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Original Research Paper

Enhancing medicine information handover at hospital discharge: Evaluation of a multifaceted intervention pilot trial

H Laetitia Hattingh [a,b,c,*], Hayley Hirsch [d], Matt Percival [e], Kate Johnston [f], Georgia Tobiano [g,h], Salim Memon [i,j], Rohan Jayasinghe [k,l,m,n], Carl de Wet [o], Mark A. Morgan [p], Noela Baglot [q], Brigid M. Gillespie [g,r]

[a] Allied Health Research, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[b] School of Pharmacy and Medical Sciences, Griffith University, QLD, 4222, Australia
[c] School of Pharmacy, The University of Queensland, QLD, 4102, Australia
[d] Pharmacy, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[e] Allied Health and Rehabilitation Services, Chronic Disease and Post-Acute Programs, Gold Coast Hospital and Health Service (GCHHS), QLD, 4215, Australia
[f] GP Partnerships and Engagement, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[g] NHMRC Wiser Wounds CRE, Griffith University, QLD, 4222, Australia
[h] Nursing and Midwifery Education and Research Unit, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[i] Strategy, Transformation and Major Capital, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[j] School of Medicine, Griffith University, Australia
[k] Cardiology, Gold Coast Hospital and Health Service, QLD, 4215, Australia
[l] Cardiology, School of Medicine and Dentistry, Griffith University, QLD, 4222, Australia
[m] Medicine, Macquarie University, Sydney, NSW, 2113, Australia
[n] Medicine, Faculty of Health Sciences and Medicine, Bond University, QLD, 4229, Australia
[o] Medical Services and Clinical Governance, South West Hospital and Health Service, QLD, 4455, Australia
[p] General Practice, Faculty of Health Sciences and Medicine, Bond University, QLD, 4229, Australia
[q] Consumer Advisory Group, Gold Coast Hospital and Health Service, Gold Coast, QLD, 4215, Australia
[r] Nursing and Midwifery Education and Research Unit, Gold Coast Health, QLD, 4215, Australia

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ABSTRACT

Background: Hospital pharmacists and doctors should collaborate to prepare discharge medicine handover information and pharmacists and nurses in providing discharge medicine counselling. This pilot trial evaluated a multifaceted intervention that included training hospital doctors to record medicine changes, patient risk stratification, and collaborative doctor and pharmacist discharge medicine reconciliation to improve information handover.

Methods: A pilot study was undertaken at two hospitals in Queensland, Australia. Evaluation incorporated an audit of intervention patient discharge medicine information handover with a control cohort and a time-and-motion observation. Eligible general medicine patients ≥65 years were recruited over nine weeks; a randomisation process was followed to select the control group. We aimed to incorporate 50 intervention patient discharges in the audit.

Results: Most of the 52 intervention and 50 control patients were male (34/52, 65.5 %; 32/50, 64.0 %); average age was 78.6 (SD = 9.0) and 77.7 (SD = 9.3) years. Medicine reconciliation was completed at the time of discharge for 50/52 (96.2 %) of intervention and 34/50 (68.0 %) of control patients; more electronic discharge summaries of intervention patients included all medicines compared to control patients; pharmacists were involved in all intervention discharges compared to 90.0 % (45/50) of control discharges. Discharge summaries of intervention patients were sent to general practitioners within 4.3 days and 9.2 days for control patients. Time-and-motion observations showed that pharmacist discharge medicine information handover time was reduced by 32 min between intervention and control cohorts.

* Corresponding author. Allied Health Research, Gold Coast Health, QLD, 4215, Australia.
E-mail address: laetitia.hattingh@health.qld.gov.au (H.L. Hattingh).

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Conclusion: Our study showed that the multifaceted intervention reduced the time required to complete discharge medicine handover information, facilitated patient discharge, and reduced the time-period of sending discharge summaries to general practitioners.

1. Introduction

Patients who transition from hospital to primary care are at risk of experiencing medication-related harm (MRH), with older people at particular risk.[1] A systematic review showed that 17 %–51 % of older people experience MRH within 30 days of hospital discharge.[2] Delayed, inaccurate, or incomplete medicine information handover between hospitals and primary care clinicians such as general practitioners (GPs), specialists and community pharmacists compromises patient safety and contributes to medication errors, the risk of MRH and hospital readmissions.,[2–4].

Hospital inpatient unit (IPU)/ward pharmacists play an important role in medicine handover during the discharge process by preparation of patients' medicine lists.[5–9] However, completion of hospital pharmacists' discharge medicine lists are often delayed due to hospital doctors needing to attend to other priorities prior to completing a final medication reconciliation.[10,11] Delayed medicine lists can lead to delayed discharges and delays in completing discharge summaries.[10,11] One solution to this problem is for pharmacists to initiate the medicine reconciliation process. A local survey of pharmacists showed support for pharmacist-led discharge medicine reconciliation to overcome these delays.[12] Pharmacist-led discharge medicine reconciliation is supported by a growing body of research evidence, showing reduced medication error rates,[13–17] doctor and nurse satisfaction[15,18] and earlier ward discharge compared to the standard model.[13]

A patient's hospital discharge summary incorporates the reconciled discharge medicine list as well as information about changes to medicines whilst in hospital and other details of the patient's hospital admission.[19] Discharge summaries are the primary source of handover between hospital and primary care clinicians[19,20] and poor quality or incomplete summaries can result in suboptimal care post-discharge and potential hospital readmission.[21,22] Research shows GPs often do not receive a patient's discharge summary prior to the first GP visit following discharge from hospital, and they may therefore not have the list of the patient's discharge medicines, which impacts their ability to provide ongoing care.[23,24] Studies highlight poor compliance with requirements to provide reconciled discharge medicine lists to patients and receiving clinicians at transitions of care.[21,25] A need for better quality and timely medicine handover to GPs has been highlighted in various studies.[26–28]

[13]Building on our evidence base, we identified a need to develop workflow models to address medicine information handover and the timely availability of the discharge medicine list to GPs and other primary care clinicians.[24,29,30] This study aimed to evaluate the pilot implementation and impact of a multifaceted intervention to improve discharge medicine information handover.

2. Method

A pilot study was implemented to evaluate and assess the preliminary effects of a multifaceted intervention on discharge medicine information handover from hospital to primary care. The implementation of the intervention was Phase 3 of a larger project: Phase 1 followed a consensus-building approach through nominal group technique methodology to rank discharge medicine handover challenges and solutions,[30] and Phase 2 was the co-design of the multifaceted intervention.[31]

2.1. Design

This pilot study involved a comparison of intervention patients with a control cohort of patients who were hospital inpatients during the same time period. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were used to report this evaluation.[32] Specific objectives were to evaluate.

1. Discharge patients' MRH risk stratification,
2. The recording of medicine changes whilst patients were in hospital in electronic medical records, and
3. The timeliness of discharge medicine information handover.

Data were collected through.

1. An audit of intervention patient discharges with a matching control cohort to address objectives 1, 2 and 3, and
2. A time-and-motion observation of intervention patient discharges with a control cohort to address objective 3.

The evaluation of the pilot feasibility through clinician and patient feedback is reported separately. Ethics approval was received by the Gold Coast Hospital and Health Services (GCHHS) Human Research Ethics Committee (Ref No. HREC/2023/QGC/94932).

2.1.1. Setting

This study was conducted at GCHHS, South-East Queensland, Australia, a health service incorporating the Gold Coast University Hospital (GCUH), a tertiary hospital, and Robina Hospital, a major regional hospital, that provide public health care services to the Gold Coast population of over 665,000.[33] In Australian hospital settings, medicine legislation is governed at jurisdictional level with doctors authorised to prescribe medicines as well as a small number of other clinicians under strict requirements e.g. nurse practitioners and midwives.[34] Changes in April 2025 to the Queensland Medicines and Poisons (Medicines) Regulation 2021 enabled Collaborative Pharmacist Medication Prescribing (CPMP_ in Queensland public health services and private health facilities.[35] CPMP incorporates hospital pharmacists conducting discharge medicine reconciliation in collaboration with doctors. Our study was conducted just before this change however, we received local approval to trial this model as part of our multifaceted intervention.

Pharmacy services at GCUH follow a ward/inpatient unit based model and the multifaceted intervention was trialed on the Cardiology and General Medicine Short Stay inpatient units. General Medicine pharmacy services at Robina Hospital are different with pharmacists managing patients across multiple inpatient units. As a result, the intervention was implemented across three specific General Medicine inpatient units at Robina Hospital: the Specialist Medical, Acute Medical and Medical Assessment units.

GCHHS clinicians use a Cerner® electronic medical record system, referred to as the integrated electronic Medical Record (ieMR) system, to record patients' clinical information including their hospital medicines management. Pharmacists prepare a comprehensive list of medicines that incorporates changes presented in patient-friendly language, called a Discharge Medication Record (DMR), for patients on multiple or high-risk medicines[36] or who had medicine changes during their admission, at discharge. This list is given to patients, sent to GPs electronically with patients' discharge summaries, and emailed or faxed to community pharmacies for patients who require dose administration aids.

2.1.2. Multifaceted intervention

The multifaceted intervention was implemented on Wednesdays and Thursdays as these were the project pharmacist's workdays between 19 June to August 28, 2024. The intervention incorporated four components[31] with one focusing on patient engagement, reported elsewhere, with the feasibility outcomes. The other three intervention components were targeted towards hospital clinicians.

1. Application of a risk stratification process to identify patients at risk of MRH post-discharge (objective 1). The target of this intervention component was to guide medicine information handover to primary care clinicians at the time of patients' discharge from hospital and to evaluate the use of an automated risk stratification process. This process incorporated:
   - Automatically extracting patients' variables from the ieMR system to calculate their MRH risk score. The PRIME (Prospective study to develop a model to stratify the RIsk of Medication-related harm in hospitalised Elderly patients) tool[37] was developed in the UK to predict MRH in older adults (≥65 years) discharged from hospital.[4,37–39] The PRIME tool had previously been used at the study site to predict patients' MRH scores through manual application of the formula.[39] For the current study, an automated process was developed to extract variables to obtain MRH risk scores:
     - Patients with a PRIME score of 15–29.9 %: DMR emailed to GPs via encrypted email,
     - Patients with a PRIME score >30 %: DMR emailed to GPs via encrypted email and a verbal medicine information handover to GPs.
   - Considering whether patients were on a dose administration aid, classified as First Nation, or were discharged to an aged care facility:
     - If yes, DMR emailed to GPs via encrypted email.

2.1.2.1. Current practice. Current practice at GCHHS was for pharmacists to send DMRs to GPs and/or community pharmacies only when patients are on a dose administration aid.

2. Training of, and encouraging, hospital doctors to record the reason for medicine changes in the ieMR dropdown option at the time of the medicine change. The target of this intervention component was to facilitate transfer of the information into the DMR (objective 2).

2.1.2.2. Current practice. There is a mandatory field in ieMR for doctors to select a dropdown option to indicate reasons for medicine changes. Current practice was that most doctors would select 'no longer required' and leave a comments box to add details blank, hence pharmacists need to search patients' clinical notes to determine reasons for medicine changes, which can be time-consuming.

3. Clinical pharmacists planning discharge medicine reconciliation in ieMR in collaboration with doctors (intern, registrar, trainee or consultant). This intervention component intended to facilitate the medicine information handover component of the discharge process (objective 3).

2.1.2.3. Current practice. Current practice at GCHHS was for IPU doctors at GCHHS to reconcile patients' medicines and generate the necessary prescriptions when the discharge process commences.

2.1.3. Participants

Potential intervention patients were consecutively sampled on intervention days. For a patient to be eligible they needed to; 1) be under a specific medical team whose doctors received training in the multifaceted intervention, 2) be discharged on that day, and 3) meet the inclusion criteria.

- ≥ 65 years of age,
- Admission to hospital for >24 h, and
- Pharmacist medication admission history notes completed before discharge.

In accordance with the literature on sample sizes for pilot studies, we aimed to incorporate approximately 50 intervention patient discharges in the audit.[40] As this was a pilot study, no hypothesis was tested.

2.1.4. Data collection

1. Audit data

The project pharmacist worked with the IPU pharmacists to identify intervention patients who were scheduled for discharge on project days and who met the inclusion criteria. An Excel spreadsheet captured details of patients who met the inclusion criteria and whether the IPU pharmacists were able to do the discharge medicine reconciliation planning in ieMR. Retrospective data for intervention and control patients were sourced from multiple medical record systems by the project pharmacist and the GCHHS data analytics team and included.

- Demographic data (age, gender),
- Presenting complaint/reason for admission,
- Medicine changes during hospital admission and recording of the changes in ieMR,
- PRIME score and classification, other potential MRH risk identifiers,
- Discharge medicine reconciliation status at discharge from hospital, and
- Time-period for sending electronic discharge summaries to primary care doctors (GPs and/or specialists).

The project pharmacist checked ieMR to assess medicine changes during hospital admission and how these were recorded in ieMR, whether medicines were reconciled at the point of discharge, and whether patients' discharge summaries included all medicines.

For the control patient cohort, data were extracted from ieMR by the local Data Analytics team for patients discharged during the same period from the same IPUs as the intervention cohort, who had similar criteria as the intervention cohort.

- ≥ 65 years of age,
- Admission to hospital for >24 h, and
- Pharmacist medication admission history note completed before discharge.

Patients were screened by the project pharmacist to exclude those who did not meet the inclusion criteria and were discharged on project days and on weekends (as different discharge processes are followed on weekends due to limited staffing). Therefore, only patients discharged on Mondays, Tuesdays, and Fridays were included as the control cohort and they had to be under the same treating teams as the intervention patients. Control cohort patients were then divided into three groups: discharged from GCUH Cardiology and General Medicine Short Stay and Robina General Medicine IPUs. Simple random sampling was used to draw a random sample from each of these groups to match the number of intervention patients from the same IPUs.

2. Time-and-motion data

Detailed observation data were collected through time-and-motion methodology to compare the required time for pharmacists to prepare the discharge medicine handover processes when they did the reconciliation planning (intervention cohort) to when doctors undertook

reconciliation planning (control cohort). Data were collected over two weeks (eight days in total): one week at GCUH Cardiology and one week at Robina Hospital General Medicine Unit. Mondays and Tuesdays were usual processes (control arm), and Wednesdays and Thursdays were intervention processes (intervention arm).

Although the initial plan was to use a mobile phone application, learnings from a previous study highlighted certain shortcomings.[11] An Excel spreadsheet was used instead to record pharmacists' activities and the time taken during usual processes and when pharmacists did the discharge medicine reconciliation planning (intervention component 3). Time was recorded on an iPhone. A 4th-year pharmacy student was trained in the usual hospital discharge medication management and data collection processes and observed the research pharmacist in data collection. Once the student was familiar with all processes, they commenced data collection by silently observing pharmacists throughout the discharge process.

Time stamps collected about each discharge.

- Preparation of discharges, including clinical review,
- Discharge medicine reconciliation,
- DMR and prescriptions printed and confirmed, and
- Discharge completed and patients ready to leave hospital.

Additional data were collected in Excel on variables to determine the number of times.

- Discharge reconciliation was adjusted by a doctor,
- Pharmacists needed to clarify or confirm medicine orders with the medical team, and
- Pharmacists were interrupted by other clinicians.

2.1.5. Statistical analysis

Statistical analysis was conducted using Stata statistical package (StataCorp. (2011). Stata Statistical Software: Release 12. College Station, TX: StataCorp LP). Descriptive statistics were used to report on numbers and percentages of intervention and control patients from various inpatient units and the two hospitals, patients' demographic details, primary complaints and hospital discharge summary details. Mean and standard deviations (SD) were calculated for intervention and control cohorts' PRIME scores, time-periods for sending of EDS, medicine changes during hospital stay and the time taken for discharge processes. For the time-and-motion data, the time spent on tasks was converted to decimals (i.e. 2 min 26 s = 2.4 min).

For outcomes in which the number of events was counted, that is, the number of times medicine changes were recorded, it was necessary to offset these counts by the number of medications (number of possible times the event could occur) for each patient. To show the effect of the intervention, a Poisson regression was used that was offset by the log of the total number of medications in each patient. The effect was recorded as the incident rate ratio (IRR), with 95 % confidence interval (CI). The incidence rate, which is equivalent to the proportion of events, was also estimated for the control and intervention groups with 95 % CIs.

3. Results

A total of 52 patients were involved in the multifaceted intervention: 35 patients at GCUH (29 Cardiology, 6 General Medicine Short Stay units) over 6 weeks, 19 June to July 31, 2024, and 17 patients at Robina Hospital over 3 weeks, 7 to August 28, 2024. Data from the randomised control cohort of 50 patients across GCUH and Robina Hospital from the same IPUs were used as the comparator cohort (Table 1).

Of the intervention patients, most were male (34/52, 65.5 %) with most control patients also being male (32/50, 64.0 %). Mean age of intervention patients was 78.6 years (SD = 9.0 years) and of control patients 77.7 years (SD = 9.3 years). Primary complaints of intervention patients were *difficulty breathing/shortness of breath/dyspnea* (13/52; 25.0 %) and *chest pain/angina* (10/52; 19.2 %) which were similar for control patients (10/50 and 6/50; 20.0 % and 12.0 %) (Table 2). Regarding discharge destination for intervention and control patients, 41 intervention and 40 control patients discharged home (78.8 % and 80 %), eight in both groups to aged care facilities (15.4 % and 16 %), two in both groups to interim care (3.8 % and 4.0 %) and one intervention patient into the transition care program (1.9 %).

Table 1
Intervention and control patients per hospital and inpatient area.

Hospital	Intervention	Control	TOTAL
	n (%)	n (%)	n
Gold Coast University Hospital			
Cardiology unit	29 (55.8)	29 (58.0)	58 (56.9)
General Medicine Short Stay unit	6 (11.5)	6 (12.0)	12 (11.8)
Robina Hospital			
[a]General Medicine units	17 (32.7)	15 (30.0)	32 (31.4)
TOTAL	52	50	102

[a] Specialist Medical, Acute Medical and Medical Assessment units.

3.1. Medication-related harm risk

Fifteen (28.8 %) intervention patients were on a dose administration aid; one was a First Nation person (1.9 %); this data was not available for control patients. Table 3 provides a summary of the PRIME scores and MRH risk classifications for intervention and control patients. The mean PRIME scores were 16.7 % and 18.7 % respectively. Although more intervention patients had a low-risk score compared to the control cohort (24/51, 47.1 % vs 12/40, 30.0 %).

3.2. Hospital discharges

Almost all (50/52, 96.2 %) of intervention patients' medicines were completely reconciled at the time of discharge compared to 34/50 (68.0 %) of control patients (Table 4). All intervention patients' discharges involved pharmacists (52/52, 100.0 %) whilst 45/50 (90.0 %) of control patients' discharges involved pharmacists (p = 0.025). More intervention patients' electronic discharge summaries included all medicines (39/52, 75.0 %) compared to control patients (36/50, 72.0 %). Most electronic discharge summaries were sent to GPs rather than specialists for both groups (34/52, 65.4 %; 37/50, 74.0 %).

Regarding the time between patients' discharge and sending of the electronic discharge summaries to primary care clinicians, the mean duration for intervention patients was 4.3 days compared to 9.2 days for

Table 2
Intervention and control patients' demographic information.

Variable	Intervention	Control
Age (years)		
Mean (SD)	78.6 (9.0)	77.7 (9.3)
Gender n (%)		
Female	18 (34.6)	18 (36.0)
Male	34 (65.5)	32 (64.0)
Primary complaint n (%)		
Difficulty breathing/Dyspnea	13 (25.0)	10 (20)
Chest pain/Angina	10 (19.2)	6 (12.0)
Syncope/Loss of consciousness	3 (5.8)	2 (4.0)
Outpatient admission	3 (5.8)	5 (10.0)
Atrial fibrillation/Palpitations	6 (11.5)	1 (2.0)
Post-procedure admission	2 (3.8)	2 (4.0)
Fall	4 (7.7)	5 (10.0)
Diarrhoea/Nausea and Vomiting	1 (1.9)	2 (4.0)
Cough	0	3 (6.0)
Fever/Infection/Confused	5 (9.6)	0
Abdominal Pain	0	2 (4.0)
Other	5 (9.6)	6 (12.0)
Null recorded	0	6 (12.0)

Table 3
Intervention and control patients' medication-related harm risk factors.

Variable	Intervention		Control	
PRIME score	**Mean**	**SD**	**Mean**	**SD**
	16.7	7.8	18.7	7.7
Risk classification	[a]n (%)		[b]n (%)	
Low (score 0–14.9 %)	24 (47.1)		12 (30.0)	
Moderate (score 15.0–29.9 %)	[c]23 (45.1)		22 (55.0)	
High (score >30 %)	[d]4 (7.8)		6 (15.0)	

[a] n = 51.
[b] n = 40 as some PRIME variables missing for some patients.
[c] Discharge Medication Record (DMR) emailed to general practitioner (GP).
[d] DMR emailed to GP and verbal handover.

Table 4
Hospital discharge summary details.

Variable	Intervention	Control
	n (%)	*n* (%)
Medication reconciliation completed at discharge		
No	0 (0)	3 (6.0)
Yes	50 (96.2)	34 (68.0)
Partially	2 (3.8)	13 (26.0)
Electronic discharge summary includes all medicines		
No	1 (1.9)	7 (14.0)
Yes	39 (75.0)	36 (72.0)
Not completed	12 (23.1)	7 (14.0)
Electronic discharge summary sent to		
GP	34 (65.4)	37 (74.0)
Specialist	5 (9.6)	5 (10.0)
Both	1 (1.9)	1 (2.0)
Not completed	12 (23.1)	7 (14.0)
Pharmacist involved in discharge		
No	0 (0)	5 (10.0)
Yes	52 (100.0)	45 (90.0)

control patients, with a mean time difference of 4.9 days, (Table 5).

3.3. Medicine changes during hospital admission and at discharge

Table 6 provides a summary of intervention and control patients' number of medicines at discharge and changes that occurred during their hospital encounter showing that intervention and control patients were on 12.4 and 11.9 medicines, respectively at the time of discharge (SD 4.0 and 4.4). There were no differences between the two cohorts except for *new temporary medicines added in hospital*.

Regarding the number of times the reason for medicine changes were recorded in the ieMR in either the dropdown menu at the time of the medicine order or in clinical notes, Poisson regression of proportions showed no difference between the intervention and control cohorts except for *reason for withheld medicine recorded in clinical notes* (see Table 7).

4. Time taken for discharge medication processes

A total of nine intervention and nine control group discharges were observed (Table 8). The mean time to prepare discharges and clinical review was 7.44 min (SD = 2.8 min) for intervention patients and 17.10 min (SD = 9.4 min) for control patients.

Regarding the effect on pharmacists' workflow.

- The discharge reconciliation was adjusted by doctors once for intervention and eight times for control patient discharges,
- The number of items to clarify were five for intervention and four for control patient discharges,
- Pharmacists had to seek clarification from treating teams three times for both intervention and control patient discharges, and
- Pharmacists were interrupted twice for intervention patient discharges and 13 times for control patient discharges.

Table 5
Time-period of electronic discharge summary sent to primary care doctors.

Variable	Intervention		Control	
	Mean (days)	95 % CI	Mean (days)	95 % CI
Electronic discharge summary to primary care doctor	4.3	1.3–7.2	9.2	4.6–13.9

Table 6
Medicine changes during admission and at discharge.

Number of:	Intervention		Control	
	Mean	SD	Mean	SD
Discharge medicines	12.4	4.0	11.9	4.4
[a]High risk medicines ceased in hospital	2.0	1.4	1.7	1.3
[a]High risk medicines changed in hospital	1.3	1.5	1.0	1.1
Other medicine changes in hospital	4.0	2.9	3.6	3.6
New medicines added in hospital	2.4	2.6	2.5	2.8
New temporary medicines added in hospital	1.3	1.4	0.8	0.9
Medicines ceased in hospital	0.8	1.3	1.0	1.2
Dose or administration changed in hospital	0.6	1.0	0.6	0.8
Medicines withheld in hospital	0.3	0.7	0.2	0.6

[a] High risk medicines defined as APINCH[36]: anti-infectives, potassium and other electrolytes (all forms e.g. oral, IV), insulin, narcotics and other sedatives, chemotherapy, heparin and other anticoagulants.

Table 7
The reason for medicine changes recorded.

Number of times:	Incidence rate ratio	95 % CI
… reason for new medicine recorded in ieMR	0.91	0.7-1.2
… reason for new medicine recorded in clinical notes	0.81	0.6-1.1
… reason for new temporary medicine recorded in ieMR	0.97	0.6-1.6
… reason for new temporary medicine recorded in clinical notes	0.92	0.6-1.5
… reason for stopping medicine recorded in ieMR	0.43	0.2-1.1
… reason for stopping medicine recorded in clinical notes	0.76	0.5-1.2
… reason for medicine dose/administration change recorded in ieMR	0.88	0.5-1.6
… reason for medicine dose/administration change recorded in clinical notes	0.89	0.6-1.4
… reason for withheld medicine recorded in ieMR	[a]	–
… reason for withheld medicine recorded in clinical notes	3.86	1.3–11.5
… reason for change recorded in ieMR order	1.09	0.8-1.5
… reason for change recorded in clinical notes	1.06	0.8-1.4
Medicine change and reason recorded in DMR	0.90	0.7-1.2

*Poisson regression.
[a] Numbers too small to do comparison.

5. Discussion

We piloted a multifaceted intervention to evaluate the impact on discharge medicine information handover from hospital to primary care. An audit of 52 intervention patients with a matching control cohort of 50 patients showed medicine reconciliation was completed at the time of discharge for more intervention patients compared to control patients (96.2 % vs 68.0 %), and more electronic discharge summaries of intervention patients included all medicines (75.0 % vs 72.0 %). Intervention patients' GPs were sent electronic discharge summaries within 4.3 days, which was on average 4.9 days quicker compared to the control patients. A time-and-motion observation showed that discharge medicine information handover time was reduced by 32 min on average when

Table 8
Time taken for discharge processes.

Activity	Intervention			Control		
	Mean time in minutes (decimals)	SD	95 % CI	Mean time in minutes (decimals)	SD	95 % CI
Time to prepare discharge and clinical review	7.44	2.84	5.26-9.63	17.10	9.42	9.86-24.34
Time between discharge reconciliation and printing prescriptions	73.55	83.46	3.77–143.33	28.71	39.45	4.27–61.70
Time discharge confirmed to reconciliation completed	28.51	26.98	7.76-49.25	113.60	117.18	31.90–259.10
Time discharge confirmed to patient leaving hospital	147.64	84.70	42.48–252.81	179.29	125.03	83.19–275.39

pharmacists conducted discharge medicine reconciliation planning.

Research showed that hospital doctors may delay the discharge medicine reconciliation process due to workload, time constraints, and a need to attend to other priorities.[10,11,41] This delay disrupts the workflow of pharmacists as they are unable to prepare discharge medicine lists and check prescriptions until reconciliation is finalised.[12] This could have downstream effects, such as postponed discharges and delayed completion of discharge summaries. Our intervention incorporated pharmacist-doctor collaborative reconciliation to facilitate the discharge reconciliation process and showed >30 min reduction in the time discharges were confirmed and patients able to leave hospital. Timely discharges are crucial to make bed space available for patients admitted to hospital, especially in inpatient areas with a high inpatient turnover rate. Both study hospitals had continuously been at 95 % bed occupancy rate within the 24-month period preceding this study.[42] Our intervention resulted in earlier discharges, which is an important finding with potential practice implications. These results were similar to findings from earlier research that showed pharmacists conducting discharge reconciliation and prescription preparation reduced patients' length of hospital stay.[13] The results of other observational studies highlighted reduced medication error rates and doctor and nurse satisfaction with this model.[14–17] Systematic reviews on pharmacy-led reconciliation services showed a significant reduction in medication discrepancies, including medication discrepancies of higher clinical impact[43] although a need was identified for processes to be standardised and for cost-benefit analysis.[44]

The time between patients' discharge and sending of the electronic discharge summaries to primary care clinicians was on average reduced by 4.9 days between intervention and control patients. Intervention patients' GPs therefore received the discharge summaries sooner, meaning that a proportion of GPs had discharge summaries prior to patients' first post-discharge appointment. The need for GPs to receive discharge summaries in a timely way was raised by our earlier research as well as the impact on patient care if discharge summaries were not available.[24,30] Timely availability of good quality discharge summaries is essential in ensuring ongoing clinical care post-discharge and to reduce the risk of hospital readmissions, morbidity and mortality.[45] Our findings also suggest that more electronic discharge summaries of intervention patients included all medicines compared to control patients.

Our study highlights the importance of integrating pharmacists more actively into the discharge planning and medicine reconciliation process and ensuring better coordination between hospital clinicians to improve patient outcomes. Our results align with international studies that showed better integration of pharmacists in the discharge process facilitated post-discharge primary physician visits,[46] patient medication adherence and a reduction in medication errors.[47] The automated risk stratification process was used to flag high-risk patients, prompt individualised medication safety, and guide discharge handover communication. The GPs of patients at highest risk in the intervention arm (risk classification >30 %) received verbal handover in addition to discharge medicine lists. Previous research has highlighted the value in verbal handover[48] and a reduction of 7-day post-discharge readmission rates when pharmacists use a risk-stratification process.[49] This approach will be used in future studies to prompt post-discharge medication management review services and evaluate the impact on hospital readmissions.[50]

There were no differences between doctors' recording of medicine changes whilst patients were in hospital between intervention and control cohorts, despite the treating teams receiving training on this at the start of the intervention. This could be due to several reasons and suggests the need to develop workflow models to drive changes. The results of systematic reviews have shown benefits in the use of interactive educational training programs for junior doctors and ongoing practice exposure to facilitate behaviour change.[51,52]

There are several limitations to this study. First, we did not evaluate the impact of the medicine handover to GPs and potential hospital readmissions. Second, we focused on elderly patients who were admitted to General Medicine IPUs. Third, this was a pilot study, conducted over a relatively short time-period with a small sample size. However, we did this as a pilot study to test intervention strategies rather than a hypothesis. Fourth, the time-and-motion study was only conducted over a 2-week period with a very small sample size. We also acknowledge that this was an Australian study and that the results may have limited application in countries with differing healthcare systems. Strengths of the study included the involvement of the research pharmacist who ensured high quality documentation for intervention patients. While this study was conducted at one health service, outcomes should be transferable to other jurisdictions.

6. Conclusion

The multifaceted intervention demonstrated improvements in the discharge process by reducing the time required for completing discharge medicine handover. This not only facilitated a faster patient discharge but also reduced the time it took to send discharge summaries to general practitioners, ensuring timely follow-up care. While these improvements contribute to better patient safety and smoother transitions, further research through larger studies is needed to assess the broader impact on healthcare system savings, specifically related to enhanced discharge processes and prevention of medication-related harm. More research is also needed to explore different approaches to the training of doctors in the recording of medicine changes in preparation for a patient's discharge.

CRediT authorship contribution statement

H Laetitia Hattingh: Writing – original draft, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Hayley Hirsch:** Writing – review & editing, Methodology, Investigation, Data curation. **Matt Percival:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Kate Johnston:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Georgia Tobiano:** Writing – review & editing, Methodology, Investigation. **Salim Memon:** Writing – review & editing, Methodology. **Rohan Jayasinghe:** Writing – review & editing, Methodology. **Carl de Wet:** MBChB, FRACGP, MMed, MHLM, PhD, Writing –

review & editing, Methodology, Conceptualization. **Mark A. Morgan:** Writing – review & editing, Methodology. **Noela Baglot:** Writing – review & editing, Conceptualization. **Brigid M. Gillespie:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Ethics approval and consent to participate

This study was approved by the Gold Coast Hospital and Health Service Human Research Ethics Committee (HREC/2023/QGC/94932) with reciprocal approvals by Griffith and Bond University Human Research Ethics Committees. All methods were carried out in accordance with good ethical and clinical practice and other relevant guidelines and regulations.

Informed, written consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

De-identified datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Declaration of interest statement

The authors do not have any interests to declare.

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