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Quality improvement of the medication system in a long-term care facility: a hybrid effectiveness-implementation study

Qualificação do sistema de medicação em uma residência de cuidados de longa duração para idosos: um estudo híbrido de efetividade-implementação

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Abstract

Objective: To describe the implementation of a quality improvement intervention for the medication system of a large not-for-profit long-term care facility (LTCF) and evaluate its effectiveness.
Methods: A type 2 effectiveness-implementation hybrid longitudinal study was carried out. We first conducted a diagnosis of the existing medication system, which included the administration of a questionnaire to LTCF staff. Then, an individualized unit-dose dispensing system was implemented and the medication system's flow was adjusted to the local reality. The effectiveness of the quality improvement intervention was assessed by comparing the following pre- and post-implementation factors: 1) time spent on each step of the medication system; 2) strengths and weaknesses observed.
Results: The diagnosis demonstrated multiple points of failure in the medication system. However, the answers to the questionnaire ran counter to what was identified, indicating a lack of knowledge about patient safety. The quality improvement intervention was associated with the following improvements in the medication system: 1) reduction in the number of prescription transcriptions; 2) reduction of medication shortages; and 3) improvement of organization, dynamics, and traceability in distribution, preparation, and administration. An average reduction of 3 hours and 57 minutes in the time spent distributing, preparing, and administering medications was also identified.
Conclusions: The quality improvement intervention was effective, increased the providers' available time, and improved the safety of medication use in the LTCF.
Keywords: homes for the aged; long-term care; medication systems; medication errors; patient safety.

Resumo

Objetivo: Descrever a implementação da qualificação do sistema de medicação de uma residência de cuidados de longa duração (CLD) filantrópica de grande porte para idosos e avaliar sua efetividade.
Metodologia: Foi realizado um estudo longitudinal híbrido de efetividade-implementação do tipo 2. Inicialmente, procedeu-se com o diagnóstico do sistema de medicação, incluindo a aplicação de um questionário para profissionais da residência de CLD. Depois, implementou-se um sistema de distribuição individualizado com dose unitária e um fluxo ajustado à realidade local. A efetividade da qualificação foi avaliada comparando os seguintes fatores pré e pós-qualificação: 1) tempo despendido nas etapas do sistema de medicação; 2) pontos fortes e falhas observadas.
Resultados: O diagnóstico demonstrou múltiplas falhas no sistema de medicação. Porém, as respostas dos profissionais da residência registradas no questionário não revelaram tal cenário, sinalizando desconhecimento desses profissionais sobre a segurança do paciente. A qualificação permitiu as seguintes melhorias no sistema de medicação: 1) redução do número de transcrições das prescrições; 2) redução do desabastecimento de medicamentos; 3) aprimoramento da organização, dinâmica e rastreabilidade na distribuição, no preparo e na administração. Também foi identificada redução média de 3 horas e 57 minutos no tempo despendido para distribuição, preparo e administração dos medicamentos.
Conclusões: A qualificação do sistema de medicação foi efetiva, aumentou a disponibilidade de tempo dos profissionais e aprimorou a segurança no uso de medicamentos na residência de CLD.
Palavras-chave: instituição de longa permanência para idosos; assistência de longa duração; sistemas de medicação; erros de medicação; segurança do paciente.

INTRODUCTION

With population aging, there has been an increase in the prevalence of chronic noncommunicable diseases,[1] making chronicity and frailty predominant characteristics of older age, which increases the demand for long-term care facilities (LTCFs).[2,3]

In Brazil, such facilities are designed to house older adults, whether independent or dependent to varying degrees, who are unable to remain with their families; experience violence or neglect; have been abandoned or made homeless; or whose family ties are fragile or broken.[2,3] In 2016, one out of every hundred Brazilians was estimated to be living in one of the country's approximately 3600 LTCFs, most of which are not-for-profit or charitable establishments (65.2%). On average, each Brazilian LTCF housed 30.4 residents, and only 15% could be considered "large" (housing 50 or more residents).[3]

The complex and frail profile of residents of LTCFs for older adults often results in polypharmacy, which can affect the safety of these individuals.[4] This is because the activities of prescribing, acquiring, distributing, and administering medications involves multiple steps and is influenced by several factors within the medication system, in addition to taking up a substantial part of the working day in a LTCF. Therefore, the performance of these activities can directly impact the safety of medication use and, consequently, the incidence of medication errors.[5-9]

Medication errors are multifactorial, complex, multidisciplinary, and reflect failures in the organization of the medication system, defined as "the profile and organization of the processes, procedures, equipment, interfaces, overall structure, and the environment or conditions under which staff work in the process of using medications".[5,10] This context must be taken into consideration in LTCFs, and there is a need for wide-ranging discussions on the prevention of medication errors and the safety of medication use in this type of facility.[7]

In this sense, several LTCFs worldwide already use processes focused on reducing the incidence of errors – including the adoption of safer dispensing systems – as a means of improving their medication systems. Such systems have been shown to improve the safety of medication use and reduce the incidence of medication errors, with good acceptability and usability.[6,7,11]

In Brazil, a pilot study evaluating the implementation of an individualized unit-dose dispensing system in a private LTCF demonstrated good staff acceptability and increased staff confidence.[12] However, data regarding medication systems or adoption of strategies to promote their improvement in Brazilian long-term care facilities are still scarce, despite the substantial complexity of the older residents of these facilities – particularly at not-for-profit LTCFs, which predominate in the country.[2,3] To fill this gap, the present study was conducted, aiming to describe the implementation of an intervention for quality improvement of the medication system of a Brazilian not-for-profit LTCF and evaluate the effectiveness of said intervention.

METHODS

A longitudinal type 2 effectiveness-implementation hybrid study was conducted to evaluate the implementation and effectiveness of a medication system quality improvement process at a long-term care facility for older adults.[13] This type of design is encouraged by the World Health Organization (WHO) for the assessment of interventions carried out in real-world settings, as is the case of the facility evaluated in this study.[14]

The study was designed in accordance with the Standards for Reporting Implementation Studies (StaRI) statement.[15] The study project was submitted to the Universidade Federal de Minas Gerais Research Ethics Committee and approved (opinion number: 58142122.2.0000.5149).

The study was conducted at a large not-for-profit LTCF in Belo Horizonte, state of Minas Gerais. With an area of approximately 10 000 m^2, the facility had 21 double rooms and 20 triple rooms (all separated by sex), as well as 10 wards with 6 beds each. In addition, it had space for physiotherapy and occupational therapy activities, a pharmacy, a cafeteria, common rooms, a chapel, and garden. At the time of the study, 85 older adults (aged 60 or older) resided in the LTCF.

The staff was initially composed of 1 coordinator, 1 physician, 2 nurses, 1 psychologist, 5 nurse technicians, 1 nursing assistant, 1 social worker, 1 occupational therapist, 1 dietetic technician, 1 physiotherapist, 3 storeroom attendants, and 41 skilled carers. The pharmacy staff consisted of a pharmacy technician and a nurse technician.

To enable proper implementation, a diagnosis and mapping of the LTCF's existing medication system were first carried out through field work.[16] Multiple data collection methods were adopted by the primary investigator and three other pharmacists with experience in the fields of care for older people and patient safety. All collected data were shared among the investigators in monthly meetings held throughout the study period, to promote reflection and emergence of insights to improve the quality of the medication system.

First, the investigators held meetings with the institution's manager and the nursing and pharmacy staff and presented the study proposal. During these meetings, the investigators adopted active listening techniques and took notes in field journals, in an attempt to get closer to the LTCF staff and thus promote an effective field research stage.[16]

The principal investigator then immersed herself in the LTCF, conducting reconnaissance of its layout and overall structure, as well as observation of the entire medication system. The time spent distributing, preparing, and administering medications was recorded. In addition, the investigator carried out a desk review of the LTCF's operating procedures, as well as an analysis of prescriptions and other institutional documents relevant to the diagnosis of the medication system.

All staff members were invited to complete an electronic questionnaire about their perceptions of the medication system in place at the LTCF and the occurrence of medication errors. The questionnaire consisted of open-ended and closed questions scored on Likert-type scales from 1 to 5 as follows:

1) assessment: "excellent", "very good", "good", "fair", and "poor";
2) agreement: "fully agree", "agree", "neither agree nor disagree", "disagree", "fully disagree"; and
3) frequency: "very often", "often", "occasionally", "rarely", and "never".

Additionally, a video describing the new individualized unit-dose dispensing system to be implemented at the LTCF was also made available with the questionnaire. After watching the video, staff members were asked to express their perceptions of the new system.

We achieved an ideal response from the population of staffers on the nursing team (nurses and nurse technicians) and on the pharmacy team (pharmacy technician and nurse technician) – i.e., 11 respondents. Administrative personnel and carers did not complete the questionnaire. However, adopting a high heterogeneity profile (prevalences of 1 to 50%), a sample size equal to or greater than eight individuals was considered statistically significant, considering a confidence level of 90% and a sampling error of approximately 15%.

An informed consent form was made available online on the screen before the instrument questions screen. The questionnaire was developed and stored on an online platform, and participants' responses were retrieved and stored in a Microsoft Excel® software database. All data were manually reviewed to detect possible errors or inconsistencies, and descriptive statistics (absolute and relative frequencies) were then generated.

An in-depth reading was carried out of the collated data (collected in the field during the immersion and observation stage and through the questionnaire addressing the staff's perceptions of the existing medication system). Subsequently, meetings were held between the investigators with the aim of generating the following deliverables:

1) a map of the existing medication system in the LTCF; and
2) the initial design of the LTCF medication system after implementation of the quality improvement intervention.

The initial design of the medication system after the quality improvement intervention was presented to the stakeholders: the institution's manager and its nursing and pharmacy staff. Any suggestions, questions, and insights arising from these meetings were used to improve the proposed design, allowing the construction of an "adjusted redesign of the medication system after the quality improvement intervention" for the LTCF. Both the original and adjusted map and designs were constructed in the Bizagi Modeler® software environment.

The intervention in the present study consisted of implementing an individualized unit-dose dispensing system with a workflow adjusted to the reality of the LTCF. The system was completely outsourced to a specialty supplier (Far.me Farmacoterapia Otimizada S.A.), which provided all oral solids free of charge in individualized boxes containing a reel of plastic packets corresponding to a 30-day supply of treatment, pre-sorted and organized in chronological order of administration. Each packet in the reel contained the oral solid dosage forms to be taken by an individual resident, duly identified with the date, time, and patient name described on the label. The side of the box contained information for traceability of the medicines, such as batch number and expiration date. Oral liquid and injectable medications were provided individually, identified with the patient's name. It is important to note that, before preparing the individual boxes and separating the other pharmaceutical forms, the staff pharmacists at the outsourced provider conducted an analysis of scanned handwritten prescriptions. These professionals also supervised the preparation of individual boxes and their organization in the LTCFs.

During implementation, the LTCF staff was supported by the study team, who introduced progressive quality improvements to the medication system after observation of and feedback from real-world events.

After implementation, the principal investigator once again carried out an immersion/observation stage in the LTCF under study, to evaluate the effectiveness of the quality improvement process of the medication system as implemented. The time spent on distribution, preparation, and administration of medications to all residents of the LTCF in the pre- and post-intervention periods was measured by the principal investigator. For purposes of comparison, the times spent on these activities were described as their standardized

average for 50 patients. The difference in average times before and after the intervention was also described. As this was an assessment of the population of the LTCF and not of a sample, statistical tests—which are based on sample variability for comparisons—were deemed unnecessary.

Additionally, the main characteristics of the medication system before and after the quality improvement intervention were compared descriptively according to the stages of the medication use process. In addition, its strengths were described, as well as observed or potential flaws.

RESULTS

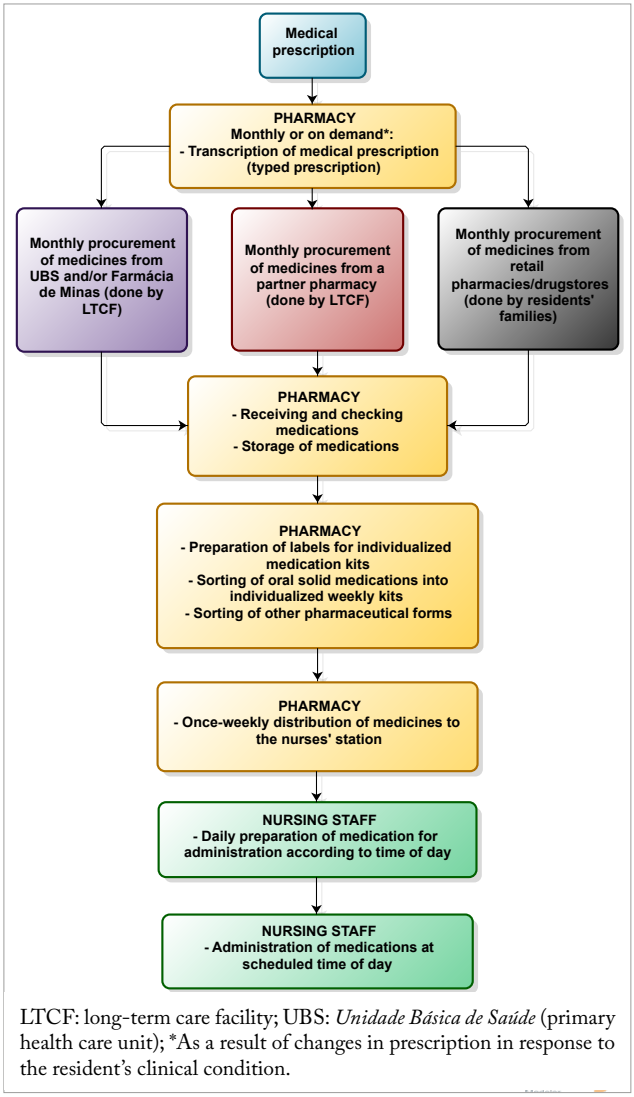
The diagnosis stage allowed the medication system to be mapped (Figure 1). Despite the multiple potential and actual flaws/weaknesses identified in the various stages of the medication system during immersion and observation, the staff's perception of the existing system in the LTCF was mostly positive, as shown in Chart 1.

Considering the preliminary presentation of the new individualized unit-dose dispensing system to be adopted in the LTCF, the staff "Fully agreed" (75%) or "Agreed" (25%) with the statement "The use of the new dispensing system with individualized boxes for each patient would provide benefits in terms of patient safety in this LTCF". In addition, the following positive points were raised among staff responses to the questionnaire: more time available to provide care to residents; greater safety and organization of the medication process; and availability of information directly on medication labels.

When questioned in person, one of the nurse technicians reported having a positive experience and excellent adaptation to the individualized unit-dose dispensing system, as she already worked with the same system at another LTCF. One of the nurses highlighted that the new medication system had the potential to reduce workload and time spent preparing medications, thus increasing the time available for dedicated patient care.

After the diagnostic stage and through interactions between the investigators and stakeholders at the LTCF, an adjusted redesign of the medication system after the quality improvement intervention was constructed (Figure 2). To ensure proper implementation, the investigators implemented educational intervention strategies, based on training given to members of the pharmacy and nursing staff.

In addition, the investigators, together with the facility's staff physician and nurses, discussed and adjusted standardized medication schedules for the residents. Priority was given to reducing the number of times medication was administered and standardizing administration times to match the times when the



LTCF: long-term care facility; UBS: *Unidade Básica de Saúde* (primary health care unit); *As a result of changes in prescription in response to the resident's clinical condition.

FIGURE 1. Map of the existing medication system in the long-term care facility.

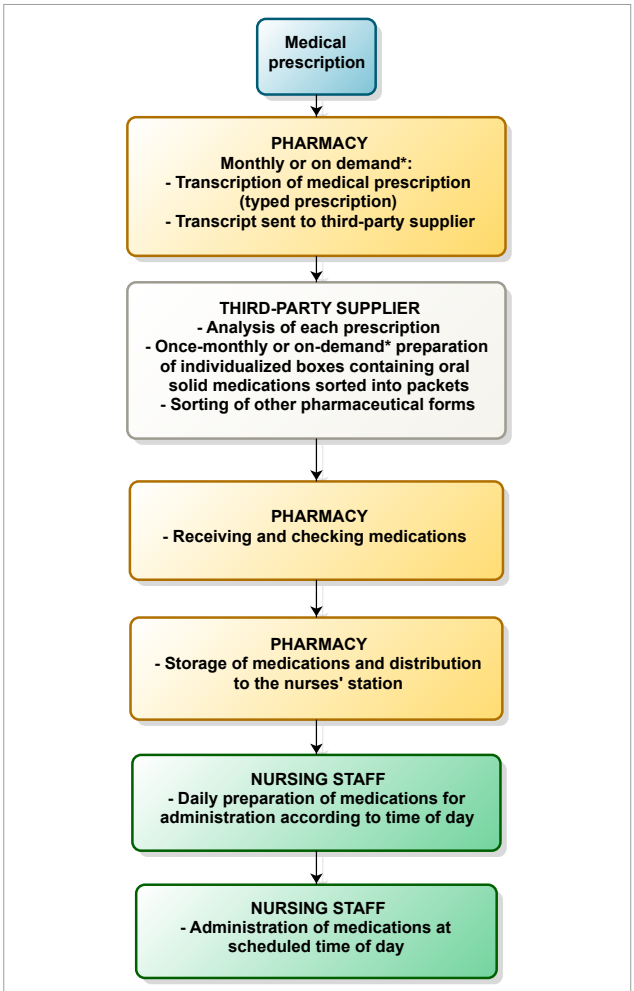
residents were in close proximity to each other. These measures were adopted to promote greater safety for residents. In addition, the outsourced supplier's staff pharmacists analyzed residents' scanned prescriptions with the aim of identifying discrepancies, reconciling information, and adjusting the timing of drug administration to the new standardized schedules.

Procurement of medicines was centralized with the company that supplied the individualized boxes, which were provided monthly and stored in alphabetical order on steel shelves located at the LTCF nurses' station. The pharmacy staff was in charge of receiving, checking and organizing the boxes, having been duly trained for this purpose.

Bottles containing tablets that were not packaged in blister packs, as well as any other pharmaceutical forms required for use by each resident, were stored in individual plastic

CHART 1. Characteristics of the existing medication system (before quality improvement intervention) and staff perceptions thereof. Long-term care facility.

Step	As observed by principal investigator	Staff perceptions questionnaire	Staff responses (%)
Prescription and transcription	Prescriptions are handwritten and later transcribed by the pharmacy staff, which leads to errors in prescription and transcription. A total of 686 prescription or transcription errors were identified for the facility's 85 older residents before the intervention.	"*All the information needed to ensure patient safety is contained in the medical prescription.*"	12.5 – "Fully agree" 25 – "Agree" 37.5 – "Neither agree nor disagree" 25 – "Disagree"
		"*How often do you think prescription errors occur?*"	25 – "Occasionally" 50 – "Rarely" 25 – "Never"
Planning and procurement	There is no planning process. Medications are procured from three different sources (local Primary Health Care Unit [public], Unified Health System specialty pharmacy [public], or private retail pharmacies) and/or purchased directly by residents' family members. Delays in the procurement or delivery of medications by private pharmacies or family members were identified, as well as drug shortages at Unified Health System pharmacies.	"*The process of acquiring medicines (whether buying them, picking them up from family members, or obtaining them from the Unified Health System) is organized.*"	12.5 – "Fully agree" 75 – "Agree" 12.5 – "Neither agree nor disagree"
		"*How often do you think the older residents run out of medication due to shortages or because the facility has run out of medication?*"	12.5 – "Often" 37.5 – "Occasionally" 37.5 – "Rarely" 12.5 – "Never"
Storage	Look-alike, sound-alike (LASA) medicines are stored in close proximity to each other. Psychotropic medications are not stored in a specifically designated, locked cabinet. There is no computer-based or even manual inventory control system of any kind. Medications are kept in a hot room with no temperature or humidity control. The storage process is frequently interrupted by nursing staff and residents.	"*In this LTCF, medications are stored in a suitable, organized environment.*"	25 – "Fully agree" 50 –"Agree" 25 – "Neither agree nor disagree"
		"*How often do you think storage errors occur?*"	25 – "Occasionally" 50 – "Rarely" 25 – "Never"
Distribution	Oral solid medications are sorted into plastic containers with lids, which are individualized for each resident for weekly or daily use. Medications are stored in plastic containers without adequate checking of the transcribed prescriptions. The process of distributing medications to residents is frequently interrupted. Pharmacy staff overworked.	*"Distribution of medications is carried out in a suitable, well-lit, organized environment."*	12.5 – "Fully agree" 62.5 –"Agree" 12.5 – "Neither agree nor disagree" 12.5 – "Disagree" 12.5 – "Fully disagree"
		"How often do you think distribution errors occur?"	12.5 – "Often" 37.5 – "Occasionally" 37.5 – "Rarely" 12.5 – "Never"
Preparation and administration	Medications are sorted into 50-mL disposable plastic cups by patient and time of day. Cups are placed on stainless steel trays and carried to the residents at different areas of the long-term care facility. The sorting environment is subject to interruptions and inattention. Plastic cups would often tip over on the tray or onto the floor as the staff member moved around the LTCF, resulting in loss of medications or mixing of medications meant for different patients. Proper administration was prevented by residents moving around the LTCF. No checks done during administration.	"*This LTCF has a separate area for preparing medicines.*"	12.5 – "Fully agree" 50 – "Agree" 37.5 – "Disagree"
		"*How often do you think medication preparation errors occur?*"	12.5 – "Often" 25 – "Occasionally" 37.5 – "Rarely" 25 – "Never"
		"*How often do you think the "five rights" of medication administration are ensured?*"	12.5 – "Very often" 62.5 – "Often" 12.5 – "Occasionally" 12.5 – "Never"



LTCF: long-term care facility; *As a result of changes in prescription in response to the resident's clinical condition.

FIGURE 2. Adjusted redesign of the medication system after quality improvement. Long-term care facility.

bins with lids and kept in a steel cabinet also located at the nurses' station. Aiming to optimize the process of medication preparation and administration at the LTCF, a medication cart was designed and provided by the outsourced supplier. It should be noted that individual medicines and boxes were also purchased sporadically as required. Recourse to this procedure was sometimes necessary due to changes in the residents' prescriptions as a result of variation in their clinical condition over the course of a month.

Implementation of the quality improvement intervention not only brought about multiple improvements and strengths at each step of the medication system, but also led to a new profile of potential or actual weaknesses (Chart 2). Regarding the time spent on completing the steps of the medication system, a 3-hour and 57-minute reduction was observed in the daily processes involving medication for the 50 older residents. Table 1 shows the average time spent daily on distribution, preparation, and administration of medications in the LTCF before and after implementation of the medication system quality improvement intervention.

DISCUSSION

This study described the implementation of a quality improvement intervention for the medication system of a large Brazilian LTCF, with a positive impact on the working time of staff members and their perception of patient safety. Medication systems are complex, and promoting their continuous improvement is essential to reducing the incidence of medication errors, especially in frail populations affected by polypharmacy, such as institutionalized older adults.[4,17]

Despite this, studies addressing this topic are nonexistent in Brazil, reflecting the low level of national investment in improving the quality of these settings.[2] A study in the United Kingdom proposed mapping the medication system of a LTCF without, however, proposing interventions to improve its quality;[17] others have evaluated isolated improvement strategies.[7,11] To the authors' knowledge, this is the first study to propose the overall evaluation and quality improvement of the medication system of a LTCF.

In the present study, substantial flaws were found in the pre-implementation period for each stage of the medication system, reflecting the limited financial and human resources of nonprofit LTCFs. This was already expected given the structural context of Brazilian charitable LTCFs, despite their nationwide importance.[2] Anchored in the potential of the studied LTCF, its large size, and its local relevance, the medication system quality improvement process led to global improvements.

Initially, the staff was divided regarding changes to their routine and to the processes of the existing medication system. However, there were no extreme or technically evidence-based stances for or against the quality improvement intervention. In this sense, when broaching this topic at the LTCF, a weak safety culture was identified, as well as a need for staff improvement regarding patient safety and the safe use of medications. Such findings have also been identified in LTCFs in Spain, the United Kingdom, and the United States.[7,18] In addition, the staff's positive perception of their existing medication system highlighted the need to strengthen the safety culture within the LTCF, as the investigators observed significantly unsafe processes during the diagnostic stage.

Safety culture, patient safety, and safe use of medications are essential topics in the continuing education of providers involved in any medication system. Therefore, it is imperative to promote educational actions that shape individual and

BOX 2. Characteristics of the medication system (after the quality improvement intervention). Long-term care facility.

Step	Characteristics
Prescription	Handwritten prescriptions are now only transcribed once and sent to the third-party supplier to order medications. • ***Strengths:*** good interaction between pharmacy staff, the third-party supplier, and the prescriber. Reduction in the number of transcriptions, which were previously done up to three times. • ***Observed or potential failures:*** Interruptions continue to occur during the prescription process. Prescriptions continue to be handwritten and require a transcription step, with no subsequent checks for proper transcription.
Procurement	All procurement is now done by the third-party supplier. • ***Strengths:*** Process has been systematized and outsourced, thus reducing shortages and delays. Reduction of excess workload on pharmacy staff. • ***Observed or potential failures:*** The pharmacy staff is now one member short. Risk of short-term shortages in the event of changes to prescriptions as there is no longer any in-house medication stock.
Distribution	Distribution is not organized by time of day in each individual box provided by the third-party supplier. The pharmacy staff receives the boxes once monthly and organizes them at the nurses' station. • ***Strengths:*** Systematized, agile process, reducing opportunities for interruption. Reduction of excess workload on pharmacy staff. • ***Observed or potential failures:*** The pharmacy staff is now one member short.
Preparation	Preparation now solely consists of the nursing staff detaching the individual plastic packets labeled with each resident's name and time of administration and containing that resident's medications. The reel of packets corresponding to each time of day was stored on a medication cart. • ***Strengths:*** Systematized, agile process, reducing opportunities for interruption. Reduction of excess workload on nursing staff. Improved identification of patients and administration times (directly on packets). • ***Observed or potential failures:*** The team was downsized after the quality improvement process. Inappropriate use of the device (on some shifts, all packets – despite different administration times – were detached simultaneously from the packet reel).
Administration	Reduction of standardized medication administration times at the LTCF from seven to five. At each administration time, a medication cart containing the packets and a bottle of water was taken to the patients. • ***Advantages and improvements:*** times when all residents could be found together at the same place, such as mealtimes, were prioritized for medication administration. Sorting of medications into sealed packets instead of plastic cups allowed better identification and reduced the risk of mixing or losing pills. • ***Observed or potential failures:*** the team was downsized after the quality improvement process. Actual use of the medication cart was limited; most of the time, the packets were kept on a stainless-steel tray instead. Standardized schedules were not fully followed; however, the frequency of administration before the scheduled time was reduced. No checks are done at the time of medication administration. Staff remains overworked.

TABLE 1. Average time spent per day on each step of the medication system in the long-term care facility.

Step	Time spent per day*		
	Before	After	Difference
Distribution	3 hours 11 minutes	18 minutes	2 hours 53 minutes
Preparation	1 hour 22 minutes	43 minutes	39 minutes
Administration	1 hour 10 minutes	45 minutes	25 minutes
Total	5 hours 43 minutes	1 hour 46 minutes	3 hours 57 minutes

*For 50 older residents.

collective attitudes and behaviors to strengthen a culture of safety.[19] Despite this, many managers and providers alike do not understand this process, and it is common for in-service training programs to be incipient or absent, which compounds the fact that the workforce in Brazilian LTCFs is insufficient and underqualified.[2,17] In this sense, we believe that the implementation of the improved medication system, as well as training addressing this topic, may have impacted the institutional perception of patient safety, although such knowledge was not assessed.

Regarding the various stages of the medication system, following the usual flow of the medication use process, the promotion of safe prescribing within the institution was deemed essential, since errors at this stage can impact all subsequent stages.[20] In this context, the use of handwritten prescriptions that were subsequently transcribed was a critical point of failure identified during the diagnostic stage, being associated with several weaknesses, such as incomplete data and illegibility.[21]

The use of a computerized physician order entry system has the potential to improve patient safety, as it provides safer

parameterization of prescriptions.[20] However, such a system could not be implemented during the quality improvement intervention, although negotiations for its adoption are ongoing.

Despite the limitations of the impact of the quality improvement process on prescribing, the process did allow staff members to become aware of the risk of interruptions and distractions at the prescribing stage. Health care facilities should provide an appropriate location for the prescription process, with as few opportunities for interruption and as few distractions as possible, as these events contribute to the incidence of medication errors.[20]

Observation of the pharmacy staff's procedures allowed the investigators to evaluate the stages of medication procurement and storage. Regarding procurement, the fact that medications were obtained from multiple sources (public and private pharmacies) overloaded the team and led to shortages. This problem was almost completely rectified after implementation of the medication system quality improvement intervention. Shortages were also identified as a critical point in the medication system of a UK LTCF, with the potential to lead to errors of omission.[17]

In contrast, after the quality improvement intervention – which, in effect, reduced the working time spent in the pharmacy –, all activities related to medication were delegated to the sole pharmacy technician, with the pharmacy's nurse technician being reassigned to direct patient care. This reassignment is understandable, as it is widely known that Brazilian LTCFs are generally understaffed and staff members are generally overworked,[2] as observed at the study site. Pharmacy staff overwork has also been reported in UK LTCFs.[22] However, despite the new functional organization implemented, the volume of work in the pharmacy sector remained significant, as reported by the staff members, exposing the medication system processes to considerable risk of failure.

Regarding medication storage, the investigation found that not even minimal measures were adopted to ensure the quality of pharmaceutical products, such as humidity, temperature, and stock control, nor were any storeroom safety measures in place – e.g., identification of high-alert medications or keeping look-alike, sound-alike (LASA) medicines physically apart. In this context, it is important to highlight the qualitative and quantitative limitations of the pharmacy staff regarding their lack of previous experience with medication storage, as well as the lack of a pharmacist on the LTCF staff, which may have had an impact on this finding. This finding may illustrate the consequences of the lack of specific regulations for the training of LTCF staff in Brazil, which disincentivizes the hiring of professionals who are actually qualified for this purpose.[23]

On the other hand, it is worth noting that the quality improvement intervention on the medication system led to better storage conditions, as the sorting and storage of all medications was outsourced to a third-party provider. Additionally, the new dispensing system eliminated the need for individual sorting of medications at the institution's pharmacy, a complex process with multiple potential points of failure, including exposure to multiple interruptions and a lack of traceability.

During the preparation and administration stages, sorting of medication into inadequately labeled disposable plastic cups was replaced by properly identified plastic packets, thus increasing patient safety. Furthermore, at the initial diagnosis stage, multiple points of failure were identified during the medication preparation and administration processes, reflecting the large volume of work done by few staff members for a large number of residents; this scenario of poor staff sizing is common in Brazilian LTCFs.[2] Studies carried out at LTCFs in other countries demonstrate that routine administrative work is substantially time-consuming from the care team, as a meticulous process that requires full attention.[5,6,8,9] Therefore, smaller teams can increase insecurity in medication administration, facilitating the occurrence of serious adverse events.[7]

The substantial reduction in time spent administering medications demonstrated the effectiveness of the quality improvement process, as identified in a U.S. LTCF that implemented a dispensing system similar to that reported herein.[6] This positive impact makes nursing staff more available for other activities involving direct care of residents. This result is in line with that found in another Brazilian study that evaluated the implementation of the same dispensing system in a pilot initiative.[12] Therefore, quality improvement initiatives such as that reported in the present study have considerable relevance and can have a positive impact on the routine processes of other Brazilian LTCFs.

Regarding medication administration, the implementation of standardized schedules which prioritized drug dispensing during meals had a favorable impact on dynamics, in addition to contributing to resident safety. This is because the administration of medications throughout the day at non-standard times or intervals is more prone to errors of omission, especially in institutions with many patients and few staff members. Therefore, administration at standard times of day is considered more appropriate in scenarios such as that of the LTCF in which this study was conducted.[24] However, the sheer size of the LTCF continued to be a critical barrier for this process at other times. Incorrect timing of drug administration was frequently identified in LTCFs in the Netherlands and the UK.[22,25] This error continued

to occur in the LTCF under study even after the quality improvement process, although its frequency was reduced.

During the quality improvement intervention, members of the nursing staff were trained on the importance of checking medications during the administration process, and were advised to check whether the date, time, and patient name printed on the packet containing the medication were correct before the medications were administered. However, their persistently overworked routine prevented the effective adoption of this process. In addition, interruptions continued to occur and were normalized by the team, as observed in two Norwegian LTCFs as well.[26] Previous studies have reported it is important to understand the interconnectivity of the elements involved in interruptions in order to propose more effective strategies for their prevention in future.[26]

The present study has some limitations that may have impacted the medication system quality improvement intervention. At times, the investigators' access to the LTCF was limited by the institution's manager, which led the diagnosis and implementation stages to take longer than desired. Despite the impossibility of inferring that the results achieved in the present study would be reproducible in other LTCFs, we believe that the fact that the study site was a not-for-profit, charitable long-term care facility – as are most LTCFs in Brazil – raises the need for diagnosis and quality improvement in these establishments, which are the subject of little research and are widely neglected by authorities in the country.[2] Furthermore, the large size of the LTCF in which the study was conducted demonstrates not only the challenges of a wide-ranging, complex medication system, but also signals great potential for improvement in smaller LTCFs by demonstrating the effectiveness of an intervention in this setting. Therefore, the limitations of this study notwithstanding, it is of undeniable relevance considering the scarcity of research carried out into LTCFs in Brazil and, above all, on their medication systems.

CONCLUSION

After an extensive diagnostic process, multiple flaws were identified in the medication system of the LTCF under study, as well as a poor overall perception of safety by its staff. The quality improvement intervention for the medication system was successfully implemented and contributed to improving the safety of medication use processes, in addition to reducing the time spent on separation, preparation, and administration of medicines. Additionally, the implementation raised awareness among staff members about the safety of medication use, although continuing education on this subject is still required. Despite their limitations, initiatives such as the one described herein should be encouraged with the aim of enhancing strategies for preventing medication errors and achieving continuous improvement in LTCFs in Brazil.

DECLARATIONS

Conflict of interest
The authors report no conflicts of interest.

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Author contributions
Ana Ludmila Santos Plauska: project administration, formal analysis, conceptualization, data curation, writing – original draft, writing – review & editing, investigation, methodology, software, validation, visualization. Hágabo Mathyell Silva: formal analysis, data curation, writing – review & editing, investigation, methodology, validation, visualization. Juliana de Oliveira Gomes Ramos: formal analysis, writing – review & editing, methodology, validation, visualization. Cristiane de Paula Rezende: formal analysis, writing – review & editing, methodology, validation, visualization. Mariana Martins Gonzaga do Nascimento: project administration, formal analysis, conceptualization, data curation, writing – original draft, writing – review & editing, investigation, methodology, software supervision, validation, visualization.

Ethical approval and informed consent
The project was approved by the Human Subjects Research Ethics Committee of UFMG (Certificate of Submission for Ethical Approval: 58142122.2.0000.5149; opinion no. 5.676.976) and was conducted in accordance with all ethical precepts set forth in Brazilian National Health Council Resolution no. 510/2016.

Data availability statement
All physical or digital data collected during the assessments, as well as evidence in support of our results and conclusions of this study, will be available upon prior request.

Reporting standards guidelines
We adopted the reporting recommendations proposed by Lengnick-Hall et al.[27]

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