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RESEARCH ARTICLE

IMPROVING ACCURACY OF DISCHARGE SUMMARY MEDICATION LISTS – A COMPREHENSIVE ELECTRONIC MEDICAL RECORD QUALITY IMPROVEMENT PROJECT

Winnie Tao[1], Hamish Rodda[2,3], Nick Monypenny[2], Paul Wembridge[1,4]*

1. Pharmacy Department, Eastern Health, 8 Arnold Street, Box Hill, Victoria, 3128, Australia
2. eHealth Department, Eastern Health, 8 Arnold Street, Box Hill, Victoria, 3128, Australia
3. Emergency Department, 8 Arnold Street, Box Hill, Victoria, 3128, Australia
4. Department of Quality, Planning and Innovation, Eastern Health, 5 Arnold Street, Box Hill, Victoria, 3128, Australia

Correspondence: pwembridge@swh.net.au

ABSTRACT

BACKGROUND:

Discharge summaries (DSs) are an important communication tool between hospital and community clinicians however errors in these documents are common. To improve the accuracy of DS information, our health network implemented a suite of quality improvement projects that promoted "More Efficient Documentation (of patient information) for Improved Care" (MEDIC).

OBJECTIVE:

The aim of this study was to determine if DSs post-implementation of the MEDIC program of work were associated with lower rates of medication errors.

DESIGN:

A retrospective pre- (March 2021) post- (March 2022) medical record audit was conducted at five public hospitals. Patients were included chronologically based on discharge date until the target sample size was reached (100 per group). For each patient, the DS medication list was compared to the pharmacy generated patient friendly medication list or interim medication administration chart and any discrepancies were considered errors. Utilisation of electronic Clinical Decision Support (CDS) was evaluated via review of the EMR.

MAIN OUTCOME MEASURE:

Medication errors.

RESULTS:

The mean number of DS medication errors was lower in the post-intervention group (3.0 vs 1.4, p<0.01). Fewer patients in the post-intervention group had one or more DS medication errors (59% vs 39%, p<0.01). Patients in the post-intervention group were less likely to have one or more high-risk medication errors (20% vs 10% p=0.048). There were 437 individual errors (pre=298, post=139). Omitted medications were less common in the post-intervention group (127 vs 11). Utilisation of EMR home medication CDS was higher in the post-intervention group (54% vs 69%, p=0.005). Pooled data from both groups showed completion of discharge medication reconciliation CDS was associated with a lower number of errors on DSs (mean: 3.7 vs 1.4, p<0.001, DS with one or more errors: 68% vs 39%, p<0.001).

CONCLUSION:
The MEDIC program of work was associated with improved DS medication list accuracy.

KEYWORD
medical errors, medication reconciliation, communication, patient discharge, electronic health records, decision support systems,

INTRODUCTION

Discharge summaries (DSs) are an important communication tool between hospital and community clinicians. [1] DSs usually contain a list of medications the patient is taking at the point of discharge however medication discrepancies or errors in these lists are common. [2-8] Errors on DSs have the potential to cause harm to patients. [9]

The Australian National Safety and Quality Health Service (NSQHS) Standards require the distribution of a current medication list with reasons for any changes to the receiving clinicians at transfer of care. [10] Our health service meets this requirement by including a list of medications in the medical DS, however, internal auditing has identified that errors are common. To improve the accuracy of DS information, our health network implemented a suite of quality improvement projects that promoted "More Efficient Documentation (of patient information) for Improved Care" (MEDIC).

The MEDIC program of work was designed to optimise the use of the Electronic Medical Record (EMR) and ensure compliance with the NSQHS Standards. [11] Interventions completed through the MEDIC program included:

- Tailoring EMR medical user interfaces and workflows to the needs of specific specialties. These interfaces provided more emphasis on the medication list and reconciliation status.
- Introduced the ability to save the progress of medication reconciliation to return to at a later point in time. Prior to the MEDIC program, clinicians would need to exit the medication reconciliation page to view other parts of the medical record (such as pathology or observations) which resulted in the need to restart the process from the beginning.
- Updated training materials, education, communication and individualised performance feedback (clinical unit) aimed at improving adoption of the full medication reconciliation lifecycle during an inpatient stay (home medication documentation, admission medication reconciliation and discharge reconciliation)
- Improvements to the outbound interfacing capabilities of the EMR for DSs and Adverse Drug Reaction (ADR)/allergies
- Transition to EMR generated Patient Friendly Medication Lists (PFML) and Interim Medication Administration Charts (IMAC)
- Workflow improvements to the ordering and administration of blood products

The MEDIC program of work was implemented in two stages across our health network between September 2021 and January 2022. Elements of the MEDIC program of work have been associated with increased provision of PFML/IMAC, decreased medication-related data entry requirements, decreased risk of transcription errors and improved compliance with the Australian National Guidelines for the On-Screen Display of Discharge Summaries. [1,12,13] To date, the effect of the MEDIC program of work on DS medication errors has yet to evaluated.

The aim of the current study was to determine if DSs post-implementation of the MEDIC program of work were associated with lower rates of medication errors.

METHODS

This pre- (March 2021) post- (March 2022) retrospective medical audit was conducted at five metropolitan public hospitals from the same healthcare network. This time period was chosen to allow sufficient time for staff familiarisation with the new processes and avoided periods of significant service disruption related to the COVID-19 pandemic. Specifically, there were no COVID-19 related "lockdowns" in metropolitan Melbourne and the overall number of cases remained low compared to other potential audit periods. [14] Four hospitals used EMR for charting inpatient medications, whilst the fifth (Hospital C)

used standardised paper medication charts. [15] All hospitals utilised EMR for discharge prescribing and DS generation.

Patients were reviewed chronologically based on discharge date until the target sample size was reached (100 per cohort). Sample size was selected to maximise the number of patients reviewed given available resources. Patients with a length of stay less than 24 hours, those without a PFML/IMAC or DS, ambulatory encounters (for example, Hospital in the Home) and emergency department presentations were excluded.

For each patient, the DS medication list was compared to the pharmacist generated PFML or IMAC, which was considered the "source of truth". Any discrepancies were considered errors. This method was adapted from that used in other studies evaluating DS medication list accuracy. [3,5-8] The study did not consider discrepancies involving time of administration (for example, 'take one tablet in the morning' written as 'take one tablet daily') as errors unless they related to "time-critical" medications as defined by the Society of Hospital Pharmacist of Australia.16 Combination medications documented in separate elements (for example, Caduet® 5/10mg documented as amlodipine 5mg and atorvastatin 10mg) and omission of medication intended for administration on the day of discharge only (for example, ferric carboxymaltose) were not considered errors.

Error types were classified using categories adapted from the Australian Commission on Safety and Quality in Health Care Medicine Incident Classification Tool. [17] A modified APINCH (A: Antimicrobials, P: Potassium and other electrolytes, I: Insulin, N: Narcotics and other sedatives, C: Chemotherapeutic agents, H: Heparin and other anticoagulants) classification which excluded antimicrobials was utilised to identify high-risk medications. [18] Polypharmacy was defined as five or more medications being taken on discharge (based on the PFML or IMAC).

Only medication related information on the DS medication list was reviewed. Medication related information elsewhere on the DS and details of ADRs were not reviewed.

Statistical significance was evaluated using chi-square test or two-tailed t-test with a p value of <0.05 considered significant. All data was recorded in a spread sheet with analysis being completed in R® or Microsoft Excel®.

The project was registered as a quality improvement activity with the health network human research and ethics committee.

RESULTS

A total of 200 patients were included in the analysis. There were significant differences in the LOS and number of medications between the groups (table 1). The rate of home medication documentation in EMR was higher in the post-intervention group (54% vs 69%, p=0.04). When compared to the pre-intervention group, the post-intervention group had fewer DS medication errors (mean: 3.0 vs 1.4, p<0.01). Patients in the post-intervention group were less likely to have one or more medication errors on their DS (59% vs 39% p<0.01).

Lower DS medication error rates were observed across all post-intervention clinical specialty subgroups with the exception of aged care although not all reached statistical significance (table 2). The post-intervention result for aged care was influenced by a single patient from Hospital E who had 32 DS medication errors. Exclusion of this patient resulted in a statistically non-significant reduction in mean DS medication errors in the aged care post-intervention subgroup (3.7 vs 1.0, p>0.05).

TABLE 1: PATIENT DEMOGRAPHICS AND CLINICAL CHARACTERISTICS

	Pre-Intervention (n=100)	Post-Intervention (n=100)	P Value
Age (mean years)	69 (21)	72 (17)	ns
Length of Stay (mean days, standard deviation (SD))	13 (14)	8 (7.3)	**<0.01**
Female (%)	48	50	ns
Discharge Medications (mean number, SD) [A]	10 (5.5)	12 (5.6)	**0.02**
Discharge High-Risk Medications (mean number, SD)[A]	0.93 (1.1)	0.94 (1.1)	ns

Site			
Hospital A (155 beds) (%)	17	16	
Hospital B (621 beds) (%)	31	55	
Hospital C (326 beds) (%) [B]	30	23	
Hospital D (158 beds) (%)	14	4	
Hospital E (64 beds) (%)	8	2	
Clinical specialty			
Aged Medicine (%)	27	11	
General Medicine (%)	23	39	
Mental Health (%)	11	7	
Specialty Medicine (%)	37	34	
Surgery (%)	2	9	
Utilisation of EMR CDS			
Home Medications (%)	54	69	**0.04**
Admission Medication Reconciliation (%)	7	10	ns
Discharge Medication Reconciliation (%)	66	66	ns

A: Based on the PFML/IMAC

B: Paper inpatient medication management

TABLE 2: DISCHARGE SUMMARY MEDICATION ERRORS (MEAN, SD)

	Pre-Intervention	Post-Intervention	Difference	p
All patients included in study	3.0 (4.4)	1.4 (3.7)	-1.6	**<0.01**
Inpatient Medication Management Process				
Electronic	3.4 (4.8)	1.5 (4.1)	-1.9	**0.01**
Paper	2.1 (3.2)	0.87 (1.7)	-1.2	ns
Site				
Hospital A	3.3 (6.0)	0.88 (2.0)	-2.4	ns
Hospital B	2.6 (3.2)	1.3 (2.3)	-1.3	**0.02**
Hospital C	2.1 (3.2)	0.87 (1.7)	-1.2	ns
Hospital D	4.5 (5.5)	0 (0)	-4.5	ns
Hospital E	4.3 (5.2)	18 (20)	+13.7	ns
Clinical specialty				
Aged Medicine	3.7 (5.5)	3.8 (9.6)	+0.1	ns
General Medicine	4.2 (5.6)	1.2 (2.5)	-3	**<0.01**
Mental Health	2.5 (2.9)	0.86 (2.3)	-1.6	ns
Specialty Medicine	1.6 (2.2)	0.88 (1.2)	-0.72	ns
Surgery	7.5 (0.71)	1.7 (2.6)	-5.8	**0.01**

There was a trend towards a lower rate of high-risk medication DS errors in the post-intervention group (mean: 0.28 vs 0.16, p>0.05). Patients in the post-intervention group were less likely to have one or more high-risk medication errors on their DS (20% vs 10% p=0.048).

The hospital which utilised paper inpatient medication management (Hospital C) had a lower rate of DS medications errors in both pre- and post- cohorts compared to pooled results of hospitals utilising electronic inpatient medication management (table 2).

When pooling results from pre- and post- intervention cohorts, utilisation of electronic discharge medication reconciliation CDS was associated with fewer DS medication errors (mean: 3.7 vs 1.4, p<0.01; DS with ≥1 medication errors: 68% vs 39% p<0.01).

A total of 437 individual errors were identified (pre: 298, post: 139) of which 42 (9.6%) involved high-risk medications. The most common medications implicated in DS errors were paracetamol, colecalciferol and macrogol (table 3). The majority (67%) of high-risk medication DS errors involved opioids or other sedatives with the most common individual medications being and oxycodone (n=11) and warfarin (n=4) (table 3). The most common errors were unintentionally omitted medication and documentation of a medication the patient was not taking prior to admission (table 4). There was a 92% decrease in the number of omitted medications in the post-intervention group (129 vs 11).

TABLE 3: MOST COMMON MEDICATIONS INVOLVED IN A DS MEDICATION ERRORS

Medications with ≥5 DS errors	Number	Percentage [A]
Paracetamol	26	5.9%
Colecalciferol	14	3.2%
Macrogol	13	3.0%
Docusate-Senna	11	2.5%
Oxycodone [B]	11	2.5%
Pantoprazole	11	2.5%
Aspirin	10	2.3%
Furosemide	10	2.3%
Pregabalin	10	2.3%
Magnesium	9	2.1%
Metoprolol	8	1.8%
Quetiapine	6	1.4%
High-Risk Medication Errors by Class	Number	Percentage [C]
Narcotics and other sedatives	28	67%
Heparin and other anticoagulants	8	19%
Insulin	5	12%
Potassium and other electrolytes	1	2.4%
Chemotherapeutic agents	0	0%

A: Denominator = all DS medication errors
B: Including combination products with naloxone
C: Denominator = high-risk DS medication errors

TABLE 4: NUMBER OF DS MEDICATION ERRORS BY ERROR CLASSIFICATION

Error classification	PRE-INTERVENTION (n=298)	POST-INTERVENTION (n=139)
Unintentionally omitted medication	129	11
Patient not taking documented medication	89	46
Duplication	34	53
Wrong dose, volume or concentration	29	17
Wrong strength	8	2
Wrong time	4	2
Incomplete or unclear documentation	4	1
Wrong rate or frequency	0	4
Wrong medication	1	1
Wrong duration	0	1
Wrong formulation	0	1

DISCUSSIONS

STATEMENT OF PRINCIPAL FINDINGS

This study has demonstrated that the MEDIC program of work was associated with a lower rate of DS medication errors. The greatest improvements in DS accuracy were observed in hospitals with inpatient electronic medication management, although the absolute DS error rate remained lower at the paper site (table 2). Furthermore, the intervention was associated with significantly higher rates of home medication documentation using the EMR, which is itself a requirement of the NSQHS Standards.[11]

The improvement observed in the post-intervention cohort of this study was driven largely by a reduction in unintentional omissions. This was likely due to the higher rates of home medication documentation in the EMR. Our EMR has built in CDS allowing the prescriber to pre-populate the discharge prescription and DS utilising information which has been documented on admission, such as the home medications.

The finding that DS medication errors are less common at sites with paper inpatient medication management may seem counter-intuitive however, one in three DSs included in this study were generated with incomplete use of the discharge medication reconciliation CDS. This CDS completion rate remained consistent in pre- and post-intervention cohorts and we theorise that this may be a possible reason for the higher overall DS medication error rates in sites using inpatient medication management. When utilising electronic inpatient medication management, inpatient orders will pre-populate the DS and when discharge medication reconciliation is not completed, this can result in duplications and unnecessary medications appearing on the DS. These types of errors were common in our study (table 4).

The case of a specialty medicine DS containing 32 errors which was described above highlights the risks associated with incomplete or inappropriate use of CDS. In this instance, none of the three stages of medication management CDS were completed resulting in a large number of duplicates and errors due to pre-populated medications from historic admissions at the health network.

In response to concerns with incomplete use of medication-related CDS, our health network has implemented a warning which is automatically added to the discharge summary when the full medication lifecycle, including discharge medication CDS has not been completed. Our EMR contains multiple reconciliation steps designed to transition medications between different contexts (historic discharge prescriptions, documented preadmission medications, current inpatient prescriptions and discharge prescriptions) minimising the need for manual data re-entry. The full medication lifecycle is considered incomplete until each reconciliation step has been completed. This warning appears with a red or orange background and details the missing reconciliation step(s). Furthermore, in instances where discharge CDS has not been started, filtering has been implemented so that only discharge prescriptions (not home and inpatient medications) pre-populate the DS.

Informal feedback from medical staff has been mostly positive and anecdotally, clinicians trust in the accuracy and validity of DSs has improved. This additional trust is likely due to the introduction of the processing logic that inserts a warning in the DS if the full medication lifecycle is incomplete which was described previously. The absence of the DS warning implies medication related information is more likely to be accurate and this assumption is supported by our finding that completion of discharge medication reconciliation was associated with a lower error rate.

STRENGTHS AND LIMITATIONS

Limitations of this study include a retrospective design, differing characteristics in pre- and post- cohorts (LOS and number of medications on discharge) and a small sample size. Retrospective audits are a common, practical method of evaluating DS medication errors and are used extensively in literature. [3, 5, 7, 8, 19] A previous study investigating DS medication errors in 515 hospital inpatients found no correlation between LOS and DS medication error rate.19 For this reason, the different LOS between cohorts was unlikely to influence the findings of our study. The post-intervention cohort in our study was taking more medicines. Despite polypharmacy being a known risk factor for DS medication errors, we still found a significantly lower DS medication error rate in the post-intervention cohort. [2, 8] When generalising the results of this study it must be noted that it was conducted at a single hospital network in metropolitan Melbourne utilising one type of EMR (Oracle Health - Cerner Millennium®). Further, to be included in our study, patients required a pharmacist generated PFML or IMAC. At our healthcare network, these tasks are prioritised towards complex patients and further research would be needed to determine if similar benefits would be observed

in less complex patient groups (89% were taking five or more medications on discharge, a known risk factor for DS medication errors). [2, 8, 20] For the same reason, our study likely overestimates the number of DS medication errors in the inpatient hospital population as a whole.

Although we did not assess the accuracy of the IMAC or PFML that was considered the "source of truth" for discharge medications, these are created through a collaborative process involving the pharmacist and physician. These collaborative processes have high levels of accuracy and have been used in previous research evaluating DS medication errors. [7, 8]

IMPLICATIONS FOR POLICY, PRACTICE AND RESEARCH

The EMR in use at our health network (Oracle Health - Cerner Millennium®) is in common use worldwide and given the widespread issue of DS medication errors, elements of the MEDIC program of work may be suitable for implementation at other health services.

Adoption of an EMR generated PFML/IMAC has enabled integration of these documents with My Health Record.21 My Health Record is a secure, consumer-controlled online service operated by the Australian Government that supports better patient and consumer outcomes through better access to information. [21] Our health network is now automatically uploading PFML/IMAC to the Pharmacist Share Medication List section of My Health Record for patients that have not withdrawn their consent. [22]

CONCLUSIONS

DS medication errors remain common and the EMR quality improvement activities (the MEDIC program of work) described in this study were associated with significantly lower DS medication error rates.

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