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# Factors associated with unplanned readmissions in a major Australian health service

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**Abstract**

**Objective.** The aim of the present study was to gain an understanding of the factors associated with unplanned hospital readmission within 28 days of acute care discharge from a major Australian health service.

**Methods.** A retrospective study of 20 575 acute care discharges from 1 August to 31 December 2015 was conducted using administrative databases. Patient, index admission and readmission characteristics were evaluated for their association with unplanned readmission in ≤28 days.

**Results.** The unplanned readmission rate was 7.4% ($n = 1528$) and 11.1% of readmitted patients were returned within 1 day. The factors associated with increased risk of unplanned readmission in ≤28 days for all patients were age ≥65 years (odds ratio (OR) 1.3), emergency index admission (OR 1.6), Charlson comorbidity index >1 (OR 1.1–1.9), the presence of chronic disease (OR 1.4) or complications (OR 1.8) during the index admission, index admission length of stay (LOS) >2 days (OR 1.4–1.8), hospital admission(s) (OR 1.7–10.86) or emergency department (ED) attendance(s) (OR 1.8–5.2) in the 6 months preceding the index admission and health service site (OR 1.2–1.6). However, the factors associated with increased risk of unplanned readmission ≤28 days changed with each patient group (adult medical, adult surgical, obstetric and paediatric).

**Conclusions.** There were specific patient and index admission characteristics associated with increased risk of unplanned readmission in ≤28 days; however, these characteristics varied between patient groups, highlighting the need for tailored interventions.

**What is known about the topic?** Unplanned hospital readmissions within 28 days of hospital discharge are considered an indicator of quality and safety of health care.

**What does this paper add?** The factors associated with increased risk of unplanned readmission in ≤28 days varied between patient groups, so a 'one size fits all approach' to reducing unplanned readmissions may not be effective. Older adult medical patients had the highest rate of unplanned readmissions and those with Charlson comorbidity index ≥4, an index admission LOS >2 days, left against advice and hospital admission(s) or ED attendance(s) in the 6 months preceding index admission and discharge from larger sites within the health service were at highest risk of unplanned readmission.

**What are the implications for practitioners?** One in seven discharges resulted in an unplanned readmission in ≤28 days and one in 10 unplanned readmissions occurred within 1 day of discharge. Although some patient and hospital characteristics were associated with increased risk of unplanned readmission in ≤28 days, statistical modelling shows there are other factors affecting the risk of readmission that remain unknown and need further investigation. Future work related to preventing unplanned readmissions in ≤28 days should consider inclusion of health professional, system and social factors in risk assessments.

**Additional keywords:** adverse event, discharge planning, hospital discharge, hospital readmission, patient readmission.

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## Introduction

In Australia, there are approximately 6 million public hospital separations per year, with increasing demand for hospital care[1] and decreasing average length of hospital stay (LOS).[1] Unplanned hospital readmissions within 28 days of hospital discharge are an indicator of the quality and safety of health care.[2,3] A recent South Australian study of general medical patients reported an unplanned 28-day readmission rate of 10.9%,[4] and Victorian data show the 30-day all-cause unplanned readmission rate is 6.2%.[2] Unplanned hospital readmissions may result from exacerbation of underlying disease or from potentially preventable failure of adequate care provision. For patients, families and carers, unplanned hospital readmissions are distressing, inconvenient and increase the risk of iatrogenic harm. For the healthcare system, unplanned hospital readmissions are costly and result in potentially avoidable resource utilisation. In Victoria during 2010–11 there were 112 641 unplanned 30-day readmissions[2] and unplanned hospital readmissions use approximately 1648 public and 456 private beds per annum.[5] It is estimated that the annual cost of unplanned hospital readmissions in Victoria is approximately A$431 million, and A$1.5 billion across Australia.[6]

Gaining a detailed understanding of the current status of unplanned hospital readmission within 28 days of discharge is problematic. Many reports focus on unplanned readmissions following a surgical procedure[1] or on specific diagnostic groups.[7] Recent studies of factors associated with unplanned hospital readmissions within 28 or 30 days of discharge have focused on specific patient cohorts, such as general medical,[4,8] orthopaedic surgery,[9] chronic disease,[10] elders[11,12] and patients with complex medication issues.[11,13] The aim of the present study was to gain a whole-of-health service understanding of the factors associated with unplanned hospital readmission with 28 days of acute care discharge from a major Australian health service.

## Methods

### Study design

A retrospective exploratory design was used. The study was approved by the Eastern Health Human Research and Ethics Committee.

### Setting and sample

The study was conducted at Eastern Health, one of the largest health services in Victoria, Australia. Eastern Health serves a community of some 750 000 people living across 2916 km$^2$.[14] Eastern Health has four acute care hospitals, three of which have emergency departments (EDs). During 2014–15, there were 135 636 acute care admissions, 151 810 ED attendances and 31 083 operations performed at Eastern Health.[14] Site A was an outer metropolitan hospital that provides emergency care, general medicine, surgery, midwifery, paediatrics and rehabilitation. Site B was a tertiary referral centre providing all services except transplant surgery, neurosurgery and cardiothoracic surgery. Site C was a metropolitan hospital providing emergency care, general and specialist medicine, general and specialist surgery, critical care services and specialist adult mental health services, but no midwifery services. Site D was an outer metropolitan hospital providing medical, ambulatory and palliative care services.

All acute care discharges from Eastern Health from 1 August to 31 December 2015 were included. These dates were chosen to avoid the period when the service moved to a new hospital at Box Hill Hospital (September 2014) and changes to coding systems (July 2015). There were 40 887 discharges: 2152 discharges were excluded. Discharges were excluded in the present study because the patient died during their index admission ($n$ = 336), the patient was coded as a 'statistical separation' ($n$ = 360), the site could not be identified ($n$ = 118) or the index admission diagnostic-related group (DRG) was R63Z Chemotherapy, as per other studies of unplanned readmissions.[2,8] Statistical separation is an administrative process indicating that the patient has been transferred to a different level of care (e.g. acute to subacute) and without physically leaving the site of original care provision.

The remaining 38 735 discharges were classified as planned readmission in ≤28 days (11.8%; $n$ = 4391), unplanned readmission in ≤28 days (6.5%; $n$ = 2529) and no readmission with 28 days of discharge (82.1%; $n$ = 31 815). Unplanned readmissions were identified by readmission type, coded as 'emergency admission' or 'other emergency'. Readmission types coded as 'maternity', 'other planned' and 'planned waiting list admission' were considered planned readmissions and were excluded from analysis.

### Data collection

The study data were extracted from organisational databases. The following data were extracted for each discharge:

- patient characteristics: age, gender, comorbidities,[15] chronic diseases
- index admission characteristics: admission source, site, admitting unit, type of admission, diagnosis, hospital LOS, state

average LOS for DRG, complications, number of hospital admission(s) and ED attendance(s) during the preceding 6 months, discharge destination and weekend or weekday discharge (for patients admitted via the ED, triage category and ED LOS were also collected; an ED LOS ≤4 h was selected as a cut-off because it is congruent with the National Emergency Access Target that aims for an ED LOS of 4 h or less[16,17])
- readmission characteristics (for discharges resulting in unplanned readmission in ≤28 days): readmission day, readmission via ED, mode of arrival to hospital, diagnosis, hospital LOS and difference between hospital LOS and state average LOS for DRG (for patients readmitted via the ED, triage category and ED LOS were also collected).

Comorbidities and complications were identified using International Classifications of Diseases 10th revision Australian Modification (ICD-10-AM) codes.[15]

### Statistical analyses

Data were analysed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarise the data; where data were not normally distributed, median and interquartile ranges (IQR) are presented.

For each discharge, patients were classified using Health Innovation and Reform Council definitions[2] as follows, and in the following order:

- Obstetric patient: any patient with an episode of care with a discharge DRG of O01 (Caesarean delivery), O02 (vaginal delivery with operating room procedure), O60 (vaginal delivery), O61 (postpartum and post abortion), O64 (false labour), O66 (antenatal and other obstetric admission)
- Paediatric patient: any episode for a patient aged ≤18 years who is not an obstetric patient
- Adult surgical patient: any episode with a discharge DRG type of 'surgical', who is not an obstetric or paediatric patient
- Adult medical patient: all other episodes (discharge DRG type of 'non-surgical')

It should be noted that exclusion of planned readmissions coded as 'maternity' as described above did not preclude the inclusion of women with an unplanned readmission for an obstetric diagnosis.

Comorbidity status was determined using the Charlson index[18] based on ICD-10-AM codes.[19] Weightings ranged from 1 to 6,[18] and a score of 0 indicated no comorbidities. 'Like DRGs' were defined as the index admission and readmission diagnoses being from the same ICD-10 disease classification chapter heading. Discharges resulting in unplanned and no readmissions ($n$ = 34 313) were randomised into a 'derivation dataset' (60%; $n$ = 20 575) and 'validation dataset' (40%; $n$ = 13 738) to enable subsequent predictive modelling. The analyses presented herein are from the derivation dataset ($n$ = 20 575). Patient and index admission characteristics (unplanned vs no readmission within 28 days) were compared using the Cochran–Mantel–Haenszel (CMH) test to account for hospital clustering effects. Using the variables that were statistically significant, binary logistic regression was used to examine factors associated with unplanned readmission.

## Results

Of the 20 575 discharges, 7.4% ($n$ = 1528) resulted in an unplanned readmission in ≤28 days. The proportion of unplanned readmissions in ≤28 days per site were as follows: Site A, 4.6% ($n$ = 178/3854); Site B, 8.8% (915/10421); Site C, 6.9% (435/6300); Site D, no unplanned readmissions ($P$ < 0.001). Adult medical patients were the most common patient group and had the highest unplanned readmission rate (Table 1).

### Readmission characteristics

The 1528 unplanned readmissions in ≤28 days occurred in 1306 patients, 171 of whom had recurrent unplanned readmissions: two readmissions ($n$ = 140), three readmissions ($n$ = 20), four readmissions ($n$ = 6), five readmissions ($n$ = 3), six readmissions ($n$ = 1) and eight readmissions ($n$ = 1). The median time between discharge and unplanned readmission was 9 days (IQR 4–17 days). Of those patients with an unplanned readmission, 11.1% ($n$ = 170) returned within 1 day and 50% of unplanned readmissions had occurred by Day 8 (Fig. 1).

Most (90.6%; $n$ = 1384) unplanned readmissions were via the ED and the majority of those patients were adult medical (74.4%; $n$ = 1137), followed by adult surgical (16.7%; $n$ = 255), obstetric (5.2%; $n$ = 79) and paediatric (3.7%; $n$ = 57). Arrival by ambulance was recorded for 44.5% ($n$ = 680) of patients and Australasian Triage Scale (ATS) category distribution was as follows: ATS 1, 1.0% ($n$ = 16); ATS 2, 18.4% ($n$ = 281); ATS 3, 45.4% ($n$ = 693); ATS 4, 24.1% ($n$ = 369); and ATS 5, 1.6% ($n$ = 25).[20] The median hospital LOS following an unplanned readmission in ≤28 days was 2 days (IQR 1–5 days), but 25.7% ($n$ = 392) of patients had a readmission hospital LOS greater than the state average for their DRG. The index admission and unplanned readmission diagnoses were like DRGs in 47.4% of discharges ($n$ = 724).

### Patient and index admission characteristics

Patients in whom discharges resulted in an unplanned readmission in ≤28 days were significantly older (median (IQR) age 65 years (43–80) vs 54 years (33–73); $P$ < 0.001) and had a longer median index admission LOS (median (IQR) 2 days (1–4) vs 1 day (1–3); $P$ < 0.001) than those without unplanned readmission. Features associated with increased odds of unplanned readmission in ≤28 days were an emergency index admission, chronic disease or comorbidities, classification as adult medical, complications during index admission, hospital admission(s) or ED attendance(s) in the 6 months preceding the index admission, index LOS greater than state average for DRG,

**Table 1. Discharges and unplanned readmissions within 28 days of acute care discharge per patient group**
Unless indicated otherwise, data are given as $n$ (%)

| Patient group | Discharges ($n$ = 20 575) | Unplanned readmission in ≤28 days ($n$ = 1528) | Unplanned readmission (in ≤28 days) rate (%) |
|---|---|---|---|
| Adult medical | 13 157 (63.9) | 1137 (74.4) | 8.6 |
| Adult surgical | 4332 (21.1) | 255 (16.7) | 5.9 |
| Obstetric | 1424 (6.9) | 72 (5.2) | 5.5 |
| Paediatric | 1662 (8.1) | 57 (3.7) | 3.4 |

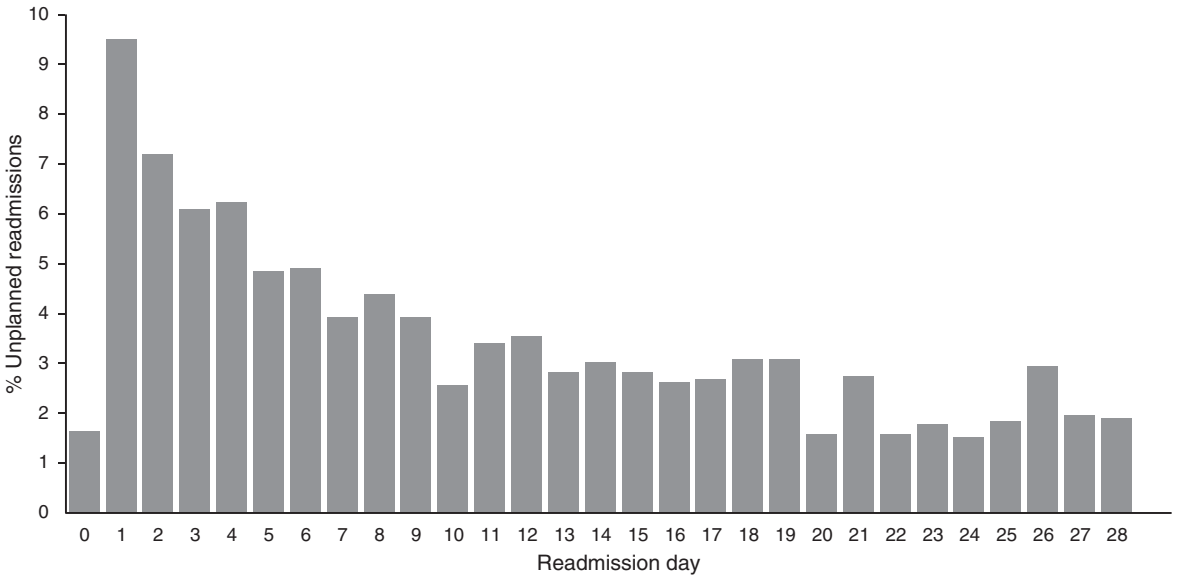


**Fig. 1.** Distribution of unplanned readmissions within 28 days of acute care discharge by readmission day.

index admission LOS of ≥3 days, left against advice, discharge to aged care and age ≥65 years (Table 2). There was a weak positive correlation between Charlson comorbidity index and index admission LOS ($r = 0.102$, $P < 0.001$).

For discharges where the index admission occurred via the ED ($n = 11\,587$), triage category ATS 2 was associated with a higher proportion of unplanned readmissions in ≤28 days, but the observed difference was <3%. Triage category ATS 4 was associated with a lower proportion of unplanned readmissions in ≤28 days, but the difference was <5%. ED LOS ≤4 h was associated with a higher proportion of unplanned readmissions in ≤28 days (Table 3). More than half the discharges resulting in unplanned readmission in ≤28 days had one or more ED attendances (49.2%; $n = 752$) or one or more hospital admissions (49.9%; $n = 762$) in the preceding 6 months. Patients in whom discharges resulted in an unplanned readmission had significantly more ED attendances (median (IQR) 2 (1–3) vs 1 (1–2); $P < 0.001$) and hospital admissions (median (IQR) 2 (1–4) vs 1 (1–2); $P < 0.001$) in the 6 months preceding the discharge resulting in an unplanned readmission. One or more ED attendances and hospital admissions occurred in 40.3% ($n = 617$) of patients; 8.8% ($n = 135$) of patients had one or more ED attendance but no hospital admissions, 9.5% ($n = 145$) of patients had one or more hospital admission but no ED attendances and 41.4% ($n = 631$) of patients had neither an ED attendance nor a hospital admission. There was a moderate positive correlation between the number of ED attendances and hospital admissions in the 6 months preceding the index admission ($r = 0.433$, $P < 0.001$).

### *Factors associated with unplanned readmission n ≤28 days*

Using unplanned readmission in ≤28 days as the independent variable, binary logistic regression was performed for each patient group using the variables that were statistically significant in the bivariate analysis (Table 2). The results of multivariate analyses are presented in Table 4. A test of the full models against constant-only models was statistically reliable (omnibus $\chi^2$ $P < 0.001$ for all models). The area under the receiver operating characteristic (ROC) curve was 72.5 for all patients and ranged from 71.0 for paediatrics to 73.8 for adult surgical patients (Table 4).

The factors associated with increased risk of unplanned readmission in ≤28 days for all patients were age ≥65 years, emergency index admission, Charlson comorbidity index >1, the presence of chronic disease or complications during the index admission, index admission LOS >2 days and hospital admission (s) or ED attendance(s) in the 6 months preceding the index admission. Health service site also affected the risk of unplanned readmission, with discharge from Sites B and C increasing the risk of unplanned readmission in ≤28 days. However, the factors associated with increased risk of unplanned readmission in ≤28 days changed with each patient group. For obstetric patients, the factors that remained statistically significant in the multivariate analysis were an LOS longer than the stage average for that DRG, index admission LOS 3–7 days, one to five hospital admission(s) or one to five ED attendance(s) in the 6 months preceding the index admission. For paediatrics, index admission LOS >2 days remained significant when adjusted for confounders. For adult surgical patients, complications during index admission, index LOS 3–7 days and ≥11 hospital admissions or one or more ED attendance(s) in the 6 months preceding the index admission and discharge from Site B were associated with an increased risk of unplanned readmission in ≤28 days. For adult medical patients, the factors associated with increased risk of unplanned readmission in ≤28 days were age ≥65 years, emergency index admission, Charlson comorbidity index ≥4, index admission LOS >2 days, left against advice and hospital admission(s) or ED attendance(s) in the 6 months preceding the index admission, as well as discharge from Site B.

## Discussion

There are five major findings in the present study. First, adult medical patients comprised the majority (74.4%) of discharges

**Table 2. Patient and index admission characteristics and unplanned readmissions within 28 days of acute care discharge**
Unless indicated otherwise, data are given as *n* (%). *P*-values were calculated using the Cochran–Mantel–Haenszel test. ED, emergency department; DRG, diagnostic-related group; LOS, length of stay

| Patient and index admission characteristics | No. discharges | Unplanned readmission in ≤28 days (*n* = 1528) | No unplanned readmission ≤28 days (*n* = 19 047) | *P*-value |
|---|---|---|---|---|
| Male gender | 9078 | 685 (44.8) | 8393 (44.1) | 0.887 |
| Emergency admission | 12 023 | 10 914 (57.1) | 1109 (72.6) | <0.001 |
| Preferred language English | 19 151 | 1400 (91.6) | 17 751 (93.2) | 0.242 |
| Chronic disease | 8152 | 800 (52.4) | 7352 (38.6) | <0.001 |
| Comorbidities | 375 | 39 (2.7) | 336 (1.8) | 0.028 |
| Charlson index 0–1 | 20 196 | 1469 (96.1) | 18 727 (98.3) | <0.001 |
| Charlson index 2–3 | 282 | 37 (2.4) | 245 (1.3) | 0.002 |
| Charlson index ≥4 | 78 | 18 (1.2) | 60 (0.3) | <0.001 |
| Patient group | | | | |
| Obstetric | 1424 | 79 (5.2) | 1345 (7.1) | 0.026 |
| Paediatric | 1662 | 57 (3.7) | 1605 (8.4) | <0.001 |
| Surgical | 4332 | 255 (16.7) | 4077 (21.4) | <0.001 |
| Medical | 13 157 | 1137 (74.4) | 12 020 (63.1) | <0.001 |
| Admission source | | | | |
| Home | 19 570 | 1442 (94.4) | 18 128 (95.2) | 0.558 |
| Nursing home | 338 | 36 (2.4) | 302 (1.6) | 0.180 |
| Hospital transfer | 489 | 45 (2.9) | 444 (2.3) | 0.441 |
| Complications during index admission | 3748 | 373 (24.4) | 3375 (17.7) | <0.001 |
| No. hospital admissions in past 6 months | | | | |
| 0 | 15 148 | 766 (50.1) | 14 382 (75.5) | <0.001 |
| 1–5 | 5020 | 644 (42.1) | 4376 (23.0) | <0.001 |
| 6–10 | 311 | 70 (4.6) | 241 (1.3) | <0.001 |
| ≥11 | 109 | 54 (3.5) | 55 (0.3) | <0.001 |
| No. ED attendances in past 6 months | | | | |
| 0 | 15 270 | 776 (50.8) | 14 494 (76.1) | <0.001 |
| 1–5 | 5152 | 686 (44.9) | 4466 (23.4) | <0.001 |
| 6–10 | 153 | 66 (4.3) | 87 (0.5) | <0.001 |
| Index LOS greater than state average for DRG | 3783 | 389 (25.5) | 3394 (17.8) | <0.001 |
| Index admission LOS (days) | | | | |
| ≤2 | 15 106 | 915 (59.9) | 14 191 (74.5) | <0.001 |
| 3–7 | 4262 | 439 (28.7) | 3823 (20.1) | <0.001 |
| >7 | 1207 | 174 (11.4) | 1033 (5.4) | <0.001 |
| Discharge at weekend | 3820 | 300 (19.6) | 3520 (18.5) | 0.189 |
| Discharge destination | | | | |
| Transitional care | 66 | 6 (0.4) | 60 (0.3) | 0.643 |
| Left against advice | 163 | 20 (1.3) | 143 (0.8) | 0.022 |
| Private home | 18 132 | 1336 (87.4) | 16 796 (88.2) | 0.832 |
| Aged care | 430 | 49 (3.2) | 381 (2.0) | 0.012 |
| Age (years) | | | | |
| 0–17 | 1667 | 1609 (8.4) | 58 (3.8) | <0.001 |
| 18–64 | 11 260 | 697 (45.5) | 10 563 (55.5) | <0.001 |
| 65–84 | 5819 | 566 (37.0) | 5253 (27.6) | <0.001 |
| ≥85 | 1829 | 207 (13.5) | 1622 (8.5) | <0.001 |

resulting in an unplanned readmission in ≤28 days and had the highest unplanned readmission rate (8.6%), followed by adult surgical (5.9%), obstetrics (5.5%) and paediatrics (3.4%). These findings resemble a state-wide review that reported medical index episodes had the highest 30-day unplanned readmission rate at 8.1%.[2] However, the readmission rates for the other groups in our sample differed, being 4.9% for paediatrics, 3.8% for adult surgical and 3.0% for obstetrics.[2] The difference in unplanned readmission rate in paediatrics and obstetrics may be affected by the inclusion of specialist and private hospitals in the state-wide review.[2]

Second, the factors associated with increased risk of unplanned readmission in ≤28 days varied between patent groups, so a 'one-size-fits-all approach' to reducing unplanned readmissions may not be effective. Further, whole-of-health service results appear to be heavily affected by specific patient groups,

**Table 3. Patient and index admission characteristics and unplanned readmission within 28 days of acute care discharge for index admissions that occurred via the emergency department (ED)**

Unless indicated otherwise, data are given as *n* (%). *P*-values were calculated using the Cochran–Mantel–Haenszel test. ATS, Australasian Triage Scale

| Patient and index admission characteristics | No. discharges | Unplanned readmission in ≤28 days (*n* = 1068) | No unplanned readmission in ≤28 days (*n* = 10 519) | *P*-value |
|---|---|---|---|---|
| Triage category | | | | |
| ATS 1 | 106 | 12 (1.1) | 94 (0.9) | 0.465 |
| ATS 2 | 2456 | 251 (23.5) | 2205 (21.0) | 0.047 |
| ATS 3 | 5647 | 564 (51.1) | 5128 (48.7) | 0.287 |
| ATS 4 | 3185 | 247 (23.1) | 2938 (27.9) | 0.004 |
| ATS 5 | 166 | 12 (1.1) | 154 (1.5) | 0.281 |
| ED length of stay (h) | | | | |
| ≤4 | 4345 | 324 (30.3) | 4076 (38.7) | <0.001 |
| >4 | 7178 | 744 (69.7) | 6443 (61.3) | <0.001 |

in this case adult medical patients, who had the highest rate of unplanned readmissions in ≤28 days. The presence of comorbidities was a significant feature in adult medical patients and this was not unexpected. When controlled for confounders, a Charlson index ≥4 retained statistical significance, suggesting that the number of comorbidities increase the risk of unplanned readmissions in ≤28 days. Health service site was also a factor affecting the risk of unplanned readmissions in ≤28 days in adult surgical and medical patients, and discharge from the largest health service site (Site B) remained significant in the regression analyses. Site B was a tertiary referral centre with a broader range of services offered than the other sites; therefore, Site B manages surgical and medical patients with higher levels of complexity. However, as described above, comorbidities were only a significant feature in medical patients, raising questions about alternative methods of measuring case complexity. Although all sites share a common governance model, they do vary in terms of size and services offered. When developing interventions aimed at decreasing the risk of unplanned readmissions in ≤28 days, between-hospital heterogeneity should be taken into account, even if targeting one specific patient group.

Third, prolonged index admission LOS was associated with an increased risk of unplanned readmissions in ≤28 days in all patient groups. One possible explanation for this finding may be that patients in whom the index admission was longer may be more complex than those who had a shorter index LOS. The optimum index admission LOS for obstetric patients to prevent readmission seems to be ≤2 or >7 days, with women discharged between 3 and 7 days more likely to have an unplanned readmission. The association between LOS between 3 and 7 days and unplanned readmission in ≤28 days in obstetric patients, who mostly have a planned LOS of <3 days, warrants further investigation to determine whether there are specific patterns of complications or other factors that may result in unplanned readmissions. In paediatric, adult surgical and adult medical patients, index admission LOS >2 days was associated with increased risk of unplanned readmission. Other studies have shown that index admission LOS between >3 and 4 days was predictive of unplanned readmission in ≤28 and 30 days in medical patients[4,8] and that increased LOS was associated with unplanned readmissions in patients following arthroscopic sugery[21] or traumatic injury,[22] medical patients of various ages[3,23] and patients discharged from hospital to the community.[24] The present study is the first to report the relationship between hospital LOS and unplanned readmission for the entire health service population, including medical, surgical, obstetric and paediatric patients.

Fourth, in the 6 months preceding the index admission, ED attendances were associated with increased risk of unplanned readmission in ≤28 days in all patient groups except paediatrics. Hospital admissions in the 6 months preceding the index admission were also a significant predictor of unplanned readmission for all patient groups. The median number of ED attendances and hospital admissions in the 6 months preceding the index admission was two for both variables. It may be expected that ED attendances and hospital admissions are inextricably linked, but only a moderate positive correlation was identified. Our observations match those of the Health Innovation Reform Council, which also found that hospital admission within the 6 months before the index admission was a significant predictor of unplanned readmission within 30 days, and noted this was the case for all patient groups (medical, surgical, paediatric and obstetric) with statistically significant odds ratios ranging from 1.35 to 4.19.[2] Other studies have also shown that previous hospitalisation increases the risk of readmission.[8,24]

Our finding of a relationship between ED attendances in the 6 months preceding the index admission and the risk of unplanned readmission in ≤28 days is similar to that of other studies.[3,24] All these studies compared no ED attendances with one or more ED attendances, so the exact trigger point for the risk of unplanned hospital readmission is not known. The present study showed that between one and five ED attendances in 6 months increased the risk of unplanned readmission in ≤28 days in obstetric, surgical and medical patients and that six or more ED attendances in 6 months retained significance for adult surgical and medical patients. These results may suggest that a higher number of ED attendances was more indicative of increased risk of unplanned readmission in surgical and medical patients, or may reflect the lower numbers and short-term nature of the obstetric conditions. The ED also features strongly during the readmission process. The majority (90.6%) of unplanned readmissions in the present study occurred via the ED. Almost half of these involved

**Table 4. Factors associated with increased risk of unplanned readmissions within 28 days of acute care discharge for different patient groups**

OR, odds ratio; CI, confidence interval; N/A, not applicable; LOS, length of stay; $AUC_{ROC}$, area under the receiver operating characteristic curve

| | All patients ($n=20556$) | | Obstetric patients ($n=1424$) | | Paediatric patients ($n=1662$) | | Adult surgical patients ($n=4332$) | | Adult medical patients ($n=13138$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | OR (95% CI) | *P*-value | OR (95% CI) | *P*-value | OR (95% CI) | *P*-value | OR (95% CI) | *P*-value | OR 95% CI) | *P*-value |
| Index admission | | | | | | | | | | |
| Adult medical patient | 1.08 (0.94–1.24) | 0.269 | N/A | | N/A | | N/A | | N/A | |
| Age ≥65 years | 1.29 (1.14–1.46) | <0.001 | N/A | | N/A | | 1.35 (0.99–1.82) | 0.052 | 1.27 (1.10–1.46) | 0.001 |
| Emergency admission | 1.60 (1.40–1.84) | <0.001 | 1.22 (0.59–2.55) | 0.588 | 3.61 (1.46–8.93) | 0.005 | 1.04 (0.77–1.41) | 0.782 | 1.86 (1.54–2.25) | <0.001 |
| Comorbidities | | | | | | | | | | |
| Charlson index 0–1 | Reference | | N/A | | N/A | | Reference | | Reference | |
| Charlson index 2–3 | 1.14 (0.78–1.65) | 0.493 | N/A | | N/A | | 0.98 (0.51–1.86) | 0.949 | 1.17 (0.74–1.86) | 0.505 |
| Charlson index ≥4 | 1.89 (1.05–3.39) | 0.033 | N/A | | N/A | | 1.30 (0.37–4.61) | 0.683 | 2.05 (1.04–4.01) | 0.037 |
| Chronic disease(s) | 1.13 (1.00–1.28) | 0.047 | 1.19 (0.58–2.47) | 0.622 | 0.89 (0.31–2.60) | 0.843 | 1.15 (0.86–1.54) | 0.340 | 1.20 (0.95–1.26) | 0.212 |
| Complications | 1.18 (1.01–1.37) | 0.033 | 0.69 (0.41–1.16) | 0.165 | 1.25 (0.50–3.15) | 0.635 | 1.47 (1.05–2.06) | 0.023 | 1.11 (0.92–1.34) | 0.279 |
| LOS longer than state average | 0.89 (0.75–1.06) | 0.185 | 2.64 (1.11–6.25) | 0.027 | 0.94 (0.39–2.24) | 0.878 | 1.13 (0.80–1.59) | 0.484 | 0.80 (0.64–0.99) | 0.042 |
| Index LOS (days) | | | | | | | | | | |
| ≤2 | Reference | | Reference | | Reference | | Reference | | Reference | |
| 3–7 | 1.48 (1.27–1.74) | <0.001 | 0.32 (0.13–0.75) | 0.009 | 2.58 (1.04–6.42) | 0.041 | 1.42 (0.95–2.13) | 0.085 | 1.58 (1.31–1.90) | <0.001 |
| >7 | 1.75 (1.35–2.26) | <0.001 | 0.98 (0.15–6.44) | 0.981 | 4.09 (1.05–16.01) | 0.043 | 2.28 (1.36–3.85) | 0.002 | 1.68 (1.20–2.35) | 0.002 |
| Left against advice | 1.66 (1.02–2.71) | 0.041 | N/A | | N/A | | 0.57 (0.08–4.28) | 0.585 | 1.82 (1.08–3.07) | 0.024 |
| In the 6 months preceding index admission | | | | | | | | | | |
| No. hospital admissions | | | | | | | | | | |
| 0 | Reference | | Reference | | Reference | | Reference | | Reference | |
| 1–5 | 1.68 (1.45–1.95) | <0.001 | 2.47 (1.40–4.36) | 0.002 | 1.77 (0.88–3.54) | 0.107 | 1.15 (0.81–1.69) | 0.439 | 1.76 (1.46–2.10) | <0.001 |
| 6–10 | 3.73 (2.68–5.18) | <0.001 | 11.35 (0.64–201.80) | 0.098 | N/A | | 2.39 (0.79–7.28) | 0.124 | 4.01 (2.79–5.75) | <0.001 |
| ≥11 | 10.89 (6.91–17.18) | <0.001 | N/A | | N/A | | 5.78 (1.28–26.18) | 0.023 | 11.72 (7.18–19.15) | <0.001 |
| No. ED attendances | | | | | | | | | | |
| 0 | Reference | | Reference | | Reference | | Reference | | Reference | |
| 1–5 | 1.81 (1.57–2.09) | <0.001 | 2.119 (1.23–3.89) | 0.007 | 1.36 (0.72–2.59) | 0.346 | 2.27 (1.62–3.19) | <0.001 | 1.73 (1.45–2.06) | <0.001 |
| ≥6 | 5.16 (3.49–7.62) | <0.001 | N/A | | N/A | | 5.29 (1.14–24.45) | 0.033 | 5.12 (3.36–7.80) | <0.001 |
| Health service site | | | | | | | | | | |
| Site A | Reference | | Reference | | Reference | | Reference | | Reference | |
| Site B | 1.61 (1.36–1.91) | 0.039 | 1.38 (0.85–2.27) | 0.209 | 0.91 (0.45–1.86) | 0.808 | 2.62 (1.48–4.63) | 0.001 | 1.56 (1.30–1.97) | <0.001 |
| Site C | 1.21 (1.01–1.46) | <0.001 | N/A (no maternity service) | | 1.76 (0.89–3.50) | 0.107 | 1.79 (0.98–3.20) | 0.059 | 1.21 (0.97–1.51) | 0.089 |
| Omnibus tests of model coefficients | | | | | | | | | | |
| $\chi^2$ | 969.227 | | 65.160 | | 29.256 | | 181.167 | | 693.917 | |
| d.f. | 18 | | 13 | | 13 | | 17 | | 17 | |
| *P*-value | <0.001 | | <0.001 | | 0.006 | | <0.001 | | <0.001 | |
| % Cases classified correctly | 92.6 | | 94.5 | | 96.6 | | 94.0 | | 91.5 | |
| $AUC_{ROC}$ | 72.5 | | 73.0 | | 71.0 | | 73.8 | | 72.3 | |

ambulance transport to hospital, and 64.8% were assessed as ATS 1, 2 or 3 suggesting urgent care requirements. Prior ED attendances could be understood to be a marker of health issues that are not adequately addressed by the patients themselves, their informal supports or community-based services.

Finally, one in 10 patients who had an unplanned readmission returned 1 day or less after discharge from their index admission, and 50% of unplanned readmissions had occurred by Day 8. This finding is similar to that of other Australian studies.[4,25] The intervals from discharge to unplanned readmission are also remarkably similar in the Australian studies reviewed, and ranged from a median of 9 days in the present study to a median of 10 days[4] and a mean of 10.7 days[25] in other studies. Although the intent of the present study was not to establish whether the unplanned readmissions in ≤28 days were preventable or not, unplanned readmissions occurring soon after acute care discharge clearly are a cause for concern and warrant further investigation.

There are several limitations to the present study that should be taken into account when interpreting the findings. First, the study was conducted at a single health service, so the generalisability of the study findings to other organisations may be limited. Second, this was a retrospective study using organisational data, so there is uncontrolled potential for random coding inaccuracies; however, this potential should be overcome by the large sample size. Diagnostic coding in Australia is closely monitored with strong adherence to coding standards[26] because public hospital funding relies on the results of data coding.[26,27] Third, the present study used organisational data from specific databases, so detailed consideration of other patient factors, such as frailty, functional status, social supports and medications, was not possible, nor was it possible to establish whether unplanned readmissions were avoidable or not. The patient groups used in the present study were as per the definitions from the Health Innovation Reform Council.[2] It is possible that these groups are too broad and do not take into account patients with diagnoses that place them at high risk of readmission, such as sepsis, acute coronary syndrome, heart failure, chronic obstructive pulmonary disease and pneumonia.[28] Finally, because we defined readmission as readmission back to the same health service, it is possible that some discharges resulted in readmissions to other health services; therefore, the true readmission rate may be under-reported.

## Conclusion

One in seven discharges resulted in an unplanned readmission in ≤28 days and one in 10 unplanned readmissions occurred within 1 day of discharge. There were specific patient and index admission characteristics associated with an increased risk of unplanned readmission in ≤28 days, but these characteristics varied between patent groups, highlighting the need for tailored interventions and the potential limitations of a 'one-size-fits-all approach' to reducing unplanned readmissions. Longer index admission LOS, and hospital admissions and ED attendances in the 6 months preceding the index admission increased the risk of unplanned readmission in ≤28 days in all patient groups and may be markers of greater health care needs or of increased complexity. Factors such as more comorbidities and older age may also be surrogate markers of complexity of care needs. It is not well understood whether unplanned readmissions occur as a result of current acute hospital models of care not adequately addressing the needs of patients with complex conditions, from disease progression in patients with complex health problems or a combination of both. The inter-relationships between these factors warrant further assessment. The present study provides useful information from organisational data regarding the risk factors for unplanned readmission, but the presence of chronic, multiple conditions, limited health literacy or limited social support are not well captured by current coding systems. A better and more detailed understanding of the characteristics of patients with unplanned readmissions is needed to improve outcomes, access and patient experience.

## Competing interests

None declared.

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