Characterization of Errors Detected During Central Order Review

Lenora Ho, Glen R. Brown and Bruce Millin

ABSTRACT

Characterization of prescribing errors detected by dispensary pharmacists in a tertiary-care teaching hospital is described. During the 25 week study period, 1330 prescribing errors were identified from a total of 237,798 medication orders processed by the pharmacy, representing a rate of 5.6 errors per 1000 orders. Resident physicians wrote more errant medication orders than any other physician class. Errors most often occurred on the general medicine teaching wards. The most common drug classes implicated were non-formulary medications and antibiotics. Approximately 11% of errors were defined as potentially fatal or severe (Type A) errors, 7% were potentially serious (Type B), 21% were potentially significant (Type C) and 61% were problem orders (Type D) based on a classification system of severity. The most common error types were inappropriate dosing of antibiotics and the prescribing of medications for patients who had a potential conflicting allergy history. The acceptance of pharmacists' suggestions was 67%. The study identified three major areas where future educational and corrective measures could be aimed: adherence to the formulary, antibiotic prescribing and allergy validation.

Key Words: *dispensary, interventions, prescribing errors*

RÉSUMÉ

Suit une analyse descriptive des erreurs de prescription décelées par les pharmaciens du dispensaire d'un hôpital universitaire de soins tertiaires. Au cours des 25 semaines qu'a durée l'étude, on a relevé 1 330 erreurs de prescription sur les 237 798 ordonnances traitées, soit un taux de 5,6 erreurs pour 1 000 ordonnances. Les médecins résidents font plus d'erreurs que leurs collègues. Les erreurs surviennent le plus fréquemment dans les services où l'on enseigne la médecine générale. Les médicaments les plus couramment concernés sont les médicaments ne faisant pas partie du formulaire et les antibiotiques. Environ 11 % des erreurs peuvent être qualifiées de potentiellement fatales ou graves (type A), 7 % de potentiellement graves (type B), 21 % de potentiellement dangereuses (type C) et 61 % de problématiques (type D), conformément au système de classification des erreurs selon leur gravité retenu. Les erreurs les plus courantes consistent en posologies inappropriées d'antibiotiques et en prescriptions de médicaments à des malades qui peuvent y être allergiques. Dans 67 % des cas, le médecin a accepté la suggestion du pharmacien. L'étude a identifié trois secteurs majeurs où il faudrait prendre des mesures correctrices ou procéder à une sensibilisation: le respect du formulaire, la prescription des antibiotiques et la vérification des allergies.

Mots clés: *dispensaire, interventions, erreurs de prescription*

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Lenora Ho, B.Sc.(Pharm) is a Pharmacy Resident, Pharmacy Department, St. Paul's Hospital, Vancouver, B.C.
Glen R. Brown, Pharm.D. is the Satellite Manager, Pharmacy Department, St. Paul's Hospital, Vancouver, B.C.
Bruce Millin, B.Sc.(Pharm.) is the Staffing Manager, Pharmacy Department, St. Paul's Hospital, Vancouver, B.C.
Address correspondence to: Glen R. Brown, Pharm.D., Pharmacy Department, St. Paul's Hospital, 1081 Burrard Street, Vancouver, B.C. V6Z 1Y6.

INTRODUCTION

Prescribing errors have been recognized as a contributor to patient illness.[1-6] Errors with the potential for causing patient morbidity can be broadly classified as therapeutic errors or communication errors. Therapeutic errors involve the prescribing of drug therapy with potential for toxicity as a result of the pharmacology, pharmacokinetics or pharmaceutics of the single or combination drug regimens in the individual patient. Communication errors involve ambiguity or incorrect interpretation by health care professionals or the patient of the physician's intent for the prescribed drug therapy. The pharmacist's responsibility in providing pharmaceutical care to the patient includes identifying, preventing and resolving potential and actual drug-related problems.[7] Thus, the identification and resolution of both therapeutic and communication prescribing errors is a component of pharmacy services provided to hospitalized patients. Efforts targeted at correcting prescribing practice deficiencies require knowledge of the number, frequency, origin and outcome of the errors.

To determine these characteristics, a review of the errors detected by dispensary pharmacists was proposed. The Pharmacy department provided a centralized drug distribution system which received drug orders from all areas of inpatient care. There were seven rotating ward-based pharmacists providing clinical pharmacy services five days per week. Each ward

pharmacist was responsible for providing clinical services to approximately three wards with a total capacity of approximately 80 beds. The scope of clinical services did not allow all prescriptions to be pre-screened by the ward pharmacist before being sent to the dispensary. Therefore, errors were still detected and corrected by dispensary personnel, despite the efforts of the ward-based pharmacist. The purpose of this study was to characterize the number, frequency, origin and outcome of prescription errors detected by dispensary personnel.

METHODS

The hospital was a 580-bed tertiary care teaching hospital with a centralized pharmacy department which provided 24-hour on site dispensary service to all areas of inpatient care. The dispensary utilized a traditional distribution system, supplemented with a selected wardstock system. Copies of all physicians' orders were received by the dispensary, where drug orders were evaluated for appropriateness by pharmacists. All drug orders were maintained on a computerized medication profile for all patients and were available to the pharmacist at time of evaluation of any single drug order.

Any drug order that contained a parameter that was written incorrectly or incompletely, or requested the commencement of potentially detrimental therapy as judged by the pharmacist, was discussed with the prescriber for clarification and possible correction. It was an established practice in the pharmacy for dispensary pharmacists to identify and file separately all physician order sheets containing orders that required contacting a physician for clarification. For retrospective quality assurance assessment, all such orders were marked with a standard form preprinted on an adhesive sticker. The pharmacist documented: the name of the physician contacted, time of contact, order in question, suggested solution, physician response, type of health care professional documenting the change (if any) in the patient's chart and the pharmacist's identification. Orders with problems that could be resolved through clarification with nursing personnel without physician involvement were also marked, but these orders were not included in this evaluation. When the nurse volunteered to accept responsibility for clarification of the problem with the physician, the order was included for evaluation. Orders clarified through referral to a ward pharmacist were included and categorized as such.

Characteristics of each order recorded for this evaluation included: physician classification, error classification, intervention outcome, drug involved and location (ward) of the patient. Physician classification was defined as: staff, resident (regardless of year in residency), intern and medical student intern (equivalent to a Clinical Clerk). Prescribing errors were classified according to the potential risk to patient well-being if dispensed as written[1,4,5,6] (Appendix A). Intervention outcome was defined as: accepted, rejected, referred or other. Accepted outcome indicated that the pharmacist's suggested corrective action was executed by the physician. Rejected outcome indicated that the pharmacist's suggested solution was not executed by the physician. Referred outcome indicated that the problem was delegated to the ward pharmacist for resolution. Outcomes recorded as "other" represented problems that were unresolved by pharmacy personnel. Drugs were classified using the American Hospital Formulary System catalogue numbers.[8]

Data were collected on a daily basis seven days a week, from August 27, 1990 to February 28, 1991. An estimate of the portion of drug orders originating from each ward was obtained from a complete count of all orders on eight arbitrarily selected days (two from each month) during the collection period. The total number of orders processed by the Pharmacy during the collection period was determined by the Pharmacy computer record utilized to establish all patient medication profiles.

RESULTS

A total of 1330 prescribing errors were detected by the dispensary pharmacists during the 25 week collection period. A rate of 5.6 errors per 1000 orders was calculated from the total of 237,798 orders processed during the collection period. Resident physicians were involved with the most errors (36%, 479/1330), while interns (27%, 355/1330), staff physicians (26%, 350/1330) and medical student interns (11%, 146/1330) wrote a lower number of erroneous orders.

Prescribing errors were classified according to potential for harm and the results are shown in Table I.

Potentially fatal or severe errors (Type A) accounted for 11% of the total. In nearly all cases (98%) the orders were for patients with an allergic history, as documented in the patients' admission information, to the prescribed drugs, or involved ordering a penicillin or cephalosporin when the allergy history was unknown to the pharmacy.

Potentially serious (Type B) errors comprised approximately 7% of the total. The majority of these errors involved the prescribing of a medication with a contraindication to use in the diagnosis (51%). Examples include the prescribing

Table I: Errors by potential for harm

Type A	Severe or potentially fatal error	# Errors (N=152)
A1	10 x normal dose, narrow therapeutic index drugs	1
A2	Other severe/fatal overdose	2
A3	Drug Allergy	149
A4	Underdosing life-threatening illness/condition	0

Type B	Potentially serious error	# Errors (N=92)
B1	4-10 x normal dose, narrow therapeutic index drugs	1
B2	Other severe/toxic dose	14
B3	Underdosing serious illness	16
B4	Wrong parameter with serious consequence	10
B5	Contraindicated in diagnosis	47
B6	Inappropriate combination therapy	4

Type C	Potentially significant error	# Errors (N=276)
C1	1.5-4 x normal dose, narrow therapeutic index drugs	3
C2	Inappropriate dose, route, etc.	194
C3	Contraindication in non-serious illness	27
C4	Underdosing non-serious illness	20
C5	Drug interaction/reaction possible	10
C6	Inappropriate combination therapy	22

Type D	Problem Orders	# Errors (N=809)
D1	Illegible	80
D2	Omission	224
D3	Incorrect parameter	151
D4	Non-formulary	262
D5	Hospital policy violation	92

of a medication for intramuscular administration in a patient on oral anticoagulants.

Potentially significant (Type C) errors accounted for 21% of the total. The most frequent type was inappropriate ordering (70%) such as prescribing of unsuitable schedules for narrow therapeutic index drugs or inappropriate dosing of any drug.

Problem orders (Type D) accounted for 61% of all prescription errors. Within this group, approximately 10% were illegible or ambiguous, 28% omitted a parameter such as drug strength or direction, 19% contained incorrect parameters that had no toxic potential but still prevented the order from being dispensed and 44% were miscellaneous such as unauthorized prescribing of a restricted or non-formulary drug.

The acceptance rate of the pharmacists' recommendations for corrective action was approximately 67% (891/1330). Rejection of the recommendation occurred in approximately 15% (200/1330) of the problems. Problems referred to ward pharmacists for clarification accounted for approximately 11% (144/1330) and were not evaluated for acceptance since this did not reflect the direct activities of the dispensary pharmacists. Approximately 7% (95/1330) were either unresolved or resolved through a health professional other than a pharmacist. Orders were recorded as unresolved if a patient was discharged from the hospital before a physician could be contacted, if the physician changed the order without pharmacists' input or if the responsibility for clarifying the problem with the physician was transferred to a nurse. The physicians accepted the pharmacists' suggestions for 71% (572/809) of Type D, 63% (174/276) of Type C, 76% (70/92) of Type B, and only 49% (75/152) of Type A errors.

The drug group associated with the largest percentage of the errors were the antibiotics at 24% (Table II). Other groups associated with large percentages were central nervous system drugs (mostly analgesics) at 9%, cardiovascular medications at 8% and non-formulary drugs at 20%.

The highest percentage of the errors originated with patients on the general medicine teaching wards (100 beds) which collectively accounted for 26% (349/1330) of all errors. Large percentages were observed on surgical units (100 beds) with 20% (271/

Table II: Errors by drug group

Drug Class	No. Errors
Antihistamines	2
Antibiotics	315
Antineoplastics	7
Autonomics	16
Sympatholytics	17
Hematological agents	21
Cardiovascular agents	110
CNS agents	121
Antiepileptics	24
Psychotropics	45
Diagnostic agents	4
Electrolyte replacement	84
Enzymes	3
Expectorants	3
Ear, nose, throat preparations	27
Gastrointestinal agents	86
Hormones	36
Insulins	34
Local anesthetics	4
Theophylline	10
Immunological agents	6
Topical	28
Vitamins	34
Miscellaneous	30
Non-formulary	262

1330), coronary care unit with 6% (78/1330), and emergency unit with 5% (70/1330).

The error rate (per thousand orders) was calculated for each ward based on the total number of orders for the collection period of 237,798 and the distribution of origin of orders recorded on the eight audit days within the collection period (Table III). The Emergency Room, the Medical Teaching Wards, and the Surgical Wards were associated with the highest error rate. The Critical Care Complex (Intensive Care Unit, Critical Care Recovery, and Post-anesthesia Recovery) and the Psychiatry Wards were associated with the lowest rates of error.

Table III: Error rate per treatment area

Area	Error rate (per 1000 orders)
Emergency/Day Clinics	11.4
Medical Teaching Wards	8.7
Surgical Wards	8.0
Renal Ward	6.6
Geriatric/Rehabilitation Ward	5.7
Palliative Care Ward	5.2
Orthopedic Ward	5.2
Neurology	4.2
Obstetric/Delivery/Nursery Wards	4.0
Critical Care (Intensive Care/Post-Surgery)	3.7
Cardiology	3.6
Psychiatry	2.0
Other	4.6
Overall	5.6

DISCUSSION

The observed error rate of 5.6 errors per 1000 orders was consistent with previously published findings of 3-19 errors per 1000 orders.[2,4] The results indentifed problem order characteristics that need to be targeted with education or corrective action to reduce the error rate. Resident physicians were associated with the most errors. This study did not record the year of the residency training of the prescribers so no evaluation of error rates with increasing residency training was possible. Despite previously published reports of error rates decreasing with increased experience,[4] the large volume of prescribing by resident physicians within our institution was presumed to be the cause of the increased error rate. The resident physician should be targeted with any program to improve prescribing.

The five most common causes of prescribing errors in decreasing order were: prescribing of non-formulary medications (D4), an omission in the drug order (D2), inappropriate dose, route, etc. (C2), titration of dose with an incorrect parameter (D3) and the presence of an allergy to the prescribed drug (A3). Each one of these errors requires a different method for resolution. The use of non-formulary medications requires educating prescribers to the drugs available on the hospital formulary and guidance in the selection of formulary alternatives. This can be facilitated through the regular publication of the formulary in an easy-to-use format such as a pocket-sized book and promotion of its use to the house staff.[9] Efforts to reduce the number of omissions in the prescription should focus on educating the medical staff on the information required for successful execution of the prescribed therapy.[10] This involves an understanding of the need to indicate concentration and rate of administration of parenteral medications and the frequency of administration of medications prescribed as required for a symptom. Correction of physician errors in selecting the dose, route, strength and titration parameters requires improving the physicians' knowledge of drug therapy. The large number of medications required in any medical practice does not allow a complete knowledge of the use of all medications.

Pharmacy Departments must promote pharmacists as a resource for drug information and dosage selection. Efforts to increase the availability and visibility of pharmacists in patient care areas should increase the frequency of consultation before erroneous orders are written. We have seen such positive developments at our institution with our ward-based pharmacists. During the data collection period for this study, the ward pharmacists made approximately 8,000 recommendations regarding drug therapy, of which approximately 87% were solicited by other health care professionals (Unpublished data). The high acceptance rate of the pharmacists' suggestions for corrective action demonstrated the value of the pharmacists' knowledge in selecting suitable drug treatment regimens. Physicians must be encouraged to consult with a pharmacist pro-actively to minimize the potential for error in prescribing and to reduce the need for reactive interventions by pharmacists.

There are multiple causes of prescribing errors in relation to the patient's allergy. Our Pharmacy and Therapeutics Committee had established that no penicillin or cephalosporin antibiotic could be dispensed by the Pharmacy before the physician indicated the patient's risk of allergic reaction to the antibiotic. To minimize the number of patients whose allergy status was unknown, a system of documenting all medication allergies upon admission was re-

quired.[11] The validity of the history should also be confirmed since many reported allergies are manifestations of side effects of the medications.[12,13] We have recently found that approximately 25% of allergy labels can be removed through questioning by a pharmacist (Unpublished data). The low acceptance rate of pharmacists' suggestions for alternative therapy in this group of problem orders suggested that physicians often reject the validity of the allergy history. These interventions could be prevented by completing a thorough allergy history upon admission to the hospital with only valid allergic reactions reported in the patients' medical records.

The characteristics of the prescribing errors identified in this report may be applicable to other teaching institutions. The problem areas identified should direct educational and corrective programs to reduce problem orders and their potential for detriment to the patient and strain on pharmacy resources.

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Appendix A

CLASSIFICATION OF ERRORS

Type A: Potentially fatal or severe
- A1. 10 fold increase above normal dosage of narrow therapeutic index drugs.
- A2. Dose of a drug theoretically resulting in either serum levels or other mechanisms associated with severe/fatal toxic reactions.
- A3. Drug ordered for a patient with a documented allergy to that drug or the prescribing of a penicillin or cephalosporin in a patient with unavailable allergy history.
- A4. Underdosing life-threatening illnesses/conditions.

Type B: Potentially serious
- B1. 4-10 fold increase above normal dosage of narrow therapeutic index drugs.
- B2. Dose of a drug theoretically resulting in either serum levels or other mechanisms associated with serious, toxic reactions.
- B3. Underdosing serious illnesses.
- B4. Ordering a medication by incorrect name, in the wrong dosage form, with the wrong strength or concentration or to the wrong patient.
- B5. Ordering a medication leading to the establishment of an inappropriate therapeutic regimen, or has a contraindication to use in the diagnosis.
- B6. Inappropriate combination therapy with drugs of the same pharmacological effect, leading to serious toxic reactions.

Type C: Potentially significant
- C1. 1.5-4 fold increase above normal dosage of narrow therapeutic index drugs.
- C2. Ordering a medication with an inappropriate dose, dosing schedule, dosage form, route of administration or treatment duration.
- C3. Ordering a medication with a wrong indication for use in non-serious illnesses and/or with potential side effects resulting.
- C4. Subtherapeutic dose for non-serious illness.
- C5. Ordering a medication that could possibly elicit a known drug interaction or reaction without appropriate precautions.
- C6. Duplicate or unnecessary combination therapy with potential toxic additive effects.

Type D: Problem orders.
- D1. Ordering a medication in an illegible or incorrect manner (e.g. misspelling) or ambiguous directions.
- D2. Omission from an order of drug name, strength, concentration, dose, dosage schedule or route of administration.
- D3. Incorrect ordering of parameters in (2), but without toxic potential.
- D4. Non-formulary medication order.
- D5. Miscellaneous/non-compliance with hospital policy.