

# Is Medical Schools, Curricula Content of Pharmacovigilance and Rational Pharmacotherapy-Related Subjects Sufficient for Future Physicians?

## Tıp Fakülteleri Ders Programlarında Farmakovijilans ve Akılcı Farmakoterapi ile İlişkili Konuların Kapsanması Gelecekteki Doktorlar Açısından Yeterli midir?

İD Müberra Devrim GÜNER<sup>a</sup>,  
İD Perihan Elif EKMEKCİ<sup>b</sup>

Departments of

<sup>a</sup>Medical Pharmacology,

<sup>b</sup>History of Medicine and Ethics,  
TOBB Economy and Technology  
University Faculty of Medicine,  
Ankara, TURKEY

Received: 18 Mar 2019

Accepted: 15 May 2019

Available online: 16 May 2019

Correspondence:

Müberra Devrim GÜNER  
TOBB Economy and Technology  
University Faculty of Medicine,  
Department of Medical Pharmacology,  
Ankara, TURKEY/TÜRKİYE  
devrimguner@etu.edu.tr

This study was presented as a poster at the 17<sup>th</sup>  
ISOP Annual Meeting, 14-18 October 2017  
Liverpool, United Kingdom.

**ABSTRACT** Underreporting of adverse drug reactions (ADRs) is a global problem and the main reasons for not reporting ADRs are either failure to recognize an ADR or failure to report the recognized ADR, which can be prevented by efficient education and training. Thus, the content on pharmacovigilance and related subjects in the curricula of the medical schools was evaluated. The web pages of the 63 Turkish medical schools that provided online curricula were evaluated for the following subjects: pharmacovigilance, toxicology, rational pharmacotherapy, drug use in special populations, good prescription writing principles, and clinical pharmacology stage. The number of hours dedicated to these subjects and the year of the course during which these subjects were taught were recorded. Of the 63 medical schools, 41 (65.1%) provide pharmacovigilance course and 33 (52.4%) rational pharmacotherapy course for 0.5-2 hours, mostly during the 3rd year of education. Thirty of the medical schools (47.6%) had clinical pharmacology and rational pharmacotherapy stage covering personal-drug selection, and clinical pharmacology of organ-systems was mostly a five-day course during the 4th or 5th years of education. The time allocated for pharmacovigilance and related subjects in the curricula of medical schools is not sufficient for the students to acquire satisfactory knowledge on ADR and to influence their attitudes as physicians in the future. In order to improve this, more time and effort must be allocated by medical schools to pharmacovigilance and rational pharmacotherapy education, particularly during the later years of medical education.

**Keywords:** Pharmacovigilance; pharmacology education; clinical pharmacology; rational pharmacotherapy; adverse drug reaction reporting

**ÖZET** Advers ilaç reaksiyonlarının (AİR) yeterince bildirilmemesi küresel bir sorundur ve bildirmemenin temel nedenleri AİR'lerin fark edilmemesi veya fark edilse bile bildirilmemesidir. Bu durumun üstesinden ancak yeterli eğitim ile gelinir. Tıp fakülteleri ders programlarında farmakovijilans ve ilgili konuların varlığı bu nedenle değerlendirildi. Türkiye'de bulunan tıp fakültelerinin 63'ü web sayfalarında ayrıntılı ders programlarını paylaşmaktadır. Bu ders programları şu konuların varlığı açısından incelenmiştir: farmakovijilans, toksikoloji, akılcı farmakoterapi, özel popülasyonlarda ilaç kullanımı, iyi reçete yazma kuralları, klinik farmakoloji stajı. Bu konuların hangi sınıfta öğretildiği ve ne kadar süre ayrıldığı kaydedilmiştir. İncelenen 63 tıp fakültesinden 41'i (%65,1) farmakovijilans dersini ve 33'ü (%52,4) akılcı farmakoterapi dersini 0,5-2 saat süre ile ve genellikle 3. sınıfta sunmaktadır. Otuz (%47,6) okul genellikle 4 veya 5. sınıfta beş iş günü süren klinik farmakoloji ve akılcı farmakoterapi stajı vermektedir ve bu staj sırasında kişisel ilaç seçimi, organ-sisteme özgü ilaçların klinik farmakolojisi gibi konular kapsamaktadır. Tıp fakülteleri eğitim programında farmakovijilans ve ilgili konulara ayrılan süre tıp öğrencisinin AİR ile ilgili tatmin edici düzeyde bilgi sahibi olması ve gelecekteki doktorlar olarak gerekli davranışı edinebilmeleri için yeterli değildir. Bu durumu düzeltmek için tıp eğitiminde farmakovijilans ve akılcı farmakoterapiye daha fazla zaman ve emek, özellikle tıp eğitiminin son yıllarında verilmelidir.

**Anahtar Kelimeler:** Farmakovijilans; farmakoloji eğitimi; klinik farmakoloji; akılcı ilaç tedavisi; advers ilaç reaksiyonu bildirim

Pharmacovigilance is defined by the World Health Organization (WHO) as “the science and activities relating to the detection, assessment, understanding, and prevention of adverse effects or any other drug-related problem”. Spontaneous reporting systems are essential to gather the safety information about a medical product, whether it is a

pharmaceutical medication, an herbal supplement, or a medical device. They are useful for the early detection of previously unrecognized adverse drug reactions (ADRs) and for obtaining information on the associations between drugs and ADRs. For a licensed medicinal product, post-marketing safety surveillances and spontaneous reports of healthcare professionals and consumers are the main and important sources of safety information.

However, underreporting is a global problem and the main reasons for healthcare professionals' not reporting ADRs are either failure to recognize an ADR or failure to report the recognized ADR which can be prevented by efficient education and training of the healthcare workforce on pharmacovigilance and rational pharmacotherapy.<sup>1-6</sup>

A safe pharmacotherapy is not only determined by the pharmacological properties of the medication but also by its use in actual practice. In theory, it is the goal of medical education to equip healthcare professionals with sufficient knowledge and skills that will enable them to initiate and follow safe and effective pharmacotherapy.<sup>7</sup>

ADRs, account for approximately 5% of all acute hospitalizations, half of which are preventable, making them a global healthcare problem.<sup>8-10</sup> Many regulatory authorities are taking initiatives to decrease the detrimental effects of ADR underreporting, one of which is the inclusion of pharmacovigilance and ADR reporting as courses in medical and healthcare professionals' undergraduate level education. If more effective education on pharmacotherapy and the symptoms and risk factors for ADRs can be imparted and imbibed by the healthcare students, the preventable half will decrease significantly, and by recognizing and reporting the ADRs promptly, the healthcare workforce will contribute to rational and safe pharmacotherapy.

Turkey became the 27<sup>th</sup> member of WHO Programme for International Drug Monitoring in 1987. Subsequently, pharmacovigilance activities accelerated in 2005 with the publication of the first regulation, which clearly defines that ADR reporting is the responsibility of all healthcare profes-

sionals. However, ADR reporting rate in Turkey is 2 reports per one million inhabitants per year, which is below the average of ADR reporting in similar-income countries.<sup>3,11</sup> According to the regulation, every hospital with 50 or more beds is required to employ a pharmacovigilance contact point (PCP), whose responsibilities would include, but would not be limited to, promoting pharmacovigilance activities, reporting ADRs, and providing training and education to healthcare professionals. Turkish Pharmacovigilance Center (TPC) oversees the employment of PCP, however, they do not follow the activities of PCPs, including the trainings provided to healthcare professionals in each institution. Due to scarceness of PCP-organized trainings, the knowledge of pharmacovigilance among healthcare professionals does not improve.<sup>6</sup> Previous studies indicated that limited knowledge is the main reason for rare ADR reporting by healthcare professionals.<sup>1,2,5,6,12,13</sup>

A major and important step for rational and safe prescribing can be taken through foreseeing, recognizing, managing, and reporting ADRs and integration of these competencies into several steps of the WHO Guide to Good Prescribing.<sup>14</sup> Despite this, healthcare curricula often teach little on pharmacovigilance and ADR reporting, with a median of 4-5.5 contact hours and the education is predominantly provided as lectures, rarely accompanied by interactive work or practice.<sup>15,16</sup>

This limited undergraduate education and training in pharmacovigilance is consistent with the low level of healthcare professionals' awareness of the subject and its reflection in their practices.<sup>6,12,13,17</sup> They often consider ADR reporting to be an additional activity rather than a routine practice.<sup>6</sup> The combination of educational efforts and financial incentives not only increases the number of reports of ADRs, but also the quality of reporting.<sup>18-21</sup> Providing education as a part of continuous medical education positively influences the reporting behavior as well.<sup>22</sup>

According to several studies, undergraduate healthcare students have positive attitudes on pharmacovigilance activities; students may recognize

the importance of ADR reporting and express the intention to report ADRs, however, they feel insufficiently prepared and lack adequate pharmacovigilance competencies.<sup>15,23-29</sup> Although pharmacovigilance training increases the students' knowledge and behaviour significantly in the short-term, in the long-term, the impact of the training is limited.<sup>25</sup> More and continuous education and training are needed for future healthcare providers to be competent in preventing, handling, and reporting ADRs in clinical practice.<sup>15,16</sup>

Interventions to educate students and healthcare professionals on pharmacovigilance have proven to be effective in increasing their knowledge and awareness, and their pharmacovigilance activities.<sup>17-22,25,30-37</sup> However, as these interventions are costly or fail to produce clinically relevant and long-term effects, it is essential to provide pharmacovigilance education to healthcare students at the university level, which will be more effective in improving their knowledge and skills for a safer pharmacotherapy and future use of these skills in their career.<sup>7,15,25</sup>

In 2016, a meeting organized by the Netherlands Pharmacovigilance Centre on behalf of the WHO stakeholders addressed and agreed on the pharmacovigilance competencies medical students need to have and the essential aspects of the subject that should be taught.<sup>38</sup> The five key aspects were understanding the importance of pharmacovigilance in the context of pharmacotherapy, and preventing, recognizing, managing, and reporting ADRs.<sup>38</sup> In order for the education and training to be effective in imparting these competencies and for them to be adopted in professional practice, the current status must be well defined and improvement areas regarding the structure and content of the medical education must be determined.

In November 2013, the Turkish Ministry of Health summarized the status of pharmacovigilance activities in the country and sent an internal correspondence to the Higher Education Council requesting to include pharmacovigilance training in the curricula of medical, pharmaceutical, dentistry, and nursing schools as well as vocational

schools for other healthcare services. Though it has been 5 years since this request was made, it may still be early to see a significant effect on the healthcare professionals' behavior. However, the impact of this request on the curricula of these higher education institutions may be perceivable even today.

Thus, the aim of this study is to define the content of pharmacovigilance and rational pharmacotherapy-related subjects in the curricula of Turkish medical schools, and to determine improvement areas in accordance with the global approach for pharmacovigilance competencies medical students need to have and essential aspects of the subject that should be taught.<sup>38</sup>

## MATERIAL AND METHODS

This study was conducted by evaluating the web pages of universities in Turkey that have medical schools approved by the Higher Education Council.

The study had been initially planned as a surveillance study, and pharmacology department heads and/or deans of all the 93 medical schools in Turkey were contacted via email and sent a survey. However only eight department heads or deans (including the pharmacology department of the author of this manuscript) responded. Thus, we decided to evaluate the curricula available on the websites of 93 medical schools. The evaluation was done during August-September 2018 and we verified the presence of the following 10 pharmacovigilance and rational pharmacotherapy-related courses in the curriculum-pharmacovigilance, ADR reporting, pharmacovigilance system in Turkey, legal aspects and legislations, rational pharmacotherapy, good prescription practices, drug toxicity, drug use in special populations and conditions, pharmacoeconomics, and clinical pharmacology.

Once verified, we noted the number of hours and the year of medical education in which the course is taught.

We also checked if the content of a curriculum meets the minimum requirements set by the National Core Medical Education Program (NCMEP).

Accreditation status and the number of academic personnel of each pharmacology department were also recorded.

The data gathered included the number of hours allocated for each of the aforementioned courses, the number of schools teaching the courses, and the year of medical education in which it was offered and were summarized using the descriptive statistics such as frequency, percentage, mean, and standard error of mean (SEM). The results were given with 95% confidentiality intervals (CI).

The sub-group comparisons, such as the medical school being a public or a private and being accredited or not, were done by using t-test and significance level was set to  $p < .05$ . SPSS 20.0 software (IBM, Armonk, New York) was used for all the analysis.

## RESULTS

We found that 63 (67.7%) of the 93 medical schools have a detailed curriculum online. Considering 11 of the public and 12 of the private medical schools are relatively new and no students have graduated out of them at the time of the evaluation and they have not shared their curricula; 63 schools having online curriculum out of 70 schools that graduated students, were considered sufficient to make the evaluation.

Of all the 93 medical schools in Turkey, 70 (75.3%) are part of the public universities with the median year of establishment is 1995. Thirteen public universities have 2 medical schools with the instruction language being Turkish in one and English in another.

The number of medical schools of private universities is 23 (24.7%), which are relatively new as compared to public medical schools: the median year of establishment of private medical schools is 2013.

For both of the public and private medical schools in Turkey, the duration of medical education is 6 years after high school. The first 3 years deal with basic health sciences and an introduction to clinics, the 4<sup>th</sup> and 5<sup>th</sup> years are spent on practi-

cal and theoretical training in medicine and surgery, and the students graduate after clinical clerkship in the 6<sup>th</sup> year.

Twenty-seven (29.0%) out of 93 medical schools (23 public, 4 private) were accredited by NCMEP. According to the recommendations of the NCMEP, in addition to the rational pharmacotherapy, drug use in special groups (pediatric, geriatric populations, pregnant or nursing women, patients with hepatic or renal problems), calculation of drug dosages, prevention, diagnosis, and treatment of drug side effects, identifying if it is a medical emergency, referring to a specialist, long-term follow up in primary care settings, and applying preventive measures should be taught at medical schools. "Adverse effects of drugs and drug interactions" is listed in "symptoms and clinical conditions." "Drugs' side effects" is classified as a multisystem problem. Adverse drug reaction reporting and other pharmacovigilance practices are not mentioned in the "record keeping, reporting, and communication" part of the basic medical practices defined by the NCMEP.

Only 9 (39.1%) of the 23 private schools shared their curriculum publicly and in detail. On the other hand, 54 (77.1%) of the public schools had detailed curriculum on their web sites.

Pharmacovigilance course was included in the curriculum of 41 (65.1%) of the 63 medical schools that shared their curriculum online. Generally, it was taught during the 3<sup>rd</sup> year of medical education and  $1.7 \pm 0.2$  hours were allocated (Table 1).

Only one school spent seven hours on therapeutic-group specific pharmacovigilance, such as "pharmacovigilance of cardiovascular drugs, central nervous drugs, etc.," during the 2<sup>nd</sup> year at medical school. Adverse drug reaction reporting was taught as a separate subject only by one medical school during the 2<sup>nd</sup> year of medical education for one hour.

Rational pharmacotherapy was taught by 33 (52.4%) medical schools, generally during the 3<sup>rd</sup> year of education for  $2.9 \pm 0.5$  hours. Rational antibiotic use was taught by 9 (14.3%) medical schools for  $1.4 \pm 0.1$  hours (Table 1).

**TABLE 1:** The pharmacovigilance and related courses in the online curriculum of medical schools.

Course	Total Number of				
	schools= 63	Public= 54	Private= 9	Accredited= 22	Non accredited= 41
Pharmacovigilance or adverse effects of drugs (n, %)	41 (65.1)	33.0 (61.1)	8 (88.9)	13 (59.1)	28 (68.3)
Time allocated for the course (hours±SEM)	1.7±0.2	1.7±0.3	1.6±0.3	1.5±0.2	1.7±0.4
Rational drug use or pharmacotherapy (n, %)	33 (52.4)	28 (51.9)	5 (55.6)	9 (40.9)	24 (58.5)
Time allocated for the course (hours±SEM)	2.9±0.5	3.2±0.5	1.5±0.2	3.1±0.5	2.9±0.5
Rational antibiotic use (n, %)	9 (14.3)	7 (13.0)	2 (22.2)	2 (9.1)	7 (17.1)
Time allocated for the course (hours±SEM)	1.4±0.1	1.4±0.1	1.5±0.2	1.5±0.2	1.4±0.1
Good prescription writing principles (n, %)	41 (65.1)	39 (72.2)	2 (22.2)	13 (59.1)	28 (68.3)
Time allocated for the course (hours±SEM)	1.7±0.2	1.7±0.2	2.0±0	2.3±0.4	1.4±0.1
Toxic effects of drugs and their treatment (n, %)	51 (81.0)	43 (79.6)	8 (88.9)	19 (86.4)	32 (78.0)
Time allocated for the course (hours±SEM)	2.4±0.2	2.5±0.2	1.9±0.2	2.4±0.4	2.4±0.3
Pharmacotherapy of pregnant or breastfeeding women (n, %)	24 (38.1)	21 (38.9)	3 (33.3)	10 (45.5)	14 (34.1)
Time allocated for the course (hours±SEM)	1.2±0.1	1.2±0.1	1.0±0.3	1.1±0.1	1.3±0.1
Pharmacotherapy of geriatric population (n, %)	17 (27.0)	12 (22.2)	5 (55.6)	6 (27.3)	11 (26.8)
Time allocated for the course (hours±SEM)	1.2±0.1	1.3±0.1	1.0±0.2	1.1±0.1	1.2±0.1
Pharmacotherapy of pediatric population (n, %)	10 (15.9)	7 (13.0)	3 (33.3)	2 (9.1)	8 (19.5)
Time allocated for the course (hours±SEM)	1.0±0.1	1.0±0	1.0±0.3	0.9±0.0	1.0±0.1
Schools providing clinical pharmacology course (n, %)	30 (47.6)	26 (48.1)	4 (44.4)	12 (54.5)	18 (43.9)
Time allocated for the clinical pharmacology course (Hours; mean ±SEM)	51.3±3.1	53.0±3.5	40.0±0.0	46.7±4.9	54.3±4.0

Good prescription writing principles were taught by 41 (65.1%) medical schools, during the 3<sup>rd</sup> year of education for 1.7±0.2 hours (Table 1). The subject was taught by significantly more public medical schools (n=39, 72.2%) than private ones (n=2, 22.2%; p=0.0039, 95% CI: 14.94-68.86). There were no differences between public and private schools regarding the time allocated for the subject.

The toxic effects of drugs were covered by 51 (81.0%) medical schools, mostly during the 3<sup>rd</sup> year of medical education, and 2.4±0.2 hours were allocated for the subject (Table 1). Organ-specific toxic effects (nephrotoxicity, hepatotoxicity, etc.) and drug poisoning were covered by seven medical schools, mostly during the 2<sup>nd</sup> or 3<sup>rd</sup> year of medical education.

Under the title of “pharmacotherapy for special groups”, pregnant or breastfeeding women was taught by 24 (38.1%) schools, geriatric population by 17 (27.0%), and pediatric population by 10 (15.9%) schools. Approximately 1 hour was allocated for these subjects and they were taught during the 3<sup>rd</sup> year of medical education (Table 1).

Pharmacotherapy of geriatric population was taught significantly more by private schools (n=5, 55.6%) than public schools (n=12, 22.2%; p=0.0381, 95% CI: 1.83-60.50). There were no differences between public and private schools regarding the time allocated for the subject.

Pharmacoeconomics knowledge is important for rational pharmacotherapy and selection of personal-drug. However, it was included in the curricula of only 2 (3.2%) medical schools for 1 hour and was taught during the 3<sup>rd</sup> year of education. The relationships of healthcare professional with pharmaceutical industry is another issue that may affect the rational prescription of therapeutics. Unfortunately, it was considered critical enough to be included in the curriculum by only 1 (1.6%) medical school. Similarly, subjects that included legal aspects of drug administration and prescription writing, and counterfeit drugs were each covered by only 1 (1.6%) public medical school.

Thirty of the medical schools (47.6%) had clinical pharmacology and rational pharmacotherapy stage mostly during the 5<sup>th</sup> year of medical school

and  $51.3 \pm 3.1$  hours were allocated for this course (Table 1). Subjects such as rational pharmacotherapy, personalized drug, clinical pharmacology for common chronic diseases-specific therapeutics, and good prescription writing principles were covered both theoretically and practically as part of the clinical pharmacology course.

Other than the two statistically significant differences between public and private schools regarding the number of schools teaching good prescription writing principles and pharmacotherapy of geriatric population, there were no significant differences between public vs. private, and accredited vs. non-accredited universities' medical schools with respect to the number of schools, time spent on each subject, and the year of education in which the subject was taught (Table 1).

The number of academic personnel in pharmacology departments was significantly different between public and private medical schools. The mean  $\pm$  SEM of academic personnel employed in the pharmacology departments of public and private medical schools was  $3.40 \pm 2.96$  and  $1.61 \pm 0.29$ , respectively ( $p < 0.01$ ; 95% CI:  $-3.06 - -0.52$ ). There was also a statistically significant difference between accredited and non-accredited medical schools in terms of academic personnel in pharmacology departments ( $5.7 \pm 0.2$  vs.  $2.2 \pm 0.6$ , respectively;  $p < 0.01$ ; 95% CI:  $2.41 - 4.45$ ). Since there are no differences regarding the subjects taught, the number of personnel does not seem to have relevance regarding the content of pharmacovigilance and rational pharmacotherapy related subjects.

Based on the limited number (8) of survey answers we received, none of the programs is fully compatible with the five key aspects of pharmacovigilance training as defined by van Eekeren R et al. Although all stated having at least one-hour of theoretical pharmacovigilance and rational pharmacotherapy courses during the 3<sup>rd</sup> year of education and covering theoretical aspects of the side effects of medications, 2 stated that they provide information on how to report ADRs and practice reporting.<sup>38</sup> Moreover, 6 stated that they were not able to provide a clinical pharmacology stage due to the lack of human resources. However, all of them stated

their awareness of the importance of a more effective training and the willingness to join a study group that will work on improving their curricula.

## DISCUSSION

Globally, most pharmacology education in medical schools is imparted during the early years of the medical school curricula, initiated by an introduction to the basic principles of pharmacodynamics and pharmacokinetics, and followed by system-specific pharmacology that is often integrated into system-based clinics and pathophysiology. Some of the medical schools offer clinical pharmacology course during the later years of education, and mostly as an elective course.<sup>27,39,40</sup> The information about global undergraduate pharmacovigilance education is limited; it has been reported that the time allocated for this education has a median of 4–5.5 contact hours, predominantly provided as lectures.<sup>15</sup> Our findings are somewhat in accordance with the information about the pharmacovigilance education provided globally, however, the time spent for this training in Turkish medical schools seems to be less than the duration reported by Hartman et al.<sup>15</sup>

Spontaneous reporting of ADRs is critical not only for individual patients, but also for ethical, socioeconomic, and public health-related reasons. Further, it is essential for improving knowledge of therapeutics. Since the course of pharmacovigilance or adverse effects of drugs was given in 49 (79.0%) of medical schools for less than two hours, pharmacovigilance education and training may not be sufficient to adopt good pharmacovigilance practices by future physicians, even though they are willing to participate in the pharmacovigilance activities.<sup>15,23,24,26-29</sup>

According to another study, current health-care workforce stated they had received none or only limited pharmacovigilance training during their education.<sup>6</sup> The research on pharmacovigilance training in Turkey is far too limited to shed light on the causes of the existing problem.<sup>15</sup> Although side effects of medications are taught during pharmacology lectures and/or clinical courses, the lack of formal pharmacovigilance and rational

pharmacotherapy courses in the existing medical education programs is the main reason of the insufficient proficiency in pharmacovigilance skills and the lack of knowledge among medical doctors. This can only be improved by modifying the medical school curriculum to include pharmacovigilance and rational pharmacotherapy education, both in theory and practice. Moreover, targeting future healthcare professionals during their undergraduate studies has the advantages of education being a part of their daily activities and the main function at their current life stage, acquiring professional skills to perform their job in the future being their goal, and their eagerness to acquire these skills, being in an academic environment where the activities of learning, teaching, and thinking are the main functions.

The pharmacovigilance education cannot be separated from the general medical pharmacology education. After finding that nearly half of the electronic prescription forms are inappropriately filled by final year medical students and more than half of them contained at least one error, Brinkman et al. evaluated the pharmacology education status with a survey sent to 185 medical schools of 27 EU countries.<sup>40,41</sup> According to this survey, a median of 68-hour compulsory course in clinical pharmacology was offered by 78% of the medical schools.<sup>41</sup> Dosing knowledge and drug calculation skills of the students were assessed by 35% and 38% of the schools, respectively.<sup>41</sup> In contrast to the rest of the students, the majority of the final year students were well prepared to write prescriptions.<sup>41</sup> Based on these findings, Brinkman et al. suggested key learning outcomes for clinical pharmacology and therapeutics education as an attempt to harmonize this education in Europe.<sup>42</sup>

In Turkey, the NCMEP was first published in 2002 and was updated in 2014 in order to harmonize, standardize, and improve the quality of medical education. The NCMEP receives suggestions and requests from all stakeholders in medical education and determines the courses that every medical education program must include. One of the criteria for medical school accreditation is having a

curriculum that meets the minimum requirements set by the NCMEP. Medical schools are required to set their curricula at least 70% in accordance with the core program. However, the program does not specifically suggest any competencies related to pharmacovigilance activities. Although there is an item titled “record keeping, reporting, and notification,” ADR reporting was not specifically suggested as an essential part of medical education by the program. Since “reporting an ADR” is defined as the “responsibility of all healthcare professionals” by a national pharmacovigilance regulation, we suggest that the next update of the NCMEP include a comprehensive handling of ADR and pharmacovigilance practices.

The results of the present study strongly suggest that improvement is needed in the areas of pharmacovigilance activities, rational pharmacotherapy, and prescription practices. Complementing theoretical training with clinical practice seems to be the most effective method that will result in behavioral change in the direction of a more rational pharmacotherapy, increase awareness of and skills to handle ADRs, and in turn decrease the ADR underreporting. Although not particularly meant for undergraduate medical education, the pharmacovigilance curriculum described by Beckman et al. and the WHO pharmacovigilance core curriculum for undergraduate medical education presented by van Eekeren et al. can be a starting point to define the basics of pharmacovigilance training and can be used to develop a program for undergraduate education of healthcare professionals.<sup>38,43</sup>

This program should focus on the 5 essential aspects of pharmacovigilance education as defined by van Eekeren et al.<sup>38</sup>

1. Understanding the importance of pharmacovigilance in the context of pharmacotherapy, with regard to influence on patients' quality of life, compliance, and satisfaction and the success and efficiency of healthcare system.

2. Preventing ADRs as much as possible with correct, safe, and rational prescribing for each individual patient. In addition to theoretical knowl-

edge of diseases and medications, a medical student also needs to learn to interpret information and perform risk evaluation by considering all the circumstances and facts that may contribute to the occurrence of ADRs.

3. Recognizing ADRs when they occur; ADRs are sometimes very hard to distinguish from the symptoms and signs of a disease, thus extensive knowledge of clinical pharmacological principles of ADRs is required to achieve this skill.

4. Management of ADRs should be done by considering several facts such as the range of their effects, from causing minimal disturbance to being life-threatening or even fatal, the compliance to therapy, and patient-physician relationships. Individualization of ADR treatment and informing all the related parties is essential during this management.

5. Reporting ADRs; many regulatory authorities mandate ADR reporting for all healthcare professionals. Thus it is essential for a medical doctor not only to have the skills and knowledge of pharmacovigilance and rational pharmacotherapy but also report an ADR in a timely and accurate manner to all the relevant parties. Considering the impact of pharmacovigilance activities on public health and health economy, the activity of reporting must be adopted as a part of routine practice, which can be achieved through extensive training on the subject.

The main law of medical ethics “first, do no harm” should also be the focus of the pharmacovigilance education program. This approach placing the safety of the patient first and arranging practice and activities accordingly will aid in decreasing drug induced harm in patients through integration of the five key aspects of pharmacovigilance education in the curriculum.<sup>38</sup>

A committee can be formed under higher education council with representatives of medical schools, students’ associations, medical associations, regulatory authorities, and maybe patient groups, to develop an extensive yet practical curriculum. Although the ethical and professional responsibil-

ity of prescribers are primarily to their patients and society, the inputs of other beneficiaries of the services of medical school graduates, such as national and global pharmacovigilance systems and pharmaceutical industry, which will use this information to improve the safety of medications, may also be consulted. This will improve the quality and practicality of pharmacovigilance education. Considering the duration of medical education, the substantial effects of such interventions will not be seen for the next 5 to 10 years; thus these interventions should be planned and put into practice as soon as possible.

## CONCLUSION

In conclusion, in order to improve the pharmacovigilance and rational pharmacotherapy knowledge and skills of future medical doctors, we urgently need to initiate a more comprehensive pharmacovigilance and rational pharmacotherapy education at undergraduate level. If medical students and medical doctors are adequately equipped with the necessary knowledge and know-how to apply the knowledge, two positive effects can be expected simultaneously: One is a decrease in the ADR directly due to rational pharmacotherapy and good prescription practices and the other is an increase in the level of awareness or alertness of possible ADR and decrease the underreporting if ADR happens.

### Acknowledgment

*The authors wish to thank Dr. Selda Emre Aydingoz for her meticulous review and editing of the manuscript. (Abstract no: 33 Pharmacovigilance and rational drug use content in pharmacology education in medical schools in Turkey. Drug Saf. 2017;40(10):950).*

### Source of Finance

*During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.*

### Conflict of Interest

*No conflicts of interest between the authors and / or family members of the scientific and medical committee members or*



members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

### Authorship Contributions

All authors contributed equally while this study preparing.

## REFERENCES

- Inman WH. Attitudes to adverse drug reaction reporting. *Br J Clin Pharmacol.* 1996;41(5): 434-5. [PubMed]
- Hazell L, Shakir SA. Under-reporting of adverse drug reactions: a systematic review. *Drug Saf.* 2006;29(5):385-96. [Crossref] [PubMed]
- Aagaard L, Strandell J, Melskens L, Petersen PS, Holme Hansen E. Global patterns of adverse drug reactions over a decade: analyses of spontaneous reports to VigiBase™. *Drug Saf.* 2012;35(12):1171-82. [Crossref] [PubMed]
- Dal Pan GJ. Ongoing challenges in pharmacovigilance. *Drug Saf.* 2014;37(1):1-8. [Crossref] [PubMed]
- Hohl CM, Small SS, Peddie D, Badke K, Bailey C, Balka E. Why clinicians don't report adverse drug events: qualitative study. *JMIR Public Health Surveill.* 2018;4(1):e21. [Crossref] [PubMed] [PMC]
- Güner MD, Ekmekci PE. Healthcare professionals' pharmacovigilance knowledge and adverse drug reaction reporting behavior and factors determining the reporting rates. *J Drug Assess.* 2019;8(1):13-20. [Crossref] [PubMed] [PMC]
- Kaeding M, Schmälter J, Klika C. Pharmacovigilance in the European Union. *Practical Implementation Across Member States.* New York: Springer; 2017. p.124. [Crossref]
- Pirmohamed M, James S, Meakin S, Green C, Scott AK, Walley TJ, et al. Adverse drug reactions as cause of admission to hospital: prospective analysis of 18820 patients. *BMJ.* 2004;329(7456):15-9. [Crossref] [PubMed] [PMC]
- Leendertse AJ, Egberts AC, Stoker LJ, van den Bemt PM; HARM Study Group. Frequency of and risk factors for preventable medication related hospital admissions in The Netherlands. *Arch Intern Med.* 2008;168(17):1890-6. [PubMed]
- Angamo MT, Chalmers L, Curtain CM, Bereznicki LR. Adverse drug reaction related hospitalisations in developed and developing countries: a review of prevalence and contributing factors. *Drug Saf.* 2016;39(9):847-57. [Crossref] [PubMed]
- Ozcan G, Aykac E, Kasap Y, Nemutlu NT, Sen E, Aydinkarahaliloglu ND. Adverse drug reaction reporting pattern in Turkey: analysis of the national database in the context of the first pharmacovigilance legislation. *Drugs Real World Outcomes.* 2016;3(1):33-43. [Crossref] [PubMed] [PMC]
- Gonzalez-Gonzalez C, Lopez-Gonzalez E, Herdeiro MT, Figueiras A. Strategies to improve adverse drug reaction reporting: a critical and systematic review. *Drug Saf.* 2013;36(5):317-28. [Crossref] [PubMed]
- Lopez-Gonzalez E, Herdeiro MT, Figueiras A. Determinants of under-reporting of adverse drug reactions: a systematic review. *Drug Saf.* 2009;32(1):19-31. [Crossref] [PubMed]
- de Vries TPGM, Henning RH, Hogerzeil HV, Fresle DA. *Guide to good prescribing-a practical manual.* Geneva: World Health Organization Action Programme on Essential Drugs; 1994. p.123.
- Hartman J, Härmark L, van Puijenbroek E. A global view of undergraduate education in pharmacovigilance. *Eur J Clin Pharmacol.* 2017;73(7):891-9. [Crossref] [PubMed]
- Reumerman M, Tichelaar J, Piersma B, Richir MC, van Agtmael MA. Urgent need to modernize pharmacovigilance education in healthcare curricula: review of the literature. *Eur J Clin Pharmacol.* 2018;74(10):1235-48. [Crossref] [PubMed] [PMC]
- Pagotto C, Varallo F, Mastroianni P. Impact of educational interventions on adverse drug events reporting. *Int J Technol Assess Health Care.* 2013;29(4):410-7. [Crossref] [PubMed]
- Pedrós C, Vallano A, Cereza G, Mendoza-Aran G, Agustí A, Aguilera C, et al. An intervention to improve spontaneous adverse drug reaction reporting by hospital physicians: a time series analysis in Spain. *Drug Saf.* 2009;32(1):77-83. [Crossref] [PubMed]
- Figueiras A, Herdeiro MT, Polónia J, Gestal-Otero JJ. An educational intervention to improve physician reporting of adverse drug reactions: a cluster-randomized controlled trial. *JAMA.* 2006;296(9):1086-93. [Crossref] [PubMed]
- Herdeiro MT, Polónia J, Gestal-Otero JJ, Figueiras A. Improving the reporting of adverse drug reactions: a cluster-randomized trial among pharmacists in Portugal. *Drug Saf.* 2008;31(4):335-44. [Crossref] [PubMed]
- Herdeiro MT, Ribeiro-Vaz I, Ferreira M, Polónia J, Falcão A, Figueiras A. Workshop-and telephone-based interventions to improve adverse drug reaction reporting: a cluster-randomized trial in Portugal. *Drug Saf.* 2012;35(8):655-65. [Crossref] [PubMed]
- Gerritsen R, Faddegon H, Dijkers F, van Grootheest K, van Puijenbroek E. Effectiveness of pharmacovigilance training of general practitioners: a retrospective cohort study in the Netherlands comparing two methods. *Drug Saf.* 2011;34(9):755-62. [Crossref] [PubMed]
- Elkalmi RM, Hassali MA, Ibrahim MI, Widodo RT, Efan QM, Hadi MA. Pharmacy student's knowledge and perceptions about pharmacovigilance in Malaysian public universities. *Am J Pharm Educ.* 2011;75(5):96. [Crossref] [PubMed] [PMC]
- Maxwell SR. How should teaching of undergraduates in clinical pharmacology and therapeutics be delivered and assessed? *Br J Clin Pharmacol.* 2012;73(6):893-9. [Crossref] [PubMed] [PMC]
- Arici MA, Gelal A, Demiral Y, Tuncok Y. Short and long-term impact of pharmacovigilance training on the pharmacovigilance knowledge of medical students. *Indian J Pharmacol.* 2015;47(4):436-9. [Crossref] [PubMed] [PMC]
- Umair Khan M, Ahmad A, Ejaz A, Ata Rizvi S, Sardar A, Hussain K, et al. Comparison of the knowledge, attitudes and perception of barriers regarding adverse drug reaction reporting between pharmacy and medical students in Pakistan. *J Educ Eval Health Prof.* 2015;12:28. [Crossref] [PubMed] [PMC]
- Abubakar AR, Haque M. Pharmacovigilance practice: the current challenges and the gaps in the medical students' curriculum. *J App Pharm Sci.* 2016;6(5):210-5. [Crossref]
- Othman GQ, Ibrahim MIM, Alshakka M, Ansari M, Al-Qadasi F, Halboup AM. Knowledge and perception about pharmacovigilance among pharmacy students of universities in Sana'a's Yemen. *J Clin Diagn Res.* 2017;11(6):FC09-13. [Crossref] [PubMed] [PMC]
- Schutte T, Tichelaar J, Reumerman MO, van Eekeren R, Rissmann R, Kramers C, et al; Education Committee/Working Group Research in Education of the Dutch Society of Clinical Pharmacology and Biopharmacy (NVKF&B), Utrecht, The Netherlands. Pharmacovigilance skills, knowledge and attitudes in our future doctors-a nationwide study in the Netherlands. *Basic Clin Pharmacol Toxicol.* 2017;120(5):475-81. [Crossref] [PubMed]

30. Durrieu G, Hurault C, Damase-Michel C, Montastruc JL. Perception of risk of adverse drug reactions: a 3-year follow-up of a cohort of medical students. *Fundam Clin Pharmacol*. 2010;24(4):423-7. [[Crossref](#)] [[PubMed](#)]
31. Tripathi RK, Jalgaonkar SV, Sarkate PV, Rege NN. Implementation of a module to promote competency in adverse drug reaction reporting in undergraduate medical students. *Indian J Pharmacol*. 2016;48(Suppl 1):S69-73. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
32. King M, Khan S. The development and piloting of "ATTEND DR," a clinical teaching tool to identify and prioritize potential causes of adverse drug reactions. *Curr Pharm Teach Learn*. 2017;9(1):66-71. [[Crossref](#)] [[PubMed](#)]
33. Patel PB, Patel TK, Anturlikar S, Khatun S, Bhabhor P, Saurabh MK. Adverse drug reactions reporting by undergraduate medical students in a tertiary care teaching hospital of India: content and quality analysis in comparison to physician reporting. *Perspect Clin Res*. 2017;8(3):137-44. [[PubMed](#)]
34. Bracchi RC, Houghton J, Woods FJ, Thomas S, Smail SA, Routledge PA. A distance-learning programme in pharmacovigilance linked to educational credits is associated with improved reporting of suspected adverse drug reactions via the UK yellow card scheme. *Br J Clin Pharmacol*. 2005;60(2):221-3. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
35. Johansson-Pajala RM, Martin L, Fastbom J, Jorsäter Blomgren K. Nurses' self-reported medication competence in relation to their pharmacovigilant activities in clinical practice. *J Eval Clin Pract*. 2015;21(1):145-52. [[Crossref](#)] [[PubMed](#)]
36. Ribeiro-Vaz I, Santos CC, Cruz-Correia R. Promoting adverse drug reaction reporting: comparison of different approaches. *Rev Saude Publica*. 2016;50:14. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
37. Ribeiro-Vaz I, Herdeiro MT, Polónia J, Figueiras A. Strategies to increase the sensitivity of pharmacovigilance in Portugal. *Rev Saude Publica*. 2011;45(1):129-35. [[Crossref](#)] [[PubMed](#)]
38. van Eekeren R, Rolles L, Koster AS, Magro L, Parthasarathi G, Al Ramimmy H, et al. What future healthcare professionals need to know about pharmacovigilance: introduction of the WHO PV core curriculum for university teaching with focus on clinical aspects. *Drug Saf*. 2018;41(11):1003-11. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
39. Ross S, Maxwell S. Prescribing and the core curriculum for tomorrow's doctors: BPS curriculum in clinical pharmacology and prescribing for medical students. *Br J Clin Pharmacol*. 2012;74(4):644-61. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
40. Brinkman DJ, Tichelaar J, Okorie M, Bissell L, Christiaens T, Likic R, et al; Education Working Group of the European Association for Clinical Pharmacology and Therapeutics (EACPT). Pharmacology and Therapeutics Education in the European Union Needs Harmonization and Modernization: a cross-sectional survey among 185 medical schools in 27 countries. *Clin Pharmacol Ther*. 2017;102(5):815-22. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
41. Brinkman DJ, Tichelaar J, Schutte T, Benemei S, Böttiger Y, Chamontin B, et al; Working Group Research on CPT Education of the European Association for Clinical Pharmacology and Therapeutics (EACPT). Essential competencies in prescribing: a first European cross-sectional study among 895 final-year medical students. *Clin Pharmacol Ther*. 2017;101(2):281-9. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
42. Brinkman DJ, Tichelaar J, Mookink LB, Christiaens T, Likic R, Maciulaitis R, et al; Education Working Group of the European Association for Clinical Pharmacology and Therapeutics (EACPT) and its affiliated Network of Teachers in Pharmacotherapy (NOTIP). Key learning outcomes for clinical pharmacology and therapeutics education in Europe: a modified Delphi study. *Clin Pharmacol Ther*. 2018;104(2):317-25. [[Crossref](#)] [[PubMed](#)] [[PMC](#)]
43. Beckmann J, Hagemann U, Bahri P, Bate A, Boyd IW, Dal Pan GJ, et al. Teaching pharmacovigilance: the WHO-ISoP core elements of a comprehensive modular curriculum. *Drug Saf*. 2014;37(10):743-59. [[Crossref](#)] [[PubMed](#)]