Impact of computerised chemotherapy prescriptions on the prevention of medication errors

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Objectives. The authors sought to evaluate the impact of computerised chemotherapy prescription on the reduction of medication errors. The purpose of this study was to assess the incidence of errors present in electronic versus manual prescription.

Material and methods. The data gathered from computerised chemotherapy prescription sheets were submitted to a prospective analysis as cases of the intervention groups. The control group was comprised of the handwritten chemotherapy prescription sheets. Chemotherapy prescriptions for consecutive oncology patients were analysed by 2 independent examiners, who investigated errors of omission, commission, interpretation of dates, abbreviations and illegible handwriting. The proportion of treatment prescriptions containing one or more errors and the median of errors were calculated in order in both groups.

Results. At least one error was detected in 100% of the manual prescriptions and in 13% of computerised prescriptions ($p < 0.001$). The median of errors per computerised prescription was 0 (range: 0-1), whereas in manual prescriptions the median was 5 (range: 1-12) ($p < 0.001$). Errors of omission were predominant in manual prescriptions. Errors of commission were limited to 1 case of unjustified cytostatic agent infra-dosage in a computerised prescription. This error was present in 3 cases in handwritten prescriptions and, in addition, 1 case of premedication drug substitution was detected. Errors of interpretation of the date, use of abbreviations and illegible handwriting were frequent among manual prescriptions and were absent from computerised prescriptions.

Conclusions. Electronic chemotherapy prescription is a powerful tool. In this study it has been shown to decrease chemotherapy-related medication errors and ensure that safe chemotherapy practices were followed.

Key words: medication error, electronic prescription, manual/handwritten prescription, computerised physician order entry.

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INTRODUCTION

In recent years, health care professionals, organisations and institutions have become especially concerned with the problem of patient safety and the quality of health care. In order to prevent adverse side-effects of medications, preventive measures have been implemented in the health care system, one of which is the detection and prevention of medication errors.

A medication error is a mistake originating in any of the various phases of the medication usage system. The National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP) defines such an error as any preventable incident that may harm the patient or lead to an inappropriate use of medication in cases where the medicine is controlled by health care professionals, patients or consumers. It includes errors committed in the areas of prescription, notification, labelling, filling, names, preparation, dispensation, distribution, administration, education, follow-up and usage[1]. These errors may provoke either potentially adverse incidents (with the ability to harm but not actually harming the patient, either by good fortune or because they are intercepted before the patient used the medication) or preventable adverse incidents (which do harm the patient). One study has demonstrated that 69% of adverse incidents are due to the use of pharmaceuticals, the majority of which are preventable[2].

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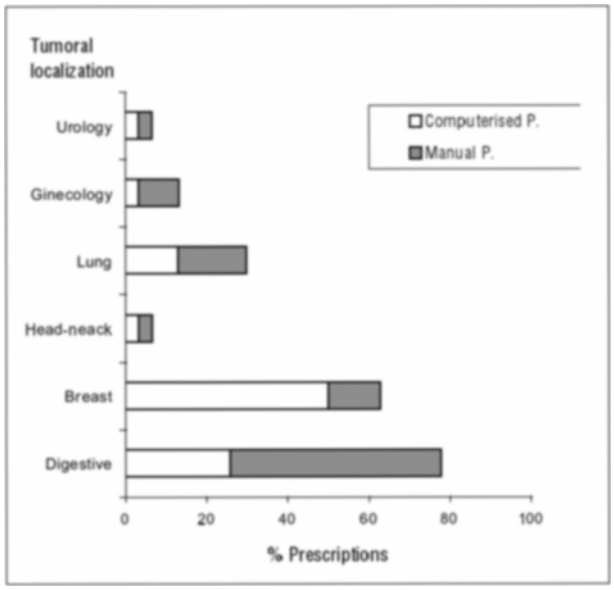

Fig. 1. Characteristics of the prescriptions.

Although adverse reactions to medication are frequent in hospitals, only 28% of these incidents are related to medication errors[3]. Most are considered minor incidents, but some errors have the potential to inflict extensive damage or serious adverse effects. It is currently accepted that between 1 and 5% of these cases actually end up harming patients[4,5]. Detecting and preventing these errors is therefore a top priority, one that is also important from the hospital's point-of-view given the consequent additional costs to the health care system[6].

Chemotherapy agents possess an inherent toxicity that differentiates them from other medications. Errors in chemotherapy can have serious consequences for patients given the limited therapeutic margin of these pharmaceuticals. In addition, other factors can increase the possibility of errors, such as externally applied individualised dosage, the variability of doses of a single pharmaceutical when applied to different tumours, the coexistence of protocols of health care and research on different doses, and even the disagreement between marketing presentations of certain cytostatic agents and their therapeutic doses[7-9]. Although side-effects provoked by chemotherapy errors are considered to be rare, mistakes can be made even in quality accredited institutions with adequate prevention systems in place. Most of the necessary measures for minimising errors entail an additional workload when these are applied using manual procedures, which is why the practical implementation of these measures is almost impossible without computerised systems[10-12]. These systems have shown great potential for improving the prescription process, reducing medication errors by 55-83%[13].

The objective of the present study is to evaluate the impact of computerised prescriptions of chemotherapy treatments on the reduction of medication errors.

MATERIALS AND METHODS

The installation of a completely computerised system for chemotherapy treatment in the Medical Oncology Department of a University Hospital was preceded by a protocol update phase, including information not only on cytostatic agents but also on antiemesis, hydration, remedial medications, etc. The activity observed in this department during the year 2005 was a total of 5,765 prescriptions/year. In November 2005 (month in which the study was performed), two oncologists used electronic prescription methods and three gave manual prescriptions. The population of patients treated and the type of chemotherapy prescribed were similar in both groups. Distribution according to tumour location can be observed in figure 1.

The computerised prescription of chemotherapy at the Medical Oncology office terminal using the Oncowin® version 4.0 computer programme (Baxter S.A., Spain), and is validated online by a pharmacist. The doctor introduces the patient's personal data and information related to the diagnosis, and then selects the treatment protocol and programmes the date on which chemotherapy should be administered. The validation process produces computerised preparation sheets with the calculations of necessary doses and identifying labels for each treatment and patient. This sheet is the work instruction document used by the nursing staff, who prepare and later administer the chemotherapy. On the other hand, handwritten physician orders are sent by fax to the Pharmacy department. In this case, there is no pharmacist validation, and the nursing staff is responsible for calculating the necessary dilutions for treatment preparation. The rest of the process is identical.

In the implementation phase, computerised and manual chemotherapy prescriptions coexist. The data reflected on the computerised prescription sheets of consecutive oncology patients has been prospectively analysed during the pharmacist validation process by two independent examiners as cases pertaining to the intervention group. The control group is comprised of the manual chemotherapy prescription sheets, which have been analysed in the same manner. All patients gave their informed consent to allow their treatment sheets to be analysed and the results to be published.

A chemotherapy prescription error was defined as any potential or real error in which the dose of chemotherapy or adjuvant medication prescribed varies from the appropriate dose for that patient, the prescription indicates an erroneous date, an incorrect treatment method or inadequate means, duration, infusion rate or concentration. It also includes the in-

TABLE 1. **Errors of omission in computerised and manual prescriptions**

Variables	Manual prescription	Computerised prescription	p
Patient's name	9/30 (30%)	0	0.0037
Age	25/30 (83%)	1/30 (3.3%)	< 0.001
Weight	4/30 (13%)	0	0.0730
Height	5/30 (17%)	0	0.0393
Body surface area	1/30 (3.3%)	0	0.5082
Physician's name	9/30 (30%)	0	0.0037
Signature	22/30 (73%)	2/30 (6.6%)	< 0.001
Diagnosis	25/30 (83%)	0	< 0.001
Pre-medication	0	0	-
Post-medication	0	0	-
Administration method	3/30 (10%)	0	0.1374
Administration frequency	14/30 (47%)	0	< 0.001
Dosage	0	0	-
Duration of infusion	15/30 (50%)	0	< 0.001

voluntary omission of any medication or illegible prescriptions that lead to confusion and may negatively affect the patient. The following types of prescription errors were taken into consideration: errors of omission (absence of any of the variables recommended in the consensus report issued by the Spanish Group for the Development of Oncological Pharmacy, or GEDEFO) (table 1)[14], errors of commission (incorrect data or any other discrepancy between the medication prescribed for chemotherapy treatment and the medication dictated by the hospital's pre-approved protocols), illegible handwriting, abbreviations and errors in reading of dates (for example, when a physician prescribes on 15 November «the same treatment as on 1 November without Irinotecan but with 375 mg Cetuximab», the nurse must look up the prescription of 1 November and then make the pertinent modifications). Justification of doses different from those dictated by the original protocol, such as reductions due to prior toxicity, were required to be noted in the patient's medical records in the case of manual or electronic prescription so that the pharmacist could take this information into account when performing validation. The analysed variables were not all given the same consideration with regard to their effects on the patients. The clinically significant errors were identified and earmarked by consensus between the two independent examiners as those which had the potential to have a serious or moderate effect on the patient.

The Epi-Info version 6 computer programme was used to perform a statistical analysis of the data. The size of the sample was calculated to identify a difference of 15% in the proportion of treatment prescriptions containing 1 or more errors in the intervention and control groups, with a power of 80% and a 0.05 type I error. The differences in the error rates of both groups were studied using Fisher's Exact chi-squared test.

RESULTS

60 prescriptions for chemotherapy treatment were included (30 computerised prescriptions/ 30 manual prescriptions). At least 1 error was detected in 100% of the manual prescriptions and in 13% of the computerised ones ($p < 0.001$). The median of errors per computerised prescription was 0 (range: 0-1), whereas that per manual prescription was 5 (range: 1-12) ($p < 0.001$).

The most common mistakes in manual prescriptions were errors of omission. In computerised prescriptions, only 1 omission was found in the age variable and 2 in the physician's signature (table 1). Errors of commission in computerised prescriptions were limited to 1 case of unjustified cytostatic agent infra-dosage. This error was present in 3 manual prescription cases and, in addition, one case was detected in which a drug was substituted in pre-medication (table 2). Errors in reading of dates, use of abbreviations and illegible handwriting were frequent in manual prescriptions and completely absent in computerised prescriptions (table 3). Clinically significant errors were only detected in 2 handwritten ($p = 0.262$) physician orders (6.6%). These errors were

TABLE 2. **Errors of commission in computerised and manual prescriptions**

Variables	Manual prescription	Computerised prescription	p
Drug substitution in pre-medication	1/30 (3.3%)	0	0.0508
Unjustified cytostatic agent infra-dosage	3/30 (10%)	1/30 (3.3%)	0.3059

TABLE 3. **Errors associated with manual prescriptions**

Variables	Manual prescription	Computerised prescription	p
Abbreviations	12/30 (40%)	0	0.0014
Illegible handwriting	3/30 (10%)	0	0.1374
Interpretation of dates	14/30 (47%)	0	< 0.001

due to illegible handwriting, specifically regarding the dose of the cytostatic agent to be administered: one was interpreted as 40 mg Paclitaxel instead of 90 mg, and another prescription read 5-fluorouracil in illegible dose. Both cases were resolved before any harm came to the patients.

DISCUSSION

The study of medication errors and their possible prevention is important to improving and increasing safety measures in the process of antineoplastic chemotherapy prescription. Computerised prescription software is considered an essential tool for minimising errors on prescriptions[10,11,13,15,16]. Making the most of the period in which an electronic programme for the prescription of chemotherapy treatment was being implemented in the Medical Oncology department, we have completed a prospective comparison of the errors in manual and computerised prescriptions.

Currently, there is no internationally regulated and approved terminology for selecting the variables that measure medication errors, which makes it difficult to analyse their magnitude and compare them with data from other studies and countries[5]. Various authors have studied the frequency of errors in chemotherapy prescriptions, but comparisons are complicated because neither the variables nor the methodology used in these studies are the same[16].

Our study is limited by its short follow-up period and the reduced number of prescriptions analysed. With regard to the methodology used, a comparison of errors made by oncologists when using both the manual and computer-assisted prescription systems would have been the most ideal approach. However, issues of infrastructure made this approach unviable. However, our study has sufficed to demonstrate that errors of omission are drastically reduced, to such a degree that in the computerised prescriptions the only omissions detected were the age of the patient in one case and the signature of the attending physician in two cases. These kinds of errors of omission are precisely the most frequent among manual prescriptions[17] and simply serves to highlight the difficulty of filling in every necessary detail on treatment prescriptions when these are completed by hand. This new way of working demands a significant cultural change for the prescribing physician[18], since electronic prescription is a complicated process that requires a learning curve wherein errors inherent in any learning process may be committed[19]. In the prescriptions analysed, we did not detect these kinds of errors, so often observed in computerised systems.

In some studies, errors of commission, including incorrect dosage calculations, account for up to 11.1% of prescription errors[20]. These errors are especially significant in the area of Medical Oncology given the narrow therapeutic margin of cytostatic agents. In our study, the electronic prescription itself and the subsequent validation in the Pharmaceutical Unit have helped to reduce dosage errors from 10% to 3.3%. In every case, the errors consisted of a dosage reduction without written justification presented by the prescribing physician. The application of computer technology to the process of chemotherapy prescription also contributes to minimising the variability of clinical praxis, as it requires all treatments to adhere to established protocols by obliging the physician to select a certain treatment for each specific patient when completing a prescription. According to the guide produced by the American Journal for Health System Pharmacists, the standardisation of prescriptions is a key factor in preventing errors involving antineoplastic agents[21]. Arbitrary substitution of pharmaceuticals in a protocol is a common error when prescribing chemotherapy treatment[22]. Our study only detected one case in which a drug was substituted in pre-medication, and this case belonged to the manual prescription group.

Studies that analyse the causes of cytostatic agent prescription errors usually conclude that poor handwriting is the primary source of such mistakes[23]. Our analysis does not differ from others that have already been published; if we add up the partially or completely illegible abbreviations and words, 50% of all handwritten prescriptions contained such errors. This serves to emphasize the definitive advantage that computerisation offers, as it would eliminate handwritten prescriptions. The errors associated with an incorrect interpretation of the date on which medication is to be administered, when the administration date is given as «same as on...» are also exclusively limited to manual prescriptions, and their abolition is usually included among strategies for the prevention of chemotherapy-related errors[24].

Given the characteristics of this study, all errors– in both manual and computerised prescriptions– were intercepted and only resulted in a more difficult validation for the pharmacist and a delay in treatment administration, never actually reaching any patients (including the errors considered of clinical significance). Therefore, it is not possible to reach a definite conclusion with regard to the prevention of adverse effects in this kind of hospital care. Although the final objective of the present study and of other similar studies is always the safety of the patient and the improvement of health care quality[25,26], new studies designed to objectively gauge the impact of these new technologies on the reduction of adverse effects and of their consequent cost to hospitals are needed[21]. Koppel et al published one of the few existing studies that analyse the medication errors inherent in computerised physician order entry systems[27]. This study demonstrated, for example, the lack of flexibility in protocols, making it difficult to adapt treatments to suit certain patients, or the loss of information due to computer error. Given that computerised prescription itself can be a source of error, the authors of the present study are currently carrying out a prospective analysis of such errors and possible measures to prevent them.

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