Revista
O Mundo da Saúde

Validation of the Drug Chain Flowchart as a preventive technology for medication errors

Renata Prado Bereta Vilela*
Marli de Carvalho Jerico**

Abstract

An important strategy for the prevention of errors is knowing of the medication process in the drug chain as well as the technologies that can prevent medication errors. This study aimed to map, describe, and validate the medication process, relating the technologies available for the prevention of medication errors in a teaching hospital. The study is documentary and observational; data triangulation was used by combining three sources of information. Flowcharts were elaborated to map the processes studied and the content was submitted for validation by 26 health professionals in five areas of care. Four Flowcharts were elaborated, totaling an average of 50 activities and the insertion of 18 preventive technologies, with a predominance of solid technologies (50%), were identified. The Hospital Information System (12.6%) was identified as the main technology that prevents medication errors; the type of error that was the most preventable with these technologies was the dose error (21%). Knowing where preventive technology operates in the drug chain is an innovation that can provide healthcare professionals with the knowledge to prevent medication errors. Also, this management favors the rationalization of activities, the definition of the role of these professionals, the time spent for executing each sub-process, the redesigning of the work process and optimization of productivity. It was concluded that the mapping of the drug chain together with the identification of technologies and their points of use provided greater visibility and authenticity of the health professionals' actions.

Keywords: Hospital Medication System; Medication Errors; Workflow; Technology; Patient safety.

INTRODUCTION

Currently, patient safety and medication errors have been a frequent concern in health institutions and of health researchers, as it is one of the most frequent types of medical errors[1]. Regarding medication safety, studies have addressed the definition of medication error, which is any event that can be avoided and that occurs in any phase of drug therapy causing or not harm to the patient[2]. Its cause, which can be related to the professional or the work process[3], and the consequences for professionals, can be a learning process based on the culture of patient safety or even extend to punitive measures[3]. Some research also addresses prevention, which involves to the use of many technologies and equipment[4]. Finally, expenses are also an object of study, and have a wide range of values reaching up

DOI: 10.15343/0104-7809.202044325337

*Faculdade de Medicina Faceres. São José do Rio Preto/SP, Brasil.
**Faculdade de Medicina de São José do Rio Preto (FAMERP). São José do Rio Preto/SP, Brasil.
E-mail: renata_bereta@hotmail.com

to US$ 5,095,640,000.00[5].

Aiming at expanding and promoting patient safety in Brazil, the National Patient Safety Program (PNSP) instituted by Ordinance 529, of April 1, 2013, brings as one of its priorities, the development of protocols for safe medication assistance[6]. In 2017, the World Health Organization (WHO) launched the third global challenge for patient safety, entitled "Medication Without Harm", which envisions "reducing by more than 50% the severe and preventable damage related to medication within the next five years"[7].

To achieve the goal launched by the third WHO challenge, several technological resources were inserted in the health area in order to facilitate or assist in daily activities (8), promoting patient safety and preventing medication errors[3]. The concept of technology in the health area is broad, comprising of human relationships (light technology), structured knowledge (light-solid technology) and equipment (solid technology)[9-10].

The medication process, also known as the drug chain, is multi-professional and composed of several sub-processes. It can be divided into prescription drugs, performed by the doctor; medication dispensing performed by the pharmacy team and the preparation and administration of medications usually performed by the Nursing team[1,11-13]. Medication errors can happen in any sub-process of the drug chain and are more frequent during prescription and administration[1]. As it is a complex and error-prone process, it is necessary to implement preventive strategies which can increase the safety of the patient and the professional during care[1].

Knowledge of the medication process supports the verification of activities, in which a risk of failure may occur, contributing to the simplification and/or implementation of technologies that act as barriers to events of medication errors[14].

Therefore, we considered relevant and to advance the area of patient safety in scientific terms, to disclose to health teams the Flowchart of the medication process in the drug chain. Additionally, we disclose where the implemented preventive technologies act which can help the team learn about the available resources and how to use them effectively; thus, promoting patient safety, organization, and evaluation of the health services. With this purpose, the objective of this study was to map, describe and validate the medication process, relating the available technologies to the prevention of medication errors in a teaching hospital.

METHODOLOGY

This was an observational, analytical, retrospective study, developed in a teaching hospital, of a special size (720 beds) with a quaternary scope, located in southeastern Brazil. This institution serves patients from the Unified Health System (SUS), health plans and individuals, totaling more than two million inhabitants/year, with an average of 46,000 visits/month, 31,388 medical prescriptions/month, and 2,106,113 dispensations/month.

Data collection took place, after approval by the Research Ethics Committee (Opinion No. 325.938). The invited professionals agreed to participate in the study, receiving prior guidance and signing the Informed Consent Form (ICF).

The study was developed in five stages. Initially, with the objective of mapping the medication process, a documentary and observational study was carried out, through analyzing the institution's Standard Operating Procedures (SOP) related to dispensation, preparation, and administration of medication. Then, the texts of the document were transformed into Flowcharts completing the second stage. Next, the third stage began with an interview with the nurses of risk management and of the institution's Integrated Center for Education and Research in Health (CIEPS), which was the field of study, for a survey of preventive technologies for medication error, implanted in the institution in 2010. These nurses were chosen for this interview because they have knowledge about this theme and participate in the implementation of these technologies in the institution.

With the design of the Flowcharts of the entire drug chain process and the list of technologies that could prevent medication errors, direct observation was carried out in relation to the activities of prescription, dispensing, preparation and administration of medication, performed by doctors, pharmacists , pharmacy technicians, nurses and nursing assistants and technicians from the institution. The researcher followed the execution of each subprocess without interfering, together with the professional performing their daily practice of activities as a nurse at the institution. During the direct observation, it was possible to verify the flow of activities of each sub-process, as well as to verify the moment when each technology was used, thus, completing the fourth step and the construction of the Flowcharts.

Finally, the fifth step was carried out, which consisted of validating the Flowcharts through individual interviews with professionals: doctors, pharmacists, pharmacy technicians, nurses, nursing assistants and technicians who participated in the hospital's medication process.

Seven Flowcharts covering the stages of the drug chain were validated following the content analysis methodology: one Flowchart for prescription, two for dispensing (standard and non-standard dispensing) and four for medication administration (separated by administration routes, one for oral and sublingual, aerosol, nasogastric enteral tube and parenteral route). For its validation, an individual semi-structured interview was conducted with each participant. Upon accepting the invitation to participate in the study, the health professional was informed about the objectives of the study and how it would be carried out. The Informed Consent Form (ICF) was signed and then the interview started with an instrument that the researcher had developed. Initially the instrument contained data identifying the participant such as? age, education, time since graduated, position at the institution, time working at the institution. Flowcharts for each area of activity were presented to each professional group, that is, doctors received the prescription subprocess, the pharmacy team received the dispensing subprocess, and the Nursing team received the medication preparation and administration subprocess. For validation, the professional was asked to look at each activity, if it was performed and if it was in the exact order. They were also asked to observe whether they used preventive technologies for medication errors and whether they were used between those activities. When the participant did not agree with some information in the Flowchart, they were instructed to make the adjustment on the sheet on which the drawing was. The suggestions were accepted and the subprocesses were modeled to more accurately represent how they are carried out in healthcare practice. The validation agreement with the pre-assessment flowchart was 70%, where 60% (n=3) was for medical prescriptions, 80% (n=8) for dispensing and 73% (n=8) for medication administration. Finally, each participant was asked to relate the preventive technology to the type of error it can prevent; it is worth mentioning that the definition of the classification of each type of error was presented.

The sample size of the participants was determined without statistical calculation, which would be one professional performing each subprocess in each of the health areas (medical clinic, surgical clinic, emergency care, critical care, and pediatrics). However, since dispensing, preparing, and administration could be carried out by a professional of technical level or higher, it was decided to include a professional of each level in each area. The nurse responsible for risk management and the coordinator of the hospital's pharmacies were also included due to their knowledge of subprocesses and the prevention of medication errors. Thus, 26 professionals randomly selected were interviewed. As a selection criterion, professionals must be working in the medication process for at least one year at this institution.

The "prescription" sub-process was validated by five doctors hired at the institution, either on-call or residents. The "dispensation" subprocess was validated by a pharmacist and a pharmacy technician from each of the five areas, with one of the pharmacists responsible for two areas (surgical inpatient unit and intensive care unit), and also by the institution's responsible technician pharmacist, totaling ten professionals. The sub-process of "administration" was performed by a nurse and a nursing technician or assistant in each area. The risk management nurse was also invited, since they could add value to this subprocess; thus, 11 nursing professionals participated.

In order to relate the technologies to the type of error that could be prevented with their use, it was chosen for each professional category to report within the subprocess of their specific area, due to their greater familiarity with the technology and the subprocess.

For the participants to classify the type of medication errors that were prevented with the technologies, the National Reference[15] and the Regional Nursing Council (COREN) of São Paulo (16) were used: 1. *Error of route*: administration in route other than the that prescribed; 2. *Dose error*: administration of a dose greater or less than the prescribed; 3. *Time error*: administration outside the pre-defined interval (at the institution, it is considered as being one hour before or after the prescribed time); 4. *Wrong patient*: administration to a different patient than prescribed; 5. *Omission error*: No administration of prescribed medication and; 6. Unauthorized medication: refers to the administration that was not prescribed or authorized by the doctor.

RESULTS

The drug chain process totaled an average of 50 activities and 17 preventive technologies for medication errors.

In the subprocess of medical prescription, 11 activities were mapped (Figure 1) which started with the visit or medical consultation and ended with the patient's evaluation. Four preventive technologies were identified (patient identification bracelet, Hospital Information System (HIS), risk management, and patient safety group): 1- Patient identification bracelet, which in this subprocess is used in the anamnesis and physical examination; and 2- HIS, which is accessed in the third activity of this subprocess, ensuring user identification through login and password. Within the HIS there are some tools that promote patient safety, such as electronic prescription that guarantees legibility and the drugs are "tied" with the correct dose, routes, and diluents. There are still warning notices for Potentially Hazardous Drugs (PHD). There is an option for the doctor to use the standard prescription of his/her specialty, which guarantees the prescription of the most frequent medications, avoiding forgetfulness; however, the standard prescription can be adapted or modified if necessary, according to the patient's particularities. Finally, 3- Risk management and 4- Patient safety group are present throughout the drug chain process, as these departments promote a safety culture in the institution, as well as monitor critical incidents that may happen.

For the analysis of the "dispensing" subprocess, it is important to remember that the individualized medication dispensing system is the system that is adopted in this research field institution. For this purpose, two different forms were described: the standard (Figure 2) and the non-standard ("pharmacy window in urgent cases") existing in the researched institution. The standard dispensation consists of 17 activities, and eight preventive technologies have been identified (SIH, Palm top, individual shift distribution, barcode reader, unified packaging, PHD identification, risk management and patient safety group). These technologies are described as follows: 1- SIH, when the doctor provides the prescription, it is automatically sent via SIH to the pharmacy. 2- The Palm top, after switching it on and selecting the employee, the sector, and

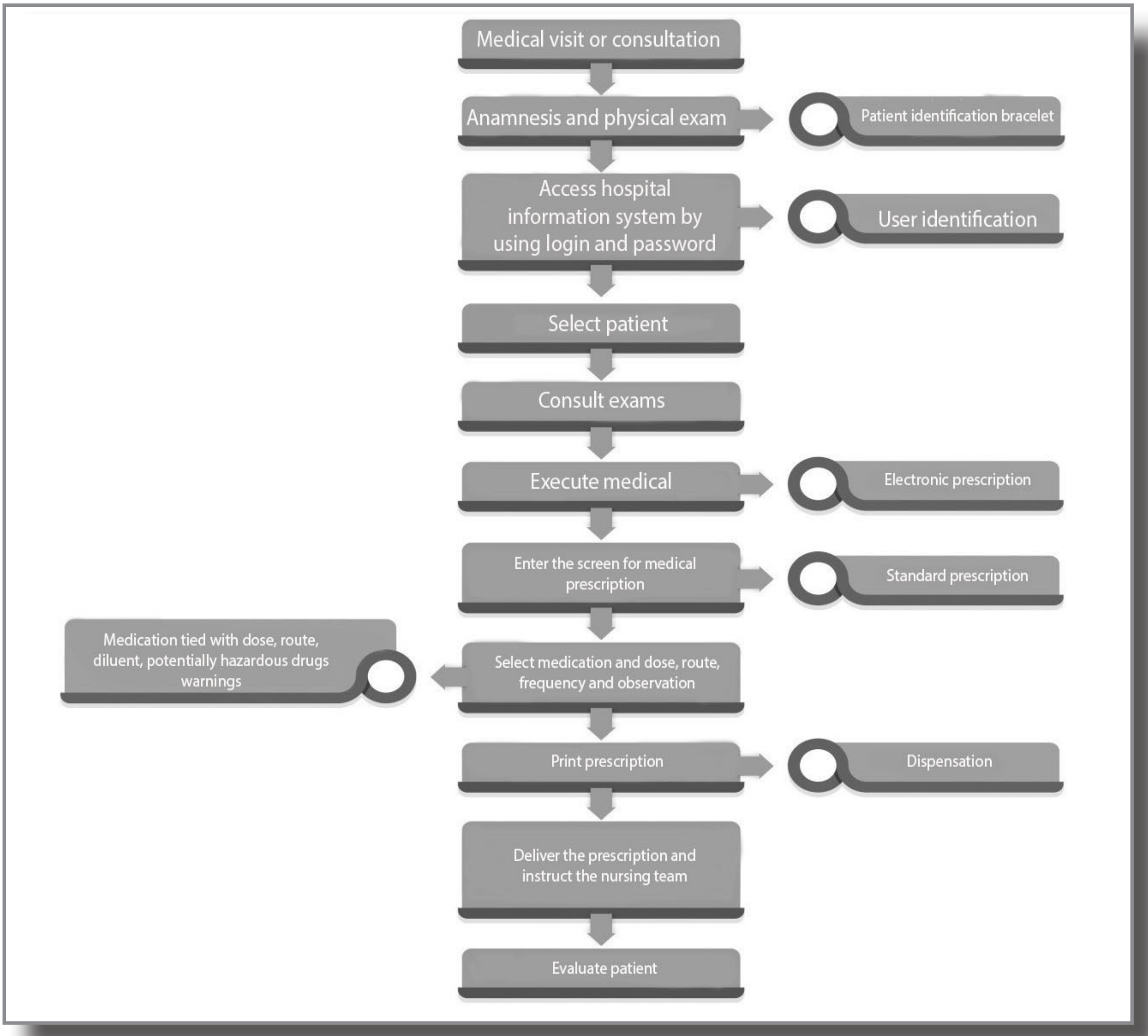

Figure 1 – Flowchart of the medical prescription subprocess and its preventive technologies for medication errors, São José do Rio Preto, SP, Brazil, 2016.

the shift, it already provides requests for the later hours to be met. 3- Individual distribution in shifts, of which the medications are distributed in three shifts (morning, afternoon, and night), which decreases the amount of medications available at the Nursing post. Each patient has his medication "tape" (plastic packaging arranged according to the schedule of administration in the medical prescription, individualized and identified for each patient) in the respective shift. 4- Barcode reader that is present in the palm top, ensures that the correct medication is dispensed, within the expiration date for the correct patient. 5- Unitarized packaging makes all medications have bar codes (even unitarized tablets), improves the visibility and legibility of the packages, in addition to allowing a colored alert stripe (red for PHD) and alert notifications. 6- Identification of PHD (label or colored plastic bag) occurs using red labels, moreover, after dispensing the medication through the palm top, the medications are placed in transparent plastic bags with the identification of the patients. When there is PHD, these plastic bags are red in order to alert the Nursing team that will administer the medication. 7- Risk management and 8- Patient safety group. For non-standard dispensing, 14 activities were described, and four technologies were identified, namely HIS, PHD identification, barcode reader, unitarized packaging, risk

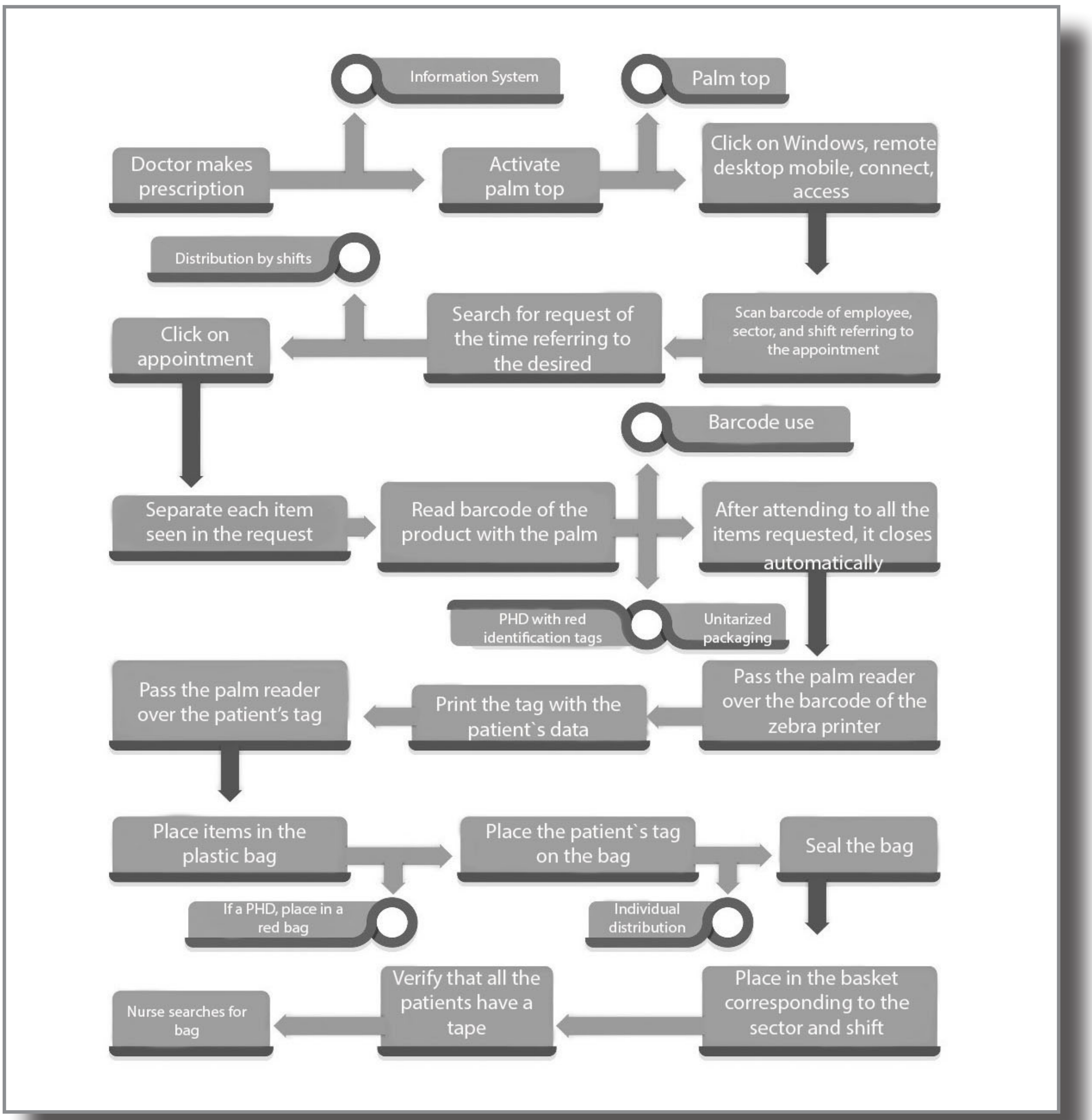

Figure 2 – Flowchart of the medical prescription subprocess and its preventive technologies for medication errors, São José do Rio Preto, SP, Brazil, 2016.

REVISTA
O MUNDO DA
SAÚDE

management and patient safety group.

For the subprocess "medication administration" two Flowcharts (Figures 3 and 4) were elaborated, divided by administration routes (oral/sublingual and parenteral), and the routes by nasogastric enteral tubes and aerosol were described, totaling an average of 23 activities (19 oral, 25 nasogastric enteral tubes, 24 aerosol and 25 parenteral application). Fifteen preventive technologies were identified: no stock of drugs, HIS, double-checking of drugs, identification for PHD, unitarized packaging, checking of the "five rights" of medication, patient identification plate and bracelet, infusion pump, colorized identification routes, training and integration of nursing professionals, Nursing Care Systematization (NCS), safety group and risk management. They are described as follows: 1- the absence of a stock of drugs in the unit eliminates the probability of administering non-prescribed medications; 2- HIS guarantees the legibility of the prescription and individual distribution in shifts; 3- double-checking is performed by two Nursing professionals in the cases of PHD; 4- identification of PHD; 5- unitarized packaging; 6- conference of the "five rights" of medication (right patient, right medicine, right way, right dose, right time); 7- patient bed identification plate and 8- patient identification bracelet; both patient identifications guarantee at least two patient identifiers. Moreover, 9- infusion pump (precise infusion flow); 10- colorized identification of route in the intensive care unit, differentiating between venous (blue), arterial (red) and gastric routes (yellow) through colored durex attached to the track ends; 11- Training and 12- integration to promote updating nursing professionals. 13- NCS acts as a preventive technology in the medication administration

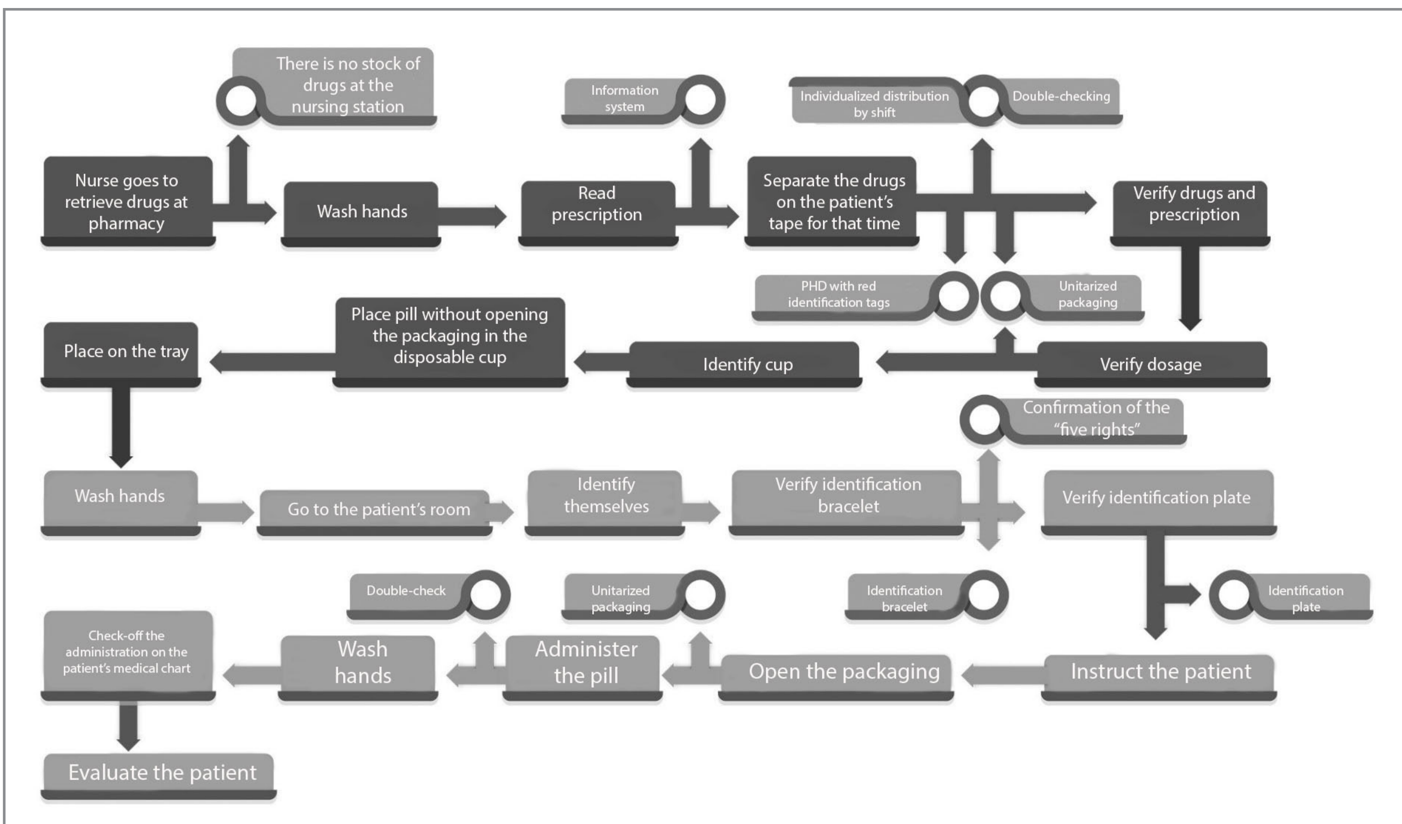

Figure 3 – Flowchart of the subprocess administration of oral medications and their preventive technologies for medication errors, São José do Rio Preto, SP, Brazil, 2016.

sub-process since through this tool the nurse can alert their team concerning the main risks of patients. There are also 14- the patient safety group and 15- risk management.

Study participants were asked to relate preventive technologies to the type of error (Table 1) that could be prevented with their use. It was observed that HIS is the technology that most prevents all types of medication errors according to the view of the professionals who validated the Flowcharts (12.6%).

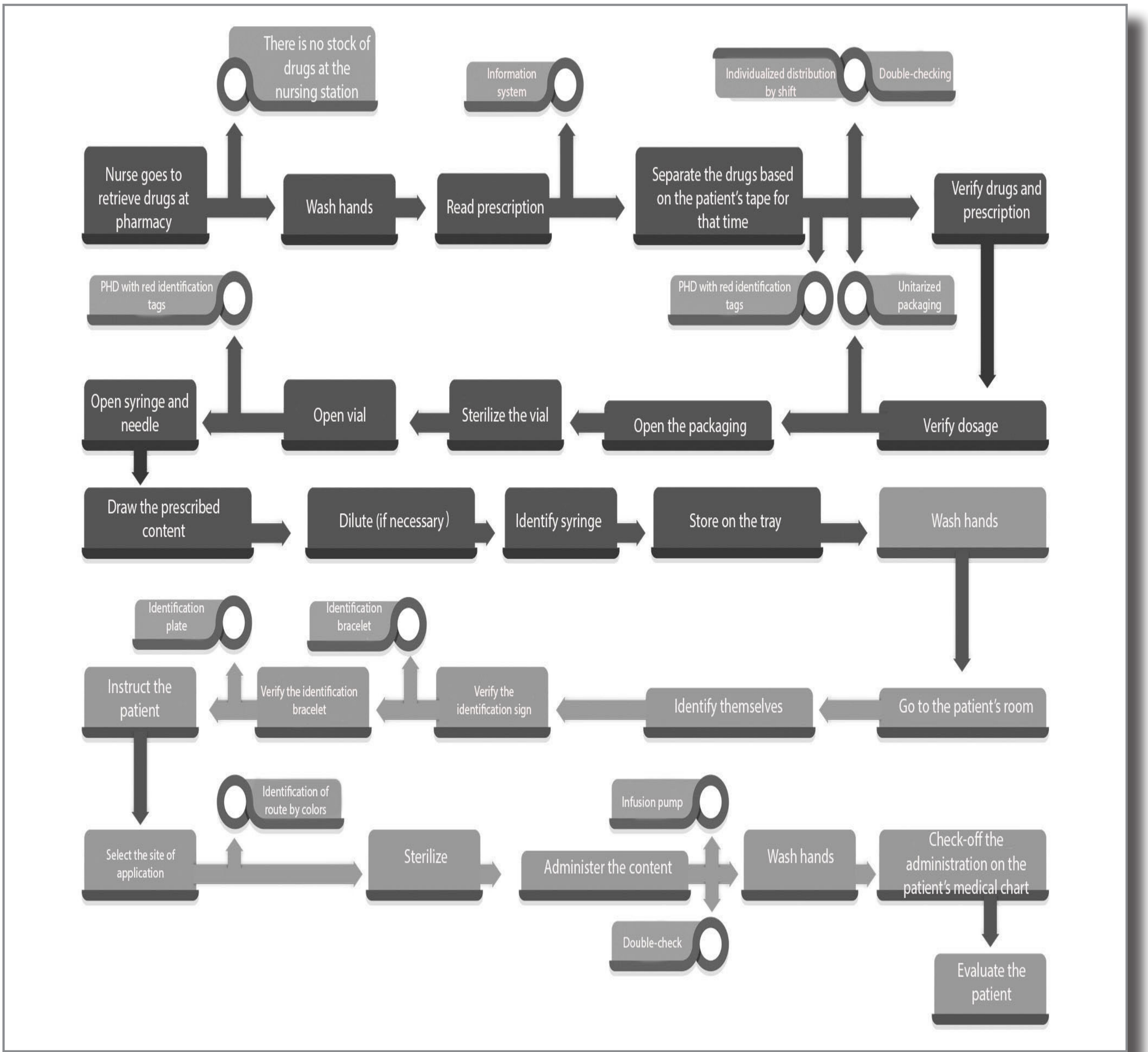

Figure 4 – Flowchart of the parenteral medication administration subprocess and its preventive technologies for medication errors, São José do Rio Preto, SP, Brazil, 2016.

Table 1 – List of professionals who validated Flowcharts between technologies with the types of medication errors that can be prevented at each stage of the drug chain, São José do Rio Preto, SP, Brazil, 2016

Error/ Technology	Technology Classification	Route n (%)	Dose n (%)	Time n (%)	Patient n (%)	Omission n (%)	AUAM n (%)	Total n (%)
T/I	Light	9 (8.1)	9 (6.7)	8 (7.3)	9 (7.3)	8 (10.7)	8 (8.7)	51 (7.9)
Five (5) rights	Light-hard	2 (1.8)	2 (1.5)	2 (1.8)	2 (1.6)	1 (1.4)	1 (1.1)	10 (1.6)
No stock	Light-hard	0 (0.0)	1 (0.7)	2 (1.8)	0 (0.0)	2 (2.7)	5 (5.4)	10 (1.6)
ID	Light-hard	3 (2.7)	9 (6.7)	12 (11.0)	14 (11.4)	5 (6.7)	6 (6.5)	49 (7.6)
DS	Light-hard	2 (1.8)	6 (4.4)	17 (15.6)	6 (4.9)	4 (5.4)	3 (3.3)	38 (5.9)
Double-checking	Light-hard	6 (5.4)	8 (5.9)	5 (4.6)	8 (6.5)	4 (5.4)	5 (5.4)	36 (5.6)
RM	Light-hard	14 (12.6)	13 (9.6)	11 (10.1)	11 (8.9)	13 (17.5)	14 (15.2)	76 (11.8)
SG	Light-hard	15 (13.6)	12 (8.9)	10 (9.2)	14 (11.4)	12 (16.2)	14 (15.2)	77 (12.0)
NCS	Light-hard	2 (1.8)	2 (1.5)	1 (0.9)	4 (3.3)	2 (2.7)	2 (2.2)	13 (1.9)
IP	Hard	2 (1.8)	9 (6.7)	3 (2.8)	2 (1.6)	1 (1.4)	0 (0.0)	17 (2.6)
UP	Hard	7 (6.3)	11 (8.1)	3 (2.8)	5 (4.1)	4 (5.4)	5 (5.4)	35 (5.4)
PHD	Hard	10 (9.0)	15 (11.1)	5 (4.6)	6 (4.9)	4 (5.4)	3 (3.3)	43 (6.7)
Route Identification	Hard	9 (8.1)	1 (0.7)	1 (0.9)	1 (0.8)	0 (0.0)	0 (0.0)	12 (1.9)
BCR	Hard	3 (2.7)	6 (4.4)	2 (1.8)	2 (1.6)	1 (1.4)	4 (4.3)	12 (1.9)
Palm top	Hard	5 (4.5)	7 (5.2)	5 (4.6)	5 (4.1)	4 (5.4)	8 (8.7)	34 (5.3)
Plate	Hard	3 (2.7)	2 (1.5)	3 (2.8)	10 (8.1)	1 (1.4)	1 (1.1)	20 (3.1)
Bracelet	Hard	3 (2.7)	2 (1.5)	3 (2.8)	13 (10.6)	1 (1.4)	2 (2.2)	24 (3.7)
HIS	Hard	16 (14.4)	20 (14.9)	16 (14.7)	11 (8.9)	7 (9.5)	11 (12.0)	81 (12.6)
Total		111	135	109	123	74	92	644

AUAM- Administration of unauthorized medication; T/I - Training and Integration; ID - Individual dispensation; DS - Dispensing by shifts; RM - Risk Management; SG - Patient safety group; NCS - Nursing Care Systematization; IP - Infusion pump; UP - Unitarized Packaging; PHD - Identification for Potentially Dangerous Medication; BCR - Barcode reader; HIS – Hospital Information System.

DISCUSSION

Understanding the subprocesses that make up the drug chain is fundamental for preventing medication errors. Based on this statement, a national multicenter study carried out in university hospitals showed that the medication process consisted of an average of 69 activities, ranging from 58 to 80 activities. Only one of the hospitals had an electronic prescription, as in the present study, whose medication process consisted of 66 activities[13]; quantitatively higher than the activities of this study, which presented 50 activities, on average. Another document infers that reducing the number of steps in the medication process is a strategy that can reduce errors in the administration of intravenous drugs[17]. Thus, it is emphasized that the greater the number of activities in the drug chain, the greater the risk of medication errors; it may also increase the demand for technological barriers capable of avoiding them.

It is worth remembering the Lean method as a “lean mindset”, in which the lower the number of steps assigned to an activity will have an impact on the increase in the quality of the service provided and the safety of the patient and health professionals[18]. Thus, the objective of this method is to reduce the number of activities to promote safer processes, increasing productivity with less waste[19]; in addition to being a viable, useful, and easy to use[20].

A quasi-experimental study, which verified the influence of redesigning nursing activities to reduce medication errors in a pediatric unit in a university hospital, indicated an overall reduction of 3.6% in errors. However, the reduction in omission errors (when the prescribed medication is not administered) was 52%[21]. A study carried out in the United Kingdom that evaluated nurses' knowledge, perceptions and opinions about double-checking medication administration in a children's hospital pointed out that the lack of knowledge about the process and clear guidelines contributed to medication errors[22]. Therefore, we can affirm that the impact of knowing about the design of the medication process, with the purpose of improving it, simplifying it and implementing preventive technologies, can reduce the occurrence of medication errors.

Meta-analysis studies that assessed the rate of medication errors in pediatric patients when prescribing, dispensing, and administering indicated that the medication process is significantly prone to errors, especially in the prescription and administration subprocesses[1]. Nevertheless, even considering that a large part of dispensing errors does not cause harm to patients, it demonstrates fragility, inefficiency and insecurity in the work process and contributes directly to increase the risks within the pediatric population, specifically; which is more susceptible to adverse events to medicines. Thus, it is evident that the adoption of preventive technologies is essential to avoid medication errors.

Currently, there are several technologies that can help prevent medication errors. An integrative review characterized scientific productions on patient safety and their contributions, pointing to light and light-hard technologies for continuing education and patient safety commissions[23]. These data are in line with the findings of the present study, since training/integration and the existence of the patient safety group were technologies validated by the professionals. A study that questioned nursing professionals about behaviors in the face of error and proposed actions to minimize them in a general hospital, also highlighted training as an important part of preventing medication errors, in addition to computerized prescriptions, a system for dispensing medications per unit dose, individualized drug labeling and fewer prescriptions at the same time[24]. A study that aimed to characterize the training related to the prevention of medication error and to verify the participation of the Nursing team in a teaching hospital pointed out that several training opportunities related to patient safety were offered. In the end, the team demonstrated some difficulties in distancing themselves from the field of work to participate in these trainings, thus requiring greater organization[25].

Other technologies are being used by nursing professionals to prevent medication errors, such as electronic medication administration records[26], standardization of medications and high alert drugs, computerized prescriptions, barcodes, medication dispensing systems by unit dose, double-checking and patient participation in therapy[27], in addition to the process of continuing education and integration of newly hired professionals[25]. A current form that can be used for learning programs among professionals is simulation, as it allows the health team to learn without directly involving the patient. Simulation, when properly regulated, has shown important results for the prevention of medication errors[28]. Again, the technologies contemplated in this study show an agreement between what is recommended in the literature and the validation performed by the professionals.

A Swiss study evaluated the patient safety culture in the emergency department of a University Hospital and pointed out that after training there was an improvement in the patient safety culture in the department related to organizational learning[29]. We can conclude that professionals often do not have sufficient knowledge about aspects related to patient safety. This aspect is observed in the present study, when professionals needed to relate the technologies to the type of error they prevented, that is, they demonstrated (n=26) insecurity and uncertainty. This fact can be proven by relating the patient's identification bracelet to the error of route, dose, or time and, in fact, the identification bracelet only guarantees the verification of the patient's identification. These data may be related to the lack of an educational culture in the face of errors (3). Failure to recognize the types of errors can lead to the inefficient use of preventive technology.

As for the classification of the technology, one is of the light type, eight of the light-hard type and nine of the hard type. The Flowchart (light-hard technology) represented in this research was valued in order to enable an understanding of how the drug chain operates in terms of structure, process, policies and technology as a tool in decision making. The HIS (hard technology) was identified in this study as the technology that most prevents the different types of medication errors. Currently, the appreciation of hard technologies is visible due to multiple factors such as the volume and flow of information, which are increasingly larger and require high speed and storage capacity. They directly contribute to the increase in efficiency, productivity of employees and better performance and cost reduction of health institutions. However, it is believed that in order to meet a set of risks and intercept them in the drug chain, there is a certain need to insert different combinations of effective and appropriate technologies for each situation without the supremacy of one or another type of technology. Thus, it is clear that despite the economic crisis, there is a high technological investment and a growing convergence in the Brazilian health scenario in creating a culture of safety in organizational environments, as they depend on the physical structure, working conditions and qualification of the professionals who work in the drug chain to make it safe.

This research presents limitations on the impossibility of generalizing the results achieved, as it is the reality of an institution selected by convenience criteria; it may be necessary to adapt the results to the different realities found in other scenarios. However, as implications for professional practice, the results showed the mapping of the activities owf the entire drug chain process, identification of the allocation points for preventive technologies and, therefore, can contribute to the organization of the work process, creating spaces for continual improvement to reduce the occurrence of medication errors.

CONCLUSION

The medication process was mapped and validated in three subprocesses and the technologies that can prevent medication errors were allocated in their place of operation. It was observed that professionals still have difficulty understanding issues related to medication errors, which can be a factor that interferes with the correct use of preventive technologies. The use of the Flowchart as one of the quality management tools applied to the practice of health professionals is an important step in ensuring safe care.

Thus, it is believed that mapping the drug chain, as well as the combination of multiple preventive technologies, can create a vision of a complete medication system and co-responsibility for both the patient and the health team and institution, aiming to meet a specific objective which is patient safety.

REFERENCES

1. Koumpagioti D, Varounis C, Kletsiou E, Nteli C, Matziou V. Evaluation of the medication process in pediatricpatients: a meta-analysis. J Pediatr (Rio J). 2014;90(4):344-355. Disponível em: https://reader.elsevier.com/reader/sd/pii/

2. Wittich CM, Burkle CM, Lanier WL. Medication Errors: An Overview for Clinicians. Mayo Clin Proc. 2014; 89(8):1116-25. Disponível em: https://www.mayoclinicproceedings.org/action/showPdf?pii=S0025-6196%2814%2900439-X Acesso em jun 2020.

3. Vilela RPB, Jericó MC. Erro de medicação: gestão do indicador para uma prática mais segura. Rev enferm UFPE on line. 2016; 10(1):119-27 Disponível em: https://periodicos.ufpe.br/revistas/revistaenfermagem/article/view/10929/12220 Acesso em jul 2016.

4. Riaz MK, Riaz M, Latif A. Review - Medication errors and strategies for their prevention. Pak J Pharm Sci. 2017; 30(3):921-928. PMID:28653940

5. Vilela RPB, Pompeo DA, Jericó MC, Werneck AL. Custo do erro de medicação e eventos adversos à medicação na cadeia medicamentosa: uma revisão integrativa. J Bras Econ Saúde. 2018;10(2):179-189. Disponível em: http://docs.bvsalud.org/biblioref/2018/09/915114/jbes102-art-11.pdf Acesso em jul 2020.

6. Brasil. Portaria 529, de 01 de abril de 2013. Institui o Programa Nacional de Segurança do Paciente. Diário Oficial da União, 01 de abril de 2013. Disponível em: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2013/prt0529_01_04_2013.html Acesso em jul 2016.

7. Wourld Health Organization. Medication Without Harm- Global Patient Safety Challenge on Medication Safety. 2017. Disponível em: http://apps.who.int/iris/bitstream/handle/10665/255263/WHO-HIS-SDS-2017.6-eng.pdf?sequence=1. Acesso em nov 2018.

8. Lopes EM, Pinheiro AKB, Pinheiro PNC, Vieira NFC. Tecnologia e práticas de enfermagem - um estudo bibliográfico. Online Brazilian Journal of Nursing. 2009; 8(1). Disponível em: http://www.objnursing.uff.br/index.php/nursing/article/view/1883/446 Acesso em jul 2016.

9. Barra DCC, Nascimento ERP, Martins JJ, Albuquerque GL, Erdmann AL. Evolução histórica e imapcto da tecnologia na área saúde e da enfermagem. Revista Eletrônica de Enfermagem. 2006; 8(3):422-30. Disponível em: https://revistas.ufg.br/fen/article/view/7081/5012 Acesso em fev 2018.

10. Brasil. Avaliação de tecnologias em saúde: ferramentas para a gestão do SUS. Editora do Ministério da Saúde. 2009. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/avaliacao_tecnologias_saude_ferramentas_gestao.pdf Acesso em dez 2017.

11. Reis HPLC, Vasconcelos HCA, Fonteles MMF. Documentação das não conformidades do ciclo farmacotapêutico no âmbito hospitalar: método HENPA (uma proposta). Revista de Ciências Farmacêuticas Básica e Aplicada. 2012; 33(4):607-615. Disponível em: https://rcfba.fcfar.unesp.br/index.php/ojs/article/view/266/264 Acesso em jul 016.

12. Pazin A Filho, Frezza G, Matsuno AK, Alcântara ST, Cassiolato S, Bitar JPS, et al. In-Hospital prescription guidelines for undergraduate medical students. Medicina (Ribeirão Preto). 2013; 46(2):183-94. Disponível em: http://revista.fmrp.usp.br/2013/vol46n2/TEM_Princ%EDpios%20de%20Prescri%E7%E3o%20M%E9dica%20Hospitalar%20para%20Estudantes%20de%20Medicina.pdf Acesso em jul 2016.

13. Cassiani SHB, Miasso AI, Silva AEBC, Fakin FT, Oliveira RC. Aspectos gerais e número de etapas do system de medicação de quatro hospitais brasileiros. Rev Latino-Am Enfermagem. 2004; 12(5):781-789. Disponível em: https://www.scielo.br/pdf/rlae/v12n5/v12n5a12.pdf Acesso em jul 2016.

14. Vilela RPB, Jericó MC. Implantação de tecnologias para a prevenção de erros de medicação em hospital de alta complexidade: análise de custos e resultados. Einstein (São Paulo). 2019; 17(4):1-7. Disponível em: https://www.scielo.br/pdf/eins/v17n4/pt_2317-6385-eins-17-04-eGS4621.pdf Acesso em jun 2020.

15. Cassiani SHB. A segurança do paciente e o paradoxo no uso de medicamentos. Rev Bras Enferm. 2005; 58(1):95-99. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0034-71672005000100019 Acesso em nov 2015

16. Conselho Regional de Enfermagem de São Paulo. Uso seguro de medicamentos: guia para preparo, administração e monitoramento. COREN-SP. 2017. Disponível em: http://www.coren-sp.gov.br/sites/default/files/uso-seguro-medicamentos.pdf Acesso em dez 2017.

17. Gimenes FRE. Administração: não basta usar, é preciso conhecer a maneira correta. OPAS. Uso Racional de Medicamentos: fundamentação em condutas terapêuticas e nos macroprocessos da Assistência Farmacêutica. 2016; 1(18):1-7. Disponível em: https://www.researchgate.net/profile/Fernanda_Gimenes3/publication/327719753_Administracao_nao_basta_usar_e_preciso_conhecer_a_maneira_correta/links/5ba095a8299bf13e6038c1cf/Administracao-nao-basta-usar-e-preciso-conhecer-a-maneira-correta.pdf Aceso em jul 2020.
18. Magalhães ALP, Erdmann AL, Silva EL, Santos JLG. Lean thinking in health and nursing: an integrative literature review. Rev Latino Am Enfermagem. 2016; 24:e2734. Disponível em: http://www.scielo.br/pdf/rlae/v24/0104-1169-rlae-24-02734.pdf Acesso em jan 2017.
19. Sanders JH, Karr T. Improving ED specimen TAT using Lean Six Sigma. Int J Health Care Qual Assur. 2015; 28(5):428-440. doi:10.1108/IJHCQA-10-2013-0117
20. Régis TKO, Santos LC, Gohr CF. A case-based methodology for lean implementation in hospital operations. J Health Organ Manag. 2019; 33(6):656-676. doi:10.1108/JHOM-09-2018-0267
21. Yamanaka TI, Pereira DG, Pedreira MLG, Peterlini MAS. Redesenho de atividades de enfermagem para redução de erros de medicação em pediatria. Rev Bras Enferm. 2007; 60(2):190-6. Disponível em: https://www.scielo.br/pdf/reben/v60n2/a11v60n2.pdf Acesso em jul 2016.
22. Alsulami Z, Choonara I, Conroy S. Nurses' knowledge about the double-checking process for medicines administration. Nurs Child Young People. 2014;26(9):21-26. doi:10.7748/ncyp.26.9.21.e378
23. Nunes FDO, Barros LAA, Azevedo RM, Paiva SS. Segurança do paciente: como a enfermagem vem contribuindo para a questão?. J Res Fundam Care Online. 2014; 6(2):841-7. Disponível em: http://www.seer.unirio.br/index.php/cuidadofundamental/article/view/3007/pdf_1297 Acesso jul 2016.
24. Silva BK, Silva JS, Gobbo AFF, Miasso AI. Erros de medicação: condutas e propostas de prevenção na perspectiva da equipe de enfermagem. Revista Eletrônica de Enfermagem. 2007; 9(3):712-23. Disponível em: https://www.fen.ufg.br/fen_revista/v9/n3/pdf/v9n3a11.pdf Acesso em jun 2016.
25. Vilela RPB, Castilho V, Jericó MC, Faria JIL. Educação permanente: tecnologia para a prevenção do erro de medicação. Cuidarte Enfermagem. 2017; 11(2): 203-208. Disponível em: http://www.webfipa.net/facfipa/ner/sumarios/cuidarte/2017v2/203.pdf Acesso em mar 2020.
26. Alanazi A, Alomar M, Aldosari H, Shahrani A, Aldosari B. The Effect of Electronic Medication Administration Records on the Culture of Patient Safety: A Literature Review. Stud Health Technol Inform. 2018; 251:223-226. doi:10.3233/978-1-61499-880-8-223
27. Jordão MM, Silva MF, Santos SV, Salum NC, Barbosa SFF. Tecnologias utilizadas pela enfermagem na prevenção de erros de medicação em pediatria. Enfermagem em Foco. 2012; 3(3):147-150. Disponível em: https://www.researchgate.net/profile/Simone_Santos16/publication/262915512_Tecnologias_utilizadas_pela_enfermagem_na_prevencao_de_erros_de_medicacao_em_pediatria/links/595008d6aca27248ae438950/Tecnologias-utilizadas-pela-enfermagem-na-prevencao-de-erros-de-medicacao-em-pediatria.pdf Acesso em jul 2016.
28. Sarfati L, Ranchon F, Vantard N, et al. Human-simulation-based learning to prevent medication error: A systematic review. J Eval Clin Pract. 2019; 25(1):11-20. doi:10.1111/jep.12883
29. Ricklin ME, Hess F, Hautz WE. Patient safety culture in a university hospital emergency department in Switzerland - a survey study. GMS J Med Educ. 2019; 36(2):Doc14. doi:10.3205/zma001222

Received in march 2020.
Accepted in august 2020.