The impact of the enhanced recovery pathway and other factors on outcomes and costs following hip and knee replacement: routine data study

Andrew Judge,[1,2,3,4*] Andrew Carr,[1] Andrew Price,[1] Cesar Garriga,[1,4] Cyrus Cooper,[1,3] Daniel Prieto-Alhambra,[1,3,4,5] Fraser Old,[6] George Peat,[7] Jacqueline Murphy,[8] Jose Leal,[8] Karen Barker,[1] Lydia Underdown,[1] Nigel Arden,[1,3] Rachael Gooberman-Hill,[2] Raymond Fitzpatrick,[9] Sarah Drew[2,10] and Mark G Pritchard[8]

[1]National Institute for Health Research Oxford Biomedical Research Centre, Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Oxford, UK
[2]National Institute for Health Research Bristol Biomedical Research Centre, Musculoskeletal Research Unit, Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]Medical Research Council Lifecourse Epidemiology Unit, University of Southampton, Southampton General Hospital, Southampton, UK
[4]Centre for Statistics in Medicine, Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, Nuffield Orthopaedic Centre, University of Oxford, Oxford, UK
[5]GREMPAL Research Group, Musculoskeletal Research Unit, Universitat Autònoma de Barcelona, Barcelona, Spain
[6]Patient representative
[7]Arthritis Research UK Primary Care Centre, Research Institute for Primary Care and Health Sciences, Keele University, Keele, UK
[8]Health Economics Research Centre, Nuffield Department of Population Health, University of Oxford, Oxford, UK
[9]Nuffield Department of Population Health, University of Oxford, Oxford, UK
[10]Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK

*Corresponding author andrew.judge@bristol.ac.uk and andrew.judge@ndorms.ox.ac.uk

Declared competing interests of authors: Andrew Judge reports grants from the National Institute for Health Research (NIHR) Health Services and Delivery Research (HSDR) programme, during the conduct of the study; that he is a subpanel member of the NIHR Programme Grants for Applied Research programme (1 September 2015 to present); that he has received personal fees from Freshfields Bruckhaus Deringer (London, UK); and that he is a member of the Data Safety and Monitoring Board (which involved receipt of fees) from Anthera Pharmaceuticals (Hayward, CA, USA). Andrew Price reports personal fees from Zimmer Biomet (Warsaw, IN, USA), DePuy (Raynham, MA, USA) and Smith & Nephew (London, UK); and grants from NIHR and Versus Arthritis (Chesterfield, UK), outside the submitted work. Cyrus Cooper reports personal fees from Alliance for Better Bone Health [Proctor & Gamble Pharmaceuticals, Inc. (Cincinnati, OH, USA) and Sanofi S.A. (Paris, France)], Amgen Inc. (Thousand Oaks, CA, USA), Eli Lilly and Company (Indianapolis, IN, USA), GlaxoSmithKline (Brentford, UK), Medtronic plc (Dublin, Ireland), Merck Sharp & Dohme (Kenilworth, NJ, USA), Novartis International AG (Basel, Switzerland), Pfizer Inc. (New York, NY, USA), F. Hoffmann-La Roche AG (Basel, Switzerland), Servier Laboratories (Suresnes, France), Takeda Pharmaceutical Company (Tokyo, Japan) and UCB Biopharma (Brussels, Belgium). Daniel Prieto-Alhambra is a member of the NIHR Health Technology Assessment Clinical Trials Committee (1 March 2018 to present); he reports grants from Amgen Inc., UCB Biopharma and Servier Laboratories and other from Janssen (Beerse, Belgium), outside the submitted work. George Peat holds an honorary public health academic contract with Public Health England (London, UK). Nigel Arden reports grants from the NIHR HSDR programme during the conduct of the study; grants from Bioiberica (Barcelona, Spain) and Merck Sharp & Dohme; and personal fees from Flexion Therapeutics (Burlington, MA, USA), Regeneron Pharmaceuticals (Tarrytown, NY, USA), Freshfields Bruckhaus Deringer, Eli Lilly and Company and Pfizer Inc., outside the submitted work.

Published January 2020
DOI: 10.3310/hsdr08040

Scientific summary

Enhanced recovery pathway following hip and knee replacement

Health Services and Delivery Research 2020; Vol. 8: No. 4
DOI: 10.3310/hsdr08040

NIHR Journals Library www.journalslibrary.nihr.ac.uk

Scientific summary

Background

In England and Wales, there are around 200,000 total hip and knee replacement operations each year, and this number is expected to increase as the result of an increasingly obese and elderly population.

Although the founding principle of the NHS is that it is free to all at the point of use, and based on clinical need and not ability to pay, inequities in access to health care have been widely described across a range of medical conditions. There is known discrepancy in access to common surgical procedures, and this has been widely disseminated through *The NHS Atlas of Variation in Healthcare* (NHS England. *The NHS Atlas of Variation in Healthcare. Reducing Unwarranted Variation to Increase Value and Improve Quality*. London: Public Health England; 2010). Nevertheless, little is known about what happens after patients obtain access to surgical procedures, in respect of potentially unwarranted geographical variations in the outcomes of surgery. The NHS Act 2006 (Great Britain. *National Health Service Act 2006*. London: The Stationery Office; 2006), as amended by the Health and Social Care Act 2012 (Great Britain. *Health and Social Care Act 2012*. London: The Stationery Office; 2012), places duties on the NHS Commissioning Board to reduce variations in access to, and outcomes from, health-care services for patients, and to assess and report on how well they have fulfilled this duty. There is a commitment to address unwarranted variations in patient outcomes in order to increase value from the health-care budget. Consequently, we first need to understand and define any geographical variation in patient outcomes of joint replacement surgery. Second, we need to determine the cause of the variation in patient outcomes.

The Department of Health and Social Care established an Enhanced Recovery Partnership Programme between April 2009 and March 2011, with total knee and hip replacements being the focus of enhanced recovery for musculoskeletal care. During this period, an enhanced recovery pathway was introduced across all NHS hospitals. The enhanced recovery pathway is a complex intervention that focuses on key areas of care across the pathway in order to improve patient care, preoperatively (for the patient to be in the best possible condition for surgery), perioperatively (the patient has the best possible management during and after their operation) and postoperatively (the patient experiences the best rehabilitation). There has been limited evidence on the efficacy of a 'national' programme in which enhanced recovery pathway has been implemented nationwide. Implementation may vary across diverse hospital settings, and implementation may be adapted to local circumstances and interpretation of the enhanced recovery pathway guidelines, reducing its effectiveness.

This report describes geographical variation in patient outcomes of total hip and knee replacement surgeries, and how trends in patient outcomes have been changing over time. It assesses the clinical effectiveness and cost-effectiveness of the national enhanced recovery pathway for total hip and knee replacement surgeries. We describe the views of patients and health-care professionals to understand the elements of health care that enable the pathway to be delivered, alongside patients' experience of care within the structure of the pathway and their preferences for care at key points in the pathway.

Objectives

1. Identification of hospital organisation, surgical factors and the enhanced recovery pathway as determinants of geographical variation in patient outcomes and NHS costs.
2. Natural experiment to determine the clinical effectiveness and cost-effectiveness of the enhanced recovery pathway.
3. Qualitative study (process evaluation) on implementation of the enhanced recovery pathway in four hospital settings.

Methods

Objective 1

Objective 1 involved statistical analysis of national linked data from the NHS Hospital and Community Health Service (monthly workforce statistics), quarterly collection from all NHS organisations that operate beds (KH03 – NHS England), the National Joint Registry, Hospital Episode Statistics and patient-reported outcomes measures. Multilevel regression models are used to describe the association of patient case mix and hospital organisational and surgical factors as potential determinants of geographical variations in patient outcomes of surgery between 2014 and 2016, and the magnitude of this variation. Geographical information systems are used to produce maps depicting geographical variation in outcomes across Clinical Commissioning Groups and graphically display the influence that hospital process factors have on explaining such variation in outcomes.

Objective 2

The project used a natural experimental study design to examine the impact that the new enhanced recovery treatment pathway has had on length of stay, admissions costs, patient-reported outcome measures, complications and revision surgery. We used the National Joint Registry, Hospital Episode Statistics and patient-reported outcomes measures linked data sets from April 2008 to December 2016. The intervention was defined as the period of national enhanced recovery after surgery (April 2009–March 2011). Interrupted time series analysis assessed the impact on trends in outcomes before, during and after the introduction of the new enhanced recovery pathway. There was a focus on the benefit of the new enhanced recovery pathway to specific patient groups, such as frail older people with complex comorbid conditions.

Data from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man, English Hospital Episode Statistics, Office for National Statistics mortality and Clinical Practice Research Datalink GOLD were used to estimate the hospital and non-hospital costs associated with primary total hip and knee replacement, and posterior revisions within the year and subsequent years of occurrence. A systematic search was performed to identify peer-reviewed studies between 2000 and 2017 that described cost–utility analysis of enhanced recovery pathways, or components of one, compared with usual care, in patients having total hip or knee replacement.

Objective 3

The process evaluation aimed to understand organisational processes that may help or hinder the implementation of the enhanced recovery after surgery programmes for total hip and knee replacement. This work used the Consolidated Framework for Implementation Research to inform interpretation of results. It also aimed to characterise patients' experiences of enhanced recovery after surgery for total hip or knee replacement, using the ethnographer Mol's work to explore how care processes are negotiated between patients and health-care professionals. The qualitative research used an ethnographic approach, which involved periods of 'fieldwork' in contexts. Ethnography aims to achieve a deep understanding of practice and systems from the perspective of people in a context. The qualitative study took place in four different hospitals within an area of England, and the settings have been chosen as the primary contexts in which hip and knee replacements are currently performed in UK health care. The four hospitals in the UK were a teaching hospital, a district general hospital, a specialist orthopaedic hospital and an independent-sector treatment centre. The ethnographic study used observations and interviews with staff involved in service delivery. Data were analysed using a thematic analysis, followed by an abductive approach, whereby themes were mapped onto the 31 constructs and five domains of the Consolidated Framework for Implementation Research. Thirty-eight staff participated, including orthopaedic surgeons, nurses and physiotherapists. In the study exploring patients' experiences of enhanced recovery after surgery, semistructured interviews were carried out with 37 patients who had experienced a total hip or knee replacement. An inductive thematic analysis was conducted to identify themes and subthemes in the responses.

Results

Geographical variation

A total of 210,725 primary total knee replacements were identified, nested in 31,715 census areas and 207 Clinical Commissioning Group areas (173,107 primary total hip replacements: 30,850 census areas and 207 Clinical Commissioning Group areas). Almost 60% of patients were women and the average age was ≈69 years. Although we identified a number of factors that predicted outcomes of surgery (e.g. age, sex, comorbidity, deprivation, baseline hip/knee function, surgical volume, numbers of orthopaedic surgeons, beds, operating theatres), these factors did not explain observed geographical variation in outcomes of surgery across Clinical Commissioning Groups. The absolute change in Oxford Knee Score varied from 11.2 to 19.1 points (Oxford Knee Score range 17.5–24.9 points), 6-month complication rate of total knee replacement varied from 1.5% to 8.4% (total knee replacement range 2.0–8.6%), mean length of stay for total knee replacement varied from 2.7 to 6.6 days (total knee replacement range 2.5–6.2 days) and hospitalisation cost varied from £4564 to £8901 (total hip replacement range £4322–8566).

Qualitative (patient experiences)

Time to surgery varied, and cancellations were emotionally difficult. Patients valued preoperative education, but timing of surgery meant that not all patients were offered educational classes. Participants wanted more information on expected progress, along with emotional support. There were different experiences of being offered a choice of anaesthesia. For some, this was explained comprehensively and before admission; others were consulted on the day of surgery, which caused anxiety. Postoperative recovery was often most challenging in the initial weeks, and some were unsure how to perform exercises or worried about unfamiliar bodily sensations. They wanted more post-discharge input to provide 'reassurance'. Follow-up appointments were considered key in recovery.

Qualitative (ethnographic study)

The results showed that 17 Consolidated Framework for Implementation Research constructs, from all five domains, influenced implementation. Within 'intervention characteristics', participants thought that enhanced recovery after surgery afforded advantages over alternative solutions and guidance was adaptable. In the 'outer setting', it was felt that enhanced recovery after surgery should be tailored to patients, and education used to empower them in their recovery. However, there were concerns about post-discharge support and tensions with primary care. Within the 'inner setting', effective multidisciplinary collaboration was achieved by transferring knowledge about patients along the care pathway and multidisciplinary working practices. Enhanced recovery after surgery was viewed as a 'message' that had to be communicated consistently. There were concerns about resources and high volumes of patients. Staff access to information varied. At the domain 'characteristics of individuals', knowledge and beliefs had an impact on implementation.

Natural experiment (interrupted time series)

A total of 438,921 primary total hip replacements and 525,088 primary total knee replacements were identified. For total hip replacements, overall length of stay decreased from 5.6 days in April 2008 to 3.6 days in December 2016 (total knee replacement range 5.7–3.6 days). Although older patients had a longer length of stay, the decreasing trend in length of stay was seen across all age groups (e.g. 4.7–3.0 days in those aged < 60 years and 8.1–5.3 days in those aged ≥ 85 years). A decreasing trend in length of stay was seen in patients with and without pre-existing comorbidity. For total knee replacements, hospital admission costs decreased from £7573 in April 2008 to £5239 in December 2016 (total knee replacement range £7461–5158). Over the study period, there was an improvement in patient-reported outcome measures, with an improvement in change in Oxford Hip Score 6 months after surgery of 17.7 points in April 2008, with this change increasing to 22.9 points in December 2016 (total knee replacement Oxford Knee Score: from 15.0 to 17.1 points). The overall proportion of complications was low and decreased from 4.1% in April 2008 to 1.7% in March 2016. For total hip replacements, 5-year revision rates declined from 5.9 (95% confidence interval 4.8 to 7.2) per 1000 implant

years at risk in April 2008 to 2.9 (95% confidence interval 2.2 to 3.9) per 1000 implant years at risk in December 2011 (total knee replacement/unicompartmental knee replacement: from 6.6/1000 to 5.4/1000). Trends in length of stay, bed costs, patient-reported outcome measures, complications and revision surgery were consistent with a continuation of a pre-existing secular trend, and were not temporally related to implementation of the national enhanced recovery after surgery programme.

Health economics (costs)

We identified 854,866 individuals undergoing total hip or knee replacements in National Joint Registry and Hospital Episode Statistics data. The mean censor-adjusted 1-year hospitalisation costs for total hip and knee replacements were £7827 (95% confidence interval £7813 to £7842) and £7805 (95% confidence interval £7790 to £7818), respectively. The censor-adjusted 2-year costs were £9258 (95% confidence interval £9233 to £9280) and £9452 (95% confidence interval £9430 to £9475) for total hip and knee replacements, respectively. Complications, revisions and death were the major predictors of 1-year hospitalisation costs. Adding primary and outpatient care, total knee replacements cost £9483 in the year of surgery, compared with £9295 for total hip replacements.

Health economics (cost-effectiveness)

We identified two cost–utility analyses of entire enhanced recovery pathways and 11 analyses of pathway components. Consistent results were found supporting enhanced recovery pathways as a whole, prophylactic systemic antibiotics, antibiotic-impregnated cement and conventional ventilation for infection prevention.

Conclusion

Our data show that outcomes of total hip and knee replacements have been gradually improving over time, with a decrease in length of stay, reduction in inpatient bed-day cost, improvement in patient-reported outcomes of pain and function, decrease in complications and reduction in 5-year revision risk. These trends of improving outcomes were seen across all age groups, and in those with and without comorbidity. However, trends of improving outcomes had begun prior to the introduction of the formal NHS enhanced recovery after surgery roll-out out and therefore are not temporally associated with the national enhanced recovery after surgery programme. These findings are positive, in highlighting that reductions in length of stay have been achieved without adversely affecting patient outcomes.

Even though patient outcomes have been improving over time, analysis of the most recent years of data identified potentially unwarranted variations in patient outcomes of total hip and knee replacements. This variation cannot be explained by differences in patient case mix, surgical factors or hospital organisational factors. This information is informative to commissioners in monitoring variations in outcomes of surgery.

The qualitative study of patients' experiences of the enhanced recovery pathway illustrates how processes of care were negotiated between patients and health-care professionals, along with the emotional and physical work that patients did as 'active' participants in their recovery. Interviews with patients included discussion around preoperative educational needs, tensions between mobilising and giving themselves time to 'heal' after surgery, and challenges post discharge. The study demonstrates that 'good care' remains an aspiration, particularly in the post-discharge period.

The ethnographic study demonstrates that successful implementation of enhanced recovery after surgery services for total hip and knee replacements depends on several aspects, such as the extent to which services have been adapted to meet individual needs, effective communication between staff and planning processes. Doing so provides information to health-care providers on how best to organise and deliver these services in the future. The study may also be of use to clinicians and researchers in helping to understand service delivery for enhanced recovery after surgery in other surgeries.

Recommendations for research

- Although national trends towards improved patient outcome are encouraging, there is still substantial variation in outcome between hospital trusts and Clinical Commissioning Groups, so there is work to be done to understand why these potentially unwarranted variations in patient outcome exist.
- Further research should explore patient experiences of referral from primary to secondary care services to provide a more comprehensive account of experiences through the care pathway. In addition, future research may consider general practitioners' views and experiences of enhanced recovery after surgery, particularly at the points of referral and discharge. This would provide a 'system-wide' understanding of the delivery of enhanced recovery after surgery.

Study registration

The study is registered as PROSPERO CRD42017059473.

Funding

This project was funded by the National Institute for Health Research (NIHR) Health Services and Delivery Research programme and will be published in full in *Health Services and Delivery Research*; Vol. 8, No. 4. See the NIHR Journals Library website for further project information.

Health Services and Delivery Research

ISSN 2050-4349 (Print)

ISSN 2050-4357 (Online)

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full HS&DR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/hsdr. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Health Services and Delivery Research* journal

Reports are published in *Health Services and Delivery Research* (HS&DR) if (1) they have resulted from work for the HS&DR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

HS&DR programme

The HS&DR programme funds research to produce evidence to impact on the quality, accessibility and organisation of health and social care services. This includes evaluations of how the NHS and social care might improve delivery of services.

For more information about the HS&DR programme please visit the website at https://www.nihr.ac.uk/explore-nihr/funding-programmes/health-services-and-delivery-research.htm

This report

The research reported in this issue of the journal was funded by the HS&DR programme or one of its preceding programmes as project number 14/46/02. The contractual start date was in December 2015. The final report began editorial review in December 2018 and was accepted for publication in August 2019. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HS&DR editors and production house have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the final report document. However, they do not accept liability for damages or losses arising from material published in this report.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).