Using a Preprinted Order Sheet to Reduce Prescription Errors in a Pediatric Emergency Department: A Randomized, Controlled Trial
Eran Kozer, Dennis Scolnik, Alison MacPherson, David Rauchwerger and Gideon Koren
Pediatrics 2005;116;1299-1302
DOI: 10.1542/peds.2004-2016

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://www.pediatrics.org/cgi/content/full/116/6/1299
Using a Preprinted Order Sheet to Reduce Prescription Errors in a Pediatric Emergency Department: A Randomized, Controlled Trial

Eran Kozer, MD*‡§; Dennis Scolnik, MB, ChB, DCH*‡; Alison MacPherson, PhD¶; David Rauchwerger, MD*; and Gideon Koren, MD‡

ABSTRACT. Objective. Medication errors are common among pediatric patients and in emergency departments (EDs). Such errors may lead to prolonged hospitalization, unnecessary diagnostic tests and treatments, and death. The objective of this study was to determine whether the use of a structured order sheet reduces the incidence of medication errors in a pediatric ED.

Methods. The study was a randomized, controlled study that was conducted in a tertiary care pediatric hospital. Eighteen days were randomized into 2 study groups: days during which the regular blank order sheets were used and days during which preprinted, formatted, order sheets were used. All patients’ charts from these days were reviewed by 2 medical students, who extracted demographic, clinical, and therapeutic data into a database. Two pediatric emergency physicians, blinded to the form used, reviewed the database and independently decided whether an error had occurred and the severity of the error.

Results. Within the study period, there were 2157 visits to the ED. A total of 2058 (95.4%) charts were available for review. A total of 411 (52.2%) orders for drugs in the ED were ordered on the regular form, and 376 (47.8%) were given on the new form. Drug errors were identified in 68 (16.6%) orders when the regular form was used and in 37 (9.8%) of the orders on the new form. Using the new form was associated with a significant reduction in the risk for an error (odds ratio: 0.55; 95% confidence interval: 0.34–0.90).


ABBREVIATIONS. ED, emergency department; OR, odds ratio; CI, confidence interval.

Medication errors are a common cause for iatrogenic adverse events. They can lead to severe consequences, including prolonged hospitalization, unnecessary diagnostic tests and treatments, and even death.

Medication errors are common among pediatric patients and in emergency departments (EDs). In a recent study, we found that 10% of children who presented to a pediatric ED experienced medication errors. We also found an increased risk for errors when a medication was ordered by a trainee and in patients with severe, compared with mild, disease. A higher risk for medication errors was found among trainees at the beginning compared with the end of the academic year.

For reducing medication errors in hospitals, various interventions have been studied. Examples include Computerized Physician Order Entry systems; having a clinical pharmacist review orders; the use of a unit dose system; using preprinted order forms; easy access to information on prescribing, such as a handheld computer; and holding educational sessions for the staff. Of these, only educational interventions have been studied in the context of the ED, showing that medical trainees scored higher on a written test when they attended an educational tutorial on writing orders. The use of a structured order form for medications has not been studied in the ED. The objective of this study was to assess the impact of a structured order sheet on the incidence of medication errors in a pediatric ED.

METHODS

The study was a randomized, controlled trial that was conducted at the Hospital for Sick Children (Toronto, Ontario, Canada), a tertiary care pediatric facility. The Research Ethics Board of the Hospital approved the study. Eighteen days were selected randomly during July 2001 by a computer-generated random numbers (block randomization) into 2 arms: days on which the regular blank order sheets (regular form) were used and those when the experimental, preprinted order sheets (Fig 1) were used. On the structured, preprinted medication order sheet, the staff were required to specify the dose, weight-adjusted dose, total daily dose, route of administration, and frequency for each medication ordered during the study. Before the study commenced, ED staff were oriented to the new forms during research and staff meetings. After this orientation, a pilot study of 50 preprinted order forms was conducted in the ED so that the investigators could obtain feedback from the staff on the practicality and utilization of the forms. On the basis of the feedback, adjustments were made to the forms before the protocol was initialized. Trainees also attended a short tutorial on the appropriate ordering of drugs before the study commenced.
On every study day, we removed all unused order forms in the ED before midnight of the previous day and replaced them with a new set of forms (either new or regular) to be used until 11:59 pm the following day.

All available patient charts were reviewed for medication errors according to a method described previously. Briefly, 2 medical students who were at the end of their second year in medical school attended 2 training sessions that included guidelines for extraction of data from charts under the supervision of 1 of the investigators (E.K.). They subsequently entered into a database the data that included information about patients' demographics, clinical condition, diagnosis, acuity of condition (based on triage category), details on the prescribing physician, the form used, and all medications prescribed and given to the patient. Drugs that were ordered on the discharge instructions, for use at home, were not included. Physicians were categorized according to their level of training as staff or trainees (interns, residents, and fellows).

Two pediatric emergency physicians, blinded to the form used, reviewed the database and independently decided whether there was an error. An error was defined as drug regimen different from the recommended (dose differed from the recommended dose by 20% or more, deviation by 2 hours or more from the recommended interval between doses, and wrong units or route of administration). The absence of date and unclear signature were not considered errors.

Drug errors were classified as insignificant/minimal risk, significant, or severe. In cases in which the raters did not agree, the case was discussed in an attempt to come to a consensus. When agreement was not reached, a third investigator reassessed the rating of that error and the median rank was used.

The reference for drug dosages was the hospital’s formulary. Drug dosages that were different from the hospital’s formulary were not considered an error when recommended by the Compendium of Pharmaceuticals and Specialties, the manufacturer, or other medical literature. Because the investigators were blinded to the time of order and because time of orders is frequently omitted in our department, especially for children with single, rapidly treated encounters, the absence of these data was not considered a medication error in the primary analysis.

The frequency of missing times was analyzed in univariate analysis.

Fig 1. New medication order form for drugs in the ED.
comparing the regular form and the new form were calculated, and statistical differences were assessed using a χ² test. Additional, stepwise, multivariable logistic regression analysis was used to compare the 2 forms. In addition to the form used to order the prescription (new vs regular), we included all of the variables that were previously associated with medication errors, including triage category, physician training, and time of visit to the ED. The analysis was conducted by prescription, not by patient. Therefore, the statistical analysis was adjusted for the clustering of patients, because each patient may have had >1 prescription but had the same form, triage category, and time of day.

RESULTS

During the study days, there were 2157 visits to the ED. A total of 2058 (95.4%) charts were available for review. A total of 795 medications were ordered. In 8 (1%) cases, there was not sufficient information to determine whether an error occurred. These orders were excluded from analysis.

A consensus between reviewers of whether an error occurred was reached in all but 7 cases. These 7 cases were reviewed by a third pediatrician (G.K.), and the median rank was used. A total of 105 (13.3%) errors were found among 787 orders. One error, a 10-fold higher dose of codeine, was considered severe; 49 were considered significant; and 55 were ranked as insignificant/minimal risk.

Within the study period, 411 orders for drugs in the ED were randomized to be ordered on the regular form and 376 on the new form. The characteristics of these orders are presented in Table 1. Although subjective feedback on the new form included concerns that the form was “too busy,” in the majority of cases, it was still completely filled in. The new form was not used in resuscitation situations, in which most orders were given in a verbal manner. There were no significant differences in the patients’ acuity (based on triage category on arrival to the ED) or the time at which the order was given with the regular form compared with the new form. The percentage of orders by a trainee was 57% on the regular form and 40% when the new form was used (P < .001). There was no difference in the error rate between staff physicians and trainees (odds ratio [OR]: 1.02; 95% confidence interval [CI]: 0.62–1.69). Time was omitted from 95 (23.1%) orders on the regular form and 47 (12.5%) orders on the new form (P < .001). Drug errors were identified in 68 (16.6%) orders when the regular form was used and in 37 (9.8%) orders on the new form. There was 1 severe error and 13 significant errors using the new form and 36 significant errors on the regular form. After controlling for clustering of patients and physician level of training, using the new form was associated with a significant reduction in the risk for an error (OR: 0.55; 95% CI: 0.34–0.90). There was an even greater reduction in the risk for a severe or significant error (OR: 0.39; 95% CI: 0.21–0.77). The final regression model included physician level of training and the form used for the prescription.

### TABLE 1. Characteristics of Medications Ordered in the ED During the Study

<table>
<thead>
<tr>
<th>Group</th>
<th>Variable</th>
<th>Regular Form, n (%)</th>
<th>New Form, n (%)</th>
<th>χ² P Value</th>
<th>Total Prescriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of physician</td>
<td>Prescribed by staff</td>
<td>411 (52.2)</td>
<td>376 (47.8)</td>
<td>&lt;.001</td>
<td>787</td>
</tr>
<tr>
<td></td>
<td>Prescribed by trainee</td>
<td>176 (42.8)</td>
<td>223 (59.3)</td>
<td></td>
<td>399</td>
</tr>
<tr>
<td></td>
<td>Urgent</td>
<td>235 (57.2)</td>
<td>153 (40.1)</td>
<td></td>
<td>388</td>
</tr>
<tr>
<td>Triage category</td>
<td>Nonurgent, semiurgent,</td>
<td>151 (36.7)</td>
<td>132 (35.1)</td>
<td>.71</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>Emergency/resuscitation</td>
<td>232 (56.4)</td>
<td>213 (56.6)</td>
<td></td>
<td>445</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28 (6.8)</td>
<td>31 (8.2)</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>Time of day</td>
<td>Midnight–4:00</td>
<td>49 (11.9)</td>
<td>59 (15.7)</td>
<td>.3</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>4:00–8:00</td>
<td>26 (6.3)</td>
<td>22 (5.9)</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>8:00–12:00</td>
<td>53 (12.9)</td>
<td>54 (14.4)</td>
<td></td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>12:00–16:00</td>
<td>59 (14.4)</td>
<td>44 (11.7)</td>
<td></td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>16:00–20:00</td>
<td>73 (17.8)</td>
<td>95 (25.3)</td>
<td></td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>20:00–midnight</td>
<td>56 (13.6)</td>
<td>55 (14.6)</td>
<td></td>
<td>111</td>
</tr>
<tr>
<td>Time omitted</td>
<td></td>
<td>95 (23.1)</td>
<td>47 (12.5)</td>
<td>&lt;.01</td>
<td>142</td>
</tr>
</tbody>
</table>

DISCUSSION

This is the first randomized, controlled study to show that a simple intervention—using a preprinted medication order form—reduces the risk for medication errors in the pediatric ED by 2-fold. Furthermore, the new form was associated with a decrease in the risk for more significant errors and a 2-fold decrease in the number of orders in which the time was omitted. Importantly, the physicians who reviewed the orders were blinded to the form used and therefore not influenced by the study hypothesis.

In a previous study,6 we found an increased risk for errors when a medication was ordered by a trainee and in patients with severe, compared with mild, disease. In the current study, there were no differences between groups in the severity of patients’ condition or in the time at which orders were given. However, despite the randomization, more orders on the regular form were noted to be given by trainees. One may argue that the observed reduction in medication errors with the new form could be partially explained by this difference. However, in a multiple logistic regression analysis, the level of training of the prescribing physician did not contribute to the increased risk for error. Equally important, the association between the form used and the rate of errors remained significant after adjustment for other variables.

Several interventions have been shown to be effective in reducing medication errors and increasing patient safety. Using a computerized Physician Order Entry may improve prescribing behaviors and reduce the number of drug errors.9 With such method, reduction of medication errors has been reported in both adults8 and pediatric inpatients.10 Despite this evidence, the use of this technology is still controversial.19 Moreover, the implementation
of such systems is expensive, and they are not available in most hospitals. A recent survey of hospitals in the United States found that computerized order entry was not available to physicians at 84% of the participating institutions. The use of such systems in the ED may be even more complicated. It has been shown that physicians spend more time writing orders when using these systems. So far, no studies have demonstrated that using computerized systems in the ED is beneficial. Because most drugs in the ED are given on an urgent basis, they are kept on the ward stock. In most cases, drugs are prepared and given by the nurses, and it is not clear whether the computerized technology (at least as it is available today) is applicable to the ED setting. Indeed, computerized order entry systems are found in only 18% of EDs with residency programs, and in many institutions, the technology has not been fully implemented even though acquired.

Other interventions, such as clinical pharmacists’ reviewing orders and the use of a unit dose system, require resources that are not always available. The use of handheld computers, which, according to physicians’ self-reporting, reduces the number of preventable adverse drug events, has not been evaluated in clinical settings.

The present study has several limitations. The design of the study, ie, identifying the errors through chart auditing, may not detect some errors and could not provide confirmation about outcomes of errors. It is also possible that physicians made fewer errors because they knew that they were being studied and the novelty of the form may have made people more careful. Therefore, the long-term effectiveness of changing forms remains unclear. Because during resuscitation most orders are given verbally, we could not assess the effect of the new form in the most severe patients.

Medication errors continue to be a major concern for patients and health care professionals. Improving patients’ safety and reducing iatrogenic injuries therefore are major priorities. In the present study, we demonstrated that a low-cost intervention, the use of a preprinted structured order form, significantly reduces medication errors among pediatric patients in the ED. We suggest that preprinted structured order forms should be incorporated into pediatric EDs. These recommendations are in agreement with the recommendations of the American Academy of Pediatrics Committee on Drugs and Hospital care, which suggest such forms as one of the strategies for reducing medication errors. Additional studies should examine the clinical impact of such intervention.

ACKNOWLEDGMENTS

This work was supported by the Trainee’s Start-up Fund, the Research Institution, The Hospital for Sick Children, and “Jonathan’s Alert,” The Hospital for Sick Children (Toronto, Ontario, Canada). Dr Kozer was a recipient of a fellowship grant from the Research Training Center, The Hospital for Sick Children. Dr Koren is a senior scientist of the Canadian Institutes for Health Research. Dr Macpherson is the recipient of a postdoctoral fellowship from the Canadian Institutes for Health Research.

We thank Eve Pinchesky and Trevor Jamieson for help.

REFERENCES

Using a Preprinted Order Sheet to Reduce Prescription Errors in a Pediatric Emergency Department: A Randomized, Controlled Trial
Eran Kozer, Dennis Scolnik, Alison MacPherson, David Rauchwerger and Gideon Koren
*Pediatrics* 2005;116;1299-1302
DOI: 10.1542/peds.2004-2016

Updated Information & Services
including high-resolution figures, can be found at:
http://www.pediatrics.org/cgi/content/full/116/6/1299

References
This article cites 21 articles, 15 of which you can access for free at:
http://www.pediatrics.org/cgi/content/full/116/6/1299#BIBL

Citations
This article has been cited by 2 HighWire-hosted articles:
http://www.pediatrics.org/cgi/content/full/116/6/1299#otherarticles

Subspecialty Collections
This article, along with others on similar topics, appears in the following collection(s):
Office Practice
http://www.pediatrics.org/cgi/collection/office_practice

Permissions & Licensing
Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
http://www.pediatrics.org/misc/Permissions.shtml

Reprints
Information about ordering reprints can be found online:
http://www.pediatrics.org/misc/reprints.shtml

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Downloaded from www.pediatrics.org by on October 22, 2009