Outpatient Prescribing Errors and the Impact of Computerized Prescribing

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BACKGROUND: Medication errors are common among inpatients and many are preventable with computerized prescribing. Relatively little is known about outpatient prescribing errors or the impact of computerized prescribing in this setting.

OBJECTIVE: To assess the rates, types, and severity of outpatient prescribing errors and understand the potential impact of computerized prescribing.

DESIGN: Prospective cohort study in 4 adult primary care practices in Boston using prescription review, patient survey, and chart review to identify medication errors, potential adverse drug events (ADEs) and preventable ADEs.

PARTICIPANTS: Outpatients over age 18 who received a prescription from 24 participating physicians.

RESULTS: We screened 1879 prescriptions from 1202 patients, and completed 661 surveys (response rate 55%). Of the prescriptions, 143 (7.6%; 95% confidence interval (CI) 6.4% to 8.8%) contained a prescribing error. Three errors led to preventable ADEs and 62 (43%; 3% of all prescriptions) had potential for patient injury (potential ADEs); 1 was potentially life-threatening (2%) and 15 were serious (24%). Errors in frequency (n=77, 54%) and dose (n=26, 18%) were common. The rates of medication errors and potential ADEs were not significantly different at basic computerized prescribing sites (4.3% vs 11.0%, P=.31; 2.6% vs 4.0%, P=.16) compared to handwritten sites. Advanced checks (including dose and frequency checking) could have prevented 95% of potential ADEs.

CONCLUSIONS: Prescribing errors occurred in 7.6% of outpatient prescriptions and many could have harmed patients. Basic computerized prescribing systems may not be adequate to reduce errors. More advanced systems with dose and frequency checking are likely needed to prevent potentially harmful errors.

KEY WORDS: medication error; electronic prescribing; ambulatory care.
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Medication errors are common in acute care hospitals, and are defined as any error in the medication process (ordering, transcribing, dispensing, administering, and monitoring). Inpatient medication ordering errors occur at rates as high as 1.5–5.3 per 100 orders, or 1.4 errors per admission.[1,2] In contrast, relatively few data are available regarding the frequency and impact of outpatient medication errors, since identification is difficult. Copies of prescriptions are not readily available for review and patients often fill prescriptions at multiple pharmacies. In addition, medication use is not well monitored because patients obtain and administer their own medications.

Studies have shown that 15% to 21% of prescriptions contain at least 1 prescribing error.[3,4] Other studies show that pharmacists need to clarify prescriptions in 1% to 5% of prescriptions.[5–7] In a recent survey, 16% of patients reported a medication error and two-thirds of cases were in outpatients.[8] In another study we performed, 11% of adverse drug events (ADEs) were due to medication errors.[9] Most of these studies describe rates of errors and error types, but do not describe the medications involved or the severity and impact of the errors.

Understanding the rate and type of outpatient medication errors is important for assessing the potential impact of safety strategies such as computerized prescribing. Among inpatients, computerized prescribing reduced the medication error rate by more than 80%.[10,11] The benefits in the outpatient setting are unknown, although many systems are currently being advocated, including electronic medical records and handheld prescribing devices.[12,13] As decisions about computerized prescribing are made, a better understanding of the relative benefit of basic systems (that improve legibility and completeness) versus more advanced systems (with decision support such as drug-dose, drug-allergy, and drug-interaction checking) is needed. Therefore, we performed a study with 2 primary goals: 1) To determine the rate, types, and severity of prescribing errors; and 2) To assess the impact of basic versus advanced computerized prescribing on these errors.

METHODS

Sites

The methods for this study are partially described in a previous article.[9] We studied 4 Boston adult primary care practices affiliated with an academic medical center. Two practices were hospital-based, and 2 practices were community-based: one of each type of practice used basic computerized prescribing and one of each type used handwritten prescriptions. The basic computerized systems (1 commercial, 1 home-grown) provided printed prescriptions and required fields (drug, dose, quantity, and duration), and offered nonmandatory default doses. The systems provided no automatic checks for correct doses, frequencies, allergies, or drug interactions. Data were collected between September 1999 and March 2000, following Institutional Review Board approval.

The authors have no conflicts of interest to report.

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Physician Participants

All physicians at 3 of the sites (6 physicians at each of the 2 sites and 5 at the third) participated in the study; 6 of 27 physicians at the fourth site were randomly selected to participate and agreed to do so. They were not blinded to the study purpose. Once the study began, a seventh physician was added at the fourth site to augment the total number of patients. All physicians were board-certified internists with a mean age range from 39 to 46.

Patients

Patients older than 18 years who were patients of participating physicians and received a prescription from this physician during an office visit (index visit) were enrolled once within the study period (4 weeks per site). Patients were excluded prior to enrollment if their physicians thought they were too ill, hearing-impaired, or unable to speak English or Russian.

Data Collection

Prescription Classification and Review. Copies of all prescriptions written by participating physicians were collected daily from each site for a 4-week period. At handwritten sites, carbon copies were obtained using pre-printed prescription pads. At computerized sites, duplicate copies were printed. A pharmacist then screened up to 3 prescriptions at random (new prescriptions preferentially over refills) per patient to identify possible prescribing errors. Errors with potential for serious harm were reported to the prescribing physician.

Patient Surveys and Chart Reviews. One day after the index visit, we sent a letter to patients explaining the study as a project to improve how medications are prescribed and soliciting telephone survey participation. Patients could decline by postcard or when telephoned. Ten to 14 days after the index visit we surveyed consenting patients about medication-related symptoms, timing, and actions taken. We also asked patients to read all their prescription bottle labels to determine prevalence of medication use. Three months later, we re-surveyed participants about symptoms and general health and a nurse examined the medical record to identify ADEs documented during that 3-month interval and to record allergies and medical conditions.

Event Definitions

A medication error was defined as any error that occurred in the medication use process (including ordering/prescribing, dispensing, adherence, and monitoring).[1] Prescribing errors were the subset of these errors related to prescribing, and the focus of this study. Medication errors that caused an injury were called preventable ADEs. Medication errors that had potential to cause injury were called potential ADEs.

Rule violations were failures to follow strict prescribing rules that were generally not confusing and generated no additional work for a pharmacist (such as failing to write "po" on prescriptions for drugs only taken orally). Because of low risk and lack of consensus that rule violations warrant practice changes, rule violations were not counted as errors.

Event Review and Classification

If a study pharmacist discovered a possible error on prescription review, 2 physicians independently reviewed the prescription (with survey and chart review information and drug toxicity references), judged whether an error had occurred, and classified as an error without potential for harm, a potential ADE, or a rule violation. Both reviewers rated the severity of potential ADEs as fatal or life threatening (e.g., respiratory failure, anaphylaxis), serious (e.g., gastrointestinal bleed or altered mental status), or significant (e.g., rash or diarrhea)[14] and determined whether the error could have been prevented with various types of computerized decision support (e.g., drug–drug interaction checking, drug-dose checking).

The study pharmacist also screened patient surveys and chart reviews for evidence of medication-related injuries. These incidents were reviewed independently by 2 physicians, who determined whether an ADE and classified severity and preventability.[9] Interrater agreement for the presence of medication errors and ADEs was high ($\kappa = 0.92$; 95% confidence interval (CI): 0.88–0.96 and $\kappa = 0.89$; 95% CI: 0.79 to 0.99 respectively).

Statistical Analyses

We compared prescribing error and potential ADE rates between computerized and noncomputerized sites. Comparisons among continuous data variables are presented as means ± standard errors, and *P* values were calculated with a Student's *t*-test. Correlations were calculated using the Spearman technique. Categorical data are presented as counts with percentages, and *P* values were calculated using a mixed effect model with random physician effect to test the computerized prescribing effect.

Because certain types of medications are prescribed more frequently than others, we also calculated prescribing error and potential ADE rates based on patient-reported prevalence of use. On the patient survey, patients were asked to list all of the medications they were taking. The number of prescriptions written within each drug class (e.g., antidepressants) was counted to determine prevalence of use. We then calculated prescribing error rates and potential ADE rates for each drug class, using the number of prescriptions written within that drug class as the denominator.

All analyses were conducted using SAS (SAS Institute, Cary, NC) and Microsoft Excel.

RESULTS

Response Rates

A total of 1879 prescriptions for 1202 patients were reviewed. Of these, 542 (29%) were found to have possible prescribing errors or rule violations and were presented to the physician panel (Table 1). Of the 1202 patients whose prescriptions were collected, 661 (55%) completed the 2-week survey and 600 (50%) completed the 3-month survey. The 541 nonparticipants included 168 who declined to participate when contacted by telephone, 139 who opted-out by postcard, 205 who could not be contacted, 24 who had language or hearing problems, and 5 with other reasons for not participating. Chart reviews were completed for 653 of 661 (99%) patients. Of study participants,

Table 1. Response Rates

	Number of Patients with Prescriptions Collected	Total Number of Prescriptions Collected	Average Number of Prescriptions per Patient*	Number of Patients with 2-Week Surveys (% of Patients with Prescriptions Collected)	Number of Patients with 3-Month Surveys (% of Patients with Prescriptions Collected)	Number of Prescriptions Screened by Pharmacist† (% of total)	Number of Prescriptions Reviewed by Physicians (% of Screened)
Site 1	267	667	2.5	150 (56)	132 (49)	486 (73)	153 (31)
Site 2	314	551	1.8	165 (53)	158 (50)	508 (92)	135 (27)
Site 3	342	458	1.3	196 (57)	169 (49)	453 (99)	93 (21)
Site 4	279	467	1.7	150 (54)	141 (51)	432 (93)	161 (37)
Total	1202	2143	1.8	661 (55)	600 (50)	1879 (88)	542 (29)

*This rate is based only on patients who received at least 1 prescription.
†Maximum 3 prescriptions screened per patient.

65% were women, the mean age was 52 years, 92% spoke English as a primary language, and 81% were white.

Types of Prescribing Errors

Of 1879 prescriptions reviewed, 143 (7.6%; 95% CI 6.4% to 8.8%) contained a prescribing error. Of these, 62 (43%) represented potential ADEs, 3 led to preventable ADEs, and 78 (55%) were errors with no potential for harm. The most frequent errors were incorrect or missing dose (n=77, 54%) or frequency (n=26, 18%; Table 2). Rule violations accounted for 203 additional events, and the most frequent type was missing route (i.e., failure to write "po") (n=193, 95%). In total, 19% of prescriptions contained either a prescribing error or rule violation.

Potential ADEs

Among 143 prescribing errors, 62 (43%; 3.3% of all prescriptions, 95% CI 2.5% to 4.1%) were classified as potential ADEs. In this subset, the most frequent types of errors were dose (n=23, 37%) and frequency (n=17, 27%) (Table 2).

Of the 62 potential ADEs, 1 was life-threatening (2%) and 15 were serious (24%). The life-threatening and serious potential ADEs are described in the Appendix (available online). Examples of serious potential ADEs included an excessive dose of naproxen ("500 mg po tid" when the maximum daily dose is 1375 mg), an incorrect duration of antibiotic treatment (a 3-day rather than 5-day course of azithromycin for a respiratory infection), and an excessive dose of verapamil (the physician wrote 1 tablet instead of the intended 1/2 tablet).

High-Risk Medications

The classes of medications most commonly involved in the 143 prescribing errors were antibiotics (n=31, 22%), nonsteroidal anti-inflammatories (n=10, 7%), narcotic analgesics (n=9, 6%), corticosteroids (n=8, 6%), and antidepressants (n=8, 6%). The same classes of medications were also most commonly involved in the subset of 62 potential ADEs: antibiotics (n=11, 18%), nonsteroidal anti-inflammatories (n=8, 13%), and narcotic analgesics (n=7, 11%).

The medications with the highest adjusted prescribing error rates based on prevalence of use were antibiotics (25%), narcotics (18%), and nonsteroidal anti-inflammatories (11%). The medications with the highest adjusted rates of potential ADEs based on prevalence of use were narcotics (14%), antibiotics (9%), and nonsteroidal anti-inflammatories (9%).

Table 2. Most Common Types of Prescribing Errors

Type of Error	Prescribing Errors (n=143)	Subset of Potential Adverse Drug Events (n=62)
Dose	77 (54%)	23 (37%)
Frequency	26 (18%)	17 (27%)
Route	19 (13%)	4 (6%)

Prescribing Errors and Computerized Prescribing

Prescriptions from basic computerized sites did not contain significantly fewer prescribing errors (4.3% vs 11.0%, P=.31; Table 3). Potential ADE rates were also not significantly different (2.6% vs 4.0%, P=0.16; Table 3). Physician reviewers judged that advanced computerized prescribing with decision support (such as drug-dose checking and drug-frequency checking) could have prevented 138 of 143 (97%) prescribing errors (Table 4) and 59 of 62 (95%) potential ADEs. The majority could have been prevented by a system requiring complete prescriptions and providing mandatory default dose and frequency lists (Table 4).

Preventable ADEs

Of the 143 prescribing errors (in 113 patients), 87 involved 71 patients who had completed a patient survey and chart review. In this group, 3 (4%) patients experienced preventable ADEs, all of which were rated as significant. One patient developed abdominal discomfort from an excessive dose of hydrocodone/acetaminophen (5/500 tabs; prescribed 12 tabs per day when recommended maximum is 8 tabs/day), a second patient developed abdominal discomfort from naproxen when he received a prescription intended for another patient, and a third patient developed abdominal discomfort from naproxen prescribed at a higher than recommended frequency (500 mg 3 times a day).

Table 3. Impact of Computerized Versus Paper Prescribing on Prescribing Errors

	Computerized Sites (# prescriptions Reviewed=939)	Handwritten Sites (# prescriptions Reviewed=940)	P Value
Prescribing errors	40 (4.3%)	103 (11.0%)	.31
Potential ADEs	24 (2.6%)	38 (4.0%)	.16
Rule violations	89 (9.5%)	114 (12.1%)	.47

ADE, adverse drug event.

Table 4. Medication Prescribing Errors Preventable with Advanced Computerized Prescribing

	Prescribing Errors (% of Total)	Prescribing Errors in Handwritten Sites (% of Total)	Prescribing Errors in Basic Computerized Sites (% of Total)	Potential ADEs (% of Total)	Potential ADEs In Handwritten Sites (% of Total)	Potential ADEs In Basic Computerized Sites (% of Total)
Total	143	103	40	62	38	24
Preventable with advanced computerized prescribing (overall)	138 (97)	102 (99)	36 (90)	59 (95)	38 (100)	21 (88)
Requiring complete prescriptions	49 (34)	38 (37)	11 (28)	16 (26)	10 (26)	6 (25)
Default dose list	36 (25)	33 (32)	3 (7)	10 (16)	9 (24)	1 (4)
Default frequency list	25 (17)	13 (13)	12 (30)	18 (29)	11 (29)	7 (29)
Drug-interaction checking	4 (3)	0	4 (10)	3 (5)	0	3 (12)
Other	24 (17)	18 (17)	6 (15)	12 (19)	8 (21)	4 (17)

ADE, adverse drug event.

DISCUSSION

In this study of 4 adult primary care practices, we found prescribing errors in about 1 of 13 prescriptions and nearly half of these errors had potential for harm. Certain classes of medications, such as antibiotics and nonsteroidal anti-inflammatory agents, were commonly implicated in prescribing errors. Basic computerized prescribing was not associated with a reduced rate of prescribing errors or potential ADEs. However, these rates could have been substantially reduced with more advanced decision support such as dose and frequency checking.

Our medication prescribing error rate of 7.6 per 100 prescriptions is substantially higher than inpatient rates of 0.4 to 5 per 100 orders found in studies using similar detection methods.[1] This difference may arise in part because outpatient prescriptions typically include more parameters (e.g., number to be dispensed, number of refills) and outpatient providers may work under more intense time pressure. Almost half of prescribing errors in this study were judged to have the potential for injury. This proportion is substantially higher than in the inpatient setting where estimates of medication errors classified as potential ADEs have ranged from 7% to 33%.[1,15] The potential for injury may be greater because this study focuses on prescribing errors whereas inpatient studies typically include transcribing, dispensing and administration errors that may be common but less serious (e.g., missing dose errors). The difference also may reflect the lack of resources (feedback from pharmacists) and lack of easy patient monitoring in the outpatient setting. Moreover, since more classes and brands of drugs are available in ambulatory care, providers may be less familiar with correct prescribing parameters.

Fewer outpatient potential ADEs were rated life-threatening or serious compared with an inpatient study (26% vs 55%).[14] However, because of the high rate of potential ADEs in the outpatient setting (3% of all prescriptions), the percentage of prescriptions with serious potential ADEs is higher (8 per 1000 prescription). Since 3 billion prescriptions are written annually in the U.S.,[16] this extrapolates to 24 million serious potential events in the U.S., if this rate is generalizable. Finally, 4% of patients with prescribing errors experienced a preventable ADE. Although a small number of prescriptions led to actual harm, the large number of prescriptions that have potential to cause serious harm clearly indicates that new error prevention strategies must be introduced into the current prescribing process.

Dose and frequency errors occurred often, paralleling the inpatient experience.[1] Certain medication classes were more likely to be involved, in particular antibiotics, narcotics, and nonsteroidal anti-inflammatory medications, likely because they are also commonly prescribed. Thus, these medications are good targets for improved prescribing decision support or physician education about appropriate prescribing. Although half of prescribing errors had no potential for harm, these too reveal systems failures. The same defect that leads to an error without injury because the drug has a broad therapeutic window (e.g., a 3-fold overdose of a stool softener) can lead to a serious injury if the drug is potentially toxic (e.g., a 3-fold overdose of a β blocker). Therefore, we believe it is important to document these errors, as they may indicate a more systemic problem.[17]

In 2 study sites, computerization of prescribing included printed prescriptions and required fields (drug, dose, quantity, and duration), some default doses and no or only optional checks for allergies and drug interactions. This basic type of electronic prescribing system did not reduce rates of medication prescribing errors. However, our data suggest that computerized prescribing with more advanced decision-support will be vital to reduce the rate of potentially harmful errors. The vast majority of potential ADEs found in the study were judged to be preventable with more advanced decision support. This was true in the inpatient experience, in which basic computerized physician order entry had a smaller effect on serious errors than on medication errors overall.[10,11] Advanced decision support that requires complete prescriptions and provides default dosing and frequencies appeared particularly important. In addition, 2 of the 3 preventable ADEs in our study could have been prevented with default doses and frequencies. Because default doses and frequencies can be readily incorporated into most commercial systems, this finding is encouraging.

Computerization of prescribing has been widely touted, but is not yet widely used.[18] Only 2% of all prescriptions written by 650,000 U.S. physicians in 1999 were written electronically with any device[19]; in contrast two-thirds of general practitioners in Britain in 1993 used electronic prescribing.[20] However, there is momentum for change. A 2002 poll by Harris Interactive showed that 82% of patients preferred an electronic

prescribing system.[21] In addition, legislation currently pending in Congress (Senate bill S.1 and House bill H.R.1) would mandate computerized prescribing. However, the question remains of what features should be included as part of this mandate.

The level of decision support among commercially available electronic prescribing systems varies substantially, and the use of decision support is often optional.[12,22] Our 2 practices with basic computerized prescribing had many prescribing errors that could have been prevented with more mandatory safeguards in place. Consequently, as practices implement computerized prescribing, defaults and at least some checks and alerts should be mandatory rather than optional. Furthermore, physicians should be informed about the purposes of such safeguards and the potential dangers of overriding them.

Our study has several limitations. It was conducted for a limited duration in only 4 urban primary care practices including many physicians with part-time practices, so the results may not be generalizable. Our study was not powered to detect modest differences in potential ADE rates between computerized and handwritten sites. In addition, physicians were not blinded to the purpose of the study and might have been particularly careful when prescribing or may have excluded patients they knew to be at high risk. If so, our findings may represent only conservative estimates of the true rates. This study focuses on prescribing errors and was not designed to detect dispensing or patient adherence errors. Future studies should investigate these subsequent steps in the outpatient medication use process. Finally, we used implicit review for our classifications of prescribing errors; however, our reliability for these classifications was good.

Prescribing errors are common in ambulatory care, and often have potential to harm patients. Office practices and health systems are beginning to develop or purchase computerized prescribing systems. Basic computerized prescribing did not result in fewer errors compared with handwritten prescribing. Therefore, to achieve a major safety benefit, computerized prescribing with advanced decision support will likely be needed.

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Supplementary Material

The following supplementary material is available for this article online:

Appendix. Description of serious and life threatening potential adverse drug events.

REFERENCES

1. **Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape LL.** Relationship between medication errors and adverse drug events. J Gen Intern Med. 1995;10:199–205.
2. **Dean B, Schachter M, Vincent C, Barber N.** Prescribing errors in hospital inpatients: their incidence and clinical significance. Qual Safety Health Care. 2002;11:340–4.
3. **Meyer TA.** Improving the quality of the order-writing process for inpatient orders and outpatient prescriptions. Am J Health Syst Pharm. 2000;57(suppl 4):4–22.
4. **Shaughnessy AF, Nickel RO.** Prescription-writing patterns and errors in a family medicine residency program. J Fam Pract. 1989;29:290–5.
5. **Hawksworth GM, Corlett AJ, Wright DJ, Chrystyn H.** Clinical pharmacy interventions by community pharmacists during the dispensing process. Br J Clin Pharm. 1999;47:695–700.
6. **Rupp MT, DeYoung M, Schondelmeyer SW.** Prescribing problems and pharmacist interventions in community practice. Med Care. 1992; 30:926–40.
7. **Buurma H, de Smet PAGM, van den Hoff OP, Egberts ACG.** Nature, frequency, and determinants of prescription modifications in Dutch community pharamacies. Br J Clin Pharmacol. 2001;52:85–91.
8. **Davis K, Schoenbaum SC, Collins KS, Tenney K, Hughes DL, Audet AJ.** Room for improvement: patients report on the quality of their health care. Available at: http://www.cmwf.org. Accessed November 1, 2003.
9. **Gandhi TK, Weingart SN, Borus J, et al.** Adverse drug events in ambulatory care. New Engl J Med. 2003;348:1556–64.
10. **Bates DW, Leape LL, Cullen DJ, et al.** Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA. 1998;280:1311–6.
11. **Bates DW, O'Neil AC, Boyle D, et al.** Potential identifiability and preventability of adverse events using information systems. J Am Med Inform Assoc. 1994;1:404–11.
12. **Bates DW, Ebell M, Gotlieb E, Zapp J, Mullins HC.** A proposal for electronic medical records in U.S. primary care. J Am Med Inform Assoc. 2003;10:1–10.
13. **Rothschild JM, Lee TH, Bae T, Bates DW.** Clinician use of a palmtop drug reference guide. J Am Med Inform Assoc. 2002;9:223–9.
14. **Bates DW, Cullen D, Laird N, et al.** Incidence of adverse drug events and potential adverse drug events: implications for prevention. JAMA. 1995;274:29–34.
15. **Lesar TS, Briceland LL, Stein DS.** Factors related to errors in medication prescribing. JAMA. 1997;277:312–7.
16. IMS Health, National Prescription Audit™ Plus 7/2003, All Channels, July 2002 through June 2003.
17. **Helmreich RL, Merritt AC.** Culture at Work in Aviation and Medicine: National, Organizational and Professional Influences. Brookfield, VT: Ashgate; 1998.
18. **Schiff GD, Bates DW.** Electronic point-of-care-prescribing: writing the "script". Dis Manage Health Outcomes. 2000;7:297–304.
19. **Rabinowitz E.** Will palm-size computers make electronic prescribing happen? Manage Care. 1999;8:59–61.
20. **Gallup poll.** Computerisation in GP practices in England and Wales: 1993 survey. NHS Management Executive 1993.
21. **Harris Interactive.** Poll: Americans prefer direct prescribing connectivity between physicians, pharmacists. Available at: http://www.surescript.com/aug10.htm. Accessed November 1, 2003.
22. **Barrett MJ, Holmes BJ, McAulay SE** Forrester Research. Electronic medical records: a buyer's guide for small physician practices. California HealthCare Foundation 2003. Available at: http://www.chcf.org. Accessed November 1, 2003.