
Downloaded from: http://researchonline.lshtm.ac.uk/4647113/

DOI: 10.17037/PUBS.04647113

Usage Guidelines

Please refer to usage guidelines at http://researchonline.lshtm.ac.uk/policies.html or alternatively contact researchonline@lshtm.ac.uk.

Available under license: http://creativecommons.org/licenses/by-nc-nd/2.5/
EVIDENCE AND IMPACT OF NHS CHOICE AND COMPETITION POLICIES ON THE DELIVERY OF PROSTATE CANCER SERVICES: A NATIONAL POPULATION BASED EVALUATION

Ajay Aggarwal

Thesis submitted in accordance with the requirements for the degree of

Doctor of Philosophy of the University of London

OCTOBER 2017

Department of Health Services Research and Policy

Faculty of Public Health and Policy

London School of Hygiene & Tropical Medicine, University of London

Funded by a Doctoral Research Fellowship from the National Institute for Health Research (NIHR)
Declaration by Candidate

I have read and understood the School’s definition of plagiarism and cheating given in the Research Degrees Handbook. I declare that this thesis is my own work, and that I have acknowledged all results and quotations from the published or unpublished work of other people.

I have read and understood the School’s definition and policy on the use of third parties (either paid or unpaid) who have contributed to the preparation of this thesis by providing copy editing or proof reading services. I declare that no changes to the intellectual content or substance of this thesis were made as a result of this advice and that I have fully acknowledged all such contributions.

I have exercised reasonable care to ensure that the work is original and does not to the best of my knowledge break any UK law or infringe any third party’s copyright or other intellectual property right.

NAME IN FULL: AJAY KUMAR AGGARWAL

STUDENT ID NO: 1406114

SIGNED: 

DATE: 16th October 2017
ABSTRACT

Background
Policies encouraging patient choice and hospital competition have been introduced across several countries with the aim of improving the efficiency, equity and quality of health care services. The English National Health Service (NHS) is an example of a publicly funded health system in which hospitals are expected to compete on quality and not price to attract patients, who themselves are allowed to choose any hospital that best meets their needs. To date, there is limited evidence about the factors that influence patients’ decisions to choose a hospital other than their nearest (“patient mobility”) or the implications of these choices on the health system.

Methods
In this thesis, national patient-level datasets and mixed quantitative and qualitative research methods were used to investigate the role of choice and competition policies on the delivery of specialist cancer services, using prostate cancer as a case study. This included an assessment of both the extent and drivers of patient mobility for curative prostate cancer treatment as well as the wider system impact of patient mobility and hospital competition on service capacity, service configuration, technology adoption and patient outcomes. Semi-structured interviews were undertaken with men previously treated for prostate cancer to provide further insight into the factors that inform and influence provider choice.

Results
Patient mobility for cancer treatment far exceeds the 5-10% considered necessary to stimulate improvements in quality. One in three men and one in five men bypassed their nearest centres for prostate cancer surgery and radiotherapy respectively. Travel time was the dominant factor influencing location of care, but its impact was less strong for younger and more affluent
socioeconomic groups. Men were attracted to centres offering innovative technologies and practices of care as well as centres that employed clinicians with a national reputation for prostate cancer. This has resulted in shifts in market share for individual cancer centres resulting in a net gain of patients for some centres - “winners” - and a net loss of patients for others - “losers”. Surgical centres classified as “losers” had a greater likelihood of closing their service. Competition between hospitals has contributed to the rapid adoption of costly technology for prostate cancer surgery. However, there is limited evidence to suggest that hospital competition improves patient outcomes.

Conclusions

The thesis demonstrates unequivocally that patient mobility and hospital competition is occurring within the NHS. Choice and competition policies rather than a coordinated policy towards centralisation have been the most significant drivers in the reconfiguration of prostate cancer surgical services in the NHS. Indicators, which accurately reflect the quality of cancer treatment delivered, are needed to guide patients’ decision-making. In their absence, patient mobility may negatively affect the efficiency and capacity of a regional or national cancer service without improvements in patient outcome, and widen socioeconomic inequalities in access to care.
Acknowledgements

Firstly, I would like to thank my primary supervisor, Jan van der Meulen who has provided outstanding supervision throughout all stages of the PhD. He has given me a wider appreciation of the research process, in particular the need to be constantly self-critical and rigorous in my approach to ensure that the body of work and its interpretation is based on a robust methodology. Thanks also to Courtney Davis at King’s College London who provided excellent qualitative research supervision.

From my research advisory team I would like to thank Daniel Lewis, Richard Sullivan, Malcolm Mason, Sarah Bernays, Heather Payne and Noel Clarke who were always available to provide expert input throughout the PhD.

Thank you also to Roger Wotton and the members of Tackle Prostate Cancer who took part in my qualitative study.

I would like to thank the National Institute for Health Research for funding the research and enabling me to receive training in quantitative and qualitative research methods, which have formed a core component of the work.

I am fortunate to have met many great people during the course of my PhD, but I would like to give a special thanks to my two desk mates, Kat Arbuthnott and Nico Berger for their good humour and friendship.

Finally, a big thank you, to my wife Jo and two daughters Eloise and Margot (who arrived during the course of the PhD) who have been a source of unfailing support and perspective throughout.
List of Abbreviations

ENT – Ear, Nose and Throat
GP – General Practitioner
GIS – Geographic Information Systems
HES – Hospital Episode Statistics
HHI - Herfindahl-Hirschman Index
HRG – Healthcare Resource Groups
HTA – Health Technology Assessment
IMD – Index of Multiple Deprivation
IMRT – Intensity Modulated Radiotherapy
LSOA – Lower Layer Super Output Area
LSHTM – London School of Hygiene and Tropical Medicine
NCRAS – National Cancer Registration and Analysis Service
NHS – National Health Service
OPCS 4 - UK Office for Population Census and Surveys Classification of Interventions and Procedures – 4th revision
PbR – Payment by Results
PROMs – Patient Reported Outcome Measures
RCS – Royal College of Surgeons
RP – Radical Prostatectomy
RT – Radiotherapy
RTDS – Radiotherapy Dataset
SCI – Spatial Competition Index
SMDT – Specialist Multidisciplinary Team
UK – United Kingdom
US – United States of America
Table of Contents

1. INTRODUCTION.................................................................................................................. 10
   1.1 Choice and Competition in the NHS in England ..................................................... 10
   1.2 Impact of Choice and Competition policy in the NHS ........................................ 12
       1.2.1 Awareness and Implementation ................................................................. 12
       1.2.2 Information sources ....................................................................................... 13
       1.2.3 Patient choice ................................................................................................. 13
       1.2.4 Equity .............................................................................................................. 14
       1.2.5 Efficiency ....................................................................................................... 15
       1.2.6 Quality ........................................................................................................... 16
   1.3 Choice and Competition policy and NHS cancer care services ......................... 18
       1.3.1 Centralisation versus a competitive environment ......................................... 18
       1.3.2 Time-frame for choice ................................................................................... 19
       1.3.3 Comparative health information in cancer care ............................................. 20
   1.4 Rationale for investigating impact of choice policies in prostate cancer ............... 21

2. RESEARCH DESIGN OVERVIEW ...................................................................................... 23
   2.1 Aims and Objectives ............................................................................................... 23
   2.2 Empirical approach to investigating patient choice ............................................. 24
   2.3 Study Design .......................................................................................................... 25
   2.4 Data Sources .......................................................................................................... 30
   2.5 Ethics ...................................................................................................................... 32

3. RESULTS CHAPTER 1 ........................................................................................................ 33
3.1 Systematic Review ........................................................................................................ 33
3.2 Research paper 1 ........................................................................................................ 33

4. RESULTS CHAPTER 2 ........................................................................................................ 60
4.1 Patient mobility for radical prostatectomy ................................................................. 60
4.2 Research paper 2 ........................................................................................................ 60

5. RESULTS CHAPTER 3 ........................................................................................................ 61
5.1 Patient mobility for radical radiotherapy ................................................................. 61
5.2 Research paper 3 ........................................................................................................ 61

6. RESULTS CHAPTER 4 ........................................................................................................ 74
6.1 Impact of choice and competition on cancer service delivery ................................. 74
6.2 Research paper 4 ........................................................................................................ 74

7. RESULTS CHAPTER 5 ........................................................................................................ 86
7.1 Impact of hospital competition on patient outcomes ............................................ 86
7.2 Research paper 5 ........................................................................................................ 86

8. RESULTS CHAPTER 6 ........................................................................................................ 87
8.1 Hospital choice – a qualitative study ....................................................................... 87
8.2 Research paper 6 ........................................................................................................ 87

9. DISCUSSION ....................................................................................................................... 88
9.1 Summary of main findings ....................................................................................... 88
9.2 Policy implications ..................................................................................................... 91
9.2.1 Patient mobility ...................................................................................................... 91
9.2.2 Determinants of patient mobility ......................................................................... 93
9.2.3  **Equity** ........................................................................................................... 95

9.2.4  **Efficiency** ...................................................................................................... 96

9.2.5  **Hospital Competition** .................................................................................... 97

9.3  Balancing competition and centralisation ............................................................. 102

  9.3.1  *Designing a health system to support patient mobility and competition* .... 102

  9.3.2  *Top down reconfiguration of cancer services* .............................................. 103

  9.3.3  *Development of indicators for quality improvement* .................................. 104

9.4  Strengths and Limitations ...................................................................................... 106

  9.4.1  *Methodological approach* ................................................................. 106

  9.4.1  *Data* ............................................................................................................. 107

  9.4.2  *Patient choice* .............................................................................................. 109

  9.4.3  *Travel time estimation* ................................................................................. 110

  9.4.5  *Determinants of mobility* .......................................................................... 110

  9.4.6  *Competition* ............................................................................................... 111

  9.4.7  *Patient outcomes* ......................................................................................... 112

10.  **CONCLUSION** .................................................................................................... 113

11.  **TRAINING** ......................................................................................................... 114

12.  **REFERENCES** ................................................................................................... 115

13.  **APPENDICES** .................................................................................................... 130

    Appendix A – Ethics approval ............................................................................... 130

    Appendix B – Participant information sheet ............................................................ 131

    Appendix C – Consent form .................................................................................... 134
1. INTRODUCTION

1.1 Choice and Competition in the NHS in England

In 2002, the then Labour government embarked on a large scale reform of the health system, marking a shift away from targets and transparent public reporting of outcomes, towards the introduction of market-related mechanisms to drive improvements in the quality of NHS services (Secretary of State for Health 2002). This was accompanied by sustained annual increases in NHS funding (Bevan, 2010). Patient empowerment and choice were the core components of “Choice and Competition” policy, with a desire to encourage greater patient consumerism and mobility between providers (Department of Health, 2005).

In 2003, the government started to encourage a diverse range of providers (public and private) to deliver clinical services in order to increase capacity to meet excess demand and drive down waiting lists (Department of Health, 2005). A new reimbursement mechanism was also introduced - “Payment by Results” (“PbR”) - whereby providers were to be paid according to nationally agreed tariffs for hospital services (Department of Health, 2002; Jones & Mays, 2009). Healthcare Resource Groups (HRGs) supported PbR by providing a classification framework of relevant hospital activities representing current practice. With tariffs for services essentially fixed, providers were therefore encouraged to compete for “market share” on measures of quality rather than price and receive financial rewards accordingly as money followed the patients (Le Grand, 2009).

Pilot provider choice schemes were introduced from 2002, including choice for
cardiac patients (Le Maistre et al, 2003), choice for patients waiting for elective surgery in London (Burge et al, 2005; Dawson et al, 2004), and choice at the point of referral (Taylor et al, 2004). In January 2006, GPs across England were required to offer patients a choice of at least four local healthcare providers at the point of referral for elective surgery (Department of Health, 2004).

By 2008, patients requiring routine elective treatment (including selected non-surgical treatments) had a “free choice” of any licenced NHS (acute or foundation trust) or independent sector provider which met the standards set by the CQC and were able to provide care at the national tariff rate (Department of Health, 2007b; Dixon et al, 2010b).

The NHS Choices website was introduced in 2007 to support patient choice, and provide information on providers and facilitate comparison (Department of Health, 2008). In addition to information sourced from the Care Quality Commission (CQC), the website presented service user ratings as well as intervention-specific quality ratings in the form of patient reported outcome measures and clinical outcome measures (e.g. hip revision rate, emergency readmission rate, and mortality rates) (Department of Health, 2008; Greaves et al, 2012; Timmins, 2008). The types of performance indicators reported continue to evolve and more recently include hospital staff recommendations. The Health and Social care Information Centre (www.hscic.gov.uk) and MyNHS (https://www.nhs.uk/Service-Search/performance/search) websites also provide comparative data on providers.

In 2017, the NHS remains committed to choice and competition policy, encouraging health care users to select providers that best meet their health care needs (Department of Health, 2016). At the same time, the NHS continues to embark on a program of regionalisation and
centralisation of specialist health care services including cancer care (Independent Cancer Taskforce, 2015).

This mixed policy approach which includes both “top down” coordination of services and competition has evolved in response to the nature of the relationship between the state, the medical profession and the public, which had historically shaped the NHS (Jones & Mays, 2009). The challenge is for these individual policy instruments to be appropriately balanced (Stevens, 2004). However empirical evidence is lacking to understand how such co-existing policies may interact or what incentives are necessary to balance them (Baicker & Levy 2013). The current evidence suggests that providers and commissioners are preferring to choose coordination or cooperation rather than competition as a means of effecting major service reconfigurations (Allen et al, 2017).

The next section appraises the literature relating to the impact of choice and competition policies in the NHS, and provides the context for this thesis, which intends to focus on the role and impact of these policies on the delivery of NHS prostate cancer services.

1.2 Impact of Choice and Competition policy in the NHS

1.2.1 Awareness and Implementation

The 2009 Kings Fund Patient Choice survey of 2,181 patients, who had been referred for a hospital outpatient appointment in the previous 2 weeks, provides the main evidence with respect to the awareness and implementation of choice policies (Dixon et al, 2010a). It highlighted two main issues. First, the lack of awareness amongst patients that they had a choice of provider for routine elective treatment (only 45% of those surveyed were aware prior to visiting their GP that they had a choice). Second, there appeared to be variation in the
implementation of choice of provider at the point of referral (only half of all patients recall being offered a choice) (Dixon et al, 2010a), which has likely resulted from a failure to engage with GPs in the choice process. GPs had initially experienced technical difficulties with the “choose and book” electronic system, which had been implemented to facilitate specialist hospital referrals. In addition, many GPs did not “buy-in” to the patient choice agenda and its expected benefits (Dixon et al, 2010a; Rosen et al, 2007; Sanderson et al, 2013). Others reported difficulty in advising on providers outside their local area, instead relying on their own knowledge of local providers (Sanderson et al, 2013).

1.2.2 Information sources

It was expected that individuals would use comparative performance data in order to make informed choices about their health care provider. However current evidence suggests that patients rarely search for health quality information, don’t trust it, or don’t use it in a rational way to make choices (Fung et al, 2008; Marshall & McLoughlin, 2010). The Kings Fund survey found that that only 4% of patients used the NHS Choices website when making decisions about treatment provider, with the majority of patients reliant on advice from their friends and family network, prior experience, and GP (Dixon et al, 2010a).

1.2.3 Patient choice

In order for choice policies to stimulate improvements in provider quality, it is expected that some patients will select a provider based on quality and be prepared to move beyond their expected provider (usually the nearest) to other providers for a particular service. In theory it is anticipated that even movement of between 5-10% of users will provide the necessary incentives to improve quality (Le Grand, 2009). However, a major critique is that there is still
limited evidence that such policies have affected where patients’ ultimately receive treatment. (Pollock et al, 2012).

The London Patient Choice Pilot (LPCP) evaluation based on 19,976 actual visits for selected ophthalmic, orthopaedic, ENT (Ear Nose and Throat), urology and general surgery procedures demonstrated that 65.5% of patients travelled beyond their local providers in order to receive quicker treatment (Dawson et al, 2004). However this was in a controlled environment where transport was free for patients choosing alternative providers and patients had already been waiting longer than 6 months for procedures at their local hospital (Burge et al, 2005). In the Kings Fund patient choice study, 31% of individuals surveyed went to a non-local provider for the last secondary care episode (Dixon et al, 2010a).

Using Hospital Episode Statistics data, Kelly and Tetlow demonstrated that the percentage of patients receiving elective surgery at their nearest Trust fell year on year from 2003/2004 to 2010/11. In 2003/2004, 68% of hip replacements and 77% of hernia operations were performed at the patient’s nearest Trust (Kelly & Tetlow, 2012). By 2010/11, this had fallen to 54% and 61% respectively. However, a notable caveat is that the study did not take into account whether the nearest Trust performed the specific intervention in question.

Whilst there is some evidence that patients in the NHS are prepared to move to alternative centres for secondary care treatment, it is inconsistent and does not include cancer care.

1.2.4 Equity

There is a concern that patient choice may exacerbate socioeconomic inequalities in access to services and the quality of care received (Dixon & Le Grand, 2006; Fotaki, 2010). However,
the results to date from studies using data on actual patient visits in the NHS have been equivocal. The London Patient Choice Pilot, demonstrated that patient’s age was positively associated with staying at the local hospital to which they were originally referred and that men are more likely than women to move to alternative hospitals (Dawson et al., 2004). This is in keeping with another study that found that elderly and more income-deprived patients are more likely to choose their nearest hospital for elective hip surgery (Beckert et al., 2012). However, a study focusing on socioeconomic differences in the choice of centre for coronary artery bypass grafting found that income was a poor predictor of responsiveness to choice policies, and that sicker patients were more responsive to differences in quality (Gaynor et al., 2016).

1.2.5 Efficiency

At the time of introducing choice and competition policies, the government attempted to encourage a diverse range of providers (public and private) to deliver clinical services in order to increase the capacity of the system to ensure sufficient choice was available to meet excess demand (Department of Health, 2005). However, there was a concern that creating spare capacity would result in inefficiencies if the increased costs of doing so were not off-set by quality and efficiency gains elsewhere (e.g. increased productivity) (Jones & Mays, 2009). However, to date there has been no evidence to suggest that such system-level inefficiencies have occurred (Farrar et al., 2009; Fotaki, 2014).

In addition, studies have demonstrated a reduction in elective waiting lists and average length of stay following the introduction of Choice and Competition policy (Cooper et al., 2011; Cooper et al., 2009; Dawson et al., 2007; Gaynor et al., 2013; Moscelli et al., 2017; Siciliani & Martin, 2007). However, it is thought that these improvements have instead resulted from
increased NHS investment on staffing capacity, as well as other target-driven performance management policies introduced during this time rather than market based reforms (Bojke et al, 2014; Brereton & Vasoodaven, 2010; Fotaki, 2014).

1.2.6 Quality

The impact of hospital competition on the quality of services in the English NHS remains unclear (Fotaki, 2014; Oliver, 2012). Three large econometric analyses reviewing the impact of post 2006 NHS choice policy reforms on quality, reported that hospitals located in the most competitive market areas, i.e. where patients have high levels of provider choice, had superior clinical quality (in terms of mortality from acute myocardial infarction (AMI)) compared to hospitals facing less competition (Bloom et al, 2015; Cooper et al, 2011; Gaynor et al, 2013).

In the study by Cooper et al, the lower 30-day acute myocardial infarction mortality rates were attributed to wider improvements in hospital performance which had been stimulated by the need to compete for elective surgical patients (e.g. cataract surgery) (Cooper et al. 2011). A later study by Bloom et al, attempted to demonstrate that the observed improvements in clinical quality in hospitals located in the most competitive market areas are due to better management practices, which has likely influenced care across medical and surgical specialities (Bloom et al, 2015).

However, these econometric studies have received a lengthy critique. First, they fail to acknowledge that mortality rates across all hospitals were falling during this time period and that differences in mortality could be attributed to the slowing down of mortality declines in less competitive markets rather than improving performance in more competitive areas (Mays, 2011). Second, there is no explanation as to how competition in the elective surgery market...
would affect outcomes for acute myocardial infarction (Pollock et al., 2012). Third, the studies do not attempt to explicitly link the effect of patient choice and competition between providers for a particular elective procedure (e.g. hip or knee replacement) on individual patient outcomes. (Bevan & Skellern, 2011). Lastly, the study findings are at odds with two previous studies analysing the impact of the 1990s internal market which demonstrated reductions in clinical quality in the most competitive markets (Propper et al, 2008; Propper et al, 2004).

A more recent NHS study focusing on the relationship between hospital market competition for elective hip replacement surgery and improvements in outcome (measured using the Oxford Hip Score - a patient reported outcome measure) found that hospital competition had no significant influence on patient outcomes (Feng et al, 2015). Conversely, another NHS study found that hospital competition was correlated with a reduction in 30-day mortality after a cardiac valve replacement (Diller et al, 2014).

When considered together these studies demonstrate that there is considerable uncertainty regarding the role of hospital competition in stimulating improvements in health care quality. In addition, there has been little or no published data investigating what the impact of patient mobility has been on individual providers; for example, the effect on capacity and practices of care if patients are indeed choosing a hospital other than their nearest. The NHS is effectively a closed box system and assuming the number of patients requiring treatment for any one condition remains stable or increases, the mobility of patients is likely to have an effect on the efficient utilisation of available capacity of individual providers and their subsequent funding (given that this follows the patient). Equally, centres may have to respond in some way to prevent local patients from leaving, or to attract new patients for a particular intervention, but the current NHS literature does not provide any evidence as to how this may occur.
1.3 Choice and Competition policy and NHS cancer care services.

Within cancer care, inequalities in service provision, access and survival have persisted across England and Wales over the last two decades (Berglund et al, 2012; Bungay, 2005; Department of Health, 2013; Haward, 2006; Hoskin et al, 2013; Jack et al, 2003; Palser et al, 2009; Rachet et al, 2010; Royal College of Surgeons of England, 2014; Williams & Drinkwater, 2009). By allowing patients to select a provider that best meets their needs and by encouraging providers to compete in order to stimulate improvements in quality, it could be argued that choice policies have the potential to minimise these inequalities.

However, to date there has been no research investigating their impact within cancer services. There are also several reasons to question whether choice policies are relevant to cancer patients and whether such policies are able to drive meaningful improvements in quality. Some of the potential issues are outlined below, many of which are also likely to be relevant to other specialist disease areas.

1.3.1 Centralisation versus a competitive environment

There is robust evidence that higher case volume and greater experience in managing cancers both at the provider and individual physician level is associated with improved survival outcomes (Birkmeyer et al, 2002; Halm et al, 2002; Wouters et al, 2009). For prostate cancer, the incidence of post-operative complications, positive surgical margins and late urinary complications are reduced when performed by “high volume” surgeons in “high volume” centres (Van Poppel & Joniau, 2008; Vickers et al, 2009). As a result, NHS Trusts have been undergoing reconfiguration of their cancer services since the early 2000s with greater

However, such organisational changes limit the potential for patient choice and competition between providers and plans for further reconfiguration of cancer services are continuing. In 2015, the NHS independent cancer task force recommended the creation of “Cancer Alliances” across England to implement its vision for improving the quality of cancer care services across the cancer care continuum (from prevention to survivorship) (Independent Cancer Taskforce, 2015). Alliances are expected to coordinate the efforts of a wide stakeholder set (including Clinical Commissioning Groups (CCGs), patients, and providers) to strengthen regional commissioning of cancer services and achieve effective implementation of its strategic goals at the local level through the 44 newly developed national Sustainability and Transformation plans (“footprints”) (NHS England, 2016). At its core is the expectation that services should meet the needs of the local population, and tie in with existing health service infrastructure and referral patterns within pre-determined geographical boundaries. It remains unknown how such changes could act to mitigate the effect of patient choice and hospital competition.

1.3.2 Time-frame for choice

Many common cancers are time sensitive, requiring the prompt initiation of treatment. This therefore limits the potential for making informed decisions about treatment providers through a review of available performance indicators. In addition, patients may have to choose between different treatment options even prior to considering where they receive their care, which for many may be too much of an additional burden given the difficulties encountered in selecting between cancer treatments (Clark et al, 2003; Clark et al, 2001; Davison & Goldenberg, 2003).
Some patients may consider moving to alternative providers to receive quicker treatment. However, for cancer care, extensive efforts have been made to ensure prompt diagnosis and treatment of suspected cancers through a system of defined targets, (Department of Health, 2000; Department of Health, 2007a; NHS England, 2015) thus reducing this as a driver to move.

There are also significant time and financial constraints that a decision to move can have on an individual seeking treatment. Treatment options are complex and may last for many months when considering chemotherapy or radiotherapy, thus limiting the opportunity to receive treatment out of area if so desired. For example, radiotherapy for prostate cancer or lung cancer can entail between 6-8 weeks of daily treatment.

1.3.3 Comparative health information in cancer care

It is expected that patients are able to select the provider that best meets their needs through a comparative review of available options. The NHS Choices website was therefore developed to provide this information. However, in cancer care there is lack of clarity as to the optimum indicators for measuring performance at the provider and individual physician level given the multidisciplinary nature of cancer treatment (Burns et al, 2016).

Outcomes from individual surgeons are now starting to be published for bowel and oesophago-gastric cancer (with other cancers to follow) (Royal College of Surgeons of England, 2016a; Royal College of Surgeons of England, 2016b). However, there is no consensus as to how best to measure performance of other surgical procedures such as a radical prostatectomy or cancer treatments such as radiotherapy.
In the absence of clear comparative health information on cancer care providers, it is unclear from the literature what information patients use to make decisions regarding their location of cancer treatment. A concern is that patients will be reliant on informal sources of information (e.g. word of mouth) when making decisions regarding their provider (Vicoor et al, 2012), which may result in choices that do not ultimately improve their health outcomes.

1.4 Rationale for investigating impact of choice policies in prostate cancer

Given the heterogeneous nature of cancers in terms of their clinical presentation, method of diagnosis, treatment options and prognosis it is necessary to study the impact of provider choice policies within a single cancer site. For the purpose of this research, I have selected prostate cancer.

Prostate cancer is the most common malignancy in men, with approximately 40,000 new cases diagnosed annually in the United Kingdom (34,000 with non-metastatic disease) (Royal College of Surgeons of England, 2016c). Compared to other common cancers such as breast, bowel and lung, the biology of the disease is such that in the non-metastatic setting, outcomes are not necessarily influenced by treatment delay. Due consideration can be made for the preferred strategy, more so than other malignancies where: (1) the optimal evidence based management strategy is often already clearly defined; (2) patients may present acutely with complications associated with localised/locally advanced disease requiring emergency intervention.

There is also evidence of regional variation in availability of prostate cancer services across England. Currently, men with non-metastatic prostate cancer are managed within specialist multidisciplinary teams (composed of one or more hospital) which usually provide all
essential treatments. The National Prostate Cancer Audit (NPCA) has highlighted national variation in the treatments offered by specialist multidisciplinary teams (SMDTs) and therefore provider choice may facilitate access to cancer treatments that are not available locally (Aggarwal et al, 2016).

Even for providers offering the same modality of treatment e.g. radical prostatectomy (RP) or external beam radiotherapy (EBRT) there is variation in the technology or technique used. For instance, radical prostatectomy may be performed as an open, laparoscopic or robot-assisted procedure (Ficarra et al, 2009). Likewise, external beam radiotherapy for prostate cancer, may be delivered with 3D conformal techniques, intensity modulated radiotherapy (IMRT), stereotactic beam radiotherapy (SBRT) or using proton beam therapy (only available outside of the UK currently) (Sheets et al, 2012; Tree et al, 2014). Patients may therefore choose to move to another hospital either because the perceived quality of that hospital is thought to be better or because they prefer to be treated using a particular technique that is not available locally.

Finally, as with other cancer and non-cancer specialist sites, policies in the NHS continue to promote the reconfiguration of prostate cancer surgical services with a view to creating higher-volume surgical units (NHS England, 2014). Both choice and competition as well as centralisation attempt to achieve gains in patient outcome, however they require different health system configurations and provider incentives. Finding the right balance between the two is therefore key (given that centralisation may negatively affect choice and competition) but there is currently limited evidence to guide how best to achieve this.
2. RESEARCH DESIGN OVERVIEW

2.1 Aims and Objectives

The PhD aims to evaluate the impact of NHS choice and competition on prostate cancer services using a mixed methods research design. There are five main research objectives.

1. To evaluate the empirical evidence for patient mobility in elective secondary care services in countries that have introduced patient choice policies.

2. To determine to what extent men diagnosed with prostate cancer in the NHS travel beyond their nearest treatment provider for curative treatment, and the patient and hospital characteristics associated with this mobility.

3. To assess the impact of patient mobility on individual providers with respect to their net gains and losses of patients.

4. To investigate the impact of hospital competition on patient outcomes for men receiving treatment for prostate cancer.

5. To understand what factors inform and influence where patients choose to receive prostate cancer treatment.

The outputs of this research are expected to provide a greater understanding of how NHS cancer patients are responding to provider choice policies and what implications this may have.
on the future organisation and delivery of cancer services and mechanisms for supporting patient choice and quality improvement.

2.2 Empirical approach to investigating patient choice

Previous studies have attempted to identify the extent to which patients actively choose their health care provider and the factors that influence this (Victoor et al, 2012). However, these are largely based on data derived from interviews, and surveys, which ask individuals about recent health care episodes or hypothetical scenarios (Albada & Triemstra, 2009; Combier et al, 2004; Dixon et al, 2010a; Finlayson et al, 1999; Schwartz et al, 2005).

Patient registration data from actual hospital episodes (revealed preferences) have been used in other studies to assess whether patients are choosing (Gutacker et al, 2016; Haynes et al, 2003). However, in reality this is limited as it is not possible to ascertain whether the patterns of service utilisation represent an active choice by the patient alone or are a consequence of pre-defined referral pathways, physician preferences or issues with capacity at their local provider. Clinicians in particular play a key role in informing and facilitating the choice process and the decision to receive treatment at a particular provider.

Given the inherent difficulties associated with establishing active choice using data on revealed preferences, one can instead ask a different empirical question: namely, whether there is evidence that patients receive care at hospitals other than their nearest. This question is related to the concept of “patient mobility”.

Patients travelling beyond their nearest provider are considered to have moved which is used as a proxy for “choice”. This is based on the assumption that patients’ act to minimize their travel times and would therefore be expected to receive treatment from their nearest provider (Burge et al, 2004; Victoor et al, 2012).
From a quantitative perspective, patient mobility is derived from knowing where a patient lives and where they move to for a health care intervention or service given the available choice of providers. This defined the empirical approach for the quantitative analyses.

In addition to the quantitative analyses, in-depth qualitative interviews were planned with men previously treated for prostate cancer in order to gain a more nuanced and in-depth understanding of the nature of the choices patient are expected to make. In particular, to what extent and in what way patients want to be given these choices as well as the factors informing and influencing their decisions regarding treatment location.

2.3 Study Design

This section provides an overview of the research design and data sources I used in the thesis. Each study component described below was designed to address a specific research objective. The results of these analyses have been presented in the form of six empirical research papers. Four have been published in the peer reviewed literature and two are currently under review.

The first component of the research was a systematic review of the published international literature to assess whether there is any empirical evidence of patient mobility for elective secondary care services in response to provider choice policies. The systematic review was also intended to inform the quantitative component of the study, both in terms of the optimum methodology to use to assess the determinants of patient choice and to guide which hospital characteristics to consider within the multivariate regression analyses. The output of this component of the research produced a published research paper which is presented in the results section:
“Patient mobility for elective secondary healthcare services in response to patient choice policies: a systematic review”

See Chapter 3, Pages 32-58

The second component of my research study was a quantitative analysis of patient mobility and its determinants using data on actual patient visits for curative prostate cancer treatment in the English NHS. Patients receiving radical prostate cancer surgery and radical radiotherapy were considered as two separate populations given the variation in the duration and intensity of these two treatments and the availability of these services in the English NHS. Patients diagnosed with metastatic disease were excluded as treatment options are standardised, and the need for rapid institution of treatment precludes the ability to choose a treatment provider in most instances.

The systematic review was integral in defining the optimum methods to use within this component of the study. For the first part of the analysis I used a hospital bypassing model (Varkevisser & Van Der Geest, 2007) to estimate the proportion of men with prostate cancer who travelled beyond their nearest provider for a particular treatment. The second part of the analysis involved using conditional logit regression, a statistical method widely used in the econometric choice literature, to analyse the determinants of patient choices by modelling the odds that a patient moved to a particular hospital as a function of travel time and hospital and patient characteristics (Beukers et al, 2014; McFadden, 1973). The outputs of the research produced two published empirical research papers relating to prostate cancer surgery and prostate cancer radiotherapy, which are presented in the results section:
“Determinants of patient mobility for prostate cancer surgery: a population-based study of choice and competition”

*See Chapter 4, Pages 59-73*

“Hospital quality factors influencing the mobility of patients for radical prostate cancer radiation therapy: a national population based study”

*See Chapter 5, Pages 74-86*

The **third component** of the research study was designed to address the impact of patterns of patient mobility on individual providers, specifically their net gains and losses of patients. This component of the study was undertaken in light of the results from the previous analyses (Chapters 4 and 5), which had demonstrated that large numbers of patients travelled beyond their nearest provider for surgery and radiotherapy in the English NHS. These gains and losses were analysed in the context of the intensity of spatial competition faced by individual treatment centres. This analysis was integral to our understanding of the impact of these policies on NHS providers given that money follows the patient and therefore decreases in patient numbers could affect the viability of the centre.

The analysis focusing on the impact of patient mobility on individual radical radiotherapy treatment providers, was included as part of the earlier analyses reviewing patient mobility patterns for prostate cancer radiotherapy in Chapter 5 “Hospital quality factors influencing the mobility of patients for radical prostate cancer radiation therapy: a national population based study”.

With respect to prostate cancer surgery, it was noted during the time-period of the analysis (2010-2014), detailed in Chapter 4 “Determinants of patient mobility for prostate cancer surgery: a population-based study of choice and competition”, that some centres closed.
their radical prostatectomy service. At the same time, there was an increase in the numbers of centres performing robot-assisted procedures. The subsequent analysis in Chapter 6 therefore investigated whether there was an association between the net gains and losses of patients by individual providers and the intensity of hospital competition, on both the observed closures of centres and the adoption of robotic surgical equipment. The output of this component of the research was published as a separate empirical research paper:

“Effect of patient choice and hospital competition on service configuration and technology adoption within cancer surgery: a national population based study”

See Chapter 6, Pages 87-98

The fourth component of the study analysed the impact of hospital competition on patient outcomes following prostate cancer surgery using multilevel regression modelling. The creation of a competitive environment to support patient choice and to provide incentives for hospitals to compete with each other is in conflict with policies that seek to centralise services into fewer centres. Centralisation aims to improve quality by eradicating very low volume surgery and to increase the number of procedures performed by remaining centres. To assess the effects of these two policies, the analysis in this chapter compares the relative impact of both hospital procedure volume and hospital competition on patient outcomes following a radical prostatectomy whilst adjusting for relevant case-mix criteria. The results of the analysis have been presented as a research paper, which has been submitted for publication:

Impact of hospital volume and hospital competition on patient outcomes following prostate cancer surgery: a national population-based study

See Chapter 7, Pages 99-128
The **fifth component** of the study utilised qualitative research methods to understand what factors inform and influence where patients choose to receive prostate cancer treatment. This involved interviews with men previously treated for prostate cancer. Men were recruited through a UK wide prostate cancer support organisation called “Tackle prostate cancer” which is composed of 55 member groups. Semi-structured interviews were undertaken with twenty-five men and the results of the analysis have been presented as a research paper, which has been submitted for publication:

“Hospital choice in the context of a cancer diagnosis: a qualitative study”

*See chapter 8, Pages 129-161*

The quantitative and qualitative components of the research were intended to be complimentary as part of a mixed methods approach to understanding how patient choice was operating within the NHS. Both sets of analyses were undertaken during the same time-period and continually evolved as part of an iterative process. For instance, factors identified within the qualitative component that have influenced choice of prostate cancer provider were assessed within the empirical model using data on actual patient visits. Likewise, the findings of the quantitative component influenced the sampling framework and the topic guide for the semi-structured interviews.

During the course of the study it was also decided to interview prostate cancer specialists (Urologists, Oncologists) working in England to help triangulate and contextualise the findings from the qualitative and quantitative studies. In total, I spoke to twenty specialists across England. The findings provided further depth to the interpretation and policy implications of my empirical findings, but have not been reported as a specific chapter in the thesis.
2.4 Data Sources

Data for the quantitative component of the study was made available through the National Cancer Registration Service in England (NCRS), which provided a linked patient level extract incorporating three data sources – Cancer Registry, Hospital Episode Statistics (HES), and The National Radiotherapy Dataset (RTDS). At the start of the PhD, linked data was available for men treated between 2010-2014 inclusive.

I had access to the data through my affiliation with the National Prostate Cancer Audit (NPCA) based at the Clinical Effectiveness Unit of the Royal College of Surgeons. The PhD research project was designed and developed by me prior to receiving funding from the National Institute for Health Research. The PhD project fits within the wider service evaluation projects that the NPCA undertakes to provide a better understanding of the determinants of variations in processes and outcomes of prostate cancer care.

Other data sources available through the NPCA include:

1. **NPCA Organisational survey** – a comprehensive review of the configuration of prostate cancer services in England also detailing the availability of essential diagnostics, staging and therapeutic facilities (e.g. robotic surgery) (Royal College of Surgeons of England, 2014).

2. **Performance indicators** – these were developed as part of the NPCA using Hospital Episode Statistics and include length of stay, 30-day emergency re-admission rates and incidence of urinary complications within 2 years of surgery. Data was available
2.5 Ethics

2.5.1 Quantitative Component

Anonymised non-identifiable secondary level patient data from the National Cancer Registration Service (NCRS) was used to undertake the quantitative analysis. The personal details only included age, ethnicity and lower layer super output areas (LSOAs) and no further identifiers. Regulatory approval, data security and governance procedures had already been established as part of the NPCA through which the data was available. Given that the PhD involved the use of anonymised secondary data, NHS REC approval was not sought in accordance with their guidelines. I received approval from the NPCA data controller, The Health Quality Improvement Partnership (HQIP), to use data collected from the audit for the purposes of my research.

2.5.2 Qualitative component

This study involved in-depth interviews with human subjects regarding personal and potentially sensitive issues related to their health, health care or in the case of health care professionals their place of work. It was therefore essential that the research methodology employed ensured the privacy, confidentiality and respect of all participants.

Participants were not recruited from the NHS and no component of the research took place on NHS premises, therefore NHS ethics was not required. Approval from the LSHTM Observational/Interventions Research Ethics Committee was therefore sought on 29th April 2015. Approval was granted on the 11th June 2015. See Appendix A (page 204) for a copy of the ethics approval.
3. RESULTS CHAPTER 1

3.1 Systematic Review

The first component of the research was a systematic review of the published literature to assess whether there is any empirical evidence of patient mobility for elective secondary care services in response to patient choice policies. The results have been presented in the form of the published article.

3.2 Research paper 1

Patient mobility for elective secondary healthcare services in response to patient choice policies: a systematic review

The online PDF can be accessed at:

RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

<table>
<thead>
<tr>
<th>Student</th>
<th>Ajay Aggarwal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Supervisor</td>
<td>Jan van der Meulen</td>
</tr>
<tr>
<td>Thesis Title</td>
<td>Evidence and impact of NHS choice and competition policies on the delivery of prostate cancer services: a national population based evaluation</td>
</tr>
</tbody>
</table>

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

<table>
<thead>
<tr>
<th>Where was the work published?</th>
<th>Medical Care Research and Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>When was the work published?</td>
<td>June 2016</td>
</tr>
<tr>
<td>If the work was published prior to registration for your research degree, give a brief rationale for its inclusion</td>
<td></td>
</tr>
<tr>
<td>Have you retained the copyright for the work?*</td>
<td>YES</td>
</tr>
</tbody>
</table>

*If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.

SECTION C – Prepared for publication, but not yet published

<table>
<thead>
<tr>
<th>Where is the work intended to be published?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Please list the paper’s authors in the intended authorship order:</td>
<td></td>
</tr>
<tr>
<td>Stage of publication</td>
<td></td>
</tr>
</tbody>
</table>

SECTION D – Multi-authored work

| For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary) | I designed the study, carried out the review and analysis, and wrote the first draft of the manuscript |

Student Signature: ________________________________ Date: 22.09.17

Supervisor Signature: ________________________________ Date: 22 Sept 2017

Improving health worldwide www.lshtm.ac.uk
Patient Mobility for Elective Secondary Health Care Services in Response to Patient Choice Policies: A Systematic Review

Ajay Aggarwal¹, Daniel Lewis¹, Malcolm Mason², Richard Sullivan³, and Jan van der Meulen¹

Abstract
Our review establishes the empirical evidence for patient mobility for elective secondary care services in countries that allow patients to choose their health care provider. PubMed and Embase were searched for relevant articles between 1990 and 2015. Of 5,994 titles/abstracts reviewed, 26 studies were included. The studies used three main methodological models to establish mobility. Variation in the extent of patient mobility was observed across the studies. Mobility was positively associated with lower waiting times, indicators of better service quality, and access to advanced technology. It was negatively associated with advanced age or lower socioeconomic backgrounds. From a policy perspective we demonstrate that a significant proportion of patients are prepared to travel beyond their nearest provider for elective services. As a consequence, some providers are likely to be “winners” and others “losers,” which could result in overall decreased provider capacity or inefficient utilization of existing services. Equity also remains a key concern.

Keywords
patient choice, provider competition, patient mobility, hospital bypassing

This article, submitted to Medical Care Research and Review on February 17, 2016, was revised and accepted for publication on May 18, 2016.

¹London School of Hygiene and Tropical Medicine, London, UK
²Cardiff University, Cardiff, UK
³King’s College London, London, UK

Corresponding Author:
Ajay Aggarwal, Department of Health Services Research and Policy, London School of Hygiene and Tropical Medicine, 15-17 Tavistock Place, London WC1H 9SH, UK.
Email: ajay.aggarwal@lshtm.ac.uk
Introduction

A number of high-income countries have introduced policies that enable patients to select a health care provider of their choice with the aim of increasing service capacity, enhancing efficiency, and improving the quality of health care delivered (Dixon, Robertson, & Bal, 2010; France & Taroni, 2005; Magnussen, Vrangbæk, & Saltman, 2009). It is expected that by publicly reporting information on the quality of providers’ services, patients will select a provider that best meets their needs. From the provider perspective, it is anticipated that this “competition in the market” offers a stimulus to become more responsive and patient-centered, thus improving performance (Berwick, James, & Coye, 2003).

Given the costs associated with reconfiguring the health care system to support patient choice and to encourage competition between providers, it is essential to understand how patients have responded to the introduction of these policies. A key question is therefore whether “patient choice” policies have encouraged patients to actively choose their provider (Dusheiko, 2014).

Studies attempting to answer this question have predominantly used data derived from surveys, asking individuals about recent health care episodes or their responses to hypothetical scenarios (Dixon, Robertson, Appleby, Burge, & Devlin, 2010; Finlayson, Birkmeyer, Tosteson, & Nease, 1999; Schwartz, Woloshin, & Birkmeyer, 2005; Victoor, Delnoij, Friele, & Rademakers, 2012). Other studies have used actual patient data from hospital or primary care episodes (Haynes, Lovett, & Sunnenberg, 2003). However, the latter studies are limited as they can only ascertain where patients were being treated and not whether they made an active choice. Furthermore, it is not possible to determine to what extent these choices were influenced by primary care physicians.

Given the inherent challenges associated with establishing active choice, one can instead ask a different empirical question: namely, whether there is evidence that patients seek care at hospitals other than their nearest. This question is related to the concept of “patient mobility.”

Even accounting for individual characteristics, the extent to which patients are able to move to alternative providers will depend on a number of circumstances, including area characteristics (e.g., urban vs. rural), the health care setting (e.g., primary vs. secondary care), the urgency of the clinical condition requiring medical support (e.g., emergency vs. elective), and the severity of the intervention (e.g., cataract surgery vs. coronary artery bypass grafting). Furthermore, the configuration of the health care market varies significantly between countries, with patient opportunity to choose dependent on organizational structures, systems of financing, and the geographical organization of specialist services.

Therefore, in this systematic review we aim to establish the evidence for patient mobility for elective services in the secondary care setting in countries that have introduced policies that enable patients to choose their health care provider. We also assess the methodological approaches used to describe patient mobility and analyze to what extent patient mobility is associated with patient, provider, and area characteristics.
Method

Search Strategy

A combined search was performed in Pubmed and Embase for articles published between January 1, 1990 and June 30, 2015 (Appendix A). Search terms were defined and modified iteratively following an initial broad search of the literature and a consultation with the authors of some retrieved studies.

Inclusion Criteria

Published full text empirical studies that investigated patient mobility and its determinants using information on the patients’ residence (e.g., zip code, county) and their actual secondary care episodes were considered for inclusion.

Two distinct types of study relating to patient mobility were identified from the preliminary analysis. The first type determines whether or not patients travel beyond their nearest secondary care provider(s) to receive care. The second type assesses the relative impact that distance on one hand and provider characteristics (e.g., quality) on the other hand have on patients’ choice of provider. Both study types were considered for inclusion and we describe the different models within these types in our “Results” section.

Only studies investigating patient mobility in European, North American (Canada and the United States) and Australasian countries, (Australia and New Zealand only) were considered. Countries had to have introduced patient choice policies in which providers are expected to compete on the basis of quality, mainly through publicly reporting indicators of provider-level performance (http://www.nhs.uk/pages/home.aspx; http://www.kiesbeter.nl/; Swedish Association of Local Authorities and Regions, 2013; Vrangbæk, Robertson, Winblad, Van de Bovenkamp, & Dixon, 2012)

Study participants must have been enrolled in a voluntary, tax-based, or social health insurance scheme and received elective (or non-emergency) outpatient/inpatient services in a secondary care setting. Only studies published in English and in peer-reviewed journals were considered for inclusion.

Exclusion Criteria

A key aspect of our study is to understand the patient and provider factors that influence where patients receive care. Therefore, we excluded studies that review patterns of mobility primarily reflecting insurer preferences for particular providers (e.g., through selective contracting and use of explicit financial incentives to channel patients to preferred providers; Boonen, Donkers, & Schut, 2011; Rosenthal, Li, & Milstein, 2009). For the same reason, we also excluded studies focusing on physician referral patterns because they primarily reflect physician preferences (Ringard, 2010).

Studies reviewing cross-border mobility were excluded. Also, studies reviewing patient mobility in the acute care setting (i.e., emergency hospital visits) were excluded.
as decisions regarding location of secondary care are constrained by the patients’ clinical condition and the necessity for urgent treatment.

Longitudinal studies that looked at the impact of the publication of performance indicators on hospital volumes or the effect of hospital competition on treatment outcomes, were excluded as they provide no explicit information on the impact of patient and provider characteristics on mobility or assessment of where patients are expected to receive their treatment based on their residence (Cooper, Gibbons, Jones, & McGuire, 2011; Cutler, Huckman, & Landrum, 2004; Laverty et al., 2012).

Articles that were published after 1990 but which used pre-1990 patient-level data were also excluded for the following reasons. First, introduction of provider choice policies did not occur before 1990 in most European countries. Second, reconfiguration of specialist services due to centralization after 1990 has influenced the choice of available providers. Third, there has been an increase in the quantity and quality of publicly available information to inform provider choice over the same period.

**Data Selection**

AA and DL independently selected articles that met the inclusion criteria based on titles and abstracts. When there was uncertainty about whether an article fulfilled the inclusion criteria, it was included for full text review. In the next stage, full text articles were reviewed independently by AA and DL. Final inclusion was based on consensus. Disagreements were resolved following discussion with JvdM. Reference lists from included studies were hand-searched for additional potentially relevant articles.

**Data Extraction**

AA independently extracted study data and consulted DL and JvdM in case of uncertainty. Data extracted included: location of study; geographical unit of analysis (regional vs. national); secondary care context (intervention/service[s] patients received), source of data (e.g., hospital discharge records); time-frame of analysis; study sample size and exclusion criteria; model for estimating patient mobility; definition of “expected” provider; construction of hospital “choice sets”; proportion of patients travelling beyond their expected provider(s); patient and provider characteristics analyzed; statistical analysis.

For “expected” provider(s) we refer to the nearest provider(s) offering the relevant intervention given the patient’s clinical condition. For hospital “choice sets,” we refer to the selection of hospitals that offer the relevant intervention as defined by the study authors. For example, this may include all hospitals within a threshold distance or region.

**Study Assessment**

The studies selected are best described as cross-sectional studies. A review of published checklists and scoring scales for systematic reviews was undertaken to identify the appropriate tool to assess the selected studies (Higgins & Green, 2008; Sanderson,
Tatt, & Higgins, 2007); however, no suitable tool was found. A 10-item checklist was therefore created and validated (Appendix B) with reference to previously published relevant checklists for observational studies (Loney, Chambers, Bennett, Roberts, & Stratford, 1998; Munn, Moola, Riitano, & Lisy, 2014; Vandenbroucke et al., 2007).

One of the methodological challenges faced in using patient mobility as a proxy for patient choice is to separate the impact of patient choice from that of other factors. Patient mobility has been conceptualized as conforming to three distinct categories (Ringard, Rico, & Hagen, 2005; Tessier, Contandriopoulos, & Dionne, 1985). First, mobility due to patient choice; second, mobility due to primary care or secondary care referral preferences induced by physicians; and third, mobility due to insufficient local supply. In reality there are inherent difficulties in separating mobility due to patient choice and physician preferences given that these decisions are rarely mutually exclusive.

A key component of our checklist was therefore to assess whether the authors had accounted for, and adequately measured, relevant patient and health system factors that influenced patient mobility in order to identify “true movers.” “True movers” are considered to be individuals who travel beyond their nearest provider to an alternative provider without the biasing effect of health system factors (e.g., explicit financial incentives to choose particular providers). AA and DL independently assessed the selected articles according to each item on the checklist. Disagreements were resolved following discussion with JvdM.

**Results**

A total of 5,994 titles and abstracts were assessed for eligibility of which 54 were selected for full text review (Figure 1). Twenty-two publications were included in the final analysis (Balia, Brau, & Marrocu, 2014; Basu, 2005; Beukers, Kemp, & Varkevisser, 2014; Chernew, Scanlon, & Hayward, 1998; Cook et al., 2009; Escarce & Kapur, 2009; Fabbri & Robone, 2010; Fattore, Petrarca, & Torbica, 2014; Hanning, Ahl, Winblad, & Lundstrom, 2012; Howard, 2006; Kronebusch, 2009; Losina et al., 2007; Messina, Forni, Collini, Quercioli, & Nante, 2013; Nostedt et al., 2014; Pope, 2009; Radcliffe, Brasure, Moscovie, & Stensland, 2003; Roh, Lee, & Fottler, 2008; Roh & Moon, 2005; Saunders, Bellamy, Menachemi, Chukmaitov, & Brooks, 2009; Sivey, 2012; Varkevisser & van der Geest, 2007; Varkevisser, van der Geest, & Schut, 2010, 2012). The reference lists of selected articles were hand-searched and a further four articles (Beckert, Christensen, & Collyer, 2012; Ho, 2006; Moscone, Tosetti, & Vittadini, 2012; Roh & Moon, 2005) met the inclusion criteria. A total of 26 articles were included in the final analysis. All articles were retrospective cross-sectional studies using administrative data on actual patient visits.

**Models to Assess Patient Mobility**

We found that the studies used three main methodological models to assess mobility. Two of the models fit within the first type of studies (determining whether or not
patients travel beyond their nearest provider; see the “Method” section). We refer to these as the “hospital bypassing model” (estimating the proportion of patients traveling beyond their expected provider for a particular intervention/service) and as the
“regional model” (estimating the proportion of patients traveling outside a predefined geographical region based on their place of residence).

A third model fits within the second type of studies (assessing the relative impact of distance and provider characteristics on the choice of provider). In this article, this is referred to as the “patient choice model.”

Table 1 outlines the key characteristics of each study according to the three models that we used to assess mobility. The studies were conducted in six countries: United States—12 studies; Italy—5 studies; Netherlands—4 studies; England—3 studies; Sweden—1 study; and Canada—1 study. Of the five studies analyzing regional mobility, four were from Italy. Seven of the 10 studies using the hospital bypassing model were undertaken in the United States.

Coronary artery bypass grafting, percutaneous coronary intervention (Cherniew et al., 1998; Moscone et al., 2012), cataract surgery, and joint replacement surgery (Beckert et al., 2012; Beukers et al., 2014; Losina et al., 2007) were the commonest elective interventions analyzed. Other studies looked at a mix of surgical and medical admissions or a variety of admission types related to a particular secondary care discipline (e.g., neurosurgical services, HIV services, cancer; Cook et al., 2009; Varkevisser & van der Geest, 2007).

**Definition of “Expected Provider” and “Choice Set”**

A number of different definitions for the expected provider were used across the selected studies (Table 1). In the majority of studies using the hospital bypassing model this was the nearest provider. However, other definitions included all providers within a threshold distance or a specific area code (Escarce & Kapur, 2009; Saunders et al., 2009). The expected provider(s) in studies using the regional model were all hospitals within an administrative or governmental region.

The choice set was constrained in some of the studies using the patient choice model to providers within a defined regional area (Moscone et al., 2012; Pope, 2009). However, other definitions were evident. For example, in a Dutch study using the patient choice model for neurosurgical services, only hospitals within an hour of the patient’s residence were included in the choice set. The authors assumed that individuals traveling further were away from home when they needed health care (Varkevisser et al., 2010). Similarly in a U.K. study, the choice set only included the nearest 10 hospitals receiving more than 30 cataract referrals from the patients’ primary care physicians (Sivey, 2012).

**Extent of Mobility**

All studies showed evidence of patient mobility in response to provider choice policies. For those studies using the hospital bypassing mode, rates ranged from 23% to 76% (Basu, 2005; Cook et al., 2009; Escarce & Kapur, 2009; Losina et al., 2007; Nostedt et al., 2014; Radcliff et al., 2003; Roh et al., 2008; Saunders et al., 2009; Varkevisser & van der Geest, 2007).
Table 1. Descriptive Analysis of Selected Articles (n = 26) Stratified According to Methodological Model.

<table>
<thead>
<tr>
<th>Study and setting</th>
<th>Geographical unit</th>
<th>Time period analyzed</th>
<th>Secondary care discipline</th>
<th>Intervention</th>
<th>Number of patient hospital episodes</th>
<th>Definition of expected provider(s)</th>
<th>Definition of “choice set”</th>
<th>Percentage travelling beyond expected provider (%)</th>
<th>Determinants of mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital bypassing model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nostetic (2014) Canada</td>
<td>One region</td>
<td>2004-2006 Surgery</td>
<td>Colorectal cancer surgery (Type N5)</td>
<td>2,086</td>
<td>8 nearest rural hospitals performing cancer surgery</td>
<td>Any hospital beyond eight nearest rural cancer surgery providers</td>
<td>(1) 46.5% bypass all rural cancer centers for rectal cancer surgery. (2) 28.8% bypass all rural cancer centers for colon cancer surgery</td>
<td>Provider characteristics—Provider reputation, Patient characteristics—Disease severity</td>
<td></td>
</tr>
<tr>
<td>Escare (2009) USA</td>
<td>One region</td>
<td>2000 Medicine</td>
<td>(1) Surgery (2) Medicine (3) Obstetrics (4) Pediatrics</td>
<td>NA</td>
<td>All hospitals within threshold distance</td>
<td>Any hospital beyond threshold distance</td>
<td>76.30%</td>
<td>Accessibility—Distance, Provider characteristics—Hospital size, advanced technology, Patient characteristics—Health insurance plan</td>
<td></td>
</tr>
<tr>
<td>Saunders (2009) USA</td>
<td>One region</td>
<td>1997-2004 Medicine</td>
<td>(1) Colonoscopy, (2) Endoscopy</td>
<td>3,543,194</td>
<td>Hospitals within patient zip code providing endoscopy services</td>
<td>Any hospital or ambulatory care center beyond patient zip code offering endoscopy services</td>
<td>52.5% for Colonoscopy, 45.4% for Upper GI endoscopy</td>
<td>Accessibility—Distance, Patient characteristics—Health insurance plan, ethnicity</td>
<td></td>
</tr>
<tr>
<td>Roh (2008) USA</td>
<td>One region</td>
<td>2000-2003 Obstetrics and Gynecology</td>
<td>NA</td>
<td>10,384</td>
<td>Nearest rural hospital</td>
<td>Any hospital beyond nearest rural provider</td>
<td>36.30%</td>
<td>Accessibility—Distance, Provider characteristics—Degree of market competition, Patient Characteristics—Health insurance plan</td>
<td></td>
</tr>
<tr>
<td>Losina (2007) USA</td>
<td>National</td>
<td>2000 Surgery</td>
<td>Knee replacement</td>
<td>113,015</td>
<td>Nearest hospital plus any hospitals within 2 miles of that hospital</td>
<td>Any hospital beyond 2 miles of patient’s nearest provider</td>
<td>42.70%</td>
<td>Provider characteristics—Provider quality, Patient characteristics—Ethnicity, socioeconomic status, urban residence</td>
<td></td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study and setting</th>
<th>Geographical unit</th>
<th>Time period analyzed</th>
<th>Secondary care discipline</th>
<th>Intervention</th>
<th>Number of patient hospital episodes</th>
<th>Definition of expected provider(s)</th>
<th>Definition of “choice set”</th>
<th>Percentage travelling beyond expected provider (%)</th>
<th>Determinants of mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verkuijst (2007)</td>
<td>National</td>
<td>2003</td>
<td>Surgery</td>
<td>Neurosurgical/orthopedic outpatient visit</td>
<td>58,475</td>
<td>Nearest hospital providing neurosurgical or orthopedic services</td>
<td>Any hospital beyond nearest provider offering neurosurgical services</td>
<td>40% for orthopedic services. 50% for neurosurgical services</td>
<td>Accessibility—Travel time Provider characteristics—Waiting times, provider quality; Patient characteristics—Patient comorbidity, age, socioeconomic status, intervention type</td>
</tr>
<tr>
<td>Roh (2005)</td>
<td>One region</td>
<td>1993-2000</td>
<td>Obstetrics</td>
<td>NA</td>
<td>19,618</td>
<td>Nearest rural hospital</td>
<td>Any hospital beyond nearest rural provider</td>
<td>NA</td>
<td>Provider characteristics—Advanced technology; Patient characteristics—Health insurance plan, disease severity, age, ethnicity</td>
</tr>
<tr>
<td>Patient choice model</td>
<td>National</td>
<td>2008-2010</td>
<td>Surgery</td>
<td>Hip replacement</td>
<td>56,236</td>
<td>Nearest hospital providing orthopedic services</td>
<td>All 92 hospitals providing orthopedic services in Netherlands</td>
<td>NA</td>
<td>Accessibility—Travel time; Provider Characteristics—Waiting time, Provider quality; Patient characteristics—Gender, Age &gt; 60 years</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study and setting</th>
<th>Geographical unit</th>
<th>Time period analyzed</th>
<th>Secondary care discipline</th>
<th>Intervention</th>
<th>Number of patients</th>
<th>Definition of expected hospital episodes</th>
<th>Definition of “choice set”</th>
<th>Percentage travelling beyond expected provider (s)</th>
<th>Determinants of mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beckert (2012)</td>
<td>National</td>
<td>2008-2009</td>
<td>Surgery</td>
<td>Hip replacement</td>
<td>39,060</td>
<td>Nearest hospital</td>
<td>30 nearest hospitals to the patient providing orthopedic services</td>
<td>40% bypass nearest hospital</td>
<td>Accessibility—Distance; Provider characteristics—Provider quality, waiting times; Patient characteristics—Age, socioeconomic status</td>
</tr>
<tr>
<td>Moncena (2012)</td>
<td>National</td>
<td>2004-2007</td>
<td>(1) Surgery, (2) Medicine</td>
<td>(1) CABG, (2) PCI</td>
<td>230,600</td>
<td>Nearest hospital</td>
<td>All hospitals within region (n = 44)</td>
<td>45% bypass hospitals within 15km of residence. 15% bypass hospitals within 50 km of residence</td>
<td>Accessibility—Distance; Provider characteristics—Hospital size, private hospital; Patient Characteristics—Social network effect, prior hospital use</td>
</tr>
<tr>
<td>Verkeijsse (2012)</td>
<td>National</td>
<td>2006</td>
<td>Medicine</td>
<td>PCI</td>
<td>2,670</td>
<td>Nearest hospital providing neurosurgery services</td>
<td>All hospitals within threshold travel time providing neurosurgery services</td>
<td>NA</td>
<td>Provider characteristics—Provider quality, provider reputation (clinical/nonclinical staff assessment)</td>
</tr>
<tr>
<td>Sivey (2012)</td>
<td>National</td>
<td>2001-2004</td>
<td>Surgery</td>
<td>Cataract</td>
<td>87,128</td>
<td>Nearest hospital receiving &gt;30 cataract referrals for each GP practice</td>
<td>Nearest 10 hospitals receiving &gt;30 cataract referrals for each GP practice</td>
<td>NA</td>
<td>Accessibility—Travel time, waiting time; Patient Characteristics—Rural residence</td>
</tr>
<tr>
<td>Verkeijsse (2010)</td>
<td>National</td>
<td>2003</td>
<td>Surgery</td>
<td>Neurosurgical outpatient visit</td>
<td>5,389</td>
<td>Nearest hospital providing PCI</td>
<td>All hospitals within threshold travel time providing PCI</td>
<td>NA</td>
<td>Accessibility—Travel time, Provider characteristics—Provider reputation (clinical/nonclinical staff assessment), waiting time; Patient Characteristics—Gender, retired status, lower socioeconomic status</td>
</tr>
<tr>
<td>Study and setting</td>
<td>Geographical unit</td>
<td>Time period analyzed</td>
<td>Secondary care discipline</td>
<td>Intervention</td>
<td>Number of hospital episodes</td>
<td>Definition of expected provider(s)</td>
<td>Definition of “choice set”</td>
<td>Percentage travelling beyond expected provider(s)</td>
<td>Determinants of mobility</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>--------------------------</td>
<td>--------------</td>
<td>---------------------------</td>
<td>-----------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Pope (2009)</td>
<td>USA, one state plus sample of other states</td>
<td>1998-2004</td>
<td>Medicine</td>
<td>Cardiology (Mixed services)</td>
<td>28,647</td>
<td>Nearest hospital</td>
<td>All hospitals within statewide sample (n = 164)</td>
<td>NA</td>
<td>Provider Characteristics—Provider quality</td>
</tr>
<tr>
<td>Ho (2006)</td>
<td>USA, five regions</td>
<td>1997-1998</td>
<td></td>
<td>Cancer, Obstetrics, Surgery, Medicine</td>
<td>NA</td>
<td>Nearest hospital</td>
<td>All hospitals within threshold distance</td>
<td>NA</td>
<td>Accessibility—Distance; Provider Characteristics—Advanced technology</td>
</tr>
<tr>
<td>Howard (2006)</td>
<td>USA, National</td>
<td>2000-2002</td>
<td>Surgery</td>
<td>Kidney transplant</td>
<td>36,991</td>
<td>Nearest kidney transplant center</td>
<td>Individualized for each patient based on threshold distance and location of nearest kidney transplant provider</td>
<td>NA</td>
<td>Accessibility—Distance; Provider Characteristics—Age, ethnicity, socioeconomic status, health insurance plan, disease severity</td>
</tr>
<tr>
<td>Chernow (1998)</td>
<td>USA, one region</td>
<td>1991</td>
<td>Surgery</td>
<td>CABG</td>
<td>8,000</td>
<td>Nearest hospital providing CABG</td>
<td>All hospitals within threshold distance</td>
<td>NA</td>
<td>Accessibility—Distance; Provider Characteristics—Provider quality; Patient Characteristics—Health insurance plan</td>
</tr>
</tbody>
</table>

(continued)
### Table 1. (continued)

<table>
<thead>
<tr>
<th>Study and setting</th>
<th>Geographical unit</th>
<th>Time period analyzed</th>
<th>Secondary care discipline</th>
<th>Intervention</th>
<th>Number of patient hospital episodes</th>
<th>Definition of expected provider(s)</th>
<th>Definition of “choice set”</th>
<th>Percentage travelling beyond expected provider (s)</th>
<th>Determinants of mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baldo (2014) Italy</td>
<td>National</td>
<td>2008</td>
<td>(1) Surgery, (2) Medicine</td>
<td>NA</td>
<td>863,953</td>
<td>All hospitals within patient’s administrative region of residence</td>
<td>All administrative regions within Italy</td>
<td>25.10%</td>
<td>Accessibility—Distance; Region Characteristics—Provider capacity (beds), GDP per capita of region, advanced technology, proportion of population &gt;65 years; Provider Characteristics—Private center; Patient Characteristics—Age; Region Characteristics—Region of residence, region size, population size.</td>
</tr>
<tr>
<td>Fatto (2014) Italy</td>
<td>National</td>
<td>2009</td>
<td>Surgery</td>
<td>Aortic valve replacement</td>
<td>11,531</td>
<td>All hospitals within patient’s administrative region of residence</td>
<td>All administrative regions within Italy</td>
<td>13.60%</td>
<td>Provider Characteristics—Private center; Patient Characteristics—Age; Region Characteristics—Region of residence, region size, population size.</td>
</tr>
<tr>
<td>Messina (2013) Italy</td>
<td>One region</td>
<td>2001-2007</td>
<td>Surgery</td>
<td>Cardiac (Type NS)</td>
<td>23,645</td>
<td>All cardiac units within patient’s health area</td>
<td>All three health areas within patient’s region</td>
<td>27%</td>
<td>Patient Characteristics—Disease severity; Region Characteristics—Local health area.</td>
</tr>
<tr>
<td>Fabbri (2010) Italy</td>
<td>National</td>
<td>2001</td>
<td>(1) Medicine, (2) Surgery</td>
<td>(1) Cancer (Mixed services), (2) Complex surgery (Type NS)</td>
<td>3,674</td>
<td>All hospitals within patient’s local health authority of residence</td>
<td>171 local health authorities within Italy</td>
<td>42% for cancer treatment, 58% for complex surgery.</td>
<td>Region Characteristics—GDP per capita of region, advanced technology, regional contiguity.</td>
</tr>
</tbody>
</table>

Note. NA = not applicable; NS = not stated; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting. Refer to the “Results” section for description of methodological models. “Expected Provider” defined as the nearest provider(s) offering the relevant intervention given the patient’s clinical condition. “Choice Set” defined as the selection of hospitals that offer the relevant intervention as defined by the study authors. Studies by Beckert (2012) and Moscone (2012) classified as patient choice model, but also used hospital bypass model as part of an initial analysis to quantify extent of mobility.


Distant Admission

Threshold distances were also used to define local and distant admissions (Basu, 2005; Escarce & Kapur, 2009; Radcliff et al., 2003; Saunders et al., 2009). In most cases, these thresholds were defined arbitrarily; however, one study created a threshold based on average distances travelled to local hospitals by patients living within the same county. Different thresholds were subsequently created according to admission type and county of residence (Basu, 2005).

Two studies used a series of increasing threshold distances to analyze patterns of mobility (Radcliff et al., 2003; Saunders et al., 2009). The results of both studies demonstrated that while patients are prepared to bypass their nearest provider, there is a threshold distance above which patients are rarely prepared to travel to receive care at an alternative center. Furthermore, the Saunders study showed that rates of hospital bypassing increased between 10 and 20 miles to 30 to 50 miles but sharply decreased beyond 30 to 50 miles (Saunders et al., 2009).

Other studies, assessed not only whether rural patients bypassed their nearest provider but whether their destination provider was a rural or urban center (Roh et al., 2008; Roh & Moon, 2005). Urban admissions were considered as a proxy for distant admission and analyzed separately to those admissions at other rural providers.

Determinants of Patient Mobility

As can be expected, all studies, irrespective of the model they used to study patient mobility, showed that accessibility to a provider has an important effect on patient mobility. Patients are more likely to receive treatment from their nearest provider (either measured in terms of distance or travel time) or at a hospital located within their region (Balia et al., 2014; Beckert et al., 2012; Beukers et al., 2014; Chernew et al., 1998; Escarce & Kapur, 2009; Ho, 2006; Howard, 2006; Kronebusch, 2009; Moscone et al., 2012; Roh et al., 2008; Saunders et al., 2009; Sivey, 2012; Varkevisser et al., 2010, 2012; Varkevisser & van der Geest, 2007).

Studies using the hospital bypassing or patient choice models considered the impact of patient and provider characteristics at the patient level on decisions to bypass or choose a particular provider (Tables 1 and 2). In contrast, the studies using the regional model considered measures describing providers at a regional level and their impact on the flow of patients between regions.

For patient characteristics, 10 out of the 17 studies that reported results demonstrated that older patients were more likely to receive treatment from their nearest hospital (Balia et al., 2014; Basu, 2005; Beckert et al., 2012; Beukers et al., 2014; Cook et al., 2009; Fattore et al., 2014; Hanning et al., 2012; Howard, 2006; Roh & Moon, 2005; Varkevisser & van der Geest, 2007). Six out of nine studies demonstrated that patients in lower socioeconomic groups were more likely to receive treatment from their nearest providers (Beckert et al., 2012; Cook et al., 2009; Howard, 2006; Losina et al., 2007; Varkevisser et al., 2010; Varkevisser & van der Geest, 2007).
<table>
<thead>
<tr>
<th>Study</th>
<th>Study described in detail?</th>
<th>Data source</th>
<th>Inclusion/ exclusion criteria specified?</th>
<th>Was the study population representative?</th>
<th>Secondary care context described in detail?</th>
<th>Appropriate hospital choice set?</th>
<th>Appropriate statistical analysis?</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Socio-economic status</th>
<th>Insurance status</th>
<th>Disease severity</th>
<th>Concomitant illnesses</th>
<th>Provider capacity</th>
<th>GP referral partners</th>
<th>Copeyments</th>
<th>Provider characteristics</th>
<th>Provider quality</th>
<th>Regional characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balza (2014)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>National administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Beekers (2014)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>National administrative database</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fantone (2014)</td>
<td>Yes</td>
<td>Inter-regional model</td>
<td>National administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Nottecott (2014)</td>
<td>No</td>
<td>Hospital bypassing model</td>
<td>Disease-specific registry</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Messina (2013)</td>
<td>Yes</td>
<td>Inter-regional model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Beckers (2012)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>National administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hanning (2012)</td>
<td>Yes</td>
<td>Inter-regional model</td>
<td>Disease-specific registry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Moscone (2012)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Vankerwaar (2012)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Health insurance claims database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Sney (2011)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>National administrative database</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fabri (2010)</td>
<td>Yes</td>
<td>Inter-regional model</td>
<td>National administrative database</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Vankerwaar (2010)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Health insurance claims database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Cook (2009)</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Disease-specific registry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Essoee (2009)</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Kronebusch (2009)</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Regional administrative database</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>NA</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study</th>
<th>Study described in detail?</th>
<th>Study design</th>
<th>Datasource</th>
<th>Inclusion/ exclusion criteria specified?</th>
<th>Was the study population representative?</th>
<th>Secondary care context described in detail?</th>
<th>Appropriate hospital choice set?</th>
<th>Appropriate statistical analysis?</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Socio-economic status</th>
<th>Insurance status</th>
<th>Disease severity</th>
<th>Comorbidities</th>
<th>Provider capacity</th>
<th>GP Referral patterns</th>
<th>Copays</th>
<th>Provider characteristics</th>
<th>Provider quality</th>
<th>Regional characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pope (2009) USA</td>
<td>No</td>
<td>Patient choice model</td>
<td>Regional administrative database</td>
<td>Unclear</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Saunders (2009) USA</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Rah (2008) USA</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>Unclear</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Lusma (2007) USA</td>
<td>No</td>
<td>Patient choice model</td>
<td>Health insurer claims database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Verheugten (2007) USA</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Health insurer claims database</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Ho (2006) USA</td>
<td>No</td>
<td>Patient choice model</td>
<td>Other</td>
<td>Unclear</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Howard (2006) USA</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Disease-specific registry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Basu (2005) USA</td>
<td>No</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>No</td>
<td>Unclear</td>
<td>Unclear</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Rah (2005) USA</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Rudolphi (2003) USA</td>
<td>Yes</td>
<td>Hospital bypassing model</td>
<td>Regional administrative database</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Cherniak (1998) USA</td>
<td>Yes</td>
<td>Patient choice model</td>
<td>Regional administrative database</td>
<td>Unclear</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Note. N/A = not applicable; ✓ = factor accounted for in study; ✗ = factor not accounted for in study.
Six of the eight studies reviewing the impact of ethnicity on patterns of mobility found a statistically significant association (Table 1). Of these, four studies demonstrated that non-White patients were less likely to bypass local rural hospitals than White patients when controlling for all other factors (Basu, 2005; Roh et al., 2008; Roh & Moon, 2005; Saunders et al., 2009). These studies also demonstrated that non-White patients are less likely to travel as far as White patients to receive treatment, especially to providers based in out-of-area urban settings. Two studies found that non-White men and women were less likely to receive care at higher quality hospitals for total hip replacement surgery and kidney transplantation (Howard & Kaplan, 2006; Losina et al., 2004).

In eight of the nine U.S. studies that included patients affiliated with different health insurance plans, the extent of mobility varied depending on health plan type (Basu, 2005; Chernew et al., 1998; Escarce & Kapur, 2009; Howard, 2006; Radcliff et al., 2003; Roh et al., 2008; Roh & Moon, 2005; Saunders et al., 2009). It is not possible to make comprehensive conclusions as to overall trend in patient mobility according to insurance plan type. However, the increased rates of mobility reported for patients with commercial health insurance plans may be due to the potentially greater number of alternative providers that are available to choose from compared with what would be the case with Health Maintenance Organizations, Medicaid, and Medicare plans (Basu, 2005; Roh et al., 2008). Another explanation could be that younger patients and those with employer-sponsored coverage were more responsive to quality-of-care differences between providers and had the means (physical/financial) to access more distant hospitals (Radcliff et al., 2003).

All six studies analyzing the effect of provider capacity (i.e., measured in terms of waiting times for a particular treatment) on patient mobility demonstrated that patients were more likely to move to providers with shorter waiting times (Beckert et al., 2012; Beukers et al., 2014; Hanning et al., 2012; Sivey, 2012; Varkevisser et al., 2010; Varkevisser & van der Geest, 2007).

All eight studies analyzing the effect of proxy measures for provider quality on patient mobility demonstrated that patients are more likely to travel further to receive treatment from providers who deliver a better quality of care according to these measures (Beckert et al., 2012; Beukers et al., 2014; Chernew et al., 1998; Howard, 2006; Kronebusch, 2009; Losina et al., 2007; Moscone et al., 2012; Pope, 2009; Varkevisser et al., 2012; Varkevisser & van der Geest, 2007). Different measures of provider quality were used in each of the studies (e.g., generic mortality rates, hospital infection rates, heart failure readmission rates, transplant failure rates, high volume surgical unit, hospital ranking). Other provider factors that are associated with a willingness to travel further are the availability of advanced technology (although not necessarily for the specialty in question) and a larger hospital (Balia et al., 2014; Escarce & Kapur, 2009; Fabbri & Robone, 2010; Ho, 2006; Roh & Moon, 2005).

In administrative regions with older populations (age >65 years) and high levels of affluence (measured as GDP per capita) patients were less likely to move to providers outside their region. Similarly patients were more likely to seek care within regions that were accessible by public and private transport (Balia et al., 2014; Fabbri & Robone, 2010; Fattore et al., 2014).
Study Assessment

Articles were assessed according to the checklist described in the “Method” section (Table 2). When reviewing the hospital choice sets, we found that 12 of the 26 studies did not state explicitly whether the alternative hospitals offered the particular service in question (Balia et al., 2014; Basu, 2005; Chernew et al., 1998; Cook et al., 2009; Escarce & Kapur, 2009; Fabbri & Robone, 2010; Ho, 2006; Moscone et al., 2012; Pope, 2009; Radcliff et al., 2003; Roh et al., 2008; Roh & Moon, 2005). Also, it is likely that the fitness of the patients and severity of the disease will have an effect on patient mobility, but only six studies assessed disease severity (Basu, 2005; Hanning et al., 2012; Howard, 2006; Messina et al., 2013; Nostedt et al., 2014; Roh & Moon, 2005) and three comorbidity (Kronebusch, 2009; Roh & Moon, 2005; Saunders et al., 2009).

Another important checklist item was that studies accounted for possible effects of copayments on decisions where to have their care or treatment. While some of the U.S. studies chose particular subpopulations (e.g., Medicare patients for whom copayments are generally fixed between providers; Losina et al., 2007; Pope, 2009), 10 of the 12 studies which looked at patients enrolled in a variety of insurance schemes made no account of the impact of variation in copayments on their destination hospital (Basu, 2005; Chernew et al., 1998; Escarce & Kapur, 2009; Ho, 2006; Howard, 2006; Kronebusch, 2009; Radcliff et al., 2003; Roh et al., 2008; Roh & Moon, 2005; Saunders et al., 2009).

Discussion

This is the first review to systematically describe and analyze the published empirical literature on patient mobility for elective services in the secondary care setting. Our review demonstrates that patients travel to a hospital other than their nearest provider for a wide variety of health care interventions.

A further major finding of this review is the identification of three main methodological models (hospital bypassing, regional, and patient choice models) used to analyze patient mobility in different health care markets. Our results demonstrate that the model used to define mobility is influenced by the health care context with no single model providing a single policy frame. For instance, the regional model has been used almost exclusively in the Italian studies, with the key variable being whether or not patients receive treatment in the administrative region they reside in. This is because the organization and administration of publicly financed health care in Italy was decentralized to 20 regions following constitutional reform in 2001 (Balica et al., 2014). Rates of inflow and outflow of patients are analyzed to assess the effectiveness of regional health care supply, and look for flow imbalances which may have an impact on regional budgets (France, Taroni, & Donatini, 2005). Sweden adopts a similar system with health care decentralized to county councils (Vrangbæk, Østergren, Birk, & Winblad, 2007).

In contrast, the United Kingdom, Netherlands, and the United States do not exhibit the same level of regional decentralization and therefore the hospital bypassing and
patient choice models were used to study mobility between health care providers. While clear differences in the nature of the health care market and extent of competition exist, the response of patients to perceived differences in provider quality is an essential component of all these three countries.

A number of the U.S. studies in our review used the hospital bypassing model to analyze the extent of “rural hospital bypassing” (i.e., the proportion of rural residents bypassing their nearest rural provider[s] to access an urban center for a particular intervention; Escarce & Kapur, 2009; Roh & Moon, 2005). The extent to which this is occurring is a particular concern in the United States due to long-standing concerns related to the availability and quality of health care resources in rural settings (Bronstein & Morrissey, 1991; Buczk, 1997; Escarce & Kapur, 2009).

The review demonstrated that variation exists in the proportion of patients moving to alternative providers for elective secondary services (23%-77%). However, we found that the extent of mobility depends on a number of factors. These include, apart from the secondary health care intervention in question, the study methods used and the geographical unit of analysis (national vs. regional).

It is unclear from the available evidence whether such mobility is sufficient for effective competition and improvements in quality. However, the results of this review demonstrate that there are actual changes in market share which may represent a major driver given the extent of mobility reported.

We found that patients were more likely to move to providers considered to be of higher quality, or that offered advanced technologies. However, mobility may have a negative effect on competition by providing increased incentives for risk selection of patients by providers in order to improve their apparent performance according to the selected indicators.

Service capacity may also be an emerging issue for high-performing centers that receive a net gain of patients due to mobility. Without adequate planning, an increased flow of patients from outside the provider catchment area may result in lengthening waiting lists. At the same time, it may result in unused capacity and resources within centers that have a net loss of patients, creating health system inefficiencies.

The effect of patient choice policies on equity remains a key concern, given that older patients and lower socioeconomic groups are less likely to travel beyond their nearest health care provider. The impact of disease complexity or comorbidities on the decision to move between providers is unclear. On the other hand, the outflow of patients from hospitals located in socioeconomically deprived settings may provide the necessary stimulus to improve provider performance and in this way benefit the majority of nonmovers.

One of the challenges in reviewing these studies is to ascertain whether they are able to identify true movers (i.e., mobility due to patient choice rather than health system factors). Our checklist sought to assess the extent to which these factors have been accounted for (Table 2). We found, particularly in the U.S. studies, that there was limited information on the choice set of hospitals available to each patient. As a result, it was not always possible to ascertain whether the choice of available hospitals considered in the study actually provided the service or intervention in question.
It was also not possible to assess the extent of selective contracting of providers by different insurers in the U.S. market, and how centralization of services contributed to patterns of mobility. A further issue in the U.S. studies was the paucity of information on the extent of variation in copayments. It was therefore not always possible to disentangle the impact between price and quality on mobility.

Primary care referral patterns and capacity of available providers (e.g., waiting lists) were rarely considered in the selected studies (Table 2), predominantly because of data constraints. Provider capacity as measured through waiting lists is an important health system factor (Dawson, Gravelle, Jacobs, Martin, & Smith, 2007) which can directly affect patient mobility (Beckert et al., 2012; Beukers et al., 2014; Sivey, 2012).

Conclusion

Provider choice policies have previously been criticized due to the lack of empirical evidence that such policies influence where patients receive treatment (Pollock et al., 2012). Our findings provide substantial evidence that patients are prepared to travel beyond their nearest provider for their care or treatment. It has been hypothesized that the driver for improving provider performance would be the threat of losing market share and that even movement of only 5% to 10% of patients would provide the necessary incentive to improve quality (Berwick et al., 2003; Le Grand, 2009). However, these results suggest that there are likely to be “winners” and “losers” from health care market reforms, which could have an impact on the configuration of existing health care markets if some providers continue to lose market share. There is therefore potentially a trade-off between the effects of mobility on improving provider quality but at the same time decreasing provider capacity.

Equity also remains an issue given that the elderly and low socioeconomic groups are less likely to travel beyond their nearest provider for health care. This in turn may result in hospitals within socioeconomically deprived areas with older demographic profiles having to manage far more complex patient cohorts (both medically and socially), which subsequently affects their quality outcomes.

Further work is required to understand the drivers of patient mobility (e.g., quality, reputation, referral patterns) and its impact on equity in access to services and patient outcomes. In this regard, our checklist for studies of patient mobility provides a framework for developing future research facilitating the comparability of study results.

Appendix A

PubMed Search String

Search (((((((((patient choice*[Title/Abstract]) OR consumer choice*[Title/Abstract]) OR patient preference*[MeSH Terms]) OR patient preference*[Title/Abstract]) OR patient mobility[Title/Abstract]) OR patient travel[Title/Abstract]) OR hospital referral*[MeSH Terms]) OR hospital referral[Title/Abstract]) OR hospital bypassing) OR hospital choice[Title/Abstract]) OR hospital market[Title/Abstract])})
AND (((((health care provider[MeSH Terms]) OR provider*[Title/Abstract]) OR hospital*[Title/Abstract]) OR doctor*[Title/Abstract]) OR Physician*[Title/Abstract]) OR “specialist care”[Title/Abstract]))

Appendix B

Study Checklist

1. Was the study setting described in detail? (Yes/No/unclear/Not applicable)

The study setting should be described in sufficient detail so that others can determine if it is comparable to the population of interest to them. This includes information on the health care environment for a particular country and differences between regions relating to provider choice policy, organization of providers, and system of reimbursement.

2. What study design was used to capture “mobility”? (State one of the following):
   a. Patient choice model
   b. Hospital bypassing model
   c. Interregional model

3. What was the main data source? (State one of the following):
   a. National administrative database
   b. Regional administrative database
   c. Disease-specific registry
   d. Health insurer claims database
   e. Other

4. Were both inclusion and exclusion criteria specified? (Yes/No/unclear/Not applicable)

This includes information on the sampling frame (e.g., entire population, random sample) and an adequate description of the inclusion and exclusion criteria in order to enable a researcher to determine if it is comparable to the population of interest to them.

5. Was the study population representative of the target population? (Yes/No/unclear/Not applicable)

The study subjects should be described in sufficient detail to ascertain whether those subjects who participated were representative of the entire population from which they were recruited.
6. Was the secondary health care context described in detail? (Yes/No/unclear/Not applicable)

The methods should be described in detail providing information on the clinical discipline being analyzed, whether the health care episodes reviewed are inpatient or outpatient based and whether they are elective or emergency care episodes. In addition, there should be information on the intervention(s) that are being analyzed. If multiple interventions or medical disciplines are included, there should be evidence of detailed subgroup analysis to allow an interpretation of differences between different sets of conditions.

7. Is the “hospital choice set” appropriate given intervention and disease status (i.e., do all hospitals offer the intervention being assessed or account for technical requirement of patient) (Yes/No/unclear/Not applicable)

8. Were the following patient characteristics influencing mobility taken into account? (✓ or ✖ or N/A, i.e., Yes or No or Not applicable)
   a. Age
   b. Gender
   c. Disease severity (e.g., cancer stage)
   d. Comorbidities
   e. Socioeconomic status
   f. Ethnicity
   g. Health insurance status (e.g., medicare vs. private insurer)

There has to be evidence that relevant patient characteristics have been included in the analysis either as confounding factors, or as exposures of interest.

9. Were the following health system characteristics influencing mobility taken into account? (✓ or ✖ or N/A)
   a. Forced mobility due to insufficient provider capacity (e.g., Waiting time)
   b. Physician-induced mobility (e.g., GP referral patterns)
   c. Copayments for health care services
   d. Characteristics of the provider (e.g., size, academic status, advanced technology availability)
   e. Provider quality metrics (e.g., disease-specific mortality, ranking)
   f. Characteristics of region (e.g., urban/rural, region size, GDP per capita)

As above, these factors must be quantified and used in the analysis as confounding factors or exposures of interest.

10. Have the authors used a statistical analysis technique that enables the reader to assess the effect of each patient or system factor (as per the papers’ specific research question[s]) on the likelihood or magnitude of patient mobility (Yes/No/unclear/Not applicable)
Authors’ Note

The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Dr Ajay Aggarwal is funded by a Doctoral Research Fellowship from the National Institute for Health Research.

References


4. RESULTS CHAPTER 2

4.1 Patient mobility for radical prostatectomy

The second component of my thesis was a quantitative analysis of patient mobility and its determinants using data on actual patient visits for curative prostate cancer treatment in the English NHS. This chapter focuses on patient mobility for radical prostate cancer surgery and the results have presented in the form of the published paper. The supplementary material referred to in the paper is available at the end of this section.

4.2 Research paper 2

“Determinants of patient mobility for prostate cancer surgery: a population-based study of choice and competition”

This paper has been embargoed pending open access publication. Hard copy of complete thesis available in LSHTM library.
5. RESULTS CHAPTER 3

5.1 Patient mobility for radical radiotherapy

After analysing the determinants of patient mobility for radical prostate cancer surgery, this chapter focused on patient mobility for radical radiotherapy. The chapter also addressed the third component of the thesis, which was an evaluation of the impact of patient mobility on individual providers in terms of their net gains and losses of patients and how this relates to the level of competition faced by each hospital. The results have been presented in the form of the published paper. The supplementary material referred to in the paper is available at the end of this section.

5.2 Research paper 3

“Hospital quality factors influencing the mobility of patients for radical prostate cancer radiation therapy: a national population based study”

The online PDF can be accessed at:

# RESEARCH PAPER COVER SHEET

**PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.**

## SECTION A – Student Details

<table>
<thead>
<tr>
<th>Student</th>
<th>Ajay Aggarwal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Supervisor</td>
<td>Jan van der Meulen</td>
</tr>
<tr>
<td>Thesis Title</td>
<td>Evidence and impact of NHS choice and competition policies on the delivery of prostate cancer services: a national population based evaluation</td>
</tr>
</tbody>
</table>

**If the Research Paper has previously been published please complete Section B, if not please move to Section C**

## SECTION B – Paper already published

<table>
<thead>
<tr>
<th>Where was the work published?</th>
<th>International Journal of Radiation Oncology Biology Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>When was the work published?</td>
<td>August 2017</td>
</tr>
<tr>
<td>If the work was published prior to registration for your research degree, give a brief rationale for its inclusion</td>
<td></td>
</tr>
<tr>
<td>Have you retained the copyright for the work?*</td>
<td>YES</td>
</tr>
</tbody>
</table>

*If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.

## SECTION C – Prepared for publication, but not yet published

<table>
<thead>
<tr>
<th>Where is the work intended to be published?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Please list the paper's authors in the intended authorship order:</td>
<td></td>
</tr>
<tr>
<td>Stage of publication</td>
<td></td>
</tr>
</tbody>
</table>

## SECTION D – Multi-authored work

<table>
<thead>
<tr>
<th>For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)</th>
<th>I designed the study, undertook the analysis and wrote the first draft of the manuscript</th>
</tr>
</thead>
</table>

Student Signature: 

Supervisor Signature: 

Date: 22.09.17

Date: 22 Sept 2017

Improving health worldwide

www.lshtm.ac.uk
Clinical Investigation

Hospital Quality Factors Influencing the Mobility of Patients for Radical Prostate Cancer Radiation Therapy: A National Population-Based Study

Ajay Aggarwal, MD,*, 1 Daniel Lewis, PhD, 1 Arunan Sujenthiran, MD, 3 Susan C. Charman, PhD, 2, 4 Richard Sullivan, MD, PhD, 5 Heather Payne, MD, 6 Malcolm Mason, MD, 6 and Jan van der Meulen, PhD 6, 5

Departments of *Health Services Research & Policy, and Social and Environmental Health Research, London School of Hygiene and Tropical Medicine, London, United Kingdom; 1Department of Radiotherapy, Guy’s & St. Thomas’ NHS Trust, London, United Kingdom; Clinical Effectiveness Unit, Royal College of Surgeons of England, London, United Kingdom; 1Institute of Cancer Policy, King’s Health Partners, London, United Kingdom; 5Department of Radiotherapy, University College London, London, United Kingdom; and 4Institute of Cancer & Genetics, School of Medicine, Cardiff University, Cardiff, United Kingdom

Received Jun 13, 2017, and in revised form Jul 29, 2017. Accepted for publication Aug 12, 2017.

Summary

Using geographic information systems and econometric modeling, we present the first national study evaluating the hospital quality factors that attract patients

Purpose: To investigate whether patients requiring radiation treatment are prepared to travel to alternative more distant centers in response to hospital choice policies, and the factors that influence this mobility.

Methods and Materials: We present the results of a national cohort study using administrative hospital data for all 44,363 men who were diagnosed with prostate cancer and underwent radical radiation therapy in the English National Health Service between 2010 and 2014. Using geographic information systems, we investigated the extent to which men choose to travel beyond (“bypass”) their nearest radiation therapy

Reprint requests to: Ajay Aggarwal, Department of Health Services Research & Policy, London School of Hygiene & Tropical Medicine, 15-17 Tavistock Place, London WC1H 9SH, United Kingdom. Tel: (+44) 2073572135; E-mail: ajay.aggarwal@lshtm.ac.uk

A.A. is funded by a Doctoral Research Fellowship from the National Institute for Health Research (grant no. DRF-2014-07-064). H.P.’s work was supported by the University College London Hospitals/University College London Comprehensive Biomedical Research Centre. J.v.d.M. is partly supported by the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care North Thames at Bart’s Health National Health Service (NHS) Trust. A.A., A.S., S.C.C., H.P., and J.v.d.M. are members of the Project Team of the National Prostate Cancer Audit (www.npca.org.uk) funded by the Healthcare Quality Improvement Partnership (http://www.hqip.org.uk). The study sponsors had no role in the design of the study; the collection, analysis, or interpretation of the data; the writing of the manuscript; or the decision to submit for publication. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research, or the Department of Health.

Hospital EpisodeStatistics were made available by the NHS Health and Social Care Information Centre ©2012, reused with the permission of NHS Digital. All rights reserved.)

Data for this study are based on patient-level information collected by the NHS, as part of the care and support of cancer patients. The data are collated, maintained, and quality assured by the National Cancer Registration and Analysis Service, which is part of Public Health England. Access to the data was facilitated by Public Health England’s Office for Data Release.

Conflict of interest: H.P. has worked as a consultant and has been paid for lectures and received hospitality to travel to meetings from Janssen, Astellas, Ferring, Sanofi Aventis, and Novartis.

Supplementary material for this article can be found at www.redjournal.org.

0360-3016/© 2017 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
http://dx.doi.org/10.1016/j.ijrobp.2017.08.018
Many countries have introduced policies that allow patients to choose the hospital where they have their treatment (1, 2). Patients are expected to choose a hospital that delivers better-quality care, and the resultant competition between providers as they attempt to attract new patients is expected to stimulate improvements in quality. However, for complex treatments such as radiation therapy we have no data to support whether patients are prepared to travel to alternative, more-distant centers, or the quality factors that influence this.

It is also debatable whether such policies are relevant in cancer care, given the increasing centralization of cancer services, which by its nature will reduce the choices available to patients (3, 4). Treatment decisions are complex, and the therapy itself may last for months, resulting in significant physical and financial burden for those considering treatment at a more-distant hospital. Furthermore, there is a lack of valid performance indicators that accurately reflect the quality of cancer treatment, especially radiation therapy.

However, radiation therapy has seen a relentless diffusion of new technologies over the last decade, which has shaped clinical practice in both the targeting and delivery of treatment. It has been suggested that in certain health care markets, clinicians and hospital providers are encouraged to diversify practice through the integration and marketing of new high-cost technologies (eg, proton beam therapy), to attract new patients. However, this has been largely anecdotal, with little or no evidence in publicly funded health systems (5, 6).

Using linked patient-level national datasets, geographic information systems, and applied econometric modeling, we investigated whether prostate cancer patients who had radical radiation therapy in the English National Health Service (NHS) “bypassed” their nearest radiation therapy provider for treatment, as well as the provider and patient characteristics associated with that mobility.

The NHS provides an ideal system for understanding the impact of patient choice policies. It is a national, single-payer, tax-based system in which care is free and not based on ability to pay for insurance or treatment. The costs of services are fixed under a national tariff, and providers are therefore expected to compete on quality and not price (7). Patients have access to all available NHS providers in England, with no explicit restrictions on the choices available.

**Methods and Materials**

We obtained individual patient-level data on all patients diagnosed with prostate cancer between January 1, 2010, and March 31, 2014 who subsequently underwent radiation therapy in the English NHS. Data were retrieved from the National Cancer Registration and Analysis Service and linked at patient level to the National Radiotherapy Dataset and Hospital Episode Statistics (8, 9). Patients who underwent radiation therapy in the private sector were not included in the analysis (<10% of eligible patients).

The National Radiotherapy Dataset provided information on each patient’s radiation therapy treatment: start and finish dates, treatment site (primary with or without regional nodes), total dose, number of fractions, and radiation therapy technique (intensity modulated radiation therapy vs 3-dimensional conformal radiation therapy). The National Cancer Registration and Analysis Service dataset...
provided information on cancer stage and the Hospital Episode Statistics dataset on age and comorbidities. Cancer severity was categorized according to a modified D’Amico classification system (10-12). The patients’ place of residence was available as the Lower Layer Super Output Area (LSOA), a geographic area that typically includes 1500 residents or 650 households (13, 14).

Travel times

The population-weighted centroids of the patients’ LSOAs (used to define patient residence) and the full postal codes for the hospitals where the radiation therapy was undertaken were inputted into a geographic information system (ESRI ArcGIS 10.3) to calculate travel times according to the fastest route by car (using Ordnance Survey MasterMap Integrated Transport Network).

Assessment of mobility

All radiation therapy treatment providers (n=57) were ranked according to the distance in terms of drive time by car from the patient’s residence. The proportion of patients not receiving care at their nearest provider (ranked >1) were considered to be “by-passers” (15).

We identified for each radiation therapy center the number of patients for whom that center was nearest but who had their treatment elsewhere—“leavers”—and also those patients for whom another radiation therapy center was nearest but who had their radiation therapy at that center—“arrivers.” A center was identified as being a “winner” or “loser” of patients if the difference between arrivals and leavers was statistically significant (16). Patients receiving radiation therapy at their nearest center were defined as “core users.”

Competition indices

For each center we also calculated a spatial competition index (SCI) as a measure of “external competition” (17, 18). The SCI provides a uniform metric that can be used across all centers in England to factor in the demand for services and the availability of alternative hospitals for patients to choose. In this analysis the SCI for a radiation therapy center was calculated according to both the number of eligible patients within a 60-minute drive and the number of alternative radiation therapy centers within a 60-minute drive for each eligible patient:

\[
SCI = 1 - \frac{1}{n} \sum_{i=1}^{n} \frac{1}{k_i}
\]

where radiation therapy center i has n eligible patients within a 60-minute drive and patient j in center i has k alternative radiation therapy centers within a 60-minute drive. The SCI ranges theoretically from 0 for centers in a monopoly environment to a value close to 1 for centers in the most competitive environment.

Patient characteristics

Four patient-level variables were derived from the linked dataset. First, patient age at the time of prostate cancer diagnosis. Second, the Royal College of Surgeons Charlson Score was used to identify the number of comorbidities (19). Third, the Index of Multiple Deprivation (IMD) was used as a measure of the patients’ socioeconomic deprivation (20). The IMD was stratified into quintiles according to the national distribution, such that 1 represents households in the 20% least deprived and 5 in the 20% most deprived LSOAs. Fourth, the patients’ area of residence was classified as urban or rural (21).

Hospital characteristics

At the start of the study there were 52 radiation therapy centers across England. A further 5 centers opened during the study period. In the absence of publicly reported performance indicators for prostate cancer radiation therapy, we created 4 hospital-level variables as proxies for quality, which may make a hospital more attractive to patients when considering where to have radiation therapy treatment. These variables were informed by the peer-reviewed literature, in-depth qualitative interviews undertaken by the study team with men previously treated for prostate cancer in the United Kingdom, and The National Prostate Cancer Audit organizational survey (22).

We identified the 28 “university teaching hospitals,” on the basis of their membership of the Association of UK University Hospitals (23). Studies have demonstrated that teaching hospital status is associated with higher quality for certain interventions compared with non-teaching hospitals and therefore may be preferentially chosen by patients (24-28).

Second, we labeled the 3 hospitals that were delivering intensity modulated radiation therapy (IMRT) as a standard of care at the start of the study period (2010) as “early IMRT adopters.” There was emerging evidence at the time that this technique delivered improved outcomes (reduced pelvic toxicity) relative to standard 3-dimensional conformal techniques (29, 30). In addition, IMRT was already a standard of care in countries such as the United States in 2010, which may have prompted patients to seek treatment at centers that offer this technique in the NHS (29, 30).

Third, we identified 8 centers that we classified as “large-scale radiation therapy units” on the basis of the number of linear accelerators on site. The median number of linear accelerators across the 57 English NHS radiation therapy centers was 4 (range, 2-12) (31). Centers with ≥8 linear accelerators on site (ie, in the top quintile based on the distribution of linear accelerators) were considered to meet this criteria. These centers may have been considered preferentially by patients owing to their large capital and staff infrastructure investment toward radiation therapy facilities or wider reputation effects from being regional centers.
Fourth, we identified 4 centers that were delivering hypofractionated radiation therapy (ie, higher dose per treatment delivered over fewer total number of attendances) as their standard dose-fractionation regimen for prostate cancer at the start of the study period in 2010. Although a dose of 74 Gy delivered over 37 treatments remains the standard of care, hypofractionated regimens halve the duration of treatment, from 8 weeks to 4 weeks (32, 33).

Statistical analysis

We used conditional logit regression to model the odds that a patient moved to a particular hospital as a function of travel time and hospital and patient characteristics (34, 35). We created a data set that included for each patient a row for each hospital providing prostate cancer radiation therapy at the time of treatment (number of hospitals varied between 52 and 57 because 5 hospitals opened during the study period). The dependent variable of the conditional logit model was a dummy variable with a value of 1 for the hospital where a patient had his treatment and a value of 0 otherwise.

Travel time was included in the model as the additional time men had to travel beyond their nearest hospital to an alternative hospital providing radiation therapy. In this way we accounted for the variation in service configuration across England. Per definition, additional travel time was 0 minutes if a patient had his radiation therapy in the nearest radiation therapy center.

First, we modeled the effect of travel time and individual hospital characteristics on the odds of moving to a particular hospital as part of a univariate analysis. In the second model, we included both hospital characteristics and travel time as part of a multivariate conditional regression model. In the third model, we included travel time, hospital characteristics, and the interactions of patient characteristics with travel time. Patient characteristics included age, comorbidity, socioeconomic background, and urban or rural residence. (We present the results of both models in Tables 3 and 4.) Stata version 14 was used to undertake the statistical analyses (StataCorp, College Station, TX).

Results

Patient population

We identified 46,654 men diagnosed with prostate cancer between January 1, 2010, and March 31, 2014 who subsequently received radiation therapy (Supplementary Material Appendix 1; available online at www.redjournal.org). Of these men, 44,860 received radical radiation therapy. A total of 497 men were excluded because they lived outside England or could not be assigned to an NHS radiation therapy provider. The final study cohort comprised 44,363 men, and patient characteristics are presented in Table 1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>12,951</td>
<td>29.2</td>
</tr>
<tr>
<td>65-69</td>
<td>9,453</td>
<td>21.3</td>
</tr>
<tr>
<td>70-74</td>
<td>12,373</td>
<td>27.9</td>
</tr>
<tr>
<td>≥75</td>
<td>9,586</td>
<td>21.6</td>
</tr>
<tr>
<td>Cancer severity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced</td>
<td>620</td>
<td>1.8</td>
</tr>
<tr>
<td>Locally advanced</td>
<td>19,037</td>
<td>55.6</td>
</tr>
<tr>
<td>Intermediate localized</td>
<td>13,292</td>
<td>38.8</td>
</tr>
<tr>
<td>Low-risk localized</td>
<td>1276</td>
<td>3.7</td>
</tr>
<tr>
<td>Insufficient staging information (n=10,138)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of comorbidities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>34,368</td>
<td>77.5</td>
</tr>
<tr>
<td>≥1</td>
<td>9,995</td>
<td>22.5</td>
</tr>
<tr>
<td>Index of multiple deprivation (national quintiles)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (least deprived)</td>
<td>10,832</td>
<td>24.4</td>
</tr>
<tr>
<td>2</td>
<td>10,780</td>
<td>24.3</td>
</tr>
<tr>
<td>3</td>
<td>9,651</td>
<td>21.8</td>
</tr>
<tr>
<td>4</td>
<td>7,336</td>
<td>16.5</td>
</tr>
<tr>
<td>5 (most deprived)</td>
<td>5,764</td>
<td>13.0</td>
</tr>
<tr>
<td>Urban rural classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>33,332</td>
<td>75.1</td>
</tr>
<tr>
<td>Rural</td>
<td>11,031</td>
<td>24.9</td>
</tr>
</tbody>
</table>

Patient mobility

In all, 9,161 men (20.7%) “bypassed” or traveled beyond their nearest radiation therapy center to an alternative, more-distant center (Table 2); 5142 men (12.6%) bypassed only 1 center, and 1125 men (2.5%) bypassed 5 or more centers for treatment (Table 2). Figure 1 demonstrates the net gains and losses of patients by individual prostate cancer radiation therapy centers (n=57) due to patient mobility during the study period. Of the 57 centers, 19 (33.3%) were classified as “winners” and 25 (43.9%) as “losers”; 13 centers had no statistically significant net gain.

<table>
<thead>
<tr>
<th>No. of hospitals bypassed*</th>
<th>No. of patients (%)</th>
<th>Travel time (min), median (interquartile range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35,202 (79.4)</td>
<td>20.7 (12.1-32.7)</td>
</tr>
<tr>
<td>1</td>
<td>5,142 (12.6)</td>
<td>38.3 (23.4-53.6)</td>
</tr>
<tr>
<td>2</td>
<td>1,764 (4.0)</td>
<td>44.0 (22.9-59.6)</td>
</tr>
<tr>
<td>3</td>
<td>822 (1.9)</td>
<td>46.7 (34.7-60.6)</td>
</tr>
<tr>
<td>4</td>
<td>308 (0.7)</td>
<td>55.6 (43.3-67.3)</td>
</tr>
<tr>
<td>≥5</td>
<td>1,125 (2.5)</td>
<td>52.9 (36.8-89.8)</td>
</tr>
</tbody>
</table>

Table 1 Characteristics of 44,363 men undergoing radical radiation therapy between 2010 and 2014 in the English National Health Service

*Hospitals are considered to be “bypassed” if a man has radiation therapy in a hospital that is further away from his place of residence in terms of travel time by car.
or loss of patients. Some of the “winners” were treating 500 or more patients than expected if they had been operating solely on men for whom they were the nearest center. Conversely, some of the “losers” were treating nearly 400 fewer procedures than expected. When considering the degree of external competition faced by each center, centers experiencing the largest net gains or losses were predominantly located in the most competitive areas (SCI between 0.70 and 1) (Fig. 2).

**Impact of travel time and patient and hospital characteristics on patient mobility**

Travel time had a very strong impact on the odds that a patient traveled to a particular hospital to receive radiation therapy in the univariate and multivariate conditional regression models (Tables 3 and 4). The odds of a patient traveling to a hospital that was up to 10 minutes further away than the patient’s nearest radiation therapy provider was found to be on average 72% smaller (odds ratio [OR] of 0.28) according to a conditional logit model that only included additional travel time (Table 3, model 1). The odds of a patient traveling to a particular hospital decreased markedly as the additional travel time increased.

The results of the univariate analysis assessing the impact of hospital characteristics on the odds of traveling further to a particular hospital are presented in Table 3 (model 1). When considering the impact of hospital characteristics on mobility patterns of patients as part of a multivariate regression model including travel time and patient characteristics, men were 3.19 times more likely to travel to a particular radiation therapy center if it offered hypofractionated radiation therapy as standard (Table 4, model 3). In addition, patients were 1.56 times more likely to travel to a center classified as a large-scale radiation therapy unit, and 1.37 times more likely to travel to a center if it was an established IMRT center. There was a small but significant increase in the likelihood that patients traveled to a specific center if it had university hospital status (OR 1.19).

The addition of patient characteristics as interaction terms into our model showed that the impact of travel time was smaller for men who were younger and for those who lived in more affluent or rural areas, because the ORs expressing the interaction terms are greater than 1 (Table 4, model 3). The greater the size of the interaction term value, the larger its attenuating effect on the impact of travel time. For example, compared with having the radiation therapy at the nearest provider, for men classified as living in urban and less affluent areas, who are aged ≥65 years, and who have comorbidities, the odds of traveling to a hospital that was up to 10 minutes further away was estimated to be 82% smaller (OR 0.18). The corresponding figure for men from rural areas (keeping all other patient characteristics the same as described) was 60% smaller (OR 0.40 = 0.18 × 2.23, based on multiplying the OR of the main effect of additional travel time with the OR of the interaction term). This implies that men from rural areas have a greater odds of traveling to an alternative hospital up to 10 minutes further away compared with men from urban areas. Different patient characteristics attenuate the effect further. For example, men from both rural and affluent areas (positive interaction terms) have an even greater odds of traveling to an alternative hospital up to 10 minutes further away (keeping all other patient characteristics the same, OR 0.51 = 0.16 × 2.23 × 1.26) compared with men from urban and less affluent areas.
Fig. 2. Graph demonstrating the impact of competition (measured by the spatial competition index [SCI]) on the net gain or loss of patients for radiation therapy centers between 2010 and 2014. SCI score = 0: Hospital facing weakest competition; SCI score = 1: Hospital facing strongest competition; size of circle = number of men expected to have radiation therapy at center; blue = centers classified as “winners”; green = centers classified as “losers”; orange = centers with no statistically significant gain or loss of patients; red = centers offering hypofractionated radiation therapy as standard.

Discussion

There is limited evidence about what factors inform and influence cancer patients’ choice of treatment provider (1). In this study we demonstrate that in the United Kingdom NHS, 1 in 5 patients who have radiation therapy treatment “bypass” their nearest radiation therapy center. Travel time had a very strong impact on where patients received their treatment, but this effect was smaller for men who were younger, more affluent, or living in rural areas. Men were more likely to travel to centers that offered shorter hypofractionated radiation therapy regimens as standard for

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unadjusted OR (model 1)*</th>
<th>95% CI</th>
<th>(P^*)</th>
<th>Adjusted OR (model 2)†</th>
<th>95% CI</th>
<th>(P^)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of additional travel time (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1</td>
<td>0.27-0.29</td>
<td>&lt;.001</td>
<td>1</td>
<td>0.27-0.28</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11-30</td>
<td>0.07</td>
<td>0.06-0.07</td>
<td>0.06</td>
<td>0.05-0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-60</td>
<td>0.006</td>
<td>0.005-0.006</td>
<td>0.005</td>
<td>0.004-0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;60</td>
<td>0.0002</td>
<td>0.0001-0.0002</td>
<td>0.0002</td>
<td>0.0001-0.0002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact of hospital characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University hospital</td>
<td>1.28</td>
<td>1.26-1.31</td>
<td>&lt;.001</td>
<td>1.18</td>
<td>1.14-1.23</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Large-scale RT unit</td>
<td>1.95</td>
<td>1.91-1.99</td>
<td>&lt;.001</td>
<td>1.55</td>
<td>1.48-1.62</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Early adopter of IMRT</td>
<td>1.15</td>
<td>1.11-1.20</td>
<td>&lt;.001</td>
<td>1.37</td>
<td>1.30-1.46</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hypofractionated treatment (standard)</td>
<td>1.73</td>
<td>1.68-1.78</td>
<td>&lt;.001</td>
<td>3.10</td>
<td>2.92-3.28</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: CI = confidence interval; IMRT = intensity modulated radiation therapy; OR = odds ratio; RT = radiation therapy.
* Model 1 presents unadjusted ORs from the univariate analysis assessing the impact of additional travel time and hospital characteristics on the odds that a patient travels to a particular hospital.
† \(P\) value based on likelihood ratio test.
‡ Model 2 presents adjusted ORs from the multivariate conditional logit analysis assessing the impact of both additional travel time and hospital characteristics on the odds that a patient travels to a particular hospital.
Table 4  Impact of travel time and hospital and patient characteristics on patient mobility in 44,363 men undergoing radical radiation therapy between 2010 and 2014 in the English National Health Service

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Adjusted OR (model 3)</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of additional travel time (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1.00</td>
<td>0.95-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11-30</td>
<td>1.02</td>
<td>0.98-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>31-60</td>
<td>1.08</td>
<td>1.04-1.13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1.10</td>
<td>1.06-1.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Impact of hospital characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University hospital</td>
<td>1.17</td>
<td>1.10-1.25</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Large-scale RT unit</td>
<td>1.39</td>
<td>1.30-1.49</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Early adopter of IMRT</td>
<td>1.37</td>
<td>1.30-1.44</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hypofractionated treatment (standard)</td>
<td>3.09</td>
<td>2.63-3.66</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Difference in impact of additional travel time</td>
<td>Interaction terms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for selected patient characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger patients (&lt;65 y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1.00</td>
<td>0.95-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11-30</td>
<td>1.02</td>
<td>0.98-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>31-60</td>
<td>1.08</td>
<td>1.04-1.13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1.10</td>
<td>1.06-1.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Patients without comorbidities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1.00</td>
<td>0.95-1.05</td>
<td>NS</td>
</tr>
<tr>
<td>11-30</td>
<td>1.02</td>
<td>0.98-1.05</td>
<td>NS</td>
</tr>
<tr>
<td>31-60</td>
<td>1.08</td>
<td>1.04-1.13</td>
<td>NS</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1.10</td>
<td>1.06-1.14</td>
<td>NS</td>
</tr>
<tr>
<td>Patients from more affluent areas (IMD 1 or 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1.00</td>
<td>0.95-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11-30</td>
<td>1.02</td>
<td>0.98-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>31-60</td>
<td>1.08</td>
<td>1.04-1.13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1.10</td>
<td>1.06-1.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Patients from rural areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>1.00</td>
<td>0.95-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>11-30</td>
<td>1.02</td>
<td>0.98-1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>31-60</td>
<td>1.08</td>
<td>1.04-1.13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1.10</td>
<td>1.06-1.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>McNalld’s pseudo R²</td>
<td>0.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: IMD = Index of Multiple Deprivation; NS = nonsignificant. Other abbreviations as in Table 3.

* Model 3 presents adjusted odds ratios from the multivariate conditional logit analysis assessing the impact of additional travel time, hospital characteristics, and patient characteristics on the odds that a patient travels to a particular hospital.

* P value based on likelihood ratio test.

* Note that the adjusted ORs for the impact of additional travel time in model 3 relates to a particular patient group: older men (≥65 years), with comorbidity (Charlson ≥1), from less affluent (IMD 3-5) and urban areas.

* The impact of selected patient characteristics on additional travel time is presented as interaction terms. These should be multiplied with the corresponding adjusted OR for additional travel time to formulate a new OR. Interaction terms can be used in any combination to assess the effect of different patient characteristics on the odds that a patient travels to a particular hospital. For example, the adjusted ORs presented (1) relate to older men (≥65 years), with comorbidity (Charlson ≥1), from less affluent (IMD 3-5) and urban areas. To calculate the new OR for younger and more affluent men traveling 11-30 minutes, but who still have comorbidity and live in urban areas, multiply 0.04 (travel time adjusted OR for 11-30 minutes) by the corresponding interaction term for men who are affluent (1.20) and men living in rural areas (2.21). The new odds ratio is 0.04 × 1.20 × 2.21 = 0.11.

That is, men with these patient characteristics have a greater odds of traveling up to 30 minutes to a particular hospital.

prostate cancer, larger established radiation therapy units, and those centers that utilized IMRT earlier. Mobility between providers resulted in winners and losers, with some centers treating hundreds more patients each year than expected if they only treated local patients.

These findings are relevant across a range of elective secondary care cancer services in countries that have introduced patient choice of provider policies (1). A substantial number of patients were prepared to bypass their nearest radiation therapy center despite the absence of comparative provider-level performance information relating to the quality of radiation therapy treatment and the prolonged duration of treatment.

The routine availability of hypofractionated radiation therapy for prostate cancer was the strongest hospital-level driver of patient mobility. It is not possible to say whether patients were prepared to travel further to these centers because hypofractionated radiation therapy is more
convenient or because patients considered these centers to be innovative and therefore potentially better (36). However, the potential desire for treatment of shorter duration correlates with our study findings that travel time has a very strong impact on the choices that patients make. In addition, previous research has shown that patients are reluctant to undergo radiation therapy compared with other prostate cancer treatment modalities, owing to its prolonged duration (37).

Patients in our cohort were more likely to travel to the 3 centers labeled as early adopters of IMRT, despite rapid expansion in the availability of IMRT across centers in England during the study period (38, 39). This suggests that there is a wider reputation effect associated with being an early adopter of innovation and that patients may have considered these centers to be at the forefront of technology (40, 41). To illustrate this point, all 3 established IMRT centers were also amongst the first adopters of stereotactic body irradiation in England (12). Similarly, patients were more likely to travel to larger-scale radiation therapy units, which may have had a wider reputation as being a regional center of excellence for radiation therapy or cancer care more generally.

The patterns of mobility observed has resulted in large and unexpected shifts in market share. Radiation therapy centers located in the most competitive areas had significant gains and losses of patients (Fig. 2). In the NHS, funding follows the patient (7), and therefore centers losing patients may have to cease providing that service owing to lost income. Such an eventuality has already transpired for surgical centers providing radical prostatectomy, several of which have closed in the last 5 years (42). This pattern of winners and losers also highlights the inefficiency and wasted capacity within the current radiation therapy service, which may further increase as a result of the current drive toward opening new radiation therapy centers across England (5 opened during the study period) to improve access to treatment. Equally, the impact on service capacity (eg, waiting times) needs to be considered for those centers treating significant numbers of out-of-area patients.

**Appropriate implementation of advanced radiation technologies**

In the absence of performance indicators, centers that diversify their clinical practice (eg, through the integration of new technology) are potentially more attractive to patients. In the United States, competition has been a key driver in the rapid expansion of innovative radiation therapies, such as IMRT, proton beam therapy, and Cyberknife, for the management of prostate cancer to maintain market share and attract new patients. This has occurred at significant additional cost without any clear evidence for benefits to patients over existing standards of care (6,30,43-46).

To avoid similar patterns of technology adoption for radiation therapy across different health systems, we recommend the use of formal health technology assessment processes to support decision making regarding the integration of new technologies in publicly funded systems (5, 47). In contrast to new cancer drugs, radiation therapy has remained beyond the remit of health technology assessment (5). The Health Economics in Radiation Oncology project, which is being carried out under the auspices of the European Society for Radiotherapy and Oncology, is attempting to define economic frameworks for assessing the clinical and economic benefit of new radiation therapy technologies and is still in its infancy (48).

There is also a necessity to develop valid performance indicators for radiation therapy to guide patient decision making and potentially stimulate improvements in treatment outcomes through “quality competition” as patients are responsive to perceived differences in quality (49). This is important, given the increasing reliance on unsubstantiated web- and media-based cancer information, especially for new technologies (50-52). A series of process indicators have been proposed by professional bodies, but these are hard for patients to interpret (53, 54). Although outcome measures are preferable, an important caveat is that these can only be published following a lag period (toxicity measures at 1 and 5 years) (55).

**Methodologic limitations**

Our modelling of patient mobility used centroids of the LSOAs, small geographic regions typically made up of approximately 650 households, to represent the location of the patients’ residence. This approach has been used in previous studies of patient mobility in England (56). However, it is likely that the “noise” added to the travel times will have attenuated rather than enhanced the observed relationships. Our model uses average drive times, which is the standardized methodology for these analyses and considered superior to straight-line distance. However, we do acknowledge that drive times are variable depending on the time of day, which may affect patients’ decision making. In addition, public transport times were not available for this analysis.

We have not included waiting times as a factor influencing provider choice, because these were not publicly available for individual centers. Some patients may have considered moving to alternative providers to receive quicker treatment; however, extensive efforts have been made in the English NHS to ensure prompt diagnosis and treatment of suspected cancer patients through a system of defined targets (57, 58). In 2014/2015 95.3% of people treated for urologic cancers in the NHS began their first definitive treatment within the 31-day target (59). Other potential determinants of mobility, such as care giver/work location, were not available in our dataset, and we were unable to assess the effect of disease severity owing to incomplete staging data. However, the overall impact on our observed patterns of mobility is likely to be small in the context of up to 20% of patients bypassing their
nearest provider. The overall predictive probability of our model, despite these exclusions, is very high, 82% (note models with values above 60% for goodness of fit estimation are considered to have a high degree of explanatory power) (60).

Conclusions

Men with prostate cancer are prepared to bypass their nearest provider for radical radiation therapy, particularly those who are younger and more affluent. They are more likely to travel to larger established centers and those that offer innovative technology and shorter radiation therapy schedules. Patient mobility varies significantly across regions and between centers and is mainly evident in areas where competition between providers is strongest. This in itself implies that competition as a mechanism to stimulate improvements in the quality of care can only work in specific parts of the country. Indicators that accurately reflect the quality of radiation therapy delivered are essential to guide patients’ choices for radiation therapy treatment. In their absence, patient mobility may negatively affect the efficiency and capacity of regional or national radiation therapy services and offer perverse incentives for technology adoption even in publicly funded health systems.

References


Supplementary Material

Appendix 1. Flow chart of men included in the study

1794 men excluded who received palliative radiotherapy

Men receiving radical radiotherapy from 2010 – 2015 with Hospital Episodes Statistics (HES) linked Cancer Repository records 46,654

Men living in England who received radical radiotherapy at an English NHS provider 44,860

Matched to 57 providers of prostate cancer radiotherapy 44,582

219 men excluded as the treatment provider was not operational when the patient was diagnosed

Final cohort 44,363
6. RESULTS CHAPTER 4

6.1 Impact of choice and competition on cancer service delivery

The previous results paper evaluated the impact of patient mobility on individual radiotherapy providers in terms of their net gains and losses of patients. With respect to prostate cancer surgery, it was noted during the time-period of analysis (2010-2014) that some centres closed their radical prostatectomy service. At the same time, there was an increase in the numbers of centres performing robot-assisted techniques. Chapter 6 analysed whether there was an association between the net gains and losses of patients by individual providers and the intensity of hospital competition on both the observed closures of centres and the adoption of robotic surgical equipment. The results have been presented in the form of the published paper. The supplementary material referred to in the paper is available at the end of this section.

6.2 Research paper 4

“Effect of patient choice and hospital competition on service configuration and technology adoption within cancer surgery: a national population based study”

The online PDF can be accessed at:

http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(17)30572-7/fulltext?elsca1=tlpr
**RESEARCH PAPER COVER SHEET**

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

**SECTION A – Student Details**

<table>
<thead>
<tr>
<th>Student</th>
<th>Ajay Aggarwal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Supervisor</td>
<td>Jan van der Meulen</td>
</tr>
<tr>
<td>Thesis Title</td>
<td>Evidence and impact of NHS choice and competition policies on the delivery of prostate cancer services: a national population based evaluation</td>
</tr>
</tbody>
</table>

**If the Research Paper has previously been published please complete Section B, if not please move to Section C**

**SECTION B – Paper already published**

<table>
<thead>
<tr>
<th>Where was the work published?</th>
<th>Lancet Oncology</th>
</tr>
</thead>
<tbody>
<tr>
<td>When was the work published?</td>
<td>October 2017</td>
</tr>
<tr>
<td>If the work was published prior to registration for your research degree, give a brief rationale for its inclusion</td>
<td></td>
</tr>
<tr>
<td>Have you retained the copyright for the work?</td>
<td>YES</td>
</tr>
<tr>
<td>Was the work subject to academic peer review?</td>
<td>YES</td>
</tr>
</tbody>
</table>

*If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

**SECTION C – Prepared for publication, but not yet published**

<table>
<thead>
<tr>
<th>Where is the work intended to be published?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Please list the paper’s authors in the intended authorship order:</td>
<td></td>
</tr>
<tr>
<td>Stage of publication</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION D – Multi-authored work**

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)

| I designed the study, undertook the analysis and wrote the first draft of the manuscript |  |

**Student Signature:**

**Supervisor Signature:**

**Date:** 22.09.17

**Date:** 22 Sept 2017

Improve health worldwide

www.lshtm.ac.uk
Effect of patient choice and hospital competition on service configuration and technology adoption within cancer surgery: a national, population-based study

Ajay Aggarwal, Daniel Lewis, Malcolm Mason, Amie Punshoham, Richard Sullivan, Jan van der Meulen

Summary
Background There is a scarcity of evidence about the role of patient choice and hospital competition policies on surgical cancer services. Previous evidence has shown that patients are prepared to bypass their nearest cancer centre to receive surgery at more distant centres that better meet their needs. In this national, population-based study we investigated the effect of patient mobility and hospital competition on service configuration and technology adoption in the National Health Service (NHS) in England, using prostate cancer surgery as a model.

Methods We mapped all patients in England who underwent radical prostatectomy between Jan 1, 2010, and Dec 31, 2014, according to place of residence and treatment location. For each radical prostatectomy centre we analysed the effect of hospital competition (measured by use of a spatial competition index [SCI], with a score of 0 indicating weakest competition and 1 indicating strongest competition) and the effect of being an established robotic radical prostatectomy centre at the start of 2010 on net gains or losses of patients (difference between number of patients treated in a centre and number expected based on their residence), and the likelihood of closing their radical prostatectomy service.

Findings Between Jan 1, 2010, and Dec 31, 2014, 192,556 patients underwent radical prostatectomy at an NHS provider in England. Of the 65 radical prostatectomy centres open at the start of the study period, 23 (35%) had a statistically significant net gain of patients during 2010–14. Ten (40%) of these 23 were established robotic centres. 37 (57%) of the 65 centres had a significant net loss of patients, of which two (5%) were established robotic centres and ten (27%) closed their radical prostatectomy service during the study period. Radical prostatectomy centres that closed were more likely to be located in areas with stronger competition (highest SCI quartile [0–87–0–92]; p<0.003) than in areas with weaker competition. No robotic surgery centre closed irrespective of the size of net losses of patients. The number of centres performing robotic surgery increased from 12 (18%) of the 65 centres at the beginning of 2010 to 39 (71%) of 55 centres open at the end of 2014.

Interpretation Competitive factors, in addition to policies advocating centralisation and the requirement to do minimum numbers of surgical procedures, have contributed to large-scale investment in equipment for robotic surgery without evidence of superior outcomes and contributed to the closure of cancer surgery units. If quality performance and outcome indicators are not available to guide patient choice, these policies could threaten health services’ ability to deliver equitable and affordable cancer care.

Funding National Institute for Health Research.

Copyright © The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY-NC-ND 4.0 license.

Introduction
The centralisation of complex cancer surgery into fewer, high-volume units is occurring across Europe, the USA, and Canada, guided by evidence that centres that carry out a high volume of surgical procedures have better outcomes of care for patients than do centres that carry out a low volume of surgical procedures. At the same time, patient choice and hospital competition policies have been introduced in several countries—and are under consideration in others—with the aim of improving the responsiveness and efficiency of health services delivered. In health-care systems where hospitals compete on quality and not on price, competition is also expected to incentivise improvements in the quality of hospital services to attract patients.

Choice and competition, as well as centralisation, attempt to achieve improvements in patient outcomes, but they require different health-system configurations and provider incentives to operate effectively. Finding the right balance between choice and competition on the one hand and centralisation on the other is therefore key, but there is little evidence to guide how best to achieve this. The UK National Health Service (NHS) is an example of a health system that remains committed to choice and competition as a health-care reform model since the inception of this model in 2006.

The cost of providing
Research in context

Evidence before this study
Several countries have introduced policies that allow patients to choose a specific health-care provider, with the aim of improving the quality of care. We did a systematic review to assess the evidence that patients with cancer are willing to travel beyond (bypass) their nearest hospital for cancer surgery, and to assess the effect of competition on outcomes of surgery. We searched PubMed and Embase for relevant articles published between Jan 1, 1990 and Dec 31, 2015. Search criteria are in the appendix. 5934 titles and abstracts were reviewed. Five studies had empirically assessed the mobility of patients for cancer surgery. Patients were attracted to hospitals that had shorter waiting lists, that offered advanced technology, and that had indicators of better service quality than other hospitals. There was significant heterogeneity in the design of empirical studies, including differences in data quality, the geographical unit of analysis, and limited control for the influence of price competition. No studies had looked at the effect of competition on outcomes of cancer.

Added value of this study
To our knowledge, this is the first national evaluation of the effect of choice and competition policies on the patterns of service configuration and technology adoption for cancer surgery. We studied travel patterns of more than 19,000 patients who had a radical prostatectomy between 2010 and 2014 in the National Health Service (NHS) in England. The mobility of men to alternative, more distant centres resulted in substantial changes in market share for individual surgical centres, which were most marked in areas of highest competition. Centres that lost local patients to other centres were at risk of closure. Patients were attracted to centres offering robotic surgery, and other centres adopted this technology to preserve their market share. We found that, between 2010 and 2017, there has been large-scale adoption of robot-assisted radical prostatectomy, increasing by three times, from 12 centres at the start of 2010 to 42 by 2017. During the same time period, 16 of the 65 NHS radical prostatectomy centres in England closed their prostate cancer surgery unit.

Implications of all the available evidence
Patients with cancer respond to policies that enable them to choose a surgical provider of their choice. In the absence of appropriate information about quality of care, policies based on patient choice and hospital competition could create incentives for adoption of new technologies without evidence of superior outcomes as hospitals look to retain and attract new patients. The resulting changes in market share for individual hospitals could threaten the viability of their surgical services.

services is fixed under a national rate tariff scheme and hospitals are expected to compete for patients on the basis of quality. Receiving care incurs no additional user charges at the point of access and patients have the right to choose and travel to any hospital that best meets their needs.

Additionally, national policy in the UK continues to advocate centralisation of specialist cancer services such as prostate and oesophagogastrectomy. Not only does this serve to reduce the number of hospitals that patients with cancer can choose from, but it is also expected that patients will receive care at their nearest (local) centre on the basis of established secondary care referral pathways for specialist cancer surgery. However, our 2017 analysis found that not all patients are following the expected referral patterns for specialised cancer surgery. One in three men who had a radical prostatectomy for prostate cancer between 2010 and 2014 in the NHS travelled beyond or bypassed their nearest prostate cancer surgery centre, in many cases across regional boundaries. This observation especially applied to younger, fitter, and more affluent men than to older, less fit, and less affluent counterparts. In the absence of indicators that accurately reflect the quality of prostate cancer surgery, men were attracted to centres offering robot-assisted radical prostatectomy or centres that employed surgeons with a national reputation for prostate cancer surgery. There is little evidence about what effect patient mobility and hospital competition have had on the configuration of specialist cancer services and the introduction of new surgical technologies into clinical practice. We used patient-level data and geographical information system modelling to analyse the effect of patient mobility for cancer surgery and hospital competition on service configuration and technology adoption within the NHS, using prostate cancer as a model. In light of our findings, we appraised the international evidence exploring the role of choice and competition policies on the delivery of cancer surgery services and considered opportunities for developing the empirical research base in this area.

Methods

Patient population
For this national, population-based study we obtained individual patient-level data from the National Cancer Registration and Analysis Service (NCRAS) for all men who were diagnosed with prostate cancer and underwent a radical prostatectomy in the NHS in England between Jan 1, 2010, and Dec 31, 2014. These data were linked at the individual patient level to Hospital Episode Statistics (HES), the administrative database of all hospital episodes in NHS hospitals in England.89 The study was exempt from NHS Research Ethics Committee approval because it involved analysis of an existing dataset of anonymised data for service evaluation.
Study design
To define each individual patient’s residence, we used the population-weighted centroids of small geographical areas termed lower super output areas (LSOAs). These weightings provide location coordinates for the greatest population density in the LSOA. There are 34753 of these small geographical areas (ie, LSOAs) in England, with an average population of about 1600.24 Both the LSOAs and full postcodes for the hospitals where the surgery was done were inputted into a geographical information system (Esri ArcGIS 10.3) to calculate travel times according to the fastest route by car to all surgical centres in England (calculated by use of the Ordnance Survey MasterMap Integrated Transport Network). Patients receiving surgery at their nearest centre were defined as core users. Those who did not receive care at their nearest surgical centre were classified as bypassers.

For each surgical centre, we identified the number of leavers—patients for whom that centre was nearest but who had their treatment at an NHS centre further away. We also identified the number of arrivers—patients for whom another centre was nearest but who had their surgery at that centre. A centre was identified as being a winner (ie, having a net gain of patients) or loser (ie, having a net loss of patients) if the difference between leavers and arrivers was statistically significant based on the conditional method for testing a difference between two Poisson means.21

For each surgical centre we calculated a spatial competition index (SCI) as a measure of external competition.22,23 The SCI provides a uniform metric that can be used across all surgical centres and that represents the demand for services and the availability of alternative hospitals. Across England, there is variation in the concentration of available hospitals depending on the degree of urbanisation or rurality. For example, the northeast (one of nine English regions) is a predominantly rural area that is 8592 km² in size and had three surgical centres at the start of the study period. Conversely, London is 1572 km² in size (and the largest urbanised region in Europe) and had ten surgical centres at the start of the study period.24

Data analysis
In this analysis, the SCI for a surgical centre was calculated on the basis of both the number of eligible patients within a 60-min drive and the number of surgical centres within a 60-min drive for each eligible patient; in the equation shown, the surgical centre i has n eligible patients within a 60-min drive, and patient j in centre i has k surgical centres within a 60-min drive:

\[
SCI_i = 1 - \frac{1}{n_i} \sum_{j=1}^{n_i} \frac{1}{k_j}
\]

The SCI ranges theoretically from 0 for centres in a monopoly environment to a value close to 1 for centres in the most competitive environment.

At the start of the study period (January, 2010) there were 65 prostate cancer surgical centres in England, of which 12 centres routinely performed robot-assisted radical prostatectomy procedures. These centres were labelled as established robotic centres. An analysis of HES data, in addition to an organisational survey produced as part of the National Prostate Cancer Audit,7 was used to evaluate the change in configuration of prostate cancer surgical units across England and the availability of robotic surgery from 2010 onwards. The \(\chi^2\) test was used to compare proportions. All analyses were done with Stata, version 14, to assess the effect of competition, as measured by the SCI, on changes in service configuration (expressed as net gains or losses of patients as defined above) and adoption of robotic surgery in the NHIS.

Role of the funding source
The funder of the study, National Institute for Health Research, had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit for publication. AA and JvDM had full access to all the data in the study, take responsibility for the integrity of the data and the accuracy of the data analysis, and had final responsibility for the decision to submit for publication.

Results
We identified 19518 men who were diagnosed with prostate cancer and underwent radical prostatectomy in

![Flowchart of men included in the study](image)

HES = Hospital Episode Statistics. NHS = UK National Health Service.
Figure 2: Mobility patterns of patients receiving radical prostate cancer surgery at two selected NHS cancer centres

Maps of the UK illustrating the mobility patterns of patients who received radical prostate cancer surgery at two selected National Health Service (NHS) cancer centres (indicated with a + symbol in the area of core users) located in the east of England (A) and southwest England (B) that had a net gain of patients from outside their local area (i.e., more arrivers than leavers). Both centres were established robotic centres. The maps include a scaled magnification of the region. (Contains National Statistics data © Crown copyright and database right 2017; NHS Research Scotland (NRS) data © Crown copyright and database right 2017; Ordnance Survey data © Crown copyright and database right 2017; Northern Ireland Statistics and Research Agency data.)

Figure 3: Net gains and losses of patients for each radical prostatectomy centre (n=65) during the study period

Established robotic radical prostatectomy centres (n=12) shown in green and centres that closed during the 2010-14 study period (n=10) shown in red. Centres in blue are centres that were neither robotic radical prostatectomy centres nor centres that closed during the study period.

The NHS in England between Jan 1, 2010, and Dec 31, 2014. Of these 19518 men, 262 (1.3%) were excluded because they either lived outside England or could not be assigned to a particular hospital; 19 256 were eligible for inclusion in the study (figure 1).

Figure 2 shows the places of residence for patients who had their prostate cancer surgery at two selected surgical centres located in the east of England (figure 2A) and southwest England (figure 2B), both of which were classified as winners. Figure 3 shows the net gains and losses of patients for each radical prostatectomy centre identified during the study period. 23 (35%) of the 65 centres were classified as winners and 37 (57%) of 65 as losers. Five centres did not have a statistically significant net gain or loss of patients. Some of the winners were doing 400 to 500 more procedures than expected if they had only been operating on local men for whom this was the nearest centre. Conversely, some of the losers were doing approximately 200 fewer procedures than expected (and 400 fewer in the case of one centre).

Figure 3 also shows the relationship between, on the one hand, radical prostatectomy centres having a net gain or net loss of patients and, on the other hand, being an established robotic centre or a centre that closed during the study period. Centres with a net gain were
more likely to be established robotic centres (ten [43%] of the 23 winners were robotic centres, compared with two [5%] of the 37 centres with a net loss; $p=0.0043$). Conversely, ten (27%) of the 37 centres with a net loss of patients closed down during the study period.

Centres with the largest net gains or losses were predominantly located in the most competitive areas (Figure 4). Established robotic centres were most likely to be located in the highest quartile (SCI 0.87–0.92) for hospital competition. Seven (41%) of the 17 centres in the highest SCI quartile were established robotic centres compared with five (10%) of the 48 other centres in the three other quartiles ($p=0.0058$). Similarly, for centre closures, six (35%) of the 17 centres in the highest SCI quartile closed compared with four (8%) of the 48 other centres ($p=0.0081$).

Both the analysis of HES and the results of the national organisational survey showed profound changes in the organisation and practices of prostate cancer surgical care that continued beyond the end of the study period (Figure 5). Between 2010 and 2017, there has been large-scale adoption of robotic surgery, increasing by three times, from 12 (18%) of 65 centres open at the start of 2010 to 39 (71%) of 55 centres open in 2014 to 42 (86%) of 49 in 2017. In the same time period, 16 (25%) of the 65 NHS radical prostatectomy centres in England closed. Both the closures and the rapid and widespread adoption of robotic surgery have been unforeseen, effectively rendering commissioning guidelines—published only in 2015 and recommending phased introduction of robotics for prostate cancer surgery—within the NHS—obsolete.15

**Discussion**

Our results suggest that, during the study period analysed, patient choice and hospital competition, rather than a coordinated policy towards centralisation, have been drivers in the changing configuration of surgical cancer services. The proportion of patients who bypassed their nearest hospital to have prostate cancer surgery elsewhere has been far larger than the 5–10% considered to be necessary in the health economics literature to incentivise improvements in hospital quality.16

In the absence of data on outcomes, the mobility of patients has been driven by factors such as availability of advanced surgical technology and the reputation of individual hospitals and clinicians.16 The resulting competition between hospitals has contributed to the closure of radical prostatectomy centres in the NHS in England and widespread adoption of robot-assisted radical prostatectomy as centres have had to respond to potential changes in their market share, which threatened both their income and their ability to meet minimum procedure volume requirements. This finding indicates that patient choice and hospital competition, although rarely considered in redesign of cancer services, are potentially powerful drivers of service change, even within publicly funded systems. It is unlikely that these findings are limited to the NHS in England or to prostate cancer surgery alone.

From a wider system perspective, the geographical layout of cancer services means that not all centres face the same competitive pressures and, in turn, will respond differently to choice and competition policies as mechanisms for quality improvement. For example, ten of the 12 established robotic centres or early adopters of robotics were located in the most competitive areas. However, we found that patients were prepared to travel substantial distances for treatment, in some cases bypassing several surgical units, which means that even centres within less competitive areas face some level of external competition for patients and subsequently become late adopters of technology to retain local patients.16

---

**Figure 4:** Effect of competition on the net gain or loss of patients for each radical prostatectomy centre during the study period.

The size of the circles corresponds to the number of men expected to have surgery at the centre. Red circles correspond to centres that closed during the study period (2010–14). Green circles correspond to established robotic centres. Blue circles correspond to centres that were neither robotic radical prostatectomy centres nor centres that closed during the study period. Spatial competition index (SCI) score 0=hospital facing weakest competition; SCI score 1=hospital facing strongest competition.

**Figure 5:** Changes in the number of robotic centres and total number of centres in the NHS in England (2009–17)

---

80
Attempts to coordinate cancer care services through centralisation and regionalisation have largely ignored the fact that patients are prepared to bypass their local services for treatment. This occurrence is partly due to the paucity of empirical evidence about the extent of patient mobility.\textsuperscript{8,9} Additionally, cancer care plans have exerted limited control of the available services and technology at the individual hospital level (eg, introduction of new devices and practices of care), which can serve as proxy measures of quality in the absence of quality indicators.\textsuperscript{7}

Substantial levels of patient mobility mean that centres need to compete with other providers to meet minimum procedure volume thresholds as set down by national policy.\textsuperscript{9} In England, each prostate cancer surgery centre is expected to do a specified number of operations per year or face the threat of closure.\textsuperscript{6,12} Competition policies have therefore stimulated a form of centralisation through natural selection, as centres act to protect their status as a cancer surgery centre, rather than through a coordinated process based on valid indicators of quality. Similar effects have been observed in the US health-care market, where both acute and non-acute care services have closed in response to competition.\textsuperscript{33,34} It is unclear whether these effects have improved the quality of care.

None of the centres that closed during the study period did so because of explicit evidence of poor quality. Instead, the closures appear to have been influenced by the decisions of individual patients in selecting their health-care provider. Further research is required to establish what effect the observed pattern of closures has had on travel times, outcomes, and equity in access to surgical services for the most vulnerable groups, given their decreased ability to travel.\textsuperscript{33,35}

The patterns of patient mobility observed occurred at a time when comparative outcome measures for prostate cancer surgery were not available. This observation highlights that providers of cancer services, just like any other industry, will consider the use of alternative incentives to attract or retain patients.\textsuperscript{36-38} Patients will gravitate to places that make themselves attractive and by doing so they will create centres that treat large numbers of patients, which itself will attract further patients.\textsuperscript{39}

Patients with prostate cancer were more likely to travel to centres that were early adopters of robot-assisted radical prostatectomy, showing the powerful effect of advanced technology on perceptions of quality. The result of this travel pattern has been that other centres have invested in costly robotic surgery to avoid losing their patients to other centres and to maintain their market share to preserve their cancer centre status, despite a scarcity of evidence for the superiority of this surgical procedure with respect to functional and oncological outcomes.\textsuperscript{45,46} Notably, none of the centres that adopted robotic surgery closed down. Similar patterns have been observed in other health-care markets across the USA and Europe, with cancer centres adopting robotic surgery to increase their market share.\textsuperscript{36,43-46}

Our previous systematic review of the literature on patient choice and competition\textsuperscript{37} identified five empirical studies in high-income settings showing that patients with several tumour types, including breast, bladder, gastric, colorectal, and thoracic cancers, were prepared to bypass their nearest surgical centre.\textsuperscript{6,30-32} The availability of advanced surgical techniques, procedure volume, and both surgeon and hospital reputation were identified as key drivers for patient mobility. Patients of advanced age and from low socioeconomic backgrounds were less likely to consider alternatives than those who were younger and more affluent.

Hospital competition, rather than the pursuit of better quality care by itself, is also cited as a major factor influencing the adoption of new technologies and diversifying individual practices of care for both cancer surgery and radiotherapy.\textsuperscript{13} There is growing evidence of rapid adoption of technology for cancer surgery across a range of cancer types, beyond prostate cancer, such as renal, colorectal, and gynaecological cancer surgery.\textsuperscript{30,31} For radiotherapy, where one would expect potentially less patient mobility than is normally observed for services because of the protracted duration of radiotherapy regimens, the past decade has also seen a substantial increase in the use of an array of high-cost technologies.\textsuperscript{64} These technologies have included intensity-modulated radiotherapy, stereotactic-beam radiotherapy, and proton-beam therapy, with providers trying to gain a competitive advantage over others.\textsuperscript{31}

The question as to whether competition can stimulate improvements in outcomes of cancer surgery remains unanswered. Two studies have analysed the effect of hospital competition on the pricing of pancreatic cancer\textsuperscript{40} and colon cancer\textsuperscript{47} surgery, and one study assessed the effect of such competition on the efficiency of cancer care delivery across tumour types in the US cancer health-care market.\textsuperscript{9} Studies across other specialties have shown mixed results for the effect of fixed-price markets on improvements in health-care quality.\textsuperscript{40,41,46-48}

The dearth of studies on patient mobility in both high-income and emerging economies is a major limitation for evidenced-based policy making to decide how best to balance patient choice and top-down policy approaches to service coordination in cancer care. We have highlighted potential approaches for management of this health system challenge.

For patients, having choice over their treatment or how a specific treatment is given might be more important than having a choice over the actual service provider.\textsuperscript{37} Therefore, differences in availability of technology at the local level, even within a system that publishes validated outcome measures, can contribute to shifts in market share.\textsuperscript{38} Investment in medical devices for cancer care\textsuperscript{41} seems to be driven predominantly by individual clinicians and clinical departments, possibly because the regulatory hurdles for adoption of new devices are relatively low compared with those of medicines.\textsuperscript{40,48}
The use of health technology assessment processes or value frameworks for all new technologies across the cancer care spectrum (i.e., medicines, radiotherapy, and surgery) would act as a meaningful first step towards providing stronger guidance on which interventions are likely to deliver the greatest value to patients and society.\textsuperscript{\texttrademark,\textcopyright} Other options for coordination of technology adoption include coverage with evidence development schemes or establishment of nationally designated research centres to trial new technologies before considering reimbursement.\textsuperscript{\textdagger} However, a significant time lag remains before functional and oncological outcomes will be available to inform national implementation, especially for conditions with a lengthy disease course—such as prostate cancer.

Competition between hospitals will continue irrespective of attempts to centralise cancer services. Whether public reporting of performance indicators could help to achieve improvements in care quality through competition is debatable.\textsuperscript{\textdagger} It might never be feasible to develop meaningful indicators for some tumour types. For example, the appropriateness of many available indicators is problematic because they can only be published after a long lag period (e.g., side-effects and survival rates at 1 and 5 years), during which clinical practice can change substantially.\textsuperscript{\textdagger} Additionally, there is little evidence to suggest that individuals are more likely to use published performance indicators than proxies for quality, such as a hospital’s or clinician’s reputation.\textsuperscript{\textdagger,\textcopyright}

However, in the absence of any indicator, hospitals will try to differentiate themselves to attract new users, and patients will continue to be reliant on lay sources of information, including industry marketing.\textsuperscript{\textdagger} This observation strengthens the need to develop and provide access to performance indicators across different tumour types to inform patients’ decision making. Performance indicators are publicly available for oesophageal and bowel cancer surgery in the NHS.\textsuperscript{\textdagger,\textcopyright} Additionally, the National Prostate Cancer Audit has completed a national Patient Reported Outcome Measures (PROMs) collection exercise for men following radical surgery or radiotherapy, with the aim of reporting risk-adjusted outcomes at the individual hospital level.\textsuperscript{\textdagger} Public reporting of outcomes would mean that quality improvement could be stimulated through hospitals competing for market share or aiming to avoid reputational losses.\textsuperscript{\textdagger,\textcopyright}

Finally, the configuration of cancer services needs to account for existing patterns of patient mobility, hospital capacity, catchment areas, and clinical quality. To this end, location-allocation modelling provides a rigorous empirical approach to optimising the configuration of health-care services (including decisions about service centralisation).\textsuperscript{\textdagger,\textcopyright} For example, it can guide which centres should close to maximise outcomes, or minimise travel distances for those individuals who face difficulties in accessing services because of financial and physical constraints.\textsuperscript{\textdagger,\textcopyright}

A limitation of our study is that we used centroids of the LSOAs as the representation of the patients’ residence. This will have added noise to the determination of centres’ net gain and net loss of patients. It is likely that this noise has attenuated rather than enhanced the observed relationships between spatial competition and technology adoption on the one hand and patient mobility on the other.

In conclusion, we show that patient choice and hospital competition can have a major influence on the configuration of cancer services. The challenge for health systems is to balance choice and competition with service centralisation, but there is a paucity of empirical evidence to inform this decision making. Our study highlights the need to have robust quality performance and outcome measures available to patients and referring health centres, to avoid reliance on often misleading surrogate indicators. Otherwise, choice and competition policies could seriously limit rather than facilitate health services’ ability to deliver equitable and affordable improvements in cancer outcomes.

Contributors
AA conceived the study, AA, JvDM, and DL were involved in the design, analysis, and interpretation. AA wrote the paper, with support from JvDM. All authors were involved in revising the work critically and approved the final version.

Declaration of interests
JvDM reports grants from Healthcare Quality Improvement Partnership during the conduct of the study. All other authors declare no competing interests.

Acknowledgments
AA is funded by a Doctoral Research Fellowship from the National Institute for Health Research. JvDM is partly supported by the NHS National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care North Thames at Bart’s Health NHS Trust. The views expressed in this publication are those of the authors and not necessarily those of the NHS, the National Institute for Health Research, or the Department of Health. Hospital Episode Statistics were made available by the NHS Health and Social Care Information Centre. (© 2012. Re-used with the permission of NHS Digital. All rights reserved.) Data for this study are based on patient-level information collected by the NHS, as part of the care and support of patients with cancer. The data are collated, maintained, and quality-assured by the National Cancer Registration and Analysis Service, which is part of Public Health England. Access to the data was facilitated by the Public Health England’s Office for Data Release. AA and JvDM are members of the Project Team of the National Prostate Cancer Audit funded by the Healthcare Quality Improvement Partnership. We thank Graham Davies for his valuable comments and insights during the drafting of the manuscript.

References


Supplementary Appendix

Research in context – Evidence before this study

Search criteria included: ((patient choice*[Ti/Abs]) OR consumer choice*[Ti/Abs]) OR patient preference*[MeSH Terms]) OR patient preference*[Ti/Abs]) OR patient mobility[Ti/Abs]) OR patient travel[Ti/Abs]) OR hospital referral*[MeSH Terms]) OR hospital referral[Ti/Abs]) OR hospital bypassing)) OR hospital choice[Ti/Abs]) OR hospital market[Ti/Abs]) OR hospital competition [Ti/Abs]) AND ((((((health care provider[MeSH Terms]) OR provider*[Ti/Abs]) OR hospital*[Ti/Abs]) OR doctor*[Ti/Abs]) OR Physician*[Ti/Abs]) OR "specialist care"[Ti/Abs]) AND cancer [Ti/Abs]))
7. RESULTS CHAPTER 5

7.1 Impact of hospital competition on patient outcomes

The fourth component of my thesis was an analysis of the impact of hospital competition on patient outcomes following prostate cancer surgery. The creation of a competitive environment to support patient choice and provide incentives for hospitals to compete with each other is in conflict with policies that seek to centralise services into fewer centres. Centralisation aims to improve quality by eradicating very low volume surgery, and to increase the number of procedures performed by remaining centres.

This chapter compares the relative impact of both hospital volume and hospital competition on outcomes following a radical prostatectomy whilst adjusting for relevant case-mix criteria. The results have been presented in the form of the submitted research paper.

7.2 Research paper 5

“Impact of hospital competition and service centralisation on patient outcomes following prostate cancer surgery: a national population-based study”

This paper has been embargoed pending open access publication. Hard copy of completed thesis available in LSHTM library.
8. RESULTS CHAPTER 6

8.1 Hospital choice – a qualitative study

The fifth component of the study utilised qualitative research methods to understand what factors inform and influence where patients choose to receive prostate cancer treatment. This involved interviews with men previously treated for non-metastatic prostate cancer in England between 2010-2015. The results have been presented in the form of the submitted research paper.

8.2 Research paper 6

“Hospital choice in the context of a cancer diagnosis: a qualitative study”

8.3 Additional information

Appendix A – Ethics approval (Page 204)
Appendix B – Participant information sheet (Page 205)
Appendix C – Consent form (Page 208)
Appendix D – Interview topic guide (Page 209)

This paper has been embargoed pending open access publication. Hard copy of complete thesis available in LSHTM library.
9. DISCUSSION

This program of research has sought to address a number of questions that have persisted since
the introduction of patient choice policies in the NHS. In the next section, I summarise the
main findings from my PhD. Following this, I discuss how the findings of my thesis have
furthered our understanding of the role and impact of choice and competition policies in the
NHS before considering future opportunities for research.

9.1 Summary of main findings

The thesis demonstrates unequivocally that Choice and Competition are occurring within the
English NHS. With respect to patient mobility for prostate cancer treatment, I find that one in
three men and one in five men bypassed their nearest centres for prostate cancer surgery and
radiotherapy respectively. Patient mobility varied significantly across English regions, with
one in two patients bypassing their nearest surgical centre in London compared to one in seven
patients in the North East Region. This pattern was related to the number of available providers
from which patients could choose in their region, although mobility across regional boundaries
was also evident, particularly for those men seeking prostate cancer surgery.

Travel time was the dominant factor influencing location of care, however younger, more
affluent men and those living in rural areas were more likely to travel further for radical
prostate cancer radiotherapy. For prostate cancer surgery, the same pattern of patient
characteristics was observed, however it was also found that fitter men with no comorbidities
were also likely to travel further for treatment. Men are prepared to travel to centres where
they think they will get the best care and outcomes. When considering the characteristics of
each hospital within a conditional logit model, I find that for prostate cancer surgery, men
were attracted to centres that were early adopters of robot-assisted radical prostatectomy and to centres that employed surgeons with a national media reputation for prostate cancer surgery. For radiotherapy, men were attracted to centres that offered hypofractionated prostate radiotherapy as their standard schedule, to large-scale regional radiotherapy units, and to centres that were early adopters of intensity-modulated radiotherapy (IMRT) in the NHS.

The mobility of patients has resulted in shifts in market share for individual cancer centres (both surgical and radiotherapy) resulting in a net gain of patients for some centres - “winners” - and a net loss of patients for others - “losers”. These patterns were more marked in areas of stronger competition as measured by a spatial competition index and resulted in some centres performing up to 400 more surgical or radiotherapy procedures than expected if they had only been treating local men for whom this was their nearest centre. Conversely, some centres were performing significantly fewer procedures (over 500 fewer in the case of one radiotherapy centre) than expected due to patients seeking care elsewhere. From an efficiency perspective, patient mobility is likely to have resulted in lengthening of waiting lists for some centres and/or wasted NHS capacity for others.

The observed shifts in market share for individual surgical providers has also had an effect on service configuration and technology adoption as outlined in Chapter 6 (pages 87-98). 25% (n=10) of the 37 radical prostatectomy centres classified as “losers” closed during the study period with no evidence that their outcomes were any worse compared to those centres which remained open. Centres that gained patients were more likely to offer robotic surgery, compared to centres that lost patients (10/23 [43.5%], compared to 2/37 [5.4%]). Of the 10 surgical centres that closed, none offered robotic surgery. It therefore appears that the co-existence of policies that requires centres to perform a minimum number of procedures with policies that allow patients to select a provider of their choice has stimulated a form of natural
selection, where hospitals compete to preserve their cancer centre status. These competitive factors have likely contributed to the large-scale investment in robotic equipment in the NHS. Between 2010 and 2017, the number of robotic centres has more than tripled – increasing from 1 in 5 (12/65) centres providing the technology in 2010 to over three quarters (42/49) in 2017.

I also attempted to analyse the complex relationship between a competitive environment and patient outcomes following prostate cancer surgery. My findings demonstrate that patients treated in centres located in the most competitive areas (as measured with a spatial competition index) had a lower chance of a 30-day emergency readmission following surgery. However, there was no association between the strength of competition and other patient outcomes such as post-operative length stay and rates of severe urinary complications. The lack of a statistically significant association between hospital procedure volume and patient outcome after controlling for procedure type is likely to be influenced by the ongoing centralisation of NHS specialist services, which has served to eradicate surgical units that were performing a very low volume of procedures. Whilst one must be cautious in the interpretation of these results, my findings suggest that an association potentially exists between a competitive environment and clinical outcomes and that plans for further centralisation of surgical services may not necessarily deliver the expected improvements in outcome.

Finally, the results of my qualitative work involving interviews with men previously treated for prostate cancer in the UK have been informative in understanding the factors that inform and influence patient choice. The findings demonstrate how the geographic configuration of specialist services, the perceived urgency of a cancer diagnosis and pre-established referral and treatment pathways all limit the opportunity to choose an alternative hospital. Patients were required to collect additional information independently and were mainly reliant on the
internet, the specialist nursing team and their individual social networks. This in itself creates socioeconomic inequities, enabling those with the relevant educational background, financial resources and confidence in negotiating care to potentially benefit from the best available treatment. However, in the absence of relevant up-to-date and interpretable information, patients were required to use a series of proxy measures and heuristics to differentiate quality and were particularly attracted to new technologies and “centres of excellence” (findings that are consistent with my quantitative results). A key advantage of the choice agenda is that it has enabled patients to “exit” care that does not meet their expectations or to bridge variations in the availability of specialist cancer treatments across the NHS.

9.2 Policy implications

The next section discusses how this program of research has enhanced our understanding of the way in which choice and competition policies are operating in the NHS, focusing on five key themes: Patient mobility, Determinants of patient mobility, Equity, Efficiency and Hospital competition.

9.2.1 Patient mobility

The first major finding from the thesis is that the proportion of patients prepared to travel beyond their nearest provider for cancer treatment has been far greater than was originally considered necessary (5-10%) to stimulate improvements in quality within a fixed-price health care market (Le Grand, 2009).

Whilst studies to date have predominantly focused on patient mobility for surgical procedures, my findings within the context of radiotherapy are particularly informative. It suggests that
patients requiring complex daily treatments for up to 8 weeks are prepared to travel to alternative centres, despite the likely physical and financial burden associated with this.

The extent of patient mobility observed is also unexpected given the current organisation of NHS specialist services and lack of clinician “buy-in” to these policies. In the current system patients are rarely, if ever, given a choice of treating hospital by their clinician, (Dixon et al, 2010a) in part because clinicians are dis-incentivised from offering alternative hospitals for the same treatment given the loss of hospital income if the patient moved elsewhere for their treatment. This may result in patients not receiving treatment in line with their preferences (Bryan et al, 2006), or in patients failing to be informed about other relevant evidence-based treatments, which although not available at their local centre, could have been offered elsewhere.

The overall rates of bypass are higher than expected given the substantial variation in the configuration of specialist services across English regions (i.e. concentration of available providers). For example, for prostate cancer surgery, the movement of patients between centres varied from one in two patients bypassing the nearest provider in London (in which there were 10 centres in 2010 covering an area of 1,572km²), to one in seven in the North East (in which there were 3 centres in 2010 covering an area of 8,592km²).

This highlights that despite these geographic barriers, health care users are responsive to perceived differences in quality between centres and are prepared to exercise their right to “choose”. One could therefore argue that the rates of bypass observed could potentially be even higher if the current system was better aligned to support hospital choice.
It is unclear from the study findings, whether cancer patients are more sensitive to choice policies than non-cancer patients. The qualitative component of the study suggests that men diagnosed with prostate cancer attempted to balance the perceived urgency of their condition with a desire to do everything possible to secure the best outcome possible. It is not possible to extrapolate these results in the context of prostate cancer to other tumour types without further investigation, given differences in their mode of presentation, disease biology, treatment (type and intensity) and availability of services nationally. However, the systematic review I undertook (Chapter 3, pages 32-58), has been informative in identifying five international studies, which demonstrated that patients with different tumour types including breast, gastric, colorectal, and thoracic cancers are prepared to travel to alternative more distant centres for surgical treatment.

9.2.2. Determinants of patient mobility

By using a mixed methods approach, my thesis has provided an in-depth insight into the sources of information and the factors that influence patients’ choice of provider. It has highlighted that a fundamental issue within the current system, which undermines the choice agenda, is the failure by policymakers to provide relevant measures of quality across difference disease interventions. In the case of prostate cancer, there is little or no information at the provider level regarding the outcomes of different treatments in terms of tumour control and quality of life. Men instead were found to rely on a series of proxy measures to identify and differentiate quality between treatments and hospitals using information largely gleaned from the internet, their specialist cancer nursing teams and their individual social networks. Whilst one may point to the generic markers of quality that are currently presented on websites such as NHS choices (e.g. infection rates), evidence from my qualitative study and the wider literature
suggests that patients rarely use these metrics, as they are difficult to interpret and personalise in the context of their own disease (Dixon et al., 2010a; Fung et al., 2008; Hildon et al., 2012; Marshall & McLoughlin, 2010; Raven et al., 2012). In diseases such as prostate cancer, patients also have the added burden of having to assess the merits of competing treatment options as well as differences in the availability of treatment services nationally.

The quantitative analyses found that men with prostate cancer were more likely to travel to centres that were early adopters of innovation such as robot-assisted radical prostatectomy or that had integrated new processes of care (e.g. hypofractionated radiotherapy). With respect to the former, this demonstrates the impact that the availability of innovative technologies has on perceptions of quality. This is likely to be partly influenced by current marketing literature available through websites and mainstream newspapers, which has a tendency to exaggerate the benefits of these innovations with respect to delivering improvements in outcome (Basto et al., 2015; Dixon et al., 2015).

Similarly, the term “centre of excellence” was applied to specific providers by men interviewed in the study based on the perceived size of the centre, the volume of procedures performed, its research activity and the profile of individual clinicians. Whilst clinician and hospital reputation has previously been highlighted as a key determinant of patient mobility in survey based studies (Schwartz et al., 2005) the quantitative component of my thesis provides a better understanding about the impact of reputation on the behaviour of patients and the choices they ultimately make.

One can therefore observe how choice and competition policies have the potential to favour particular providers irrespective of the outcomes they deliver, or indeed how providers including those delivering cancer services will adopt a competitive strategy to establish a
strong position in the market by differentiating their practices of care (Baker & Phibbs, 2002; De Kuijper, 2009; Lutz, 1991). New patients will gravitate to these places and by doing so create specialist centres that treat a large number of patients, which in itself will attract further patients.

Another key determinant of mobility identified in the qualitative interviews was the desire for some patients to exit care that did not meet their needs or which they considered inadequate (Hirschman, 1970). It is arguable that this represents a success of the choice agenda and has allowed patients to access care that meets their own expectations, as previously this would not have been possible. However, a concern which arises is that some patients are moving to alternative cancer centres because the management plan at their local hospital is limited or does not take into account current advances in care. Whilst some individuals are clearly able to bridge these gaps, it remains unknown what the impact on outcomes are for those who are not able to evaluate differences in care or who do not have the financial resources to travel elsewhere.

9.2.3 Equity

Patient choice policies were expected to improve equity in access to the best available health care services for NHS patients, irrespective of their ability to pay (Le Grand, 2009). Prior to the introduction of these policies, patients could only choose an alternative hospital if they opted out of the NHS, and received care privately. However, the quantitative analyses demonstrate unequivocally a clear socioeconomic gradient in a patients’ willingness or ability to travel.
Younger, fitter and more affluent men were more likely to bypass their nearest provider for prostate cancer surgery, and younger and more affluent men for radiotherapy. The qualitative component of my thesis also supported these findings. It identified a subset of men who appeared to have inherent advantages based on socioeconomic status in accessing information, maximising their choice options, and benefiting from what they perceive to be the “best” health care.

From a wider NHS perspective, there is a real concern that offering patients a choice of their treatment provider may widen socioeconomic inequalities in access to services and the quality of care received, especially where men from lower socioeconomic backgrounds are unable to move to higher performing centres due to economic constraints (Dixon & Le Grand, 2006; Fotaki, 2010). In addition, current patterns of mobility, may result in hospitals within socioeconomically deprived areas with older demographic profiles having to manage far more complex patient cohorts (both medically and socially), which will likely impact on their quality outcomes and ability to retain local patients.

9.2.4 Efficiency

My thesis demonstrates that patient choice policies have created “winners” and “losers” in the health system due to patients considering treatment in hospitals other than their nearest. I assessed this empirically by considering the difference between the number of patients treated in a centre and the number expected to be treated based on each patient’s residence. For some surgical centres, nearly 80% of patients for whom that centre was the nearest provider chose to have their treatment elsewhere. Conversely, other centres were performing up to 200% more operations than expected because patients from elsewhere travelled to these centres for their surgery. Similar findings were observed for radiotherapy providers in the NHS. From an
efficiency perspective, patient mobility is likely to have resulted in lengthening of waiting lists for some centres and/or wasted NHS capacity for others.

9.2.5 Hospital Competition

In the NHS, policies promoting choice and competition are operating alongside those that aim to centralise specialist health care services. The likely effect of these policies working in parallel on the equity, efficiency and quality of health care services was unknown at the time that choice and competition was introduced (Jones & Mays, 2009). Nor was there any guidance/evidence as to how these policies could be appropriately balanced. In this regard, the results from my thesis have been informative by highlighting from a conceptual point of view, two different ways in which competition is operating in the NHS and the implications on the wider health system of having a mixed-policy environment.

The competitive environment

The first way in which competition is influencing the delivery of health care is through the creation of a health care environment in which patients can select and travel to a health care provider of their choice. We know, from this program of research (and others), that patients are prepared to select and travel to a health care provider of their choice and that patient mobility is largely concentrated in the most competitive areas where there is a plurality of available providers (Damiani et al., 2005; Gaynor et al., 2013). This environment is thought to stimulate improvements in quality for individual hospitals as they seek to retain and attract new patients to prevent the loss of income and to also preserve their reputation (Le Grand, 2009). This has been demonstrated in published studies which sought to analyse the impact of hospital competition on outcomes of medical and surgical care (Chou et al., 2014; Cooper et al., 2011; Diller et al., 2014; Hibbard et al., 2005).
In Chapter 6 (pages 87-98), we can see how a highly competitive environment influenced practices of care for prostate cancer surgery at the individual hospital level. I found that seven (41.2%) of 17 centres in the highest quartile for hospital competition were established robotic centres compared with five (10.4%) of the 48 other centres in the three other quartiles (p=0.0050).

Given these observations from my own study and the wider literature, I attempted to analyse the relationship between a competitive environment and patient outcomes following prostate cancer surgery (Chapter 7, pages 99-128). I found that patients treated in centres located in the most competitive areas (as measured with a spatial competition index) had a lower chance of a 30-day emergency readmission following surgery. However, there was no association between the strength of competition and other patient outcomes such as post-operative length stay and rates of severe urinary complications.

The results need to be considered cautiously given the limitations of the study, namely the paucity of patient outcome measures I had available, the lack of information about individual surgeon volume (which may be more relevant), and the underpowered nature of the study given it was an analysis of 65 centres. In addition, the international literature to date has largely supported an association between increasing procedure volume and outcomes. However, the findings from my analysis suggest that an association potentially exists between a competitive environment and clinical outcomes for prostate cancer surgery, and that further centralisation may not deliver the expected improvements in outcome by increasing the volume of procedures performed.

Further research using additional patient outcome measures and across different tumour types and interventions is required before any definitive recommendations can be made regarding
the relative merits of competition and centralisation as a mechanism to improve cancer outcome. This includes a better understanding of the impact of reconfiguring the health system to support either one of the two policies on the equity and efficiency of health care delivery, and the trade-offs that need to be considered if seeking to improve quality.

**Competition as a mechanism for centralisation - “survival of the fittest”**

A major finding from this research program is that patient choice and hospital competition, rather than a coordinated policy towards centralisation, have been the most significant drivers in the configuration of prostate cancer surgical services in the NHS. The incentive for NHS centres to compete has been two-fold. First, payment follows the patient, and therefore the loss of patients from their catchment areas affects hospital income and the viability of the service (Department of Health, 2012). Second, centralisation is largely driven by the need of a surgical service to meet procedure volume targets each year. Those centres not able to meet these targets are at risk of closure.

This link between choice and competition and centralisation has not previously been observed in the NHS and highlights that whilst attempts have been made by policymakers to “control” the healthcare system centrally, it is in fact patients and clinicians that have had a substantial impact on the design of the health service. For example, centres classified as “losers” were more likely to close their service. In addition, the rapid and widespread adoption of robotic surgery in the NHS has been unforeseen, effectively rendering commissioning guidelines, published only in 2015 recommending a phased introduction of robotics for prostate cancer surgery within the NHS, obsolete. By 2015, 39 (71%) of the 55 centres open already offered robot-assisted radical prostatectomy.
Although the creation of a “survival of the fittest” environment was never explicitly intended within the original policy framework (Jones & Mays, 2009), some observers noted at the advent of such policies that it was an inevitability, and framed the potential consequences in both negative and positive lights.

From a negative perspective, it was thought that the reconfiguration of services in response to patient demand rather than the health care needs of the population within a region, may lead to inequities in access to services for the most vulnerable groups given their decreased ability to travel (Paton, 2010). This has potentially been borne out in my study as patient mobility (and the subsequent shifts in market share for individual providers) was largely observed amongst younger, fitter, more affluent men. We also do not know whether the process of “natural selection” resulted in the closure of the worst performing centres (with respect to quality) or whether patients bypassing their nearest providers had better cancer outcomes.

Observers also highlighted the potential inefficiencies that could result from such policies as providers seek to make themselves more attractive to patients, advising the government to heed lessons from the US health system, which had a well-established health care market at the time (Fotaki, 2014; Fotaki et al., 2008; Kuttner 2008; Pauly, 2005). The thesis demonstrates the case in point, as surgical centres investing in costly robotic equipment fared better than those who did not in attracting patients and reducing the threat of closure. However, there is little evidence that such investment and changes in practices of care have ultimately improved quality.

From the perspective of the wider NHS, this should serve as a warning as to the potential inefficiencies that result from a lack of appropriate indicators regarding the quality of care to direct patient choice (Arrow, 2001). In their absence, my thesis suggests that such policies
could lead to a technological “arms race” which may inflate the cost of delivering health care without any tangible improvement in outcomes.

Whilst these have been the main concerns of the choice and competition agenda, many of which have been realised, others would argue that the current patient choice/hospital competition model is achieving exactly what has always been desired in the NHS. Simon Stevens (current Chief Executive of the NHS) wrote the following in support of competition in the BMJ in 2011 (Stevens, 2011).

“competition might diminish tiresome but repeated top-down NHS reorganisations and pointless bureaucratic restructuring, which history suggests are the inevitable result of day to day central government control. Imagine instead a world where clinicians controlled more of their own destiny, where those with creative ideas and innovative approaches were free to form new organisations or partnerships, and which would succeed based on the extent to which they met patients’ needs and preferences. This is a conception of the NHS not as a giant hierarchically organised healthcare factory—as now—but as an evolving, plural, distributed, and self directed health ecosystem. Many European healthcare systems operate more like that—why not the NHS?”

My case study in prostate cancer surgery demonstrates that this vision of a dynamic evolution of services in response to patient preferences has become a reality. If working as intended this will serve to reduce inefficiencies in the current system by weeding out centres, which have the greatest net loss of patients. However, paradoxically, this is moving us away from the competitive environment on which these policies are predicated.
9.3 Balancing competition and centralisation

The next section discusses how best to optimise the health care system if a mixed-policy approach is the preferred strategy within the NHS. i.e. a health care system, which seeks to maintain a competitive environment, continues top down reconfiguration of specialist services, and at the same time wishes to encourage dynamic changes in the delivery of services in response to patient demand.

9.3.1 Designing a health system to support patient mobility and competition

If the creation of a competitive environment is to be the dominant mechanism by which the health system delivers improvements in healthcare quality, the availability of alternative providers and the travel time between them are important factors (Balia et al., 2014; Damiani et al., 2005; Gaynor et al., 2010). The analysis of patients undergoing surgery and radiotherapy highlights how the spatial configuration of alternative providers (as measured with a spatial competition index) greatly influences the patterns of patient mobility and explains the regional variation we demonstrate. As a result, the geographical layout of cancer services means that not all centres face the same competitive pressures and in turn they will respond differently to choice and competition policies as a mechanism for quality improvement.

To increase the level of competition across England, new specialist cancer providers would be required, especially in regions such as the North East of England, Yorkshire and Humberside, and the East of England. In designing the optimum geographic location of new specialist centres, location allocation modelling, provides a robust empirical approach by accounting for existing patterns of mobility, clinical quality and hospital capacity within the health service (Santibáñez et al.; Wang & Onega, 2015).
9.3.2 Top down reconfiguration of cancer services

In the current policy environment it is unclear how strategic plans for the reconfiguration of specialist cancer services are being formulated (e.g. NHS cancer alliances or cancer vanguards) (Independent Cancer Taskforce, 2015). It is imperative that such decisions are based on substantive evidence that centres provide either the best care, improved access or have the capacity to expand their services in the context of increasing demand, rather than be based on the perceived profile or reputation of a centre.

Two empirical approaches to the reconfiguration of services using econometric and geographic methods could be considered to assist in this complex process. Econometric analyses can be used to predict the impact of the closure of cancer treatment units on travel times, equality in access and outcomes using data on an individual’s willingness to travel and quality preferences derived from the conditional logit analyses undertaken in this study (Kobayashi et al, 2015; Poeran et al, 2014). Pilot closures may be based on several relevant factors, for example closing the: (1) worst performers (if outcome data is available), (2) low volume centres, (3) centres that are frequently bypassed and therefore potentially represent wasted NHS capacity, (4) or those centres which do not have all cancer treatment modalities available onsite (e.g. radiotherapy and surgery). In this way, one can simulate multiple options for service reconfiguration, and assess their likely health system effect.

Similarly, using willingness to travel coefficients, geographical techniques such as location allocation modelling as described before, can identify which treatment centres to close in order to minimise disparities in access to cancer care (Wang & Onega, 2015). This involves a step-wise approach that considers the impact of closures of each centre in the choice set before assigning which closure is likely to have the least impact on access expressed in terms of travel
time or distance. This is important as inequities in access have been observed for older, and lower socioeconomic groups with comorbidity, which can subsequently affect outcomes.

9.3.3 Development of indicators for quality improvement

If a bottom-up approach (led by patients and clinicians) to service configuration and quality improvement is the preferred strategy within the NHS, efforts need to be made to fill the current gaps with respect to information about the quality of cancer treatment (both surgery and radiotherapy) delivered by individual providers. This information needs to be provided in a format that is interpretable for patients and will assist in their decision making (Department of Health, 2016). The qualitative component of my research demonstrated the current information anarchy that exists in prostate cancer with little if any independent information about aspects of care that patients value, for example, their likely functional and oncological outcomes from treatment.

Instead, patients remain reliant on a variety of different types and sources of information (e.g. word of mouth, the internet, personal knowledge) as well as the media interpretation of technological developments (Abrishami et al., 2014; Dixon et al., 2010a; Victoor et al., 2012). In addition, specialist centres continue to differentiate their practices of care which adds further complexity for patients when considering what are the best treatments and who are the best practitioners.

It is a recommendation of this thesis that the development and reporting of patient-level outcomes for interventions should be undertaken as part of a public engagement strategy, which seeks to better understand what the public wish to see reported with regards to the quality of care delivered by individual cancer providers and clinicians. Whilst most attention
has been devoted to the development of outcome measures which reflect the quality of treatment, in reality there are many other aspects of quality that patients are likely to value and would wish to see reported. A public engagement approach can also assist in the development of an online platform, which allows individuals with cancer and their carers/relatives to better assess differences in the quality of care and provide guidance on the value of new innovations that are increasingly marketed and publicised in the media (Aggarwal et al, 2014).

With respect to outcome indicators, it is important to acknowledge that it may be difficult (or not ever be possible) to develop meaningful indicators for some tumour types. For example, the appropriateness of many indicators that are currently available is problematic because they can only be published or measured after a long lag period (e.g. side-effects/survival rates at 1 and 5 years) during which time clinical practice can change considerably (Walker et al, 2013). Neither is it helpful to merely publish a series of process indicators, which may be difficult for patients to interpret and do not necessarily help to differentiate the quality of care between providers (Danielson et al, 2011). It is also not clear as to the level at which these outcomes should be reported, for example at the individual hospital or clinician level. There is an ongoing debate within the surgical arena as to whether individual surgeon volume is a stronger predictor of outcome than hospital level procedure volume. However, moves towards clinician based outcome reporting are controversial (Jenkins & Cooper; Trinh et al, 2013), and may prove particularly challenging for radiotherapy given the multidisciplinary nature of treatment delivery.

Despite these limitations, the current Secretary of State for Health - Jeremy Hunt - remains firmly committed to the transparent reporting of outcomes on sites such as MyNHS (Jeremy Hunt, 2017). In addition, progress continues to be made in the development of clinically relevant quality measures. For example, indicators reflecting aspects of the quality of prostate
cancer surgery and radiotherapy have been recently developed using administrative datasets by the National Prostate Cancer Audit (Royal College of Surgeons of England, 2016c; Sujenthiran et al., 2017a). They have helped to define differences in the outcomes between alternative treatment techniques (e.g. Intensity modulated radiotherapy versus 3D conformal radiotherapy) (Sujenthiran et al., 2017a; Sujenthiran et al., 2017b) and are now being used to differentiate the quality of treatment at the level of individual providers. These indicators await formal inclusion in the Clinical Outcomes Program which is an initiative that since 2013 aims to publish quality measures at the level of the individual consultant, team or unit (Health Quality Improvement Partnership, 2016).

9.4 Strengths and Limitations

The strengths and limitations of specific methods and analytical approaches have been discussed in the preceding chapters, and this section will focus on more overarching themes.

9.4.1 Methodological approach

A key strength of the thesis has been the use of quantitative and qualitative research methods, which has meant that the findings are nuanced and more attentive to the effect of such on policies on individuals as well as the overall patient group. Throughout the thesis, I have attempted to keep the patient as the main focus, understanding how individual characteristics (e.g. socioeconomic status) impact on their ability to travel to alternative hospitals and in turn to understand the factors which potentially influence where they ultimately decide to receive treatment. Much of the discussion around the impact of “choice” would have been lost if a singular approach had been undertaken.
In addition, the design of the study has enabled each method to inform the other. In particular, the systematic review of the literature informed the quantitative approach to investigating patient choice and in conjunction with the qualitative interviews identified factors influencing patient mobility, which could subsequently be assessed within the quantitative model. Both quantitative and qualitative analyses were undertaken during the same time-period and ensured that the methods and specific areas of investigation continually evolved as part of an iterative process.

9.4.1 Data

A major strength of my thesis was that it used linked national level patient datasets. Only a small proportion of total number of NHS patients (1-2%) receiving either surgery or radiotherapy during the time-period of analysis were excluded. Exclusions predominantly related to men either residing outside of England or because they received treatment at an unrecognised surgical or radiotherapy provider.

The NHS itself is an ideal forum for understanding the impact of patient choice policies. It is a national single-payer, tax-based system, in which care is free at the point of access and not based on ability to pay for insurance or treatment. Since 2008, patients have access to all available NHS providers in England with no explicit restrictions on the choices available. I was careful to ensure the choice-set of available centres was accurate and included closures or openings of centres during the time-period of analysis.

Previous analyses focusing on patterns of patient mobility have used regional, or insurer-based patient databases or limited national samples of patients (Ho, 2006; Messina et al, 2013; Pope, 2009). There has been a lack of clarity regarding whether the “choice set” of hospitals from
which patients are expected to choose actually perform the procedure in question (Chernew et al, 1998). In addition, many studies perform an aggregated analysis that attempts to look at mobility patterns for multiple elective interventions or mixed acute/elective patients (Kronebusch, 2009). This fails to understand the nuances affecting particular treatment decisions for specific diseases and interventions. Many also do not account for pre-existing specialist referral patterns based on insurance status (e.g. preferred providers) or the influence of co-payments on patient choice (Escarce & Kapur, 2009; Ho, 2006). My analysis of the radiotherapy dataset (RTDS) was particularly unique, as there are few databases internationally that provide such detail with respect to total doses and fractionation schedules and allowed me to analyse the impact of variations in radiotherapy practice on patient mobility.

The main issue with respect to the data was the high proportion of patients with missing cancer staging information (approximately 25-30%). I was therefore not able to assess the impact of cancer stage on the patterns of patient mobility observed. However, given that disease stage is unlikely to preclude treatment at any one location (surgical and radiotherapy centres are able to readily treat patients with intermediate and locally advanced disease (Royal College of Surgeons of England, 2016c)) the impact on patient mobility is likely to be small.

Comorbidity scores (presented as the RCS Charlson Score (Armitage et al, 2010)) were available using the HES dataset and the inclusion of this information for each individual patient as a co-variate, offered insight into the impact of a patients’ fitness on their propensity to travel beyond their nearest hospital.

Ideally, the analysis would have used patient postcodes to identify their residence, however these were not available due to data restrictions. Lower layer super output areas (LSOAs) were
used instead. These encompass approximately 650 households (1500 residents) and the geographic point coordinates used in the analysis were centred on the most population dense areas within the LSOAs to improve accuracy (population-weighted centroids). Other studies have used Middle Layer Super output areas, which cover a population of 5000 residents, or GP post-codes which are not as precise. The use of LSOAs will have added “noise” in the evaluation of travel times which will have attenuated rather than enhanced the observed relationships.

9.4.2 Patient choice

As discussed in the introduction, it is not possible to ascertain empirically from administrative data whether patients have made an active choice to receive care at a particular centre. The thesis therefore used patient mobility as a proxy measure as it can be quantified. This is a strength of the study as it appreciates the complexity of investigating choice and what can be inferred using quantitative data. In the wider literature, quantitative studies using similar methods that claim to have quantified patient choice (predominantly in the health economics literature) are in fact only describing patterns of mobility. It is for this reason I used a mixed methods approach to understand the complexity of patient choices in the context of a cancer diagnosis.

The thesis was unable to assess the impact of the patient’s GP on a decision to move. Given that the GP has no incentive to refer to any one provider in the NHS, it is accepted that many such decisions are made in partnership and to separate the relative impacts on decision-making is empirically very challenging.
9.4.3 *Travel time estimation.*

My model uses average drive times, which is the standardised methodology for these analyses and considered superior to straight-line distance. However, I do acknowledge that drive times are variable depending on the time of day, which may affect patient’s decision-making. In addition, public transport times were not available for this analysis. The use of public transport times would be recommended for future work and could act as a sensitivity analysis.

Our estimation of hospital bypassing may be affected in circumstances where men reside at the boundaries of two different specialist multidisciplinary (SMDT) networks for prostate cancer (Aggarwal et al, 2016). For example, whilst the diagnostic centre they initially present to may be their closest hospital, the surgical or radiotherapy centre associated with this diagnostic centre as part of the SMDT network may be located further away from the patient’s residence than the surgical centre of a different SMDT network. This may affect the estimations of the proportion of bypassers in both directions. For example, patients initially offered treatment at a more distant radiotherapy centre, may request to receive care at their nearest radiotherapy centre instead, which would mean they are technically “non-bypassers” according to the definitions used, despite choosing to change their treatment location.

9.4.5 *Determinants of mobility*

A major limitation of the study is that performance measures that accurately reflect the quality of prostate cancer treatment are currently not available. As a result, the study uses a series of proxy measures to define quality as well as other hospital factors, which could influence a decision to move. The hospital characteristics considered were informed by the peer-reviewed literature, in depth qualitative interviews, and the National Prostate Cancer Audit Organisational survey (Royal College of Surgeons of England, 2014).
A notable exclusion was waiting times for procedures as some patients may have considered moving to alternative providers to receive quicker treatment. However, extensive efforts have been made in the English National Health Service to ensure prompt diagnosis and treatment of suspected cancer patients through a system of defined targets. In 2014/2015 95.3% of people treated for urological cancers in the NHS began their first definitive treatment within the 31 day target (NHS England, 2015).

Other potential determinants of mobility such as care giver/work location were not available in our dataset. Procedure volume was considered as a covariate, however this information was not publicly available during the time of the analysis to inform patient decision-making and therefore not included.

9.4.6 Competition

The study used a spatial competition index as a proxy measure for competition. A number of measures are proposed in the literature, of which the most commonly used metric is the Herfindahl-Hirschman Index (HHI), which is a measure of market concentration (Wong et al, 2005). It is calculated by squaring the market shares of individual providers (number of patient predicted to be treated or actually treated by each centre) in a particular market area. If there is an equal split of patients between centres then it is considered a market with low concentration. Equally, if there is one dominant centre in the market area, this is considered a concentrated market. My empirical analysis did not use HHI as there was no established definition for market structure with several alternatives used in the literature depending on the availability of data (Cooper et al, 2011; Gaynor et al, 2013; Gravelle et al, 2012). In addition, a hospital which has lots of nearby competitors but attracts the majority of patients due to perceived quality in their market area would be considered to be in a monopoly environment.
Instead, I decided to use a spatial competition index, as a measure of the external competition faced by each individual treating centre. This metric accounts for the demand for services (number of eligible patients) and the availability of alternative hospitals within 60 minutes drive time. This was adapted from other studies (Gravelle et al., 2012) which have previously used this measure of competition, and was preferred for this analysis, as it took into account regional variation in the availability of alternative providers and provided an ideal measure of a hospital’s competitive environment.

9.4.7 Patient outcomes

A major limitation of the thesis is the lack of more recent data on patient outcomes of surgical treatment quality including rates of incontinence, sexual dysfunction and tumour margin status. In addition, it was not possible to factor in individual surgeon volume. However, one could argue that this sums up the current policy context in which decisions regarding the costly reconfiguration of services are being undertaken without national level evidence that they will ultimately improve outcomes.

The recent PROMS exercise undertaken by the National Prostate Cancer Audit would mean that further evaluation using more sensitive measures of treatment quality could be undertaken in the future. Equally, since the study period of analysis in the paper (2008-2011) the number of prostate cancer surgical centres has decreased from 65 to 49. The analysis could therefore be repeated in the future to assess the relative impacts of “centralisation” and “competition” on quality as part of a difference in differences approach.
10. **CONCLUSION**

Choice and competition policies were introduced in the NHS on the supposition that they would drive up quality, enhance equity in access, and afford patients greater choice and control of their health care. The thesis demonstrates that patients with cancer are prepared to travel in significant numbers, to alternative more distant centres for treatment, based on where they think they will get the best care and outcomes. Health care providers in turn appear to be adopting a competitive strategy aiming to attract new patients using specific branding or special ingredients (e.g. new practices or processes of care) whilst not necessarily improving the quality of care delivered. The patterns of mobility observed are inequitable and are largely manifest by younger more affluent patients. There is also evidence that such policies create inefficiencies in the delivery of specialist prostate cancer services by increasing costs and having a negative impact on capacity. Finally, the overall impact of hospital competition on improving patient outcomes remains unclear and policy makers need to proceed with caution when considering the optimum reconfiguration of health services in the absence of hospital level data on outcomes.
11. TRAINING

As part of my Doctoral Research Fellowship funded by the NIHR I have undertaken training in research methods relevant to my PhD study as outlined below.

Quantitative

- Introduction to STATA – Imperial College London
- Analysing patient level data using Hospital Episode Statistics – University of York
- Introduction to Arc GIS – University of Southampton
- Advanced Arc GIS – University of Southampton
- Statistical Methods in Epidemiology – LSHTM
- Choice modelling and stated choice survey design – University of Leeds

Qualitative

- Qualitative Research Methods – Oxford University
- Qualitative Methodologies – LSHTM
- Nvivo – University of Surrey
12. REFERENCES


De Kuijper M (2009) Profit power economics: a new competitive strategy for creating sustainable wealth: Oxford University Press on Demand


Department of Health (2008) High Quality Care for All - NHS next stage review final report


Department of Health (2016) The NHS Choice Framework: what choices are available to me in the NHS?


122


Jeremy Hunt (2017) My digital pledge for the NHS. In *The Times*

Jones L, Mays N (2009) Systematic review of the impact of patient choice of provider in the English NHS. *London: London School of Hygiene and Tropical Medicine*


Mays N (2011) Is there evidence that competition in healthcare is a good thing? No. *BMJ 343*


Royal College of Surgeons of England (2016b) *National Oesophago-Gastric Cancer Audit*.

Royal College of Surgeons of England (2016c) National Prostate Cancer Audit - Third Year Annual Report - Results of the NPCA Prospective Audit and Patient Survey.


Secretary of State for Health (2002) Delivering the NHS Plan: next steps on investment next steps on reform, HMSO L (ed)


Stevens S (2011) Is there evidence that competition in healthcare is a good thing? Yes. *BMJ 343*


13. APPENDICES

Appendix A – Ethics approval

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: + 44 (0) 20 7636 8636
www.lshtm.ac.uk

Observational / Interventions Research Ethics Committee

LSHTM
11 June 2015

Dear

Study Title: Choice and Competition: Does provider choice improve quality outcomes for cancer patients?
LSHTM Ethics Ref: 9737

Thank you for responding to the Observational Committee’s request for further information on the above research and submitting revised documentation. The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion
On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion
Approval is dependent on local ethical approval having been received, where relevant.

Approved documents
The final list of documents reviewed and approved by the Committee is as follows:

<table>
<thead>
<tr>
<th>Document Type</th>
<th>File Name</th>
<th>Date</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covering Letter</td>
<td>Covering letter ethics committee response - 9737</td>
<td>09/06/2015</td>
<td>V1</td>
</tr>
</tbody>
</table>

After ethical review
The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

Professor John DH Porter
Chair
ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

Improving health worldwide

Page 1 of 2
Appendix B – Participant information sheet

Experience and management of prostate cancer

We would like to invite you to take part in our research study. Before you decide whether you would like to, please read this information so you know what the study is about and what taking part means for you.

What is the study about?
We would like to better understand how men with prostate cancer are being treated. We are especially interested in how patients’ choose their treatment and where they are treated. We intend to do this by talking to men who have been diagnosed with non-metastatic prostate cancer in the last three years. We want to understand the patient journey and the process men go through when making decisions regarding their care. This will help guide what information is needed to help people with their choices and how best to organise cancer services in England to improve the quality of care.

Who is carrying out this study?
The study is led by a researcher from the London School of Hygiene and Tropical Medicine (LSHTM) (see www.lshtm.ac.uk) who works within cancer services in the NHS. He will be supported by a team of researchers who specialise in cancer services and health care quality improvement. The study is funded by the National Institute for Health Research (NIHR) (see www.nihr.ac.uk).

Why have I been asked?
The regional leads of “Tackle Prostate Cancer” have agreed for the research team to approach its members within the local prostate cancer support groups in England. You have been asked as we want to understand the experiences of men with prostate cancer. We are interested in the choices people make about going to healthcare services and the support they receive when making important decisions regarding their care.
What does taking part involve?
We would like you take part in a one-to-one interview with the lead researcher. This would be at a time convenient for you. We anticipate that the interview will last between half an hour and an hour and it will take place by telephone or Skype. The interview will involve discussing your views, opinions and experiences in greater detail. If you would prefer the interview to be done face to face, arrangements can be made to make this possible.

Do I have to take part?
Your contribution is very important to us but it is entirely up to you. If you do take part, you don’t have to answer all the questions and you can end the interview at any time.

What will happen to the information I give?
This study will help health professionals to improve the care we can provide to men with prostate cancer and potentially other cancers. Everything you tell us will be strictly confidential. No one will be able to trace anything said in the interview back to you as an individual. Data and results from this study will not include any names or identifying information and will be stored securely in line with the research team’s policies.

What’s in it for me?
We have found that people find being interviewed a positive experience. It’s an opportunity to talk about your life to an attentive listener. At the same time you will be contributing to research of national importance which may have an impact on the care that other men in a similar situation receive.

What do I do if I am interested in taking part?
If you are interested in taking part we would be grateful if you could reply to the introductory email/letter sent by the “Tackle Prostate Cancer” regional lead indicating you would be happy to be contacted about the study. Following this one of the research team will phone you to talk to you about whether you would like to take part in an interview and answer any questions you may have about the study.

If you have any questions or would like to know more, please contact:
Appendix C – Consent form

Experience and management of prostate cancer

Consent form

Please read the following statements, initial those you agree with in the box on the right, and then sign your name at the end:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I confirm that I have read the information sheet for the above study and have had the opportunity to ask questions.</td>
</tr>
<tr>
<td>2.</td>
<td>I agree to take part in an interview.</td>
</tr>
<tr>
<td>3.</td>
<td>I agree to the interview being audio recorded.</td>
</tr>
<tr>
<td>4.</td>
<td>I understand that all information I give during the interview will be strictly confidential.</td>
</tr>
<tr>
<td>5.</td>
<td>I understand that the results of the study will be anonymised. This means that no one will be able to trace anything I say during the interview back to me.</td>
</tr>
<tr>
<td>6.</td>
<td>I understand that anonymised, unidentifiable quotes of mine may be used in reports of the study.</td>
</tr>
<tr>
<td>7.</td>
<td>I understand that my participation is voluntary and that I can stop the interview at any time without giving any reason.</td>
</tr>
<tr>
<td>8.</td>
<td>I am willing for members of the project research team to have access to my anonymised responses.</td>
</tr>
<tr>
<td>9.</td>
<td>I understand that anonymised information I give may be reviewed by the authorities responsible for regulating the study (the London School of Hygiene &amp; Tropical Medicine).</td>
</tr>
<tr>
<td>10.</td>
<td>I am willing for the anonymised information that I give to be stored in a secure data repository if required.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of participant</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you would like more information, please contact: Dr Ajay Aggarwal email: ajay.aggarwal@lshtm.ac.uk
Appendix D – Interview topic guide

Initial narrative

- When did you first get a sense that things weren’t right?
  - What were you thinking at that time?
  - Did you search for any information or speak to anyone at this stage?

- Who did you go to for advice?

Initial GP consultation

- What was recommended?
  - If referral for diagnosis recommended – were you given a choice of where you could be referred?
  - If no – would you have liked to be offered a choice? Was it important to you at this time? (see next section – place of diagnosis)
  - Did you request an alternative referral? If yes why?

- How did you decide where to go? (If yes to latter question or first question)
  - What options were you considering?
  - What information sources did you use?
  - Did you speak to anyone?
  - What factors were most important in your decision?

Place of diagnosis

- What hospital were you referred to?
  - How did you feel about being referred there?
  - Had you or anyone you knew had any experience of the hospital that you were being referred to?
  - Did you know anything about the consultant or department?

What happened after the referral? – (e.g. tests etc)

- Did you search for any information or speak to anyone regarding your referral? (Note this is a trigger for information seeking and interpretation)
- What investigations did you have and where?
Diagnosis

- **At what stage were you given the diagnosis?** (if not discussed in relation to previous question)
  - Who did you see? Was this at the same hospital you were initially referred?
  - Did you have any expectations or preferences before the consultation?

- **How did you feel when you were given the diagnosis?**
  - What was explained to you about the processes you were going to go through?

- **If diagnosis and treatment discussion not at the same stage refer to information seeking section first?**

- **Overall - how did you feel about the consultation (and the physician) and the information you were given?** (Reassured/trust/sufficient info?)

Treatment options

- **At what point did the discussion regarding treatment take place and with whom?**
  - Did you feel in a position to have a discussion about treatment at that stage?
  - Did you have any other treatment options in mind at the time of the meeting?

- **What options were you given with regards to treatment and where you might have it?**
  - Was the planned location of treatment where you expected it?
  - Had you heard anything/had experience of these hospitals before?

- **Did you ask about any other treatments/hospitals?**
  - Did you request a referral elsewhere?
  - If yes - Did you feel comfortable doing this? How did the clinician respond?
  - If no would you liked to have been given a choice of other options?

- **What factors were most important to you when considering the options?**
  - (If not discussed in above question) Was the location of the treatment important to you? – Would you have considered any other locations for your treatment?

- **What information were you given?** – leaflets/experiential
• Did you have an opportunity to talk to anyone else at this stage?

• How were things left at the end of the consultation?
  o Did a decision have to be made at this time?
  o Time frame for decision making? Await further appointments?

• Did you feel in a position to make a choice at this stage? (if requirement to choose at this stage)

• Overall - how did you feel about the consultation (and the physician) and the information you were given? (Reassured/trust/sufficient info?)

Information seeking and interpretation

• What happened when you got home?
  o Had you had any experience of cancer – personally or someone else?
  o Who did you speak to? (GP, friends, family, specialist nurse)

• Did you search for any information yourself?
  o If no did anyone search for any information on your behalf?
  o If yes - What motivated this decision? What were you looking for and why?

• Were you considering any other treatments or locations?

• What type of information did you find?
  o Was the information you found helpful?
  o Were you able to understand the information? Did you Trust it?
  o How did you process the information/what weight did you attach to the info sources?
  o Did you look at any NHS choices or Doctor Foster websites?

• What information would you like to have been given?

• How did the conversations you had or the information you found affect your decision making or choices?

Follow up consultation

• What happened at the follow up consultation? Who did you see?
Did you enquire about any other options or ask for a referral elsewhere?
How did the clinician respond? How did you feel about doing this?

- Were you able to go to the hospital or receive the treatment that you wanted?
- Overall - how did you feel about the consultation (and the physician) and the information you were given? (Reassured/trust/sufficient info?)

Location of Treatment

- Where did you have your treatment in the end?
- How did you get there?
- Was there anything particularly good or bad about the hospital? (probe – something particular bad about the hospital you were receiving treatment in or something that would have attracted you to a different hospital?)

Decision making/choice

- Looking back on it now, do you feel like you made the decision or would you describe it differently?
- Do you feel comfortable with how decisions were made about your treatment? (probe – explore at the time? And now?)
- Do you feel you had much choice in the decision making process? (probe – would you have preferred things to be different, in what way?)

Closing Questions

- Is there anything else you would like to tell me about?