Assessing the Accuracy of Computerized Medication Histories

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Objective: To determine the accuracy of computerized medication histories.

Study Design: Cross-sectional observational study.

Patients and Methods: The study sample included 493 Department of Veterans Affairs primary care patients aged 65 years or older who were receiving at least 5 prescriptions. A semistructured interview confirmed medication, allergy, and adverse drug reaction (ADR) histories. Accuracy of the computerized medication lists was assessed, including omissions (medications not on the computer record) and commissions (medications on the computer record that were no longer being taken). Allergy and ADR records also were assessed.

Results: Patients were taking a mean of 12.4 medications: 65% prescription, 23% over-the-counter products, and 12% vitamins/herbals. There was complete agreement between the computer medication list and what the patient was taking for only 5.3% of patients. There were 3.1 drug omissions per patient, and 25% of the total number of medications taken by patients were omitted from the electronic medical record. There were 1.3 commissions per patient, and the patients were not taking 12.6% of all active medications on the computer profile. In addition, 23.2% of allergies and 63.9% of ADRs were not in the computerized record.

Conclusions: Very few computerized medication histories were accurate. Inaccurate medication information may compromise patient care and limit the utility of medication databases for research and for assessment of the quality of prescribing and disease management.

(Am J Manag Care. 2004;10(part 2):872-877)

Studies have demonstrated that the medication profile in outpatient and inpatient medical charts often is inaccurate.[1,2] Due to the lack of reliability of the medical record as an accurate source of medication history, many hospitals and clinics have begun using computerized medication profiles, and many groups and government agencies advocate computerized medical records and physician order entry to reduce the incidence of adverse drug events and medication errors.[3-5] However, little is known about the accuracy and reliability of computerized medication lists.

In addition, pharmacy benefit management (PBM) databases are increasingly being utilized in clinical research. Information from these large databases has been used to assess compliance and adverse drug events in several studies.[6-8] In addition to these private insurance databases, the Department of Veterans Affairs (VA) has a large pharmacy database used for clinical research. This VA pharmacy database has been utilized to calculate the Chronic Disease Score (RxRisk-V) to assess the burden of chronic disease on treated populations,[9] assess healthcare utilization within the VA system,[10] and evaluate prescribing practices.[11] To our knowledge, no studies have evaluated the validity of clinical data found in computer medical records.

This study was performed to evaluate the agreement between information in the VA computerized medication profile and information obtained through a structured medication history.

METHODS

Setting

The study was conducted at the Iowa City, Iowa VA Medical Center (VAMC) primary care clinics. The Iowa City VAMC is a 100-bed hospital and a primary teaching affiliate of the University of Iowa Carver College of Medicine. Sixty internal medical residents, 10 staff physicians, 4 physician's assistants, and 3 nurse practitioners staff the primary care clinics.

Patients

The patients in this evaluation were aged 65 years and older, were enrolled in a primary care clinic at the Iowa City VAMC, and had active prescriptions for 5 or more regularly scheduled nontopical medications. Patients with impaired cognitive function or enrolled in a pharmacist-based anticoagulation clinic were excluded. Patients gave informed consent, and the institutional review board at the University of Iowa Carver College of Medicine and Iowa City VAMC approved the study protocol.

Data

A clinical pharmacist evaluated patients at their clinic visit. The evaluation consisted of a focused record

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This research was supported by a grant from the Health Services Research and Development Service, Department of Veterans Affairs (SAF 98-152). Dr Kaboli is supported by a Research Career Development Award from the Health Services Research and Development Service, Department of Veterans Affairs (RCD 03-033-1).

Presented at the 27th Annual Meeting of the Society of General Internal Medicine, Chicago, Ill, May 13, 2004.

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review of the computerized medical record, a semistructured patient interview, identification and classification of medication-related problems, and a history of allergies and adverse drug reactions (ADRs). Medication lists compiled by structured patient interview were compared with computerized medication profiles at the time of the interview to determine overall agreement. Patients were instructed to bring all of their medications with them for the interview.

Table 1. Patient Characteristics and Agreement Between Structured Pharmacist Interview and Computerized Medical Record

Patient Characteristic	Mean or Percentage
No.	493
Mean age, y (± SD)	74.3 ± 5.3
Male	97.8%
Has drug copayment	70.0%
Average number of medications* listed on computer record (± SD)	10.7 ± 4.5
Average number of medications* taken per patient (± SD)	12.4 ± 4.8
Patients with complete agreement between computer record and patient report (% of total number of patients)	26 (5.3%)
Mean number of commissions† per patient (± SD)	1.3 ± 1.6
No. of commissions† (% of total number of medications listed)	665/5253 (12.6%)
Mean number of omissions‡ per patient (± SD)	3.1 ± 2.8
No. of omissions‡ (% of total number of medications taken)	1531/6119 (25.0%)

*Medications include prescription, over-the-counter, and vitamin/herbal products.
†Commissions are the number of medications that were on the computer record, but that were not being taken by the patient. The denominator is the number of medications on the computer list.
‡Omissions are the number of medications that were not on the computer record, but that were being taken by the patient. The denominator is the number of medications taken by the patients.

Accuracy of the computerized medication list was assessed by 3 methods. The first was the percentage of patients who had *perfect agreement* between the medication profile gathered via structured interview (ie, the actual number and names of the medications taken) and the number and names of the medications on the computerized record. The second method assessed *omissions,* which were defined as medications that were not on the computer record, but that currently were taken by the patient. To determine the overall percentage of omissions, the denominator was the actual number of medications taken by the patient. Finally, *commissions* were defined as medications that were on the computer record, but that were not currently taken by the patient. To determine the overall percentage of commissions, the denominator was the total number of medications on the computer record. Omissions and commissions were reported as both the mean number of medications per patient and a percentage of the total number of medications for all patients in aggregate.

The effect of copayment status on commission and omission rates also was examined. Veterans who receive medications dispensed by the VA may be required to make a copayment for their medications. The typical copayment is $7.00 for a 30-day supply of a medication.

Allergy and ADR agreement between computerized profiles and structured patient interview was assessed. An allergy was defined as a known sensitivity or hypersensitivity to a drug, and an ADR was defined as any noxious, unintended, and undesired effect of a drug after doses used in humans for prophylaxis, diagnosis, or therapy. The structured interview was compared with the computerized allergy/ADR information to assess perfect agreement of the allergy/ADR information. Omissions were reported as both the number of patients with an allergy or ADR not included on the medication profile, and the number of allergy and ADR omissions for all patients in aggregate. Commissions included the number of allergies and ADRs found on the computer medical record, but denied by the patient.

Analysis

Proportions, means, and standard deviations were reported where appropriate. Differences between copayment status were compared with a Student's *t* test. All analyses were conducted using SAS version 8.1 for Windows (SAS Institute. Cary, NC).

RESULTS

A total of 493 patients were evaluated. Their mean age was 74.3 years, 97.8% were male, and 70.0% made a copayment for their medications (**Table 1**). Patients had a mean of 10.7 medications on their computer medication profile and were taking a mean of 12.4 medications. Of all medications, 65% were prescription, 23% were over-the-counter (OTC) products, and 12% were vitamins/herbals. The percentage of patients with complete agreement between their computerized medication profile and what they were actually taking was 5.3%.

There was a mean of 1.3 commissions per patient; 12.6% of all medications on the computer list were not

Table 2. Omissions and Commissions Related to Copayment Status*

Computerized Profile Data	Copayment		
	Yes	No	*P* (*t* test)
No. of patients†	344 (70%)	147 (30%)	
Total number of medications	3319	1910	
Mean number of medications per patient (± SD)	9.6 ± 4.1	13.0 ± 4.6	<.01
Mean number of commissions per patient (± SD)	1.3 ± 1.6	1.6 ± 1.7	.06
Total number of commissions of medications	433/3319 (13.0%)	230/1910 (12.0%)	
Total number of medications taken by patients	4050	2037	
Mean number of medications per patient (± SD)	11.8 ± 4.8	13.9 ± 4.4	<.01
Mean number of omissions per patient (± SD)	3.4 ± 3.0	2.4 ± 2.3	<.01
Total number of omissions of medications taken by patients	1164/4050 (28.7%)	357/2037 (17.5%)	

*Copayment status indicates whether veterans were required to make a copayment (yes or no) for medications. Typical copayments were $7.00 per 30-day supply of each medication.
†Because copayment status was not available for 2 patients, the total is 491 patients.

being taken by patients (Table 1). There was a mean of 3.1 omissions per patient; 25.0% of all medications the patients were taking were not included on the computerized medication profile. Our results indicate that very few patients had complete agreement between the structured medication history and computerized medication lists.

We also evaluated the effect of copayment status on the accuracy of the medication profile (**Table 2**). In our sample, 70% of the patients were required to make a copayment for their medications. Patients with a copayment had a mean of 9.6 medications listed on their computerized medication profile, compared with 13.0 in the group without a copayment ($P < .01$). The copayment group had a mean of 1.3 commissions per patient, and the group without a copayment had a mean of 1.6 commissions per patient ($P = .06$). That is, in the copayment group, 13.0% of medications were commissions, compared with 12.0% in the group that did not have to make a copayment. Copayment status was not significantly associated with number of commissions.

To evaluate the omissions, the denominator becomes the total number of medications the patient was actually taking. The copayment group was actually taking a mean of 11.8 medications, compared with 13.9 for the group without a copayment ($P < .01$). The copayment group had 3.4 omissions per patient, and the group without a copayment had 2.4 ($P < .01$) That is, 28.7% of the medications taken by patients with a copayment were not included on the computerized medication record, compared with only 17.5% for patients who did not have a copayment. Patients with a copayment had a significantly higher number of omissions on their computerized record.

Table 3 lists the commissions and omissions by mutually exclusive drug classes. Cardiovascular (16.2%), topical (13.3%), and gastrointestinal (11.5%) agents represent the drug classes most frequently included on the computerized profile that the patients were no longer taking (commissions). Vitamins/minerals (26%), anticoagulant/antiplatelet agents (12.2%), and gastrointestinal agents (11.5%) were the classes of medications most frequently omitted from the computerized medication list (omissions).

Table 4 lists the top 10 commissions and omissions by individual drug name. Aspirin (5.0%), docusate (3.5%), and albuterol (3.1%) were the 3 agents most likely to be found on the computerized list, but which patients were no longer taking (commissions). Sixty-six percent of all commissions were prescription medications. The individual drugs most frequently omitted on the computerized profile were aspirin (10.4%), multivitamins (8.2%), and acetaminophen (6.7%). Thirty-four percent of all omissions were prescription medications.

Two thirds of patients (n = 318) had complete agreement between the computer record and patient report for allergies and ADRs (**Table 5**). Thirty-eight patients (7.7%) reported at least 1 allergy that was not on the computerized medication record. Of the 215 allergies reported by these patients (some patients had more than 1 allergy), 50 allergy omissions (23.2%) were not in the computerized medication record. There were only 2 (0.9%) allergy commissions, in which the patient denied an allergy that was in the computer medical record.

A total of 140 patients (28.3%) reported at least 1 ADR that was not on the computer medication record. Of the 360 total ADRs confirmed by patients, 230 (63.9%) were not included in the computerized medication record. There were 6 ADR commissions (1.6%), in which the patient denied an ADR that was recorded in the computer medical record.

Table 3. Top 18 Commissions and Omissions by Drug Class*

Commissions (n = 636)		Omissions (n =1509)	
Cardiovascular	103 (16.2%)	Vitamins/minerals	393 (26.0%)
Topicals†	97 (13.3%)	Anticoagulant/antiplatelet‡	184 (12.2%)
Gastrointestinal	73 (11.5%)	Gastrointestinal	173 (11.5%)
Respiratory	59 (9.3%)	Herbals	138 (9.2%)
NSAIDS/COX-2 inhibitors	47 (7.4%)	Cardiovascular	124 (8.2%)
Vitamins/minerals	38 (6.0%)	Topicals†	87 (5.8%)
Anticoagulant/antiplatelet‡	38 (6.0%)	Acetaminophen	84 (5.6%)
Ophthalmologic	33 (5.2%)	Respiratory	70 (4.6%)
Endocrine	27 (4.2%)	NSAIDS/COX-2 inhibitors	68 (4.5%)
Antibiotics	20 (3.1%)	Ophthalmologic	35 (2.3%)
Psychiatric drugs	19 (2.9%)	Endocrine	32 (2.1%)
Antihistamines	18 (2.8%)	Antihistamines	22 (1.5%)
Urinary agents	15 (2.4%)	Psychiatric drugs	21 (1.4%)
Nasal sprays	12 (1.9%)	Urinary agents	18 (1.2%)
Miscellaneous	11 (1.7%)	Antibiotics	17 (1.1%)
Acetaminophen	10 (1.6%)	Nasal sprays	16 (1.1%)
Narcotics	8 (1.3%)	Narcotics	16 (1.1%)
Herbals	2 (0.31%)	Miscellaneous	11 (0.7%)

*Commissions are the number of medications that were on the computer record, but that were not being taken by the patient. Omissions are the number of medications that were not on the computer record, but that were being taken by the patient. COX-2 indicates cyclooxegenase-2; NSAID, nonsteroidal anti-inflammatory drug.
†Includes dermatologic and ophthalmic agents.
‡Includes warfarin, aspirin, clopidogrel, and ticlopidine.

DISCUSSION

Our findings have significant implications for patient care as well as research using PBM databases. Because only approximately 1 in 20 patients had perfect agreement between their computerized medication profile and what they were actually taking, systems need to be in place to review medication use at every clinic visit and hospital discharge. This lack of agreement is a function of multiple factors. The first factor influencing the accuracy of the computerized medication profile is the inability to add medications to the VA computer profile that the patient purchased over the counter or that were prescribed by non-VA providers. The VA pharmacy computer system was designed only to include medications dispensed by the VA. This would explain why the top 6 most frequent omissions were OTC medications most likely purchased by the patients outside the VA system. However, the fact that 34% of all omissions were prescription medications purchased outside the VA system is cause for concern. This limitation of the VA computer system significantly hampers the ability to accurately record all the medications a patient is taking.

The VA has recognized this problem, and in the fall of 2004, it is revising the computerized medication profile across the VA to allow non-VA prescribed medications to be recorded. Although this change will allow care providers to input outside medications, it still requires someone to take an accurate medication history and keep the computer profile up to date. This limitation in medication profiles also has been identified by the Joint Commission on Accreditation of Healthcare Organization and has been targeted in their 2005 ambulatory-care national patient safety goals, which state that organizations will "accurately and completely reconcile medications across the continuum of care."[12]

A second reason for the inaccuracy of the computerized profile is failure to update the computerized medical record. Medications may be discontinued by the patient or non-VA providers without informing the primary care provider. Non–primary care providers in the VA also may discontinue or start a medication, especially over the telephone, and fail to update the computerized profile. Entire medication profiles often are renewed at each visit or hospitalization without closely examining the list. This practice may lead to carry over of medications that were previously discontinued by the primary care provider or other providers. The proposed VA computer modifications will not correct the 12.6% commission rate; fixing this problem will require care providers to remove medications that a patient is no longer taking from the active list.

Copayment status also played a significant role in the accuracy of the computerized medication record. Although there was no significant difference in the commission rate by copayment status, patients with a

Table 4. Top 10 Commissions and Omissions by Drug Name*

Commissions (n = 636)		Omissions (n =1509)	
Aspirin	32 (5.0%)	Aspirin	158 (10.4%)
Docusate	22 (3.5%)	Multivitamin	123 (8.2%)
Albuterol inhaler	20 (3.1%)	Acetaminophen	101 (6.7%)
Furosemide	18 (2.8%)	Calcium/vitamin D	82 (5.4%)
Acetaminophen	18 (2.8%)	Vitamin E	64 (4.2%)
Bacitracin/polymyxin	17 (2.7%)	Vitamin C	35 (2.3%)
Ranitidine	16 (2.5%)	Nitroglycerin	34 (2.2%)
Lisinopril	15 (2.4%)	Docusate	30 (2.0%)
Ipratropium inhaler	15 (2.4%)	Aquaphilic ointment	26 (1.7%)
Topical capsaicin	13 (2.0%)	Ibuprofen	24 (1.6%)

*Commissions are the number of medications that were on the computer record, but that were not being taken by the patient. Omissions are the number of medications that were not on the computer record, but that were being taken by the patient.

Table 5. History of Allergy and Adverse Drug Reaction Agreement Between Computer Medical Record and Patient Interview*

Allergy and ADR Data	No. (%) (n = 493)
Perfect agreement between computer record and patient report for allergies and ADRs	318 (64.5)
No. of patients with a confirmed allergy not documented on medication profile	38 (7.7)
Total number of confirmed allergies	215
Allergy omissions†	50/215 (23.2)
Allergy commissions‡	2/217 (0.9)
Number of patients with a confirmed ADR not documented on medication profile	140 (28.3)
Total number of confirmed ADRs	360
ADR omissions†	230/360 (63.9)
ADR commissions‡	6/366 (1.6)

*ADR indicates adverse drug reaction.
†Omissions are the total number of allergies/ADRs that were not on the computer record, but that were reported by patients. The denominator is the total number of allergies/ADRs confirmed by patients.
‡Commissions are the total number of allergies/ADRs that were on the computer record, but that were denied by patients. The denominator is the total number of allergies/ADRs both confirmed and denied by patients.

copayment were much more likely to have medication omissions than those without a copayment. This probably is because many medications, both prescription and nonprescription, can be obtained outside the VA for less than the $7.00 copayment for a 30-day supply. For example, aspirin, multivitamins, and some analgesics and cardiovascular agents can be obtained for less cost to the patient outside the VA. In addition, for the 30% of patients who did not have a copayment, there was likely no financial incentive to purchase any medications outside the VA. Interestingly, patients with no copayment also were taking, on average, more medications than patients who had a copayment. This may be because the medications were free, or because this group of patients had greater illness burden requiring more chronic medication use.

Allergy and ADR information also was frequently inaccurate, with 23.2% of allergies and 63.9% of ADRs not documented in the computerized medication record. This lack of documentation can pose a risk to patients if they are prescribed a medication to which they have a serious allergy such as anaphylaxis. In addition, adverse outcomes or unnecessary medical care could result if patients are prescribed medications to which they already have a known intolerance (ADR).

One of the main concerns about not having an accurate computerized medication profile is patient safety. Adverse drug events and drug–drug or drug–disease interactions are common in outpatients and may lead to excess clinic visits, hospitalizations, side effects, and costs. Drug classes with high risk for drug–drug or drug–disease interactions include cardiovascular drugs, agents that affect the central nervous system, and anticoagulant/antiplatelet agents.[13] These classes account for 26% of the commissions and 23% of the omissions in our study. In a study of outpatients by Gandhi et al, 25% experienced an adverse drug events over a 3-month period.[14] The mean age of their study population was 52 years, and the mean number of medications taken by these patients was 1.53. Our study population was older (mean age 74.3 years) and taking more medications (mean of 12.4), putting them at much higher risk for adverse drug events. In a recent ambulatory VA study of potential drug–dietary supplement interactions, 45% had a potential interaction of any severity, and 6% had the potential for a severe inter-

action.[15] A large meta-analysis found that at least 5% of all hospital admissions are due to ADRs, and about 4% of patients admitted due to drug reactions die.[16] Another study found 5% to 9% of hospital costs were due to ADRs.[17] These studies underscore the potential risk patients incur when taking medications, and although no studies have shown that having more accurate medication histories prevents these adverse outcomes, working with more accurate information is a vital component to safe prescribing and monitoring of medication use.

Inaccurate medication lists also can impact assessments of quality of care. For example, aspirin use in postmyocardial infarction patients is a frequent quality indicator. However in our study sample, 5% of commission and 10% of omission medications were aspirin. Some patients who appear to be taking aspirin are not, and many who do not appear to be receiving aspirin are actually taking it. In addition, cardiovascular drugs, including angiotensin-converting enzyme inhibitors and beta-blockers, represent 8.2% of all omissions. These classes of drugs also are critical in the management of conditions such as congestive heart failure and postmyocardial infarction. These omissions can lead to prescribing of medications that patients are already taking or of similar medications (ie, therapeutic duplication). Similarly, clinicians may fail to realize a patient is not actually taking 1 of the commission drugs and therefore not prescribe medically necessary medications.

Further, our findings identify some of the limitations of using PBM data for quality assurance and research purposes. Although no computerized medication record system will be perfectly accurate all of the time, our results suggest areas for potential improvement. Specifically, a system should be designed that allows for the inclusion of OTC products, vitamins/herbals, and prescription medications from both within and outside the healthcare system. Another area for improvement would be to develop a system that allows for systematic evaluation of medication lists by nurses, providers, and pharmacists. This system should reinforce the need to update medication lists when providers discontinue medications and to use caution when renewing entire profiles. Involving patients by giving them medication lists to review prior to clinic visits also may be a method to continuously update medication profiles.

There are some limitations to our study. The first is that it was conducted in a single VA primary care clinic. Although all VA clinics use the same computerized medical record, there may be systematic differences in the way each facility updates its computerized medical record. Another limitation is the accuracy of the patients' reports of what they were taking. However, the study had a systematic method for reviewing medications, and patients were instructed to bring all of their medications to the clinic for review. Therefore, we do not believe that accuracy of patient reports was an area of significant bias in our study. However, one prior study did show that patient reports during a clinic visit had at least 1 omission 48% of the time, so our findings may in fact be underrepresenting the problem of omissions.[18]

CONCLUSIONS

Our findings outline potential limitations of the VA computerized medication profile. Inaccurate medication lists could result in risks to patient safety and impact the assessment of quality of care. In addition, when using pharmacy records for research, it is important to understand the limitations of the database. When existing computerized medication records are modified (or new systems are developed), the medication profile needs to be systematically assessed and the accuracy maximized, and users should be informed of the inherent limitations of such systems.

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