DOI: https://doi.org/10.17921/2447-8938.2021v23n4p316-322

Medication Errors in Compounding Pharmacy

Erros de Medicação em Farmácia de Manipulação

Silésia Helena Barboteu Martins de Amorim[a]; Luis Phillipe Nagem Lopes[b]; Vanessa Brandão de Souza Belmiro[c]; Márcia Maria Barros dos Passos[d]; Mariana Sato de Souza de Bustamante Monteiro[a]; Eduardo Ricci Junior[c]; Elisabete Pereira dos Santos[a]; Zaida Maria Faria de Freitas*[c]

[a]Universidade Federal do Rio de Janeiro, Faculty of Pharmacy. RJ, Brazil.
[b]Universidade Federal do Rio de Janeiro, Pharmacy Course. RJ, Brazil.
[c]Universidade Federal do Rio de Janeiro, Faculty of Pharmacy, Stricto Sensu Graduate Program in Pharmaceutical Science and Technology. RJ, Brazil.
[d]Universidade Federal do Rio de Janeiro, Hospital Pharmacy and Pharmacovigilance. RJ, Brazil.
*E-mail: zaida@pharma.ufrj.br.

Abstract

The traditional role of compounding pharmacies is to make drugs prescribed by physicians for patients with needs that cannot be met by commercially available drugs. Medication errors have attracted attention of health authorities since they compromise the patient's assistance, enhance morbidity rates and increase the healthcare costs. This study analyzed medication errors that occurred in a compounding pharmacy school in order to identify types and periodicity and to outline strategies in the service delivery process to mitigate such errors. This is a retrospective descriptive study carried out from March to June of 2018 and based on the analysis of occurrences recorded by the service sector of a magistral pharmacy school in Rio de Janeiro. The errors were classified according to the stage in the pharmaceutical assistance process and reached 124 records, with an average of 1.03 occurrence/day. The main causes were prescription errors (95 occurrences or 76.60%), administering (12 occurrences or 9.68%), labeling (7 occurrences or 5.65%), dispensing (7 occurrences or 5.65%) and handling (3 occurrences or 2.42%). The errors in the prescription stage, the most frequent ones, were potential but intercepted and cleared before they resulted in a harmful outcome. This study identified medication errors in a magistral pharmacy. The errors were potential but intercepted and resolved before they resulted in a harmful outcome. The results points to the need for systematic surveillance of adverse events in a more active way and for standardizing the procedures throughout the process, from assessing the medical prescription to guiding the patient for proper administration and storage.

Keywords: Pharmaceutical Preparations. Risk Management. Pharmacovigilance. Pharmacoepidemiology.

Resumo

O papel tradicional das farmácias de manipulação é manipular medicamentos prescritos por médicos para pacientes com necessidades que não podem ser atendidas pelos medicamentos disponíveis no mercado. Os erros de medicação são eventos que vêm recebendo grande destaque entre autoridades sanitárias por contribuírem com o aumento das taxas de morbidade e dos custos do sistema de saúde, comprometendo a qualidade da assistência prestada ao paciente. as it involves legal and ethical aspects of impact on professional practice. Errors in the administration of medications point out the responsibility of the nursing category. An adequate performance of this role enables the prevention of real errors. The purpose of this study was to analyze nursing responsibilities in the administration of medications through a bibliographical research in the Medline and Lilacs data bases (1997/1999O presente estudo teve por objetivo analisar os principais erros de medicação observados em uma Farmácia Escola magistral localizada no sudeste do Brasil. Foi desenvolvido um estudo descritivo retrospectivo no período de março a junho de 2018, baseado na análise das ocorrências de erros de medicação registradas no período. Os erros foram classificados de acordo com as etapas da assistência farmacêutica. Um total de 124 registros foram verificados no período, com média diária de 1,03 ocorrências/dia. As principais causas destes registros foram em 95 (76,60%) devido a erros de prescrição, 3 (2,42%) referentes à erros de manipulação dos medicamentos, 7 (5,65%) erros de rotulagem, 7 (5,65%) erros de dispensação, e 12 (9,68%) referentes à erros de administração do medicamento pelo paciente. Os erros de maior frequência foram relacionados à escrituração da prescrição. Os erros verificados eram potenciais e foram interceptados e resolvidos antes que resultassem em um desfecho danoso. Os resultados indicaram a necessidade de avançar para uma vigilância sistemática de eventos adversos de forma mais ativa e padronização das condutas relacionadas aos processos desde a avaliação da qualidade da prescrição até a orientação para administração e guarda adequada do medicamento pelo paciente.

Palavras-chave: *Preparações Farmacêuticas. Gestão de Riscos. Farmacovigilância. Farmacoepidemiologia.*

1 Introduction

The traditional role of compounding pharmacies is to make drugs prescribed by physicians for patients with needs that cannot be met by commercially available drugs[1]. The preparation of compounded drugs comes through pharmacotechnical operations, aiming at the production of magistral, officinal drugs as well as the partition of pharmaceutical specialties for human use[2].

Compounding pharmacies currently represent a market of approximately 7,000 pharmaceutical establishments and have a major impact on the social health. The regulation is carried out by the National Health Surveillance Agency, that establishes the minimum requirements to compound medicines for human use, ensuring their quality, safety, effectiveness and

promoting their safe and rational use[2].

According to good handling practices, several procedures, such as recording all stages of the process, are necessary to guarantee the full traceability and mitigate adverse events or quality deviations related to the compounded drugs[2].

Pharmacovigilance in the pharmacy school must consider all the activities that might cause medication errors, from the issue identification, assessment or understanding to the prevention of adverse events, using systematic surveillance[2]. Adverse events are any damage or injury caused to the patient by the medical intervention through medications, and may come from unintentional acts[3]. In this context, medication errors, in theory, may refer to the mistaken patient, the wrong medication, the wrong galenic formulation, the wrong dosage or administration route[3]. Medication errors are frequent but fortunately only a small proportion results in some damage[4].

They are events that have attracted great attention among health authorities in Brazil since they compromise the patient's assistance and increase the morbidity rates and the healthcare costs.

The definition of medication error includes any preventable event that can lead to the inappropriate use of a medication and that may cause harm to the patient [5]. Thus, medication errors with potential damage are called potential adverse events; these errors can be intercepted before they reach the patient, or reach the patient without consequence. Therefore, a medication error is considered a preventable adverse event[3].

A systematic review work with meta-analysis including 60 studies from different countries found a variation in prevalence from 2% to 94% of medication errors related to professional practice, health products, procedures and systems, including prescription, order communication, labeling, packaging and product nomenclature, handling, distribution, administration, education, monitoring and use[7].

The sources of errors are multifactorial and have many lines of responsibility, running through all health professionals and the patient as well[8]. An instrument that has been used as a basis for studying the causes of medication errors in some countries was developed by the National Coordinating Council for Medications Error Reporting and Prevention (NCCMERP)[5]. This document contains a taxonomic classification of medication errors, which helps to assess, classify and correct such failures[5].

The analysis of medication errors and their causes are fundamental to implement safety protocols for prevention, reduction and the protection of all involved[9]. The fastest and most effective methods for generating alerts or hypotheses of error causality are direct clinical observation and notification. They also assist in the design of specific studies of active pharmacovigilance towards the identification of safety profiles of drugs for the general public or even specific subpopulations[10].

There are few studies in the scientific literature for the hospital environment in developed countries. However, this work addresses the profile of medication errors in a pharmacy school for the lack of studies in this environment. It surely is a potential observatory of these events since all stages of the medicine cycle, except for administration, are present there. This study analyzed medication errors that occurred in a compounding pharmacy school in order to identify types and periodicity and to outline strategies in the service delivery process to mitigate such errors.

2 Material and Methods

This is a retrospective, descriptive and exploratory study carried out from March to June of 2018 and based on the analysis of occurrences recorded by the service sector of a magistral pharmacy school in Rio de Janeiro.

Magistral pharmacy school in Rio de Janeiro is a health establishment integrated to a public university in Rio de Janeiro. It assists an average of 300 patients/day, mainly from the public health system, and was first intended to provide medicines at affordable prices to the general public. Nowadays, it also contributes with teaching, research and extension in the scope of magistral and officinal medicines preparation.

An occurrence book was implemented at the service sector for remarks during the work process. The sample comprised records from March to June 2018 and were made by magistral pharmacy school in Rio de Janeiro monitors, who work daily in the dispensing sector under the supervision of pharmacist tutors or our team researchers.

The data were transferred to an electronic database and analysed according to a corresponding matrix previously prepared. The content was initially classified into six categories of analysis, stated according to the theoretical framework on medication error: (I) prescription errors; (II) administration errors committed by the patient; (III) dispensing errors; (IV) labeling errors; and (V) handling errors.

The prescription error is defined as an unintentional decision or writing error (compared to the established clinical practices) which can reduce the treatment effectiveness or increase the risk of harm to the patient. It is in disagreement with the Brazilian health regulations (Law 5991/73), as follows: lack of information, erasure, illegibility, misspelling and incompleteness of the patient's partial name, doctor's partial name, partial drug identification, dose, pharmaceutical form, dosage, duration of treatment, date of prescription, signature or stamp, as well as incorrect description of the drug, whether in the dose, concentrations, route of administration, quantity or recommendation[11].

Handling errors took place during the drug preparation process and involved pharmaceutical calculations, including the separation of assets, weighing, handling, the choice of packaging, and product filling[5].

Divergences between the order written in the medical

prescription and the service were considered dispensing errors, i.e. dispensing a dose different from that prescribed, dispensing a wrong pharmaceutical form, or dispensing a different container size than that stated in the medical prescription[5].

The divergences between the way of using the drug therapy performed by the patient/caregiver and that recommended by the prescriber regarding the administration of the drug or dose, dosage form, dosage or correct route of administration were defined as administration errors [5].

The analysis was categorized according to the type of medication errors, i.e. prescription errors, dispensing errors, administration errors as well as handling errors for it is a magistral pharmacy.

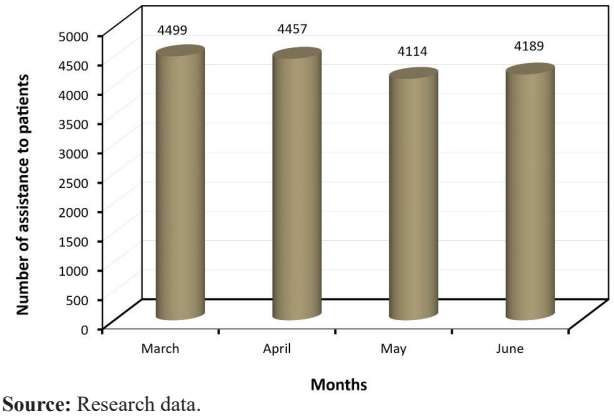
Microsoft Office Excel 2010® statistical program was used for data analysis. The absolute and relative periodicities were calculated for all types of prescription errors.

The data usage was previously authorized by the Institution's general management and are exempt from the CEP/CONEP system evaluation (HUCFF-UFRJ- 1.636.337). According to the CNS Resolution 510/2016, a study that aims at the theoretical deepening of cases that emerge spontaneously and contingently in professional practice do not need to be evaluated by that Committee, as long as they do not reveal data that can identify the subject. Thus, the present work obtained the data registered in the occurrence book, which are presented in an aggregated form, maintaining total confidentiality and secrecy of the subjects who described the reports.

3 Results and Discussion

From March to June of 2018, there were 124 records of medication errors in 17,259 visits, a range of 4,114 - 4,499, an average of 4,314.75 and a standard deviation of 211.20, as described in Figure 1. The rate of occurrence in the period was 0.7%.

Figure 1 - Distribution of attendance frequency from March to June 2018



Source: Research data.

Within the reasons for errors, 95 occurrences or 76.60% were related to prescription, 12 occurrences or 9.68% for administration, 7 occurrences or 5.65% for labeling, 7 occurrences or 5.65% for dispensing, and 3 occurrences or 2.42% for handling, as described in Table 1. Table 1 describes the frequency distribution of the number of occurrences of medical errors in the period from March to June 2018.

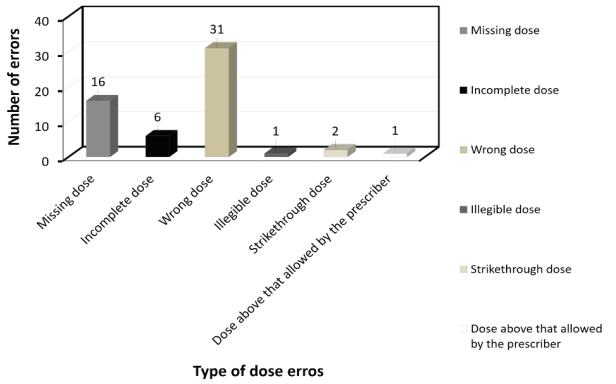
Table 1 - Frequency distribution of Medication Errors in the period according to theoretical framework

Variable	Description	Quantity	%
Prescription	Dose-related error	57	76.6%
	Erasure in the name of the medicine	3	
	Erasure in dosage	2	
	Erasure on date	2	
	Wrong medication administration schedule	3	
	Absence of the patient's name	8	
	Absence of stamp and / or signature	4	
	Shaky signature	1	
	Wrong drug name	2	
	Abbreviated drug name	3	
	Wrong Drug Name	1	
	Two patients in the same prescription	1	
	Ambiguity of treatments	3	
	Illegible prescription	2	
	Incomplete formulation	2	
	Pharmacotechnical incompatibility	1	
Dispensing	Drug exchange caused by namesake	1	5.65%
	Changing patients whose medication was the same	1	
	Misguided patient	2	
	Pharmaceutical form other than that prescribed	1	
	Ineffective label, receipt and prescription check	2	
Administration	Higher dose intake than prescribed	3	9.68%
	Mix vitamin D in water	3	
	Mix vitamin D and calcium powder in water	2	
	Dripping vitamin D directly into the mouth	2	
	Dripping vitamin D onto the hand	1	
	Lower dose intake than prescribed	1	
Handling	Batch loss after wrong weighing of active ingredient	1	2.42%
	Medicament with inadequate viscosity	1	
	Interaction between active ingredient and packaging causing change in drug properties	1	
Labeling	Wrong label due to packaging similarity	5	5.65%
	Label with wrong amount of medication	2	
Total	**-**	**124**	**100%**

Fonte: the authors.

Figure 2 shows the dose errors (57), since they were more prominent among the prescription errors and constituted the most frequent medication errors.

Figure 2 - Distribution of prescription errors regarding dose



Source: Research data.

There was a 0.7% rate of medication errors within the data herein, a very low rate compared to other studies described in the literature. However, a recent meta-analysis study found a prevalence rate from 2% to 94% of medication errors in the set of studies observed[6]. There was a large discrepancy in the prevalence rates of medication errors among those studies, which was explained by the different detection approaches, mainly for the different methods to determine the numerators (number of medication errors) and their denominators (sample where the medication errors are entered), making it difficult to compare rates among different studies[3]. Herein the medication error index was obtained by dividing the frequency of medication errors (numerator) by the number of visits in the period (denominator) - in other words, the number of occurrences divided by the number of opportunities for occurrences.

The data have shown a high prevalence of errors related to prescriptions (76.60%), likewise international[12-14] and national[12,14-16] studies. Indeed, a recent systematic review work, which included 60 studies from different countries, found a prevalence of 77%[6]. In Brazil, numerous studies point out prescription errors of various kinds, including illegibility, lack of drug description or usage, and lack of information about the user or the prescriber[14].

Medical prescriptions play an important role in the prevention of failures. Thus, they should be clear, legible and complete and avoid abbreviations. However, the absence of a terminology standardisation in Brazil is a concern.

Most of the prescription errors were related to writing, such as erasures, abbreviations or incomplete information. Among them, errors related to the dose stood out, especially those in disagreement with the scientific literature for their higher or lower concentration of the drug. Such an error is serious since it jeopardises the pharmaceutical manufacturing and the use of the medication by the patient. In this context, it is necessary to contact the prescriber to clarify doubts and facilitate handling with due safety.

The data herein are in agreement with those already published in the literature, and point out prescription errors as the major contributors to the occurrence of medication errors. Koper[17] evaluated the frequency of medication errors in primary care patients. They found that 44% of prescriptions were overdosing or under-dosing the drug. In this context, the correct writing is essential for the drug therapy effectiveness, as it can interfere with the drug acquisition, its preparation and administration[18].

In regard to compounded medications, the risk is much greater, since manufacturing a medication with a very high dose of the drug can lead to intoxication or even to death. Countless studies have demonstrated drug overdosing with a narrow therapeutic window, for example, Clonidine[19], 4 Amino-pyrine[20] and Hydrocortisone[21] with death outcome. In Brazil, casualties related to the misuse of Clonidine, Colchicine and Flutamide in compounded medications were reported to the Health Surveillance Agency, which published the Resolution 1621 in 2003 and the Public health alert 7 in 2004, as a result.

To define the concentration of a drug, the use of zero before the comma (BR) or decimal point (UK) should be avoided, as it can cause confusion and 10 times greater dose[22]. Thus, a metric system should be adopted with a clearly indicated unit of measurement. When prescribing volumes with fractional numbers, it is important to observe whether the comma (or decimal point) is well positioned and clear[22].

The second most observed prescription error in other Brazilian studies was related to dosage. A study conducted at a university hospital in northeastern Brazil indicated that within 98% of prescription errors, the most frequently ones were related to dosage[23]. Thus, the Safety Protocol for Prescribing, Using and Administering Medicines was established, providing guidance on the importance of a clear dosage description and indicating risks[24].

Moreover, prescription errors can also lead to misinterpretations of medications or routes of administration. This can happen both in the dispensing phase, performed by the pharmacist, and in the administration phase, performed by the patient or caregiver[22]. One of the strategies to improve the quality of prescriptions is to transform handwriting into digitalised content, as well as to encourage the contact between the pharmaceutical professional and the prescriber to inform non-conformities and irregularities [18].

Other strategies, such as the development of guidelines for the correct prescription, continuing education and prescribers training have been approached[22].

Most of the prescriptions received by the magistral pharmacy school in Rio de Janeiro come from a university hospital in the city of Rio de Janeiro, which aims at the theory-practice integration and professional experience of its students. In this sense, it is believed that these improvement strategies are more significantly attached to this environment

than to other hospitals.

Three errors related to handling were recorded. This stage is prone to errors that undermine the quality of the products, such as wrong weighing, mixing, cross contamination and negligence. The magistral pharmacy school in Rio de Janeiro carries out its activities striving to minimize them. It uses the Handling Order, as recommended by RDC 67, which allows the traceability of medicines in all handling stages and guarantees their quality. As a pharmacy school, most of the drugs are handled by students under the supervision of pharmaceutical tutors so that errors and contamination problems are minimised.

Labeling errors were also found in seven cases. They include deviations in quality that can cause administration and dispensing inaccuracies[1]. The institution's labeling sector uses the Formula Certa® system as follows: the drugs are previously registered with information such as name, dose, volume, unit of measure (grams or number of capsules), pharmaceutical form, internal/external use, and expiration date. When the patient acquires the medication, his or her name, the doctor's ID, the medication quantity (according to the respective sanitary regulation), the batch number as well as the purchase registration number are mentioned[26].

One label with a mistaken drug name due to packaging similarity and one another with the wrong amount of medication were identified. According to the Institute for Safe Practices in the Use of Medicines[27], a recent review of the guidelines for good labeling and packaging practices suggests that drugs, whose names are similar to others commonly used, should have the part of the name that differentiates them highlighted, with capital or bold letters.

The information layout, color or lack of legibility on the labels can increase the risk of errors, leading to wrong administration. In the particular case of the magistral pharmacy school in Rio de Janeiro, the scenario of this work, the use of a single software, qualified people in its operation, and greater autonomy to carry out its updates arise as strategies to improve the labeling process.

Likewise, the patient's name is described on the labeling of manipulated drugs, since the formulas are tailor made for his or her needs. Thus, the right medication for the right patient must be guaranteed, and the information for the appropriate treatment established by the qualified professional must appear on the label, such as safe use and storage instructions, manufacture and expiration date[2].

Dispensing errors, such as changing the patient's name, the drug or the prescribed dosage form were also observed (5.11%). Aldhwaihi, in his systematic review study[28], also found a dispensing error rate that varied between 0.015% to 33.5%, depending on the medication distribution system. In that study, dispensing the wrong medication, dose or dosage form was the most frequent. The factors associated with those errors were high workload to reduced staff, similar products exchange, lack of experience, distractions and interruptions in communication within the dispensary staff. Another observational study that included 50 pharmacies in 6 cities in the United States observed 77 occurrences (2%) in 1448 prescriptions, of which 5 were considered clinically relevant errors[29].

In accordance with the literature, the factors associated with dispensing errors were generally related to the lack of knowledge, memory lapses, problems with the medicine labeling or packaging, lack of standardisation of procedures, communication failures, work overload, lack of attention, haste in dispensing, inadequate physical space, distractions and interruptions during the work process[30].

The patient must be guaranteed the correct medication, dose, quantity and information for its use. Therefore, the guidance at the dispensing stage must be clear and simple. This will lead to the correct, effective and safe use of the medication throughout the treatment[31].

Regarding medication errors related to the patient administration, twelve occurrences were observed. Most of the reports were related to the administration of vitamin D, which is manipulated in the magistral pharmacy school in Rio de Janeiro in an oily solution, due to its lipophilic characteristics. Along with the primary packaging, the patient is provided with a dropper.

It is recommended that the vitamin D is taken after meals, then it is conjugated to the bile salts and better absorbed by the body; that it is not dripped in water, as it will not solubilise but compromise the dose due to its adherence on the container body; that it is not administered directly into the mouth so that the drop count is not lost or the solution is not contaminated in case the dropper touches the tongue; and that it is dripped alone into a spoon.

In addition, it is also fundamental to check whether the patient has liver or kidney disease, for the vitamin D activation occurs in those organs. These patients must therefore use calcitriol, its active ingredient. Eventually, the magistral pharmacy school in Rio de Janeiro product does not serve them.

Other administration errors from miscommunication, included over- or under-dosing after replacing the previous dosage. Glucosamine sulfate is usually prescribed at a dose of 1.5 g. However, the magistral pharmacy school in Rio de Janeiro commercializes it in 750 mg and 500 mg doses, since it is unable to handle the capsule with the total of active ingredient. Therefore, the drug is marketed according to the available doses, which may consequently change the number of capsules. This variation in the amount of capsules was responsible for confusing the patient, leading to excessive or insufficient intake. This issue was also noticed with the medicine calcium carbonate, which is sold in powder form and must be solubilised in water. Some patients do not follow the prescribed dose because they found the volume was too

low.

Clear communication is essential in this context but, sometimes, lack of time or knowledge can harmfully affect it. Guidelines can be omitted due to lack of technical skill and cause misunderstandings. Patients, within the scope of the magistral pharmacy, do not listen to the guidelines because they are in a hurry or think they already know how to administer the medication. There are cases of polypharmacy, that is, different guidance is transmitted so that the patient and/or caregiver is confused. Last but not least, the pharmacy environment and its high flow of patients affects the time for individual guidance, as well.

The physician should prescribe and advise on the use of the drugs, as to the indication, dose, dosage and time of treatment. In addition, the pharmacist must consider the possibility of food and drug interactions, physical-chemical incompatibility, and the guidelines for use, transport and storage. In the magistral scope, the medication is customised and does not have a package insert[1], and therefore communication must be clear and have appropriate language for effective understanding.

The dispensing stage is the last barrier for intercepting errors and making the treatment safer. Some studies show that patients who take active roles in their health care are empowered and reduce the medication error rates[9].

This study was not carried out in community or hospital pharmacies so the data differ from those found in the literature. Nevertheless, the profile of medication errors herein suggests that a pharmacovigilance system through voluntary notifications be implemented to mitigate errors. Such implementation requires time and cooperation from all the agents involved, but ensures the health status integrity of patients who use compounded drugs, and improves the work of all those involved in the magistral pharmacy school in Rio de Janeiro. In this context, the regular record of medication errors in databases is encouraged as an initial version of a notification system, which shows the magistral pharmacy school in Rio de Janeiro significant interest in the safety, quality and effectiveness of medicines.

The professionals' mistaken perception that associates reporting medication errors with punitive actions is a high obstacle[5]. Although the number of incidents is roughly real due to the non-reported events, this approach has a relatively low cost as the collected data is a byproduct of routine care[3,32].

Minor issues can also be recorded in the pharmacy's occurrence book, such as packaging distinction, meetings for communication improvement within the team itself to point out the observed medication errors and difficulties for carrying out activities, etc.

With regard to technology, it is possible to create barcode cards that gather the patients' registration information and include only the drugs of interest on the sales page; to generate an automatic label with QR code for each semi-finished drug, to be read by a portable reader and have the drug information cross-referenced with the patient's information.

This study was somehow constrained by a short evaluation period, since the analysed data was specially collected during the establishment operation period; by the intrinsic subjectivity for the selection of occurrence records due to the lack of a method with a trustful inclusion and exclusion criteria; and by the lack of standardization regarding the classification of medication errors.

Few studies have been carried out on the analysis of the safety use of magistral medicines, which makes this work relevant. Therefore, it is expected to considerably contribute to the discussion over the theme and improve the magistral pharmacy school in Rio de Janeiro 's activities.

4 Conclusion

This study identified medication errors in a magistral pharmacy. The errors were potential but intercepted and resolved before they resulted in a harmful outcome. The data indicated the need for systematic surveillance of adverse events and standard procedures during the processes, from the evaluation of the prescription quality to the guidance for correct administration and proper medication storage by the patient. It has a great potential to assist in the relevant approach to medication errors in the magistral sector. In addition, it contributes to the pharmacists' awareness towards the safety quality of compounded drugs, and highlights a very broad area for research development.

Acknowledgements

The authors would like to thank the UFRJ University Pharmacy for the support received during the development of this work.

References

1. Brazil. Law No. 13.021, of August 8, 2014. Provides for the Exercise and Supervision of Pharmaceutical Activities; 2014.
2. Brazil. Resolution of the Collegiate Board (RDC) No. 67, of October 8, 2007. Provides for Good Practices in Manipulating Magistral and Workshop Preparations for Human Use in Pharmacy and its Attachments; 2007.
3. Seidling HM, Bates DH. The Pharmacoepidemiology of Medication Errors. In: STROM, B. Pharmacoepídemiology. New York: John Wyley & Sons Inc; 2020.
4. Coimbra JA, Cassiani SH. Nursing responsibility in the administration of medication: some reflections for a safe practice with quality Rev Latinoam Enferm 2001;9(2):56-60. doi:10.1590/s0104-11692001000200008
5. National Coordinating Council for Medication Error Reporting Prevention. NCC MERP: the first tem years: "defining the problem and developing solutions". Rockville; 2005
6. Assiri GA, Shebl NA, Mahmoud MA, Aloudah N, Grant E, Aljadhey H, et al. What is the epidemiology of medication errors, error-related adverse events and risk factors for errors in adults managed in community care contexts? A systematic review of the international literature. BMJ Open 2018;8(5). doi:10.1136/bmjopen-2017-019101

7. Gimenes FRE, Marques TC, Teixeira TCA, Mota MLS, Camargo Silva AEB, Cassiani SHB. Administración de medicamentos en vías diferentes de las indicadas en la prescripción médica. Rev Lat Am Enferm 2011;19(1):11-7. doi:10.1590/S0104-11692011000100003

8. Awé C, Lin SJ. A patient empowerment model to prevent medication errors. J Med Syst 2003;27(6):503-17. doi:10.1023/A:1025929714386

9. Melo, FO, Caveião C. Medication errors in hospitals and pharmacovigilance in patient safety. St Catarina UNINTER. Published online 2015:1-16.

10. Pan American Health Organization. Good Pharmacovigilance Practices for the Americas. Washington: World Health Organization; 2011.

11. Brazil. Law No. 5,991, of December 19, 1973. Provides for Sanitary Control of the Trade in Drugs, Medicines, Pharmaceutical and Related Supplies, and Provides Other Provisions. Diário Oficial União. December 21, 1973; 1973.

12. Guzatto P, Bueno D. Analysis of drug prescriptions dispensed in the pharmacy of a basic health unit in Porto Alegre - RS. Rev HCPA 2007;27(3):20-26.

13. Mastroianni PC. Analysis of the legal aspects of drug prescriptions. Rev Ciênc Farm Bás Apl 2009;30(2).

14. Valadão AF, Firmino KF, Moreira ALP. Study of medication prescriptions in the Basic Health Units of Coronel Fabriciano 2008;89(4):298-301.

15. Pande MNR, Amarante PDC, Baptista TWF. This illustrious stranger: considerations on the prescription of psychiatric drugs in early childhood. Cien Saude Coletiva 2020;25(6):2305-2314. doi: 10.1590/1413-81232020256.12862018

16. Costa PQ, Lima ESJ, Coelho LLH. Prescription and preparation of medicines without formulation suitable for children: a hospital based study. Braz J Pharm Sci 2009;45(1):57-66. doi: doi.org/10.1590/S1984-82502009000100007

17. Koper D, Kamenski G, Flamm M, Böhmdorfera B, Sönnichsena A. Frequency of medication errors in primary care patients with polypharmacy. Fam Pract. 2013;30(3):313-9. doi:10.1093/fampra/cms070

18. Abjaude SAR, Zanetti ACB, Marques LAM, Rascado RR. Analysis of drug prescriptions dispensed at the Pharmacy School of UNIFAL-MG. Rev Univ Vale Rio Verde 2012;10(2):211-9. doi: 10.5892/ruvrv.2012.102.211219

19. Romano MJ, Dinh A. A 1000-fold overdose of clonidine caused by a compounding error in a 5-year-old child with attention-deficit/hyperactivity disorder. Pediatrics 2001;108(2 II):471-3. doi:10.1542/peds.108.2.471

20. Schwam E. Severe accidental overdose of 4-aminopyridine due to a compounding pharmacy error. J Emerg Med 2011;41(1):51-54. doi:10.1016/j.jemermed.2009.04.037

21. Barillas JE, Eichner D, Van Wagoner R, Speiser PW. Iatrogenic cushing syndrome in a child with congenital adrenal hyperplasia: erroneous compounding of hydrocortisone. J Clin Endocrinol Metab 2018;103(1):7-11. doi:10.1210/jc.2017-01595

22. Araújo PTB, Uchôa SAC. Evaluation of the quality of medication prescription at a teaching hospital. Cienc Saude Coletiva 2011;16:1107-14. doi: 10.1590/S1413-81232011000700042

23. Néri ED, Gadêlha PG, Maia SG. Drug prescription errors in a Brazilian hospital. Rev Assoc Med Bras 2011;57(3):306-314. doi: 10.1590/s0104-42302011000300013

24. Safety Protocol in Prescribing Use and Administration of Medicines. https://www20.anvisa.gov.br/segurancadopaciente/index.php/publicacoes/item/seguranca-na-prescricao-uso-e-administracao-de-medicamentos. Acessed Jun 25, 2020.

25. Ribeiro AMRF. Analysis of the Prescription of Pharmaceutical Manipulated in the Porto Region. 2014. https://bdigital.ufp.pt/handle/10284/4408..

26. Brazil. Resolution of the Collegiate Board (RDC) No. 71, of December 22, 2009. Provides on the Labeling of Medicines. Official Diary of the Union.; 2009.

27. Institute for Safe Practices in the Use of Medicines - ISMP. Labeling and packaging of medicines with a focus on patient safety is the theme of an international meeting. https://www.ismp-brasil.org/site/noticia/rotulagem-e-embalagem-de-medicamentos-com-foco-na-seguranca-do-paciente-e-tema-de-encontro-internacional. Acessed June 25, 2020.

28. Aldhwaihi K, Umaru N, Pezzolesi C, Schifano F. A systematic review of the nature of dispensing errors in hospital pharmacies. Integr Pharm Res Pract 2016;5:1. doi: 10.2147/iprp.s95733

29. Flynn EA, Barker KN, Carnahan BJ. National observational study of prescription dispensing accuracy and safety in 50 pharmacies. J Am Pharm Assoc 2003;43(2):191-200. doi:10.1331/108658003321480731

30. Anacleto TA, Perini E, Rosa MB, César CC. Medication errors and drug-dispensing systems in a hospital pharmacy. Clinics 2005;60(4):325-332. doi: 10.1590/S1807-59322005000400011

31. Júnior L, Siqueira DP, Silva JS. Drug error in primary and secondary health care: dimension, causes and prevention strategies. Rev Port Saúde Pública 2010:40-6.

32. Lobo MGAA, Pinheiro SMB, Castro JGD, Momenté VG, Pranchevicius MCS. Adverse drug reaction monitoring: Support for pharmacovigilance at a tertiary care hospital in Northern Brazil. BMC Pharm Toxicol 2013;14:5. doi:10.1186/2050-6511-14-5