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Abstract

We investigate differences in patients' length of stay between National Health Service (NHS) public hospitals, public treatment centres and private treatment centres that provide elective (non-emergency) hip replacement to publicly-funded patients. We find that private treatment centres and public treatment centres have on average respectively 40% and 18% shorter length of stay compared to NHS public hospitals, even after controlling for differences in age, gender, number and type of diagnosis, deprivation and geographical variation. We therefore interpret such differences as due to efficiency as opposed to selection (treatment of less complex cases). Quantile regression suggests that the proportionate differences between different provider types are larger at the higher conditional quantiles of length of stay compared to the lower ones.

JEL classification: I11, I18

Keywords: Length of stay, public hospitals, treatment centres, private providers

1 Introduction

The hospital sector has lagged behind other sectors of the economy in moving toward greater specialisation (Essletzbichler, 2003) but is beginning to catch up. The number of orthopaedic, cardiac or general surgery specialist hospitals in the United States increased from 29 in 1990 to 91 in 2005 (Shactman, 2005; Schneider et al., 2008) after which the government imposed a moratorium on further development, concerned primarily that hospitals were specialising merely on the most profitable procedures (Shactman, 2005). In contrast the English government has been actively encouraging the creation of both public and private treatment centres that specialise in a limited set of elective procedures, such as hip and knee replacements or cataract removals.

In this study we assess whether provision of care in specialised treatment centres is more efficient than in the more traditional hospital setting. Efficiencies in treatment centres may derive from economies of scale, whereby the unit cost of treatment falls as volume increases, and from specialisation, where it is cheaper to concentrate on providing a limited set of activities, rather than a diverse range of services (Schneider et al., 2008). We also investigate the relative efficiency of private and public provision, the expectation being that private providers have stronger incentive to contain costs and behave more efficiently. Efficiency is examined by comparing differences in length of stay among public hospitals, and public and private treatment centres.

Differences in length of stay may be indicative not of efficiency but patient selection. Selection may be due to diverse causes. First, private providers may ‘cherry pick’ less severe cases within any reimbursement category to boost profits (Shactman, 2005). In contrast, even if public providers are able to retain surpluses, these must be re-invested, so the absence of external claimants to surpluses places them under less pressure to engage in selection of less costly patients. Second, treatment centres tend to be less well equipped than hospitals, making them less suited to provide complex

care. For this reason treatment centres usually apply exclusion criteria (Mason et al., 2008). Third, hospitals tend to be more prestigious and attract highly-specialised doctors with the skills to treat more complex cases. As these factors may lead to differences in patient complexity across organisations, it is important to account for the possibility in evaluating relative efficiency.

We contribute to the extensive literature which investigates differences in behaviour between types of providers. Efficiency studies tend to find either that public providers are more efficient or that differences are not related to ownership.[1] A clear relationship between ownership type and quality of care has yet to be established.[2] The paper is organized as follows. Section 2 provides the econometric specification. Section 3 describes the data. Section 4 discusses the results. Section 5 concludes.

2 Econometric specification

The purpose of this study is to investigate differences in patients' length of stay (defined with LOS), between types of provider.[3] Our linear regression model is:

$$Ln(LOS_{ij}) = \alpha + \beta_1 d_1 + \beta_2 d_2 + \beta_3 \mathbf{s_{ij}} + u_{ij} \qquad (1)$$

[1] Herr (2008) finds that in Germany public hospitals are more efficient than private and non-profit hospitals. Farsi and Filippini (2008) in Switzerland find no significant differences between public, for-profit and no-profit hospitals. Marini et al. (2008) investigate the change in England of hospital status from 'public hospital' to 'Foundation Trust', a status which confers more financial independence and less monitoring and find that the new status had limited impact on behaviour. Barbetta, Turati and Zago (2007) find that the mean efficiency of public and non-profit hospitals converged after the introduction of the DRG system in Italy. In his review of 317 published papers on frontier efficiency measurement, Hollingsworth concluded that public hospitals tend to be more efficient than their private counterparts (Hollingsworth, 2008).

[2] In Taiwan, Lien et al. (2008) find that non-profit hospitals provide care of a higher quality than for-profit hospitals. In contrast, Jensen, Webster and Witt (2009) find that in Australia private hospitals have lower readmission and mortality associated with acute myocardial infarction. However, in her study of French hospitals, Milcent (2005) finds that differences in mortality rates are not significantly different once severity is taken into account. Similarly, in their meta-analysis of US hospitals, Eggleston et al. (2008) find that whether for-profit hospitals provide lower or higher quality depends on the context (region, data source and period). Conclusions may have also be specific to the procedure under consideration: a study in England found that private treatment centres offer better outcomes for cataract surgery and hip replacement, whereas the public sector achieves better outcomes for hernia repair (Browne et al., 2008).

[3] Length of stay is measured as the difference between the dates of the patient's admission to and discharge from the hospital.

where LOS_{ij} is the length of stay of patient i in hospital j; d_1 and d_2 are two dummy variables equal to 1 if the hospital is either a public or a private treatment centre (the reference group are hospitals); $\mathbf{s_{ij}}$ is a vector of variables, which captures regional dummies, demographic variables (age and gender), and patients co-morbidities through primary, secondary and tertiary diagnosis at admission and the total number of diagnoses.

The coefficients β_1 and β_2 capture the extent to which patients treated in public and private treatment centres differ in their LOS from those treated in hospitals. By comparing β_1 and β_2 when the co-morbidity vector is included and when it is not, we can identify the extent to which differences in LOS are due to treatment centres treating patients of different complexity (selection) as opposed to differences in their efficiency. For example, suppose that when omitting the vector $\boldsymbol{s}$ in the regression equation we find that β_2 is negative. Then, patients treated in private treatment centres have a shorter length of stay. If after the inclusion of the vector $\boldsymbol{s}$, the coefficient β_2 reduces, then part of the differences in LOS can be attributed to differences in the characteristics of patients being treated (ie to selection).

Since the distribution of LOS is skewed we use the log transformation of LOS as the dependent variable. We estimate equation 1 using OLS. To identify the differential impact of type of provider along the conditional distribution of length of stay we apply quantile regression.

3 Data

We use data from the Hospital Episode Statistics (HES) in year 2006/7. HES comprises individual patient records about everyone whose care was funded by the English National Health Service (NHS). We focus on those patients who received a cemented or uncemented primary hip replacement (HRG H80 or H81). Each patient record contains a range of variables including demographic (e.g. age and gender) and

clinical information (e.g. diagnosis, procedures performed).[4] The estimation sample includes 42948 patients, of which 1841 were treated by public treatment centres and 938 by private treatment centres. The sample includes 173 public hospitals, six public treatment centres and 14 private treatment centres.

We control for various patient characteristics including age, gender, and number and type of diagnosis. For age, we construct seven groups: 18-29 years old, 30-39, 40-49, ..., 70-79, above 80. We use the diagnosis fields in HES which record up to 12 diagnoses using ICD-10 codes. For the type of diagnosis, we include dummy variables for each individual diagnoses to allow a fully flexible (non-linear) specification. We separate dummy variables for primary and other diagnoses. For primary diagnoses, because of the extremely large number of diagnoses recorded, we only include dummies for diagnoses with at least 40 observations: this gives 28 dummy variables. The three most common primary diagnoses are different types of coxarthrosis (arthritis of the hip). Similarly for secondary diagnoses, to keep the number of variables to a manageable level we only include dummy variables for the most common 37 individual secondary diagnoses, covering 80% of admissions. The four most common are hypertension (high blood pressure), presence of (existing) joint implants, Type 2 diabetes and asthma. Because we don't have a dummy variable for every secondary diagnosis, and HES records up to 11 secondary diagnoses for each patient, we also control for the number of additional diagnoses (for which we don't have an individual diagnosis dummy) using a dummy variable specification. We control for the number of procedures for each patient in the same way. The average per-patient number of diagnoses and procedures is larger in public hospitals (2.8, 2.3) than in public treatment centres (2.5, 2.2) or private treatment centres (1.1, 1.5).

We control for two characteristics of hospitals which may influence LOS: Foundation Trusts, and teaching status. The government has granted Foundation Trusts greater

[4] All public providers routinely provide HES data for every inpatient and day case patient they treat. Private treatment centres are contractually obliged to submit HES data for the NHS funded patients they treat.

financial independence than other public hospitals giving them a stronger incentive to contain costs. Teaching hospitals may have longer LOS because of sicker patients, higher quality of care and more time spent with patients for teaching purposes. We also control for the income deprivation of the population served by each provider and for the region in which the provider is located.[5]

Table 1 provides the descriptive statistics. Hospitals have the longest LOS (7.5 days) followed by public treatment centres (5.9 days) and private treatment centres (4.5 days). Patients are on average one year younger in hospitals. The proportion of female patients is 62% in hospitals, 64% in public treatment centres and 59% in private treatment centres. There is a higher proportion of uncemented hip prosthesis (HRG H81) in public treatment centres (48%) than in hospitals (29%) or private treatment centres (11%). Current NICE guidance favours cemented hip prosthesis as being lower cost and more viable in the long-term (NICE, 2000).

TABLE 1 HERE

4 Results

Table 2 provides the OLS estimates of the model described in Equation 1.

TABLE 2 HERE

Looking first at column 1, with no controls (except for a dummy for HRG81) patients treated in public treatment centres have 17% shorter LOS, and private treatment centres have 46% shorter LOS than those treated in hospitals. As shown in column 2, these differences are little changed after controlling for hospital characteristics, regional dummies and local income deprivation: public and private treatment centres

[5] The IMD income deprivation score provides the proportion of the local population in the area where the patient lives living in households reliant on one or more means-tested benefits (Noble et al., 2004). Patients are from more deprived areas in public hospitals (12%) than in public or private treament centres (both 10%). We have nine dummy variables to account for the ten regions in England.

have 20% and 49% shorter LOS compared to hospitals. Foundation and teaching status of hospital appear to have no effect on LOS but income deprivation does have a substantial impact, increasing LOS.

Column 3 shows results when controlling for patient's age, gender, type and number of diagnoses. This also does not substantially change differences in LOS across providers: public treatment centres still have 18% shorter LOS than hospitals. The difference between hospitals and private treatment centres is smaller and equal to 40% (6 percentage-points down). This suggests that patient selection explains a small part of the shorter LOS achieved by private treatment centres.

There is clear relationship between LOS and age, with younger patients having shorter stays. Female patients have about 9% longer LOS than male patients. The three most common primary diagnoses have no significant effect on LOS. The results for individual secondary diagnoses show the presence of hypertension has no effect on LOS, whereas diabetes and asthma increase LOS by about 4% and 7% respectively. Patients with higher number of additional secondary diagnoses have substantially longer LOS: patients with 3 additional diagnoses have 17% longer LOS.

Table 3 and Figure 1 provide quantile regression results. The specification is similar to the model in column (4) in Table 2 (in terms of variable choice). To allow quantile regression models to converge we simplify the specification of dummy variables for diagnoses to include only the most common ten diagnoses for primary and secondary diagnoses. The results suggest that the proportionate difference between public hospitals, public treatment centres and private treatment centres are larger at the higher conditional quantiles of LOS and smaller at the lower quantiles. Public treatment centres have 26% shorter LOS compared to public hospitals at the 90% quantile, falling to 9% at the 10% quantile. Similarly, private treatment centres have 52% shorter LOS compared to public hospitals at the 90% quantile, reducing to 35% at the 10% quantile. Figure 1 plots the effect of provider type on LOS over the five quantiles.

TABLE 3 AND FIGURE 1 HERE

5 Concluding remarks

In contrast to the United States, government policy in England has been to encourage delivery of care to NHS patients in specialised treatment centres rather than in traditional hospital settings. This policy has been subject to criticism, particularly pertaining to the role that the private sector has played (House of Commons Health Committee, 2006; Pollock and Godden, 2008; Mason et al., 2010; Street et al., 2010). Despite these criticisms, though, the evidence presented here demonstrates that the length of stay for people having a hip replacement is lower in treatment centres than in hospitals and that this is not due to the different characteristics of patients in these settings.

Treatment centres are able to deliver care more efficiently than hospitals because of their ability to benefit from: specialisation; economies of scale in the production of a limited set of procedures; avoiding the disruption that hospitals face by having to re-schedule elective work to accommodate patients requiring emergency care (Royal College of Surgeons, 2007).

We also find length of stay is lower in private treatment centres than in their public counterparts. This may be because they have a greater incentive than public providers to restrain costs. It will be important to ensure that these lower lengths of stay do not come at the expense of reduced outcomes, though early evidence for these patients is reassuring (Browne et al., 2008).

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Table 1: Descriptive Statistics										
Variable	NHS public hospital		Public treatment centre		Private treatment centre		All			
	mean	sd	mean	sd	mean	sd	mean	sd	min	max
Length of Stay	7.455	4.780	5.866	2.572	4.481	1.494	7.322	4.689	1	155
HRG H81 (uncemented)	0.291	0.454	0.495	0.500	0.113	0.317	0.296	0.456	0	1
Foundation Trust	0.313	0.464	0.174	0.380	0.000	0.000	0.301	0.459	0	1
Teaching Trust	0.118	0.323	0.000	0.000	0.000	0.000	0.111	0.314	0	1
IMD - income deprivation	0.119	0.098	0.106	0.088	0.095	0.068	0.117	0.097	0	0.83
Age	68.675	10.916	69.344	10.684	69.998	8.699	68.733	10.865	18	102
Female	0.619	0.486	0.643	0.479	0.586	0.493	0.619	0.486	0	1
Individual Primary Diagnoses:										
M169 "Coxarthrosis, unspecified	0.499	0.500	0.193	0.395	0.445	0.497	0.485	0.500	0	1
M161 "Other primary coxarthrosis"	0.294	0.456	0.552	0.497	0.514	0.500	0.310	0.463	0	1
M160 "Primary Coxarthrosis, bilateral"	0.062	0.240	0.024	0.153	0.009	0.092	0.059	0.235	0	1
Individual Secondary Diagnoses:										
I10X "Hypertension"	0.319	0.466	0.353	0.478	0.058	0.233	0.314	0.464	0	1
Z966 "Presence of orthopaedic joint implants"	0.101	0.301	0.154	0.361	0.005	0.073	0.101	0.301	0	1
E119 "Non-insulin dependent diabetes"	0.054	0.226	0.061	0.240	0.012	0.108	0.053	0.225		
J459 "Asthma"	0.051	0.220	0.037	0.190	0.007	0.086	0.049	0.216		
Number of diagnoses	2.828	1.857	2.494	1.531	1.143	0.557	2.777	1.843	1	12
Number of procedures	2.321	0.808	2.152	0.512	1.465	0.508	2.295	0.802	1	10
Transfers-In	0.001	0.038	0.000	0.000	0.000	0.000	0.001	0.037	0	1
Transfers-Out	0.023	0.149	0.010	0.098	0.009	0.092	0.022	0.146	0	1
Observations	40169		1841		938		42948			

Table 2: Log-Linear regressions									
	[1]			[2]			[3]		
	Coeff	S.E.		Coeff	S.E.		Coeff	S.E.	
Public treatment centre	-0.171	0.018	***	-0.199	0.031	***	-0.177	0.031	***
Private treatment centre	-0.463	0.049	***	-0.491	0.062	***	-0.401	0.065	***
HRG H81	-0.129	0.017	***	-0.118	0.015	***	-0.033	0.016	**
Foundation Trust				0.011	0.028		0.015	0.026	
Teaching Trust				-0.013	0.036		-0.020	0.033	
IMD - Income deprivation				0.217	0.050	***	0.203	0.044	***
Age 18-29							-0.212	0.028	***
Age 30-39							-0.200	0.023	***
Age 40-49							-0.181	0.015	***
Age 50-59							-0.158	0.008	***
Age 60-69							-0.117	0.006	***
Age 80+							0.215	0.008	***
Female							0.090	0.006	***
Individual Primary Diagnosis (26 dummy variables):									
M161 "Other primary coxarthrosis"							-0.004	0.020	
M160 "Primary Coxarthrosis, bilateral"							0.001	0.024	
Individual secondary diagnoses (33 dummy variables)									
I10X "Hypertension"							0.003	0.006	
Z966 "Presence of orthopaedic joint implants"							-0.048	0.009	***
E119 "Non-insulin dependent diabetes"							0.069	0.010	***
J459 "Asthma"							0.037	0.010	***
Number of additional secondary diagnoses									
1 additional diagnosis							0.065	0.007	***
2 additional diagnoses							0.100	0.01	***
3 additional diagnoses							0.172	0.016	***
Number of Procedures									
2 Procedures							-0.050	0.058	
3 Procedures							-0.019	0.059	
4 Procedures							0.053	0.062	
Transfer-in							-0.084	0.149	
Transfer-out							0.032	0.047	
Constant	1.933	0.013	***	1.897	0.014	***	1.856	0.067	***
Observations	42948			42948			42948		
R-sq	0.045			0.065			0.267		

Notes: OLS regressions of ln(Length of Stay) on four different sets of regressors. Reference category patient is in an NHS public hospital, HRG H80, Age70-79, Male, Primary Diagnosis=M169 (coxarthrosis, unspecified), no secondary diagnosis, 1 procedure, 1 diagnosis, North-East STHA. Models 2 and 3 contain 9 additional dummy variables for Strategic Health Authorities. Model 3 includes 26 additional dummy variables for primary diagnoses, 33 additional dummy variables for individual secondary diagnoses, 6 additional variables for 5 to 10 procedures and 8 additional dummy variables for 4 to 11 additional secondary diagnoses for which the coefficient estimates are not shown.

Table 3: Quantile regressions

	10%			30%			50%			70%			90%		
	Coeff	S.E.		Coeff	S.E.		Coeff	S.E.		Coeff	S.E.		Coeff	S.E.	
Public treatment centre	-0.090	0.015	***	-0.160	0.010	***	-0.192	0.011	***	-0.218	0.012	***	-0.264	0.017	***
Private treatment centre	-0.350	0.030	***	-0.423	0.019	***	-0.491	0.020	***	-0.502	0.017	***	-0.520	0.018	***
HRG H81	-0.048	0.007	***	-0.039	0.005	***	-0.034	0.005	***	-0.023	0.005	***	-0.005	0.008	
Foundation Trust	0.023	0.006	***	0.008	0.005		0.016	0.005	***	0.014	0.006	**	0.016	0.009	*
Teaching Trust	0.001	0.009		-0.018	0.008	**	-0.021	0.009	**	-0.013	0.008		-0.013	0.013	
IMD - Income deprivation	0.068	0.034	**	0.162	0.023	***	0.195	0.023	***	0.264	0.023	***	0.358	0.040	***
Female	0.122	0.006	***	0.099	0.005	***	0.090	0.005	***	0.075	0.005	***	0.060	0.008	***
Individual Primary Diagnosis (10 dummy variables):															
M161 "Other primary coxarthrosis"	-0.010	0.006		0.001	0.006		0.012	0.005	**	0.013	0.005	**	0.001	0.009	
M160 "Primary Coxarthrosis, bilateral"	0.011	0.014		0.004	0.009		0.012	0.010		0.011	0.011		0.016	0.014	
Individual secondary diagnoses (10 dummy variables)															
I10X "Hypertension"	0.007	0.007		0.001	0.004		-0.002	0.005		-0.001	0.005		-0.006	0.008	
Z966 "Presence of orthopaedic joint implants"	-0.058	0.009	***	-0.041	0.008	***	-0.053	0.007	***	-0.048	0.008	***	-0.058	0.012	***
E119 "Non-insulin dependent diabetes"	0.057	0.016	***	0.058	0.010	***	0.065	0.01	***	0.072	0.013	***	0.085	0.020	***
J459 "Asthma"	0.042	0.011	***	0.038	0.010	***	0.036	0.01	***	0.032	0.009	***	0.038	0.020	*
Transfer-in	-0.292	0.061		-0.201	0.155		-0.043	0.085		0.054	0.048		-0.054	0.128	
Transfer-out	-0.113	0.024		-0.003	0.017		0.030	0.015		0.093	0.023		0.207	0.043	
Constant	1.506	0.030		1.763	0.023		1.936	0.020		2.123	0.023		2.565	0.049	
Observations	42948			42948			42948			42948			42948		
Pseudo R-sq	0.074			0.102			0.117			0.129			0.172		

Notes: Quantile regressions of the 10th, 30th, 50th, 70th and 90th conditional percentiles of ln(Length of Stay). Reference category patient is in an NHS public hospital, HRG H80, Age70-79, Male, Primary Diagnosis=M169 (coxarthrosis, unspecified), no secondary diagnosis, North-East STHA. Additional dummy variables for six age groups, seven individual primary diagnoses, six individual secondary diagnosis, the number of additional secondary diagnoses (one to six), five procedures and nine Strategic Health Authorities are also included but coefficient estimates are omitted to save space.

Figure 1: Marginal effects across conditional quantiles of ln(length of stay)