ORIGINAL ARTICLE

Results of a program to prevent medication errors in a pediatric emergency department

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Background and objective: Drug prescription errors are a significant cause of preventable morbidity and mortality in children. Our aim was to assess whether the frequency of medication error decreased after a prevention program was implemented in a pediatric emergency department.

Material and methods: Observational pre- and postintervention study. We identified errors made in November 2009 (preintervention period) by reviewing patient records. Errors were classified by type (dose, indication, route of administration), level of seriousness (low, moderate, high), and associated factors (staff experience, seriousness of the emergency, day of the week, hour of the day). In 2010 sessions to provide information about the detected errors were held and informative posters were hung in the department. Errors were again identified in November 2010 (postintervention period) and the results were compared.

Results: Errors were made most often with bronchodilators, corticosteroids, and anti-inflammatory drugs. In the first period, out of 445 prescriptions made, 49 errors (11%) were detected; in the second period, 48 errors in 557 prescriptions (8.6%) were detected. The difference was not significant. The rate of dosage error decreased significantly between the 2 periods (7.4% vs 3.8%, *P*=.016), but we saw no significant changes in incorrect indication, choice of route of administration, or seriousness. During the postintervention period, fewer errors were made in the most serious emergencies (11.6% vs 5.7%; *P*=.005) and between midnight and 8 a.m. (16.2% vs 6.1%; *P*=.02).

Conclusions: The error prevention program allowed us to reduce some types of medication error but follow-up and continued insistence on vigilance is required. [Emergencias 2012;24:91-95]

Key words: Prescription error. Medication error. Prevention. Training. Patient safety. Emergency health services.

Introduction

Patient safety is a key objective in pediatric emergency departments. The effects of medication account for most adverse events linked to emergency attention, as shown by the EVADUR study[1]. Medication error is a common and preventable cause of morbidity: hospitalization generates long, complementary tests and unnecessary treatments, and may even lead to patient death. In fact, errors in drug prescriptions are the eighth leading cause of death in the United States[2,3]. The probability of these errors is greatly increased in the emergency department (ED) due to pressure of work, different levels of experience of emergency physicians and fatigue accentuated during holidays and night shifts, as described in other studies[1,4,5].

Multiple prevention strategies have managed to reduce these errors, including computerized data entry[6], pharmacist review of prescriptions[7] or training[8]. Dissemination and training have been tested in several studies. Kozer et al. conducted an information session followed by an examination for advanced medical students doing rotations and first-year residents before rotation in the ED, but did not observe a significant reduction of errors[9]. In Great Britain educational strategies to

reduce prescription error were reviewed in different medical centers: pediatric presentations, workbooks, computerized training programs, practical questions and assessment of competence to prescribe; however, no validated tool was found and the impact of these measures in improving prescription error was not evaluated[10]. An Argentine pediatric study involving neonates and hospitalized children introduced several training strategies, disseminating and facilitating the expression of errors; the study showed reduced prescription error[11]. The objective of this work was to assess the impact on prescription error reduction after applying preventive measures, error diffusion and training.

Method

This was an observational study conducted pre and post-intervention. The first week of November 2009 (period 1 or pre-intervention) we revised all computerized pediatric emergency reports at our tertiary university hospital which receives about 100,000 visits per year. The ED has at least one medical professional 24 hours a day who works exclusively in the emergency department and oversees the work of residents. All medications prescribed in the ED are validated by the head nurse and reflected in the discharge report. The reports were reviewed by 3 pediatricians, following the reference protocols and clinical guidelines used in our center[12,13]. We analyzed the medication administered n the ED and excluded prescriptions for home or hospital use.

Errors were classified according to type of error, severity and factors associated with these errors. Regarding the type of error, dosage error was defined as a 20% decrease or increase compared to the recommended dose; inadequate indication when it differed from our protocol and clinical guidelines[12-13] (eg paracetamol or ibuprofen for moderate-severe pain, or no treatment for pain). Regarding the seriousness of the error, Kozer criteria[5] were followed and those of the "National Patient Safey Agency" adapted[14]: a) a minor error is one that does not involve a risk to the patient (eg. less than 1 mg / kg of oral prednisolone for moderate-severe bronchospasm); b) intermediate error involving moderate risk (eg. less than 75% dose of ceftriaxone for bacteremia or diazepam for febrile seizure), and c) serious error with risk of causing life-threatening conditions (eg. allergic reactions). Finally, regarding the factors associated with errors, these were major risk factors as described in other studies[4,5], as follows: a) the highest level of urgency according to triage level using the Spanish Triage System (SET) and the software program web_e-PATv[3] based on the Andorra Triage Model and SET15 which establishes levels 1-2-3 for greater urgency, and levels 4-5 for less urgency, b) lower patient age; c) any experience of the physician [less experience in first and second year residents (R1 and R2) and external rotations (masters, foreign residents and family medicine residents) and greater experience in third and fourth year residents (R3 and R4) and associate appointments] d) public holidays, with increased risk of errors, and e) night shift (0-8 hours, associated with more errors than daytime work periods 8-24 h).

- Introduction and objectives: the importance of safety in prescribing medication, the most susceptible population and the drugs associated with most errors.
- Types of errors: dose, indication, route of administration.
- Seriousness of errors.
- Factors related to errors: younger age, less experience of the physician, level of urgency, holidays, nights.
- Preventive strategies:
  1) Attention on prescribing (posters in emergencies).
  2) Training (courses).
  3) Reduction of workload (shifts, use of generics, lists of drugs most commonly used).
  4) Review (review of reports by first-year Residents and family physicians, review of prescriptions by a pharmacist).
  5) Technology (computer systems, automated dispensing systems, etc.).
  6) Better communication (between professionals and patient families).

Figure 1. Informative sessions.

We defined 2 study periods: period 1 (2009, pre-intervention) and period 2 (2010, post-intervention). In period 1 we reviewed all emergency reports which detailed treatments administered in the ED in order to identify treatment failures at that time, and designed a plan for improvement and prevention. In 2010 we established prevention strategies: sessions were conducted (Figure 1) and informational posters were placed in all ED bays (Figure 2), with diffusion of the errors found and strategies to prevent them. In period 2 were re-assessed prescription errors after implementing the preventive measures, comparing the same variables in the same week and month of the two periods.

Statistical analysis was performed with the program SPSS (version 19.0). We performed a de-

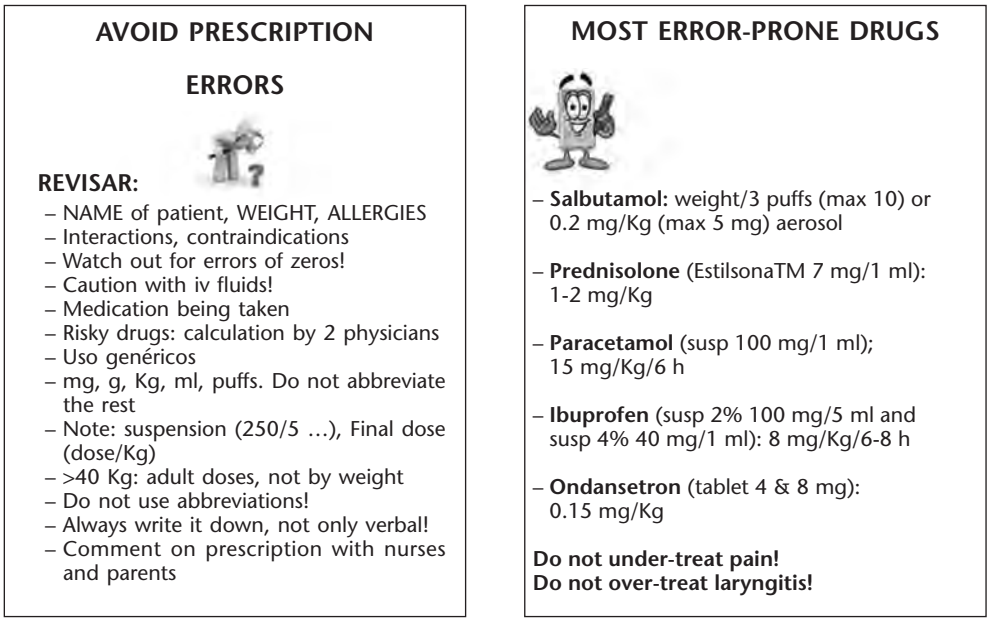

Figure 2. Informative posters displayed in ED bays.

scriptive study with quantitative variables expressed as median and 25-75 percentile or mean and standard deviation and qualitative variables expressed as frequencies and percentages. Assumptions of normality were checked for the applicability of the usual parametric statistical tests. Differences between the two periods (2009-2010) and different types of error we used chi-square test for qualitative variables and Student's t test for quantitative variables. If the parameters did not meet the applicability criteria we used non-parametric tests (Fisher exact, Kruskal-Wallis H). Differences with a p value < 0.05 were considered statistically significant.

Results

Most of the medication errors were associated with bronchodilators, corticosteroids and anti-inflammatory drugs (Table 1). In period 1, we found 309 indication errors in 2,460 reports (12.5%) compared to 334 of 1,756 (19%) in period 2. In period 1, we found 49 errors of prescription of 445 performed (11%) compared to 48 of 557 in period 2 (8.6%) (p = NS). As for the type of error, we found a significant decrease in errors of dosage, but not in indication and route of administration. An error of zeros or decimal points was detected in both periods (0.2%). The most frequent errors of indication in period 2 were for under-treatment of pain (12.4%), similar to that found in period 1. Regarding the seriousness of the errors, results were similar in both periods. There were no fatal errors in either of the two periods (Table 2). We observed a significant decrease in total errors for the most urgent cases and those treated at night. Less experienced physicians made fewer errors, but the difference with respect to other physicians was not statistically significant (Table 3).

Discussion

Medication errors have considerable impact on ED patients and their prevention is essential to avoid adverse effects in a specially susceptible population. This study involved warning posters and training sessions for all ED personnel followed by an evaluation of the impact of these measures.

The highest number of errors involved drugs frequently used in the ED, namely bronchodilators, corticosteroids and anti-inflammatory agents,

Table 1. Drugs associated with the highest number of medication error

	N (%)
Bronchodilators	30 (35.3)
Steroids	20 (23.5)
Anti-inflammatories	8 (9.4)
Antiemetics	7 (8.2)
Serotherapy	5 (5.9)
Antipyretics	3 (3.5)
Antibiotics	1 (1.2)
Others	11 (12.9)

Table 2. Differences in types of error between the two study periods

	Period 1 n (%) n = 445	Period 2 n (%) n = 557	p value
Total	49 (11)	48 (8.6)	n.s.
Dosage	33 (7.4)	21 (3.8)	0.016
Indication	16 (3.6)	27 (4.8)	n.s.
Route of administration	2 (0.4)	0 (0)	n.s.
Seriousness*			
Slight	47 (95.9)	46 (95.8)	n.s.
Moderate	2 (4.1)	2 (4.2)	n.s.

ns: not significant (p > 0.05). *Percentage of the total number of errors.

Tabla 3. Factors associated with medication errors in the two study periods

Errors	Period 1 Top of Form (%)	Period 2 Top of Form (%)	p value
Age (years, median 25-75%)	2.7 (1.5-6)	3.5 (1,5-9.5)	n.s.
Level of triage:			
Level 2-3	36/309 (11.6)	24/423 (5.7)	0,005
Level 4-5	11/116 (9.5)	20/114 (17.5)	n.s.
Professional experience:			
Less (R1-R2, others)	36/270 (13.3)	26/310 (8.4)	n.s.
Greater (R3-4, specialists)	16/175 (9.1)	22/247 (9.3)	n.s.
Day of the week:			
Holidays	16/157 (10.2)	17/280 (6.1)	n.s.
Weekdays	33/288 (11.4)	31/277 (11.2)	n.s.
Time of day:			
Night (0-8 h)	18/111 (16.2)	8/130 (6.1)	0.02
Day (8-24 h)	31/334 (9.3)	40/427 (9.4)	n.s.

ns: not significant (p > 0.05).

with a distribution similar to that of other studies[4,5]. The high percentage of errors involving bronchodilators and corticosteroids may be because the study was conducted at a time with a large proportion of respiratory processes and greater use of these drugs.

The error rate was similar in both periods (8.6 and 11%) and also similar to those observed in other EDs (10%)[5], but greater than in hospitalized patients (4-6%)[16] and lower than in prehospital centers[17], pediatric and neonatal intensive care units 2 and home hospitalization[18] (12-21%). Miscalculation of doses (including errors of zeros)19 and inadequate indication were the most frequent errors in both periods, as reported in other studies[20,21]. In study period 2 we observed a significant reduction in dosage errors, which could be due to the training measures and dissemination of information, especially the posters placed in every ED bay. Other strategies described in the literature to minimize dosing errors are computerized dose calculation to aid the clinician[22,23] and training of young residents in dose calculation[8]. Indication errors were similar in both periods, and the most frequent was insufficient analgesia to ease the patient's pain, an error widely reported in the literature[24].

We would emphasize the importance of education and dissemination of protocols among residents at the beginning their period of rotation in the ED and frequent refresher courses for all physicians working the ED, which may help reduce these errors.

Other strategies that have proved useful in reducing prescription errors are: the use of supportive technology (computerized data entry, with support for the clinician: allergy alarms, interactions, lists of the most commonly used drugs[25], bar-coded medication[26], automated dispensing systems, etc.)[27], the introduction of a pharmacist to review prescriptions[7], avoidance of unlicensed drugs[28] and improved communication between professionals and families[29], among others[30]. The reduction of errors at night, observed in the post-interventional period, could be due to the posters with information on drug doses, especially helpful for younger residents who are less supervised at night. Increased knowledge and attention to errors after diffusion has helped to reduce them.

This study has certain limitations. First, it was a retrospective study. Second, it only showed a tendency to reduced errors in less experienced physicians; this could have reached statistical significance with a greater sample size. And third, we found large differences in the percentage of errors between different studies, probably because of the wide range of criteria for defining prescription error and the seriousness of such error. Establishing general principles might facilitate more comparable results. In any case, we conclude that the preventive measures implemented have reduced some types of medication error, but it is necessary to maintain and develop them.

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Resultados de una estrategia de prevención de errores de medicación en un servicio de urgencias pediátrico

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Objetivos: Los errores de prescripción farmacológica son causa de una importante y prevenible morbimortalidad en niños. Nuestro objetivo fue valorar la reducción estos errores de medicación en un servicio de urgencias pediátrico tras aplicar estrategias de prevención.
Método: Estudio observacional pre y postintervención. En noviembre de 2009 (periodo 1) se revisaron los errores de prescripción a través de las historias informatizadas, que se clasificaron en: tipo (dosis, indicación, vía de administración), gravedad (leve, moderado o grave) y factores asociados (experiencia del facultativo, nivel de urgencia, día de la semana y hora del día). Durante el 2010 se realizaron sesiones con difusión de los errores detectados y se colgaron carteles informativos en urgencias. En noviembre de 2010 (periodo 2) se reevaluaron los mismos parámetros y se compararon los resultados.
Resultados: Los fármacos con más errores fueron los broncodilatadores, los corticoides y los antiinflamatorios. En el periodo 1 se detectaron 49 errores de 445 prescripciones (11%) y en el periodo 2, 48 errores entre 557 prescripciones (8,6%), (p = NS). Disminuyeron los errores de dosis (7,4% *vs* 3,8%; p = 0,016), sin cambios significativos en los de indicación y vía de administración, ni en la gravedad de los errores. Se observó una reducción significativa del total de errores en los pacientes más urgentes (11,6% *vs* 5,7%; p = 0,005) y por las noches (0-8 h) (16,2% *vs* 6,1%; p = 0,02).
Conclusiones: Las medidas implantadas han permitido disminuir algunos tipos de errores de medicación pero es necesario mantener el seguimiento e insistir en estrategias de prevención. [Emergencias 2012;24:91-95]

Palabras clave: Errores de prescripción. Errores de medicación. Estrategias de prevención. Formación. Seguridad del paciente. Urgencias.