



## Patient Safety: Strategies for Detection and Prevention of Medication Errors in an Argentinian Hospital

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**SUMMARY.** Safety is a fundamental principle of patient care and a critical component of quality management. Medication errors are the most common type of errors in health care, leading to increased morbidity, mortality and economic burden to health services. The objective of the present study was to determine the impact of intervention strategies implemented for detection and prevention of medication errors during the use of medications in a public Hospital of Argentina. An evaluative research was made, by comparison of medication errors between two periods: pre and post interventions in the processes of prescription, dispensing and administration of medicines. Errors were characterized by Ruiz Jarabo classification. After the application of the intervention strategies the total number of errors decreased 41.63%; with 4.66 errors/patient (39.55% reduction) and 69.16 errors/100 patients-day (30.06% reduction). Two contributing factors rates fell: communication system deficiency from 77.40 to 47.20% and Medication distribution system from 67.94 to 33.97%. The intervention strategies applied reached a reduction in number of errors and the application of quality management tools allowed synergic interaction between the health care team.

**RESUMEN.** La seguridad es un principio fundamental de la atención al paciente y un componente crítico de la gestión de la calidad. Los errores de medicación son el tipo más común de errores en la atención de salud, lo que lleva a un aumento de la morbilidad, la mortalidad y la carga económica a los servicios de salud. El objetivo del presente estudio fue determinar el impacto de las estrategias de intervención aplicadas para la detección y prevención de errores de medicación en el uso de medicamentos en un hospital público de Argentina. Se llevó a cabo una investigación evaluativa, mediante la comparación de los errores de medicación entre dos períodos: antes y después de las intervenciones en los procesos de prescripción, dispensación y administración de medicamentos. Los errores se caracterizaron por la clasificación de Ruiz Jarabo. Después de la aplicación de las estrategias de intervención el número total de errores disminuyó un 41,63%; con 4,66 errores/paciente (reducción de 39,55%) y 69,16 errores/100 pacientes-día (30,06% de reducción). Dos factores contribuyentes se redujeron: la deficiencia en el sistema de comunicación de 77,40 a 47,20% y la distribución de medicación en el sistema de 67,94 a 33,97%. Las estrategias de intervención aplicadas lograron una reducción del número de errores y la aplicación de herramientas de gestión de la calidad permitieron la interacción sinérgica del equipo de salud.

### INTRODUCTION

Safety is a fundamental principle of patient care and a critical component of quality management. Its improvement demands a complex system-wide effort, involving a broad range of actions, including safe use of medicines. It requires a comprehensive, multifaceted approach to identifying and managing actual and potential risks to patient safety in individual services and finding broad long-term solutions for the system as a whole<sup>1,2</sup>.

Medication errors are recognized as the most common type of error in health care, causing a threat to hospital inpatients, leading to increased morbidity, mortality and economic burden to health services<sup>2,3</sup>. These errors are defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in control of health care professionals, patients, or consumers. Such events may be related to professional practice,

**KEY WORDS:** Drug use evaluation, Medication errors, Patient safety, Pharmacoepidemiology, Quality management.

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health care products, procedures, and systems, including prescription, order communication, dispensing, distribution, administration, education, monitoring, and use <sup>4</sup>.

Health care organizations should develop and maintain a continuous process to detect, clarify, prevent and reduce the incidence of errors <sup>1,5</sup>. In the case of medication errors, they are predominantly system problems that can, to a great extent, be addressed with medication process system improvements <sup>6</sup>.

A fundamental purpose of pharmaceutical services in any setting is to ensure the safe and appropriate use of medicines <sup>7</sup>. So, the main objectives of a medication distribution system in health care organizations are to assure the availability of prescribed medicines, to rationalize the drug therapy, to reduce the medication errors, to enhance the correct administration of medicines to the patient and to improve the integration of the pharmacists to the health care team <sup>8</sup>.

From the Pharmaceutical Care philosophy point of view, a patient-centered practice, considered as the responsible provision of drug therapy for the purpose of the achieving definite outcomes that improve the patient's quality of life, the pharmacists are responsible for optimizing the availability of drug therapy in a more effective and safe way <sup>9,10</sup>.

The use of quality management tools allows performing a deep analysis of the medicine-use system, identifying problems and their causes, and then proposes strategies of intervention with all the participants involved within the different processes <sup>11</sup>. The cycle of Plan-Do-Study-Act, often called the Deming or Shewhart cycle, provides a framework for the improvement of a process or system. The application of this cycle implies the development of four phases: *Plan*, that aims to choose and analyze what the team intends to improve; the second phase, *Do*, that aims to implement the changes or interventions decided in the plan phase; *Study*, that represents the main phase of the cycle because it is where the researchers assess the results of the implementation; the fourth phase, *Act*, that aims to define whether to adopt the change or to abandon it or to run through the cycle again. After planning a change, implementing and then monitoring it, the researchers must decide if it is worth continuing that particular change <sup>11-13</sup>.

The medication distribution system applied in a public teaching Hospital of Rosario (Argentina) seemed to be inadequate to achieve its

objectives, and although it was recognized that medication errors occur, they were not identified. Therefore, members of the health care team of the Hospital decided to work together to identify and prevent medication errors, applying the Shewhart cycle as an instrument of quality management. The study was focused in three processes of the medication use system: prescription, dispensing and administration of medications. In the initial 'Plan' phase were considered: the objectives of the medication distribution system, the medicine policies of the Hospital and the medication error definition by National Coordinating Council for Medication Error Reporting and Prevention (NCMERPP) from the United States <sup>4</sup>. Data of medication errors were extracted from the records of medicines for each patient of one general ward of the Hospital, then these errors were characterized and indicators were estimated to establish their incidence. Using these data the health care team applied quality management tools in the following sequence: *flowcharts* to describe the processes; *cause effect diagrams or Ishikawa graphics* to identify causes of medication errors; then the team selected two relevant causes (double record of the prescription of medications and lack of clear medicine policies) and for them they developed *brainstormings* and *nominal groups* to propose and weight solutions, and finally a *decision matrix* in order to prioritize these solutions as interventions strategies <sup>14</sup>.

In the next phase, *Do*, two interventions were implemented in the same general ward of the Hospital: the inclusion of a single record for "prescription, dispensing and administration of medicines" in the patient's medical history with a carbon paper copy for Pharmacy, which requires daily update by the physician and eliminates the "double prescription"; and the standardization of this new method of labour with a specific Standard Operative Procedure to be followed by all the professionals involved in the drug use <sup>14</sup>.

The focus of this work is in the third phase of the Shewhart cycle: Study. Thus, data retrieved will help to the decision making process of the health care team and authorities of the Hospital to determine if interventions would be definitely applied (*Act phase*).

The aim of this work is to determine the impact of the intervention strategies implemented for the detection and prevention of medication errors during the use of medications in this public Hospital of the city of Rosario (Argentina).

## MATERIAL AND METHODS

This is an evaluative research, applying a pre and post intervention evaluation. The study was held in a public teaching Hospital in Rosario, a general hospital with 190 beds, and a referent in the region.

The medicine distribution system applied in the Hospital involved prescription of medicines, by recording the medicine order first in the medical history and later in another record in the service of Pharmacy; based in this last record Pharmacy issued the medicines, dispensing them by the method of daily doses for individual patients, without the assistance of pharmacists to the patient care delivery areas; then nurses receipted the medicines and performed the administration process. Medical history records and Pharmacy records were kept on paper.

The ward selected for the study has 21 beds, for adult patients, with average days of stay of 8.6 and an average of 14.2 medication doses/patient/day. It represented 12.6 % of the beds with this medication distribution system in the Hospital. All the patients admitted to the area during the study period were included.

In the *Plan* phase data was recollected during a period of three months. A standardized method for identifying and recording medication errors, for medication records reviewing and for gathering data for indicators was based on the following: definition of medication error by the NCMERPP; medication policies, records and medication use processes applied in the Hospital; and the Ruiz Jarabo classification of medication errors, which was recommended by National Health Authorities for the characterization of errors<sup>4,15,16</sup>. In order to obtain data of medication errors, a daily and entire record review of the processes of prescription, dispensing and administration of medications for each patient of this general ward was carried out. All the data gathered by the daily and systematic review of medical histories and records of the Pharmacy were transcript to individual formularies for each patient a day, allowing to visualize the whole medicine-use pathway and also to characterize the errors by the Ruiz Jarabo classification. Subsequently, these errors were sorted out according to this classification, and two indicators were estimated to establish the incidence of the medication errors: average number of errors by patients and number of identified errors for 100 day/patient<sup>5,17</sup>.

Considering this information and by the ap-

plication of quality management tools, the health team identified and agreed on strategies that were approved by the authorities, and then implemented in the same ward in study. After an interval of four months to get an adaptation to the changes, the data recollection was reinitiated with the same previous methodology, for another period of three months, from November 2010 to February 2011, to allow the comparison between the two periods: before and after the interventions.

Comparisons of medication errors between the two periods considered the two indicators of incidence, and the characterization by the Ruiz Jarabo classification in the following main dimensions: "Information about the error", "Error consequences", "Medication information", "Type of errors", "Causes and contributing factors (work system related)"<sup>15</sup>.

The project was approved by the Hospital Committee of Pharmacy and Therapeutic Research and by the Bioethics' Commission, Faculty of Biochemical and Pharmaceutical Sciences, National University of Rosario.

## RESULTS

During the three months of the pre-intervention period 230 patients were admitted in the ward in study, age from 21 to 82 years, receiving treatment with an average number of 8 medications prescribed, with a range between 1 and 20 (considering the parenteral hydration with the addition of minerals as only one medication). The number of medication errors detected was 1,775, with the incidence indicators showing these results: 7.71 errors/patient and 98.89 errors/100 patients-day. During the three months of the post-intervention period the ward admitted 222 inpatients, age from 19 to 78 years, with an average number of 7 medications prescribed, with a range between 1 and 22. After the application of the intervention strategies the total number of errors was 1,036; meaning 4.66 of errors/patient and 69.16 errors/100 patients-day. These results show reductions of 41.63 % in the total number of errors, 39.55% in the first indicator and 30.06% in the second indicator of incidence.

The number of active ingredients involved in the errors of the first period was 71 and in the post intervention period was 73. More than 90% of these medications were included in the Formulary of the Hospital. During the time that lasted this study there were no modifications in the medication policy or in the medicine distribu-

tion system implemented in the Hospital, only the interventions proposed by this study.

Medication errors were characterized using the different dimensions of the Ruiz Jarabo classification. Regarding the “Personnel initially generating the error”, in the dimension “Information about error”, those generated by Resident physician changed from 876 (49.35% of the total of errors in the pre-intervention stage) to 88 (8.49 % of the total of errors after application of interventions), those by Pharmacist from 187 to 198, and those by Nurse from 712 to 750.

In the dimension “Error consequences”, the Category B “An error occurred but the medication did not reach the patient” was the most significant with 1,062 errors in the pre-intervention period, and in the second period this category was reduced to 292, with an increase of the Category A: Potential errors. In this same dimension, for the sub dimension “Probability of error

recurrence” the multi-disciplinary team assigned the majority of the errors in the two periods to the subcategory “Probable”, considering that although processes were modified there were still many of the contributing factors.

The characterization for the dimensions “Type of errors” and “Causes and contributing factors” is shown in Tables 1 and 2, respectively. It must be considered that, for practical reasons, tables show only the most relevant data to compare the selected dimensions, although the classification included more sub items.

**DISCUSSION**

The purpose of the study was the improvement of the medicine-use system to enhance patient safety and thus the quality of health care. Applying team work and quality management tools, two intervention strategies were implemented: a single record for “prescription, dis-

Error characteristics	Number of medication errors: N (%)	
	Pre-intervention	Post-intervention
<b>Process of the therapeutic chain where the error occurred</b>		
Acquisition and selection of medication	125 (7.04%)	41 (3.95 %)
Prescription in patient’s medical history	93 (5.23%)	85 (8.20 %)
Prescription in pharmacy	784 (44.16%)	0 (0%)
Dispensing	61 (3.43%)	163 (15.73%)
Administration in nurse units	712 (40.11%)	738 (71.23%)
<b>Type of errors</b>		
Medication inappropriate or not indicated according to diagnosis	248 (13.97%)	241 (23.26%)
Omission of the prescription of a needed medication	504 (28.39%)	8 (0.77%)
Omission of the dispensing	46 (2.59 %)	169 (16.31%)
Omission of the administration	510 (28.73%)	350 (33.78%)
Improper dose	112 (6.30%)	83 (8.01%)
Wrong time of administration	39 (2.19%)	5 (0.48%)

**Table 1.** Medication errors in the two periods, dimension “Error characteristics”.

Causes and contributing factors	Number of medication errors: N (%)	
	Pre-intervention	Post-intervention
<b>Causes</b>		
Incomplete or incorrect written communication	1,676 (94.42%)	840 (81.08%)
Failure to follow work procedures	1,210 (68.16%)	706 (68.14%)
<b>Contributing factors (system related)</b>		
Lack of standardization of procedures or practices	617 (34.76%)	528 (50.96%)
Deficient communication system	1,374 (77.40%)	489 (47.20%)
Deficient medication distribution system	1,206 (67.94%)	352 (33.97%)

**Table 2.** Medication errors in the two periods, dimension “Causes and contributing factors”.

dispensing and administration of medicines" in the patient's medical history, and the standardization of this new method of labour with a specific Standard Operative Procedure.

The medication distribution system held in the Hospital had a singular step in the prescription process: physicians prescribe initially in the medical history of the patient (available in the nurse office), and then they go to the Pharmacy service and write again the prescription in another record (the health care team called this phase 'double prescription'). This step was considered not only one of the main causes of medication errors in the cause-effect diagram but it also demanded a modification in the Ruiz Jarabo classification, generating a new item in the dimension "Error Characteristics-Process of the therapeutic chain where the error occurred", called "Prescription in Pharmacy". The intervention strategies eliminated this phase, implementing a single formulary for the prescription, dispensing and administration processes, for each patient, that has to be updated daily, and inserted in the medical history, with a carbonic copy for Pharmacy.

Although these interventions were implemented with the approval of the Hospital authorities, these changes faced two important barriers. There was an initial resistance of some physicians to the use of this single record for "prescription, dispensing and administration of medicines" in the medical history because it requires a daily update, arguing that it took a lot of time because they are handwritten records. It must be considered that this update is relevant to avoid confusions, forgetfulness and mistakes that contribute to medication errors. After different meetings, where the data retrieved by the study were displayed, they understood the extent of the medication errors and accepted to prescribe using the new record. Medication errors associated to prescription descended noticeably, from 49.39 to 8.20%, showing the impact of the interventions in the prescription process. In relation, the item 'Omission of the prescription of a needed medication' has abruptly decreased (20.39 to 0.77%), probably due to the fact that the previous double prescription phase generated the possibility to forget any of the medicines to prescribe (taking into consideration all the data involved in a prescription) or a confusion with the patients' data or identification.

The other barrier arises with the medication

administration process itself. The nurse labour union did not agree with the single record, so they continue registering the medication administration in a different sheet in the medical history. Errors characterized as 'Administration in the Nurse Unit' vary from 712 to 738, what seems a light difference, but the percentage related with the total number of errors increased from 40.11 to 71.23%.

In the dispensing process, although the Pharmacy promoted these changes, there are still many errors and they have increased slightly (3.43 to 15.73%). This could be due, in part, to the substitution of highly trained personnel for this task in this specific ward for a new one with less experience. This shows the relevance of human factor in generating medication errors<sup>18</sup>.

Regarding the probability of recurrence of errors, the work team scored all of the identified medication errors as "Probable" because although this study has introduced important changes, many of the Causes and Contributing factors related to the system still persist. The written standard operative procedure for this change is one of the few in the entire Hospital, and the hospital medicine policy is not clear for all the members of the health care team. The interventions generated an important reduction in two contributing factors: Communication system deficiency (77.40 to 47.20%) and Medication distribution system (67.94 to 33.97%). We must consider also the personnel reluctance to change. This issue was overcome with the aid of the quality management tools, however we were working with a group of very involved health professionals, and during the application of the intervention, the conflict with the nurse union appeared.

As it is known, electronic prescription has an important impact on reducing medication errors<sup>19,20</sup>. Therefore, the health care team proposed it as an intervention in the brainstorming, but during the development of the decision matrix, in order to prioritize interventions considering feasibility, this option was discarded because the Hospital is still waiting for the implementation of a comprehensive electronic system for the next two years.

These results help the decision making process of the health care team and authorities so that the intervention strategies that were initially applied in one ward of the Hospital are now implemented in the whole Hospital, reaching

the *Act* phase of the Shewhart cycle. Although perhaps it seems to be a small change in the whole net of hospital processes, the methodology applied helped to obtain the authorities' acceptance and facilitate the implementation of interventions in an institution that has a culture with high reluctance to change. They can also be considered as impacts of the research process itself on health care practice: the strengthening to work together for patient safety, and the recognition of quality management tools for improving hospital processes.

Medication errors occur in all stages of the medication-use process, most frequently at the prescription and administration stages. Data from a variety of settings demonstrate that medication errors are common, although error rates depend on the thoroughness of the error detection methods used<sup>2,5,21,22</sup>. Studies related to medication errors in Argentina are limited, they are mainly presented in conferences, and there is no comprehensive source of information about medication errors. Our study included all the phases of the medication distribution system and retrieved information from all the records associated in a daily basis, during three months in each period. The no inclusion of direct observation as a mechanism to gather data can be considered a limitation of this study.

A before and after intervention study developed in a paediatric hospital in the United Kingdom showed a diminution of medication errors after changes on medication policies, dispensing process and training<sup>23</sup>. Others studies assessed the impact of interventions on medicines distribution systems, as electronic prescribing; one of them achieved a decrease on prescribing error rate from 93 of 2450 medication orders (3.8%) to 48 of 2353 (2.0%), in another one the non-missed-dose medication error rate fell 81 percent, from 142 per 1,000 patient-days in the baseline period to 26.6 per 1,000 patient-days in the final period<sup>24,25</sup>.

The incidence indicators of medication errors applied are useful instruments to visualize the impact of the interventions put into practice. However, they should be progressively improved, and need to be complemented by the information of the characterization of the errors, provided by a standard taxonomy of medication errors. In this study we applied the Ruiz Jarabo classification because Health Authorities in our country proposed its use. In this manner, it would be possible to compare results among

different settings and promote the interaction between them to achieve solutions<sup>15</sup>.

The goal of drug therapy is the achievement of defined therapeutic outcomes that improve a patient's quality of life while minimizing patient risk, and medication errors represent a serious problem to the quality of health care delivery. Considering that, in our country there is an urgent need to improve methods for identifying and registering medication errors, and to estimate systematically the related indicators. Thus, these data should be used to visualize the magnitude of the problem and to prevent and manage medication errors<sup>5,26,27</sup>.

## CONCLUSIONS

The results of this study demonstrate that the intervention strategies applied reached a reduction in the total number of errors in the post-intervention period. The application of quality management tools allowed the participation of the whole health care team, with a synergic interaction that generated intervention strategies by consensus.

Health care workers and organizations should be motivated to support the full engagement in enhancing the safety of patients. In addition, providers and leaders of health care organizations should generate the necessary atmosphere and infrastructure for continuous learning about and improving the safety of all phases in the medication-use process<sup>5</sup>.

**Acknowledgments.** The authors gratefully acknowledge the expertise and valuable contributions of health care team members and scholarship students of Pharmacy who participated in the study and made this paper possible.

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