Fluck, D., Murray, P., Robin, J., Fry, C. H., & Han, T. S. (2020). Early emergency readmission frequency as an indicator of short, medium, and long-term mortality post-discharge from hospital. *Internal and emergency medicine*. https://doi.org/10.1007/s11739-020-02599-3

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

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Received: 12 October 2020 / Accepted: 2 December 2020
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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, ± 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 ≥ 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 ≥ 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 ≥ 2 readmissions: event rate = 36.1%, hazard ratio = 3.4 (95%CI = 2.9–4.0). Within the age groups 18–49, 50–59, 60–69, 70–79 and ≥ 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

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 ≥ 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%, 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 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 ≥ 2 times. Prolonged LOS was considered as those staying in hospital ≥ 2 weeks (top 10th centile of LOS).

### Statistical analysis

Continuous data are presented as mean ± 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 ± 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 ≥ 2 readmissions...
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 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...
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, 3.7, 2.9, 2.1 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.

| Primary diagnosis on first admission | Disorders from first admission in relation to subsequent readmission frequency (%) | χ² | p |
|-------------------------------------|---------------------------------------------------------------------------------|----|----|
|                                    | 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            | 1.1 | 2.6 | 3.2 | 80.1 | < 0.001 |
| Pulmonary disorders                 | 9.4 | 16.8| 21.3| 279.3| < 0.001 |
| Asthma                              | 0.7 | 0.5 | 0.5 | 1.6  | 0.439  |
| Chronic obstructive pulmonary disease| 1.3 | 2.3 | 4.8 | 106.2| < 0.001 |
| Pneumonia                           | 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             | 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                       | 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

a Specific conditions within categories of disorders

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

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: χ² = 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).
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 ≥ 2 times. However, mortality rates in those who were readmitted ≥ 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 ≥ 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 ≥ 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.
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 healthcare 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% ≥ 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
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.

Acknowledgements The authors wish to thank patients and all those who were involved in the project, and Dr Erica Heppleston (Quality Department, Ashford and St Peter’s Hospitals NHS Foundation Trust) who performed the study coordination and data collection.

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

| Logistic regression | Age and sex adjusted mortality a |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---------------------|---------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                     | 1 readmission b                  | Event rate (%) | OR | 95% CI | p   | ≥ 2 readmissions b | Event rate (%) | OR | 95% CI | p   |
| Death within 30 days|                                 |               |    |        |     |                |               |    |        |     |
| 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 |
| Death within 6 months|                                 |               |    |        |     |                |               |    |        |     |
| 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 |

Cox regression Age and sex adjusted mortality a

| Cox regression | Age and sex adjusted mortality a |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|----------------|---------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                 | 1 readmission b                  | Event rate (%) | HR | 95% CI | p   | ≥ 2 readmissions b | Event rate (%) | HR | 95% CI | p   |
| Death over two years|                                 |               |    |        |     |                |               |    |        |     |
| 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 |

aAge and sex adjustment for all analyses including individual age bands
bReference group: No readmission; OR odds ratio; HR hazard ratio
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.

Funding None.

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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