

# Patient hospital choice for hip replacement: empirical evidence from the Netherlands

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Received: 14 January 2013 / Accepted: 23 September 2013 / Published online: 25 October 2013  
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**Abstract** In the Dutch health care system, hospitals are expected to compete. A necessary condition for competition among hospitals is that patients do not automatically choose the nearest hospital, but are—at least to some extent—sensitive to differences in hospital quality. In this study, an analysis is performed on the underlying features of patient hospital choice in a setting where prices do not matter for patients as a result of health insurance coverage. Using claims data from all Dutch hospitals over the years 2008–2010, a conditional logit model examines the relationship between patient characteristics (age, gender and reoperations) and hospital attributes (hospital quality information, waiting times on treatments and travel time for patients to the hospitals) in the market for general non-emergency hip replacement treatments. The results show that travel time is the most important determinant in patient hospital choice. From our analysis, however, it follows that publicly available hospital quality ratings and waiting times also have a significant impact on patient hospital choice. The panel data used for this study (2008–2010) is rather short,

which may explain why no coherent and persistent changes in patient hospital choice behaviour over time are found.

**Keywords** Patient choice · Quality information · Hospital demand · Time variation

**JEL Classification** I11 · D12 · C25

## Introduction

In the Netherlands, patients' choice behaviour has become increasingly important for hospitals because of competition-based health care reforms. To promote competition, however, patients should be sensitive to quality differences among healthcare providers. In the empirical literature, especially in the United States, patients' sensitivity for quality differences between health care providers is researched. These studies find that patients are more likely to choose providers with higher quality, all else being equal. Various forms of quality measurement and public reporting are used to provide information to patients about the quality of the available hospitals. In both the US and the UK, for example, health care 'report cards' on quality are used as a health policy tool for comparing the quality of health care providers and to support and stimulate quality improvements [6]. In the Netherlands, several quality indicators and hospital ratings are also available. Varkevisser et al. [20], however, indicated two important limitations of the quality information currently available for patients. First, outcome indicators (e.g. % of readmissions) are not adjusted for case-mix and may therefore not provide a correct signal of hospital quality. Second, consumer information sometimes conflicts on both top-performing and bottom-performing hospitals, which may complicate patient choice. The latter was also found by Rothberg et al. [10] for

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US hospital quality information. After comparing five local hospital rankings, they found a lack of consistency, mainly due to the different measurement methods used. Inconsistencies in the disclosure of information leave patients with conflicting information for their hospital choice.

Although access, interpretation and consistency of the available quality information may be conflicting, a number of studies have measured the relevance of quality information in patient hospital choice, indicating patients' responsiveness to quality information on hospital care. That is, despite their current shortcomings, hospital quality indicators seem to be relevant for patient hospital choice. In particular, when insurance coverage is comprehensive, patients face a trade-off between hospital quality and travel time. This trade-off might be differentiated by patient characteristics.

Previous studies examining patient hospital choice are most often from the US. Overall, these studies find that patients are more likely to choose providers with high quality levels, all else being equal (e.g. [2–5, 8, 13, 14]). Empirical studies on patient hospital choice in Europe are still scarce, but this body of literature is growing. In a study of three Scandinavian countries, Vrangbaek et al. [21] differentiated between the external institutional factors (e.g. travel time, waiting time and quality of care) and the intrinsic patient factors (patient characteristics), concluding that most patients prefer to visit the nearest hospital. In a Dutch study among non-emergency orthopaedic care and neurosurgery patients, Varkevisser and Van der Geest [18] indicated that patients generally dislike travelling, and bypass the nearest hospital only for particular reasons like a higher quality and/or shorter waiting times. Patient characteristics like age and social status are found to have a significant impact on this trade-off. In another study on Dutch neurosurgery patients, Varkevisser et al. [19] estimated patients' time-elasticity to assess hospital substitutability in case of full insurance. They concluded that in general, patients are averse to travel and less likely to choose a university medical centre, and are more likely to choose a hospital with waiting times below average. In a study with English cataract patients, Sivey [12] found a significant stronger effect of travel time on the probability of hospital choice in the trade-off for patients between travel time and waiting time. Varkevisser et al. [20] examined the relationship between hospital quality, measured by publicly available quality ratings, and patient hospital choice for angioplasty in the Netherlands. In this study, they found that Dutch patients have a high propensity to choose hospitals with a good reputation, both overall and for cardiology, and a low readmission rate after treatment for heart failure. Their simulation results, however, showed that patients' willingness to travel is modest; i.e. most patients moving to a hospital with a hypothesized lower readmission rate came from the hospital(s) closest to it. After examining patient hospital choice for elective hip replacements, Beckert et al. [1] showed that in

addition to distance, patients in England also take quality into account when making their choice of hospital.

To date, outside the context of US hospital markets, only few econometric studies have been conducted to examine the effect of hospital quality, as measured by publicly available quality ratings, on patient hospital choice. Our paper contributes to this small but emerging empirical literature. Here, patient hospital choice is studied in the Dutch market for non-emergency hip replacement by examining the relationship between travel time, publicly available hospital quality information, and hospital waiting time and patient hospital choice using claims data from all Dutch hospitals over the years 2008–2010. In the Netherlands, hip replacement treatment is provided by all hospitals, and is therefore a commonly available treatment. Compared to the previous studies of Varkevisser et al. [19, 20], this paper uses a nationwide data set covering multiple recent years, rather than older claims data for a single year from one large Dutch health insurer. This offers us a unique opportunity to get a deeper understanding of patient hospital choice and its potential consequences for hospital competition. The more patients take quality into account when making their choice of hospital, the more incentives hospitals have to improve quality, which is crucial for the success of a market-based health care system.

The remainder of the paper is organised as follows. The “[Market for hip replacement in the Netherlands](#)” section briefly introduces the market for hip replacement in the Netherlands. The “[Data](#)” section describes the data used for estimating the conditional logit choice model. The “[Model and results](#)” section presents the results of the different model specifications. The “[Simulation results](#)” section uses the estimates of the preferred model for simulating patients' responsiveness to hypothetical changes in hospital quality ratings, and the “[Conclusion](#)” section concludes.

## Market for hip replacement in the Netherlands

Each patient admitted to a Dutch hospital or visiting a hospital's outpatient clinic is categorised into a diagnosis and treatment combination (DTC), which includes all inpatient and outpatient hospital activities and services associated with the patient's care from the initial consultation to the final check-up. For most routine services, hospitals and health insurers are allowed to negotiate prices per DTC,<sup>1</sup> including hip replacements. This competition between hospitals and health insurers is based on price and quality of care, in which hospitals are encouraged to lower their prices and improve their quality in order to be attractive to patients by serving their needs and to

<sup>1</sup> At this moment, insurers are allowed to negotiate for 70 % of the total hospital services in the Netherlands.

health insurers, as the latter are allowed to selectively contract hospitals in order to serve best the needs of their enrollees at the lowest price [11, 17]. During our study period 2008–2010, however, Dutch health insurers did not selectively contract hospitals for hip replacement.<sup>2</sup> As a result, patients do not face a restricted choice set and all costs are fully reimbursed by their insurer, regardless of the hospital in which they are treated. Therefore, patients base their choices on other features like quality of care, proximity and waiting times. Hence, these are important competition parameters for hospitals.

In the Netherlands, hip replacement treatments on average induce almost 20,000 hospitalizations a year. Hip replacements mainly occur at older ages, and about 70 % of the patients are female. These treatments are performed in all Dutch academic, tertiary teaching and general hospitals, and may therefore be considered as a common treatment in the Netherlands. Considering the availability of this treatment, patients travel on average about 19 min to a hospital for a non-emergency hip replacement treatment.

Public reporting of comparative information about the quality of Dutch hospitals began in 2005. Since then, several indicators of hospital quality have been made publicly accessible on the government-sponsored patient-oriented health care portal [www.KiesBeter.nl](http://www.KiesBeter.nl) (literally: “make better choices”).<sup>3</sup> Patients can use the website to compare hospitals on different sets of outcome measures developed by the Dutch Health Care Inspectorate (IGZ) in cooperation with stakeholders (hospitals and physicians). The sets, published on the Internet with a 1-year time lag, include indicators of overall hospital quality and the quality of treatment for specific diseases. Other sources of hospital quality information are the annual quality ratings of the daily newspaper AD and the weekly magazine Elsevier.

## Data

For this study, we obtained individual patient-level data from the Dutch Healthcare Authority (NZa), containing patient and hospital information on hip replacement treatments in all Dutch hospitals over the years 2008–2010.<sup>4</sup> Our study sample includes detailed information on more than 55,000 hospital visits for non-emergency hip replacements in the Netherlands.

<sup>2</sup> In 2011/2012 health insurers started with selective contracting for different types of complex cancer surgery using minimum volume standards.

<sup>3</sup> Recent numbers on the use of the website show an increase of 4.3 million users in 2009 to 4.9 million users in 2010. The awareness of this website in the Netherlands is currently about 18 % [9].

<sup>4</sup> The NZa collects this data from DBC Information System (DIS), which is based on the registration by each institution for medical care of the performed combination of diagnose and treatment. The patient registration of the NZa only includes completed DTCs for which hospitals turned in a bill to a health insurer.

On an individual basis, we observe each patient’s age, gender, zip code of residence, hospital where he/she was treated, and the starting date of his/her treatment. From this information, three different dummy variables are constructed to capture patient heterogeneity. These variables indicate whether the patient is male or female, whether the patient is younger than 60 years of age or 60 years or older, and whether the patient was admitted to the hospital for hip replacement before. The hospital-level data contains hospital characteristics and data on publicly available quality information for patients, and waiting times for hip replacement considering all 92 hospitals included in this research. The hospital characteristics include each hospital’s size (number of beds), type (university medical centre, tertiary teaching or general hospital), zip code and number of orthopaedists. The hospital quality information consists of indicators from the Healthcare Inspectorate (IGZ), the rating from AD, and the rating from Elsevier. This information is publicly available for patients, and consists of both disease-specific (IGZ) and overall (AD, Elsevier) quality ratings. The indicator from IGZ measures the percentage of patients treated within one calendar day after admission. The AD quality indicator consists of 33 criteria focusing on medical and overall quality of the hospital. The scores on the individual criteria are summated to an overall rating. The Elsevier rating is based on a broader list of indicators, measuring the medical quality performance, safety of the patient, available equipment, management and nursing. The available quality information used in the econometric analysis is based on the most recently released data at the moment of choice by the patient in the data set. This is done by linking the moment of the choice by the patient to the publicly available quality information at that time. The patient’s moment of hospital choice is determined by correcting the opening date of the DTC for the hospital’s waiting time. Hospitals’ waiting times for hip replacement are obtained from Mediquest and included in the analysis as an independent variable.<sup>5</sup>

Finally, travel time is calculated as the fastest route to travel by car from patient zip code to hospital zip code. The database with patient-level and hospital-level data, containing the quality information and waiting times per hospital, is designed as an unrestricted choice-set by enumerating the hospital alternatives per patient. These alternatives contain all optional hospitals providing hip replacement treatments in the Netherlands ( $n = 92$ ).

The descriptive statistics of the study sample are presented in Table 1 for the period 2008–2010, as well as by year.<sup>6</sup>

<sup>5</sup> Mediquest is an independent research bureau collecting specialism-specific and disease-specific (including non-emergency hip replacement) waiting times per hospital. On behalf of patients’ choice information, Mediquest monthly delivers an update of actual waiting times to KiesBeter.nl.

<sup>6</sup> Overall, correlations between the explanatory variables are weak, suggesting that multicollinearity is not likely to cause any problems.

**Table 1** Descriptive statistics

	2008–2010 (# patients = 56,256)				2008 (# patients = 17,337)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
<i>Patient characteristics</i>								
Age	69.5	10.3	4	99	69.3	10.3	14	98
Gender (male)	0.3	0.5	0	1	0.3	0.5	0	1
Actual travel time	19.0	17.1	0	602	18.8	15.9	0	462
Reoperation	0.0	0.2	0	1	0.0	0.2	0	1
<i>Hospital attributes</i>								
Academic	0.1	0.3	0	1	0.1	0.3	0	1
Tertiary teaching	0.3	0.5	0	1	0.3	0.5	0	1
General	0.6	0.5	0	1	0.6	0.5	0	1
Size (number of beds)	580.0	300.5	138	1,320	576.0	298.1	138	1,320
Number of orthopaedists	4.3	2.0	0.5	13	4.2	2.0	0.5	13
Waiting time (weeks)	7.6	4.7	1	50	7.9	4.5	1	30
IGZ	85.3	10.3	32.4	100	84.2	7.1	55.9	100
Elsevier	29.0	13.4	1	62	22.0	9.3	1	45
AD	63.7	7.9	38	90.5	60.2	7.6	38	80.5
	2009 (# patients = 21,176)				2010 (# patients = 17,743)			
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.
<i>Patient characteristics</i>								
Age	69.4	10.4	13	99	69.6	10.3	4	98
Gender (male)	0.3	0.5	0	1	0.3	0.5	0	1
Actual travel time	19.2	18.3	0	602	19.1	16.7	0	500
Reoperation	0.0	0.18	0	1	0.0	0.2	0	1
<i>Hospital attributes</i>								
Academic	0.1	0.4	0	1	0.1	0.3	0	1
Tertiary teaching	0.3	0.5	0	1	0.3	0.5	0	1
General	0.6	0.5	0	1	0.6	0.5	0	1
Size (number of beds)	581.3	301.3	138	1,320	582.3	301.9	138	1,320
Number of orthopaedists	4.4	2.0	0.5	13	4.4	2.1	0.5	13
Waiting time (weeks)	7.6	4.4	1	36	7.3	5.2	1	50
IGZ	85.8	10.6	32.4	100	85.7	12.2	32.4	100
Elsevier	24.4	11.3	1	62	41.2	10.4	1	62
AD	63.4	7.2	43.9	82.2	67.6	7.2	53.4	90.5

## Model and results

### Patient choice

A choice model will be estimated on the revealed preferences of patients. It is assumed that patients behave as rational agents. Within this rational nature, patients will maximize utility in their hospital choices. A patient-level utility function is used, to examine patient preferences within the field of a competitive market in which hospitals differ in quality, as measured by publicly available quality ratings. This considers a discrete choice model, as it

usually derives under the assumption of utility maximizing behaviour by the decision maker, in this case the patient [16]. The following equation specifies the utility that patient  $i$  derives from visiting hospital  $j$ :

$$U_{ij} = \delta \times T_{ij} + \sum_{k=1}^n \gamma_k \times H_{kj} + \sum_{l=1}^m \chi_l \times P_{li} \times T_{ij} + \sum_{k=1}^n \sum_{l=1}^m \sigma_{kl} \times P_{li} \times H_{kj} + \varepsilon_{ij} \quad (1)$$

where  $T_{ij}$  reflects the travel time from patient  $i$ 's home to hospital  $j$ ;  $H_{kj}$  provides the vector for all hospital  $j$ 's

attributes, containing type, size, number of orthopaedists, waiting time and the hospital quality indicators of IGZ, AD and Elsevier;  $P_{ii}$  represents a vector for the characteristics of patient  $i$  affecting the choice behaviour (age, gender and reoperation<sup>7</sup>). In this study, prices are irrelevant, since as explained in “[Market for hip replacement in the Netherlands](#)” section, patients are fully insured for these hospital services without facing out-of-pocket payments differentiated among the healthcare providers. Therefore, from the patient’s perspective, hospitals are differentiated by geographic location and quality only. The patient characteristics are included in interaction with both travel time and the hospital characteristics, in order to estimate the variation in the trade-off between travel time and hospital quality based on patient attributes like age, gender and whether the treatment was a reoperation. For all patients, an unrestricted choice set of 92 hospitals is defined ( $N_j$ ), i.e. all hospitals in the Netherlands. In this choice model, patient  $i$ , given his characteristics, will choose hospital  $j$  if this hospital provides the patient a higher utility than the alternative hospitals in the choice set ( $N_j$ ).<sup>8</sup>

#### Conditional logit model

We estimate Eq. 1 as a conditional logit model [7]. That is, the dependent variable is a dummy variable assigned the value 1 when patient  $i$  visited hospital  $j$  and the value 0 otherwise. As the parameters in the conditional logit model are fixed, the possible variation in patients’ choice for a hospital related to patient characteristics is captured in the model by using interaction effects to take into account patient heterogeneity observed in our data (age, gender and reoperation). The conditional logit model exhibits independence from irrelevant alternatives (IIA). From the IIA property, it follows that the relative odds of choosing one hospital alternative over another hospital are the same no matter what other hospital alternatives are available to the patient, or what the attributes of the other hospital alternatives are [16].<sup>9</sup> Since our unrestricted choice set is likely to include hospital

alternatives that are never seriously considered by the patient, e.g. because these hospitals are located very far away, we also estimated the conditional logit model with two different restricted choice sets—that is, by excluding all hospitals that would require more than 60 min of travel time from the patient’s home and by including only the twenty closest hospitals. These robustness checks show that different definitions of each patient’s choice set did not alter the signs and magnitudes of the estimated coefficients.

#### Model specifications

In this research, the alternative-specific variables are the patient’s travel time to hospital  $j$ , its general attributes (type, size, number of orthopaedists), the hospital’s waiting time and hospital specific quality information (IGZ, AD, Elsevier). The conditional logit is applied to model the expected utility of patient  $i$  in terms of the attributes of the alternatives, rather than the characteristics of the individuals. For empirical specification of the model (see Eq. 1), the dependent variable is defined as the hospital choice, indicating value 1 when patient  $i$  visited hospital  $j$  and value 0 otherwise. The choice set of hospital alternatives is defined per patient and, as already mentioned, includes all Dutch hospitals. The size of the hospital is included in the hospital characteristics as a control variable in order to counter the effect that patients may be more likely to visit a larger hospital than a smaller one.

#### Estimation results

Table 2 presents the estimation results for four different models. First a restricted choice model with only travel time included is estimated.<sup>10</sup> From this model 1, it follows that patients, as expected, dislike travel time. The probability that a patient chooses a particular hospital decreases when that hospital is further away, all else being equal. At the aggregate level, the explanatory power of this model—measured by McFadden’s  $R^2$ —is fairly good, indicating that travel time seems to be the most important determinant of patient hospital choice for non-emergency hip replacement. In model 2, several other hospital attributes are added, while model 3 also takes patient heterogeneity into account by adding interaction variables.<sup>11</sup> Concerning the

<sup>7</sup> Reoperation is a term used by surgeons for the duplication of a surgical procedure. This may involve surgery at the same site, at another site for the same condition, or to repair a feature from a previous surgery.

<sup>8</sup> In the Netherlands, as in many other European countries, general practitioners (GPs) function as gatekeepers. Dutch GPs are, however, not responsible for choosing hospitals on the patient’s behalf. Patients choose hospitals themselves, though they are most often advised by their GP. In this paper, we assume GPs to be perfect agents for their patients, since they do not face financial incentives to behave otherwise and neglect patients’ preferences.

<sup>9</sup> To avoid the IIA property, some recent studies have used the mixed logit model for analysing patient hospital choice [8, 20]. Mixed logit

Footnote 9 continued

models, however, require other assumptions, such as the distribution of the random coefficients.

<sup>10</sup> Likelihood ratio tests reveal that models with more explanatory variables are statistically preferred over the model with travel time alone. The results from these tests are available on request.

<sup>11</sup> Unfortunately, our data do not include a rich set of patient characteristics.

**Table 2** Conditional logit model of patient hospital choice for hip replacement

	Model 1		Model 2		Model 3		Model 4	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Travel time	-0.1615	0.0006*	-0.1616	0.0006*	-0.1748	0.0008*	-0.1748	0.0011*
Academic			-1.6175	0.0328*	-2.1169	0.0468*	-1.9899	0.0634*
Tertiary teaching			-0.1932	0.0164*	-0.2441	0.0218*	-0.2756	0.0319*
Size (number of beds)			0.0013	0.0000*	0.0013	0.0000*	0.0013	0.0001*
Orthopaedists (number)			0.0233	0.0033*	0.0231	0.0043*	0.0319	0.0060*
Waiting time			-0.0286	0.0015*	-0.0327	0.0021*	-0.0295	0.0029*
Elsevier			0.0032	0.0007*	0.0026	0.0009*	0.0007	0.0013
AD			0.0165	0.0009*	0.0164	0.0013*	0.0137	0.0017*
IGZ			-0.0035	0.0006*	-0.0044	0.0008*	-0.0047	0.0015*
Man × travel time					0.0049	0.0012*	0.0049	0.0012*
Man × academic					0.1938	0.0706*	0.1971	0.0706*
Man × tertiary teaching					0.0121	0.0352	0.0102	0.0352
Man × size					0.0000	0.0001	0.0000	0.0001
Man × orthopaedists					-0.0013	0.0069	-0.0014	0.0069
Man × waiting time					0.0007	0.0033	0.0007	0.0033
Man × Elsevier					0.0011	0.0015	0.0011	0.0015
Man × AD					-0.0007	0.0020	-0.0007	0.0020
Man × IGZ					0.0003	0.0013	0.0003	0.0013
Age <60 × travel time					0.0491	0.0013*	0.0491	0.0013*
Age <60 × academic					1.1046	0.0776*	1.0997	0.0775*
Age <60 × tertiary teaching					0.2084	0.0414*	0.2066	0.0414*
Age <60 × size					-0.0001	0.0001	-0.0001	0.0001
Age <60 × orthopaedists					0.0106	0.0081	0.0105	0.0081
Age <60 × waiting time					0.0077	0.0037*	0.0076	0.0037*
Age <60 × Elsevier					0.0001	0.0018	0.0003	0.0018
Age <60 × AD					0.0059	0.0024*	0.0058	0.0024*
Age <60 × IGZ					0.0024	0.0016	0.0025	0.0016
Reoperation × travel time					-0.0011	0.0032	-0.0012	0.0033
Reoperation × academic					1.9809	0.1358*	1.9709	0.1359*
Reoperation × tertiary teaching					0.3467	0.0975*	0.3347	0.0976*
Reoperation × size					0.0005	0.0002*	0.0005	0.0002*
Reoperation × orthopaedists					0.0227	0.0188	0.0252	0.0188
Reoperation × waiting time					0.0279	0.0066*	0.0305	0.0067*
Reoperation × Elsevier					0.0083	0.0039*	0.0087	0.0039*
Reoperation × AD					-0.0147	0.0058*	-0.0165	0.0058*
Reoperation × IGZ					0.0012	0.0034	0.0015	0.0034
2009 × travel time							0.0015	0.0013
2009 × academic							-0.0264	0.0759
2009 × tertiary teaching							0.1110	0.0388*
2009 × size							-0.0001	0.0001
2009 × orthopaedists							-0.0193	0.0076*
2009 × waiting time							-0.0044	0.0036
2009 × Elsevier							0.0038	0.0016*
2009 × AD							-0.0041	0.0022
2009 × IGZ							0.0008	0.0017
2010 × travel time							-0.0025	0.0015
2010 × academic							-0.5377	0.0953*
2010 × tertiary teaching							-0.0571	0.0442
2010 × size							0.0001	0.0001



**Table 2** continued

	Model 1		Model 2		Model 3		Model 4	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
2010 × orthopaedists							0.0048	0.0084
2010 × waiting time							−0.0051	0.0041
2010 × Elsevier							0.0013	0.0019
2010 × AD							0.0192	0.0026*
2010 × IGZ							−0.0016	0.0018
Number of observations		5,175,552		5,175,552		5,175,552		5,175,552
McFadden's $R^2$		0.698		0.711		0.716		0.717

\* Significance at the 5 % level

general effects, all estimated coefficients are significant at a 5 % significance level. This indicates that the included independent variables in the model significantly explain patient choices for hospitals.<sup>12</sup> The estimated coefficients on the type of the hospital (academic and tertiary teaching hospital) are both negative, suggesting that patients are less likely to choose an academic hospital or a tertiary teaching hospital compared to a general hospital. Concerning patients' preferences for general hospitals, we can think of two possible explanations. First, GPs might advise patients to not visit an academic hospital because for non-complex care, like hip replacements, academic hospitals are not systematically classified among the best Dutch hospitals. Second, patients may expect to get more personal attention in a general hospital than in hospitals that are also aimed at clinical research as well as medical education, and where it is more likely for them to be (initially) treated by a medical resident rather than a fully qualified physician. The coefficient of the quality indicator IGZ is negative, which suggests that the higher the percentage of patients treated within one calendar day after admission, the less likely patients are to choose the hospital. Since according to the IGZ, a higher percentage reflects better quality, this result is counterintuitive and unlikely. We cannot think of any potential explanation other than that this general quality indicator is either misinterpreted by patients or inversely correlated with an unobserved hospital attribute that has a positive effect on patient choice. The estimated coefficient of the Elsevier hospital rating is positive, indicating that

patients more likely choose higher quality hospitals, as measured by publicly available quality ratings. A similar effect is found for the AD hospital quality scores. The result on waiting time suggests that patients' preferences for a certain hospital decreases by a longer waiting time, as indicated with a negative sign.

Overall, the estimation results suggest that hip replacement patients prefer general hospitals nearby with short waiting times and with high quality ratings. Concerning patient heterogeneity, some of the estimated coefficients for the interaction variables are indeed significant. It is found that men are willing to travel farther than women and are less reluctant to go to an academic hospital. Older people prefer hospitals closer by and general hospitals over academic and top clinical ones. Furthermore, for older people, the negative effect of waiting time is stronger and the positive effect of the AD quality indicator is somewhat weaker. Reoperation patients prefer academic, tertiary teaching and bigger hospitals more than patients with a first operation. Also for those patients, higher waiting times seem to be less problematic whereas their preferences for the different quality indicators show mixed results.

Since our panel data set covers 3 different years (2008–2010), model 4 examines whether patient preferences changed over time by including extra variables interacting with each hospital attribute with year dummies for 2009 and 2010. Most importantly, it was tested whether the relation between hospital quality ratings and patient choice became stronger over the years. For the AD hospital ranking, however, we found a significant greater impact on hospital choices of this quality indicator in 2010 compared to 2008. For the Elsevier hospital ranking, we found a significant effect in 2009 compared to 2008. The preference for shorter waiting times increased over time, but the increase is not significant. Though some coefficients are statistically significant, coherent and persistent changes in patient hospital choice behaviour over time are not found. The fact that the panel used for this study (2008–2010) is rather short may be an explanation for this.

<sup>12</sup> To measure our model's goodness-of-fit, based on Town and Vistness [15], a "hit-or-miss" criterion is constructed for model 3, where the predicted patient choice was the hospital with the highest predicted probability. The model correctly predicted about 70 % of patients' hospital choices, suggesting a high degree of explanatory power. The accuracy of the model is also measured at an individual hospital level in a market share analysis. This is done by comparing the market share according to actual patient choices as observed in the claims data, with the market share predicted by the model (see Table 4).

**Table 3** Simulation results

Hospital	Predicted	Waiting time		AD		Elsevier	
		Predicted	% $\Delta$	Predicted	% $\Delta$	Predicted	% $\Delta$
1. Tergooiziekenhuizen	1,101	1,209	9.8	1,193	8.4	1,125	2.2
2. Medisch Centrum Alkmaar	1,238	1,297	4.8	1,288	4.0	1,251	1.1
3. Ziekenhuis Twente	1,248	1,306	4.6	1,298	4.0	1,261	1.0
4. Amphia Ziekenhuis	1,448	1,535	6.0	1,522	5.1	1,468	1.4
5. Martini Ziekenhuis	1,108	1,172	5.8	1,162	4.9	1,123	1.4
6. Haga Ziekenhuis	921	1,010	9.7	997	8.3	941	2.2
7. Isala Klinieken	1,273	1,334	4.8	1,325	4.1	1,287	1.1
8. Jeroen Bosch Ziekenhuis	1,126	1,213	7.7	1,200	6.6	1,145	1.7
9. Meander Medisch Centrum	1,129	1,244	10.2	1,227	8.7	1,155	2.3
10. Gelre Ziekenhuizen	761	816	7.2	807	6.0	773	1.6
11. Diaconessenhuis	802	902	12.5	887	10.6	824	2.7
12. Rijnland Ziekenhuis	620	694	11.9	683	10.2	636	2.6
13. Canisius-Wilhemina Ziekenhuis	728	784	7.7	775	6.5	740	1.6
14. St. Antonius Ziekenhuis	889	988	11.1	973	9.4	911	2.5
15. Maxima Medisch Centrum	699	757	8.3	748	7.0	712	1.9

### Simulation results

The use of simulations for examining patients' responsiveness to hypothetical changes in hospital quality ratings is very common in the contemporary literature on patient hospital choice (e.g. [1, 8, 12, 20]). Using the estimated coefficients from model 3 (see Table 2), we examined how hospital demand is predicted to be affected by hypothetical changes in the AD and Elsevier quality ratings, as well as hypothetical changes in hospital waiting time.<sup>13</sup> Table 3 shows the percentage change in hospital demand as a result of changing one hospital quality indicator within one hospital, holding all other hospital attributes constant. These percentages are obtained by simulating one standard deviation improvements (see descriptive statistics in Table 1) in the quality indicators and waiting time for each of the 15 hospitals with the largest market shares. From Table 3, it follows that for most hospitals, patient demand is fairly sensitive to changes in waiting time and scores in the AD hospital rating. For the Elsevier rating, it can be concluded that improved scores seem to have only a small effect on hospitals' predicted market shares.

### Conclusion

In this research, an analysis is performed on the underlying features of the concept of patient hospital choice. Using a nationwide data set from the Dutch Healthcare Authority (NZa)

<sup>13</sup> Note that because the estimated coefficient for IGZ quality rating is counterintuitive and implausible, this variable is not included in the simulation analysis.

with individual patient-level claims for non-emergency hip replacement during the period 2008–2010, a conditional logit model proved patients' responsiveness to hospitals according to differences in travel time, waiting time and hospital quality ratings. Overall, hip replacement patients are more likely to visit general hospitals located nearby, hospitals with shorter waiting times and hospitals with high quality ratings. Despite the uncertainty on the accuracy of the publicly available quality information on hospitals, from our analysis it follows that patients are sensitive to quality differences as presented in hospital ratings. Hence, though travel time is clearly the most important determinant in patient hospital choice, publicly available hospital quality ratings and waiting times are also found to have a significant impact on patient hospital choice. Unfortunately, the panel used for this study (2008–2010) is rather short, which may explain why no coherent and persistent changes in patient hospital choice behaviour over time are found. From our analysis, however, it clearly follows that in the Dutch market for hip replacement, patients are sensitive to differences in hospital quality as measured by publicly available quality information. From a policy perspective, this main finding implies that in a market-based health care system, increased transparency on quality and waiting times is likely to strengthen hospital competition. However, we only have claims data for years in which hospital quality information was already publicly available, and therefore cannot isolate the impact of the provision of quality information on patient hospital choice directly. In other words, our results are not informative about the impact of the public release of quality information. Further research using detailed claims data from before and after the publication of hospital quality ratings is needed for this.



The most important limitations of this research can be summarised as follows. First, since only one type of treatment (non-emergency hip replacement) is included in the data set, no general conclusions to the concept of patient hospital choice can be drawn from this research only. Further research is encouraged to include other treatments as well. Second, the role of the general practitioner (GP) as the patient's referring agent could not explicitly be taken into account. The contribution of the GP in the decision of patients, and therefore patients' responsiveness to hospital quality, is necessarily considered as a black box, because there is no data available on the underlying features influencing GPs in their advice to patients to choose a specific hospital for their treatment. If GPs are using the same publicly available information as patients, the effect of quality is also visible in the estimates on the patient level. However, further research using data on the contribution of the GP within patient hospital choice decisions is needed to better understand and predict patient hospital choices. Third, only little variation in patient heterogeneity is observed in our data set. The conditional logit model therefore only takes age, gender and reoperation into account. From previous studies, however, it follows that using more detailed patient characteristics may improve the accuracy of the choice model. Fourth, we only have data for a 3-year period (2008–2010). Further research is encouraged to study the preliminary dynamic effects found in this study over a longer time period.

## Appendix

See Table 4.

**Table 4** Hospitals' actual and predicted market shares

Hospital	Actual market share		Predicted market share		Actual versus predicted	
1. Tergooiziekenhuizen	1,552	2.8 %	1,101	2.0 %	−451	−29.1 %
2. Medisch Centrum Alkmaar	1,457	2.6 %	1,238	2.2 %	−219	−15.0 %
3. Ziekenhuis Twente	1,448	2.6 %	1,248	2.2 %	−200	−13.8 %
4. Amphia Ziekenhuis	1,394	2.5 %	1,448	2.6 %	54	3.9 %
5. Martini Ziekenhuis	1,275	2.3 %	1,108	2.0 %	−167	−13.1 %
6. Haga Ziekenhuis	1,197	2.1 %	921	1.6 %	−276	−23.1 %
7. Isala Klinieken	1,112	2.0 %	1,273	2.3 %	161	14.5 %
8. Jeroen Bosch Ziekenhuis	1,085	1.9 %	1,126	2.0 %	41	3.8 %
9. Meander Medisch Centrum	1,062	1.9 %	1,129	2.0 %	67	6.3 %
10. Gelre Ziekenhuizen	1,048	1.9 %	761	1.4 %	−287	−27.4 %
11. Diaconessenhuis	1,013	1.8 %	802	1.4 %	−211	−20.8 %
12. Rijnland Ziekenhuis	1,004	1.8 %	620	1.1 %	−384	−38.2 %
13. Canisius-Wilhemina Ziekenhuis	998	1.8 %	728	1.3 %	−270	−27.1 %
14. St. Antonius Ziekenhuis	987	1.8 %	889	1.6 %	−98	−9.9 %
15. Maxima Medisch Centrum	978	1.7 %	699	1.2 %	−279	−28.5 %
Other 78 hospitals	38,646	68.7 %	41,165	73.2 %	2,519	6.5 %
Total	56,256		56,256			

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