

# Detection and correction of prescription errors by an emergency department pharmacy service

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## ABSTRACT

**Objectives:** Emergency departments (EDs) are recognized as a high-risk setting for prescription errors. Pharmacist involvement may be important in reviewing prescriptions to identify and correct errors. The objectives of this study were to describe the frequency and type of prescription errors detected by pharmacists in EDs, determine the proportion of errors that could be corrected, and identify factors associated with prescription errors.

**Methods:** This prospective observational study was conducted in a tertiary care teaching ED on 25 consecutive weekdays. Pharmacists reviewed all documented prescriptions and flagged and corrected errors for patients in the ED. We collected information on patient demographics, details on prescription errors, and the pharmacists' recommendations.

**Results:** A total of 3,136 ED prescriptions were reviewed. The proportion of prescriptions in which a pharmacist identified an error was 3.2% (99 of 3,136; 95% confidence interval [CI] 2.5–3.8). The types of identified errors were wrong dose (28 of 99, 28.3%), incomplete prescription (27 of 99, 27.3%), wrong frequency (15 of 99, 15.2%), wrong drug (11 of 99, 11.1%), wrong route (1 of 99, 1.0%), and other (17 of 99, 17.2%). The pharmacy service intervened and corrected 78 (78 of 99, 78.8%) errors. Factors associated with prescription errors were patient age over 65 (odds ratio [OR] 2.34; 95% CI 1.32–4.13), prescriptions with more than one medication (OR 5.03; 95% CI 2.54–9.96), and those written by emergency medicine residents compared to attending emergency physicians (OR 2.21, 95% CI 1.18–4.14).

**Conclusions:** Pharmacists in a tertiary ED are able to correct the majority of prescriptions in which they find errors. Errors are more likely to be identified in prescriptions written for

older patients, those containing multiple medication orders, and those prescribed by emergency residents.

## RÉSUMÉ

**Objectifs:** C'est connu, les services d'urgence (SU) sont un lieu où le risque d'erreurs de prescription est élevé. Alors, les pharmaciens peuvent jouer un rôle important dans la révision des prescriptions dans le but de repérer et de corriger les erreurs. L'étude avait pour objectifs de décrire la fréquence des erreurs de prescription décelées par les pharmaciens au SU et leur type, de déterminer la proportion des erreurs susceptibles de correction et de cerner les facteurs associés aux erreurs de prescription.

**Méthodes:** Il s'agit d'une étude d'observation, prospective, menée dans un SU d'enseignement, de soins tertiaires, pendant 25 semaines consécutives. Les pharmaciens ont révisé toutes les prescriptions documentées, rédigées au SU, puis marqué et corrigé les erreurs. Il y a eu une collecte de renseignements sur les données démographiques des patients, sur les éléments concernant les erreurs de prescription ainsi que sur les recommandations des pharmaciens.

**Résultats:** Au total, 3136 prescriptions rédigées au SU ont été révisées. La proportion de prescriptions comportant une erreur décelée par les pharmaciens s'est élevée à 3.2% (99 sur 3136; intervalle de confiance [IC] à 95%: 2.5–3.8). Les types d'erreur relevés étaient la mauvaise dose (28 sur 99; 28.3%), une prescription incomplète (27 sur 99; 27.3%), la mauvaise fréquence (15 sur 99; 15.2%), le mauvais médicament (11 sur 99; 11.1%), la mauvaise voie d'administration (1 sur 99, 1.0%) et le reste (17 sur 99; 17.2%). Le service de pharmacie a corrigé 78 erreurs (78 sur 99; 78.8%). Les facteurs associés aux erreurs de prescription comprenaient

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un âge supérieur à 65 ans chez les patients (risque relatif approché [RRA]: 2.34; IC à 95%: 1.32–4.13), la prescription de plus d'un médicament (RRA: 5.03; IC à 95%: 2.54–9.96) et la rédaction de prescriptions par les résidents en médecine d'urgence comparativement aux urgentologues traitants (RRA: 2.21; IC à 95%: 1.18–4.14).

**Conclusions:** Les pharmaciens dans un SU de soins tertiaires sont capables de corriger la plupart des erreurs décelées

dans les prescriptions. Le risque d'erreur est plus élevé dans les prescriptions concernant les patients âgés, celles comptant plusieurs médicaments et celles rédigées par les résidents en médecine d'urgence.

**Keywords:** adverse drug events, emergency department, patient safety, pharmacist, prescription errors

Emergency departments (EDs) are high-risk settings for medical errors.<sup>1</sup> Emergency physicians provide episodic care to patients they typically do not have a previous relationship with in urgent and emergent situations and in a suboptimal environment. Factors such as overcrowding,<sup>2</sup> staffing shortages,<sup>3,4</sup> frequent interruptions, and handovers in care<sup>4</sup> contribute to making the ED a high-risk setting.

Medication errors are one of the most common types of ED errors.<sup>3,5,6</sup> Most medication errors are related to one or more of “five wrongs” involved in the act of prescribing: wrong drug, wrong dose, wrong route, wrong time, and wrong patient.<sup>7,8</sup> Certain types of drugs, such as analgesics, antibiotics, sedatives, and cardiovascular drugs, have been associated with more frequent prescription errors compared to other drug classes.<sup>3,7,9</sup> In addition, prescribing to more complex and acutely ill patients at nighttime, on weekends, or by trainees has been associated with more frequent errors.<sup>7,9</sup>

Previous studies have estimated the proportion of prescriptions with errors in adult inpatients and in ED patient populations at between 0.4 and 6.3%.<sup>5,10–13</sup> Other studies in the pediatric ED setting have found that as many as 10% of medical charts contained prescription errors.<sup>9,14,15</sup> However, these studies were conducted either in inpatient or pediatric patient populations, used retrospective designs, or were based on a short period of data collection.

There is increasing evidence for the benefits of employing a pharmacist in the ED<sup>16–21</sup> and the important role pharmacists can play in identifying and decreasing prescription errors.<sup>10–12,20–23</sup> To date, no studies have described the frequency of, classification of, and risk factors for prescription errors in Canadian EDs.<sup>6</sup>

The objectives of this study were to describe the frequency and type of prescription errors detected by pharmacists in EDs, determine the proportion of

errors that could be corrected, and identify factors associated with prescription errors.

## METHODS

### *Study design and setting*

This was a single-centre, prospective, observational study conducted in the ED of the Jewish General Hospital, a tertiary care teaching hospital in Montreal. Our ED serves an adult patient population and had an annual census of 66,000 in 2008. This study was approved by the Research Ethics Committee of the Jewish General Hospital.

At the time of the study, the daily operations of the ED were divided into three clinical shifts composed of a day shift (08:00–16:00), an evening shift (16:00–24:00), and a night shift (24:00–08:00). Two pharmacists and one pharmacy technician participated in this study. One pharmacist and one pharmacy technician were on site on weekdays from 08:00 to 16:00, whereas one technician was on site between 16:00 and 21:00 on weekday evenings. No pharmacy service was available between 21:00 and 08:00 on weekdays or at any time on weekends and holidays. The pharmacists' duties included supplying medications that were not available in the ED and reviewing all ED prescriptions, including transcribed verbal orders. The pharmacy service was informed of the objectives of this study; however, their duties were not altered by participation.

We included all prescriptions that were written or verbally transmitted and transcribed in our ED for 25 consecutive weekdays between November 17 and December 19, 2008. We excluded discharge prescriptions and prescriptions written during weekends.

Medication orders in our ED were written by attending and resident physicians on standardized paper forms located in the patients' charts and were picked up by nurses. Nurses gave a copy of the

recorded prescription to the pharmacist for review for the purposes of this study, obtained the medication, and then carried out the order. Physicians communicated verbal orders directly to nurses. Nurses then recorded verbal orders on a prescription sheet and carried them out. Verbal orders were countersigned by the physician at a subsequent point in time. The copy of transmitted verbal orders was given to the pharmacist for review.

Every morning, the incoming pharmacist reviewed all retained copies of prescriptions written in the ED during the previous evening, night, and early morning. The pharmacist identified prescriptions that were erroneous and attempted to correct them by speaking with the physician if the patient was still in the ED and the medication had not yet been dispensed or was an ongoing prescription.

Prescriptions were deemed to have an error if the on-duty ED pharmacist recommended making any addition or modification to them. The pharmacist contacted the physician to clarify any uncertainties about the determination of the appropriateness of or indication for the prescription. For example, if a penicillin-allergic patient was prescribed ticarcillin-clavulanate, the pharmacist would contact the physician and recommend an alternate antibiotic. When the pharmacy technician suspected an error, he or she reported this to the pharmacist as soon as possible. The pharmacist then reviewed the prescription and contacted the physician regarding any errors.

Pharmacists initially classified errors at the time of reviewing the prescriptions. Subsequently, two other researchers (N.S. and T.C.) reviewed all cases and, for cases with disagreement, determined the error classification through discussion and consensus. Patient charts and pharmacy records were used during this process. We classified errors into six categories: 1) wrong drug; 2) wrong dose; 3) wrong frequency; 4) wrong route; 5) incomplete prescriptions; and 6) others. The wrong drug category included patient allergy to a prescribed drug or an inappropriate drug for the disease. Wrong dose, wrong frequency, and wrong route were determined according to usual hospital and pharmacy practice. Incomplete prescription included missing information related to route, dose, or medication frequency. The other category included redundant medications, missing signatures, nonformulary medications, illegible prescriptions, and conflicting orders.

### **Data collection**

For the purposes of data collection, the pharmacist attached a note to the copy of all prescriptions in which one or more errors were found. These copies were collected from the pharmacy service on a daily basis. The pharmacist's note provided information on the category of error identified, the nature of the pharmacist's recommendation, and whether or not the recommendation was followed. In addition, the prescriber, the time and date of the prescription, and the number of medication orders written on the prescription were recorded. Prescribers included attending emergency physicians, emergency residents, and specialist consultants (staff and residents). Information on the patients' age, gender, triage code, chief complaint, main diagnosis, mode of arrival, and stretcher use was obtained through our ED electronic database.

### **Outcome measures and data analysis**

The primary outcome was the number and proportion of prescription errors identified by the pharmacy service. Secondary outcomes were the error categorization, proportion of errors corrected, and factors associated with prescription errors.

Descriptive statistics such as means (with standard deviations), medians (with interquartile ranges), and proportions (with 95% confidence intervals [CIs]) were used to describe the baseline characteristics of enrolled patients. We conducted univariate analyses using *t*-tests, chi-square tests, or Fisher exact tests as required to determine whether there were any associations between the presence of one or more prescription errors and the following variables defined a priori: age > 65 years, the number of prescribed medications (one medication,  $\geq 2$  medications), prescriber type (attending emergency physician, emergency resident, specialist consultant [attending physicians and residents]), arrival by ambulance (yes, no), Canadian Triage Acuity Scale (CTAS) triage level (grouped into CTAS 1 and 2, CTAS 3, and CTAS 4 and 5), and shift (day, evening, and night) during which the prescription was written. Those variables that were associated with the occurrence of one or more prescription errors based on the results of univariate analyses ( $p \leq 0.10$ ) were entered into a logistic regression model with a generalized estimating equation (GEE) to identify variables independently

associated with prescription errors. The GEE analysis was used to account for the clustering effect of prescriptions nested within patient visits. The results from the logistic regression analysis are presented as odds ratios (ORs) and 95% CIs. All data management and statistical analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC).

## RESULTS

The study sample was made up of 1,088 ED visits from 1,025 unique patients. Table 1 shows the baseline characteristics of patients and ED visits in the study. The median age of patients was 75.3 years. The median ED length of stay was 31.8 hours. Forty-eight percent of ED visits occurred during the daytime, and 47% led to a hospitalization. These visits generated 3,136 ED prescriptions containing 11,313 medication orders that were reviewed by the ED pharmacy service.

**Table 1. Baseline characteristics of patients (*N* = 1,025) and ED visits (*N* = 1,088) in the study**

Characteristic	
Patient	
Median age, yr (interquartile range)	75.3 (60–84)
Female gender, <i>n</i> (%)	576 (53.0)
Visit	
CTAS triage category, <i>n</i> (%)	
1	4 (0.4)
2	348 (32.0)
3	592 (54.4)
4	141 (13.0)
5	3 (0.3)
Mode of arrival, <i>n</i> (%)	
By ambulance	509 (46.8)
Walk-in	579 (53.2)
Shift of ED visit, <i>n</i> (%)	
Day shift	517 (47.5)
Evening shift	393 (36.1)
Night shift	178 (16.4)
Most common chief complaints	
Abdominal pain	119 (10.9)
Chest pain	119 (10.9)
Shortness of breath	111 (10.2)
Generalized weakness	60 (5.5)
Nausea or vomiting	49 (4.5)
Disposition, <i>n</i> (%)	
Hospitalized	509 (46.8)
Nonhospitalized	579 (53.2)
Median ED length of stay, hr (interquartile range)	31.8 (19.5–55.7)

CTAS = Canadian Triage and Acuity Scale; ED = emergency department.

Among the prescriptions reviewed, 99 errors (99 of 3,136; 3.2%; 95% CI 2.5–3.8) were identified among 81 prescriptions (see Appendix, available at <http://www.cjem-online.ca>), illustrating that some prescriptions contained multiple errors. Pharmacists corrected 78 (78.8%) of the errors identified.

Figure 1 shows the types of prescription errors identified and the proportions corrected within each category. Among 99 errors, 28 (28.3%) were due to the wrong dose, followed by incomplete prescription (27; 27.3%), other (17; 17.2%), wrong frequency (15; 15.2%), wrong drug (11; 11.1%), and wrong route of administration (1; 1.0%).

Table 2 illustrates prescription characteristics and includes the proportion of errors classified according to the shift that the prescriptions were written in, categorized by type of prescriber, patient age, and number of medication orders on the prescription.

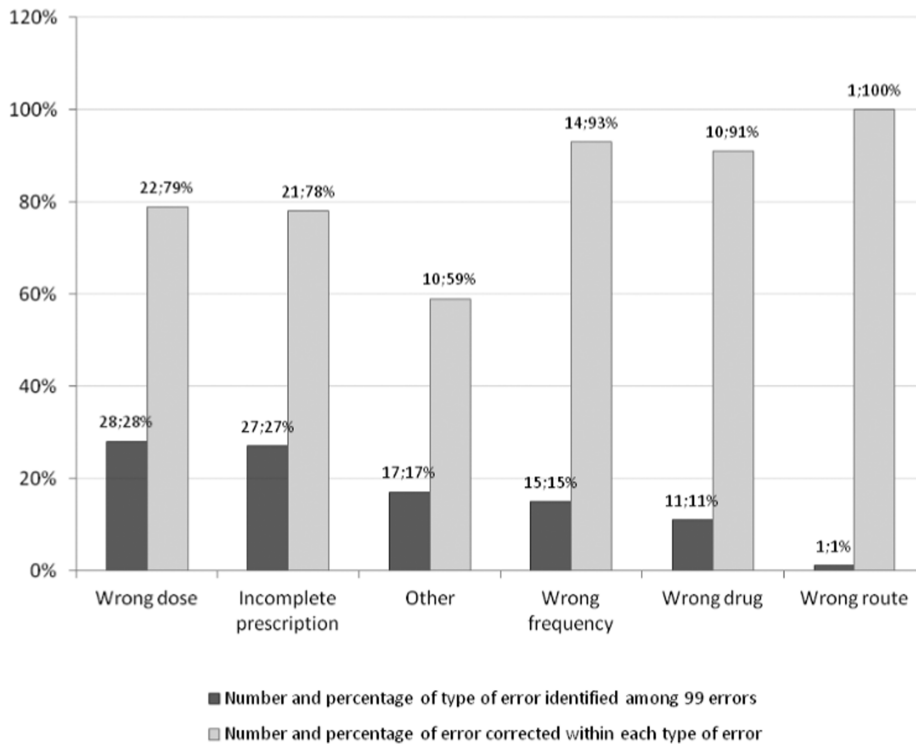
On univariate analyses, four factors were found to be associated with the presence of prescription errors, at a significance level of  $\leq 0.1$ : patient age, number of prescribed medications, prescriber type, and means of arrival. Table 3 shows the factors independently associated with prescription errors on multivariable analysis. Prescriptions written for patients over the age of 65 years (OR 2.34; 95% CI 1.32–4.13), those that included more than one medication order (OR 5.03; 95% CI 2.54–9.96), and those written by emergency residents (OR 2.21; 95% CI 1.18–4.14) compared to attending emergency physicians were all found to have a higher odds of a prescription error.

Table 4 provides a categorization of prescription errors by type of medication. The most frequent drug classes associated with prescription errors were cardiovascular drugs (21 of 99; 21.2%), neurologic drugs (10 of 99; 10.1%), and inhaled medications (9 of 99; 9.1%). The most frequent drugs with errors were diltiazem (7 of 99; 7.1% of all errors), acetylcysteine (4 of 99; 4.0%), and carbidopa-levodopa (4 of 99; 4.0%).

We found no errors among the 142 verbal orders that were transcribed and reviewed. The three most common verbal orders were for intravenous fluids (33 of 142; 23.2%), acetaminophen (23 of 142; 16.2%), and morphine (16 of 142; 11.3%).

## DISCUSSION

This study describes the frequency and types of prescription errors detected and corrected by the



**Figure 1.** Types of prescription errors and proportions corrected (n; %).

pharmacy service in a tertiary ED. Through multi-variable analysis, we identified factors that were associated with prescription errors in our ED. Pharmacists identified 99 (3.2%) errors in 3,136 ED prescriptions, of which 78.8% were corrected through their intervention.

The proportion of errors we found is within the range reported in other studies.<sup>5,10-12,24,25</sup> Variability in this estimate is likely due, at least in part, to the different methodologies and settings in which other studies were conducted. When describing the types of prescription error, Kozer and colleagues found a

**Table 2. Prescription characteristics (N = 3,136)\***

Characteristic	Error (n = 81)	No error (n = 3,055)	Total (n = 3,136)
Shift during which the prescription was written, n (%)			
Day shift	12 (1.5)	809 (98.5)	821
Evening shift	37 (3.8)	929 (96.2)	966
Night shift	16 (2.5)	625 (97.5)	641
Shift information missing	16 (2.5)	692 (97.7)	708
Type of prescriber, n (%)			
EM attending staff	29 (2.1)	1,328 (97.9)	1,357
EM residents	16 (5.6)	268 (94.4)	284
Specialty consultants and residents	36 (2.4)	1,453 (97.6)	1,489
Prescriber type missing	0 (0)	6 (100)	6
Patient age, n (%)			
≥ 65 years old	67 (3.2)	2,059 (96.8)	2,126
< 65 years old	14 (1.4)	996 (98.6)	1,010
Number of medication orders per prescription, n (%)			
One medication order	9 (0.8)	1,188 (99.2)	1,197
≥ 2 medication orders	72 (3.7)	1,867 (96.3)	1,939

EM = emergency medicine.  
 \*Note that 99 errors were identified in 81 prescriptions.

**Table 3. Factors independently associated with prescription errors on multivariable analysis**

Factor name	Factor level	Odds ratio	95% CI
Type of prescriber	Emergency medicine residents	2.21	1.18–4.14
	Specialty staff and residents	0.84	0.51–1.40
	Emergency attending staff	1.00	Reference
Age	≥ 65 yr	2.34	1.32–4.13
	< 65 yr	1.00	Reference
Number of medication orders per prescription	2 or more medications ordered	5.03	2.54–9.96
	1 medication ordered	1.00	Reference

similar pattern in the pediatric setting.<sup>9</sup> The majority of prescription errors were related to the wrong dose (49%) and the wrong frequency (43%), whereas the wrong route (3%), the wrong drug (2%), and the wrong information (3%) were far less common. In another study in both adult and pediatric patients, Rothschild and colleagues similarly found drug dose errors (40%) to be the most common.<sup>13</sup>

We found three factors that were more likely to be associated with prescription errors: prescriptions written by emergency medicine residents, those written for elderly patients, and those involving multiple medications. The first factor may be a reflection of the complexity for trainees of prescribing in the ED. Emergency medicine residents, when compared to emergency attending physicians, are less familiar with medications, dosages, dosing regimens, and treatments because they have less experience with the breadth of medical problems encountered in the ED. With regard to age, our findings are consistent with other studies showing that physicians are more likely to commit errors when prescribing to the elderly.<sup>26–28</sup> Elderly

patients tend to have more comorbidities and a larger number of coprescribed medications, both of which can result in contraindications and interactions, thus complicating the prescribing process. Finally, and similar to the findings of Patanwala and colleagues,<sup>29</sup> our finding with regard to multiple medicine prescriptions is explained by the fact that the complexity of prescribing increases as the number of medications ordered increases, thus compounding the potential for error.

Although the pharmacy service was not available 24/7 during the study period, this service was able to correct the majority of identified prescription errors. Errors that were not corrected predominantly arose as a result of patients leaving the ED before the pharmacist was able to review the prescription.

Among the 65 prescriptions with errors where the shift was identified, more than half of the errors (37 of 65) occurred during the evening. This may have arisen because of pharmacists' availability during the day shift to assist with complicated prescriptions, thus contributing to safer prescribing during these times. The proportion of prescription errors involving cardiovascular and neurologic drugs, vitamins, and supplements may be due to the wide range of formulations available for these agents. Rothschild and colleagues also found that central nervous system drugs and cardiovascular drugs were commonly associated with prescription errors.<sup>13</sup> Similarly, different brands of supplements may contain varying amounts of compounds and can be confusing for prescribers. Inhalers and ophthalmic solutions can represent unconventional prescriptions, and prescribers unfamiliar with these may be more prone to error.<sup>30</sup>

Very little research has been published on verbal orders.<sup>31</sup> Although we acknowledge the potential dangers of verbal orders, we found no errors among

**Table 4. Categorization of prescription errors by type of medication**

Medication category	Number of errors (%) (N = 99)
Cardiovascular	21 (21.2)
Neurologic	10 (10.1)
Inhaled medications	9 (9.1)
Ophthalmic drops	8 (8.1)
Vitamins and supplements	8 (8.1)
Antimicrobials	7 (7.1)
Gastrointestinal	6 (6.1)
Diabetes	6 (6.1)
Psychiatric	6 (6.1)
Other	18 (18.2)

the 142 verbal orders we reviewed. This counter-intuitive finding is consistent with those of another study looking at verbal orders in the paediatric inpatient setting, which found a fourfold decreased risk of error associated with verbal orders compared to handwritten orders.<sup>32</sup> Increased vigilance by the transcribers and the commonality of and resulting familiarity with medications that are typically prescribed verbally may explain these findings.

## LIMITATIONS

This study has limitations that should be considered when interpreting our findings. It was conducted at a single adult tertiary care centre, which limits the generalizability of our findings. Moreover, we relied solely on the pharmacy service for the detection and correction of prescription errors. It is possible that the pharmacy service did not detect all errors that occurred and that some of the apparent errors detected may have arisen from intentional variations on the part of the prescriber. Notes stapled to the prescription indicated an error, but we assumed that no note signified the lack of an error, although some such cases could have represented a missing note. In addition, we may have missed some prescriptions for which copies were accidentally discarded or misplaced. Because of the pharmacy service schedule, we collected data only for a limited period of time during weekdays. Consequently, our results may not reflect the proportion or types of errors occurring on weekends or holidays. We did not study adverse drug reactions, drug interactions, the need for closer monitoring, or the need for antidotes as a result of ED prescriptions; therefore, we are unable to determine the impact of the prescription errors that we identified and did not correct.

## CONCLUSIONS

Pharmacists in a tertiary ED are able to correct the majority of prescriptions in which they found errors. Errors are more likely to be identified in prescriptions written for older patients, those containing multiple medication orders, and those prescribed by emergency residents. Finally, we found no errors in any of the verbal orders we reviewed. A better understanding of the consequences of prescription errors that are not intercepted, as well as of the causes of prescription

errors, may lead to further improvements in medication safety in the ED.

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Appendix. Details of prescription errors		
Situation	Type of error	Medication involved
72-year-old woman presenting to the ED after a fall and complaining of left ankle pain (CTAS 3); patient was admitted under Internal Medicine ⇒ Total number of errors = 1 1) 25 mg was prescribed instead of patient's regular dose, 20 mg	Wrong dose	Rosuvastatin (Crestor)
77-year-old man complaining of generalized weakness (CTAS 3); patient was discharged home ⇒ Total number of errors = 1 2) 40 mg was prescribed instead of 30 mg	Wrong dose	Mirtazapine
78-year-old man complaining of chest pain, hypotensive (CTAS 2); patient admitted under Internal Medicine ⇒ Total number of errors = 1 3) Wrong dose of medication was prescribed	Wrong dose	Clopidogrel (Plavix)
87-year-old man with hemoptysis × 1 sent to the ED by MD office (CTAS 2); patient was admitted under Internal Medicine ⇒ Total number of errors = 1 4) 1,000 U PO q.d. was prescribed instead of 10,000 U PO q.week	Wrong dose	Vitamin D
42-year-old man presenting to the ED with seizure (CTAS 3); patient was discharged home ⇒ Total number of errors = 1 5) Incorrect dose was prescribed	Wrong dose	Carbamazepine
77-year-old man sent to the ED by MD office to rule out aneurysm (CTAS 2); patient was discharged home ⇒ Total number of errors = 1 6) Medication was prescribed × 6 the normal dose	Wrong dose	Acetylcysteine (Mucomyst)
75-year-old man complaining of difficulty to walk (CTAS 4); patient was admitted under Medicine ⇒ Total number of errors = 1 7) 175 mg was prescribed instead of 75 mg	Wrong dose	Spironolactone
64-year-old man with fall, head trauma, rectal bleeding (CTAS 2); patient was discharged home ⇒ Total number of errors = 1 8) 16 mg was prescribed instead of 160 mg	Wrong dose	Fenofibrate (Lipidil)
92-year-old woman with cough transferred from another acute care hospital (CTAS 3); patient was admitted to the medical short-stay unit under Internal Medicine ⇒ Total number of errors = 1 9) Patient was prescribed 30 mg instead of 80 mg	Wrong dose	Gliclazide (Diamicron MR)
55-year-old woman complaining of bilateral knee swelling (CTAS 4); patient was discharged home ⇒ Total number of errors = 1 10) Wrong dose was prescribed	Wrong dose	Mesalamine (Mesasal)
69-year-old man presenting with retrosternal chest pain × 4 days (CTAS 3); patient was discharged home ⇒ Total number of errors = 1 11) Dose prescribed was too low	Wrong dose	Diltiazem
92-year-old woman complaining of shortness of breath (CTAS 3); patient was admitted under Medicine ⇒ Total number of errors = 1 12) Wrong dose was prescribed	Wrong dose	Diltiazem
61-year-old man known for diabetes presenting with bilateral lower leg oozing ulcers × 2 weeks, unable to ambulate (CTAS 3); patient was discharged home ⇒ Total number of errors = 1 13) Uremol cream 1,000% was prescribed; should be 10%	Wrong dose	Hydrocortisone
55-year-old man presenting to the ED with retrosternal chest pain (CTAS 2); patient was admitted to the medical short-stay unit under Medicine ⇒ Total number of errors = 1 14) Prescription did not mention extended release	Wrong drug	Diltiazem ER/CD
67-year-old man sent to the ED for angiography and admission under palliative care (CTAS 3); patient was admitted under Medicine ⇒ Total number of errors = 1 15) Prescription did not mention extended release	Wrong drug	Diltiazem ER/CD

Appendix. Continued		
Situation	Type of error	Medication involved
73-year-old man complaining of right hand numbness and weak fingers (CTAS 3); patient was discharged home ⇨ Total number of errors = 1 16) Prescription did not mention Diamicon MR	Wrong drug	Gliclazide (Diamicon MR)
72-year-old man complaining of weakness and dysuria, known for Crohn disease (CTAS 3); patient was admitted under Internal Medicine ⇨ Total number of errors = 1 17) Diamicon was prescribed instead Diamicon MR	Wrong drug	Gliclazide (Diamicon MR)
81-year-old man presenting to the ED because of blood in colostomy bag (CTAS 3); patient was discharged home ⇨ Total number of errors = 1 18) Inappropriate indication considering patient condition	Wrong drug	Metformin
78-year-old man complaining of increased shortness of breath on exertion for 2–3 weeks (CTAS 2); patient was admitted under Cardiology ⇨ Total number of errors = 1 19) Medication was prescribed q.d. instead of t.i.d.	Wrong frequency	Sildenafil
84-year-old woman presenting to the ED with diarrhea; patient was discharged home ⇨ Total number of errors = 1 20) Medication was prescribed b.i.d. instead of q.d.	Wrong frequency	Cal D (Calcium and Vitamin D supplement)
90-year-old woman presenting with forehead and mouth trauma post fall (CTAS 3); patient was admitted under Family Medicine ⇨ Total number of errors = 1 21) Incorrect frequency; should not be as needed	Wrong frequency	Budesonide-formoterol (Turbuhaler)
83-year-old man presenting to the ED with respiratory distress (CTAS 2); patient was admitted under Internal Medicine ⇨ Total number of errors = 1 22) Medication was prescribed b.i.d. instead of q.d.	Wrong frequency	Verapamil
79-year-old woman complaining of chest pain (CTAS 3); patient was discharged home ⇨ Total number of errors = 1 23) Medication was prescribed q.4.h. instead of q.i.d.	Wrong frequency	Carbidopa-levodopa (Sinemet)
91-year-old woman complaining of suprapubic pain (CTAS 3); patient was discharged ⇨ Total number of errors = 1 24) 10,000 IU was prescribed q.d. instead of q.week	Wrong frequency	Vitamin D
91-year-old woman complaining of pelvic pain (CTAS 4); patient was admitted under Palliative Care (same patient as above, different visit) ⇨ Total number of errors = 1 25) Medication was prescribed q.d. instead of q.week	Wrong frequency	Risedronate
80-year-old woman complaining of right facial numbness (CTAS 3); patient was discharged home ⇨ Total number of errors = 1 26) Medication was prescribed q.d. instead of b.i.d.	Wrong frequency	Fluticasone-salmeterol (Advair)
80-year-old woman complaining of dizziness and shortness of breath (CTAS 2); patient was discharged home ⇨ Total number of errors = 1 27) Medication was prescribed 100 mg q.d. instead of 50 mg b.i.d.	Wrong frequency	Metoprolol
93-year-old woman complaining of shortness of breath (CTAS 4); patient was discharged home ⇨ Total number of errors = 1 28) Prescription did not mention the dose	Incomplete prescription	Rivastigmine patch
95-year-old man presenting to the ED with chest pain (CTAS 3); patient was admitted under Medicine ⇨ Total number of errors = 1 29) Prescription did not mention the dose	Incomplete prescription	Fluticasone (Flovent)
75-year-old woman presenting to the ED with shortness of breath with cough and green secretions (CTAS 3); patient was discharged home ⇨ Total number of errors = 1 30) Prescription did not mention the dose	Incomplete prescription	Irbesartan (Avapro)

Appendix. Continued		
Situation	Type of error	Medication involved
80-year-old man with fall, laceration, and bleeding on back of head; patient on warfarin (CTAS 4); patient was discharged home ⇒ Total number of errors = 1		
31) Prescription did not mention the dose	Incomplete prescription	Fluticasone-salmeterol (Advair)
81-year-old woman who fell (CTAS 2); patient was admitted under Medicine ⇒ Total number of errors = 1		
32) Prescription did not mention the dose	Incomplete prescription	Travoprost
73-year-old man complaining of dysuria and lower abdominal pain (CTAS 3); patient was discharged home ⇒ Total number of errors = 1		
33) Prescription did not mention the dose	Incomplete prescription	Carbidopa-levodopa (Sinemet)
64-year-old woman presenting with slurred speech and LOC, (CTAS 2); patient was admitted under Cardiology ⇒ Total number of errors = 1		
34) Prescription did not mention the frequency	Incomplete prescription	Clotrimazole (Canesten)
99-year-old woman who fell (CTAS 3); patient was discharged ⇒ Total number of errors = 1		
35) Prescription did not mention the frequency	Incomplete prescription	Furosemide (Lasix)
82-year-old woman complaining of chest pain (CTAS 3); admitted under Surgery ⇒ Total number of errors = 1		
36) Prescription did not mention the frequency	Incomplete prescription	Nitroglycerin patch
96-year-old woman presenting to the ED with shortness of breath and cyanosis (CTAS 2); patient was admitted under Cardiology ⇒ Total number of errors = 1		
37) Prescription did not mention the route	Incomplete prescription	Morphine
86-year-old woman presenting to the ED with rectal bleeding (CTAS 3); patient was admitted to medical short-stay unit under Medicine ⇒ Total number of errors = 1		
38) Duration of treatment was not indicated on prescription	Incomplete prescription	Pantoprazole (Pantoloc)
94-year-old woman presenting to the ED because of rib pain (CTAS 3); patient died in ED ⇒ Total number of errors = 1		
39) Prescription mentioned only "0.5" instead of 0.5% Timoptic XE	Incomplete prescription	Timolol
84-year-old man complaining of shortness of breath exacerbation (CTAS 2); patient was admitted under Cardiology ⇒ Total number of errors = 1		
40) Prescription did not mention the dose or frequency	Incomplete prescription	Vita-3 (multivitamins)
88-year-old woman presenting to the ED for right knee pain post fall (CTAS 3); patient was discharged home ⇒ Total number of errors = 1		
41) Prescription did not mention dose or frequency	Incomplete prescription	Mirtazapine
83-year-old man complaining of hemoptysis (CTAS 3); patient was admitted under Internal Medicine ⇒ Total number of errors = 1		
42) Prescription did not mention the dose or frequency	Incomplete prescription	Latanoprost
96-year-old woman with syncope (CTAS 3); patient was admitted under Family Medicine ⇒ Total number of errors = 1		
43) Prescription did not mention any dose, route, or frequency	Incomplete prescription	LMWH protocol
67-year-old woman sent by day hospital for PICC line insertion (CTAS 4); patient was admitted under Internal Medicine ⇒ Total number of errors = 1		
44) Prescription did not mention the route or concentration	Incomplete prescription	Latanoprost
36-year-old man presenting with nausea and vomiting, abdominal pain, and diarrhea (CTAS 3); patient was discharged home ⇒ Total number of errors = 1		
45) Prescription not signed by MD	Other: no signature	—
54-year-old woman presenting to the ED because of weakness (CTAS 3); patient was discharged home ⇒ Total number of errors = 1		

Appendix. Continued		
Situation	Type of error	Medication involved
46) Prescription not signed by MD 94-year-old man with cancer presenting with general deterioration (CTAS 3); patient was admitted under Medicine ⇨ Total number of errors = 1	Other: no signature	—
47) Prescription not signed by MD 74-year-old woman complaining of sore throat (CTAS 3); patient was admitted under Family Medicine ⇨ Total number of errors = 1	Other: no signature	—
48) Prescription not signed by MD 90-year-old man complaining of shortness of breath (CTAS 2); patient was discharged home ⇨ Total number of errors = 1	Other: no signature	—
49) Medication not available in hospital 85-year-old man complaining of vomiting (CTAS 3); patient was admitted under Surgery ⇨ Total number of errors = 1	Other: nonformulary medication	Sameterol xinafoate (Serevent Diskus)
50) Medication formulation not available in hospital 74-year-old man with a gait disturbance (CTAS 2); patient was admitted under Family Medicine	Other: nonformulary medication	Levodopa-carbidopa (Levocarb)
51) Medication not available in hospital 81-year-old woman complaining of shortness of breath and cough (CTAS 2); patient was discharged home ⇨ Total number of errors = 1	Other: nonformulary medication	Forza (multivitamins)
52) Patient is already taking ipratropium (Atrovent) 81-year-old man complaining of chest pain (CTAS 2); patient was admitted under Cardiology ⇨ Total number of errors = 1	Other: redundant medication	Tiotropium bromide (Spiriva)
53) Patient is already taking antacid (Maalox) 58-year-old woman complaining of general weakness post diarrhea (CTAS 2); patient was discharged home ⇨ Total number of errors = 1	Other: redundant medication	Antacid (Diovol)
54) Patient is already taking pantoprazole (Pantoloc) 80-year-old woman presenting to the ED with altered mental status × 1 week (CTAS 2); patient was discharged home ⇨ Total number of errors = 1	Other: redundant medication	Omeprazole
55) Patient is already taking dorzolamide-timolol (Cosopt) 71-year-old man sent to the ED by MD office to rule out PE (CTAS 2); patient was admitted to the medical short-stay unit under Medicine ⇨ Total number of errors = 1	Other: redundant medication	Timolol
56) Patient has already been prescribed prednisone 71-year-old man complaining of sore throat (CTAS 3); patient was admitted to the medical short-stay unit under medicine ⇨ Total number of errors = 1	Other: redundant medication	Methylprednisolone
57) Prescription was illegible 86-year-old woman complaining of hip pain (CTAS 4); patient was sent to rehabilitation ⇨ Total number of errors = 1	Other: illegible writing	Vancomycin
58) Prescription was illegible 30-year-old woman complaining of nausea and vomiting (CTAS 3); admitted to the short-stay unit under Medicine ⇨ Total number of errors = 1	Other: illegible writing	Folate
60) Prescription states to decrease drip to 2 units per hour and to stop drip	Other: conflicting orders	Insulin human recombinant (Humulin R)

Appendix. Continued		
Situation	Type of error	Medication involved
65-year-old man complaining of left-sided chest pain and shortness of breath (CTAS 2); patient was admitted under Cardiology ⇒ Total number of errors = 1		
59) Prescription time too early when angiogram was not scheduled yet	Other: medication prescribed at the wrong time	Acetylcysteine (Mucomyst)
67-year-old man complaining of weakness and dizziness (CTAS 3); patient was discharged home ⇒ Total number of errors = 2		
61) 10 mg was prescribed instead of 80 mg	Wrong dose	Telmisartan (Micardis)
62) 10 mg was prescribed instead of 0.5 mg	Wrong dose	Dutasteride (Avodart)
83-year-old man presenting to the ED because of abnormal blood test (CTAS 3); patient was discharged home ⇒ Total number of errors = 2		
63) Wrong dose of medication was prescribed	Wrong dose	Metformin
64) Wrong dose of medication was prescribed	Wrong dose	Dramamine
72-year-old man presenting to the ED with deterioration and confusion, urinary incontinence, and chills (CTAS 3); patient was admitted to the medical short-stay unit under Medicine ⇒ Total number of errors = 2		
65) 1.5 mg was prescribed; medication does not exist in this format	Wrong dose	Olanzapine
66) 1.5 mg was represcribed by another MD; medication does not exist in this format	Wrong dose	Olanzapine
68-year-old man complaining of hematuria (CTAS 3); patient was discharged home ⇒ Total number of errors = 2		
67) 180 mg QD was prescribed instead of 240 mg q.d.	Wrong dose	Diltiazem
68) Prescription did not mention extended release	Wrong drug	Diltiazem ER/CD
88-year-old man presenting to the ED with increased shortness of breath and confusion (CTAS 2); patient was admitted under Internal Medicine ⇒ Total number of errors = 2		
69) Medication was prescribed 120 mg instead of 300 mg	Wrong dose	Diltiazem
70) Prescription did not mention the dose	Incomplete prescription	Tiotropium bromide (Spiriva)
82-year-old man presenting to the ED with sudden onset of shortness of breath (CTAS 2); patient was discharged home ⇒ Total number of errors = 2		
71) 400 mg was prescribed instead of 1,200 mg	Wrong dose	Acetylcysteine (Mucomyst)
72) Medication was prescribed PO instead of IV	Wrong route	Acetylcysteine (Mucomyst)
82-year-old man complaining of pain behind the head, nausea and vomiting (CTAS 3); patient was admitted under Internal Medicine ⇒ Total number of errors = 2		
73) Wrong dose was prescribed	Wrong dose	Amiodarone
74) Prescription did not mention the duration	Incomplete prescription	Amiodarone
79-year-old man sent to the ED for dialysis with increased shortness of breath (CTAS 2); patient was admitted under Family Medicine ⇒ Total number of errors = 2		
75) Medication prescribed q.d.; q.d. is incorrect for renal failure indication	Wrong frequency	Levofloxacin (Levaquin)
76) Prescription did not mention the frequency	Incomplete prescription	Albuterol (Ventolin)
86-year-old man with hyperkalemia who refuses to take his meds (CTAS 3); patient was discharged home ⇒ Total number of errors = 2		
77) Prescription did not mention the dose	Incomplete prescription	Oral iron (Palafer)
78) Prescription did not mention the frequency	Incomplete prescription	Betamethasone
60-year-old woman complaining of left-sided heaviness and weakness (CTAS 2); patient was admitted under Internal Medicine ⇒ Total number of errors = 2		
79) Prescription did not mention the dose	Incomplete prescription	Fluticasone (Flovent)

Appendix. Continued		
Situation	Type of error	Medication involved
80) Both medications were prescribed at the same time  61-year-old man presenting to the ED with loss of consciousness and hypotension (CTAS 2); patient was discharged home ⇒ Total number of errors = 3	Other: redundant medication	Pantoprazole (Pantoloc)/esomeprazole (Nexium)
81) Wrong dose was prescribed	Wrong dose	Entacapone (Comtan)
82) Wrong dose was prescribed	Wrong dose	Carbidopa-levodopa (Sinemet)
83) Medication was prescribed q.d. instead of q.4h.	Wrong frequency	Entacapone (Comtan)
79-year-old woman not responding to stimulus since the day before, was brought to the ED (CTAS 1); patient was admitted under Internal Medicine ⇒ Total number of errors = 3		
84) Medication does not exist in the prescribed format	Wrong dose	Bupropion (Zyban)
85) Timentin was prescribed despite a documented allergy to penicillin	Wrong drug	Ticarcillin-clavulanate (Timentin)
86) Timentin was prescribed despite a documented allergy to penicillin (different prescription)	Wrong drug	Ticarcillin-clavulanate (Timentin)
77-year-old man complaining of shortness of breath and weakness (CTAS 3); patient was admitted to the medical short-stay unit under Medicine ⇒ Total number of errors = 3		
87) Medication was spelled incorrectly	Wrong drug	Pilocarpine (Isopto Carpine)
88) Medication was prescribed b.i.d. instead of t.i.d.	Wrong frequency	Pilocarpine (Isopto Carpine)
89) Medication was prescribed T.i.d. instead of b.i.d.	Wrong frequency	Dorzolamide (Cosopt)
74-year-old woman presenting with right hip pain (CTAS 3); patient was discharged home ⇒ Total number of errors = 3		
90) Septra was prescribed instead of Septra DS	Wrong drug	Trimethoprim-sulfamethoxazole (Septra)
91) Medication prescribed t.i.d. instead of q.am	Wrong frequency	Celecoxib (Celebrex)
92) Patient is on medication but omitted from prescription	Incomplete prescription	Calcium + vitamin D (Carbocal D)
71-year-old woman sent to the ED by MD office for psychiatric evaluation (CTAS 3); patient was admitted under Psychiatry ⇒ Total number of errors = 3		
93) Medication was prescribed q.h.s. instead of q.i.d.	Wrong frequency	Sertraline
94) Prescription did not mention the route or frequency	Incomplete prescription	Propranolol
95) Prescription did not mention the route or frequency	Incomplete prescription	Novofurantoïn
42-year-old woman sent to the ED by MD office for psychiatric evaluation (CTAS = N/A); patient was discharged home ⇒ Total number of errors = 4		
96) 225 mg was prescribed instead of 262.5 mg	Wrong dose	Venlafaxine (Effexor XR)
97) 375 mg was prescribed instead of 250 mg	Wrong dose	Divalproex sodium (Epival)
98) Pravastatin was prescribed in ED, but patient is on fenofibrate (Lipidil) and not Pravastatin	Wrong drug	Pravastatin
99) Prescription did not mention the route	Incomplete prescription	Gabapentin

CD = ; CTAS = Canadian Triage and Acuity Scale; ED = emergency department; IV = intravenous; LMWH = low-molecular-weight heparin; LOC = loss of consciousness; MD = physician; MR = modified release; PE = pulmonary embolism; PICC = peripherally inserted central catheter; PO = oral; XR = extended release.