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Medication Error and Interprofessional Communication-Related Factors Contributing to Hospitalisation in Community-Dwelling Older Adults in Australia

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Abstract

Background: Population ageing is a worldwide phenomenon. It is common for older adults to develop multiple age-related illnesses and the prevalence of multimorbidity increases substantially with age. Multimorbid adults are frequently treated with several concurrent medications and the regimen may be complex requiring multiple steps in the preparation of a medication prior to its administration. Polypharmacy is a concerning trend and older adults have a 100% risk of experiencing adverse drug events when taking ten or more medications concurrently. Discharge summaries communicating the number of medications, changes made to medication regimens during hospitalisations and the requirement for ongoing monitoring in the community are often incomplete. The aim of this study was to investigate contributing factors to medication-related hospitalisation, length of stay or readmission in older community-dwelling persons and examine the quality of discharge summaries. **Methods:** Descriptive and correlational analyses of demographic, clinical, admission, readmission, length of stay and medication variables were examined in Australia in 2016-2018. Discharge summaries were analysed for completeness, timeliness and interprofessional communication. **Results:** There were 295 participants, mean age 80 years, 55% were female, taking an average of 11 prescribed medications and with a mean Medication Regimen Complexity Index score of 34. Medication errors that were unrecognised at the time of hospitalisation were present in 19% of the sample. Factors associated with medication error were older age and a longer median length of stay. Fewer than 52% of these older patients had detailed discharge summaries. **Conclusion:** The prevalence of polypharmacy and medication regimen complexity at admission was high. A high proportion of older adults on medical units may have unrecognised medication errors impacting their admission. Medical discharge summaries are inadequately addressing this issue for patients returning to the care of their family physician.

Keywords

Medication Error, Aged, Hospital Admission, Length of Stay, Discharge Communication

1. Introduction

Medication error (ME) is a significant cause of adverse drug events (ADEs) [1]. An ADE can be defined as an undesirable pharmacological effect of a drug when administered at the recommended dose or, an unintentional overdose and ADE risk increases by 10% with each medication ingested, coming closer to 100% risk with ten or more medications [2]. Older adults experience more ADEs than younger adults because of age-related physiological and pharmacokinetic changes that reduce that body's ability to deliver drugs to their target organs (distribution), decreased capacity to break down drugs (metabolism) or changes to the way in which the body removes waste products (clearance) [3]. These physiological and pharmacokinetic changes are compounded by increased prevalence of multimorbidity and a concomitant increase in the number of medications prescribed in this population [4]. In the patient safety literature, inappropriate medication use and polypharmacy are reported to be major factors that put older adults at risk for ADEs [5], in addition to decreased social support for this population [6]. The high-risk profile of older adults related to medication administration error results in increased health care utilisation and emergency department presentations [7] [8]. In the international literature, other contributing factors are reported to be advancing age, multimorbidity, dementia, frailty and limited life expectancy [9]. A retrospective study of Department of Veterans' Affairs health records, aimed at identifying avoidable hospitalisations, coincidentally identified that in veterans aged 65 years and over, just over 20% of admissions were due to potentially preventable medication-related events [10].

One further issue implicated in hospitalisations from medication-related events is the quality of discharge communication. In a pilot study examining the relationship between cognitive impairment and medication self-management errors in older persons discharge home from the hospital, 87% of patients reported that they were not having any difficulty self-medicating post-discharge, but over half were discovered to have one or more medication discrepancies [11]. Medication discrepancies are defined as inconsistencies between two or more medictaion lists. Discrepancies commonly occur among older patients at discharge and are often the result of poorly communicated information or inadequacies in the physicians' discharge summary [12].

The rationale for undertaking this study is that the Sunshine Coast, in South East Queensland (SEQ) has an ageing population that is higher than the national average, comprising 18% aged 65 years and over compared with 14% nationally [13]. It is estimated that this will increase to 21.8% by 2026, while the proportion of the population aged 85+ is expected to treble [14]. Population ageing in Australia has been increasing steadily since 1970. It is predicted to continue because of the increase in life expectancy and, post-war baby boomers are now entering the older age group (65 years and older). The proportional effect of this is greatest on the two oldest age groups, 80 - 84 years and 85 years and over. These age groups have respectively increased their proportion of the older population by 22% and 66% since 1991, and by 29% and 14% since 1971 [13]. Although the increasing ageing population is a national phenomenon, the impact is reported to be felt earlier and more profoundly in coastal communities as the population in these localities continues to grow [14]. These communities are generally older, have more of the very old and have many self-funded retirees who have moved away from family support [14]. This study is significant because no previous data on this subject exists in this region. Arguably, the coastal communities of SEQ have a demographic that provides a view of the future demographic for Australia and highlights the need for immediate medication safety interventions in countries with similar health systems and burgeoning older, multimorbid populations.

2. Aims

The study aimed to investigate contributing factors to medication-related hospitalisation, length of stay or readmission in older community-dwelling persons and examine the quality of discharge summaries. The critical variables of interest were the number of medications, regimen complexity and co-morbidities.

3. Methods

3.1. Study Design and Setting

A retrospective study was used and was based on a chart review. The data were collected from patient medical records after initial presentation to hospital from a community setting. Two regional hospitals in South-East Queensland were used: Hospital A, a tertiary referral hospital with approximately 400 acute and sub-acute beds and Hospital B, a 450 bed tertiary teaching hospital that opened in April 2017. A convenience, sequential sample of patients were included the study following admission to the Medical Assessment and Planning Unit (MAPU).

3.2. Participants

Participants eligible for the study included adults, aged 65 years or over, hospitalised between July 2016 and July 2018. All patients admitted to the MAPU during the study period were assessed for inclusion. Many patients are admitted for investigation and it is only after assessment that it becomes clear that a medication error was implicated in the reason for admission. Consequently, on admission patients were assessed by the admitting physician who determined which of the study participants had some degree of medication error that contributed to the reason for admission. As a class of medication error, accidental poisoning by drugs was an inclusion criterion if explanatory text was available for review. Participants were excluded if admitted with a diagnosis of suicide attempt since it was not considered to be a class of medication error. The pre-existing data in the medical records of all eligible patients were reviewed by trained nursing personnel and made accessible to the principal investigator once all documents were de-identified. The medical records of all eligible patients were accessed.

3.3. Sample Size

G*power™ software program was used to calculate sample size [15]. For a linear model including eight variables with small to moderate effect and 95% power a sample of n = 236 was required. To allow for the exclusion of patients with incomplete medical records a cohort of 300 patients who were admitted to the designated hospital sites in the defined study period were included, was identified and their records were accessed.

3.4. Data Collection

Data of age, gender, reason for admission/diagnosis, co-morbid conditions, medications taken prior to admission, length of stay and time to readmission within 28 days were collected. Discharge summaries completed for the target admission were accessed and textual data abstracted. The names of all medications prescribed during the target admission were collected to assess the quality of the discharge summary using seven criteria that included: whether the summary was complete; completed within 48 hours of discharge; directed to allied health professionals; directed to the General Practitioner (GP-family physician); lists patients' medications; changes made to medications during the hospital stay and identifies any medication monitoring.

If the treating physician had identified that a potential medication error had contributed to admission, the medication error was classified into four distinct groups using the categories developed by the research team. These were:

Group A—Self-administered or carer-administered medication error;

Group B—Incorrectly prescribed medication error;

Group C—Physiological reactions to medication;

Group D—Control (hospital admissions for an event not related to medication).

The Charlson Comorbidity Index (CCI) was calculated from the audited data. CCI is a diagnosis-based score used to predict 10-year survival demonstrating that increasing frequency and severity of co-morbidities shortens life expectancy. A weighting is assigned to each of the 17 conditions (in 19 disease categories), plus one point for every decade of age over 50 years, to a maximum of 4 points. The sum of the weighted conditions provides a numeric comorbidity score (range: 0 to 33) for each patient [16]. Simply put, a higher score indicates that the patient is older and sicker. The Charlson Comorbidity Index (CCI) possesses face and content validity, good interrater and test-retest reliability, and excellent predictive validity for mortality from co-morbid indices in medical records [17] [18].

The Medication Regimen Complexity Index (MRCI) score was also calculated. MRCI is used to quantify the complexity of each medication regimen. The 65-item instrument assigns complexity scores to the medication regimen of individual patients based on medication dosage forms, dosing frequencies, and additional administration instructions, such as the specified time of administration, or if food is advised with the medication or not. It is composed of 3 separate sections in order to capture data on dosage forms (section A), dosing frequency (section B) and additional directions (section C). The total score is equal to the sum of the weighted scores of all 3 sections. The minimum index for someone on a medication is 1.5 and there is no established maximum because the number of medications varies from person to person. A higher score indicates a more complex medication regimen. The tool has both convergent (Spearman's rho = 0.9, $p < 0.0001$) and discriminate validity (Spearman's rho = 0.34, $p = 0.1$ for age and $p = 0.487$ for gender) and interrater and test-retest reliabilities were greater than or equal to 0.9 for both the total test and the subscale evaluations [19].

3.5. Ethics Approval

The study was approved by the Health Service Human Research Ethics Committee (HREC)/16/QPCH/153 and University HREC A16874 and included site-specific approval and a waiver of consent.

3.6. Data Analysis

Data were analysed according to the 4 research aims using IBM™SPSS Statistics version 24. Continuous variables are presented as mean ± standard deviation or median (range) and categorical variables as frequency and percentage. Comparisons between groups were assessed using Mann-Whitney tests. The association between nominal variables was performed using the Chi-square test and comparisons of interval data (CCI, MRCI, number of medications).

4. Results

4.1. Sample Characteristics

Three hundred individuals were eligible for the study and data were available for 98% (n = 295) of these patients. Five participants were excluded from the study due to missing data. Table 1 shows the demographic and clinical characteristics of participants. The mean age was 79.8 years and there were more women (55%)

Table 1. Characteristics of participants in the four groups (n = 295).

Variable	Group without medication error n = 244	Group with medication error n = 51	Self- or carer-administered medication error	Physiological reaction to medication	Total n = 295
Age [Mean/SD]	79.8 (8.30)	79.8 (7.50)	78.8 (7.80)	80.6 (7.30)	79.8 (8.20)
Female [Frequency/%]	131 (54%)	32 (62%)	12 (60%)	20 (67%)	163 (55%)
CCI Score [Mean/SD]	5.6 (2.0)	5.4 (2.1)	4.8 (2.1)	5.9 (2.1)	5.6 (2.1)
MRCI Score [Mean/SD]	34.8 (19.5)	31.8 (17.6)	28.4 (15.8)	34.2 (19.1)	34.3 (19.2)
No. of prescribed medications [Mean/SD]	11.1 (0.1)	10.3 (0.5)	8.6 (0.4)	11.6 (0.5)	11.0 (0.0)

Sample sizes for some of these calculations vary due to missing data.

than men in the sample. The mean co-morbidity score was 5.6 and the mean number of prescribed medications was 11.0. More of the self- or carer-administered medication errors (60%) and physiological reactions to medications (67%) occurred in women. All groups had similar CCI scores but the group without medication error had the higher medication complexities. Only one participant presented with a medication error that was due to an incorrectly prescribed medication and this data is not included in Table 1 or Table 3.

Table 2 shows the frequency of comorbid conditions of the sample participants at the time of hospitalisation. Data are organised using thirteen categories and are adapted from the International Classification of Diseases Diagnosis Codes presented in the Charlson Comorbidity Index [16]. Cardiovascular diseases that include hypertension, atrial fibrillation and myocardial infarction were the most frequently reported comorbidities at 71.9%, with joint and connective tissue conditions such as osteoarthritis at 36.6%, followed by hyper- and dyslipidaemia at 33.9%. Gastrointestinal conditions that included gastro-oesophageal reflux disease and diverticulitis occurred in 29.8% of participants and obesity 2.0% in this population.

4.2. Length of Stay and Readmission

In Table 3 the median length of stay was three days (Interquartile range (IQR) = 5) for patients without medication error and four days (IQR = 10) for those with medication error. This difference was not statistically significant (MWU = 5688.5; p = 0.33). The longest length of stay was for those admitted with self-administered medication error with a median of 8.5 days (IQR = 15). In total 97 (32%) of the sample were readmitted within 28 days. A smaller proportion of those whose admission was associated with a medication were re-admitted compared to the group without medication error (26% versus 34%).

Factors associated with length of stay

No association was found between length of stay and CCI score (r = 0.007; p = 0.914); MRCI score (r = 0.009; p = 0.886); or number of prescribed medications (r = −0.24; p = 0.697). There was a slight negative association between age and

Table 2. Characteristics of participants' comorbidities (n = 295).

	n (%)
Cardiovascular	212 (71.9)
Renal	34 (11.5)
Endocrine	61 (20.7)
Gastrointestinal	88 (29.8)
Liver/metabolic	64 (21.7)
Respiratory/pulmonary	70 (23.7)
Malignancy	79 (26.8)
Depression/mental health/anxiety	42 (14.2)
Dementia/cognitive impairment	40 (13.6)
Peripheral vascular	36 (12.2)
Cerebrovascular	48 (16.3)
Joint and connective tissue	108 (36.6)
Obesity	6 (2.0)

Table 3. Statistics for readmission rates and LOS.

Variable	Group without medication error n = 244	Group with medication error n = 51	Self-or carer administered medication error	Physiological reaction to medication	Total n = 295
Readmission [Frequency/%]	84 (34%)	13 (26%)	5.0 (25%)	7.0 (23%)	295 (100%)
Length of Stay (Days) [Median/IQR]	3.0 (5.0)	4.0 (10.0)	8.5 (15.0)	2.0 (8.0)	3.0 (6.0)

Length of stay was positively skewed > 1.96 (non-parametric test median and interquartile range used).

length of stay ($r = -0.14$; $p = 0.02$) and, although statistically significant, this association means that only 2% of the variability in length of stay is explained by the variability in age which appears to be clinically insignificant. A point-biserial correlation was undertaken to determine the relationship between length of stay and gender and there was no correlation ($r_{pb} = 0.021$, $p = 0.751$).

Readmission

There were no statistically significant associations between readmission and MRCI score ($r_{pb} = -0.017$; $p = 0.78$) nor number of medications prescribed ($r_{pb} = 0.020$; $p = 0.75$). In addition, there were no statistically significant relationships between gender (χ^2 (df) = 0.42(1); $p = 0.52$) age ($r_{pb} = 0.091$; $p = 0.12$) and CCI score ($r_{pb} = 0.067$; $p = 0.29$) and readmission.

4.3. Quality of Discharge Summaries

Table 4 presents the frequency and percentage results related to the quality of discharge summaries provided for the two groups of patients, those with and without medication error as a factor in their admission. In general, those who had a medication error implicated in their admission had a higher frequency of completed discharge summaries and more information was included about their medication regimen compared to the group without medication error. However, proportions of patients that had detailed summaries that listed medications,

Table 4. Frequencies and percentages of aspects of discharge summaries.

Discharge summary information	No medication error (n = 244) [Frequency %]	Medication error (n = 51) [Frequency %]	Total (n = 295) [Frequency %]
Completed	229 (94%)	49 (96%)	278 (94%)
Completed within 48 hours of discharge	197 (81%)	43 (84%)	240 (81%)
Directed at allied health professional	2.00 (0.8%)	3.0 (6%)	5.00 (2%)
Directed to GP	165 (68%)	36 (71%)	201 (68%)
Summary lists patient's medications	121 (50%)	31 (61%)	152 (52%)
Summary identifies change to medication regimen during recent stay	111 (46%)	28 (55%)	139 (47%)
Summary identifies any medication related monitoring	85.0 (35%)	21 (41%)	106 (369%)

changes to medications and identified medications requiring monitoring was less than 52% overall.

5. Discussion

This preliminary study was undertaken in a coastal area of Australia with a high population of older adults. It investigated hospitalisations of older adults where a medication error, in the community, was subsequently found to be a contributing factor to hospital admission. In this study, 17% (n = 51) had a medication error-related reason for their hospitalisation, most occasions of which were not identified prior to hospitalisation. The results revealed a mean age of 80 years and an average co-morbidity (CCI) score of 5.6 revealing an estimated 10-year survival of 2% - 21% [16]. Similarly, a retrospective chart audit of 164 patients (aged 50 years and over) in major metropolitan teaching hospital in Australia revealed a mean age of 74 years, high co-morbidity score using the CCI, a median of nine prescribed medications with 20% of patients from residential care and 37% living alone [20].

On average, our patients were taking 11.0 prescribed medications and the mean MRCI score was high at 34.3 [19]. Polypharmacy is a concerning trend and these results mirror larger epidemiological studies conducted in other countries with similar health systems, such as Scotland [21]. One significant concern is the 100% risk of ADE when patients take ten or more medications concurrently, as seen in this study, and is consistent with earlier research [2].

In our study, we found that there was no statistically significant difference in length of stay between those admitted with and without medication error. The longest length of stay was for those admitted with self-administered medication error. However, the greater proportion of those readmitted within 28 days were patients in the group without medication error (n = 244) rather than those with medication error (n = 51). The group without medication error was over 4.5 times larger than the group with a medication-related reason for hospitalisation, the mean age was 80 years old and the average CCI was high at 5.6. These factors may explain this study finding since multimorbidity and advancing age are reported to increase healthcare utilisation [9]. In addition, demographic and clinical factors are recognised as significant contributing factors to readmission rates at 30-, 60- or 90-day periods in this population and these timeframes are the most frequently researched [6].

Our study suggests a high rate of availability of discharge summaries within 48 hours (83% in the medication associated group). However, there remains substantial room for improvement in availability of medication lists, documentation of changes to medications and guidance about the monitoring required since the proportions of patients that had detailed summaries was less than 52% of the study sample. The literature reveals mounting unease about the quality of interprofessional communication between hospital and primary care providers particularly where medication changes have been made during the hospital stay. In one study, 95% of patients had a discharge summary but for 19% the summaries were not completed or transmitted to primary care givers within two weeks [22]. In one Australian study, discharge summaries were not available for 72% of the sample, especially for those aged 70 to 80 years, compared to those over 80 years old [23].

Finally, we examined factors affecting readmission rates and length of stay related to medication error and our findings highlight that medication-related hospitalisation and length of stay is a complex relationship and remains difficult to predict. Our study results do not reveal statistically significant associations between demographic, clinical, medication related factors and readmission rates and length of stay. However, the international literature reports on the prevalence and contributing factors to ADEs in developed and developing countries and reveals that adverse drug reactions were most common in older adults, female gender and with increased number of medications [24].

It is widely acknowledged that increasing interactions with and dependency on health care systems is common with advancing age [25]. In order for health care policy makers to optimise service utilisation for older adults who frequently transition between the hospital and home environments, evidence of inpatient hospitalisation patterns and precipitating circumstances in medication error are required [6]. In addition, the results of this study highlight the need for better continuity of care between hospital and primary healthcare services. A systematic review of approaches for improving continuity of care in medication management reported a need to move from epidemiological studies to well-designed intervention studies that include outcome measures and cost-effectiveness analysis [26].

6. Strengths and Limitations

The strengths of the study were that the research questions were well defined, inclusion and exclusion criteria were explicitly developed and the data abstractors were trained in reviewing charts and were monitored in the use of standardised, electronic abstraction forms. A particular strength was that medical clinicians were asked to determine whether medication error was a contributing factor to admission. Most other similar studies rely on admission diagnostic coding and a suspected contribution of a medication error may not be coded. Limitations relate to the study sample and design. Although the sample size was *considered a priori*, it used a small convenience sample due to time and resource constraints. The results of this study may be generalised to community-dwelling older adults in coastal/regional areas and caution should be used when generalising the results more broadly. The critical variables under examination were number of medications, regimen complexity and comorbidities. The scope of the research did not permit detailed examination of the types of medications contributing to medication error.

7. Conclusions

In this study of older community-dwelling persons in Australia, the prevalence of polypharmacy and medication regimen complexity at admission was high. A high proportion of older adults on medical units may have unrecognised medication errors impacting their admission. Medical discharge summaries inadequately addressed this issue for patients returning to the care of their GP. Consequently, predictive studies of the factors affecting readmission rates and length of stay related to medication error and inadequate discharge information need to be undertaken with larger sample sizes and involving multiple health care sites because the coastal communities of SEQ have a demographic that provides a view of the future demographic for Australia.

Currently, in Australia, the Domiciliary Medication Management Review (DMMR) may only be initiated by a patient's GP after assessing the patient's need for the service. In terms of policy change, there is an opportunity for nurses concerned about patient medication safety, in the transition to home, to advocate that the Discharge Summary include a request for the GP to assess medication administration safety and consider referral for a DMMR.

With regard to clinical practice imperatives, the results of this study confirm that there is a significant cohort of older persons who are discharged from the hospital not being confident and competent in the self- or carer-administration of medications. Hospital nurses are in an ideal position to assess patient and carer competence and, in collaboration with pharmacy staff, provide "just-in-time" medication education.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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