ORIGINAL ARTICLE

Medication reconciliation errors according to patient risk and type of physician prescriber identified by prescribing tool used

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Objectives. To study the frequency of medication reconciliation errors (MREs) in hospitalized patients and explore the profiles of patients at greater risk. To compare the rates of errors in prescriptions written by emergency physicians and ward physicians, who each used a different prescribing tool.

Methods. Prospective cross-sectional study of a convenience sample of patients admitted to medical, geriatric, and oncology wards over a period of 6 months. A pharmacist undertook the medication reconciliation report, and data were analyzed for possible associations with risk factors or prescriber type (emergency vs ward physician).

Results. A total of 148 patients were studied. Emergency physicians had prescribed for 68 (45.9%) and ward physicians for 80 (54.1%). A total of 303 MREs were detected; 113 (76.4%) patients had at least 1 error. No statistically significant differences were found between prescriber types. Factors that conferred risk for a medication error were use polypharmacy (odds ratio [OR], 3.4; 95% CI, 1.2–9.0; *P*=.016) and multiple chronic conditions in patients under the age of 80 years (OR, 3.9; 95% CI, 1.1–14.7; *P*=.039).

Conclusion. The incidence of MREs is high regardless of whether the prescriber is an emergency or ward physician. The patients who are most at risk are those taking several medications and those under the age of 80 years who have multiple chronic conditions.

Keywords: Medication reconciliation. Medication errors. Patient safety. Emergency health services. Polypharmacy. Comorbidity.

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Perfil de riesgo y análisis comparativo de los errores de conciliación de medicamentos según el médico prescriptor y la herramienta de prescripción

Objetivo. Estudiar la frecuencia y el perfil de los pacientes ingresados que tienen mayor riesgo de errores de conciliación (EC) y si las prescripciones originadas por los médicos de urgencias (MU), mediante una herramienta de prescripción electrónica de texto libre, presentan más EC que las realizadas por los médicos responsables de la planta de hospitalización (MPH) con un programa de prescripción electrónica asistida.

Método. Estudio de una serie de casos prospectivos con análisis transversal que incluyó por oportunidad a los pacientes ingresados en plantas de hospitalización convencional de los servicios de medicina interna, geriatría y oncología durante un periodo de 6 meses. Los EC detectados por un farmacéutico se analizaron en función de los factores de riesgo teóricos y del responsable de la prescripción (MU frente a MPH).

Resultados. Se incluyeron 148 pacientes, 68 (45,9%) con prescripción de los MU y 80 (54,1%) de los MPH. El farmacéutico detectó 303 EC y 113 pacientes (76,4%) presentaron al menos un EC. No hubo diferencias significativas según el responsable de la prescripción conciliada. Los EC se asociaron a la polimedicación [OR 3,4 (IC 95%:1,2-9,0; p = 0,016)] y el tener pluripatología en el grupo de pacientes menores de 80 años [OR 3,9 (IC95%:1,1-14,7; $p_{interacción}$ = 0,039)].

Conclusiones. La frecuencia de EC es elevada indistintamente de si el responsable de la prescripción fue el MU o el MPH. Los pacientes con mayor riesgo de EC fueron los polimedicados y los menores de 80 años con pluripatología.

Palabras clave: Conciliación de la medicación. Errores de medicación. Seguridad del paciente. Urgencias. Polimedicación. Comorbilidad.

Introduction

The ENEAS[1] and EVADUR[2] studies conducted in Spain have estimated that in the hospital environment there is a high incidence of adverse events (AE), which are related to medication in 37.4% of those admitted and in 37,6% of those who come to the emergency department (ED). Medication is the most frequent cause of adverse event in hospitalized patients, and the second cause of visits to the emergency department. In addition to the impact on patient safety, these AEs entail a greater use of healthcare resources[1-3].

One of the most frequent medication errors are unintentional discrepancies that are generated between two drug treatments of the same patient separated by a care transition. Systematic reviews reveal that the lack of sufficient coordination measures in these transitions generates discrepancies in 40%-80% of patients, and of these, 11%-59% can cause potential damage[4-7]. These discrepancies are called medication reconciliation errors (MREs) and are considered preventable medication errors. In the hospital environment, these errors can happen at the time of admission, at discharge and in the changes of care responsibility. To date, there are no effective computerized tools that detect their occurrence[8,9].

The medication reconciliation (MR) carried out by pharmacy departments has been shown to be an effective measure in the detection and reduction of MREs in hospitalized patients and, therefore, to reduce the AE that may arise from them[4-7,10-12]. This intervention has also been implemented effectively in many national and international EDs, as it is a key point of care transition. Studies published in this regard are also demonstrating their efficacy in increasing patient safety[13-19]. For all these reasons, numerous health institutions have already implemented standardized MR procedures in hospitals[20-22].

However, the limited resources available within the current economic panorama make it impossible to provide hospitals with pharmacist templates that cover the MR of all their patients, both of the ED and of the hospitalization wards. This entails the need to identify the optimal place to perform MR intervention to obtain maximum effectiveness at the lowest possible cost. Establishing MR in the ED would involve all patients from the first moment of entry to the hospital, which would entail the need for at least one pharmacist 24 hours a day, 7 days a week, 365 days a year. The other option would be to wait for hospital admission and that the MR be carried out by a regular pharmacist in the usual work shift in the hospitalization units.

In parallel, it is also convenient to know if there is any type of patient that can be more benefited by MR. In this sense, there are works that propose as risk factors for MREs, polymedication, advanced age and multipathology[5,23,24], although these may vary depending on the field of study. To determine in which place and in which patients it would be convenient to prioritize MR intervention by the pharmacy department, this study was designed to study the frequency and profile of hospitalized patients who have a higher risk of MREs and whether the prescriptions originated by emergency physicians (EP) using a free-text electronic prescription tool present more MREs than those performed by the physicians in the hospital wards (PHW) with an electronic prescription-assisted program.

Method

Descriptive study of a series of cases with prospective data collection and cross-sectional analysis that included by chance the patients admitted to the conventional hospitalization facility of the internal medicine (IM), geriatric medicine (GM) and medical oncology (ONC) services, for a period of 6 months in a third level university hospital. For the study, the corresponding approval was obtained from the Clinical Research Ethics Committee of the centre.

A pilot MR program was developed on admission carried out by the pharmacy service that was carried out sequentially in the services of IM (3 months), GM (2 months) and ONC (1 month), between June and December of the 2014. Adults admitted to these services were included, to whom the pharmacist reviewed the treatment reconciliation. Those that did not have previous chronic treatment or that had been reconciled directly by the pharmacist without previous intervention of a doctor were excluded.

A pharmacist within the multidisciplinary team reviewed, during the morning shift of the working days, the reconciliation of the prescription made by the doctor in charge of the treatment on the day of the patient's admission to the ward or the closest to it during his hospital stay. For this, the pharmacist previously compiled the list of chronic medications of the patient admitted by comparing at least two objective information sources (primary care prescription, medical history of the emergency department, other previous clinical reports, patient list and medication boxes) and subsequent confirmation with a protocolled clinical interview with the patient or caregiver. This was carried out whenever there was no express opposition or collaboration was impossible, and was carried out by means of closed questions to clarify discrepancies found among the other sources. In addition, open questions were formulated to investigate self-medication habits, adherence to treatment, allergies or drug intolerances, and the use of medicinal plants. They also consulted possible temporary treatments that were taking prior to admission. Subsequently, the pharmacist compared the chronic medication obtained with the active prescription of the hospitalized patient. Those discrepancies found that were not considered as justifiable based on the new clinical situation of the patient were discussed with the attending physician and the care team, who either justified them or confirmed them as MRE.

The prescription reviewed by the pharmacist could come from the EP that used an electronic free-text prescription tool or from the PHW with an electronically assisted prescription (EAP) program. During the period of 8 - 15 h of the working days the prescription was made by the PHW, and in the rest of the cases it used to come from the EP. For the present study, the pharmacist identified the person responsible for the prescription based on the format of the revised prescription sheet. At the time of the act of reconciliation of the pharmacist, the prescription of the EP was considered when the format coincided with the prescription sheet of the medical history of the ED (SISU®) and the physicians in the hospital wards when the for-

mat was the treatment sheet of the EAP program (Farmatools®).

The pharmacist collected the origin of the prescription and those characteristics of the patient that a priori could be related with greater probability of MREs: age, number of comorbidities, polymedication and degree of dependency for basic activities of daily life (BADL). Age was categorized at the cut-off point of 80 years. Pluripathology was defined as the presence of two or more chronic pathologies (hypertension, dyslipidaemia, diabetes mellitus, chronic obstructive pulmonary disease or asthma, heart failure, another cerebrovascular disease other than heart failure and neoplasia). Polypharmacy was considered if the patient took 5 or more chronic medications, such being those approved by the regulatory agencies that the patient took on a regular basis with an established regimen. No demand or rescue medication was included. The phytotherapy for therapeutic purposes was not considered medicine although its use was recorded. Other clinical data were also recorded, such as clinical history, social support and swallowing problems.

The main outcome variable was the number of MREs detected, defined as any discrepancy between the chronic treatment of the patient and their prescription of admission that was not justifiable due to their new clinical situation. The classification of the MREs by typology was based on the criteria described by the Consensus Group of the Spanish Society of Hospital Pharmacy (SEFH)[25] (mismas siglas porque es un organismo español), and its classification according to severity was based on the criteria of the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP)[26].

The sample size was determined with the program GRANMO® version 7.12 and was justified for an RE probability of 75%[27] with an accuracy of 7% and a confidence level of 95%. We deduced that 147 patients were needed.

The characteristics of the reconciled patients were summarized by absolute frequencies and percentages, and were compared using the chi-square test or Fisher's exact test as appropriate. The quantitative variables were described in mean and standard deviation (SD) or in median and interquartile range (IQR). The association of these was evaluated with the Student's t test, previous study of the variance homogeneity, or with the median test when necessary. The MREs detected were analysed by the origin of the prescription (EP versus PHW) and by the theoretical risk factors. To study the association of MREs, the proportions of patients with and without MREs were compared, calculating the odds ratio (OR) crude and adjusted by logistic regression models using as a dependent variable the probability of having at least one MRE detected and including the variables with $p < 0.10$. The interaction terms observed were included in the model. A significance value of $p < 0.05$ was assumed. The analyses were carried out with the help of the statistical package SPSS version 20.0.

Results

The MR by the pharmacist was performed in 158 admitted patients. For the present study, 148 patients were included. Four patients were excluded, due to not having previous chronic treatment, 2 patients due to the reconciliation of the pharmacist before the prescription of the doctor and 4 patients whose data were incomplete.

The average age of the sample was 78 (SD 14) years, and 75 (50.7%) were women. The responsibility for prescribing was in 68 cases (45.9%) of the EP and in 80 cases (54.1%) of the PHW. Table 1 shows the demographic and social characteristics of the patients included in the study, as well as the univariate analysis based on the person responsible for the prescription. The only statistically significant difference found between the two groups was the admission medical service ($p < 0.001$).

The conciliation of 1,722 prescription lines was reviewed. The total of chronic medication lines reviewed was 1,169, and 141 were high-risk medications (HRM) according to the list published by the Institute for the Safe Use of Drugs in 2012[28].

In the total number of prescriptions for hospitalized patients, 1,301 were found. discrepancies, of which 998 were justified. 303 MREs were detected and 113 (76.4%) patients presented at least one MREs in their prescriptions, 17 MREs affected HRM that involved, among others, opioid analgesics, oral anticoagulants and subcutaneous insulins. The most frequent error was the unwarranted omission of a chronic medication (55.8%) and most of the errors were detected when they had already reached the patient, but without causing harm (61.1%) (Figure 1). In the 68 prescriptions of the EP, 158 MREs were detected compared to 145 MREs found in the 80 treatments administered by PHW. Table 2 reflects the analysis based on the origin of the prescription. No statistically significant differences were found between the two groups of prescriptions with respect to the median of MREs nor in the percentage of patients with MREs.

When the univariate analysis of the factors that a priori were considered that could be related with greater probability of MREs was performed, only statistically significant differences were found regarding the polypharmacy ($p = 0.001$) (Table 3).

In the logistic regression model to evaluate the probability of having at least one MRE, which included age, dependence, polypharmacy, pluripathology and the origin of the prescriptions, it was found that pluripathology significantly increases MREs in patients younger than 80 years [OR 3.95 (95% CI: 1.07-14.66)] and, however, in patients aged 80 years or older the effect is inverse and not significant ($p_{interaction} = 0.039$) (Table 4 and Figure 2).

Discussion

The main results of this study are: 1) there is a high incidence of MREs in hospital admission prescriptions, regardless of their origin; 2) the prescriptions prescribed

Table 1. Sociodemographic and clinical characteristics of the sample: global and disaggregated according to the origin of the prescription of income

	Total N = 148 n (%)	Emergencies N = 68 n (%)	Ward N = 80 n (%)	p
Age in years [mean (SD)]	78.1 (14)	79.9 (12.8)	76.5 (14.9)	0.137
Sex [n (%)]				0.611
Man	73 (49.3)	32 (47.1)	41 (51.3)	
Woman	75 (50.7)	36 (52.9)	39 (48.8)	
Service [n (%)]				< 0.001
Internal Medicine	67 (45.3)	40 (58.8)	27 (33.8)	
Geriatric Medicine	54 (36.5)	25 (36.8)	29 (36.3)	
Oncology	27 (18.2)	3 (4.4)	24 (30.0)	
Dependency for the BADL [n (%)]				0.578
Dependent	38 (25.7)	15 (22.1)	23 (28.8)	
Partially dependent	39 (26.4)	20 (29.4)	19 (23.8)	
Independent	71 (48.0)	33 (48.5)	38 (47.5)	
Degree of attendance [n (%)]				0.666
Live alone	28 (19.4)	14 (21.5)	14 (17.7)	
Live accompanied	52 (36.1)	22 (33.8)	30 (38.0)	
Live assisted 24 hours	49 (34.0)	24 (36.9)	25 (31.6)	
Institutionalized	15 (10.4)	5 (7.7)	10 (12.7)	
Peculiarities of oral route[n (%)]				0.085
Any	95 (74.2)	46 (83.6)	49 (67.1)	
Dysphagia	25 (19.5)	6 (10.9)	19 (26.0)	
Enteral probes	8 (6.3)	3 (5.5)	5 (6.8)	
Comorbidities [mean (SD)]	2.7 (1.3)	2.6 (1.3)	2.7 (1.3)	0.486
Pluripathology [n (%)]				0.929
Yes	118 (79.7)	54 (79.4)	64 (80.0)	
No	30 (20.3)	14 (20.6)	16 (20.0)	
No. of drugs [median (IQR)]	7.7 (3.3)	7.8 (3)	7.7 (3.5)	0.785
Polymedicated [n (%)]				0.863
Yes	121 (81.8)	56 (82.4)	65 (81.3)	
No	27 (18.2)	12 (17.6)	15 (18.7)	
Phytotherapy* [n (%)]				0.373
Yes	24 (16.2)	12 (23.1)	12 (16.7)	
No	100 (67.6)	40 (76.9)	60 (83.3)	

SD: Standard deviation; BADL: Basic activities of daily life; IQR: Interquartile range; No: Number; * The variable "Phytotherapy" was analysed in 124 patients.

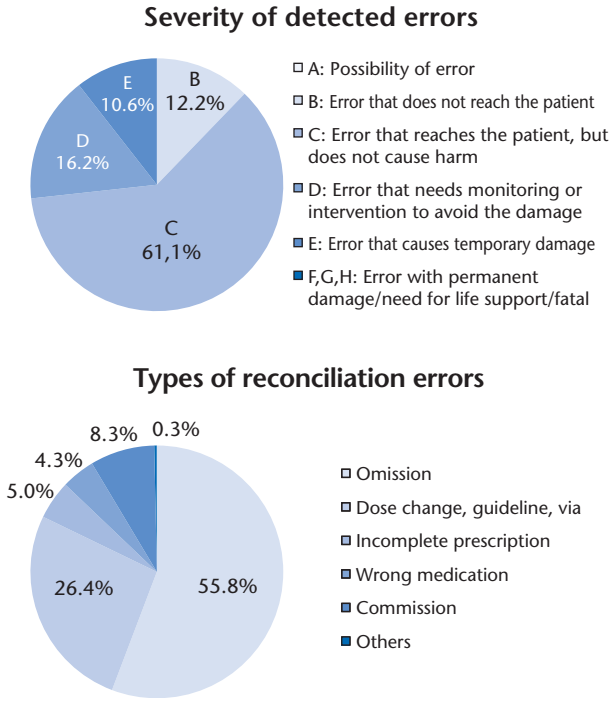

Figure 1. Classification of reconciliation errors by their severity and typology.

by the EP, using a free text prescription tool in effect during the start of hospitalization, do not show significant differences in the detected MREs compared to those made by the PHW with a EAP program; and 3) the profile with the highest risk of MRE on admission is that of the polymedicated patient and the multi-pathological patient in the group under 80 years of age.

The incidence of MREs found is high, it affects HRM and should be taken into account, although it corresponds to a multitude of previous studies that treat MR upon admission to hospitalized patients. The diversity of these studies, both in design and in scope, only allows the direct comparison of these in broad strokes. Thus, in Spain, we have the recent multicentre study by Baena Parejo et al.[29] in 2015 conducted in several EDs, from which a very similar percentage of patients with MREs is extracted (79.3%). Likewise, the work of Belda Rustarazo et al.[30] in 2015 carried out in an internal medicine department obtained a similar frequency of MREs. The results presented here are also in line with other works outside the Spanish context that conclude that between 60% and 80% of patients have MREs at admission[5,23,24].

Regarding the frequency of MREs in the prescriptions made by the EP, compared to those of the PHW, the results show that there are no significant differen-

Table 2. Descriptive analysis of the reconciliation errors found globally and according to the origin of the medical prescription

	Total N = 148 n (%)	Emergencies N = 68 n (%)	Ward N = 80 n (%)	p
Nº of MREs [median (IQR)]	2 (1-3)	2 (1-3)	2 (0-3)	0.291
Patients ≥ 1 MREs				0.232
Yes	113 (76.4)	55 (80.9)	58 (72.5)	
No	35 (23.6)	13 (19.1)	22 (27.5)	
Nº of MREs in patients with MREs [median (IQR)]	2 (1.5-3)	2 (2-4)	2 (1-3)	0.528

Nº: number; MREs: Medication reconciliation errors; IQR: Interquartile range.

Table 3. Univariate analysis of the presence of reconciliation errors (MREs) in patients according to variables that a priori could be related to a greater likelihood of MREs (n = 148)

	No EC N = 35 n (%)	≥ 1 EC N = 113 n (%)	p
Polypharmacy [n (%)]			0.001
Yes	22 (62.9)	99 (87.6)	
No	13 (37.1)	14 (12.4)	
Pluripathology [n (%)]			0.060
Yes	24 (69.6)	94 (83.2)	
No	11 (30.4)	19 (16.8)	
Dependency for BADL [n (%)]			0.214
Yes	15 (42.9)	62 (54.9)	
No	20 (57.1)	51 (45.1)	
Prescription origin [n (%)]			0.232
EP	13 (37.1)	55 (48.7)	
PHW	22 (62.9)	58 (51.3)	
Age ≥ 80 years [n (%)]			0.653
Yes	18 (51.4)	63 (55.8)	
No	17 (48.6)	50 (44.2)	

MREs: Reconciliation errors; BADL: Basic activities of daily life; EP: Emergency physician; PHW: Ward physician.

ces, although there is evidence of a small increase in prescriptions from the ED. It should be taken into account that the PHW always had the previous treatment prescribed by the EP, given that almost all of the patients were admitted through the ED. In addition, the treatment sheets prescribed de novo by PHW, whether on duty or fixed, were performed with a EAP program, which would entail an additional improvement in the safe prescription of medication. The significant differences found in the conservation pattern of the prescription of the EP, depending on the medical service of admission, must also be taken into consideration as a conditioning factor when judging the results of the study. The PHW of the oncology service normally did not preserve the prescription of the EP and prescribed and conciliated the treatment upon admission of the patient in almost all cases, since it is a unit with oncologists on duty. However, the revised prescriptions that had been prescribed by the EP belong to a greater extent to medical services that do not have their own guards, in which physicians of any other medical specialty can also participate. Therefore, when reviewing a prescription of EP maintained in the hospitalization ward, it could not be certain whether it had been reconciled subsequently or not by the PHW on duty. All this may have influenced the higher incidence of RE in the group prescribed by EP and with our design you cannot quantify its impact.

Regarding the risk factors related to a higher incidence of MREs, the study highlights the polymedication and the pluripathology in patients under the age of 80 years. Polypharmacy as a risk characteristic is widely recognized in multiple previous studies[5,23,24,28]. However, they have concluded that advanced age and multipathology are directly and independently related to the increase in MREs. At this point, our results differ from the outstanding studies by Mueller et al.[5], Hellstrom et al.[23] and Salanitro et al.[24], since they show that pluripathology has an especially relevant effect in the group under the age of 80 years.

The main limitation of the study is given by its typology, since it is an analysis of a care registry whose design was performed retrospectively. On the other hand, since it is a registry of clinical data, there are potential non-quantified variables that could have influenced the results. Despite this, our work allows us to conclude that the frequency of MREs is high, regardless of whether the one responsible for the prescription is EP or PHW, as well as the profile of patients with higher risk of MREs are polymedicated and those under 80 with multiple pathologies. However, it is not possible to answer in which care unit the MR should preferably be implanted by pharmacists. Both health care units can also benefit from a MR program, since the origin of MREs can be found rather in the deficiencies in the communication of the treatment of patients and the lack of accessible unified supports where to consult the usual medication in a way reliable,

Table 4. Logistic model to study the probability of reconciliation erro

	p	Adjusted Odds ratio	CI 95% OR Lower	CI 95% OR Higher
Dependent (Yes/No)	0.213	1.77	0.72	4.33
Polymedicated (Yes/No)	0.016	3.36	1.25	9.02
Pluripathology (Yes/No) in patients under 80 years of age	0.04	3.95	1.07	14.66
Pluripathology (Yes/No) in patients with 80 or more years	0.530	0.58	0.1	3.22
Emergency department vs Ward	0.188	1.74	0.76	3.98

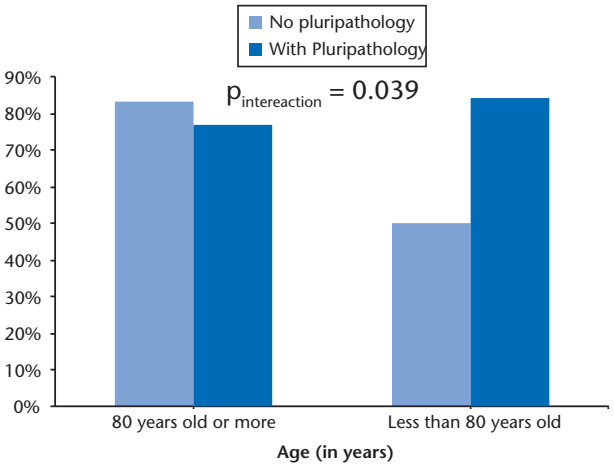

Figure 2. Incidence of conciliation errors in patients according to age and the presence of pluripathology.

more than in the usual procedure of the medical units, their care pressure or the use of EAP. However, the high percentage of patients affected by MREs makes the early implementation of a protocolled MR necessary and, with the data available so far, the unit chosen for this will depend on the resources of the centre. In order to optimize its effectiveness, MR should perhaps be prioritized in polymedicated patients and in multi-pathological patients under 80 years of age. Future work should be aimed at determining more precisely both the patient profile and the care location where the MR may be more beneficial in designing intervention strategies, while implementing communication systems and creating figures such as the pharmacist, responsible for their coordination, who can guarantee a safe transition between the different levels of care.

Conflicting interests

The authors declare no conflict of interest in relation to this article.

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Ethical Responsibilities

The study was approved by the Clinical Research Ethics Committee of the San Carlos Clinical Hospital of Madrid.

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