

CLINICAL SCIENCE

ASSESSMENT OF INFORMATIZATION FOR THE DISPENSING OF MEDICATIONS AT A UNIVERSITY HOSPITAL

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doi: 10.1590/S1807-59322010000400011

Serafim SAD, Forster AC, Simões MJS, Penaforte TR. Assessment of informatization for the dispensing of medications at a university hospital. Clinics. 2010;65(4):417-24.

INTRODUCTION: Informatics and automation are important tools for the reduction of work, errors and costs in a hospital pharmacy.

OBJECTIVES: To describe the structuring and function of an informatized system for the dispensing of medications and to assess its effect on nursing and pharmacy services during the period from 1997 to 2003.

MATERIALS AND METHODS: In this descriptive and retrospective study, we performed an analysis of documents addressing the structuring and implementation of the informatized medication dispensing system. In addition, we analyzed the perceptions of nurses, pharmacists and pharmacy assistants who participated in the structuring phase of the system when interviewed about the effect of informatization on administrative aspects (e.g., requisition of medications, presentation of the dispensed medication and system operationalization).

RESULTS: The major advantages provided by the new system were 1) the elimination of manual transcripts for prescribed medications, 2) increased speed, 3) better identification of the doses prescribed by physicians, 4) medication labels containing all necessary identification and 5) practicality and safety of optical bar code-based verification of the requested and dispensed medications.

CONCLUSIONS: The great majority of the interviewees considered the informatized medication supply system to be of good quality. Analysis of the data provided information that could contribute to the expansion and refinement of the system, provide support for studies regarding the utilization of medications and offer new perspectives for work and productivity.

KEYWORDS: Dispensing of medications; Medication errors; Hospital pharmacy; Informatics; Electronic prescription.

INTRODUCTION

Pharmaceutical assistance comprises a set of activities involving medications that must be performed in a systematic manner, i.e., activities that are articulated and synchronized for the benefit of the patient. It results from a combination of structure, personnel and technologies for

the development of services within a given social context. Thus, the organization of work is required for increased complexity of the pharmaceutical assistance according to the level of improvement in the activities and the quality of the services rendered.¹

In a complex environment such as health care, the pharmaceutical care provided by the hospital also represents a complex system. This is because it concerns one of the basic instruments for patient care and involves high costs. Thus, among the many challenges faced by the hospital pharmacy is the promotion of the safe and rational use of medications at the level of assistance as well as at the economic level.²

Hospital units have high and increasing operational expenses. There is a constant pressure for increased quality and productivity without increased investment. Logistic planning, especially in the pharmacy, is fundamental to guaranteeing the supply of medicines and medical devices.

Study conducted at the Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (HCFMRP-USP) - Ribeirão Preto/SP, Brazil.

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Received for publication on January 04, 2010

First review completed on January 15, 2010

Accepted for publication on January 15, 2010

It is therefore imperative to use a rational system for the distribution of medications.

One of the activities with the greatest impact on the management of the pharmacy is the distribution and/or dispensing of medications. The choice of a system of medication distribution should be based on the structural and assistential profile of the hospital to guarantee an efficient, effective, economic and safe supply. The following types of systems for the distribution of medications can be found in hospitals: collective, individualized, combined and unit dose.³

Several Brazilian hospitals have already used or given priority to systems of individualized or unit doses. These systems, however, require more information about the medications given to the patients, such as data on the pharmacological therapy, pharmacokinetic and pharmacodynamic aspects, and possible drug interactions. In addition to the risk of errors, the difficulty of manually accessing this information is a drawback in medium- to large-sized hospitals.⁴

Informatization of health care and hospital processes almost always results in a reduction of work, errors and costs. One of the main challenges, however, resides in implementing solutions that have significant functional effects associated with low operational costs; such solutions might truly contribute to an improvement in the quality of service.⁵ Within the pharmaceutical services, informatics and automation are important tools for the optimization of activities; they reduce the time of execution and improve quality, guarantee a lower rate of medication errors, facilitate other activities such as pharmacovigilance and pharmacoepidemiology, and permit a rationalized use of medications. In the logical sequence of initiating the process of informatization in the hospital environment, the first step is usually to implement electronic prescriptions.

The use of software for electronic medical prescriptions facilitates therapeutic conduct by permitting real-time access to basic information regarding the patient and the drugs. Moreover, it guarantees greater precision in the dispensing of medications by preventing errors related to the reading and interpretation of the prescription. An electronic system also provides other advantages, such as the calculation and verification of the doses and better control of the stock.

In view of these advantages and considering “electronic prescribing to be a useful intervention for reducing the risk of medication errors and Adverse Drug Events (ADEs)...” and “offering advanced decision support functionality in hospital settings,” several international organizations, including the American Society of Hospital Pharmacists (ASPH) and the British Department of Health, have emphatically recommended the use of the informatized system and of electronic prescriptions in place of manual prescriptions.^{6,7}

Nonetheless, limitations of computerized systems were observed by Ammenwerth et al.,⁸ who stated that “Less evidence is available for systems outside the U.S., for primary care settings, and for specific commercial systems. Therefore, more studies are necessary.”

On this basis, the objective of the present study was to describe the structuring and functioning of an informatized system for the dispensing of medications and to evaluate its effect on the nursing services and on the services of the Division of Pharmaceutical Assistance at a university hospital.

MATERIALS AND METHODS

Study site

The hospital evaluated was an autarchic entity with the characteristics of a teaching hospital integrated into the Unified Health System (SUS) at the tertiary level. The hospital’s basic objectives were teaching, research and assistance. To perform its institutional activities, the hospital consisted of two assistance units and a Regional Hemotherapy Center. The hospital studied was large (860 active beds) and provided tertiary and quaternary care.⁹

The medicines dispensed at the hospital were purchased, internally produced or provided by other public organizations (Municipal Health Secretariat and/or State Health Secretariat).

Assessment of system implementation after informatization

To assess the functioning of the informatization system implemented for the dispensing and administration of medicines to patients admitted to the hospital, interviews were held with the nurses, pharmacy assistants and pharmacists involved. An analysis of all records collected between 1997 to 2003 regarding the implementation of the informatized system was performed.

It is important to emphasize that the aim of the present study was to evaluate the system of medication distribution to admitted patients and not the electronic prescription system. For this reason, physicians did not participate as research subjects.

Analysis of documents

We first evaluated protocols, reports, minutes of meetings and official correspondences that recorded the entire process of elaboration, implementation and development of the informatized system. We also investigated the events that triggered the need for restructuring the operational system

of the hospital, the participation of the professionals in the elaboration and development of the project and the changes made to the routine of the hospital pharmacy and admitting units as a consequence of the informatization process.

The second stage consisted of a questionnaire given to the nurses, pharmacy assistants and pharmacists to evaluate the system. This questionnaire contained questions regarding the effect of the implemented routines on the daily activities of each professional (Table 1). The questionnaire was elaborated considering the relevant aspects observed by the senior investigator based on experience. It consisted of 16 structured and 2 open questions that covered aspects related to the medications and to the possibility of medication errors with the new system, as well as suggestions on how to improve the process.

Approximately 15 minutes were required to conduct each interview. The study population consisted of 83 professionals: 58 nurses and 25 pharmacy staff, which consisted of 10 pharmacists and 15 pharmacy assistants. The inclusion criterion was that the professional had to have participated in all phases, including the elaboration, structuring, development and implementation of the new system.

The study was approved by the Research Ethics Committee of the hospital under study, and all participants gave written informed consent according to resolution 196/96. The identity of the interviewees was kept confidential and

anonymity of the information was guaranteed. Data were statistically analyzed using the contingency table method with a chi-square test and Fisher's exact test. The latter test was used when the expected number of counts was less than five as recommended in the literature.⁹

RESULTS

In 1997, the prescriptions of medications written on a patient's medical records were transcribed to requisition forms (two copies) that were filled out manually by a clerk or nurse. Because this was a manual process of great volume executed by unqualified personnel, there was the possibility of errors. In addition, the entire existing informatics structure was obsolete with remote processing terminals. The volume of activities often prevented immediate access to the patient's information.

These factors led to the decision to create a new information system and consequently a new operational system to dispense medications. This involved the implementation of a new technological base and the meeting of the new requirements for the economical performance of the hospital.

For the development of the new drug prescription system, the Fournier approach was used. This approach employs six phases: research, preliminary analysis, detailed analysis,

Table 1 - Items on the form for data collection regarding the informatized system for dispensing of medication from the Pharmacy Division, 2004.

FORM FOR DATA COLLECTION		
REQUISITION		
Paper quality		Good, Regular, Poor
Printing quality		Good, Regular, Poor
Information content		Good, Regular, Poor
Ease of identification of patient data		Good, Regular, Poor
Spacing between items		Good, Regular, Poor
Ease of identification of the medicine		Good, Regular, Poor
MEDICINES DISPENSED		
Packaging system		Good, Regular, Poor
Barcode label	Size	Good, Regular, Poor
	Legibility	Good, Regular, Poor
	Content	Good, Regular, Poor
	Compatibility between identification of the medication and the prescription	Good, Regular, Poor
Type of organization in the medication cart		Good, Regular, Poor
INFORMATIZED SYSTEM FOR THE REQUISITION OF MEDICATIONS		
Quality	Functionality (is the system adequate for your needs and objectives as a user?)	Yes, No
	Safety (is the system reliable?)	Yes, No
	Utilization (does the system facilitate learning and operationalization?)	Yes, No
	Efficiency (does the system permit greater agility in the filling of medical prescriptions?)	Yes, No
What in the system do you believe to be contributing to the reduction of errors of dispensation/administration of medications by the nursing staff? As a nursing/pharmacy professional, based on the information provided in this form, what would you change in this process if you could, and why?		

implementation, and maintenance.¹⁰ The initial phases involved an ample discussion with all of the functional areas linked to the new system, with strong and weak points as well as opportunities being exhaustively analyzed to create a robust concept of “what to do.” The hospital administration opted for internal development of the software for the system to create an effective informatics structure for the hospital itself.

The analysis phase of the project was based on the structured methodology of system development, using data modeling to create diagrams and documentation of the model that consisted of 43 data tables. The project phase was completely based on the technique of system prototyping, with periodic work meetings to validate the functioning of the software. Eight months were needed to finalize the new system, and the technologies adopted in its conception were as follows: front-end visual Delphi, back-end Oracle, Windows NT for the databank server, and Windows 95 for the work stations.¹¹

A pilot plan was conceived and carried out to initially test as well as evaluate the system. During the execution of the pilot plan, all necessary adjustments were made to define the entire hardware and software structure.

The system was implanted in January 1998, at first in the Pediatrics Sector and later covering the entire hospital by december of the same year. This gradual implementation permitted the necessary adaptations to the program and the training of all professionals (physicians, nurses, pharmacists and assistants).

For access to the databank, all users of the system were registered based on the right to access the prescriptions, requisitions and dispensations according to the level of prescribing authority of each professional (physician, nurse, and pharmacist).

Functioning of the system: the electronic prescription

The system permits registered physicians to prescribe medications, diets, parenteral nutrition, medical care, and blood derivatives. The electronic prescription permits all medication requests to be sent to the Division of Pharmaceutical Assistance in accordance with Law n° 9787/99¹², adopting the Common Brazilian Denomination (DCB in the Portuguese acronym) or the International Common Denomination (ICD).

The prerequisite for the prescription of antimicrobial medications is the electronic filling of the control form by the physician according to the routine established by the Committee for the Control and Use of Antibiotics (CUCA).

Because of the legal impossibility of informatization, the only documents required to be filled out on paper are

the prescriptions of medications under special control (psychotropics and narcotics) according to the regulation established by Judicial Directive MS n 344/1998.¹³

All of the information in the prescription and the electronic signature of the issuing doctor are recorded in the databank and made available on the microcomputer network of the hospital for an undetermined period of time.

Requisition of medications

The nurses view the prescription issued by the physician on the computer and complete the data regarding the necessary quantity and times of administration. After the information is completed, they issue a requisition. The requisition then receives a number and is sent electronically to the pharmacy.

Dispensing of the medications

The sector for the dispensing of medications is equipped with three microcomputers that are monitored 24 hours a day. The following types of requisitions were programmed based on the priority of care: normal, urgent, hospital discharge, automatic replacement, and parenteral nutrition.

All of medications available on shelves of supply area were previously fractionated, packaged and identified with labels containing: generic name, pharmaceutical form, dose, number of the fabrication lot, expiration date, and barcode (for optical identification).

When a project involving hospital informatization is started, large groups of variables are created that are part of the equation that will define and conduct the project. These include the level of financial investment and logistic support (which are the most relevant aspects); the complexity of the business processes to be informatized; difficulties related to the selection and application of technological and methodological options; technical habilitation; recycling; updating and performance of the informatics team; the motivation, educational level, and involvement of the users; and the quality and quantity of their training.

Impact assessment for the new system

The form used to assess the impact of the new system was divided into three parts that included aspects related to the requisition of medications, the medications dispensed by the pharmacy and the informatized system (Table 1).

The aspects considered for the requisition of medications were paper and printing quality, information content, patient identification, spacing of the items, and identification of the medications.

Regarding the dispensing of medications, the considered aspects included the packaging system, characteristics of the label, compatibility between the data on the label and the organization of the cart used for distributing the medications.

The perceptions of the informatized system were studied on the basis of functionality, safety, utilization and efficiency.

Requisition of medications

The quality of the paper form used to print the medication requests was considered good by 84.5% (49/58) of the nursing staff and regular by 56.0% (14/25) of the pharmacy staff.

In general, 70.7% of the nursing staff and 80% of the pharmacy staff considered the legibility of the items listed on the requisition to be good.

Regarding the information on the form for the requisition of medications, 77.6% (45/58) of the nursing staff and 60.0% (15/25) of the pharmacy staff stated that they were satisfied with its content; this contributed to improved performance in daily activities.

The ease of identifying patient data (name, hospital registration number and admission bed) was considered to be adequate by 79.3% (43/58) of the nursing staff and by 60.0% (15/25) of the pharmacy staff.

The spacing used between one item and another in the requisition form was considered to be good by 77.6% (45/58) of the nursing staff and by 96.0% (24/25) of the pharmacy staff.

The medication and the prescribed dose identification were considered good by 72.4% (42/58) of the nursing staff and regular by 52.0% (13/25) of the pharmacy staff.

Dispensing of medications

The nursing (84.5%, 49/58) and pharmacy staff (80.0%, 20/25) was satisfied with the system used by the pharmacy for fractionation of the medications dispensed. A total of 79.3% (46/58) of the nursing staff and 64.0% (26/25) of the pharmacy staff considered the information present on the label to agree with the content of the medical prescription.

Regarding the label used to identify the medication, its size was considered to be good by 84.5% of the nursing staff (49/58) and 68.0% (17/25) of the pharmacy staff. The label was considered to be legible by 82.8% (48/58) and 56.0% (14/25) of the nursing and pharmacy staff, respectively. The information on the label was considered to be good (permitting easy and perfect identification) by 82.8% (48/58) of the nursing staff and 76.0% (19/25) of the pharmacy staff.

Perceptions of the informatized system

The system functionality was considered adequate by 77.6% (45/58) of the nursing staff and 84.0% (21/25) of the pharmacy staff. The system was considered safe by 84.5% (49/58) of the nursing staff and 72.0% (18/25) of the pharmacy staff.

Regarding the speed of prescription processing, 62.1% (36/58) of the nursing staff and 88.0% (22/25) of the pharmacy staff considered the current system to be faster than the previous one.

Most of the interviewees (93.1% of the nursing staff and 96.0% of the pharmacy staff) considered the system to be easy to learn and use. To evoke new contributions to refine the system, the interviewees were asked to give their perceptions of factors that might further contribute to the reduction of medication errors (Table 2).

Table 2 - Perceptions of nurses, pharmacists and pharmacy assistants regarding the informatized system, 2004.

FUNCTIONALITY			
	YES	NO	TOTAL
NURSING	45	13	58
PHARMACY	21	4	25
TOTAL	66	17	83

Fisher's exact test= 0.570

SAFETY			
	YES	NO	TOTAL
NURSING	49	9	58
PHARMACY	18	7	25
TOTAL	67	16	83

Pearson chi²(1) = 1,7493 Pr = 0.186

UTILIZATION			
	YES	NO	TOTAL
NURSING	54	4	58
PHARMACY	24	1	25
TOTAL	78	5	83

Fisher's exact test= 1,000

EFFICIENCY			
	YES	NO	TOTAL
NURSING	36	22	58
PHARMACY	22	3	25
TOTAL	58	25	83

Fisher's exact test = 0.020

Regarding the requisition of medications, the following changes were suggested: improving the quality of the printing paper, emphasizing the identification of patient data, increasing the speed of informing the prescribing physician about unavailable medications, informatization of the medical prescription block for medications under special control (psychotropics), blocking duplicate prescriptions or requisitions, sending the medical prescription directly to the pharmacy without nurse intervention, making it obligatory for the physician to fill out all the prescription fields, and using a laser printer to increase the legibility of requisitions and prescriptions (Table 3).

Table 3 - Suggestions for the reduction of errors in the administration of medications based on the informatized system, 2004.

SUGGESTIONS	
NURSING	<ul style="list-style-type: none"> - better legibility preventing errors of interpretation - reliability of the data (no need for transcription) - complete identification of the patient and of the medications prescribed - rapidity - better identification of the doses prescribed by the physician - compatibility between prescription and patient number - possibility of revising previous requisitions - packaging of the medications containing all the necessary identification
PHARMACY	<ul style="list-style-type: none"> - better visualization of the requisition of medications, elimination of manual transcription - use of the generic name of the medication - availability of the complete prescription information - verification of the requisitioned and dispensed medication by optical reading of the barcode

Regarding the medications dispensed by the pharmacy, improvements were suggested for identification of the products in the package, adaptation of the distribution system to the current needs. Improvements were also suggested regarding the amount of information provided about the drugs, such as stability, medicamentous interactions, maximum permitted dose, and precautions about use.

The data related to the different aspects considered in the questionnaire, i.e., the requisition and dispensing of medications and the informatization system, were statistically analyzed using the contingency table method (chi-square test and Fisher's exact test).¹⁴ No associations were detected between professional category and perception of the different aspects considered.

DISCUSSION

"The proper medication for the proper patient and at the proper time."⁶ This statement describes one of the main responsibilities of the professionals of a hospital pharmacy, i.e., the distribution of medications.

Medication distribution systems involve the flow of medication from its entry into the pharmacy to its administration to the patient. Even though this is a simple concept, an efficient system of distribution requires considerable planning, organization and resources.

As institutions grow and diversify, the distribution of medications becomes logistically more complex, requiring methods aimed at reducing or eliminating errors. Among these methods is the implementation of an informatized system for the control of stock and dispensing of medications. Other measures regarding working performance should be considered, such as full access to the medical prescription on the part of the pharmacists, correct identification of the medication (on the prescription and on the label of the product to be dispensed), implementation of a distribution system based on unit dose, multiple checking at the time of dispensing the medication, and patient counseling.

The system of distributing medications to hospitalized patients is unique to each hospital and is characterized by the dispensing of medications to each patient over a period of 24 hours. The informatized system is based on the electronic medical prescription viewed on a computer screen at the pharmacy and printed on a form for use. After pharmaceutical evaluation, the medications are dispensed by optical reading of the barcode.

During the phase of checking the electronic request, it is possible to detect errors such as: omission of distribution, overdosing, under dosing, incorrect medication, dispensing a medication without a prescription, inadequate interpretation of the prescription, incompatible medications, the wrong pharmaceutical form, an adulterated pharmaceutical form, an inadequate route of administration and an expired medication.

Such detection allows the prevention of medication errors and agrees with the recommendations of the American Society of Health-System Pharmacists.⁶ The standardization of the prescription and dispensing process is considered to be an essential strategy to facilitate the identification and prevention of these errors.¹⁵

Ammenwert et al.⁸ reported a comparative study between electronic prescriptions and other forms of registering hospital prescriptions, and showed a greater reduction of prescription errors when using electronic prescriptions than reported in earlier studies.

Other important aspects in the dispensing process are the packaging and labeling characteristics, which must be correct as established by law, thereby permitting the adequate preservation and unequivocal identification of the medication. If fractionation is needed, the division of a medication into doses that correspond to the medical prescription should follow the regulations of RDC nº 135/2005.¹⁶ This regulation authorizes such activity under the responsibility and guidance of the pharmacists, and requires that the original quality and efficacy of the products be preserved.

The introduction of the barcode for the medications involved a sizable modification of the area used for fractionating medications in the pharmacy because, according to an internal survey, only 40% of the manufacturers placed barcodes on the packages of their medications. In addition, all tablets and ampoules dispensed first needed to be packaged and labeled. This triggered a considerable increase in work, requiring the new system to automate the main operations performed in the pharmacy.

The acquisition of a machine for the simultaneous packaging of double-unit doses of solid medications (tablets, capsules and pills) with the capacity of 120 doses per minute reduced the demand for human resources. The equipment executes all packaging of solid units, requiring the work of only one employee. After entering product information such as lot, term of validity, code in the institution and the quantity to be processed into the computer, the employee simply inspects the entire process.

A correct and rational distribution must guarantee rapid delivery and safety as well as efficiency of the information and control system. Rapid delivery means that the process should be carried out within the desired time on the basis of an established flow diagram, preventing delays and/or shortages in the system. Safety is the guarantee that the products will reach the users in the correct quantities and with the desired quality. An efficient information and control system implies that the distribution should always be monitored, providing up-to-date information at any given time regarding the “physical-financial” position of the stocks, the quantities received and distributed, the data regarding consumption and demand of each product, the maximum and minimum stocks, the replacement points, the quantities that were acquired, and any other information needed for adequate management.

One of the challenges for large hospitals with a large number of employees is to train all of these professionals. The system developed here was easy to learn and use, which facilitated the training.

Listening to the professionals involved was essential to improving the informatized system, mainly because of the value of practical experience.

The professionals suggested some aspects that might contribute to the reduction of errors in medication, such as verification of patient identification and the medication prescribed, as well as verifying all information by means of the barcode. They also suggested modifications to the requisition form regarding patient data, informatization of the prescription block for psychotropics, and exclusion of the need for nurses when communicating the prescription to the pharmacy. The staff of the pharmacy division suggested improvements related to the medications and their manipulation.

Although the implemented informatized system represents a great advance for improving the quality of care and productivity, this new approach does not exempt individuals from their responsibilities.

CONCLUSIONS

In the present study, the incorporation of informatics into the activities of a hospital pharmacy was found to permit an improved quality of patient care by the rapid and precise transmission of information that could be revised and corrected, as well as through an improved work routine. The informatized system facilitated the clinical and economical management of the service, providing more information about the consumption of medications and related materials.

According to the professionals involved in implementing this new process, the use of electronic prescriptions contributed to the reduction of errors in dispensed medications by streamlining the system. Moreover, it provided better safety control during the requisition of the medication by eliminating manual transcription. The use of the generic name of the medication and the provision of information about it encouraged rational use, and the barcode offered better reliability in the dispensing of medications prescribed.

In addition to reducing errors of dispensation, rationalizing the distribution and increasing the control of medications, the implementation of the system permitted the creation of a solid base of management information. Thus, the benefits of this system are not simply limited to the management plane; it also permits pharmacotherapeutic monitoring as well as other activities that ensure the achievement of the desired clinical results and the rational use of medications.

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