

# THE EFFECT OF A SHORT TUTORIAL ON THE INCIDENCE OF PRESCRIBING ERRORS IN PEDIATRIC EMERGENCY CARE

Eran Kozer<sup>1,2,3</sup>, Dennis Scolnik<sup>1,2</sup>, Alison Macpherson<sup>4,5</sup>, David Rauchwerger<sup>1</sup>, Gideon Koren<sup>2</sup>

<sup>1</sup>Division of Emergency Services, <sup>2</sup>Division of Clinical Pharmacology and Toxicology, <sup>3</sup>The Hospital for Sick Children, Department of Paediatrics, University of Toronto, Pediatric Emergency Services, Assaf Harofeh Medical Center, Zerifin, Israel, <sup>4</sup>School of Kinesiology and Health, York University, Toronto, Ontario, <sup>5</sup>Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada

Corresponding Author: [erank@asaf.health.gov.il](mailto:erank@asaf.health.gov.il)

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## ABSTRACT

### Background

In the paediatric emergency department (ED) trainees are more likely to commit prescribing errors.

### Objective

To determine whether a short educational intervention reduces the incidence of prescribing errors among trainees in a pediatric ED.

### Methods

A prospective cohort study at the ED of a tertiary paediatric hospital. All fellows and residents arriving at the ED at the beginning of the academic year were invited to participate in a 30-minute tutorial focusing on appropriate methods for prescribing medications, followed by a written test. Eighteen days were selected randomly during July 2001. All the charts from these days were reviewed for medication errors. Two reviewers, blinded to whether or not a particular physician attended the tutorial, independently decided whether or not an error had occurred. The main outcome measure was the number of prescribing errors.

### Results

Twenty-two trainees worked in the ED during July 2001. Of these, 13 trainees attended the tutorial. Eight hundred and ninety nine orders given by trainees were evaluated. We identified 66 (12.4%) errors in 533 orders given by those who attended tutorial, and 46 (12.7%) errors in 363 orders given by those who did not attend tutorial. The adjusted odds of a medication error was not significantly different between those who did not attend the tutorial and those who did (OR: 1.07 95% CI: 0.66-1.70).

### Conclusions

A short tutorial, followed by a written test, administered to trainees before entering their rotation in the paediatric ED, did not appear to reduce prescribing errors.

**Key Words:** *Emergency medicine, medication errors, paediatrics, education*

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Ten percent of children treated in paediatric emergency departments are subjected to medication errors.<sup>1</sup> Medication errors are a major cause of iatrogenic adverse events.<sup>2,3</sup> They can lead to severe consequences including prolonged hospitalization, unnecessary diagnostic tests and

treatments, and even death.<sup>3-5</sup> In a previous study<sup>1</sup> we found that, compared to staff physicians, trainees were more likely to commit prescribing errors. We also found a higher risk for medication errors among trainees at the beginning, as compared to the end, of the academic year. These

findings, suggest that experience and training may reduce prescribing errors. Holding educational sessions for the staff<sup>6</sup> has been suggested as a strategy to reduce prescribing errors. One previous study demonstrated that medical trainees scored higher on a written test if they attended an educational tutorial on writing orders.<sup>7</sup> However, the effect of an educational intervention on the incidence of medication errors has not been evaluated in the paediatric ED. The objective of the present study was to determine whether a short educational intervention reduces the incidence of prescribing errors among trainees in a paediatric ED.

## METHODS

The study was a prospective cohort study, conducted at the Hospital for Sick Children, a tertiary care paediatric facility in Toronto, Canada. The hospital is the primary paediatric training site for University of Toronto medical residents. It was conducted within a study on the effect of order form on medication errors.<sup>8</sup> At the beginning of the academic year, and before they started their rotation in the ED, all fellows and residents beginning their emergency medicine rotation on July 1<sup>st</sup> 2001 were invited to attend a 30 minute tutorial. The tutorial focused on appropriate methods for prescribing medications in the ED. It was given by one of the senior investigators (EK) and included instructions on how to prescribe medications for children (see Table 1).

**TABLE 1** Medication errors tutorial content

<p><b>Introduction</b></p> <ul style="list-style-type: none"><li>• Medication errors as a cause for iatrogenic adverse effects</li><li>• Magnitude of the problem</li><li>• Findings of previous study done at HSC ED.</li></ul> <p><b>Basic concepts in drug prescription</b></p> <ul style="list-style-type: none"><li>• Dose based on body weight and body surface area</li><li>• Single dose versus total daily dose</li><li>• Drug selection</li><li>• Route, interval, duration</li></ul> <p><b>References for medication doses</b></p> <ul style="list-style-type: none"><li>• The Hospital Formulary</li><li>• The Compendium of Pharmaceuticals and Specialties</li></ul> <p><b>Written test</b></p>
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This tutorial was based on the findings from our previous study and designed to prevent some of the more common errors. For example, since we noticed that in the first study some physicians ordered the total daily dose of a drug three times a day instead of dividing it in three doses, the issue of total daily dose was addressed in the tutorial. Following the tutorial a written test (Table 2) was administered.

**TABLE 2** Medication errors tutorial test questions

**For each case presented please prescribe the medications needed the same way you would order them in the Emergency Department. References for drug dosage taken from the Hospital Formulary are attached.**

1. You are treating a 4-year-old boy with Sickle Cell disease and severe pain. The treatment of choice in such cases is intravenous morphine bolus followed by continuous morphine infusion. The child's weight is 16kg.

Please write your orders for morphine here:

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2. You are treating a 14-day-old baby girl (3.5 kg weight) with fever and irritability. After completing a full sepsis work-up you decide to treat her with ampicillin and cefotaxime.

Please order the medications for the child:

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3. You examined a 1.5-year-old (12 kg) child with fever and found acute otitis media. After discussing the case with the attending physician in the ED you decide to treat the patient with amoxicillin (regular dose) and Tylenol (paracetamol) and to send him home. There is no known drug allergy.

Please write the prescription for amoxicillin and instructions for paracetamol for this patient:

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4. You are treating a 6-year-old (weight 20 kg) boy with an acute asthmatic attack. You decided to treat him with ventolin (salbutamol) and atrovent (ipratropium bromide) and with oral dexamethasone. Since the patient is in acute respiratory distress you decide to give him 3 doses of nebulized ventolin and atrovent over one hour and then to continue with nebulized ventolin every 30-60 minutes until his condition starts to improve.

Please write your orders here:

The hospital formulary was provided and the use of calculators was allowed. This test was piloted on several ED trainees from the previous year to ensure that the questions were clear and understandable. Changes were made to the test based on feedback received during this pilot.

A computer generated random numbers chart selected Eighteen days randomly during July 2001. All the charts from these days were reviewed for medication errors according to a method previously described.<sup>1</sup> Briefly, two medical students reviewed the charts and extracted the data into a database that included information about patients' demographics, clinical condition, diagnosis, acuity of condition (based on triage category), details on the prescribing physician, and all medications prescribed and given to the patient (including medications prescribed for use in the ED and medications given by the ED physician to be used at home). Physicians were categorized as juniors (interns and first and second year residents), or seniors (third and fourth year residents and fellows) if they worked independently and were not required to review cases with the attending physician.

Two paediatric emergency physicians, blinded to level of training of the prescribing physician and to whether or not that physician attended the tutorial, reviewed the database and independently decided whether or not an error occurred. Error was defined as drug regimen different from that recommended (dose differed from the recommended dose by 20% or more, deviation by 2 hours or more from the recommended interval between doses, wrong units or route of administration). The reference for drug administration was the hospital's formulary.<sup>9</sup> However, a drug regimen different from the hospital's formulary was not considered an error if recommended by the Compendium of Pharmaceuticals and Specialties<sup>10</sup>, the manufacturer, or other medical literature. Although the absence of date and time on an order may have significant medico-legal implications, we did not classify this as an error for the purpose of the current analysis.

In cases where the investigators did not agree, the case was discussed in an attempt to come to a consensus. If agreement was still not reached, a third investigator re-assessed the order

and decided whether or not an error occurred. The Research Ethics Board at the Hospital for Sick Children approved the study.

### Statistical Analysis

A database including all prescriptions written by trainees during the 18-day study period was used to assess the incidence of medication errors. The database included medications prescribed for use in the ED and medications given by the ED physician to be used at home. Frequency distributions for all variables comparing those who attended the tutorial to those who did not attend were calculated, and statistical differences assessed using the chi-square test. Further, stepwise multivariable logistic regression analysis was used to compare the two groups. In addition to whether the trainee attended the tutorial (yes vs. no), we included variables previously associated with medication errors, including triage category, physician training (junior vs. senior), time of visit to the ED, and the form used for the prescription (during this period, in our ED, orders could be written on one of three different forms). 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 more than one prescription, but had the same form, triage category, time of day, and physician.

## RESULTS

Twenty-two trainees worked in the ED during July 2001. They include ten juniors (interns and first and second year residents), four senior residents (third and fourth year residents) and eight fellows. Of these, 13 trainees attended the tutorial (eight junior resident, one senior resident and four fellows) and completed a written test before they started to work in the ED.

Five of the 13 physicians who completed the test made calculation errors in the test. Of 113 orders written for the test there were 17 errors, nine of them in calculation. Other errors were: using the wrong units (milligram instead of microgram) in one case, and using the wrong dosage form (tablets for an infants) in another. Three orders for a drug were omitted and three

physicians did not calculate the dose of a continuous morphine infusion.

During the study days there were 2157 visits to the ED. Two thousand fifty-eight (95.4%) charts were available for review. Trainees wrote 976 orders. In 77 orders it was impossible to determine if the physician attended the tutorial (physicians from other services, signature not clear etc). Of the remaining 899 orders, junior residents wrote 476 orders and seniors (senior residents and fellows) 423. Fifty-six (11.8%) errors were made by juniors and 56 (13.2%) by seniors (OR: 0.87, 95% CI 0.58-1.32).

We identified 66 (12.4%) errors in 533 orders written by those who attended the tutorial, and 46 errors in 363 (12.7%) orders written by those who did not attend the tutorial. There was no significant difference in errors between the groups (adjusted OR: 1.07 95% CI: 0.66-1.70).

## DISCUSSION

In the present study we found that a short tutorial, given to trainees before they started their rotation in the ED, did not appear to reduce the incidence of prescribing errors. We did not find a significant difference in the incidence of prescribing errors between trainees at different levels of training. We also found that in a written quiz, five of thirteen (38%) trainees committed a calculation error.

In a previous study<sup>1</sup> we found an increased risk for errors when trainees ordered medications. We also found that trainees committed more errors at the beginning of the academic year. The intervention in the current study was designed to address these issues. We identified the typical types of errors occurring in the ED and gave a short tutorial in which we discussed these errors and how to avoid them. Despite being specifically designed to prevent medication errors in the paediatric ED of a tertiary care facility the tutorial failed to do so.

Education and training have been suggested as strategies to reduce medication errors.<sup>7,11-16</sup> However, educational interventions are not always beneficial. For example, in a study among nurses<sup>17</sup> there was no significant difference between nurses assigned to educational interventions and nurses in a control group, in a drug calculation test. The

fact that the intervention failed to reduce prescribing errors may have several reasons.

It is possible that the group of trainees that did not attend the tutorial was different from that which attended the tutorial. The tutorial was given during orientation, and it is possible that fellows and senior residents who had worked in the hospital previously, and were more familiar with the ED, chose not to attend it. It is also possible that the trainees who attended the tutorial were those who were less confident in prescribing drugs or those who knew they are prone to commit medication errors. In such cases, the fact that the incidence of errors in both groups was similar may reflect a reduction in the incidence of error among those who attended the tutorial. This can be answered only through a randomized trial.

The intervention in the present study was single and short-term. A longer or continuous intervention may have had a better effect. For example, a structured program, focusing on a small number of drugs, improved nurses performances.<sup>14</sup> Their program consisted of a pretest, a pharmacology lecture, calculation problems, a hands-on practicum, and a posttest. A two-year program of continuous evaluation and feedback<sup>6</sup> significantly improved prescription-writing skills among family medicine residents.

Even a brief educational intervention might be beneficial. In a study conducted among emergency medicine residents,<sup>7</sup> physicians were asked to complete an eight-question test. After completing the test, the right answers were given and key concepts discussed for 30 minutes. Physicians' scores in a second test, given six weeks later were significantly higher. It is important to note that the effect of the intervention on the incidence of errors committed by the participants during work was not evaluated in this study.

Although designed to address specific problems in the paediatric ED our intervention tool may have missed some of the problems. For example, three of the trainees could not calculate the dose of a continuous morphine infusion at the end of the tutorial suggesting the tool was not good enough in addressing this issue.

It is also worth noting that although many of those who attended the tutorial committed prescribing errors (most of them in simple

calculations) at the end of the tutorial we do not know how many errors would have occurred without it. It is therefore possible that the intervention still prevented some of the typical errors occurring in the paediatric ED.

Laser et al<sup>18</sup> found a higher incidence of prescribing errors among first year residents. In a previous study<sup>1</sup> we found a higher risk for an error when a trainee ordered a medication. However, in that study we did not differentiate between trainees at different levels of training. In the present study we compared senior residents and fellows (some of them qualified paediatricians) with first and second year residents, expecting to find a higher error rate among junior residents, however no such difference was found. Because of the small numbers we did not compare first year residents to other trainees and the possibility that error rate in this group is higher cannot be excluded. It is also worth noting that most junior residents (8/10) attended the tutorial and the possibility that the tutorial had some effect on their performances cannot be excluded. The findings in the present study are in agreement with previous studies that found no difference between attending physicians and trainees<sup>19</sup> in the risk for an error and no difference in the risk for a calculation error among first, second, and third year residents.<sup>11</sup>

Almost 40% of the trainees committed at least one calculation error in a written test. These results are in agreement with previous studies<sup>11,12,20</sup> that found that a large proportion of physicians and students commit calculation errors. It is also in agreement with a study on medication errors that identified slips in attention as a major factor contributing to errors.<sup>15</sup> Since the test was anonymous, we do not know if the physicians who committed more errors in the test also made more prescribing errors in the ED. It is therefore not clear if using such test could identify those physicians that are more likely to err.

The present study has several limitations. The design of the study (i.e. 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 the physicians performed better knowing that they were studied. As mentioned above, it was not a

randomized study and the group of physicians who took the tutorial might be different from those who did not.

Medication errors continue to be a major concern for patients and health professionals. Improving patients' safety and reducing iatrogenic injuries is therefore a major priority.<sup>16,21,22</sup> Several interventions have been shown to be effective in reducing medication errors and increasing patient safety. Such interventions include the use of Computerized Physician Order Entry (CPOE),<sup>23-25</sup> having a clinical pharmacist review orders,<sup>26</sup> the use of a unit dose system,<sup>27</sup> and using a handheld computer.<sup>28</sup>

CPOE's are based on a computer program that can detect and prevent medication errors. The rate of medication errors was reported to decrease by 40% in wards that started to use CPOE compared to wards which continued to use hand written orders<sup>25</sup> and a paediatric ICU implementation of CPOE almost entirely eliminated (99% reduction) prescribing errors.<sup>29</sup> Using a combined system of CPOE and unit dosing dispensing system reduced prescribing dispensing and administration errors.<sup>27</sup>

The rate of errors may be extremely high during resuscitations.<sup>30</sup> Using a standard dosing system (Broselow tape) may significantly reduce the rate of dosing errors during resuscitations.<sup>31</sup> Including pharmacists as part of the healthcare team is another effective intervention to reduce errors.<sup>26</sup> The pharmacist can review the physician's orders and detect errors that are not easily identified by physicians, such as drug interactions, wrong solvents, and infusion rates.

These interventions, although effective, are expensive and are not available in many institutions. We recently showed that using a pre-printed order sheet significantly reduces medication errors.<sup>8</sup> Educational interventions do not require sophisticated equipment and it is therefore tempting to suggest using them. The fact that the intervention we used failed to reduce prescribing errors does not rule out the possibility that a different educational intervention would be beneficial. Suggested guidelines<sup>16</sup> for educational interventions to reduce medication errors focused on reinforced communication skills among healthcare professionals, instruction, and practice in performing the mathematical calculations used

in patient care with special emphasis on the common errors and carefully monitoring patients to identify possible errors.

However, as this study shows, the effect of educational intervention on the rate of prescribing errors is yet to be proven.

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### **Competing Interest Statement**

All the authors declare that they have no competing interests.

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