Anales de Pediatría 94 (2021) 238–244

analesdepediatría

www.analesdepediatria.org

ORIGINAL ARTICLE

Reduction of reconciliation errors in chronic pediatric patients through an educational strategy☆

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Received 23 April 2020; accepted 14 July 2020
Available online 5 March 2021

KEYWORDS
Medication errors;
Medication reconciliation;
Patient admission;
Patient safety

Abstract
Background: Medication reconciliation errors, also known as unintentional discrepancies, are frequent during admission, especially in chronic patients, and have impact in safety. Educational interventions can be a reduction strategy.
Material and Methods: Quasi-experimental study, before-after design. Participants were chronic patients admitted into hospitalization services. Medication reconciliation was conducted at admission. The intervention consisted of a training to each prescribing physician with study contents and printed educational material. To study the association between intervention and change of frequency of unintentional discrepancies was made a logistic regression model, adjusting for selected variables.
Results: A sample of 54 patients was studied in each stage. In the first stage it was observed that 42,6% of patients had at least one unintentional discrepancy. After intervention the proportion of patients with at least one unintentional discrepancy decreased to 24,1% ($P = ,041$). In both stages, omission was the main category of unintentional discrepancy. The significant reduction after the intervention is maintained by controlling for variables such as emergency admission and pre-admission service.
Conclusions: Incidence of unintentional discrepancies in admission is high in chronic hospitalised patients and can be reduced through an educative strategy.

☆ Please cite this article as: González C, González G, Plaza-Plaza JC, Inés Godoy M, Cárcamo M, Rojas C. Reduccion de errores de conciliacion en pacientes cronicos pediatricos mediante una estrategia educativa. An Pediatr (Barc). 2021;94:238–244.

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PALABRAS CLAVE
Errores de medicación;
Conciliación de la medicación;
Seguridad del paciente;
Admisión paciente

Reduccion de errores de conciliacion en pacientes cronicos pediatricos mediante una estrategia educativa

Resumen
Introducción: Los errores de conciliación, o discrepancias no justificadas (DNJ), son frecuentes durante la admisión a hospitalización de los pacientes pediátricos crónicos y tienen impacto en la seguridad. Las intervenciones educativas podrían ser una estrategia para su reducción.
Pacientes y métodos: Estudio cuasi – experimental, diseño antes – después en pacientes crónicos pediátricos. Se realizó en una primera etapa, la conciliación de los medicamentos prescritos tras la admisión hospitalaria, y se calculó la frecuencia de pacientes con al menos una DNJ. La intervención educativa consistió en una formación a cada médico con los conceptos de conciliación de la medicación, los resultados de la primera etapa y una infografía que se distribuyó en las áreas de prescripción. En una segunda etapa, se procedió de la misma forma que en la primera etapa. Para estudiar la asociación entre la intervención y el cambio en la frecuencia de DNJ se realizó un modelo de regresión logística, ajustando por covariables. Se utilizó un nivel de significación del 5%.
Resultados: Se estudió una muestra de 54 pacientes en cada etapa. En la primera, un 42,6% de los pacientes presentó al menos una DNJ. Tras la intervención la proporción se redujo a un 24,1% ($P = ,041$). En ambas etapas la omisión fue la principal categoría de DNJ. La reducción significativa tras la intervención se mantuvo al controlar por variables como ingreso por urgencia y servicio de preadmisión.
Conclusiones: La frecuencia de DNJ en la admisión es alta en pacientes crónicos hospitalizados y puede ser reducida mediante una estrategia educativa.

Introduction

Medication errors (MEs) are one of the most common sources of drug adverse events in hospital-based care,[1] and an important proportion of them emerge during transitions of care, such as admission, transfer within the hospital or discharge.[2,3] Medication discrepancy is defined as any difference between the medication use history and the medication orders following a transition of care.[2] On one hand, intended discrepancies correspond to an intentional decision by the prescriber, whether documented or not, to add, change or discontinue a drug. On the other, unintended discrepancies correspond to reconciliation errors (REs).[4] Medication reconciliation is a formal process by which health care professionals, in cooperation with patients, ensure complete, appropriate and accurate information about medication by producing the ''best-possible medication history'' (BPMH) for the purpose of prescribing medication at the given transition.[5] The World Health Organization and the International Joint Commission consider addressing reconciliation problems a priority due to their significant impact on patients and health care systems.[6,7]

The paediatric population is particularly vulnerable to drug adverse events, which may be even more frequent in this age group compared to adults.[8] In recent years there has been an increase in the number of children with chronic disease, who may be more vulnerable and have more complex medical needs,[9] and it is fair to assume that in this context, there is a higher risk of reconciliation errors,[10,11] especially in patients who are taking many drugs before admission.[12] A systematic review on the subject that combined the information of 10 paediatric studies found that the proportion of patients with unintended discrepancies on admission ranged from 22% to 72%.[13]

Some of the factors that facilitate the emergence of REs are the lack of integrated electronic health records systems, lack of knowledge of patients regarding their own medication, low literacy of patients or parents or legal guardians, and documentation deficiencies in health records.[12,14,15] The lack of training of physicians in matters concerning drug safety, especially in problems associated with transitions of care, could be remedied with educational interventions. These may be simpler than other interventions and achieve changes in prescription practices.[16] Collaborative educational interventions aimed at reducing REs have been evaluated and found to be successful in adult patients in developed countries,[17,18] but few studies have evaluated educational interventions in countries where the issue of medication reconciliation has not been addressed through public health policies. Furthermore, there is a dearth of data regarding the frequency of REs in the chronically ill paediatric population. In light of all of the above, we conducted a study with the aim of establishing the frequency of unintended discrepancies on admission in chronically ill paediatric patients and evaluate changes in unintended discrepancies following an educational intervention.

Sample and methods

We conducted a pre- post-intervention quasi-experimental study.[19] In the initial phase, we measured the frequency of unintended discrepancies on hospital admission (phase 1, 8 weeks: May–June 2018), followed by the intervention (July) and a second phase during which we evaluated the same variables studied in the initial phase (phase 2, 7 weeks: August–September 2018). The study was conducted in the medical-surgical (Med Surg) inpatient units of the Hospital Pediátrico Dr. Exequiel González Cortés (HEGC) in the Santiago Metropolitan Region in Chile, which comprise a total of 119 beds.

We included patients aged less than 18 years admitted on weekdays to inpatient units from the emergency department, the outpatient speciality clinics (OSCs) of the hospital or health care facilities outside the hospital, who had chronic disease as defined by Huynh et al.[20] and had been taking at least 1 drug for at least 3 months for treatment of a specific disease at the time of the interview. We recorded the primary diagnoses referring to the chronic diseases using the codes of the International Statistical Classification of Diseases, 10th revision (ICD-10).[21]

Intervention. We implemented the intervention after the completion of phase 1. The intervention consisted in a training for all prescribers, delivered in a group format by 2 of the researchers during working hours. Physicians that were unable to attend received the training individually at a later time. The training consisted of a single 15-minute face-to-face session in the form of a class, and there was no evaluation of the knowledge acquired at the end of the session. The contents covered by the training were: 1) definition of the problem; 2) objectives and methods of the proposed intervention; 3) presentation of the results of phase 1; 4) recommendations to avoid reconciliation errors. At the end of the training, some time was devoted to questions and answers and to discuss what had been learned. In addition, an infographic with the contents of the training was produced and displayed in the room where physicians wrote the prescriptions. We considered that the intervention was completed once all the medical staff had undergone training.

To obtain the BPMH, we collected information regarding previous prescriptions from 4 sources: interview with the parents/legal guardians (at the time of inclusion in the study), internal documentation of outpatient pharmacy services, last medical prescription received by the parent/legal guardian and patient records. The researcher responsible for data collection was not involved in the care of the patients under study and did not communicate with prescribers, except to resolve discrepancies. We compared the BPMH with the prescriptions made in hospital within 24 h of admission to Med Surg services. We identified unintended discrepancies (UIDs), which were considered REs, by reviewing the clinical records and consulting with the prescriber to differentiate them from intended adjustments. We categorised REs based on the type of drug involved according to the Anatomical Therapeutic Chemical (ATC) classification system group and on the potential of the error to reach and harm the patient according to the established severity categories (from A to I).[22] We categories discrepancies by type as ''omission'' (lack of a necessary chronic medication), ''change in dose, route or frequency of administration'' (the prescription of the chronic medication was maintained but its dosage was changed by mistake) and ''addition of unnecessary medication'' (initiation of medication that the patient did not need on the current transition and that the prescriber believed was part of the chronic medication of the patient). To prevent misclassification bias, each discrepancy was reviewed by a multidisciplinary group consisting of 2 pharmacists, 1 midwife and 1 nurse, none of which was involved in the care of the patients under study.

Statistical analysis

We calculated the necessary sample size for a 95% level of confidence (two-tailed) and a power of 80%, assuming a 60% reduction in the frequency of patients with at least 1 UID from an initial estimated percentage of 45%[20] and a 10% loss to follow-up, which was of 52 patients in each of the phases.

We have expressed continuous data as mean ± standard deviation (SD) if they were normally distributed and otherwise as median and interquartile range (IQR). To assess the differences between phases, we used the Student *t*-test for normally distributed variables and the Mann-Whitney *U* test for those not following a normal distribution. When it came to categorical variables, we expressed them as percentages and assessed for the presence of significant differences between groups using the χ^2 test.

We calculated the frequency of patients with at least 1 UID in each phase. To analyse the association between the intervention and changes in the frequency of UIDs, we fitted a logistic regression model adjusting for covariates selected based on the previous literature,[12,15] including age, sex, educational attainment of the interviewed parent/legal guardian, preadmission clinic (HEGC vs another hospital/primary care system), admission via the emergency department, number of medications before admission and number of medications added upon admission. We conducted univariate analyses to assess the association of these variables and IUD. If the univariate analysis yielded a *P*-value of less than .25, we included the variable as explanatory variable in the logistic regression model, and we then selected the final model based in the significance of the covariates, choosing the most parsimonious model with the fewest predictor variables applying the Akaike Information Criterion (AIC)[23] and the Bayesian information criterion (BIC).[24] We compared the pre- and post-intervention phases by calculating odds ratios (ORs), which we considered statistically significant if the corresponding 95% confidence interval (CI) did not contain the value 1.

We analysed the data with the software STATA® (serial number 301406367260). We defined statistical significance as a *P*-value of less than .05.

Ethical aspects

The study was approved by the Research Ethics Committee of the Department of Health of the South Metropolitan Area (SSMS), and we obtained signed written consent and assent, as applicable, for participation of the patients in the study.

Results

Participants

The study included a sample of 54 patients in the preintervention period (phase 1) and a sample of 54 patients in the post-intervention period (phase 2) (Table 1). There were no losses in any of the groups. The patients aged 2–12 years predominated in both phases (70.4% of the total in phase

Table 1 Characteristics of the 108 patients enrolled, comparing the two phases of the study.

	Phase 1 ($n = 54$)	Phase 2 ($n = 54$)	*P*
Age (years), median (IQR)	3.2 (1.7–8.9)	2.9 (1.1–6.8)	.1936
Sex, n (%)			.5640
Male	26 (48.1%)	29 (53.7%)	
Female	28 (51.9%)	25 (46.3%)	
[0,1–4]			
Primary diagnosis, n (%)			.744
Diseases of the respiratory system	20 (37%)	22 (40.7%)	
Neoplasm	11 (20.4%)	9 (16.7%)	
Diseases of the nervous system	10 (18.5%)	7 (13%)	
Diseases of the genitourinary system	3 (5.6%)	8 (14.8%)	
Diseases of the musculoskeletal system and connective tissue	3 (5.6%)	2 (3.7%)	
Congenital malformations, deformations and chromosomal abnormalities	3 (5.6%)	2 (3.7%)	
Other	4 (7.4%)	4 (7.4%)	
[0,1–4]			
Educational attainment of parent/guardian, n (%)			.511
Primary education	7 (12.9%)	9 (16.7%)	
Secondary education	32 (59.3%)	26 (48.1%)	
Higher education	15 (27.8%)	19 (35.2%)	
[0,1–4]			
Preadmission services, n (%)			.837
HEGC	37 (68.5%)	36 (66.7%)	
Another hospital/PC	17 (31.5%)	18 (33.3%)	
[0,1–4]			
Admission via emergency department, n (%)			.667
Yes	38 (70.4%)	40 (74.1%)	
[0,1–4]			
Number of comorbidities, median (IQR)	1 (1–3)	1.5 (1–3)	.7722
Number of prescribed drugs before admission, median (IQR)	3 (1–4)	3 (1–6)	.2365
Number of drugs prescribed on admission, media de (IQR)	5 (4–7)	4 (4–8)	.1298

HEGC, Hospital Pediátrico Dr. Exequiel González Cortés; IQR, interquartile range; PC, primary care.

1 and 66.7% of the total in phase 2). What we considered the primary diagnoses for the purpose of the study belonged in the ICD-10 categories of diseases of the respiratory system, neoplasms, diseases of the nervous system and diseases of the genitourinary system, with no statistically significant differences in their distribution between phases (Table 1).

During the 2 phases, a total of 15 paediatrics residents and 24 paediatricians were on staff in the Med Surg units, all of who were active in both phases save for 3 residents that were only involved in phase 1. All prescribers participated in the educational intervention. The total number of beds was the same during both phases, with an occupancy of 92% in phase 1 and 95% in phase 2.

The interviews with the patients and parents/legal guardians were the main source of information (with 100% participation in both phases). Other sources were used to supplement the information obtained in the interview in 68.6% of patients in phase 1 and 34.9% of patients in phase 2. Based on the BPMH, the total number of drugs prescribed to the patients before admission was 180 for the 54 patients in phase 1 and 223 for the 54 patients in phase 2 (Table 2). The drugs prescribed most frequently were fluticasone (11 prescriptions), trimethoprim/sulfamethoxazole (10), salbutamol (8) and valproic acid (8) in phase 1, and fluticasone (14), salbutamol (14), budesonide (10), cetirizine (7) and trimethoprim/sulfamethoxazole (7) in phase 2. The total number of drugs prescribed in hospital within 24 h of admission to the Med Surg unit was 296 in phase 1 and 336 in phase 2. The comparison of these prescriptions with those documented in the BPMH resulted in the identification of a total of 117 discrepancies in phase 1, of which 36 were UIDs. In the post-intervention period, we found a total of 100 discrepancies, of which 17 were UIDs. The group of drugs involved most frequently in UIDs in phase 1 were drugs acting on the respiratory system (R), amounting to 26.2% of the total, a percentage that decreased to 10.8% after the intervention (Table 2).

We determined that in phase 1, 37.1% of medication errors could have caused harm (categories E through H) and 1.9% could have been fatal. In phase 2, 18.5% had the potential to cause harm and none had the potential to cause death. Omission was the most frequent type of UID in both phases, and we did not find an association between the educational intervention and the distribution of the different types of UID ($P = .132$) (Table 3).

In phase 1, we found at least 1 UID in 42.6% of patients, and we observed a statistically significant decrease to 24.1% in this percentage after the intervention ($P = .041$). The

Table 2 Distribution by ATC group of the 403 drugs recorded in the BPMH and percentage in each group with at least 1 UID in each phase.

ATC group	Name of ATC group	Phase 1 ($n = 180$) UIDs, *n* (% of the group with at least 1 UID)	Phase 2 ($n = 223$)
A	Alimentary tract and metabolism	7 (19.4%)	7 (13.5%)
B	Blood and blood forming organs	2 (16.7%)	0 (0%)
C	Cardiovascular system	1 (8.3%)	1 (4.8%)
D	Dermatologicals	1 (33.3%)	0 (0%)
G	Genito-urinary system and sex hormones	0 (0%)	1 (50%)
H	Systemic hormonal preparations, excluding sex hormones and insulins	2 (20%)	0 (0%)
J	Antiinfectives for systemic use	3 (20%)	0 (0%)
L	Antineoplastic and immunomodulating agents	2 (20%)	0 (0%)
M	Musculoskeletal system	0 (0%)	0 (0%)
N	Nervous system	7 (20%)	1 (3.5%)
P	Antiparasitic products, insecticides and repellents	0 (0%)	0 (0%)
R	Respiratory system	11 (26.2%)	7 (10.8%)
S	Sensory organs	0 (0%)	0 (0%)
V	Various	0 (0%)	0 (0%)
	TOTAL	**36 (20%)**	**17 (7.6%)**

ATC, Anatomical Therapeutic Chemical Classification System; BPMH, best possible medication history; UID, unintended discrepancy.

Table 3 Distribution of the types of UID in the 2 phases of the study.

	Phase 1 ($n = 36$)		Phase 2 ($n = 17$)	
	% (*n*)	95% CI	% (*n*)	95% CI
Omission	69.4% (25)	51.9—83.7	94.1% (16)	71.3—99.9
Change in dose, route or frequency of administration	27.8% (10)	14.2—45.2	5.9% (1)	0.15—28.7
Addition of unnecessary medication	2.8% (1)	0.07—14.5	0% (0)	–

CI, confidence interval; UID, unintended discrepancy.

Table 4 Final logistic regression model that included the factors with an independent association with the presence of UID.

Variable	OR	95% CI	*P*
Admission via emergency department			.023
No	1		
Yes	3.48	1.18—10.25	
[0,1−4]			
Preadmission services			.086
HEGC	1		
Another hospital/PC	0.43	0.16—1.12	
[0,1−4]			
Intervention			.030
No	1		
Yes	0.38	0.16—0.91	
Constant	0.39	0.15—0.56	

CI, confidence interval; HEGC, Hospital Pediátrico Dr. Exequiel González Cortés; PC, primary care; OR, odds-ratio; UID, unintended discrepancy.

mean number of UIDs per patient in phase 1 was 0.67 ± 0.95, compared to 0.32 ± 0.69 after the intervention ($P = .031$). The post-intervention decrease in the frequency of patients with at least 1 UID continued to be statistically significant after controlling for variables such as admission via de emergency department or preadmission services (OR, 0.38; 95% CI, 0.16—0.91; $P = .03$) (Table 4). Admission via the emergency department was a significant risk factor (OR, 0.48; 95% CI, 1.18—10.25; $P = .023$) (Table 4).

Discussion

In our study, we observed that an educational strategy achieved a reduction of 43% in the proportion of chronically ill paediatric patients with at least 1 UID on admission to hospital, as well as a 52% decrease in the mean number of UIDs per patient. We ought to highlight the considerable magnitude of this problem in our sample. As our findings suggest and stated by the World Health Organization,[6] reconciliation errors are common and therefore a significant concern for health care institutions. In Chile, the health record systems of hospitals in the public health care system are not usually part of integrated systems allowing access to accurate information about medication when patients transition from primary care or hospital outpatient speciality clinics. Also, the public health authorities have not made medication reconciliation processes and resources mandatory in the country.

It is known that the fragmentation of health care systems and the scarce communication between levels of care increase the risk of UIDs.[25] This, in combination to the high probability of medical errors in complex chronic patients,[10] explains the substantial proportion of UIDs found in the initial phase of our study. Despite all these risk factors, our new educational strategy achieved a reduction in UIDs by addressing a single element out of the broad range of contributing factors, which was the awareness of care teams of this problem.

Some of the interventions found the reduce UIDs include the taking of the BPMH by a pharmacist, the use of information and communication technologies, a multidisciplinary approach to care delivery and educational interventions aimed at prescribers.[26,27] Issues related to drug safety, such as medication reconciliation, are barely addressed in the educational curricula of the various health care professions. Interventions and strategies must be undertaken to ensure competence of health care professionals in this area in order to prevent drug adverse events.[28,29] Continuing education of health care professionals and the passive dissemination of information by means of presentations and print materials are approaches that can change behaviour of medical providers[30,31] and were the key to the success of our educational intervention. Another strength of the intervention was that it was developed based on the information collected in phase 1, along the lines of the auditing and feedback strategies that have been proven to achieve changes in behaviour in health care professionals.[32]

In phase 1, there was a high proportion of patients with at least 1 UID that was consistent with previous studies.[13] As reported in the literature, a high proportion of UIDs had the potential to harm patients, and omissions were the most frequent type of UID.[20,33] When it came to the severity of the error, our findings were similar to those of Tam et al. (2005), who based on the data from 6 studies ($n = 588$ patients) estimated that 11%–59% of medication errors on admission were clinically relevant.[34] Previous studies that implemented educational interventions observed a similar impact on UIDs in adult patients,[17,18] and it appears that making these trainings mandatory for the staff is needed to achieve this beneficial effect.[35]

We found a reduction in the frequency of UIDs per drug in most ATC groups after the intervention. Since the most frequent type of UID was omission, we believe that the training may have motivated prescribers to take an appropriate medication history, actively seeking to identify chronic medications. Since we did not have separate records for each of the prescribers, we were unable to evaluate the impact of the intervention at the individual level, which would have allowed us to understand the mechanism of its effect and optimise its future impact through its redesign.

One of the strengths of the study is the method used to detect UIDs, which was based on standardised procedures endorsed by international drug safety groups.[6,36] The review of each UID by a multidisciplinary team and the previous training of the raters improved the accuracy of UID detection process. Another strength was the inclusion of several covariates in the multivariate model and that the strength of the association was maintained after adjusting for these potential confounders. Another salient finding was that despite a higher occupancy in phase 2 for reasons that we were unable to determine, the effect of the intervention was maintained. It is known that increases in the workload of prescribers are associated with an increased risk of adverse events.[37] It would be worth conducting future studies to elucidate the impact of workloads on the magnitude and direction of the effect of the intervention.

As is the case of any study on this subject, our study had certain limitations[38]: it is possible that despite the generation of comparable groups, unknown factors unrelated to the intervention could explain the reduction in UIDs, such as the complexity of the medication regimens of the patients under study, among others. Also, although at least 1 month in each phase was a winter month, (a month with a high number of admissions due to respiratory illness), we cannot rule out the potential influence of seasonality in the difference observed between phases. In addition, the assumptions made for the sample size calculation differed from the actual observations, which may entail a loss of statistical power in the study, and therefore future studies with larger samples are necessary to corroborate our findings.

The proposed intervention is simple, reproducible, requires few resources and does not depend on the presence of an established process of medication reconciliation in the given health care facility. In addition, it underscores the importance of adequate history taking to pursue an objective and complete medication history. Any institution that seeks to address this issue should assume that this problem exists and that the implementation of the educational strategy will improve care processes regardless of whether the problem is or not first measured in the institution.

In conclusion, the implementation of an educational intervention achieved a reduction in unintended discrepancies in prescription in hospitalised paediatric patients with chronic disease. A significant proportion of unintended discrepancies could have produced harm.

Funding

The authors did not receive any external funding to carry out this study.

Conflicts of interest

The authors have no conflicts of interest to declare.

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