# Unintended Medication Discrepancies at the Time of Hospital Admission

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**Background:** Prior studies suggest that unintended medication discrepancies that represent errors are common at the time of hospital admission. These errors are particularly worthy of attention because they are not likely to be detected by computerized physician order entry systems.

**Methods:** We prospectively studied patients reporting the use of at least 4 regular prescription medications who were admitted to general internal medicine clinical teaching units. The primary outcome was unintended discrepancies (errors) between the physicians' admission medication orders and a comprehensive medication history obtained through interview. We also evaluated the potential seriousness of these discrepancies. All discrepancies were reviewed with the medical team to determine if they were intentional or unintentional. All unintended discrepancies were rated for their potential to cause patient harm.

**Results:** After screening 523 admissions, 151 patients were enrolled based on the inclusion criteria. Eighty-one patients (53.6%; 95% confidence interval, 45.7%-61.6%) had at least 1 unintended discrepancy. The most common error (46.4%) was omission of a regularly used medication. Most (61.4%) of the discrepancies were judged to have no potential to cause serious harm. However, 38.6% of the discrepancies had the potential to cause moderate to severe discomfort or clinical deterioration.

**Conclusions:** Medication errors at the time of hospital admission are common, and some have the potential to cause harm. Better methods of ensuring an accurate medication history at the time of hospital admission are needed.

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THE INSTITUTE OF MEDICINE report on medical error generated increased attention to the issue of patient safety in the health care system.[1] Among hospital inpatients, medications are a leading cause of adverse events, and errors involving medications are frequent.

An accurate medication use history is an integral part of the patient assessment on admission to the hospital. An erroneous medication use history may result in failure to detect drug-related problems as the cause of hospital admission or lead to interrupted or inappropriate drug therapy during hospitalization. Either occurrence may adversely affect patient safety. Following hospital discharge, the perpetuation of these errors may result in drug interactions, therapeutic duplication, other unintended adverse events, and additional costs.[2-4] These errors are particularly worthy of attention because they are not likely to be detected by computerized physician order entry systems.[5] For example, the most common error in the medication use history is omitting a medication that is taken at home[2,3]; a computerized physician order entry system cannot detect such an error without linkage to a community pharmacy database. The growing hospitalist model of inpatient care may introduce an additional opportunity for medication errors at the time of hospital admission.[6]

Limited data suggest that errors in the medication use history are a potentially serious safety issue. Up to 60% of patients admitted to the hospital will have at least 1 discrepancy in their admission medication history.[2,3] One study[7] indicated that approximately 6% of patients will experience an inadvertent drug discontinuation of a serious nature on admission to the hospital. Unfortunately, most studies fail to distinguish between unintentional or erroneous medication changes and intentional adjustments guided by the patient's clinical condition at the time of admission. Other studies are limited by small sample size, retrospective design,

and nonconsecutive patient enrollment. Few studies have examined the potential clinical importance of the discrepancies.

The completeness of the medication use history depends on different factors, including the time available to conduct the interview, language barriers, the severity of the patient's illness, the patient's cognitive status, and the patient's familiarity with his or her medication regimen. In the absence of a structured process for conducting the interview, information may be erroneously inferred from prescription vials and written medication lists without confirmation from patients.[3]

The objectives of this study were to prospectively identify unintended discrepancies between the physicians' admission medication orders and a comprehensive medication use history obtained by a pharmacist or a trained pharmacy or medical student and to evaluate the potential clinical significance of these discrepancies.

## METHODS

The study was conducted at a 1000-bed tertiary care teaching hospital affiliated with the University of Toronto. During 3 months in 2003, all consecutive patients admitted to the general internal medicine clinical teaching units were prospectively identified using a computer-generated admission roster that was reviewed daily with the admitting teams. Weekend and holiday admissions were reviewed on the first working day following admission.

Each medical chart was screened, and patients were included in the study if they reported using at least 4 regular prescription medications before admission. The following patients were excluded: patients who were unable to communicate and did not have a caregiver who could be interviewed, patients who had been transferred to the hospital from a nursing home or long-term care facility, and patients who were discharged from the hospital within 24 hours or before an interview could be conducted. We also excluded patients who were in isolation to avoid unnecessary contact between research staff and potentially infectious patients during and after the recent severe acute respiratory syndrome crisis in Toronto.

At the study hospital, clinical pharmacists are assigned to the general internal medicine clinical teaching units and are involved in the provision of pharmaceutical care. These pharmacists continued with their normal duties during the study. However, these pharmacists are not routinely involved in documenting patients' admission medication histories, unless specifically requested to do so. At the study institution, this function is primarily the responsibility of the admitting resident physician or medical student. In routine clinical practice, the residents and students generally obtain medication history information while the patient is in the emergency department. Depending on circumstances, the resident will use various sources of information, including patient and family interviews, review of medication lists or vials, or follow-up with the community pharmacy or family physician. There is no linkage to an electronic record of outpatient prescriptions to allow verification of medication histories.

A member of the study team reviewed each medical chart to determine the physician-recorded medication history, the nurse-recorded medication history, the admission medication orders, and demographic information. Forty-eight hours from the time of admission was allowed for clarification of admission medication orders to permit normal processes of care to correct problems occurring at the time of admission. These normal processes would include clinical pharmacists clarifying unclear admission medication orders.

Patients were visited by a member of the study team (a pharmacist, pharmacy student, or medical student). A thorough history of all regular medication use (prescription and nonprescription) was conducted, using some or all of the following sources of information: patient or caregiver interview, inspection of prescription vials, and follow-up with a community pharmacy or review of a current medication list printed by the community pharmacy.

We defined a medication discrepancy as any difference between the medication use history and the admission medication orders. Discrepancies included but were not limited to the following: omission or addition of a medication, substitution of an agent within the same pharmacologic class, and change in dose, frequency, or route of administration. All discrepancies were reviewed with the admitting medical team. We then asked the medical team to indicate whether the identified discrepancies were intended or unintended. It was the responsibility of the members of the medical team to make changes in the inpatient medication orders after unintended discrepancies were brought to their attention. For 2 weeks, we used a stopwatch to prospectively record among 38 patients the time required to complete the medication use history and reconcile any discrepancies.

Three general internal medicine hospitalists (S.S., D.N.J., and E.E.E.) independently classified each unintended discrepancy for its potential to cause harm. We defined class 1 discrepancies as those unlikely to cause patient discomfort or clinical deterioration. An example would be a patient prescribed 20 mg/d of atorvastatin calcium on admission, despite reporting a dosage of 10 mg/d on interview. Class 2 discrepancies were those with the potential to cause moderate discomfort or clinical deterioration. An example would be a patient prescribed 25 mg of atenolol twice daily on admission, despite reporting a dosage of 25 mg/d on interview. Class 3 discrepancies had the potential to result in severe discomfort or clinical deterioration. An example would be a patient admitted with gastrointestinal hemorrhage who was ordered 2.5 mg/d of ramipril on admission but reported no prior use of ramipril during the interview. Disagreements were resolved by discussion, and consensus was reached for all discrepancies.

Descriptive and statistical analysis was completed using Excel 2000 (Microsoft, Redmond, Wash) and SPSS (version 10; SPSS Inc, Chicago, Ill) for Windows. Exploratory analyses were performed for bivariate associations between baseline variables and discrepancies using *t* tests. Interrater reliability for assessing the potential for discrepancies to cause patient harm was analyzed using a $\kappa$ score for multiple observers.[8]

Patients or family members provided written informed consent. The Sunnybrook and Women's College Health Sciences Centre Research Ethics Board approved the study protocol.

## RESULTS

During the 3-month study, 523 patients were admitted. Of these, 151 (28.9%) met the inclusion criteria. We excluded 372 patients for the following reasons: reported use of fewer than 4 medications (182 patients), discharged home before a medication use interview could be conducted (72 patients), resided at a nursing home or long-term care facility (69 patients), isolated for infection control (27 patients), refused to participate (12 patients), and inability to communicate, with no available family members (10 patients).

The characteristics of the 151 patients in the study population are summarized in **Table 1**. Most of the

**Table 1. Characteristics of 151 Study Members***

| Characteristic | Value |
|---|---|
| Sex | |
| Male | 62 (41.1) |
| Female | 89 (58.9) |
| Age, mean ± SD, y | 77 ± 10 |
| Residence | |
| Home alone | 74 (49.0) |
| Home with family or caregiver | 77 (51.0) |
| Admission day | |
| Weekday | 113 (74.8) |
| Saturday or Sunday | 38 (25.2) |
| Admission time | |
| Daytime, 8 AM or later | 40 (26.5) |
| Nighttime, 8 PM or later | 111 (73.5) |
| Admission diagnosis | |
| Gastrointestinal hemorrhage | 19 (12.6) |
| Stroke syndrome | 14 (9.3) |
| Heart failure | 10 (6.6) |
| COPD exacerbation or pneumonia | 10 (6.6) |
| Delirium or confusion | 10 (6.6) |
| Length of stay, d | |
| Median | 7.0 |
| Interquartile range | 4-13 |

Abbreviation: COPD, chronic obstructive pulmonary disease.
*Data are given as number (percentage) unless otherwise indicated.

patients were older (mean age, 77 years) and women (58.9%), and they were admitted with different medical conditions.

We completed medication use interviews with all 151 participants. Of these, 109 (72.2%) had medication vials available for inspection. For the remaining patients, medications were verified with the community pharmacy (26 patients) or from a written list of medications used at home (16 patients).

Eighty-one patients (53.6%; 95% confidence interval, 45.7%-61.6%) had at least 1 unintended discrepancy. We identified 140 unintended discrepancies among these 81 patients. The overall rate of unintended discrepancies was 0.93 per patient. The most common error (46.4%) was omission of a regularly used medication. Other types of errors are summarized in **Table 2**. Most discrepancies were associated with cardiovascular drugs (26.6%) and central nervous system drugs (25.9%).

There was fair interrater reliability for judging the potential severity of discrepancies ($\kappa$=0.26, 95% confidence interval, 0.16-0.36).[8] Consensus was easily achieved in areas of disagreement. Most (61.4%) of the discrepancies were deemed unlikely to cause harm (class 1). However, 32.9% of the discrepancies were judged to have the potential to cause moderate discomfort or clinical deterioration (class 2), and 5.7% were judged to have the potential to cause severe discomfort or clinical deterioration (class 3) (Table 2). The details of the discrepancies that were assigned a class 3 potential severity rating are summarized in **Table 3**. Some examples include the following: 2 patients who continued taking their own nonsteroidal anti-inflammatory drug, without the admitting physician's knowledge, after being hospitalized for a gastrointestinal hemorrhage; 1 patient whose prednisone was omitted; and 1 patient who was prescribed an incorrect medication as a result of the habit of storing tablets in prescription vials labeled for other drugs.

The association between unintended discrepancies and other potentially important variables was explored (**Table 4**). No significant associations were observed between unintended discrepancies and weekend admission, nighttime admission, or admission during high workload periods. Also, there was no relationship between the number of medications that the patient was taking before admission (as determined during the interview) and the risk for unintended discrepancies. The median time for the entire process of medical chart review, interview, and follow-up on discrepancies was 24 minutes (interquartile range, 20-30 minutes).

## COMMENT

Among our study population of mainly older patients taking at least 4 prescribed medications, 53.6% had at least 1 unintended medication discrepancy at the time of hospital admission. The most common type (46.4%) of discrepancy involved the omission of a medication that the patient was taking before admission. Based on consensus review, it was determined that 38.6% of the identified discrepancies had the potential to cause moderate to severe discomfort or clinical deterioration. We did not find a significantly higher rate of discrepancies for admissions taking place on the weekend, overnight, or during high workload periods or for patients reporting the use of 8 or more medications.

Our results confirm the high rate of medication error at the time of hospital admission. Lau et al[2] found that 67% of 304 general medicine inpatients had an admission medication discrepancy. Beers et al[3] interviewed 122 older inpatients and found a 60% discrepancy rate. Neither of these studies distinguished intended changes from unintended discrepancies, and neither evaluated the potential severity of discrepancies.

Van Hessen et al[7] compared the hospital medication records and outpatient pharmacy records of 205 patients and found that 6% of patients experienced at least 1 potentially serious inadvertent drug discontinuation. Another study[9] of 60 patients revealed that more than a third experienced at least 1 clinically important and unintentional drug omission at the time of admission.

Problems with medication reconciliation occur not only at the time of hospital admission but also on discharge. Two recent studies[10,11] have demonstrated a high rate of adverse events among medical patients after discharge from the hospital. Forster et al[10] found that almost 1 in 5 patients experienced an adverse event during the transition from the hospital to home. Adverse drug events were the most common (66%), and most (62%) were considered preventable or ameliorable. A follow-up study[11] demonstrated similar findings, with 23% of patients experiencing an adverse event following hospital discharge. Again, adverse events involving medications were the most common (72%), and almost half of the adverse events were considered ameliorable or preventable. An interventional study[12] suggested that involvement of a

**Table 2. Type and Potential Severity of Unintended Discrepancies***

| Type of Discrepancy | No. | Class 1† | Class 2‡ | Class 3§ |
|---|---|---|---|---|
| Drug omission | **65** | 44 (67.7) | 18 (27.7) | 3 (4.6) |
| Discrepant dose | **35** | 22 (62.9) | 13 (37.1) | 0 |
| Discrepant frequency | **24** | 15 (62.5) | 8 (33.3) | 1 (4.2) |
| Incorrect drug | **16** | 5 (31.3) | 7 (43.8) | 4 (25.0) |
| **Total** | **140** | **86** (61.4) | **46** (32.9) | **8** (5.7) |

*Data are given as number (percentage).
†Discrepancy had no potential to result in discomfort or clinical deterioration.
‡Discrepancy had potential to result in moderate discomfort or clinical deterioration.
§Discrepancy had potential to result in severe discomfort or clinical deterioration.

**Table 3. Details of the 8 Discrepancies Assigned a Class 3 Severity Score***

| Reason for Admission | Medication Regimen† | Description of Discrepancy |
|---|---|---|
| Pleural effusion | Atorvastatin calcium, captopril, enteric-coated aspirin | Patient was keeping potassium chloride tablets in a prescription vial labeled with her husband's name and directions for the use of diclofenac sodium–misoprostol (Arthrotec). On admission, patient was ordered Arthrotec 50, 3 times daily, instead of potassium chloride. |
| UGIB | Glyburide, clopidogrel bisulfate, simvastatin, ramipril, metoprolol tartrate, enteric-coated aspirin | Patient was taking slow-release diclofenac, 75 mg/d, before admission. While in the hospital, without the physician's knowledge, patient continued to use own supply of diclofenac while being treated for a UGIB. |
| Confusion | Metformin hydrochloride, lansoprazole, meloxicam | Patient reported use of prednisone, 7.5 mg/d, before admission, which was not ordered on admission. |
| Gastrointestinal bleed (diverticulosis) | Enalapril maleate, metoprolol | Patient was taking diclofenac, 50 mg as needed, before admission. While in the hospital, without the physician's knowledge, patient continued to use own supply of diclofenac. |
| Acute pulmonary edema | Levodopa-carbidopa, venlafaxine hydrochloride, allopurinol, furosemide, enteric-coated aspirin | Patient was taking levodopa-carbidopa (Sinemet; 200 mg of levodopa and 50 mg of carbidopa), 3 times daily, before admission but was ordered 200 mg of levodopa and 50 mg of carbidopa, twice daily, on admission orders. |
| Dementia | Donepezil hydrochloride, glyburide, levothyroxine sodium, losartan potassium, ranitidine hydrochloride | Diazepam, 15 mg every night, was ordered on admission. Patient's family reported no prior use of diazepam. |
| Stroke | Ramipril, isosorbide dinitrate, pindolol, warfarin sodium, lovastatin, enteric-coated aspirin | Propafenone hydrochloride, 150 mg/d, was ordered on admission. On interview, patient reported discontinued use of propafenone several months before admission. |
| UGIB | Atorvastatin, levothyroxine sodium, omeprazole magnesium, metoprolol, sertraline hydrochloride, hydralazine hydrochloride, nitroglycerin patch, insulin, ferrous gluconate | Ramipril, 2.5 mg/d, was ordered on admission, based on incorrect information from a previous volume of the patient's medical record. Patient reported no use of ramipril before admission. |

Abbreviation: UGIB, upper gastrointestinal bleed.
*Discrepancy had potential to result in severe discomfort or clinical deterioration.
†Determined during patient interview.

pharmacist in discharge planning and postdischarge telephone follow-up reduced unplanned return visits to the emergency department. One potential mechanism for this effect was the identification and correction of medication errors at the time of discharge.

A limitation of this study is the absence of a gold standard for the identification of home medication use. We relied on the report of the patient or caregiver in conjunction with collateral information from medication vials or pharmacy contacts whenever possible. Previous research suggests that our study assessments provided the best available measure of patients' actual home medication use. First, using simulated patients, Dawson and Gray[13] showed that physicians obtained, on average, 79% of the complete drug history for prescription drug use and 45% for over-the-counter drug use, whereas pharmacists obtained a 100% complete history for both categories of drug use. Second, using a validated questionnaire, pharmacists solicited clinically important information on drug use that had been missed by the admitting physician in 1 of every 9 newly admitted medical and surgical patients.[14] Third, Gurwich[15] reported that

**Table 4. Association Between Selected Variables and Unintended Discrepancies**

| Characteristic | Mean Rate per Patient of Unintended Discrepancies: For Patients With Characteristic | Mean Rate per Patient of Unintended Discrepancies: For Patients Without Characteristic | Difference (95% Confidence Interval) | *P* Value |
|---|---|---|---|---|
| Nighttime admission (n = 111)* | 0.83 | 1.27 | –0.45 (–0.98 to 0.08) | .10 |
| Weekend admission (n = 38)† | 1.13 | 0.86 | 0.27 (–0.18 to 0.73) | .23 |
| Admitted during high workload period (n = 55)‡ | 0.93 | 0.96 | –0.03 (–0.43 to 0.37) | .88 |
| Reported use of ≥8 medications on interview (n = 65) | 1.10 | 0.79 | 0.31 (–0.10 to 0.72) | .13 |

*8 PM or later.
†Saturday or Sunday.
‡A 24-hour period with ≥10 admissions.

pharmacists obtained more information during their medication history interviews, documenting a mean of 5.6 medications per patient compared with 2.4 documented by physicians.

We focused on general medical patients with unplanned hospital admissions who reported the use of at least 4 medications. Error rates may differ on services other than general internal medicine, with admissions that are elective or involve transfers from other health care facilities, or among patients taking fewer than 4 medications. Also, our findings may not be representative of other institutions that use different processes for admission medication reconciliation. Although every attempt was made to interview patients or family members and inspect prescription vials or medication bottles for all subjects included in the study, the inspection of the medications was not possible in 27.8% of cases. In these situations, the interviewer relied on written medication lists provided by the patient or family or follow-up with the community pharmacy. Our small sample lacked power to detect associations between unintended discrepancies and baseline variables of interest. Finally, the rating method used for assessing the potential severity of the discrepancies has not been validated, and the interobserver agreement was only fair.

The data presented herein suggest that the processes for recording medication histories on admission to the hospital are inadequate, potentially dangerous, and in need of improvement. The discrepancies outlined in Table 3 would probably not have been prevented by a computerized physician order entry system. Training admitting physicians and medical students may have some benefit, but there are often significant barriers to obtaining accurate and complete medication information during the admission process. Development of computer systems that allow transfer of medication histories and prescription information between hospitals and community pharmacies has the potential to improve this process. Such systems provide the possibility of "seamless pharmaceutical care" when patients are transferred between primary and secondary care.[2] Such a system has been developed in British Columbia and can be accessed in hospital emergency departments.[16]

Systematic pharmacist consultation may be an effective solution,[4,14,15] but implementing a 24-hour hospital-wide pharmacy service would be difficult for most institutions. A partial service may be more practical, and several models could be investigated. For example, a pharmacist could work in the emergency department or admissions area during certain hours to conduct medication histories as patients are admitted to the hospital. Institutions could add medication history interviews to the other clinical pharmacy services already provided. Targeting the service to selected patient populations at high risk for drug-related complications (eg, older patients taking multiple medications) may be useful.[4] With this type of service, pharmacists could review the medication use history of selected patients as soon as possible after admission.

Regardless of the model used, additional pharmacist staffing would probably be required to provide this type of service. Based on the patient selection criteria used in this study (ie, patients admitted from home taking ≥4 medications), we estimate that a pharmacist would need to spend approximately 5 h/wk (at Can $35/h) to provide this service to patients on a similar general internal medicine clinical teaching unit. However, this calculation is based on uninterrupted work-flow times and may underestimate the actual time required outside of the research setting. In our 12-week study, there were 8 potentially severe discrepancies, so the incremental cost of pharmacists' time to identify and correct each of these was estimated at Can $300. This may be an economically attractive option when considering the direct costs of an adverse drug event (US $2000-$4700).[17,18]

In summary, 53.6% of older medical patients taking at least 4 medications have unintended medication discrepancies at the time of hospital admission, and more than a third of these had potential to cause moderate or severe harm. To improve patient care and minimize the potential costs of preventable adverse drug events, the health care system should explore ways to improve the accuracy of the hospital admission medication history.

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