAM ile ilişkili ilaç hatalarını önlemek ve çözmek için çok önemlidir. Bu çalışma, eczacılık öğrencilerinin HAM hakkındaki bilgilerini değerlendirmeyi amaçlamıştır.*

Gereç ve Yöntem: *Eczacılık öğrencileri (3., 4. ve 5. sınıf öğrencileri) arasında çevrimiçi anket yoluyla kesitsel bir çalışma Ankara, Türkiye'de yapılmıştır. Türkçe validasyonu yapılan Yüksek Riskli İlaçlar Hakkında Bilgi Anketi kullanılmıştır. Bilgi sorularından sadece doğru cevaba 1 puan verildi. Uygulamaları sırasında HAM kullanımı için kullandıkları yaygın kaynaklar değerlendirildi.*

Sonuç ve Tartışma: *Ankete katılan 124 öğrencinin %80.6'sı kızdır. Öğrencilerin yaş ortalaması [standart sapma (SSD)] 23.3 ± 1.37 olarak bulunumuştur. Eczacılık 3., 4. ve 5. sınıf öğrencilerinin oranı sırasıyla %51.6, %16.1 ve %32.3'tür. Öğrencilerin ortalama ± SD puanı 20 üzerinden 6.8 ± 3.28'dir. 5. sınıf öğrencilerinin (8.00 ± 2.90) 3. sınıf öğrencilerine göre (5.89 ± 3.15) daha yüksek puan alma olasılığı daha fazla bulunumuştur (p = 0.003). RxMediaPharma® (yerel çevrimiçi ilaç bilgi veritabanı), eczacılık öğrencileri tarafından en çok (%75,0) kullanılan kaynaktı. Eczacılık öğrencilerinin HAM hakkındaki bilgileri yeterli bulunamamıştır. Eczacılık öğrencilerinin HAM'ı yönetme konusundaki bilgilerini ve hazırlıklarını geliştirmek için klinik eczacılık müfredatının başlarında eğitimsel müdahaleler gereklidir.*

Anahtar Kelimeler: *Anket, bilgi, klinik eczacılık eğitimi, yüksek riskli ilaçlar*

INTRODUCTION

Medication error is defined as any avoidable event that may lead to or cause inappropriate medication use or harm to patients [1]. It can cause injury and avoidable harm in health care systems [2]. It can occur when medications are being prescribed, prepared, dispensed, or administered [1,3]. Not all medication errors cause harm to the patients [3]. Harm due to medication errors are commonly associated with high alert medications (HAM). The Institute for Safe Medication Practices described HAM as a group of medications causing serious harm to the patients when they are used in error [3]. These medications involve groups of narcotics, electrolytes, opiates, anticoagulants, benzodiazepines, cardiovascular, chemotherapeutic, and neuromuscular blocking drugs [4]. The top HAM is insulin, intravenous anticoagulants, opiates and narcotics, injectable potassium chloride or phosphate concentrate, and concentrated sodium chloride [5].

According to the World Health Organization (WHO)'s 2017 "Medications without Harm" Report, the overall WHO global aim is to reduce medication errors by 50% over 5 years [6]. To achieve this aim, improvements in medication prescribing, dispensing, administering, monitoring and use are necessary [6]. However, there could be knowledge gap among the health care professionals to identify HAM. For example, a survey showed that less than 70% of pharmacists, nurses and physicians were able to define HAM [7]. It was improved by the implementation of medication safety-related HAM interventions within the health care setting [7]. One approach is to educate and train health care professionals about the use of HAM. A HAM program was introduced by the leaders, physicians, nurses, pharmacists, quality leaders, and labor unions which worked on medication safety issues so that medication harms would be reduced [8]. The program included a standardized process for handling HAM, education about HAM and monitoring of its sustainability [8]. A statistically significant reduction in medication errors was determined for 23 months after the program initiation [8]. Therefore, developing standardized processes, education and training of health care professionals while handling HAM was useful.

Pharmacists play an important role in medication safety. This role covers leading, planning and monitoring of safe medication use [9]. Specifically, developing risk-specific protocols for HAM, determining and assessing high-risk processes that need attention, protocols, and training as well as tracking and monitoring medication errors can be included in the list of pharmacists' responsibilities [9]. Therefore, education and training about medication errors especially for HAM must be improved in the current pharmacy curriculum to make students ready for pharmacy practice where they will routinely review prescribing, dispensing, and administering practices of HAM. However, little is known about

pharmacy students' knowledge and practice about HAM in Türkiye. The present study aimed to assess the knowledge of pharmacy students about HAM to consider whether it is sufficient enough in the pharmacy curriculum.

MATERIAL AND METHOD

A cross-sectional study was conducted among pharmacy students at a state university faculty of pharmacy located in Ankara, Türkiye. An online survey was created using Google Forms. All 3rd, 4th and 5th-year students were invited to participate. During the study period, a total of 587 pharmacy students were eligible. Students were eligible if they were 18 years or older and either 3rd, 4th or 5th-year. The 1st and 2nd-year students were not involved because the questions were associated with the lectures taught at senior levels. The responses were collected from 1 May 2021 to 31 October 2021. Electronic informed consent was taken from all the students who accepted to participate. It was mandatory to answer all the questions anonymously. The study was approved by the Ankara University Ethics Committee (Date: April 26, 2021; No: 07-87).

The High Alert Medications Knowledge Questionnaire was developed by Hsaio and his team [10]. Turkish reliability and validation were performed by Ozturk and her team [11]. The approval to use the Turkish version of the questionnaire was taken from the author. Turkish version of the survey applied to students. The questionnaire includes a total of 20 items about important knowledge of HAM such as its use, prescribing, dosage, storage, delivery route, administration and regulation. Items are to be ranked as true, false or unknown by survey participants. The scale ranged from 0-20, a correct answer is given 1, and the wrong answer/ not knowing was evaluated as 0. A higher score means a better knowledge of HAM [11].

The practice of pharmacy students was evaluated by asking which resources they used when they need information about HAM. It is a part of measuring the practice but would not comprise practice as a whole. A list of common resources used by pharmacists in Türkiye as well as an open section to type in alternative resources was provided in the questionnaire.

For the descriptive and inferential statistics, IBM SPSS Statistics version 26 and Microsoft Excel for Windows version 2016 were used. Categorical variables were described with numbers and percentages. Parametric continuous variables were described with the mean ± standard deviation (SD). Normality was checked among continuous variables. Based on the variables, ANOVA and Post Hoc tests were used to see meaningful differences between student groups. For post hoc analysis, Benforoni test was chosen because it is applicable for equal or unequal size of students groups.

RESULT AND DISCUSSION

A total of 124 pharmacy students participated in the study (response rate: 21.1%). The majority of the students were female (80.6%). The mean ± SD of the students was 23.3 ± 1.37 years. The percentages of the 3rd, 4th and 5th-year students were 51.6%, 16.1% and 32.3%, respectively. The mean ± SD score of the students was 6.8 ± 3.28 out of 20. (Table 1).

Table 1. Demographics of the pharmacy students

Demographics, n=124	**Value**
Female, n (%)	100 (80.6)
Age, mean ± SD	23.30 ± 1.37
Education year	
Third year	64 (51.6)
Fourth year	20 (16.1)
Fifth year	40 (32.3)

There were statistically significant differences in knowledge scores between 3rd, 4th and 5th-year students (p=0.003). The 5th-year students (mean ± SD: 8.0 ± 2.90) were more likely to get higher scores compared to 3rd- year students (mean ± SD: 5.89 ± 3.15) (p=0.003). The scores of 4th-year students

(mean ± SD: 7.6 ± 3.61) were not statistically different from 3th (p=0.103) and 5th-year students (p=0.861).

At least half of the students answered correctly to the Item 4 of the questionnaire, which was about port-A route (50.0%), Item 5, which was about insulin syringe (50.8), Item 7, which was about Ca gluconate and $CaCl_2$ (50.8%), Item 11, which was about fentanyl skin patch (58.9%), Item 12, which was about distinctive labelling of medication (91.9%), and Item 13, which was about heparin and insulin storage (56.5%) (Table 2).

Table 2. Answers to the high alert medications questions

Questions	True, n (%)	False, n (%)	Do not know, n (%)	Correct answer, n (%)
1. 'cc' or 'ml' is the dosage expression for insulin injection.	72 (58.1)	38 (30.6)	14 (11.3)	38 (30.6)
2. When an emergency such as ventricular fibrillation happens, push fast 7.5% KCl 10 ml into IV.	23 (18.5)	13 (10.5)	88 (71.0)	13 (10.5)
3. Fast IV infusion of 3% NaCl 500 ml for a patient who has a low sodium level.	38 (30.6)	25 (20.2)	61 (49.2)	25 (20.2)
4. The Port-A route can be used for blood withdrawal and drug injection generally.	41 (33.1)	62 (50.0)	21 (16.9)	62 (50.0)
5. The insulin syringe can be replaced by 1 ml syringe.	21 (16.9)	63 (50.8)	40 (32.3)	63 (50.8)
6. Fast IV push 1:1000 epinephrine 1 ampule for a patient who has a mild allergic reaction.	35 (28.2)	24 (19.4)	65 (52.4)	24 (19.4)
7. 10% Ca gluconate and 10% $CaCl_2$ are the same drug and interchangeable.	11 (8.9)	63 (50.8)	50 (40.3)	63 (50.8)
8. 7.5% KCl is better added to Ringer's solution for rapid infusion.	23 (18.5)	9 (7.3)	92 (74.2)	9 (7.3)
9. When an emergency happens, fast IV push 10% $CaCl_2$ 10 ml in 1-2 minutes.	29 (23.4)	7 (5.6)	88 (71.0)	7 (5.6)
10. For chemotherapy dose calculation, adults are based on body weight, while children are based on body surface area.	78 (62.9)	13 (10.5)	33 (26.6)	13 (10.5)
11. Taken fentanyl skin patch as regulated narcotic.	73 (58.9)	7 (5.6)	44 (35.5)	73 (58.9)
12. Use distinctive labelling on look-alike drugs.	114 (91.9)	5 (4.0)	5 (4.0)	114 (91.9)
13. For convenience, heparin and insulin should be stored together in the refrigerator.	23 (18.5)	70 (56.5)	31 (25.0)	70 (56.5)
14. Use 'Amp' or 'Vial' for dose expression instead of 'mg' or 'gm'.	58 (46.8)	44 (35.5)	22 (17.7)	44 (35.5)
15. If award stores atracurium for tracheal intubation, the drug should be stored with other drugs and easily accessed by nurses.	22 (17.7)	33 (26.6)	69 (55.6)	33 (26.6)
16. 7.5% KCl is frequently used, so it should be easily and freely accessed by nurses	41 (33.1)	21 (16.9)	62 (50.0)	21 (16.9)
17. If a patient can tolerate it, potassium can be administered orally instead of IV route.	39 (31.5)	23 (18.5)	62 (50.0)	39 (31.5)
18. Each drug better has multiple concentrations for a nurse to choose.	32 (25.8)	59 (47.6)	33 (26.6)	59 (47.6)
19. For paediatric dose, use teaspoon for dose expression.	63 (50.8)	42 (33.9)	19 (15.3)	42 (33.9)
20. Use 'U' instead of 'unit' for dose expression.	69 (55.6)	36 (29.0)	19 (15.3)	36 (29.0)

KCl: potassium chloride; Ca: calcium; NaCl: sodium chloride; $CaCl_2$: calcium chloride; IV: intravenous

Less than a quarter of the students were able to answer correctly to the questions mainly about the administration of the HAM. However, more than a quarter of them were able to answer the questions associated with the storage and prescription of HAM (Table 2). For example, a few students answer correctly to the Item 2 of the questionnaire, which was about emergency use of KCl (10.5%), Item 3, which was about administering intravenous (IV) infusion to the patient with low sodium level (20.2%), Item 6, which was about administration of epinephrine in allergic reactions (19.4%), Item 8, which was about mixing KCl and Ringer's solution (7.3%), Item 9, which was about administering fast $CaCl_2$ in an emergency (5.6%), Item 10, which was about calculation of the dose of chemotherapy (10.5%), and Item 16, which was about accessibility of KCl by nurses (16.9%) (Table 2).

The top 5 resources that students used for HAM were RxMediaPharma® (local online drug information database) (75.0%), pharmacists (59.7%), Pubmed®/Medline® (49.2%), Hacettepe University Drug and Poison Information Centre (HIZBIM) (12.9%), Medscape® (11.3%) and Drugs.com (11.3%), respectively (Figure 1).

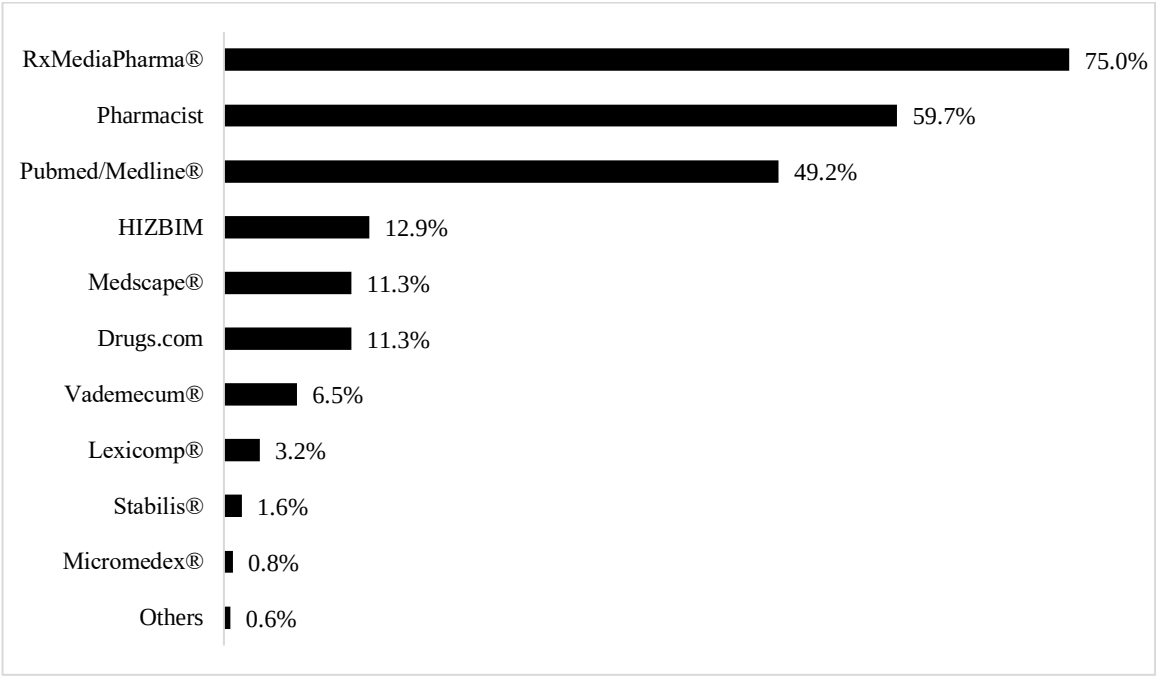

Figure 1. Students' answers for the information resources used for high alert medications
HIZBIM: Hacettepe University Drug and Poison Information Center; Others: tebrp® (Turkish Pharmacists' Association Pharmaceutical Care Assistant, ndrugs.com, FDA, CDC and NCBI

According to the results of this study, pharmacy students' knowledge about HAM is poor. Since pharmacists are the health care professionals who provide counselling and review about mediation use, it is crucial to teach them about HAM to avoid medication-related harms to the patients. However, to the best of our knowledge there is no study that evaluates the knowledge of pharmacy students about HAM.

A high number of medication errors reported in studies needs pharmacists' interventions [12]. Multiple interventions to reduce medication errors showed that pharmacists play a key role to eliminate the errors [12]. One way of the intervention is to make pharmacists educate other health care professionals. The other way of intervention, which is a prior step, is to educate pharmacists to improve their knowledge so that medication errors can be reduced through their involvement. This is because the lack of pharmaceutical knowledge has an important effect on the occurrence of medication errors and their prevention [13]. Education seemed to be one of the solutions to reduce medication errors [14].

In this study, the knowledge of pharmacy students was investigated as a starting point to see if future educational interventions/modules/seminars were needed to be placed in the pharmacy

curriculum. This was in line with the Accreditation Council for Pharmacy Education (ACPE) guideline, which requires that pharmacy students can apply "*quality improvement strategies, medication safety and error reduction programs and research processes to minimize drug misadventures and optimize patient outcomes*" when they graduate [15]. In response to this requirement, investigators from the United States developed an Educating Pharmacy Students and Pharmacists to Improve Quality Program. This program aimed to improve the knowledge and skills of pharmacy students to reduce medication errors and to apply quality improvement techniques for patient safety [16]. This program was inserted into the pharmacy curriculum of the 19 colleges and schools of pharmacy in the United States [16]. Another approach is interprofessional education of medication safety on the medication error [14]. The education program targeted the physicians, nurses and clinical pharmacists at intensive care units [14]. Interprofessional education enables two or more professionals to learn together and each other as well as improves teamwork and quality of care [14]. After the program implementation medication errors were reduced [14]. Therefore, interprofessional education can be effective for medication safety.

The questions on prescribing, dosage, storage, delivery route, and regulation about HAM are more likely to be answered correctly by the pharmacy students compared to those on administration. One possible reason is that pharmacists in Türkiye do not administer medications. It is mainly the nurses' responsibility. Pharmacy students might have felt that they did not need to know the administration of medications, or they have never learned before. However, they must still know the information about medication administration to provide appropriate answers in case they are asked by nurses or other health care professionals in clinical settings.

One of the roles of pharmacist regarding HAM is monitoring safety of high alert and look alike and sound alike medicines, developing risk-specific protocols, and conducting double checks for medications [17]. A study was conducted to monitor of HAM by clinical pharmacists in a hospital setting [18]. Clinical pharmacist developed a rapid HAM feedback system to evaluate HAM use so that patient harm would be eliminated [18]. Pharmacists involvement in HAM use can eliminate medication associated fatal events.

Gaps is education and knowledge about HAM can result to medication harms and errors [19]. Because HAM has the highest risk to cause patient harm [20]. Pharmacists are responsible for safe medication use. It is their one of the crucial roles to eliminate medication harms. This role is defined by American Society of Health System Pharmacists (ASHP) as a medication safety expert and leader [21]. Pharmacists must have enough knowledge of good practices relating to the process of prescribing, preparation, dispensing, administration, and monitoring of medications to ensure patient safety in each process [20]. The training of pharmacists must include analytic abilities and organized approach to develop and monitor patient safety [20].

In our faculty, pharmacology, analytical chemistry lectures are included in the curriculum starting from 2nd year while other lectures such as pharmaceutical technology, pharmaceutical chemistry, pharmacotherapy and toxicology lectures are included starting from 3rd year. Thus, students are expected to have certain level of knowledge in chemical and formulation perspective about HAM starting from 3rd grade. Since the study was conducted in May, it means third year students were about to complete their lectures in the year. However, such topics covered by the HAM questionnaire are not covered in clinical pharmacy lectures. Special attention must be given in clinical pharmacy lectures so that students will understand more about clinical perspective of HAM.

Most of the students who participated in the questionnaire were female. In Türkiye, the number of admissions of female pharmacy students is higher than those of male students. Thus, the participant can represent the general pharmacy student population. Fifth year students were more likely to get higher scores. It was also expected that higher year students had more internships or lectures that they could learn more about HAM. However, there were several limitations of this study. Due to the low response rate and conducting in a single center, it limited the generalizability of the findings. The non-responders and those who stopped completing the survey halfway were not recorded. Further studies are needed to investigate more on the knowledge of HAM among pharmacy students and strategies on how to improve the use of HAM to eliminate medication errors. This study can highlight the issue of poor knowledge of HAM and the necessity of place for HAM in the clinical pharmacy curriculum as well as guide other institutions to take any actions for strengthening HAM use.

In conclusion, the findings of this study highlighted the poor knowledge about HAM among pharmacy students. It is important to have high alert medication education in the clinical pharmacy curriculum. Especially in faculties where the knowledge of HAM is poor, it is crucial to educate students to reduce future medication errors and hence to promote patient safety in the future.

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AUTHOR CONTRIBUTIONS

Concept: A.S., B.O.; Design: A.S., B.O; Control: A.S., B.O; Sources: A.S., B.O; Materials: A.S.; Data Collection and/or Processing: A.S.; Analysis and/or Interpretation: A.S.; Literature Review: A.S., B.O; Manuscript Writing: A.S., B.O; Critical Review: A.S., B.O.; Other: -

CONFLICT OF INTEREST

The authors declare that there is no real, potential, or perceived conflict of interest for this article.

ETHICS COMMITTEE APPROVAL

The Ethics Committee for Human Research of Ankara University is approved the study (Date: April 26, 2021; No: 07-87).

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