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Quantifying Discharge Medication Reconciliation Errors at 2 Pediatric Hospitals

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Abstract

Introduction: Medication reconciliation errors (MREs) are common and can lead to significant patient harm. Quality improvement efforts to identify and reduce these errors typically rely on resource-intensive chart reviews or adverse event reporting. Quantifying these errors hospital-wide is complicated and rarely done. The purpose of this study is to define a set of 6 MREs that can be easily identified across an entire healthcare organization and report their prevalence at 2 pediatric hospitals. **Methods:** An algorithmic analysis of discharge medication lists and confirmation by clinician reviewers was used to find the prevalence of the 6 discharge MREs at 2 pediatric hospitals. These errors represent deviations from the standards for medication instruction completeness, clarity, and safety. The 6 error types are Duplication, Missing Route, Missing Dose, Missing Frequency, Unlisted Medication, and See Instructions errors. **Results:** This study analyzed 67,339 discharge medications and detected MREs commonly at both hospitals. For Institution A, a total of 4,234 errors were identified, with 29.9% of discharges containing at least one error and an average of 0.7 errors per discharge. For Institution B, a total of 5,942 errors were identified, with 42.2% of discharges containing at least 1 error and an average of 1.6 errors per discharge. The most common error types were Duplication and See Instructions errors. **Conclusion:** The presented method shows these MREs to be a common finding in pediatric care. This work offers a tool to strengthen hospital-wide quality improvement efforts to reduce pediatric medication errors. *(Pediatr Qual Saf 2021;6:e436; doi: 10.1097/pq9.0000000000000436; Published online July 28, 2021.)*

INTRODUCTION

Medication errors are a well-known cause of patient harm in the United States, resulting in an estimated 7,000 patient deaths annually.[1] Transitions of care, including hospital admissions, transfers, and discharges, are considered high risk for introducing such medication errors.[2,3] The Joint Commission's National Patient Safety Goals and the Institute for Healthcare Improvement identify accurate medication reconciliation as a critical element to patient safety.[4,5] The Centers for Medicare & Medicaid Services Electronic Health Records (EHRs) Incentive Program has encouraged the use of electronic medication reconciliation processes as part of its Promoting Interoperability Program.[6] Effective practices are shown to reduce patient harm, including a study that showed 75% of clinically important medication discrepancies are identified and corrected.[7] However, inaccurate medication reconciliation is common, with pediatric studies showing errors in 22%–72.3% of cases.[8,9] As a result, numerous quality improvement efforts in pediatric institutions have focused on tracking and decreasing medication reconciliation errors (MREs).[10,11] However, the reach of these quality improvement efforts is typically limited by the time and clinical expertise required to evaluate a relatively small sample of reconciled medication lists,[8,12] or reliance on a system of voluntary reporting of adverse medication events.[13]

Attempts to reduce MREs across an entire healthcare organization face significant barriers. Effective quality improvement requires iterative evaluations of a given intervention, yet the cost of completing multiple,

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large-scale, manual reviews of medication reconciliation accuracy is prohibitive. Strategies to offer targeted interventions (ie, supplemental pharmacist review or staff training) are difficult without insight into where MREs commonly arise within an organization. Some EHR functionality can reduce MREs,[14,15] including tracking medication reconciliation completion rates.[11] However, a recent single-site study showed medication reconciliation completion status correlates poorly with medication reconciliation accuracy.[16]

The purpose of this study is to propose a set of 6 MREs that can be easily tracked across an entire hospital system to support iterative, large-scale quality improvement efforts to reduce medication errors. This study pilots a process of algorithmic and clinician review of discharge medication lists at 2 pediatric hospitals, each using a different commercial EHR product. The primary reported metric is the prevalence of the proposed MREs.

METHODS

Lucile Packard Children's Hospital is a 303-bed academic, freestanding, tertiary care children's hospital affiliated with Stanford University. Seattle Children's Hospital is a 407-bed, freestanding children's hospital that serves as a quaternary referral center for Alaska, Idaho, Montana, Washington, and Wyoming. Study data were completed discharge medication lists from January 1, 2018, to June 30, 2018, from the EHRs (Epic Systems, Verona, Wis.; Cerner Health Corporation, Kansas City, Mo.) of both participating institutions. These data were limited to include only patients discharged from inpatient pediatric medical and surgical services (ie, excluded admissions to areas such as obstetric care, infusion, or imaging, and excluded ambulatory and emergency department visits). Discharge medication lists were limited only to those medications that the patient was instructed to continue taking after discharge, either from a newly prescribed medication or continuing a prehospitalization medication. Associated admission medication lists were not included in this study.

A team that included a physician, inpatient pharmacist, and EHR data analyst designed a rule-based algorithm to identify 6 types of MREs related to medication reconciliation safety, completeness, and clarity. These errors represent deviations from the standards established by the MARQUIS (Multi-Center Medication Reconciliation Quality Improvement Study) guidelines developed by the Society of Hospital Medicine (errors 1–5, below) and the evidence that computerized clinical decision support (CDS) is beneficial in reducing medication prescription errors (errors 5 and 6, below).[17–20]

The 6 MREs are as follows:

1. Duplication Errors

The same medication appears more than once on a discharge medication list. No error was recorded if the discharge medication list showed a valid indication for duplication.

2. Missing Medication Route Errors

Medication instructions lack the administration route.

3. Missing Medication Dose Errors

Medication instructions lack the administration dose.

4. Missing Medication Frequency Errors

Medication instructions lack administration frequency.

5. Unlisted Medication Errors

Recorded medication names such as Unlisted Medication, Nonformulary, or similar generic labels. Reviewers marked this result as erroneous if the medication was, in fact, in the EHR database or if the medication was not in the EHR database and not explicitly named elsewhere on the prescription. The medication name is essential information, and mapping a medication within the EHR enables additional prescription safety tools, such as drug–drug and drug–disease interactions, allergy warnings, and dose range checking.

6. See Instructions Errors

Medications for which some or all of the components of the administration instructions (dose, frequency, and route) were not provided in the discrete fields and instead provided as free text in an "Instructions" comment box. This finding is an error because it bypasses available medication prescription safety tools (eg, dose range checking, weight-based dosing, cumulative daily dosing, and automated prescription translation).

See Table 1 for examples of the above error types. See Table 2 for a description of the logic used by the algorithm to flag each error type. A physician or pharmacist reviewed all errors identified by the algorithm, and only those confirmed by clinician review were considered errors. A clinician did not review medications that were not flagged as erroneous by the algorithm. All reviewers agreed on definitions of error types, with site-specific interpretations reviewed and confirmed by each institution's review team.

Each discharge medication's outcome metric was a binary indicator for each of the six types of MRE, indicating the confirmed presence or absence of the given error type. Multiple error types could be present for a single medication. Statistical analysis included overall error counts, error counts by error type, errors per discharge, and percent of discharges with at least 1 error.

RESULTS

This study reviewed 67,339 discharge medications (63% from Institution A and 37% from Institution B). Institution A averaged 7.1 medications per discharge, whereas Institution B averaged 6.9 medications per

Table 1. Example Discharge Medication List

	Medication Name	Dose	Frequency	Route	Instructions
No Error	Zonisamide 100mg tablet	600 mg	Daily	Oral	Take 6 tablets by mouth daily
Duplication Error	Diazepam 2mg tablet	2 mg	Daily	Oral	Take 1 tablet by mouth daily
	Diazepam 2mg tablet	2 mg	Daily	Oral	Take 1 tablet by mouth daily
Missing Route Error	Zonisamide 100mg tablet	600 mg	Daily		Take 6 tablets daily
Missing Dose Error	Zonisamide 100mg tablet		Daily	Oral	Take by mouth daily
Missing Frequency Error	Zonisamide 100mg tablet	600mg		Oral	Take 6 tablets by mouth
Unlisted Medication Error	Unlisted Med	2 tablets	Daily	Oral	Take 2 tablets by mouth daily
See Instructions Error	Baclofen 10mg tablet				Take 1 tablet by mouth daily

Medication instructions without an error and with one of each error type are shown.

discharge. For Institution A, there were 4,234 errors, with 29.9% of discharges containing at least 1 error. This result corresponds to an average of 0.7 errors per discharge. For Institution B, there were 5,942 errors, with 42.2% of discharges containing at least 1 error, corresponding to an average of 1.6 errors per discharge (see Table 3). The most common error types were Duplication errors and See Instructions errors, for Institution A and Institution B, respectively. Figure 1 shows the count of discharge medications with errors identified at each institution, and Figure 2 shows the percent of discharge medications with errors identified at each institution.

Reviewers for Institution A confirmed 51% of errors identified by the algorithm, and reviewers for Institution B confirmed 41%. See Figure 3 for a summary of the error identification process.

DISCUSSION

This report defines a novel set of 6 discharge MREs commonly found in discharge medication lists from 2 pediatric hospitals.

A review of the literature failed to identify any other reports of large-scale MRE detection programs. An earlier systematic review identified studies that quantify MREs in pediatric hospitals and the largest sample size was less than 300 patients.[8] Because of its high false-positive rate of 55%, the algorithm presented here is not intended to identify MREs alone. Instead, it functions as a screening tool to increase the efficiency of a clinician reviewer. The errors confirmed by clinician review can then guide further interventions, such as pharmacist review of medication lists or clinician education,[21] to decrease MREs, and improve medication safety. Furthermore, this method's relative ease enables iterative measurements in conjunction with the implementation of other interventions. Additional refinement of the algorithm is necessary to lower the false-positive rate to decrease the time required for clinician review and encourage broader adoption of the tool. This refinement could occur through narrowing its focus onto a subset of the six error types, adaptation to address local prescribing conventions, and incorporating EHR-specific characteristics.

This study defines a set of MREs in which the medication reconciliation process fails to provide clear and complete information to patients and their families. The communication of accurate medication instructions is critical to preventing medication errors. The American Academy of Pediatrics cites "miscommunication" and "improper documentation" as 2 of the top 10 reasons for medication errors in pediatric care.[20] The Joint Commission identifies poor communication in transitions of care "as a cause of many medication errors."[22] Missing or duplicated medication information on hospital discharge can cause significant downstream harm due

Table 2. Description of Logic Used by Algorithm to Flag Errors, by Error Type

Medication Name	Dose	Frequency	Route	Instructions	SIG
A	B	C	D	E	F

Error Type	Algorithm Logic to Flag Error
Duplication Error	A is listed two or more times on a discharge medication list
Missing Route Error	D is empty
Missing Dose Error	B is empty
Missing Frequency Error	C is empty
Unlisted Medication Error	A contains "NF" or "Non Formulary" or "Unlisted"
See Instructions Error	(B and C and D are empty) and (E or F is not empty)

Upper section represents a generic medication from a discharge medication list, with letters A–F representing components of the medication instructions. Lower portion outlines logic to flag each error type.

Table 3. Results Summary, by Institution

	Institution A	Institution B
Total number of discharge medications	42,139	25,200
Total number of discharges	5,936	3,640
No. discharges with at least 1 error	1,773	1,537
Total number of errors	4,234	5,942
Average number of errors per discharge	0.7	1.6
Percent of discharges with at least 1 error	29.9%	42.2%

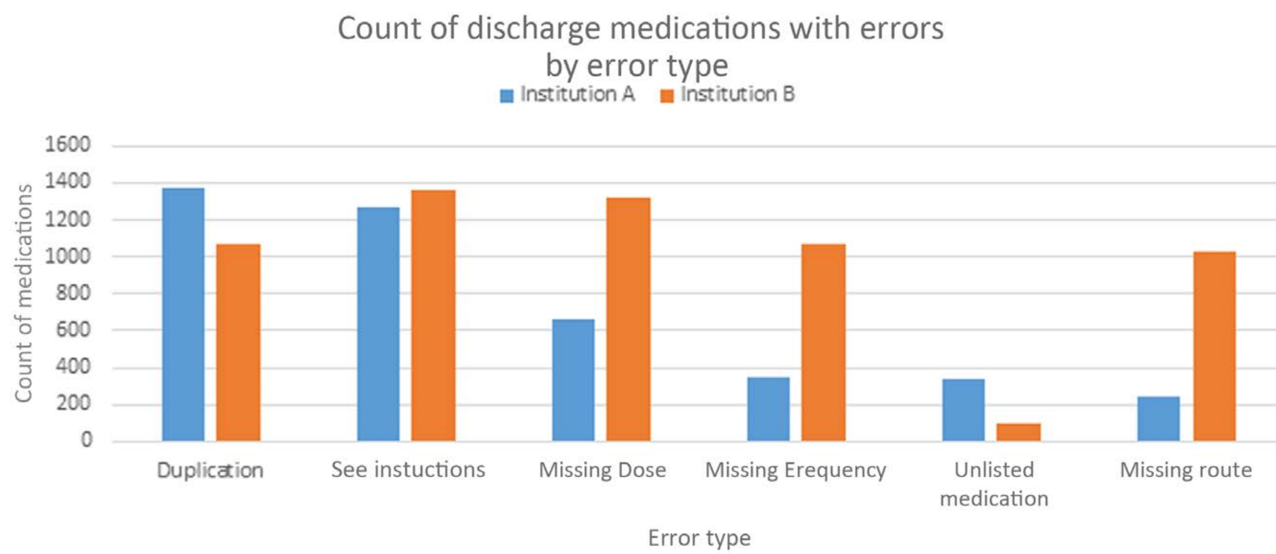

Fig. 1. Total number of each error type identified at each institution (N = 10,176). Error types ordered by descending count of Institution A.

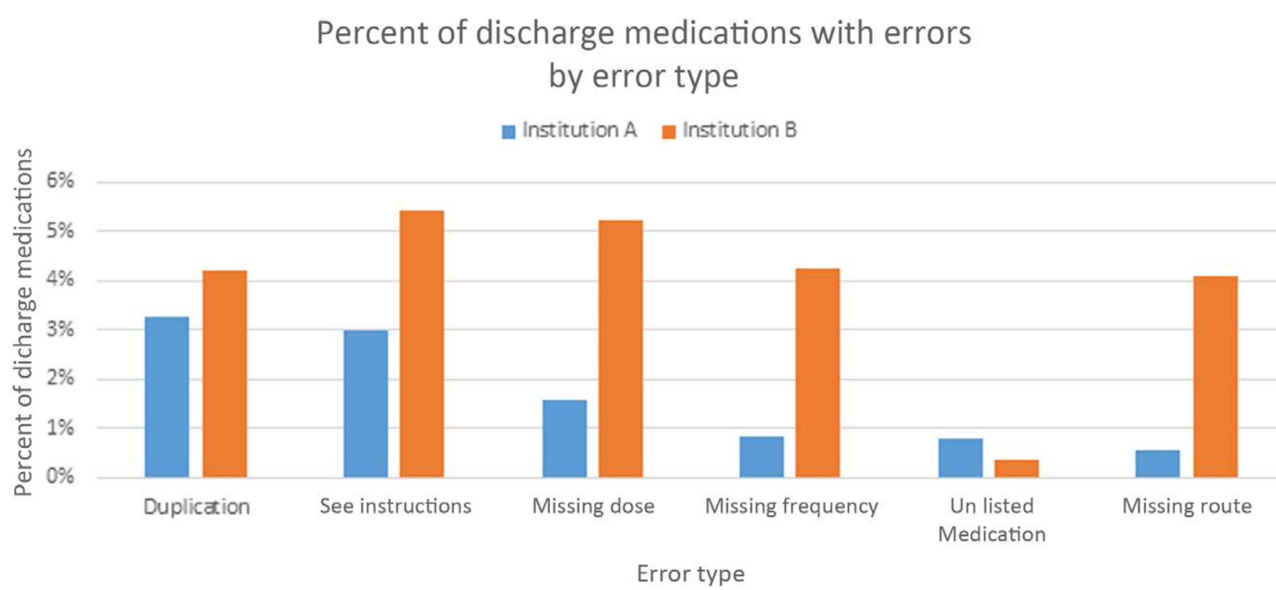

Fig. 2. Numerator is the number of each error type identified at each institution; the denominator is the number of total discharge medications at each institution. Note that multiple errors could be present for a single discharge medication. Error types ordered by descending percent value of Institution A.

to patient, caregiver, and outpatient provider confusion. Discharge medication lists are also frequently the starting point for subsequent admission medication reconciliations ambiguities, potentially contributing to errors during future hospitalizations.

This study's limitations include incomplete capture of all discharge medication errors—missed inaccuracies include those medication errors due to dose, route, frequency, formulation, and instruction errors and not due to an omission. Omitted or erroneously continued medications were also not identified by this methodology. An additional limitation includes the inability to assess alternative methods of communicating medication instructions outside of the discharge medication list (eg, verbal review, medication calendars, and prescription labels) that may have counteracted errors detected or created new ones. Variability in reviewer clinical role (ie, MD vs. PharmD) may have impacted the interpretation of clinical appropriateness of errors flagged as Duplication errors.

The National Coordinating Council of Medication Error Reporting and Prevention's Taxonomy of Medication Errors would conservatively categorize these MREs as Category C ("An error occurred that reached the patient, but did not cause patient harm").[23] Discharge workflows at both participating institutions include providing the family with a printed copy of the

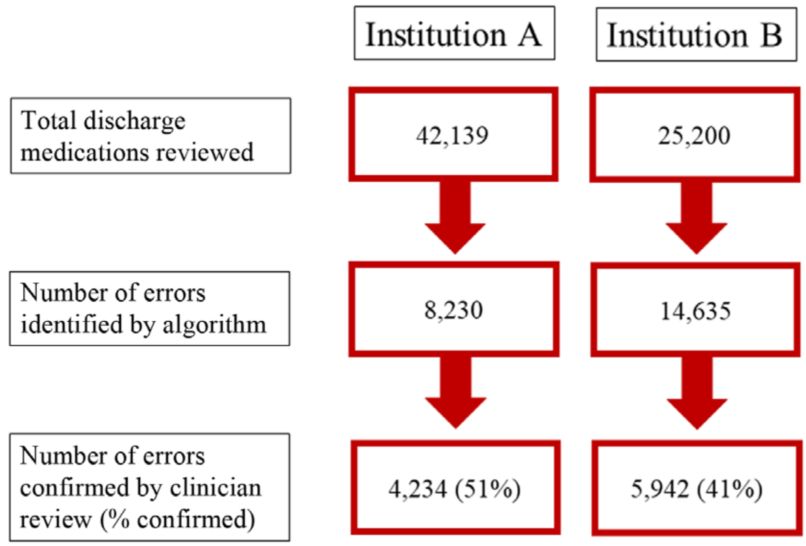

Fig. 3. At each institution, all discharge medications were analyzed by an algorithm to identify six error types. A clinician reviewed each error identified by the algorithm. Reported errors were only those confirmed by a clinician.

discharge medication list. However, a discharge medication list is neither a prescription nor an inpatient medication order; thus, it does not serve as the primary source of medication administration instructions. The extent to which an unclear medication list leads to direct patient harm is unknown and would benefit from further study.

This study does not establish benchmark comparisons between institutions regarding these MREs. Factors affecting the error rates include local prescribing practices, ongoing quality improvement efforts, and heterogeneous patient populations. For example, the endocrinology department at Institution B does not include insulin dosing instructions for diabetic patients on their discharge medication lists. Instead, it uses a separate instructions document with the appropriate regimen. This practice is counted as an error for this study but is well within appropriate practice standards.

Additionally, Institution A is undertaking a medication safety quality improvement initiative that began approximately 1 year before the study period. It uses the presented monitoring tool in monthly tracking reports. This initiative includes monitoring individual and department medication reconciliation accuracy, fine-tuning workflows within the EHR, and identifying clinicians who may benefit from additional EHR training. No such interventions have taken place at Institution B. Finally, this study does not include patient demographics, disease type, or disease severity information. This limits comparisons between the 2 patient populations.

While not without limitations, this approach to monitoring discharge MREs begins an essential conversation about how to better leverage EHRs to improve medication safety on a large scale. For example, Institution B is integrating this method into the EHR to provide real-time feedback to providers at the time of medication reconciliation completion with warnings about duplicated medications. Further work is needed to investigate the concordance between MREs identified by this approach and more established methods, such as pharmacist and patient medication reviews.

CONCLUSIONS

This study defines a set of 6 discharge MREs and shows them to be common occurrences in discharge medication lists from two pediatric hospitals. Tracking these MREs offers a feasible approach to iterative, hospital-wide monitoring and could be a valuable tool in quality improvement efforts to reduce pediatric medication errors.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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