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Richard Cookson

Mauro Laudicella

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Do the poor still cost more?
The relationship between small area income deprivation and length of stay for elective hip replacement in the English NHS from 2001/2 to 2006/7

Richard Cookson and Mauro Laudicella, University of York

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Abstract
We examine whether hospital patients living in low income areas of England cost more to treat, using elective hip replacement as a tracer procedure and length of stay as a cost indicator. Anonymous hospital records are extracted on all 235,813 patients admitted to English NHS Hospital Trusts for elective total hip replacement from 2001/2 through 2006/7. The relationship between length of stay and small area income deprivation is modelled using linear regression, allowing for patient characteristics (age, sex, number of diagnoses, procedure type), time trends and Trust effects. Patients from the most income deprived decile of areas stay 12-15% longer than those from the least deprived decile, or 8% longer after adjusting for patient characteristics and Trust effects. This relationship did not change during the period, despite substantial NHS expenditure growth and reform along with substantial declines in average length of stay and waiting time. The major determinants of length of stay are age and number of diagnoses. Under the current NHS fixed price payment system, there are incentives for hospitals to avoid offering hip replacements to elderly patients, patients with substantial co-morbidity and, to a lesser extent, patients from low income areas.

Keywords: Health Care Economics and Organizations, Hospital Costs, Length of Stay, Prospective Payment System, Socioeconomic Factors

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Conflicts of interest
None.

Correspondence to:
Dr Richard Cookson, Department of Social Policy and Social Work, University of York, York YO10 5DD, Tel: 01904 321248, Fax: 01904 321270, Email: rc503@york.ac.uk

1. Introduction

The relationship between socio-economic status and treatment cost is of interest in all publicly funded health systems responsible for delivering socio-economic equality of access. It is of particular interest in the English NHS, which has recently introduced a case-based prospective payment system of fixed hospital prices per patient treated, following the US, Australia and several other mostly European countries (Street and Maynard, 2007). If patients from low socio-economic groups stay longer in hospital and cost more to treat than others, and yet attract the same fixed price payment, then hospitals may have an incentive to delay, dilute, divert or deny their treatment – thus potentially undermining equality of access.

This is not "merely" a financial issue, but also reflects non-financial opportunity costs to the hospital in terms of alternative possible uses of scarce resources. For example, imagine a hospital treats 200 patients a year with average length of stay 5 days plus 50 patients with average length of stay 10 days. If the hospital could somehow avoid treating the 50 long staying patients, this would release 500 bed days which could be put to alternative use – for example, in treating 100 additional short staying patients to reduce waiting times.

Two decades ago, following the introduction of the Medicare prospective payment system in 1983, a classic US study found that the poor do indeed cost more (Epstein, Stern and Weissman, 1990). That study of 16,908 patients admitted in 1987 to five Massachusetts hospitals found that patients in the lowest third of socio-economic status (by patient level income, occupation and education) had between 3 to 30% longer stays and probably also required more resources, after adjusting for case-mix using Diagnosis Related Group (DRG), age, and severity. Unfortunately, however, it is not straightforward to generalise the findings from this US study to a different health system such as the present day English NHS, which has a different set of health care institutions, incentives and professional practice styles and which serves patients facing a different set of socio-economic conditions.

The present study aims to collect evidence on this issue using routine patient level hospital records covering all NHS Hospital Trusts in England. This includes almost all NHS funded operations – apart from the small fraction carried out under the "Independent Sector Treatment Centre" programme (see below) – but does not include privately funded operations. We use length of stay as a proxy for cost, since detailed micro-costing data on individual patients is not routinely available. We use a small area level index of income deprivation as a proxy for socio-economic status, since routine patient level data on income and other aspects of socio-economic status is not available. We use patient level repeated cross section data for an unbalanced panel of all NHS Hospital Trusts followed for six financial years 2001/2 through 2006/7, which enables us to examine how far the answer to our headline question changes over time.

We focus on the tracer procedure of elective primary total hip replacement. This is a good clear indicator procedure for our headline question because it has (i) substantial length of stay, (ii) a simple fixed price with no risk adjustment for age, sex or severity of illness, and (iii) considerable evidence of pre-existing socio-economic inequality in use of care prior to the introduction of fixed price payment (Cookson, Dusheiko and Hardman, 2007). Hip replacement is also of interest in its own right, as a high volume procedure (the NHS does about 40 thousand elective primary total hip replacements a year) with a high political profile during the period under consideration, due to severe waiting time problems and particular difficulty in meeting government waiting time targets.

2. Background

This six year period we examine is a period of persistently falling length of stay, allowing us to examine whether length of stay declines at different rates across different socio-economic groups. This period encompasses the introduction of a number of relevant policy initiatives that have attracted international interest. First, an aggressive sequence of maximum waiting time targets for first elective hospital admission coupled with sanctions for poorly performing managers: 18 months by March 2001 then falling by three months a year to 6 months by March 2005 (Propper et al., 2008). Second, an ambitious system of fixed price hospital payment, piloted in 2003/4 and 2004/5 for growth activity in some elective care – including hip replacement – and implemented fully for all elective care from 2005/6 (Street and Maynard, 2007). Third, new private sector entry into the publicly funded NHS market for high volume, low risk elective hospital procedures under the "Independent Sector Treatment Centre" (ISTC) programme (Propper, Wilson and Burgess, 2006). ISTC activity comprised 0.07% of total NHS elective activity in 2003/4 rising to 0.66%, 0.92% and 1.20% in subsequent years to 2006/7, including 7% of elective hip replacement activity in 2006/7 (Audit Commission, 2008). Fourth, from 2001/2, the targeting of additional health care resources (about half of one percent of total health expenditure) to areas with the largest avoidable mortality, initially through the NHS resource allocation formula then from 2004/5 in a separately funded initiative known as the "Spearhead Group" (Smith, 2008, Department of Health, 2004).

The English NHS fixed price hospital payment system is known as "Payment by Results", and uses a DRG-style system known as "Healthcare Resource Groups" (HRGs), which are baskets of clinically similar treatments with similar resource use. In 2006/7, the standard price for a primary elective total hip replacement, code HRG 80, was £5,176 (Department of

Health, 2006). This was a simple fixed price with no risk adjustment for observable cost drivers such as age, sex, and number of diagnoses; and no supplementary payment for complications requiring additional hospital resources. The only supplementary payment was a per diem payment of £217 for length of stay beyond a trim point of 16 days. This supplementary payment was intended to compensate for the extra costs of exceptionally long staying patients, without giving any incentive to increase length of stay.

Since the introduction of the NHS prospective payment system, the price of each elective and non elective procedure has been based on the national average cost of producing the corresponding HRG two years before, as reported by each hospital. Hospital costs are recorded in the national "Reference Cost" dataset, which supplies information on costs in every NHS Hospital Trust in England at level of HRG produced. This Reference Cost dataset is the most disaggregated level of information on hospital costs routinely collected in the NHS, and micro-costing data itemising resource use for individual patients is not available.

2. Methods

Linear regression is used to examine the relationship between patient level length of stay and small area income deprivation decile, controlling for other factors. Patient level covariates include age, sex number of diagnoses and whether the procedure was cemented or uncemented. Year dummies are used to allow for general national trends in length of stay, and year-specific NHS Hospital Trust dummies are used to allow for Trust-specific supply factors such as hospital efficiency and practice style which may vary both between hospitals and over time. To allow for non-linear relationships with length of stay, area income deprivation, age, and number of diagnoses were divided into ordered groups and modelled using dummy variables. Age was divided into five age groups: age 45-54, 55-64, 65-74, 75-

84 and 85+. Number of diagnoses was divided into seven groups: 1 through 6 diagnoses and 7 or more diagnoses. Clustered standard errors at Trust level were used to account for potential correlation of the error term within providers. Each Trust reports its own data, thus differences in accounting practices between organisations might otherwise result in biased standard errors.

A number of different models were explored in sensitivity analysis, to examine how far cross-sectional relationships changed over time, and to check for possible age-deprivation interactions and diagnosis-deprivation interactions. The main models explored in sensitivity analysis have the following covariates, and are estimated with and without Hospital Trust effects:

- **Model 1 (year interactions only):** deprivation decile, year, sex, age group, diagnosis group, uncemented, year times deprivation decile, year times age group, year times diagnosis group
- **Model 2 (deprivation interactions only)**: deprivation decile, year, sex, age group, diagnosis group, uncemented, deprivation decile times diagnosis group, deprivation decile times age group
- **Model 3 (no interactions):** deprivation decile, year, sex, age group, diagnosis group, uncemented

The full results are available from the authors on request.

We exclude long-staying outliers with length of stay greater than 60 days, making up 1,265 cases or just over 0.5% of the total.

3. Data

We use anonymous individual hospital records for all patients admitted for elective hip replacement in English NHS Hospital Trusts for each financial year from 2001/2 through 2006/7. We include all elective admissions involving primary total prosthetic replacement of the hip joint. The latter are identified by OPCS-4 codes W37.1, W38.1 and W39.1 as reported under the main operation of the first episode of care. These codes represent the three main variants of this procedure – “using cement”, “not using cement”, and “not elsewhere classified”. We exclude patients coming for revisions or conversions of previous hip operations as their length of stay might partially depend on the quality of care received in past admissions. We also exclude other types of hip replacement operation such as hybrid prosthetic replacements, resurfacings, and prosthetic replacement of the neck of femur.

Due to mergers, the number of NHS Hospital Trusts fell during the period from 167 in 2001/2 to 155 in 2002/3, then 153 in 2003/4, and finally down to 151 in 2006/7. We exclude activity from “Independent Sector Treatment Centres”, which grew from 0% up to about 7% of NHS hip replacement activity from 2003/4 to 2006/7, due to substantially incomplete reporting of this data (Audit Commission, 2008). There are no publicly available data on privately funded hospital activity in England for the period under consideration. The most recent publicly available data is a sample survey in 1997/8, which found that private activity made up 22.5% of all elective total hip replacement activity in England (Williams et al., 2000).

Hospital records are extracted from the national “Hospital Episode Statistics” database as continuous inpatient spells (CIPS), which allow for transfers between different consultants both within the same hospital and between hospitals. The standard unit of activity available to users of the Hospital Episode Statistics database is the “finished consultant episode” (FCE).

This is defined as the time the patient spends under the care of the same consultant. However, this can only measure length of stay for the period during which the initial hip replacement procedure is performed, before the patient is transferred to another consultant or hospital for any further treatment that may be necessary. The use of CIPS allows us accurately to measure length of stay for the full period of care from admission to discharge, including treatments for any complications following the first FCE and transfers to different providers of care. The computation of CIPS requires a complex matching algorithm. We use a new CIPS matching algorithm developed and tested by one of the authors (ML), which improves upon the algorithm used by Lakhani and colleagues (Lakhani et al., 2005). The new algorithm, and the rigorous process of validation it has undergone, is detailed in (Castelli, Laudicella and Street, 2008), pp 14-20 Section 2. A non-trivial proportion of elective hip replacement patients are transferred to another consultant or hospital: 6% of continuous inpatient spells with length of stay less than or equal to 60 days involved two ore more finished consultant episodes, and 3.6 % involved a transfer to another hospital.

Patient covariates include age, sex, whether the procedure was cemented or uncemented, and the total number of diagnoses at the time of admission to hospital (including secondary diagnoses as well as the primary diagnosis of osteoarthritis). The number of diagnoses reported in the HES dataset runs from 1 to a maximum of 14 from 2002/3 onwards (though only a maximum of 7 diagnoses in 2001/2). Number of diagnoses is sometimes referred to as number of co-morbidities (Hamilton and Bramley-Harker, 1999). However, as well as the primary diagnosis and any co-morbidities diagnosed at the time of admission, this indicator also includes diagnoses acquired during the first FCE of hospital stay, including any surgical complications and hospital acquired infections. So to some extent this indicator may pick up variations in quality of care, as well as variations in patient co-morbidity.

Small area income deprivation is measured at Lower Super Output Area (LSOA) level using the income deprivation domain of the English Indices of Multiple Deprivation 2004 (IMD 2004). There are 32,378 LSOAs in England with a mean population of 1,500 individuals and a minimum of 1,000. The IMD 2004 income domain score indicates the proportion of the LSOA population in 2001 who were living in low income households reliant on one or more means tested benefits, based on population census and benefit claims data (Office of the Deputy Prime Minister, 2004). The income domain score was divided into deciles based on the population of income deprivation scores for all English LSOAs, rather than the population of income deprivation scores for all NHS hip replacement patients in our study. A patient's deprivation decile thus reflects the degree of income deprivation in their neighbourhood relative to England as a whole, and is comparable from one year to another. Simply dividing the study population of hip replacement patients into ten equally sized groups by deprivation score yields a less general and less comparable indicator. The deprivation mix among hip replacement patients may differ from the deprivation mix among the general population, and may vary from one year to the next as a result of changes in hospital admission practices and other aspects of hospital supply and demand.

4. Results

4.1 Descriptive statistics

Table 1: Global descriptive statistics for key variables (pooled across all years)

Variables	Obs	Mean	Std. Dev.	Median	Min	Max
Patient length of stay (days)	235,813	9.52	6.06	8	0	60
Patient male or not	235,773	0.38	0.49	0	0	1
Patient age	235,760	69.64	9.42	70	45	103
Patient area income deprivation score	235,813	0.12	0.10	0	0	0.96
Patient number of diagnoses	235,813	2.50	1.71	2	1	14
Patient receiving uncemented hip replacement (rather than cemented)	235,813	0.19	0.40	0	0	1
Hospital Trust total activity 2001-2006	182	1,303	906	1,271	18	4,307
Hospital Trust total activity by year	932	254	150	228	4	905

Table 1 presents global descriptive statistics for the main variables used in regressions, across all six years from 2001/2 to 2006/7, excluding patients with length of stay over 60 days. The median length of stay is 8 days, with mean 9.5 days and standard deviation 6.02 days. The median age is 70, 38% of the patients are male, and 19% receive uncemented hip replacement. The median number of diagnoses at the admission is 2, with mean 2.82 and standard deviation 2.65.

Table 2: Descriptive statistics for key variables by year and deprivation group (most deprived decile of IMD income deprivation score versus others)

Table 2

Variables		**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Mean length of stay (days)	(1) Most deprived (*)	11.82	11.31	10.51	10.05	9.47	8.51
	(2) Others	10.87	10.53	9.76	9.33	8.64	7.86
	gap (1) - (2)	0.95	0.78	0.74	0.73	0.83	0.65
	ratio (1) / (2)	1.09	1.07	1.08	1.08	1.10	1.08
Patients treated	(1) Most deprived (*)	2,855	3,054	3,240	3,096	3,228	3,026
	(2) Others	31,777	35,119	38,246	37,451	37,982	36,739
	(3) Total	34,632	38,173	41,486	40,547	41,210	39,765
	Ratio (1) / (3)	0.082	0.080	0.078	0.076	0.078	0.076
Mean age	(1) Most deprived (*)	68.62	68.15	68.45	68.53	68.45	68.64
	(2) Others	69.43	69.48	69.58	69.88	69.92	70.07
	gap (1) - (2)	-0.81	-1.33	-1.13	-1.35	-1.47	-1.44
	ratio (1) / (2)	0.99	0.98	0.98	0.98	0.98	0.98
Mean number of diagnoses	(1) Most deprived (*)	2.26	2.31	2.40	2.63	2.97	3.11
	(2) Others	2.20	2.25	2.33	2.60	2.68	2.83
	gap (1) - (2)	0.06	0.06	0.06	0.03	0.28	0.28
	ratio (1) / (2)	1.03	1.03	1.03	1.01	1.11	1.10
Proportion male	(1) Most deprived (*)	0.362	0.380	0.363	0.370	0.355	0.378
	(2) Others	0.384	0.388	0.387	0.383	0.379	0.377
	gap (1) - (2)	-0.022	-0.007	-0.024	-0.014	-0.023	0.000
	ratio (1) / (2)	0.944	0.981	0.938	0.964	0.939	1.001
Proportion of uncemented hips	(1) Most deprived (*)	0.10	0.11	0.15	0.19	0.23	0.32
	(1) Others	0.11	0.13	0.15	0.20	0.25	0.32
	gap (1) - (2)	-0.01	-0.02	0.00	-0.01	-0.02	0.00
	ratio (1) / (2)	0.94	0.86	0.98	0.93	0.93	1.00

(*) = patients resident in the most deprived 10% of Engish small areas

Table 2 presents mean length of stay by year and deprivation group, comparing patients living in the most income deprived decile of English small areas with other patients. Mean length of stay is persistently higher in the deprived group. Length of stay falls year-on-year in both groups at a similar rate, resulting in a fairly stable ratio despite the declining absolute gap. Patients living in the most income deprived decile of areas on average stay about 7-10% longer than other patients throughout the period, or 0.95 days longer in 2001/2 falling to 0.65 days longer in 2006/7. The mean number of diagnoses increased throughout the period in both groups, initially at a similar rate though more rapidly in the deprived group in 2005/6. The mean number of diagnoses in the most deprived decile was only 1-3% higher in the most deprived decile between 2001/2 and 2004/5, rising to 10-11% higher in 2005/6 and 2006/7. There was little difference between the two groups in the age and gender mix or the proportion of uncemented hip replacements. The total number of admissions increases substantially in the period considered: from 31,777 in 2001/2 to 36,739 in 2006/7. This might explain the rise in the average age and number of diagnoses of patients admitted along the period examined. Interestingly, the number of admissions reaches a peak in 2003/4 and falls slightly thereafter. This trend might be partially explained by the growing activity of independent sector treatment centres (ISTCs), which become progressively operational in orthopaedic care from 2004/5 yet whose activity has been excluded from our dataset due to incomplete reporting. Finally, the deprivation mix changed slightly over time with the proportion of hip replacement patients from the most deprived decile of English small areas falling from 8.2% in 2001 to 7.6% in 2006/7.

Figure 1: Patient length of stay in 2006/7, comparing patients in the most deprived decile of areas versus others (Kernel density plot, truncated at 60 days)

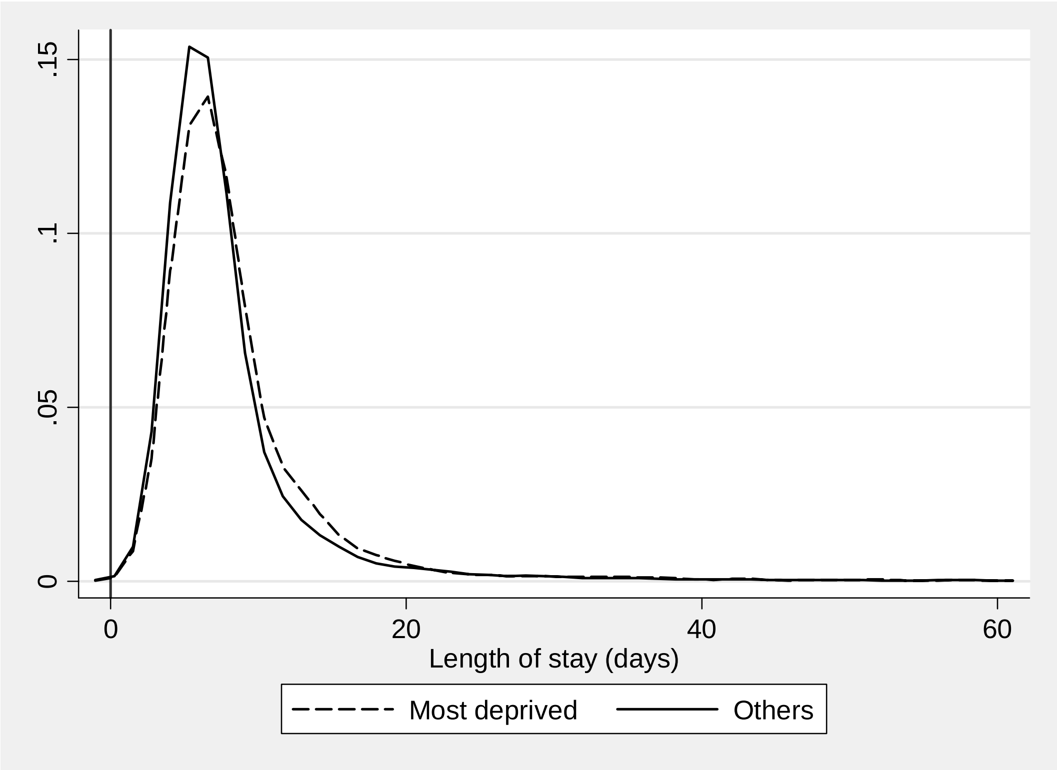


Figure 1 shows kernel density plots of length of stay for patients in 2006/7, comparing patients living in the most income deprived decile of English small areas versus others. It is clear that the vast majority of patients stay less than 20 days, though there is a long thin tail of outlier long-staying patients. Patients from income deprived areas stay somewhat longer than others, with a larger proportion in the 5-10 day range and a smaller proportion in the 10-20 day range. There appears to be relatively little difference in the proportion of long staying outlier patients in the two groups. The differences in mean length of stay observed in table 2 thus do not appear to be driven by a small number of outlier patients.

Table 3: Mean length of stay by financial year and small area income deprivation decile

IMD income deciles	2001	2002	2003	2004	2005	2006
Least deprived decile 1	10.53	9.87	9.31	8.87	8.25	7.59
2	10.36	10.16	9.54	9.04	8.38	7.59
3	10.45	10.17	9.54	9.05	8.34	7.62
4	10.66	10.42	9.54	9.15	8.57	7.70
5	10.77	10.31	9.87	9.32	8.70	7.76
6	10.94	10.62	9.88	9.51	8.72	7.90
7	11.18	10.91	9.94	9.58	9.01	8.08
8	11.49	11.01	10.09	9.69	8.91	8.18
9	11.37	11.20	10.32	9.79	8.96	8.46
Most deprived decile 10	11.82	11.31	10.51	10.05	9.47	8.51
Gap (1) - (10)	1.29	1.43	1.20	1.19	1.22	0.93
Ratio (1) / (10)	1.12	1.15	1.13	1.13	1.15	1.12

Note: Deciles are based on the distribution of IMD 2004 income deprivation scores in the national population of English LSOAs, rather than the study population of hip replacement patients

Table 3 presents mean length of stay by income deprivation deciles for each financial year from 2001/2 through 2006/7. The absolute gap in length of stay between the most and least income deprived deciles fell substantially from 1.3 days to 0.9 days between 2001/2 and 2006/7. However, the ratio between the two remained fairly constant: mean length of stay remained 12-15% higher for patients in the most deprived decile than patients in the least deprived decile, throughout the six year period.

Figure 2: Mean length of stay by small area income deprivation decile by financial year from 2001/2 to 2006/7

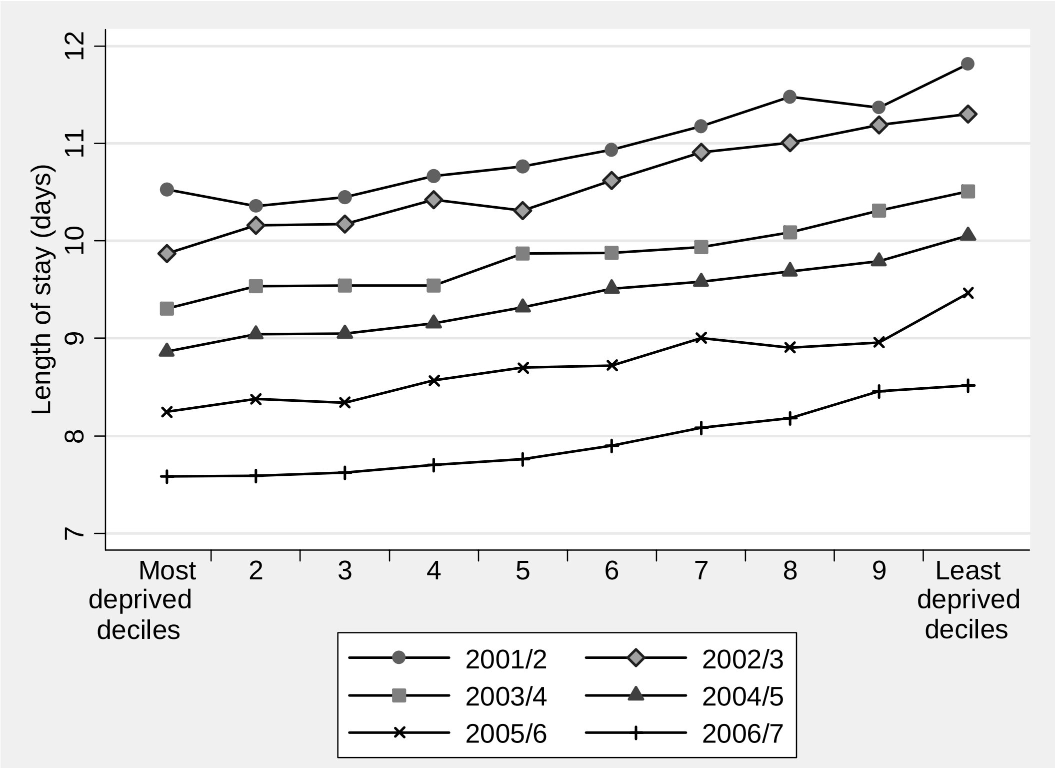


Figure 2 illustrates the same information in a line chart. The lines show a clear gradient in length of stay rising from the first to tenth income deprivation deciles, for each of the six years. The lines also illustrate the substantial year-on-year fall in length of stay throughout the period.

We now turn to the regression analysis, to see how far these descriptive associations are modified after controlling for other determinants of length of stay – i.e. patient characteristics and Trust level supply factors – that may co-vary with area deprivation.

4.2 Regression analysis

Table 4: Length of stay regression results (Model 1)

Dependent variable: length of stay (days)	Without Trust effects	With Trust effects
2nd deprivation decile	-0.468**	-0.201
3rd deprivation decile	-0.491**	-0.153
4th deprivation decile	-0.792***	-0.365**
5th deprivation decile	-1.001***	-0.535***
6th deprivation decile	-1.081***	-0.537***
7th deprivation decile	-1.213***	-0.658***
8th deprivation decile	-1.378***	-0.828***
9th deprivation decile	-1.436***	-0.828***
least deprived decile	-1.306***	-0.793***
year_2002	-0.381**	0.257
year_2003	-1.044***	-0.402**
year_2004	-1.412***	-2.647***
year_2005	-2.070***	-5.525***
year_2006	-2.807***	-6.833***
5th deprivation decile 2005	0.267	0.0430
5th deprivation decile 2006	0.470	0.248
6th deprivation decile 2005	0.407	0.155
6th deprivation decile 2006	0.506	0.253
7th deprivation decile 2005	0.396	0.115
7th deprivation decile 2006	0.505*	0.219
8th deprivation decile 2005	0.446	0.150
8th deprivation decile 2006	0.601**	0.355**
9th deprivation decile 2005	0.525*	0.228
9th deprivation decile 2006	0.656**	0.291
least deprived decile 2005	0.227	0.0636
least deprived decile 2006	0.526*	0.302
uncemented hip	-0.0299	0.221*
uncemented hip_2006	-0.255	-0.318**
male	-0.674***	-0.705***
age 55-64	0.366***	0.326***
age 65-74	1.237***	1.226***
age 75-84	3.603***	3.560***
age 85plus	7.663***	7.609***
age 55-64_2005	-0.335***	-0.254**
age 55-64_2006	-0.230*	-0.144
age 65-74_2005	-0.476***	-0.429***
age 65-74_2006	-0.658***	-0.568***
age 75-84_2005	-0.786***	-0.696***
age 75-84_2006	-1.076***	-0.972***
age 85plus_2002	-0.728**	-0.759**
age 85plus_2003	-0.771**	-0.800**
age 85plus_2004	-0.374	-0.286
age 85plus_2005	-1.076***	-0.927**
age 85plus_2006	-1.767***	-1.635***
2 diagnoses	0.541***	0.813***
3 diagnoses	1.403***	1.758***
4 diagnoses	2.218***	2.705***
5 diagnoses	3.328***	4.000***
6 diagnoses	4.484***	5.452***
7 diagnoses or more	6.296***	7.595***
2 diagnoses_2003	-0.321**	-0.237**
2 diagnoses_2004	-0.342***	-0.265**
2 diagnoses_2005	-0.187	-0.351***
2 diagnoses_2006	-0.265**	-0.397***
3 diagnoses_2003	-0.473***	-0.367**
3 diagnoses_2004	-0.603***	-0.465***
3 diagnoses_2005	-0.556***	-0.701***
3 diagnoses_2006	-0.610***	-0.762***
4 diagnoses_2004	-0.747***	-0.574***
4 diagnoses_2005	-0.654**	-0.846***
4 diagnoses_2006	-1.016***	-1.205***
5 diagnoses_2004	-0.819**	-0.595*
5 diagnoses_2005	-0.768**	-1.047***
5 diagnoses_2006	-1.100***	-1.406***
6 diagnoses_2004	-1.074*	-1.086**
6 diagnoses_2005	-0.949*	-1.422***
6 diagnoses_2006	-1.210**	-1.758***
7 diag. or more_2005	0.0959	-0.565
7 diag. or more_2006	-0.599	-1.264**
Constant	9.347***	10.25***
Observations	235,773	235773
Clusters	182	182
R-squared	0.181	0.228

Notes:

(1) *** p<0.01, ** p<0.05, * p<0.1; coefficients significant at 5% or above are also shaded

(2) The reference group is patients living in most deprived 10% of English LSOA, year 2001, cemented hip, age 45-54, one diagnosis, hospital of treatment Wirral Hospital NHS Trust (hosp2xi = 18)

(3) Due to space constraints, this table has been shortened by leaving out a number of non-significant coefficients. The full table is available from the authors on request.

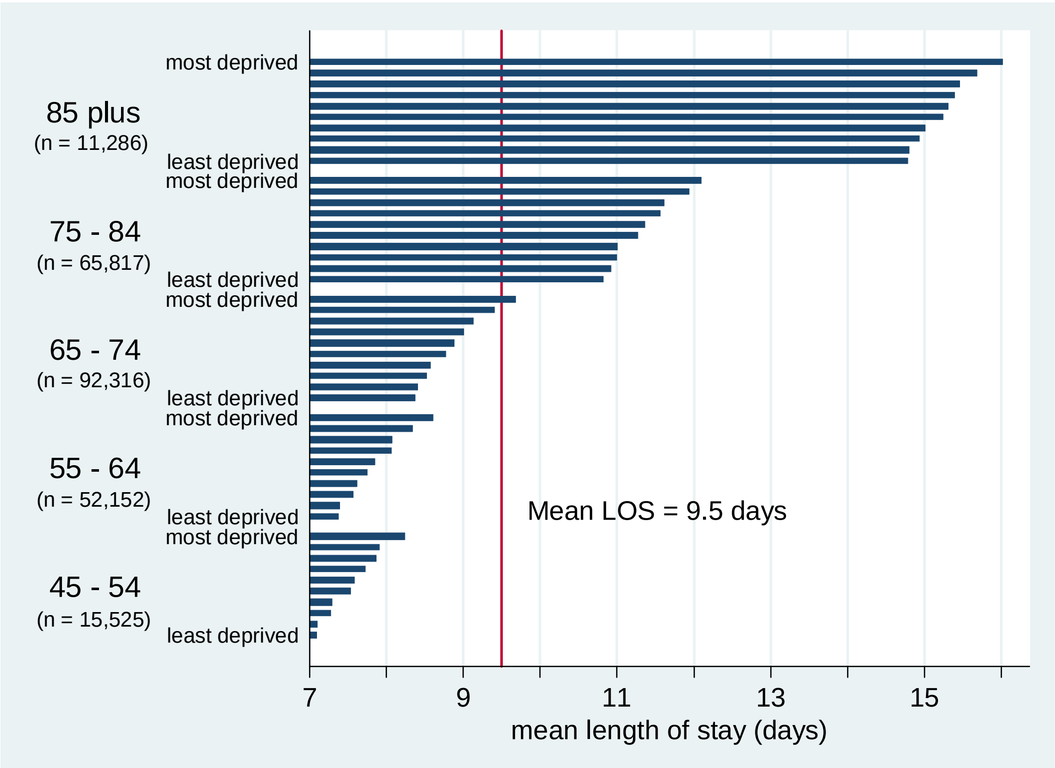
Table 4 presents the main regression results from model 1, which shows coefficients relative to a reference group of patients living in the most deprived decile of English small areas in 2001/2. After controlling for patient characteristics (age, sex, number of diagnoses, cemented or uncemented procedure), patients from the least income deprived tenth of areas stay 1.3 days longer than patients from the most income deprived tenth of areas. This figure falls to 0.8 days after controlling for Trust effects, suggesting that some but not all of this length of stay difference is supply driven: i.e. due to income deprived patients being treated by Trusts with longer length of stay. After controlling for Trust effects, the magnitude of this association is comparable to that of gender, with women staying 0.7 days longer than men.

After controlling for patient characteristics, the effect of deprivation on length of stay does not change substantially or significantly across the six years. Of the 45 coefficients on the deprivation times year interactions (not all of which are reported due to space constraints) only one is significant at 5% (or two without controlling for Trust effects). However, there is a pattern of positive coefficients on year interactions with less deprived deciles in 2005/6 and 2006/7, suggesting a small reduction in absolute length of stay differentials between the most deprived decile and less deprived deciles in these two years.

The largest determinants of length of stay are age group and diagnosis group, irrespective of controls for Trust level supply effects. In the reference year of 2001/2, with Trust controls, patients age 75-84 stayed on average 3.6 days longer than patients age 45-54, and patients age 85 or above stayed 7.6 days longer. The magnitude of these age associations fell slightly over time, and by 2006/7 had fallen to 2.6 days (3.6 minus 1.0) and 6.0 days (7.6 minus 1.6) respectively. Turning to diagnosis group, with Trust controls, in 2001/2 patients with seven or more diagnoses stayed on average 7.6 days longer than those with only one diagnosis, falling to 6.3 days (7.6 – 1.3) by 2006/7. The magnitude of these diagnosis associations increased slightly after controlling for Trust supply effects. This pattern of results is consistent with the findings from the other regression models.

There were no significant, substantial or systematic interactions between age and deprivation or between diagnosis group and deprivation.

Figure 3: Modelled mean length of stay by age group and deprivation decile (Model 1)



Figures 3 and 4 present predictions from model 1 in graphical form. Figure 3 shows the model predicted relationships between length of stay, age group and income deprivation decile. Age is a larger determinant of length of stay than deprivation, especially for age 75-85 and age 85 plus. However, there is nevertheless a fairly smooth "social gradient" within each age group, as length of stay increases with each income deprivation decile.

Figure 4: Modelled mean length of stay by number of diagnoses and deprivation decile (Model 1)

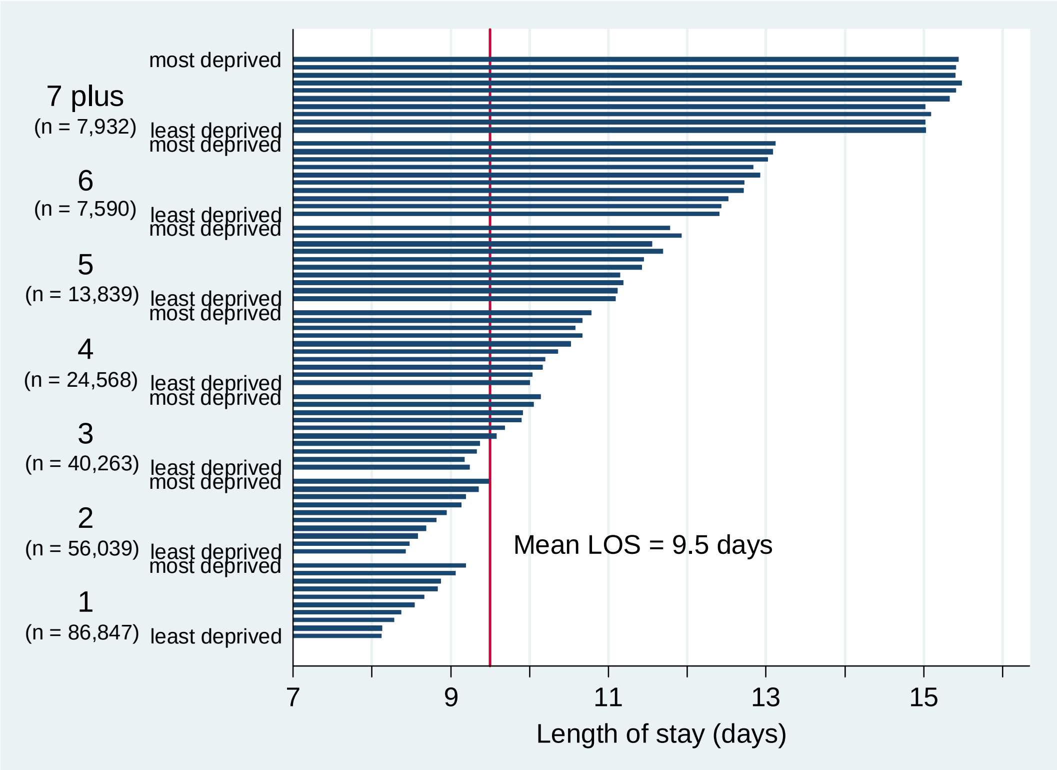
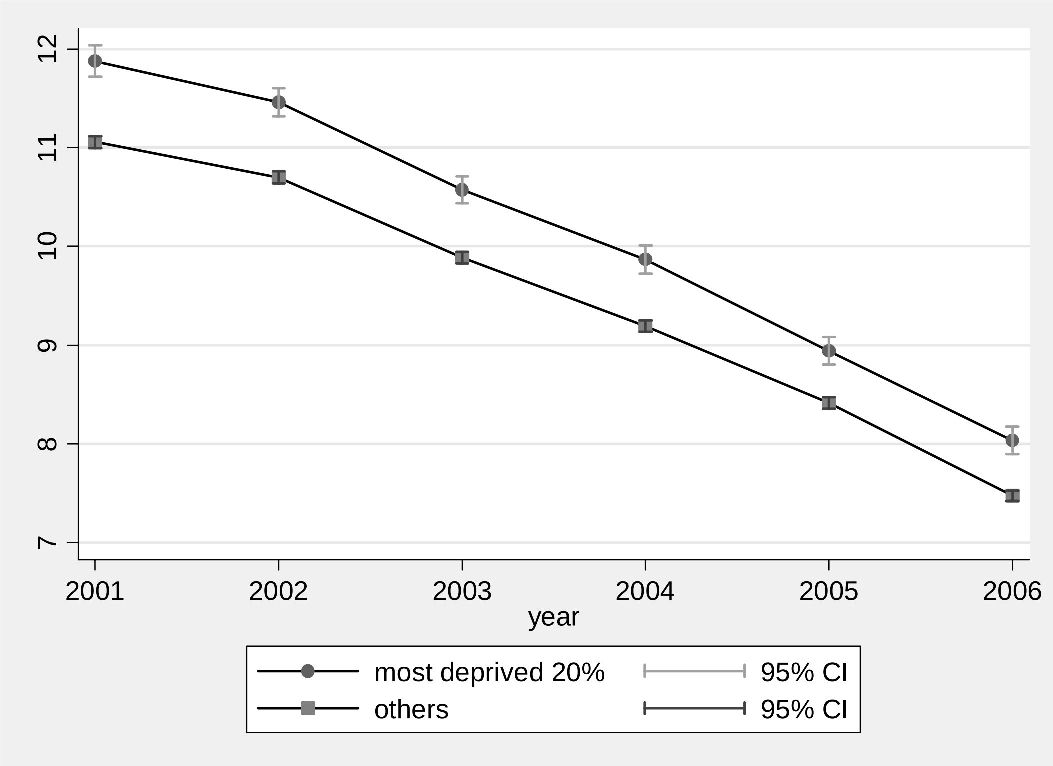


Figure 4 shows the predicted relationships between length of stay, number of diagnoses and income deprivation decile. The number of diagnoses at the admission is also a larger determinant of length of stay than deprivation. Again, however, there remains a fairly smooth "social gradient" within each diagnosis group.

Figure 5: Mean length of stay by deprivation and year (standardised for age, sex and number of diagnoses using Model 3)



Finally, figure 5 shows mean length of stay by deprivation and year, after adjusting for age, sex and number of diagnoses using model 3 (with no interaction terms). This shows a slightly declining absolute gap in length of stay between patients living in deprived and non-deprived areas declines over time. However, as the regression coefficients make clear, this decline is largely driven by a diminution in role of age and number of diagnoses as drivers of length of stay. The "pure" association between area-based income deprivation and length of stay, purged of the changing role of patient need covariates over time, has not changed much.

5. Discussion

The major determinants of length of stay for elective total hip replacement are age and co-morbidity. In 2006/7, after adjusting for patient characteristics and Trust supply effects, we find that patients over 85 stay about 6 days longer than patients age 45-54; and patients with seven or more diagnoses stay more than 6 days longer than patients with one diagnosis. These are considerable differences, in the context of an overall mean length of stay of just under 8 days in 2006/7.

These differences declined from 2001/2 to 2006/7 as is shown by the estimated coefficients for their interaction with time in Table 4. For instance, the difference in length of stay between patients age over 85 and ones age 44-54 drops by 1.6 days in 2006 as compared with the same difference in 2001. A similar downward trend it is found in the differences in length of stay between groups of patients with different numbers of diagnoses. This suggests that hospitals are responding to some extent to the financial incentives embedded in the NHS reforms introduced during the period. Reducing length of stay allows the hospital to treat more patients. This helps to shorten waiting times and also generates higher revenue under the new prospective payment system. NHS hospitals have progressively cut mean length of stay for elective hip replacement during the period considered. Hospitals were particularly successful in reducing length of stay for groups of patients with the longest hospital stays, such as the elderly and patients with substantial co-morbidity.

On average, elective hip replacement patients living in more income deprived areas of England stay longer in hospital than patients living in less income deprived areas. Between 2001/2 and 2006/7, mean length of stay declined at a similar rate across all area income deprivation groups. This has resulted in declining absolute gaps in length of stay between income deprivation groups, even though the corresponding ratios have not changed much. For example, without adjusting for other factors, patients in the most deprived decile of areas stay on average 12-15% longer than patients living in the least deprived decile, with an absolute gap of 1.3 days in 2001/2 falling to 0.9 days by 2006/7.

This difference persists after adjusting for patient characteristics and Trust effects, although its magnitude declines after adjusting for Trust effects. After controlling for Trust effects, in addition to patient characteristics, patients in the most income deprived decile stay 8% longer than patients in the least deprived decile, or 0.80 days longer. After these adjustments, the absolute gap in length of stay does not fall substantially or significantly over time. The underlying relationship between area-based income deprivation and length of stay has not changed over time from 2001/2 to 2006/7. The persistence and stability of this relationship during this period is noteworthy, given the substantial decline in mean length of stay from 10.95 days to 7.91 days along with the substantial decline in mean waiting times from 250 days to 150 days. The relationship between deprivation and length of stay appears to be a deep-seated one, which was not altered by the major expenditure increases and reforms to the NHS from 2001/2 to 2006/7.

Under the current NHS fixed price payment system, therefore, there are some economic incentives for NHS hospitals to avoid offering elective hip replacements to elderly patients, patients with substantial co-morbidity and, to a lesser extent, patients from low income areas.

One reason for a significant association between length of stay and area income deprivation is that people in income deprived areas tend to have more co-morbidity – such as obesity, heart conditions, and other health problems – and hence take longer to recover. Our regression analysis partly allows for this, by controlling for the patient's number of diagnoses and by testing for interactions between number of diagnoses and deprivation. However, we do not explicitly allow for the type or severity of co-morbidity. Another possible explanation is that patients from deprived areas may have less pleasant and supportive household environments to return to. Finally, there may also be socio-cultural factors relating to patient and professional behaviour, such as the quality of communication and diagnosis and patient adherence to medication and physical recovery regimes.

Whatever the reasons, there is a clear and statistically significant positive association between length of stay and area-based income deprivation. This association remained remarkably stable from 2001/2 to 2006/7, despite substantial falls in length of stay across all patient groups. The poor, it would seem, still cost more.

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