Frequent identical admission-readmission episodes are associated with increased mortality

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ABSTRACT

Frequent emergency readmissions may associate with health consequences. We examined the association between readmissions within 28days of hospital discharge and mortality in 32,270 alive-discharge episodes (18-107years). Data collected between 01/04/2017 and 31/03/2019 are presented as age- and sex-adjusted hazard ratios (HR) with 95% confidence interval (CI).

Compared with no readmission, mortality risk over a two year period was increased with one non-identical admission-readmission (AR) episode: HR=2.4 (2.2-2.7), ≥2 non-identical AR episodes: HR=3.0 (2.7-3.4), one identical AR episode: HR=4.7 (95%CI=3.6-6.1), and ≥2 identical AR episodes: HR=5.0 (3.8-6.7). Eight conditions associated with AR episodes had increased risk of mortality including congestive heart failure: HR=2.7 (2.2-3.2), chronic pulmonary obstructive disease: HR=3.0 (2.5-3.6), pneumonia: HR=2.0 (1.8-2.3), sepsis: HR=2.2 (1.9-2.5), endocrine disorders: HR=1.9 (1.6-2.3), urinary tract infection: HR=1.5 (1.3-1.7), psychiatric disorders: HR=1.5 (1.1-2.1) and haematological disorders: HR=1.5 (1.2-1.9). Frequent identical AR episodes, particularly from chronic and age-related conditions, are associated with increased mortality.

Keywords: Health economics; healthcare services; readmission prevention; quality of care

INTRODUCTION

Emergency readmission frequency is an indicator of quality of care and cost-efficiency.[1-4] Early emergency readmissions recorded by the National Health Service (NHS) in 2017-18 showed that there were 484,609 emergency readmissions to hospital within 30 days of discharge, a 22% rise over the previous five years.[5,6] The underlying reasons for this increase in readmission rate remain unclear but the growing population who live with age-related chronic conditions[7] may be a major contributing factor. The cost of emergency readmissions is huge, estimated to be in the order of $26 billion *per annum* in the US.[8] Specifically, the cost of readmissions for initial respiratory and cardiac conditions range from $8,500 to $9,500, rising to $10,000 for sepsis[3] and $13,500 for coronary artery bypass graft.[4]

Early emergency readmission indicates poor health status of an individual.[9-11] Hitherto, there is a paucity of data on frequent readmissions, particularly for the same condition, and its relationship to health consequences. In this study, we aimed to: i) examine the associations of frequent early readmission for the same condition with all-cause mortality, ii) identify conditions presented in the first (index) admission that are most commonly associated with frequent readmissions, and iii) relate these frequently-readmitted conditions to the risk of mortality.

METHODS

Design, participants and setting

In this two-year follow up study, data of consecutive alive-discharge episodes were collected between 1st April 2017 and 31st March 2019 in an NHS hospital.[12,13]

Data procurement

Index diagnoses presented in the first admission, coded according to the international classification of diseases,[14] were recorded. Information on the frequency of early readmissions (within 28 days of hospital discharge), mortality within 30 days and six months after hospital discharge, and over a two-year period was documented. Cancer and obstetrics admissions were not included in line with the NHS data collection for emergency hospital admissions.[15]

Definition of types of readmission

The type of readmission was defined as an "identical admission-readmission (AR) episode" or a "non-identical AR episode", *i.e.* readmission either for the same or for a different condition from that of the index admission. For example, if an index admission were for congestive heart failure (CHF) and a readmission were also for CHF after discharge, then the type of readmission is considered as an identical AR episode; a readmission with a condition other than CHF is considered as a non-identical AR episode.

Categorisation of variables

The frequency of readmissions within 28 days of hospital discharge was categorised into three groups: no readmission, one readmission, and ≥2 readmissions. Five categories were thus created according to the frequency and type of readmissions: no readmission, one non-identical AR episode, ≥2 non-identical AR episodes, one identical AR episode, and ≥2 identical AR episodes.

Statistical analysis

Chi squared tests were used to explore the association between categorical variables. The five classes of frequency and type of readmission were used to predict mortality within 30 days and within six months of hospital discharge (an event occurring at a single time point) using multivariable stepwise logistic regression, and to predict mortality over two years (a time-dependent event) using multivariable stepwise Cox regression. Data were adjusted for age and sex and presented as odds ratio (OR) and hazard ratio (HR) respectively, with 95% confidence intervals (CI). Analyses were performed using IBM SPSS Statistics, v25.0 (IBM Corp., Armonk, NY).

RESULTS

Subject characteristics

A total of 32,270 patients (14,878 men and 17,392 women) of mean age 64 ±20.5 years (range 18-107 years) were recruited. **Supplementary Table 1** shows patient characteristics including primary (index) diagnoses presented in the first admission. The proportions of patients with no readmission, one readmission and ≥2 readmissions within 28 days of first hospital discharge were 88.5, 8.1 and 3.3%. Of those readmitted once, 92.9% were non-identical AR episodes and 7.1% were identical AR episodes. Among those readmitted ≥2 times, 89.9% were non-identical AR episodes and 10.1% were identical AR episodes. There were 2.6, 6.8, and 10.2% of patients who died within 30 days, within six months and over two years post-discharge, respectively. The mean age of death was 81 ±12 years.

Association of frequency and type of readmission with mortality

Overall the proportion of patients with no readmission who died was 7.9%. Mortality increased to 25.2, 35.0, 25.5, 45.8% for those with one non-identical AR episode, ≥2 non-identical AR episodes, one identical AR episode and ≥2 identical AR episodes respectively (group differences: χ^2 = 1828, p <0.001).

After adjustment for age and sex, Kaplan-Meier survival plots revealed that the survival probability was lower with increasing frequency of readmission. For a given readmission frequency, an identical AR episode lowered the survival probability further. Thus individuals at the highest risk of death had the highest frequency of identical AR episodes (**Figure 1**).

Multivariable Cox regression was conducted to assess mortality within a two year period of study. Compared with patients who were not readmitted (reference group), age and sex adjusted risk of mortality was increased for those with one non-identical AR episode: HR (95%CI) = 2.4 (2.2-2.7), ≥2 non-identical AR episodes: HR = 3.0 (2.7-3.4), one identical AR episode: HR = 4.7 (3.6-6.1), and ≥2 identical AR episodes: HR = 5.0 (3.8-6.7) (**Table 1**). Similar patterns of the association between frequency and type of readmission with mortality within 30 days, and with mortality within six months of discharge were also observed (**Supplementary Table 2**).

Association of index admissions with frequency and type of readmission

From all index admissions examined, higher proportions of frequent readmissions for identical AR episodes were observed among five conditions: CHF, chronic obstructive pulmonary disease (COPD), pneumonia (except ≥2 identical AR episodes), endocrine

disorders and urinary tract infection (UTI). Sepsis (7.0%), psychiatric disorders (2.2%) and medical device complications (4.3%) peaked at ≥2 non-identical AR episodes while haematological disorders (3.2%) and dermatological disorders (7.9%) peaked at one identical AR episode (**Figure 2**). There was a trend for a decrease in readmissions for rheumatolgoical disorders, non-specific bodily pain and bone fractures, while the remaining conditions did not asssociate with frequency and type of readmission (**Supplementary Table 3**).

Association of index admissions with mortality

Multivariable stepwise Cox regression simultaneously analysed all variables related significantly to higher risk of readmission. This showed that the age and sex adjusted mortality over the two-year period was increased with eight index diagnoses presented on the first admission - CHF: HR = 2.7 (2.2-3.2), COPD: HR = 3.0 (2.5-3.6), pneumonia: HR = 2.0 (1.8-2.3), sepsis: HR = 2.2 (1.9-2.5), endocrine disorders: HR = 1.9 (1.6-2.3), UTI: HR = 1.5 (1.3-1.7), psychiatric disorders: HR = 1.5 (1.1-2.1) and haematological disorders: HR = 1.5 (1.2-1.9). The adjusted mortality was also increased for any one of the eight index admissions: HR = 2.0 (1.8-2.1) (**Table 2**). The proportion of any one of these eight index admissions for no readmission was 16.7%, rising to 29.5, 35.2, 33.7 and 48.6% for those with one non-identical AR episode, ≥2 non-identical AR episodes, one identical AR episode, and ≥2 identical AR episodes respectively (group differences: $\chi^2 = 513$, $p < 0.001$). These eight conditions were also associated with higher risk of death within 30 days and six months of hospital discharge (**Supplementary Table 4**).

Kaplan-Meier survival plots revealed that the survival probability for individuals with any one of the eight conditions related to identical AR episodes (see above) was lower than those who were not admitted with any of these conditions (**Figure 3**).

DISCUSSION

In this large study, we found frequent identical admission-readmission episodes, specifically for chronic or age-related conditions, were associated with increased risk of death within 30 days, within six months and over two years post-discharge. These findings shed further light on the aetiology of individuals at highest risk of readmissions and mortality, and provide crucial information for healthcare professionals. As far as we are aware, this observation has not been published in the current literature.

We found that the survival probability declined with increasing frequency of readmissions and with identical AR episodes for the same condition. Furthermore, identical AR episodes were an additional risk for lower survival probability for any given frequency of readmission. Thus individuals who had two or more identical AR episodes for the same condition were at the highest risk of death. These risks could be explained, in part, by the underlying illness of the patient. Using multivariable stepwise logistic regression techniques, eight major conditions were identified as most significantly related to frequent identical AR episodes. Individuals with at least one of these eight conditions were at 2-3 times greater risk of death within 30 days, within six months and over two years post-discharge. Of interest, a pattern emerged for identical AR episodes and non-identical AR episode admissions. Frequent identical AR episodes comprised a cluster of chronic conditions and common age-related infections. This raises the possibility that individuals with identical AR episodes

represent those with progressive deterioration of a condition towards the end stage. These include: CHF, COPD, endocrine disorders (including diabetes), and common infections in older patients such as pneumonia, sepsis and UTI which recur frequently in such individuals due to their decreased ability to recover. By contrast, non-identical AR episodes comprised mostly acute conditions such as myocardial infarct, stroke and bone fractures which tend to be managed differently (see below).

Intuitively, it makes sense to accept that individuals with chronic or age-related conditions are inevitably at greater risk of frequent readmissions and mortality. However there are also individuals with other serious conditions who were not at increased risk for frequent identical AR episodes such as stroke, bone fractures and myocardial infarction. This may be explained by rehabilitation programmes that have been established for these conditions where the level of post-discharge support is more readily available, so that patients are less likely to be readmitted within 28 days of discharge. There may be other reasons for some conditions to be associated with recurrent readmission. These include: a 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] It is well recognised that the task of reducing hospital readmissions remains challenging in many high income countries.[17,18] Further research should focus on safe discharge,[19] follow-up care for patients[20-22] and effective communication with primary care physicians.[23]

The identification of eight conditions that carry greater mortality risk with identical AR episodes in this study is consistent with previous studies. These conditions include

index diagnosis of CHF,[24,25] COPD,[24-26] pneumonia,[25] endocrine conditions,[26] UTI[25] and psychiatric disorders.[27] However, our observation of increased risk of mortality in patients with frequent AR episodes for haematological disorders is novel. Other factors that also associate with readmissions include: referral from primary care physicians, deprivation status, male gender, multiple co-morbidities,[24] longer initial length of stay in hospital[28] and older age.[24,28] Socioeconomic deprivation among patients with sickle cell disease in England are other risk factors for readmissions and inpatient mortality.[29] We also found older age and men to significantly associate with increased risk of readmissions and death.

Further studies would be warranted to examine the level of social and healthcare support for these individuals to reduce readmissions and health consequences. A small pilot study (n = 41) of older patients (>70 years) with a post-discharge care bundle, compared to none, showed that fewer patients were readmitted. For those who were, the interval between first admission and any readmission was longer and constituted a lower proportion.[30] The care bundle consisted of medication reconciliation by a clinical pharmacist, condition-specific education and enhanced discharge planning by a care coordinator, with telephone follow-up. Another study using a similar tool showed over two-thirds of patients, especially those with illiteracy, found communication with a pharmacist to be helpful.[31] Early readmission rates could even be lowered by a simple telephone contact with patients within 48 hours of discharge compared to those with none.[32] These studies suggest that specific discharge care bundles are needed to meet the needs of different patients groups, taking into account their age and underlying health conditions. For example, discharge support for young patients with type-1 diabetes would be quite different from those of

other groups described above. An important support for patients with type-1 diabetes is regular surveillance to ensure long-term compliance with insulin treatment. This requires integrated health and social care, involving family members, community healthcare teams including diabetes specialist nurses and general practitioners.[33] By contrast, older individuals with care-needs require hospital-based multidisciplinary teams working with community-based multidisciplinary teams to provide coordinated support through the discharge journey. For those at risk of hospital readmission, the discharge coordinator is responsible for referring to the relevant community-based health and social care practitioners prior to discharge.[34]

The strengths of this study lie in its large number of consecutive adult patients with a wide range of age (18 to 107 years). This enabled us to estimate the risk of mortality by different categories of frequency and type of readmission that has not been explored in previous studies. Appropriate adjustments were made including age and sex. Characteristics of this study are similar to those of the UK population.[12,35,36] There are inevitably certain limitations including potential loss of patients who might have moved to another area, so that readmissions might have been underestimated, particularly over the two-year period analysis. Others factors that may introduce a bias that will underestimate readmission frequency: for example, some patients who developed a terminal illness would need palliative care instead of hospital readmission. Furthermore, readmission would also be underestimated for those who sustained a hip fracture or stroke and were transferred to rehabilitation.

In conclusion, eight index conditions - namely: CHF, COPD, pneumonia, sepsis, endocrine disorders, UTI, psychiatric and haematological disorders were identified

among individuals with frequent identical AR episodes. Such patients are associated with increased mortality within 30 days and six months post-hospital discharge, and over a two-year period.

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LEGENDS

Figure 1. Age and sex adjusted Kaplan-Meier survival curves comparing different categories of frequency and type of readmission.

Figure 2. Proportions of eight index admissions in relation to frequency and type of readmission.

Figure 3. Age and sex adjusted Kaplan-Meier survival curves comparing individuals without against those with any one of the eight index admissions (CHF, COPD, pneumonia, sepsis, endocrine disorders, UTI, psychiatric and haematological disorders).

Table 1. Risk of death over a two year period comparing patients who were not readmitted, readmitted once or 2 times of different or the same condition.

	Risk of mortality over a two y			
	HR	95% CI	*p*	HR
No readmission (reference group)	1	--	--	1
1 non-identical AR episode	3.62	3.31-3.95	<0.001	2.43
≥2 non-identical AR episodes	5.32	4.74-5.97	<0.001	3.03
1 identical AR episode	4.54	3.48-5.91	<0.001	4.69
≥2 identical AR episodes	7.75	5.84-10.29	<0.001	5.01

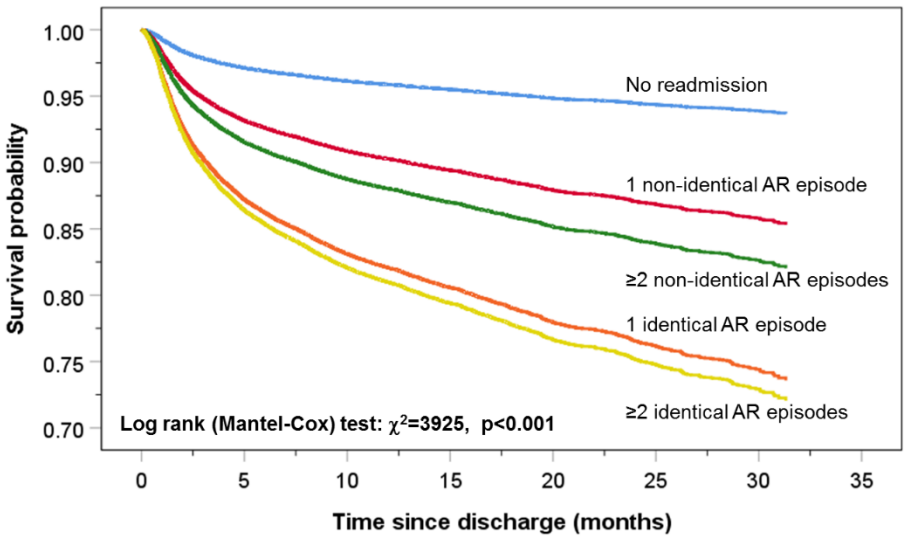
HR, hazard ratio; CI, confidence interval; AR, admission-readmission

Table 2. Multivariable stepwise Cox regression to assess the risk of mortality over a two year period from conditions most commonly associated with frequent emergency readmissions (**see Supplementary Table 3**).

	Risk of mortalit			
	Unadjusted			
Died over a two year period	**HR**	**95% CI**	***p***	**HR**
Congestive heart failure	5.18	4.35-6.17	<0.001	2.6
Chronic obstructive pulmonary disease	4.21	3.53-5.03	<0.001	2.9
Pneumonia	3.47	3.12-3.87	<0.001	2.0
Sepsis	2.47	2.14-2.84	<0.001	2.2
Endocrine disorders	1.49	1.24-1.79	<0.001	1.9
Urinary tract infection	2.70	2.35-3.11	<0.001	1.4
Psychiatric disorders	1.77	1.28-2.46	0.001	1.5
Haematological disorders	1.37	1.08-1.74	0.009	1.5
Any one of the eight index admissions	2.69	2.51-2.88	<0.001	1.9

HR, hazard ratio; CI, confidence interval

Figure 1.



Number at-risk

Time (months)	0	5	10	15	20	25	30	35
No readmission	28548	27303	24592	18472	12762	7563	2386	0
1 non-identical AR episode	2476	2045	1795	1340	925	533	142	0
≥2 non-identical AR episodes	949	723	614	445	317	157	40	0
1 identical AR episode	190	140	132	100	76	47	18	0
≥2 identical AR episodes	107	69	58	42	29	21	6	0

Figure 2.

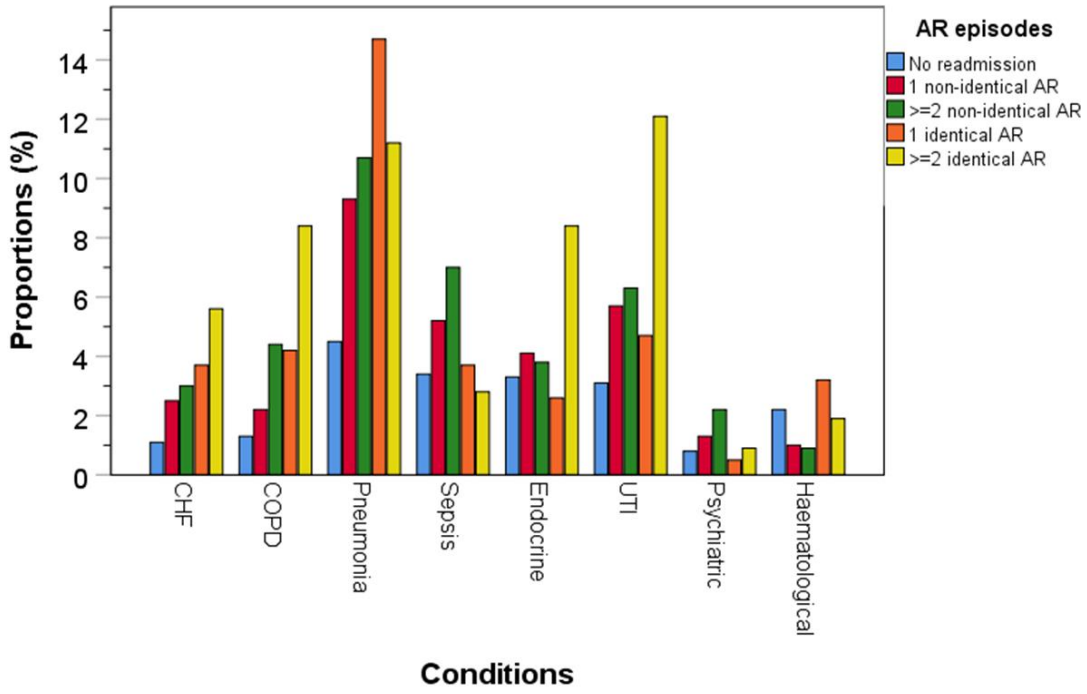
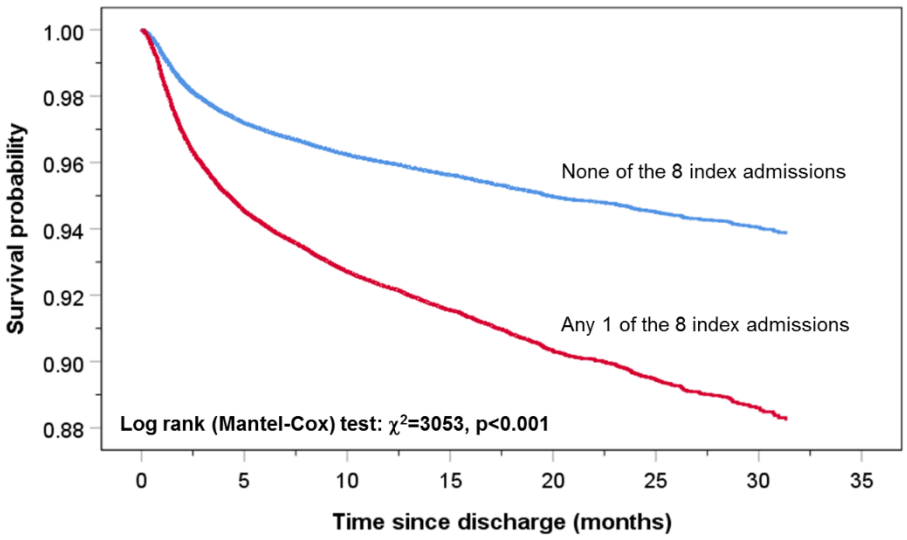

AR episodes
No readmission
1 non-identical AR
>=2 non-identical AR
1 identical AR
>=2 identical AR
Proportions (%)
0
2
4
6
8
10
12
14
CHF
COPD
Pneumonia
Sepsis
Endocrine
UTI
Psychiatric
Haematological
Conditions

Figure 3.



Number at-risk

Time (months)	0	5	10	15	20	25	30	35
None of the 8 index admissions	25375	23286	19323	14077	9192	4512	1076	0
Any 1 of the 8 index admissions	6891	5760	4626	3294	2075	970	223	0