ARTICLE
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Implementation of two software models for the surveillance and the detection of errors in prescriptions for the parenteral nutrition production in a specialized Compounding Center

Implantação de dois modelos de programas computacionais para vigilância e detecção de erros em prescrições na produção de nutrição parenteral em uma farmácia de manipulação especializada

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ABSTRACT

Introduction: Errors involving the prescription of medications are frequent in the health area, causing adverse events in hospitalized patients and economic losses in the productive process. The verification of the prescriptions, which must be elaborated in a complete and legible way, is of great importance in surveillance and prevention of errors. **Objective:** The objective of this work was to analyze the results of the implementation of two computational programs, Microsoft Excel for MAC version 15.27 for the preparation of electronic prescription, made available to the prescriber physician, and the Enterprise Resource Planning, for error alerts on the production line of parenteral nutritions, in the period 2006 to 2015. **Method:** The method used was based on a case study, conducted through a longitudinal survey of primary data, of an exploratory and descriptive nature, with participant observation in the implementation of softwarein a specialize Compounding Center. **Results:** In the year 2015, 39.5% of the prescriptions were sent through fax or email. However, such prescriptions received a number of Occurrences of Potential Errors (OPE) of 97.9%. **Conclusions:** The softwareof production proved to be an important tool of quality, especially in the production of PN for newborns, since it was identified the prevalence of alerts of prescription errors, in the proportion of 1.7 alerts for each elaborated prescription.

KEYWORDS: Electronic Prescription; Production; Parenteral Nutrition; Alert

RESUMO

Introdução: Os erros envolvendo a prescrição de medicamentos são frequentes na área da saúde, causando eventos adversos em pacientes hospitalizados e perdas econômicas no processo produtivo. A verificação das prescrições possui grande importância na vigilância e prevenção de erros, que devem ser elaboradas de forma completa e legível. **Objetivo:**Analisar os resultados da implantação de dois programas computacionais: o Microsoft® Excel para Mac Versão 15.27, para elaboração de prescrição eletrônica, disponibilizada para o médico prescritor, e o *Enterprise Resource Planning*, para os alertas de erros na linha de produção de nutrições parenterais, no período de 2006 a 2015. **Método:** Estudo de caso, realizado por meio de um levantamento longitudinal de dados primários, de natureza exploratória e descritiva, com observação participante na implantação dos programas computacionaisem uma farmácia de manipulação especializada. **Resultados:** No ano de 2015, 39,5% das prescrições foram enviadas por meio de fax ou e-mail, porém para tais prescrições recebidas o número de Ocorrências de Erros Potenciais (PEO) foi de 97,9%. **Conclusões:** O programa computacional de produção demonstrou ser uma importante ferramenta de qualidade, principalmente na produção de NP para recém-nascidos, visto que identificou a prevalência de alertas de erros em prescrições, na proporção de 1,7 alerta para cada prescrição elaborada.

PALAVRAS-CHAVE: Prescrição Eletrônica; Produção; Nutrição Parenteral; Alerta

INTRODUCTION

According to Raimbault et al.[1], Parenteral Nutrition (PN) is a vital medical intervention that meets the nutritional needs of patients whose gastrointestinal tract is not functioning properly, in both pediatric and adult populations. The preparation of parenteral solutions is an intricate process that involves many professionals and systems in a standardized fashion. The prescribing step of PN requires the attention of all professionals involved, from the prescribers (responsible for making legible and thorough prescriptions) to the pharmacists in charge of the production line, who check the composition of the PN and provide favorable and safe conditions for the drug therapy[2].

PN is made based on a customized medical prescription for a critical inpatient[3]. Producing PN solutions is a complex process, since these solutions typically contain a mixture of more than ten different solutions[1]. Furthermore, the compounding of PN is tailored to each patient's individual needs and the formulations are prescribed according to age group, gender, patient status, and specific disease[4]. Its use is indicated when the patient is unable to use the enteral route or in cases that have underlying diseases that hinder ingestion, digestion or absorption of food. PN is administered intravenously and the formulations are specially prepared for this purpose. Professionals prescribe and employ amounts of small-volume parenteral solutions (SVPS) like vitamins, minerals and electrolytes and large-volume parenteral solutions (LVPS) like sterile water, lipids, amino acid source and dextrose[5].

Errors in administering solutions and medication often occur in hospitals. They are classified as adverse events (AEs), which in healthcare settings can be identified as "unintentional injury or harm to the patient by assistance intervention, and not by the underlying disease [...] avoidable, unavoidable or error"[6]. It should be noted that the AEs that most commonly affect the lives of patients and their families, the environment of healthcare professionals and society are: healthcare-associated infections (HAI); medication events; wrong dose or route; serious adverse drug reactions; diagnostic errors; failures in communication between professionals; performing surgeries on the wrong patient or wrong body parts (laterality); and the retention of foreign bodies[7]. These errors have severe consequences for the patients and can often lead to death. They also have consequences and penalties to healthcare professionals and institutions[8]. Prescriptions are of great importance in the prevention of AEs. When they are incomplete or illegible (nomenclature of prescribed drugs is not standardized, there are abbreviations and erasures), they contribute to the occurrence of errors[2].

PN prescription is submitted to a compounding center that specializes in the preparation of customized medications. For PN to be safely administered, it is necessary to control the work area, the aseptic technique, the handlers and the compounded solution, according to Ordinance n. 272, of April 8, 1998. The compounding should be done by a skilled professional in an appropriate sterile environment[9].

Information technology (IT) is being increasingly used to support the health of the population, as well as public health activities. It can improve actions in surveillance; health monitoring, prevention and promotion; and disease control. One thing that has evolved as a consequence of the digital age is the use of electronic prescribing software that can reduce prescription errors, among other functions[3,10]. Electronic prescribing is the procedure in which the physician prepares the prescription directly on the computer and sends it electronically, thus avoiding errors caused by misunderstanding of illegible handwriting or ambiguous and incomplete prescriptions[11]. Also according to the author, in the electronic prescription system, the software can suggest alternatives to the prescribed medication and diagnostic study, according to the clinical physician's information. This helps structure the prescription, check for allergies, interactions with other medications, as well as frequency that medication is being given to the patient. Therefore, it improves the strategies used to reduce errors resulting from poorly formulated or illegible prescriptions through data consistency.

Implementing an electronic drug prescribing system with clinical decision support features is a strategy to prevent errors. Consequently, the use of automated prescribing systems is an effective tool to: reduce medication errors[12], AEs, guide the prescription of optimal doses and reduce the length of hospitalization. The acquisition of information through error notification systems is a prerequisite to prevent prescribing errors and failures, as well as for the adoption of shared criteria aiming at the standardization of procedures in health institutions. In addition, prescribers should be informed of errors in their procedures[12].

According to Almeida[13], the expression "data consistency" in an algorithm is the verification of whether the data entered is valid or not, i.e., consistency means to verify whether the data are within the established limits or not. Data consistency is used to check data validity so that the proper execution of the algorithm can be ensured. If wrong data are entered, the algorithm will have to accept a new input until the data are in accordance with the required specifications. For this to come about, one can use a repeating structure with testing at the end[13].

Cassiani, Freire and Gimenes[14] pointed that electronic prescriptions can also have errors, although they represent significant progress for the strategies designed to minimize these risks. However, to further prevent medication errors, modifications and improvements to these systems are still needed. In this case, physicians' awareness of the importance of training programs for the use of the electronic system is extremely important, for it can help reduce adverse events as a result of poorly prepared prescriptions.

The safety of patients who depend on PN is linked to the time required by the medical prescription (which contains the formulation of the solution) and the timing of the pharmacy specialized in the production of the PN. In order to achieve fast, customized and safe PN production, pre-check steps prior to the handling and preparation are important to reduce prescribing errors. This can reduce the impact on delivery times, reduce AEs and costs for the company.

The pursuit of solutions for the detection of PN prescribing errors is yet a field to be understood in the system of production of medical supplies as a step of the care process and also to ensure patient safety. This paper aims to answer the following research question: how has the implementation of computer programs contributed to the detection of alerts or deviations of PN prescriptions in a specialized compounding pharmacy between 2006 and 2015?

The objective of the study was to evaluate the implementation of computer programs for the design of electronic prescriptions and for the detection of deviations in prescriptions sent by fax or e-mail in a compounding pharmacy specialized in PN. We surveyed the main errors and deviations in the preparation of PN and analyzed the changes in the technological adhesion of clients (prescribing physicians) to the production flow over time, pointing to the medical professionals what patients need more caution and care during the preparation and use of PN.

METHOD

Creswell and Clark[15] determined mixed methods as the combination of quantitative and qualitative techniques in the same research design. Quantitative data, such as numbers and indicators, can be analyzed using statistics (frequency, mean, median, mode) and qualitative research focuses on the process experienced by the subjects, such as document analysis, interviews and participant observation or not. We conducted a mixed exploratory and longitudinal study (with participant observation by one of the authors). The study analyzes the timeline of the phenomenon, based on the survey of primary data on the implementation of programs between 2006 and 2015.

The institution that was the object of this study is a compounding pharmacy specialized in the production of PN. It is part of a multinational pharmaceutical group of the LCC type, with both public and private hospitals as clients, mainly in the Brazilian state of São Paulo. Considered small, it has about 60 employees distributed in the following departments: production, quality assurance, logistics and sales, human resources, procurement, finance, engineering and maintenance, and information technology.

Prescriptions made by their medical clients used to be sent by fax and e-mail. As of 2006, a computer program was implemented to enable customized and dedicated electronic prescription. It is accessed online with the prescriber's username and password. The prescriber then fills in the predetermined blanks with all the necessary information for the PN to be compounded. Prior to sending the prescription to production, the electronic prescription program performs a first check called 1st Consistency, in which components and their quantities are evaluated and compared against preset parameters of the prescription program. This is done taking into account the interaction between components and patient data like age, weight and height.

After mapping the PN request flowchart, the errors, deviations and prescribing alerts from 2006 to 2015 were quantified (in the registration system). Primary data were obtained from the IT department. Between 2006 and 2015, a total of 839,624 prescriptions (fax, e-mail and electronic prescription) were computed.

Figure 1 shows the flowchart of the production process, from the preparation of the electronic prescription by the client to the shipping of the product compounded by the institution that was the object of this study.

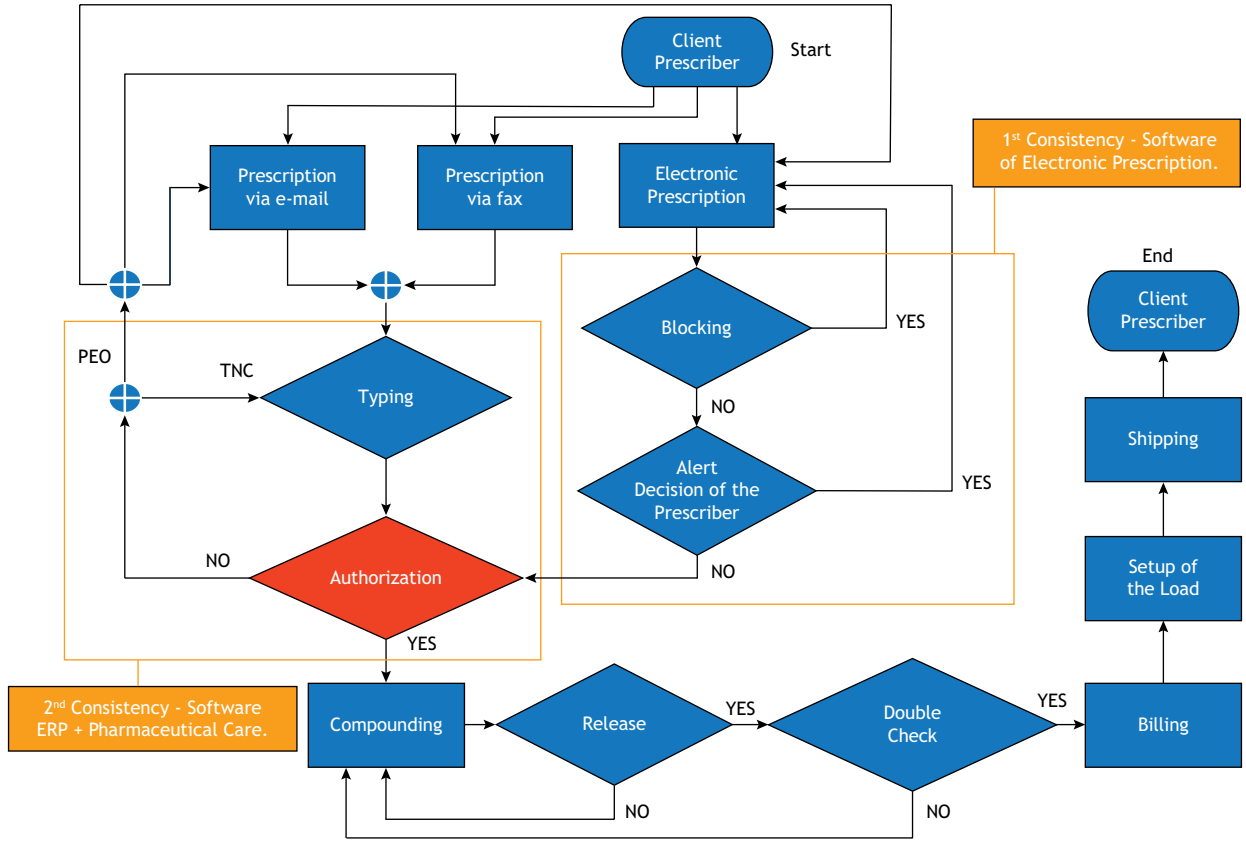
We considered the total number of prescriptions with "alerts" and/or "deviations", since these are critical control points that may interrupt the sequence of the product request process until these "deviations" are fixed or elucidated. The "alerts" and/or "deviations" detected at each stage of the process (either in the 1st or in the 2nd Consistency) for each type of prescription that was sent (electronic or fax/e-mail) were assessed and ordered as described in Table 1.

Survey data from the IT department were obtained through screeners especially designed for the results of the present study with Microsoft® Excel for Mac Version 15.27. The 1st Consistency is performed by the electronic prescription program, together with the prescribing physician. In this case, the prescription is checked by the client and has not yet been sent to production. If there is any data nonconformity, the prescription is blocked by the program and returned to the requester for correction. In the 1st Consistency step there are three different paths or situations generated by the automated system:

1. Blocking: situation in which the prescription is not sent for compounding due to a highly critical error or failure that may jeopardize patient safety. In this case, the prescription must be amended so that it fits with the predetermined parameters.

2. Alert: situation in which changes in the prescription are recommended according to the information entered by the prescriber. In this case, the prescriber may or may not follow the recommendations of the program, and the prescription can be sent even without the changes.

3. Submission: if the program does not find or detect any "blocking" or "alert", the prescription is sent to the compounding pharmacy for the step of "authorization" by the pharmaceutical assistance team (2nd Consistency).



Source: Prepared by the authors.
PEO: Potential error occurrence; TNC: Typing nonconformity; ERP: Enterprise Resource Planning.

Figure 1. Flowchart of the production process.

Table 1. Consistency survey for quantitative assessment.

Type of Prescription	Consistency	Type of Occurrence	Period
Electronic prescription	1st Consistency	Number of "Alerts"	March 2006 to December 2015
Electronic prescription	2nd Consistency	Number of PEO "Deviations"	June 2008 to December 2015
Prescriptions sent via fax and email	2nd Consistency	Number of PEO "Deviations"	June 2008 to December 2015
Prescriptions sent via fax and email	2nd Consistency	Number of TNC "Deviations"	December 2013 to December 2015

Source: Prepared by the authors.
PEO: Potential error occurrence; TNC: Typing nonconformity.

The "Alert" is the step in which the program suggests to the prescribing physician a change in the prescription due to incompatible calculations. If in the 1st Consistency the parameters are correct and according to the predetermined specifications, the prescription is forwarded to the second check or 2nd Consistency, where it is checked again before being sent for compounding. This step is performed by the Enterprise Resource Planning program (ERP) with the participation of the team of pharmacists. The 2nd Consistency is the last step of checking all types of prescriptions sent (via fax, email or through the electronic prescription program) prior to their submission for compounding. If there are any nonconformities and/or deviations, like a dosing error, the responsible pharmacist generates the so-called Potential Error Occurrence (PEO), informing the prescribing physician of the necessary amendments.

It is noteworthy that in the 2nd Consistency step the prescriptions sent by fax and e-mail are transcribed into the registration system by an employee of the institution and evaluated by the team of pharmaceutical assistance. It is the last step before the prescription is sent for production. Its implementation began in June 2008. For this reason, the survey was conducted as of this date. In December 2013, a tool was implemented in the ERP program for the measurement and evaluation of the "deviations" occurred during the typing/transcribing of the prescriptions sent

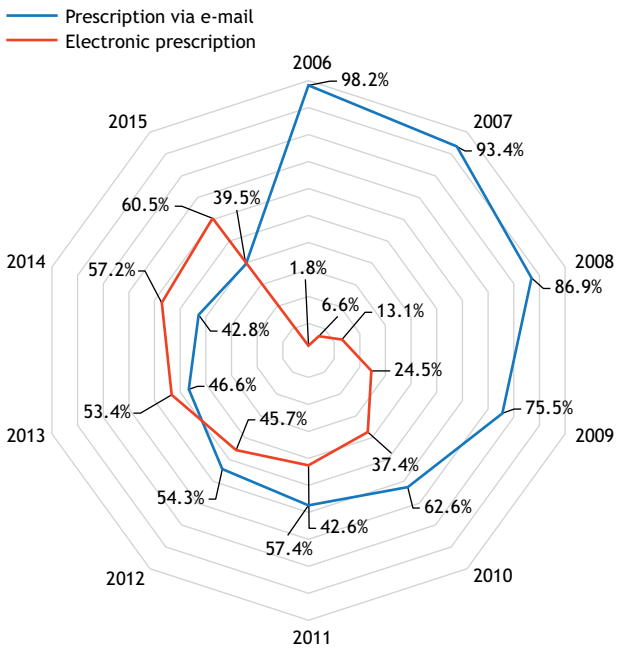
via fax and via e-mail. In the case of prescriptions received via fax or e-mail, if the responsible pharmacist finds a typo coming from the employee in charge of the transcription and not from the prescriber, in the 2nd Consistency, a Typing Nonconformity (TNC) is recorded and the prescription is sent back to the typing step for correction.

RESULTS

Of the total prescriptions (n = 839,624), 510,439 were faxed or emailed and 329,185 were electronic prescriptions. Figure 2 shows the percentage (%) of prescriptions sent electronically, via fax and e-mail, according to the survey from 2006 to 2015.

It was only between 2012 and 2013 that the number of prescriptions sent by electronic means exceeded the prescriptions sent by fax and e-mail. In 2015, the percentage of prescriptions sent electronically was 60.5% of the total, whereas 39.5% of prescriptions still used fax or e-mail. The prescriptions were classified by age group. According to the State Department of Health, the neonatal or newborn (NB) period goes from birth until the time the child is 27 days, 23 hours and 59 minutes old. From the 28th day until the child is 18 years old, they are classified as pediatric patients. After the age of 18, they are considered adults[16].

The largest number of electronic prescriptions corresponded to NB prescriptions, which accounted for most of the demand of the compounding pharmacy. Figure 3 shows the percentage of electronic prescriptions received from 2006 to 2015 by age group (patient/year): adult, pediatric and newborn.



Source: Prepared by the authors.

Figure 2. Percentage per year of prescription sent by fax, email and electronically.

The mean number of prescriptions received for NB patients from 2006 to 2015 was 76.3%, for adults 18.5% and for pediatric patients 5.2%, with a median of 74.7%, 18.6% and 5.3%, respectively. The total alerts recorded were 438,624, of which 2,769 were alerts for adult prescriptions, 20,515 were pediatric prescription alerts and 415,340 were newborn prescription alerts. The highest occurrence of "alerts" is in electronic prescriptions for newborns. The mean of "alerts" received in the period from 2006 to 2015 was 95.1% for newborn prescriptions, 4.3% for pediatric prescriptions and 0.6% for adult prescriptions. The medians were of 94.8%, 4.6% and 0.6%, respectively (Table 2).

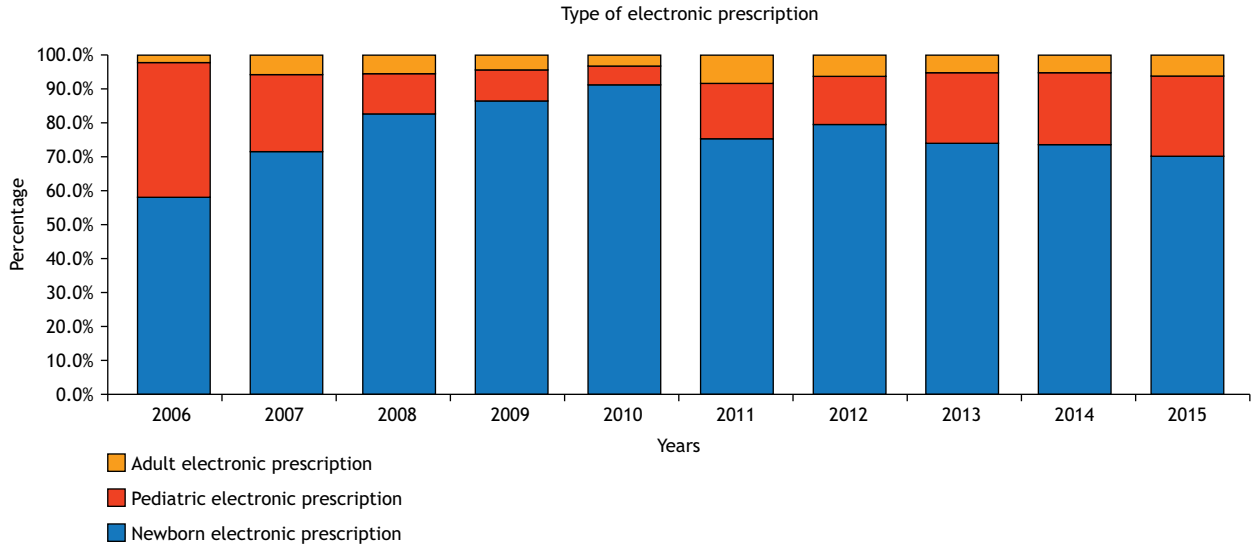
In the present study, when it comes to the electronic prescriptions for newborns and the number of "alerts", we found a ratio of 1.7 alerts/prescription. In the case of pediatric prescriptions, we had 1.1 alerts/prescription, and one "alert" per 21.5 prescriptions for adults. One of the reasons for the high volume of alerts in the case of newborns is that, because of the small volume of the prescribed parenteral nutrition, the number of unwanted chemical interactions between the components is greater, and the prescriber must do all calculations and arrangements to prevent this interaction from happening. In the year of implementation of the ERP program (2008), the number of PEO in the 2nd Consistency was 5,702, of which 95 came from electronic prescriptions and 5,607 came from prescriptions sent via e-mail and fax. TNC data began to be recorded in December 2013. The total recorded until 2015 was 1,951. Data are further represented in percentages for better quantitative analysis in Table 2.

The survey has shown that of the total percentage of PEO, the errors in prescriptions received by fax and e-mail are higher than the errors found in prescriptions received through the electronic prescription program. The mean of the total percentage of PEO opened from 2008 to 2015 for prescriptions received via fax and e-mail was 97.9% and of PEO opened for electronic prescriptions was 2.1%, with medians of 98.4% and 1.6, respectively. Because of the alert screeners, electronic prescriptions had an advantage in terms of the percentage of errors over other forms of PN request (e-mail or fax). Over the years there was an increase in the use of electronic prescription, however, in 2015, 39.5% of prescribers continued to use fax and e-mail.

DISCUSSION

Although commercially available ready-to-use products exist, certain critical medical situations require custom-made PN in their composition. This PN must be produced daily and automatically, based on a medical prescription.

Standardized formulations can be prepared internally in hospitals by hospital pharmacists, however, standardized hospital solutions have a high risk of microbiological contamination and should remain stable throughout their period of use[17]. An alternative for hospitals is to outsource PN production to specialized compounding pharmacies, but disadvantages include longer response times. A survey from the UK has shown that



Source: Prepared by the authors.

Figure 3. Percentage of annual electronic prescriptions by age group.

Table 2. Survey of alert data and occurrences.

Item	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Mean
Alerts adult electronic prescription	0.0%	0.1%	1.6%	0.6%	0.2%	0.6%	0.5%	0.7%	0.7%	0.7%	0.6%
Alerts pediatric electronic prescription	2.1%	5.2%	4.9%	4.2%	3.1%	4.5%	3.2%	4.7%	5.3%	6.0%	4.3%
Alerts NB electronic prescription	97.9%	94.7%	93.5%	95.1%	96.7%	94.9%	96.3%	94.6%	93.9%	93.3%	95.1%
PEO electronic prescription	NA	NA	1.5%	2.3%	1.3%	0.9%	1.0%	1.8%	2.2%	5.9%	2.1%
PEO fax and email	NA	NA	98.5%	97.7%	98.7%	99.1%	99.1%	98.2%	97.8%	94.1%	97.9%
TNC	NA	NA	NA	NA	NA	NA	NA	4	1114	833	-

Source: Prepared by the authors.
NA: Not applicable; NB: Newborn; PEO: Potential error occurrence; TNC: Typing nonconformity.

only 50% of neonatal intensive care units used in-hospital prepared PN, 10% were purchased from both outsourced and hospital-produced facilities, and other hospitals relied only on outsourced services[17].

Standardized PN, although less costly, may be inappropriate in many clinical situations. Today, ready-to-use or industrial PN formulations are not allowed in Canada. Its use has also been banned for children under one year of age in the United States[1]. The management of preterm infants requires specific PN, since some nutrients are essential for their development. The prescription of PN in neonatology is standardized according to the recommendations of the European Society of Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the European Society for Clinical Nutrition and Metabolism (ESPEN)[18].

The pursuit of the reduction of prescribing errors in PN is also warranted by the production costs, which represent significant values of about USD 20,625 to USD 30,968 per month. Discard costs range from USD 2,072 to USD 2,511 per month, mainly because of amino acids, which are responsible for most of these losses[1]. The electronic prescription system has enabled higher quality of care to patients, demonstrating that this model can contribute to the reduction of medication errors. Research has shown that professional performance and medication error rates can improve with the use of electronic tools or computer systems, such as pharmacotherapeutic decision support programs, which often include drug interaction check[17]. Many healthcare organizations seek software packages for their businesses to enable their companies to automate and integrate most of their processes, thus producing and accessing information in real time. This type of integrated management system, called ERP, is basically characterized by the integration of different areas of the organization into one, without separating the departments that preceded it[20].

Although health information systems and computer programs are recognized as tools that reduce costs and increase the effectiveness of care, less than 10% of US hospitals have an integrated system, although computerized prescription systems have been available for roughly 30 years[21]. Despite the advantages over manual or non-computerized methods, electronic prescription programs still have problems, like the cost of purchasing the product and the low compliance of users. These issues occur due to little or no end-user participation during product

specification. According to Devine et al.[22], better readability of electronic prescribing systems, reductions in prescribing errors, implementation of drug interaction alerts and hypersensitivity are not directly linked to system satisfaction levels, but due to both inability and the operation of these systems, which makes deployment difficult. When planning is structured and in line with customer requirements or needs, development time and rework decrease. There is also increased quality and the efforts of developers can focus on developing the software system in order to maximize end user satisfaction[23].

The data presented corroborate the findings of the study on the high demand of PN for newborns and the high rate of medication errors in children, in the stages of prescription and drug administration. In the study by Kaushal et al.[24], such a predominance of pediatric prescription errors was also noted. Medication errors as potential sources of harm were three times more common in hospitalized pediatric patients than in adults. The management of preterm infants requires specific PN and the pediatric population is subject to medication errors due to the large variation in body mass that requires the calculation of single drug doses based on the patient's weight or body surface, age and clinical condition. The amino acids present in the PN can degrade over time by oxidation. Therefore, it is mandatory to check amino acid stability during the storage of these solutions. The relationship between essential and nonessential amino acids must also be preserved to promote nitrogen balance and anabolism in premature infants[25]. According to Lewis et al.[26], an analysis estimated the incidence of prescription errors at a median of 7% of drug requests, 52 errors per 100 admissions, and 24 errors per 1,000 patients per day.

Dispensing errors are made by both the prescriber and at the time of dispensation. They are identified when the pharmacist makes a careful assessment of the prescription and double-checks it. This is a procedure whose purpose is to detect dispensing errors and flag them before they leave the pharmacy. This is safer for the patients, given that the double-check work done by the pharmacist prevents the wrong drug from reaching them[27].

Similarly, in the production of PN, the pharmaceutical intervention in the 2nd Consistency step was fundamental in the prevention of AEs due to prescribing errors, ensuring the quality of care and patient safety, and reducing hospital costs as a consequence. The use of the program or the intervention of the pharmacist alone are not enough. As strategies to minimize prescribing errors, there is the implementation of electronic prescribing, the training of prescribers (importance of legible prescription) and the double-check by the pharmacist after the 1st Consistency.

Still on clear and legible prescriptions, Volpe et al.[11] have pointed out that abbreviations or acronyms are commonly used in manual prescriptions, with the purpose of saving time. However, these are risk factors, once they can be mistakenly interpreted by healthcare professionals. Illegibility also increases the risk of errors in medication administration. These risk factors were analyzed and screeners were enhanced with the electronic prescription system.

The implementation of the electronic prescription system in a hospital is a time consuming process that is constantly being updated. However, some barriers emerged at the same speed as information technology. This implementation requires the participation of various players, as well as the collaboration of managers and board to make the project feasible[27].

Another obstacle to the compliance with electronic prescriptions is the lack of interest in the use of new technologies by medical professionals. Data presented by the Regional Center for Studies on the Development of the Information Society[28] have shown that the vast majority of health facilities in Brazil use computers (94%) and internet (91%) in their activities. However, in the workplace, access to computers and the internet by physicians is lower than the availability of these tools in the establishment in general, and 23% of physicians reported having attended a course or training on the use of Information and Communication Technologies (ICT) in health. Among health professionals, 63% of physicians have access to computers at work and 60% have access to the internet, according to data from the Regional Center for Studies on the Development of the Information Society (CETIC)[28], which corroborate the numbers of the present study. While electronic prescribing reduces Potential Error Occurrences in the 2nd Consistency step and the increase in the number of electronic prescriptions became more evident between 2006 and 2015, only about 60% of requests were made through the submission of electronic prescriptions.

Silva and Marques[29] pointed out that in the globalized world information is made available in an exacerbated manner. Technology is an inherent part of the process, which makes ICT compliance necessary so that the information can be processed as quickly as possible. Providing greater awareness among physicians and interns about the importance of training programs for the use of the system, which aims to limit adverse errors resulting from poor prescriptions, is critical[30]. According to McDonald[31], we are entering the age of healthcare computerization, which is largely catalyzed by the perceived benefits to patient safety and the widespread promotion of this information by a wide range of stakeholders.

According to Anvisa[32], attention needs to be paid to new types of prescription errors, which may be caused by changes in the prescription form (handwritten, typed, pre-typed and electronic). Manual prescribing can lead to a high number of errors, although some of these prescriptions may even be legible. Rosa et al.[33] have analyzed 4,026 prescriptions of potentially hazardous drugs and, according to the prescription structure, pointed out that the predominance of errors was found in the prescriptions made by hand. Regarding the type of error, 47% were in the patient's name and 19.3% were illegible prescriptions. The authors suggested the need for standardization in the prescribing process, as well as the elimination of manual prescriptions. Using pre-typed or edited prescriptions can reduce potentially hazardous drug-related errors[33]. The Ministry of Health recommends the use

of digitized and electronic prescriptions as a way to improve legibility. In such cases, it is recommended that forms without lines be used for printing to avoid medication errors caused by the overlapping of lines with letters and numbers[32].

CONCLUSIONS

Over the years, the use of two computer program models has been shown to reduce the amount of deviations and errors in the compounding of PN found in the prescriptions analyzed in the present study. The "alert" system assists the prescriber in preparing the prescription before it is sent to production, thus avoiding risk and rework. The role of the pharmacist in the 2nd Consistency step is still fundamental in pharmaceutical care. This demonstrates that the professional's expertise should be combined with the ERP program system for the preparation of safe PN, especially for newborns.

Despite many years of implementation of the programs in the system, prescriptions sent by fax are still part of the culture of prescribing physicians. This is either because of obstacles inherent in health establishments or because of difficulties in professional compliance. Although ICT are becoming increasingly common, some professionals are still resistant to adopting them. The big challenge for the future is for these professionals to adapt, as the fax machine itself is now considered obsolete.

The main limitation found throughout this research was related to data collection from all years so that we could quantify the "alerts" and "deviations" found in the electronic prescriptions, fax and e-mail. That was because these records did not exist until 2007 and screeners were incorporated only in 2008, as well as the TNC, which was only established in 2013. There was also no quantitative study on the number of "blockings" done in the 1st Consistency, in which the prescription is not sent to the compounding pharmacy and the prescriber must make the necessary amendments for its submission, since these actions are not registered in the program.

The proposition to the IT department was the creation of new descriptive screeners and records, thus facilitating the institution's research and consultation of the main causes and incidence of errors. For future research, it is also proposed that a study be done according to the characteristics of the institutions, their prescribers and product types, the needs of their patients, and identifying the clusters (hospitals in urban centers, outside city centers, small towns, with or without internet access, number of inpatients, for example).

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Conflict of interest

The authors report that there is no potential conflict of interest with peers and institutions, nor political or financial conflicts in this study.