

Review article

Patient safety in antibiotic use in hospitals: a literature review

Segurança do paciente no uso de antibiótico hospitalar: uma revisão da literatura

Seguridad del paciente en el uso de antibiótico hospitalario: una revisión de la literatura

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RESUMO

Justificativa e objetivos: Os antimicrobianos estão entre os medicamentos de uso mais preocupantes dentro do ambiente hospitalar por conta de erros relacionados a sua prescrição, dispensação, preparo e administração. O presente estudo tem por objetivo verificar os principais erros descritos na literatura relacionados ao uso de antibiótico em pacientes hospitalizados. **Métodos:** Trata-se de uma revisão integrativa de caráter exploratório e abordagem descritiva. Os dados foram buscados nas bases eletrônicas: PubMed, Literatura Latino-Americana e do Caribe, Ciências da Saúde (LILACS) e *Scientific Electronic Library Online* (SCIELO), utilizando os Descritores em Ciência da Saúde (Decs): “medication error” and “patient safety” and “antibiótic”, entre os anos de 2013 e 2017. **Resultados:** foram encontrados 40 artigos, destes, 14 foram selecionados, catalogados e analisados, a partir de uma comparação sobre os principais tipos de erros de medicamentos, intervenções realizadas e custos dos principais desfechos. **Conclusão:** Embora os estudos analisados não abordem especificamente os erros de medicação, pode-se constatar que os principais erros consistem na prescrição dos antibióticos. Reforça-se, portanto, a necessidade de educação continuada dos profissionais envolvidos e o uso da tecnologia na forma de sistemas informatizados para reduzir os erros deste e dos demais tipos de medicação em hospitais.

Descritores: Erros de medicação; Segurança do paciente; Antibióticos.

ABSTRACT

Background and objectives: The antimicrobials are among the most worrying drugs in the hospital environment due to errors related to their prescription, dispensing, preparation and administration. The present study has the objective of verifying the literature on the main errors related to the use of antibiotics in hospitalized patients. **Methods:** This is an integrative exploratory review, with a descriptive approach. The data were searched for in electronic databases: PubMed, Latin American and Caribbean Health Sciences Literature (LILACS) and Scientific Electronic Library Online (SCIELO), using the Health Science Descriptors (Decs): “medication errors” and “patient safety” and “antibiotic” and looking for publications between 2013 and 2017. **Results:** A total of 40 studies were found, of which 14 were selected, recorded and analyzed, based on a comparison about the main types of medication errors, interventions and costs of the main outcomes. **Conclusion:** Although the studies

analyzed did not specifically address medication errors, it can be observed that the main errors are related to antibiotic prescribing. Therefore, it is necessary to implement continuing education for the professionals involved and use of computerized systems to reduce these errors and other types of medication errors in hospitals.

Descriptors: Medication errors; Patient safety; Antibiotics.

RESUMEN

Justificación y objetivos: Los antimicrobianos están entre los medicamentos más preocupantes dentro del ambiente hospitalario debido a errores relacionados con su prescripción, dispensación, preparación y administración. El presente estudio tiene como objetivo verificar los principales errores descritos en la literatura relacionados con el uso de antibióticos en pacientes hospitalizados. **Métodos:** Se trata de una revisión integradora de carácter exploratorio y enfoque descriptivo. Los datos se fueron buscados en las bases electrónicas: PubMed, Centro Latinoamericano y del Caribe de información en Ciencias de la Salud (LILACS) y Scientific Electronic Library Online (SCIELO), utilizando los Descriptores en Ciencia de la Salud (Decs): “errores de medicación” y “Seguridad del paciente” y “antibiótico”, entre los años 2013 y 2017. **Resultados:** fueron encontrados 40 artículos, de éstos, 14 fueron seleccionados, catalogados y analizados, a partir de una comparación sobre los principales tipos de errores de medicamentos, intervenciones y los costos de los principales resultados. **Conclusión:** Aunque los estudios analizados no abordan específicamente los errores de medicación, se puede constatar que los principales errores consisten en la prescripción de los antibióticos. Se refuerza, por lo tanto, la necesidad de educación continuada de los profesionales involucrados y el uso de la tecnología en la forma de sistemas informatizados para reducir los errores de éste y de los demás tipos de medicación en los hospitales. **Descriptor:** Errores de medicación; Seguridad del paciente; Antibióticos.

INTRODUCTION

Hippocrates (460 – 370 BC) had already alluded to the importance of patient safety when he said: “first, do no harm”. However, it was in 1999 that the topic came to prominence and was materialized in the report “To Err is Human”, by the Institute of Medicine. From then on, health organizations around the world have been working to identify and reduce the main risks of the health and disease process. Among the proposals for safe care are the identification of the patients, effective communication between health professionals, safe prescriptions in the use and administration of medications, safe surgery, risk of falls and pressure injuries and proper hand hygiene.¹

In Brazil, the Ministry of Health has instituted the National Patient Safety Program, so that, together with the World Health Organization (WHO), we can reduce preventable risks and harm to the patient. This program is recommended to develop strategies for the provision of safe care. In 2017, the UN launched a program for the reduction of medication errors. Prescribing, dispensing and administration processes are related to strategies that can reduce 50% of preventable damage over a five-year period.¹⁻⁴

Drug administration errors can be made by trained and experienced healthcare professionals who, when exposed to strenuous work environments, can generate outcomes that interfere in the development of new practices that guarantee proper and rational use of medications. Irrational use and administration of medications affect not only the patient, but also the hospital environment, as it can increase medication costs and lead to ineffective treatment, recurrence of infections and increased microbial resistance.⁵

Prescription of medication is one of the steps of the medication process and corresponds to the beginning of a process which will result in a safe or unsafe medication administration. For this reason, one should take some precautions to make an objective and complete prescription that will reduce the doubts of the team responsible for administering the medications. As already verified in some studies, many prescriptions in hospitals do not meet the standards for clarity of information and have a large number of abbreviations that affect their understanding. In addition, lack of information on dosage is another factor that influences the effectiveness of medications, as dosages lower or higher than required can be administered.^{5,6}

The occurrence of medication errors is more common in the pharmacological classes of bronchodilators, analgesics, antihypertensives and antibiotics, as well as gastric acid inhibitors. In hospital sectors that deal with a greater number of medications and more severe pathologies, such as ICUs (Intensive Care Units), flaws in drug distribution and administration systems are even more relevant, as they compromise patient care and patient safety. This reiterates the need for better patient monitoring and greater investment in educational practices for the healthcare team.^{6,7}

Currently, the United Nations (UN) estimates that at least one person dies per day due to medication errors. In the United States, about 1.3 million people may be harmed by these errors every year. However, these data encompass the countries with better patient safety culture; this is a much bigger problem in other countries around the world, where prescription, dispensing, preparation, administration or use of medications in the wrong way can cause harm, disabilities and even death.⁹

Based on the subject of patient safety, antimicrobials are among the most worrying drugs in the hospital environment and are related to the most serious medication errors in the world. The Institute For Safe Medication Practices (ISMP) recommends to classify them as high-alert medications, specifying their identification and being extra careful in the prescription, dispensing and administration, as they are also known as potentially dangerous

drugs.¹⁰ Therefore, the present study aims to verify the literature on the main errors related to the use of antibiotics in hospitalized patients.

METHODS

The present study consists of an integrative review, with an exploratory and descriptive approach that allows reporting published data. For data collection, the following criteria were applied to the scientific publications of the area under study: I) research articles carried out in a hospital environment; II) articles published in English, Spanish and Portuguese; III) articles published in the last five years (2013-2017), from January 2013 to December 2017.

The selection of articles occurred from April 1, 2013 to April 20, 2018. The starting date was determined based on the creation of Ordinance MS/GM, no. 529. This ordinance establishes the National Patient Safety Program (PNSP), which obliges health services to develop and implement initiatives aimed at patient safety in different areas of care, organization and management of health services, through the implementation of risk management and Patient Safety Centers in health facilities.⁴

Data was searched in the electronic databases PubMed, Latin American and Caribbean Health Sciences Literature (LILACS), and Scientific Electronic Library Online (SciELO), which encompass several national and international journals. The descriptors, according to the Health Science Descriptors (Decs), were: “*medication errors*” and “*patient safety*” and “*antibiotic*”.

The search was carried out by two researchers independently and the pre-selection of articles in the databases was performed by the keywords. The abstracts were read from the application of the inclusion criteria for the selection of articles.

For the collection of information and comparisons, a form with the following information was elaborated: title, authors, year of publication, database, objective, methods, main results and conclusion. The data was analyzed descriptively, comparing studies regarding the main types of medication errors and the interventions performed in the selected articles and/or relating the costs of the main outcomes.

RESULTS AND DISCUSSION

A total of 40 articles were found using the keywords in the databases described. Thirty-eight studies were found in the PubMed database and the two others were found in LILACS and SciELO, respectively. According to the inclusion criteria, 26 articles were not selected, as

the research was not carried out in a hospital environment. The results regarding the application of the form are described in Table 1.

Table 1 – Summary of the evaluation of articles on patient safety and hospital use of antibiotics, over a 5-year period, from 2013 to 2018.

Title	Author/Year	Objective	Method	Results	Conclusion
<i>PubMed</i>					
I. A report of the efforts of the veterans' health administration national antimicrobial stewardship initiative ¹¹	Kelly AA, Jones MM, Echevarria KL, et al., 2017	To detail the activities of the Veterans Health Administration (VHA) and evaluate outcomes of the Antimicrobial Stewardship Initiative.	Evaluation before and after the implementation of measures for the appropriate use of antibiotics, through bibliographic research.	Antibiotic use in patients decreased 12% after the start of activities; significant decline in the use of prescribed antimicrobials.	Implementation of a national antimicrobial management program with continuing education, disease-specific guidelines, and development of example policies.
II. Reducing unnecessary antibiotic use in the neonatal intensive care unit (SCOUT): a prospective interrupted time-series study ¹²	Cantey, JB, Wosniak PS, Pruszyński JE, et al., 2016	To identify antibiotic management strategies in a neonatal intensive care unit by surveillance and assessment of antibiotics, identifying where their use can be reduced.	Observational study carried out between March and November 2012 that monitored and analyzed antibiotic use and length of hospital stay.	There was an overall decrease of 27% in antibiotic use. No difference in safety outcomes was observed between the intervention and baseline periods.	Assessment of antibiotic consumption in a Neonatal Intensive Care Unit can inform high-yield stewardship targets tailored to the individual centre and implemented in collaborative manner.
III. Does electronic medication reconciliation at hospital discharge decrease prescription medication errors? ¹³	Alisson GM, Weigel B, Holcroft C, et al., 2015	To measure types and prevalence of intravenous antibiotic errors at hospital discharge before and after the addition of an electronic discharge medication reconciliation tool.	Retrospective study conducted in a hospital, evaluating 100 prescriptions before and after the implementation of the EDMRT program. Dosage and route of administration were compared with the discharge prescription and the last one during admission.	Prevalence of medication errors decreased from 30% (30/100) among pre-EDMRT subjects to 15% (15/100) errors among post-EDMRT subjects. Dosage errors were the most common.	Electronic medication reconciliation may be an important tool in efforts to decrease antibiotic errors at hospital discharge.
IV. Prospective, controlled and study of an intervention to reduce errors in neonatal antibiotic orders ¹⁴	Garner SS, Cox TH, Hill EG, et al., 2015	To evaluate the effectiveness of an interactive computerized order set with decision support (ICOS-DS) in preventing medication errors in neonatal late-onset sepsis (LOS).	Prospective, controlled comparison of error rates in antibiotic orders for neonates admitted to the Neonatal Intensive Care Unit with suspected LOS, after implementation of the ICOS-DS.	Error rate per order decreased from 1.7 to 0.8. The prescribing error rate per order increased from 0.4 to 0.7 because of the use of incorrect patient weight. Errors were not significantly different for handwritten versus ICOS-DS orders.	The ICOS-DS significantly improved the quality of neonatal LOS antibiotic orders, but the use of incorrect patient weights increased prescribing errors.

<p>V. Antibiotic prescribing at the transition from hospitalization to discharge: a target for antibiotic stewardship¹⁵</p>	<p>Yogo N, Haas MK, Knepper BC, et al., 2015</p>	<p>To evaluate prescribing practices at the transition from inpatient to outpatient care, to evaluate the appropriateness of antibiotic prescriptions at this transition, and to identify factors associated with inappropriate prescriptions.</p>	<p>Retrospective cohort study of adult inpatients prescribed an oral antibiotic at the time of hospital discharge. A combination of electronic data and manual chart review was used. Dose, treatment duration, indication and agent were evaluated.</p>	<p>Of 300 patients prescribed oral antibiotics at the time of hospital discharge, urinary tract infection, pneumonia, and skin infections accounted for 60% of the treatment indications. Discharge prescriptions were inappropriate in 53% of 150 cases reviewed.</p>	<p>It is suggested that oral antibiotic prescribing at the transition from inpatient to outpatient care is an important and under-recognized opportunity to improve antimicrobial use.</p>
<p>VI. Economic impact of redundant antimicrobial therapy in US hospitals¹⁶</p>	<p>Schultz L, Lowe TJ, Srinivasan A, et al., 2014</p>	<p>To explore the incidence and economic impact of potentially redundant antimicrobial therapy.</p>	<p>Retrospective analysis of data from 505 hospitals. The therapy was identified from pharmacy records and was defined as patients receiving treatment with overlapping antibiotic spectra for 2 or more consecutive days.</p>	<p>Evidence of inappropriate antimicrobial therapy was found in 78% of hospitals, representing 32,507 cases. Days of redundant therapy totaled 148,589, representing greater than \$12 million in potentially avoidable healthcare costs.</p>	<p>Appropriate use of antimicrobials may reduce the risk of harm to patients and lower healthcare costs.</p>
<p>VII. The cost of excessive postoperative use of antimicrobials: the context of a public hospital¹⁷</p>	<p>Santana SR, Viana AC, Santiago JS, et al., 2014</p>	<p>To assess the use of antimicrobials in relation to their inappropriate use and economic impact during the postoperative period.</p>	<p>Prospective cohort study using data from 237 medical records of patients operated between November 1, 2008 and December 31, 2008.</p>	<p>Among 237 patients, 91,56% used antimicrobials. The most prescribed antimicrobial was cephalothin, in 41,5% of cases. The direct cost of antimicrobial therapy represented 63,78% of all pharmacological therapy.</p>	<p>Excessive use of antimicrobials with questionable indications creates situations that compromise patient safety and increase hospital costs.</p>
<p>VIII. Reductions in invasive device use and care costs after institution of a daily safety checklist in a pediatric critical care unit¹⁸</p>	<p>Torrigo R, Nowak JE, Leonard CS, et al., 2014</p>	<p>To assess whether the Safety Checklist can be used to improve safety and reduce costs.</p>	<p>Implementation of the Safety Checklist in the pediatric ICU at children's hospitals and clinics during a 21-month period, to prompt the care team to address quality and safety items during rounds.</p>	<p>The daily safety checklist was successfully implemented. There were improvements on invasive device use, costs, antibiotic and laboratory test use and compliance with standards.</p>	<p>The optimization of invasive devices, decreased hospital infections and, consequently, reduced antibiotic use. The checklist resulted in a better quality of patient care.</p>
<p>IX. An intervention to improve the timing of vancomycin levels¹⁹</p>	<p>Melanson SEF, Mijailovic AS, Wright APM, et al., 2013</p>	<p>To assess collection of blood sample for vancomycin levels before and after an intervention to reduce mistimed vancomycin levels.</p>	<p>Implementation of an information technology that provided educational instructions to nurses and determined the percentage of levels drawn too early for 27 months before and 14 months after the intervention.</p>	<p>Timing errors decreased from 39% to 32%. Common causes of mistimed levels were: unclear provider orders, scheduling levels to be drawn with morning laboratory tests, lack of communication between providers, and failure to adjust the blood draw in relation to the previous dose</p>	<p>A real-time, IT-based intervention that links the timing of levels with medication administration might have a more substantial impact, minimizing errors related to vancomycin dosage.</p>

X. Incidence of adverse drug events in an academic hospital: a prospective cohort study ²⁰	Aljadhey H, Mahamoud MA, Mayet A, et al., 2013	To determine the evidence of adverse drug events (ADEs) and assess their severity and preventability.	Evaluation of prescriptions of 997 patients admitted to a hospital in four months.	A total of 361 incidents were identified, of which 78% were considered to be an ADE, potential ADE or medication error by reviewers. Of the 223 medication errors were identified, 30% were harmless, 59% had the potential to cause harm and 11% resulted in harm.	The incidence of ADEs in a Saudi hospital was 8.5 per 100 admissions. Therefore, interventions to reduce ADEs should target the application stage.
XI. Risk of medication safety incidents with antibiotic use measured by defined daily doses ²¹	Hamad A, Cavell G, Wade P, et al., 2013	To determine the number and nature of reported antibiotic-associated Medication Incidents (MI) and to use Defined Daily Doses (DDDs) to calculate the incident rate of the most commonly used antibiotics in a hospital environment.	Evaluation of antibiotic use in hospitals for 2 years. Drug consumption data was used to calculate DDD for each antibiotic. Outcome measures: the number of antibiotic-related MIs reported and the incident rate for the 10 antibiotics most commonly associated with MIs at each hospital.	Most of MIs occurred in prescribing and administration (most common: omission/delay and dose/frequency). Penicillin and aminoglycosides were the most frequently reported. Using DDDs, cefotaxime, gentamicin and vancomycin had the highest rates.	Using DDDs in the analysis of MIs allowed determination of an incident rate, providing more useful information than the absolute numbers alone. It also enabled more specific interventions to minimize antibiotic prescription and administration errors.
XII. Missed medication doses in hospitalized patients: a descriptive account of quality improvement measures and time series analysis ²²	Coleman JJ, Hodson J, Brooks HL, et al., 2013	To investigate the changes in overdue doses rates over a 4-year period in a National Health Service (NHS) hospital, following the implementation of interventions associated with an electronic prescribing system.	Interventions: ability to pause medication doses; clinical dashboards; visual indicators for overdue doses; and overdue doses root cause analysis (RCA) meetings and a National Patient Safety Agency (NPSA) Rapid Response Alert.	Rates of both missed antibiotic and non-missed antibiotic doses decreased significantly with the introduction of dashboards (reductions of 0.60 and 0.41 percentage points, respectively), as well as overdue doses (reductions of 0.83 and 0.97 percentage points, respectively), and the publication of a NPSA Quick Response Alert.	Electronic prescribing systems can facilitate data collection relating to missed medication doses. Interventions providing hospital staff with information about overdue doses at a ward level can help promote reductions in overdue doses rates.
Title	Author/Year	Objective	Method	Results	Conclusion
<i>Lilacs</i>					
XIII. Compliance and non-compliance in the preparation and administration of antibacterial drugs ²³	Pereira FGF, Aquino GA, Melo GAA, et al., 2016	To assess compliance and non-compliance in the preparation and administration of antibacterial drugs.	Observational and cross-sectional study carried out in medical clinic units of a teaching hospital. Sample: 265 doses of antibacterial with preparation and administration steps observed with two checklists in the three work shifts.	The most frequent non-compliance observed in both stages was compliance with the requirements of nursing techniques, 265 (100%). The organization was associated with error in the choice of the medication (p=0,027), and the use of prescription and confirmation of the patient's name had no relation to the errors (p=0,942).	Behavioral changes in the work process need to be implemented to reduce non-compliance and, consequently, medication errors.

Title	Author/Year	Objective	Method	Results	Conclusion
<i>Scielo</i>					
XVI. Relation between safe use of medicines and Clinical Pharmacy Services at Pediatric Intensive Care Units ²⁴	Okumura LM, Silva DM, Comarella L, 2016	To discuss the effect of implementing a bedside Clinical Pharmacy Service (CPS) in a Brazilian Pediatric Intensive Care Unit (PICU).	Cross-sectional study carried out in a 12-bed PICU in Campo Largo, Brazil. Subjects aged <18 years admitted to the PICU were included for descriptive analysis when they received a CPS intervention.	141 Drug-Related Problems (DRPs) in 53 patients. Most common interventions: prevention of incompatible intravenous solutions and inadequate doses. 5 of the top 10 medications associated with DRPs were antimicrobials.	Adverse drug reactions due to DRPs can be prevented in collaboration with other healthcare professionals. Problems can be avoided with active, evidence-based strategies to reduce drug-related morbidity and antimicrobial resistance.

The literature review found publications of the last five years, addressing different perspectives on antibiotic use in hospitals, their relationship with the success of treatments and errors occurred from prescription to administration. These publications point out to the importance of each professional in interdisciplinary work and the relevance of using computerized systems to help reduce medication errors, whether in dosage, in type of medication, in the form of administration or others.

The approach used in article I addresses the issue of minimizing medication errors through continuing education, such as educational programs, tools and resources like the antimicrobial stewardship initiative. All of these actions were adopted with the objective of reaching the goal of reducing inpatient antibiotic use by 20 percent by 2020 in the United States, which demonstrates that medication error rates are already a focus in public health care.¹¹

The World Alliance Against Antibiotics Resistance (WAAAR) raises concern about stewardship in the prescription of antibiotics for critically ill patients. One of the possible resources to minimize antibiotic resistance and eliminate adverse drug reactions (ADR) is to involve all health professionals, who then can share the responsibility for thoughtful medication use and adoption of strict infection control practices in ICUs.²⁵

Addressing medication errors related to oral antibiotics prescribed at hospital discharge, the authors of article V identified that UTI, CAP, and SSTI accounted for most of the inappropriate prescriptions. The transition from inpatient to outpatient care was seen as an important opportunity to improve antimicrobial use. In addition, in the interventions carried out during the study, reductions in the use of antibiotics and in the duration of treatment were

observed, demonstrating that the volume of prescribing of some antibiotics is inadequate and should be improved.¹⁵

In the United States, the Agency for Healthcare Research and Quality (AHRQ) is also concerned with resistance and has created a stewardship program to improve antibiotic use. Hospital institutions and outpatient medical clinics receive support to develop and/or improve antibiotic prescribing through evidence-based medicine. Based on this support, this agency, along with the Clinical Excellence Commission, seek to develop a patient safety culture, improve work and communication in the healthcare team and, as a positive consequence, optimize antibiotic prescribing.^{26, 27}

Article X shows that, between 2006 and 2009, 95 deaths or serious harm due to medications errors were recorded in hospitals in the United Kingdom. Antibiotic-associated incidents are common during prescription and administration. Thus, one of the considerations of the study is that hospital data should categorize antibiotics in the same manner, so that they can be compared and to generate interventions that can minimize error recurrence.²⁰

Many studies prove that interventions involving the multidisciplinary team can contribute to minimize harm to patients. The work carried out by microbiologists, clinical pharmacists, nurses and infectious disease doctors in a hospital environment provided a basis of knowledge regarding multi-drug resistant infections.²⁸ The Antimicrobial Stewardship program contributes to the management of antimicrobial resistance using this primary basis to identify the profile of resistant bacteria in each institution and prioritize strategies to reduce this problem.^{29, 30}

Few data are available on adverse drug events in developing countries and the study carried out in article XI was the first to address the issue in Saudi Arabia. In addition to identifying anticoagulants, antibiotics and antihypertensives as the medications most involved in errors the study states that innumerable resources are needed so that medication safety prevention and intervention practices are implemented and treated as a priority. Among them are resources for training, research, and the inclusion of computerized systems involving pharmacists in the monitoring of medicines.²¹

Some errors in medication administration, as indicated in article XIII, are influenced by work routine and organizational factors. Cleaning, organization or good use of space, reduced flow of people, reduced visual and noise pollution, system notifications, error reports and routine checks are examples of organizational factors that can help reducing medication errors.²³

An observational study conducted with 124 nurses, with four-hour observations in three different ICUs, corroborates article XIII. This study found that 35% of medication-related errors were related to increased workload, with a significant increase in the night shift.³¹ Survey of indicators such as monitoring and harm identification are strategies to minimize errors. Based these practices, training and continuing education can be carried out with the aim of achieving more quality in the health services provided to patients.^{32, 33}

Article III presented a successful application of a computerized system – the Electronic Medication Reconciliation –, in which admission orders were issued electronically, with the option to select appropriate medications. Mandatory items included strength, form of medication, dosage, route and schedule for medications, in addition to medical history of each patient and administration of their medications during and after hospitalization. In this study, dosage was indicated as the main error, which can be reduced by eliminating “distracted prescription” and handwriting errors when prescription is done electronically.¹³

In article XIV, the technology was implemented through the Clinical Pharmacy Service (CPS), composed of professionals from various specialties, who concluded that medications should be adjusted, especially in relation to concentrations, so that they are adequate according to the patient’s weight and other risk factors that may alter medication performance and even its excretion.²⁴

Clinical pharmacy was fundamental in reducing errors in medication prescribing, dispensing and administration, as well as costs and length of stay. Interventions in antibiotic prescribing decreased hospitalization by 1.95 days, affecting the mortality rate.³⁴ In another study with a total of 253 interventions, the interventions resulted in a reduction of approximately NT\$ 92,066 and two day in the length of stay.³⁵

Another effective example of information system was addressed in article I, in which, through a different approach, the ICOS-DS was used as a tool to support and verify the medication prescribed by the doctor. After inserting patient information, such as weight, age, and even results of clinical exams, the instrument indicates whether the prescribed antibiotic is suitable for treatment and determines the dosage regimen automatically, which can be altered by the professional. The use of this tool resulted in the reduction of prescribing errors and of prescribed medication. Even though the practitioner may ignore the system’s proposal, it was found that it is of great value as a support for decision-making.¹⁴

The study carried out in article XII pointed out that, according to a review of medication incident reports across the National Health Service (NHS) in the United Kingdom, missed or delayed medication are the second leading cause of medication errors. The events associated

with this incidence occur, in general, in the form of omission of medicines on admission or discharge, omission of details about the drug (formulation or dosage, for example) or omission of treatment. The electronic prescribing system cannot eliminate errors in the administration of medication, but it can help improve care. In this case, with board-level involvement focused on quality improvement and supervision of the use of the system, there was a better performance regarding medication errors, with prescription data always available for consultation. As a result, overdue medication rates decreased, as did mortality rates, indicating an increase in the quality of care in the hospital.¹²

A higher frequency of errors occurs in patients admitted to the ICU, precisely because there is a higher number of comorbidities and these patients require extensive care and a greater quantity of medications. In this context the most common errors are related to dosage, time of administration and omission of dose.³⁶ A study found 90.761 damages with antibiotic doses over four months, and 7.2% were related to omissions.³⁷

Another example of the use of computerized systems was in article IX, where information technology was used to ensure correct timing, which is a difficulty in many institutions. However, it was found that the intervention of the system will only be effective with the adherence of the clinical staff of the hospitals, so that the medications are administered at the correct time and dosage.¹⁹

In terms of costs, in article VII, antimicrobial therapy was cited as responsible for approximately 64% of the cost of pharmacological therapies in the hospital. In post-operative cases, for example, prolonging the use of antibiotics after the surgical procedure leads to increased treatments costs and risks of developing bacterial resistance. Interruptions in the use of antibiotics also affect the cost generated by medication errors and may be due to lack of information in the evaluation report with dispensing by the pharmacy, nursing failure related to dose omission, interruption in administration, or even lack of medication. According to the study, to reduce these costs, there must be strict control of the times of dilution and the intervals between antibiotic doses. This action is necessary so that the effect between the peak of the medication and the minimum level required for bacterial death is effective.¹⁷

Article VI examined the incidence of redundant antibiotic combinations in US hospitals and identified the existence of high treatment costs associated with combinations in these avoidable patterns. It also found that these combinations contribute to bacterial resistance. According to the authors, if the findings of the study were used in American hospital practice, the cost savings from eliminating redundant antibiotic therapy could exceed US\$ 163 million in a year, without considering lower incidence combinations and labor costs for pharmacy and

nursing employees, nursing and other hospital operations. In addition to excess costs, there is risk of side effects and drug-drug interactions that can harm the patients. Institutions are responsible for a conscious administration of antibiotics, promoting patient safety and public health. As an alternative, institutions can eliminate duplicative antibiotic therapy.¹⁶

Data show that by 2050 about 10 million deaths a year and a productivity cost of up to 100 trillion dollars can occur if the necessary measures to combat bacterial resistance have not been taken.³⁸ It is estimated that medication errors in hospitals can lead to an extra cost of approximately U\$ 29 billion per year.³⁹ A study evaluated 158 interventions accepted in prescriptions with carbapenems, compared with a group of non-accepted interventions, and found that 10 deaths occurred in the group of non-accepted interventions and use of this class of drugs was inappropriate in 45% of these cases.⁴⁰

As pointed out in article VIII, costs and adverse events important issues in healthcare, and the use of new methods of improvement is necessary. Still in the United States, the estimated cost of medical errors ranged between \$5 and \$29 billion a year. In this context, safety checklists were used to audit and report compliance and conscious use of antibiotics, which resulted in improvements in quality of care and patient safety, especially in intensive care.¹⁸

CONCLUSION

Although the studies analyzed did not specifically address medication errors, it can be observed that reduction in antibiotic use is related to a reduction of prescribing, dispensing and administration errors. The use of information technology in the various steps of the medication process is essential to monitor the process and avoid errors. Another important action is continuing education, which was proven to be effective for training multidisciplinary teams, combined with the reduction of patient harm indicators, especially regarding the use of antimicrobials and bacterial resistance.

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