ARTICLE IN PRESS
EJINME-03674; No of Pages 5
European Journal of Internal Medicine xxx (2017) xxx–xxx
Contents lists available at ScienceDirect
European Journal of Internal Medicine
journal homepage: www.elsevier.com/locate/ejim

Original Article

Deprivation status and the hospital costs of an emergency medical admission

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ARTICLE INFO

Article history:
Received 22 May 2017
Received in revised form 11 September 2017
Accepted 13 September 2017
Available online xxxx

Keywords:
Costs
Deprivation
Length of stay
Emergency medical admissions

ABSTRACT

Background: Deprivation has been shown to adversely affect health outcomes. However, whether deprivation increases hospitalisation costs is uncertain. We have examined the relationship between deprivation and the costs of emergency medical admissions in a single centre between 2008–2014.
Methods: We calculated the total hospital costs of emergency admissions related to their deprivation status, based on area of residence (Electoral Division - small census area). We used truncated Poisson and quantile regression methods to examine relationships between predictor variables and total hospital episode costs.
Results: Over the study period, 29,508 episodes were recorded in 15,932 patients. Compared with the least deprived (Q1), the incidence rate ratios (IRR) for annual costs were increased to Q3 1.15 (95% CI: 1.12, 1.19), Q4 2.39 (95% CI: 2.30, 2.49) and Q5 2.76 (95% CI: 2.68, 2.85). The margin statistic cost estimate per thousand population increased from 183.8 K€ in Q1 to 507.9 K€ in Q5. The total bed days/1000 population increased as follows (compared with Q1): Q3 IRR 1.41 (95% CI: 1.37, 1.45), Q4 1.96 (95% CI: 1.89, 2.03) and Q5 3.04 (95% CI: 2.96, 3.12). The margin statistic bed day estimate (/1000 population) increased from 218.7 in Q1 to 664.0 in Q5.
Conclusion: Deprivation status had a profound impact on total hospital costs for emergency medical admissions. This was primarily mediated through a tripling of total bed days in the most deprived groups.

1. Introduction

Socio-economic deprivation is defined as a state of "observable and demonstrable disadvantage relative to the local community to which an individual belongs [1]." A large body of research has established that deprivation is a predictor of adverse health outcomes including greater hospital admission rates [2], increased length of stay [3] and has been shown to influence mortality [4,5]. Patients from lower socio-economic geographical areas have been shown to access more emergency care, attend Accident & Emergency (A&E) with less serious conditions, and are less likely to attend outpatient appointments [6]. Whilst previous work has also shown that social deprivation increases hospital resource use, few studies have shown that deprivation directly affects hospital costs [3,7]. In this study, we examined the relationship between deprivation and hospital costs for emergency medical admissions, using a database of all acute medical emergency admissions between 2008 and 2014 admitted to our institution.

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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 [8]. Our study site is located in the inner city of Dublin with a catchment population composed of high rates of social disadvantage when compared with other acute hospitals within the Dublin metropolitan area [9].

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 [10], the patient electronic record, and laboratory system. Data captured includes the unique hospital number, patient demographics, principal and secondary diagnoses, procedures performed, and admission and discharge dates. Additional

https://doi.org/10.1016/j.ejim.2017.09.017
0953-6205/

information cross-linked and automatically uploaded to the database includes physiological and laboratory parameters [11].

2.3. Study inclusion criteria

For this study, data was related to all emergency general medical patients admitted to SJH between 2008 and 2014 who were resident within the catchment area. Approximately 75% of emergency admissions live in the catchment area. We can only calculate the admission incidence rates for patients resident in our catchment area.

2.4. Hospital costings

The Republic of Ireland proposes to introduce a Money Follows the Patient (MFTP) system, where a case-based funding model with Diagnosis-Related Groups (DRG's) compares hospital costs, quality and efficiency. The calculation of costs per case is adjusted by reference to the relative cost weight of each DRG. The hospital costing of the price of an episode of care encompasses all costs appropriately associated with the delivery of that care and includes: 1) Pay costs 2) Non-pay costs (e.g. drugs, medical supplies etc.) and 3) Diagnostics' costs. Appendix I illustrates a worked example of how individual patient costs are calculated. The hospital uses a number of standard accounting costing methodologies such as Activity Based Costing and Absorption Costing [12,13]. Both methods are used in parallel to cost individual patient episodes of care by directly linking cost to patient clinical data. We calculated the total hospital costs arising in emergency medical admissions from each Electoral Division and calculated the average annual cost per Electoral Division over the 7-year period. These costs were then attributed to the reservoir of potential 'patients' within each area – (i.e. the adult population) and expressed as cost/1000 patient population.

2.5. Deprivation

To classify deprivation, we used the public domain Irish National Deprivation Index for Health and Health Services Research, derived by the Small Area Health Research Unit (SAHRU) at Trinity College Dublin [14]. The SAHRU group employed census data from the Central Statistics Office (CSO) (1991, last updated in 2006) to compute a functional index of deprivation using the electoral divisions as the base unit. The Republic of Ireland has 3440 electoral divisions, the smallest administrative areas for which population statistics are gathered by the CSO. Using principal components analysis (PCA), a weighted combination of four indicators, relating to unemployment, social class, type of housing tenure and car ownership was derived, as described by the SAHRU investigators [14]. We have previously described the methodology used more fully; the deprivation index scores were ranked from low (least deprived) to high (most deprived) and divided into quintiles according to their ranked raw scores [11]. Using an address, data at an individual level were geo-coded and matched with the SAHRU deprivation raw score and 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 [15]. There are 74 Electoral Divisions in the hospital catchment area with a population of 210,443 persons, as per 2006. The median population per Electoral Division was 2845 (IQR 2020, 3399). These areas were ranked nationally as Deprivation Quintile I ($n = 13$), Quintile III ($n = 5$), Quintile IV ($n = 4$) and Quintile V ($n = 49$). There are no Q2 Electoral Divisions within the hospital catchment area.

2.6. Statistical methods

Descriptive statistics were calculated for background demographic data, including means/standard deviations (SD), medians/interquartile ranges (IQR), or percentages. Comparisons between categorical variables and mortality were made using chi-square tests. We employed a truncated Poisson model and used robust standard errors for the parameter estimates, as recommended by Cameron and Trivedi [16]. The Poisson regression coefficients are the log of the rate ratio: the rate at which events occur is called the incidence rate. Thus, with the truncated Poisson regression model, we can interpret the coefficients in terms of incidence rate ratios (IRR). We used the margins command in Stata 13.1 to estimate and interpret adjusted predictions for sub-groups, while controlling for other variables such as illness severity, using computations of average marginal effects. Margins are statistics calculated from predictions of a previously fitted model at fixed values of some covariates and averaging or otherwise over the remaining covariates. Hospital costs typically have considerable heteroskedasticity (i.e. a high degree of cost variability even when known predictors are considered) [17]. Consequently, we used quantile regression analysis when examining the impact of predictors of resource use, which allows for marked differences in the dependent variable at different quantiles of the predictor variable.

Adjusted odds ratios (OR) and 95% confidence intervals (CI) or incidence rate ratios (IRR) were calculated for those predictors that significantly entered the model ($p < 0.10$). 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

A total of 29,508 episodes were recorded in 15,932 patients resident within the catchment area between 2008 and 2014. These episodes represented all emergency medical admissions who had been discharged home or who had suffered an in-hospital death within 30 days of admission. The characteristics of the patient cohort are shown in Table 1. The majority of admissions were from the more socially deprived section of

Table 1
Demographics of emergency medical admissions (2008–2014).

Factor	Level	Quintile 1/3	Quintile 4/5	p-Value
N		2857	26,651	
Gender	Male	1281 (44.8%)	13,114 (49.2%)	<0.001
	Female	1576 (55.2%)	13,537 (50.8%)	
Outcome	Alive	2705 (94.7%)	25,560 (95.9%)	0.002
	Died	152 (5.3%)	1091 (4.1%)	
Age, median (IQR)		75.0 (57.2, 83.7)	63.0 (44.7, 78.0)	<0.001
LOS (days)		5.6 (2.4, 11.3)	5.3 (2.3, 10.0)	0.001
Acute illness severity	1	58 (2.2%)	802 (3.2%)	<0.001
	2	156 (5.9%)	1672 (6.7%)	
	3	221 (8.3%)	3060 (12.3%)	
	4	339 (12.8%)	4232 (16.9%)	
	5	534 (20.1%)	4837 (19.4%)	
	6	1350 (50.8%)	10,375 (41.5%)	
Charlson index	0	1326 (46.4%)	11,163 (41.9%)	<0.001
	1	825 (28.9%)	8434 (31.6%)	
	2	706 (24.7%)	7054 (26.5%)	
Disabling disease	0	254 (8.9%)	2405 (9.0%)	0.22
	1	606 (21.2%)	5955 (22.3%)	
	2	789 (27.6%)	7594 (28.5%)	
	3	710 (24.9%)	6405 (24.0%)	
	4	498 (17.4%)	4292 (16.1%)	
Sepsis group	0	2193 (76.8%)	20,368 (76.4%)	0.46
	Neg	554 (19.4%)	5351 (20.1%)	
	Pos	110 (3.9%)	932 (3.5%)	
MDC respiratory	0	2249 (78.7%)	19,411 (72.8%)	<0.001
	1	608 (21.3%)	7240 (27.2%)	
MDC cardiovascular	0	2264 (79.2%)	22,333 (83.8%)	<0.001
	1	593 (20.8%)	4318 (16.2%)	
MDC neurology	0	2332 (81.6%)	22,093 (82.9%)	0.087
	1	525 (18.4%)	4558 (17.1%)	

Deprivation status quintiles 1/3 or quintiles 4/5 with hospital catchment area. IQR: interquartile range, LOS: length of stay.

Please cite this article as: McCabe JJ, et al, Deprivation status and the hospital costs of an emergency medical admission, Eur J Intern Med (2017), https://doi.org/10.1016/j.ejim.2017.09.017