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RESEARCH ARTICLE

Exploring discharge prescribing errors and their propagation post-discharge: an observational study

Ciara O' Riordan[1,2] · Tim Delaney[1,2] · Tamasine Grimes[1,2]

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Abstract *Background* Discharge prescribing error is common. Little is known about whether it persists post-discharge. *Objective* To explore the relationship between discharge prescribing error and post-discharge medication error. *Setting* This was a prospective observational study (March–May 2013) at an adult academic hospital in Ireland. *Method* Patients using three or more chronic medications pre-admission, with a clinical pharmacist documented gold-standard pre-admission medication list, having a chronic medication stopped or started in hospital and discharged to home were included. Within 10–14 days after discharge a gold standard discharge medication was prepared and compared to the discharge prescription to identify differences. Patients were telephoned to identify actual medication use. Community pharmacists, general practitioners and hospital prescribers were contacted to corroborate actual and intended medication use. Post-discharge medication errors were identified and the relationship to discharge prescribing error was explored. *Main outcome measured* Incidence, type, and potential severity of post-discharge medication error, and the relationship to discharge prescribing. *Results* Some 36 (43 %) of 83 patients experienced post-discharge medication error(s), for whom the majority (n = 31, 86 %) were at risk of moderate harm. Most (58 of 66) errors were discharge prescribing errors that persisted post-discharge. Unintentional prescription of an intentionally stopped medication; error in the dose, frequency or formulation and unintentional omission of active medication are the error types most likely to persist after discharge. *Conclusion* There is a need to implement discharge medication reconciliation to support medication optimisation post-hospitalisation.

Keywords Clinical pharmacy · Hospital discharge · Ireland · Medication reconciliation · Medication safety · Post-discharge medication use · Prescribing error

Impact of findings on pharmacy and clinical practice

- Discharge prescribing errors are common and the majority persist after hospitalisation resulting in error reaching the patient and persisting.
- Omission of medication remains the most common type of discharge prescribing error and for most patients is linked to continued omission post-hospitalisation.
- The medication reconciliation process should aim to produce a complete and accurate list of current medication, detail any changes made during hospitalisation, and ensure that all intended changes are implemented and communicated to the patient and the next care provider.
- Failure to explicitly communicate that a long-term medication was intentionally stopped during hospitalisation may result in that medication being restarted following discharge.
- Erroneous prescribing of intentionally stopped medication is unlikely to be identified following discharge and will likely result in discrepant continuation of the medication post-discharge.

✉ Tamasine Grimes
tagrimes@tcd.ie

[1] Pharmacy Department, Tallaght Hospital, Dublin 24, Ireland

[2] School of Pharmacy and Pharmaceutical Sciences, Trinity College Dublin, Dublin, Ireland

Introduction

Transitioning to primary care following acute hospitalisation can be a vulnerable time for patients and their families [1, 2]. Adverse drug events (ADEs) have been identified as the most common type of adverse event following discharge [3, 4]. Failure to reconcile medications on discharge and to communicate medication changes can contribute to post-hospital ADEs [5, 6]. In the United Kingdom inefficiencies at the primary–secondary care interface have been identified as an underlying cause of prescribing error in general practice [7]. Studies have found discrepancies between the patient's recalled post-hospital medication regimen and hospital discharge letters [8, 9]. A Canadian case–control cohort study in patients aged ≥66 years identified an increased risk of discontinuation of long-term medication in hospitalised patients compared to non-hospitalised, and that discontinuation of certain medication classes was associated with increased risk of emergency department visit, hospitalisation and mortality [5].

Medication reconciliation (MR) reduces the likelihood of medication error at care transition points [10–12]. Pharmacist-led MR programmes have been identified as effective at improving post-hospital healthcare utilisation [13]. Discharge medication reconciliation (DMR) has been described as a more complex task than admission medication reconciliation (AMR) [14]. AMR involves reconciling the pre-admission medications with those prescribed at admission whereas DMR involves reviewing pre-admission medications, changes made and any additions during hospitalisation and comparing them to the discharge prescription, ensuring that all medications are appropriately continued, resumed or discontinued. This new list should ideally be shared with the patient and the next healthcare provider [15]. MR is resource intensive, time consuming and difficult to implement in practice [15]. Although evidence exists that discharge and post-discharge prescribing errors are common [16–19], we are not aware of any study that has examined the relationship between discharge prescribing and post-discharge medication error.

Aim of the study

The aim of this study was to explore the relationship between discharge prescribing error and post-discharge medication error.

Ethics approval

The study was approved by the hospital's Research Ethics Committee (Reference number—2012/12/07). Written informed consent was obtained from all study participants.

Method

Study setting and context

This was a cross-sectional descriptive study, conducted at a 600-bed acute academic hospital in Dublin, Ireland, serving half a million population, managing approximately 18,000 inpatient episodes annually. The hospital delivers general medical, surgical and specialist services (oncology, haematology, dialysis, orthopaedic trauma centre, vascular surgery, urology and neurology). Standard clinical pharmacy practice during this study saw the clinical pharmacists involved in patient care at admission and during inpatient episode, but with no involvement at discharge. Patients do not receive any supply of medication from the hospital at discharge. This is typical for acute public hospitals in Ireland [20].

Sampling

A consecutive sampling technique was employed using the Hospital Admission Office daily list of potential discharges. All adult in-patients discharged alive to home from any adult department were eligible for inclusion if they satisfied all of the following: using three or more medications for the management of chronic condition(s) prior to hospitalisation, having a new chronic medication commenced or discontinued during the hospital stay, and having a gold-standard pre-admission medication list (GSPAML) documented by a clinical pharmacist. Exclusion criteria were: non-English speaking patients and no translator available, terminally ill patients (documented life expectancy 6-months or less) and readmitted patients already enrolled in the study. A pragmatic approach was taken to recruitment, with a target of two study patients recruited per working day. A sample size was not calculated.

Definitions

- *Gold standard pre-admission medication list* The GSPAML was the most comprehensive list describing the patient's exposure (actual use) to medication prior to admission. The method of building the GSPAML in this study hospital has previously been described [21] and involves corroboration between at least two information sources, one of which is the patient or carer.
- *Gold standard discharge medication list* The GSDML was the complete and comprehensive list of ongoing medication at discharge and any chronic medication(s) that were discontinued during the hospitalisation.

- *Prescribing error* was based on the definition by Dean et al. [22], having regard to situations that should and should not be defined as error: a prescribing decision or a prescription writing process that results in an unintentional, significant reduction in the probability of treatment being timely and effective or increase in the risk of harm, when compared with generally accepted practice, as previously employed [17, 23]. As per Wong et al. [14] and Grimes et al. [17], we also recorded an absence of documentation on the discharge prescription that a chronic pre-admission medication was discontinued in the hospital as an error (termed a communication error). Therefore a *discharge prescribing error* was defined as a deviation between the GSDML and the discharge prescription. These were then categorised as [17]:
  - Omission of a medication
  - Dose/frequency/formulation
  - Prescription of a chronic pre-admission medication that was intentionally discontinued during hospital stay
  - Communication error.
- *Post-discharge medication error* was defined as the patient's actual medication use unintentionally deviating from the GSDML, and having been corroborated as unintentional by the prescriber (or by the community pharmacist where it involved a dispensing discrepancy). This was necessarily broader than prescribing error, as it potentially included dispensing and medication error, and therefore the more expansive term "medication" error was employed.
- *Propagation proportion* The proportion of discharge prescribing errors that persisted after discharge and reached the patient, and the proportion of patients experiencing a discharge prescribing error which propagated through to use post-discharge.

Data collection and process of error identification

Data were collected over 10-weeks (March–May 2013, Fig. 1). Patient recruitment occurred during the first 8-weeks. The GSPAML and the in-patient medication list on the day of discharge were recorded immediately after discharge. Details of recorded intended medication changes and demographic and clinical data were obtained from the healthcare record. Using this information, the GSDML was created. At least 10 days after discharge, the discharge prescription was compared to the GSDML and any differences between them were noted. The patient or nominated carer was then telephoned to determine what medication(s) were being used i.e., the actual patient medication list. The prescribing hospital doctor was contacted to clarify whether any discrepancies that reached the patient were intentional, and the presence of a discharge prescribing error (including communication error) was identified. The community pharmacist was contacted to determine what medication(s) were dispensed post-hospitalisation. The general practitioner (GP) was contacted to determine whether any differences between the hospital discharge prescription and any GP prescription(s) were intentional. The actual patient medication list was compared to the GSDML and any differences were noted and discussed with the prescriber(s) or community pharmacist to confirm whether it was indeed unintended. Each discharge prescribing error was examined to identify whether it propagated to a post-discharge medication error; each post-discharge medication error was reviewed to identify whether it originated and propagated from the discharge prescription, or whether it was newly introduced in the process following discharge.

Outcome measures

The main outcomes measured were the incidence, type and potential severity of post-discharge medication error. The incidence was reported at two levels: per medication using the number of medication on the GSDML as the denominator; and per patient using the number of patients in the study as the denominator. Potential severity of post-discharge medication error was assessed using a reliable, validated method employing four clinicians (a hospital doctor, a GP and two hospital pharmacists) who independently scored each error using a visual analogue scale of 0 (no harm) to 10 (death) [24]. Three of these assessors were independent of the study, while the fourth (a clinical and academic pharmacist) was the research supervisor. Each assessor had access to the anonymised case vignette detailing the demographics, presenting complaint, diagnoses, relevant laboratory and investigation detail and the medication lists from pre-admission to post-discharge. The four assessors' independent error scores were summed and divided by four to calculate the mean score. This mean score was used as an index of severity: 1–2 defined as minor; 3–7 as moderate and 8–10 as severe [24]. The score was reported per error and per patient—where a patient experienced more than one error, the highest scoring error was recorded as the patient score.

Data analysis

Descriptive statistics were reported. Distribution of continuous data was explored using the Kolmogoroff–Smirnov

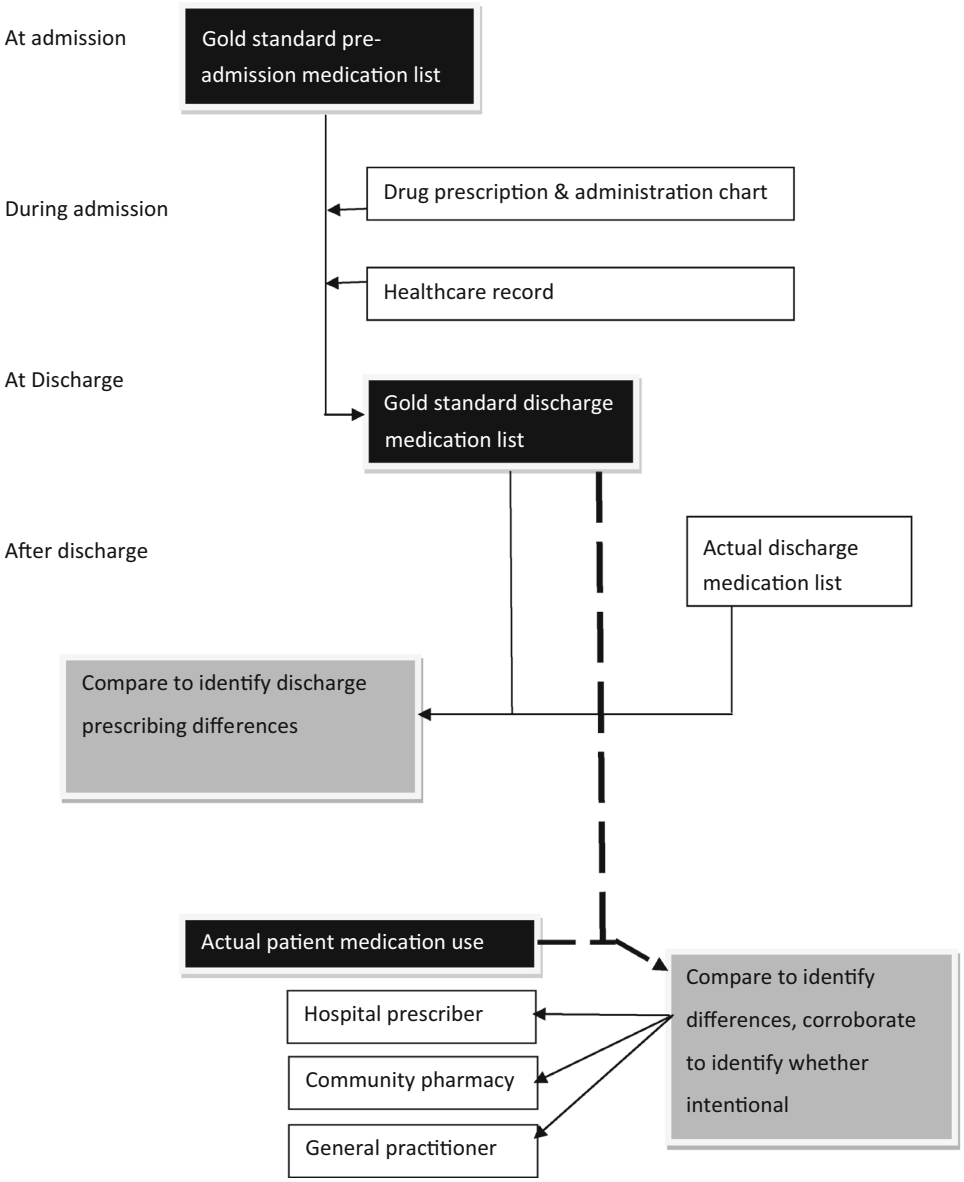

Fig. 1 Data collection process

test. Mean and standard deviation (SD) was used to describe parametric data, median with inter-quartile range (IQR) was used to describe non-parametric. Data analysis was supported by using IBM SPSS Statistics Data Manager, version 22.

Results

Some 533 patients were screened for eligibility, and 83 patients were analysed in the study (Fig. 2): typically older patients, emergency admission, receiving acute medical care (Table 1). During the 10–14 days post discharge, 80 (96.4 %) of patients attended the community pharmacy, of whom 66 (79.5 %) also attended the GP, while three (3.6 %) patients attended neither. Data were collected for 851 medications: cardiovascular (36 %), central nervous system (14.3 %), gastrointestinal (13.2 %) and endocrine (9.9 %) drugs.

Discharge prescribing error and post-discharge medication error: incidence

Some 107 discharge prescribing errors were identified, affecting 47 (56.6 %) patients, and 58 of these errors reached 32 patients who followed the discrepant regimen resulting in unintended post-discharge medication error (Table 2; Fig. 3). Of the 47 patients with discharge prescribing error(s), 22 experienced one error, ten experienced two errors, six experienced three and the remainder four or

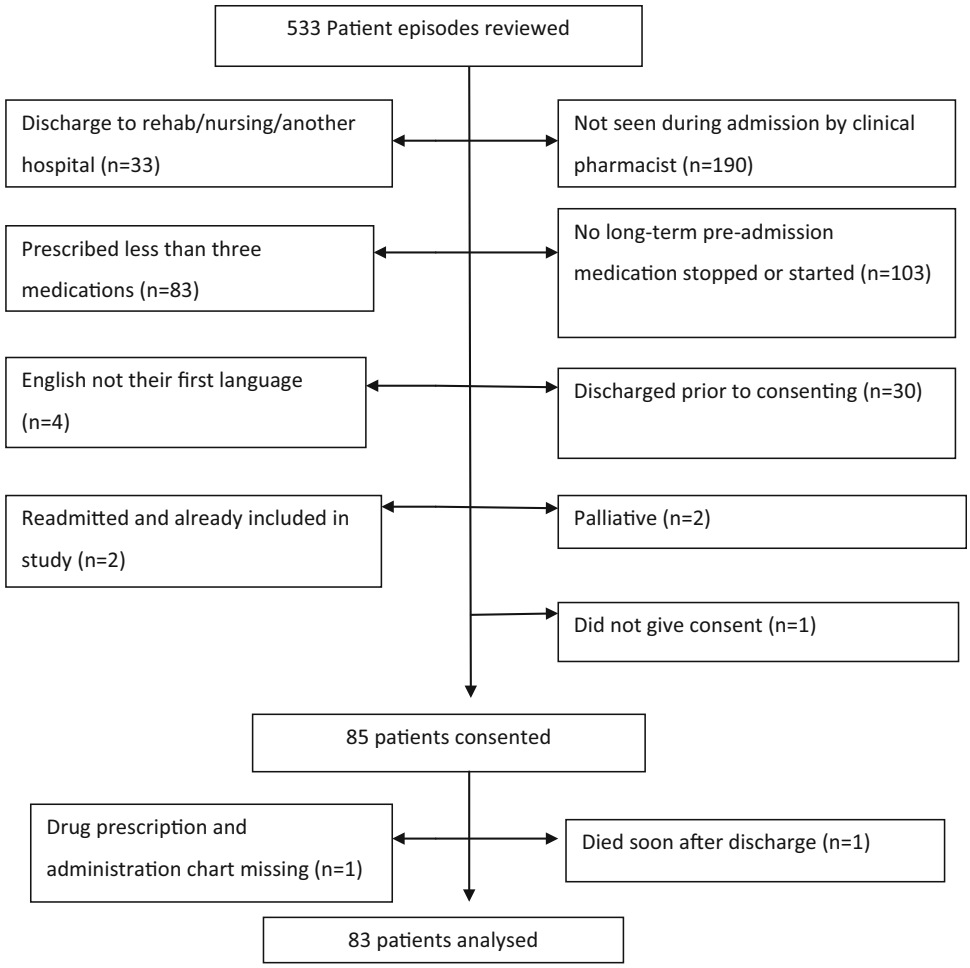

Fig. 2 Flow diagram of patients included in the analyses

Table 1 Characteristics of the study population (n = 83)

Age, years, median (IQR)	70 (60–77)
Gender, male, n (%)	51 (61.4)
Medical, versus surgical, care, n (%)	60 (72.3)
Pre-admission medications, median (IQR)	7 (5–9)
Discharge medications, median (IQR)	8 (6–11)
Admitted as emergency, versus elective, n (%)	72 (86.7)
Electronic medication reconciliation tool used, n (%)	39 (47.0)
Charlson co-morbidity index, median (IQR)	2 (1–3)
Length of stay, median, (IQR)	15 (9–25)
Presenting complaint per body system	
Cardiovascular, n (%)	21 (25.3)
Gastro-intestinal, n (%)	13 (15.7)
Respiratory system, n (%)	11 (13.3)
Neoplasms, n (%)	8 (9.6)
Musculoskeletal system, n (%)	6 (7.2)

more discharge prescribing errors. A total of 36 patients (43.4 %) followed a discrepant regimen that constituted a post-discharge medication error(s), involving 66 medications. Of these 36 patients, 20 patients experienced a single error, six patients experienced two errors, six experienced three and the remaining four experienced four post-discharge medication errors. Most post-discharge medication errors (n = 32 patients, n = 58 medication) were related to a discharge prescribing error propagating to the post-discharge period and reaching the patient. A further eight post-discharge medication errors, unrelated to a discharge prescribing error, were identified in seven patients. These included prescribing and dispensing error in primary care. Three of these seven patients experienced post-discharge medication error(s) related to both discharge prescribing error(s) and newly introduced post-discharge error(s) (Fig 3).

Categorisation of error

Omission was the most common type of discharge prescribing error, and the unintended prescription at discharge of a chronic pre-admission medication which had been intentionally stopped during hospital stay was the most likely to persist after discharge (Table 2).

Table 2 Categorisation and frequency of discharge prescribing error and clinical significance of post-discharge medication error

Category	Discharge prescribing error		Post-discharge medication error		Propagation proportion	
	Per medication	Per patient	Per medication	Per patient	Per medication (%)	Per patient (%)
Omission of a medication						
Frequency (N)	44	23	24	16	54.5	69.6
Potential severity (mean, SD)			3.5, 1.8			
Dose/frequency/formulation						
Frequency (N)	23	18	16	7	69.6	38.9
Potential severity (mean, SD)			3.6, 1.6			
Prescription at discharge of a chronic pre-admission drug that was intentionally discontinued during hospital stay						
Frequency (N)	13	7	13	7	100	100
Potential severity (mean, SD)			4.4, 1.1			
Communication error						
Frequency (N)	27	17	5	3	18.5	17.6
Potential severity (mean, SD)			3.2, 1.3			
Sub-total	**107/851 (12.6 %)**	**47/83 (56.6 %)**	**58/851 (6.8 %)**	**32/83 (38.6 %)**	**54.2**	**68.1**
Potential severity (mean, SD)			3.7, 1.6			
Introduced after discharge						
Frequency (N)	N/A	N/A	8	7	N/A	
Potential severity (mean, SD)			3.2, 1.1			
Total	107		66	36/83 (43.4 %)	N/A	
Potential severity (mean, SD)			3.6, 1.5			

Potential severity of errors

The majority of post-discharge medication errors were judged to have the potential to cause moderate harm (Table 3). There was no apparent difference in severity consequent to different error types.

Discussion

We identified that unintended medication use within 10–14 days of discharge is common, carries the potential to cause harm and frequently propagates from discharge prescribing errors. This study provides evidence that many discharge prescribing errors are not recognized as such at a later stage of the patient journey and the likelihood of detection may be influenced by the error type. We identified that unintentional prescription of an intentionally stopped medication; error in the dose, frequency or formulation and unintentional omission of active medication are the error types most likely to persist. Absence of explicit communication that a chronic pre-admission medication was stopped during hospitalisation, or was withheld at discharge, was relatively less likely to propagate to unintended medication use after discharge. This is one of the first studies, to our knowledge, that investigated the relationship between intended medication use, discharge prescribing and actual post-discharge medication use.

Our findings speak to the well-established need for interventions to prevent medication error at discharge to support safe and intended medication use following hospitalisation. MR is a process that reduces the prevalence of medication error at care transition points [10–12]. Internationally, health systems have struggled to deliver successful, consistent MR, a process which is recognised as being time consuming and resource intensive [15]. Systematic reviews identify that involvement of hospital pharmacists in medication management during hospitalisation is an effective way to support MR [10, 11]. In this study, clinical pharmacists were involved in medication history taking, but were not involved in DMR. Furthermore, evidence from another systematic review [25] shows that interventions which integrate hospital pharmacists, community pharmacists and general practitioners, and that are designed to deal with information (quality of information), co-ordination of care, and communication (exchange of information) tend to be more successful in improving the transition from secondary to primary care [26–28]. This may include the direct provision of

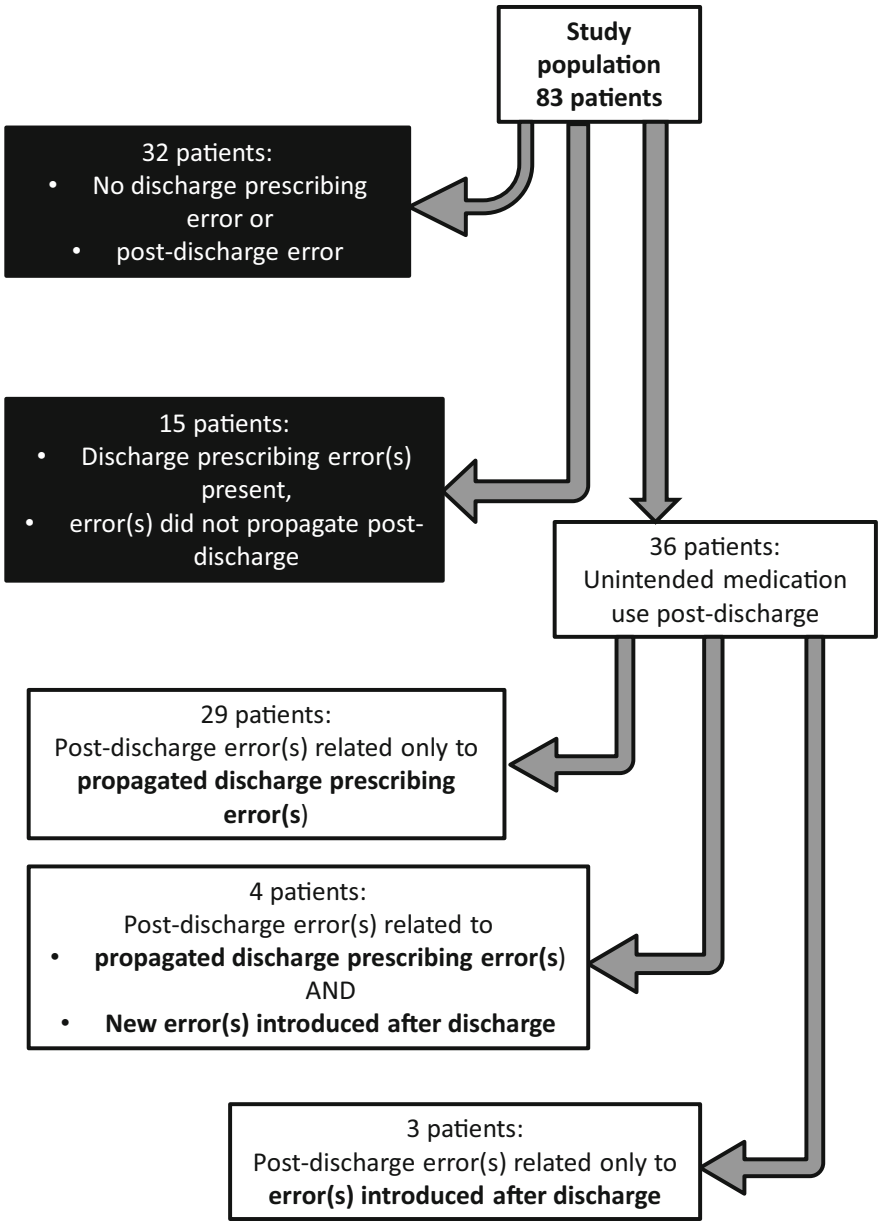

Fig. 3 Frequency and type of discharge prescribing error and post-discharge medication error

information to a nominated community pharmacist [29], an intervention which has been shown to identify drug related problems post-hospitalisation [30]. There is also evidence that use of data input fields that both prompt and support completion of explicit communication regarding medication changes during hospitalisation, for example in electronic discharge prescribing systems, support compliance with MR [19, 31].

The majority of post-discharge medication error was identified as having the potential to cause moderate harm. Pippins et al. [32], found that discharge errors pose a greater risk to patient care than errors introduced at admission. They argue that hospitalisation itself is highly monitored in contrast to the post-discharge setting and therefore the potential for a discharge error to escalate to a potential ADE post-discharge is greater. Our findings support this, given that the normal post-discharge care process, where 96 % of patients attended the community pharmacy and 80 % attended the GP, allowed for the persistence of errors through to unintended patient medication use. This is consistent with opinion that medication safety efforts should be directed at reducing the number of prescribing and transcribing errors in the first instance to minimise the possible impact that they have on administration errors further on in the process [33].

Our study has a number of limitations: small sample size at a single time point and single hospital site, limiting the generalizability of the findings beyond the study sample.

Table 3 Potential for harm consequent to post-discharge medication error

	Mean score	Scores assigned to the error (%)	Score assigned to the patient
Minor	1–2	14 (21.2)	4
Moderate	3–7	51 (77.3)	31
Severe	8–10	1 (1.5)	1
Denominator		66 errors	36 patients
Sample case studies for each severity grade			
Nature of error: Omission error			
Potential for harm: Minor			
Man with pancreatic adenocarcinoma with liver metastasis admitted for management of disease progression. Pancreatic enzymes 25,000 units as required with snacks was added to a background of 40,000 units regularly three times daily with main meals. Pancreatic enzymes 25,000 units as required with snacks omitted from discharge prescription and the patient was not taking the enzymes for a 10 day period following discharge			
Nature of error: Prescription of intentionally stopped long-term medication			
Potential for harm: Moderate			
Woman with lower respiratory tract infection, supra-ventricular tachycardia (SVT) and worsening heart failure on a background of heart failure and chronic obstructive pulmonary disease. Was using salbutamol inhaler and Combivent® nebules (salbutamol and ipratropium) pre-admission. Salbutamol (both inhaler and nebuliser) was intentionally stopped because of potential to contribute to SVT, patient was commenced on plain ipratropium nebules. The salbutamol and Combivent® were restarted on the discharge prescription in error, and the ipratropium was omitted in error. The patient was prescribed and using salbutamol inhaler and Combivent® nebules after discharge			
Nature of error: Introduction of new error post-discharge			
Potential for harm: Moderate			
Older woman admitted with a urinary tract infection (UTI) on a background of Alzheimer's disease, stroke, type 2 diabetes mellitus, chronic back pain, recurrent UTIs, cholecystitis, iron deficiency anaemia, diarrhoea, hypertension, osteoporosis and diverticulitis. Regular paracetamol and as required oxycodone were prescribed for pain on admission. During the 60-day hospital stay, six doses of oxycodone 2.5 mg were administered. At discharge regular paracetamol and as required oxycodone were prescribed. In primary care the oxycodone was unintentionally prescribed as regular oxycodone 2.5 mg twice daily and the patient received this for 10 days after discharge			
Nature of errors: Communication error × 3, Omission error × 1			
Potential for harm: Moderate			
Older man admitted with amaurosis fugax. Antithrombotics were reviewed, clopidogrel was added; aspirin and dipyridamole were stopped (no communication of this to primary care). Lormetazepam was stopped (no communication of this to primary care) and replaced with zolpidem (omitted from discharge prescription). Amlodipine was stopped as no longer clinically indicated (no communication of this to primary care). Following discharge, patient continued to use dipyridamole (and clopidogrel), lormetazepam and amlodipine			
Nature of error: Omission error			
Potential for harm: Severe			
Man with solid tumour admitted with neutropenic sepsis, diagnosed with deep vein thrombosis during admission. Therapeutic enoxaparin was prescribed during admission but was unintentionally omitted from the discharge prescription. The patient did not use therapeutic enoxaparin, or any other anticoagulant, for a 10 day period following discharge			

However, the identified prevalence of discharge prescribing error is consistent with multiple previous Irish studies [17, 23, 34, 35], supporting its generalizability. Efforts were taken to minimise any potential reactive or observational bias by not disclosing the study purpose to medical, surgical or nursing staff contacted for the purpose of clarifying or remediating the identified errors. Clinical pharmacists were aware of the study, and this could have influenced their behaviour. The definition of prescribing error was employed in previous studies investigating discharge medication safety [14, 22] and was applied consistently during this study. The GSDML was composed by the main investigator, a clinical pharmacist, using a similar approach to that described for the GSPAML, however the method has not been validated. The GSPAML and GSDML were held as the most accurate reflection of medication at admission and discharge, respectively, and involved a rigorous building process. Despite this, it is extremely difficult to establish these lists and a potential bias is that they were not always accurate. Concerted efforts were made to confirm whether discrepancies were unintentional; if there was any doubt they were not defined as error. Thus there may be an underestimation of the actual rate of errors.

Our findings are highly intuitive and it could be argued they are already known internationally: there is a need for competent DMR. However, the findings demonstrate a gap between evidence, policy and practice, and endorse the

need for a strategy to implement DMR to optimise medication use in the vulnerable post-hospitalisation period.

Conclusion

This study highlights that unintended post-discharge medication use is common, and carries potential to cause harm. It is likely that discharge prescribing errors will result in post-discharge medication error, including both unintended consumption and unintended omission. A variety of error types (medication omission, error regarding frequency or dose, and absence of explicit communication regarding intentional changes) may reach the patient and persist post-discharge. The findings of this study provide further evidence of the need to implement a structured and organised discharge medication reconciliation.

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Conflicts of interest None.

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