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# The Accuracy of Electronic Medical Record Medication Reconciliation in Emergency Department Patients

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## Abstract

**Background—**Medication history discrepancies have the potential to cause significant adverse clinical effects for patients. More than 40% of medication errors can be traced to inadequate reconciliation.

**Objective—**The objective of this study was to determine the accuracy of electronic medical record (EMR) reconciled medication lists obtained in an academic emergency department (ED).

**Methods—**Comprehensive research medication ingestion histories for the 48 hours preceding emergency department (ED) visit were performed and compared to reconciled EMR medication lists in a convenience sample of ED patients. The reconciled EMR list of prescription, non-prescription, vitamins, herbals, and supplement medications were compared against a structured research medication history tool. We measured the accuracy of the reconciled EMR list versus the research history for all classes of medications as the primary outcome.

**Results—**502 subjects were enrolled. The overall accuracy of EMR recorded ingestion histories in the preceding 48 hours was poor. The EMR was accurate in only 21.9% of cases. Neither age ≥ 65 (OR 1.3 [95% CI: 0.6, 2.6]) nor gender (female versus male: OR 1.5 [95% CI: 0.9, 2.5]) were predictors of accurate EMR history. In the inaccurate EMRs, prescription lists were more likely to include medications that the subject did not report using (78.9%), while the EMR was more likely to not to capture non-prescriptions (76.1%), vitamins (73.0%), supplements (67.3%), and herbals (89.1%) that the subject reported using.



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**Conclusion—**Medication ingestion histories procured through triage EMR reconciliation are often inaccurate and additional strategies are needed to obtain an accurate list.

### Keywords

Electronic medical record; emergency department medications; medication reconciliation; medication history; reconciliation

## Introduction

Medication history discrepancies have the potential to cause significant pain or clinical deterioration in more than 38% of patients admitted to the hospital (1). Medication reconciliation involves collecting a complete list of current medications and then updating the medical record to include all active medications and remove all inactive medications. Medication reconciliation is the first step in preventing medication errors, and The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has mandated reconciliation during each patient encounter since 2005 (2).

While reconciliation is mandated and routinely performed, there is evidence that the process does not result in an accurate medication list. Up to 60% of patients admitted to the hospital have at least 1 medication reconciliation error (1, 3, 4). More than 40% of medication errors can be traced to inadequate reconciliation in handoffs during admission, transfer, and discharge of patients (5). Once an error occurs, it is likely to be carried through patient care transitions; therefore, obtaining the most accurate medication history in the emergency department can improve patient safety (1).

Electronic medical records (EMR) are becoming more common and offer several advantages over paper records for medication reconciliation. First, the EMR generates consistent, updated information for all providers caring for the patient (6, 7). Second, it can automatically identify duplicate therapies and medication interactions (8). Finally, the EMR can generate a list for patients to improve compliance after discharge (9). However, if the EMR is inaccurate, these advantages are lost. The objective of this study was to determine the accuracy of EMR reconciled medication lists obtained in an academic emergency department (ED).

## Methods

### Patients and Study Setting

This was a secondary analysis of a prospective observational cohort gathered in an academic US ED with approximately 72,000 patient visits per year. A convenience sample of ED patients was enrolled between June 4$^{th}$, 2012 and January 25$^{th}$ 2013. Enrollment was performed between the hours of 9am and 5pm. The subjects recruited during “business hours” are not statistically different, in regards to sex and race, when compared to the overall ED population demographics. This sampling method outperforms 4-hour time block sampling (10). Subjects included in the parent study if they self-reported pain or nausea identified during the initial nursing assessment. Subjects were randomized to protocolized opioid and anti-emetic medication administration (11). Patients were excluded if they were

under 18 years of age, unable to speak English, or previously diagnosed with chronic pain or cyclic vomiting. Overdose patients and those with acute altered mental status were excluded. In patients with dementia or critical illness the medication ingestion history was reconciled with the healthcare proxy. Patients were approached after triage, after nurse medication reconciliation, and after initial stabilization when the patient arrived by ambulance. The local institutional review board approved the study and all subjects provided written informed consent. The research was performed in accordance with the Declaration of Helsinki, as revised in 2000 (12).

## Medication Ingestion Histories

Following nursing EMR medication list reconciliation, detailed medication histories for the 48 hours preceding the ED visit were obtained by the principal investigator or a professional research assistant trained in identical methods. All prescription, non-prescription, vitamin, herbals, and supplement medications were captured along with the dose and time since the patient's last dose. Medication histories were gathered in a structured format. Initially, we asked, "what medications have you taken in the last 48 hours?" We then asked specifically about the use of prescription medications, non-prescription medications, vitamin, herbals or traditional medications, and dietary supplements. All reported medications were recorded. When available, pill bottles were obtained to verify medication doses. If the patient had difficulty recalling the prescription name, their pharmacy was contacted to ensure accuracy of the obtained history. Over the counter non-prescription combination formulations were reconciled using internet pictures to verify the specific product ingested. Interviews ranged from approximately thirty seconds, for those not taking medications, to approximately 5 minutes in patients with several co-morbidities.

The electronic medical record, previously updated by the triage nurse or treating nurse, was compared with the research history. An "accurate history" was considered 100% agreement between reconciled EMR and the research medication ingestion history. 100% agreement was used as "accurate" since any inaccuracy, regardless of medication class, may result in negative effects on clinical conditions or result in medication interactions. Episodically taken medications were considered accurate if listed "as needed" (PRN) in the EMR. Dose discrepancies were not considered inaccurate if the medication was listed in the EMR but the dose was different per the research history. Each EMR was coded as 1) medications in EMR, patient taking 2) medications in EMR, patient not taking 3) medications not in EMR, patient not taking or 4) medications not in EMR, patient taking. Therefore each record could have 2 inaccuracies (both medications in EMR but patient not taking and medications not in EMR but patient taking).

## Classification of medications

A prescription medication was considered any medication that could only be obtained with a physician prescription. Non-prescription medications were considered to be any medication available in any form not requiring a prescription. For instance, while ibuprofen is available as a prescription, it would be classified as a non-prescription medication. Combination vitamin formulations, including supplements such as iron or folic acid, were coded as each individual medication in the formulation; the vitamin was classified as such and the iron or

folic acid were classified as supplements. Herbal medications were considered to be anything that is solely plant derived. Therefore, fish oil and glucosamine were considered supplements. Vitamins and supplements were not considered inaccurate if listed generically, such as multivitamin containing both vitamins and supplements.

### Statistical Analysis

We measured the accuracy of the EMR medication list compared to the reported medication use for each medication category. Odds ratios were calculated for the accuracy of the medication list when patients were either taking or not taking medication classes. Predictive values for the EMR and research history concordance were calculated. A logistic regression analysis including age ≥ 65 years, gender, and patient report of taking a prescription, non-prescription, vitamins, supplements, and herbal as the predicting variables of an accurate EMR. Analysis was performed with JMP® 10.0.

## Results

Five hundred and two of 655 (76.6%) approached patients consented to enrollment. The overall demographics of the sample were representative of the ED population during the sampling period (Table 1). Two hundred eighty six (56.9%) of the patients were enrolled through triage; the remainders were enrolled in the ED after initial stabilization or after ambulance arrival. Based upon the research medication history, the median number of medications taken by subjects was 3 (IQR: 1, 6). Prescription medications were used more commonly than any other medication class (n=438, 87.3%).

The overall accuracy of EMR recorded ingestion histories in the preceding 48 hours was poor. Overall, the EMR was 100% accurate in only 21.9% of cases. Predicting variables in the logistic model of an accurate EMR were a subject history of having taken a prescription (OR 4.2 [95% CI: 2.1, 8.5]), a non-prescription (OR 7.9 [95% CI: 4.6, 13.9]), not taking a vitamin (OR 0.4 [95% CI: 0.2, 0.8]), or taking a supplement (OR 2.2 [95% CI: 1.1, 4.5]) in the 48 hours prior to ED presentation. Neither age ≥ 65 (OR 1.3 [95% CI: 0.6, 2.6]), gender (female versus male: OR 1.5 [95% CI: 0.9, 2.5]), nor herbal medication ingestion (OR 0.9 [95% CI: 0.5, 1.8]) were predictors of accurate EMR history.

The inaccuracy was consistent whether patients were taking a medication or not (OR 1.06 [95% CI: 0.5, 2.28]), meaning the EMR was inaccurate for subjects taking medications and those that were taking none. Twenty-eight patients had no medications listed in the EMR and only 10 of these patients reported not taking any medications in the preceding 48 hours. The negative predictive values of the reconciled EMR were particularly poor for prescriptions and non-prescription medication classes (Table 2). This means that if the reconciled list does not contain a prescription or non-prescription, the patient is actually not taking the class in only 46.7% and 41.7% of cases, respectively. The higher positive and negative predictive values for vitamins, herbals, and supplements are a reflection of the overall lower use of these classes rather than improved history taking for these classes.

In the inaccurate EMRs, prescription medication lists were more likely to include medications that the subject did not report using and were more likely to not include non-

prescription, vitamins, supplements, and herbals that the subject reported using (Table 3). Three hundred and seventy two (74.1%) of the 502 patients enrolled reported taking non-prescription medications in the prior 48 hours yet 45% of the reconciled EMRs were inaccurate for this class; 76.1% of the inaccurate charts required additions to the non-prescription medication list. Vitamins, supplements, and herbals needed additions with high frequency as well (Table 3).

## Discussion

Medication lists available at the time of initial emergency physician (EPs) contact are often inaccurate. This has significant implications for physicians wishing to initiate medication therapy immediately. An inaccurate medication ingestion history in the EMR limits the utility of automated checks for medication interactions and would not identify duplicate therapies. This highlights the need for improved medication reconciliation early in the care of ED patients.

Increasing the accuracy of reconciled medication lists can be accomplished in several ways; either physicians or nurses must spend the time to specifically ask about each class of medication, or pharmacy technicians must be available to reconcile medication ingestion histories early in the patient encounter. Nurses have been shown to spend in excess of an hour per patient admission or transfer trying to accurately identify medications a patient has been receiving (5). This is clearly not feasible in an ED setting. Physicians fail to identify 10–67% of medications on routine history during patient care (13) and triage nurses miss at least 1 medication in 48% of cases (14). Pharmacist (15) or pharmacy technicians utilizing a structured history are superior to a nurse or physician obtained reconciliation in patients admitted to the hospital (16). EPs and nurses are often focused on direct patient care and stabilization, making pharmacy technicians the preferable resource to improve medication reconciliation. This also suggests that a more structured informational technology solution, such as forced entry fields for each medication class, may improve the reconciliation process.

We were not able to identify demographic factors associated with increased risk to provide an inaccurate history. Histories are inaccurate across all demographics and all medication classes. In our ED, reconciliation was more likely to be accurate only if the patient was not taking the specific medication class. Importantly, prescription medication lists commonly contained too many medications while non-prescription medication lists were inaccurate due to omissions. This suggests a reliance on previously populated medication lists within the EMR; prior lists seem to be accepted as accurate rather than systematically reconciled. Non-prescription, vitamins, supplements, and herbals do not seem to be adequately captured in the EMR. While increased age leads to increased co-morbidity and subsequently an increase in the number of medications this was not associated with less accurate EMR reconciliation. We believe that poorly reconciled non-prescriptions, vitamins, and supplements likely explains the pervasive inaccuracy in the younger demographic.

Medication doses were captured as part of the medication ingestion history though dosing discrepancies were not considered to be inaccurate in this study. This may bias the results

toward the null hypothesis, that EMR reconciliation is accurate. Certainly higher doses of some medications, such as antiepileptics, are more likely to lead to significant ADEs and we would not have identified the dosing inaccuracies.

There are several implications of inaccurate medication histories in the EMR. Providing urgent pharmaceutical intervention and changing outpatient therapy without knowing the medications a patient is taking is a significant safety concern. Overlooked non-prescriptions can result in duplication. Examples of this are adding a prescription NSAID when someone is already taking non-prescription ibuprofen, or supratherapeutic ingestion of a potentially toxic medication, such as addition of an acetaminophen-opioid combination in someone taking non-prescription acetaminophen. One prior study found that half of missed medications are clinically important in patients admitted to the hospital (13). In addition, physicians may believe a patient is taking a prescription and assume that recurrent disease represents treatment failure rather than non-compliance. This flawed interpretation may lead to a physician choosing second line therapies. These second line choices inherently decrease safety and efficacy as well as increase health care costs.

Accurate medication reconciliation is necessary to perform a valid medication review and avoid drug-drug interaction (17). While the EMR is a valuable tool to capture medication histories, it is clear that in our population the data captured by the tool is inaccurate. Additional strategies, such as pharmacy technician reconciliation, are needed to improve the accuracy of EMR medication lists in the ED.

## Limitations

The internal validity of our study is limited by using patient histories as the gold standard. It is possible patients did not remember their medication ingestions accurately though we contend that the structured format is more likely to be accurate than the EMR list. It is possible that medication history may improve when asked several times throughout an ED stay resulting a bias toward inaccurate EMR medications lists. This possibility supports our assertion that a structured medication history may augment the initial EMR medication reconciliation. We used a business hour non-consecutive sampling method and it is possible that histories obtained at different times may have different accuracy. This is the most feasible sampling method within our ED and represents sex and race demographics well (10). Since random 24 hour, 7 days a week or true random sampling was logistically infeasible for this prospective study, this method allowed a reasonable demographic representation of our ED population. However, using this sampling method we can’t account for variability in the reconciliation practices of other shifts. The external validity of the study is limited because we did not enroll all patients presenting to the ED but rather a convenience sample of patients with nausea or pain. It is possible that these symptoms decrease the ability to accurately reconcile their medication lists. However, we approached the vast majority of patients immediately after triage reconciliation when symptoms were presumably unchanged. Pain is the most common symptom bringing patients to the ED accounting for up to 78% of all chief complaints (18–20). Therefore the chosen population represents a large proportion of the overall ED population. We also did not include non-English speaking patients and therefore these results can’t be generalized to these patients.

The vast majority of EDs rely on nurses to reconcile medication lists of patients and more than 80% of hospitals utilize an EMR (21). Variability in EMRs or reconciliation protocols may alter the accuracy of reconciled lists between hospitals.

### Conclusion

In conclusion, medication ingestion histories procured through triage EMR reconciliation are often inaccurate and additional strategies are needed to obtain an accurate list.

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## Article Summary

1. **Why is this important?** Electronic medical record (EMR) medication lists are used to reconcile patient medication lists in the emergency department (ED). Failure to accurately update this list can lead to duplication of therapies or drug-drug interactions.
2. **What does this study attempt to show?** This study sought to determine the accuracy of reconciled EMR lists in ED patients.
3. **What are the key findings?** Reconciled EMR lists were inaccurate in 78.1% of patients. The biggest drivers of these discrepancies are failure to remove discontinued prescription medications and failure to capture over-the-counter medications (OTCs).
4. **How is patient care impacted?** Inaccurate medication lists put patients at risk of therapy duplication or drug-drug interactions. Additional resources, such as pharmacy technicians, are needed to improve medication reconciliation in the EMR.

**Table 1**

Subject Demographics

| Demographic Variable | Total Group n=502 |
|---|---|
| **Age, years (Range, IQR)** | 39 (18–89, 22, 53) |
| **Male n (%)** | 198 (39.4) |
| **Ethnicity** | |
| **Hispanic/Latino n (%)** | 98 (19.5) |
| **Race** | |
| **Caucasian n (%)** | 326 (64.9) |
| **African American n (%)** | 162 (32.3) |
| **Asian n (%)** | 9 (1.8) |
| **American Indian/Alaskan Native n (%)** | 19 (3.8) |
| **Native Hawaiian/Pacific Islander n (%)** | 6 (1.2) |
| **Median number of medications taken (Range, IQR)** | 3 (0–33, 1, 6) |

**Table 2**

**The Accuracy of The Reconciled EMR**

Individual EMRs may have medications added and deleted therefore the total positive and negative values may total more than the total number of subjects taking the medication class. Each EMR was coded as 1) medications in EMR, patient taking 2) medications in EMR, patient not taking 3) medications not in EMR, patient not taking or 4) medications not in EMR, patient taking. Therefore each record could have 2 inaccuracies (medications in EMR but patient not taking and medications not in EMR but patient taking). The positive (PPV) and negative predictive values (NPV) of the reconciled EMR medication lists were calculated.

| Medication class, number taking the class Total n=502 | Accurate EMRs In Subjects Taking the Class n (%) | EMR Including Medication | | EMR Not Including Medication | | PPV | NPV |
|---|---|---|---|---|---|---|---|
| | | History Positive (True Positive) | History Negative (False Positive) | History Negative (True Negative) | History Positive (False Negative) | | |
| **Prescriptions** n=438 | 229 (45.6%) | 365 | 218 | 64 | 73 | 62.6% | 46.7% |
| **Non-prescriptions** n=372 | 275 (54.8%) | 190 | 81 | 130 | 182 | 70.1% | 41.7% |
| **Vitamins** n=209 | 401 (79.9%) | 117 | 27 | 293 | 92 | 81.3% | 76.1% |
| **Supplements** n=111 | 409 (81.5%) | 55 | 9 | 493 | 75 | 85.9% | 86.8% |
| **Herbals** n=100 | 448 (89.2%) | 64 | 9 | 402 | 46 | 87.7% | 89.7% |

## Table 3

The Composition of Inaccurate Medication Ingestion Histories by Medication Class.

| Medication Class | Number Inaccurate n (%) | EMR missed a medication subject reported n (%) | EMR included medication subject did not report n (%) |
|---|---|---|---|
| **Prescriptions** | 392 (78.1%) | 104 (26.5%) | 313 (79.8%) |
| **Non-prescriptions** | 226 (45.0%) | 172 (76.1%) | 72 (31.8%) |
| **Vitamins** | 100 (19.9%) | 73 (73.0%) | 29 (29.0%) |
| **Herbals** | 55 (10.9%) | 37 (67.3%) | 7 (12.7%) |
| **Supplements** | 92 (18.3%) | 81 (89.1%) | 11 (11.9) |