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Aggarwal, A; Lewis, D; Charman, SC; Mason, M; Clarke, N; Sullivan, R; van der Meulen, J (2017) Determinants of Patient Mobility for Prostate Cancer Surgery: A Population-based Study of Choice and Competition. *European urology*. ISSN 0302-2838 DOI: <https://doi.org/10.1016/j.eururo.2017.07.013>

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DOI: [10.1016/j.eururo.2017.07.013](https://doi.org/10.1016/j.eururo.2017.07.013)

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1 **Determinants of patient mobility for prostate cancer surgery: a population-**
2 **based study of choice and competition**

3

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26 **KEY WORDS:**

27 Patient mobility; patient choice; provider competition; equity; cancer; robotic surgery;

28 reputation

29

30 **WORD COUNT: 1754**

31

32

33 ABSTRACT

34 Many countries have introduced policies that enable patients to select a health care
35 provider of their choice with the aim of improving the quality of care. However, there is
36 little information about the drivers or the impact of patient mobility. Using administrative
37 hospital data ($n=19,256$) we analysed the mobility of prostate cancer patients who had
38 radical surgery in England between 2010 and 2014. Our analysis, using geographic
39 information systems and multivariable choice modelling, found that 33.5% ($n= 6,465$) of
40 men bypassed their nearest prostate cancer surgical centre. Travel time had a strong impact
41 on where patients moved to but was less of a factor for men who were younger, fitter, and
42 more affluent (p always <0.001). Men were more likely to move to hospitals that provided
43 robotic prostate cancer surgery (odds ratio 1.42, $p<0.001$) and to hospitals that employed
44 surgeons with a strong media reputation (odds ratio 2.18, $p<0.001$). Patient mobility
45 occurred in the absence of validated measures of the quality of care, instead influenced by
46 the adoption of robotic surgery and the reputation of individual clinicians. National policy
47 based on patient choice and provider competition may have had a negative impact on
48 equality of access, service capacity, and health system efficiency.

49 Patient summary

50 In this study we assessed the reasons why men would choose to have prostate cancer
51 surgery at a centre other than their nearest. We found that in England men were attracted
52 to centres that carried out robotic surgery and employed surgeons with a national
53 reputation.

54

55 Many high-income countries have introduced policies that aim to improve the quality of
56 care by stimulating competition between hospital providers and allowing patients to choose
57 the hospital where they have treatment.¹ In publicly funded health care markets such as the
58 UK, funding follows the patient, creating quite powerful incentives for hospitals to attract
59 new patients by demonstrating superior quality.²

60

61 To date, our understanding of the extent and determinants of patient mobility across health
62 services remains limited, due to a paucity of available research and heterogeneity in the
63 design of empirical studies.³ The aim of the present study is to undertake the first-ever
64 national analysis assessing the impact of choice and competition policies within cancer care.
65 Our aim was to investigate whether prostate cancer patients, who had a radical
66 prostatectomy (RP) in the English NHS, travelled beyond (“bypassed”) their nearest hospital,
67 and the hospital and patient characteristics associated with that mobility.

68

69 We obtained individual patient-level data on all men (n=19, 256) who were diagnosed with
70 prostate cancer and underwent RP in the English NHS between 1st January 2010 and 31st
71 December 2014 from the National Cancer Registration and Analysis Service (NCRAS) and
72 linked at patient level to Hospital Episode Statistics (HES). Patient characteristics of the
73 study cohort are presented in Supplementary Table 1.

74

75 The population weighted centroids of the patients’ Lower Super Output Areas (geographic
76 areas defined by the Office for National Statistics that typically includes 1,500 residents or

77 650 households) and the full postcodes for the hospitals where the surgery was undertaken
78 were inputted into a geographical information system (ESRI ArcGIS 10.3) to calculate travel
79 times according to the fastest route by car (using Ordnance Survey MasterMap Integrated
80 Transport Network). For each patient, the travel time to all prostate cancer surgical centres
81 (n=65) was calculated. The proportion of patients not receiving care at their nearest centre
82 were considered to be “bypassers”.

83

84 We determined three hospital-level characteristics. These were informed by a systematic
85 review of the literature and qualitative interviews with both men previously treated for
86 prostate cancer and uro-oncology specialists currently practicing in the UK.

87

88 We labelled the 12 hospitals that carried out robotic prostatectomies at the start of the
89 study period as “established robotic centres”. We identified the 31 “university teaching
90 hospitals”, based on their membership of the Association of UK University Hospitals. We
91 also defined the 12 hospitals with a “strong media reputation”, based on whether or not
92 they employed urologists that were listed in 2010 as the “best” prostate cancer surgeons in
93 the UK by the “Daily Mail”,⁴ which is the only nationally published source recognising expert
94 prostate cancer surgeons. Further details on selection of hospital characteristics is available
95 in the supplemental content.

96

97 Conditional logit regression was used to model the odds that a patient moved to a particular
98 hospital as a function of travel time and hospital and patient characteristics.⁵ For each
99 patient, we created a data set that included for each patient a row for each hospital
100 providing prostate cancer surgery at the time of treatment (number of hospitals varied

101 between 57 and 65 as eight hospitals closed during the study period). The dependent
102 variable of the conditional logit model was a dummy variable with a value of 1 for the
103 hospital where a patient had his treatment and a value of 0 otherwise. Patient
104 characteristics were included as interaction terms with travel time in the model and
105 included age, number of comorbidities, socioeconomic status (based on national quintiles of
106 the Index of Multiple Deprivation)⁶, and urban or rural residence.⁷ Further detail on patient
107 characteristics and the statistical methods is available in the supplemental content.

108

109 Our analysis demonstrated that 6,465 men (33.5%) “bypassed” the nearest centre that
110 carried out prostate cancer surgery. 2386 men (12.4%) bypassed at least three hospitals for
111 their treatment and 1,258 men (6.5%) at least five hospitals (Supplementary Table 2). There
112 were clear differences in bypass rates between the nine English regions. In London, 50.9% of
113 men had their prostate cancer surgery at the nearest centre whilst corresponding
114 percentages were 86.5% in the North East and 80.6% in Yorkshire and Humberside
115 (Supplementary Table 3).

116

117 Travel time had a strong impact on the odds that a patient chose a particular hospital to
118 receive surgery. The odds of a patient choosing a hospital that was up to 10 minutes further
119 away than the patient’s nearest hospital that carried out prostate cancer surgery was found
120 to be on average 78% smaller (OR of 0.22). The odds decreased markedly as the additional
121 travel time increased (Table 1).

122

123 The addition of patient characteristics as interaction terms into our model demonstrated
124 that the impact of travel time was smaller for men who were younger, for those who were
125 fitter (no recorded comorbidities), and for those who lived in more affluent or rural areas
126 (odds ratios larger than “1” (Table 1)). For example, again compared to having the surgery at
127 the nearest hospital, for men in rural areas, the likelihood of moving to a hospital that was
128 up to 10 minutes further away was estimated to be 2.5 times smaller ($= 1 / (0.22 \times 1.79)$)
129 whereas the corresponding figure for men from urban areas is 4.8 ($= 1 / 0.22$).

130

131 Patients were 1.42 times more likely to move to one of the 12 hospitals that were
132 established robotic centres compared to those that were not and 2.18 times more likely to
133 move to the 12 hospitals that employed surgeons who had a strong media reputation (Table
134 1). University teaching hospital status had a small but statistically significant impact (OR
135 1.09, $p < 0.001$) on attracting patients.

136

137 These findings have a number of policy implications that are relevant across a range of
138 elective secondary care services in countries that have introduced patient choice of provider
139 policies.³ A substantial number of patients, well above the 5% to 10% thought to be
140 necessary to incentivise improvements in quality,⁸ were prepared to move to hospitals
141 further away for radical prostatectomy. This occurred in the absence of evidence that these
142 hospitals achieved better outcomes. Instead, they responded to the availability of more
143 advanced surgical technology and the perceived reputation of the hospitals’ surgeons.

144

145 The provision of robotic surgery has been noted to attract patients to providers in health
146 care markets across Europe and North America,⁹ resulting in a rapid growth in the number
147 of providers offering this technology. Our own data supports this: men were more likely to
148 choose one of the 12 established robotic centres in the NHS. It is likely that this competitive
149 advantage has contributed to the large-scale investment in equipment for robotic surgery
150 across the NHS.¹⁰ There has been a more than threefold increase in the number of centres
151 offering this modality between 2010 and 2016 (from 12 to 42 centres).

152

153 Hospital and clinician reputation have also been identified in other studies as important
154 factors influencing decision making for cancer surgery.¹¹ This suggests that patients, with or
155 without guidance from their primary care physician, social and medical networks or clinician
156 who diagnosed the cancer, respond to indicators that in their view reflect differences in
157 treatment quality.¹²

158

159 The list of prostate cancer surgeons with a national reputation was compiled by the Daily
160 Mail following a survey of urologists working in the UK. Much of the intelligence is therefore
161 likely to be representative of the discussions that are ongoing within particular regions both
162 amongst clinicians as well as patient and carer support groups. It can therefore be
163 considered as a proxy for the wider reputation of hospitals.

164

165 The patterns of mobility observed in England has resulted in large and unexpected shifts in
166 market share for hospitals carrying out prostate cancer surgery. For some hospitals, nearly

167 80% of patients for whom that hospital was the nearest provider chose to have their
168 treatment elsewhere. Conversely, other hospitals were performing up to 200% more
169 operations than expected because patients from elsewhere travelled to these hospitals for
170 their surgery. Such extremes of mobility are likely to have a negative impact on health
171 system efficiency (due to lengthening waiting lists for some and unused capacity for others)
172 with some surgical units facing the threat of closure given that funding is contingent on the
173 number of procedures performed.^{2,10} Equally, surgical unit closures and the greater
174 regionalization that results may serve to improve efficiency.

175

176 Our modelling of patient mobility had a number of limitations. First, we used administrative
177 dataset and it is likely that we have missed less severe comorbid conditions. Second, the
178 study used centroids of small geographical areas to represent the location of the patients'
179 residence. This will have added "noise" to the determination of travel times.

180

181 In conclusion, men are willing to travel for prostate cancer surgery, especially those that are
182 relatively young, fit and affluent. The study highlights that without appropriate quality
183 information to guide patients' choices, patients are influenced by the reputation of hospitals
184 and their surgeons and the availability of innovative technologies. National policy based on
185 patient choice and provider competition may have a negative impact on service capacity,
186 equality of access, and health system efficiency.

187

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214

215

216 **Acknowledgements**

217 AA is funded by a Doctoral Research Fellowship from the NHS National Institute for Health
218 Research (DRF-2014-07-064). JvdM is partly supported by the NHS National Institute for
219 Health Research Collaboration for Leadership in Applied Health Research and Care North
220 Thames at Bart's Health NHS Trust. The views expressed in this publication are those of the
221 authors and not necessarily those of the NHS, the National Institute for Health Research, or
222 the Department of Health.

223 Hospital Episode Statistics were made available by the NHS Health and Social Care
224 Information Centre (© 2012, Re-used with the permission of NHS Digital. All rights
225 reserved.)

226 The cancer data used for this study are based on information collected and quality assured
227 by Public Health England's National Cancer Registration and Analysis Service. Access to the
228 data was facilitated by the Public Health England's Office for Data Release.

229 AA, SC, NC, and JvdM are members of the Project Team of the National Prostate Cancer
230 Audit (www.npca.org.uk) funded by the Healthcare Quality Improvement Partnership
231 (<http://www.hqip.org.uk/>).

232 **Table 1** – Impact of travel time and hospital and patient characteristics on patient mobility in 19,256
 233 men undergoing radical prostatectomy between 2010-2014 in the English National Health Service.¹
 234

	Adjusted odds ratio	95% CI	p value ²
Impact of additional travel time (mins)³			
	1		<0.001
<10	0.22	0.18-0.27	
11-30	0.03	0.03-0.04	
31-60	0.004	0.003-0.006	
>60	0.0005	0.0003-0.0006	
Difference in impact of additional travel time for selected patient characteristics⁴			
Younger patients (< 65 years)			
			<0.001
<10	1.11	1.01-1.23	
11-30	1.14	1.02-1.28	
31-60	1.40	1.20-1.64	
>60	1.37	1.18-1.59	
Patients without comorbidities			
			<0.001
<10	1.16	0.97-0.98	
11-30	1.12	0.90-1.39	
31-60	1.78	1.23-2.58	
>60	1.32	0.97-1.81	
Patients from more affluent areas (IMD 1 or 2)			
			<0.001
<10	1.08	0.98-1.23	
11-30	1.36	1.21-1.52	
31-60	1.35	1.15-1.59	
>60	1.12	0.97-1.29	
Patients from rural areas			
			<0.001
<10	1.79	1.57-2.04	
11-30	2.19	1.93-2.48	
31-60	2.61	2.23-3.05	
>60	2.14	1.84-2.47	
Impact of hospital characteristics			
University hospital	1.09	1.05-1.15	<0.001
Established robotic centre	1.42	1.33-1.52	<0.001
Strong media reputation	2.18	2.05-2.31	<0.001
McFadden's pseudo R²		0.70	

235

236 Notes:

- 237 1. Odds ratio represent differences in the odds that a patient moves to a particular hospital as a function
 238 of travel time and hospital and patient characteristics.
 239 2. P value based on likelihood ratio test
 240 3. Note that the adjusted odds ratios for additional travel time relates to older men (≥ 65 years), with
 241 comorbidity (Charlson ≥ 1), from less affluent (IMD 3-5), and living in an urban area.
 242 4. Impact of patient characteristics on the odds ratio representing the impact of additional travel time
 243 (see results section for interpretation).