Health Policy 120 (2016) 89–99

Contents lists available at ScienceDirect

Health Policy

journal homepage: www.elsevier.com/locate/healthpol

Have hospital readmissions increased in the face of reductions in length of stay? Evidence from England

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ARTICLE INFO

Article history:
Received 13 March 2015
Received in revised form
12 November 2015
Accepted 17 November 2015

Keywords:
English hospitals
Length of stay
Readmissions
In-hospital mortality
Quicker and sicker

ABSTRACT

We assess the relationship between changes in hospital length of stay (LoS) and hospital quality, as measured by 28-day emergency readmission. We estimate regression models to analyse LoS and other factors associated with readmission for all those admitted for hip replacement (n = 496,334), hernia repair (n = 413,712) or following a stroke (n = 480,113) in England between 2002/3 and 2007/8. There were reductions in LoS over time while changes in crude readmission rates varied by condition. Given the high mortality rate for stroke, it is critical to account for the probability of surviving the initial admission when evaluating readmissions. Conditional upon survival, the probability of readmission was greater for stroke patients who originally had a shorter LoS and for hernia patients who had an overnight stay but there is no relationship between LoS and readmission for patients who had hip replacement. The evidence does not generally suggest that reductions in LoS were associated with an increased probability of emergency readmission.

1. Introduction

Concerns have been voiced that pressure for hospitals to reduce length of stay (LoS) may have adverse consequences on the quality of care experienced by patients. The "quicker and sicker" argument posits that if patients are discharged prematurely, in a less stable condition, they are at greater risk of subsequent readmission to hospital. Various studies have explored the relationship between LoS and readmission, most famously that by Kosecoff et al. who found some evidence to support the "quicker and sicker" argument following the introduction of prospective payment for Medicare patients in the United States [1]. Evidence from later studies is not definitive: some finding no relationship [2,3], others that reductions in LoS were associated with increased readmissions [4], and another that longer LoS was associated with higher readmission [5].

To guard against adverse consequence of premature discharge, some jurisdictions penalise hospitals with higher than expected readmission rates [6,7]. This requires taking account of the characteristics of patients that might be related to the probability of readmission. Such predictive factors include the patient's functional status, presence of co-morbidities, the type of procedure performed, whether there were post-operative complications [8,9]; measures of socioeconomic status, such as poverty, education level, housing and marital status [10,11]; and organisational characteristics of the local health-system [12]. But in a systematic review of risk prediction models for hospital readmissions, most were found to perform poorly [13], which could be due partly to the limited information in routine administrative datasets.

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http://dx.doi.org/10.1016/j.healthpol.2015.11.003
0168-8510/

Even with better risk-adjustment, readmission rates have been criticised as a performance measure because they are correlated with another commonly used measure of hospital quality, namely in-hospital mortality [14]. If hospitals are more successful at ensuring that patients survive their initial admission, their readmission rates will likely be higher because the average health status of their survivors will be lower than if those most at risk of death had, indeed, died. In view of this, Laudicella et al. argue that readmission rates should be calculated conditional upon the likelihood that patients survive the initial admission [14]. By the same token, the relationship between LoS and readmission should also be estimated conditional upon survival. Previous studies have not done this, thereby potentially providing an inaccurate assessment of the relationship.

We employ this analytical approach, and explore the relationships between LoS, in-hospital mortality and readmissions. We focus on patients admitted to hospitals with one of three conditions, stroke (n = 480,113), hip replacement (n = 496,334) and hernia repair (n = 413,712), chosen because patients with these conditions differ markedly in terms of their LoS, and mortality and readmission rates. We evaluate these relationships for all patients admitted to English hospitals between the fiscal years 2002/3 through to 2007/8. This was a period when hospitals were under ever increasing pressure to reduce LoS, brought about by the phased introduction of the English version of prospective payment known as Payment by Results [15]. Receiving a fixed payment – the national tariff – for each type of patient treated, hospitals had stronger incentives to reduce the average cost of care, the most obvious strategy being to reduce LoS. Indeed, for all three conditions, there were pronounced reductions in LoS (or in the probability of staying overnight) over the period. We use 2002/3 as the first study period because this is the year prior to the introduction of PbR. In our exploration of the relationships between LoS, in-hospital mortality and readmissions we condition on the proportion of hospital income received from PbR, noting that other studies have found an association with LoS but not with mortality or readmission [16].

The remainder of the paper is organised as follows. In Section 2 we detail the methods we employ to explore the relationships between mortality, readmission and LoS. Section 3 provides details of the study dataset and Section 4 contains our empirical results. Section 5 discusses our results and conclusions.

2. Methods and modelling approach

We examine the relationship between LoS and emergency re-admission within 28 days after discharge, conditional on patients surviving their initial hospital stay. Rather than study all patients admitted to hospital, we focus on people admitted for stroke care, hip replacement and hernia repair because they have very different baseline LoS and mortality and re-admission rates.

The probability of in-hospital survival is estimated as a probit model. In modelling the probability of readmission we follow Laudicella et al. [14] who recognise that the likelihood of readmission is, in part, a reflection of the survival rate associated with the initial admission. If patient characteristics are not perfectly observable and hospitals differ in the quality of care they provide, then hospitals with low mortality rates are likely to have a larger share of un-observably sicker patients at risk of a readmission.

To address this, Laudicella et al. [14] estimate Heckman's bivariate sample selection model, with the probability of readmission conditioned on survival. This involves identifying variables that explain the probability of survival (the selection equation) but which are uncorrelated with the probability of readmission (the outcome equation). Laudicella et al. note that mortality risk is greater during weekends and over long bank holiday periods (such as at Easter and Christmas) because experienced nursing and medical staff are less available [17]. But the day of the original admission has no bearing on the probability of readmission, this being dependent '. . .on post-operative care that can be provided more flexibly over a long period of time once survival has been assured.' We adopt this identification strategy by including indicators of the admission day in the survival model but not in the readmission model.

The bivariate sample selection model comprises two equations. We first model the probability of patient i in hospital h at time t surviving the first admission, as a function of the latent propensity of surviving S^*_{iht}

$$S^*_{iht} = \propto + \beta_1 X_{iht} + \beta_2 D_{iht} + \gamma Z_{ht} + T_t + \varepsilon_{1iht}$$

$$S_{iht} = \begin{cases} 1 & \text{if } S^*_{iht} > 0 \\ 0 & \text{if } S^*_{iht} \leq 0 \end{cases}$$

where X_{iht} is a vector of socio-economic, diagnosis and treatment variables measured for each patient; D_{iht} is a vector of dummy variables reflecting the day of admission or whether it occurred during Christmas, Easter or bank (public) holidays; Z_{ht} is a vector of characteristics describing the hospital, including teaching status, location and the proportion of the hospital's funding that was subject to PbR; T_t is a vector of year dummies (baseline 2002/3); and ε_{1iht} is random error assumed to take a bivariate standard normal distribution and to be uncorrelated with the explanatory variables.

We allow for correlation between ε_{1iht} and the equivalent error term ε_{2iht} from the readmission equation, and model readmission conditional upon the patient having survived the original admission, assuming a latent propensity of readmission R^*_{iht} observed only when $S^*_{iht} > 0$:

$$R^*_{iht} = \propto + \beta_1 LoS_{iht} + \beta_2 X_{iht} + \gamma Z_{ht} + T_t + u_{ht} + \varepsilon_{2iht}$$

$$R_{iht} = \begin{cases} 1 & \text{if } R^*_{iht} > 0 \\ 0 & \text{if } R^*_{iht} \leq 0 \end{cases}$$

where LoS_{iht} is vector of variables including the patient's LoS and LoS inter-acted with the year of admission, which captures trends in LoS over time. These models are estimated separately for the three conditions. If there is no evidence of sample selection, or the identification strategy does not hold, the probability of readmission is estimated without having conditioned on survival.