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ORIGINAL ARTICLE

New technologies applied to the medication-dispensing process, error analysis and contributing factors

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Abstract
Objective: Calculate error prevalence occurred in different medication-dispensing systems, the stages of occurrence, and contributing factors.
Methodology: Prospective observational study. The staging of the dispensing process were reviewed in five dispensing systems: Stock, Unitary-Dose dispensing systems (UDDS) without Computerised Prescription Order Entry (CPOE), CPOE-UDDS, Automated Dispensing Systems (ADS) without CPOE and CPOE-ADS. Dispensing errors were identified, together with the stages of occurrence of such errors and their contributing factors.
Results: Two thousand one hundred eighty one errors were detected among 54,169 opportunities of error. Error-rate: Stock, 10.7%; no-CPOE-UDDS, 3.7%, CPOE-UDDS, 2.2%, no-CPOE-ADS, 20.7%; CPOE-ADS, 2.9%. Most frequent stage when error occurs: Stock, preparation of order; no-CPOE-UDDS and CPOE-UDDS, filling of the unit dose cart; no-CPOE-ADS and CPOE-ADS, filling of the ADS. Most frequent error: Stock, no-CPOE-ADS and CPOE-ADS, omission; CPOE-UDDS, different amount of drug and no-CPOE-UDDS, extra medication. Contributing factor: Stock, CPOE-ADS and no-CPOE-ADS, stock out/supply problems; CPOE-UDDS, inexperienced personnel and deficient communication system between professionals; no-CPOE-UDDS, deficient communication system between professionals.
Conclusions: Applying new technologies to the dispensing process has increased its safety, particularly, implementation of CPOE has enabled to reduce dispensing errors.

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PALABRAS CLAVE
Error de dispensación;
Error de medicación;
Sistemas de distribución de medicamentos;
Proceso farmacoterapéutico;
Calidad

Nuevas tecnologías aplicadas al proceso de dispensación de medicamentos. Análisis de errores y factores contribuyentes

Resumen
Objetivo: Calcular la prevalencia de los errores producidos en diferentes sistemas de dispensación de medicamentos, las etapas en que se producen y los factores contribuyentes.
Métodos: Estudio observacional prospectivo. Se revisaron las etapas del proceso de dispensación en 5 sistemas de dispensación: stock o botiquín de planta, sistema de distribución de medicamentos en dosis unitaria (SDMDU) sin prescripción electrónica asistida (PEA), SDMDU con PEA, sistema automatizado de dispensación (SAD) sin PEA y SAD con PEA. Se identificaron los errores de dispensación, las etapas en que ocurrieron dichos errores y sus factores contribuyentes.
Resultados: De 54.169 oportunidades de error, se detectaron 2.181 errores. Tasa de error: stock, 10,7%; SDMDU sin PEA, 3,7%; SDMDU con PEA, 2,2%; SAD sin PEA, 20,7%; SAD con PEA, 2,9%. Etapa más frecuente en la que se produce el error: stock, preparación del pedido; SDMDU sin PEA y con PEA, llenado del carro; SAD sin PEA y con PEA, llenado del SAD. Error más frecuente: stock, SAD sin PEA y con PEA, omisión; SDMDU con PEA, diferente cantidad de medicamento; SDMDU sin PEA, sobra medicamento. Factor contribuyente: stock, SAD sin PEA y con PEA, rotura de stock/desabastecimiento; SDMDU con PEA, personal sin experiencia y sistema de comunicación deficiente entre profesionales; SDMDU sin PEA, sistema de comunicación deficiente entre profesionales.
Conclusiones: La aplicación de nuevas tecnologías en el proceso de dispensación ha aumentado su seguridad, concretamente la implantación de la PEA ha permitido disminuir los errores en el proceso de dispensación.

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 wide range of measures relating to improving performance, environmental safety and risk management, including the safe use of medicines, equipment safety, safe clinical practice and a safe care setting.[1]

The current idea of patient safety places the main responsibility for adverse events on defects in system design, organisation and functioning rather than on suppliers or the individual products.[1] System failures are due to multiple errors occurring together, and human error is not the only main explanation.

Furthermore, the incorporation of information technology into the practices of hospital pharmacy services (PS) means it is necessary to investigate any possible errors this could entail. At the end of 2008, after the analysis of Medmarx data regarding the incidence of adverse effects caused directly by information technology in the healthcare sector, the Joint Commission warned of the need to set up and implement this technology safely, and therefore, organisations must pay special attention to the contributing factors which can put patient safety at risk, and suggest any action to be taken.[2] Furthermore, analysing the processes of the use of medication, it is essential to consider the influence of human factors on safety at any stage of these processes. These, and the conditions under which they are carried out, involve a wide variety of activities and people. Thus, it is of particular interest for organisations to perform an analysis of the root cause of the errors that could be due to a human factor and, after detecting them, to put in place the necessary measures to improve safety.[3]

According to the WHO, thinking in terms of systems is the best way to adopt definitive solutions to reduce risks.[1] System (latent) failures pose the greatest risk to patient safety as they lead workers into making mistakes and they are able to cause many types of errors.[4] Most articles published about medication-related safety focus on medication errors in general and in particular on dispensing errors and the analysis of the causes and contributing factors.[5-11] However, they do not usually identify in which stage or phase of the dispensing process these errors occur.

The aim of this study is to calculate the prevalence of errors produced in different medication dispensing systems, the stages in which they occur and the contributing factors.

Methodology

1. *Study design:* a prospective observational study was performed which involved checking all the phases of medication dispensing in the different systems established in the hospital. Data collection was performed by one single pharmacist.
2. *Study setting:* PS of a 1,070-bed general hospital. It uses the Hospiwin 2000 v6® computer application for the global management of the PS.
   The dispensing systems were: stock; unitary-dose dispensing system (UDDS) without computerised prescription order entry (CPOE), CPOE-UDDS; an

Table 1 Stages in each dispensing system

Dispensing system	Stages considered
Stock	Order preparation, filling the Kardex® horizontal carousel and maintenance of the Mercurio® database
No-CPOE-UDDS	Filling the Kardex® vertical carousel, filling the trolley, maintenance of Mercurio®, transcription and validation
CPOE-UDDS	Filling the Kardex® vertical carousel, filling the Kardex® horizontal carousel, filling the trolley, maintenance of Mercurio® and validation
No-CPOE-ADS	Filling the ADS, filling the Kardex® horizontal carousel, maintenance of Mercurio®, maintenance of the ADS medication database and preparation of orders
CPOE-ADS	Filling the ADS, filling the Kardex® horizontal carousel, maintenance of Mercurio®, maintenance of the ADS medication database and preparation of orders and validation

Kardex®: automated storage; Mercurio®: Kardex® computer application.
ADS indicates automated dispensing system; CPOE, computerised physician entry order; UDDS, unit dose distribution system.

automated dispensing system (ADS) without CPOE and ADS with CPOE.

Stock or dispensary: Every week the PS receives the online orders for medication from the different hospital units (HU); one or more auxiliary nurses prepare the medication using the automated storage carousel (Kardex® horizontal). There is a connection between the computerised medication order module in Hospiwin 2000 v6® and the automated storage unit (Mercurio®).

UDDS with transcription: consists of dispensing medication identified by patient and in sufficient quantities to cover 24 h of treatment. The stages of the process in this system follow this order: The PS receives a copy of the treatment order for each patient; transcription by a pharmacist (introduces the medication prescribed in the treatment order into the computerised prescription module [Hospiwin 2000 v6®]); validation of the complete treatment by a pharmacist and preparation of the medication in the unit dose trolley by the auxiliary nurses of the PS. Preparation of the medication involves 2 automated storage carousels (Kardex® vertical) and the program (Hospiwin 2000 v6®) is connected to the Kardex® computer application (Mercurio®) to convey the information regarding all the medication to be put in each trolley.

UDDS with CPOE: only differs from the previous dispensing system in that there is no transcription of the treatment by the pharmacist, rather the doctor prescribes it directly with the computer program (Hospiwin 2000 v6®).

ADS without CPOE: the ADS is refilled twice a day (in the morning and in the afternoon). The stages of the process in this system follow this order: the computer program in the ADS issues a daily replenishment report, which one or more auxiliary nurses use to prepare the medication for filling it. To prepare this medication, an automated horizontal storage carousel (Kardex®) is used. Then, the ADS in each HU are filled.

ADS with CPOE: the stages of the process in this system are the same as in ADS with CPOE, but 2 more stages are added: electronic validation by the pharmacist of the treatment prescribed by the doctor, and checking the communication between the computerised prescription system (Hospiwin 2000 v6®) and the ADS dispensing system (Mercurio®).

There is an interface between the ADS and CPOE computer systems.[12]

3. *Study variables:*
   - *Dispensing error:* any discrepancy with regard to the established procedure in each stage of the dispensing process.

     The study analysed the errors that occurred in each stage of each dispensing system. The stages considered are shown in Table 1.
   - *Opportunity for error:* for stock, the number of medication order lines was considered; in no-CPOE-ADS, the number of medication order lines to replenish; in CPOE-ADS, CPOE-UDDS and no-CPOE-UDDS, the number of medication order lines validated. These last 3 systems are the only ones which can be compared with each other because the same criterion has been used to define the opportunities for error.
   - *Contributing factors:* classified following the methodology of Otero López et al.[13]
   - *Type of error:* classified following the methodology of Otero López et al.[13]
4. *Sample size*

   The sample size was calculated from a 2 week-long pilot study. Data collection was carried out on working days from Monday to Friday over a 6 month period between February and October 2008 (from 25 February until 31 October). July and August were excluded from the study because working conditions during this time vary considerably from those during the rest of the year (staff changes, reduced healthcare burden).

   To ensure a big enough sample size for the different procedures, we considered a proportion of error of 20%, a delta of 10% and an alpha of 0.05 would be necessary. It was decided to perform a daily check of 10 stock orders, 4 orders of no-CPOE-UDDS, 5 orders of CPOE-

Table 2 Errors, their contributing factors and most frequent associated types of errors occurring in each dispensing system

DS	Error rate (%)	Stage in which error occurred (%)	Contributing factor (%)	Type of error
Stock	511/4,776 (10.7)	Error in order preparation (10.4)	Stock breakage/shortage (6.3)	Omission (6.3)
			System inertia (0.9)	Different quantity of medication (2.7)
No-CPOE-UDDS	512/13,645 (3.7)	Error in filling trolley (1.9)	Deficient communication system between professionals (0.4). Others (0.4)	Excess medication (0.8)
			Inexperienced staff (0.3)	Different quantity of medication (0.4)
		Validation error (1.1)	System inertia (0.9)	Omission (0.3)
			Staff shortage (0.8)	Different quantity of medication (0.2)
		Transcription error (0.6)	Staff shortage (0.3)	Different quantity of medication (0.2)
			Others (0.2)	Omission (0.1)
CPOE-UDDS	435/20,240 (2.2)	Error in filling trolley (1.7)	Inexperienced staff (0.3)	Different quantity of medication (0.5)
			Deficient communication system between professionals (0.2)	Omission (0.4)
			Stock breakage/shortage (0.2)	Wrong dispenser box (0.4)
		Validation error (0.3)	Others (time of validation of medication order, staff situation, day of the week) (0.2)	Different dose (0.2)
			System inertia (0.1)	Different pharmaceutical type (0.05)
			Staff shortage (0.1)	
No-CPOE-ADS	327/1,576 (20.7)	Error in filling ADS (20.4)	Stock breakage/shortage (7.8)	Omission (11)
			Staff shortage (2.3)	Different quantity of medication (5.6)
CPOE-ADS	396/13,932 (2.9)	Error in filling ADS (2.2)	Stock breakage/shortage (1)	Omission (0.1)
			Deficient preparation/dispensing system (0.2)	Different quantity of medication (0.6)
		Validation error (0.6)	System inertia (0.3)	Communication error between systems (0.4)
			Staff shortage (0.3)	Different dose (0.2)

Results expressed as relative frequency: errors, contributing factors, type of error/opportunity for error.
ADS indicates automated dispensing system; CPOE, computerised physician entry order; DS, dispensing system; UDDS, unit dose distribution system.

UDDS, 4 orders of no-CPOE-ADS and 4 orders of CPOE-ADS over a period of 127 working days.

An order was taken to be all the medication dispensed by one of the following established dispensing systems:

Floor stock or dispensary: medication dispensed by HU according to the online order made by the corresponding department.

CPOE-UDDS and no-CPOE-UDDS: medication dispensed by HU and patient according to the validated medication order for a 24 h period.

CPOE-ADS and no-CPOE-ADS: medication dispensed by HU according to programmed refill lists generated automatically by the computer application forming the database of the ADS. The study did not consider errors which might have occurred on the hospital floor once the ADS were replenished, such as possible errors by nursing staff when handling medication.

5. *Study procedure, recruitment and information gathering*

To determine which dispensing system would be checked each day, a random sample was performed in blocks of 5. Every day, the pharmacist carried out a randomisation of the corresponding dispensing system to select the orders to be checked. The check of each system was performed with the following methodology:

Stock: the medication prepared by the auxiliary nurses was checked, comparing it with the online order requested by the corresponding HU.

No-CPOE-UDDS: first, a check was made of the computer transcription of the medication order performed by the pharmacists, comparing it with the copies of the medication orders received in the PS. Then, a check was performed of the pharmacist's validation of the patient's complete treatment prior to the day of the check, comparing it with the copy of the medication order received on the day of the check or with the previous day if it was not possible to read all the treatment on the latest copy. Finally, the preparation of the medication trolley carried out by the auxiliary nurses was checked, comparing it with the medication lists on the trolley which were produced by the pharmacists after validating the treatments.

CPOE-UDDS: the pharmacist's electronic validation and the preparation of the medication trolley carried out by the auxiliary nurses were checked, comparing them with the lists of medication on the trolley which were produced by the pharmacists after validating the treatments.

No-CPOE-ADS: the refilling of the ADS performed by the auxiliary nurse was checked, comparing it with the replenishment report created automatically by the ADS.

CPOE-ADS: a check was made of the pharmacist's electronic validation and the connection between Hospiwin® and the computer application which creates the database of the ADS.

Also, the refilling of the ADS performed by the auxiliary nurse was checked, comparing it with the replenishment report created automatically by the ADS.

6. *Statistical analysis*

The discrete variables are expressed as absolute and relative frequency.

To study the association between the type of system and the frequency of each error, univariate logistic regression models were used to quantify the association using odds ratios with 95% confidence intervals.

The reference category was the no-CPOE-UDDS.

All the contrasts were bilateral. Statistical significance was considered to be 0.05.

7. *Ethical considerations*

- The study was not submitted for approval by the ethics committee since it does not involve patients.
- Before the study began, all the hospital staff involved in the dispensing process attended a session to inform them about the study.

Results

When the study finished the following number of orders in each dispensing system had been checked: Stock, 179; no-CPOE-UDDS, 79; CPOE-UDDS, 106; no-CPOE-ADS, 107; and CPOE-ADS, 84. The loss rate was 16.6%. Losses in the stock dispensing system were due to it being impossible to check the total number of orders assigned by the randomisation process because it would have resulted in delays in their preparation. In the other systems the losses were due to the

Table 3 Error rate and odds ratio for validation and filling errors in unit dose medication distribution system with computerised physician entry order (CPOE) in automated dispensing with CPOE in relation to the unit dose distribution system without CPOE

	No-CPOE-UDDS	**CPOE-UDDS**				**CPOE-ADS**			
	Errors/OE (%)	*Errors/OE (%)*	*OR*	*CI 95%*		*Errors/OE (%)*	*OR*	*CI 95%*	
				Lower	Higher			Lower	Higher
Validation error	146/13,645 (1.1)	63/20,240 (0.3)	0.289	0.215	0.388	83/13,932 (0.6)	0.554	0.423	0.726
Filling error	265/13,645 (1.9)	345/20,240 (1.7)	0.876	0.745	1.029	309/13,932 (2.2)	1.145	0.97	1.352

ADS indicates automated dispensing system; CI, confidence interval; CPOE, computerised physician entry order; OE, opportunity for error; OR, odds ratio; UDDS, unit dose distribution system.

fact that it was not possible to check the entire calculated sample as it would have caused delays in the dispensing of medication.

A total of 2,181 errors were detected out of 54,169 opportunities for error in all the dispensing systems analysed. Table 2 shows the error rate for each system. This table also includes the stages of the dispensing process in which errors were most commonly observed, the types of errors and their contributing factors. The results are expressed as relative frequencies (stage in which the error, contributing factor or type of error/ opportunity for error in each dispensing system).

Taking the no-CPOE-UDDS as the reference and calculating the odds ratio, an analysis was performed of the validation and refill errors, as well as the types of errors occurring in the UDDS and ADS with CPOE (Tables 3 and 4).

Table 5 shows the contributing factors for each dispensing system.

Discussion

Nowadays, it is common for different medication dispensing systems to be implemented in hospitals due, on the one hand, to the new technology available, and on the other, to the real possibilities of meeting the healthcare demand for medication in hospitals. Five dispensing systems coexist in our hospital and for this reason we considered it necessary to perform a study to enable us to identify the stages in the dispensing process in which errors occur and classify them. This is a key aspect of our research, since the published literature concerning safety aspects in the medication use process focuses on the analysis of medication errors occurring at any time during this process; we have not found a study whose aim is to identify the errors, the stage in the dispensing process when these occur, or the factors which contribute to them. Climent et al make a global estimation for medication distribution systems of the types of errors and medication involved, analysing the factors associated with them.[14] Other authors have also analysed dispensing errors and their causes.[6,10,11,15-17] In turn, Rickrode et al[18] carried out a study through an internal communication system in the PS to obtain information about any event that could have the potential to cause an error, such as errors of execution or planning, in order to be able to take measures to correct these potential problems.

The diversity of definitions and methodologies used by the different authors makes it difficult to compare the results, both between them and with our own. However, we think that the global error rate and the errors identified in the validation and transcription stages of the UDDS in our study can be compared with the dispensing, validation and transcription errors identified in other studies.

The stock dispensing system had an error frequency of 10.7%, with the most common one being the preparation of the order. Other authors have found an error frequency in the dispensing system of between 2%-20%.[7] New technology may have contributed to this improvement as in the 1970s the frequency of these errors was 31%.[5] The main dispensing errors made at the time of preparing the order were omitting the medication and changing the quantity prescribed. Although we did not measure administrative errors,

Table 4 Error rate and odds ratio for different errors in unit dose medication distribution system (UDDS) without computerised physician entry order (CPOE), UDDS with CPOE and automated dispensing with CPOE relation to the unit dose distribution system without CPOE

	No-CPOE-UDDS	**CPOE-UDDS**				**CPOE-ADS**			
	Errors/OE (%)	*Errors/OE (%)*	*OR*	*CI 95%*		*Errors/OE (%)*	*OR*	*CI 95%*	
				Lower	Higher			Lower	Higher
Excess medication	154/13,645 (1.13)	73/20,240 (0.36)	0.317	0.24	0.419	5/13,932 (0.04)	0.031	0.013	0.077
Different quantity	117/13,645 (0.86)	97/20,240 (0.48)	0.557	0.425	0.729	84/13,932 (0.60)	0.701	0.529	0.929
Omission	94/13,645 (0.69)	84/20,240 (0.42)	0.598	0.445	0.804	177/13,932 (1.27)	1.879	1.462	2.416
Different dose	42/13,645 (0.31)	49/20,240 (0.24)	0.786	0.52	1.188	23/13,932 (0.17)	0.536	0.322	0.891
Different pharmaceutical type	16/13,645 (0.12)	1/20,240 (0.05)	0.042	0.006	0.317	6/13,932 (0.04)	0.367	0.144	0.938
Wrong medication	12/13,645 (0.09)	15/20,240 (0.07)	0.843	0.394	1.801	15/13,932 (0.11)	1.224	0.573	2.617

ADS indicates automated dispensing system; CI, confidence interval; CPOE, computerised physician entry order; OE, opportunity for error; OR, odds ratio; UDDS, unit dose distribution system.

Table 5 Contributing factors by dispensing system

Contributing factor	Stock, %	No-CPOE-UDDS, %	CPOE-UDDS, %	No-CPOE-ADS, %	CPOE-ADS, %
Lack of procedure norms	0.59	0	0	0	0
Deficient communication system between professionals	0	10.55	11.26	0	0
Deficient communication system. No CPOE	0	0.2	1.38	0	0
Stock breakage/shortage	59.1	2.34	8.28	37.92	35.1
Deficient preparation/dispensing system	0	0	0	5.81	7.07
Lack of healthcare staff	1.17	0	0	0	0
Staff shortage	2.15	31.64	7.82	11.31	15.4
Inexperienced staff	0	9.57	14.48	0.61	2.02
Lighting	1.17	0	0	0	0
Noise	2.54	0	0	0	0
Frequent interruptions	3.72	4.49	5.29	1.53	0.25
System inertia	8.61	24.22	7.59	2.45	12.88
Others	5.48	23.63	15.86	0.61	7.07

ADS indicates automated dispensing system; CPOE, computerised physician entry order; UDDS, unit dose distribution system.

according to Climent et al, the omission of a dose or a medication can occur with a frequency of 20.4% and 13.4%, respectively, so we believe that measures have to be taken to improve this dispensing system.[14] In our case, the shortage or breakage of stock were the fundamental contributing factors. In this respect, it is necessary to point out that 4 months before beginning the study the use of the Kardex® horizontal had been implemented in the hospital so the process of adjusting the maximum and minimum stocks was still in progress and this may have contributed to the high levels of stock shortage and breakage. Furthermore, although working norms had been defined and the auxiliary nursing staff trained, they still lacked expertise in the use of the system.

In the two ADS, filling errors were detected, but no data has been published comparing this automated system interconnected with CPOE and without it. The absolute error frequencies in the ADS with and without CPOE were 396 and 327, and the relative frequencies were 2.9% and 20.7%, respectively. This difference is due to the fact that, while in the no-CPOE-ADS the opportunities for error only include the restocked medication lines, in the CPOE-ADS the denominator was much greater as the number of opportunities for error included each of the lines prescribed by the doctor and validated by the pharmacist, both in the CPOE program and in the ADS computer system.

In the no-CPOE-UDDS the error frequency was 3.7%. The first papers published in the 1970s and 1980s produced dispensing error rates ranging between 1.7% and 8%,[5,19] which is the range within which our results lie. Since then numerous studies with diverse results have been published, although with methodologies and definitions which are very different to each other, and also to those in our study. Beso et al, Lisby et al, Bohand et al and Cina et al[6,10,19,20] show dispensing error rates between 4% and 2.1%; in Spain, 2 studies find dispensing error rates of 1.04% and 2.13%, respectively.[15,21] Omission, different quantities of medication, the presence of non-prescribed medication in the patient's dispenser box and different doses were the most frequent types of error occurring in the no-CPOE-UDDS. These results agree with other studies which show dispensing errors due to omission, dispensing incorrect doses, mistaken medication and dispensing a different quantity of medication.[6,10,11,15,19]

In the 1990s the first studies appeared which demonstrated improvements in safety with the use of computerised electronic prescription systems.[22] In our study it is only possible to compare the dispensing systems with CPOE (UDDS and ADS) and no-CPOE-UDDS since the opportunities for error defined for the rest of the dispensing systems are very different. We found that the dispensing systems with CPOE showed a statistically significant reduction in validation errors, something observed in other studies.[21,23] Furthermore, there was a reduction in all dispensing errors, except omission in CPOE-ADS, which increased. We think that this is because in this dispensing system the shortage or breakage of stock had a much greater influence than in the UDDSs. The shortage or breakage of the stock of a medication in Kardex horizontal carousels does not always imply a lack of it in Kardex® vertical carousels, so the omission of medication while filling the trolleys did not occur in UDDS. Furthermore, in the study design, any omission of medication was considered to be a dispensing error. The study did not take into account if the ADS had a stock of the omitted medication at the time of replenishment, a fact that would reduce the importance of these dispensing errors since it would not impede the patient being administered the medication. These aspects of the study could explain why the error rate is not lower for the CPOE-ADS with regard to the CPOE-UDDS, and thus it is not possible to conclude that the latter system increases the safety of our dispensing process. More studies are necessary, therefore, to enable us to make a final assessment of this.

Just as the methodology of dispensing errors and classification vary considerably between different authors, the same happens when analysing the contributing factors,

as some of the papers do not state the method used to classify them and, therefore, it is difficult to obtain comparable results. The contributing factors most frequently associated with dispensing errors were, besides the shortage and breakage of stock which has been mentioned, deficient communication between professionals, staff shortages, inexperienced staff, and system inertia. Other contributing factors, such as deficient preparation/dispensing systems, affected the ADS, while the UDDSs were particularly affected by frequent interruptions. It is worth commenting that in the "others" section, and in particular in the UDDS with and without CPOE, the contributing factors were the validation time, the complexity of the trolley, and communication errors between computer systems.

Further contributing factors found by other authors are: frequent interruptions[6,11]; distractions[6,11]; absence of communication[11,17]; oversights and errors due to overconfidence and not checking the dispensary[21]; lack of knowledge of the staff and the absence of a safety culture[6]; lapses of concentration and not reading the working lists.[15] Although we have not determined the causes of the errors, other authors, such as Font Noguera et al[16] and Delgado et al,[21] do analyse them and find they include forgetfulness and carelessness, and not following the established norms.

In our study we have not analysed the dispensing errors which reached the patients but, as Anacleto et al[11] remark, detecting them indicates the quality of the service given by the staff of the PS and, therefore, it is necessary to establish preventive measures and working procedures which lead to safer dispensing. In this respect, besides introducing changes in working procedures,[10,15] the use of automated and computerised processes (dispensing and prescriptions) can result in a reduction in these errors. With the results obtained, we have reviewed all our working procedures, improving the communication between the staff of the PS and also staff training, and solving technical problems which occurred due to the recent automation of some of our systems. At the time of writing this article, the PS had just obtained the ISO-9001:2008 quality certificate, so we are continuing to make advances in improving our working conduct to reduce the number of errors and improve the quality of the service we offer.

The results of this study have allowed us to know the errors in our system in all the stages of the dispensing process, and to know the fundamental contributing factors, and we have been able to identify the system's weaknesses. Furthermore, we have redesigned the dispensing process to increase its safety.

The limitations of the study include the fact that the study design did not account for urgent orders (which could arise at any time and day), requests for restricted medication (requiring validation by a pharmacist and following a different procedure to those included in this study), and dispensing carried out on Saturdays, Sundays or public holidays. Therefore, we are not aware of the errors that could occur in these cases or if they are more or less vulnerable to error than the systems analysed in the study.

Another aspect worth pointing out is that the study was performed by a single observer, which could lead to bias from the observer himself. There is also possible bias due to the direct observation method used, which leads to the staff behaving differently when they are being observed. However, the high efficiency of the data collection method compensates for this bias, as Climent et al[14] mention in their study.

The latest error classification by Otero López et al was not used because it was published halfway through the data collection period of our study.

The use of new technology in dispensing processes has improved their safety, and in particular the implementation of the CPOE has made it possible to reduce the number of errors in the dispensing process.

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