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The dynamics of the emergency medical readmission — The underlying fundamentals

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ABSTRACT

Background: Hospital readmissions are a perennial problem. We reviewed readmissions to one institution (2002–2015) and investigated their dynamics.
Methods: 96,474 emergency admissions (in 50,701 patients) to an Irish hospital over a 15-year period were studied, and patterns surrounding early (<28 days) and late (any other) readmissions determined. Univariate and logistic or truncated Poisson regression methods were employed.
Results: Early readmission rate averaged 9.6% (95% CI: 9.4, 9.8) with a low/high of 8.4% (95% CI: 7.8, 9.1) and 10.3% (95% CI: 9.6, 11.0) respectively with no overall time trend. Early readmissions represented 20.1% (95% CI: 19.8, 20.5) of emergency medical readmissions. Median time to first readmission was 55 weeks (95% CI: 13, 159), time to second was 35 weeks (95% CI: 9, 98); by the 7th/8th readmissions, intervals were 13 weeks (95% CI: 4, 36) and 11 weeks (95% CI: 4, 30). Readmissions were older 67.1 years (95% CI: 48.3, 79.2) vs. single admissions 53.9 years (34.3, 72.4) and stayed longer — 5.8 days (2.7, 10.6) vs. 3.9 days (1.5, 8.0). Readmissions had more Acute Illness Severity, Charlson Co-Morbidity and Chronic Disabling Disease. Between 2002 and 2015 the logistic adjusted model of 30-day in-hospital mortality reduced from 6.1% (95% CI: 5.7, 6.5) to 4.4% (95% CI: 4.1, 4.7) (RRR 30.4%).
Conclusion: Early hospital readmission rate did not change over 15 years despite improvements in hospital mortality outcomes. Readmissions have a consistent pattern related to patient illness and social characteristics; the fundamentals are driven by disease progression over time.

1. Introduction

There is a rising trend of unplanned hospital medical readmissions; a particular concern are those occurring early — defined as within 1 month of hospital discharge [1]. This trend is of concern due to the questions it raises regarding the quality of care during the index hospitalisation, and also because of the overall increased burden on the acute hospital service provider [1,2]. There is the view that an early hospital readmission reflects inferior hospital care; a meta-analysis of 16 studies [3] suggested that the risk of early readmission (within 31 days) was increased by 55% with care that was judged to be of relatively low quality. Further a systematic review by Ashton et al. indicated that on average, substandard care increased the risk of early readmission by 24% [4]. However, when DesHarnais et al. [5] ranked 300 hospitals on 3 risk adjusted indices of hospital quality, mortality, readmissions and complications, there was no relationship between a hospital's ranking on any one of these indices and it's ranking on the other two. On balance the evidence suggests that readmission rates, uncorrected for confounding medical, social and hospital factors, are a poor guide to quality of care [1,6].

It has been estimated that 13% of inpatients in the United States use more than half of all hospital resources through repeated admissions [7,8]. Reported rates of unplanned emergency readmissions are 15.1% at 28 days from North East Thames [9], 28% at three months in Edinburgh [10], 38% at six months in London [11], and 19.5% at one year in Galway [12]. Overall, it has been estimated that 7% of hospital discharges result in a readmission [13], but <25% of these may be preventable [14].

The objective of this paper is to evaluate the evidence base as to whether interventions aiming to address preventing early readmissions are realistically based; we review the dynamics of readmissions with a prospectively collected database of nearly 100,000 emergency medical admissions, between 2002 and 2016, and the evidence of the data.

2. Methods

2.1. Background

St James's Hospital (SJH) serves as a secondary care centre for emergency admissions for its catchment area of 270,000 adults. Emergency medical patients are admitted from the Emergency Department to an Acute Medical Admission Unit (AMAU) — the operation and outcome of which have been described elsewhere [15].

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2.2. Data collection

For audit purposes we employed an anonymous patient database assembling core information about each clinical episode from elements contained on the patient administration system, the national hospital in-patient enquiry (HIPE) scheme [16], the patient electronic record, and laboratory system. Data captured includes the unique hospital number, patient demographics, principal and secondary diagnoses, procedures performed, admission and discharge dates. Additional information cross-linked and automatically uploaded to the database includes physiological and laboratory parameters.

From modeling laboratory data collected at time of hospital admission we developed a predictive algorithm based on serum sodium, potassium, urea, albumin, red cell distribution width, and white blood cell count. The underlying principle is that deviation beyond the boundaries of 'normal homeostasis' is an estimate of risk, although the relationship is non-linear and differs for each variable. Six groups were originally defined with a 30-day mortality risk increasing in an exponential fashion [17]. We assessed the ability of known predictors — Acute Illness Severity [18,19], Charlson Co-Morbidity Index [20] and Chronic Disabling Score [21] to predict any end-points, including 30-day hospital mortality, Length of Hospital stay (LOS) and any readmission (early <28 days or any).

2.3. Deprivation status and calculations

A National Deprivation Index for Health Services Research was derived by the Small Area Health Research Unit (SAHRU) at Trinity College Dublin [22]. The census data from the Central Statistics Office (CSO) (1991, was utilized to compute a functional index of deprivation using the 3440 electoral divisions (ED's) within the Republic of Ireland; these are smallest administrative areas for which population statistics are released. A weighted combination of four indicators, relating to unemployment, social class, type of housing tenure and car ownership ranked each small area [22]. The national deprivation index scores were ranked by decile from low (least deprived) to high (most deprived) according to their ranked raw scores [23]. There are 74 EDs in the hospital catchment area with a population of 210,443 persons, as per 2006. The median population per ED was 2845 (IQR 2020, 3399). These areas were ranked nationally as Deprivation Quintile I ($n = 14$), Quintile III ($n = 6$), Quintile IV ($n = 5$) and Quintile V ($n = 49$).

Using an address, data at an individual level were geo-coded and matched with the SAHRU deprivation raw score and related rank quintile. These attribute data were joined to the small area polygon geometries based upon their relative geographic positions, using the ArcGIS 10 Geographic Information System software implementation of the Point-in-Polygon algorithm, as outlined by Shimrat [24].

2.4. Study inclusion criteria

For this study, data was related to all emergency general medical patients admitted to SJH between 2002 and 2016. Each emergency medical patient was referred to the team of the 'on-call' Acute Medicine Consultant – 'on-take' for a 24 h period – most ~90% remained under the care of the admitting consultant for the duration of their admission. Approximately 9.9% of our patients stay >30 days with a median LOS of 54.8 days (IQR 38.8, 97.2). Consequently, the LOS data represents a highly skewed distribution. Although the clinical episode is complete for the majority by day 30, some patients remain for social reasons related to the lack of long-term care facilities. We have therefore chosen a truncated end-point (at the 30-day end-point) for mortality analyses, to avoid these additional confounders. Readmissions obviously consider all patient episodes, irrespectively of length of hospital stay.

2.5. Statistical methods

Descriptive statistics were calculated for background demographic data, including means/standard deviations (SD), medians/inter-quartile ranges (IQR), or percentages. Comparisons between categorical variables and mortality were made using chi-square tests.

Logistic regression analysis was used to examine all significant outcome predictors ($p < 0.10$ from the univariate analysis) on 30-day in hospital mortality; in addition to the Acute Illness Severity Score [18,19], Charlson Co-Morbidity Index [20] and Chronic Disabling Score [21] to predict any end-points, including 30-day hospital mortality, Length of Hospital stay (LOS) and any readmission (early <28 days or any). We then used backwards and forwards stepwise methods to determine the optimal predictors, while testing the goodness-of-fit using the Hosmer and Lemeshow's tests. The latter test is based on the expectation, that the predicted and observed frequency should match closely, and that the more closely they match, the better the fit. Adjusted Odds Ratios (OR), Relative Risk Reduction (RRR), and Number Needed to Treat (NNT) and 95% confidence intervals (CI) were calculated where appropriate.

Statistical significance at $P < 0.05$ was assumed throughout. Stata v.13.1 (Stata Corporation, College Station, Texas, USA) was used for analysis.

3. Results

3.1. Patient demographics

There were a total of 96,306 episodes recorded in 50,701 patients admitted as medical emergencies between 2002 and 2016. The proportion of males was 48.9%. The median (IQR) length of stay (LOS) was 4.7 (1.9, 9.1) days. The median (IQR) age was 58.7 (37.4, 76.0) years, with the upper 10% boundary at 86.1 yr. The major disease categories (MDC) were respiratory (25.4%), cardiovascular (16.6%), neurological (16.3%), gastrointestinal (10.2%), hepatobiliary (4.5%) and renal (4.9%). The majority of admissions were from the more socially deprived section of society (Quintiles IV & V: 89.7%).

Table 1 describes the demographic characteristic of the first and subsequent readmissions. Readmissions were older 67.1 years (95% CI: 48.3, 79.2) vs. single admissions 53.9 years (34.3, 72.4) and stayed longer — readmission 5.8 days (2.7, 10.6) vs. single admission 3.9 days (1.5, 8.0). Readmissions had more Acute Illness Severity, Charlson Co-Morbidity and Chronic Disabling Disease (Table 1). Readmissions had more respiratory, but less cardiovascular and neurological MDC codings. Total readmissions (i.e. not just early <28 days) were clearly time dependent; their cumulative proportion increased from 23.5% in 2003 to 45.9% in 2016. Overall early readmissions (<28 days) represented 9.6% (95% CI: 9.4, 9.8) of emergency medical admitted episodes.

3.2. Time pattern of readmission (Figs. 1 & 2)

Between 2002 and 2016, from a total of 96,306 episodes there were 33,254 episodes with no readmission (34.5%); the readmission rate overall (excluding the first admission of a series of readmissions) was 47.6% (95% CI: 47.3, 48.0). The respective calculated readmission rates at 1, 3, 5 and 10 yr were 32.4%, 40.6%, 48.9% and 53.3% respectively. Over the 15 yr period, early readmissions (<28 days) represented 20.1% (95% CI: 19.8, 20.5) of all readmissions.

Following an emergency medical admission, the risk of a readmission is high initially but rapidly falls albeit with a long tail (Fig. 1). The best fit of the time to readmission was the beta density distribution function. The alpha 1 and 2 parameters were 0.70 and 2.17 respectively. The calculated time to readmission for the 5th, 10th, 25th, 50th, 75th, and 90th centiles were 6, 14, 48, 145, 288 and 441 weeks.

The time from the first to each subsequent readmission is described (Fig. 2). The median time was calculated in weeks between the first and