

# Frequency, type and clinical importance of medication history errors at admission to hospital: a systematic review

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## Abstract

**Background:** Over a quarter of hospital prescribing errors are attributable to incomplete medication histories being obtained at the time of admission. We undertook a systematic review of studies describing the frequency, type and clinical importance of medication history errors at hospital admission.

**Methods:** We searched MEDLINE, EMBASE and CINAHL for articles published from 1966 through April 2005 and bibliographies of papers subsequently retrieved from the search. We reviewed all published studies with quantitative results that compared prescription medication histories obtained by physicians at the time of hospital admission with comprehensive medication histories. Three reviewers independently abstracted data on methodologic features and results.

**Results:** We identified 22 studies involving a total of 3755 patients (range 33–1053, median 104). Errors in prescription medication histories occurred in up to 67% of cases: 10%–61% had at least 1 omission error (deletion of a drug used before admission), and 13%–22% had at least 1 commission error (addition of a drug not used before admission); 60%–67% had at least 1 omission or commission error. Only 5 studies ( $n = 545$  patients) explicitly distinguished between unintentional discrepancies and intentional therapeutic changes through discussions with ordering physicians. These studies found that 27%–54% of patients had at least 1 medication history error and that 19%–75% of the discrepancies were unintentional. In 6 of the studies ( $n = 588$  patients), the investigators estimated that 11%–59% of the medication history errors were clinically important.

**Interpretation:** Medication history errors at the time of hospital admission are common and potentially clinically important. Improved physician training, accessible community pharmacy databases and closer teamwork between patients, physicians and pharmacists could reduce the frequency of these errors.

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quirement and a 2005 Hospitals' National Patient Safety Goal established by the US Joint Commission on Accreditation of Healthcare Organizations.<sup>2,3</sup>

Accurate medication histories at the time of hospital admission are an important element of medication safety. First, they may uncover reasons for a patient's illness, such as adverse drug events or nonadherence to drug therapy. Second, medication history errors may result in interrupted or inappropriate drug therapy during and following the hospital stay. Third, computerized physician order entry (CPOE) systems could fail to detect these errors. For example, CPOE systems would not be capable of detecting unintentional omissions of medications taken before admission without a link to community pharmacy databases.

Given the potential importance of and growing health policy focus on medication history errors at the time of hospital admission and the lack of previously published comprehensive reviews of this topic, we conducted a systematic review of the literature describing the frequency, type and clinical importance of such errors.

## Methods

A structured search strategy was developed using relevant articles on file. We searched MEDLINE for English-language articles published from 1966 through April 2005 using the following MeSH (medical subject heading) terms: "medication history taking," "medication errors," "physicians," "pharmacists," "prescription medications," "pharmaceutical preparations," "hospital medication systems," "hospital pharmacy services" and "medical records." The search strategy was deliberately broad to ensure inclusion of the maximum number of relevant articles (details of the search strategy appear in an online appendix, available at [www.cmaj.ca/cgi/content/full/173/5/510/DC1](http://www.cmaj.ca/cgi/content/full/173/5/510/DC1)). All bibliographies of papers identified in the search were screened for additional articles, and this was done subsequently for all papers retrieved. We searched the EMBASE and CINAHL databases using a similar search strategy.

Two of us (V.C.T. and R.M.) identified relevant articles for retrieval by screening the titles, abstracts and subject headings of the MEDLINE citations for the following inclusion criteria: primary research article; comparison of physician-acquired medication histories (chart notes, admission orders or medication administration record) with comprehensive medication histories; adult inpatient population; and sample size of at least 30 patients. Full-

Up to 27% of all hospital prescribing errors can be attributed to incomplete medication histories at the time of admission.<sup>1</sup> There is growing interest in the identification and rectification of medication errors at the time of admission, transfer and discharge ("medication reconciliation"). Medication reconciliation is a 2005 Canadian Council on Health Services Accreditation re-

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text versions of the identified papers were retrieved and screened again by the 2 independent readers for the inclusion criteria.

All included articles were independently reviewed by 3 of us (V.C.T., N.F. and E.E.E.) for methodological features and results. Any discrepancies were resolved through discussion.

The reviewed studies were analyzed on the basis of their explicit descriptions of prospective or retrospective design, use of consecutively enrolled patients and adequate blinding. Quality grades were assigned as follows: grade A studies had prospective enrolment of consecutive patients and a sample size of at least 100 patients; grade B studies had prospective enrolment of consecutive patients and a sample size of less than 100; grade C studies included all other designs.

We sought data on prescription medication histories obtained by physicians at the time of hospital admission. Such data could include physician admission notes, admission medication orders or medication administration records. We also recorded data on the main comparative measure, which was usually a comprehensive medication history completed by a pharmacist. The comparative measure could have included a patient interview, a review of the physician's admission notes or admission medication orders, a review of medication lists, and contact with community pharmacists and physicians. An error in a prescription medication history was defined as a discrepancy between the medication history obtained by the physician and the comprehensive medication history. We also recorded discrepancies for nonprescription medications, allergy history and prior adverse drug reactions, when reported. Discrepancies between physician-acquired medication histories and comprehensive medication histories are not necessarily errors. Some "discrepancies" may be intentional therapeutic adjustments of the patient's usual medications by the treating physician. Physicians may choose to discontinue a specific medication, or adjust its dose, without documenting a reason in the chart. Therefore, we sought evidence from the studies of discussions with ordering physicians to distinguish intentional from unintentional discrepancies.

Certain medication history errors have more potential for harm than others. A reduction in laxative dose may have less consequence than the abrupt discontinuation of a  $\beta$ -blocker, for example. Therefore, we sought data from each study regarding the clinical importance of the errors.

We calculated the proportion of patients with 1 or more prescription medication history errors and the mean number of medication discrepancies per patient from each study whenever possible. The study methods and results were heterogeneous, and therefore we made no attempt to combine results for a meta-analysis.

## Results

The screening and selection process of relevant studies is summarized in Fig. 1. No additional relevant papers were found in the EMBASE and CINAHL searches.

We included 22 studies in our review. These studies enrolled a total of 3755 patients (range 33–1053, median 104). The methodological features of the studies are summarized in Table 1 (a more detailed version of the table is available online at [www.cmaj.ca/cgi/content/full/173/5/510/DC2](http://www.cmaj.ca/cgi/content/full/173/5/510/DC2)). Five studies had a prospective design and enrolled consecutive patients.<sup>4,5,10,19,23</sup> Seven studies were retrospec-

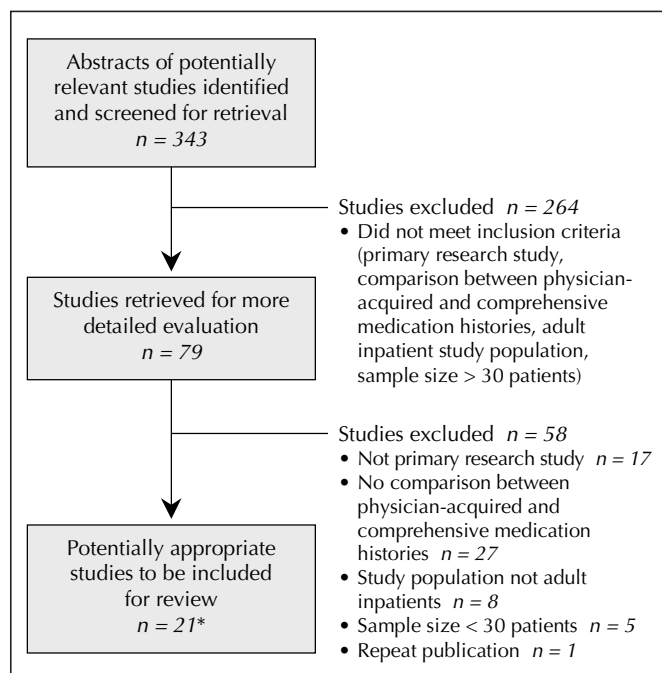
tive.<sup>6,9,11,14,17,18,24</sup> A total of 8 studies enrolled consecutive patients.<sup>4-7,10,19,21,23</sup> Four of the studies had a blinded design: the pharmacist investigators obtained their comprehensive medication histories independent of the physicians' medication histories.<sup>4,8,9,25</sup> Ten of the studies were conducted on medical wards,<sup>5,9,11,12,15,17,19,21,23,25</sup> 4 on mixed medical and surgical wards,<sup>8,13,16,22</sup> 2 on surgical wards,<sup>4,6</sup> 1 in the emergency department<sup>7</sup> and 1 in a psychiatric hospital;<sup>14</sup> 4 studies did not explicitly state the hospital ward setting.<sup>10,18,20,24</sup> Twelve of the studies described explicit inclusion and exclusion criteria; the most common inclusion criteria were that the patient was taking at least 1 prescription medication and that he or she was able to provide a medication history.

## Frequency of errors

Studies reported that 10%–67% of patients had at least 1 prescription medication history error (Table 1). When nonprescription drugs were included, the frequency of errors was 27%–83%. When information regarding drug allergies or prior adverse drug reactions was added the frequency was 34%–95% of patients with at least 1 error.

## Types of errors

There was considerable variation in the definition of medication history errors at admission. Some studies included only omission errors (deletion of a drug used before admission), whereas others included frequency and dose errors as well as commission errors (addition of a drug not



**Fig. 1: Method of study selection.** \*An additional study not indexed in MEDLINE was identified through review of relevant subspecialty journals.

used before admission). Examples of these error types are shown in Table 2.

Studies reported that 10%–61% of patients had at least 1 omission error and that 13%–22% had at least 1 commission error; 60%–67% had at least 1 omission or commission error.<sup>6,10,14,19</sup> Three studies that evaluated a broad range of error

types found that omission errors accounted for 42%–59% of all prescription medication history errors, whereas errors in dose or frequency accounted for 30%–42%.<sup>5,15,22</sup>

Five studies explicitly distinguished between unintentional discrepancies (medication history errors) and intentional therapeutic changes.<sup>5,9,12,15,16</sup> Four of these studies reported the

**Table 1: Summary of studies of medication history errors included in review (abridged\*)**

Study	Sample size	Quality grade†	Type of medication history error‡	Prescription medications		Other main results
				% of patients with ≥ 1 error	Mean no. of errors per patient	
Akwagyriam et al <sup>7</sup>	33	B	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Incorrect dose</li> </ul>	–	1.5	73% of patients had ≥ 1 error (mean 2.3 errors per patient) when both prescription and nonprescription medications were included in medication history
Badowski et al <sup>8</sup>	80	C	<ul style="list-style-type: none"> <li>• Incorrect drug name</li> <li>• Incorrect strength</li> <li>• Incorrect dose</li> </ul>	57	–	95% of patients had ≥ 1 error when prescription medications, nonprescription medications, drug allergies and compliance were included in medication history
Barger et al <sup>9</sup>	50	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	–	Pharmacist-acquired medication histories yielded twice as many prescription medications as physician-acquired medication histories
Beers et al <sup>10</sup>	122	A	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> </ul>	60	–	52% of patients had prescription errors if only omission errors were included; 83% of patients had ≥ 1 error when both prescription and nonprescription medications were included in medication history
Brookes <sup>11</sup>	109	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> <li>• Incorrect strength</li> <li>• Incorrect dose</li> </ul>	–	–	61% of patients had ≥ 1 error when both prescription and nonprescription medications were included in medication history
Cohen et al <sup>12</sup>	60	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	–	48% of patients had ≥ 1 error when both prescription and nonprescription medications were included in medication history
Cornish et al <sup>5</sup>	151	A	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> <li>• Incorrect dose</li> <li>• Incorrect frequency</li> </ul>	54	0.9	–
Covington et al <sup>13</sup>	58	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	2.7	–
Dobbs <sup>14</sup>	50	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	24	0.4	48% of patients had ≥ 1 error when prescription medications, nonprescription medications, adverse drug events and alcohol use were included in medication history
Dodds <sup>4</sup>	146	A	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	–	Mean 0.4 errors per patient when prescription and nonprescription medications were included in medication history
Drewett <sup>15</sup>	80	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Incorrect dose</li> <li>• Incorrect frequency</li> </ul>	–	–	34% of patients had ≥ 1 error (mean 0.3 per patient) when prescription medications, nonprescription medications and drug allergies were included in medication history

proportion of patients who had at least 1 medication history error (range 27%–54%);<sup>5,12,15,16</sup> the fifth study showed that the comprehensive medication history yielded twice as many prescription medications as the physician-acquired medication history.<sup>9</sup> Three of the 5 studies reported the proportion of discrepancies that were unintentional (range 19%–75%).<sup>5,9,16</sup>

One of the 5 studies examined prescription medications only,<sup>5</sup> reporting that 54% of the patients had at least 1 medication history error. In the 3 studies that examined discrepancies in prescription and nonprescription medication histories as well as other aspects of the medication history, 27%–48% of the patients had at least 1 medication history error.<sup>12,15,16</sup>

**Table 1 continued**

Study	Sample size	Quality grade†	Type of medication history error‡	Prescription medications		Other main results
				% of patients with ≥ 1 error	Mean no. of errors per patient	
Gleason et al <sup>16</sup>	204	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> <li>• Incorrect dose</li> <li>• Incorrect frequency</li> </ul>	–	–	Up to 27% of patients had ≥ 1 unintended discrepancy between admission orders and comprehensive medication history (mean 0.34 discrepancies per patient) when both prescription and nonprescription medications were included in medication history
Gurwich <sup>17</sup>	86	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	3.2	–
Hocking et al <sup>6</sup>	1053	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	10	–	–
La Verde <sup>18</sup>	205	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Incorrect dose</li> </ul>	–	–	Pharmacist-acquired medication histories yielded 87% more information than physician-acquired medication histories; pharmacists noted more prescription medications than physicians
Lau et al <sup>19</sup>	304	A	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> </ul>	67	1.5	61% of patients had prescription errors when only omission errors were included
Massey <sup>20</sup>	60	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Incorrect strength</li> <li>• Incorrect dose</li> </ul>	–	–	42% of patients had ≥ 1 error when prescription medications, nonprescription medications, drug allergies and adverse drug reactions were included in medication history
Montpetit et al <sup>21</sup>	43	B	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Incorrect frequency</li> </ul>	–	–	Pharmacists performing structured interviews with a patient-completed form obtained 91%–99% of the total prescription medication information, as compared with 68%–84% of information acquired by physicians and nurses in chart notes
Nicholls et al <sup>22</sup>	328	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> <li>• Incorrect dose</li> <li>• Incorrect frequency</li> </ul>	–	0.3	–
Truitt et al <sup>23</sup>	186	A	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> </ul>	–	0.9	75% of patients had ≥ 1 error (mean 2.24 per patient) when both prescription and nonprescription medications were included in medication history
Walche et al <sup>24</sup>	247	C	<ul style="list-style-type: none"> <li>• Omission</li> </ul>	–	–	Mean 1.9 prescription medications per patient identified in pharmacist-acquired medication histories, as compared with mean 1.3 per patient in physician-acquired medication histories
Wilson et al <sup>25</sup>	100	C	<ul style="list-style-type: none"> <li>• Omission</li> <li>• Commission</li> </ul>	–	0.5	Mean 1.2 errors per patient when prescription and nonprescription medications were included in medication history

Note: "error" = discrepancy between physician-acquired medication history and comprehensive medication history.

\*Details about the sources of medication histories (physician and comprehensive) appear in an expanded online version of this table (available at [www.cmaj.ca/cgi/content/full/173/5/510/DC2](http://www.cmaj.ca/cgi/content/full/173/5/510/DC2)).

†Grade A studies had prospective enrolment of consecutive patients with a sample size of at least 100; grade B studies had prospective enrolment of consecutive patients with a sample size of less than 100; grade C studies included all other designs (e.g., retrospective and nonconsecutive patient studies).

‡Omission error = deletion of a drug used before admission, commission error = addition of a drug not used before admission. See Table 2 for examples of the types of medication errors.

### Sources of medication histories

There was some heterogeneity in the methods used to obtain the physician-acquired medication histories. Most studies used the physicians' admission chart notes. Two used admission medication orders.<sup>5,16</sup> Two other studies used medication administration records.<sup>12,15</sup>

There was significant heterogeneity in the methods used to obtain the comprehensive medication histories. One retrospective study relied solely on chart notes written by pharmacists.<sup>17</sup> Other studies used a pharmacist's interview alone, but the content and method of the interview was often not explicitly stated.<sup>4,7-9,13,20,24,25</sup> Several other studies used explicit structured interview methods to obtain drug information.<sup>6,21,23</sup> Finally, some obtained the comprehensive medication history from multiple sources, which may have included interviews, physician chart notes, standardized forms, family physician records, inspection of medication vials, and review of community pharmacy records and hospital records.<sup>5,11,12,15,16,18,19,21</sup>

### Clinical importance of errors

Six studies described the clinical importance of medication history errors.<sup>5,7,8,12,16,20</sup> Clinical importance was usually determined by consensus among a panel of experts that included physicians or pharmacists or both. Only 1 of these studies examined prescription medication history errors in isolation: it found that 39% of the errors had the potential to cause moderate or severe patient discomfort or deterioration in the patient's condition.<sup>5</sup>

Three studies included both prescription and nonprescription medication history errors. One showed that 41% of the errors were clinically important.<sup>7</sup> Another showed that 3% of the patients had medications omitted from their

medication history that were "life saving" and that 24% of the patients would have gained "significant benefit" if their omitted medications had been included.<sup>12</sup> The third study found that 22% of the errors had the potential to cause harm if the medication was continued during the hospital stay and that 59% had the potential to cause harm if the medication was continued beyond discharge.<sup>16</sup>

Two other studies also evaluated clinical importance; however, they included errors related to drug allergy or adverse drug reaction histories in their analysis. Badowski and coauthors<sup>8</sup> determined that 11% of the discrepancies between pharmacist- and physician-acquired medication histories were clinically important. In the other study, 8 clinically significant discrepancies were identified among 60 patients;<sup>20</sup> we were unable to calculate the proportion of patients who had at least 1 clinically significant discrepancy, because the patients could have had multiple discrepancies.

The prescription medications most often involved in medication history errors were cardiovascular agents (e.g., nitrates, digoxin,  $\beta$ -blockers), sedatives (e.g., benzodiazepines) and analgesics (e.g., NSAIDs, opioids).<sup>5,6,10,19,23,25</sup>

### Interpretation

We found that discrepancies between physician-acquired prescription medication histories and comprehensive medication histories at the time of hospital admission were common, occurring in up to 67% of cases. Published studies reported that 10%–61% of patients had at least 1 omission error in their prescription medications, that 13%–22% had at least 1 commission error and that 60%–67% had at least 1 omission or commission error. Five studies explicitly distinguished between unintentional discrepancies (errors) and intentional therapeutic changes through discussions with ordering physicians. These studies found that up to 54% of patients had at least 1 medication history error and that 19%–75% of the errors were unintentional. Limited data suggested that 11%–59% of the medication history errors were clinically important.

Our review reveals that prescription medication history errors at the time of hospital admission are disturbingly common and potentially harmful to patients. Our review also uncovered important considerations for future studies. First, actual medication exposure in the hospital is best reflected by admission medication orders or medication administration records, not by physician chart notes. Second, the main comparator should be a comprehensive medication history that includes an interview, inspection of medication vials or lists, or both, and contact with community pharmacies or family physicians. Comprehensive medication histories routinely obtain more information than physician-acquired histories and have been found to be highly accurate when used in patient simulations where the "actual" medication use is known.<sup>8,17</sup> Third, there must be a distinction between intentional and unintentional discrepancies through discussion with ordering physicians. Fourth, a broad spectrum of errors,

**Table 2: Examples of medication history errors\***

Type of error	Example
Omission	A patient admitted because of recurrent presyncope was taking digoxin 0.125 mg daily before admission to hospital. The digoxin therapy was not recorded in the medication history
Commission	A stroke patient with aphasia was admitted to hospital. The family provided the medication vials from home, and these medications were ordered, including propafenone. After recovering from his aphasia, the patient stated that his cardiologist had advised him to stop the propafenone therapy several months ago
Incorrect frequency	A patient admitted for diabetes management was taking amlodipine, 5 mg twice daily. The treating physician ordered amlodipine 5 mg daily
Incorrect dose	A patient admitted because of a gastrointestinal bleed was taking metoprolol 12.5 mg twice daily before admission to hospital, but the medication history and medication orders indicated metoprolol 50 mg twice daily.

\*Examples were obtained from a prospective study of medication discrepancies at hospital admission.<sup>5</sup>

including those of omission, commission and dose or frequency, should be evaluated. Finally, the actual or potential clinical importance of the errors should be assessed.

Our review has several additional limitations. First, publication bias may have suppressed studies that showed low error rates. Second, our classification system for methodologic quality was arbitrary. Third, the studies in our review had a wide range of methods and results that made meta-analysis impossible. Although it is clear that prescription medication history errors are common, a precise description of the problem remains elusive. Some studies systematically overestimated errors because of the failure to distinguish between intentional and unintentional discrepancies. Other studies underestimated errors by focusing only on omission errors. Many studies excluded patients who could not provide a medication history; the error rate would likely be higher among such patients.

The results of our review indicate a need for a systematic approach to ensure the acquisition of accurate medication histories at the time of hospital admission. Physicians may benefit from additional training in obtaining complete medication histories. Such training may improve accuracy and may also help physicians recognize when a medication history is likely to be incomplete. There are many barriers to obtaining accurate medication histories, including patient illness, patient knowledge, availability of medication vials for inspection and lack of access to community pharmacy records. In addition, comprehensive medication histories take 9–30 minutes to complete,<sup>4,5,16–18,23,25</sup> a potentially overwhelming task for busy admitting physicians. Pharmacists could be routinely involved in ensuring accurate medication histories at the time of admission, with particular attention to high-risk groups (e.g., patients with cognitive impairment using multiple medications). Patients and family members could assume a proactive role by bringing necessary medication information to the hospital and drawing attention to any deviations from the prescribed regimen. Integrated community pharmacy databases accessible to hospital staff could also enhance the accuracy of medication histories.

This article has been peer reviewed.

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**Contributors:** Vincent Tam and Edward Etechells contributed significantly to the systematic review's conception and design and to the acquisition, analysis and interpretation of the data. Vincent Tam wrote the first draft of the manuscript and, along with Edward Etechells, was substantially involved in subsequent revisions. Sandra Knowles and Patricia Cornish contributed to the acquisition of the data. Nowell Fine and Romina Marchesano contributed significantly to the acquisition

and analysis of the data. All of the authors provided critical revisions to the manuscript and provided final approval of the submitted manuscript.

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