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Waiting Time Prioritisation: Evidence from England

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Abstract

A number of OECD countries have introduced waiting time prioritisation policies which give explicit priority to severely ill patients with high marginal disutility of waiting. There is however little empirical evidence on how patients are actually prioritised. We exploit a unique opportunity to investigate this issue using a large national dataset with accurate measures of severity on over 200,000 patients. We link data from a national patient-reported outcome measures survey to administrative data on all patients waiting for a publicly funded hip and knee replacement in England during the years 2009-12. We find that patients suffering the most severe pain and immobility have shorter waits than those suffering the least, by about 29% for hip replacement and 9% for knee replacement, and that the association is approximately linear. These differentials are more closely associated with pain than immobility, and are larger in hospitals with longer average waiting times.

Keywords: Waiting times, severity, prioritisation, patient-reported outcome measures

1. Introduction

Waiting times are a major health policy concern in several OECD countries (Siciliani et al. 2013). Patients seeking publicly funded care often have to wait weeks or months for many common elective procedures, such as cataract surgery and hip and knee replacement. For example, in 2012 mean waiting times for hip replacement were above 80 days in several OECD countries, with considerable variations, e.g. above 150 days in Spain and about 50 days in the Netherlands (Siciliani et al. 2014). Waiting times may generate discontent amongst patients as benefits from treatment get postponed and suffering and uncertainty are prolonged (Lindsay and Feigenbaum 1984).

In the presence of constraints on capacity combined with public health insurance and limited or zero co-payments, demand for treatment is likely to exceed supply, so that not all patients can be treated immediately. Patients are therefore added to a waiting list and have to wait for public treatment unless they are willing to pay for private care. Waiting times can be thought of as a non-monetary price which brings together the demand for and the supply of treatments in a public healthcare system (Martin and Smith 1999; Martin and Smith 2003; Iversen and Siciliani 2011).

A number of countries have experimented with policies to reduce waiting times, either by increasing the capacity of the healthcare system, e.g. by allowing privately operated providers to treat publicly-funded patients (Naylor and Gregory 2009), incentivising healthcare providers through maximum waiting time targets or guarantees (Propper et al. 2008a), or by limiting demand through more stringent admission policies. These policies have shown varying degree of success (Siciliani and Hurst 2005; Siciliani et al. 2013).

Waiting time prioritisation policies are intended to improve the management of the waiting list - rather than affect demand or supply directly - and are common across OECD countries (Siciliani et al. 2013). The key idea is simple. Given that waiting lists are unavoidable, they should be prioritised efficiently so as to reduce suffering among more severely ill patients with higher marginal disutility of waiting. From a theoretical perspective, it has been shown that such policies are welfare improving even in settings where severity is only partially observable, since prioritisation reduces the overall deadweight loss from waiting (Gravelle and Siciliani 2008; Gravelle and Siciliani 2009).[1]

Countries tend to differ in the way prioritisation operates. Some countries have developed formal prioritisation tools based on detailed scores following a specialist visit (e.g. in Canada and New Zealand for selected procedures) while others rely on relatively informal and generic tools (such as Australia and Italy, which recommend different maximum waiting times based on three or four groups of patients). For example, as part of the Western Canada Waiting List project, scoring tools have been developed that integrate objective and subjective clinical and social measures to calculate an overall priority score. For hip and knee replacement surgery this priority score is determined based on patients' pain on motion (e.g. bending, up to 13 points), pain at rest (e.g. sitting, up to 11 points), ability to walk without pain (up to 7 points), other functional limitations (e.g. putting shoes on, managing stairs, up to 19 points), among other factors. Similar tools are used in New Zealand to prioritise patients for several procedures (e.g. for coronary bypass, hip and knee joint replacements) and specialties (e.g. in general and vascular surgery, orthopaedics, ophthalmology and plastic surgery).[2] In Norway, a recent policy has introduced a maximum

[1] See also Siciliani and Iversen (2012) for a simpler model.
[2] As an example, patients affected by 'Lens-induced glaucoma' should be treated within four weeks (urgent, 71-90 points); patients categorised as 'Cataract extraction required in order to treat posterior segment disease' within 12 weeks (semi-urgent, 51-70 points); all other cataracts: (1-50 points) according to visual acuity score (max 5 points), clinical modifiers (max 5 points), severity

waiting time guarantee where patients are eligible to treatment within an individually determined waiting time. National guidelines were developed to stipulate maximum medically acceptable waits for a range of diagnoses (see Siciliani et al. (2013) for a detailed description of prioritization policies).[3]

The English NHS does not implement a formal prioritisation policy. Hospital trusts and consultants are allowed to manage the waiting list as they see fit, which gives rise to local variation in admission policies. In some instances waiting lists may be managed according to a *first-come-first-serve* rule, whereas in other instances management may take into account severity. For example, Leeds Teaching Hospitals NHS Trust sets out the requirement to treat patients '*in order by clinical priority, and then in strict chronological order*' (Leeds Teaching Hospitals NHS Trust 2014, p.4).

Despite the substantial interest in waiting-time prioritisation by policy makers and healthcare managers, there is very limited evidence within the empirical literature about the degree of waiting time prioritisation for patients affected by a common condition. It is therefore not evident a) to what extent patients are prioritised on the waiting list, b) how steep the severity gradient in waiting is, and c) whether waits reduce linearly or non-linearly with severity. Without this information it is difficult for decision-makers to determine whether more efforts should be devoted to further encourage prioritisation of patients on the waiting list. We aim at filling this gap in knowledge.

The lack of empirical studies on this topic may be explained by the absence of accurate measures of severity in large-scale administrative databases. These databases are typically limited to measures of comorbidity burden, which are poor proxies for general health status.[4] In this study, we take advantage of a new dataset containing detailed measures of patient self-reported health status collected alongside routine surgery as part of the national patient-reported outcome measures (PROM) programme. Since April 2009, all patients undergoing four elective surgical procedures (unilateral hip replacement, unilateral knee replacement, groin hernia repair and varicose vein surgery) in the English National Health Service (NHS) have been invited to report their health status before and several months after surgery (Department of Health 2008). The pre-operative health status of the patient is measured through condition-specific instruments (such as the Oxford Hip Score) and the generic EuroQol-5D instrument.

We focus on hip and knee replacement, which are common elective procedures and are the focus of waiting time prioritisation policies in a number of OECD countries (e.g. Canada, New Zealand). We test the extent to which more severely ill patients (as measured by the Oxford Hip and Knee Scores (OHS/OKS) which captures patients' joint-related pain and degree of mobility and autonomy) in the English NHS wait less. We also explore the differential role of pain and mobility on waiting time by splitting the Oxford scores into sub-components. We estimate Poisson models to allow for the discrete measure of inpatient waits (in days) and the skewed distribution of waiting times. Critically, we control for hospital fixed effects. Therefore, differences in waits across patients with different severity arise within the hospital rather than across hospitals.

of visual impairment (max 10 points), ability to work, give care, live independently (max 5 points), other disability (max 5 points). If patients score 21-50 they are considered 'routine' and should be treated within six months. Patients scoring less than 20 are 'deferrable' (Siciliani and Hurst 2005).

[3] They were developed in co-operation between Directorate of Health and Regional Health Authorities and cover conditions within 32 main 'medical chapters'. These describe a selection of medical conditions, a typical patient, and a recommendation on maximum waiting time. It is physicians at hospitals who ultimately decide and the actual wait may therefore vary over recommendations, e.g. due to patient's age, treatment efficacy, or co-morbidities.

[4] Gutacker et al. (2015a) report that patients' self-reported pre-operative health status correlates poorly (ρ=-0.13) with the number of Elixhauser comorbid conditions; a commonly used proxy for comorbidity burden.

Our key result is that patients with higher severity tend to wait less but the effect appears to be modest. Hip replacement patients in the top severity group wait approximately 9% (or 8 days) less than those with average severity, and the total gap between patients in the most and least severe groups is 29% (or 25 days). There is heterogeneity across treatments: the gradient for patients in need of knee replacement is substantially flatter, with no discernible prioritisation taking place between patients in above average severity. Moreover, while both mobility and pain affect patients' wait for hip replacement, only pain matters for knee replacement.

When we split the sample between hospitals with high (above median) and low (below median) waits, we find that the gradient between severity and waiting is more pronounced in hospitals with longer waits. This suggests that doctors enhance prioritisation when waits increase in the attempt to reduce the overall disutility from waiting. However, overall we find that prioritisation is currently limited in scope and therefore we suggest that governments could do more to further encourage waiting time prioritisation.

1.1. Related literature

The study contributes to the existing literature on the role of waiting times in the health sector. A key focus in this literature has been the estimation of demand and supply elasticities to waiting times. These studies typically find that demand is inelastic to waiting times (with an elasticity of about -0.1) while supply elasticity estimates vary depending on study design (Martin and Smith 1999; Martin and Smith 2003; Martin et al. 2007); see also Iversen and Siciliani (2011) for a review. Some studies focus on specific policy interventions such as the introduction of maximum waiting-time guarantees combined with penalties for non-compliance (e.g. Propper et al. 2008a; Dimakou et al. 2009) or the effect of competition (Siciliani and Martin 2007; Propper et al. 2008b). Other studies focus on waiting-time inequalities by socioeconomic status. Cooper et al. (2009) find that people living in more affluent areas waited less than those in more deprived areas for cataract, hip and knee replacement surgery performed in the English NHS (see also Laudicella et al. (2012), who focus on variations in waiting times within hospitals). Similarly, Monstad et al. (2014) find that in Norway richer men and more educated women tend to wait less for hip replacement; see also Kaarboe and Carlsen (2014). Similar evidence for Australia is provided by Sharma et al. (2013) and Johar et al. (2013). There are also a number of empirical studies that estimate the effect of longer waiting time on pre- and post-operative patient health. Hoogeboom et al. (2009) provide a systematic review of the medical literature and find that longer waiting time is not associated with deteriorations in health status while waiting up to six months. Using observational data from the national PROM programme in England, Nikolova et al. (forthcoming) estimate that patients' post-operative health status deteriorates by 0.1% of the outcome measure range per additional week of wait.

Some recent studies from Norway focus on prioritisation. Askildsen et al. (2011) compare recommended maximum waiting times by medical guidelines with actual waiting times. These guidelines recommend a differential waiting time across different conditions rather than within a given condition (the focus being therefore quite different from prioritisation within a condition as we pursue in this study). They find that patients with the most severe conditions receive lower priority than recommended. The related study by Januleviciute et al. (2013) also suggests that the introduction of such guidelines had no effect on improving waiting time prioritisation across four major severity groups; see also Askildsen et al. (2010).

2. Methods

We estimate fixed effects Poisson regression models to relate the number of days on the waiting list w_{ij} for patient $i = 1, \ldots, n_j$ in hospital $j = 1, \ldots, J$ to observed patient characteristics and the provider of care (Cameron and Trivedi 1998).[5] The model is specified as

$$w_{ij} = exp(\beta_1^{'} s_{ij} + \beta_2^{'} x_{ij} + h_j) \tag{1}$$

Coefficient estimates are semi-elasticities, representing the proportionate change in the dependent variable resulting from a one unit change in the independent variable. We also report average partial effects (APEs) on the untransformed scale.[6] We obtained cluster-robust Huber-White standard errors to account for potential over-dispersion (Cameron and Trivedi 1998).

The variable s_{ij} is our key variable of interest. It measures severity in terms of patients' pain at rest or in movement, and their ability to move about. This information is available from a national census of all patients undergoing elective hip or knee replacement (more details are provided in the data section). The vector β_1 thus provides an estimate of the degree of waiting-time prioritisation on the list according to severity as measured by pain and immobility. We allow for the relationship between severity and waiting time to be non-linear by splitting severity into twelve bands, thus allowing for a potentially non-linear 'severity gradient' in waiting time.

There may be a number of other patient characteristics that are used for prioritisation and are correlated with unobserved components of severity. We explore the robustness of the estimated severity gradient in β_1 to the inclusion of these characteristics. The vector x_{ij} includes the patient's age (coded as 0-44, 45-54, 55-64, 65-74, 75-84 and 85+), sex and age-sex interactions as well as the number of emergency admissions to hospital during the past 365 days, indicators for Elixhauser co-morbid conditions and approximate socio-economic status (in quintile groups). *A priori*, age should affect only the eligibility criteria for a hip (or knee) replacement within the NHS, not whether they are prioritised on the list. However, age may be correlated with other factors of severity not already accounted for through patients' self-reported health. Similarly, patients may be prioritised according to their co-morbidity burden and general health status as approximated by past emergency admissions.

All models include hospital fixed effects h_j to control for differences in waiting times across hospitals which may arise from unobserved supply factors (e.g. availability of beds, nurses, doctors, infrastructure, management and organization, and quality) and unobserved regional demand factors such as overall health of the population. Hence, the coefficients on severity and other control variables are estimated from within-provider variation only.

All analyses were conducted in Stata version 13.

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[5] The use of Poisson regression is preferable over (log-transformed) linear regression because it accounts for the skewed distribution of waiting time and does not suffer from re-transformation bias (Manning 1998; Gould 2011).

[6] The non-linear nature of the model requires evaluating APEs at the observed level of all covariates, including the overall intercept. The fixed effect (FE) Poisson estimator in Stata 13 does not include an overall intercept in the model. Instead it specifies the hospital FEs as the sum of the intercept plus the hospital-specific deviations from it. All FEs are conditioned out of the likelihood prior to estimation. In order to recover the overall intercept, we follow Cameron and Trivedi (1998, p.281) and first calculate the hospital FEs as

$$\widehat{h}_j = \frac{\sum_i w_{ij}}{\sum_i exp(\widehat{\beta}_1' s_{ij} + \widehat{\beta}_2' x_{ij}}$$

and then take the average across all j, i.e. $\sum_j \widehat{h}_j$. We then use this overall intercept in the calculation of the APEs.

3. Data

We use patient-level data from Hospital Episode Statistics (HES) for all elective admissions for patients aged 18 or over who underwent NHS-funded primary (i.e. non-revision) hip or knee replacement surgery between April 2009 and March 2012 in NHS or private providers.[7] HES contains rich information on patients' demographic and medical characteristics, small area of residence and on the hospital stay itself. Privately-funded patients treated in the private sector are not included in HES and are excluded from our analysis.[8]

We extract data on a number of patient characteristics from HES, including patients' age, gender, the number of emergency admissions in the year prior to their joint replacement surgery, as well as the number of Elixhauser comorbid conditions recorded in all admissions in the previous year or the current admission (Elixhauser et al. 1998; Gutacker et al. 2015b). We measure waiting time for each patient as the time (in days) between the specialist's decision to add the patient to the waiting list and their admission. We use the 2010 Index of Deprivation (McLennan et al. 2011) to attribute to each patient the proportion of residents claiming means-tested social security benefits in their Lower Super Output Area (LSOA), which we interpret as a proxy of income deprivation.[9]

We link these data to information obtained as part of the national PROM programme (Department of Health 2008). Since April 2009, all NHS-funded hip and knee replacement patients are invited to report their health status and health related quality of life before and six months after surgery using a paper-based questionnaire. The pre-operative questionnaire is administered by the hospital providing the surgery, either on admission or during the last outpatient appointment preceding admission. The paper questionnaires are then collated and sent to a central agency to be scanned and linked to the inpatient records using a linkage algorithm developed by the Health & Social Care Information Centre. The post-operative questionnaire is posted to patients by the central agency six months post surgery. Participation in the PROM survey is compulsory for providers but optional for patients. Complete pre- and post-operative questionnaires can be linked to HES records for about 60% of patients.[10]

Each PROM questionnaire includes a condition-specific and a generic instrument. The Oxford Hip or Knee Scores (OHS/OKS) are condition-specific instruments with 12 questions on joint-related functioning and pain (Dawson et al. 1996; Dawson et al. 1998). Each item is scored on a five-point scale, ranging from four (no problems) to zero (severe problems). The overall score ranges from zero (worst) to 48 (best) and is calculated by simple summation across items. For our main analysis we split this score into twelve equally sized groups of four points each (coded as 0-4, 5-8, 9-12, 13-16, 17-20, 21-24, 25-28, 29-32, 33-36, 37-40, 41-44, 45-48). In further analysis we also use two sub-scores based on items relating to mobility and pain (see Appendix for how items are matched to sub-scores); again coded as groups of four points. The PROM questionnaire also includes the EQ-5D, a generic measure of HRQoL that can be applied to different health conditions (Brooks 1996). We focus on the Oxford scores throughout this paper because i) we expect them to be more sensitive to differences in severity as considered by the consultant than the EQ-5D, ii) we do not wish to make comparisons across conditions, and iii) their focus on pain and mobility mirrors the criteria used for prioritisation of hip replacement patients in the Canadian

[7] See Department of Health (2008) for procedure codes. Patients having revision surgery are likely to differ from those receiving primary surgery and are therefore excluded from our study.
[8] Around 11% of the English population have supplementary private insurance and 16% of hip replacement surgeries are funded privately (Commission on the Future of Health and Social Care in England 2014).
[9] LSOAs have an average population of 1,500 inhabitants and are intended to be homogeneous with respect to housing tenure and accommodation type.
[10] We provide characteristics of responders and non-responders in Table 2 in the results section.

context (see Introduction). The correlation between the condition-specific and generic measures is high, with ρ=0.74 for OHS and the EQ-5D utility score and ρ=0.70 for OKS and EQ-5D utility score.

No ethical approval was required for secondary data analysis.

4. Results

4.1. Descriptive statistics

Over the three-year period considered there have been about 104,000 publicly funded hip replacement procedures and about 111,000 knee replacement procedures for which pre-operative PROM data are available. Descriptive statistics are provided in Table 1.

Table 1: Descriptive Statistics

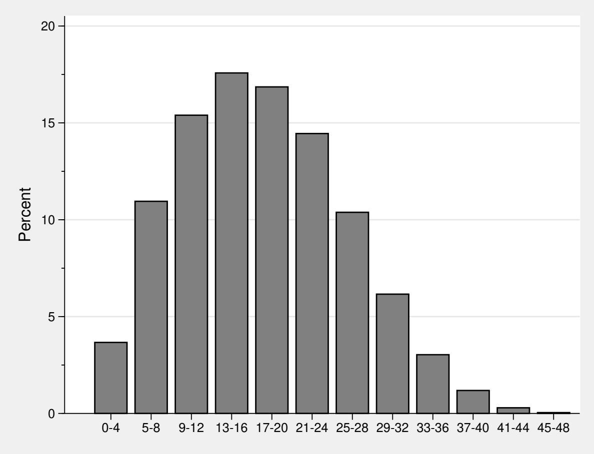
	Hip replacement (N=103,518)		Knee replacement (N=110,844)	
Description	Mean	SD	Mean	SD
Waiting time (in days)	83.1	49.6	87.1	52.6
Pre-operative Oxford Score	17.6	8.3	18.4	7.8
Age	67.6	11.2	69.2	9.3
Gender (0=female, 1=male)	0.41	0.5	0.43	0.5
Percentage of individuals in households receiving low-income benefits	0.12	0.1	0.13	0.1
Number of emergency admissions in last 365 days	0.11	0.5	0.10	0.5
Number of Elixhauser comorbidities: 0	0.35	0.5	0.28	0.4
Number of Elixhauser comorbidities: 1	0.29	0.5	0.28	0.4
Number of Elixhauser comorbidities: 2	0.18	0.4	0.21	0.4
Number of Elixhauser comorbidities: 3-4	0.12	0.3	0.15	0.4
Number of Elixhauser comorbidities: 5+	0.06	0.2	0.08	0.3
Financial year 2009/10	0.28	0.4	0.29	0.5
Financial year 2010/11	0.35	0.5	0.34	0.5
Financial year 2011/12	0.37	0.5	0.37	0.5

For hip replacement patients, the average observed waiting time (our dependent variable) is 83 days. Patients are on average 68 years old and nearly 60% of patients are female. The average pre-operative OHS is 17.6 points (on a range from 0 to 48). Patients had an average of 0.1 emergency admissions in the year proceeding hospital admission for an elective hip replacement. Only 65% of patients had at least one comorbid condition with only 6% reporting more than five. The average waiting time for knee replacement surgery is slightly higher than for hip replacement surgery (87 vs 83 days). The other patient characteristics are comparable to those of hip replacement patients and are not repeated here (but see Table 1 for details). The distributions of pre-operative OHS and OKS are shown in Figures 1a and 1b.

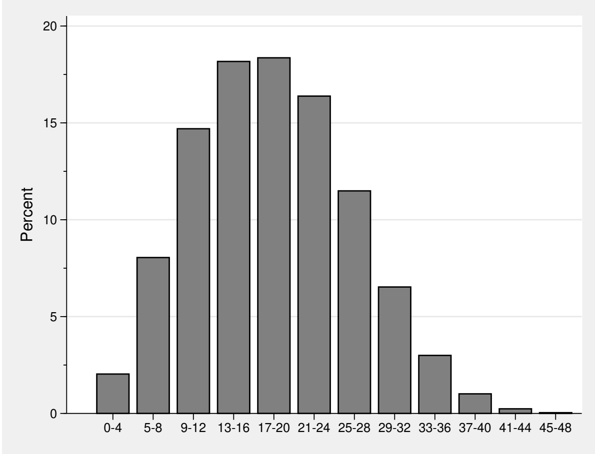
Not all patients respond to the PROM survey. Table 2 compares the characteristics of responders and non-responders as derived from HES. The gap in average waiting time between responders and non-responders is one day for hip replacement patients and two days for knee replacement patients. Given that the average waiting time is above 80 days, these differences are negligible. Similarly, while non-responders tend to be slightly older, have a higher comorbidity burden and have been admitted more often to hospital as an emergency in the preceding year, these differences are small in size and unlikely to induce bias.

4.2. Estimates of the severity gradient in waiting time

Table 3 and Table 4 provide our key results for patients in need of hip and knee replacement, respectively. All specifications include hospital and year fixed effects (not reported). Differences in waiting times across patients with different severity can be interpreted as within the hospital, rather than across hospitals. The



(a) Hip replacement



(b) Knee replacement

Figure 1: Distribution of pre-operative Oxford Hip/Knee Scores

Table 2: Comparison of responders and non-responders

	Hip replacement				Knee replacement			
	Responders (N=103,518)		Non-responders (N=72,339)		Responders (N=110,844)		Non-responders (N=83,275)	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Waiting time	83.11	49.6	84.19	54.7	87.14	52.6	89.13	57.8
Age	67.59	11.2	68.67	11.7	69.16	9.3	70.12	9.5
Gender (0=female, 1=male)	0.41	0.5	0.39	0.5	0.43	0.5	0.42	0.5
Percentage of individuals in households receiving low-income benefits	0.12	0.1	0.13	0.1	0.13	0.1	0.14	0.1
Number of Elixhauser comorbidities	1.55	3.0	1.76	3.6	1.79	3.2	1.95	4.1
Number of emergency admissions in last 365 days	0.11	0.5	0.15	0.5	0.10	0.5	0.13	0.5

Table 3: Regression results - hip replacement

	Pre-operative health only		Pre-operative health and age/sex		Full adjustment	
Covariate	Est	SE	Est	SE	Est	SE
Pre-operative score: 5-8	0.050	0.011***	0.047	0.011***	0.047	0.011***
Pre-operative score: 9-12	0.068	0.010***	0.065	0.010***	0.065	0.010***
Pre-operative score: 13-16	0.084	0.011***	0.080	0.011***	0.081	0.011***
Pre-operative score: 17-20	0.095	0.012***	0.092	0.011***	0.095	0.011***
Pre-operative score: 21-24	0.112	0.012***	0.109	0.012***	0.111	0.012***
Pre-operative score: 25-28	0.139	0.012***	0.136	0.012***	0.139	0.012***
Pre-operative score: 29-32	0.161	0.013***	0.161	0.013***	0.165	0.013***
Pre-operative score: 33-36	0.170	0.015***	0.168	0.014***	0.172	0.015***
Pre-operative score: 37-40	0.192	0.017***	0.191	0.017***	0.197	0.017***
Pre-operative score: 41-44	0.213	0.033***	0.212	0.033***	0.217	0.033***
Pre-operative score: 45-48	0.273	0.084**	0.276	0.084**	0.285	0.084***
Age: 45-54			-0.032	0.016*	-0.034	0.016*
Age: 55-64			-0.078	0.016***	-0.080	0.016***
Age: 65-74			-0.110	0.016***	-0.114	0.016***
Age: 75-84			-0.133	0.017***	-0.138	0.017***
Age: 85+			-0.137	0.019***	-0.141	0.019***
Male			-0.045	0.019*	-0.047	0.019*
Past emergency utilisation					-0.017	0.006**
SES (2nd quintile)					0.000	0.005
SES (3rd quintile)					0.007	0.006
SES (4th quintile)					0.015	0.006*
SES (5th quintile - most deprived)					0.015	0.006*
N	103,518		103,518		103,518	

*** $p<0.001$; ** $p<0.01$; * $p<0.05$

Notes: Estimates are semi-elasticities and relative to patient aged <44, female, and pre-operative Oxford score of 0-4. All models include hospital and year fixed effects. Standard errors are robust to over-dispersion. Age-sex interactions not reported (mostly statistically insignificant).

model in Column (1) only includes the Oxford Score. The model in Column (2) extends this to account for patient's age and gender, and the model in Column (3) contains a full set of control variables. The severity gradient is formed by the coefficients on each of the Oxford Score groups. It is robust to the inclusion of additional control variables. We therefore focus our discussion on the results in Column (3).

Table 3 suggests that hip replacement patients with lower severity, as measured by the Oxford Hip Score, wait longer. The quantitative effect appears to be modest. Compared to patients in the top severity group (0-4 points) patients of average severity (17-20 points) wait 9% (or about 8 days) longer. Patients with least severity (with a score above 37 points) wait at least 20% (16 days) longer. The gap between most and least severe patients is on average 25 days. Figure 2 plots the average partial effect of Oxford Hip Scores on waiting times in terms of days waited. The severity gradient increases linearly across the entire range, suggesting a simple prioritisation mechanism.

Several other patient characteristics are also predictive of waiting time. For a given level of severity, older patients tend to wait less. Patients over 65 years old wait about 11-14% less than patients below 45 years (and about 8-10% less than patients aged 45-54). Male patients wait 5% less. The age gradient is not statistically significantly different for men and women and it is therefore not reported. Patients who had been admitted to hospital as an emergency within the last year wait less than those who had not. Only a few Elixhauser comorbidities have a statistically significant effect on observed waiting time (not reported). Finally, there remains a statistically significant but very small socio-economic gradient in waiting time even after conditioning on pre-operative severity and other patient characteristics. Patients in the most income-deprived fifth of neighbourhoods wait approximately 1.5% longer than those in the least

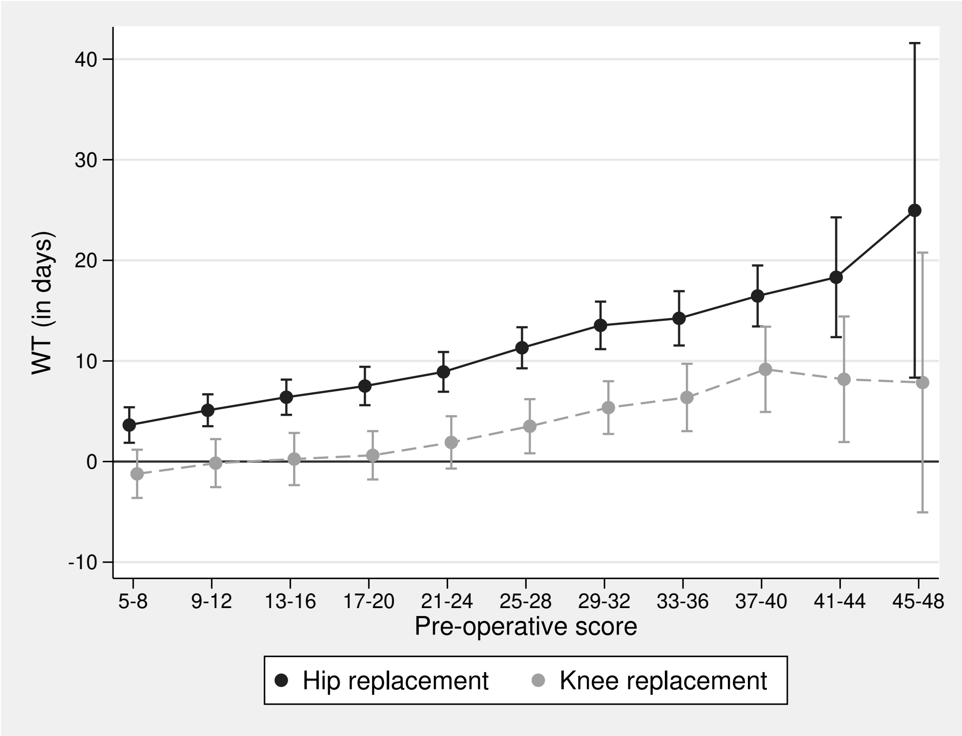


Figure 2: Partial effect of severity on waiting time (in days)

deprived fifth of neighbourhoods. If some of these patient characteristics pick up unobserved severity differences, our severity gradient should be considered a lower bound estimate of the true gradient.

Table 4 reports results for knee replacement. The results are analogous to those for hip replacement, though the gradient associated with OKS is notably flatter at about half the slope. Patients below 25 OKS points do not differ significantly in waiting times. Patients with scores in the range of 25 to 44 wait about 4-10% longer compared to patients with a score below 25. The overall effect of severity on waiting time is small and different severity groups differ by no more than 10 days (see Figure 2). Again, prioritisation appears to be almost linear, ignoring the top two groups which include very few observations and are estimated with large confidence intervals. Patients older than 75 years wait about 7% less than younger patients. There is no statistically significant difference across genders or socio-economic groups.

4.3. Different dimensions of severity: pain or mobility

We now explore whether prioritisation differs by pain and mobility. The results in Table 5 show that, for hip replacement surgery, both pain and mobility matter but the effect of pain on prioritisation is larger. For example, a patient who scores 13-16 points on the pain score (higher scores indicate lower pain) is expected to wait 8% (7 days) longer than a patient with extreme pain, for a given level of mobility (see also Figure 3). Conversely, a patient who scores 13-16 points on the mobility score is only expected to wait 4% (3 days) longer than the most immobile patient.

The results are different for knee replacement. Here, it is mainly different degrees of pain that generate differences in waiting times and account for most of the gradient. Variations in severity due to mobility have generally no effect on prioritisation (Figure 3).

Table 4: Regression results - knee replacement

	Pre-operative health only		Pre-operative health and age/sex		Full adjustment	
Covariate	Est	SE	Est	SE	Est	SE
Pre-operative score: 5-8	-0.015	0.014	-0.015	0.014	-0.014	0.014
Pre-operative score: 9-12	-0.004	0.014	-0.002	0.014	-0.002	0.014
Pre-operative score: 13-16	-0.003	0.015	0.001	0.015	0.003	0.015
Pre-operative score: 17-20	-0.001	0.014	0.005	0.014	0.007	0.014
Pre-operative score: 21-24	0.011	0.015	0.019	0.015	0.022	0.015
Pre-operative score: 25-28	0.026	0.015	0.037	0.015*	0.040	0.016**
Pre-operative score: 29-32	0.045	0.015**	0.057	0.015***	0.061	0.015***
Pre-operative score: 33-36	0.053	0.018**	0.068	0.019***	0.072	0.019***
Pre-operative score: 37-40	0.081	0.023***	0.098	0.023***	0.101	0.023***
Pre-operative score: 41-44	0.072	0.033*	0.088	0.034**	0.091	0.034**
Pre-operative score: 45-48	0.073	0.069	0.089	0.070	0.088	0.070
Age: 45-54			0.003	0.028	-0.001	0.028
Age: 55-64			-0.004	0.028	-0.009	0.028
Age: 65-74			-0.048	0.028	-0.054	0.028
Age: 75-84			-0.068	0.029*	-0.075	0.029**
Age: 85+			-0.065	0.029*	-0.070	0.029*
Male			-0.005	0.041	-0.004	0.041
Past emergency utilisation					-0.013	0.004***
SES (2nd quintile)					-0.001	0.005
SES (3rd quintile)					-0.006	0.005
SES (4th quintile)					-0.007	0.006
SES (5th quintile - most deprived)					0.000	0.006
N	110,844		110,844		110,844	

*** $p<0.001$; ** $p<0.01$; * $p<0.05$

Notes: Estimates are semi-elasticities and relative to patient aged <44, female, and pre-operative Oxford score of 0-4. All models include hospital and year fixed effects. Standard errors are robust to over-dispersion. Age-sex interactions not reported (mostly statistically insignificant).

Table 5: Effect of pain and mobility on waiting time

	Pain		Functioning	
Covariate	Est	SE	Est	SE
Hip replacement (N=103,518)				
Pre-operative score: 5-8	0.027	0.005***	0.019	0.006**
Pre-operative score: 9-12	0.050	0.006***	0.031	0.007***
Pre-operative score: 13-16	0.082	0.008***	0.039	0.008***
Pre-operative score: 17-20	0.097	0.012***	0.059	0.011***
Pre-operative score: 21-24	0.083	0.025***	0.078	0.018***
Knee replacement (N=110,844)				
Pre-operative score: 5-8	0.015	0.004***	-0.003	0.008
Pre-operative score: 9-12	0.037	0.007***	-0.011	0.009
Pre-operative score: 13-16	0.059	0.011***	0.005	0.010
Pre-operative score: 17-20	0.119	0.029***	0.014	0.011
Pre-operative score: 21-24			0.029	0.013*
Pre-operative score: 25-28			-0.003	0.029

*** $p<0.001$; ** $p<0.01$; * $p<0.05$

Notes: Estimates are semi-elasticities and relative to pre-operative score of 0-4. All models include hospital and year fixed effects + a full set of control variables (see text). Standard errors are robust to over-dispersion.

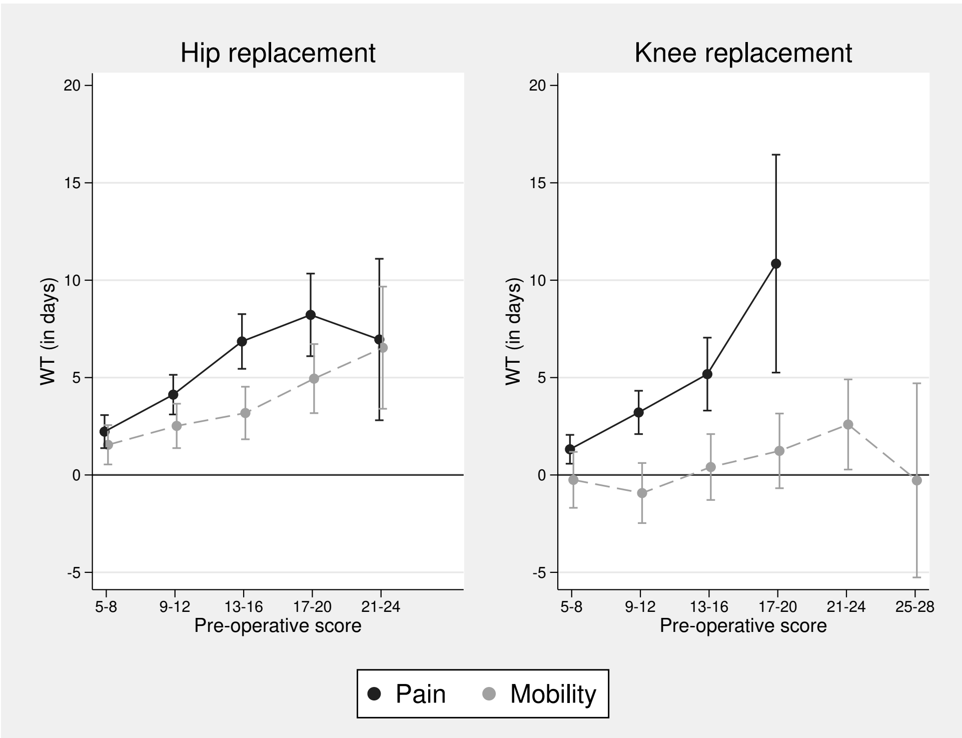


Figure 3: Differential effect of pain and mobility on waiting time

4.4. Hospitals with long and short waiting times

We also test whether prioritisation is more pronounced when waiting times are longer. To do so we split the sample into two groups, hospitals with an average wait above the median and hospitals below the median.[11]

Table 6 provides the results. We focus on our preferred specification, which includes all controls. It shows that the prioritisation gradient is comparable among the two groups when differences in waits are measured in percentage points (with possibly a stronger gradient in long-wait hospitals for low OHS scores, i.e. high severity, and a weaker gradient for high scores). However, the underlying levels are different.

Figure 4 plots the gradients in days. Excluding the two top groups (i.e. low-severity patients with infrequent observations) less severe patients can wait up to 19 days longer than severe patients in high-wait hospitals. Conversely, less severe patients in low-wait hospitals wait only up to 10 days longer. Therefore waiting time prioritisation is more pronounced in absolute terms in hospitals with longer average waiting times.

A similar picture arises when looking at knee replacement patients (Figure 5). Prioritisation is more pronounced in long-wait hospitals. In short-wait hospitals there are very little discernible differences between different severity groups. In high-wait hospitals, prioritisation tends to be linear and patients with lower severity wait up to about 10 days longer.

Table 6: Difference in waiting time gradient between short and long wait hospitals

	Hip replacement				Knee replacement			
	Low waiting time hospitals		High waiting time hospitals		Low waiting time hospitals		High waiting time hospitals	
Covariate	Est	SE	Est	SE	Est	SE	Est	SE
Pre-operative score: 5-8	0.042	0.025	0.048	0.012***	-0.043	0.030	-0.008	0.016
Pre-operative score: 9-12	0.056	0.021**	0.068	0.011***	-0.033	0.033	0.005	0.015
Pre-operative score: 13-16	0.073	0.021***	0.083	0.012***	-0.051	0.032	0.016	0.017
Pre-operative score: 17-20	0.096	0.023***	0.094	0.013***	-0.031	0.030	0.016	0.016
Pre-operative score: 21-24	0.127	0.024***	0.107	0.013***	-0.013	0.030	0.030	0.017
Pre-operative score: 25-28	0.153	0.026***	0.136	0.013***	0.030	0.034	0.041	0.017*
Pre-operative score: 29-32	0.199	0.031***	0.157	0.014***	0.033	0.035	0.066	0.016***
Pre-operative score: 33-36	0.193	0.038***	0.168	0.016***	0.057	0.040	0.073	0.021***
Pre-operative score: 37-40	0.161	0.047***	0.203	0.018***	0.101	0.044*	0.099	0.027***
Pre-operative score: 41-44	0.314	0.126*	0.202	0.031***	0.069	0.091	0.093	0.035**
Pre-operative score: 45-48	0.808	0.448	0.226	0.067***	-0.251	0.214	0.129	0.074
N	30,373		73,145		35,151		75,693	

[11] The median hospital level waiting time is 78 days for hip replacement surgery and 80 days for knee replacement surgery.

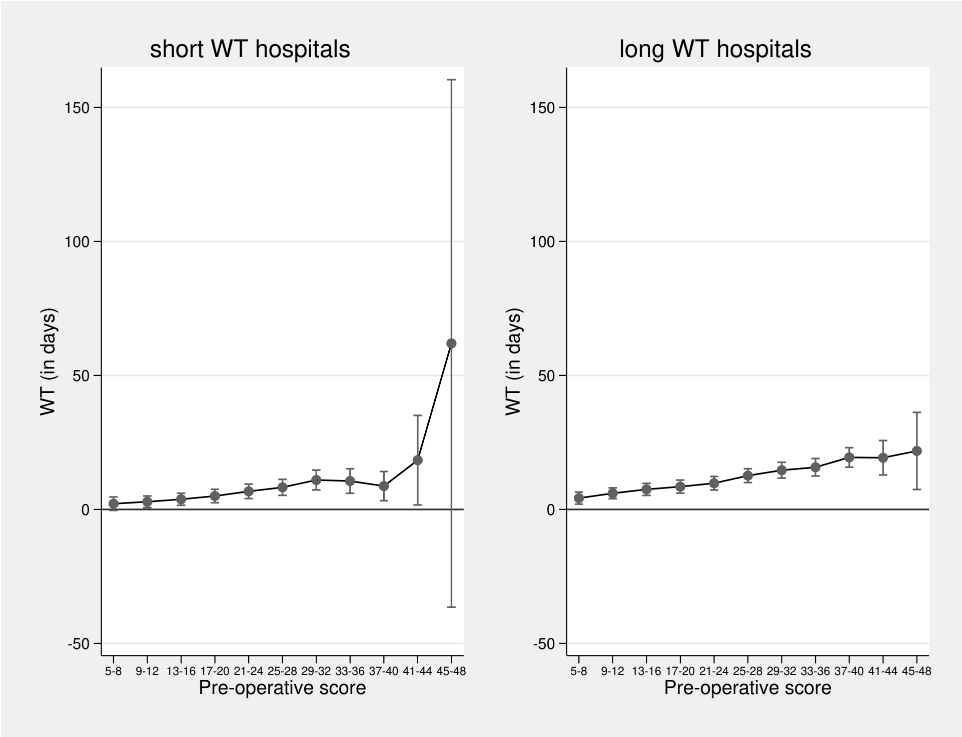


Figure 4: Partial effect of severity on waiting time in short and long wait hospitals - hip replacement

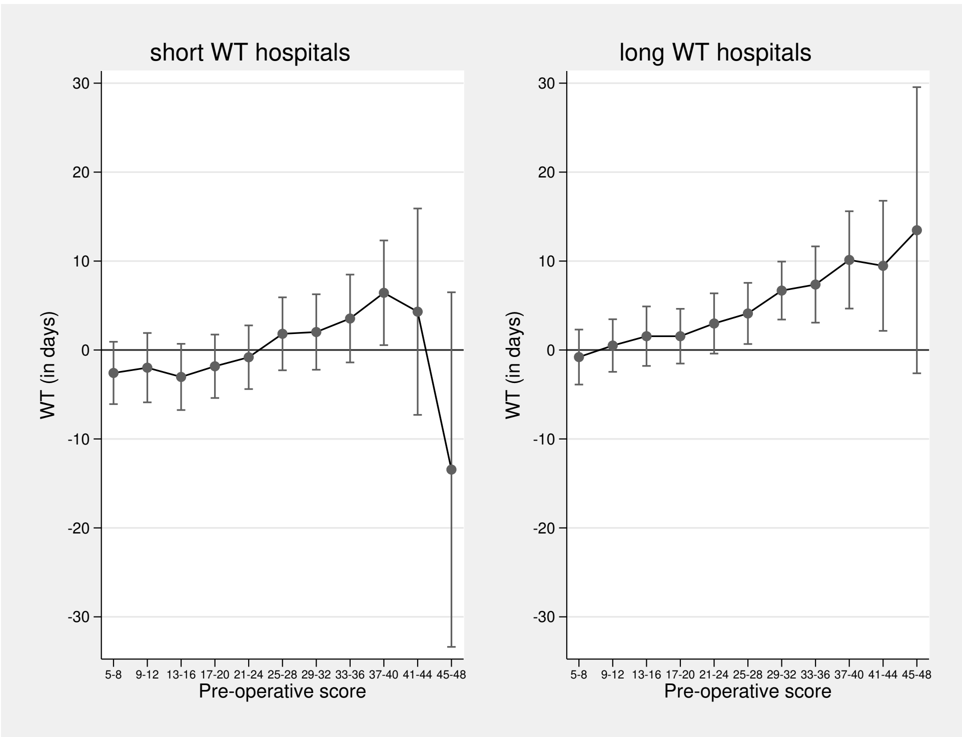


Figure 5: Partial effect of severity on waiting time in short and long wait hospitals - knee replacement

5. Discussion

Many OECD countries are either faced with cuts to their healthcare budgets or small nominal growth, in part driven by efforts to reduce budget deficits in the aftermath of the global economic crisis. This is likely to affect the supply of care, which can no longer keep up with the increasing demand for care due to an aging population. As a result, many healthcare systems are seeing and will see increases in waiting time for elective surgery.

Waiting time prioritisation policies are one way to optimise the management of the waiting list and thus maximise patients' welfare. A number of countries have adopted formal or informal processes by which patients are prioritised according to their observed severity, i.e. the need for timely care. Yet, there is little empirical evidence on the degree to which prioritisation policies are implemented or how steep the severity gradient in waiting time is in practice.

Using data on waiting time and self-reported pre-operative health status for over 200,000 patients undergoing elective hip and knee replacement in the English NHS, we demonstrate a statistically significant, albeit modest severity gradient in waiting time. For every four points on the Oxford Hip Score (ranging from 0 (worst) to 48 (best)) we see an increase in waiting time of approximately two days. This applies across the entire range of severity. Conversely, waiting times increase by approximately 1-2 days for every four points increase on the Oxford Knee Score for knee replacement patients with pre-operative scores above 24. There is no discernible gradient among more severe patients. Prioritisation for hip and knee replacement surgery is driven primarily by the amount of pain patients receive from their joint, with less importance given to mobility.

The overall severity gradient in waiting time seems modest in absolute terms. This may be because the English NHS has not adopted a formal model of prioritisation for hip and knee replacement surgery, i.e. it implements a 'first-come-first-serve' model, or because average waiting times are now at a historic low so that prioritisation is considered less important.

Prioritisation is enhanced when waits are longer. This is supported by our finding that hospitals with above median waiting times tend to show stronger prioritisation in absolute terms than hospitals with below median waiting times. As waiting times begin to gradually increase again in the English NHS, we would expect to see more prioritisation taking place.

Several other patient characteristics are associated with differences in waiting time. For example we observe an age gradient. This may be considered as pro-elderly evidence of inequality in access to care. However, it may also be a selection issue in terms of which patients are able and willing to choose privately funded treatment — for example, if elderly patients are wealthier than younger patients with severe osteoarthritis. We also cannot rule out that our measure of severity is imperfect and that these variables capture some unobserved component of severity. In this case, our estimate of the severity gradient is a lower bound.

More generally, our study has a number of possible limitations. First, our pre-operative health status measures are taken at the time of admission, not when the specialist makes the decision to add the patient to the waiting list. This may potentially overestimate the severity of some patients if the patients' health status deteriorates during long waits. However, a recent systematic review by Hoogeboom et al. (2009) finds that the degree of deterioration in health during waiting times < 6 months is likely to be minimal and we therefore do not expect this to be a serious concern for our study. Second, not all patients respond to the PROM questionnaire, which may give rise to possible selection bias. However, such bias is likely to be small as we find only very small difference in the average waiting time for responders and non-responders.

6. Conclusions

Hip and knee replacement patients in the English NHS are being prioritised according to severity, even though no formal national prioritisation policy is currently in place. However, the degree of prioritisation is modest. The size of the gradient implies that those responsible for the waiting list either believe that the marginal disutility of waiting for surgery does not vary substantially across patients, or that they find it difficult (perhaps even unethical) to prioritise patients according to their pain and limitations to mobility. There is a clear rationale for prioritising patients on the list: the overall pain and limitations to mobility can be reduced by letting more severe patients wait less. Following initiatives in other OECD countries, the English NHS and other healthcare systems faced with increasing excess demand for elective surgery should put more emphasis in encouraging further prioritisation on the list and consider formal policies to enforce this.

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Appendix

Table A1: Mapping of questions to sub scores - Oxford Hip Score

#	Pain
1	How would you describe the pain you usually had from your hip?
2	Have you had any sudden, severe pain - 'shooting', 'stabbing' or 'spasms' - from the affected hip?
3	Have you been troubled by pain from your hip in bed at night?
4	For how long have you been able to walk before pain from your hip becomes severe? (With or without a stick)
5	After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your hip?
6	How much has pain from your hip interfered with your usual work (including housework)?
	Mobility
7	Have you had any trouble with washing and drying yourself (all over) because of your hip?
8	Have you had any trouble getting in and out of a car or using public transport because of your hip?
9	Have you been able to put on a pair of socks, stockings or tights?
10	Could you do the household shopping on your own?
11	Have you been able to climb a flight of stairs?
12	Have you been limping when walking, because of your hip?

Table A2: Mapping of questions to sub scores - Oxford Knee Score

#	Pain
1	How would you describe the pain you usually have from your knee?
2	Have you been troubled by pain from your knee in bed at night?
3	For how long have you been able to walk before pain from your knee becomes severe? (With or without a stick)
4	After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your knee?
5	How much has pain from your knee interfered with your usual work (including housework)?
	Mobility
6	Have you had any trouble with washing and drying yourself (all over) because of your knee?
7	Have you had any trouble getting in and out of a car or using public transport because of your knee?
8	Have you been limping when walking, because of your knee?
9	Could you kneel down and get up again afterwards?
10	Have you felt that your knee might suddenly 'give way' or let you down?
11	Could you do the household shopping on your own?
12	Could you walk down one flight of stairs?