




# Early emergency readmission frequency as an indicator of short-, medium- and long-term mortality post-discharge from hospital

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## Abstract

Frequent emergency readmissions, an indicator of quality of care, has been rising in England but the underlying reasons remain unclear. We examined the association of early readmissions with subsequent mortality in adults, taking into account the underlying presenting diagnoses and hospital length of stay (LOS). Data of alive-discharge episodes were prospectively collected between 01/04/2017 and 31/03/2019 in an National Health Service hospital, comprising 32,270 patients (46.1% men) aged 18–107 years (mean = 64.0,  $\pm$  SD = 20.5 years). The associations of readmission frequency within 28 days of discharge and mortality within 30 days and 6 months of hospital discharge, and over a 2-year period were evaluated, adjusted for presenting diagnoses, LOS, age and sex during the first admission. Analysis of all patients 18–107 years (reference: no readmission) showed mortality within 30 days was increased for 1 readmission: event rate = 9.2%, odds ratio (OR) = 3.4 (95% confidence interval (CI) = 2.9–4.0), and  $\geq 2$  readmissions: event rate = 10.0%, OR = 2.6 (95% CI = 2.0–3.3), and within 6 months for 1 readmission: event rate = 19.6%, OR = 3.0 (95% CI = 2.7–3.4), and  $\geq 2$  readmissions: event rate = 27.4%, OR = 3.4 (95% CI = 2.9–4.0), and over a 2-year period for 1 readmission: event rate = 25.5%, hazard ratio = 2.2 (95% CI = 2.0–2.4), and  $\geq 2$  readmissions: event rate = 36.1%, hazard ratio = 2.5 (95% CI = 2.2–2.8). Within the age groups 18–49, 50–59, 60–69, 70–79 and  $\geq 80$  years, readmissions were also associated with increased risk of mortality within 3 months and 6 months of discharge, and over 2-year period. In conclusion, early hospital readmission predicts short-, medium- and long-term mortality post-discharge from hospital in adults aged 18–107 years, independent of underlying presenting conditions, LOS, age and sex. Further research focussing on safe discharge and follow-up patient care may help reduce preventable readmissions and post-discharge mortality.

**Keywords** Health economics · Healthcare services · Readmission prevention · Quality of care

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## Abbreviations

CI	Confidence interval
ICD	International classification of diseases
LOS	Length of stay
NHS	National Health Service
OR	Odds ratio
HR	Hazard ratio

## Introduction

Emergency readmission frequency has been a major focus of research of healthcare services, used as a measure of quality of care and cost-efficiency, primarily in older adults [1–4]. A study of over 14 million emergency admissions in US adults  $\geq 18$  years revealed that the cost of a readmission within 30 days of discharge from hospital was about US \$10,000 for sepsis and US \$8500–9500 for respiratory

and cardiac conditions [2]. Another US study showed the cost of an early readmission after a discharge for coronary artery bypass graft was greater—\$13,500 [4]. Early emergency readmissions are continuously recorded by National Health Service (NHS) hospitals. Healthwatch England analysed data from 70 out of 125 hospitals and found that in 2017–18, the number of emergency readmissions increased by 9%; the fastest rate over the previous 5 years. There were 484,609 emergency readmissions to hospital within 30 days, a 22% rise over the previous 5 years, with numbers readmitted within 24 h of discharge ('failed discharge') from hospital rose by 33% in the same period [5, 6]. The underlying reasons for these increases in readmissions remain unclear and has led Healthwatch England to conclude that "Most troubling is that the sector still cannot report on how many emergency readmissions were unavoidable and which ones could be prevented, or use this insight to learn" [5]. However, increased readmission could be explained, in part, by the rising admissions in recent years. The total annual number of hospital admissions across all English hospitals in 2006 was 11 million, which rose by 28% to over 14 million in 2016. The corresponding figures for those older than 65 years were 4 million in 2006 and 6 million in 2016, a rise of 46%, [7] while the trends in hospital length of stay (LOS) for those staying at least one night showed a marginal increase between 2010 and 2014, from 6.85 to 6.92 days [8].

Other than being an indicator of quality of care, early emergency readmission also reflects poor health status of an individual [9–11]. Hitherto, there is a paucity of data on its relationship with health consequences, such as mortality. In this study, we examined the associations of early readmission frequency on all-cause mortality within 30 days and 6 months after discharge from hospital and over a 2-year period, in adults aged 18–107 years, taking into account the presenting diagnoses and LOS.

## Methods

### Participants and setting

In line with the NHS, information for every patient attending emergency department is recorded using Patient Administration System (PAS) including demographics, diagnosis, co-morbidities, dates of admission and discharge. Data of consecutive alive-discharge episodes over 2 years between 1 April 2017 and 31 March 2019 extracted from PAS in a single NHS hospital [12, 13].

### Outcome measures

Information on the frequency of unplanned admissions and all-cause readmissions within 28 days, and all-cause

mortality within 30 days and 6 months after hospital discharge, and over 2-year period was recorded. Primary diagnoses presented in the first admission were coded according to international classification of diseases (ICD-10) [14]. Cancer and obstetrics spells were excluded in line with the NHS data collection for general hospital admissions [15]. LOS was calculated as the duration between the dates of first admission and first discharge.

### Categorisation of variables

Age was categorised by decades from 50 years old: 50–59, 60–69 and 70–79 years. All those aged 18–49 years were grouped together due to low mortality rates, while those aged 80–107 years were combined together due to small numbers. The frequency of readmissions within 28 days of discharge was categorised into three groups: No readmission, readmitted once, and readmitted  $\geq 2$  times. Prolonged LOS was considered as those staying in hospital  $\geq 2$  weeks (top 10th centile of LOS).

### Statistical analysis

Continuous data are presented as mean  $\pm$  standard deviation, except some skewed data sets that are shown as median values (25%, 75% interquartiles). Chi-square tests were used to assess the relationship between readmission frequency and mortality, and Kruskal–Wallis  $H$  test to assess differences in LOS between different categories of readmission frequency. The frequency of readmission was used to predict mortality within 30 days and within 6 months of hospital discharge using multivariable stepwise logistic regression, and mortality over a 2-year period using multivariable stepwise Cox regression. Kaplan–Meier curves were constructed to examine survival time after hospital discharge in relation to readmission frequency. Data were adjusted for age and sex and primary diagnosis at presentation and prolonged LOS during the first admission for all ages and for different age categories. Odds ratio (OR) and hazard ratio (HR) are given with 95% confidence intervals (CI). Analyses were performed using IBM SPSS Statistics, v25.0 (IBM Corp., Armonk, NY).

## Results

### Subject characteristics

A total of 14 878 men and 17 392 women of mean age  $64 \pm 20.5$  years were studied. Table 1 shows patient characteristics including primary diagnoses presented in the first admission and age distribution. The proportions of patients with no readmission, one readmission and  $\geq 2$  readmissions

**Table 1** Characteristics of 14,878 men aged 18.0–104.1 years (mean = 63.9 ± SD = 19.3 years) and 17,392 women aged 18.0–106.7 (mean = 64.1 ± SD = 21.6 years)

	<i>n</i>	%
Age distribution		
18–49.9 years	8403	26.0
50–59.9 years	4304	13.3
60–69.9 years	4739	14.7
70–79.9 years	6068	18.8
≥ 80 years	8756	27.1
Primary diagnosis on first admission		
Sepsis	1170	3.6
Viral infections	145	0.4
Haematological disorders	676	2.1
Metabolic and endocrine disorders	1084	3.4
Diabetes <sup>b</sup>	350	1.1
Psychiatric disorders	279	0.9
Neurological disorders	722	2.2
Ophthalmic disorders	163	0.5
Cardiovascular disorders	4416	13.7
Congestive heart failure <sup>b</sup>	405	1.3
Pulmonary disorders	3367	10.4
Asthma <sup>b</sup>	207	0.6
Chronic obstructive pulmonary disease <sup>b</sup>	470	1.5
Pneumonia <sup>b</sup>	1692	5.2
Gastrointestinal disorders	4144	12.8
Dermatological disorders	1083	3.4
Musculoskeletal disorders	3169	9.8
Urological disorders	3686	11.4
Urinary tract infection <sup>b</sup>	1116	3.5
Bodily pain	4344	13.5
Bone fractures	2624	8.1
Hip fractures <sup>b</sup>	639	2.0
Medical device-related complications	1015	3.1
Others (not specified)	183	0.6
Stayed in hospital ≥ 2 weeks	3228	10.0
Number of readmissions within 28 days of discharge		
None	28,548	88.5
Once	2666	8.3
≥ 2 times	1056	3.3
Mortality status		
Death within 30 days of first admission	834	2.6
Death within 6 months of first admission <sup>a</sup>	2192	6.8
Death within a 2-year period	3305	10.2

<sup>a</sup>This group includes those who died within 30 days of admission

<sup>b</sup>Specific conditions within categories of disorders

within 28 days of first hospital discharge were 88.5, 8.1 and 3.3%, and over a 2-year period were 78.4, 13.5 and 8.1%, respectively. Readmission rates increased incrementally with age groups 18–49, 50–59, 60–69, 70–79 and ≥ 80 years

from 5.0, 5.8, 6.7, 8.0, to 13.7% for one readmission and 1.0, 1.5, 2.4, 3.3 to 6.7% for ≥ 2 readmissions, respectively. There were 2.6, 6.8, and 10.2% of patients who died within 30 days, after 6 months and after 2 years post discharge, respectively. The mean age of death (81 ± 12 years) was similar among all groups.

### Association of primary diagnoses and LOS during admission with readmission frequency

Admissions for sepsis, diabetes, psychiatric, congestive heart failure, chronic obstructive pulmonary disease, pneumonia, urinary tract infection, musculoskeletal disorders and bodily pain, medical device-related complications, and prolonged LOS all linked to subsequent readmissions within 28 days of charge from hospital (Table 2). The median (interquartile range) of the preceding hospital LOS during the first hospital admission was 2.1 (0.9–5.1) days for no readmission, 6.6 (2.7–13.3) days for 1 readmission and 11.3 (6.7–19.8) days for ≥ 2 readmission (Kruskal–Wallis *H* test for group differences:  $\chi^2 = 1765$ ,  $p < 0.001$ ).

### Association of readmission frequency on mortality

Among those who were not readmitted, readmitted once, and readmitted ≥ 2 times within 28 days of discharge, the mortality rates within 30 days of discharge were 1.7, 9.2 and 10.0% ( $\chi^2 = 779$ ,  $p < 0.001$ ), and within 6 months of discharge were 4.8, 19.6 and 27.4% ( $\chi^2 = 1572$ ,  $p < 0.001$ ). Figure 1a–c shows that mortality rates increased progressively with age and increasing frequency of readmission. Within each age group of 18–49, 50–59, 60–69, 70–79 and ≥ 80 years, the mortality rates within 30 days of discharge for those who were not readmitted were 0.1, 0.5, 1.3, 2.1 and 4.1%; readmitted once were 1.2, 2.4, 6.3, 8.9 and 14.2%; and readmitted ≥ 2 times were 1.1, 4.6, 7.1, 9.9 and 12.6% (Fig. 1a). The corresponding mortality rates for those who were readmitted within 6 months of first discharge were: 0.4, 1.5, 3.6, 5.7 and 11.9% for no readmission; 2.6, 7.6, 13.9, 19.8 and 29.5% for one readmission; and 5.7, 10.8, 22.3, 32.0 and 31.7% (Fig. 1b). Within 2 years of discharge, these were 0.6, 2.6, 5.5, 9.8 and 19.0% for no readmission, 3.1, 1.0, 18.0, 28.0 and 37.6% for one readmission, and 10.3, 13.8, 25.0, 41.9 and 42.4% (Fig. 1c).

The mortality rates within 30 days and 6 months of discharge, and over 2-year period all increased progressively with age, with higher rates for longer-term mortality (Fig. 2a–c). Analysis of short-term (within 30 days) mortality showed that compared with those who were not readmitted, patients who were readmitted just once or ≥ 2 times had similarly higher rates of mortality (Fig. 2a). When the analysis was extended to medium term (6 months) or long term (2-year period), mortality rates in those admitted once

**Table 2** Health conditions presented as primary diagnoses and prolonged length of stay during first hospital admission in relation to subsequent readmission frequency

Primary diagnosis on first admission	Disorders from first admission in relation to subsequent readmission frequency (%)			$\chi^2$	<i>p</i>
	No readmission	1 readmission	≥ 2 readmissions		
Sepsis	3.4	5.1	6.5	47.1	<0.001
Viral infections	0.5	0.3	0.2	3.3	0.194
Haematological disorders	2.2	1.1	1.0	20.3	<0.001
Metabolic and endocrine disorders	3.3	4.0	4.3	6.5	0.039
Diabetes	1.0	1.6	2.2	20.8	<0.001
Psychiatric disorders	0.8	1.2	2.1	23.8	<0.001
Neurological disorders	2.3	1.8	2.7	3.2	0.198
Ophthalmic disorders	0.5	0.2	0.3	8.7	0.013
Cardiovascular disorders	13.7	13.3	13.0	0.9	0.630
Congestive heart failure <sup>a</sup>	1.1	2.6	3.2	80.1	<0.001
Pulmonary disorders	9.4	16.8	21.3	279.3	<0.001
Asthma <sup>a</sup>	0.7	0.5	0.5	1.6	0.439
Chronic obstructive pulmonary disease <sup>a</sup>	1.3	2.3	4.8	106.2	<0.001
Pneumonia <sup>a</sup>	4.6	9.7	10.8	193.1	<0.001
Gastrointestinal disorders	12.9	12.5	11.1	3.6	0.169
Dermatological disorders	3.4	2.9	3.4	1.7	0.436
Musculoskeletal disorders	10.5	5.1	2.7	144.4	<0.001
Urological disorders	11.3	12.3	12.1	2.8	0.237
Urinary tract infection <sup>a</sup>	3.1	5.7	6.9	86.1	<0.001
Bodily pain	13.8	11.9	8.4	31.0	<0.001
Bone fractures	8.2	7.7	6.6	4.1	0.128
Hip fractures <sup>a</sup>	1.9	2.7	2.0	7.0	0.030
Medical device-related complications	3.1	3.7	4.3	8.0	0.019
Prolonged LOS in hospital (≥ 2 weeks)	7.8	21.6	39.3	1557	<0.001

LOS length of stay

<sup>a</sup>Specific conditions within categories of disorders

and ≥ 2 times uncoupled from each other with the widest gap among those aged 60–79 years (Fig. 2b, c).

Compared with patients with no readmission, the OR of mortality within 30 days of discharge in those who were readmitted once was 3.4 (95%CI=2.9–4.0) and ≥ 2 times was 2.6 (95%CI=2.0–3.3) for all ages, and for each age category from 18–49, 50–59, 60–69, 70–79 and ≥ 80 year: ORs were 10.7, 3.9, 4.0, 3.2 and 3.2 for 1 readmission and 10.2, 5.6, 3.7, 2.8 and 2.4 for ≥ 2 readmissions, respectively. The OR of mortality within 6 months of discharge in those who were readmitted once was 3.0 (95%CI=2.7–3.4) and ≥ 2 times was 3.4 (95%CI=2.9–4.0) for all ages, and for each age category from 18–49, 50–59, 60–69, 70–79 and ≥ 80 year: ORs were 7.5, 4.5, 3.3, 3.2 and 2.7 for 1 readmission and 12.4, 5.9, 4.1, 5.1 and 2.7 for ≥ 2 readmissions, respectively (Table 3).

Compared to those with no readmission (mean for survival time from discharge = 30.2 months, 95%CI=30.1–30.3), those who were readmitted once or ≥ 2 times had a significantly shorter survival with mean for survival time

from discharge = 24.9 days (95%CI=24.4–25.4) and 21.9 (95%CI=21.0–22.7) days, respectively, log-rank (Mantel–Cox) test:  $\chi^2=3876$ ,  $p<0.001$  (Fig. 3). Mortality over the 2-year period was increased for those who were readmitted once: event rate = 25.5%, HR = 2.2 (95%CI=2.0–2.4), and ≥ 2 times: event rate = 36.1%, HR = 2.5 (95%CI=2.2–2.8) for all ages, and for each age category from 18–49, 50–59, 60–69, 70–79 and ≥ 80 year: HRs were 4.9, 3.3, 2.7, 2.5 and 2.0 for 1 readmission and 12.4, 3.7, 2.9, 3.5 and 2.2 for ≥ 2 readmissions, respectively (Table 3).

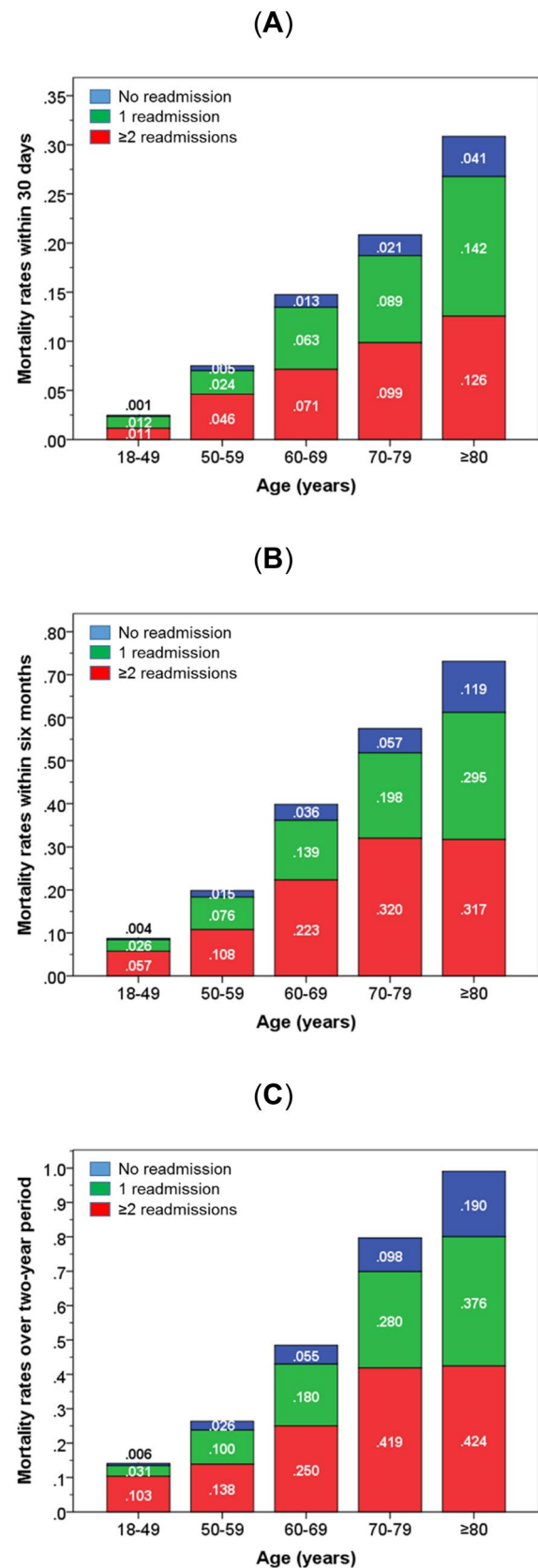
## Discussion

This study found early emergency readmission frequency was a significant predictor of all-cause mortality within 30 days or 6 months post hospital discharge, and also over a 2-year period, in all age groups spanning 18–107 years, independent of presenting diagnosis, LOS, age and sex.

**Fig. 1** Stacked bar charts showing rates of mortality within 30 days (a) and 6 months (b) of discharge from first admission, and over a 2-year period (c) according to readmission status in different age categories. Note: the numbers represent the rates of mortality within each category of readmission status

Our findings are highly relevant both to clinical research and healthcare planning to further examine underlying reasons for the rising rates of early readmissions in England [5, 6].

We observed that short-term mortality rates (within 30 days of discharge) were similar for patients who were readmitted either once or for  $\geq 2$  times. However, mortality rates in those who were readmitted  $\geq 2$  times rose to a higher level when longer-term (within 6 months or over a 2-year period) mortality rates were examined. These differences could be explained, in part, by the higher prevalence of underlying conditions presented on first admission among those who were readmitted multiple times but who were able to survive over a short period, *i.e.* proportionally more of those readmitted  $\geq 2$  times die after 30 days of discharge than those who were readmitted once. Another explanation of this result could be that the 30-day mortality is an endpoint observed too early for patients readmitted  $\geq 2$  times, as these patients may have lived long enough to be admitted to the hospital two times or more. However, we did not have the timings between first hospital discharge and second readmission in this group of patients. It is likely that there are other reasons yet to be elucidated since readmission frequency predicts mortality independently of conditions presented on admission. This fundamental conundrum has been highlighted by Healthwatch England because the rates of readmissions continue to rise steadily in England without a clear explanation [5]. There are likely to be many factors contributing to this rise, including aspects related to patient discharge activities, such as the lack of explanation of the discharge plan provided to the patient, poor execution of discharge instructions, and lack of communication with primary care and coordination of care post-discharge, all of which are risk factors for avoidable readmissions [16]. Efforts have been made to reduce hospital readmissions, such as the Hospital Readmissions Reduction Program in the US, with mixed results [17]. A recent study showed that telephone contact with patients within 48 h of discharge lowered early readmission rates compared with those who had no contact (9.2% versus 15.7%,  $p=0.011$ ) [18]. Further research is therefore needed, focussing on safe discharge [19] and follow-up care for patients [20–22] and effective communication with primary care physicians [23]. The uncoupling of mortality rates between frequency of readmissions narrowed in the oldest age group may be due to higher rates of mortality or palliation in the community among this group which prevent them from readmissions.

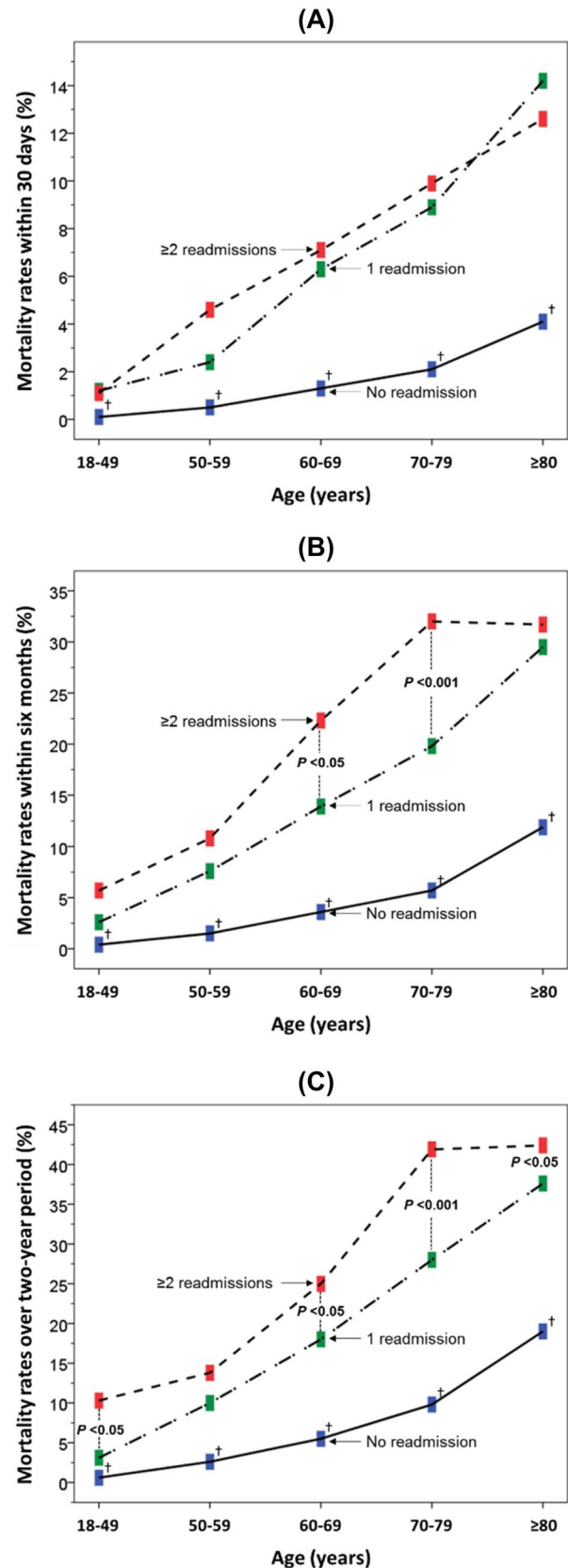




**Fig. 2** Mortality rates within 30 days (a) and 6 months (b) of discharge from first admission, and over a 2-year period (c) according to admission frequency in different age categories. Denotes differences from “no readmission group”:  $p < 0.001$

Readmission frequency is routinely documented and assessed by secondary care centres as a way to identify frequent hospital users to provide care-support for patients in the community, [2] which both benefits patients and health-care services. Evidence from this study further extends its utility as a simple and practical indicator of post-discharge mortality, even just a single readmission within 28 days of hospital discharge can identify those at high risk of death. The overall rates of readmission of 11.6% (8.3% once and 3.3%  $\geq 2$  times) observed in our study are at the lower end of those reported previously (11.6–18.4%) [24–26]. One factor is likely to be due to age differences between various study populations. As observed in our study of the incremental increase in readmission rates with age. The mortality rates observed in our study were also comparable to those recently reported for 30 days [27] and 6 months of discharge [28, 29]. As expected, the rates of mortality also increased with age. However, within each age category, the rates of mortality were consistently higher among individuals who were readmitted to hospital more frequently, suggesting that the risk of death from readmissions extends to the less-studied younger adults. Our recent study found that a risk of prolonged LOS in hospital ( $> 17$  days) for patients admitted with hip fractures was increased by fourfold in those who acquired nosocomial pneumonia or a urinary tract infection [30]. This raises the possibility that patients who face emergency readmissions spend overall a much longer time in the risky hospital environment, such that mortality could, at least in part, be linked to hospital acquired complications. Conditions presented on admission may also play a key role in future readmissions and mortality. In the UK, the rates of admission with non-specific chest pain (22%) and abdominal pains (20%), urinary tract infection (11%), acute mental crisis (10%), COPD (10%) and angina (6%) are among the highest in patients  $> 75$  years [31]. Excess admission rates have been reported to occur for pneumonia, congestive heart failure and COPD in older individuals and during the months of the influenza season [32].

The strengths of this study lie in its large number of consecutive patients, which enable us to estimate the risk of mortality by decades of age, ranging from 18 to 107 years. Appropriate adjustments were made including age, sex and presenting diagnoses. Characteristics of this study have been shown to be similar to those of the UK population [12, 33, 34]. There are certain limitations in the present study that may arise from patients who have left our catchment area or those who were readmitted to other centres this would lead to an underestimation of



**Table 3** Stepwise multivariable logistic and Cox regression examining the association of readmission frequency and mortality, adjusted for age, sex and conditions presented as primary diagnosis (reported in Table 1) and prolonged LOS

Logistic regression	Age and sex adjusted mortality <sup>a</sup>							
	1 readmission <sup>b</sup>				≥ 2 readmissions <sup>b</sup>			
	Event rate (%)	OR	95% CI	<i>p</i>	Event rate (%)	OR	95% CI	<i>p</i>
<b>Death within 30 days</b>								
All ages	9.2	3.4	2.9–4.0	<0.001	10.0	2.6	2.0–3.3	<0.001
18–49 years	1.2	10.7	3.6–32.0	<0.001	1.1	10.2	1.3–81.4	0.028
50–59 years	2.4	3.9	1.5–10.0	0.006	4.6	5.6	1.5–20.9	0.010
60–69 years	6.3	4.0	2.3–6.9	<0.001	7.1	3.7	1.6–8.2	0.002
70–79 years	8.9	3.2	2.2–4.7	<0.001	9.9	2.8	1.7–4.8	<0.001
≥ 80 years	14.2	3.2	2.6–4.0	<0.001	12.6	2.4	1.8–3.1	<0.001
<b>Death within 6 months</b>								
All ages	19.6	3.0	2.7–3.4	<0.001	27.4	3.4	2.9–4.0	<0.001
18–49 years	2.6	7.5	3.4–15.4	<0.001	5.7	12.4	4.3–35.5	<0.001
50–59 years	7.6	4.5	2.6–7.8	<0.001	10.8	5.9	2.5–14.2	<0.001
60–69 years	13.9	3.3	2.3–4.8	<0.001	22.3	4.1	2.5–6.9	<0.001
70–79 years	19.8	3.2	2.5–4.2	<0.001	32.0	5.1	3.6–7.1	<0.001
≥ 80 years	29.5	2.7	2.2–3.2	<0.001	31.7	2.7	2.2–3.3	<0.001
<b>Cox regression</b>								
Age and sex adjusted mortality <sup>a</sup>								
1 readmission <sup>b</sup>				≥ 2 readmissions <sup>b</sup>				
Event rate (%)	HR	95% CI	<i>p</i>	Event rate (%)	HR	95% CI	<i>p</i>	
<b>Death over two years</b>								
All ages	25.5	2.2	2.0–2.4	<0.001	36.1	2.5	2.2–2.8	<0.001
18–49 years	3.1	4.9	2.6–9.0	<0.001	10.3	12.4	5.8–26.6	<0.001
50–59 years	10.0	3.3	2.1–5.1	<0.001	13.8	3.7	1.8–7.5	<0.001
60–69 years	18.0	2.7	2.0–3.6	<0.001	25.0	2.9	1.9–4.4	<0.001
70–79 years	28.0	2.5	2.0–3.0	<0.001	41.9	3.5	2.7–4.4	<0.001
≥ 80 years	37.6	2.0	1.8–2.3	<0.001	42.4	2.2	1.9–2.5	<0.001

<sup>a</sup>Age and sex adjustment for all analyses including individual age bands

<sup>b</sup>Reference group: No readmission; *OR* odds ratio; *HR* hazard ratio

readmission rates. Studies have variably used between 28 and 30 days to define the period of early emergency readmission, [35] while we used 28 days for our definition, as guided by the NHS, [36] which would capture slightly lower numbers of readmissions. However, these differences do not affect the outcome of our studies since the primary purpose of our study was not intended for

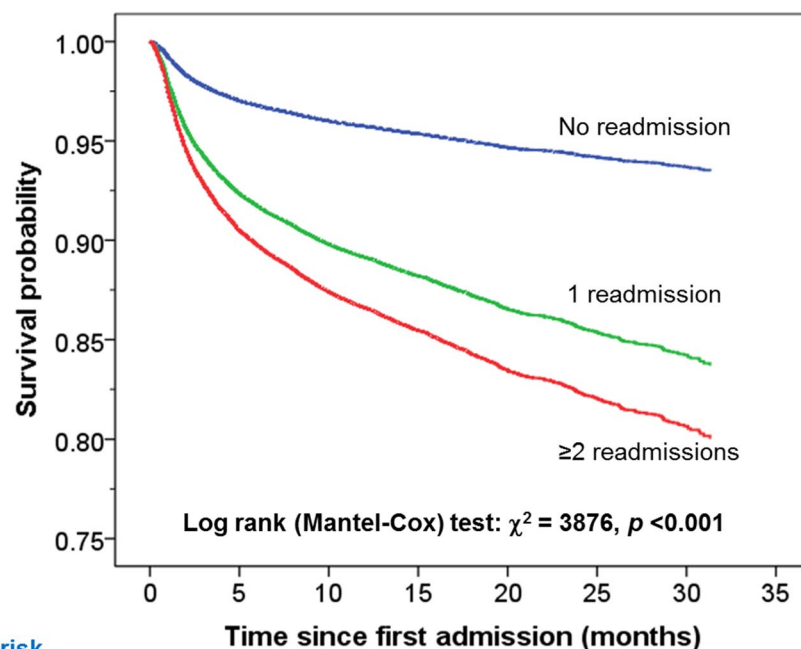
comparison of the performance of the frequency of readmissions with other studies.

In conclusion, early hospital readmission predicts short-, medium- and long-term mortality post-discharge from hospital in adults aged 18–107 years, independent of underlying presenting conditions, LOS, age and sex. Further research focussing on safe discharge and follow-up patient care may help reduce preventable or avoidable readmissions and post-discharge mortality.

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**Author contributions** TSH and DF reviewed the topic related literature and performed the study concept and analysis design. DF, PM and JR

**Fig. 3** Kaplan–Meier survival plot in patients with different frequency of readmissions. The table beneath the figure shows the number of at-risk patients at various time points for the three readmission frequency cohorts



**Number at risk**

Time (months)	0	5	10	15	20	25	30	35
No readmission	28548	27303	24592	18472	12762	7563	2386	0
1 readmission	2666	2185	1927	1440	1001	580	160	0
≥2 readmissions	1056	792	672	487	346	178	46	0

commented on the manuscript. TSH wrote the first draft, analysed, interpreted the data and revised the manuscript. CHF edited the manuscript. All authors checked, interpreted results and approved the final version.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

**Ethical approval** This study does not require NHS Research Ethics Committee approval since it involves secondary analysis of anonymised data. This study was conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Human and animal rights** This article does not contain any studies with animals performed by any of the authors.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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