National Joint Registry
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HIPS
KNEES
ANKLES
ELBOWS
SHOULDERS

National Joint Registry

17th Annual Report 2020

Surgical data to 31 December 2019

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Introduction

The National Joint Registry (NJR) collects information about hip, knee, ankle, elbow and shoulder joint replacement operations (arthroplasty) from all participating hospitals in England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey. As the largest of its kind in the world, the registry has recently been described in UK Parliament as a global exemplar by the Under Secretary of State for Health and Social Care.

The purpose of the registry is to record patient information and provide data on the performance and longevity of replacement joint implants, the surgery outcomes for the hospitals where these operations are carried out and the performance of the surgeons who conduct the procedures.

The NJR produces this Annual Report summarising its work and sharing the analysis of data for the past year visually in tables and graphs, for procedures across each of the joints as well as implant and hospital outcomes. NJR data have been analysed by expert statisticians and the results published annually with the aim of enhancing safety, whilst continually improving clinical outcomes for the benefit of patients and the whole healthcare sector - results are also shared with implant manufacturers. The report also includes some short excerpts which showcase NJR's contribution to orthopaedic research activity, demonstrating the value of the use of this collected data.

The work of the NJR and the contribution of patients

The registry has shown that orthopaedic surgery, as one of the main uses of implants in the UK, is demonstrating the highest standards of patient safety with regard to the use of implants. Now with well over three million records, NJR data are also made available under strict security conditions to medical and academic researchers, to further progress the pool of work in measuring and understanding which practices provide better outcomes.

NJR's data collection and analysis work provides evidence to drive the continuous development and implementation of measures to ensure implant safety is always top of the agenda, to enhance patient outcomes and reduce revision rates year-on-year, to improve standards in quality of care, and to address overall cost-effectiveness in joint replacement surgery.

The NJR is very grateful to all patients who having undergone a joint replacement have provided their data over the years, which has enabled such a rich and valuable data source. The registry is also appreciative of the work of data entry staff in participating hospitals, who willingly engage in our stringent data quality award programmes to ensure our information is as accurate and thorough as possible.

* use MY data

This work uses data provided by patients and collected by hospitals as part of their care and support.

Summary of content for the NJR Annual Report

Summary	Content	Full information can be found
Introduction	Introduction to the NJR and Foreword from the NJR Steering Committee Chairman	In this report and via reports.njrcentre.org.uk
Executive summary	Summary of this year's report by the NJR Editorial Board Chairman and NJR Medical Director	In this report and via reports.njrcentre.org.uk
Clinical activity 2019	Statistics on joint replacement activity for hip, knee, ankle, elbow and shoulder activity for the period 1 January to 31 December 2019	reports.njrcentre.org.uk through interactive reporting
Outcomes after joint replacement surgery 2003-2019	Detailed statistical analyses on hip and knee replacement surgery using data from 1 April 2003 to 31 December 2019. Updated analyses of primary ankles and shoulders representing data collected since 1 April 2010 and 1 April 2012 respectively. Analyses on provisional data for elbows using data collected since 1 April 2012	In this report
Implant and unit-level activity and outcomes	Indicators for hip and knee joint replacement procedures by Trust, Local Health Board and unit. Plus commentary on implant performance and those that have higher than expected rates of revision and were reported to the MHRA	In this report and via reports.njrcentre.org.uk and download area
Developments	Information on the work of the NJR committees and NJR development to 31 March 2020	reports.njrcentre.org.uk
NJR's governance and operational structure	Composition, attendance, declarations of interest for the NJR Steering Committee, sub-committees and terms of reference	reports.njrcentre.org.uk and download area
Research	Published and approved research papers using NJR data	reports.njrcentre.org.uk and download area

NJR Reports online

Clinical activity 2019 overview

The interactive portion of the NJR's 17th Annual Report can be found online via the registry's dedicated NJR Reports website at: reports.njrcentre.org.uk.

Here we present data on clinical activity during the 2019 calendar year. This includes information on the volumes and surgical techniques in relation to procedures submitted to the NJR, with the most recent data being for the period 1 January 2019 to 31 December 2019. To be included in these tables and graphs, all procedures must have been entered into the NJR by 29 February 2020.

The double page infographic spread at the end of this report offers a visual summary of key facts relating to the analysis of clinical activity during the 2019 calendar year. This can also be downloaded as a waiting room poster via **reports.njrcentre.org.uk/downloads**.

The information found online now includes historical data, going back to 2005 in most cases. Using the dedicated website, readers are able to use interactive, filterable graphs to identify the key information and trends associated with the following reports for hip, knee, ankle, elbow and shoulder data (where sufficient data are available):

- Total number of hospitals and treatment centres in England (including the Isle of Man and the States of Guernsey), Wales and Northern Ireland able to participate in the NJR and the proportion actually participating
- Number of participating hospitals and the number and type of procedures performed
- Number of procedures undertaken as a proportion of all procedures submitted annually
- Procedure details by type of provider
- Primary procedure details by type of provider
- Types of primary replacements undertaken
- Patient characteristics for primary replacement procedures, according to procedure type
- Age and gender for primary replacement patients
- Patients' physical status classification (ASA grades) for primary replacement procedures
- Body Mass Index (BMI) for primary replacement patients
- Indications for primary procedure based on age groups
- Age of patients undergoing primary joint replacement
- Surgical technique for primary replacement patients
- Thromboprophylaxis regime for primary replacement patients, prescribed at time of operation
- Reported untoward intra-operative events for primary replacement patients, according to procedure type
- Patient characteristics for revision procedures, according to procedure type
- Indication for surgery for revision procedures
- Trends in use of the most commonly used brands

For hips specifically

- Components removed during hip revision procedures
- Components used during single-stage hip revision procedures
- Trends in femoral head size and hip articulation

For knees specifically

- Implant constraint for primary procedures
- Bearing type for primary procedures

Navigating the NJR Reports online facility

What can you find at NJR Reports online?

Simply navigate the left hand tabs to view information on the volumes and surgical techniques in relation to procedures submitted to the NJR.

Left hand tabs: Here, the information is segregated by report and information type. A wealth of updates are available, from further information on data collection and quality, to the work of our committees and progress of NJR developments.

Top tabs: If you require information about specific procedures, go straight to the data by clicking on the joint type most relevant to you.

There is also implant and hospital specific information available, a glossary and a downloadable infographic to make all the information as accessible as possible to all of our visitors.

Full NJR Reports website at: reports.njrcentre.org.uk

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1. Chairman's Foreword

Chairman's Foreword

Laurel Powers-Freeling
Chairman, National Joint Registry Steering Committee (NJRSC)

The NJRSC oversees the strategic and operational work programme of the registry and I am delighted to have performed the role of Chairman of the Committee over the past eight years. In each of those years, I have had exciting news to share regarding the evolution of the NJR. While this year has been very challenging in the wake of the pandemic - NJR nonetheless delivered a number of important developments. This Annual Report provides the opportunity to reflect back on our work over the last year and look to the year ahead. Highlights are summarised here in this 17th edition of our Annual Report.

Our work and developments

Managing the impact of the COVID-19 crisis: This year the NJR undertook a radical review of our proposed 2020/21 annual work plan and budget to reflect the impact of the COVID-19 crisis and recognition that NHS funds and administrative capacity needed to be directed elsewhere. With delegated authority from the NJRSC, the Executive Committee considered how resources could be conserved until we could re-engage in collecting, processing and analysing data for our work and re-instating income collection via Trust subscription payments. As a result, our development plans and expenditure programme for 2020/21 have been significantly reduced. This will be reviewed for FY2021/22.

Supporting the Independent Medicines and Medical Devices Safety Review [IMMDSR]: The NJR was invited to provide evidence to the IMMDSR, chaired by Baroness Cumberlege, on how a high impact clinically-led registry can improve device safety through continuous monitoring. The recently published review report recommended setting up an implantable medical devices registry and cited the NJR as a global exemplar of such a registry. NHSX, which has been requested by the Secretary of State to deliver appropriate options for a wider device registry, has asked to work with the NJR to undertake an in-depth analysis of our operating model for potential adoption or re-use. We are pleased to share NJR best practice with NHSX on this national data strategy and this work will form a major area of focus for the NJR in the coming year. It will also provide an opportunity to continue to secure support for the NJR/BOA/TORUS proposal for a National Musculoskeletal Registry that aligns to this national data strategy of establishing larger integrated data sets.

Automating our Data Quality Audit: Data quality has continued to be a priority for the NJR. However, our audit process is labour intensive so the NJR has now begun a national roll out of a semi-automated process enabling units to check their data quality on a regular basis, while reducing the burden on resources and ensuring the audit activity becomes part of the normal workflow. Roll out is underway for hip and knee data and will be followed by shoulders, elbows and ankles, with full roll out across all joints by the end of FY2020/21.

Modernising our IT Platform: We have commissioned the development of a cloud-ready, platform-based application framework for provision of future NJR services that will focus on developing a modern, unified environment and ability to move to cloud-based infrastructure. This will amalgamate our currently separate reporting portals to a single NJR securely encrypted cloud-based platform, providing

increased flexibility for all future change, enhance user and public interrogation of the data and have the capacity to extend to any additional registry alignment.

Articulating NJR benefits: Work commenced to better communicate the benefits of the NJR, realised over the past 17 years. Phase one provided a summary for hospital executives of the benefits to their services that become available by subscribing to the NJR **https://njr-subscriber-benefits.webflow.io/**. Phase two will take place during FY2020/21 and will take a broader view, including quantified impact metrics, of the improvements in arthroplasty practice and benefits to hospitals, surgeons, patients, regulators and policymakers associated with the NJR.

Identifying and preventing 'Never Events': Following the NHS Healthcare Safety Investigation Branch requirement to reduce the number of 'Never Events' associated with joint replacement surgery, the NJR has been working to deliver validation rules that apply in data entry to an external environment, for use in support of intra-operative checks. We have developed an Application Programming Interface (API) to allow hospital theatre systems to interface with NJR's checking rules. A smartphone application is also being developed so clinical teams can undertake validation checks even if their hospital does not have a compatible front-end system.

Unveiling a Patient Decision Support Tool: We have launched the NJR Patient Decision Support Tool, a web-enabled personalised decision-making tool for patients considering hip or knee replacement. This tool, whose development was in collaboration with the Universities of Sheffield and Bristol and supported by the charity Versus Arthritis, will help patients considering joint replacement make evidence-based choices about their treatment and share decision-making with their clinicians when considering the benefits and risks of undergoing joint replacement. Work to enhance the tool will continue.

The people who make NJR a success

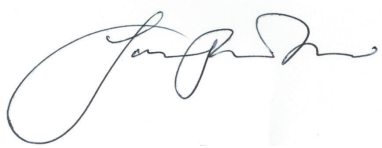
This year has seen a number of changes to the NJRSC membership. My sincere thanks to outgoing co-opted member Matthew Porteous, who as Chairman of the NJR Regional Clinical Coordinators and Data Quality sub-committees and Vice Chairman of the Surgeon Performance sub-committee, has made an outstanding contribution to the NJR over many years. In addition, my thanks go to NHS Trust management member, Rob Hurd, for his valuable advice and considerable contribution to the NJR.

My appreciation also to outgoing MHRA representative, Khalid Razak, for his significant contribution to the NJRSC and valuable support to the Implant Scrutiny sub-committee. I look forward to working with his successor, Sharon Knight, and continuing our close working relationship with the MHRA. Our final outgoing member is Don McBride, who I thank for his contribution this year as BOA President, which has been important in continuing our valued relationship with the orthopaedic profession. I look forward to welcoming his successor Bob Handley, who takes up post from September.

As ever, my grateful thanks go to the NJR Regional Clinical Coordinators who underpin and champion the work and success of the NJR at a local level. Also to our contract partners Northgate Public Services (UK) Ltd and the University of Bristol for their excellent work throughout the year in supporting the NJR to deliver its work agenda and objectives - particularly in the past few months with the challenges of different modes of working that result from the COVID-19 pandemic.

I would like to end by thanking all members of the NJRSC and sub-committees, for their valuable contribution. In particular, my thanks to Tim Wilton, NJR Vice Chairman and Medical Director, for his clinical expertise and leadership, and to the Chairs of each of our sub-committees - Peter Howard, Mark Wilkinson and Mike Reed - for their hard work and insight. Without their dedication, the NJR would not be the world leading arthroplasty register and global exemplar of an implantable device registry that it is. I would encourage you to read the reports from each committee Chairman at **reports.njrcentre.org.uk** where they provide strategic oversight into key work areas.

Finally, my thanks to the NJR Management team, especially to our Operations Director, Elaine Young, who provides constant and positive support for the NJR and ensures that we deliver what we promise…and more.



Laurel Powers-Freeling

Chairman, National Joint Registry Steering Committee

2. Executive Summary

Executive summary

Professor Mike Reed
Chairman, Editorial Board

Mr Tim Wilton
NJR Medical Director

The NJR Editorial Board develops the strategy and style of the report and all members take responsibility for producing a report that is rigorously edited, taking almost a full year to write and review. The Board brings together experts on data collection and reporting as well as generous input from patients, clinicians from specialist societies and members of the NJR management team.

Each year the Editorial Board aims to make progress in reporting on our rich data resource, making data easily accessible to improve patient outcomes.

Specific additions to this year's report have been:

- Dual mobility hip replacement
- Knee replacement and resurfacing of the patella by brand
- Survival of unicompartmental knee replacement
- Separation of cemented and uncemented prostheses at brand level
- Multicompartmental knee replacement
- Construct based knee analysis

In addition there has been considerable work to elaborate and refine the characterisation and classification of implants so that clearer definition of sub-groups can be now used throughout the elbow and shoulder sections.

This report is based on data up to the end of 2019 and thus outcomes are not affected by the COVID-19 pandemic. The NJR and its committees have continued to be visible at both national and international meetings with a presence at the specialist society conferences, many of which have been held virtually this year. The NJR has always been pleased to support the British Orthopaedic Association (BOA), British Elbow and Shoulder Society (BESS), British Hip Society (BHS), British Association for Surgery of the Knee (BASK), British Orthopaedic Foot and Ankle Society (BOFAS), European Hip Society (EHS), European Orthopaedic Research Society (EORS) and the European Federation of National Associations of Orthopaedics and Traumatology (EFORT).

The 17th Annual Report will be formally launched at the BOA Online Congress in September 2020. There will be no printed copy this year.

There is considerable additional information available online and we would encourage you to explore the NJR's dedicated annual report website at **reports.njrcentre.org.uk**. The website offers a helpful interactive platform for the descriptive NJR data, with supporting appendices; and, when published, the latest NJR Patient Guides.

Commentary on findings

This year NJR's Annual Report is based on 3,016,279 records and the NJR maintains its position as the largest orthopaedic registry in the world. The report presents joint replacement up to 16 years of follow-up, with data on hips, knees, shoulders, elbows and ankle replacements. A further quarter of a million records were added this year.

The following numbers of linkable primary joint replacements are available for analysis: 1,191,253 hips, 1,300,897 knees, 6,589 ankles, 45,784 shoulders and 4,373 elbow replacements. There are further linkable revisions for each joint.

Hip replacement

Many brand combinations are reporting cumulative probability of revision up to 15 years, and in Table 3.H6 the overall success of hip replacement survival at 15 years is:

- 12.95% revision in female patients aged under 55 (males: 10.68%)
- 9.41% revision in female patients aged 55 to 64 (males: 9.36%)
- 5.74% revision in female patients aged 65 to 74 (males: 7.29%)
- 3.63% revision in female patients aged 75 and over (males: 5.07%)

Hybrid hips continue to take ground from both cemented and uncemented hip replacement and these are now as common as uncemented hip replacement. With respect to implant bearing choice in cemented hip replacement, the use of metal-on-polyethylene dominates, but in uncemented and hybrid hip replacements ceramic-on-polyethylene is becoming more dominant.

Across all of hip replacement, use of the 28mm head is decreasing, with 32mm heads becoming more common. In cemented hip replacement 28mm and 32mm heads are chosen at similar rates after years of 28mm predominating.

In Table 3.H5, revision of dual mobility bearings, predominantly metal-on-polyethylene-on-metal, is presented. With the available follow-up, revision rates are generally higher than non-dual mobility bearings.

The median number of primary total hip replacements per surgeon is around 21 per year.

Knee replacement

Many brand combinations are reporting out to 15 years, and in Table 3.K6 the overall success of knee replacement survival at 15 years is:

- 15.74% revision in female patients aged under 55 (males: 16.21%)
- 8.44% revision in female patients aged 55 to 64 (males: 9.01%)
- 4.66% revision in female patients aged 65 to 74 (males: 5.27%)
- 2.67% revision in female patients aged 75 and over (males: 2.84%)

Broadly speaking, unconstrained knee replacements appear to be outperforming posterior stabilised (PS) knee replacements at 15 years. The degree to which this higher rate is seen in PS knees varies between brands, so surgeons would be well-advised to check the precise results for their chosen implant against the details in Table 3.K9 (b). Monobloc tibias perform particularly well at 15 years but this is based on low numbers.

Table 3.K7 (b) reports cumulative revision by brand with and without patella resurfacing, and there are differences between these brands. Although there is, in general, a higher revision rate for those knees where the patella was not resurfaced primarily, there is a wide variation in this respect between brands and types of total knee replacement and this is important information for the practising knee surgeon. There are, in fact, one or two constructs where this general rule is reversed so surgeons should neither assume that primary resurfacing makes no difference to the revision rate nor should they assume it necessarily lessens the revision rate. Surgeons are encouraged to check the results for their favoured implants.

ODEP ratings for knees take into consideration the different revision rates according to the sub-division within brands so it is important that surgeons check the exact sub-type they are using or some surgeons may get a shock when they see their own published ODEP rating usage.

Results for multicompartmental replacements are presented and show broadly similar revision rates to patellofemoral replacement at five years. These rates are generally higher than those seen with other types of knee replacement although it is not yet possible to say whether that trend will persist at longer follow-up.

The median number of primary total knee replacements per surgeon is around 40 per year, whereas for unicompartmental knees the median number per surgeon is approximately seven per year. This issue has been the subject of formal advice from BASK, that for better results and lower revision rates, surgeons should be performing at least ten unicondylar replacements per year, if they do the operation at all.

The early re-revision rate is marginally lower in cruciate retaining (CR) and posterior stabilised (PS) knees if the patella was not resurfaced at the primary operation. This presumably reflects the fact that some of the first revisions in those knees were to perform a secondary resurfacing, and might indicate that those secondary resurfacing procedures were therefore associated with a lower risk of subsequent re-revision, than revisions where other components are replaced.

Ankle replacement

A total of 6,589 ankle replacements have been analysed for this report which although a tiny proportion of the hip and knee procedures does nevertheless represent a huge collection of total ankle replacements.

In 2019, the median number of cases per consultant (5) and per unit (3) remains very low in comparison with hips and knees and only a small proportion (3.2%) of surgeons perform more than 20 cases per annum. It seems unlikely that these small volumes of ankle replacement performed by many surgeons represent the best way to ensure improved outcomes for the patients. Guidance from BOFAS about this issue can be seen in section 3.4.4.

About a quarter of revision operations gave infection as the indication, but only a small number of these suggested that there was a high suspicion of infection at the time of revision surgery. Overall, revision of ankle replacement is running at around 10% at nine years, which is a similar rate to that for unicondylar knees. Relatively few of these ankle revisions are for something comparatively “minor” such as “bearing exchange”, so if the actual overall revision rate remains similar to that for unicondylar knees that will not be a reason for us to be complacent.

Under-reporting of amputation and perhaps of arthrodesis following failed ankle replacement remains a problem, and this may need to be addressed on a wider front than through the foot and ankle surgery community, as some of these procedures may be done by a wide variety of surgeons.

There are quite large differences shown between revision rates for different ankle replacement brands but the data about this should be interpreted with some caution. There are some surgeons who perform much larger numbers than average so that if they have particularly good (or particularly poor) revision rates those surgeons could introduce disproportionate influence to the implant results.

Due to the withdrawal of the high-selling Mobility implant from the market five years ago and almost simultaneous introduction of the Infinity implant, which immediately became the best-seller, it will be several more years before meaningful longer-term comparisons will be possible between revision rates of some of the most popular ankle implants.

Shoulder replacement

This report relates to 45,784 primary and 5,087 revision shoulder replacements. The numbers of cases continue to increase year on year, but analysis of the outcomes remains challenging due to a number of conflicting issues relating to shoulder arthroplasty specifically. The categorisation of the implants has not been clear in the past for a number of reasons:

1) The constructs have rapidly evolved and are complex and variable;

2) the devices are not necessarily used as an entire joint construct in every case;

3) some manufacturers have many shoulder implant brands and surgeons are able to mix components from these different brands to make a shoulder construct; and

4) there has been confusion in the past over precisely how some cases would properly be classified due to partly missing implant descriptors.

This year, a new revised classification framework will enable extensive revision of the categories and re-classification of some implants which will greatly enhance the future analysis of these operations.

Reverse polarity total shoulder replacement continues to increase in proportion to humeral hemiarthroplasty and conventional total shoulder replacement, so that of all fully classified procedures this has increased from 26.8% to 52.2% from 2012 to 2019. In addition, there remain another 13.3% which are not yet fully confirmed in the new classification and many of these are also reverse polarity shoulders.

The median number of cases performed by a surgeon each year remains low compared to hips or knees, and despite this the number of surgeons performing these operations has increased significantly in seven years.

In comparing revision rates for different types of shoulder replacement, higher rates of revision for all types of humeral hemiarthroplasty can be seen compared to reverse polarity or stemmed conventional total shoulder replacements. It is very difficult to identify the degree to which such differences might be due to intrinsic differences in the success of the implants, differences in indication and potential differences in the ease of revision (and consequently willingness to perform revision surgery). The reader is therefore advised to interpret these revision results with caution.

Revision rate is regarded by shoulder surgeons as a relatively poor indicator of the success of the procedure as there may be a significant proportion of patients with poor function and ongoing symptoms who have not had revision surgery. Other outcomes are therefore vital and the PROMs programme seeks to provide such additional evidence. The completeness of the PROMs data is not good at present however and so it should again be interpreted with great caution. This is illustrated in Figure 3.S5, which shows that the revision rate in those returning valid PROMs is better than that for the rest of the shoulder patients.

Despite this drawback, the shoulder PROMs cohort is one of the largest in the world and it is interesting to see that the limited data available suggests that the PROMs gain after humeral hemiarthroplasty is less than after either reverse polarity or conventional total shoulder procedures. Since humeral hemiarthroplasty also has higher revision rates this implies that the revision rate is truly worse, rather than reflecting a lower threshold for revision surgery, however more in-depth analysis of other confounders is needed to clarify this.

Considerable variation is seen in the revision rates for individual implant brands, but at present for most shoulder brands these are not available for more than a few years. Nevertheless, that some reverse shoulders show higher rates of revision after just one year than some others show at six years is of concern, even with relatively small numbers of cases available for analysis.

Elbow replacement

This report relates to 4,373 primary elbow replacements performed for trauma and elective indications, over 2,000 of which have been implanted in the last three years. Although this represents a very large collection of elbow replacements, the procedures are varied, as are the indications, so that the categorisation into sub-groups still leaves relatively small groups which are currently difficult to analyse in terms of outcome.

The extensive re-classification work has enabled much more clarity, for example, whether the procedure has included a radial head implant and whether the distal humeral implant has been used as a hemiarthroplasty.

Although similar for the first three years, the revision rate for acute trauma cases is better than for elective cases thereafter. The numbers for trauma cases are relatively small and the indications for acute surgery are somewhat different. The difference between acute and elective outcomes will therefore need further elaboration when larger numbers are available.

The very small numbers of elbow replacements performed by surgeons, and by each unit, continue and have not changed significantly in the last three years. This is the subject of a discussion process with Getting It Right First Time (GIRFT) and the British Elbow and Shoulder Society (BESS) to decide whether regional rationalisation of these procedures can be introduced.

Concluding acknowledgements

The NJR continues to work collaboratively with many stakeholders; the most important, of course, are the patients we serve, and whom we would like to thank for allowing the NJR to use their data.

The NJR is a huge team effort. Many thanks also to the following without which the NJR could not function:

All members of the NJR Steering Committee

Members of the NJR sub-committees:

- Executive
- Data Quality
- Editorial Board
- Implant Scrutiny
- Medical Advisory
- Regional Clinical Coordinators
- Research
- Surgical Performance

Members of the Data Access Review Group

Members of the NJR Patient Network

Other organisations:

- Medicines and Healthcare products Regulatory Agency (MHRA)
- Care Quality Commission (CQC)
- NHS England
- NHS Digital
- NHS Improvement
- Getting It Right First Time (GIRFT)
- British Orthopaedic Association (BOA)
- British Hip Society (BHS)
- British Association for Surgery of the Knee (BASK)
- British Elbow and Shoulder Society (BESS)
- British Orthopaedic Foot and Ankle Society (BOFAS)
- European Orthopaedic Research Society (EORS)
- Healthcare Quality Improvement Partnership (HQIP)
- Northgate Public Services (UK) Ltd
- University of Bristol
- University of Oxford
- Confidentiality Advisory Group
- Association of British HealthTech Industries (ABHI)

On a personal note, we would particularly like to thank Laurel Powers-Freeling, Chairman of the NJR and Elaine Young, NJR Director of Operations.

Northgate Public Services, University of Bristol and University of Oxford teams have done a first-class job, as always.

Particular personal thanks to Vicky McCormack and Deirdra Taylor for getting the final report into shape.

Professor Mike Reed
Chairman of the NJR Editorial Board

and

Mr Tim Wilton
NJR Medical Director

3. Outcomes after joint replacement 2003 to 2019

3.1 Summary of data sources, linkage and methodology

The main outcome analyses in this report relate to primary and revision joint replacements, unless otherwise indicated. We included all patients with at least one primary joint replacement carried out between 1 April 2003 and 31 December 2019 inclusive, whose records had been submitted to the NJR before 1 March 2020.

Information governance and patient confidentiality:

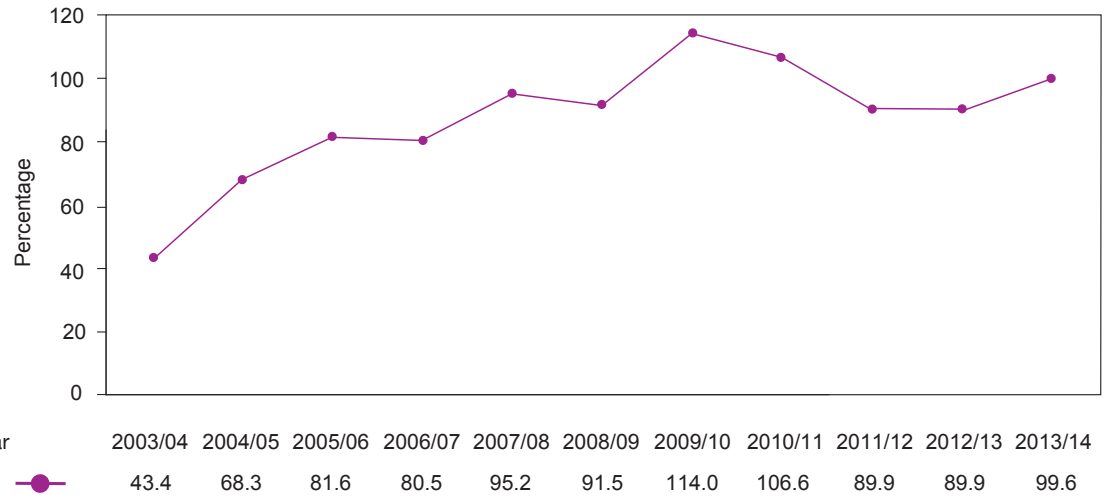
NJR data are collected via a web-based data entry application and stored and processed in Northgate Public Services' (NPS) data centre. NPS is ISO 27001 and ISO 9001 accredited, and compliant with the NHS's Data Security and Protection Toolkit. Data linkage to other datasets is approved by the Health Research Authority under Section 251 of the NHS Act 2006. Please visit **https://www.hra.nhs.uk/about-us/committees-and-services/confidentiality-advisory-group/**.

Data quality:

High quality data is the foundation of any joint replacement register and the National Joint Registry fully understands and endorses this. From inception, it was mandatory to record hip and knee arthroplasty procedures from the independent sector but not initially so in NHS hospitals. It was not until 1 April 2011 that it also became mandatory to enter publicly financed procedures into the NJR.

When the NJR was started, the funding model was based on a levy system. The manufacturer collected a small levy for every construct they sold. This practice continued from 2003 to 2014 after which the funding model changed. This levy system generated an additional source of data from which the NJR could compare sales to uploads into the NJR. This process gave a crude estimate of the compliance of the NJR and for the first four years of the registry, compliance could have been improved. Post 2008 the compliance was in excess of 95% and on occasion greater than 100%. When compliance was over 100%, this was indicative of the practice of stockpiling prostheses, see Figure 3.D1.

Figure 3.D1 Compliance rates from 2003 to 2014.

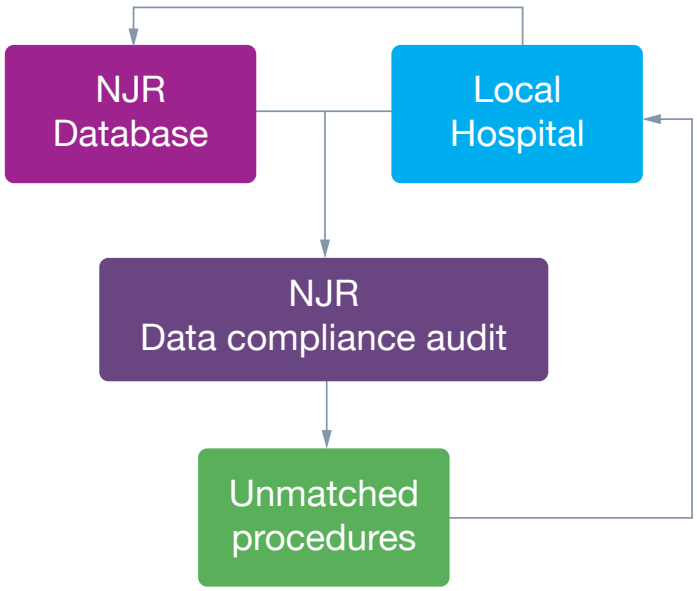


Comparing procedures to a levy had utility, however it was not sufficiently refined to distinguish within year compliance and differential compliance in the upload of primary and revision procedures. An additional comparator was therefore needed to assess compliance, and the Hospital Episode Statistics (HES) service has been used for this purpose for English hospitals since 2006.

The comparison of data entry on to the NJR and HES data gave a clear indication of the degree to which data might be missing, but does not itself supply or correct the missing data. For this reason a formal audit cycle capable of reconciling two sources of data and allowing their correction was set up using data from each NHS hospital's Patient Administration System (PAS) and each independent hospital's business administration system.

In 2015 a comprehensive retrospective audit of 149 NHS trusts for procedures uploaded in the 2014/15 financial year was initiated. This audit compared procedures uploaded to the NJR against a local hospital's Patient Administration System (PAS). Records were identified from the local hospital-based OPCS4 codes and then matched to records held within the NJR, see Figure 3.D2. Records that were found on the local hospital PAS but not on the NJR were subsequently uploaded to the NJR bringing compliance as near to 100% as possible. This procedure could not be followed if the patient had not given consent to data release. It was expected that neither the NJR nor the local hospital's PAS system alone could be regarded as a definitive list of hip or knee replacements, however, the union of both the NJR and local hospital data was considered the gold standard from which to calculate voluntary unprompted compliance at upload. This figure is important for healthcare provider institutions as a measure of compliance with data entry processes but does not represent the final data completeness of records in the NJR. It is important to note that nearly all unmatched procedures identified by the audit were subsequently uploaded into the NJR.

Figure 3.D2 Schematic presentation of NJR data compliance audit.



The audit was expanded to include hip and knee procedures performed in the independent sector in the 2015/16 financial year, ensuring complete coverage of all hips and knees recorded by the NJR. Since then the audit process has been repeated each year.

Table 3.D1 Percentage compliance prior to the audit cycle.

	Percentage missing NJR records (%)			
Procedure	2014/15	2015/16	2016/17	2017/18
Hip primary	4.3	5.4	4.19	4.16
Hip revision	8.1	11.42	8.74	9.15
Knee primary	3.5	4.86	3.83	3.41
Knee revision	8.8	12.45	9.25	8.77

The results from both phases of the audit are tabulated above. Voluntary unprompted compliance was greater than 95% for primary procedures and greater than 90% for revision procedures in the first year of the audit. This has subsequently been improved by the audit cycle.

Following the audit, 96.7% of all primary and revision procedures have been uploaded into the NJR for patients who consented to use of their data.

In 2019 the NJR developed an automated audit matching tool to assist in the process of auditing trusts and generating further capacity to expand the data compliance audit to shoulders, elbows and ankles replacements.

Missing data:

The effect of missing data on the statistical analysis of data is well documented. Data which is systematically missing (Missing Not at Random) has the potential to induce bias i.e. to distort the truth. This is why compliance of reporting data to the NJR by a specific consultant or unit is essential to the quality assurance process of consultants and units. Analysis of data which is missing in either a random (Missing Completely At Random) fashion or random within known strata (Missing At Random), e.g. method of fixation, is known to yield unbiased results. We believe that a coordinated systematic agreement of individuals across the registry to under-report the failure of a specific implant is exceedingly unlikely. Nevertheless, we believe if this did happen the issue would be identified and corrected by the audit process. The low revision rates of either hip or knee replacements also makes it exceedingly difficult to predict which is likely to fail. Therefore, planning to omit selected primary joint replacements which are anticipated to fail within ten years following surgery would be unlikely to succeed. Increased centralisation of revision joint replacement, by specialist revision surgeons, also means there is little motivation to omit revision which would largely have been primary cases of another surgeon or another unit.

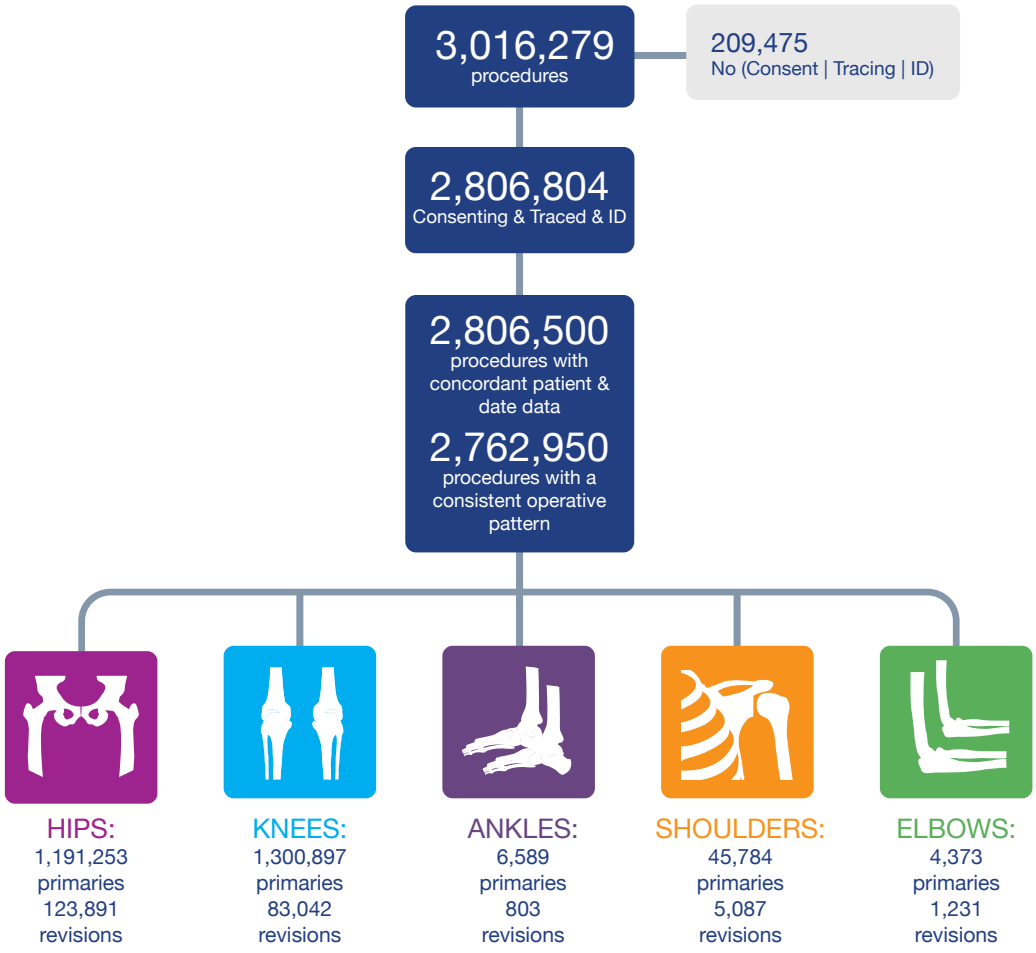
We believe that missing data within the register can be considered missing completely at random. We propose that this missing data mechanism will ensure that the quality assurance process of prostheses entered into the NJR, consultant and units is statistically valid.

Patient level data linkage:

Documentation of implant survivorship and mortality requires linkage of person-level identifiers, in order to identify primary and revision procedures and mortality events within the same individual.

Starting with a total of 3,016,279 NJR source records, 6.9% were lost because no suitable person-level identifier was found (see Figure 3.D3). Full details of the inclusion and exclusion criteria can be seen at the beginning of each sub-section of each type of joint replacement. Cases from Northern Ireland were excluded because of unresolved issues around tracing mortality; and cases from the Isle of Man were also excluded due to the inability to audit them against local hospital data. Patients with longer follow-up may be less representative of the whole cohort of patients undergoing primary joint replacement than those patients with shorter follow-up, due to difficulties with data linkage and differential rates of reporting over time.

Figure 3.D3 Initial numbers of procedures for analysis.



Linkage between primaries and any associated revisions (the 'linked files'):

A total of 2,548,896 linked and analysable primary joint replacements have been recorded by the NJR, i.e. hip, knee, ankle, shoulder or elbow. Implant survivorship is first described with respect to the lifetime of the primary joint only. In sections 3.2 and 3.3, we also provide an overview of further revisions following the first hip or knee revision procedure.

As in previous years, the unit of observation for all sets of survivorship analysis has been taken as the individual primary joint replacement. A patient with left and right replacements of a particular type, therefore, will have two entries, and an assumption is made that the survivorship of a replacement on one side is independent of the other. In practice, this would be difficult to validate, particularly given that some patients will have had primary replacements of other joints that were not recorded in the NJR. Established risk factors, such as age, are recorded at the time of primary operation and will therefore be different for the two procedures unless the two operations are performed on the same date.

Within the NJR, a revision is defined as any operation performed to add, remove or modify one or more components of a joint replacement or to perform a debridement and implant retention (DAIR) of a joint replacement. This therefore not only includes complete replacement of one or both of the main components of any joint replacement, but also, for example, liner and/or head exchange at surgery for suspected infection and secondary patella resurfacing of an existing total knee replacement. Additionally we have included DAIRs without modular exchange of components in this definition.

Analytical methods and terminology

The NJR annual report uses a variety of statistical methods to reflect the diversity and range of performance within joint replacement. Analyses are tailored to ensure results are reported in units that can be easily interpreted. Here we define important concepts which underpin the analyses in the following sections.

All cause / all construct revision

All cause revision is used as the primary outcome in the majority of analyses due to the difficulties in defining cause-specific failure i.e. several indications may have been given for a particular revision. In addition, we consider the construct as a single entity, for example, in hips we do not differentiate between stem and acetabular failure as it is sometimes difficult to identify which prosthetic element failed first or is causally responsible for the failure. It is incorrect to assume that the failure of implants that make up a construct are independent of each other. In knees, we similarly do not differentiate between failure of components within the tibia, femur or patella. Secondary patella resurfacing after a total knee replacement is considered a revision. In shoulders, elbows and ankles we take the same approach and do not differentiate between the failure of different components within the joint. Conversions of one type of shoulder replacement to another are considered a revision.

Debridement And Implant Retention - DAIR

Debridement And Implant Retention (DAIR) without modular exchange is now included in the NJR data as of MDSv7 (June 2018). DAIRs with modular exchange should have been collected (as a type of single-stage revision) from inception and their reporting in hips, knees, shoulders and elbows, along with all other procedures captured by the NJR, has been mandatory since 1 April 2011. Before MDSv7, DAIRs with modular exchange were considered to be a revision in hip, knee, shoulder and elbow but not ankle replacements. In MDSv7, all joint types are treated the same and a DAIR with modular exchange is considered to be a revision in all recorded joint replacements.

Terminology note: Hip replacements

There are four distinctive design features reflected in the analysis of data collected in the registry and these are: 1) the type of hip replacement i.e. total hip replacements (THR) and hip resurfacings (the NJR does not collect data on hip hemiarthroplasty); 2) the fixation

of the replacement i.e. cemented, uncemented, hybrid and reverse hybrid; 3) the bearing surfaces of the hip replacement; and 4) the size of femoral head/internal diameter of the acetabular bearing.

Cemented constructs are fixed using bone cement in both the femoral stem and acetabulum. Uncemented constructs rely on press fit and osseous integration within the femur and acetabulum that may be supplemented (e.g. by screw fixation). Hybrid constructs contain a cemented femoral stem and an uncemented acetabulum. Reverse hybrid constructs contain an uncemented femoral stem and a cemented acetabulum. By convention, the bearing material of the femoral head is listed before the acetabulum. Currently, the eight main categories of bearing surfaces for hip replacements are ceramic-on-ceramic (CoC), ceramic-on-metal (CoM), ceramic-on-polyethylene (CoP), metal-on-metal (MoM), metal-on-polyethylene (MoP), metal-on-polyethylene-on-metal (MoPoM), ceramic-on-polyethylene-on-metal (CoPoM), and resurfacing procedures.

The metal-on-metal group in this section refers to patients with a stemmed prosthesis (THR) and metal bearing surfaces (a monobloc metal acetabular cup or a metal acetabular cup with a metal liner). Although they have metal-on-metal bearing surfaces, resurfacing procedures, which have a surface replacement femoral prosthesis combined with a metal acetabular cup, are treated as a separate category. Ceramic-on-ceramic and metal-on-polyethylene resurfacings are now being implanted and in future reports these will be reported as a new category, although the numbers are likely to remain too small for meaningful analysis for a number of years. Three bearing materials being listed indicates the use of dual-mobility bearing devices. The size of the femoral head or inner diameter of a component is expressed in millimetres.

Terminology note: Knee replacements

Knee replacements within the NJR are principally defined by the number and type of compartments replaced, the fixation of the components (cemented, uncemented or hybrid), level of constraint, the mobility of the bearing, whether the implants are of a modular design and the presence or absence of a patella in the primary knee replacement.

The knee is made up of three compartments: medial, lateral and patellofemoral. When a total knee replacement (TKR) is implanted, the medial and lateral compartments are always replaced, and the patella may be resurfaced. If a single compartment is replaced then the term unicompartmental is applied to the implant (UKR). The medial, lateral or patellofemoral compartments can all be replaced independently, if clinically appropriate. Medial and lateral unicompartmental knee replacements are also referred to as medial or lateral unicondylar knee replacements. We also use the term multicompartmental knee replacement to indicate the combination of more than one unicompartmental knee replacement.

Knee replacements are also characterised by their level of constraint (stabilisation). For example, there is variation in the constraint of the tibial insert's articulation with the femoral component depending on whether the posterior cruciate ligament is preserved (cruciate retaining; CR) or sacrificed (posterior stabilised; PS) at the time of surgery. Additional constraint may be necessary to allow the implant to deal with additional ligament deficiency or bone loss (where constrained condylar (CCK) or hinged knee implants would be used) in a primary or revision procedure.

In modular tibial components, the tibial insert may be mobile or remain in a fixed position on the tibial tray. This also applies to medial and lateral unicompartmental knees. Many brands of total knee implant exist in fixed and mobile forms with options for either CR or PS constraint. Tibial elements may or may not be of modular design. Modularity allows some degree of patient-specific customisation. For example, modular tibial components are typically composed of a metal tibial tray and a polyethylene insert which may vary in thickness. Non-modular tibial components consist of an all-polyethylene tibial component (monobloc polyethylene tibia) available in different thicknesses.

The NJR now distinguishes between medial and lateral unicondylar knee replacements during the data collection process; however this was not so in earlier versions of the minimum dataset form (MDS).

In addition, we now report multicompartmental knee replacements which may include unicondylar and patellofemoral or two unicondylar replacements.

With regard to the use of the word 'constraint' here, for brevity, total knee replacements are termed unconstrained (instead of posterior cruciate-retaining) or posterior-stabilised (instead of posterior cruciate-stabilised).

We assume the absence of a patella in the upload of knee components is indicative that the patella has not been resurfaced.

Terminology note: Ankle replacements

Ankle replacements used within the NJR are principally uncemented devices. However, in terms of fixation we now report the presence or absence of cement used within the ankle construct. The presence of cement is defined by the inclusion of cement product details within the prosthesis upload.

Terminology note: Shoulder replacements

Shoulder replacements within the NJR are principally defined by the type and sub-type of replacement. The four main types of replacement are 1) proximal humeral hemiarthroplasty, 2) conventional total shoulder replacement, 3) reverse polarity total shoulder replacement and 4) interpositional arthroplasty. There are three main sub-types based on variations on the humeral side of the joint. These include 1) resurfacing i.e. putting a new metal surface over the existing humeral head, 2) stemless i.e. removing the humeral head and putting on a new head with an anchoring device which does not project beyond the metaphysis of the proximal humerus, and 3) stemmed i.e. replacing the humeral head and utilising an anchoring device which projects into the diaphysis of the humerus.

Descriptive statistics

In simple cases we tend to report simple descriptive statistics including: numbers (n), frequencies (N=), percentages (%), minimums (min), maximums (max), interquartile ranges (IQR) (25th centile, 75th centile), means (SD) and medians (50th centile) of the data.

Survival analysis methods

In more complex analyses that focus on either implant failure (denoted revision), recurrent implant failure (re-revision) or mortality we use 'survival analysis methods' which are also known as 'time to event' methods.

Survival analysis methods are necessary in joint replacement data due to a process known as 'censoring'. There are two forms of censoring which are important to consider in joint replacement registry data: administrative censoring and censoring due to events, such as death.

Administrative censoring creates differential amounts of follow-up time, i.e. patients from 2003 will have been followed up for more than 16 years, whilst patients collected last year will have one year of follow-up or less. Survival analyses methods allow us to include all patients in one analysis without being concerned if patients have one day, one year or one decade of observed follow-up time; these methods automatically adjust analyses for the amount of follow-up time.

In the case of analyses which estimate implant failure, death events are also censored, specifically they are considered non-informative censoring events. This assumes that death is unrelated to a failing implant, and can be safely ignored whilst estimating implant failure (revision). See Sayers et al. 2018 Acta Orthopaedica, 89:3, 256-258, for an extensive discussion on this problem.

The survival tables in this report show 'Kaplan-Meier' (KM) estimates of the cumulative chance (probability) of failure (revision) or death, at different times from the primary operation. In the joint replacement literature they are often referred to as KM or simply survival estimates. We additionally show 95% Confidence Intervals for each estimate (95% CI). Confidence intervals illustrate the uncertainty around the estimate, with wide confidence intervals indicating greater uncertainty than narrow ones. Strictly they are interpreted in the context of repeated sampling i.e. if the data were collected in repeated samples we would expect 95% CIs generated to contain the true estimate

in 95% of samples. However, confidence intervals are strongly influenced by the numbers of prosthesis constructs at risk and can become unreliable when the numbers at risk become low. In tables, including risk tables within figures, we highlight in *blue italics* all estimates where there are less than 250 prosthesis constructs at risk or remaining at risk at that particular time point.

Kaplan-Meier estimates can also be displayed graphically using a connected line plot. Figures are joined using a 'stair-step' function. Each 'stair' is flat, reflecting the constant nature of the estimate between the events of interest. When a new event occurs the survival estimate changes, creating a 'step'. Changes in the numbers at risk because of censoring do not themselves cause a step change but if the numbers at risk become low, when an event does occur, the stair-step might appear quite dramatic. Whenever possible, the numbers at risk at each time point have been included in the figures, allowing the reader to more appropriately interpret the data given the number of constructs at risk. We highlight in *blue italics* all estimates where there are less than 250 prosthesis constructs at risk or remaining at risk at that particular time point. The Kaplan-Meier estimates shown are technically 1 minus the Kaplan-Meier estimate multiplied by 100, therefore they estimate the cumulative percentage probability of construct failure.

In the case of revisions, no attempt has been made to adjust for the risk of death, as analyses attempt to estimate the underlying implant failure rate in the absence of death, see Sayers et al. 2018 Acta Orthopaedica, 89:3, 256-258 for an extensive discussion on competing risks. Briefly, the Kaplan-Meier estimator estimates the probability of implant failure (revision) assuming the patient is still alive.

Prosthesis Time Incidence Rates - PTIRs

Prosthesis time incidence rates are used to describe the incidence (the rate of new events) of specific modes of failure in joint replacement. The PTIR expresses the number of revisions divided by the total of the individual prosthesis-years at risk. Figures here show the numbers of revisions per 1,000 years at risk. PTIR in other areas of research are often known as 'person-time' incident rates, however, in joint replacement registers the base unit of analysis is the 'prosthesis construct'.

Note: This method is only appropriate if the hazard rate (the rate at which revisions occur in the unrevised cases) remains constant across the follow-up period. The latter is further explored by sub-dividing the time interval from the primary operation into intervals and calculating PTIRs for each interval. We have explored temporal changes for hips and knees in this report.

3.2 Outcomes after hip replacement

3.2.1 Overview of primary hip replacement surgery

This section looks at revision and mortality outcomes for all primary hip operations performed between 1 April 2003 and 31 December 2019 (inclusive). Patients operated on at the beginning of the registry therefore had a potential 16.75 years of follow-up. This year, follow-up is reported at a maximum of either 15 or 16 years in the tables and figures, although beyond 15 years the numbers at risk are particularly low in some categories.

Figure 3.H1 (page 42) describes the data cleaning applied to produce the total of 1,191,253 hips included in the analyses presented in this section.

Over the lifetime of the registry, the 1,191,253 primary hip replacement procedures contributing to our revision analyses were carried out by a total of 3,720 unique consultant surgeons working across 476 units. Over the last three years (1 January 2017 to 31 December 2019), 281,196 primary hip procedures (representing 24.1% of the current registry) were performed by 2,303 consultant surgeons working across 420 units.

Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 64 (interquartile range (IQR) 4 to 209) and the median number of procedures per unit was 607 (IQR 299 to 926). A proportion of consultants will have commenced independent practice during this period, some may have retired, and some surgeons may have periods of inactivity within the coverage of the NJR, therefore their apparent caseload would be lower.

The majority of primary hip procedures were carried out on women (females 59.9%: males 40.1%). The median age at primary operation was 69 (IQR 61 to 76) years. Osteoarthritis was given as a documented indication for surgery in 1,090,244 (91.5% of the cohort) and was the sole indication given in 1,052,601 (88.4%) primary hip replacements.

Figure 3.H1 Hip cohort flow diagram.

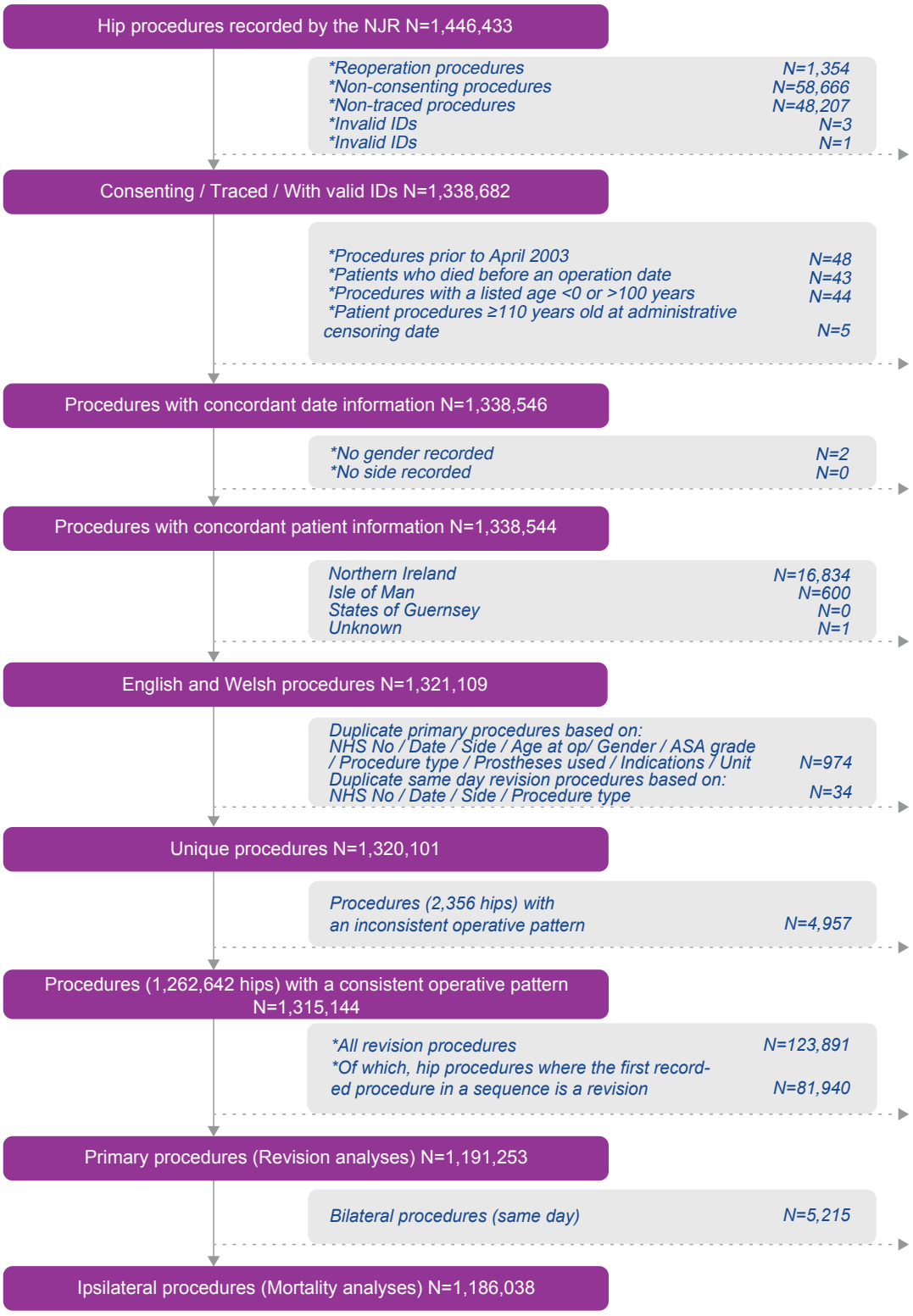


Table 3.H1 Number and percentage of primary hip replacements by fixation and bearing.

Fixation	Bearing surface within fixation group	Number of primary hip operations	Percentage of each bearing type used within each method of fixation	Percentage of all primary hip operations
All cases		1,191,253		100
All cemented		378,279		31.8
	MoP	328,507	86.8	27.6
	MoM	411	0.1	<0.1
	CoP	46,957	12.4	3.9
	MoPoM	2,197	0.6	0.2
	Others	207	0.1	<0.1
All uncemented		444,739		37.3
	MoP	173,611	39.0	14.6
	MoM	29,029	6.5	2.4
	CoP	108,161	24.3	9.1
	CoC	130,627	29.4	11.0
	CoM	2,152	0.5	0.2
	MoPoM	724	0.2	0.1
	CoPoM	319	0.1	<0.1
	Others	116	<0.1	<0.1
All hybrid		261,765		22.0
	MoP	149,561	57.1	12.6
	MoM	2,733	1.0	0.2
	CoP	79,343	30.3	6.7
	CoC	26,528	10.1	2.2
	MoPoM	2,761	1.1	0.2
	CoPoM	670	0.3	0.1
	Others	169	0.1	<0.1
All reverse hybrid		31,207		2.6
	MoP	21,273	68.2	1.8
	CoP	9,720	31.1	0.8
	Others	214	0.7	<0.1
All resurfacing		39,065		3.3
	MoM	38,919	99.6	3.3
	Others	146	0.4	<0.1
Unclassified		36,198		3.0

Table 3.H1 shows the breakdown of cases by the method of fixation and within each fixation sub-group, by bearing surfaces. Bearing surface combinations are reported as a separate group where there were more than 250 cases. The most commonly used operation type overall remains cemented metal-on-polyethylene (86.8% of all cemented primaries, 27.6% of all primaries). In this year's report, dual mobility bearings are included as separate categories for the first time.

The dual mobility bearings are described either as dual mobility, to contrast to standard unipolar bearings, or where numbers allow, are categorised by the material of each part of the bearing surface (e.g. metal-on-polyethylene-on-metal (MoPoM) and ceramic-on-polyethylene-on-metal (CoPoM)). The numbers of other combinations of dual mobility (such as ceramic-on-polyethylene-on-ceramic (CoPoC)) were too small to include as separate groups this year.

Table 3.H2 Percentage of primary hip replacements by fixation, bearing and calendar year.

	2004 n= 42,573	2005 n= 40,663	2006 n= 48,511	2007 n= 60,898	2008 n= 67,425	2009 n= 68,577	2010 n= 71,063	2011 n= 74,042	2012 n= 78,262	2013 n= 80,425	2014 n= 87,668	2015 n= 89,819	2016 n= 94,131	2017 n= 95,909	2018 n= 95,610	2019 n= 95,677
All cemented	**53.6**	**46.0**	**40.3**	**37.4**	**31.9**	**30.0**	**29.6**	**30.2**	**31.8**	**32.1**	**31.1**	**30.1**	**28.6**	**27.4**	**27.0**	**26.0**
Cemented by bearing surface:																
MoP	50.5	43.0	37.4	34.8	29.2	27.3	26.4	26.7	27.8	27.7	26.3	25.1	23.5	22.0	21.7	20.5
MoM	0.1	0.1	0.2	0.2	0.1	<0.1	<0.1	<0.1	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CoP	3.0	2.9	2.8	2.4	2.6	2.7	3.1	3.4	3.9	4.3	4.5	4.6	4.7	4.9	4.9	5.2
MoPoM	0	0	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.4	0.4	0.3	0.3
Others	0	0	0	0	0	<0.1	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1
All uncemented	**18.3**	**24.2**	**28.3**	**31.5**	**37.3**	**40.8**	**43.1**	**42.8**	**44.1**	**41.9**	**40.3**	**39.0**	**38.2**	**37.5**	**36.4**	**34.9**
Uncemented by bearing surface:																
MoP	7.5	9.4	9.6	10.1	12.3	14.4	16.0	16.5	17.5	17.2	16.7	16.2	15.9	15.6	15.2	13.4
MoM	1.9	5.4	8.3	10.4	11.1	7.9	3.2	0.4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CoP	5.1	5.1	4.5	4.0	3.8	4.5	5.4	5.9	7.2	8.2	9.5	11.4	12.5	14.1	14.8	16.0
CoC	3.9	4.3	5.8	6.9	9.7	13.1	17.4	19.5	19.1	16.3	14.0	11.4	9.7	7.6	6.2	5.2
CoM	<0.1	<0.1	<0.1	0.1	0.4	0.9	1.0	0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
MoPoM	<0.1	<0.1	0	0	0	<0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
CoPoM	0	0	0	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
Others	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All hybrid	**12.7**	**13.9**	**15.1**	**14.8**	**14.7**	**15.4**	**15.8**	**16.7**	**17.4**	**19.9**	**22.7**	**25.3**	**27.7**	**29.8**	**31.6**	**34.7**
Hybrid by bearing surface:																
MoP	8.8	9.4	9.9	9.9	9.9	10.4	10.7	11.3	11.4	11.9	13.1	14.0	14.8	15.5	15.1	16.4
MoM	0.7	0.6	0.7	0.8	0.7	0.4	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1
CoP	1.5	1.2	1.3	1.0	1.3	1.8	1.9	2.2	3.1	5.0	7.0	8.9	10.7	12.3	14.5	16.2
CoC	1.7	2.7	3.2	2.9	2.7	2.9	3.0	3.1	2.9	2.7	2.4	2.1	1.6	1.4	1.1	0.9
MoPoM	0	<0.1	0	0	0	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8
CoPoM	0	0	0	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.3
Others	<0.1	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note: Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures of this bearing type.

Table 3.H2 (continued)

	2004 n= 42,573	2005 n= 40,663	2006 n= 48,511	2007 n= 60,898	2008 n= 67,425	2009 n= 68,577	2010 n= 71,063	2011 n= 74,042	2012 n= 78,262	2013 n= 80,425	2014 n= 87,668	2015 n= 89,819	2016 n= 94,131	2017 n= 95,909	2018 n= 95,610	2019 n= 95,677
All reverse hybrid	**0.7**	**0.9**	**1.0**	**1.6**	**2.4**	**2.6**	**2.7**	**3.1**	**3.1**	**3.0**	**3.1**	**3.2**	**3.2**	**3.2**	**2.9**	**2.3**
Reverse hybrid by bearing surface:																
MoP	0.5	0.6	0.8	1.0	1.7	1.8	1.9	2.1	2.0	2.0	2.0	2.1	2.2	2.3	2.0	1.6
CoP	0.2	0.2	0.2	0.6	0.7	0.8	0.8	0.9	1.1	1.0	1.1	1.0	1.0	0.9	0.8	0.7
Others	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All resurfacing	**9.7**	**10.3**	**10.3**	**9.6**	**8.1**	**6.0**	**3.6**	**2.4**	**1.4**	**1.1**	**0.9**	**0.9**	**0.7**	**0.7**	**0.6**	**0.6**
Resurfacing by bearing surface:																
MoM	9.7	10.3	10.3	9.6	8.1	6.0	3.6	2.4	1.4	1.1	0.9	0.9	0.7	0.6	0.5	0.6
Others	0	<0.1	<0.1	<0.1	0	0	0	0	0	0	<0.1	0	<0.1	0.1	0.1	<0.1
Unclassified	**4.9**	**4.7**	**4.9**	**5.1**	**5.7**	**5.2**	**5.2**	**4.8**	**2.3**	**2.0**	**1.9**	**1.6**	**1.6**	**1.4**	**1.4**	**1.4**
All types	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Note: Percentages calculated as percentage of total yearly operations.
Note: A zero represents no procedures of this bearing type.

Table 3.H2 shows the annual rates by fixation and bearing groups for each year for primary hip replacements. Although the absolute number of cemented implants used annually has remained stable between 2006 and the current year, the proportion of all hips that are cemented has nearly halved. The percentage of hybrid implants used has tripled over the same period and the use of uncemented implants doubled. Figure 3.H2 (a) illustrates the temporal changes in fixation and type of primary hip replacements. Figure 3.H2 (b) shows dual mobility bearings as a separate group to illustrate their steadily increasing use, which has been most marked in the hybrid fixation group (see Table 3.H2).

Figure 3.H2 (a) Fixation by year of primary hip replacement.

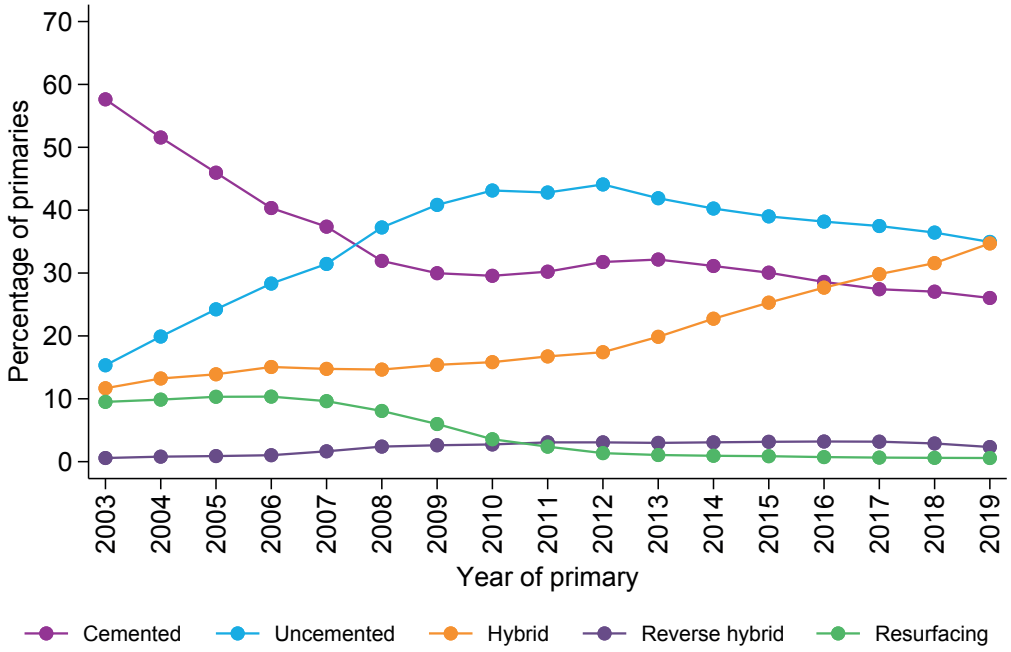


Figure 3.H2 (b) Unipolar **THR fixation** and main bearing type by **year** of primary hip replacement.

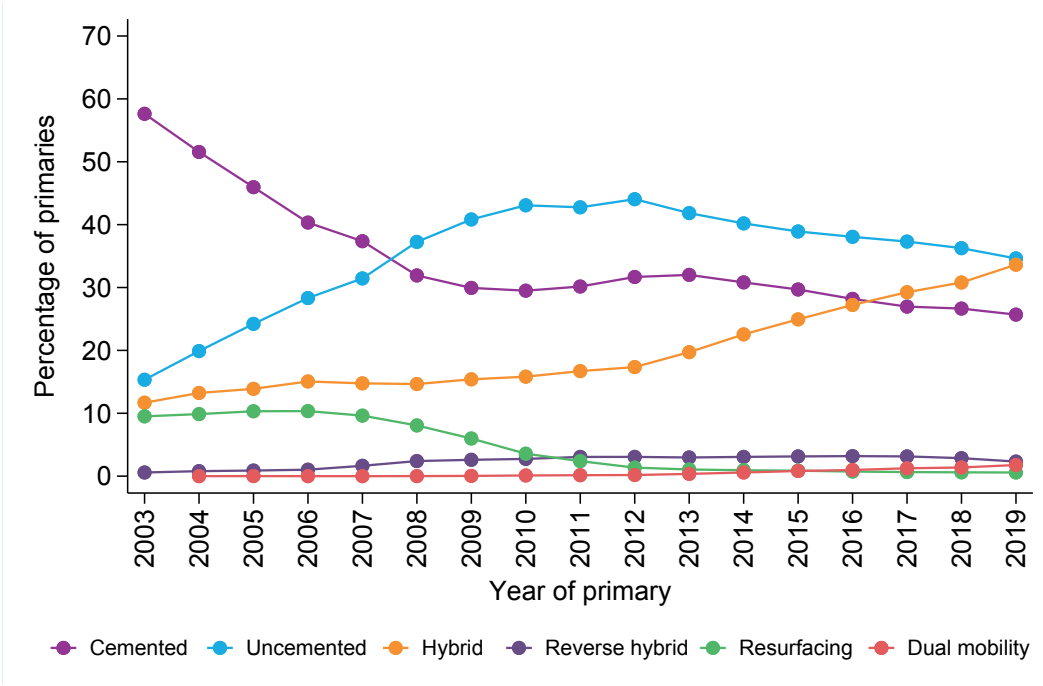
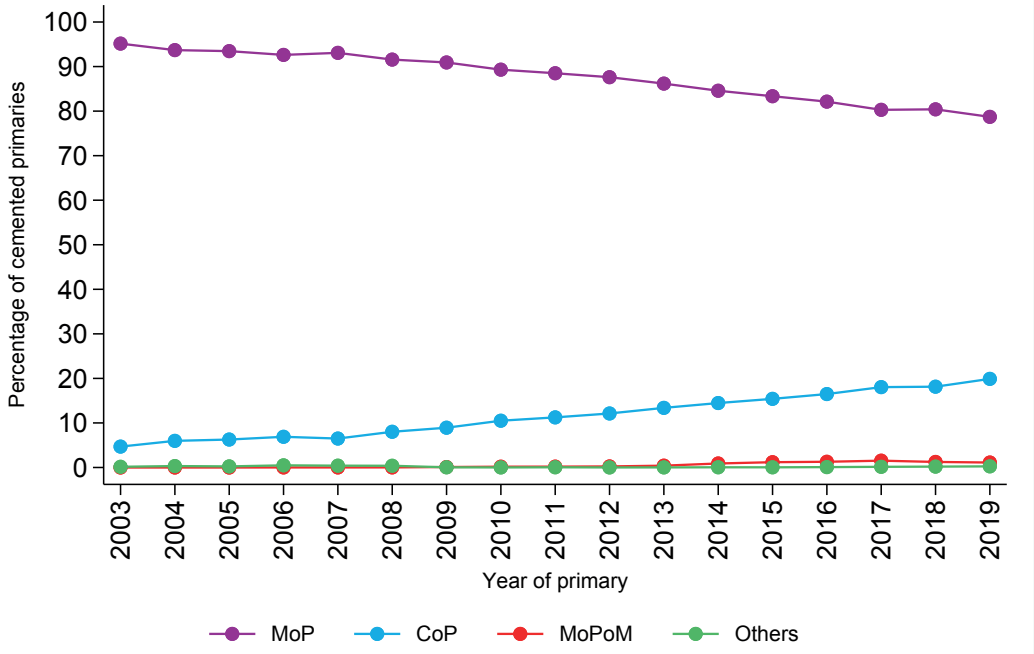


Figure 3.H3 (a) Cemented primary hip replacement **bearing** surface by **year**.



Figures 3.H3 (a) to (d) illustrate the temporal changes in the bearing surface. Groups that contain more than 500 procedures are plotted separately. Since 2012 there has been a marked increase in the use of ceramic-on-polyethylene bearings and a corresponding decrease in the use of ceramic-on-ceramic bearings.

Figure 3.H3 (b) Uncemented primary hip replacement bearing surface by year.

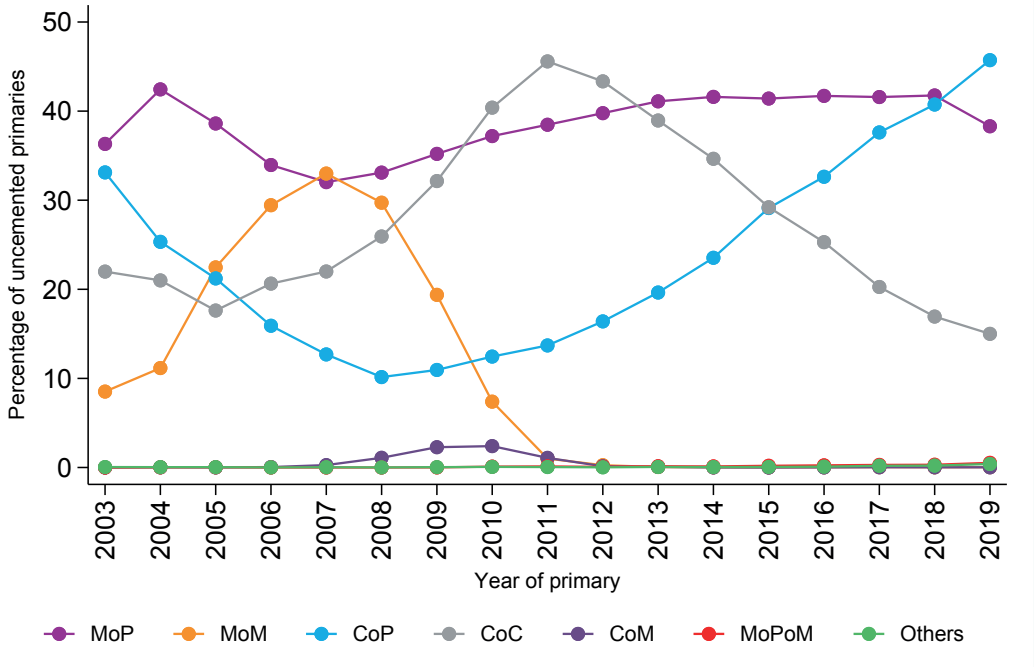


Figure 3.H3 (c) Hybrid primary hip replacement **bearing** surface by **year**.

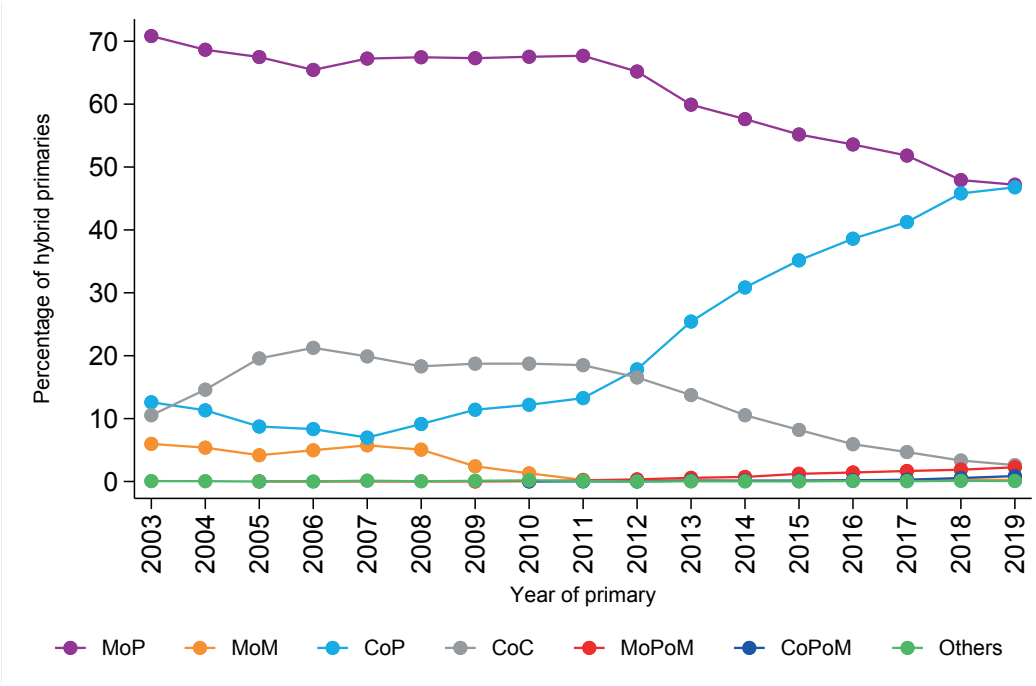


Figure 3.H3 (d) Reverse hybrid primary hip replacement bearing surface by year.

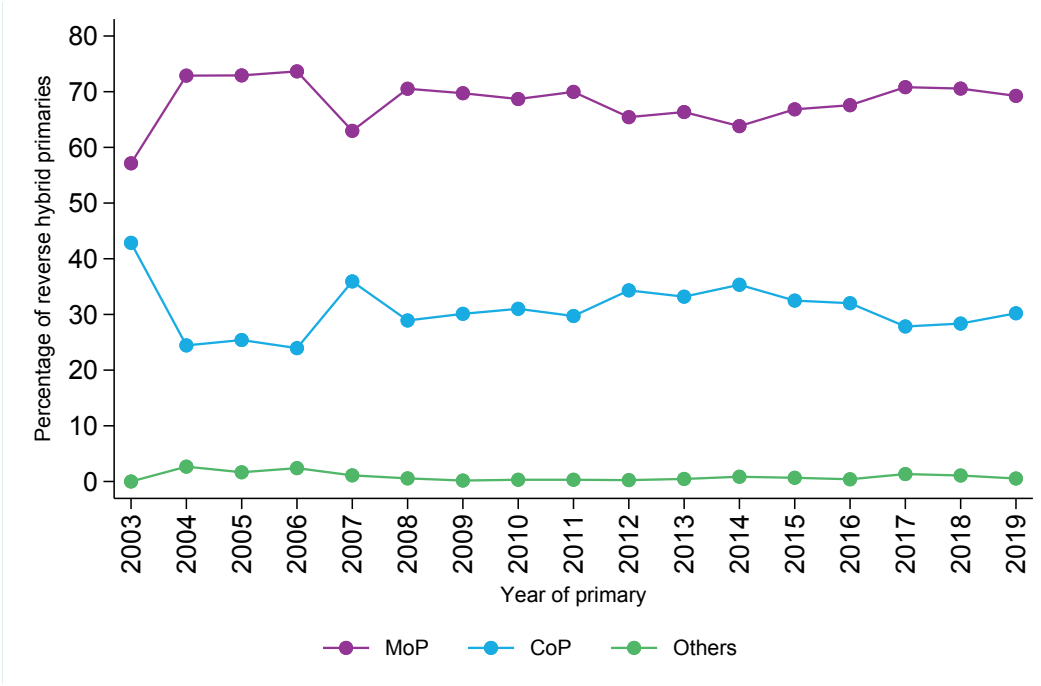
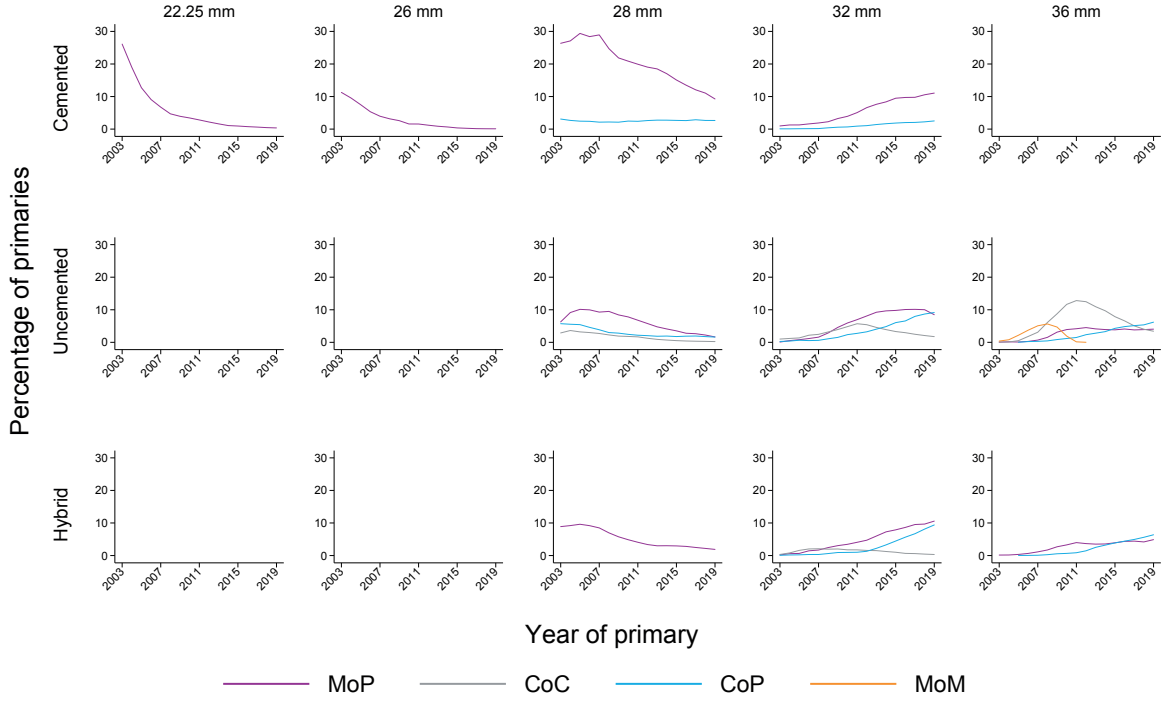


Figure 3.H3 (e) Trends in **fixation**, **bearing** and **head size** in primary unipolar total hip replacement by **year**.



Note: Only combinations with ≥2% use in any year are plotted.

Figure 3.H3 (e) illustrates the temporal changes in common head sizes, by method of fixation and bearing type in primary unipolar total hip replacement. In 2003 the vast majority of hip replacements utilised heads of 28mm or smaller across all fixation methods. Since 2003, a progressive shift away from small (22.25mm or 26mm) heads in cemented hip replacements to larger head sizes (>28mm) with alternative fixation methods (uncemented or hybrid) has been observed. In 2019 the three most common head sizes are 32mm (1st), 36mm (2nd) and 28mm (3rd), with 22.25mm and 26mm rarely being used. The use of ceramic-on-ceramic bearings across all head sizes, but most notably 36mm, has declined since 2011. This decline, conversely, corresponds with an increase in ceramic-on-polyethylene bearings with 32mm heads. The choice of bearing, head size and fixation method is much more heterogeneous in 2019 compared to 2003.

Table 3.H3 provides a breakdown by fixation type and bearing surface describing the age and gender profile of recipients of primary hip replacements. Patients receiving resurfacing and ceramic-on-ceramic bearings tended to be younger and those receiving metal-on-polyethylene-on-metal dual mobility bearings were older than the other groups. Those receiving resurfacings were more likely to be men.

Table 3.H3 Age at primary hip replacement by fixation and bearing.

Fixation	By bearing surface within fixation group	N	Age (years)		Percentage males (%)
			Median (IQR*)	Mean (SD)	
All cases		**1,191,253**	**69 (61 to 76)**	**68.1 (11.4)**	**40.1**
All cemented		**378,279**	**74 (68 to 79)**	**73.0 (9.1)**	**33.5**
Cemented and					
	MoP	328,507	75 (69 to 80)	74.2 (8.2)	32.9
	MoM	411	72 (65 to 78)	71.1 (9.6)	33.3
	CoP	46,957	65 (59 to 71)	64.5 (10.4)	38.1
	MoPoM	2,197	77 (69 to 83)	75.5 (10.6)	30.7
	Others	207	75 (65 to 83)	72.3 (13.3)	28.5
All uncemented		**444,739**	**65 (58 to 72)**	**64.4 (11.3)**	**44.9**
Uncemented and					
	MoP	173,611	71 (64 to 76)	69.9 (9.5)	41.4
	MoM	29,029	63 (57 to 70)	63.0 (11.1)	50.8
	CoP	108,161	64 (57 to 70)	63.0 (10.1)	46.1
	CoC	130,627	60 (52 to 66)	58.7 (11.2)	47.1
	CoM	2,152	63 (56 to 69)	62.0 (10.6)	42.1
	MoPoM	724	72 (61 to 79)	69.6 (13.3)	40.1
	CoPoM	319	59 (51 to 69)	60.4 (13.1)	58.6
	Others	116	62 (52 to 71)	60.8 (13.8)	45.7
All hybrid		**261,765**	**70 (63 to 77)**	**69.1 (10.9)**	**37.4**
Hybrid and					
	MoP	149,561	74 (68 to 79)	73.1 (8.7)	34.9
	MoM	2,733	65 (57 to 74)	64.6 (12.5)	46.4
	CoP	79,343	66 (59 to 72)	64.9 (10.6)	40.6
	CoC	26,528	60 (53 to 66)	59.0 (11.3)	40.8
	MoPoM	2,761	76 (68 to 82)	74.1 (11.2)	34.3
	CoPoM	670	68 (58 to 77)	66.9 (13.1)	46.7
	Others	169	67 (58 to 74)	65.4 (13.1)	48.5
All reverse hybrid		**31,207**	**70 (64 to 77)**	**69.7 (9.8)**	**36.8**
Reverse hybrid and					
	MoP	21,273	73 (68 to 78)	72.8 (8.1)	35.5
	CoP	9,720	64 (58 to 69)	63.0 (9.7)	39.8
	Others	214	72 (56 to 81)	67.9 (16.0)	29.9
All resurfacing		**39,065**	**55 (48 to 60)**	**53.9 (9.1)**	**73.2**
Resurfacing and					
	MoM	38,919	55 (48 to 60)	53.9 (9.1)	73.2
	Others	146	55 (48 to 62)	54.3 (11.0)	51.4
Unclassified		**36,198**	**69 (60 to 77)**	**67.7 (12.5)**	**39.1**

*IQR=interquartile range.

Table 3.H4 Primary hip replacement patient **demographics**.

	Males N (%)		Females N (%)		All N (%)	
Total	**478,258**		**712,995**		**1,191,253**	
ASA 1	86,831 (18.2)		100,817 (14.1)		187,648 (15.8)	
ASA 2	310,640 (65.0)		494,436 (69.3)		805,076 (67.6)	
ASA 3	77,638 (16.2)		113,981 (16.0)		191,619 (16.1)	
ASA 4	3,088 (0.6)		3,675 (0.5)		6,763 (0.6)	
ASA 5	61 (<0.1)		86 (<0.1)		147 (<0.1)	
Osteoarthritis as a reason for primary	443,597 (92.8)		646,647 (90.7)		1,090,244 (91.5)	
Osteoarthritis as the sole reason for primary	429,318 (89.8)		623,283 (87.4)		1,052,601 (88.4)	
Age	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
	66.5 (11.6)	68 (59 to 75)	69.2 (11.2)	70 (63 to 77)	68.1 (11.4)	69 (61 to 76)

Table 3.H4 shows the American Society of Anesthesiologists (ASA) grade and indication for primary hip replacement by gender. A greater number of females than males undergo primary hip replacement and ASA 2 is the most common ASA grade. Only a small number of patients with a grade greater than ASA 3 undergo a primary hip replacement. The majority of cases are performed for osteoarthritis. A total of 1,052,601 (88.4%) primary hip replacements were recorded in the NJR where the sole indication was osteoarthritis.

3.2.2 First revisions after primary hip surgery

A total of 34,978 first revisions of a hip prosthesis have been linked to NJR primary hip replacement surgery records of operations undertaken between 2003 and 2019.

Figures 3.H4 (a) and (b) illustrate temporal changes in the overall revision rates using Kaplan-Meier estimates; procedures have been grouped by the year of the primary operation. Figure 3.H4 (a) plots each Kaplan-Meier survival curve with a common origin, i.e. time zero is equal to the year of operation. This illustrates that revision rates increased between 2003 and 2007/8 and then declined between 2007/8 and 2019.

Figure 3.H4 (a) KM estimates of cumulative **revision** by **year**, in primary hip replacements.

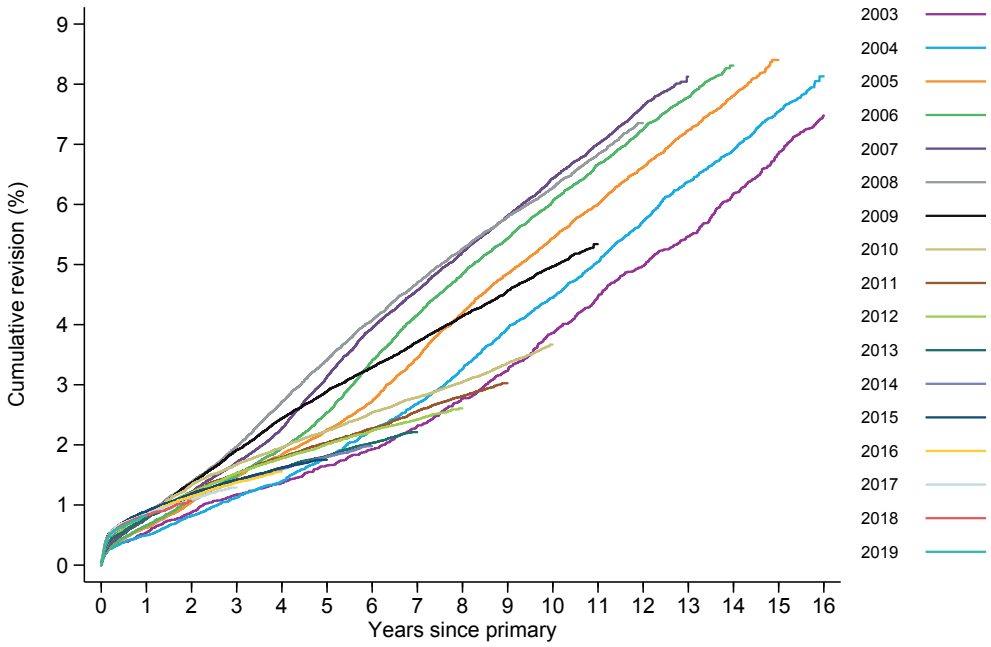


Figure 3.H4 (b) KM estimates of cumulative **revision** by **year**, in primary hip replacements plotted by year of primary.

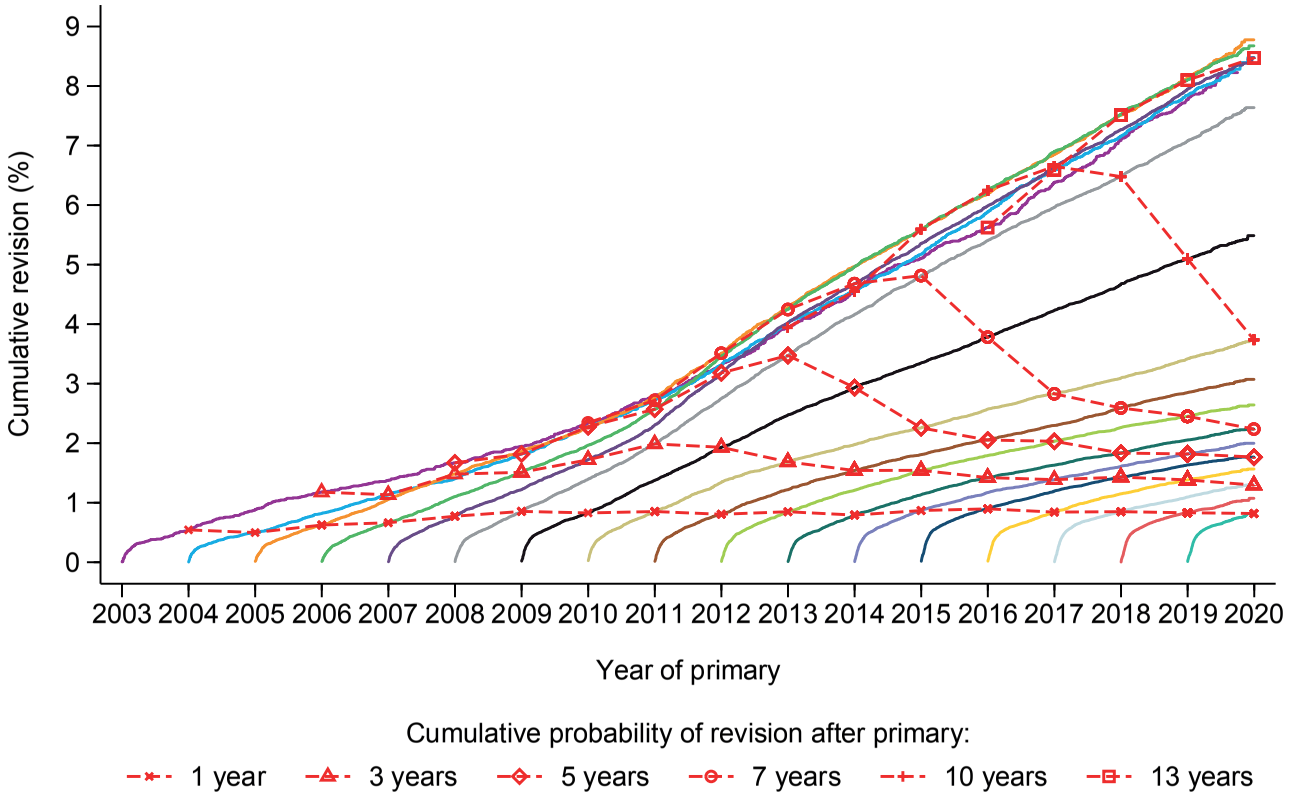


Figure 3.H4 (b) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. In addition, the revision rate at 1, 3, 5, 7, 10 and 13 years has been highlighted. Figure 3.H4 (b) separates each year, allowing changes in failure rates over time to be clearly identified. If revision surgery and timing of revision surgery were static across time, it would be expected that all of the failure curves would be the same shape and equally spaced; departures from this indicate a change in the number and timing of revision procedures. It is also very clear that the 3, 5, 7 and 10-year rate of revision increases for operations occurring between 2003 and 2008 and then reduces for operations occurring between 2008 and 2019. The early increases may be partly a result of under-reporting in the earlier years of the registry, but is also contributed to by the usage of metal-on-metal bearings, which peaked in 2008 and then fell (see Table 3.H2). Given a similar pattern is observed in knees, which were not affected by the high revision rates of metal-on-metal bearings, the decreases observed since 2009 also represent improved outcomes overall as a result of clinician feedback and adoption of evidence-based practice.

Table 3.H5 (page 58) provides Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, firstly for all cases combined and then by type of fixation and by bearing surface within each fixation group. The table shows updated estimates at 1, 3, 5, 10, 13 and 15 years from the primary operation together with 95% Confidence Intervals (95% CI). Estimates in blue italics indicate time points where fewer than 250 cases remained at risk, meaning that the estimates are less reliable. Kaplan-Meier estimates are not shown at all when the numbers at risk fell below ten cases.

Further revisions in the italicised groups would be highly unlikely and, when they do occur, they may appear to have a disproportionate impact on the Kaplan-Meier estimate, i.e. the step upwards may seem steeper. Furthermore, the upper 95% CI at these time points may be underestimated. Although a number of statistical methods have been proposed to deal with this, they typically give different values and, as yet, there is no clear consensus for the large datasets presented here.

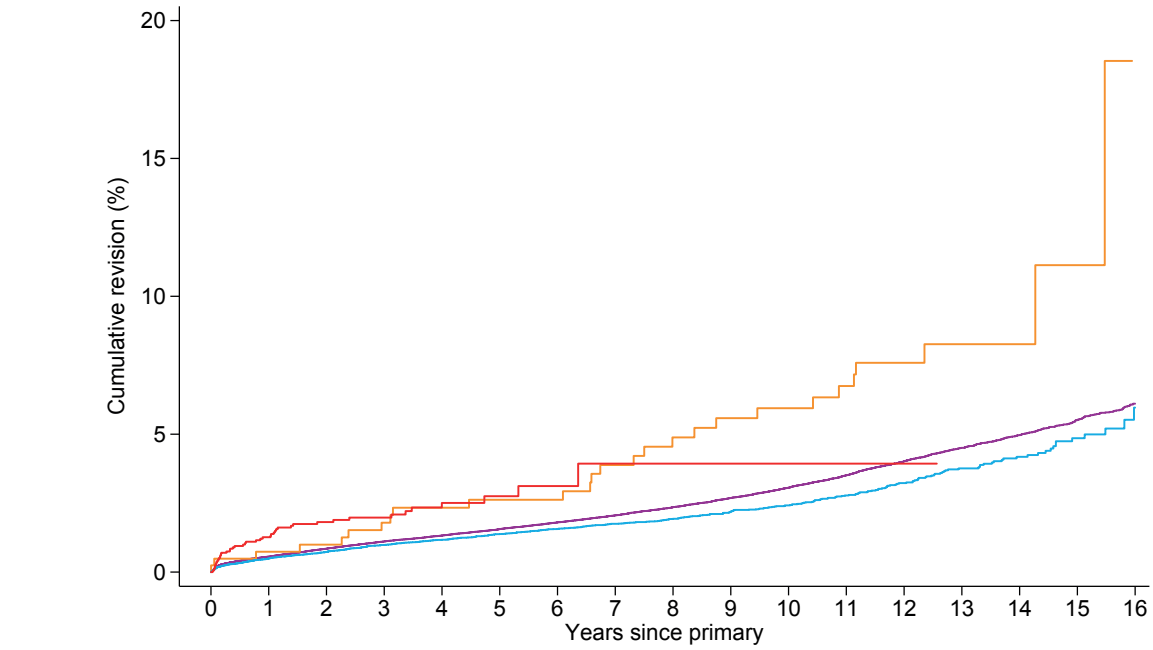
The revision rate of dual mobility bearings appears marginally higher at five years than that of other unipolar bearings, except metal-on-metal, however the numbers at risk are small and thus it is difficult to draw firm conclusions as yet.

Table 3.H5 KM estimates of cumulative **revision** (95% CI) by **fixation** and **bearing**, in primary hip replacements.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation	Bearing surface	N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years
All cases*		**1,191,253**	**0.81 (0.79-0.83)**	**1.52 (1.50-1.55)**	**2.24 (2.21-2.27)**	**4.56 (4.51-4.62)**	**6.30 (6.22-6.39)**	**7.53 (7.40-7.67)**
All cemented		**378,279**	**0.56 (0.53-0.58)**	**1.10 (1.07-1.14)**	**1.54 (1.50-1.59)**	**3.01 (2.93-3.09)**	**4.45 (4.32-4.58)**	**5.46 (5.27-5.66)**
Cemented and	MoP	328,507	0.56 (0.54-0.59)	1.11 (1.07-1.15)	1.56 (1.51-1.61)	3.06 (2.98-3.14)	4.50 (4.37-4.64)	5.51 (5.31-5.72)
	MoM	411	0.74 (0.24-2.27)	1.79 (0.86-3.72)	2.62 (1.42-4.83)	*5.94 (3.86-9.10)*	*8.26 (5.57-12.17)*	*11.13 (6.23-19.45)*
	CoP	46,957	0.49 (0.43-0.56)	0.98 (0.89-1.08)	1.38 (1.26-1.50)	2.42 (2.21-2.65)	3.76 (3.38-4.19)	4.85 (4.22-5.58)
	MoPoM	2,197	*1.27 (0.86-1.86)*	*1.98 (1.43-2.73)*	2.75 (1.95-3.89)	*3.93 (2.37-6.49)*		
	Others	207**	*1.10 (0.27-4.37)*	*1.10 (0.27-4.37)*	*1.10 (0.27-4.37)*			
All uncemented		**444,739**	**0.97 (0.94-1.00)**	**1.80 (1.76-1.84)**	**2.66 (2.61-2.71)**	**5.52 (5.42-5.62)**	**7.50 (7.33-7.67)**	**8.75 (8.49-9.01)**
Uncemented and	MoP	173,611	1.04 (0.99-1.09)	1.68 (1.62-1.74)	2.13 (2.06-2.21)	3.82 (3.68-3.96)	5.48 (5.22-5.74)	6.64 (6.22-7.08)
	MoM	29,029	1.06 (0.95-1.18)	3.49 (3.28-3.71)	7.72 (7.41-8.03)	17.75 (17.30-18.22)	21.41 (20.86-21.97)	23.24 (22.49-24.02)
	CoP	108,161	0.83 (0.78-0.89)	1.41 (1.33-1.49)	1.84 (1.74-1.93)	3.07 (2.90-3.26)	3.95 (3.68-4.24)	5.01 (4.56-5.51)
	CoC	130,627	0.96 (0.91-1.01)	1.78 (1.71-1.85)	2.32 (2.24-2.41)	3.61 (3.48-3.74)	4.69 (4.46-4.94)	5.69 (5.24-6.17)
	CoM	2,152	0.56 (0.32-0.98)	2.75 (2.13-3.55)	4.81 (3.97-5.82)	7.95 (6.83-9.25)		
	MoPoM	724	1.88 (1.09-3.21)	2.75 (1.70-4.43)	*2.75 (1.70-4.43)*			
	CoPoM	319	*1.34 (0.50-3.53)*	*2.67 (0.90-7.81)*	*2.67 (0.90-7.81)*			
	Others	116**	*3.45 (1.31-8.93)*	*7.15 (3.64-13.82)*	*8.32 (4.39-15.44)*	*19.33 (11.46-31.54)*		
All hybrid		**261,765**	**0.79 (0.76-0.83)**	**1.32 (1.27-1.37)**	**1.82 (1.76-1.88)**	**3.38 (3.27-3.50)**	**4.57 (4.39-4.75)**	**5.65 (5.34-5.99)**
Hybrid and	MoP	149,561	0.84 (0.79-0.88)	1.36 (1.30-1.43)	1.83 (1.75-1.91)	3.22 (3.08-3.37)	4.35 (4.13-4.58)	5.44 (5.05-5.87)
	MoM	2,733	0.85 (0.56-1.27)	2.70 (2.14-3.41)	5.90 (5.03-6.93)	16.21 (14.71-17.84)	19.55 (17.83-21.42)	*22.38 (20.07-24.91)*
	CoP	79,343	0.75 (0.69-0.82)	1.21 (1.13-1.30)	1.56 (1.45-1.67)	2.48 (2.25-2.73)	3.44 (2.97-3.98)	4.68 (3.80-5.76)
	CoC	26,528	0.60 (0.52-0.70)	1.10 (0.98-1.24)	1.63 (1.47-1.80)	2.80 (2.56-3.05)	3.68 (3.35-4.06)	4.17 (3.66-4.74)
	MoPoM	2,761	1.30 (0.92-1.84)	1.98 (1.42-2.76)	*2.40 (1.71-3.35)*			
	CoPoM	670	1.01 (0.45-2.26)	*1.53 (0.65-3.54)*	*1.53 (0.65-3.54)*			
	Others	169**	*1.87 (0.61-5.69)*	*2.86 (1.05-7.63)*	*2.86 (1.05-7.63)*	*2.86 (1.05-7.63)*		
All reverse hybrid		**31,207**	**0.87 (0.77-0.98)**	**1.54 (1.40-1.69)**	**2.07 (1.90-2.25)**	**3.60 (3.28-3.96)**	**5.54 (4.78-6.42)**	*7.52 (5.86-9.62)*
Reverse hybrid and	MoP	21,273	0.90 (0.78-1.03)	1.52 (1.36-1.71)	2.00 (1.79-2.22)	3.67 (3.25-4.14)	5.50 (4.58-6.61)	*7.44 (5.47-10.08)*
	CoP	9,720	0.78 (0.62-0.98)	1.53 (1.29-1.81)	2.08 (1.79-2.42)	3.23 (2.75-3.79)	*5.45 (4.16-7.12)*	*7.57 (4.83-11.77)*
	Others	214**	*2.45 (1.03-5.80)*	*3.30 (1.46-7.38)*	*10.24 (5.70-18.02)*	*21.64 (13.38-33.91)*	*21.64 (13.38-33.91)*	
All resurfacing		**39,065**	**1.21 (1.11-1.33)**	**2.99 (2.82-3.16)**	**5.27 (5.05-5.50)**	**10.66 (10.33-10.99)**	**13.16 (12.78-13.55)**	**14.84 (14.37-15.33)**
Resurfacing and	MoM	38,919	1.21 (1.11-1.33)	2.99 (2.82-3.16)	5.27 (5.05-5.50)	10.66 (10.33-10.99)	13.16 (12.78-13.55)	14.84 (14.37-15.33)
	Others	146**	*1.44 (0.36-5.65)*					

*Includes 36,198 with unsure fixation/bearing surface; **Wide CI because estimates are based on a small group size.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

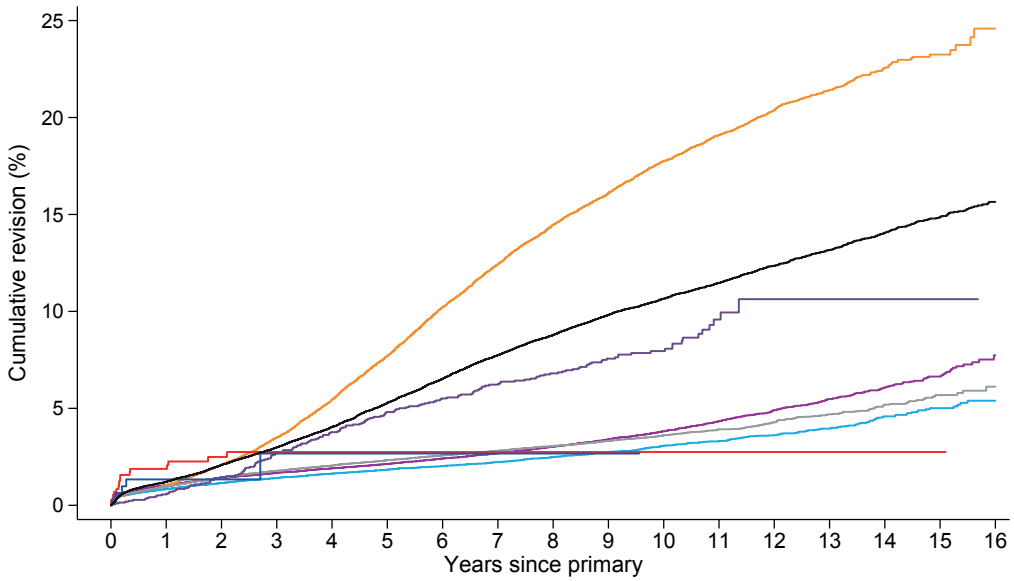
Figure 3.H5 KM estimates of cumulative **revision** in **cemented** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk															
MoP	328507	300544	273208	245488	217059	188850	161198	135551	111915	91401	73143	56724	41850	28238	17883	9070	3069
MoM	411	393	379	365	346	333	317	295	281	267	*249*	*223*	*165*	*104*	*46*	*21*	*5*
CoP	46957	41425	36318	31213	26573	22237	18209	14721	11678	9166	7064	5345	3824	2608	1602	781	*210*
MoPoM	2197	1728	1327	910	586	327	*144*	*81*	*51*	*30*	*11*	*3*	*1*	*0*	*0*	*0*	*0*

Figures 3.H5 to 3.H8 (pages 60 to 62) illustrate the differences between the various bearing surface sub-groups for cemented, uncemented, hybrid and reverse hybrid hips, respectively. Metal-on-metal bearings continue to perform worse than all other options regardless of fixation. The failure rates for ceramic-on-polyethylene bearings remain particularly low and it is encouraging that these are becoming more widely used with time. Dual mobility bearings do seem to have slightly higher early revision rates than other options for cemented and uncemented fixation. Given the relatively small numbers and the likely case mix selection, these patterns should continue to be monitored.

Figure 3.H6 KM estimates of cumulative **revision** in **uncemented** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.

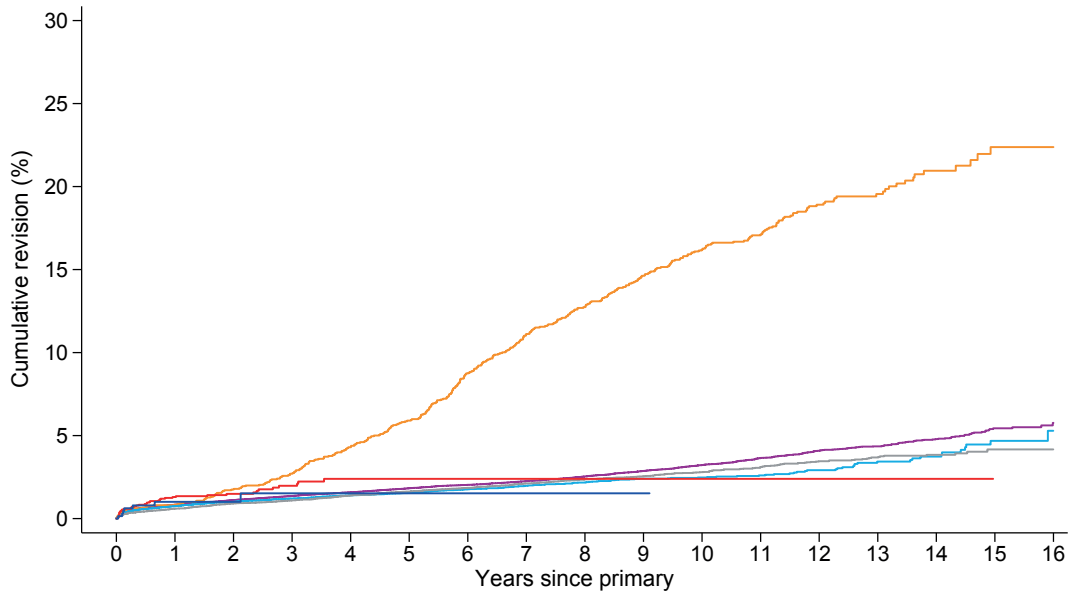


Key:

Numbers at risk

MoP	173611	156921	139941	122724	105663	89515	73741	59403	46029	34826	25101	17189	11056	6879	3841	1638	402
MoM	29029	28418	27834	27054	26084	24992	23825	22722	21565	20261	17679	13344	8231	4196	1771	483	*92*
CoP	108161	91465	76599	62563	50382	39933	31511	24842	19243	14990	11383	8576	6420	4428	2767	1375	448
CoC	130627	123811	116741	108418	98514	87527	74837	61661	47179	33487	22190	14186	8553	4987	2630	1217	335
CoM	2152	2119	2077	2018	1966	1912	1872	1811	1727	1394	771	257	*40*	*6*	*1*	*1*	*0*
MoPoM	724	514	398	291	*208*	*149*	*114*	*78*	*57*	*27*	*3*	*1*	*1*	*1*	*1*	*1*	*0*
CoPoM	319	*182*	*115*	*65*	*35*	*26*	*14*	*7*	*3*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Resurfacing	39065	37963	36967	35896	34695	33359	31985	30616	29089	26951	24218	20300	15445	10516	6467	3247	1062

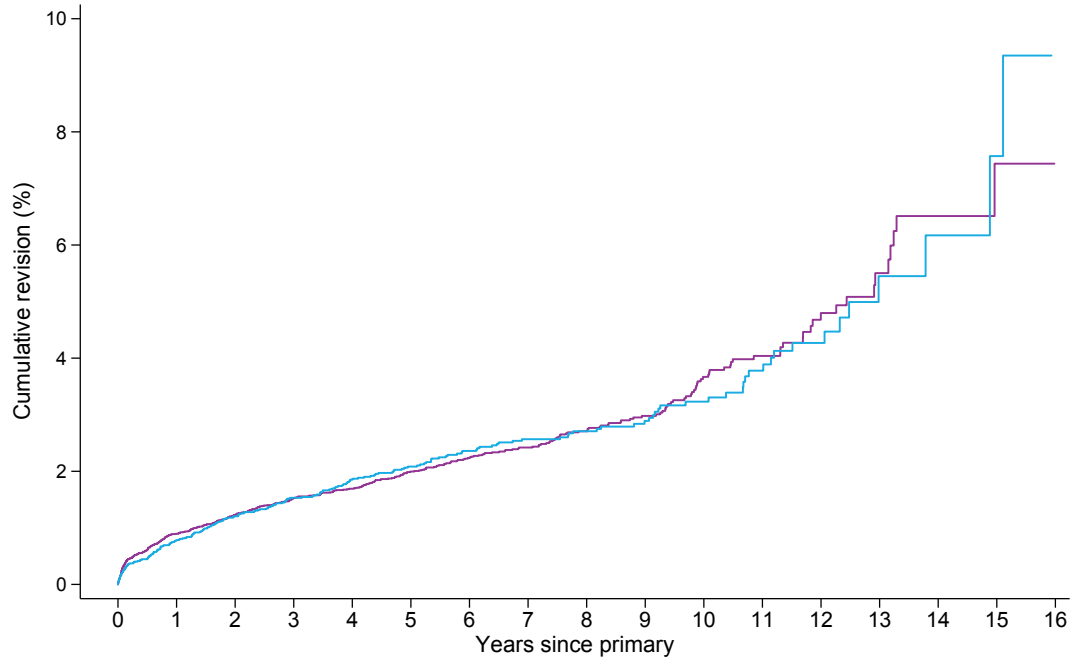
Figure 3.H7 KM estimates of cumulative **revision** in **hybrid** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk																
MoP	149561	130294	113461	96537	80757	66995	54682	44785	35891	28006	21389	15787	11015	6994	4082	1966	607
MoM	2733	2609	2437	2302	2172	2085	1959	1845	1749	1630	1447	1247	889	544	322	*180*	*65*
CoP	79343	62810	48601	36586	26482	18566	12620	8692	6449	4908	3676	2606	1814	1261	791	417	*132*
CoC	26528	25378	24137	22608	20865	18837	16661	14420	12136	9906	7858	6000	4363	2826	1527	598	*140*
MoPoM	2761	1889	1288	796	460	*238*	*120*	*57*	*23*	*5*	*1*	*1*	*1*	*1*	*1*	*0*	*0*
CoPoM	670	374	*204*	*125*	*74*	*44*	*23*	*4*	*3*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Figure 3.H8 illustrates the revision rate of metal-on-polyethylene and ceramic-on-polyethylene bearings used with reverse hybrid fixation in primary total hip replacement. This shows little difference for the first 12 years. After 12 years the numbers at risk are very low and thus it is difficult to interpret survivorship at greater than 12 years.

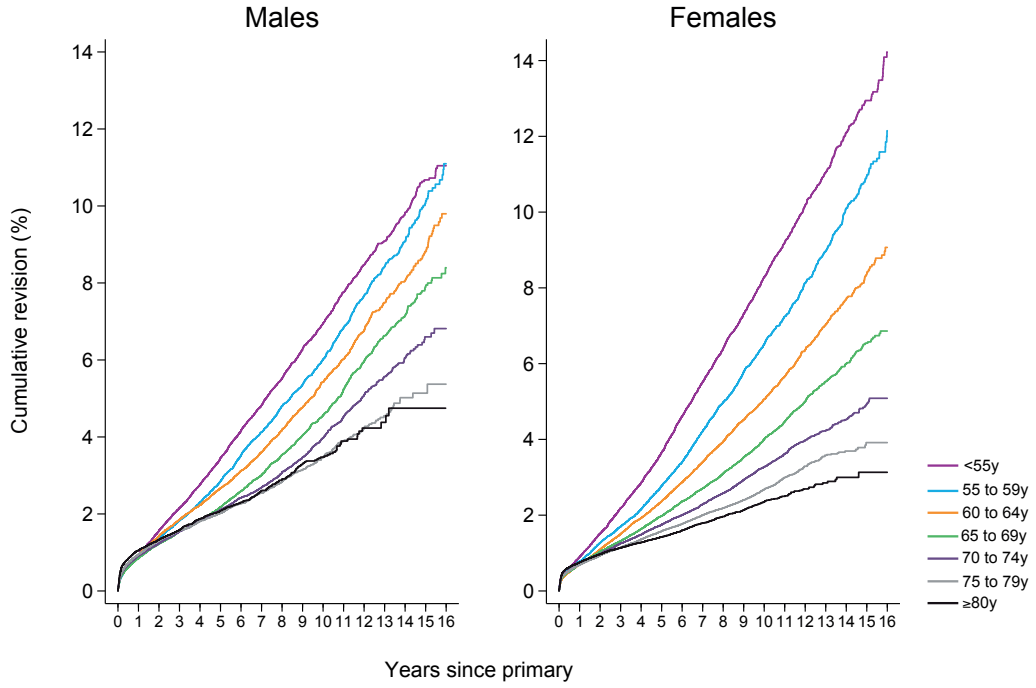
Figure 3.H8 KM estimates of cumulative **revision** in **reverse hybrid** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk															
MoP	21273	19183	16881	14376	12061	9959	8105	6429	4900	3541	2414	1516	803	427	*238*	*100*	*22*
CoP	9720	8908	8018	7078	6038	5066	4094	3301	2497	1859	1326	871	494	*205*	*118*	*59*	*21*

In Figures 3.H9 (a) and 3.H9 (b), the whole cohort has been sub-divided by age at primary operation and by gender. Across the whole group, there was an inverse relationship between the probability of revision and the age of the patient. A closer look at both genders (Figure 3.H9 (a)) shows that the variation between the age groups was greater in women than in men. Thus, for example, women under 55 years had higher revision rates than their male counterparts in the same age band, whereas women aged 80 years and older had a lower revision rate than their male counterparts.

Figure 3.H9 (a) KM estimates of cumulative **revision** in **all** primary hip replacements by **gender** and **age**.



In Figure 3.H9 (b), primary total hip replacements with metal-on-metal (or uncertain) bearing surfaces and resurfacings have been excluded. The revision rates for the younger women are noticeably reduced compared to the data in Figure 3.H9 (a) which includes metal-on-metal bearings; an age trend is seen in both genders but rates for women are lower than for men across the entire age spectrum. The age mediated disparity in revision rates for women appears to be increasing with longer follow-up.

Figure 3.H9 (b) KM estimates of cumulative **revision** in **all** primary hip replacements by **gender** and **age**, **excluding MoM** and **resurfacing**.

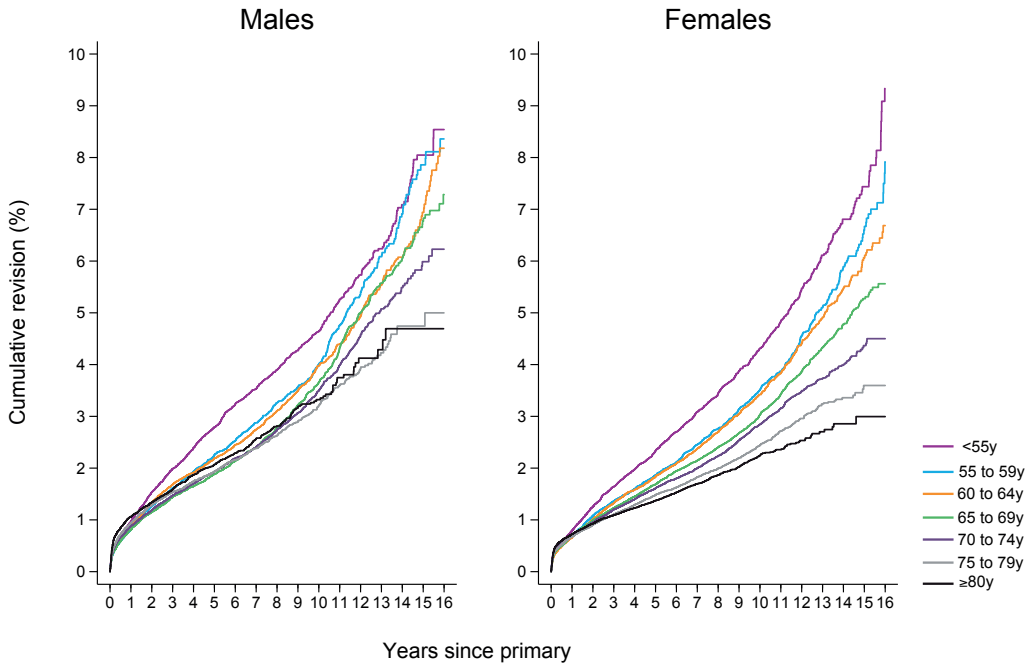


Table 3.H6 further expands Table 3.H5 to show separate estimates for males and females within each of four age bands, <55, 55 to 64, 65 to 74 and ≥75 years. Estimates are shown at 1, 3, 5, 10, 13 and 15 years after the primary operation. These refine results shown in earlier reports, but now with larger numbers of cases and therefore generally narrower confidence intervals. The relatively good results obtained with ceramic-on-ceramic and ceramic-on-polyethylene bearings in younger patients are striking. Resurfacing arthroplasty continues to show high failure rates in all groups, especially women. Even in males under 55 years of age, resurfacing has twice the revision rate of some alternatives out to 13 years. Dual mobility age and gender sub-groups are too small at this stage to provide firm conclusions on relative revision rates.

Table 3.H6 KM estimates of cumulative **revision** (95% CI) of primary hip replacements by **gender**, **age group**, **fixation** and **bearing**.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All cases	<55	71,185	0.94 (0.87-1.02)	2.16 (2.05-2.27)	3.45 (3.30-3.60)	6.96 (6.70-7.22)	9.09 (8.74-9.45)	10.68 (10.17-11.20)	71,708	0.90 (0.83-0.97)	2.18 (2.07-2.30)	3.65 (3.50-3.81)	8.29 (8.00-8.58)	11.04 (10.64-11.47)	12.95 (12.38-13.54)
All cemented	<55	5,149	0.75 (0.54-1.03)	1.81 (1.46-2.24)	2.52 (2.08-3.05)	4.84 (4.04-5.79)	7.49 (6.25-8.98)	*9.73 (7.98-11.84)*	7,918	0.66 (0.50-0.87)	1.47 (1.22-1.79)	2.24 (1.90-2.64)	4.97 (4.30-5.73)	7.35 (6.31-8.54)	*8.82 (7.46-10.41)*
MoP	<55	2,137	0.96 (0.62-1.49)	2.35 (1.76-3.12)	3.24 (2.52-4.16)	6.19 (4.95-7.73)	9.53 (7.72-11.74)	*12.30 (9.91-15.21)*	3,665	0.81 (0.57-1.17)	1.74 (1.35-2.25)	2.46 (1.97-3.07)	5.53 (4.62-6.61)	8.21 (6.88-9.78)	9.60 (7.93-11.59)
CoP	<55	2,953	0.60 (0.38-0.97)	1.43 (1.03-1.99)	1.99 (1.48-2.65)	3.44 (2.59-4.57)	*4.88 (3.52-6.76)*	*5.82 (3.84-8.77)*	4,162	0.47 (0.30-0.73)	1.19 (0.88-1.60)	2.01 (1.57-2.59)	4.25 (3.32-5.42)	*6.02 (4.48-8.06)*	*7.67 (5.46-10.72)*
MoPoM	<55	38	*0*	*0*					67	*5.50 (1.79-16.20)*	*5.50 (1.79-16.20)*	*5.50 (1.79-16.20)*			
All uncemented	<55	38,216	0.99 (0.90-1.10)	2.26 (2.11-2.43)	3.58 (3.37-3.80)	7.35 (6.96-7.76)	9.52 (8.95-10.14)	*10.97 (10.11-11.91)*	40,360	0.91 (0.82-1.01)	2.08 (1.94-2.23)	3.36 (3.17-3.57)	7.13 (6.76-7.51)	9.66 (9.07-10.28)	*10.89 (10.09-11.75)*
MoP	<55	4,766	0.98 (0.73-1.31)	2.04 (1.65-2.52)	3.02 (2.50-3.65)	5.45 (4.53-6.56)	7.74 (6.26-9.55)	*9.70 (7.40-12.66)*	5,813	1.00 (0.77-1.30)	1.83 (1.50-2.24)	2.50 (2.09-3.00)	4.36 (3.61-5.25)	7.19 (5.71-9.04)	*8.87 (6.80-11.53)*
MoM	<55	3,303	0.76 (0.51-1.12)	3.62 (3.03-4.32)	7.72 (6.85-8.69)	17.62 (16.33-19.00)	21.09 (19.60-22.68)	*22.33 (20.56-24.22)*	2,388	1.85 (1.38-2.47)	5.82 (4.95-6.84)	12.72 (11.44-14.13)	26.67 (24.92-28.51)	30.83 (28.88-32.87)	*32.69 (30.46-35.04)*
CoP	<55	9,898	1.09 (0.90-1.32)	1.90 (1.62-2.23)	2.60 (2.22-3.03)	3.76 (3.08-4.58)	4.69 (3.64-6.02)	*6.11 (4.39-8.46)*	10,276	0.87 (0.71-1.08)	1.52 (1.28-1.80)	2.19 (1.86-2.57)	3.86 (3.17-4.69)	5.21 (4.10-6.63)	*6.60 (4.99-8.71)*
CoC	<55	19,937	0.99 (0.86-1.13)	2.15 (1.95-2.37)	3.02 (2.77-3.29)	4.60 (4.22-5.01)	5.35 (4.80-5.96)	*6.68 (5.55-8.04)*	21,496	0.80 (0.69-0.93)	1.82 (1.64-2.01)	2.53 (2.32-2.77)	4.46 (4.10-4.86)	5.66 (5.08-6.31)	*6.07 (5.26-7.01)*
CoM	<55	197	*1.02 (0.26-4.02)*	*4.66 (2.45-8.77)*	*7.92 (4.85-12.80)*	*12.08 (8.10-17.81)*			269	0	*4.98 (2.92-8.43)*	*8.83 (5.96-13.00)*	*11.35 (8.02-15.94)*		
MoPoM	<55	41	*2.50 (0.36-16.45)*	*2.50 (0.36-16.45)*					56	*1.79 (0.25-12.01)*	*1.79 (0.25-12.01)*				
CoPoM	<55	58	*0*	*0*					45	*2.22 (0.32-14.75)*					
Others	<55	16	*0*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*				17	*5.88 (0.85-34.98)*	*11.76 (3.08-39.40)*	*11.76 (3.08-39.40)*			
All hybrid	<55	10,878	0.90 (0.74-1.10)	1.67 (1.42-1.95)	2.35 (2.04-2.71)	5.23 (4.58-5.98)	7.35 (6.32-8.53)	*9.84 (8.14-11.86)*	13,998	0.70 (0.57-0.85)	1.30 (1.11-1.52)	1.92 (1.67-2.20)	4.20 (3.70-4.77)	5.87 (5.11-6.74)	*7.78 (6.47-9.35)*
MoP	<55	1,750	1.58 (1.09-2.30)	2.73 (2.03-3.67)	3.56 (2.70-4.70)	6.54 (5.01-8.50)	*9.50 (7.00-12.82)*	*12.13 (8.62-16.94)*	2,489	0.71 (0.44-1.14)	1.69 (1.23-2.33)	2.26 (1.69-3.02)	4.53 (3.50-5.84)	*6.56 (4.97-8.64)*	*11.08 (7.98-15.29)*
MoM	<55	312	0	2.30 (1.10-4.76)	4.35 (2.55-7.38)	*16.35 (12.54-21.16)*	*20.32 (15.97-25.66)*	*27.39 (20.56-35.93)*	223	*1.80 (0.68-4.72)*	*3.21 (1.54-6.61)*	*8.03 (5.07-12.60)*	*21.76 (16.66-28.14)*	*24.37 (18.91-31.08)*	*27.97 (20.09-38.12)*
CoP	<55	5,449	0.90 (0.67-1.20)	1.52 (1.19-1.95)	2.03 (1.58-2.59)	*3.48 (2.55-4.73)*	*5.38 (3.18-9.04)*	*7.07 (3.83-12.86)*	6,551	0.71 (0.53-0.95)	1.19 (0.93-1.52)	1.38 (1.08-1.76)	3.30 (2.43-4.49)	*4.43 (2.90-6.73)*	*4.43 (2.90-6.73)*
CoC	<55	3,198	0.60 (0.38-0.94)	1.21 (0.88-1.67)	1.83 (1.40-2.39)	3.46 (2.74-4.35)	4.47 (3.44-5.79)	*5.71 (3.97-8.16)*	4,565	0.58 (0.39-0.85)	1.07 (0.81-1.43)	1.72 (1.36-2.17)	3.15 (2.57-3.86)	4.64 (3.74-5.75)	*5.45 (4.09-7.24)*

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
MoPoM	<55	81	*2.53 (0.64-9.76)*	*4.61 (1.45-14.09)*	*4.61 (1.45-14.09)*				105	*2.13 (0.53-8.29)*	*2.13 (0.53-8.29)*	*2.13 (0.53-8.29)*			
All reverse hybrid	**<55**	**874**	**1.29 (0.72-2.31)**	**2.52 (1.63-3.89)**	**3.10 (2.05-4.66)**	*6.23 (4.08-9.46)*	*9.12 (5.42-15.15)*	*14.53 (7.97-25.67)*	**1,242**	**1.17 (0.69-1.96)**	**1.95 (1.29-2.96)**	**3.14 (2.20-4.47)**	*5.75 (4.11-8.02)*	*7.48 (4.94-11.26)*	*9.41 (5.61-15.56)*
MoP	<55	170	*0.63 (0.09-4.41)*	*4.23 (1.92-9.21)*	*4.23 (1.92-9.21)*	*8.29 (3.78-17.69)*	*12.88 (5.51-28.50)*		254	*0.42 (0.06-2.97)*	*0.95 (0.24-3.75)*	*1.55 (0.50-4.78)*	*3.45 (1.37-8.57)*	*6.29 (2.29-16.68)*	
CoP	<55	691	1.47 (0.80-2.72)	2.16 (1.28-3.62)	2.89 (1.78-4.66)	*5.77 (3.49-9.47)*	*7.82 (4.16-14.43)*	*13.96 (5.57-32.63)*	953	1.30 (0.74-2.28)	2.06 (1.30-3.25)	2.91 (1.92-4.38)	*4.54 (2.88-7.11)*	*5.66 (3.33-9.54)*	
Others	<55	13							35	*2.86 (0.41-18.60)*	*6.46 (1.64-23.66)*	*19.21 (8.37-40.60)*	*43.29 (25.68-66.18)*		
All resurfacing	**<55**	**13,684**	**0.85 (0.71-1.02)**	**2.19 (1.95-2.45)**	**3.92 (3.59-4.27)**	**7.63 (7.16-8.13)**	**9.46 (8.89-10.06)**	**10.74 (10.01-11.53)**	**5,539**	**1.25 (0.99-1.58)**	**4.97 (4.43-5.58)**	**9.19 (8.46-9.99)**	**19.80 (18.75-20.90)**	**23.41 (22.25-24.62)**	***25.77 (24.43-27.18)***
MoM	<55	13,644	0.86 (0.72-1.03)	2.19 (1.95-2.45)	3.91 (3.59-4.26)	7.63 (7.16-8.13)	9.45 (8.88-10.05)	10.74 (10.00-11.53)	5,506	1.24 (0.98-1.56)	4.97 (4.43-5.58)	9.19 (8.45-9.98)	19.80 (18.75-20.89)	23.41 (22.25-24.62)	25.77 (24.43-27.18)
Others	<55	40	*0*						33	*3.33 (0.48-21.39)*					
All cases	**55 to 64**	**117,356**	**0.91 (0.86-0.97)**	**1.84 (1.76-1.93)**	**2.74 (2.64-2.85)**	**5.67 (5.49-5.85)**	**7.88 (7.61-8.15)**	**9.36 (8.97-9.77)**	**142,411**	**0.73 (0.68-0.77)**	**1.58 (1.51-1.65)**	**2.53 (2.44-2.62)**	**5.63 (5.46-5.80)**	**7.81 (7.57-8.06)**	**9.41 (9.05-9.78)**
All cemented	**55 to 64**	**17,372**	**0.64 (0.53-0.78)**	**1.47 (1.29-1.67)**	**2.03 (1.81-2.27)**	**4.27 (3.87-4.70)**	**6.62 (6.00-7.29)**	**8.22 (7.38-9.14)**	**28,798**	**0.48 (0.41-0.57)**	**1.10 (0.98-1.23)**	**1.69 (1.54-1.86)**	**3.64 (3.36-3.95)**	**5.76 (5.32-6.25)**	**7.07 (6.47-7.73)**
MoP	55 to 64	11,036	0.69 (0.55-0.87)	1.73 (1.49-2.00)	2.37 (2.09-2.70)	5.01 (4.51-5.56)	7.54 (6.81-8.34)	9.28 (8.32-10.36)	19,373	0.52 (0.43-0.63)	1.24 (1.09-1.42)	1.92 (1.72-2.14)	4.00 (3.67-4.37)	6.22 (5.71-6.78)	7.61 (6.94-8.35)
MoM	55 to 64	26		*0*	*0*	*0*			55	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*1.89 (0.27-12.65)*	*8.43 (3.24-20.99)*	*14.85 (6.72-31.04)*	
CoP	55 to 64	6,221	0.57 (0.41-0.80)	0.97 (0.74-1.26)	1.35 (1.07-1.72)	2.31 (1.80-2.96)	3.83 (2.86-5.12)	*4.62 (3.29-6.47)*	9,222	0.38 (0.27-0.53)	0.76 (0.60-0.98)	1.14 (0.92-1.42)	2.49 (2.02-3.07)	3.89 (3.09-4.89)	*4.77 (3.47-6.54)*
MoPoM	55 to 64	84	*0*	*1.69 (0.24-11.43)*	*1.69 (0.24-11.43)*				130	*0.89 (0.13-6.17)*	*0.89 (0.13-6.17)*	*2.73 (0.63-11.32)*			
All uncemented	**55 to 64**	**60,947**	**0.91 (0.84-0.99)**	**1.89 (1.78-2.01)**	**2.84 (2.69-2.99)**	**6.29 (6.01-6.58)**	**8.86 (8.41-9.33)**	**10.35 (9.64-11.12)**	**69,456**	**0.79 (0.73-0.86)**	**1.70 (1.61-1.81)**	**2.69 (2.56-2.83)**	**5.98 (5.74-6.24)**	**7.97 (7.60-8.36)**	**9.77 (9.16-10.42)**
MoP	55 to 64	14,799	0.97 (0.82-1.14)	1.90 (1.68-2.15)	2.52 (2.25-2.81)	4.90 (4.40-5.46)	7.27 (6.42-8.22)	8.88 (7.57-10.40)	18,729	0.75 (0.63-0.89)	1.60 (1.42-1.80)	2.04 (1.83-2.28)	3.99 (3.61-4.40)	5.77 (5.15-6.45)	7.69 (6.62-8.92)
MoM	55 to 64	5,176	0.85 (0.64-1.14)	3.06 (2.63-3.57)	6.65 (6.00-7.37)	16.61 (15.60-17.69)	21.10 (19.84-22.43)	*22.36 (20.58-24.28)*	4,848	0.91 (0.68-1.22)	3.85 (3.34-4.43)	9.40 (8.60-10.26)	22.52 (21.34-23.75)	26.44 (25.10-27.85)	*29.19 (27.39-31.10)*
CoP	55 to 64	17,457	0.84 (0.71-0.99)	1.45 (1.27-1.66)	1.89 (1.66-2.15)	3.22 (2.78-3.73)	4.39 (3.69-5.21)	*6.01 (4.77-7.56)*	20,025	0.66 (0.56-0.79)	1.30 (1.14-1.48)	1.74 (1.54-1.97)	3.17 (2.77-3.63)	3.84 (3.30-4.46)	4.84 (3.97-5.89)
CoC	55 to 64	23,065	0.94 (0.82-1.07)	1.83 (1.66-2.02)	2.40 (2.20-2.62)	3.83 (3.52-4.18)	4.97 (4.41-5.61)	*6.40 (5.21-7.84)*	25,270	0.89 (0.78-1.02)	1.58 (1.43-1.74)	2.06 (1.89-2.25)	3.17 (2.91-3.45)	4.21 (3.76-4.72)	5.73 (4.72-6.95)

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
CoM	55 to 64	317	0.63 (0.16-2.50)	2.88 (1.51-5.47)	5.19 (3.21-8.34)	*6.73 (4.39-10.27)*			465	0.43 (0.11-1.71)	1.96 (1.02-3.73)	3.28 (1.99-5.38)	*6.66 (4.70-9.39)*		
MoPoM	55 to 64	60	*0*	*0*	*0*				67	*3.13 (0.79-11.98)*	*3.13 (0.79-11.98)*	*3.13 (0.79-11.98)*			
CoPoM	55 to 64	56	*0*	*0*					35	*3.23 (0.46-20.77)*					
Others	55 to 64	17	*5.88 (0.85-34.98)*	*5.88 (0.85-34.98)*	*5.88 (0.85-34.98)*				17		*0*	*9.09 (1.33-49.19)*			
All hybrid	**55 to 64**	**21,326**	**0.85 (0.74-0.99)**	**1.57 (1.40-1.76)**	**2.17 (1.95-2.41)**	**3.94 (3.55-4.37)**	**5.47 (4.87-6.14)**	**6.88 (5.93-7.98)**	**31,566**	**0.59 (0.51-0.69)**	**1.19 (1.07-1.33)**	**1.73 (1.57-1.91)**	**3.70 (3.39-4.03)**	**4.99 (4.55-5.47)**	**5.92 (5.26-6.67)**
MoP	55 to 64	6,503	1.01 (0.79-1.29)	1.83 (1.52-2.21)	2.40 (2.02-2.85)	4.17 (3.54-4.91)	5.56 (4.67-6.60)	*7.08 (5.72-8.75)*	10,868	0.74 (0.59-0.92)	1.27 (1.07-1.52)	1.86 (1.60-2.16)	3.77 (3.32-4.29)	5.26 (4.61-6.00)	6.29 (5.34-7.41)
MoM	55 to 64	390	0.77 (0.25-2.37)	4.29 (2.65-6.92)	7.37 (5.12-10.57)	15.89 (12.45-20.16)	*20.65 (16.46-25.72)*	*22.98 (17.34-30.10)*	426	0.71 (0.23-2.18)	3.45 (2.06-5.76)	8.13 (5.81-11.30)	22.64 (18.71-27.24)	*26.88 (22.54-31.87)*	*29.03 (24.26-34.50)*
CoP	55 to 64	9,963	0.79 (0.63-0.99)	1.38 (1.14-1.66)	1.72 (1.42-2.08)	2.96 (2.27-3.86)	*4.57 (3.20-6.50)*	*7.03 (4.44-11.05)*	13,819	0.54 (0.42-0.68)	1.07 (0.89-1.29)	1.38 (1.15-1.65)	2.48 (1.96-3.12)	3.85 (2.81-5.27)	*5.34 (3.37-8.42)*
CoC	55 to 64	4,259	0.69 (0.48-0.99)	1.19 (0.90-1.57)	1.80 (1.42-2.27)	2.78 (2.25-3.43)	3.61 (2.86-4.54)	*3.98 (3.11-5.08)*	6,196	0.41 (0.27-0.60)	1.01 (0.79-1.30)	1.45 (1.17-1.80)	2.64 (2.21-3.16)	3.10 (2.58-3.72)	*3.22 (2.66-3.89)*
MoPoM	55 to 64	114	*4.31 (1.63-11.15)*	*4.31 (1.63-11.15)*	*7.04 (2.70-17.68)*				169	*1.86 (0.60-5.66)*	*3.39 (1.16-9.72)*	*3.39 (1.16-9.72)*			
CoPoM	55 to 64	74	*1.43 (0.20-9.71)*	*1.43 (0.20-9.71)*					71	*1.49 (0.21-10.13)*	*1.49 (0.21-10.13)*				
Others	55 to 64	23	*0*	*7.69 (1.12-43.36)*					17	*6.25 (0.90-36.77)*	*6.25 (0.90-36.77)*	*6.25 (0.90-36.77)*			
All reverse hybrid	**55 to 64**	**2,474**	**0.93 (0.61-1.41)**	**1.87 (1.38-2.54)**	**2.58 (1.95-3.40)**	**4.16 (3.06-5.65)**	*7.57 (4.69-12.11)*	*11.42 (5.52-22.82)*	**3,889**	**0.93 (0.67-1.29)**	**1.80 (1.40-2.30)**	**2.54 (2.04-3.16)**	**4.38 (3.49-5.49)**	*7.40 (5.37-10.14)*	*10.22 (6.32-16.29)*
MoP	55 to 64	979	0.85 (0.43-1.69)	1.49 (0.87-2.56)	2.43 (1.51-3.89)	*4.91 (2.92-8.19)*	*10.99 (5.99-19.70)*	*10.99 (5.99-19.70)*	1,648	1.25 (0.81-1.93)	2.06 (1.45-2.92)	3.06 (2.25-4.16)	5.53 (4.04-7.53)	*9.23 (6.13-13.78)*	*14.49 (7.77-26.13)*
CoP	55 to 64	1,485	0.98 (0.58-1.66)	2.12 (1.47-3.07)	2.69 (1.90-3.78)	*3.68 (2.57-5.26)*	*4.30 (2.83-6.50)*		2,217	0.70 (0.42-1.16)	1.62 (1.15-2.28)	2.12 (1.55-2.90)	3.28 (2.36-4.54)	*5.57 (3.41-9.02)*	*5.57 (3.41-9.02)*
Others	55 to 64	10							24	*0*	*0*	*7.69 (1.12-43.36)*	*16.08 (4.27-50.60)*		
All resurfacing	**55 to 64**	**11,681**	**1.22 (1.04-1.44)**	**2.38 (2.12-2.68)**	**3.82 (3.48-4.20)**	**7.08 (6.60-7.59)**	**9.03 (8.44-9.66)**	**10.26 (9.51-11.07)**	**4,203**	**1.69 (1.34-2.13)**	**4.47 (3.89-5.14)**	**8.54 (7.73-9.43)**	**17.56 (16.42-18.77)**	**21.32 (20.03-22.69)**	**23.80 (22.27-25.42)**
MoM	55 to 64	11,654	1.22 (1.03-1.43)	2.37 (2.11-2.67)	3.82 (3.48-4.19)	7.08 (6.60-7.59)	9.03 (8.44-9.66)	10.26 (9.50-11.07)	4,183	1.70 (1.35-2.14)	4.49 (3.90-5.16)	8.55 (7.74-9.45)	17.57 (16.43-18.79)	21.34 (20.04-22.70)	23.81 (22.28-25.43)

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
Others	55 to 64	27	*3.85 (0.55-24.31)*						20	*0*					
All cases	**65 to 74**	**164,903**	**0.88 (0.84-0.93)**	**1.55 (1.48-1.61)**	**2.15 (2.07-2.23)**	**4.28 (4.14-4.42)**	**6.13 (5.90-6.36)**	**7.29 (6.94-7.65)**	**254,724**	**0.70 (0.67-0.74)**	**1.28 (1.24-1.33)**	**1.86 (1.80-1.92)**	**3.63 (3.53-3.74)**	**4.88 (4.72-5.03)**	***5.74 (5.51-5.98)***
All cemented	**65 to 74**	**49,288**	**0.64 (0.58-0.72)**	**1.24 (1.14-1.35)**	**1.75 (1.62-1.88)**	**3.68 (3.46-3.92)**	**5.73 (5.37-6.11)**	**6.92 (6.40-7.47)**	**91,991**	**0.47 (0.43-0.52)**	**1.04 (0.98-1.12)**	**1.51 (1.42-1.60)**	**2.91 (2.76-3.06)**	**4.13 (3.91-4.35)**	**5.05 (4.73-5.38)**
MoP	65 to 74	42,772	0.67 (0.59-0.75)	1.27 (1.17-1.39)	1.80 (1.66-1.94)	3.83 (3.59-4.09)	5.98 (5.59-6.38)	7.09 (6.56-7.66)	80,701	0.47 (0.42-0.52)	1.04 (0.97-1.12)	1.52 (1.43-1.62)	2.98 (2.83-3.14)	4.17 (3.95-4.41)	5.08 (4.76-5.43)
MoM	65 to 74	58	*1.72 (0.24-11.62)*	*3.54 (0.90-13.45)*	*3.54 (0.90-13.45)*	*6.02 (1.95-17.80)*	*6.02 (1.95-17.80)*		101	*0.99 (0.14-6.82)*	*0.99 (0.14-6.82)*	*3.10 (1.01-9.30)*	*5.34 (2.25-12.37)*	*8.01 (3.87-16.16)*	
CoP	65 to 74	6,268	0.45 (0.31-0.65)	0.90 (0.69-1.19)	1.30 (1.01-1.67)	2.13 (1.66-2.73)	3.03 (2.29-4.01)	*4.91 (3.19-7.51)*	10,775	0.51 (0.39-0.67)	1.04 (0.85-1.27)	1.32 (1.09-1.59)	2.05 (1.68-2.49)	3.57 (2.80-4.55)	*4.77 (3.57-6.37)*
MoPoM	65 to 74	171	*1.84 (0.60-5.59)*	*3.71 (1.51-8.95)*	*3.71 (1.51-8.95)*				384	0.53 (0.13-2.09)	*0.53 (0.13-2.09)*	*1.56 (0.39-6.09)*			
Others	65 to 74	19	*0*						30	*4.55 (0.65-28.13)*					
All uncemented	**65 to 74**	**67,379**	**0.95 (0.88-1.03)**	**1.69 (1.60-1.80)**	**2.37 (2.25-2.50)**	**4.82 (4.58-5.07)**	**6.79 (6.37-7.24)**	**7.95 (7.29-8.66)**	**86,149**	**0.90 (0.84-0.96)**	**1.57 (1.49-1.66)**	**2.34 (2.23-2.45)**	**4.75 (4.55-4.97)**	**6.23 (5.91-6.56)**	**6.88 (6.43-7.37)**
MoP	65 to 74	30,075	0.92 (0.82-1.04)	1.61 (1.47-1.77)	2.01 (1.84-2.19)	3.95 (3.62-4.32)	5.90 (5.25-6.62)	6.60 (5.77-7.54)	42,327	0.93 (0.85-1.03)	1.48 (1.37-1.61)	1.92 (1.78-2.06)	3.34 (3.10-3.61)	4.60 (4.19-5.05)	5.16 (4.54-5.86)
MoM	65 to 74	4,565	1.08 (0.82-1.42)	2.95 (2.49-3.49)	6.09 (5.42-6.84)	13.58 (12.56-14.67)	16.65 (15.35-18.04)	*18.62 (16.68-20.75)*	4,646	1.12 (0.86-1.47)	3.57 (3.07-4.15)	8.69 (7.90-9.55)	19.22 (18.07-20.43)	22.10 (20.79-23.48)	*24.22 (22.06-26.54)*
CoP	65 to 74	17,196	0.81 (0.68-0.95)	1.27 (1.10-1.46)	1.55 (1.35-1.77)	2.47 (2.11-2.89)	3.24 (2.66-3.96)	*4.89 (3.64-6.55)*	20,735	0.75 (0.64-0.88)	1.27 (1.12-1.45)	1.65 (1.46-1.87)	2.83 (2.48-3.23)	3.71 (3.18-4.32)	4.11 (3.44-4.91)
CoC	65 to 74	15,120	1.13 (0.97-1.32)	1.81 (1.61-2.04)	2.29 (2.06-2.56)	3.17 (2.83-3.53)	4.72 (3.94-5.66)	*5.24 (4.07-6.73)*	17,868	0.90 (0.77-1.05)	1.49 (1.32-1.68)	1.78 (1.59-1.99)	2.46 (2.19-2.76)	3.11 (2.63-3.67)	*3.32 (2.72-4.06)*
CoM	65 to 74	304	1.33 (0.50-3.49)	3.72 (2.08-6.61)	5.14 (3.13-8.39)	*8.67 (5.88-12.68)*			380	0.53 (0.13-2.10)	1.60 (0.72-3.53)	3.51 (2.05-5.96)	*8.18 (5.62-11.82)*		
MoPoM	65 to 74	70	*0*	*0*	*0*				132	*2.31 (0.75-6.98)*	*4.71 (1.93-11.22)*	*4.71 (1.93-11.22)*			
CoPoM	65 to 74	39	*0*						37	*2.70 (0.39-17.68)*					
Others	65 to 74	10							24	*8.33 (2.15-29.39)*	*12.50 (4.21-33.92)*	*12.50 (4.21-33.92)*			

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All hybrid	65 to 74	36,134	0.93 (0.83-1.04)	1.51 (1.38-1.65)	2.00 (1.84-2.17)	3.76 (3.44-4.10)	5.09 (4.60-5.62)	5.99 (5.20-6.91)	61,034	0.76 (0.69-0.83)	1.19 (1.10-1.28)	1.66 (1.55-1.78)	2.93 (2.72-3.15)	3.72 (3.43-4.05)	4.43 (3.96-4.94)
MoP	65 to 74	20,886	0.91 (0.79-1.05)	1.50 (1.33-1.69)	2.03 (1.82-2.25)	3.76 (3.38-4.19)	5.16 (4.58-5.82)	6.16 (5.19-7.30)	37,948	0.77 (0.69-0.87)	1.25 (1.14-1.37)	1.72 (1.58-1.88)	3.01 (2.76-3.28)	3.79 (3.45-4.17)	4.53 (3.99-5.13)
MoM	65 to 74	335	1.20 (0.45-3.17)	2.18 (1.05-4.53)	4.33 (2.53-7.35)	*14.59 (10.85-19.48)*	*17.02 (12.78-22.48)*	*18.36 (13.62-24.51)*	411	1.23 (0.51-2.92)	2.31 (1.21-4.39)	6.30 (4.22-9.33)	*13.58 (10.33-17.74)*	*16.25 (12.45-21.06)*	*17.58 (13.22-23.17)*
CoP	65 to 74	11,733	0.95 (0.78-1.15)	1.43 (1.21-1.70)	1.64 (1.38-1.95)	2.54 (1.98-3.24)	*2.54 (1.98-3.24)*	*3.62 (1.97-6.61)*	18,268	0.70 (0.58-0.83)	1.06 (0.91-1.24)	1.38 (1.18-1.61)	1.75 (1.46-2.09)	2.34 (1.69-3.24)	*3.21 (2.06-4.97)*
CoC	65 to 74	2,797	0.76 (0.50-1.17)	1.47 (1.07-2.00)	2.02 (1.54-2.66)	2.95 (2.27-3.83)	*4.40 (3.26-5.93)*	*4.40 (3.26-5.93)*	3,777	0.70 (0.48-1.02)	0.87 (0.62-1.23)	1.27 (0.94-1.70)	2.27 (1.75-2.94)	2.75 (2.09-3.62)	*2.75 (2.09-3.62)*
MoPoM	65 to 74	276	*3.06 (1.46-6.35)*	*4.33 (2.00-9.26)*	*4.33 (2.00-9.26)*				493	1.51 (0.72-3.15)	*2.31 (1.16-4.58)*	*2.31 (1.16-4.58)*			
CoPoM	65 to 74	84	*1.43 (0.20-9.71)*	*5.71 (1.23-24.35)*					104	*0.97 (0.14-6.69)*	*0.97 (0.14-6.69)*				
All reverse hybrid	65 to 74	4,563	1.04 (0.78-1.39)	1.79 (1.42-2.25)	2.17 (1.75-2.70)	3.67 (2.89-4.65)	*5.11 (3.56-7.31)*	*6.60 (3.92-10.99)*	7,849	0.55 (0.41-0.74)	1.02 (0.81-1.29)	1.55 (1.27-1.90)	2.85 (2.30-3.53)	*4.20 (2.99-5.90)*	*4.20 (2.99-5.90)*
MoP	65 to 74	3,202	1.30 (0.95-1.77)	2.02 (1.56-2.61)	2.53 (1.98-3.22)	4.26 (3.24-5.60)	*5.34 (3.88-7.33)*	*7.35 (4.10-12.99)*	5,830	0.55 (0.38-0.78)	1.02 (0.78-1.33)	1.47 (1.16-1.86)	3.01 (2.34-3.87)	*3.55 (2.63-4.79)*	*3.55 (2.63-4.79)*
CoP	65 to 74	1,350	0.45 (0.20-1.01)	1.26 (0.76-2.09)	1.37 (0.84-2.24)	*2.38 (1.49-3.81)*	*4.95 (1.76-13.56)*		1,991	0.46 (0.24-0.88)	0.94 (0.58-1.50)	1.63 (1.11-2.41)	2.28 (1.49-3.50)	*5.73 (2.71-11.92)*	
Others	65 to 74	11							28	*7.43 (1.91-26.61)*	*7.43 (1.91-26.61)*	*14.55 (4.59-40.93)*			
All resurfacing	65 to 74	3,011	1.97 (1.53-2.53)	3.01 (2.45-3.69)	4.40 (3.71-5.22)	7.47 (6.52-8.54)	8.98 (7.84-10.28)	*9.60 (8.34-11.05)*	713	1.55 (0.86-2.78)	3.11 (2.06-4.69)	6.03 (4.49-8.07)	14.33 (11.87-17.24)	*18.31 (15.34-21.78)*	*21.74 (17.67-26.59)*
MoM	65 to 74	3,004	1.97 (1.53-2.54)	3.02 (2.46-3.70)	4.41 (3.72-5.23)	7.47 (6.53-8.55)	8.99 (7.85-10.29)	*9.61 (8.34-11.06)*	698	1.58 (0.88-2.83)	3.17 (2.10-4.77)	6.09 (4.54-8.15)	14.41 (11.94-17.34)	*18.41 (15.43-21.89)*	*21.84 (17.76-26.69)*
All cases	≥75	124,814	1.00 (0.94-1.05)	1.57 (1.50-1.65)	2.05 (1.96-2.14)	3.48 (3.32-3.66)	4.52 (4.23-4.84)	5.07 (4.63-5.54)	244,152	0.72 (0.69-0.76)	1.14 (1.10-1.19)	1.50 (1.45-1.56)	2.53 (2.44-2.63)	3.30 (3.14-3.47)	3.63 (3.38-3.89)
All cemented	≥75	54,950	0.82 (0.75-0.90)	1.34 (1.24-1.45)	1.79 (1.67-1.92)	3.11 (2.88-3.35)	4.03 (3.67-4.43)	4.61 (4.09-5.19)	122,813	0.46 (0.43-0.50)	0.87 (0.81-0.92)	1.17 (1.11-1.24)	2.03 (1.91-2.15)	2.67 *(2.48-2.86)*	2.98 (2.69-3.29)
MoP	≥75	52,055	0.81 (0.74-0.90)	1.33 (1.23-1.44)	1.78 (1.65-1.91)	3.11 (2.88-3.36)	4.06 (3.69-4.47)	4.65 (4.12-5.26)	116,768	0.46 (0.42-0.50)	0.86 (0.81-0.92)	1.17 (1.10-1.24)	2.04 (1.92-2.16)	2.66 (2.47-2.86)	2.98 (2.69-3.30)
MoM	≥75	46	*0*	*0*	*2.56 (0.37-16.84)*	*11.07 (3.59-31.36)*			106	*0*	*3.24 (1.06-9.71)*	*3.24 (1.06-9.71)*	*6.23 (2.60-14.53)*	*8.46 (3.74-18.53)*	

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
CoP	≥75	2,446	0.77 (0.49-1.22)	1.38 (0.96-2.00)	1.75 (1.23-2.49)	*2.42 (1.62-3.62)*	*2.42 (1.62-3.62)*		4,910	0.42 (0.27-0.65)	0.73 (0.51-1.04)	0.94 (0.67-1.32)	1.28 (0.91-1.80)	*2.35 (1.35-4.09)*	*2.35 (1.35-4.09)*
MoPoM	≥75	382	1.97 (0.94-4.10)	*3.08 (1.66-5.68)*	*4.02 (2.08-7.68)*				941	1.11 (0.60-2.06)	1.86 (1.12-3.10)	*2.54 (1.50-4.30)*			
Others	≥75	21	*0*						88	*1.16 (0.16-7.97)*	*1.16 (0.16-7.97)*				
All uncemented	**≥75**	**32,934**	**1.31 (1.20-1.44)**	**1.92 (1.77-2.08)**	**2.42 (2.24-2.61)**	**4.07 (3.74-4.44)**	**5.33 (4.60-6.17)**	*5.56 (4.72-6.54)*	**49,298**	**1.23 (1.13-1.33)**	**1.72 (1.60-1.84)**	**2.17 (2.04-2.32)**	**3.83 (3.58-4.11)**	**5.30 (4.78-5.87)**	*5.79 (5.03-6.67)*
MoP	≥75	22,203	1.41 (1.26-1.57)	2.01 (1.83-2.21)	2.41 (2.20-2.65)	3.52 (3.16-3.92)	4.93 (3.88-6.25)	*5.33 (4.08-6.95)*	34,899	1.23 (1.12-1.35)	1.64 (1.51-1.78)	2.03 (1.88-2.20)	3.44 (3.15-3.76)	4.35 (3.82-4.96)	*5.16 (4.14-6.42)*
MoM	≥75	1,704	1.02 (0.63-1.63)	1.90 (1.34-2.70)	3.74 (2.89-4.83)	8.60 (7.14-10.33)	*10.19 (8.35-12.42)*		2,399	1.30 (0.92-1.84)	3.01 (2.39-3.79)	4.90 (4.08-5.88)	9.41 (8.17-10.82)	*12.66 (10.63-15.04)*	
CoP	≥75	5,316	1.06 (0.81-1.38)	1.51 (1.20-1.91)	1.96 (1.57-2.45)	2.88 (2.14-3.86)	*3.38 (2.30-4.97)*	*3.38 (2.30-4.97)*	7,258	1.04 (0.83-1.31)	1.50 (1.23-1.82)	1.80 (1.49-2.17)	2.92 (2.36-3.60)	*3.70 (2.76-4.94)*	*3.70 (2.76-4.94)*
CoC	≥75	3,460	1.20 (0.89-1.63)	1.84 (1.43-2.36)	2.03 (1.60-2.58)	3.59 (2.75-4.66)	*4.06 (2.93-5.62)*		4,411	1.51 (1.19-1.91)	1.90 (1.53-2.35)	2.07 (1.68-2.55)	3.22 (2.51-4.14)	*7.40 (4.23-12.77)*	*7.40 (4.23-12.77)*
CoM	≥75	88	*0*	*0*	*2.76 (0.70-10.59)*	*4.26 (1.39-12.63)*			132	*0*	*0.78 (0.11-5.37)*	*0.78 (0.11-5.37)*	*1.94 (0.48-7.76)*		
MoPoM	≥75	119	*3.47 (1.32-9.00)*	*4.67 (1.95-10.95)*	*4.67 (1.95-10.95)*				179	*1.22 (0.31-4.81)*	*2.25 (0.70-7.09)*	*2.25 (0.70-7.09)*			
CoPoM	≥75	34	*3.23 (0.46-20.77)*						15	*0*					
All hybrid	**≥75**	**29,467**	**0.94 (0.84-1.06)**	**1.55 (1.40-1.71)**	**2.00 (1.82-2.20)**	**3.48 (3.09-3.92)**	**4.73 (3.95-5.66)**	*5.07 (4.10-6.27)*	**57,362**	**0.76 (0.69-0.83)**	**1.13 (1.04-1.23)**	**1.54 (1.42-1.66)**	**2.26 (2.06-2.47)**	**2.72 (2.41-3.06)**	*3.08 (2.39-3.95)*
MoP	≥75	23,048	0.93 (0.81-1.07)	1.58 (1.41-1.77)	2.03 (1.82-2.26)	3.41 (3.00-3.88)	4.71 (3.87-5.72)	*5.10 (4.03-6.44)*	46,069	0.78 (0.70-0.87)	1.17 (1.07-1.28)	1.52 (1.40-1.66)	2.25 (2.03-2.49)	2.77 (2.43-3.15)	*3.17 (2.41-4.16)*
MoM	≥75	231	*0.87 (0.22-3.43)*	*1.42 (0.46-4.38)*	*2.02 (0.75-5.34)*	*10.41 (6.02-17.67)*	*10.41 (6.02-17.67)*		405	0.50 (0.12-1.98)	1.71 (0.77-3.79)	*4.44 (2.58-7.59)*	*9.20 (6.15-13.65)*	*9.20 (6.15-13.65)*	
CoP	≥75	5,032	1.05 (0.79-1.39)	1.50 (1.16-1.93)	2.04 (1.59-2.61)	*2.63 (1.95-3.54)*	*2.63 (1.95-3.54)*		8,528	0.68 (0.52-0.89)	0.92 (0.72-1.17)	1.49 (1.17-1.91)	*1.55 (1.22-1.99)*	*1.55 (1.22-1.99)*	*1.55 (1.22-1.99)*
CoC	≥75	577	1.25 (0.60-2.60)	1.45 (0.72-2.87)	1.69 (0.88-3.25)	*2.95 (1.45-5.96)*			1,159	0.44 (0.18-1.05)	0.74 (0.37-1.48)	1.17 (0.64-2.14)	*1.47 (0.79-2.73)*	*1.47 (0.79-2.73)*	
MoPoM	≥75	476	0.25 (0.04-1.77)	*0.63 (0.15-2.57)*	*0.63 (0.15-2.57)*				1,047	0.63 (0.28-1.40)	1.11 (0.53-2.36)	*1.94 (0.93-4.02)*			
CoPoM	≥75	85	*0*	*0*					130	*1.98 (0.49-7.83)*	*1.98 (0.49-7.83)*				

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

Table 3.H6 (continued)

Fixation group/ bearing	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
Others	≥75	18	*0*						24	*4.17 (0.60-26.08)*	*4.17 (0.60-26.08)*				
All reverse hybrid	**≥75**	**3,575**	**1.14 (0.83-1.55)**	**1.94 (1.51-2.49)**	**2.44 (1.92-3.10)**	*3.80 (2.77-5.21)*	*4.66 (3.25-6.66)*		**6,741**	**0.83 (0.64-1.08)**	**1.29 (1.03-1.60)**	**1.60 (1.30-1.97)**	**2.80 (2.21-3.55)**	*3.66 (2.72-4.92)*	*3.66 (2.72-4.92)*
MoP	≥75	3,201	1.17 (0.85-1.62)	2.03 (1.57-2.63)	2.49 (1.94-3.20)	*3.99 (2.84-5.59)*	*4.97 (3.38-7.27)*		5,989	0.82 (0.62-1.08)	1.29 (1.02-1.63)	1.57 (1.25-1.96)	2.80 (2.15-3.63)	*3.19 (2.40-4.24)*	*3.19 (2.40-4.24)*
CoP	≥75	344	0.90 (0.29-2.76)	*1.26 (0.47-3.32)*	*2.11 (0.94-4.68)*	*2.68 (1.26-5.68)*			689	0.73 (0.30-1.74)	1.06 (0.51-2.22)	1.47 (0.76-2.83)	*2.48 (1.34-4.57)*		
Others	≥75	30	*0*	*0*					63	*3.42 (0.87-13.01)*	*3.42 (0.87-13.01)*				
All resurfacing	**≥75**	**204**	*1.50 (0.48-4.57)*	*2.05 (0.77-5.38)*	*3.96 (1.90-8.18)*	*6.93 (3.86-12.26)*	*6.93 (3.86-12.26)*		**30**	*3.33 (0.48-21.39)*	*7.36 (1.88-26.54)*	*7.36 (1.88-26.54)*	*15.08 (4.66-42.86)*		
MoM	≥75	203	*1.50 (0.49-4.57)*	*2.05 (0.77-5.39)*	*3.97 (1.90-8.18)*	*6.93 (3.86-12.27)*	*6.93 (3.86-12.27)*		27	*3.70 (0.53-23.51)*	*7.72 (1.98-27.52)*	*7.72 (1.98-27.52)*	*15.41 (4.83-43.20)*		

Note: All cases includes unclassified hip types.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Rows with no data or only zeros have been suppressed.

3.2.3 Revisions after primary hip replacement: effect of head size for selected bearing surfaces / fixation sub-groups

This section updates results from the 16th Annual Report on the effect of head size on the probability of revision following primary hip replacement. In total, six bearing groups were defined, and head sizes with less than 500 implantations within each group were excluded:

a) Metal-on-polyethylene cemented monobloc cups n=348,925

b) Metal-on-polyethylene uncemented metal shells with polyethylene liners n=319,860

c) Metal-on-metal uncemented metal cups or metal shells with metal liners n=30,983

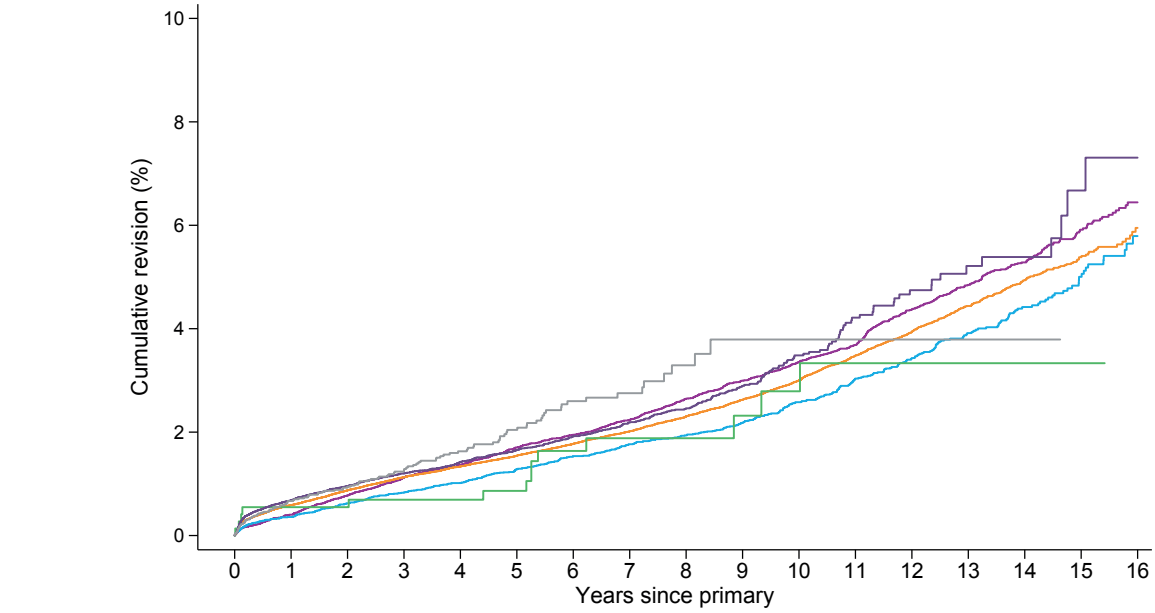
d) Ceramic-on-polyethylene cemented monobloc cups n=56,627

e) Ceramic-on-polyethylene uncemented metal shells with polyethylene liners n=185,250

f) Ceramic-on-ceramic uncemented metal shells with ceramic liners n=153,505

Figures 3.H10 (a) to 3.H10 (f) (on pages 73 to 78) show respective percentage cumulative probabilities of revision (Kaplan-Meier estimates) for various head sizes, for each of the groups with follow-up up to 16 years following the primary hip replacement.

Figure 3.H10 (a) KM estimates of cumulative **revision** of primary **cemented MoP** hip replacement **(monobloc cups)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



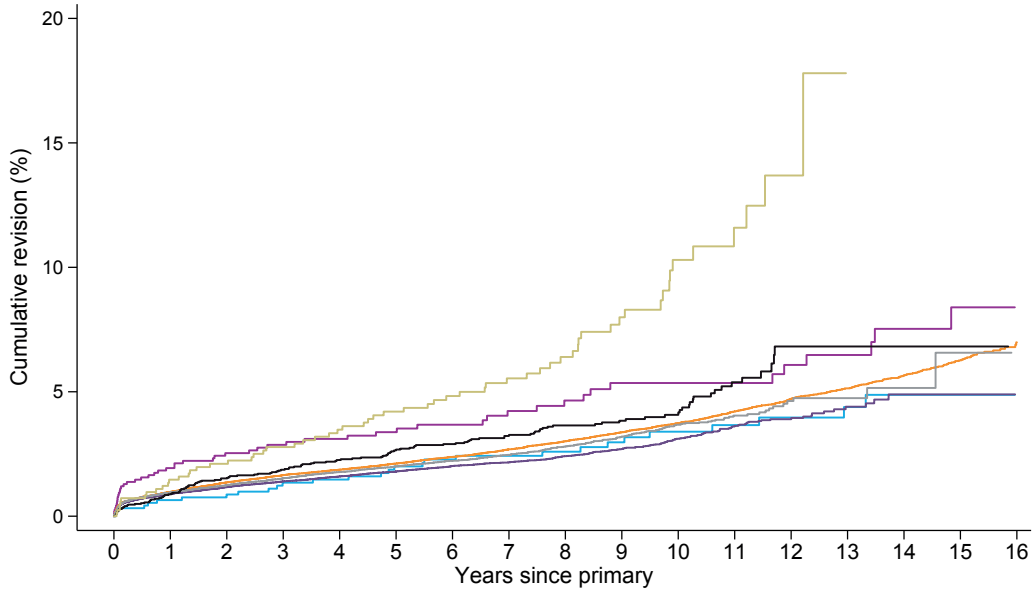
Key:

Numbers at risk

22.25	34631	33462	32296	30867	29248	27457	25608	23490	21050	18494	15893	13344	10849	8237	5793	3444	1303
26	18830	18293	17801	17209	16431	15565	14454	13241	11872	10410	9056	7494	5916	4428	3027	1634	563
28	209465	195371	180142	163628	146138	128076	109433	91638	75118	60382	47070	35248	24569	15282	8896	3914	1180
30	730	710	692	659	612	531	427	324	266	*219*	*179*	*130*	*84*	*50*	*29*	*4*	*1*
32	78067	65229	53668	43073	33232	24555	17533	12068	7778	5033	3116	1865	1140	620	339	*152*	*44*
36	7202	5946	4850	3870	3025	2288	1555	957	503	*219*	*78*	*15*	*1*	*1*	*1*	*0*	*0*

In Figure 3.H10 (a), for metal-on-polyethylene cemented monobloc cups, there was a statistically significant effect of head size (overall difference P<0.001 by logrank test) on revision rates. Overall, implants with head size 32mm had the worst failure rates over the entire duration of follow-up, but implants with head size 36mm had the worst failure rates in the first eight years of follow-up. The numbers at risk for patients who received 36mm heads after eight years are too small for meaningful comparison.

Figure 3.H10 (b) KM estimates of cumulative **revision** of primary **uncemented MoP** hip replacements **(metal shells and polyethylene liner)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



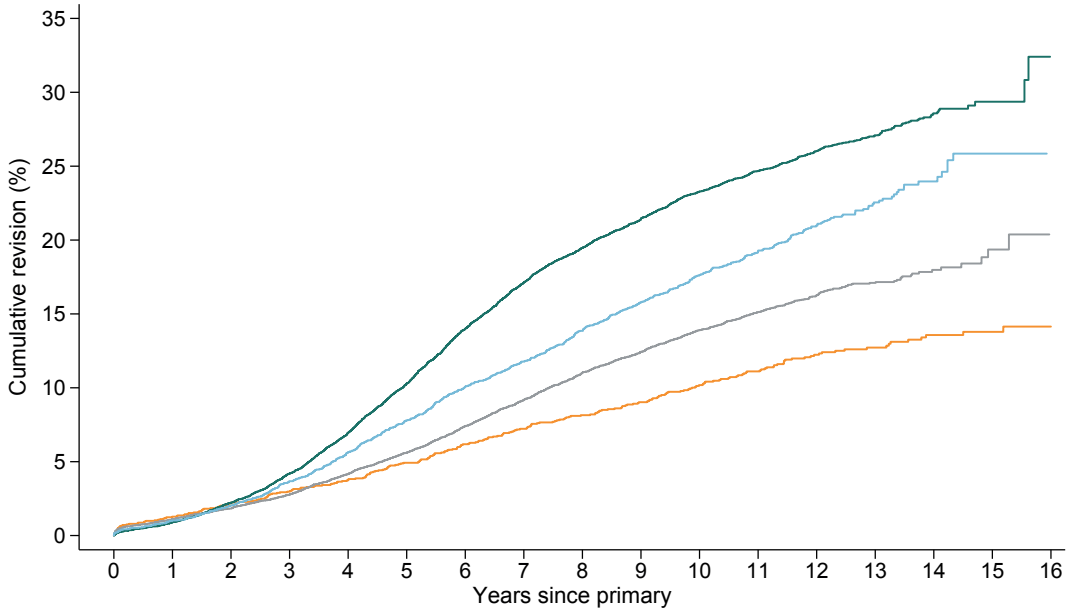
Key:

Numbers at risk

22.25	1178	1023	929	830	746	662	575	500	435	370	331	293	*247*	*196*	*147*	*91*	*28*
26	934	906	862	812	772	727	678	613	549	478	404	345	284	*220*	*150*	*83*	*22*
28	101170	95682	90032	83685	76885	69803	62375	55209	47592	39946	32427	25242	18194	12004	7068	3229	937
32	141230	121335	102056	83250	65982	50750	37155	26338	17869	11644	7061	3865	1928	914	334	*107*	*4*
36	71056	61126	52760	44392	36222	29295	22992	17445	12146	7783	4382	2009	831	307	*107*	*42*	*9*
40	3460	3304	3184	3059	2919	2726	2495	2251	1850	1416	974	563	*179*	*13*	*5*	*3*	*0*
44	832	790	742	707	683	642	582	495	398	307	*201*	*118*	*31*	*0*	*0*	*0*	*0*

Figure 3.H10 (b) shows revision rates for different head sizes for metal-on-polyethylene uncemented metal shell with polyethylene liners. There was a statistically significant effect of head size (overall P<0.001), with head size 44mm showing the worst failure rates, but there were small numbers of 44mm heads at risk after nine years.

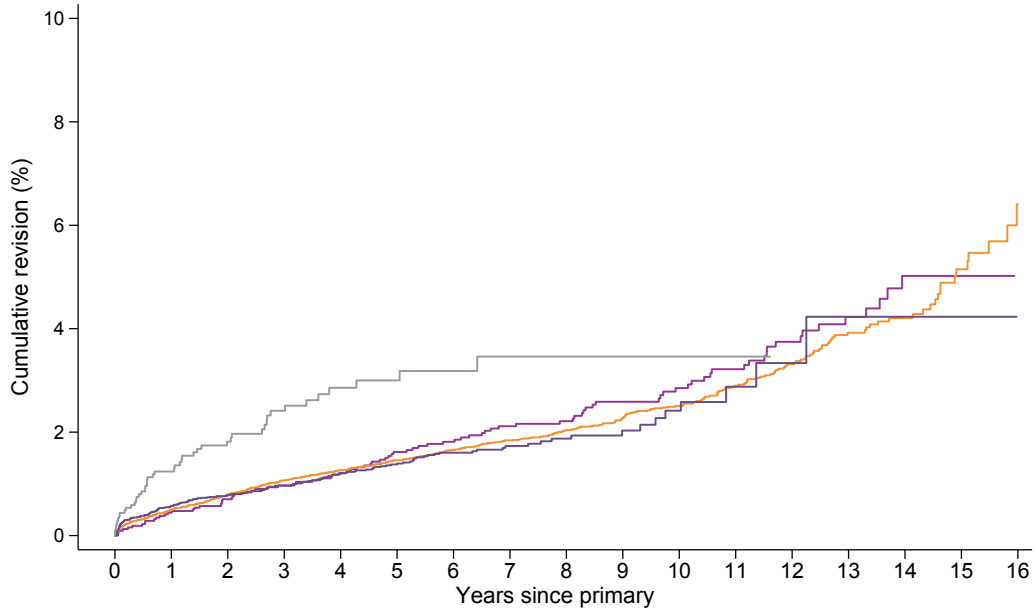
Figure 3.H10 (c) KM estimates of cumulative **revision** of primary **uncemented MoM** hip replacement **(monobloc cups or metal shell liner)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk															
28	2521	2416	2305	2203	2126	2060	1996	1940	1835	1712	1550	1306	1020	704	510	298	*93*
36	12552	12240	11979	11682	11277	10850	10374	9890	9359	8774	7492	5362	3153	1498	562	*137*	*22*
38 to 48	11685	11495	11254	10899	10447	9931	9349	8832	8391	7901	7037	5589	3486	1816	750	*151*	*19*
50 to 54	4225	4150	4063	3938	3804	3656	3509	3382	3237	3047	2656	2044	1288	662	258	*73*	*22*

Figure 3.H10 (c) shows revision rates for metal-on-metal uncemented metal cup / metal shell with metal liners. Smaller heads had lower failure rates (overall P<0.001), with a head size of 28mm having the lowest rate of failure in this group.

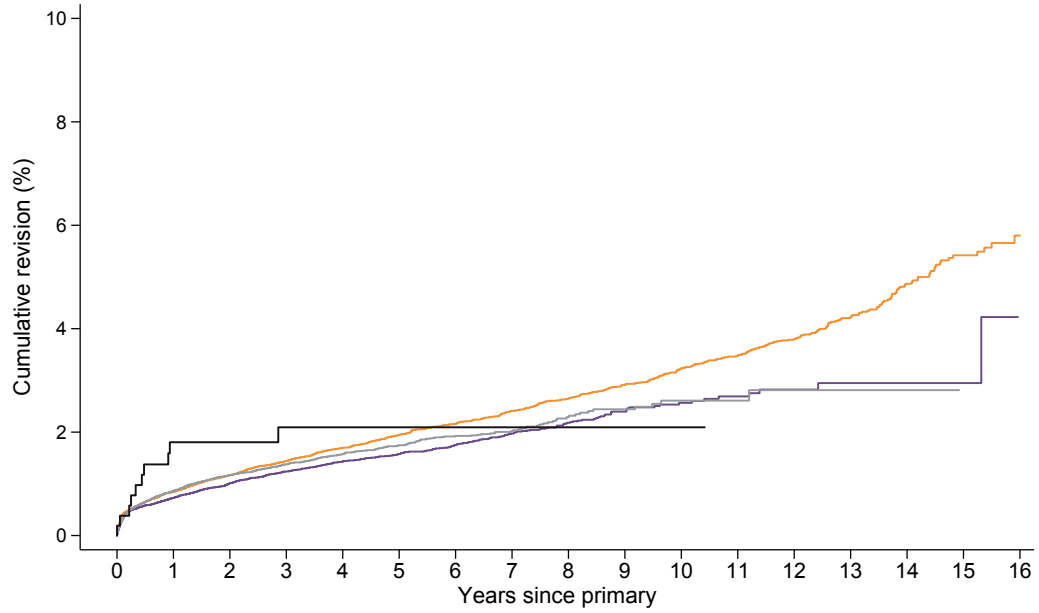
Figure 3.H10 (d) KM estimates of cumulative **revision** of primary **cemented CoP** hip replacement **(monobloc cups)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk																
22.25	3188	3112	3022	2912	2787	2598	2371	2127	1892	1631	1419	1198	931	662	384	*165*	*0*
28	34528	31384	28240	24833	21720	18723	15712	12991	10437	8286	6355	4721	3257	2081	1298	659	*226*
32	16844	14144	11721	9503	7338	5429	3807	2619	1678	1023	589	286	*125*	*68*	*38*	*16*	*5*
36	2067	1648	1317	1011	742	533	396	272	*160*	*79*	*21*	*5*	*0*	*0*	*0*	*0*	*0*

Figure 3.H10 (d) shows revision rates for ceramic-on-polyethylene cemented monobloc cups, with a statistically significant difference between the head sizes overall (P<0.001) with head size 36mm having the worst failure rate. In contrast to the metal-on-polyethylene cemented monobloc cups, the 32mm head sizes had some of the lowest revision rates.

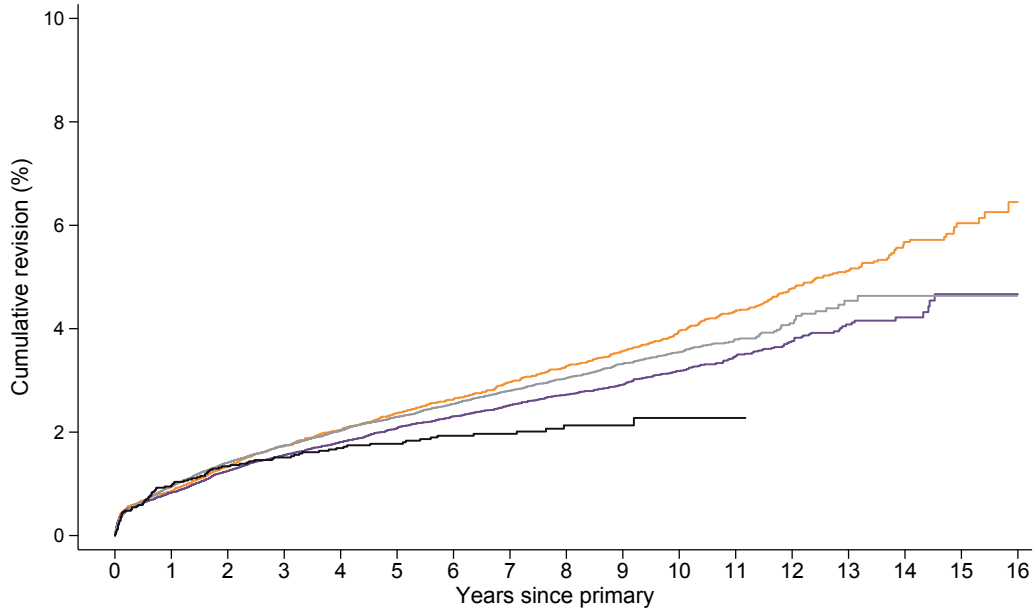
Figure 3.H10 (e) KM estimates of cumulative **revision** of primary **uncemented CoP** hip replacement **(metal shell and polyethylene liner)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk																
28	37220	33925	30553	27213	24056	21331	18707	16596	14498	12539	10611	8676	6829	4876	3121	1634	554
32	86371	68906	53692	40513	29830	21205	14766	10198	7086	4752	2910	1708	960	574	332	*124*	*25*
36	61136	48974	38769	29608	21509	14791	9783	6055	3593	2205	1252	560	255	*96*	*13*	*0*	*0*
40	523	452	396	326	279	263	*212*	*175*	*105*	*50*	*10*	*0*	*0*	*0*	*0*	*0*	*0*

For uncemented ceramic-on-polyethylene metal shells used with polyethylene liners (Figure 3.H10 (e)), whilst there was a statistically significant difference between the four head sizes shown (P<0.001), the best implant survival was with the 32mm and 36mm heads at ten years follow-up with 28mm and 40mm heads showing worse outcomes whilst the numbers at risk remained above 250.

Figure 3.H10 (f) KM estimates of cumulative **revision** of primary **uncemented CoC** hip replacement **(metal shell and ceramic liner)** by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk																
28	18604	18073	17513	16872	16147	15320	14345	13264	11913	10278	8661	7154	5542	3937	2468	1235	338
32	48520	46093	43454	40381	36944	33025	28657	24039	19014	14281	10429	7220	4656	2703	1305	486	*116*
36	81778	77199	72464	66926	60136	52473	43633	34865	25651	17291	10474	5762	2698	1162	375	*90*	*17*
40	4603	4359	4182	3940	3639	3315	2862	2259	1485	790	252	*14*	*0*	*0*	*0*	*0*	*0*

Figure 3.H10 (f) shows revision rates for uncemented ceramic-on-ceramic hip replacements by head size. There are statistically significant differences between all four head sizes shown (P<0.001). A head size of 40mm showed the best survival rate, though there were small numbers in this bearing group. A head size of 28mm had the highest failure rates in the long term, while 32mm and 36mm showed similar failure rates, but were worse than those of head size 40mm.

3.2.4 Revisions after primary hip surgery for the main stem / cup brand combinations

As in previous reports, only stem / cup brand combinations with more than 2,500 procedures for cemented, uncemented, hybrid and reverse hybrid hips or more than 1,000 procedures in the case of resurfacings are included. The figures in blue italics are at time points where fewer than 250 cases remained at risk; no results are shown at all where the number had fallen below ten cases. No attempt has been made to adjust for other factors that may influence the chance of revision so the figures are unadjusted cumulative probabilities of revision. Given that the sub-groups may differ in composition with respect to age and gender, the percentage of males and the median (IQR) of the ages are also shown in these tables.

Table 3.H7 shows Kaplan-Meier estimates of the cumulative percentage probability of revision of primary hip replacement (for any reason) for the main stem / cup brand constructs.

Table 3.H7 KM estimates of cumulative **revision** (95% CI) of primary hip replacement by **fixation**, and **stem / cup** brand. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Stem:cup brand	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Cemented									
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	3,306	75 (70 to 79)	31	0.62 (0.40-0.95)	1.27 (0.93-1.74)	1.58 (1.19-2.10)	2.77 (2.12-3.63)	*3.32 (2.48-4.44)*	
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	4,584	77 (72 to 81)	33	0.34 (0.21-0.57)	0.96 (0.69-1.34)	1.34 (0.99-1.81)	2.32 (1.73-3.11)	*3.99 (2.12-7.43)*	
C-Stem AMT Cemented Stem[St] : Marathon[C]	12,759	75 (70 to 80)	32	0.44 (0.34-0.58)	0.95 (0.77-1.17)	1.25 (1.01-1.54)	*1.97 (1.39-2.79)*		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	5,894	72 (66 to 77)	40	0.37 (0.24-0.56)	0.89 (0.67-1.18)	1.19 (0.93-1.54)	2.74 (2.22-3.37)	4.19 (3.42-5.13)	*4.83 (3.66-6.36)*
C-Stem Cemented Stem[St] : Marathon[C]	9,230	68 (59 to 75)	41	0.46 (0.34-0.63)	0.98 (0.78-1.22)	1.39 (1.13-1.70)	2.50 (1.97-3.17)		
CPT[St] : Elite Plus Ogee[C]	3,034	73 (67 to 79)	36	0.66 (0.43-1.03)	1.50 (1.11-2.00)	2.18 (1.70-2.78)	3.93 (3.17-4.86)	5.32 (4.24-6.68)	*6.29 (4.71-8.37)*
CPT[St] : ZCA[C]	17,985	77 (71 to 81)	31	0.88 (0.75-1.03)	1.49 (1.31-1.69)	2.16 (1.93-2.42)	3.87 (3.46-4.33)	4.85 (4.27-5.51)	5.28 (4.45-6.26)
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	4,617	72 (66 to 78)	38	0.33 (0.20-0.55)	1.13 (0.86-1.48)	1.79 (1.43-2.24)	3.58 (3.03-4.23)	5.12 (4.38-5.98)	6.36 (5.39-7.49)
Charnley Cemented Stem[St] : Charnley Ogee[C]	10,466	73 (67 to 78)	38	0.38 (0.28-0.52)	1.23 (1.03-1.46)	1.90 (1.64-2.19)	3.77 (3.37-4.22)	5.26 (4.72-5.86)	6.44 (5.72-7.24)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	6,911	74 (68 to 79)	29	0.38 (0.26-0.56)	0.77 (0.59-1.01)	1.18 (0.94-1.48)	2.54 (2.14-3.01)	3.46 (2.94-4.07)	4.17 (3.48-5.00)
Exeter V40[St] : Cenator Cemented Cup[C]	2,522	75 (69 to 80)	32	0.64 (0.39-1.04)	1.39 (0.99-1.93)	2.05 (1.55-2.71)	2.80 (2.17-3.61)	4.80 (3.71-6.21)	*5.16 (3.92-6.78)*

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Exeter V40[St] : Charnley and Elite Plus LPW[C]	5,304	73 (68 to 79)	31	0.64 (0.45-0.90)	1.27 (0.99-1.62)	1.50 (1.19-1.90)	2.24 (1.77-2.82)	2.96 (2.30-3.80)	*3.30 (2.44-4.45)*
Exeter V40[St] : Elite Plus Cemented Cup[C]	5,189	73 (67 to 79)	33	0.33 (0.21-0.53)	0.64 (0.45-0.90)	0.87 (0.64-1.17)	1.51 (1.16-1.98)	2.48 (1.85-3.34)	*3.82 (2.65-5.48)*
Exeter V40[St] : Elite Plus Ogee[C]	25,949	74 (69 to 80)	35	0.40 (0.33-0.49)	0.87 (0.76-1.00)	1.22 (1.08-1.37)	2.27 (2.04-2.51)	2.93 (2.62-3.27)	3.44 (2.97-3.99)
Exeter V40[St] : Exeter Contemporary Flanged[C]	91,491	74 (69 to 79)	34	0.55 (0.50-0.60)	1.01 (0.94-1.08)	1.39 (1.30-1.47)	2.48 (2.33-2.64)	3.51 (3.26-3.79)	4.49 (4.00-5.03)
Exeter V40[St] : Exeter Contemporary Hooded[C]	28,966	75 (70 to 80)	32	0.93 (0.83-1.05)	1.63 (1.48-1.79)	2.17 (2.00-2.36)	4.03 (3.73-4.36)	6.54 (5.97-7.18)	7.99 (7.09-9.00)
Exeter V40[St] : Exeter Duration[C]	16,885	73 (67 to 79)	32	0.60 (0.49-0.73)	1.19 (1.04-1.37)	1.64 (1.45-1.84)	3.87 (3.53-4.24)	5.81 (5.29-6.37)	6.82 (6.12-7.60)
Exeter V40[St] : Exeter X3 Rimfit[C]	36,059	70 (63 to 77)	34	0.50 (0.43-0.58)	0.89 (0.79-1.01)	1.32 (1.17-1.47)			
Exeter V40[St] : Marathon[C]	8,023	71 (64 to 78)	36	0.47 (0.34-0.65)	0.90 (0.69-1.16)	1.24 (0.96-1.59)	*1.91 (1.40-2.60)*		
Exeter V40[St] : Opera[C]	2,810	74 (68 to 80)	32	0.40 (0.22-0.71)	0.85 (0.57-1.28)	1.29 (0.92-1.80)	3.27 (2.53-4.23)	5.65 (4.34-7.34)	*8.54 (5.96-12.16)*
MS-30[St] : Low Profile Durasul Cup[C]	3,973	74 (68 to 80)	32	0.23 (0.12-0.45)	0.53 (0.34-0.83)	0.79 (0.53-1.16)	1.67 (1.19-2.35)	2.35 (1.55-3.56)	*2.35 (1.55-3.56)*
Muller Straight Stem[St] : Low Profile Durasul Cup[C]	3,839	75 (70 to 80)	28	0.55 (0.36-0.85)	0.92 (0.65-1.29)	1.19 (0.87-1.62)	2.66 (2.01-3.53)	*4.03 (2.94-5.50)*	*5.54 (3.56-8.56)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	5,431	75 (70 to 80)	29	0.45 (0.30-0.66)	1.08 (0.83-1.40)	1.52 (1.22-1.90)	2.44 (2.00-2.98)	4.07 (3.27-5.07)	*4.94 (3.76-6.50)*
Uncemented									
Accolade[St] : Trident[SL]	27,016	66 (59 to 73)	44	0.94 (0.83-1.07)	1.90 (1.74-2.07)	2.56 (2.37-2.77)	4.23 (3.94-4.55)	5.63 (5.04-6.29)	*6.29 (5.02-7.86)*
Accolade II[St] : Trident[SL]	10,686	65 (57 to 72)	46	0.97 (0.79-1.19)	1.50 (1.23-1.83)	1.97 (1.48-2.63)			
Anthology[St] : R3 Cementless[SL]	4,710	62 (54 to 69)	42	1.14 (0.87-1.49)	1.74 (1.39-2.17)	2.25 (1.82-2.78)	*4.75 (3.20-7.02)*		
Corail[St] : ASR Resurfacing Cup[C]	2,747	61 (54 to 67)	54	0.98 (0.68-1.43)	7.43 (6.50-8.48)	23.52 (21.96-25.18)	43.88 (41.98-45.82)	47.92 (45.89-50.00)	
Corail[St] : Duraloc Cementless Cup[SL]	4,002	70 (64 to 75)	39	0.75 (0.53-1.08)	1.68 (1.32-2.13)	2.47 (2.02-3.01)	5.45 (4.74-6.26)	8.83 (7.79-10.01)	11.43 (10.00-13.06)
Corail[St] : Pinnacle Gription[SL]	9,590	66 (58 to 74)	41	0.94 (0.76-1.16)	1.64 (1.37-1.96)	2.55 (2.11-3.08)			
Corail[St] : Pinnacle[SL]	163,061	66 (59 to 73)	45	0.78 (0.74-0.82)	1.51 (1.45-1.57)	2.23 (2.15-2.32)	5.00 (4.83-5.17)	6.99 (6.69-7.31)	*8.18 (7.48-8.93)*

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Corail[St] : Trilogy[SL]	3,195	68 (61 to 74)	40	0.60 (0.39-0.95)	1.07 (0.76-1.50)	1.58 (1.18-2.10)	3.05 (2.41-3.86)	3.56 (2.74-4.63)	*3.56 (2.74-4.63)*
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	4,702	62 (52 to 70)	38	1.37 (1.07-1.76)	1.91 (1.54-2.38)	2.22 (1.80-2.75)			
Furlong HAC Stem[St] : CSF[SL]	17,076	69 (63 to 76)	40	1.10 (0.95-1.27)	1.81 (1.62-2.03)	2.19 (1.98-2.43)	3.61 (3.31-3.93)	4.36 (4.01-4.75)	5.35 (4.85-5.91)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	24,159	66 (59 to 73)	45	1.11 (0.98-1.25)	1.77 (1.61-1.95)	2.07 (1.89-2.27)	2.73 (2.48-3.00)		
M/L Taper Cementless[St] : Continuum[SL]	6,082	61 (53 to 68)	50	1.25 (1.00-1.56)	1.81 (1.50-2.19)	2.20 (1.83-2.63)			
M/L Taper Cementless[St] : Trilogy IT[SL]	5,198	64 (55 to 71)	51	1.24 (0.97-1.59)	2.10 (1.72-2.57)	2.42 (1.98-2.95)			
Metafix Stem[St] : Trinity[SL]	6,277	64 (56 to 70)	46	0.82 (0.62-1.08)	1.23 (0.97-1.56)	1.44 (1.13-1.84)			
Polarstem Cementless[St] : R3 Cementless[SL]	16,088	66 (58 to 72)	46	0.74 (0.61-0.89)	0.98 (0.82-1.16)	1.26 (1.05-1.51)	*1.54 (1.25-1.90)*		
SL-Plus Cementless Stem[St] : EP-Fit Plus[SL]	5,448	66 (59 to 73)	43	1.28 (1.01-1.61)	2.69 (2.28-3.16)	3.85 (3.35-4.42)	6.15 (5.47-6.92)	7.24 (6.40-8.18)	*7.95 (6.83-9.24)*
Synergy Cementless Stem[St] : R3 Cementless[SL]	3,751	65 (57 to 71)	51	0.91 (0.65-1.28)	1.32 (1.00-1.76)	1.77 (1.36-2.29)	*4.12 (2.67-6.34)*		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	25,772	65 (58 to 72)	44	1.10 (0.98-1.24)	1.53 (1.38-1.69)	1.81 (1.65-1.99)	2.41 (2.17-2.67)	*2.70 (2.27-3.22)*	
Taperloc Complete Cementless Stem[St] : Exceed ABT[SL]	3,662	63 (56 to 70)	49	0.83 (0.58-1.19)	1.40 (1.04-1.86)	1.65 (1.23-2.21)			
Hybrid									
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	16,389	71 (65 to 77)	38	0.71 (0.59-0.85)	1.22 (1.04-1.43)	1.70 (1.45-1.99)	3.22 (2.56-4.05)	*3.41 (2.68-4.33)*	
CPCS[St] : R3 Cementless[SL]	3,938	74 (68 to 79)	32	0.84 (0.59-1.19)	1.45 (1.06-1.99)	1.80 (1.29-2.52)			
CPT[St] : Continuum[SL]	10,050	70 (62 to 77)	37	1.52 (1.29-1.78)	2.31 (2.00-2.66)	2.73 (2.36-3.15)	*4.79 (3.32-6.87)*		
CPT[St] : Trabecular Metal Modular Cementless Cup[SL]	2,693	72 (64 to 79)	31	1.14 (0.80-1.63)	1.82 (1.36-2.43)	2.33 (1.77-3.06)	*4.14 (3.10-5.53)*	*4.81 (3.33-6.92)*	
CPT[St] : Trilogy IT[SL]	10,398	69 (62 to 76)	37	1.27 (1.07-1.51)	1.88 (1.61-2.19)	2.32 (1.98-2.73)			

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H7 (continued)

Stem:cup brand	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
CPT[St] : Trilogy[SL]	23,819	72 (65 to 78)	35	0.92 (0.81-1.05)	1.46 (1.31-1.63)	2.22 (2.02-2.45)	4.12 (3.71-4.58)	5.25 (4.65-5.92)	5.35 (4.73-6.05)
Exeter V40[St] : ABG II Cementless Cup[SL]	2,635	65 (59 to 73)	34	0.27 (0.13-0.56)	0.74 (0.47-1.16)	1.22 (0.85-1.74)	2.22 (1.67-2.95)	3.14 (2.41-4.09)	3.96 (2.94-5.31)
Exeter V40[St] : Pinnacle[SL]	9,058	72 (65 to 78)	38	0.81 (0.64-1.02)	1.20 (0.99-1.47)	1.50 (1.24-1.81)	2.67 (2.14-3.34)	*3.72 (2.59-5.32)*	
Exeter V40[St] : R3 Cementless[SL]	2,729	72 (65 to 78)	31	0.79 (0.52-1.21)	1.35 (0.95-1.91)	1.63 (1.15-2.31)	*2.52 (1.34-4.73)*		
Exeter V40[St] : Trident[SL]	100,124	69 (61 to 76)	40	0.61 (0.56-0.66)	1.08 (1.01-1.16)	1.44 (1.35-1.53)	2.56 (2.39-2.73)	3.36 (3.09-3.66)	3.92 (3.45-4.46)
Exeter V40[St] : Trilogy[SL]	14,451	70 (63 to 76)	40	0.57 (0.46-0.70)	0.90 (0.76-1.08)	1.28 (1.10-1.49)	2.28 (2.00-2.59)	3.05 (2.66-3.50)	3.51 (2.97-4.15)
Exeter V40[St] : Tritanium[SL]	5,769	67 (60 to 74)	45	1.08 (0.83-1.39)	1.65 (1.32-2.06)	2.17 (1.74-2.70)	*3.16 (2.30-4.34)*		
Taperfit Cemented Stem[St] : Trinity[SL]	5,987	71 (65 to 77)	34	0.90 (0.69-1.19)	1.36 (1.07-1.74)	1.58 (1.21-2.06)			
Reverse hybrid									
Corail[St] : Elite Plus Ogee[C]	3,076	72 (65 to 77)	37	0.66 (0.43-1.02)	1.50 (1.12-2.02)	1.94 (1.48-2.54)	3.13 (2.41-4.05)	*5.18 (3.74-7.16)*	*5.18 (3.74-7.16)*
Corail[St] : Marathon[C]	15,098	70 (64 to 76)	39	0.64 (0.52-0.79)	1.14 (0.97-1.34)	1.40 (1.20-1.64)	2.21 (1.77-2.76)		
Resurfacing									
ASR Resurfacing Cup	2,920	55 (49 to 60)	69	1.64 (1.24-2.18)	5.87 (5.08-6.79)	13.29 (12.11-14.59)	26.22 (24.65-27.88)	29.75 (28.07-31.52)	*31.10 (29.18-33.12)*
Adept Resurfacing Cup	3,691	54 (47 to 59)	75	1.13 (0.83-1.53)	2.48 (2.01-3.04)	4.50 (3.86-5.25)	8.13 (7.23-9.13)	11.25 (9.82-12.88)	
BHR Resurfacing Cup	22,302	55 (48 to 60)	75	1.02 (0.90-1.16)	2.32 (2.13-2.53)	3.59 (3.35-3.85)	7.60 (7.23-7.99)	9.65 (9.21-10.12)	11.15 (10.61-11.72)
Conserve Plus Resurfacing Cup	1,321	56 (50 to 61)	64	2.05 (1.41-2.97)	5.17 (4.10-6.51)	8.31 (6.94-9.94)	14.11 (12.32-16.14)	15.60 (13.64-17.81)	*17.13 (14.29-20.46)*
Cormet 2000 Resurfacing Cup	3,612	55 (48 to 60)	65	1.52 (1.17-1.98)	3.78 (3.20-4.45)	7.73 (6.90-8.65)	16.91 (15.71-18.18)	21.10 (19.70-22.58)	24.37 (22.61-26.25)
Durom Resurfacing Cup	1,689	55 (49 to 60)	70	1.36 (0.91-2.04)	3.56 (2.78-4.56)	5.47 (4.49-6.67)	8.53 (7.28-9.98)	10.05 (8.64-11.68)	*10.99 (9.35-12.90)*
Recap Magnum	1,693	54 (49 to 59)	73	1.95 (1.39-2.73)	3.37 (2.61-4.35)	5.58 (4.58-6.79)	10.40 (9.00-12.00)	*13.23 (11.32-15.42)*	

Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H8 further divides the data by stratifying for bearing surface. This table shows the estimated cumulative percentage probability of revision for the resulting fixation / bearing sub-groups, provided there were more than 2,500 procedures for unipolar bearings, or more than 1,000 procedures for dual mobility bearings.

Table 3.H8 KM estimates of cumulative **revision** (95% CI) of primary hip replacement by **fixation**, **stem / cup** brand, and **bearing**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
Cemented										
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	3,280	75 (71 to 79)	31	0.62 (0.40-0.96)	1.28 (0.94-1.75)	1.60 (1.20-2.12)	2.80 (2.14-3.67)	*3.35 (2.50-4.49)*	
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	MoP	4,013	77 (73 to 82)	32	0.34 (0.20-0.58)	0.96 (0.67-1.35)	1.32 (0.96-1.81)	2.40 (1.76-3.25)	*4.09 (2.19-7.58)*	
C-Stem AMT Cemented Stem[St] : Marathon[C]	MoP	10,443	77 (72 to 81)	31	0.40 (0.29-0.55)	0.96 (0.77-1.21)	1.34 (1.06-1.69)	*2.15 (1.40-3.29)*		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	MoP	4,962	73 (68 to 78)	39	0.41 (0.27-0.64)	0.99 (0.74-1.33)	1.30 (1.00-1.70)	2.98 (2.39-3.71)	4.48 (3.62-5.54)	*5.32 (3.88-7.27)*
C-Stem Cemented Stem[St] : Marathon[C]	MoP	5,269	73 (68 to 78)	37	0.38 (0.24-0.59)	0.83 (0.61-1.15)	1.17 (0.87-1.58)	*2.47 (1.77-3.43)*		
C-Stem Cemented Stem[St] : Marathon[C]	CoP	3,961	59 (52 to 65)	46	0.57 (0.38-0.87)	1.16 (0.85-1.59)	1.67 (1.26-2.22)	*2.56 (1.82-3.59)*		
CPT[St] : Elite Plus Ogee[C]	MoP	2,968	73 (67 to 79)	36	0.61 (0.39-0.97)	1.42 (1.05-1.93)	2.12 (1.65-2.73)	3.91 (3.14-4.86)	5.34 (4.23-6.72)	*6.34 (4.72-8.48)*
CPT[St] : ZCA[C]	MoP	17,008	77 (72 to 81)	31	0.92 (0.79-1.08)	1.54 (1.36-1.75)	2.24 (1.99-2.51)	3.96 (3.54-4.43)	4.87 (4.29-5.54)	5.34 (4.48-6.36)
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	MoP	4,617	72 (66 to 78)	38	0.33 (0.20-0.55)	1.13 (0.86-1.48)	1.79 (1.43-2.24)	3.58 (3.03-4.23)	5.12 (4.38-5.98)	6.36 (5.39-7.49)
Charnley Cemented Stem[St] : Charnley Ogee[C]	MoP	10,466	73 (67 to 78)	38	0.38 (0.28-0.52)	1.23 (1.03-1.46)	1.90 (1.64-2.19)	3.77 (3.37-4.22)	5.26 (4.72-5.86)	6.44 (5.72-7.24)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	6,911	74 (68 to 79)	29	0.38 (0.26-0.56)	0.77 (0.59-1.01)	1.18 (0.94-1.48)	2.54 (2.14-3.01)	3.46 (2.94-4.07)	4.17 (3.48-5.00)
Exeter V40[St] : Charnley and Elite Plus LPW[C]	MoP	4,173	75 (71 to 80)	28	0.66 (0.46-0.97)	1.26 (0.95-1.67)	1.49 (1.15-1.94)	2.42 (1.87-3.14)	3.32 (2.52-4.36)	*3.71 (2.69-5.09)*
Exeter V40[St] : Elite Plus Cemented Cup[C]	MoP	4,896	74 (68 to 79)	32	0.35 (0.22-0.56)	0.61 (0.43-0.88)	0.81 (0.59-1.12)	1.43 (1.08-1.90)	2.29 (1.66-3.16)	*3.14 (2.13-4.61)*

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
Exeter V40[St] : Elite Plus Ogee[C]	MoP	23,610	75 (70 to 80)	34	0.39 (0.32-0.48)	0.87 (0.75-1.00)	1.20 (1.06-1.36)	2.26 (2.03-2.52)	2.92 (2.60-3.27)	3.47 (2.97-4.06)
Exeter V40[St] : Exeter Contemporary Flanged[C]	MoP	84,578	75 (70 to 80)	34	0.55 (0.51-0.61)	1.01 (0.94-1.09)	1.39 (1.31-1.48)	2.50 (2.34-2.67)	3.51 (3.25-3.80)	4.55 (4.04-5.13)
Exeter V40[St] : Exeter Contemporary Flanged[C]	CoP	6,913	66 (61 to 71)	37	0.51 (0.36-0.71)	0.98 (0.76-1.27)	1.30 (1.03-1.65)	2.18 (1.71-2.77)	*3.63 (2.62-5.03)*	*3.63 (2.62-5.03)*
Exeter V40[St] : Exeter Contemporary Hooded[C]	MoP	27,065	76 (70 to 81)	32	0.94 (0.83-1.07)	1.63 (1.48-1.79)	2.17 (1.99-2.37)	3.99 (3.69-4.33)	6.51 (5.91-7.16)	7.92 (7.01-8.94)
Exeter V40[St] : Exeter Duration[C]	MoP	15,912	74 (68 to 79)	32	0.61 (0.50-0.75)	1.22 (1.06-1.41)	1.68 (1.49-1.90)	3.92 (3.57-4.30)	5.84 (5.31-6.43)	6.84 (6.13-7.63)
Exeter V40[St] : Exeter X3 Rimfit[C]	MoP	25,591	73 (67 to 79)	33	0.50 (0.42-0.60)	0.88 (0.76-1.02)	1.28 (1.11-1.47)			
Exeter V40[St] : Exeter X3 Rimfit[C]	CoP	10,468	62 (56 to 68)	38	0.47 (0.36-0.63)	0.92 (0.74-1.14)	1.40 (1.15-1.72)			
Exeter V40[St] : Marathon[C]	MoP	5,657	75 (69 to 80)	34	0.53 (0.37-0.76)	0.96 (0.71-1.30)	1.23 (0.92-1.65)	*2.04 (1.38-3.00)*		
Exeter V40[St] : Opera[C]	MoP	2,677	75 (69 to 80)	31	0.38 (0.20-0.70)	0.85 (0.56-1.30)	1.32 (0.94-1.85)	3.31 (2.55-4.30)	5.71 (4.38-7.43)	*8.27 (5.74-11.85)*
MS-30[St] : Low Profile Durasul Cup[C]	CoP	2,546	71 (66 to 76)	31	0.16 (0.06-0.43)	0.52 (0.30-0.92)	0.68 (0.41-1.14)	1.25 (0.78-2.00)	*1.86 (1.04-3.32)*	*1.86 (1.04-3.32)*
Muller Straight Stem[St] : Low Profile Durasul Cup[C]	MoP	3,112	75 (70 to 80)	28	0.59 (0.37-0.93)	0.92 (0.63-1.34)	1.25 (0.89-1.75)	2.87 (2.10-3.90)	*4.51 (3.17-6.40)*	*5.39 (3.49-8.29)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	MoP	4,962	75 (70 to 81)	30	0.41 (0.26-0.63)	1.08 (0.82-1.41)	1.57 (1.24-1.97)	2.54 (2.06-3.13)	3.97 (3.16-4.99)	*4.74 (3.51-6.37)*
Uncemented										
Accolade[St] : Trident[SL]	MoP	12,460	71 (64 to 76)	41	0.97 (0.81-1.16)	1.98 (1.75-2.25)	2.76 (2.48-3.08)	5.11 (4.62-5.65)	*7.40 (6.33-8.64)*	
Accolade[St] : Trident[SL]	CoP	7,145	62 (55 to 67)	46	0.84 (0.65-1.08)	1.57 (1.30-1.89)	1.87 (1.57-2.24)	2.74 (2.19-3.42)	*3.16 (2.28-4.39)*	*3.16 (2.28-4.39)*
Accolade[St] : Trident[SL]	CoC	7,358	62 (55 to 68)	46	0.99 (0.79-1.25)	2.04 (1.74-2.39)	2.78 (2.42-3.18)	3.96 (3.50-4.48)	4.90 (4.14-5.78)	*5.88 (4.12-8.35)*
Accolade II[St] : Trident[SL]	MoP	4,127	70 (64 to 76)	43	0.96 (0.69-1.33)	1.33 (0.97-1.82)	*1.47 (1.05-2.07)*			
Accolade II[St] : Trident[SL]	CoP	6,001	62 (55 to 69)	47	1.04 (0.80-1.36)	1.74 (1.35-2.26)	*2.11 (1.41-3.16)*			
Anthology[St] : R3 Cementless[SL]	MoP	3,744	63 (55 to 70)	39	1.19 (0.89-1.60)	1.80 (1.41-2.30)	2.17 (1.71-2.76)	*2.59 (2.00-3.34)*		

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
Corail[St] : ASR Resurfacing Cup[C]	MoM	2,747	61 (54 to 67)	54	0.98 (0.68-1.43)	7.43 (6.50-8.48)	23.52 (21.96-25.18)	43.88 (41.98-45.82)	47.92 (45.89-50.00)	
Corail[St] : Duraloc Cementless Cup[SL]	MoP	3,680	70 (65 to 75)	38	0.63 (0.42-0.94)	1.47 (1.12-1.92)	2.30 (1.85-2.85)	5.32 (4.59-6.16)	8.49 (7.41-9.72)	10.82 (9.33-12.54)
Corail[St] : Pinnacle Gription[SL]	MoP	3,534	74 (68 to 79)	36	1.12 (0.81-1.53)	1.69 (1.28-2.24)	2.54 (1.87-3.45)			
Corail[St] : Pinnacle Gription[SL]	CoP	3,763	64 (57 to 70)	43	0.62 (0.41-0.94)	1.37 (0.98-1.94)	2.14 (1.45-3.16)			
Corail[St] : Pinnacle[SL]	MoP	65,725	71 (65 to 77)	41	0.80 (0.73-0.87)	1.29 (1.20-1.38)	1.58 (1.48-1.69)	2.87 (2.67-3.09)	4.05 (3.64-4.50)	*4.55 (3.87-5.35)*
Corail[St] : Pinnacle[SL]	MoM	11,887	67 (60 to 74)	47	0.87 (0.72-1.06)	2.44 (2.17-2.73)	5.18 (4.79-5.60)	13.33 (12.69-13.99)	16.52 (15.72-17.35)	*18.07 (16.77-19.47)*
Corail[St] : Pinnacle[SL]	CoP	40,657	64 (57 to 69)	46	0.65 (0.58-0.74)	1.08 (0.97-1.19)	1.47 (1.33-1.63)	2.64 (2.27-3.08)	*3.11 (2.53-3.82)*	*4.06 (2.50-6.55)*
Corail[St] : Pinnacle[SL]	CoC	42,959	59 (52 to 66)	49	0.85 (0.76-0.94)	1.81 (1.68-1.94)	2.47 (2.32-2.62)	3.97 (3.74-4.22)	5.18 (4.69-5.73)	*6.82 (4.98-9.30)*
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	CoC	4,025	60 (50 to 69)	39	1.27 (0.96-1.68)	1.70 (1.33-2.19)	2.07 (1.62-2.64)			
Furlong HAC Stem[St] : CSF[SL]	MoP	8,071	73 (67 to 78)	39	1.36 (1.13-1.64)	2.17 (1.87-2.52)	2.51 (2.19-2.88)	4.30 (3.82-4.84)	5.12 (4.54-5.77)	5.81 (4.99-6.76)
Furlong HAC Stem[St] : CSF[SL]	CoP	7,355	67 (61 to 73)	41	0.77 (0.59-0.99)	1.33 (1.09-1.62)	1.71 (1.43-2.04)	2.70 (2.32-3.14)	3.43 (2.96-3.96)	4.45 (3.79-5.23)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	MoP	5,797	74 (70 to 79)	40	1.66 (1.36-2.02)	2.32 (1.95-2.74)	2.85 (2.43-3.34)	3.90 (3.29-4.62)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoP	3,234	67 (62 to 72)	46	0.95 (0.67-1.36)	1.68 (1.27-2.21)	1.96 (1.51-2.55)	2.97 (2.20-4.00)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoC	15,128	63 (56 to 69)	47	0.93 (0.79-1.10)	1.59 (1.40-1.80)	1.81 (1.60-2.04)	2.28 (2.02-2.58)		
Metafix Stem[St] : Trinity[SL]	CoP	2,648	64 (57 to 70)	48	0.81 (0.53-1.26)	1.13 (0.75-1.69)	1.36 (0.90-2.04)			
Metafix Stem[St] : Trinity[SL]	CoC	2,612	60 (52 to 66)	45	0.71 (0.45-1.13)	1.12 (0.77-1.64)	1.28 (0.88-1.86)			
Polarstem Cementless[St] : R3 Cementless[SL]	MoP	14,340	67 (59 to 73)	46	0.77 (0.64-0.93)	1.01 (0.84-1.21)	1.34 (1.10-1.63)			
SL-Plus Cementless Stem[St] : EP-Fit Plus[SL]	MoP	2,903	68 (62 to 75)	40	1.35 (0.99-1.85)	2.69 (2.15-3.36)	3.59 (2.95-4.36)	6.35 (5.37-7.50)	*7.53 (6.27-9.03)*	*9.45 (6.84-12.99)*

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
Synergy Cementless Stem[St] : R3 Cementless[SL]	MoP	3,012	66 (57 to 72)	50	0.94 (0.65-1.35)	1.21 (0.87-1.68)	1.45 (1.06-1.98)	*1.83 (1.33-2.51)*		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	MoP	8,285	72 (66 to 77)	40	1.28 (1.06-1.55)	1.81 (1.54-2.13)	2.08 (1.78-2.43)	2.74 (2.28-3.28)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoP	5,433	65 (58 to 70)	46	0.84 (0.63-1.12)	1.03 (0.79-1.35)	1.19 (0.92-1.55)	*1.90 (1.40-2.57)*		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoC	12,041	61 (54 to 67)	47	1.09 (0.92-1.30)	1.54 (1.33-1.78)	1.89 (1.65-2.16)	2.41 (2.09-2.78)	*2.65 (2.13-3.30)*	
Hybrid										
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	MoP	8,667	75 (71 to 80)	35	0.75 (0.58-0.96)	1.34 (1.09-1.65)	1.81 (1.47-2.22)	*2.59 (1.84-3.65)*	*3.03 (2.02-4.54)*	
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	CoP	5,959	67 (60 to 71)	42	0.67 (0.48-0.92)	1.01 (0.75-1.34)	1.16 (0.85-1.59)	*1.84 (1.03-3.29)*		
CPCS[St] : R3 Cementless[SL]	MoP	3,573	74 (69 to 80)	31	0.81 (0.55-1.18)	1.45 (1.03-2.03)	1.59 (1.12-2.26)			
CPT[St] : Continuum[SL]	MoP	5,145	75 (70 to 80)	34	1.70 (1.37-2.10)	2.46 (2.03-2.98)	2.84 (2.31-3.49)			
CPT[St] : Continuum[SL]	CoP	3,420	65 (59 to 71)	40	1.31 (0.97-1.77)	2.15 (1.65-2.79)	2.50 (1.89-3.29)			
CPT[St] : Trilogy IT[SL]	MoP	5,071	74 (69 to 79)	34	1.56 (1.25-1.95)	2.28 (1.87-2.78)	3.01 (2.43-3.72)			
CPT[St] : Trilogy IT[SL]	CoP	3,997	65 (59 to 70)	40	1.01 (0.73-1.38)	1.57 (1.19-2.07)	1.73 (1.31-2.30)			
CPT[St] : Trilogy[SL]	MoP	15,079	73 (67 to 79)	35	0.87 (0.74-1.04)	1.44 (1.26-1.65)	2.23 (1.99-2.51)	4.17 (3.73-4.66)	5.30 (4.67-6.00)	*5.40 (4.75-6.14)*
CPT[St] : Trilogy[SL]	CoP	8,740	69 (62 to 75)	36	1.01 (0.81-1.25)	1.49 (1.24-1.79)	2.20 (1.83-2.65)	*2.77 (2.24-3.43)*	*3.94 (2.16-7.13)*	
Exeter V40[St] : Pinnacle[SL]	MoP	6,066	75 (70 to 80)	31	0.83 (0.63-1.10)	1.25 (0.99-1.58)	1.55 (1.25-1.94)	2.65 (2.06-3.41)	*3.78 (2.57-5.56)*	
Exeter V40[St] : Pinnacle[SL]	CoP	2,726	65 (59 to 71)	53	0.70 (0.44-1.10)	0.96 (0.63-1.44)	1.18 (0.79-1.75)	*2.48 (1.46-4.19)*		
Exeter V40[St] : Trident[SL]	MoP	52,332	73 (68 to 79)	37	0.64 (0.58-0.72)	1.14 (1.05-1.24)	1.47 (1.35-1.60)	2.67 (2.42-2.95)	3.51 (3.09-3.99)	*4.21 (3.51-5.06)*
Exeter V40[St] : Trident[SL]	CoP	33,081	65 (58 to 71)	42	0.56 (0.48-0.65)	0.94 (0.82-1.06)	1.18 (1.04-1.35)	1.97 (1.62-2.40)	*2.24 (1.68-2.98)*	*2.24 (1.68-2.98)*
Exeter V40[St] : Trident[SL]	CoC	12,948	59 (53 to 65)	44	0.54 (0.43-0.69)	1.07 (0.90-1.26)	1.58 (1.37-1.81)	2.74 (2.44-3.07)	3.59 (3.17-4.07)	4.12 (3.46-4.90)
Exeter V40[St] : Trident[SL]*	MoPoM	1,113	75 (67 to 82)	34	1.10 (0.61-1.99)	1.92 (1.07-3.45)	*2.32 (1.28-4.16)*			
Exeter V40[St] : Trilogy[SL]	MoP	11,730	71 (65 to 77)	40	0.56 (0.44-0.71)	0.89 (0.73-1.08)	1.30 (1.10-1.54)	2.33 (2.02-2.68)	3.15 (2.70-3.67)	3.49 (2.92-4.16)

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

Table 3.H8 (continued)

Stem:cup brand	Bearing surface	N	Median (IQR) age at primary	Percentage (%) males	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
Exeter V40[St] : Trilogy[SL]	CoP	2,720	63 (58 to 69)	43	0.56 (0.34-0.92)	0.92 (0.62-1.37)	1.15 (0.80-1.65)	2.06 (1.53-2.77)	2.69 (1.97-3.65)	*3.50 (2.33-5.25)*
Exeter V40[St] : Tritanium[SL]	CoP	3,033	64 (57 to 69)	47	1.11 (0.78-1.56)	1.66 (1.21-2.26)	2.24 (1.65-3.06)			
Taperfit Cemented Stem[St] : Trinity[SL]	MoP	3,096	75 (70 to 80)	33	1.08 (0.77-1.53)	1.64 (1.21-2.22)	1.77 (1.29-2.43)			
Reverse hybrid										
Corail[St] : Marathon[C]	MoP	10,534	73 (68 to 78)	37	0.65 (0.51-0.83)	1.14 (0.94-1.39)	1.38 (1.15-1.67)	2.02 (1.61-2.54)		
Corail[St] : Marathon[C]	CoP	4,564	63 (56 to 68)	41	0.62 (0.42-0.90)	1.14 (0.85-1.52)	1.44 (1.10-1.89)	*2.63 (1.67-4.14)*		

*Inclusion criteria relaxed to show the newly identified dual mobility hips with at least 1,000 procedures.
Note: Blank cells indicate that the number at risk at the time shown has fallen below ten and thus estimates have been omitted as they are highly unreliable.
Note: [St] = Stem; [C] = Cup; [SL] = Shell liner.

3.2.5 Revisions for different causes after primary hip replacement

Overall, 34,978 (2.9%) of the 1,191,253 primary hip replacements had an associated first revision. The most common indications for revision were aseptic loosening (8,579), dislocation / subluxation (6,050), adverse soft tissue reaction to particulate debris (5,494, a figure that is likely to be an underestimate due to changes in MDS collection, see later), infection (5,178) and pain (4,848). Pain was not usually cited alone; in 3,301 out of the 4,848 instances, it was cited together with one or more other indications. Associated PTIRs for these and the other indications are shown in Table 3.H9 (page 88). Here, implant wear denotes either wear of the polyethylene component, wear of the acetabular component or dissociation of the liner.

The number of adverse reactions to particulate debris is likely to be underestimated because this was not solicited (i.e. it was not available as an indication for revision) on the revision data collection forms in the early phase of the registry, i.e. was not included in MDSv1 and MDSv2. Some of these cases may have recorded the indication for revision as 'other' but this is not definitively known. Adoption of the later revision report forms (MDSv3 onwards) was staggered over time and so revisions associated with a few primaries as late as 2011 had revisions reported on MDSv1 and MDSv2 of the data collection forms. Restricting our analyses to primaries from 2008 onwards, as done in recent annual reports, ensures that >99% of revisions were recorded on later forms (MDSv3 onwards). It was noted that only 2,532 of the 5,494 instances of adverse reactions to particulate debris would thus be included, i.e. 2,962 of the earlier cases are therefore missing. Therefore, two sets of PTIRs are presented: one set for all primary hip replacements, which are likely to be underestimates, and the other set for all primary hip replacements performed since the beginning of 2008, which has better ascertainment but does not include the cases with the longest follow-up.

Table 3.H9 reports revision by indication with further breakdowns by hip fixation and bearing. Metal-on-metal (irrespective of the type of fixation) and resurfacings seem to have the highest PTIRs for both aseptic loosening and pain. Metal-on-metal bearings have the highest incidence of adverse reaction to particulate debris.

Table 3.H9 PTIR estimates of **indications** for hip **revision** (95% CI) by **fixation** and **bearing**.

Fixation/ bearing type	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris**	Adverse reaction to particulate debris for primaries from 1.1.2008***: Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years
All cases*	7,176.2	1.20 (1.17-1.22)	0.68 (0.66-0.69)	0.84 (0.82-0.86)	0.72 (0.70-0.74)	0.70 (0.68-0.72)	0.33 (0.32-0.35)	0.29 (0.27-0.30)	0.27 (0.26-0.28)	0.15 (0.14-0.16)	0.03 (0.03-0.04)	0.42 (0.40-0.43)	0.77 (0.75-0.79)	5,033.5	0.50 (0.48-0.52)
All cemented	2,383.7	1.09 (1.05-1.13)	0.27 (0.25-0.29)	0.84 (0.80-0.88)	0.68 (0.65-0.72)	0.52 (0.50-0.55)	0.19 (0.17-0.21)	0.22 (0.20-0.24)	0.19 (0.17-0.20)	0.08 (0.07-0.09)	0.01 (0.01-0.02)	0.14 (0.13-0.16)	0.03 (0.03-0.04)	1,489.9	0.03 (0.02-0.04)
Cemented and															
MoP	2,116.9	1.11 (1.07-1.16)	0.27 (0.25-0.30)	0.86 (0.82-0.90)	0.68 (0.64-0.71)	0.53 (0.50-0.57)	0.19 (0.18-0.21)	0.23 (0.21-0.25)	0.20 (0.18-0.21)	0.07 (0.06-0.09)	0.01 (0.01-0.02)	0.15 (0.13-0.16)	0.03 (0.02-0.04)	1,289.4	0.03 (0.02-0.04)
MoM	4.0	2.26 (1.18-4.35)	0.25 (0.04-1.78)	1.26 (0.52-3.02)	0.75 (0.24-2.34)	1.01 (0.38-2.68)	0	1.01 (0.38-2.68)	0.50 (0.13-2.01)	1.01 (0.38-2.68)	0	0.50 (0.13-2.01)	0.75 (0.24-2.34)	0.9	0
CoP	256.1	0.85 (0.75-0.97)	0.23 (0.18-0.30)	0.66 (0.57-0.77)	0.73 (0.63-0.84)	0.39 (0.32-0.47)	0.17 (0.12-0.23)	0.15 (0.11-0.20)	0.11 (0.08-0.16)	0.10 (0.07-0.14)	0.00 (0.00-0.03)	0.11 (0.08-0.16)	0.04 (0.02-0.08)	193.0	0.05 (0.02-0.09)
MoPoM	6.3	0.80 (0.33-1.92)	0.16 (0.02-1.14)	1.28 (0.64-2.56)	2.08 (1.21-3.58)	2.40 (1.45-3.98)	0.16 (0.02-1.14)	0.16 (0.02-1.14)	0	0	0	0.64 (0.24-1.70)	0	6.2	0
All uncemented	2,657.5	1.40 (1.35-1.44)	0.83 (0.79-0.86)	0.86 (0.82-0.89)	0.72 (0.69-0.76)	0.69 (0.66-0.73)	0.45 (0.43-0.48)	0.30 (0.28-0.32)	0.36 (0.34-0.39)	0.21 (0.19-0.22)	0.05 (0.04-0.06)	0.55 (0.52-0.57)	1.25 (1.21-1.29)	2,084.5	0.82 (0.79-0.86)
Uncemented and															
MoP	980.4	1.10 (1.03-1.17)	0.45 (0.41-0.49)	1.06 (1.00-1.13)	0.68 (0.63-0.73)	0.89 (0.83-0.95)	0.41 (0.38-0.46)	0.23 (0.20-0.26)	0.44 (0.40-0.48)	0.10 (0.08-0.12)	0.05 (0.04-0.06)	0.27 (0.24-0.31)	0.19 (0.17-0.22)	785.0	0.19 (0.17-0.23)
MoM	283.1	3.57 (3.36-3.80)	3.61 (3.39-3.83)	0.83 (0.73-0.94)	1.45 (1.32-1.60)	0.78 (0.68-0.89)	0.77 (0.67-0.88)	1.38 (1.25-1.52)	0.63 (0.55-0.73)	0.18 (0.13-0.23)	0.09 (0.06-0.13)	2.35 (2.18-2.53)	10.32 (9.95-10.70)	140.4	9.91 (9.40-10.45)
CoP	500.0	0.95 (0.87-1.04)	0.36 (0.31-0.42)	0.99 (0.90-1.08)	0.65 (0.58-0.72)	0.56 (0.49-0.63)	0.39 (0.34-0.45)	0.13 (0.11-0.17)	0.31 (0.26-0.36)	0.11 (0.08-0.14)	0.04 (0.02-0.06)	0.28 (0.24-0.33)	0.07 (0.05-0.10)	394.2	0.06 (0.04-0.09)
CoC	871.4	1.25 (1.18-1.32)	0.60 (0.55-0.65)	0.57 (0.52-0.62)	0.57 (0.52-0.62)	0.53 (0.48-0.58)	0.43 (0.38-0.47)	0.10 (0.08-0.13)	0.22 (0.19-0.26)	0.40 (0.36-0.44)	0.05 (0.04-0.07)	0.41 (0.36-0.45)	0.14 (0.12-0.17)	743.1	0.14 (0.11-0.17)
CoM	19.1	3.04 (2.35-3.93)	1.41 (0.97-2.06)	0.52 (0.28-0.97)	1.10 (0.72-1.69)	0.52 (0.28-0.97)	0.63 (0.36-1.11)	0.63 (0.36-1.11)	0.52 (0.28-0.97)	0.16 (0.05-0.49)	0.16 (0.05-0.49)	1.10 (0.72-1.69)	2.20 (1.63-2.98)	18.5	2.17 (1.59-2.95)
MoPoM	2.2	2.30 (0.96-5.53)	0.92 (0.23-3.68)	0.92 (0.23-3.68)	1.84 (0.69-4.91)	2.30 (0.96-5.53)	0	0	0.92 (0.23-3.68)	0	0	0.92 (0.23-3.68)	0.46 (0.06-3.27)	2.1	0.47 (0.07-3.33)

*Including 36,198 with unknown fixation/bearing.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.

Table 3.H9 (continued)

Fixation/ bearing type	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Periprosthetic fracture	Malalignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris**	Adverse reaction to particulate debris for primaries from 1.1.2008***: Prosthesis-years at risk (x1,000)	Adverse reaction to particulate debris for primaries from 1.1.2008***: Number of revisions per 1,000 prosthesis-years
All hybrid	1,295.6	0.55 (0.51-0.59)	0.33 (0.30-0.36)	0.98 (0.93-1.03)	0.83 (0.78-0.88)	0.91 (0.86-0.96)	0.26 (0.23-0.29)	0.17 (0.15-0.20)	0.21 (0.19-0.24)	0.14 (0.12-0.16)	0.02 (0.01-0.03)	0.26 (0.24-0.29)	0.22 (0.19-0.25)	984.9	0.13 (0.11-0.15)
Hybrid and															
MoP	786.5	0.56 (0.51-0.61)	0.26 (0.23-0.30)	1.08 (1.01-1.16)	0.81 (0.75-0.88)	0.98 (0.91-1.05)	0.26 (0.23-0.30)	0.17 (0.15-0.20)	0.24 (0.20-0.27)	0.09 (0.07-0.12)	0.02 (0.01-0.03)	0.20 (0.17-0.23)	0.07 (0.05-0.09)	585.7	0.06 (0.05-0.09)
MoM	24.9	3.06 (2.44-3.83)	3.02 (2.41-3.78)	1.33 (0.94-1.87)	1.21 (0.84-1.73)	1.97 (1.49-2.61)	0.52 (0.30-0.90)	1.65 (1.21-2.24)	0.36 (0.19-0.70)	0.32 (0.16-0.64)	0.08 (0.02-0.32)	2.37 (1.84-3.06)	7.60 (6.59-8.77)	9.2	6.41 (4.96-8.27)
CoP	274.6	0.29 (0.24-0.37)	0.18 (0.13-0.24)	1.03 (0.91-1.15)	1.02 (0.90-1.14)	0.86 (0.76-0.98)	0.17 (0.13-0.23)	0.09 (0.06-0.13)	0.17 (0.13-0.22)	0.11 (0.07-0.15)	0.02 (0.01-0.05)	0.25 (0.20-0.32)	0.04 (0.02-0.07)	245.7	0.04 (0.02-0.07)
CoC	201.5	0.54 (0.44-0.65)	0.46 (0.38-0.57)	0.44 (0.36-0.54)	0.53 (0.43-0.64)	0.52 (0.43-0.63)	0.32 (0.25-0.41)	0.11 (0.07-0.17)	0.15 (0.11-0.22)	0.35 (0.27-0.44)	0.02 (0.01-0.06)	0.26 (0.20-0.34)	0.13 (0.09-0.19)	136.4	0.14 (0.09-0.22)
MoPoM	6.2	0.65 (0.24-1.73)	0.16 (0.02-1.15)	1.14 (0.54-2.39)	2.44 (1.47-4.04)	1.95 (1.11-3.43)	0.16 (0.02-1.15)	0.32 (0.08-1.30)	0.16 (0.02-1.15)	0.16 (0.02-1.15)	0	0.32 (0.08-1.30)	0.16 (0.02-1.15)	6.1	0.16 (0.02-1.16)
All reverse hybrid	**167.1**	**1.33 (1.17-1.52)**	**0.36 (0.28-0.46)**	**0.91 (0.78-1.07)**	**0.75 (0.63-0.90)**	**0.68 (0.57-0.82)**	**0.31 (0.23-0.40)**	**0.20 (0.14-0.28)**	**0.23 (0.17-0.32)**	**0.05 (0.03-0.10)**	**0.02 (0.01-0.06)**	**0.32 (0.24-0.42)**	**0.11 (0.07-0.17)**	**144.0**	**0.06 (0.03-0.12)**
Reverse hybrid and															
MoP	111.4	1.23 (1.04-1.45)	0.24 (0.17-0.35)	0.97 (0.80-1.17)	0.76 (0.62-0.94)	0.77 (0.62-0.95)	0.27 (0.19-0.39)	0.20 (0.13-0.30)	0.21 (0.14-0.31)	0.04 (0.02-0.11)	0.02 (0.00-0.07)	0.27 (0.19-0.39)	0.07 (0.04-0.14)	96.2	0.05 (0.02-0.12)
CoP	54.8	1.53 (1.24-1.90)	0.57 (0.40-0.80)	0.77 (0.57-1.04)	0.73 (0.54-0.99)	0.49 (0.34-0.72)	0.33 (0.21-0.52)	0.18 (0.10-0.34)	0.29 (0.18-0.48)	0.05 (0.02-0.17)	0.04 (0.01-0.15)	0.35 (0.22-0.54)	0.04 (0.01-0.15)	47.2	0.02 (0.00-0.15)
All resurfacing	**398.2**	**2.32 (2.18-2.48)**	**3.29 (3.11-3.47)**	**0.27 (0.22-0.32)**	**0.48 (0.42-0.55)**	**1.13 (1.03-1.24)**	**0.62 (0.55-0.71)**	**0.93 (0.84-1.03)**	**0.27 (0.22-0.32)**	**0.25 (0.20-0.30)**	**0.06 (0.04-0.09)**	**1.72 (1.60-1.85)**	**3.95 (3.76-4.15)**	**160.2**	**3.31 (3.04-3.61)**
Resurfacing and															
MoM	397.9	2.32 (2.18-2.48)	3.29 (3.12-3.47)	0.27 (0.22-0.33)	0.48 (0.42-0.55)	1.13 (1.03-1.24)	0.62 (0.55-0.71)	0.93 (0.84-1.03)	0.26 (0.22-0.32)	0.25 (0.20-0.30)	0.06 (0.04-0.09)	1.72 (1.60-1.86)	3.95 (3.76-4.15)	160	3.32 (3.05-3.61)

*Including 36,198 with unknown fixation/bearing.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.

Table 3.H10 PTIR estimates of indications for hip revision (95% CI) by years following primary hip replacement.

Time since primary	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:												Adverse reaction to particulate debris for primaries from 1.1.2008***	
		Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Peri-prosthetic fracture	Malalignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris**	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years
All cases	7,176.2	1.20 (1.17-1.22)	0.68 (0.66-0.69)	0.84 (0.82-0.86)	0.72 (0.70-0.74)	0.70 (0.68-0.72)	0.33 (0.32-0.35)	0.29 (0.27-0.30)	0.27 (0.26-0.28)	0.15 (0.14-0.16)	0.03 (0.03-0.04)	0.42 (0.40-0.43)	0.77 (0.75-0.79)	5,033.5	0.50 (0.48-0.52)
<1 year	1,128.9	1.03 (0.97-1.09)	0.53 (0.49-0.57)	2.50 (2.41-2.59)	1.92 (1.84-2.00)	1.71 (1.63-1.79)	0.73 (0.68-0.78)	0.07 (0.06-0.09)	0.32 (0.28-0.35)	0.21 (0.19-0.24)	0.10 (0.08-0.12)	0.71 (0.66-0.76)	0.09 (0.08-0.11)	938.8	0.11 (0.09-0.13)
1 to 3 years	1,916.6	0.99 (0.95-1.04)	0.72 (0.68-0.76)	0.61 (0.58-0.65)	0.71 (0.67-0.74)	0.38 (0.36-0.41)	0.32 (0.30-0.35)	0.14 (0.12-0.15)	0.13 (0.11-0.14)	0.12 (0.10-0.13)	0.03 (0.02-0.04)	0.36 (0.33-0.39)	0.22 (0.20-0.24)	1,547.9	0.25 (0.23-0.28)
3 to 5 years	1,478.9	0.95 (0.90-1.00)	0.78 (0.74-0.83)	0.46 (0.43-0.49)	0.44 (0.41-0.47)	0.44 (0.41-0.48)	0.24 (0.21-0.26)	0.21 (0.19-0.24)	0.19 (0.17-0.21)	0.11 (0.10-0.13)	0.02 (0.01-0.03)	0.38 (0.35-0.41)	0.72 (0.68-0.77)	1,128.9	0.59 (0.54-0.63)
5 to 7 years	1,082.6	1.16 (1.10-1.23)	0.82 (0.77-0.87)	0.44 (0.40-0.48)	0.37 (0.33-0.40)	0.54 (0.50-0.59)	0.24 (0.21-0.27)	0.32 (0.29-0.36)	0.24 (0.21-0.27)	0.14 (0.12-0.17)	0.02 (0.01-0.03)	0.40 (0.36-0.44)	1.31 (1.24-1.38)	755.7	0.81 (0.75-0.88)
7 to 10 years	1,009.9	1.53 (1.45-1.61)	0.62 (0.57-0.67)	0.55 (0.50-0.60)	0.38 (0.34-0.42)	0.65 (0.60-0.70)	0.24 (0.21-0.27)	0.54 (0.50-0.59)	0.34 (0.31-0.38)	0.16 (0.14-0.19)	0.01 (0.01-0.02)	0.38 (0.34-0.42)	1.55 (1.48-1.63)	570.2	1.05 (0.97-1.14)
10 to 13 years	447.6	2.26 (2.12-2.40)	0.37 (0.32-0.43)	0.61 (0.54-0.69)	0.41 (0.36-0.48)	0.91 (0.83-1.01)	0.20 (0.16-0.25)	0.85 (0.77-0.94)	0.68 (0.61-0.76)	0.22 (0.18-0.27)	0.01 (0.01-0.03)	0.26 (0.22-0.32)	1.70 (1.58-1.82)	92.0	1.76 (1.51-2.05)
13 to 15 years	95.2	2.65 (2.34-3.00)	0.38 (0.27-0.52)	0.72 (0.57-0.92)	0.47 (0.35-0.63)	0.72 (0.57-0.92)	0.22 (0.14-0.34)	1.11 (0.92-1.35)	1.20 (1.00-1.44)	0.35 (0.25-0.49)	0.01 (0.00-0.07)	0.28 (0.19-0.41)	1.50 (1.28-1.77)		
≥15 years*	16.4	3.34 (2.57-4.36)	0.36 (0.16-0.81)	0.55 (0.28-1.05)	0.24 (0.09-0.65)	1.03 (0.64-1.66)	0.30 (0.13-0.73)	1.16 (0.74-1.81)	1.34 (0.88-2.03)	0.36 (0.16-0.81)	0	0.12 (0.03-0.49)	0.97 (0.60-1.59)		

*Current maximum observed follow up is 16.75 years.
**Rates are likely to be underestimated: this reason was not solicited in the early phase of the registry (revision report forms MDSv1/MDSv2).
***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly gave this indication for revision as an option.
Note: Blank cells where there are no current data.

In Table 3.H10, the PTIRs for each indication are shown separately for different time periods from the primary hip replacement, within the first year, and between 1 to 3, 3 to 5, 5 to 7, 7 to 10, 10 to 13, 13 to 15 and ≥15 years after surgery (the maximum follow-up for any implant is now 16.75 years). Revision rates due to aseptic loosening are fairly constant until five years and then begin to steadily increase. Revision due to pain rises out to seven years and then declines. The rates due to subluxation / dislocation, infection and malalignment were all higher in the first year and then fell. In the case of periprosthetic fracture, the highest rates were seen in the first year, these then declined markedly before beginning to rise again around ten years. Adverse reaction to particulate debris increased with time, as did lysis, although the PTIRs for the latter were low.

Figures 3.H11 (a) to 3.H11 (g) (pages 92 to 95) show how PTIRs for aseptic loosening, pain, dislocation / subluxation, infection, lysis and adverse soft tissue reaction to particulate debris changed with time. Only sub-groups with a total overall prosthesis-years at risk of more than 150,000 have been included. With time from the operation, PTIRs for aseptic loosening tended to rise in cemented fixations and follow a fairly similar pattern in uncemented metal-on-polyethylene and metal-on-metal bearings. In uncemented ceramic-on-polyethylene, ceramic-on-ceramic, hybrid ceramic-on-ceramic and resurfacings, the PTIRs were reasonably consistent over time. In hybrid metal-on-polyethylene and ceramic-on-polyethylene bearings, there were marked increases at later time points. For pain, PTIRs were either fairly consistent or had a small initial peak followed by a decline to fairly constant rates for all bearings apart from uncemented metal-on-metal and resurfacings where rates started high, rose to peaks at five years and then declined again. Conversely, there was a high initial rate for dislocation / subluxation in all fixation / bearing groups which later fell but then began to rise again in all groups apart from cemented metal-on-polyethylene, uncemented metal-on-metal, hybrid ceramic-on-ceramic and resurfacing (Figure 3.H11 (c)). Revision rates for infection were initially high and then fell in all groups apart from uncemented metal-on-metal primary total hip replacement (Figure 3.H11 (d)). The opposite was seen for lysis with increasing rates over time in all groups (Figure 3.H11 (e)).

Revision rates due to an adverse reaction to particulate debris increased with time, up to seven years in uncemented metal-on-metal primary total hip replacement and resurfacings (Figures 3.H11 (f) and (g)). Confidence Intervals have not been shown here for simplicity but could be quite wide; these trends require more in-depth investigation.

Figure 3.H11 (a) PTIR estimates of aseptic loosening by fixation and bearing.

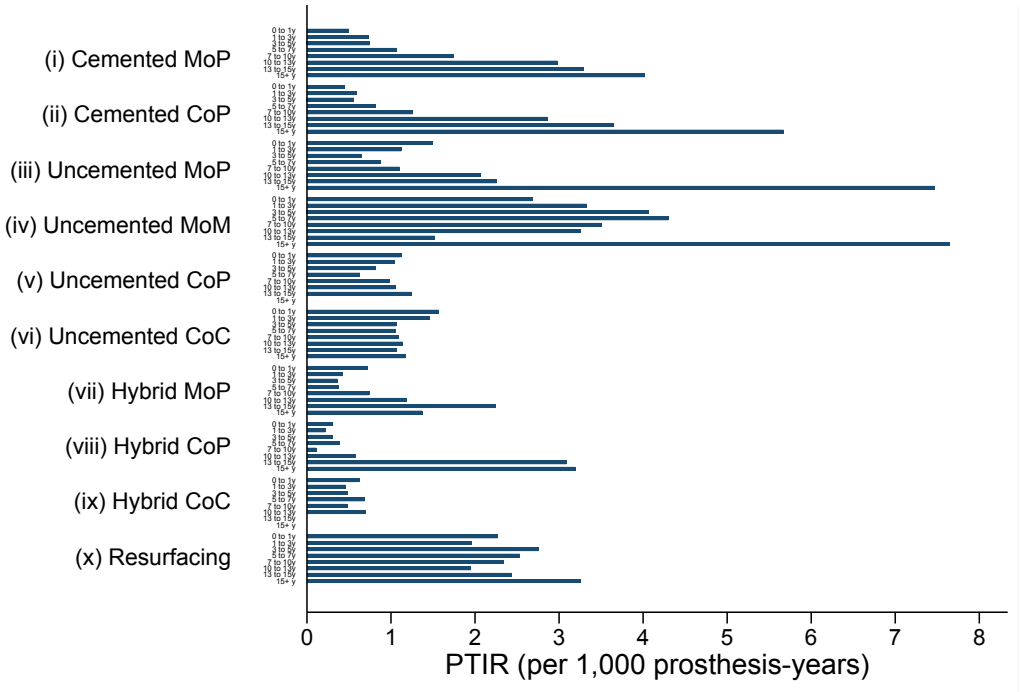


Figure 3.H11 (b) PTIR estimates of pain by fixation and bearing.

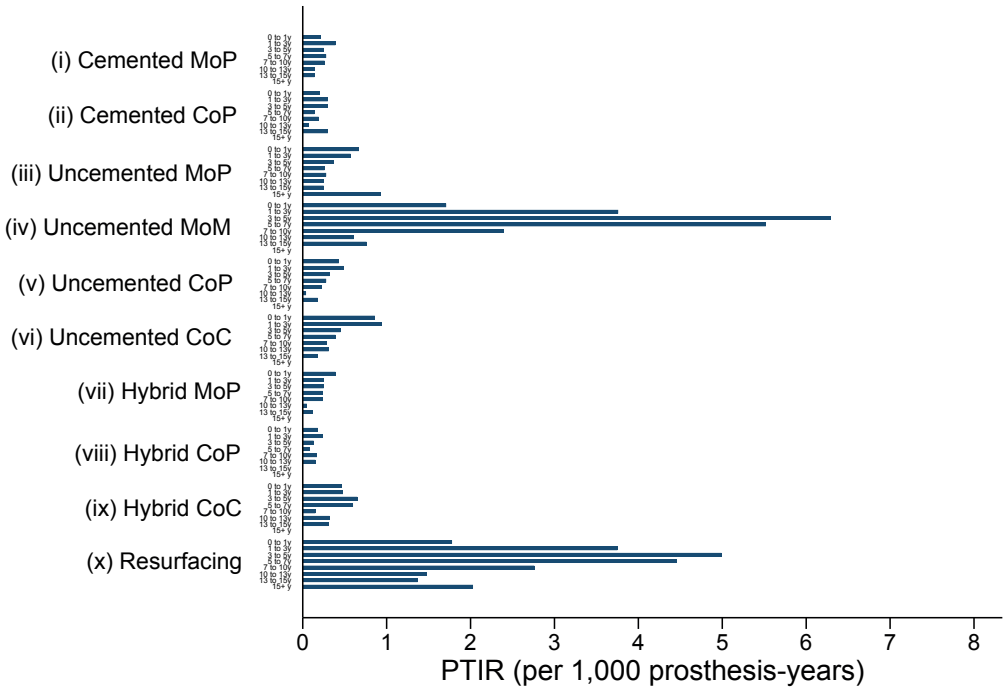


Figure 3.H11 (c) PTIR estimates of **dislocation** / **subluxation** by **fixation** and **bearing**.

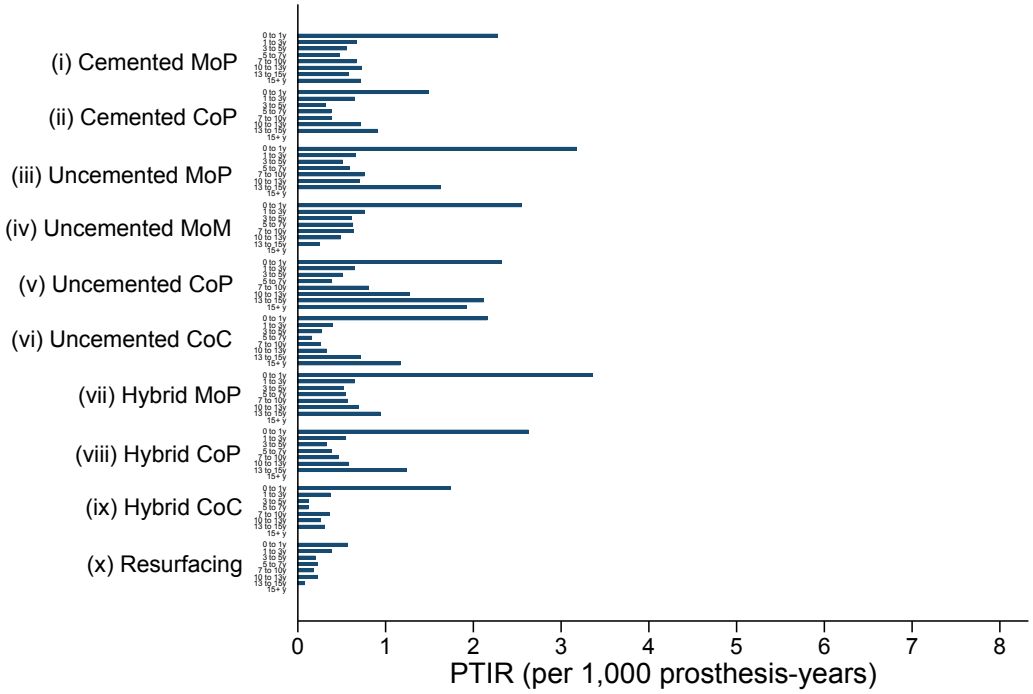


Figure 3.H11 (d) PTIR estimates of **infection** by **fixation** and **bearing**.

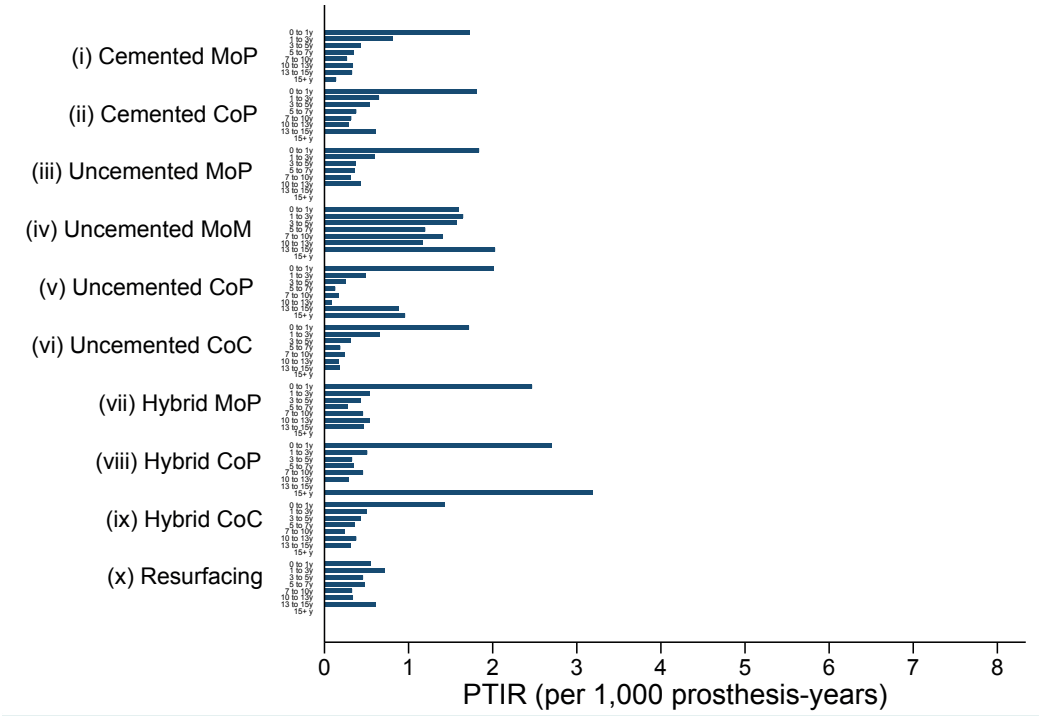


Figure 3.H11 (e) PTIR estimates of lysis by fixation and bearing.

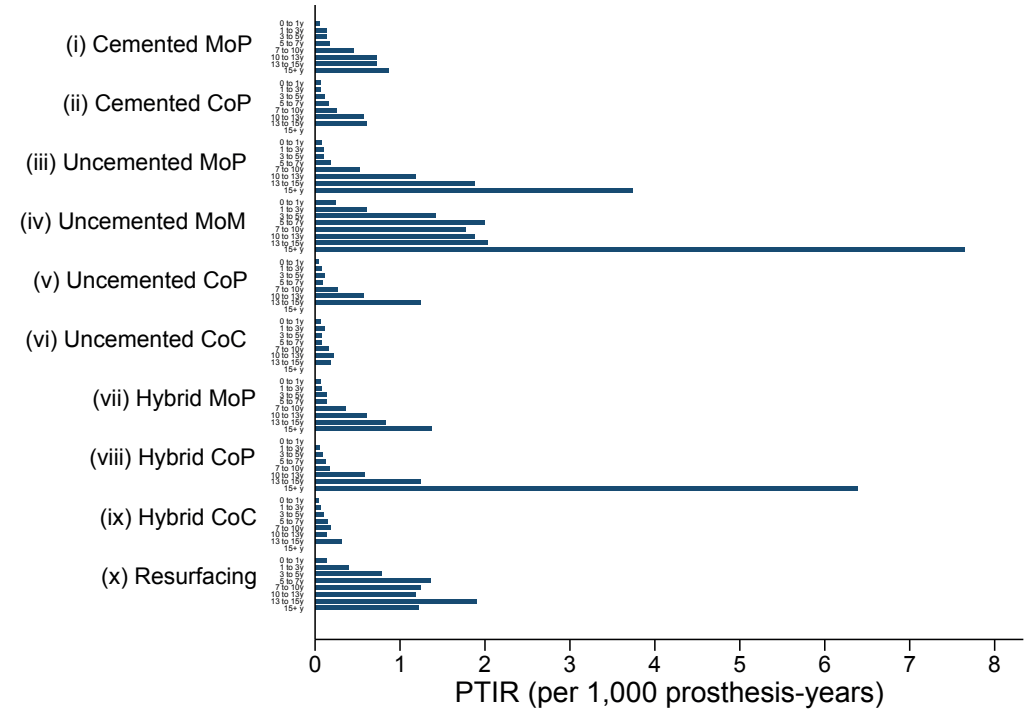


Figure 3.H11 (f) PTIR estimates of adverse soft tissue reaction by fixation and bearing.

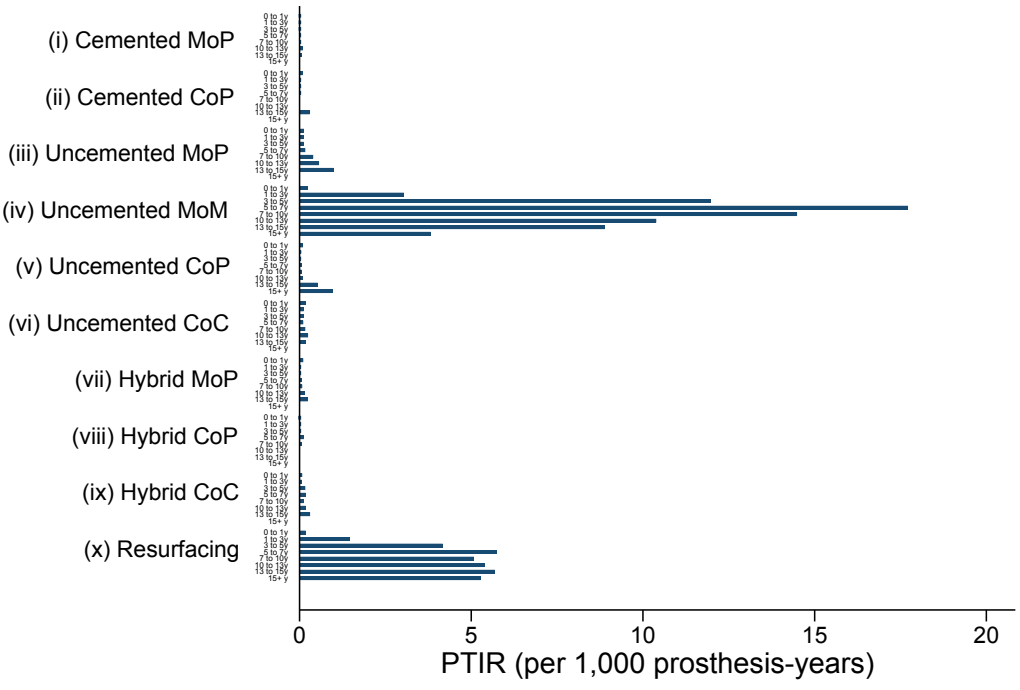
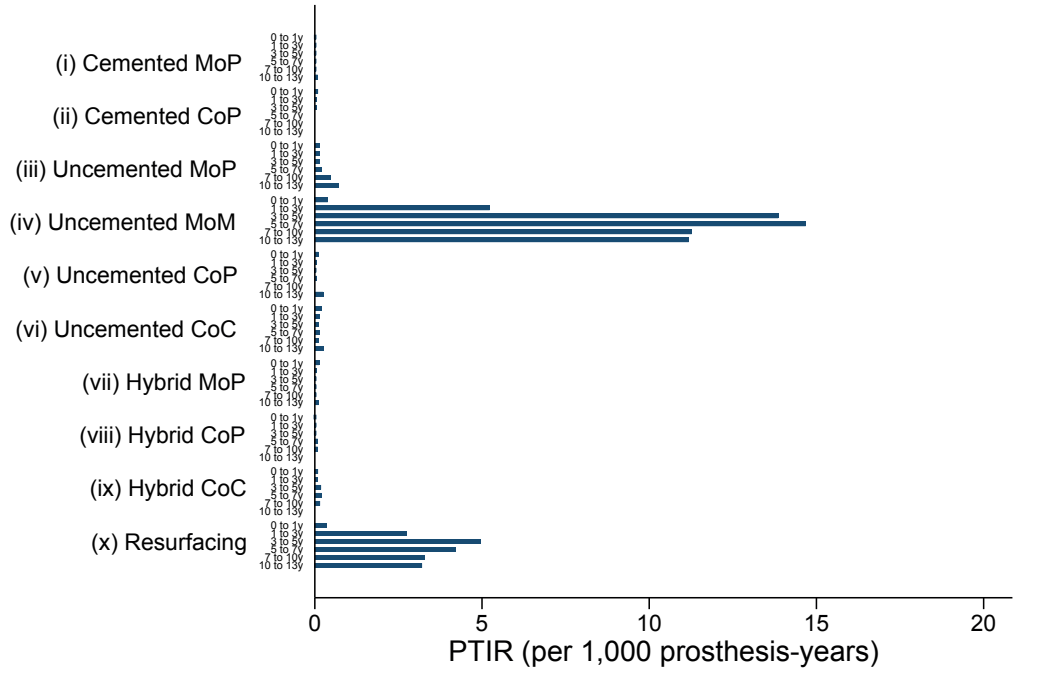


Figure 3.H11 (g) PTIR estimates of **adverse soft tissue reaction** by **fixation** and **bearing**, since 2008.



3.2.6 Mortality after primary hip replacement surgery

This section describes the mortality of the cohort up to 15 years from primary hip replacement, according to gender and age group. Deaths recorded after 31 December 2019 were not included in the analysis. For simplicity, it is not taken into account whether the patient had a first (or further) joint revision after the primary operation when calculating the cumulative probability of death. Whilst such surgery may have contributed to the overall mortality, the impact of this is not investigated in this report (see survival analysis methods note in section 3.1). Amongst the 1,191,253 primary hip replacements, there were 5,215 bilateral operations, with the left and right side operated on the same day; here the second of the two has been excluded, leaving 1,186,038 primary hip replacements, of whom 196,857 had died before the end of 2019.

Table 3.H11 KM estimates of cumulative **mortality** (95% CI) by **age** and **gender**, in primary hip replacement.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Age group (years)	N	Time since primary					
		30 days	90 days	1 year	5 years	10 years	15 years
All cases	1,186,038*	0.22 (0.21-0.22)	0.46 (0.45-0.47)	1.45 (1.43-1.47)	9.48 (9.42-9.54)	25.09 (24.97-25.20)	43.12 (42.89-43.35)
Males							
<55 years	70,237	0.08 (0.06-0.10)	0.16 (0.14-0.20)	0.53 (0.47-0.58)	2.27 (2.15-2.40)	5.15 (4.93-5.38)	9.61 (9.08-10.16)
55 to 59 years	48,462	0.06 (0.04-0.08)	0.20 (0.16-0.24)	0.61 (0.55-0.69)	3.31 (3.14-3.50)	8.69 (8.34-9.05)	16.48 (15.70-17.29)
60 to 64 years	67,981	0.11 (0.09-0.14)	0.24 (0.21-0.28)	0.83 (0.77-0.91)	4.74 (4.56-4.92)	12.23 (11.89-12.58)	24.20 (23.37-25.04)
65 to 69 years	81,255	0.16 (0.13-0.19)	0.35 (0.31-0.40)	1.10 (1.03-1.18)	6.80 (6.61-7.00)	18.77 (18.38-19.17)	37.89 (36.98-38.81)
70 to 74 years	83,054	0.20 (0.17-0.23)	0.43 (0.39-0.48)	1.57 (1.49-1.66)	10.40 (10.16-10.64)	28.91 (28.46-29.37)	55.71 (54.74-56.68)
75 to 79 years	67,585	0.39 (0.34-0.44)	0.75 (0.69-0.82)	2.48 (2.36-2.60)	16.51 (16.19-16.84)	45.93 (45.35-46.51)	76.97 (75.86-78.06)
80 to 84 years	39,883	0.75 (0.67-0.84)	1.42 (1.30-1.54)	4.06 (3.86-4.26)	26.55 (26.03-27.07)	66.23 (65.44-67.02)	*91.26 (90.20-92.24)*
≥85 years	17,180	1.66 (1.47-1.86)	2.94 (2.69-3.20)	7.67 (7.27-8.09)	43.26 (42.37-44.17)	85.58 (84.64-86.49)	*97.94 (97.11-98.58)*
Females							
<55 years	71,025	0.06 (0.04-0.08)	0.20 (0.17-0.24)	0.64 (0.59-0.71)	2.49 (2.37-2.63)	5.12 (4.90-5.34)	8.33 (7.86-8.82)
55 to 59 years	56,079	0.07 (0.05-0.09)	0.18 (0.15-0.22)	0.59 (0.52-0.65)	2.99 (2.83-3.15)	6.98 (6.69-7.28)	12.46 (11.84-13.11)
60 to 64 years	85,499	0.07 (0.05-0.09)	0.17 (0.15-0.20)	0.60 (0.55-0.65)	3.66 (3.52-3.81)	9.22 (8.95-9.50)	18.53 (17.86-19.22)
65 to 69 years	118,550	0.08 (0.06-0.10)	0.21 (0.19-0.24)	0.73 (0.69-0.79)	4.76 (4.63-4.90)	13.56 (13.27-13.85)	28.38 (27.68-29.09)
70 to 74 years	135,393	0.12 (0.10-0.13)	0.27 (0.24-0.29)	0.94 (0.89-1.00)	7.03 (6.87-7.19)	21.47 (21.14-21.80)	44.36 (43.59-45.13)
75 to 79 years	120,745	0.21 (0.19-0.24)	0.43 (0.40-0.47)	1.45 (1.38-1.52)	11.33 (11.13-11.54)	34.37 (33.96-34.78)	66.26 (65.42-67.09)
80 to 84 years	81,166	0.34 (0.30-0.38)	0.77 (0.71-0.83)	2.45 (2.34-2.56)	18.44 (18.13-18.76)	53.45 (52.91-53.99)	84.61 (83.79-85.41)
≥85 years	41,944	0.80 (0.72-0.89)	1.74 (1.61-1.87)	4.75 (4.55-4.97)	32.13 (31.60-32.66)	74.73 (74.05-75.40)	*95.39 (94.56-96.13)*

*Some patients had operations on the left and right side on the same day. The second of 5,215 pairs of simultaneous bilateral operations were excluded.

Table 3.H11 shows Kaplan-Meier estimates of cumulative percentage mortality at 30 days, 90 days and at 1, 5, 10 and 15 years from the primary hip replacement, for all cases and by age and gender. It is clear that younger patients had a lower risk of death. These differences were apparent at 30 days, with approximately half the risk of death for a male patient under the age of 55 compared to one aged 65 to 69 years. These differences persisted to one year and then diverged further with over three times the risk of death in the older group at 15 years. For a similar age group comparison, there was little initial difference for females but by ten years, there was twice the risk of death in the older group. It is worthy of note that for all cases in the NJR, there is almost a 10% risk of death by five years, over 25% by ten years and over 40% by 15 years after primary hip replacement.

3.2.7 Primary hip replacement for fractured neck of femur compared with other reasons for implantation

As total hip replacement is an increasingly utilised treatment option for fractured neck of femur, this section further updates results from last year's annual report on revision and mortality rates for primary total hip replacements performed as a result of fractured neck of femur compared to cases implanted for other indications. A total of 40,811 (3.4%) of the primary total hip replacements were performed for a fractured neck of femur (NOF)†.

Table 3.H12 shows that the proportion of primary hip replacements performed for an indication of fractured neck of femur has continued to increase with time to a maximum of 5.5% in 2018, up from 5.2% in 2017. The use of dual mobility bearings has become more popular in this group and accounted for 8.4% of cases in 2019.

†These comprised 2,227 cases with the indication for primary hip replacement including fractured neck of femur in the early phase of the registry (i.e. 201,208 implants entered using MDSv1 and v2) and 38,584 cases with indications including acute trauma neck of femur in the later phase (i.e. 990,045 entered using MDSv3, v6 and v7).

Table 3.H12 Number and percentage fractured NOF in the NJR by year.

Year of primary	N (Primary total hip replacements for all indications)	N (NOF) (%)	NOF treated with	
			Dual mobility, N(%)	Unipolar, N(%)
2003	14,471	139 (1.0)	0 (0.0)	139 (100.0)
2004	28,102	292 (1.0)	0 (0.0)	292 (100.0)
2005	40,663	390 (1.0)	0 (0.0)	390 (100.0)
2006	48,511	528 (1.1)	0 (0.0)	528 (100.0)
2007	60,898	780 (1.3)	0 (0.0)	780 (100.0)
2008	67,425	866 (1.3)	1 (0.1)	865 (99.9)
2009	68,577	1,083 (1.6)	11 (1.0)	1,072 (99.0)
2010	71,063	1,368 (1.9)	8 (0.6)	1,360 (99.4)
2011	74,042	1,718 (2.3)	19 (1.1)	1,699 (98.9)
2012	78,262	2,441 (3.1)	21 (0.9)	2,420 (99.1)
2013	80,425	3,123 (3.9)	73 (2.3)	3,050 (97.7)
2014	87,668	3,725 (4.2)	150 (4.0)	3,575 (96.0)
2015	89,819	4,203 (4.7)	188 (4.5)	4,015 (95.5)
2016	94,131	4,835 (5.1)	295 (6.1)	4,540 (93.9)
2017	95,909	4,947 (5.2)	320 (6.5)	4,627 (93.5)
2018	95,610	5,233 (5.5)	340 (6.5)	4,893 (93.5)
2019	95,677	5,140 (5.4)	431 (8.4)	4,709 (91.6)
Total	1,191,253	40,811 (3.4)	1,857 (4.6)	38,954 (95.4)

Table 3.H13 Fractured **NOF** vs. **OA only** by **gender**, **age** and **fixation**.

	Reason for primary hip replacement		
	Fractured neck of femur (n=40,811)	Osteoarthritis only (n=1,052,601)	Comparison
% Females	72.6%	59.2%	P<0.001 (Chi-squared test)
Median age (IQR)			
Both genders	73 (66 to 79)	70 (62 to 76)	P<0.001 (Mann-Whitney U-test)
Males only	72 (65 to 79)	68 (60 to 75)	P<0.001 (Mann-Whitney U-test)
Females only	73 (66 to 79)	71 (63 to 77)	P<0.001 (Mann-Whitney U-test)
% Hip type*			
All cemented	43.4	32.8	Overall P<0.001 (Chi-squared test)
All uncemented	20.3	39.1	
All hybrid	34.0	21.9	
All reverse hybrid	2.3	2.7	
All resurfacing	<0.1	3.5	

*Excludes 97,841 cases who had other reasons in addition to osteoarthritis.

Table 3.H13 compares the fractured neck of femur group with the remainder with respect to gender and age composition together and type of hip replacement received. A significantly larger percentage of the fractured neck of femur cases, compared with the remainder, were women (72.6% versus 59.2%: P<0.001, Chi-squared test).

The fractured neck of femur cases were significantly older (median age 73 years versus 70 years at operation: P<0.001 by Mann-Whitney U-test). Cemented and hybrid hips were used more commonly in fractured neck of femur cases than in hip replacements performed for other indications, but cemented fixation was still used in under half of the patients. Figure 3.H12 (a) shows that the cumulative revision rate was higher in the fractured neck of femur cases group compared with the remainder (P<0.001, logrank test). This effect was not fully explained by differences in age and gender, as stratification by these variables left the result unchanged (P<0.001 using stratified logrank test: 14 sub-groups of age <55, 55 to 59, 60 to 64, 65 to 69, 70 to 74, 75 to 79, ≥80 for each gender). Figure 3.H12 (b) (page 100) shows similar cumulative revision rates for dual mobility compared to unipolar total hip replacement bearings in the hip fracture population out to five years at which point the numbers fall below 250 in the dual mobility group. Whilst the difference here is not significant, it is interesting that this is a different pattern seen to dual mobility bearings in cemented and uncemented fixation groups in elective total hip replacement where the early revision rates appear higher in the dual mobility bearings.

Figure 3.H13 (page 101) shows a markedly worse overall mortality in the fractured neck of femur cases compared to cases implanted for other indications (P<0.001, logrank test). As in the overall mortality section, the second of 5,215 simultaneous bilateral procedures were excluded. Gender / age differences did not fully explain the difference seen as a stratified analysis still showed a difference (P<0.001) but the results warrant further exploration.

Figure 3.H12 (a) KM estimates of cumulative **revision** for **fractured NOF** and **OA only** cases for primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

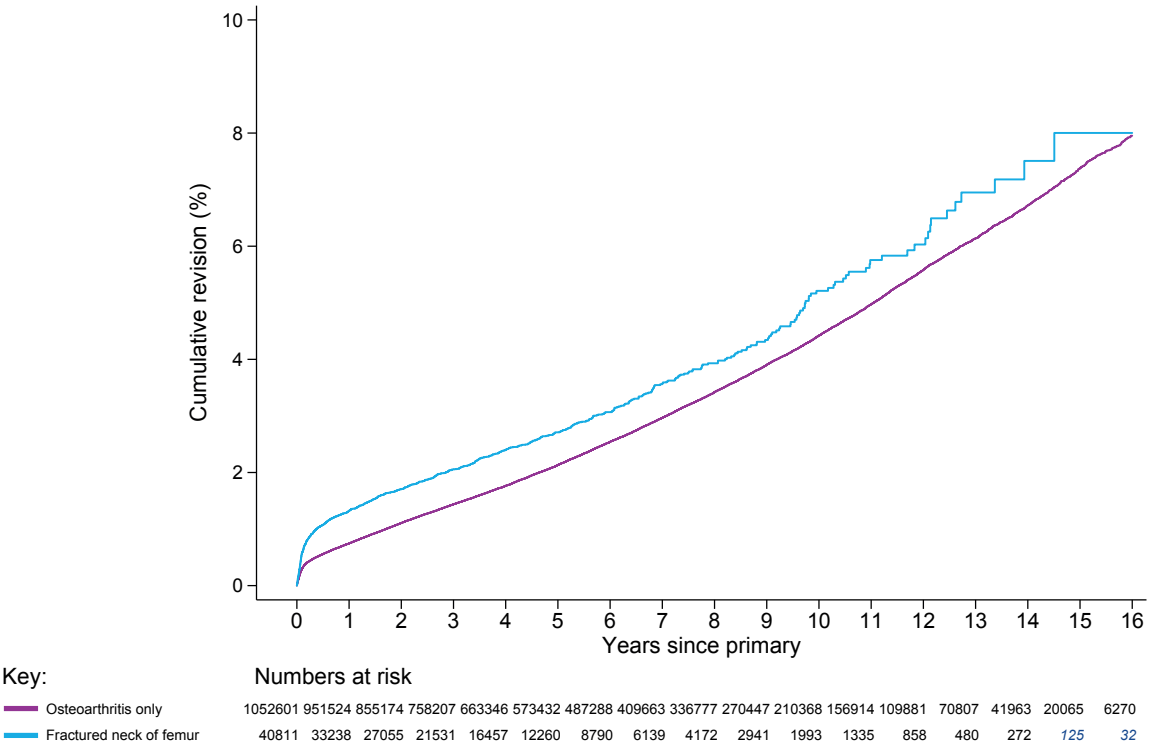
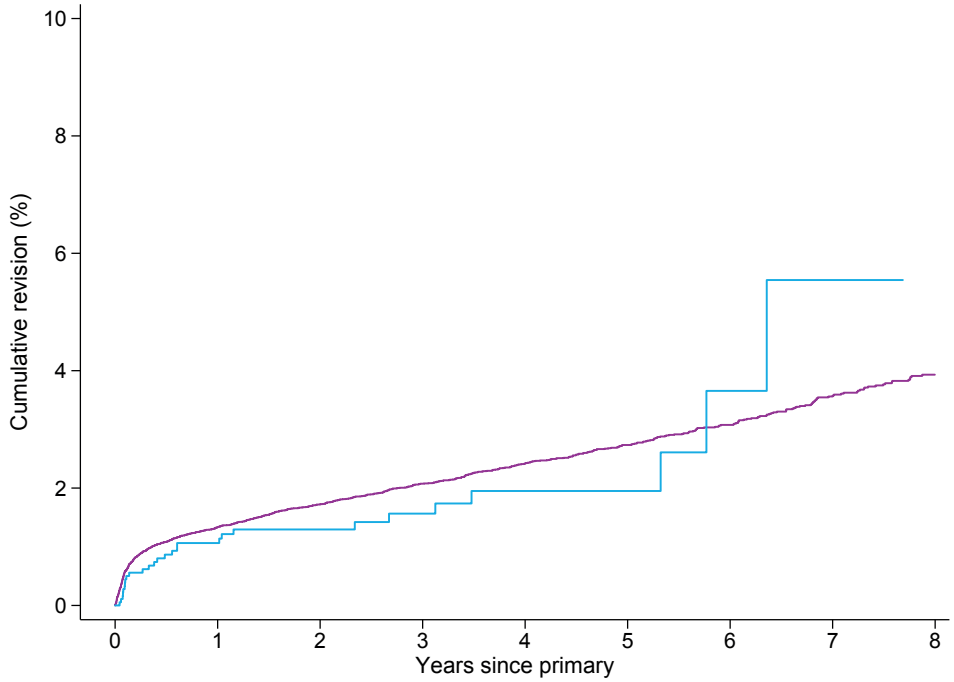
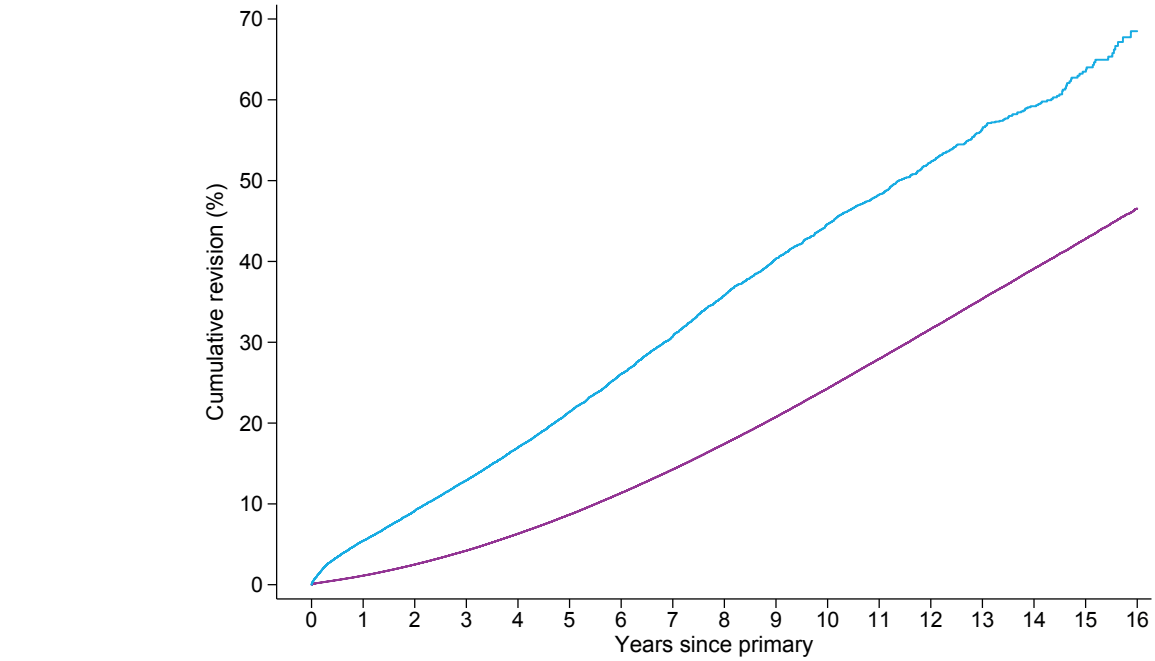


Figure 3.H12 (b) KM estimates of cumulative **revision** by **bearing** type for **fractured NOF** cases in primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
Unipolar bearings	38954	31932	26127	20933	16117	12073	8718	6113	4155
Dual mobility	1857	1306	928	598	340	*187*	*72*	*26*	*17*

Figure 3.H13 KM estimates of cumulative **mortality** for **fractured NOF** and **OA only** in primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



3.2.8 Overview of hip revision procedures

This section looks at all hip revision procedures performed since the start of the registry, 1 April 2003, up to 31 December 2019, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total, there were 123,891 revisions on 106,367 individual patient-sides (100,026 actual patients). In addition to the 34,978 first revised primary hip replacements described in section 3.2.2 of this report, there were 81,940 revision procedures for which no primary hip replacement had been recorded in the NJR.

Revisions are classified as single-stage, stage one and stage two of two-stage revisions. Information on stage one and stage two revisions are entered into the database separately, whereas in practice a stage two revision has to be linked to a preceding stage one revision. Although not all patients who undergo a stage one of two revision will undergo a stage two of two revision, in some cases stage one revisions have been entered without a stage two, and vice versa, making identification of individual revision episodes difficult. An attempt has been made to do this later in this section.

Table 3.H14 Number and percentage of hip revisions by procedure type and year.

Year of revision surgery	Type of revision procedure			All procedures
	Single-stage N(%)	Stage one of two-stage N(%)	Stage two of two-stage N(%)	
2003*	348 (24.4)	0 (0.0)	1,080 (75.6)	1,428
2004	1,965 (72.1)	118 (4.3)	642 (23.6)	2,725
2005	3,460 (87.3)	202 (5.1)	303 (7.6)	3,965
2006	4,199 (86.8)	269 (5.6)	371 (7.7)	4,839
2007	5,562 (87.5)	338 (5.3)	459 (7.2)	6,359
2008	6,035 (86.2)	419 (6.0)	550 (7.9)	7,004
2009	6,317 (84.3)	517 (6.9)	659 (8.8)	7,493
2010	7,046 (86.5)	501 (6.2)	598 (7.3)	8,145
2011	7,973 (87.5)	531 (5.8)	612 (6.7)	9,116
2012	9,249 (88.1)	604 (5.8)	650 (6.2)	10,503
2013	8,534 (87.8)	567 (5.8)	623 (6.4)	9,724
2014	8,408 (87.0)	666 (6.9)	592 (6.1)	9,666
2015	8,018 (86.0)	708 (7.6)	596 (6.4)	9,322
2016	7,701 (87.3)	583 (6.6)	538 (6.1)	8,822
2017	7,639 (87.3)	604 (6.9)	508 (5.8)	8,751
2018	7,226 (87.7)	547 (6.6)	466 (5.7)	8,239
2019	6,820 (87.5)	523 (6.7)	447 (5.7)	7,790
Total	106,500 (86.0)	7,697 (6.2)	9,694 (7.8)	123,891

*Incomplete year.
Note: Single-stages include DAIRs (Debridement And Implant Retention) and hip excision arthroplasty.

Table 3.H14 gives an overview of all hip replacement revision procedures carried out each year since April 2003. There were a maximum number of 11 documented revision procedures associated with any individual patient side (making up ten revision episodes as one episode consisted of a stage one of a two-stage procedure and a stage two of a two-stage procedure).

The incidence of revision hip replacement peaked in 2012 and has steadily declined since then, despite the increasing number of at-risk implants prevailing in the dataset.

Table 3.H15 (a) Number and percentage of hip revision by indication and procedure type.

Reason	Type of revision procedure		
	Single-stage N(%) (n=106,500)	Stage one of two-stage N(%) (n=7,697)	Stage two of two-stage N(%) (n=9,694)
Aseptic loosening	50,266 (47.2)	920 (12.0)	1,947 (20.1)
Pain	18,146 (17.0)	812 (10.5)	812 (8.4)
Dislocation / subluxation	17,319 (16.3)	309 (4.0)	457 (4.7)
Lysis	15,867 (14.9)	703 (9.1)	616 (6.4)
Implant wear	14,913 (14.0)	327 (4.2)	357 (3.7)
Periprosthetic fracture	12,244 (11.5)	298 (3.9)	418 (4.3)
Other indication	7,556 (7.1)	262 (3.4)	753 (7.8)
Malalignment	5,807 (5.5)	108 (1.4)	104 (1.1)
Infection	4,998 (4.7)	6,293 (81.8)	6,145 (63.4)
Implant fracture	3,853 (3.6)	79 (1.0)	149 (1.5)
Head-socket size mismatch	737 (0.7)	21 (0.3)	22 (0.2)
Adverse reaction to particulate debris*	9,838 (10.9) n=89,927	221 (3.3) n= 6,692	158 (2.3) n=6,772

*Not recorded in the early phase of the registry; MDSv3, v6 and v7 only.

Table 3.H15 (b) Number and percentage of hip revision by indication and procedure type in last five years.

Reason	Type of revision procedure		
	Single-stage N(%) (n=37,417)	Stage one of two-stage N(%) (n=2,965)	Stage two of two-stage N(%) (n=2,557)
Aseptic loosening	14,822 (39.6)	244 (8.2)	185 (7.2)
Dislocation / subluxation	6,788 (18.1)	117 (3.9)	81 (3.2)
Periprosthetic fracture	5,800 (15.5)	131 (4.4)	128 (5.0)
Implant wear	5,146 (13.8)	134 (4.5)	74 (2.9)
Lysis	4,849 (13.0)	227 (7.7)	108 (4.2)
Adverse reaction to particulate debris	4,369 (11.7)	106 (3.6)	71 (2.8)
Infection	2,623 (7.0)	2,532 (85.4)	2,022 (79.1)
Other indication	1,965 (5.3)	78 (2.6)	159 (6.2)
Pain	1,965 (5.3)	68 (2.3)	37 (1.4)
Malalignment	1,808 (4.8)	35 (1.2)	17 (0.7)
Implant fracture	1,429 (3.8)	21 (0.7)	18 (0.7)
Head-socket size mismatch	169 (0.5)	3 (0.1)	3 (0.1)

Table 3.H15 (a) shows the stated indication for the revision hip replacement surgery. Please note that, as several indications can be stated, the indications are not mutually exclusive and therefore column percentages may not add up to 100%. Aseptic loosening is the most common indication for revision.

Table 3.H15 (b) shows the stated indication for revision hip replacement surgery performed in the last five years (1,826 days). The most notable difference, between all the data and that recorded in the last five years is surgeons citing pain as an indication for revision, falling from 17.0% to 5.3% of single-stage revisions. The ratio of stage two of two-stage, stage one of two-stage and single-stage revisions overall (1:0.79:11.0) is different compared to those performed in the last five years (1:1.16:14.6).

3.2.9 Rates of hip re-revision

In most instances (90.2% of 106,367 individual patient-sides), the first revision procedure was a single-stage revision, however in the remaining 9.8% it was part of a two-stage procedure. For a given patient-side, survival following the first documented revision hip replacement procedure for those with a linked primary in the NJR (n=34,978) has been analysed. This analysis is restricted to patients with a linked primary procedure so that there is confidence that the next observed procedure on the same joint is the first revision episode. If there is no linked primary record in the dataset, it cannot be determined if the first observed revision is the first revision or if it has been preceded by other revision episodes. The time from the first documented revision procedure (of any type) to the time at which a second revision episode was undertaken has been determined. For this purpose, an initial stage one followed by either a stage one or a stage two have been considered to be the same revision episode and these were disregarded, looking instead for the start of a second revision episode. (The maximum number of distinct revision episodes for any patient-side was determined to be ten).

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were calculated. There were 3,916 re-revisions and, for 4,737 cases, the patient died without having been re-revised. The censoring date for the remainder was the end of 2019.

Figure 3.H14 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision between 1 and 15 years since the primary operation.

Figure 3.H14 (a) KM estimates of cumulative **re-revision** in linked primary hip replacements (shaded area indicates point-wise 95% CI). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

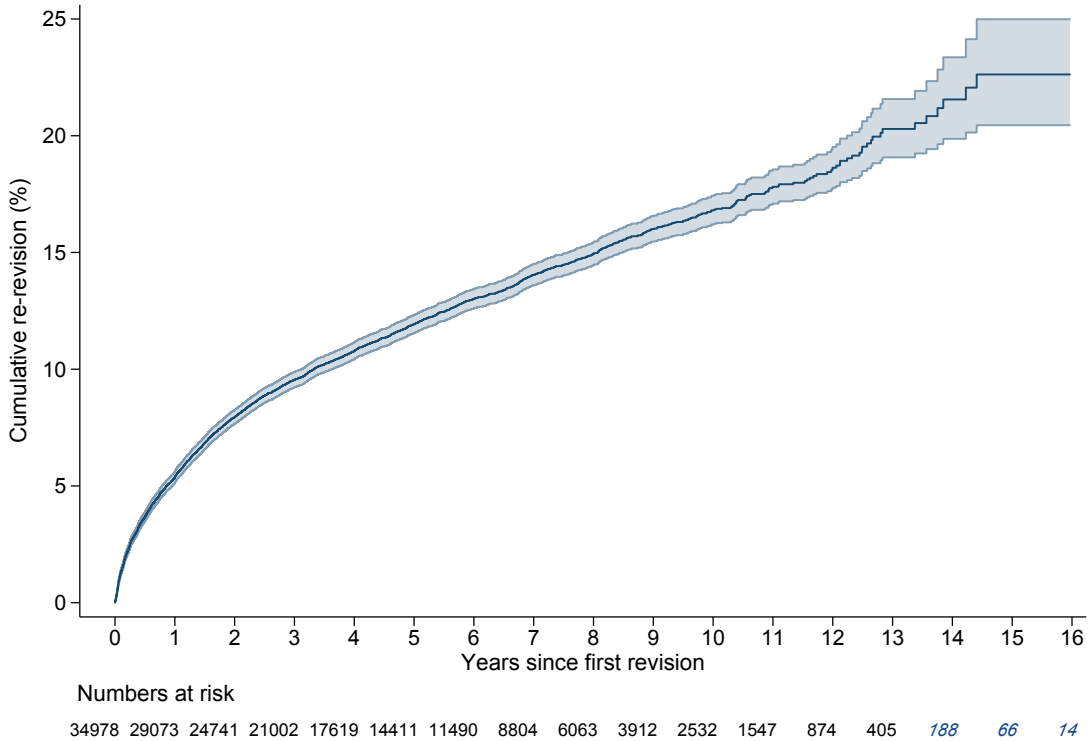
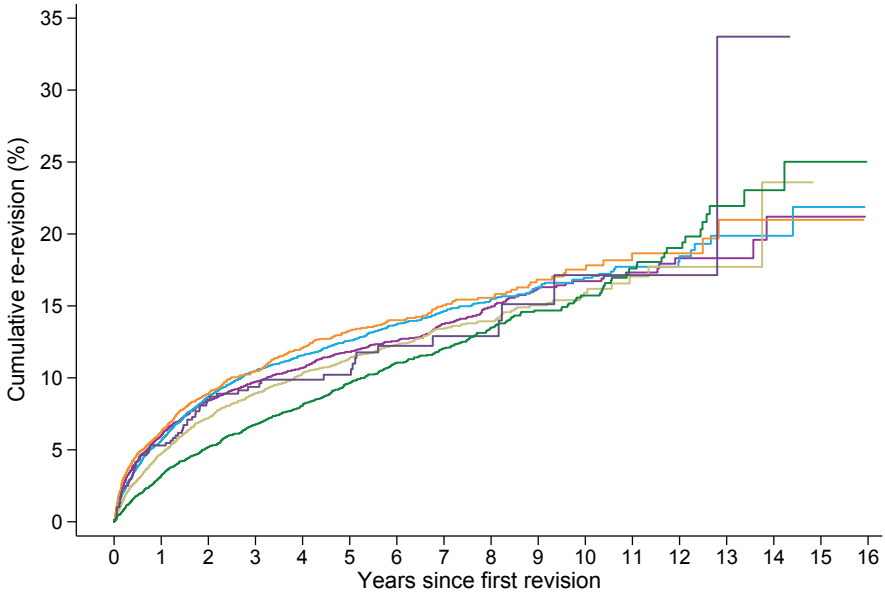


Figure 3.H14 (b) KM estimates of cumulative **re-revision** by **primary fixation** in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

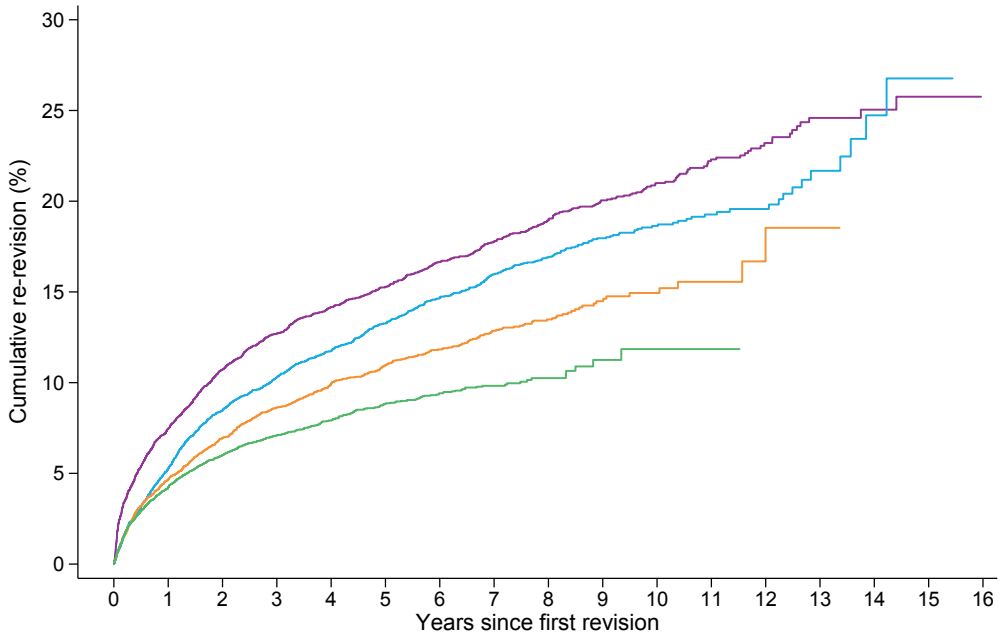
Numbers at risk

Cemented	7928	6240	5093	4133	3342	2623	2020	1546	1090	739	508	336	*202*	*97*	*40*	*18*	*2*
Uncemented without MoM	10109	8313	6963	5788	4786	3761	2885	2183	1512	1036	669	398	*219*	*112*	*54*	*17*	*4*
Uncemented MoM	5288	4733	4269	3851	3384	2906	2388	1750	1071	548	314	*164*	*72*	*22*	*10*	*1*	*1*
Hybrid	5055	3959	3189	2555	1993	1533	1162	893	642	435	277	*168*	*106*	*55*	*26*	*11*	*3*
Reverse hybrid	698	563	446	367	293	*233*	*173*	*120*	*86*	*54*	*30*	*13*	*7*	*2*	*1*	*0*	*0*
Resurfacing	4375	4015	3671	3335	2992	2661	2287	1851	1311	866	573	373	*211*	*94*	*46*	*12*	*4*

Figure 3.H14 (b) shows estimates of re-revision by type of primary hip replacement. Resurfacing has the lowest re-revision rate until approximately seven years after which the revision rate appears to be worse than that associated with alternatives. However, after ten years the numbers at risk are low and should therefore be interpreted with caution.

Figure 3.H14 (c) shows the relationship between time to first revision and the risk of subsequent revision. The earlier the primary hip replacement is revised, the higher the risk of a second revision. There is a relationship between the indication for first revision and time to first revision; earlier in this report (section 3.2.5) it is shown, for example, that revisions for dislocation / subluxation and pain were more prevalent in the early period after the primary hip replacement and aseptic loosening and pain later on. The relationship between (i) the time to first revision and the subsequent time to re-revision, and (ii) the indication for the first revision and the time to re-revision requires further investigation.

Figure 3.H14 (c) KM estimates of cumulative **re-revision** by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

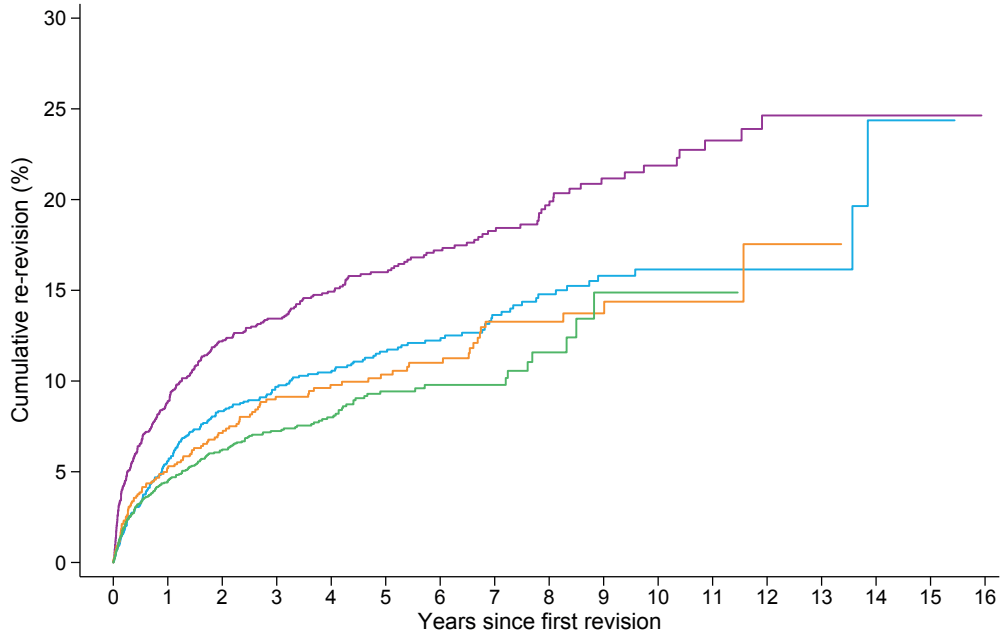


Key:

Numbers at risk

First rev. <1y	9400	7719	6583	5605	4742	3933	3209	2657	2098	1585	1189	807	503	275	*140*	*61*	*14*
First rev. 1 to 3y	6924	6007	5306	4681	4146	3569	3066	2588	2052	1461	955	602	327	*128*	*48*	*5*	*0*
First rev. 3 to 5y	5365	4690	4231	3796	3417	3016	2602	2016	1287	650	329	*133*	*44*	*2*	*0*	*0*	*0*
First rev. ≥5y	13289	10657	8621	6920	5314	3893	2613	1543	626	*216*	*59*	*5*	*0*	*0*	*0*	*0*	*0*

Figure 3.H15 (a) KM estimates of cumulative **re-revision** in **cemented** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



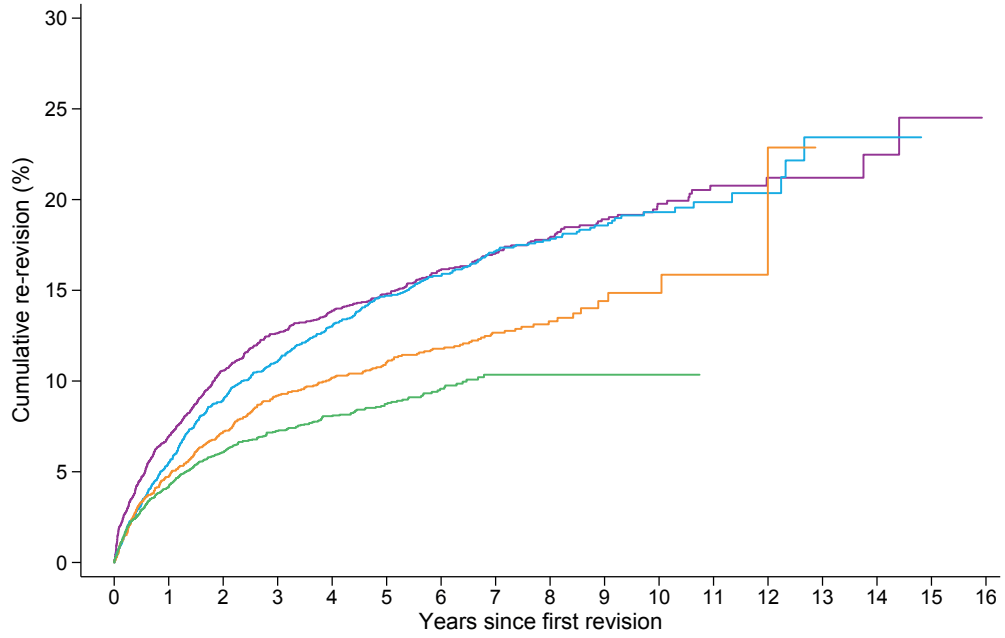
Key:

Numbers at risk

First rev. <1y	2054	1625	1352	1129	926	763	611	488	365	261	*199*	*141*	*97*	*58*	*27*	*13*	*2*
First rev. 1 to 3y	1708	1442	1244	1075	934	771	629	514	391	291	*210*	*152*	*88*	*37*	*13*	*5*	*0*
First rev. 3 to 5y	1097	886	756	624	533	439	358	277	*204*	*134*	*80*	*41*	*17*	*2*	*0*	*0*	*0*
First rev. ≥5y	3069	2288	1742	1305	949	650	422	267	*130*	*53*	*19*	*2*	*0*	*0*	*0*	*0*	*0*

For those with a documented primary hip replacement within the NJR, Figures 3.H15 (a) to (e) show cumulative re-revision rates following the first revision hip replacement, according to the main fixation used in the primary. Each sub-group has been further sub-divided according to the time interval from the primary hip replacement to the first revision, i.e. less than 1 year, 1 to 3, 3 to 5 and more than 5 years. For cemented, uncemented, hybrid, reverse hybrid and resurfacing hip replacements, those who had their first revision within one year, or between one and three years of the initial primary hip replacement, experienced the worst re-revision rates.

Figure 3.H15 (b) KM estimates of cumulative **re-revision** in **uncemented** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

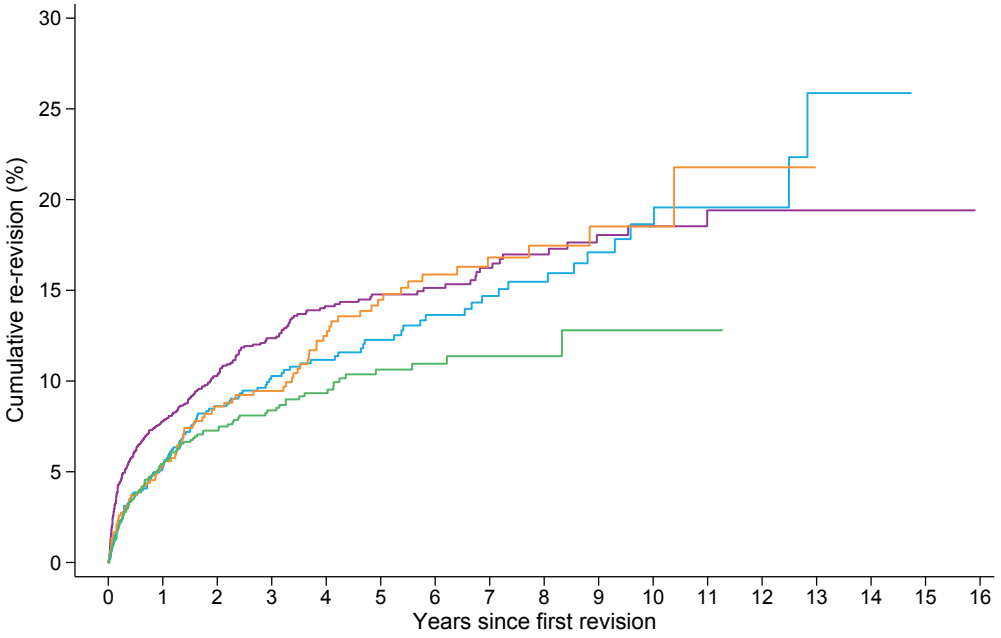


Key:

Numbers at risk

First rev. <1y	4206	3555	3072	2667	2304	1915	1545	1268	969	707	511	322	*177*	*93*	*50*	*18*	*5*
First rev. 1 to 3y	3089	2716	2441	2177	1936	1667	1439	1193	928	636	375	*205*	*103*	*41*	*14*	*0*	*0*
First rev. 3 to 5y	2466	2197	2005	1811	1647	1455	1254	930	513	*200*	*90*	*35*	*11*	*0*	*0*	*0*	*0*
First rev. ≥5y	5636	4581	3719	2985	2282	1630	1035	541	*173*	*42*	*7*	*0*	*0*	*0*	*0*	*0*	*0*

Figure 3.H15 (c) KM estimates of cumulative **re-revision** in **hybrid** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

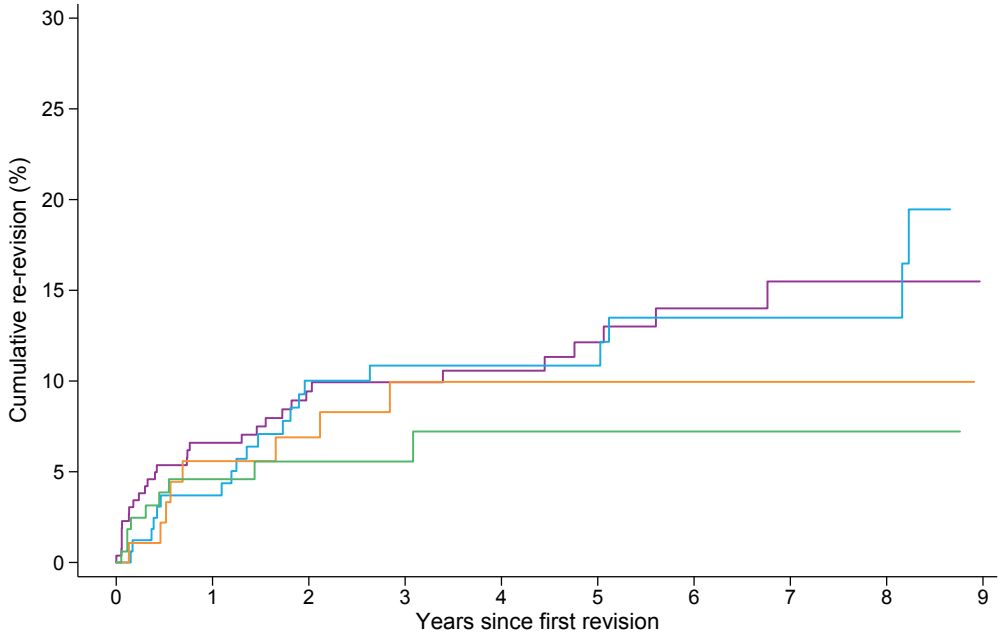


Key:

Numbers at risk

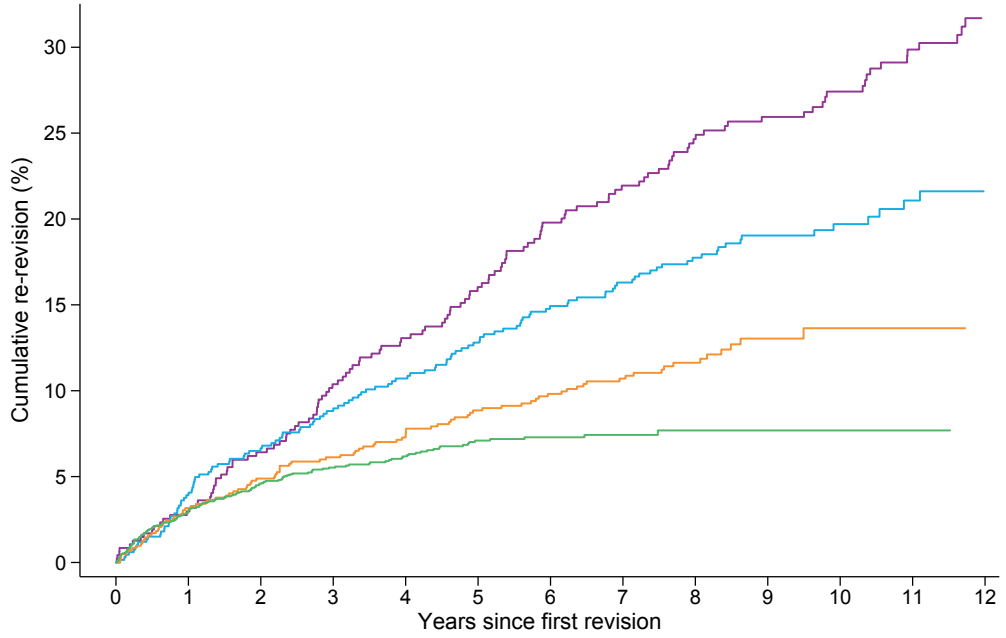
First rev. <1y	1997	1538	1250	984	763	574	438	349	272	*197*	*139*	*92*	*60*	*36*	*19*	*11*	*3*
First rev. 1 to 3y	1019	826	672	547	444	357	283	*231*	*181*	*128*	*88*	*59*	*40*	*19*	*7*	*0*	*0*
First rev. 3 to 5y	666	538	449	387	327	272	*211*	*160*	*118*	*73*	*41*	*15*	*6*	*0*	*0*	*0*	*0*
First rev. ≥5y	1373	1055	816	636	458	331	*230*	*154*	*71*	*37*	*9*	*2*	*0*	*0*	*0*	*0*	*0*

Figure 3.H15 (d) KM estimates of cumulative **re-revision** in **reverse hybrid** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
First rev. <1y	264	*220*	*181*	*153*	*123*	*102*	*79*	*52*	*40*	*27*
First rev. 1 to 3y	*169*	*146*	*120*	*100*	*85*	*68*	*53*	*43*	*29*	*20*
First rev. 3 to 5y	*97*	*82*	*68*	*53*	*42*	*33*	*21*	*14*	*10*	*5*
First rev. ≥5y	*168*	*115*	*77*	*61*	*43*	*29*	*20*	*11*	*7*	*2*

Figure 3.H15 (e) KM estimates of cumulative **re-revision** in **resurfacing** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

First rev. <1y	472	454	431	404	386	361	339	324	300	273	*233*	*185*	*127*
First rev. 1 to 3y	668	637	608	583	562	536	515	481	422	316	*224*	*153*	*75*
First rev. 3 to 5y	824	792	771	751	713	678	638	545	382	*210*	*100*	*34*	*9*
First rev. ≥5y	2411	2132	1861	1596	1331	1086	796	501	*207*	*67*	*16*	*1*	*0*

Table 3.H16 (a) shows the re-revision rate of the 34,978 primary hip replacements registered in the NJR that were revised. Of these, 3,916 were re-revised. Table 3.H16 (b) shows that primary hip replacements that fail within the first year after surgery have approximately twice the chance of needing re-revision at each time point compared with primaries that last more than five years.

Table 3.H16 (a) KM estimates of cumulative **re-revision** (95% CI).
Blue italics signify that fewer than 250 cases remained at risk at these time points.

	Number of first revised joints at risk of re-revision	Time since first revision					
		1 year	3 years	5 years	10 years	13 years	15 years
Primary recorded in the NJR	34,978	5.39 (5.15-5.64)	9.54 (9.22-9.88)	11.92 (11.54-12.32)	16.80 (16.19-17.42)	20.29 (19.07-21.57)	*22.62 (20.45-24.99)*

Table 3.H16 (b) KM estimates of cumulative **re-revision** (95% CI) by **years since first failure**.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Primary in the NJR where the first revision took place:	Number of first revised joints at risk of re-revision	Time since first revision				
		1 year	3 years	5 years	7 years	10 years
<1 year after primary	9,400	7.46 (6.93-8.02)	12.72 (12.02-13.45)	15.25 (14.46-16.08)	17.76 (16.85-18.71)	21.00 (19.87-22.18)
1 to 3 years after primary	6,924	5.32 (4.81-5.89)	10.29 (9.56-11.07)	13.29 (12.44-14.19)	16.00 (15.02-17.03)	18.63 (17.47-19.86)
3 to 5 years after primary	5,365	4.69 (4.15-5.30)	8.60 (7.85-9.42)	10.95 (10.08-11.90)	12.86 (11.87-13.91)	14.94 (13.67-16.31)
≥5 years after primary	13,289	4.22 (3.88-4.59)	7.10 (6.63-7.59)	8.84 (8.28-9.45)	9.83 (9.17-10.53)	*11.85 (10.25-13.69)*

Note: Maximum interval was 16.6 years.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.
Note: Data has not been presented for 13 and 15 years due to low numbers.

Table 3.H16 (c) KM estimates of cumulative **re-revision** (95% CI) by **fixation** and **bearing**.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation	Bearing surface	n	Time since first revision				
			1 year	3 years	5 years	7 years	10 years
All	**All**	**34,978**	**5.39 (5.15-5.64)**	**9.54 (9.22-9.88)**	**11.92 (11.54-12.32)**	**14.04 (13.60-14.50)**	**16.80 (16.19-17.42)**
All cemented	**All**	**7,928**	**6.02 (5.50-6.59)**	**9.73 (9.04-10.47)**	**11.80 (11.00-12.67)**	**13.75 (12.78-14.79)**	**16.72 (15.38-18.17)**
	MoP	7,122	5.99 (5.44-6.58)	9.49 (8.77-10.26)	11.42 (10.59-12.32)	13.43 (12.42-14.51)	16.32 (14.93-17.83)
	CoP	731	6.11 (4.53-8.21)	12.33 (9.86-15.35)	*15.42 (12.47-18.99)*	*16.69 (13.51-20.54)*	*20.87 (16.17-26.70)*
All uncemented	**All**	**15,397**	**5.33 (4.98-5.70)**	**9.91 (9.42-10.43)**	**12.16 (11.59-12.75)**	**14.22 (13.57-14.91)**	**16.59 (15.70-17.53)**
	MoP	4,364	5.45 (4.80-6.19)	10.26 (9.32-11.29)	11.84 (10.79-12.98)	14.47 (13.17-15.89)	16.49 (14.78-18.37)
	MoM	5,288	4.70 (4.16-5.32)	8.92 (8.16-9.76)	11.36 (10.47-12.31)	13.41 (12.40-14.50)	15.91 (14.45-17.51)
	CoP	1,920	6.08 (5.07-7.28)	11.43 (9.96-13.12)	13.48 (11.78-15.41)	14.65 (12.76-16.80)	*16.73 (14.24-19.60)*
	CoC	3,620	5.58 (4.87-6.40)	10.05 (9.05-11.15)	12.55 (11.39-13.82)	14.42 (13.09-15.87)	17.07 (15.30-19.03)
All hybrid	**All**	**5,055**	**6.29 (5.63-7.02)**	**10.48 (9.59-11.45)**	**13.30 (12.22-14.47)**	**15.04 (13.78-16.41)**	**17.53 (15.82-19.40)**
	MoP	2,972	6.70 (5.83-7.69)	10.25 (9.12-11.50)	12.82 (11.46-14.32)	14.09 (12.56-15.79)	*16.00 (14.04-18.20)*
	MoM	411	4.32 (2.70-6.85)	10.76 (8.00-14.40)	*14.20 (10.92-18.36)*	*16.60 (12.89-21.24)*	*20.94 (15.66-27.68)*
	CoP	1,010	6.00 (4.64-7.73)	10.09 (8.13-12.48)	*14.58 (11.70-18.10)*	*16.08 (12.68-20.28)*	*16.08 (12.68-20.28)*
	CoC	607	5.60 (4.01-7.79)	10.89 (8.53-13.87)	*12.62 (9.98-15.90)*	*15.62 (12.29-19.74)*	*19.95 (15.01-26.24)*
All reverse hybrid	**All**	**698**	**5.30 (3.84-7.31)**	**9.38 (7.27-12.05)**	*10.22 (7.96-13.07)*	*12.90 (9.98-16.60)*	*17.14 (12.14-23.91)*
	MoP	459	5.56 (3.76-8.19)	*9.42 (6.89-12.82)*	*10.35 (7.60-14.02)*	*13.99 (10.14-19.14)*	*18.72 (12.20-28.13)*
All resurfacing	**All**	**4,375**	**3.18 (2.70-3.75)**	**6.75 (6.02-7.57)**	**9.65 (8.75-10.64)**	**12.05 (11.00-13.20)**	**15.73 (14.29-17.30)**
Unclassified	**All**	**1,525**	**6.32 (5.18-7.69)**	**9.82 (8.35-11.54)**	**12.45 (10.73-14.43)**	**15.31 (13.27-17.63)**	*17.20 (14.79-19.94)*

Note: Maximum interval was 16.6 years.
Note: Data has not been presented for 13 and 15 years due to low numbers.

Table 3.H16 (c) shows cumulative re-revision rates at 1, 3, 5, 7 and 10 years following the first revision for those with documented primary hip replacements within the NJR, broken down by fixation types and bearing surfaces.

The failure rates for resurfacings were comparatively low, but Figure 3.H14 (b) (page 105) shows that after ten years the failure rate of re-revisions following resurfacing is becoming higher than alternatives.

3.2.10 Reasons for hip re-revision

Tables 3.H17 (a) and (b) show a breakdown of the stated indications for the first revision and for any second revision (note the indications are not mutually exclusive). Table 3.H17 (a) shows the indications for recorded revisions in the NJR and Table 3.H17 (b) reports the indications for the first linked revision and the number and percentage of first linked revisions that were subsequently revised. The final column in Table 3.H17 (b) reports the indications for all the second linked revisions e.g. 828 linked second revisions recorded aseptic loosening as an indication. It is interesting to note that both dislocation and infection are much more common indications for a second revision than first revision. This shows the increased risk of instability and infection following the first revision of a hip replacement compared to that of primary hip replacement.

Table 3.H17 (a) Number of revisions by indication for all revisions.

Reason for revision	All recorded revisions (%)
Aseptic loosening	53,133 (42.9)
Pain	19,770 (16.0)
Dislocation / subluxation	18,085 (14.6)
Infection	17,436 (14.1)
Lysis	17,186 (13.9)
Implant wear	15,597 (12.6)
Periprosthetic fracture	12,960 (10.5)
Malalignment	6,019 (4.9)
Implant fracture	4,081 (3.3)
Head/socket size mismatch	780 (0.6)
Other indication	8,571 (6.9)
Adverse reaction to particulate debris*	10,217 (8.2)

*Adverse reaction to particulate debris was only recorded using MDSv3 onwards and as such was only a potential reason for revision among a total of 103,391 revisions as opposed to 123,891 revisions for the other reasons.

Table 3.H17 (b) Number of revisions by indication for first linked revision and second linked re-revision.

Reason for revision	First linked revision		Second linked revision
	N	Subsequently re-revised, N(%)	N
Aseptic loosening	8,579	807 (9.4)	828
Dislocation / subluxation	6,050	696 (11.5)	975
Infection	5,178	916 (17.7)	1,205
Periprosthetic fracture	5,053	522 (10.3)	314
Pain	4,848	590 (12.2)	402
Malalignment	2,402	216 (9.0)	194
Lysis	2,050	165 (8.0)	156
Implant wear	1,924	173 (9.0)	178
Implant fracture	1,087	109 (10.0)	106
Head/socket size mismatch	235	35 (14.9)	15
Other indication	3,005	393 (13.1)	271
Adverse reaction to particulate debris*	2,461	230 (9.3)	110

*Adverse reaction to particulate debris was only recorded using MDSv3 onwards and as such was only a potential reason for revision among a total of 21,964 revisions as opposed to 34,978 revisions for the other reasons.

Tables 3.H18 (a) and (b) show that the numbers of revisions and the relative proportion of revisions with a linked primary in the NJR increased with time. Approximately 50% of revisions performed in 2019 had a linked primary in the NJR. This is likely to reflect improved data capture over time, improved linkability of records and the longevity of hip replacements with a proportion of primaries being revised being performed before NJR data capture began or outside the coverage of the NJR.

Table 3.H18 (a) Number of revisions by year.

Year of first revision in the NJR*	Number of first revisions*	Number of first revisions (%) with the associated primary recorded in the NJR
2003	1,405	43 (3.1)
2004	2,635	142 (5.4)
2005	3,749	304 (8.1)
2006	4,481	461 (10.3)
2007	5,857	812 (13.9)
2008	6,305	1,154 (18.3)
2009	6,557	1,511 (23.0)
2010	7,071	1,948 (27.5)
2011	7,941	2,653 (33.4)
2012	9,026	3,336 (37.0)
2013	8,224	3,042 (37.0)
2014	8,083	3,089 (38.2)
2015	7,654	3,227 (42.2)
2016	7,249	3,211 (44.3)
2017	7,128	3,306 (46.4)
2018	6,707	3,394 (50.6)
2019	6,295	3,345 (53.1)
Total	106,367	34,978 (32.9)

*First documented revision in the NJR.

Table 3.H18 (b) Number of revisions by year, stage, and whether or not primary is in the NJR.

Year of first revision in the NJR*	Single-stage		First documented stage of two-stage	
	Primary not in the NJR	Primary in the NJR	Primary not in the NJR	Primary in the NJR
2003	326	15	1,036	28
2004	1,821	105	672	37
2005	3,117	249	328	55
2006	3,645	373	375	88
2007	4,602	684	443	128
2008	4,681	952	470	202
2009	4,570	1,249	476	262
2010	4,711	1,717	412	231
2011	4,896	2,385	392	268
2012	5,312	3,010	378	326
2013	4,867	2,743	315	299
2014	4,645	2,795	349	294
2015	4,120	2,903	307	324
2016	3,801	2,925	237	286
2017	3,581	3,033	241	273
2018	3,088	3,144	225	250
2019	2,777	3,084	173	261
Total	64,560	31,366	6,829	3,612

*First documented revision in the NJR.

3.2.11 90-day mortality after hip revision

The overall cumulative percentage mortality at 90 days after hip revision was lower in the cases with a primary hip replacement recorded in the NJR compared with the remainder (Kaplan-Meier estimates 1.34 (95% CI 1.22-1.46) versus 1.83 (1.73-1.93)), which may reflect the fact that this patient group were younger at the time of their first revision, median age of 69 (IQR 61 to 77) years compared to the group without primaries documented in the NJR who had a median age of 74 (IQR 66 to 80) years. The percentage of males was similar in both groups (44.2% versus 42.5% respectively).

3.2.12 Conclusions

As in previous annual reports, implants have been analysed by revision of the construct, rather than revision of a single component, as the mechanisms of failure (such as wear, adverse reaction to particulate debris and dislocation) are interdependent between different parts of the construct. Revision analyses have also been stratified by age and gender. The highest failure rates are among young women and the lowest among older women. When data on metal-on-metal is excluded, young women have similar revision rates to young men. Once again, it must be emphasised that implant survivorship is only one measure of success and cannot be used as an indication of satisfaction, relief of pain, improvement in function and greater participation in society. The data clearly show that constructs fail at different rates depending on the age and gender of the recipients.

Overall, the number of primary hip replacements recorded annually in the NJR continues to increase with 1,307,375 now recorded, of which 1,191,253 were available for analysis.

Since 2003 the types of implants utilised have changed dramatically and these changes continue. Between 2003 and 2007 cemented fixation was the most common, followed by uncemented fixation. Between 2008 and 2016 uncemented fixation was the most common followed by cemented fixation, with hybrid fixation increasing steadily since 2012.

For the first time, in 2019, hybrid fixation (34.7%) was as common as uncemented fixation (34.9%). Since 2011, the use of ceramic-on-ceramic bearings has declined whilst the use of ceramic-on-polyethylene bearings has increased at roughly the same rate, with ceramic-on-polyethylene bearings now being the second most commonly chosen bearing after metal-on-polyethylene. It is now possible to report on dual mobility; this is used in different bearing combinations and the numbers this year allow us to report on metal-on-polyethylene-on-metal and ceramic-on-polyethylene-on-metal within some sub-groups. Their use does seem to be increasing. Given that the proposed benefits of dual mobility bearings include reduced risk of early revision due to dislocation, perhaps at an increased risk of long term wear, it is interesting to note that for elective indications, there appears to be a higher risk of early revision. The numbers are not yet sufficient to comment on longer term risks or in the sub-groups described. It is possible that this is a case mix selection effect and annual reports will continue to report on these patterns, particularly if adoption continues to increase. A different pattern is observed when dual mobility is used for patients with a fractured neck of femur without this early higher rate of revision.

Since the 12th Annual Report in 2015, data has been presented by age and gender comparing combinations of fixation and bearing. This assists clinicians and patients in choosing classes of prostheses that are the most appropriate for particular types of patients. For example, in males under 55 years of age, at ten years post-surgery, hybrid ceramic-on-polyethylene and ceramic-on-ceramic constructs have revision rates of less than 4%, whilst cemented metal-on-polyethylene constructs have revision rates of 6.19% (95% CI 4.95-7.73) and uncemented ceramic-on-ceramic bearings 4.60% (95% CI 4.22-5.01). Resurfacings in this group have higher revision rates than all other options other than uncemented metal-on-metal stemmed hip replacements and these rates are twice that of established alternatives. In contrast, in women under 55 years, cemented ceramic-on-polyethylene constructs give excellent results with a 4.25% (95% CI 3.32-5.42) revision rate at ten years. However, cemented metal-on-polyethylene has a higher revision rate, whilst results for uncemented constructs with metal-on-polyethylene, ceramic-on-polyethylene and ceramic-on-ceramic bearings are not statistically different from those achieved by cemented ceramic-on-polyethylene. Again, resurfacing fares poorly in this group with ten-year revision rates six times higher than the best performing option, typically four to five times higher than most other options and only better than uncemented metal-on-metal stemmed hip replacements. For patients over 75 years old, all combinations except those with metal-on-metal bearings have good outcomes, with cemented and hybrid ceramic-on-polyethylene possibly having the lowest failure rates.

Both male and female patients aged over 75 years have a less than 6% risk of revision at 15 years. The 15-year mortality rate in men aged 75 to 79 years is 76.97% (95% CI 75.86-78.06) and in women aged 75 to 79 years is 66.26% (95% CI 65.42-67.09). This clearly shows that in older patients the vast majority

of treatment strategies will last the rest of the patients' lives. Even in those aged 65 to 69 years at the time of surgery, 62% of males and 72% of females are still alive 15 years later.

The outcomes of different head sizes (bearing diameters) with alternative fixation and bearing types have been examined and these results are interesting. With metal-on-polyethylene and ceramic-on-polyethylene, large head sizes appear to be associated with higher failure rates particularly with 36mm heads used with cemented fixation and heads >36mm used with hybrid and uncemented fixation. Ceramic-on-ceramic bearings have lower failure rates with larger bearings as predicted by Alison Smith's flexible parametric survival models published in the Lancet in 2012 (Smith et al., 2012).

With regard to specific branded stem / cup combinations, some of the best implant survivorships are still achieved by mix and match cemented hard-on-soft bearing constructs, although this practice remains contrary to MHRA and manufacturers' guidelines for usage.

It is encouraging that the most commonly used constructs by brand in cemented and hybrid fixation have good results. This does not hold true for uncemented fixation, but further breakdown by bearing type for commonly used uncemented implants shows that results are acceptable if metal-on-metal bearings are excluded.

Metal-on-metal stemmed and resurfacing implants continue to fail at higher than expected rates and their use is now extremely rare. The best performing brand of resurfacing has a failure rate of 9.64% (95% CI 9.20-10.10) at 13 years. The use of metal-on-metal bearings has undoubtedly led to a large excess of revisions which would not have occurred if alternate bearings had been used. This has been modelled and published in the Journal of Bone and Joint Surgery. For every 100 MoM hip-resurfacing procedures, it is estimated that there would be 7.8 excess revisions by ten years, and similarly for every 100 stemmed MoM THR procedures that there would be 15.9, which equates to 8,021 excess first revisions (Hunt et al., 2018).

It is striking to note the high rates of revision for adverse soft tissue reaction to particulate debris in patients who have received metal-on-metal bearings. Analysis of stemmed metal-on-metal bearings by head size shows that 28mm heads have the best survivorship, but this is still poor compared to alternatives.

Revision rates by year of surgery for the entire cohort increased dramatically from 2003 to 2008 and then declined until 2013. This matches the use of resurfacing arthroplasty and stemmed metal-on-metal with the peak usage of these devices in 2008 corresponding with the highest failure rates by year of primary surgery. This demonstrates the profoundly negative effect metal-on-metal has had on hip replacement outcomes. However, as this temporal trend with a lesser magnitude is also present after knee replacement, it is likely that other factors also contribute to the decline in revision rates. For example, the decline coincides with the commencement of clinician feedback.

Consistent with results from previous years' reports, similar revision rates were observed for total hip replacement performed as a result of fractured neck of femur and those done for other causes. As expected, mortality rates were higher for the fractured neck of femur group.

The number of revision total hip replacements recorded in the NJR increased to a peak of 10,504 in 2012 and since then has declined steadily to 8,240 in 2018 and 7,791 in 2019. Please note that there may be a small number of late registrations for 2019 and thus the figure for this year may be revised upward slightly in the next annual report. Aseptic loosening is the most common reason for revision, accounting for nearly half of all cases, followed by pain and instability.

Risk of re-revision rate is strongly associated with time to first revision; 12.69% (95% CI 11.99-13.44) of hips revised within a year of primary surgery are re-revised within three years. In contrast, when the primary lasts at least five years the re-revision rate is 7.10% (95% CI 6.63-7.60). Re-revision rates up to seven years appear to be independent of the fixation and bearing of the primary hip replacement.

Smith AJ, Dieppe P, Vernon K, Porter M, Blom AW; National Joint Registry of England and Wales. Failure rates of stemmed metal-on-metal hip replacements: analysis of data from the National Joint Registry of England and Wales. Lancet. 2012 Mar 31;379(9822):1199-204.

Hunt LP, Whitehouse MR, Beswick A, Porter ML, Howard P, Blom AW; Implications of Introducing New Technology: Comparative Survivorship Modelling of Metal-on-Metal Hip Replacements and Contemporary Alternatives in the National Joint Registry. J Bone Joint Surg Am. 2018 Feb 7;100(3):189-196.

3.3 Outcomes after knee replacement

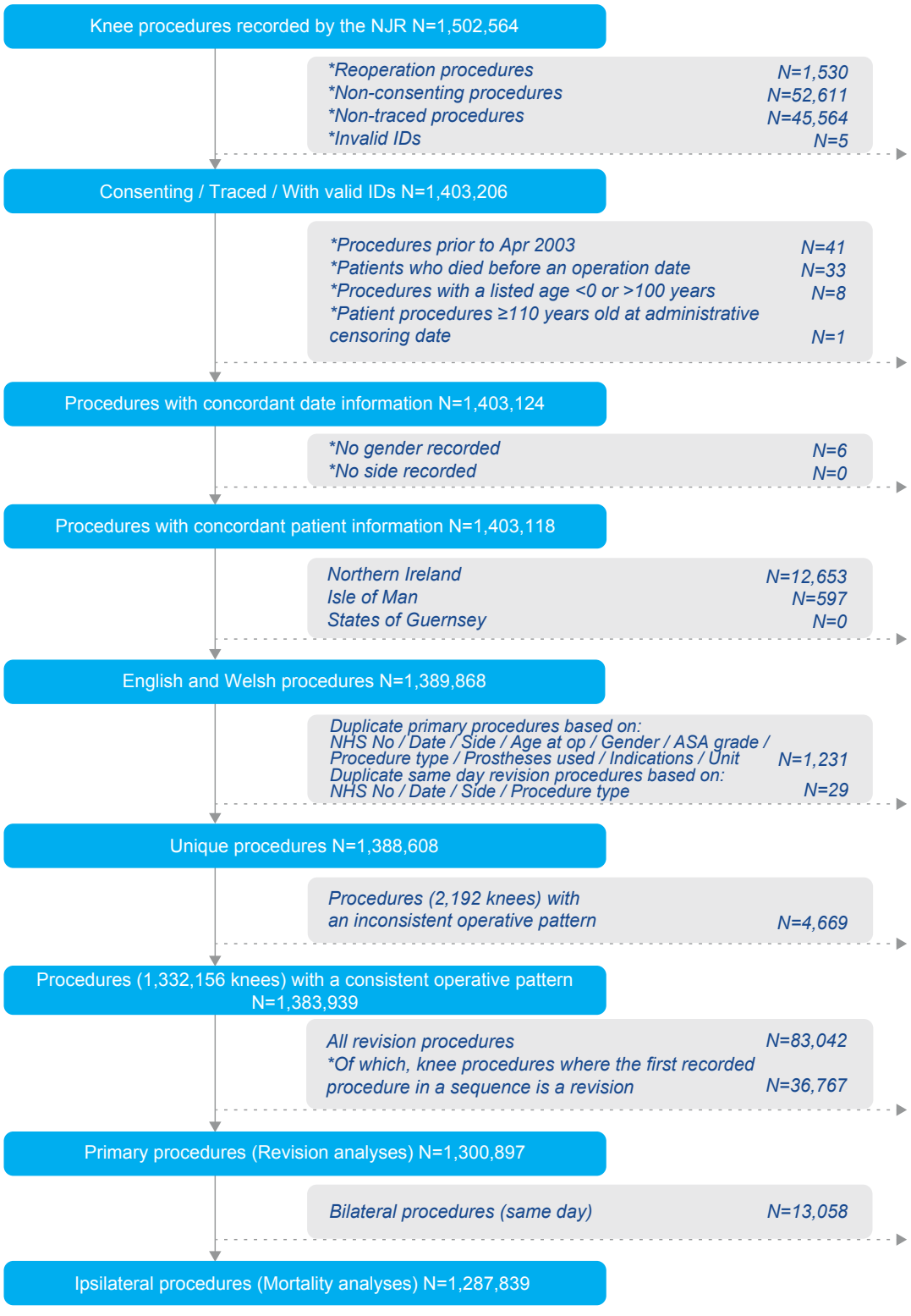
3.3.1 Overview of primary knee replacement surgery

This section looks at revision and mortality outcomes for all primary knee operations performed between 1 April 2003 and 31 December 2019 (inclusive). Patients operated on at the beginning of the registry therefore had a potential 16.75 years of follow-up.

The outcomes of total and partial knee replacement procedures are discussed throughout this section, hereafter referred to as total (TKR) and unicompartmental (UKR) knee replacement. Brief details of the type of orthopaedic surgery involved for each form of replacement can be found in section 3.1. Of special note here, is that the NJR data collection process now distinguishes between medial and lateral unicondylar replacements, although this was not the case in the past. This distinction is available for cases reported on the MDS version 7 forms but not previous versions. Cases are therefore not reported separately in this year's report, but work is ongoing to determine if this distinction can be defined from data entered in previous versions of the MDS with the introduction of the new component database. If this is possible, it will be reported in future annual reports. The term multicompartmental knee replacement has been introduced to refer to instances when more than one unicompartmental construct is implanted simultaneously.

Figure 3.K1 (page 122) describes the data cleaning applied to produce the total of 1,300,897 primary knee procedures included in the analyses presented in this section.

Figure 3.K1 Knee cohort flow diagram.



Over the lifetime of the registry, the 1,300,897 primary knee joint replacement procedures contributing to our revision analyses were carried out by a total of 3,386 unique consultant surgeons working across 466 units.

Over the last three years (1 January 2017 to 31 December 2019), 312,167 primary knee procedures (representing 24.0% of the current registry) were performed by 1,929 consultant surgeons working across 403 units. Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 121 (IQR 40 to 232) and the median number of procedures per unit was 671 (IQR 329 to 1,032). A proportion of consultants will have commenced independent practice during this period, some may have retired, and some surgeons may have periods of inactivity within the coverage of the NJR, therefore their apparent caseload would be lower.

Over this three-year period, there have been 273,364 primary total knee replacements performed by 1,914 surgeons (median=109 cases per surgeon; IQR 39 to 200) in 403 separate units (median=671 cases per unit; IQR 329 to 1,032). In the same time period, there have been 33,676 primary unicondylar knee procedures performed by 808 consultant surgeons (median=21 cases per surgeon; IQR 5 to 53) in 368 units (median=49 cases per unit; IQR 19 to 110).

The majority of primary knee replacements were carried out on women (females 56.6%; males 43.4%). The median age at primary operation was 70 years (IQR 63 to 76) and the overall range was 7 to 100 years, see Table 3.K3 (page 128) and commentary later for discussion of age at primary by type of knee replacement. Osteoarthritis was given as a documented indication for surgery in 1,267,054 procedures (97.4% of the cohort) and was the sole indication given in 1,256,129 (96.6%) primary knee procedures.

Data in this section is presented at 1, 3, 5, 10, 13 and 15 years. Although data is available out to 16.75 years, a 16-year column would predominantly present small numbers with wide confidence intervals around estimates so has not been included.

Table 3.K1 (page 124) shows the breakdown of cases by type of knee replacement, the method of fixation, constraint and bearing used. A breakdown within each method of fixation of the percentage of constraint and bearing types used is shown in a separate column. Cemented TKR is the most commonly performed type of knee replacement (83.7% of all primary knee replacements). A further 4.2% were either all uncemented or hybrid TKRs. Most unicompartmental knee replacements were unicondylar (9.1% of the total) with the remainder being patellofemoral (1.2%).

More than half of all operations (57.5%) were TKRs which were all cemented and unconstrained (cruciate retaining) with a fixed bearing, followed by 20.0% which were all cemented and posterior stabilised with a fixed bearing. Within each method of fixation, it can be seen that uncemented and hybrid prostheses are mostly unconstrained but almost equally likely to have a mobile or fixed bearing. Approximately two-thirds (68.6%) of cemented TKRs are unconstrained and have a fixed bearing. Unicondylar knee surgery typically involves the use of a mobile bearing (62.5%). A number of primary knee replacements could not be classified according to their bearing / constraint (approximately 1.7% of the total cohort).

Table 3.K1 Number and percentage of primary knee replacements by fixation, constraint and bearing.

Type of primary knee operation		Number of primary knee operations	Percentage of each constraint type used within each method of fixation	Percentage of all primary knee operations
Fixation method	Constraint and bearing type			
All types		1,300,897		100.0
Total knee replacement				
All cemented		1,089,478		83.7
Cemented and	unconstrained, fixed	747,669	68.6	57.5
	unconstrained, mobile	39,220	3.6	3.0
	posterior-stabilised, fixed	260,493	23.9	20.0
	posterior-stabilised, mobile	12,659	1.2	1.0
	constrained condylar	9,824	0.9	0.8
	monobloc polyethylene tibia	17,680	1.6	1.4
	pre-assembled/hinged/linked	1,933	0.2	0.1
All uncemented		45,908		3.5
Uncemented and	unconstrained, fixed	17,554	38.2	1.3
	unconstrained, mobile	24,702	53.8	1.9
	posterior-stabilised, fixed	3,366	7.3	0.3
	other constraints	286	0.6	<0.1
All hybrid		9,664		0.7
Hybrid and	unconstrained, fixed	6,403	66.3	0.5
	unconstrained, mobile	2,121	21.9	0.2
	posterior-stabilised, fixed	734	7.6	0.1
	other constraints	406	4.2	<0.1
Unicompartmental knee replacement				
All unicondylar, cemented		91,861		7.1
Cemented and	fixed	36,677	39.9	2.8
	mobile	49,004	53.3	3.8
	monobloc polyethylene tibia	6,180	6.7	0.5
All unicondylar, uncemented/hybrid		26,455		2.0
Uncemented/hybrid and	fixed	1,135	4.3	0.1
	mobile	24,921	94.2	1.9
	monobloc polyethylene tibia	399	1.5	<0.1
Patellofemoral		15,083		1.2
Multicompartmental		572		<0.1
Unclassified		21,876		1.7

Table 3.K2 Percentage of primary knee replacements by fixation, constraint, bearing and calendar year.

Fixation/bearing/ constraint	2004 n=41,588	2005 n=42,514	2006 n=50,343	2007 n=67,028	2008 n=74,448	2009 n=76,605	2010 n=79,196	2011 n=82,788	2012 n=86,663	2013 n=86,396	2014 n=96,202	2015 n=100,051	2016 n=104,908	2017 n=106,574	2018 n=101,976	2019 n=103,617
Total knee replacement																
All cemented	**78.5**	**79.3**	**78.8**	**78.9**	**79.3**	**80.2**	**81.6**	**83.2**	**85.7**	**86.8**	**86.7**	**86.7**	**86.4**	**86.0**	**85.3**	**84.9**
Cemented and																
unconstrained, fixed	52.2	52.0	49.9	49.8	50.7	52.2	53.5	55.9	58.8	59.4	60.5	61.5	62.1	61.6	61.2	61.6
unconstrained, mobile	4.1	5.5	6.5	6.4	5.6	4.7	4.0	2.9	2.4	2.1	1.9	1.7	1.7	1.6	1.6	1.5
posterior-stabilised, fixed	20.3	19.4	19.6	19.8	20.4	20.8	21.2	21.1	20.8	20.9	20.2	19.8	19.4	19.6	19.1	18.5
posterior-stabilised, mobile	1.0	1.6	1.8	1.6	1.4	1.4	1.4	1.2	1.1	1.2	1.0	0.8	0.6	0.4	0.3	0.3
constrained condylar	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.5	0.8	1.0	1.2	1.0	1.1	1.3	1.4
monobloc polyethylene tibia	0.2	0.3	0.6	0.9	0.8	0.7	1.0	1.6	2.0	2.1	1.9	1.5	1.5	1.6	1.6	1.4
pre-assembled/hinged/ linked	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.2
All uncemented	**6.3**	**5.9**	**6.3**	**6.3**	**6.0**	**5.5**	**4.6**	**4.0**	**3.2**	**2.5**	**2.5**	**2.3**	**2.0**	**2.0**	**1.8**	**1.8**
Uncemented and																
unconstrained, fixed	2.4	2.2	2.4	2.8	2.6	2.5	1.7	1.4	1.0	0.7	0.6	0.7	0.8	0.8	0.8	0.9
unconstrained, mobile	3.3	3.3	3.4	3.2	3.1	2.6	2.6	2.4	2.0	1.6	1.6	1.4	1.1	1.0	0.8	0.7
posterior-stabilised, fixed	0.6	0.5	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.1
other constraints	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
All hybrid	**2.7**	**2.4**	**1.7**	**1.4**	**1.3**	**1.2**	**0.9**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.2**	**0.3**	**0.3**
Hybrid and																
unconstrained, fixed	2.3	1.9	1.2	1.0	1.1	0.9	0.7	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
unconstrained, mobile	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.1	0.1	0.1
posterior-stabilised, fixed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1
other constraints	<0.1	0.2	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note: Data from 2003 has been included in 2004 since 2003 was not a complete year.

Table 3.K2 (continued)

Fixation/bearing/ constraint	2004 n=41,588	2005 n=42,514	2006 n=50,343	2007 n=67,028	2008 n=74,448	2009 n=76,605	2010 n=79,196	2011 n=82,788	2012 n=86,663	2013 n=86,396	2014 n=96,202	2015 n=100,051	2016 n=104,908	2017 n=106,574	2018 n=101,976	2019 n=103,617
Unicompartmental knee replacement																
All unicondylar, cemented	8.0	8.2	8.8	8.3	8.3	8.0	7.8	7.1	6.9	6.6	6.4	6.0	5.9	6.0	6.7	7.2
Unicondylar, cemented and																
fixed	0.8	1.0	1.0	1.0	1.2	1.4	1.8	1.9	2.3	2.7	3.0	3.3	3.6	4.1	5.0	5.8
mobile	6.5	6.2	6.6	6.4	6.4	6.0	5.5	4.7	4.1	3.4	3.0	2.5	1.9	1.7	1.4	1.2
monobloc polyethylene tibia	0.7	0.9	1.2	0.9	0.7	0.6	0.5	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2
All unicondylar, uncemented/hybrid	0.1	0.2	0.2	0.3	0.4	0.7	0.9	1.2	1.2	1.4	2.0	2.8	3.4	3.9	4.3	4.3
Unicondylar, uncemented/hybrid and																
fixed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
mobile	<0.1	0.1	0.1	0.2	0.3	0.5	0.7	1.0	1.1	1.4	1.9	2.7	3.3	3.8	4.1	4.1
monobloc polyethylene tibia	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Patellofemoral	0.9	1.0	1.1	1.3	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1.1	1.0	1.1	0.9	0.9
Multicompartmental	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Unclassified	3.5	3.1	3.1	3.6	3.2	3.0	2.7	2.6	1.2	1.0	0.8	0.7	0.8	0.7	0.7	0.6
All types	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Data from 2003 has been included in 2004 since 2003 was not a complete year.

Table 3.K2 (page 125) shows the annual rates for the usage of primary knee replacements. Overall, more than 83% of all types of primary knee replacement utilised all cemented fixation and since 2004, the share of all implant replacements of this type has increased by about five percentage points. The main decline in the type of primary knee replacements carried out has been in the use of all uncemented and hybrid total knee replacements over time (now 2.1% of all knee replacements). Usage of each implant of this type has decreased proportionally to less than a quarter of those figures reported for 2004 (when they were 9.0% of all knee replacements).

Figure 3.K2 illustrates the temporal changes in fixation, highlighting the dominance of cemented TKR primaries.

Figure 3.K2 Fixation by year of procedure in primary knee replacement.

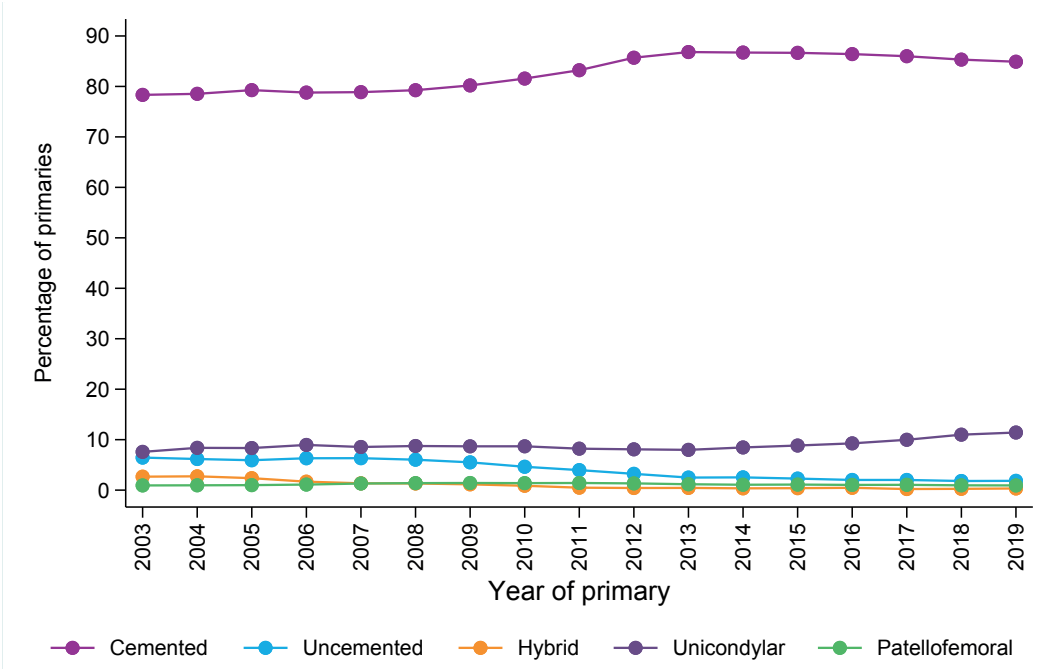


Table 3.K3 Age at primary knee replacement by **fixation**, **constraint** and **bearing** type.

Fixation	Constraint and bearing type	N	Age of patient (years)		Percentage (%) male[3]
			Median (IQR)[1]	Mean (SD)[2]	
All types		**1,300,897**	**70 (63 to 76)**	**68.9 (9.6)**	**43.4**
All cemented		**1,089,478**	**70 (64 to 76)**	**69.7 (9.3)**	**42.3**
Cemented and	unconstrained, fixed	747,669	70 (64 to 76)	69.6 (9.1)	42.9
	unconstrained, mobile	39,220	69 (62 to 76)	68.6 (9.6)	42.0
	posterior-stabilised, fixed	260,493	70 (64 to 77)	69.8 (9.4)	41.1
	posterior-stabilised, mobile	12,659	66 (60 to 74)	66.5 (10.1)	44.7
	constrained condylar	9,824	71 (63 to 78)	69.9 (10.5)	36.5
	monobloc polyethylene tibia	17,680	74 (69 to 79)	73.5 (8.2)	40.8
	pre-assembled/hinged/linked	1,933	75 (65 to 82)	73.0 (12.7)	27.8
All uncemented		**45,908**	**69 (62 to 75)**	**68.2 (9.5)**	**48.6**
Uncemented and	unconstrained, fixed	17,554	69 (62 to 75)	68.1 (9.8)	50.0
	unconstrained, mobile	24,702	69 (62 to 75)	68.5 (9.2)	46.6
	posterior-stabilised, fixed	3,366	67 (59 to 74)	66.7 (10.6)	53.0
	other constraints	286	67 (60 to 73)	66.4 (9.1)	74.1
All hybrid		**9,664**	**69 (62 to 76)**	**68.7 (9.8)**	**44.5**
Hybrid and	unconstrained, fixed	6,403	70 (63 to 76)	69.0 (9.5)	45.3
	unconstrained, mobile	2,121	69 (62 to 76)	68.6 (9.8)	38.5
	posterior-stabilised, fixed	734	68 (60 to 75)	67.1 (10.8)	46.9
	other constraints	406	66 (58 to 75)	65.8 (10.7)	58.9
All unicondylar, cemented		**91,861**	**64 (57 to 71)**	**63.7 (9.8)**	**53.2**
Unicondylar, cemented and	fixed	36,677	63 (56 to 70)	63.1 (10.0)	55.3
	mobile	49,004	64 (57 to 71)	64.2 (9.5)	51.6
	monobloc polyethylene tibia	6,180	64 (57 to 71)	63.9 (10.1)	53.4
All unicondylar, uncemented/hybrid		**26,455**	**65 (58 to 71)**	**64.7 (9.6)**	**55.1**
Unicondylar, uncemented/hybrid and	fixed	1,135	66 (57 to 73)	65.1 (11.1)	45.3
	mobile	24,921	65 (58 to 71)	64.6 (9.5)	55.8
	monobloc polyethylene tibia	399	65 (59 to 72)	65.6 (9.2)	42.9
Patellofemoral		**15,083**	**58 (50 to 67)**	**58.7 (11.7)**	**22.6**
Multicompartmental		**572**	**60 (53 to 67)**	**60.4 (10.0)**	**46.9**
Unclassified		**21,876**	**69 (61 to 75)**	**68.1 (10.3)**	**43.7**

[1]IQR = Interquartile range - age of middle 50% of patients at time of primary knee operation.
[2]SD = standard deviation.
[3]The percentage male figures are based on a total number of primary knee replacements.

Table 3.K3 shows the age and gender distribution of patients undergoing primary knee replacement. The median age of a person receiving a cemented TKR was 70 years (IQR 64 to 76 years). Patients receiving UKRs were typically six (unicondylar; median age 64 years; IQR 57 to 71) and 12 years younger (patellofemoral; median age 58 years; IQR 50 to 67) compared to all knee replacements.

Women are more likely to have a primary TKR; 57.7%, 51.4% and 55.5% of cemented, uncemented and hybrid type procedures respectively are carried out on female patients. Conversely, cemented and uncemented unicondylar surgery is performed on a higher proportion of males (53.2% and 55.1% respectively). Patellofemoral surgery is predominantly carried out on females (77.4% of patients) who are typically younger than a TKR or unicondylar patient with a median age at operation of 58.

Table 3.K4 shows the ASA grade and indication for knee replacement by gender for all primary knee replacements. A greater number of females than males undergo knee replacement and ASA 2 is the most common ASA grade. Only a small number of patients with a grade greater than ASA 3 undergo knee replacement. The majority of cases are performed for osteoarthritis; 1,256,129 (96.6%) of all 1,300,897 knee replacements with a reason for primary surgery recorded in the NJR are performed for osteoarthritis as the sole indication.

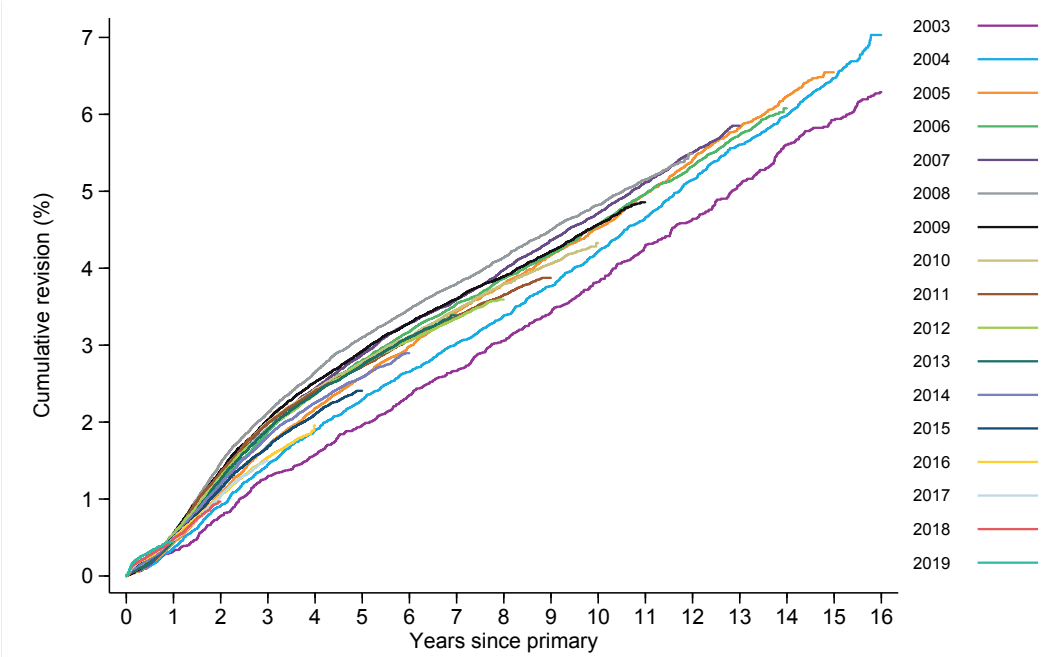
Table 3.K4 Primary knee replacement patient **demographics**.

	Males N (%)		Females N (%)		All N (%)	
Total	**564,506**		**736,391**		**1,300,897**	
ASA 1	75,568 (13.4)		74,839 (10.2)		150,407 (11.6)	
ASA 2	397,015 (70.3)		539,097 (73.2)		936,112 (72.0)	
ASA 3	89,873 (15.9)		120,189 (16.3)		210,062 (16.1)	
ASA 4	1,997 (0.4)		2,190 (0.3)		4,187 (0.3)	
ASA 5	53 (<0.1)		76 (<0.1)		129 (<0.1)	
Osteoarthritis as a reason for primary	554,137 (98.2)		712,917 (96.8)		1,267,054 (97.4)	
Osteoarthritis as the sole reason for primary	549,277 (97.3)		706,852 (96.0)		1,256,129 (96.6)	
Age	Mean (SD) 68.6 (9.3)	Median (IQR) 69 (62 to 75)	Mean (SD) 69.2 (9.8)	Median (IQR) 70 (63 to 76)	Mean (SD) 68.9 (9.6)	Median (IQR) 70 (63 to 76)

Note: Percentages in this table are calculated by column.

3.3.2 First revision after primary knee surgery

Figure 3.K3 (a) KM estimates of cumulative **revision** by **year**, in primary knee replacements.



A total of 37,794 first revisions of a knee prosthesis have been linked to NJR primary knee replacement surgery records of operations undertaken between 2003 and 2019. Figures 3.K3 (a) and (b) illustrate temporal changes in the overall revision rates using Kaplan-Meier estimates; procedures have been grouped by the year of the primary operation. Figure 3.K3 (a) plots each Kaplan-Meier survival curve with a common origin, i.e. time zero is equal to the year of operation. This illustrates that there was a small increase in revision rates up until 2008 followed by a small decline.

Figure 3.K3 (b) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. Figure 3.K3 (b) separates each year allowing changes in failure rates to be clearly identified. In addition, the revision rates at 1, 3, 5, 7, 10 and 13 years have been highlighted. If revision rates and timing of revision rates were static across time, it would be expected that all failure curves would be the same shape and equally spaced; a departure from this indicates a change in the number and timing of revision procedures.

The cumulative probability of a joint being revised at three and five years increased for each operative year group between 2003 and 2008; the probability of being revised at three and five years reduced for operations performed between 2009 and 2019. From the peak in 2008, the yearly survivorship curves are less divergent, i.e. a slowing in the observed trend.

Possible reasons for a peak in the probability of revision in the 2008 cohort are: 1) the registry was not capturing the full range and number of operations taking place in units in England and Wales until 2008, and 2) there could be bias in terms of the general overall health, risk of revision, and other key characteristics of the patients on record in the NJR in the early years. Given that similar, more marked, patterns are observed in primary hip replacements and that the start of the reduction coincides with the period where clinician feedback and performance analyses were introduced, it is likely that these patterns represent improved survivorship as a result of clinician feedback and improved adoption of evidence-based practice.

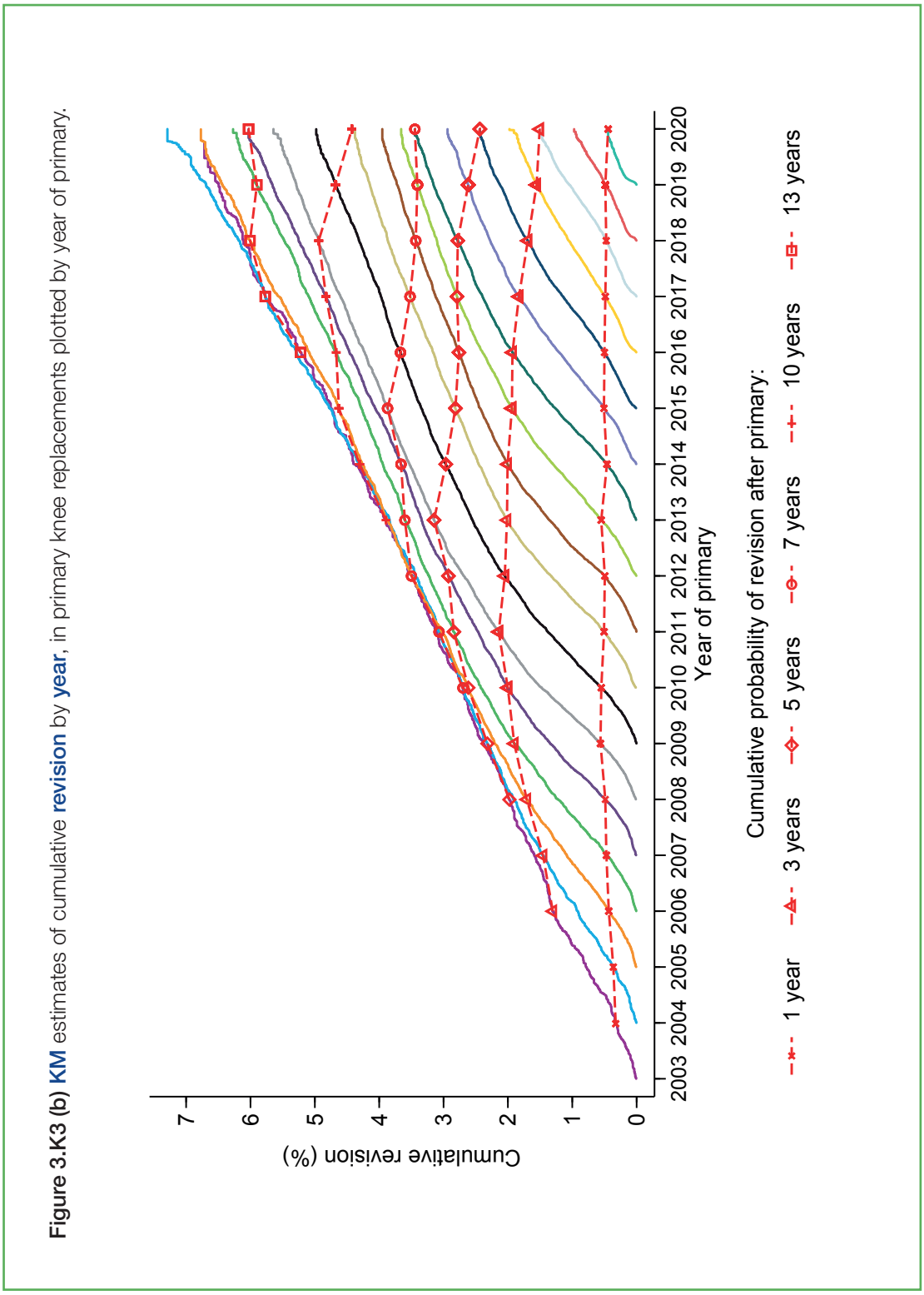


Figure 3.K3 (b) KM estimates of cumulative **revision** by **year**, in primary knee replacements plotted by year of primary.

Table 3.K5 KM estimates of cumulative **revision** (95% CI) by **fixation**, **constraint** and **bearing**, in primary knee replacements.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation/constraint/ bearing type	N	Time since primary					
		1 year	3 years	5 years	10 years	13 years	15 years
All types	1,300,897	0.50 (0.49-0.51)	1.82 (1.79-1.84)	2.65 (2.62-2.68)	4.34 (4.30-4.39)	5.54 (5.47-5.61)	6.36 (6.24-6.47)
Unclassified	21,876	*0.72 (0.62-0.85)*	*2.25 (2.06-2.47)*	*3.23 (2.99-3.48)*	*5.47 (5.13-5.84)*	*6.78 (6.31-7.28)*	7.65 (6.97-8.40)
All cemented	1,089,478	0.42 (0.41-0.43)	1.53 (1.50-1.55)	2.19 (2.16-2.23)	3.39 (3.34-3.43)	4.18 (4.11-4.25)	4.75 (4.64-4.86)
unconstrained, fixed	747,669	0.38 (0.37-0.40)	1.41 (1.39-1.44)	2.00 (1.97-2.04)	3.06 (3.00-3.11)	3.84 (3.76-3.93)	4.41 (4.28-4.55)
unconstrained, mobile	39,220	0.50 (0.44-0.58)	1.83 (1.70-1.98)	2.71 (2.55-2.89)	4.17 (3.94-4.41)	4.86 (4.58-5.16)	5.45 (5.01-5.92)
posterior-stabilised, fixed	260,493	0.48 (0.45-0.51)	1.73 (1.68-1.79)	2.57 (2.50-2.64)	4.05 (3.94-4.15)	4.90 (4.76-5.05)	5.46 (5.24-5.68)
posterior-stabilised, mobile	12,659	0.63 (0.51-0.79)	2.14 (1.89-2.41)	2.93 (2.64-3.25)	4.35 (3.95-4.79)	5.13 (4.62-5.70)	6.01 (5.18-6.97)
constrained condylar	9,824	0.90 (0.73-1.12)	2.21 (1.90-2.56)	2.85 (2.47-3.30)	4.49 (3.64-5.54)	*4.76 (3.79-5.97)*	*5.45 (3.97-7.45)*
monobloc polyethylene tibia	17,680	0.37 (0.29-0.48)	1.37 (1.19-1.56)	1.85 (1.64-2.10)	2.51 (2.20-2.86)	3.07 (2.51-3.75)	*3.07 (2.51-3.75)*
pre-assembled/hinged/linked	1,933	2.07 (1.50-2.85)	4.47 (3.55-5.60)	6.08 (4.93-7.47)	*9.68 (7.60-12.29)*	*11.75 (8.85-15.51)*	*11.75 (8.85-15.51)*
All uncemented	45,908	0.57 (0.51-0.65)	2.13 (2.00-2.28)	2.90 (2.74-3.07)	4.17 (3.96-4.39)	5.15 (4.87-5.45)	5.85 (5.45-6.28)
unconstrained, fixed	17,554	0.64 (0.53-0.77)	2.35 (2.12-2.59)	3.06 (2.79-3.35)	4.31 (3.97-4.67)	5.30 (4.85-5.79)	5.89 (5.30-6.55)
unconstrained, mobile	24,702	0.51 (0.43-0.61)	1.94 (1.77-2.13)	2.72 (2.51-2.94)	3.86 (3.59-4.15)	4.70 (4.33-5.09)	5.43 (4.88-6.03)
posterior-stabilised, fixed	3,366	0.64 (0.42-0.98)	2.45 (1.96-3.07)	3.46 (2.85-4.19)	5.90 (4.98-6.99)	7.84 (6.52-9.41)	*8.84 (7.17-10.89)*
other constraints	286	0.74 (0.18-2.92)	*2.37 (1.07-5.21)*	*2.79 (1.34-5.77)*	*3.32 (1.67-6.57)*		
All hybrid	9,664	0.52 (0.39-0.69)	1.71 (1.47-2.00)	2.36 (2.06-2.70)	3.52 (3.12-3.96)	4.17 (3.69-4.72)	*4.39 (3.85-5.01)*
unconstrained, fixed	6,403	0.46 (0.32-0.66)	1.62 (1.33-1.97)	2.21 (1.87-2.62)	3.21 (2.78-3.71)	3.84 (3.31-4.46)	4.11 (3.51-4.82)
unconstrained, mobile	2,121	0.86 (0.54-1.37)	1.69 (1.21-2.36)	2.26 (1.67-3.07)	3.74 (2.75-5.08)	*4.61 (3.20-6.61)*	*4.61 (3.20-6.61)*
posterior-stabilised, fixed	734	0	2.47 (1.44-4.23)	4.06 (2.63-6.24)	*5.98 (4.11-8.65)*	*6.57 (4.48-9.57)*	*6.57 (4.48-9.57)*
other constraints	406	0.50 (0.12-1.97)	2.26 (1.18-4.29)	3.04 (1.74-5.29)	*4.85 (3.01-7.76)*	*5.54 (3.42-8.91)*	
All unicondylar, cemented	91,861	1.01 (0.95-1.08)	3.91 (3.78-4.05)	5.94 (5.77-6.11)	11.03 (10.76-11.31)	14.91 (14.50-15.33)	17.49 (16.88-18.13)
fixed	36,677	0.68 (0.60-0.77)	2.92 (2.73-3.13)	4.56 (4.29-4.85)	8.60 (8.07-9.18)	11.80 (10.86-12.81)	*12.96 (11.69-14.35)*
mobile	49,004	1.28 (1.18-1.38)	4.42 (4.24-4.61)	6.59 (6.37-6.83)	11.99 (11.65-12.33)	16.01 (15.53-16.51)	18.90 (18.17-19.65)
monobloc polyethylene tibia	6,180	0.75 (0.56-1.00)	4.54 (4.02-5.11)	6.70 (6.06-7.40)	11.27 (10.35-12.26)	14.63 (13.40-15.96)	*16.22 (14.69-17.89)*
All unicondylar, uncemented/hybrid	26,455	1.21 (1.08-1.35)	2.94 (2.71-3.18)	4.21 (3.90-4.55)	8.31 (7.49-9.22)	*13.41 (11.19-16.02)*	*14.19 (11.60-17.30)*
fixed	1,135	0.28 (0.09-0.87)	3.27 (2.24-4.74)	6.68 (5.00-8.89)	*11.33 (8.73-14.63)*	*14.77 (10.91-19.85)*	
mobile	24,921	1.26 (1.12-1.41)	2.93 (2.70-3.18)	4.06 (3.75-4.40)	8.38 (7.42-9.46)	*13.35 (10.76-16.49)*	*14.52 (11.29-18.57)*
monobloc polyethylene tibia	399	0.51 (0.13-2.01)	2.30 (1.20-4.37)	3.41 (1.99-5.80)	*5.71 (3.71-8.75)*		
Patellofemoral	15,083	1.07 (0.91-1.25)	6.01 (5.61-6.43)	9.90 (9.37-10.45)	19.35 (18.49-20.25)	24.40 (23.18-25.68)	*27.28 (25.46-29.20)*
Multicompartmental	572	1.08 (0.48-2.38)	7.14 (5.24-9.68)	9.99 (7.67-12.95)	*13.58 (10.58-17.35)*		

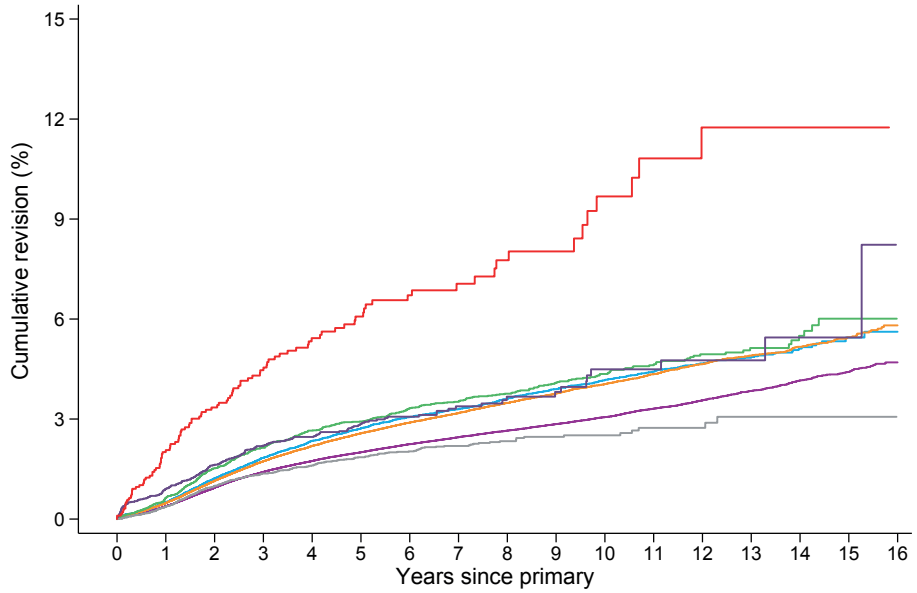
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K5 shows Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, for the cohort of all primary knee replacements. This is broken down for TKR by knee fixation type (cemented, uncemented or hybrid) and sub-divided further within each fixation type by the constraint (unconstrained, posterior-stabilised, constrained condylar and highly constrained implants) and bearing mobility (fixed or mobile) and for UKR, by bearing mobility (fixed or mobile). The table shows updated estimates at 1, 3, 5, 10, 13 and 15 years from the primary operation together with 95% Confidence Intervals (95% CI).

Where groups have less than 250 cases remaining at risk, the figures are shown in blue italics. Further revisions in these groups would be highly unlikely and, when they do occur, they may appear to have a disproportionate impact on the Kaplan-Meier estimate, i.e. the step upwards may seem steeper. Furthermore, the upper 95% CI at these time points may be underestimated. Although a number of statistical methods have been proposed to deal with this, they typically give different values and, as yet, there is no clear consensus for the large datasets presented here. Kaplan-Meier estimates are not shown at all when the numbers at risk fell below ten.

Figures 3.K4 (a) to 3.K4 (d) illustrate the differences in revision rates between the types of knee replacement, fixation and constraint. It is worth noting the different vertical scales between the four figures. The results show the lowest revision rates for cemented unconstrained fixed bearing TKR and cemented TKR with monobloc polyethylene tibias. The revision rates in cemented TKRs that are posterior-stabilised and those that have mobile bearings remain higher. The revision rates for UKRs remain substantially higher than for TKR, this is most marked in the patellofemoral replacement and multicompartmental groups.

Figure 3.K4 (a) KM estimates of cumulative **revision** in **primary total cemented** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk																
Unconstrained, Fixed	747669	674520	601415	525825	452182	383593	319832	264726	212304	166421	126681	92027	62458	38918	22745	10208	3048
Unconstrained, Mobile	39220	37083	34744	32317	29834	27485	25053	22643	20123	17352	14199	10876	7400	4305	2197	793	*227*
Posterior-stabilised, Fixed	260493	237490	213725	188684	164708	141641	119853	100194	81410	64268	48800	35257	23628	14596	8429	3935	1182
Posterior-stabilised, Mobile	12659	12202	11645	10967	10177	9264	8182	7061	6029	5004	3936	3029	2165	1327	701	255	*73*
Constrained Condylar	9824	8112	6636	5334	4148	2964	2003	1349	922	670	481	367	265	*159*	*103*	*43*	*14*
Monobloc Polyethylene Tibia	17680	15907	13959	11985	10194	8483	6611	4796	3298	2209	1547	1081	651	321	*150*	*57*	*23*
Pre-assembled/hinged/linked	1933	1623	1390	1177	981	778	631	464	353	264	*196*	*138*	*94*	*54*	*30*	*14*	*1*

Figure 3.K4 (b) KM estimates of cumulative **revision** in **primary total uncemented** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

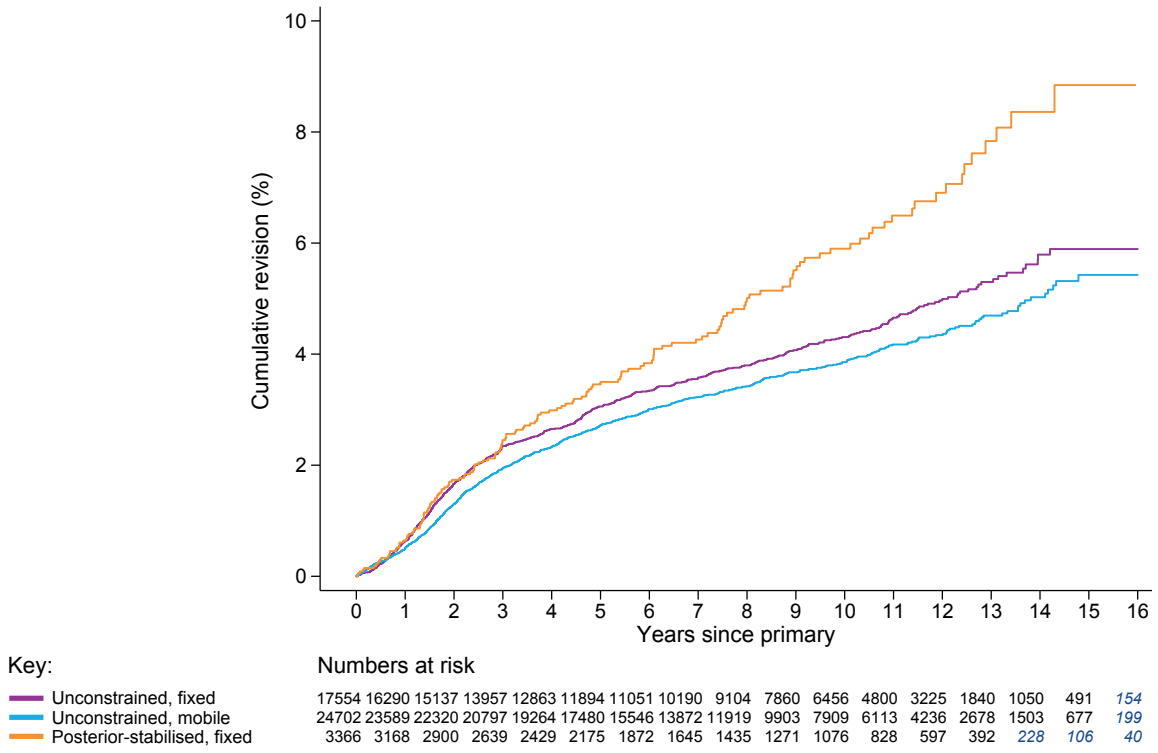


Figure 3.K4 (c) KM estimates of cumulative **revision** in **primary total hybrid** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

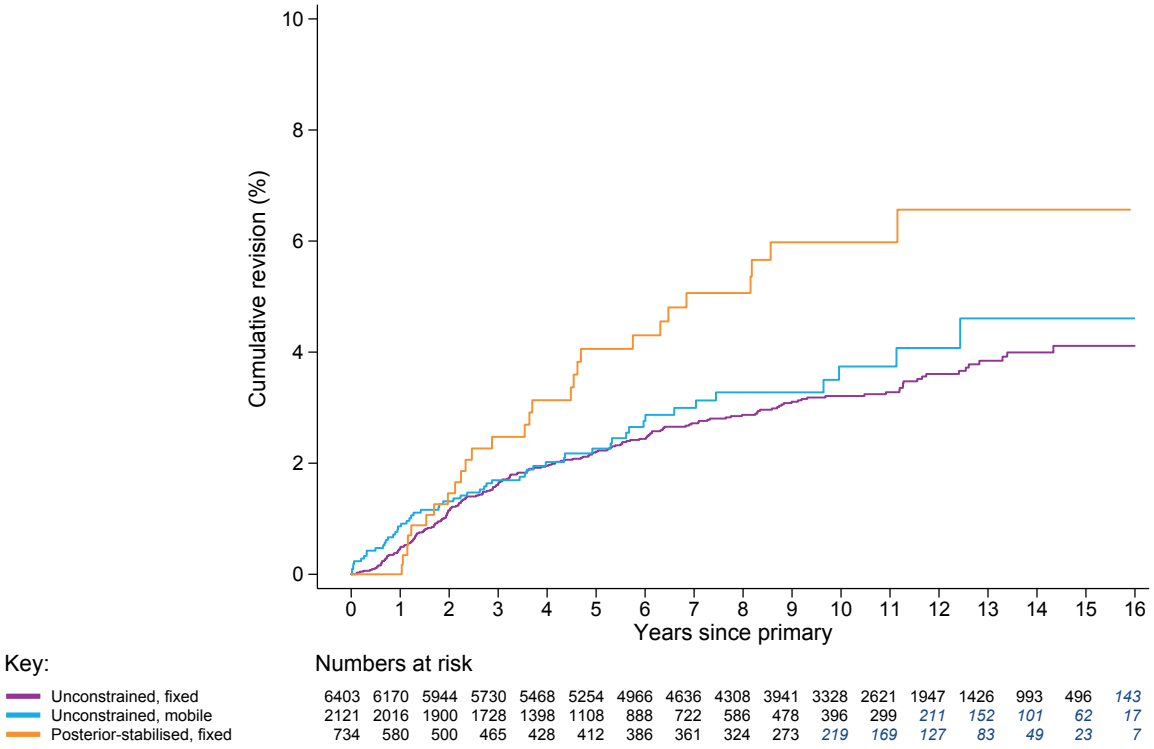
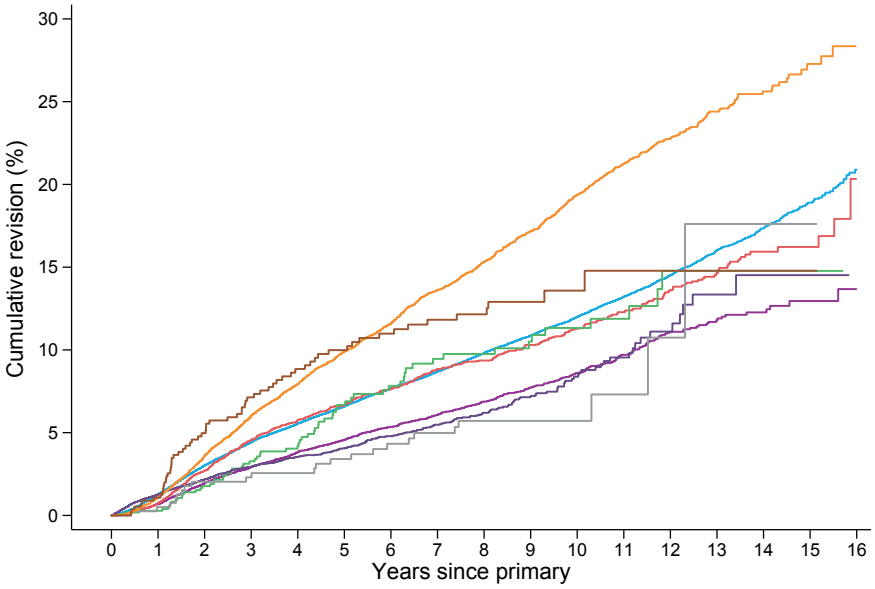


Figure 3.K4 (d) KM estimates of cumulative **revision** in **primary unicondylar or patellofemoral** knee replacements by **fixation**, **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

Numbers at risk

Cemented, fixed	36677	30393	24832	20233	16283	12919	10015	7687	5792	4293	2987	2068	1345	837	477	*201*	*63*
Cemented, mobile	49004	46982	44429	41665	38820	35623	32065	28623	24779	20784	16641	12533	8629	5381	3105	1455	416
Cemented, monobloc polyethylene tibia	6180	5861	5439	5014	4565	4183	3767	3349	2891	2499	2099	1676	1242	795	389	*166*	*27*
Uncemented/hybrid, fixed	1135	943	787	657	545	433	363	314	274	*223*	*178*	*120*	*69*	*37*	*24*	*7*	*4*
Uncemented/hybrid, mobile	24921	20357	15947	11786	8345	5710	3916	2805	1921	1187	689	354	*183*	*93*	*44*	*14*	*4*
Uncemented/hybrid, monobloc polyethylene tibia	399	392	382	373	356	332	300	277	*220*	*146*	*81*	*40*	*18*	*5*	*2*	*1*	*0*
Patellofemoral	15083	13910	12532	11085	9762	8455	7334	6220	5077	4008	3036	2173	1416	821	469	*203*	*64*
Multicompartmental	572	540	495	456	409	375	335	292	*237*	*157*	*77*	*44*	*21*	*8*	*6*	*4*	*3*

Figure 3.K5 (a) KM estimates of cumulative **revision** in **primary total** knee replacements by **gender** and **age**.

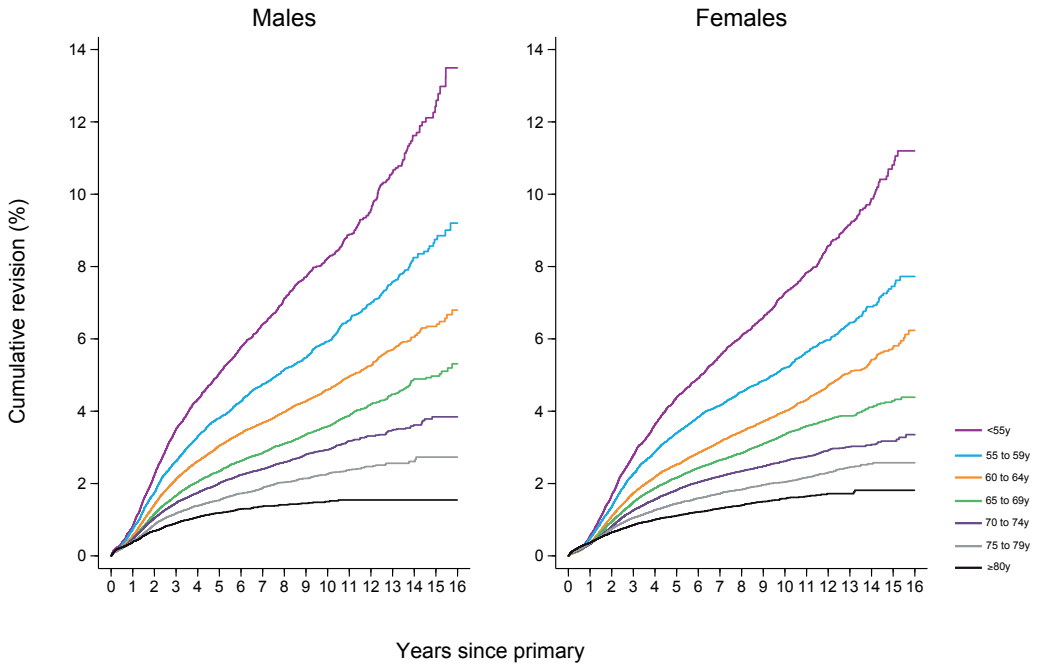


Figure 3.K5 (a) shows that the chance of revision after primary TKR is far higher in younger patient cohorts and that men were slightly more likely, overall, to have a first revision compared to women of comparable grouped age, if they were under the age of 70 when they underwent primary surgery.

Figure 3.K5 (b) KM estimates of cumulative **revision** in **primary unicondylar** knee replacements by **gender** and **age**.

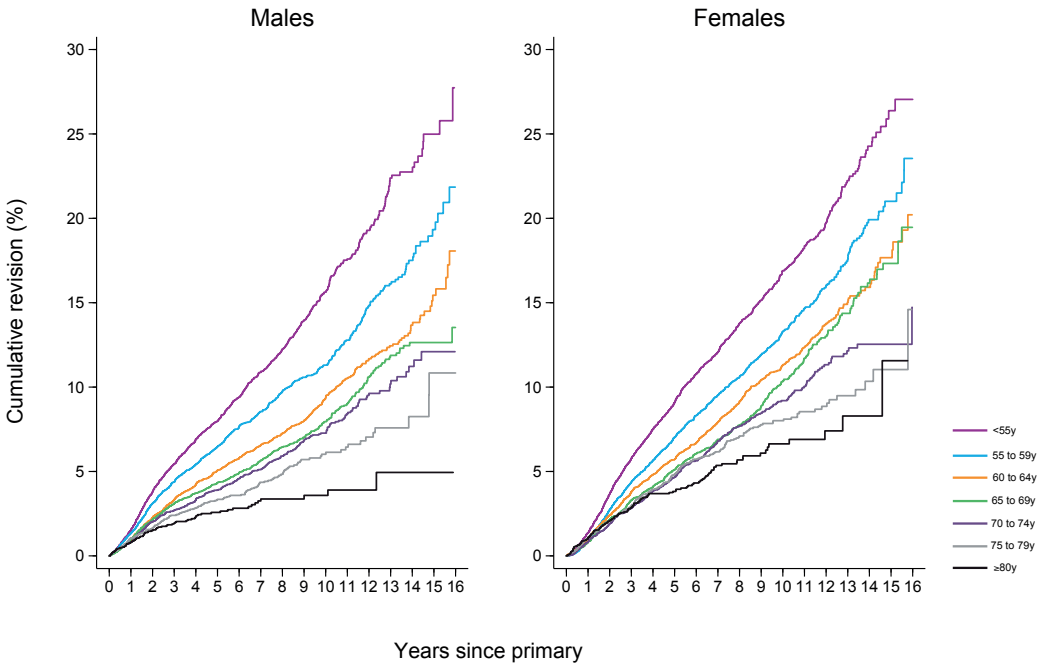


Figure 3.K5 (b) shows that the risk of revision of primary unicondylar knee replacement is, again, substantially higher for younger patient cohorts but that there are less marked differences in younger patients in the risk of revision according to gender. The risk of revision is higher in all age groups than it is for TKR; note the differences in the vertical axes.

Table 3.K6 (page 140) shows gender and age stratified Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any cause, firstly for all cases combined, then by knee fixation / constraint / bearing sub-divisions. Estimates are shown, along with 95% CIs, for males and females within each of four age bands, <55, 55 to 64, 65 to 74 and ≥75 years for revision rate at 1, 3, 5, 10, 13 and 15 years after the primary operation.

Table 3.K6 KM estimates of cumulative **revision** (95% CI) by **gender**, **age**, **fixation**, **constraint** and **bearing**, in primary knee replacements.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All cases	<55	40,194	1.06 (0.96-1.16)	4.21 (4.00-4.42)	6.11 (5.85-6.38)	10.62 (10.21-11.05)	14.17 (13.53-14.84)	16.21 (15.28-17.19)	57,361	0.76 (0.69-0.84)	3.74 (3.58-3.91)	5.94 (5.72-6.16)	10.56 (10.20-10.92)	13.46 (12.95-13.99)	15.74 (14.94-16.58)
Unclassified	<55	898	1.82 (1.12-2.96)	5.32 (3.98-7.08)	7.87 (6.18-9.99)	14.20 (11.69-17.20)	*18.17 (14.74-22.29)*	*18.17 (14.74-22.29)*	1,228	1.57 (1.01-2.46)	5.13 (4.00-6.58)	8.62 (7.10-10.45)	13.27 (11.25-15.63)	*16.31 (13.77-19.26)*	*20.97 (15.70-27.68)*
All cemented	<55	26,012	0.83 (0.72-0.95)	3.45 (3.22-3.70)	4.97 (4.68-5.28)	8.17 (7.72-8.65)	10.41 (9.74-11.12)	12.43 (11.35-13.60)	37,740	0.54 (0.47-0.62)	2.72 (2.55-2.91)	4.30 (4.07-4.54)	7.25 (6.88-7.63)	9.13 (8.60-9.70)	10.83 (9.98-11.75)
unconstrained, fixed	<55	17,156	0.79 (0.67-0.94)	3.17 (2.89-3.46)	4.45 (4.11-4.81)	7.49 (6.94-8.07)	9.62 (8.79-10.53)	11.61 (10.27-13.11)	25,241	0.45 (0.37-0.55)	2.36 (2.16-2.57)	3.88 (3.61-4.17)	6.49 (6.06-6.95)	8.47 (7.81-9.19)	10.24 (9.21-11.38)
unconstrained, mobile	<55	1,339	1.06 (0.63-1.79)	4.29 (3.30-5.56)	6.22 (5.00-7.74)	8.75 (7.21-10.61)	*11.12 (8.88-13.88)*	*12.87 (9.80-16.80)*	1,703	0.66 (0.37-1.19)	2.92 (2.19-3.88)	4.94 (3.95-6.17)	7.79 (6.43-9.43)	*8.41 (6.91-10.22)*	*8.96 (7.20-11.12)*
posterior-stabilised, fixed	<55	6,282	0.73 (0.54-0.98)	3.80 (3.33-4.35)	5.87 (5.24-6.57)	9.86 (8.88-10.95)	12.71 (11.24-14.36)	*14.69 (12.39-17.36)*	9,204	0.64 (0.49-0.83)	3.39 (3.01-3.81)	5.05 (4.56-5.59)	9.02 (8.21-9.90)	11.55 (10.34-12.90)	*13.24 (11.27-15.53)*
posterior-stabilised, mobile	<55	689	1.32 (0.69-2.53)	4.40 (3.07-6.26)	5.68 (4.15-7.76)	8.32 (6.31-10.94)	*8.67 (6.58-11.40)*	*11.95 (7.77-18.15)*	771	1.31 (0.71-2.42)	4.67 (3.38-6.45)	6.06 (4.56-8.04)	8.47 (6.55-10.92)	*8.83 (6.82-11.39)*	*11.73 (7.90-17.22)*
constrained condylar	<55	320	1.94 (0.87-4.26)	*4.87 (2.84-8.28)*	*6.19 (3.70-10.26)*	*8.64 (5.07-14.52)*	*8.64 (5.07-14.52)*		473	0.45 (0.11-1.78)	2.42 (1.26-4.62)	*2.89 (1.54-5.41)*	*5.38 (2.05-13.71)*	*5.38 (2.05-13.71)*	
monobloc polyethylene tibia	<55	161	*0.65 (0.09-4.55)*	*4.87 (2.35-9.96)*	*4.87 (2.35-9.96)*	*7.41 (3.80-14.19)*	*7.41 (3.80-14.19)*		257	1.20 (0.39-3.68)	*3.91 (2.05-7.39)*	*5.81 (3.31-10.12)*	*5.81 (3.31-10.12)*	*5.81 (3.31-10.12)*	
pre-assembled/hinged/ linked	<55	65	*3.23 (0.82-12.30)*	*5.09 (1.66-15.00)*	*9.56 (4.04-21.72)*	*15.33 (7.40-30.26)*			91	*4.69 (1.78-12.02)*	*10.23 (5.21-19.54)*	*13.91 (7.61-24.69)*			
All uncemented	<55	1,840	0.73 (0.42-1.25)	4.12 (3.26-5.19)	5.91 (4.85-7.21)	9.07 (7.62-10.78)	*12.09 (10.01-14.57)*	*13.45 (10.80-16.70)*	1,934	0.75 (0.44-1.26)	3.85 (3.05-4.86)	5.58 (4.58-6.79)	8.06 (6.76-9.60)	10.13 (8.41-12.18)	*11.84 (9.42-14.82)*
unconstrained, fixed	<55	784	0.93 (0.44-1.94)	4.41 (3.10-6.25)	6.07 (4.46-8.23)	9.06 (6.92-11.81)	*13.80 (10.25-18.44)*	*13.80 (10.25-18.44)*	768	1.10 (0.55-2.19)	3.39 (2.26-5.06)	4.52 (3.15-6.46)	7.14 (5.23-9.71)	*8.80 (6.45-11.95)*	*10.27 (6.99-14.96)*
unconstrained, mobile	<55	811	0.75 (0.34-1.67)	4.08 (2.89-5.76)	6.06 (4.54-8.07)	9.22 (7.16-11.83)	*9.97 (7.73-12.81)*	*12.71 (8.87-18.05)*	969	0.63 (0.28-1.39)	3.72 (2.67-5.17)	5.68 (4.33-7.43)	7.83 (6.13-9.96)	*10.58 (8.10-13.77)*	*12.70 (9.18-17.45)*
posterior-stabilised, fixed	<55	220	*0*	*3.07 (1.39-6.71)*	*4.27 (2.15-8.38)*	*8.53 (4.74-15.11)*	*15.31 (8.41-26.99)*		191	*0*	*6.30 (3.54-11.10)*	*8.91 (5.46-14.37)*	*12.67 (8.13-19.46)*	*12.67 (8.13-19.46)*	
other constraints	<55	25	*0*	*5.56 (0.80-33.36)*	*11.11 (2.90-37.58)*				6						
All hybrid	<55	361	0.56 (0.14-2.21)	3.49 (2.00-6.07)	6.03 (3.93-9.20)	*8.62 (5.97-12.37)*	*11.15 (7.63-16.13)*	*11.15 (7.63-16.13)*	441	0.69 (0.22-2.13)	2.87 (1.64-5.00)	4.96 (3.22-7.59)	*7.79 (5.45-11.06)*	*8.40 (5.87-11.94)*	*9.50 (6.45-13.89)*
unconstrained, fixed	<55	205	*0.49 (0.07-3.43)*	*3.03 (1.37-6.61)*	*5.66 (3.18-10.00)*	*6.76 (3.98-11.37)*	*10.45 (6.22-17.27)*	*10.45 (6.22-17.27)*	264	0.76 (0.19-3.01)	3.54 (1.86-6.70)	5.17 (3.04-8.74)	*7.04 (4.42-11.11)*	*7.88 (4.97-12.40)*	*9.47 (5.73-15.44)*
unconstrained, mobile	<55	71	*0*	*2.92 (0.74-11.18)*	*4.86 (1.57-14.49)*	*13.14 (5.67-28.80)*			102	*0.98 (0.14-6.76)*	*2.06 (0.52-7.99)*	*3.69 (1.17-11.35)*	*9.51 (3.68-23.38)*		

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
posterior-stabilised, fixed	<55	46	*0*	*0*	*3.03 (0.43-19.63)*	*10.63 (3.47-30.06)*			49	*0*	*2.44 (0.35-16.08)*	*7.32 (2.42-21.00)*	*9.82 (3.80-24.09)*		
other constraints	<55	39	*2.56 (0.37-16.84)*	*10.26 (3.98-25.06)*	*12.82 (5.55-28.10)*	*12.82 (5.55-28.10)*	*12.82 (5.55-28.10)*		26			*3.85 (0.55-24.31)*	*11.54 (3.87-31.64)*	*11.54 (3.87-31.64)*	
All unicondylar, cemented	**<55**	**7,917**	**1.52 (1.27-1.82)**	**5.82 (5.29-6.40)**	**8.64 (7.98-9.36)**	**16.32 (15.22-17.50)**	**22.78 (20.98-24.71)**	*25.42 (22.92-28.14)*	**8,918**	**1.38 (1.16-1.66)**	**6.08 (5.57-6.63)**	**9.53 (8.87-10.24)**	**17.45 (16.40-18.56)**	**22.83 (21.27-24.49)**	*27.01 (24.54-29.68)*
fixed	<55	3,833	1.10 (0.81-1.51)	4.19 (3.53-4.96)	6.30 (5.43-7.32)	11.12 (9.49-13.01)	*15.43 (12.16-19.48)*	*15.43 (12.16-19.48)*	3,882	0.84 (0.59-1.21)	4.48 (3.80-5.28)	7.02 (6.08-8.09)	15.33 (13.24-17.73)	*19.38 (16.37-22.87)*	*21.13 (16.91-26.24)*
mobile	<55	3,536	1.83 (1.43-2.33)	7.02 (6.21-7.93)	10.04 (9.06-11.12)	18.41 (16.95-19.99)	25.27 (23.03-27.69)	*28.65 (25.53-32.06)*	4,470	1.84 (1.48-2.28)	6.91 (6.18-7.71)	10.83 (9.92-11.83)	18.91 (17.58-20.31)	24.58 (22.67-26.63)	*28.75 (25.82-31.93)*
monobloc polyethylene tibia	<55	548	2.24 (1.28-3.92)	7.72 (5.70-10.42)	12.35 (9.69-15.68)	*22.06 (18.13-26.69)*	*27.43 (22.57-33.08)*	*27.43 (22.57-33.08)*	566	1.27 (0.61-2.64)	8.81 (6.67-11.59)	12.26 (9.68-15.46)	*18.05 (14.69-22.07)*	*22.85 (18.33-28.28)*	*29.96 (22.41-39.34)*
All unicondylar, uncemented/hybrid	**<55**	**2,002**	**1.55 (1.08-2.22)**	**3.63 (2.81-4.68)**	**4.40 (3.44-5.61)**	*11.24 (8.42-14.91)*	*26.51 (15.30-43.53)*		**2,226**	**1.30 (0.89-1.89)**	**4.22 (3.35-5.31)**	**6.80 (5.48-8.42)**	*13.14 (9.89-17.35)*	*16.36 (10.49-25.03)*	
fixed	<55	97	*0*	*4.15 (1.35-12.40)*	*6.15 (2.31-15.85)*	*12.33 (5.38-26.86)*			111	*0*	*5.38 (2.04-13.78)*	*7.58 (3.13-17.72)*	*15.57 (6.92-32.93)*		
mobile	<55	1,884	1.64 (1.14-2.35)	3.58 (2.75-4.66)	4.28 (3.32-5.52)	*11.41 (8.28-15.63)*			2,092	1.38 (0.95-2.01)	4.22 (3.33-5.35)	6.74 (5.39-8.42)	*12.48 (9.05-17.09)*		
monobloc polyethylene tibia	<55	21	*0*	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*				23			*4.35 (0.62-27.07)*			
Patellofemoral	**<55**	**1,100**	**2.48 (1.70-3.63)**	**10.11 (8.37-12.20)**	**14.69 (12.50-17.22)**	*24.23 (20.98-27.89)*	*32.10 (27.30-37.51)*	*39.35 (30.70-49.43)*	**4,770**	**0.88 (0.65-1.20)**	**6.55 (5.83-7.36)**	**10.63 (9.67-11.67)**	**21.85 (20.18-23.63)**	*27.93 (25.45-30.59)*	*30.73 (27.33-34.43)*
Multicompartmental	**<55**	**64**	*0*	*8.13 (3.46-18.44)*	*9.80 (4.52-20.53)*				**104**	*0.97 (0.14-6.69)*	*9.86 (5.43-17.56)*	*15.85 (9.83-25.01)*	*19.81 (12.50-30.57)*		
All cases	**55 to 64**	**141,273**	**0.71 (0.67-0.76)**	**2.57 (2.48-2.66)**	**3.75 (3.64-3.86)**	**6.04 (5.87-6.21)**	**7.81 (7.58-8.06)**	**9.01 (8.66-9.38)**	**168,279**	**0.48 (0.45-0.52)**	**2.27 (2.19-2.35)**	**3.41 (3.31-3.51)**	**5.70 (5.55-5.85)**	**7.29 (7.08-7.51)**	**8.44 (8.13-8.77)**
Unclassified	**55 to 64**	**2,585**	**1.03 (0.70-1.50)**	**3.08 (2.47-3.85)**	**3.87 (3.17-4.73)**	**6.69 (5.66-7.89)**	**9.16 (7.71-10.87)**	*9.80 (8.15-11.77)*	**2,988**	**0.61 (0.39-0.97)**	**2.77 (2.22-3.44)**	**3.59 (2.96-4.36)**	**6.20 (5.30-7.25)**	**7.44 (6.31-8.76)**	*8.81 (7.16-10.82)*
All cemented	**55 to 64**	**107,751**	**0.62 (0.58-0.67)**	**2.29 (2.20-2.39)**	**3.31 (3.19-3.43)**	**5.04 (4.87-5.21)**	**6.30 (6.06-6.56)**	**7.19 (6.83-7.56)**	**135,932**	**0.40 (0.36-0.43)**	**1.90 (1.83-1.98)**	**2.81 (2.71-2.91)**	**4.39 (4.25-4.54)**	**5.55 (5.34-5.77)**	**6.33 (6.02-6.65)**
unconstrained, fixed	55 to 64	74,902	0.55 (0.50-0.61)	2.12 (2.02-2.24)	3.04 (2.90-3.18)	4.52 (4.33-4.73)	5.86 (5.56-6.18)	6.68 (6.26-7.12)	93,970	0.37 (0.33-0.41)	1.77 (1.68-1.87)	2.54 (2.43-2.66)	3.92 (3.76-4.09)	5.08 (4.83-5.34)	5.95 (5.56-6.36)
unconstrained, mobile	55 to 64	4,506	0.73 (0.51-1.02)	2.63 (2.19-3.16)	3.75 (3.21-4.38)	5.79 (5.08-6.60)	6.49 (5.69-7.41)	*8.36 (6.54-10.66)*	5,420	0.49 (0.33-0.72)	2.16 (1.79-2.60)	3.19 (2.74-3.73)	5.07 (4.45-5.77)	6.28 (5.48-7.20)	*6.81 (5.77-8.03)*
posterior-stabilised, fixed	55 to 64	24,679	0.78 (0.67-0.90)	2.68 (2.47-2.91)	3.96 (3.70-4.25)	6.26 (5.87-6.68)	7.70 (7.16-8.28)	8.59 (7.83-9.42)	31,966	0.44 (0.37-0.52)	2.23 (2.06-2.41)	3.48 (3.26-3.71)	5.44 (5.12-5.78)	6.47 (6.05-6.93)	7.10 (6.51-7.73)

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
posterior-stabilised, mobile	55 to 64	1,846	0.83 (0.50-1.37)	2.47 (1.85-3.31)	3.08 (2.37-4.01)	4.96 (3.94-6.24)	*5.28 (4.19-6.65)*	*6.04 (4.40-8.26)*	2,099	0.34 (0.16-0.71)	1.83 (1.33-2.52)	3.12 (2.43-3.99)	4.83 (3.91-5.95)	6.59 (5.19-8.37)	*7.32 (5.48-9.76)*
constrained condylar	55 to 64	866	0.87 (0.41-1.81)	2.04 (1.20-3.45)	3.72 (2.39-5.76)	*4.64 (2.75-7.80)*	*4.64 (2.75-7.80)*		1,162	0.54 (0.24-1.21)	1.97 (1.24-3.13)	2.13 (1.36-3.35)	*7.96 (4.48-13.96)*	*9.58 (5.38-16.75)*	
monobloc polyethylene tibia	55 to 64	853	0.88 (0.42-1.83)	2.05 (1.24-3.39)	3.58 (2.37-5.37)	*4.70 (3.09-7.12)*	*4.70 (3.09-7.12)*	*4.70 (3.09-7.12)*	1,119	0.28 (0.09-0.85)	1.61 (0.97-2.66)	2.54 (1.65-3.90)	*4.23 (2.72-6.55)*	*6.65 (4.02-10.89)*	*6.65 (4.02-10.89)*
pre-assembled/hinged/ linked	55 to 64	99	*5.46 (2.31-12.65)*	*12.17 (6.70-21.57)*	*15.44 (8.98-25.83)*	*22.99 (12.99-38.75)*			196	*2.73 (1.14-6.43)*	*3.36 (1.52-7.33)*	*4.77 (2.40-9.36)*	*9.56 (4.86-18.37)*		
All uncemented	**55 to 64**	**6,169**	**0.60 (0.43-0.83)**	**2.43 (2.06-2.87)**	**3.39 (2.94-3.91)**	**5.37 (4.75-6.07)**	**6.79 (5.96-7.73)**	*7.25 (6.29-8.34)*	**5,863**	**0.65 (0.47-0.89)**	**2.59 (2.20-3.05)**	**3.71 (3.23-4.25)**	**5.46 (4.84-6.16)**	**6.62 (5.84-7.49)**	*8.14 (6.88-9.63)*
unconstrained, fixed	55 to 64	2,457	0.51 (0.29-0.90)	2.66 (2.06-3.43)	3.64 (2.92-4.54)	6.08 (5.05-7.31)	7.01 (5.80-8.46)	*8.23 (6.50-10.40)*	2,173	0.71 (0.43-1.18)	2.95 (2.29-3.79)	3.76 (3.00-4.71)	5.61 (4.62-6.80)	6.82 (5.59-8.31)	*8.07 (6.32-10.27)*
unconstrained, mobile	55 to 64	3,055	0.53 (0.33-0.87)	2.30 (1.81-2.92)	3.37 (2.76-4.12)	4.67 (3.90-5.58)	6.45 (5.30-7.84)	*6.45 (5.30-7.84)*	3,260	0.56 (0.36-0.89)	2.31 (1.84-2.91)	3.58 (2.97-4.31)	5.02 (4.24-5.95)	5.61 (4.72-6.68)	*7.28 (5.58-9.47)*
posterior-stabilised, fixed	55 to 64	603	1.19 (0.57-2.48)	2.09 (1.19-3.65)	2.48 (1.48-4.16)	*6.18 (4.17-9.12)*	*7.63 (5.05-11.45)*	*7.63 (5.05-11.45)*	403	1.03 (0.39-2.72)	3.16 (1.81-5.50)	4.64 (2.90-7.36)	*8.40 (5.79-12.10)*	*12.96 (8.94-18.58)*	*14.73 (9.88-21.65)*
other constraints	55 to 64	54	*2.00 (0.28-13.36)*	*4.18 (1.06-15.72)*	*4.18 (1.06-15.72)*				27	*0*	*0*	*0*			
All hybrid	**55 to 64**	**1,073**	**0.38 (0.14-1.02)**	**1.67 (1.04-2.68)**	**3.05 (2.14-4.34)**	**4.54 (3.35-6.14)**	*6.69 (4.93-9.03)*	*7.38 (5.30-10.21)*	**1,266**	**0.56 (0.27-1.18)**	**2.23 (1.53-3.24)**	**3.07 (2.22-4.24)**	**4.56 (3.45-6.02)**	**5.03 (3.79-6.66)**	*5.03 (3.79-6.66)*
unconstrained, fixed	55 to 64	682	0.30 (0.07-1.19)	1.52 (0.82-2.81)	2.93 (1.88-4.56)	4.19 (2.86-6.10)	*5.84 (4.04-8.41)*	*6.68 (4.46-9.93)*	804	0.88 (0.42-1.83)	2.56 (1.66-3.94)	3.36 (2.30-4.90)	4.84 (3.51-6.66)	5.43 (3.93-7.48)	*5.43 (3.93-7.48)*
unconstrained, mobile	55 to 64	221	*0.45 (0.06-3.17)*	*0.45 (0.06-3.17)*	*1.65 (0.53-5.08)*	*1.65 (0.53-5.08)*	*3.74 (1.13-12.03)*	*3.74 (1.13-12.03)*	319	0	1.34 (0.50-3.53)	*1.77 (0.74-4.22)*	*4.27 (1.73-10.35)*	*4.27 (1.73-10.35)*	
posterior-stabilised, fixed	55 to 64	95	*0*	*2.90 (0.73-11.15)*	*4.52 (1.47-13.42)*	*8.37 (3.53-19.16)*			90	*0*	*2.63 (0.66-10.11)*	*5.54 (2.11-14.11)*	*7.14 (3.02-16.36)*	*7.14 (3.02-16.36)*	
other constraints	55 to 64	75	*1.35 (0.19-9.21)*	*5.41 (2.06-13.76)*	*6.78 (2.88-15.52)*	*11.27 (5.30-23.11)*	*15.71 (7.35-31.79)*		53		*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	
All unicondylar, cemented	**55 to 64**	**17,602**	**0.99 (0.85-1.15)**	**3.97 (3.67-4.29)**	**5.95 (5.57-6.36)**	**10.54 (9.95-11.15)**	**14.40 (13.55-15.30)**	**17.47 (16.11-18.94)**	**14,741**	**0.92 (0.78-1.10)**	**4.19 (3.86-4.55)**	**6.58 (6.15-7.04)**	**12.55 (11.88-13.27)**	**16.55 (15.59-17.56)**	**19.68 (18.29-21.16)**
fixed	55 to 64	7,254	0.57 (0.41-0.78)	2.41 (2.04-2.85)	4.18 (3.62-4.81)	7.44 (6.41-8.62)	*10.73 (8.88-12.94)*	*13.34 (10.18-17.39)*	5,497	0.62 (0.44-0.88)	3.43 (2.91-4.04)	5.41 (4.70-6.22)	10.13 (8.80-11.65)	*13.27 (11.23-15.64)*	*14.92 (12.31-18.03)*
mobile	55 to 64	9,199	1.33 (1.11-1.58)	4.81 (4.38-5.28)	6.86 (6.34-7.42)	11.72 (10.98-12.50)	15.50 (14.50-16.57)	18.83 (17.23-20.57)	8,214	1.17 (0.96-1.43)	4.55 (4.11-5.03)	7.14 (6.58-7.75)	13.41 (12.58-14.29)	17.75 (16.60-18.97)	21.21 (19.55-23.00)
monobloc polyethylene tibia	55 to 64	1,149	0.72 (0.36-1.43)	4.98 (3.81-6.48)	7.17 (5.73-8.95)	12.29 (10.22-14.75)	*17.22 (14.31-20.65)*	*18.26 (15.10-21.98)*	1,030	0.40 (0.15-1.05)	4.78 (3.60-6.33)	6.66 (5.23-8.47)	12.40 (10.24-14.98)	*14.69 (12.05-17.83)*	*16.42 (13.28-20.20)*

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All unicondylar, uncemented/hybrid	55 to 64	4,901	1.51 (1.19-1.91)	2.83 (2.35-3.40)	4.01 (3.36-4.79)	*7.78 (6.13-9.86)*	*10.28 (7.33-14.30)*		3,809	1.18 (0.87-1.60)	3.29 (2.69-4.02)	4.73 (3.92-5.71)	*9.96 (7.89-12.53)*	*13.60 (9.83-18.65)*	
fixed	55 to 64	171	*0*	*1.61 (0.40-6.32)*	*8.20 (4.14-15.87)*	*11.62 (6.24-21.08)*			157	*0*	*2.44 (0.79-7.40)*	*5.79 (2.61-12.62)*	*14.54 (7.48-27.23)*		
mobile	55 to 64	4,679	1.58 (1.25-2.00)	2.91 (2.42-3.51)	3.84 (3.20-4.61)	*7.70 (5.85-10.11)*	*8.83 (6.25-12.39)*		3,565	1.23 (0.90-1.68)	3.33 (2.71-4.10)	4.68 (3.83-5.71)	*9.97 (7.68-12.90)*	*10.69 (8.11-14.02)*	
monobloc polyethylene tibia	55 to 64	51	*0*	*0*	*0*	*4.72 (1.20-17.59)*			87	*1.15 (0.16-7.88)*	*3.48 (1.13-10.39)*	*4.67 (1.78-11.96)*	*5.99 (2.53-13.82)*		
Patellofemoral	55 to 64	1,082	1.95 (1.26-3.00)	5.91 (4.59-7.60)	10.86 (8.95-13.15)	*23.18 (19.79-27.04)*	*29.74 (24.81-35.40)*	*31.23 (25.72-37.60)*	3,578	0.84 (0.59-1.21)	5.73 (4.97-6.59)	9.99 (8.95-11.14)	18.92 (17.28-20.68)	*24.51 (22.19-27.03)*	*27.27 (24.16-30.70)*
Multicompartmental	55 to 64	110	*0*	*6.52 (3.16-13.19)*	*8.56 (4.54-15.82)*	*15.16 (8.00-27.67)*			102	*2.04 (0.51-7.92)*	*7.77 (3.77-15.66)*	*10.39 (5.52-19.10)*	*15.36 (8.89-25.82)*		
All cases	65 to 74	224,466	0.53 (0.50-0.56)	1.72 (1.66-1.77)	2.40 (2.33-2.48)	3.75 (3.64-3.86)	4.74 (4.58-4.91)	5.27 (5.05-5.50)	276,807	0.37 (0.35-0.39)	1.51 (1.46-1.56)	2.22 (2.16-2.28)	3.56 (3.46-3.65)	4.25 (4.13-4.38)	4.66 (4.49-4.84)
Unclassified	65 to 74	3,668	0.61 (0.40-0.93)	1.88 (1.48-2.40)	2.87 (2.35-3.50)	4.52 (3.80-5.37)	5.40 (4.46-6.53)	*6.50 (5.04-8.38)*	4,283	0.60 (0.40-0.88)	1.76 (1.40-2.22)	2.49 (2.04-3.03)	4.35 (3.70-5.11)	4.89 (4.12-5.80)	*4.89 (4.12-5.80)*
All cemented	65 to 74	187,921	0.47 (0.44-0.51)	1.55 (1.49-1.61)	2.17 (2.10-2.25)	3.25 (3.14-3.36)	3.98 (3.82-4.14)	4.44 (4.21-4.68)	242,596	0.33 (0.30-0.35)	1.33 (1.28-1.38)	1.95 (1.88-2.01)	2.94 (2.85-3.03)	3.40 (3.29-3.52)	3.69 (3.53-3.85)
unconstrained, fixed	65 to 74	132,197	0.45 (0.42-0.49)	1.42 (1.36-1.49)	1.98 (1.90-2.07)	2.88 (2.76-3.01)	3.59 (3.40-3.78)	4.07 (3.79-4.37)	166,550	0.28 (0.25-0.30)	1.22 (1.16-1.28)	1.75 (1.68-1.83)	2.67 (2.57-2.78)	3.11 (2.97-3.25)	3.41 (3.22-3.62)
unconstrained, mobile	65 to 74	6,425	0.46 (0.32-0.67)	1.85 (1.54-2.23)	2.71 (2.31-3.16)	4.09 (3.56-4.70)	4.57 (3.98-5.25)	*4.74 (4.07-5.51)*	8,320	0.44 (0.32-0.61)	1.69 (1.43-2.01)	2.42 (2.09-2.80)	3.77 (3.33-4.28)	4.23 (3.72-4.81)	*4.57 (3.90-5.36)*
posterior-stabilised, fixed	65 to 74	43,148	0.54 (0.47-0.61)	1.79 (1.66-1.93)	2.55 (2.39-2.73)	4.06 (3.81-4.32)	4.92 (4.57-5.29)	5.39 (4.93-5.90)	58,790	0.41 (0.36-0.47)	1.49 (1.39-1.60)	2.31 (2.17-2.45)	3.42 (3.23-3.62)	3.95 (3.71-4.21)	4.20 (3.90-4.52)
posterior-stabilised, mobile	65 to 74	1,994	0.51 (0.27-0.95)	1.96 (1.42-2.70)	2.75 (2.09-3.62)	3.56 (2.72-4.65)	*4.41 (3.31-5.86)*	*4.41 (3.31-5.86)*	2,396	0.59 (0.35-1.00)	1.96 (1.47-2.61)	2.61 (2.03-3.37)	3.83 (3.01-4.86)	4.39 (3.41-5.65)	*4.39 (3.41-5.65)*
constrained condylar	65 to 74	1,326	0.93 (0.51-1.67)	2.63 (1.80-3.83)	3.60 (2.54-5.10)	*5.26 (3.28-8.36)*	*5.26 (3.28-8.36)*	*8.64 (3.83-18.88)*	2,253	0.88 (0.56-1.38)	2.32 (1.71-3.14)	3.05 (2.28-4.08)	*3.37 (2.51-4.52)*	*3.37 (2.51-4.52)*	*3.37 (2.51-4.52)*
monobloc polyethylene tibia	65 to 74	2,674	0.12 (0.04-0.37)	1.55 (1.11-2.16)	2.04 (1.51-2.77)	*2.74 (2.04-3.69)*	*3.31 (2.18-5.01)*		3,973	0.37 (0.22-0.63)	1.59 (1.22-2.07)	2.12 (1.67-2.70)	2.82 (2.20-3.61)	*3.15 (2.33-4.24)*	*3.15 (2.33-4.24)*
pre-assembled/hinged/ linked	65 to 74	157	*3.32 (1.40-7.80)*	*8.08 (4.54-14.16)*	*10.56 (6.16-17.81)*	*14.55 (8.95-23.19)*			314	1.36 (0.51-3.58)	*3.81 (2.06-6.99)*	*5.28 (3.08-8.99)*	*6.94 (3.74-12.72)*	*6.94 (3.74-12.72)*	

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All uncemented	**65 to 74**	**8,728**	**0.57 (0.43-0.75)**	**1.85 (1.58-2.17)**	**2.36 (2.04-2.72)**	**3.42 (2.99-3.91)**	**4.20 (3.60-4.88)**	*4.63 (3.89-5.50)*	**8,725**	**0.48 (0.35-0.65)**	**2.26 (1.96-2.61)**	**3.01 (2.65-3.41)**	**3.87 (3.44-4.36)**	**4.33 (3.84-4.89)**	**4.73 (4.08-5.48)**
unconstrained, fixed	65 to 74	3,384	0.59 (0.37-0.92)	2.20 (1.74-2.79)	2.84 (2.30-3.52)	3.83 (3.14-4.67)	4.40 (3.52-5.49)	*4.40 (3.52-5.49)*	3,117	0.50 (0.30-0.83)	2.64 (2.11-3.30)	3.21 (2.62-3.94)	4.08 (3.37-4.93)	4.70 (3.86-5.72)	*5.03 (4.02-6.29)*
unconstrained, mobile	65 to 74	4,651	0.48 (0.32-0.74)	1.56 (1.23-1.97)	1.93 (1.55-2.40)	3.12 (2.56-3.79)	4.09 (3.26-5.12)	*4.66 (3.59-6.05)*	5,074	0.50 (0.34-0.74)	2.06 (1.69-2.50)	2.90 (2.45-3.43)	3.74 (3.19-4.38)	4.06 (3.46-4.78)	*4.26 (3.56-5.08)*
posterior-stabilised, fixed	65 to 74	604	1.02 (0.46-2.26)	2.14 (1.22-3.74)	3.04 (1.87-4.94)	*3.69 (2.31-5.87)*	*4.25 (2.63-6.85)*	*5.53 (3.09-9.80)*	504	0.20 (0.03-1.40)	2.28 (1.23-4.21)	3.06 (1.78-5.22)	*4.21 (2.56-6.88)*	*4.81 (2.92-7.87)*	*7.53 (3.48-15.89)*
other constraints	65 to 74	89	*1.15 (0.16-7.88)*	*2.43 (0.61-9.40)*	*2.43 (0.61-9.40)*	*2.43 (0.61-9.40)*			30	*0*	*0*	*0*			
All hybrid	**65 to 74**	**1,692**	**0.43 (0.20-0.89)**	**1.71 (1.17-2.48)**	**1.99 (1.41-2.82)**	**2.95 (2.16-4.01)**	**3.37 (2.44-4.64)**	*3.37 (2.44-4.64)*	**1,956**	**0.52 (0.28-0.96)**	**1.57 (1.09-2.24)**	**1.75 (1.24-2.47)**	**2.51 (1.85-3.39)**	**2.78 (2.05-3.76)**	*3.01 (2.19-4.13)*
unconstrained, fixed	65 to 74	1,195	0.26 (0.08-0.79)	1.58 (1.00-2.50)	1.87 (1.22-2.86)	2.71 (1.87-3.92)	*2.92 (2.02-4.23)*	*2.92 (2.02-4.23)*	1,305	0.31 (0.12-0.83)	1.27 (0.78-2.07)	1.27 (0.78-2.07)	2.14 (1.45-3.16)	2.47 (1.68-3.63)	*2.75 (1.85-4.09)*
unconstrained, mobile	65 to 74	311	1.33 (0.50-3.49)	*2.04 (0.92-4.49)*	*2.49 (1.19-5.18)*	*3.89 (1.96-7.64)*	*6.30 (2.68-14.41)*	*6.30 (2.68-14.41)*	469	1.29 (0.58-2.85)	2.70 (1.54-4.71)	*3.40 (2.00-5.73)*	*3.86 (2.29-6.45)*	*3.86 (2.29-6.45)*	*3.86 (2.29-6.45)*
posterior-stabilised, fixed	65 to 74	119	*0*	*3.43 (1.12-10.25)*	*3.43 (1.12-10.25)*	*5.40 (1.98-14.24)*	*5.40 (1.98-14.24)*		139	*0*	*1.08 (0.15-7.39)*	*2.24 (0.56-8.67)*	*2.24 (0.56-8.67)*	*2.24 (0.56-8.67)*	
other constraints	65 to 74	67	*0*	*0*	*0*	*0*	*0*		43			*0*	*0*	*0*	
All unicondylar, cemented	**65 to 74**	**16,360**	**0.87 (0.73-1.03)**	**3.03 (2.76-3.33)**	**4.30 (3.97-4.67)**	**7.96 (7.41-8.55)**	**11.40 (10.51-12.36)**	**12.59 (11.48-13.80)**	**12,972**	**0.79 (0.65-0.96)**	**3.12 (2.81-3.46)**	**4.96 (4.56-5.40)**	**9.87 (9.19-10.59)**	**13.36 (12.38-14.41)**	**15.23 (13.93-16.64)**
fixed	65 to 74	6,438	0.68 (0.49-0.93)	2.45 (2.04-2.93)	3.32 (2.81-3.93)	5.95 (4.93-7.18)	*10.18 (7.64-13.50)*	*10.18 (7.64-13.50)*	4,768	0.47 (0.31-0.73)	2.19 (1.76-2.74)	3.40 (2.79-4.14)	6.72 (5.40-8.34)	*8.14 (6.35-10.39)*	*8.14 (6.35-10.39)*
mobile	65 to 74	8,844	1.04 (0.85-1.28)	3.33 (2.96-3.73)	4.65 (4.21-5.13)	8.73 (8.04-9.47)	12.13 (11.11-13.25)	*13.50 (12.20-14.93)*	7,377	1.04 (0.83-1.30)	3.57 (3.16-4.04)	5.68 (5.15-6.27)	11.15 (10.32-12.04)	14.95 (13.78-16.21)	*17.12 (15.58-18.81)*
monobloc polyethylene tibia	65 to 74	1,078	0.47 (0.20-1.14)	3.38 (2.41-4.72)	5.51 (4.21-7.19)	7.19 (5.60-9.22)	*10.05 (7.66-13.14)*	*11.11 (8.18-15.01)*	827	0.25 (0.06-0.98)	3.21 (2.16-4.75)	4.60 (3.29-6.41)	7.18 (5.35-9.60)	*10.17 (7.64-13.49)*	*11.15 (8.17-15.13)*
All unicondylar, uncemented/hybrid	**65 to 74**	**5,288**	**1.09 (0.84-1.43)**	**2.54 (2.10-3.08)**	**3.51 (2.90-4.24)**	*4.89 (3.91-6.09)*	*12.55 (6.80-22.55)*		**4,022**	**0.92 (0.66-1.29)**	**2.99 (2.42-3.69)**	**4.68 (3.83-5.73)**	*9.82 (7.38-13.01)*	*18.17 (10.17-31.26)*	
fixed	65 to 74	165	*0.62 (0.09-4.30)*	*6.14 (3.10-11.96)*	*9.84 (5.45-17.45)*	*13.48 (7.70-23.03)*			190	*0*	*2.54 (0.82-7.68)*	*7.29 (3.50-14.85)*	*10.38 (5.41-19.43)*		
mobile	65 to 74	5,059	1.10 (0.84-1.45)	2.37 (1.93-2.90)	3.15 (2.57-3.86)	*4.35 (3.38-5.59)*	*14.49 (7.37-27.39)*		3,747	0.99 (0.71-1.39)	3.00 (2.42-3.73)	4.43 (3.58-5.48)	*11.15 (7.81-15.79)*		
monobloc polyethylene tibia	65 to 74	64	*1.56 (0.22-10.58)*	*4.74 (1.55-13.97)*	*6.50 (2.49-16.43)*	*8.34 (3.55-18.93)*			85	*0*	*2.44 (0.62-9.41)*	*3.71 (1.21-11.06)*	*3.71 (1.21-11.06)*		

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
Patellofemoral	65 to 74	740	1.82 (1.06-3.11)	6.62 (4.95-8.84)	10.24 (8.03-13.02)	*18.95 (15.28-23.36)*	*18.95 (15.28-23.36)*		2,179	0.86 (0.54-1.36)	5.36 (4.45-6.46)	8.50 (7.31-9.87)	17.89 (15.87-20.15)	*21.91 (19.35-24.76)*	*24.90 (20.76-29.71)*
Multicompartmental	65 to 74	69	*2.90 (0.73-11.10)*	*6.06 (2.31-15.37)*	*9.89 (4.53-20.86)*	*13.95 (7.16-26.20)*			74	*1.45 (0.21-9.84)*	*5.86 (2.24-14.87)*	*7.54 (3.20-17.21)*	*9.43 (4.32-19.90)*		
All cases	≥75	158,573	0.43 (0.39-0.46)	1.13 (1.08-1.19)	1.50 (1.43-1.57)	2.20 (2.09-2.31)	2.51 (2.36-2.67)	2.84 (2.54-3.18)	233,944	0.39 (0.36-0.41)	1.04 (1.00-1.09)	1.43 (1.38-1.49)	2.09 (2.01-2.17)	2.47 (2.36-2.60)	2.67 (2.51-2.85)
Unclassified	≥75	2,416	0.34 (0.17-0.68)	0.99 (0.65-1.51)	1.57 (1.11-2.21)	2.90 (2.17-3.87)	*2.90 (2.17-3.87)*	*2.90 (2.17-3.87)*	3,810	0.56 (0.37-0.86)	1.31 (0.99-1.74)	1.82 (1.42-2.33)	2.75 (2.20-3.44)	3.40 (2.54-4.55)	*3.40 (2.54-4.55)*
All cemented	≥75	139,508	0.39 (0.35-0.42)	1.05 (1.00-1.11)	1.38 (1.31-1.45)	1.96 (1.85-2.07)	2.22 (2.07-2.38)	2.37 (2.15-2.61)	212,018	0.35 (0.33-0.38)	0.94 (0.90-0.99)	1.28 (1.23-1.34)	1.83 (1.76-1.92)	2.14 (2.03-2.26)	2.26 (2.12-2.41)
unconstrained, fixed	≥75	96,349	0.37 (0.33-0.41)	1.01 (0.94-1.08)	1.30 (1.22-1.38)	1.85 (1.73-1.98)	2.11 (1.93-2.30)	2.25 (1.99-2.55)	141,304	0.32 (0.29-0.35)	0.90 (0.84-0.95)	1.20 (1.14-1.27)	1.74 (1.65-1.84)	2.03 (1.89-2.17)	2.09 (1.94-2.25)
unconstrained, mobile	≥75	4,222	0.37 (0.22-0.61)	1.00 (0.73-1.38)	1.54 (1.18-2.01)	1.89 (1.46-2.45)	*2.20 (1.54-3.14)*	*2.20 (1.54-3.14)*	7,285	0.42 (0.30-0.60)	0.92 (0.72-1.18)	1.37 (1.10-1.69)	1.86 (1.52-2.28)	2.32 (1.81-2.97)	*2.32 (1.81-2.97)*
posterior-stabilised, fixed	≥75	33,001	0.43 (0.36-0.50)	1.13 (1.01-1.26)	1.53 (1.38-1.68)	2.27 (2.04-2.52)	2.54 (2.25-2.87)	*2.76 (2.28-3.34)*	53,423	0.37 (0.32-0.43)	1.03 (0.94-1.13)	1.43 (1.32-1.54)	2.03 (1.88-2.20)	2.32 (2.11-2.55)	2.62 (2.27-3.03)
posterior-stabilised, mobile	≥75	1,127	0.55 (0.25-1.21)	1.44 (0.87-2.37)	1.58 (0.96-2.57)	*1.93 (1.20-3.10)*	*1.93 (1.20-3.10)*		1,737	0.47 (0.24-0.94)	0.92 (0.55-1.52)	1.31 (0.84-2.03)	1.84 (1.20-2.82)	*2.62 (1.55-4.42)*	*2.62 (1.55-4.42)*
constrained condylar	≥75	1,069	0.92 (0.48-1.77)	2.08 (1.28-3.36)	2.36 (1.46-3.82)	*3.15 (1.71-5.75)*			2,355	1.03 (0.69-1.55)	1.60 (1.13-2.28)	1.83 (1.28-2.61)	*2.09 (1.41-3.11)*	*2.09 (1.41-3.11)*	
monobloc polyethylene tibia	≥75	3,523	0.30 (0.16-0.56)	1.08 (0.77-1.53)	1.34 (0.97-1.86)	*1.62 (1.18-2.22)*	*1.62 (1.18-2.22)*		5,120	0.43 (0.28-0.67)	0.86 (0.63-1.17)	1.13 (0.85-1.52)	1.49 (1.09-2.04)	*1.49 (1.09-2.04)*	
pre-assembled/hinged/ linked	≥75	217	*0.49 (0.07-3.40)*	*2.23 (0.84-5.85)*	*2.23 (0.84-5.85)*				794	1.51 (0.84-2.71)	3.08 (1.99-4.76)	*4.16 (2.76-6.25)*	*6.63 (4.06-10.75)*		
All uncemented	≥75	5,558	0.54 (0.38-0.78)	1.34 (1.05-1.70)	1.77 (1.43-2.19)	2.33 (1.91-2.85)	2.33 (1.91-2.85)	*2.33 (1.91-2.85)*	7,091	0.53 (0.39-0.74)	1.30 (1.05-1.60)	1.63 (1.35-1.98)	1.99 (1.66-2.39)	2.74 (2.13-3.51)	*2.96 (2.25-3.89)*
unconstrained, fixed	≥75	2,151	0.64 (0.37-1.10)	1.08 (0.70-1.65)	1.55 (1.07-2.24)	1.93 (1.35-2.74)	*1.93 (1.35-2.74)*	*1.93 (1.35-2.74)*	2,720	0.72 (0.46-1.13)	1.54 (1.13-2.11)	1.98 (1.49-2.62)	1.98 (1.49-2.62)	*2.93 (1.98-4.34)*	*2.93 (1.98-4.34)*
unconstrained, mobile	≥75	3,005	0.51 (0.31-0.85)	1.35 (0.98-1.86)	1.72 (1.28-2.30)	2.36 (1.80-3.10)	*2.36 (1.80-3.10)*	*2.36 (1.80-3.10)*	3,877	0.42 (0.26-0.68)	1.18 (0.88-1.59)	1.38 (1.04-1.82)	1.90 (1.46-2.47)	*2.24 (1.69-2.97)*	*2.65 (1.81-3.87)*
posterior-stabilised, fixed	≥75	358	0.29 (0.04-2.01)	*2.71 (1.36-5.37)*	*3.53 (1.91-6.50)*	*4.74 (2.67-8.36)*	*4.74 (2.67-8.36)*		483	0.42 (0.11-1.68)	0.89 (0.34-2.37)	*1.96 (0.92-4.16)*	*3.45 (1.80-6.56)*	*5.81 (2.41-13.64)*	*5.81 (2.41-13.64)*
other constraints	≥75	44	*0*	*2.50 (0.36-16.45)*	*2.50 (0.36-16.45)*				11		*0*				

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K6 (continued)

Fixation/constraint/ bearing type	Age at primary (years)	Males							Females						
		N	Time since primary						N	Time since primary					
			1 year	3 years	5 years	10 years	13 years	15 years		1 year	3 years	5 years	10 years	13 years	15 years
All hybrid	≥75	**1,173**	**0.44 (0.18-1.06)**	**0.92 (0.50-1.71)**	**1.33 (0.77-2.30)**	**2.27 (1.39-3.68)**	*2.27 (1.39-3.68)*	*2.27 (1.39-3.68)*	**1,702**	**0.67 (0.37-1.21)**	**1.32 (0.86-2.02)**	**1.55 (1.04-2.31)**	**2.07 (1.43-3.00)**	*2.07 (1.43-3.00)*	*2.07 (1.43-3.00)*
unconstrained, fixed	≥75	818	0.38 (0.12-1.19)	0.93 (0.44-1.94)	1.45 (0.78-2.70)	*2.41 (1.40-4.12)*	*2.41 (1.40-4.12)*	*2.41 (1.40-4.12)*	1,130	0.63 (0.30-1.32)	1.20 (0.70-2.06)	1.52 (0.94-2.48)	2.05 (1.32-3.18)	*2.05 (1.32-3.18)*	*2.05 (1.32-3.18)*
unconstrained, mobile	≥75	213	*0.94 (0.24-3.71)*	*0.94 (0.24-3.71)*	*0.94 (0.24-3.71)*	*0.94 (0.24-3.71)*			415	0.99 (0.37-2.62)	1.28 (0.53-3.06)	*1.28 (0.53-3.06)*	*2.05 (0.82-5.07)*	*2.05 (0.82-5.07)*	
posterior-stabilised, fixed	≥75	84	*0*	*1.67 (0.24-11.25)*	*1.67 (0.24-11.25)*	*1.67 (0.24-11.25)*			112	*0*	*4.24 (1.38-12.64)*	*4.24 (1.38-12.64)*	*4.24 (1.38-12.64)*		
other constraints	≥75	58	*0*	*0*	*0*	*3.23 (0.46-20.77)*			45	*0*	*0*	*0*	*0*	*0*	
All unicondylar, cemented	≥75	**7,019**	**0.82 (0.63-1.07)**	**2.21 (1.86-2.62)**	**3.14 (2.70-3.65)**	**5.35 (4.62-6.19)**	**6.78 (5.64-8.15)**	*9.52 (6.65-13.55)*	**6,332**	**1.17 (0.93-1.48)**	**3.11 (2.69-3.61)**	**4.70 (4.14-5.33)**	**7.82 (6.99-8.76)**	**9.37 (8.20-10.70)**	*11.38 (9.20-14.04)*
fixed	≥75	2,764	0.48 (0.27-0.85)	1.35 (0.92-1.98)	2.27 (1.60-3.22)	*3.06 (2.07-4.51)*	*6.66 (2.92-14.77)*		2,241	0.82 (0.50-1.33)	2.65 (1.95-3.59)	3.87 (2.93-5.11)	*5.74 (4.31-7.62)*	*5.74 (4.31-7.62)*	
mobile	≥75	3,729	1.10 (0.81-1.50)	2.76 (2.26-3.36)	3.70 (3.10-4.41)	6.02 (5.12-7.06)	*7.36 (6.07-8.91)*	*10.56 (7.26-15.24)*	3,635	1.37 (1.04-1.81)	3.49 (2.93-4.16)	5.25 (4.54-6.08)	8.62 (7.60-9.78)	*10.61 (9.15-12.29)*	*13.08 (10.43-16.35)*
monobloc polyethylene tibia	≥75	526	0.39 (0.10-1.53)	1.68 (0.84-3.33)	*2.50 (1.38-4.50)*	*6.18 (3.69-10.27)*	*6.18 (3.69-10.27)*		456	1.12 (0.47-2.66)	2.08 (1.09-3.97)	3.16 (1.84-5.39)	*5.89 (3.77-9.15)*	*5.89 (3.77-9.15)*	
All unicondylar, uncemented/hybrid	≥75	**2,390**	**1.36 (0.95-1.94)**	**2.22 (1.64-3.01)**	**2.67 (1.95-3.67)**	*4.49 (2.69-7.45)*			**1,817**	**0.70 (0.40-1.23)**	**1.96 (1.35-2.84)**	**3.06 (2.17-4.31)**	*4.86 (3.11-7.55)*		
fixed	≥75	81	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*				163	*0.63 (0.09-4.38)*	*2.61 (0.83-8.07)*	*3.86 (1.43-10.23)*	*5.58 (2.25-13.49)*		
mobile	≥75	2,274	1.38 (0.96-1.98)	2.30 (1.69-3.13)	2.81 (2.03-3.88)	*4.63 (2.59-8.21)*			1,621	0.72 (0.40-1.30)	1.95 (1.31-2.89)	3.10 (2.14-4.47)	*5.55 (3.09-9.85)*		
monobloc polyethylene tibia	≥75	35		*0*	*0*				33			*0*			
Patellofemoral	≥75	**484**	**0.45 (0.11-1.77)**	**3.01 (1.72-5.26)**	*4.07 (2.46-6.72)*	*6.61 (3.97-10.91)*	*6.61 (3.97-10.91)*		**1,150**	**0.54 (0.24-1.20)**	**2.91 (2.03-4.16)**	**5.93 (4.55-7.71)**	*9.26 (7.25-11.78)*	*9.26 (7.25-11.78)*	
Multicompartmental	≥75	**25**		*5.00 (0.72-30.53)*	*5.00 (0.72-30.53)*				**24**	*0*	*0*	*0*			

Note: Total sample on which results are based is 1,300,897 primary knee replacements.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Unicompartmental knee replacements seem to fare worse compared to TKR, with the chance of revision at each estimated time point being approximately double or more than that of a TKR (Table 3.K5 on page 132). The revision rate for cemented unicondylar (medial or lateral UKR) knee replacements is 3.3 times higher than the observed rate for cemented TKR at 10 years and 3.7 times higher at 15 years. The revision rate for uncemented unicondylar (medial or lateral UKR) knee replacements is 2.5 times higher than for cemented TKR at 10 years and 3.0 times higher at 15 years, although the numbers for the last estimate are small and should be treated with caution. The revision rate for patellofemoral replacement is 5.7 times higher than for cemented TKR at 10 and 15 years although again, the number of patellofemoral replacements at risk at 15 years is small. Multicompartmental knee replacements have relatively small numbers, at five years the risk of revision is 4.6 times higher than for cemented TKR, 1.7 times higher than for cemented unicondylar knee replacements and 2.4 times higher than for uncemented unicondylar knee replacements. The rates are approximately equivalent to those seen for patellofemoral replacements.

First revision of an implant is slightly less likely in females than males overall for the most commonly used fixation method (cemented) but, broadly, a patient from a younger age group is more likely to be revised irrespective of gender, with the youngest group having the worst predicted outcome in terms of the risk of subsequent revision (Table 3.K6 on page 140). Conversely, female patients are more likely to have a unicondylar implant revised in the longer term compared to their male, age-equivalent counterpart, except for under the age of 55. For patellofemoral implants, males are generally more likely to undergo revision than their age-matched female counterparts. The numbers for multicompartmental knee replacements are small in the age and gender stratified groups but overall, the risk of revision is markedly higher than total knee replacement and more in keeping with patellofemoral replacement out to five years where the numbers at risk remain above 250.

3.3.3 Revisions after primary knee replacement surgery by main brands for TKR and UKR

As in previous reports, only brands that have been used in a primary knee replacement in 1,000 or more operations have been included (Tables 3.K7 (a) and (b) and Table 3.K8 (on pages 148 to 156). Table 3.K7 (b) shows a breakdown of these included brands according to whether the patella was resurfaced or not at the time of the primary procedure. In Table 3.K9 (a) (page 157) brands are displayed with a breakdown according to fixation, constraint and bearing mobility where there are more than 2,500 operations for TKR and more than 1,000 operations for UKR. Table 3.K9 (b) (page 161) provides an additional breakdown for the TKRs displayed in Table 3.K9 (a) according to whether the patella was resurfaced or not. Further breakdowns by component are available from other sources of information, such as ODEP. The figures in blue italics are at time points where fewer than 250 primary knee replacements remain at risk. No results are shown at all where the number had fallen below ten cases. No attempt has been made to adjust for other factors that may influence the chance of revision, so the figures are unadjusted probabilities. Given that the sub-groups may differ in composition with respect to age and gender, the percentage of males and the median (IQR) of the ages are also shown in these tables.

Table 3.K7 (a) KM estimates of cumulative **revision** (95% CI) by **total knee** replacement **brands**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
All total knee replacements	1,145,052	70 (63 to 76)	43	0.43 (0.42-0.44)	1.56 (1.53-1.58)	2.23 (2.20-2.26)	3.42 (3.38-3.47)	4.23 (4.16-4.30)	4.80 (4.70-4.90)
ACS PC[Fem]ACS[Tib]	1,138	68 (61 to 73)	50	0.71 (0.36-1.42)	2.59 (1.79-3.73)	3.24 (2.32-4.51)	*4.77 (3.44-6.60)*		
Advance MP Stature[Fem] Advance[Tib]	1,497	69 (62 to 75)	13	0.07 (0.01-0.48)	1.68 (1.12-2.52)	2.54 (1.81-3.55)	*2.94 (2.11-4.10)*		
Advance MP[Fem] Advance[Tib]	8,860	70 (64 to 76)	48	0.58 (0.44-0.76)	2.14 (1.85-2.48)	3.05 (2.69-3.46)	4.47 (3.96-5.03)	5.12 (4.44-5.91)	*5.44 (4.56-6.48)*
Advance PS[Fem] Advance[Tib]	1,390	72 (66 to 77)	45	0.60 (0.30-1.20)	2.79 (2.00-3.89)	3.48 (2.57-4.70)	6.40 (4.87-8.38)	*8.11 (6.01-10.89)*	*8.11 (6.01-10.89)*
AGC V2[Fem:Tib]	36,334	71 (65 to 77)	39	0.32 (0.27-0.39)	1.54 (1.42-1.67)	2.21 (2.06-2.37)	3.54 (3.34-3.76)	4.83 (4.52-5.15)	5.94 (5.47-6.45)
AGC V2[Fem]AGC[Tib]	2,671	70 (64 to 76)	99	0.19 (0.08-0.45)	1.36 (0.98-1.89)	2.03 (1.55-2.67)	3.48 (2.78-4.35)	5.58 (4.37-7.12)	*7.31 (5.40-9.85)*
AGC[Fem:Tib]	2,072	70 (64 to 76)	91	0.59 (0.33-1.03)	2.01 (1.48-2.73)	2.68 (2.05-3.50)	4.92 (3.91-6.18)	*6.74 (5.16-8.76)*	*6.74 (5.16-8.76)*
AGC[Fem]AGC V2[Tib]	26,911	71 (64 to 77)	39	0.27 (0.22-0.34)	1.56 (1.42-1.72)	2.21 (2.03-2.40)	3.54 (3.28-3.81)	4.68 (4.29-5.11)	6.25 (5.50-7.10)
AS Columbus Cemented[Fem] Columbus[Tib]	1,866	65 (59 to 71)	40	0.29 (0.12-0.70)	1.81 (1.20-2.73)	2.31 (1.54-3.47)			
Attune[Fem]Attune FB[Tib]	25,723	69 (62 to 76)	43	0.41 (0.34-0.50)	1.69 (1.50-1.90)	2.71 (2.32-3.17)			
Attune[Fem]Attune RP[Tib]	4,254	69 (62 to 76)	44	0.21 (0.11-0.43)	1.05 (0.73-1.51)	1.71 (1.17-2.50)			
Columbus Cemented[Fem] Columbus[Tib]	14,623	71 (65 to 77)	44	0.47 (0.37-0.60)	1.58 (1.38-1.82)	2.27 (2.00-2.57)	3.28 (2.85-3.78)	*3.56 (2.99-4.23)*	*3.56 (2.99-4.23)*
E-Motion Bicondylar Knee[Fem] E-Motion[Tib]	3,387	67 (61 to 74)	44	0.66 (0.43-1.00)	2.47 (1.98-3.06)	3.45 (2.86-4.16)	4.73 (3.94-5.67)	*5.26 (4.34-6.36)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	1,278	76 (68 to 83)	28	1.35 (0.83-2.19)	3.51 (2.56-4.80)	5.27 (4.02-6.89)	*8.66 (6.42-11.64)*	*11.13 (7.89-15.59)*	*11.13 (7.89-15.59)*
EvolutionMP[Fem:Tib]	1,551	69 (62 to 76)	45	0.59 (0.29-1.17)	2.01 (1.30-3.10)	*2.75 (1.77-4.26)*			
Genesis II Oxinium[Fem] Genesis II[Tib]	10,959	59 (54 to 65)	40	0.56 (0.43-0.72)	2.48 (2.18-2.82)	3.62 (3.24-4.04)	6.32 (5.70-7.00)	7.56 (6.68-8.54)	8.27 (7.13-9.59)
Genesis II[Fem:Tib]	81,899	71 (65 to 77)	42	0.47 (0.42-0.52)	1.57 (1.48-1.67)	2.14 (2.03-2.26)	3.17 (3.00-3.36)	3.49 (3.25-3.75)	3.80 (3.28-4.39)
Insall-Burstein II Microport[Fem] Insall-Burstein (Microport)[Tib]	2,020	71 (65 to 77)	45	0.35 (0.17-0.73)	1.74 (1.25-2.43)	2.93 (2.26-3.79)	5.09 (4.16-6.22)	6.71 (5.56-8.10)	7.33 (6.06-8.85)
Journey II BCS Oxinium[Fem] Journey[Tib]	3,486	66 (59 to 72)	41	0.62 (0.39-0.97)	2.96 (2.23-3.90)	*3.29 (2.47-4.38)*			
Kinemax[Fem:Tib]	10,881	71 (64 to 77)	43	0.24 (0.16-0.35)	1.73 (1.50-2.00)	2.68 (2.39-3.01)	4.72 (4.32-5.17)	6.10 (5.61-6.64)	6.78 (6.22-7.39)

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
LCS Complete[Fem] M.B.T.[Tib]	28,496	70 (63 to 76)	44	0.43 (0.36-0.52)	1.70 (1.55-1.87)	2.52 (2.33-2.72)	3.71 (3.46-3.99)	4.33 (3.99-4.71)	*4.58 (4.10-5.12)*
LCS[Fem:Tib]	2,002	70 (63 to 76)	41	0.65 (0.38-1.12)	1.78 (1.28-2.47)	2.32 (1.74-3.09)	2.99 (2.31-3.88)	3.36 (2.62-4.31)	3.80 (2.98-4.84)
Legion[Fem]Genesis II[Tib]	1,045	71 (65 to 77)	44	0.50 (0.21-1.19)	1.60 (0.97-2.65)	2.20 (1.40-3.45)			
Maxim[Fem] Vanguard[Tib]	1,883	70 (63 to 76)	42	0.38 (0.18-0.79)	1.91 (1.38-2.65)	2.83 (2.16-3.71)	5.48 (4.45-6.74)	7.78 (6.35-9.51)	*9.86 (7.75-12.49)*
MRK[Fem:Tib]	14,586	70 (64 to 77)	44	0.30 (0.22-0.41)	1.19 (1.01-1.40)	1.67 (1.45-1.93)	2.85 (2.47-3.28)	3.16 (2.69-3.71)	*3.52 (2.75-4.49)*
Natural Knee II[Fem] NK2[Tib]	2,814	70 (64 to 76)	42	0.32 (0.17-0.62)	1.34 (0.97-1.85)	2.22 (1.72-2.84)	4.03 (3.31-4.91)	6.39 (5.24-7.79)	*7.15 (5.68-8.99)*
Nexgen LCCK[Fem] Nexgen[Tib]	1,014	71 (63 to 79)	37	1.33 (0.77-2.28)	2.93 (1.98-4.33)	3.73 (2.57-5.40)	*5.70 (3.68-8.78)*	*6.88 (4.20-11.15)*	*6.88 (4.20-11.15)*
Nexgen[Fem:Tib]	167,832	70 (64 to 76)	42	0.38 (0.35-0.41)	1.35 (1.29-1.41)	2.13 (2.05-2.21)	3.64 (3.51-3.77)	4.45 (4.26-4.65)	4.86 (4.58-5.16)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet)[Tib]	3,205	67 (59 to 74)	47	0.47 (0.29-0.79)	1.94 (1.50-2.51)	2.67 (2.13-3.33)	4.55 (3.76-5.49)	5.74 (4.69-7.03)	*7.20 (5.58-9.26)*
Nexgen[Fem]TM Monoblock[Tib]	4,244	64 (58 to 71)	57	0.60 (0.41-0.89)	2.62 (2.17-3.16)	3.33 (2.81-3.94)	4.38 (3.77-5.09)	4.93 (4.22-5.76)	*5.23 (4.35-6.28)*
Optetrak CR[Fem] Optetrak[Tib]	1,638	70 (63 to 76)	43	0.86 (0.51-1.45)	3.45 (2.66-4.47)	4.90 (3.94-6.09)	7.80 (6.42-9.47)	*8.21 (6.73-9.98)*	*8.21 (6.73-9.98)*
Persona CR[Fem] Persona[Tib]	3,294	70 (63 to 76)	46	0.19 (0.08-0.47)	0.54 (0.24-1.19)	*2.10 (0.81-5.42)*			
Persona PS[Fem] Persona[Tib]	1,266	70 (63 to 76)	42	0.53 (0.24-1.17)	1.78 (1.08-2.92)	*3.99 (2.50-6.32)*			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	17,154	65 (58 to 72)	47	0.63 (0.52-0.76)	2.03 (1.83-2.26)	2.83 (2.58-3.10)	4.03 (3.71-4.37)	4.75 (4.34-5.20)	*5.35 (4.59-6.23)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	166,590	70 (64 to 76)	43	0.39 (0.36-0.43)	1.32 (1.26-1.38)	1.83 (1.76-1.90)	2.58 (2.49-2.67)	3.07 (2.96-3.19)	3.46 (3.31-3.62)
PFC Sigma Bicondylar Knee[Fem] PFC Sigma Bicondylar[Tib]	184,814	70 (64 to 77)	42	0.38 (0.35-0.41)	1.46 (1.40-1.52)	2.03 (1.95-2.10)	2.80 (2.69-2.91)	*2.95 (2.82-3.09)*	
Profix[Fem:Tib]	3,849	73 (67 to 78)	43	0.42 (0.26-0.69)	1.36 (1.03-1.78)	1.78 (1.40-2.26)	2.67 (2.18-3.26)	3.06 (2.50-3.75)	*4.39 (3.18-6.04)*
Rotaglide +[Fem:Tib]	1,999	70 (63 to 76)	44	0.65 (0.38-1.13)	3.03 (2.36-3.90)	3.90 (3.12-4.86)	6.44 (5.39-7.70)	7.73 (6.51-9.16)	*8.78 (7.34-10.47)*
Rotaglide[Fem:Tib]	1,449	71 (63 to 77)	39	0.49 (0.23-1.02)	2.37 (1.69-3.32)	3.86 (2.93-5.07)	4.34 (3.32-5.66)	*6.57 (4.57-9.40)*	*6.57 (4.57-9.40)*
Saiph[Fem:Tib]	1,484	69 (63 to 76)	37	0.65 (0.32-1.30)	1.51 (0.92-2.49)	*1.70 (1.04-2.76)*			
Scorpio NRG[Fem:Tib]	14,094	70 (64 to 76)	43	0.41 (0.32-0.53)	1.60 (1.40-1.82)	2.46 (2.21-2.75)	3.76 (3.39-4.16)	*4.39 (3.82-5.05)*	
Scorpio[Fem:Tib]	3,255	68 (61 to 75)	45	0.37 (0.21-0.65)	2.17 (1.72-2.74)	3.12 (2.57-3.80)	4.67 (3.96-5.49)	5.41 (4.58-6.38)	*5.78 (4.73-7.05)*
Scorpio[Fem]Scorpio NRG[Tib]	21,682	71 (64 to 77)	42	0.44 (0.36-0.54)	1.83 (1.66-2.02)	2.63 (2.42-2.86)	4.04 (3.77-4.33)	4.95 (4.62-5.29)	5.15 (4.80-5.53)

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Sphere[Fem]GMK[Tib]	1,485	69 (62 to 75)	44	0.92 (0.52-1.62)	2.34 (1.57-3.48)	3.11 (2.12-4.56)			
TC Plus[Fem:Tib]	16,004	70 (64 to 76)	45	0.69 (0.57-0.83)	1.80 (1.61-2.02)	2.40 (2.17-2.65)	3.53 (3.24-3.85)	4.24 (3.88-4.63)	*4.99 (4.35-5.74)*
Triathlon[Fem:Tib]	133,729	70 (63 to 76)	43	0.51 (0.47-0.55)	1.55 (1.48-1.63)	2.19 (2.10-2.29)	3.37 (3.18-3.56)	3.89 (3.56-4.24)	
Unity Knee[Fem] Unity[Tib]	1,364	70 (63 to 76)	45	0.24 (0.08-0.74)	0.68 (0.32-1.45)	*1.17 (0.55-2.48)*			
Vanguard[Fem:Tib]	80,048	70 (63 to 76)	42	0.39 (0.34-0.43)	1.53 (1.44-1.63)	2.18 (2.06-2.30)	3.24 (3.01-3.50)	*3.56 (3.20-3.96)*	

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) KM estimates of cumulative **revision** (95% CI) in **total knee** replacement **brands** by whether a **patella** component was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	Patella status	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
					1 year	3 years	5 years	10 years	13 years	15 years
All total knee replacements	**With Patella**	**435,168**	**70 (63 to 76)**	**38**	**0.41 (0.40-0.43)**	**1.32 (1.28-1.36)**	**1.91 (1.87-1.96)**	**3.02 (2.95-3.09)**	**3.75 (3.64-3.86)**	**4.28 (4.12-4.44)**
	Without Patella	**709,884**	**70 (63 to 76)**	**45**	**0.44 (0.42-0.45)**	**1.70 (1.66-1.73)**	**2.41 (2.37-2.45)**	**3.65 (3.60-3.71)**	**4.50 (4.41-4.59)**	**5.09 (4.96-5.23)**
ACS PC[Fem] ACS[Tib]	With Patella	78	68.5 (61 to 75)	27	*1.28 (0.18-8.75)*	*2.73 (0.69-10.52)*	*2.73 (0.69-10.52)*			
	Without Patella	1,060	67.5 (61 to 73)	52	0.67 (0.32-1.40)	2.57 (1.76-3.75)	3.26 (2.31-4.58)	*4.82 (3.46-6.71)*		
Advance MP Stature[Fem] Advance[Tib]	With Patella	505	69 (62 to 75)	12	0	0.48 (0.12-1.91)	*1.49 (0.61-3.59)*	*1.96 (0.86-4.40)*		
	Without Patella	992	69 (62 to 75)	14	0.10 (0.01-0.73)	2.23 (1.46-3.40)	3.04 (2.11-4.38)	*3.44 (2.39-4.93)*		
Advance MP[Fem] Advance[Tib]	With Patella	3,036	70 (63 to 76)	43	0.50 (0.30-0.83)	1.54 (1.15-2.07)	2.12 (1.64-2.74)	3.48 (2.76-4.38)	3.89 (3.02-5.00)	*4.41 (3.20-6.06)*
	Without Patella	5,824	70 (64 to 76)	50	0.62 (0.44-0.86)	2.46 (2.08-2.91)	3.54 (3.06-4.08)	4.94 (4.30-5.67)	5.85 (4.85-7.04)	*5.85 (4.85-7.04)*
Advance PS[Fem] Advance[Tib]	With Patella	241	71 (66 to 76)	34	*0.90 (0.23-3.55)*	*4.32 (2.27-8.15)*	*5.40 (3.02-9.56)*	*9.53 (5.78-15.50)*	*9.53 (5.78-15.50)*	*9.53 (5.78-15.50)*
	Without Patella	1,149	72 (66 to 78)	47	0.54 (0.24-1.21)	2.46 (1.67-3.63)	3.07 (2.15-4.37)	5.71 (4.13-7.87)	*7.80 (5.47-11.07)*	*7.80 (5.47-11.07)*
AGC V2[Fem:Tib]	With Patella	11,446	71 (65 to 77)	31	0.26 (0.18-0.37)	1.22 (1.03-1.45)	1.81 (1.57-2.08)	2.92 (2.59-3.30)	4.00 (3.49-4.57)	4.88 (4.12-5.77)
	Without Patella	24,888	71 (65 to 77)	42	0.35 (0.29-0.44)	1.68 (1.53-1.85)	2.39 (2.20-2.59)	3.81 (3.56-4.09)	5.18 (4.80-5.57)	6.36 (5.79-6.99)
AGC V2[Fem] AGC[Tib]	With Patella	713	70 (64 to 75)	99	0.14 (0.02-0.99)	1.76 (1.00-3.07)	2.25 (1.36-3.71)	*4.55 (3.08-6.68)*	*5.73 (3.74-8.72)*	*5.73 (3.74-8.72)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Time since primary						
				Percentage (%) male	1 year	3 years	5 years	10 years	13 years	15 years
	Without Patella	1,958	70 (64 to 76)	99	0.21 (0.08-0.55)	1.21 (0.81-1.82)	1.95 (1.41-2.70)	3.10 (2.35-4.08)	5.46 (4.07-7.31)	*7.69 (5.37-10.96)*
AGC[Fem:Tib]	With Patella	655	70 (64 to 76)	87	0.62 (0.23-1.64)	1.75 (0.97-3.14)	2.13 (1.24-3.65)	*4.36 (2.72-6.94)*	*5.81 (3.55-9.43)*	*5.81 (3.55-9.43)*
	Without Patella	1,417	70 (63 to 76)	93	0.57 (0.29-1.14)	2.12 (1.48-3.04)	2.92 (2.14-3.97)	5.15 (3.96-6.69)	*7.23 (5.24-9.93)*	*7.23 (5.24-9.93)*
AGC[Fem]AGC V2[Tib]	With Patella	9,108	71 (64 to 77)	34	0.22 (0.14-0.34)	1.18 (0.97-1.43)	1.70 (1.44-2.01)	3.01 (2.61-3.46)	4.31 (3.69-5.04)	*6.39 (5.18-7.86)*
	Without Patella	17,803	71 (64 to 77)	41	0.30 (0.23-0.39)	1.76 (1.57-1.97)	2.46 (2.24-2.71)	3.81 (3.48-4.16)	4.84 (4.35-5.37)	5.98 (5.09-7.02)
AS Columbus Cemented[Fem] Columbus[Tib]	With Patella	1,205	65 (59 to 71)	39	0.18 (0.05-0.74)	1.53 (0.89-2.65)	2.08 (1.21-3.58)			
	Without Patella	661	64 (58 to 70)	40	0.48 (0.16-1.50)	2.37 (1.26-4.43)	*2.75 (1.50-5.00)*			
Attune[Fem] Attune FB[Tib]	With Patella	11,999	70 (62 to 76)	39	0.38 (0.28-0.51)	1.41 (1.16-1.71)	2.40 (1.85-3.11)			
	Without Patella	13,724	69 (62 to 75)	47	0.44 (0.34-0.58)	1.93 (1.66-2.24)	2.98 (2.46-3.62)			
Attune[Fem] Attune RP[Tib]	With Patella	2,731	69 (62 to 76)	40	0.20 (0.08-0.47)	0.95 (0.58-1.54)	1.30 (0.76-2.21)			
	Without Patella	1,523	69 (62 to 76)	51	0.24 (0.08-0.74)	1.23 (0.71-2.11)	*2.32 (1.36-3.92)*			
Columbus Cemented[Fem] Columbus[Tib]	With Patella	4,069	71 (64 to 77)	39	0.70 (0.48-1.02)	1.37 (1.03-1.81)	1.76 (1.36-2.29)	*3.49 (2.35-5.17)*	*5.05 (2.99-8.49)*	
	Without Patella	10,554	71 (65 to 77)	46	0.39 (0.28-0.53)	1.66 (1.42-1.95)	2.44 (2.12-2.81)	3.32 (2.85-3.85)	*3.32 (2.85-3.85)*	
E-Motion Bicondylar Knee[Fem] E-Motion[Tib]	With Patella	323	66 (60 to 73)	33	0.94 (0.30-2.88)	5.71 (3.63-8.91)	*8.29 (5.57-12.23)*	*8.29 (5.57-12.23)*		
	Without Patella	3,064	68 (61 to 74)	46	0.63 (0.40-0.98)	2.11 (1.64-2.70)	2.94 (2.37-3.64)	4.26 (3.49-5.21)	*4.80 (3.90-5.92)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	With Patella	251	75 (66 to 82)	29	*1.69 (0.64-4.45)*	*3.30 (1.57-6.83)*	*5.05 (2.73-9.24)*	*8.18 (4.10-15.98)*		
	Without Patella	1,027	76 (69 to 83)	28	1.27 (0.72-2.22)	3.57 (2.52-5.04)	5.34 (3.95-7.20)	*8.79 (6.31-12.18)*	*10.46 (7.35-14.78)*	*10.46 (7.35-14.78)*
EvolutionMP [Fem:Tib]	With Patella	506	71 (65 to 78)	44	1.03 (0.38-2.78)	*2.35 (1.09-5.05)*	*2.35 (1.09-5.05)*			
	Without Patella	1,045	68 (62 to 75)	45	0.41 (0.15-1.10)	1.86 (1.10-3.15)	*2.80 (1.66-4.68)*			
Genesis II Oxinium[Fem] Genesis II[Tib]	With Patella	5,853	59 (54 to 65)	36	0.43 (0.29-0.64)	1.81 (1.47-2.22)	2.41 (2.00-2.90)	4.28 (3.58-5.12)	*5.21 (4.20-6.45)*	*6.47 (4.69-8.91)*
	Without Patella	5,106	59 (54 to 64)	44	0.70 (0.50-0.98)	3.22 (2.73-3.78)	4.95 (4.32-5.67)	8.44 (7.45-9.56)	9.89 (8.56-11.41)	*10.26 (8.78-11.97)*
Genesis II[Fem:Tib]	With Patella	37,354	71 (65 to 77)	38	0.47 (0.40-0.54)	1.31 (1.19-1.44)	1.69 (1.54-1.85)	2.42 (2.19-2.66)	2.75 (2.40-3.15)	*2.92 (2.46-3.47)*

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Time since primary						
				Percentage (%) male	1 year	3 years	5 years	10 years	13 years	15 years
	Without Patella	44,545	71 (65 to 77)	46	0.47 (0.41-0.54)	1.77 (1.65-1.91)	2.49 (2.33-2.66)	3.72 (3.47-3.99)	4.02 (3.70-4.37)	*4.44 (3.64-5.40)*
Insall-Burstein II Microport[Fem] Insall-Burstein (Microport)[Tib]	With Patella	1,106	71 (65 to 77)	43	0.09 (0.01-0.65)	0.75 (0.38-1.50)	2.24 (1.49-3.35)	4.42 (3.28-5.94)	5.99 (4.57-7.85)	*6.53 (4.97-8.56)*
	Without Patella	914	71 (65 to 77)	48	0.66 (0.30-1.47)	2.94 (2.01-4.29)	3.76 (2.69-5.25)	5.91 (4.49-7.75)	7.56 (5.83-9.78)	*8.25 (6.33-10.70)*
Journey II BCS Oxinium[Fem] Journey[Tib]	With Patella	2,804	66 (59 to 72)	41	0.44 (0.25-0.80)	1.78 (1.20-2.64)	*1.98 (1.32-2.97)*			
	Without Patella	682	65 (57 to 72)	43	1.22 (0.61-2.43)	*6.95 (4.68-10.27)*	*7.93 (5.21-11.99)*			
Kinemax[Fem:Tib]	With Patella	4,360	71 (64 to 77)	37	0.25 (0.14-0.46)	1.25 (0.96-1.63)	1.77 (1.41-2.22)	3.69 (3.14-4.35)	5.05 (4.35-5.86)	5.67 (4.86-6.60)
	Without Patella	6,521	71 (64 to 77)	47	0.23 (0.14-0.39)	2.06 (1.74-2.44)	3.30 (2.88-3.77)	5.41 (4.86-6.03)	6.81 (6.15-7.53)	7.52 (6.77-8.34)
LCS Complete[Fem] M.B.T.[Tib]	With Patella	1,380	69 (62 to 76)	33	0.59 (0.29-1.17)	2.24 (1.54-3.25)	3.67 (2.71-4.97)	5.49 (4.16-7.23)	*6.12 (4.45-8.39)*	
	Without Patella	27,116	70 (63 to 76)	45	0.43 (0.36-0.51)	1.68 (1.53-1.85)	2.46 (2.27-2.67)	3.63 (3.37-3.91)	4.24 (3.90-4.62)	*4.52 (4.01-5.08)*
LCS[Fem:Tib]	With Patella	221	70 (63 to 76)	38	*1.36 (0.44-4.15)*	*4.62 (2.51-8.41)*	*5.10 (2.86-9.02)*	*5.64 (3.24-9.72)*	*6.31 (3.70-10.67)*	*7.12 (4.23-11.86)*
	Without Patella	1,781	70 (63 to 76)	42	0.57 (0.30-1.05)	1.43 (0.97-2.11)	1.97 (1.41-2.75)	2.67 (1.99-3.57)	2.99 (2.26-3.96)	3.38 (2.58-4.44)
Legion[Fem] Genesis II[Tib]	With Patella	170	69 (62 to 76)	34	*1.21 (0.30-4.76)*	*2.51 (0.95-6.55)*	*3.21 (1.35-7.55)*			
	Without Patella	875	71 (66 to 78)	46	0.36 (0.12-1.11)	1.42 (0.79-2.56)	2.01 (1.18-3.40)			
Maxim[Fem] Vanguard[Tib]	With Patella	533	70 (63 to 76)	31	0.57 (0.18-1.75)	1.56 (0.78-3.09)	2.17 (1.21-3.89)	*4.25 (2.67-6.75)*	*6.41 (4.04-10.11)*	*6.41 (4.04-10.11)*
	Without Patella	1,350	70 (63 to 76)	46	0.30 (0.11-0.80)	2.05 (1.41-2.98)	3.09 (2.28-4.19)	5.95 (4.71-7.49)	8.29 (6.61-10.36)	*10.93 (8.38-14.19)*
MRK[Fem:Tib]	With Patella	5,131	71 (64 to 77)	38	0.24 (0.14-0.43)	1.07 (0.80-1.42)	1.57 (1.22-2.01)	2.57 (2.02-3.26)	2.90 (2.22-3.77)	*3.40 (2.36-4.89)*
	Without Patella	9,455	70 (64 to 76)	47	0.33 (0.23-0.48)	1.26 (1.03-1.53)	1.73 (1.45-2.06)	3.02 (2.53-3.60)	*3.28 (2.69-3.99)*	*3.28 (2.69-3.99)*
Natural Knee II[Fem]NK2[Tib]	With Patella	1,531	70 (64 to 76)	41	0.46 (0.22-0.96)	1.66 (1.13-2.45)	2.65 (1.94-3.60)	4.27 (3.29-5.53)	*6.64 (5.08-8.66)*	*7.98 (5.37-11.76)*
	Without Patella	1,283	70 (63 to 76)	42	0.16 (0.04-0.63)	0.96 (0.55-1.68)	1.70 (1.11-2.60)	3.76 (2.76-5.09)	6.09 (4.52-8.19)	*6.64 (4.84-9.07)*
Nexgen LCCK[Fem] Nexgen[Tib]	With Patella	475	71 (63 to 78)	37	0.65 (0.21-2.00)	2.20 (1.09-4.40)	*2.20 (1.09-4.40)*	*6.12 (2.72-13.48)*		
	Without Patella	539	72 (64 to 79)	36	1.91 (1.03-3.53)	3.55 (2.21-5.67)	*4.94 (3.19-7.59)*	*5.49 (3.55-8.45)*	*7.24 (4.07-12.70)*	*7.24 (4.07-12.70)*
Nexgen [Fem:Tib]	With Patella	48,893	70 (63 to 76)	37	0.41 (0.35-0.47)	1.40 (1.29-1.51)	2.24 (2.09-2.40)	3.91 (3.65-4.18)	4.61 (4.27-4.98)	4.86 (4.46-5.29)

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Time since primary						
				Percentage (%) male	1 year	3 years	5 years	10 years	13 years	15 years
	Without Patella	118,939	70 (64 to 76)	44	0.37 (0.33-0.40)	1.33 (1.26-1.40)	2.08 (1.99-2.18)	3.53 (3.38-3.69)	4.39 (4.16-4.63)	4.88 (4.51-5.27)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet) [Tib]	With Patella	1,055	67 (59 to 74)	38	0.48 (0.20-1.16)	2.55 (1.71-3.78)	3.43 (2.42-4.85)	6.40 (4.86-8.40)	*7.40 (5.57-9.78)*	*9.86 (6.94-13.93)*
	Without Patella	2,150	67 (59 to 75)	51	0.47 (0.25-0.87)	1.66 (1.19-2.32)	2.32 (1.73-3.10)	3.66 (2.82-4.74)	*4.98 (3.73-6.62)*	*5.62 (4.01-7.86)*
Nexgen[Fem] TM Monoblock[Tib]	With Patella	413	62 (56 to 69)	55	0.50 (0.13-1.98)	2.07 (1.04-4.09)	2.89 (1.61-5.16)	*5.33 (3.36-8.41)*	*7.33 (4.33-12.28)*	
	Without Patella	3,831	64 (58 to 71)	57	0.61 (0.41-0.92)	2.68 (2.20-3.25)	3.37 (2.83-4.02)	4.28 (3.65-5.02)	4.72 (4.01-5.55)	*5.04 (4.14-6.14)*
Optetrak CR[Fem] Optetrak[Tib]	With Patella	645	70 (64 to 76)	43	0.94 (0.42-2.08)	2.40 (1.45-3.95)	3.77 (2.52-5.62)	*7.02 (4.97-9.88)*	*7.51 (5.31-10.56)*	
	Without Patella	993	69 (63 to 76)	43	0.81 (0.41-1.62)	4.12 (3.04-5.58)	5.64 (4.35-7.30)	8.31 (6.56-10.51)	*8.68 (6.82-11.02)*	*8.68 (6.82-11.02)*
Persona CR[Fem] Persona[Tib]	With Patella	1,219	69 (62 to 75)	41	0.28 (0.09-0.88)	*0.61 (0.19-1.96)*	*0.61 (0.19-1.96)*			
	Without Patella	2,075	70 (63 to 76)	49	0.14 (0.03-0.56)	0.49 (0.17-1.43)	*2.41 (0.88-6.50)*			
Persona PS[Fem] Persona[Tib]	With Patella	451	69 (62 to 75)	35	0.54 (0.14-2.18)	*0.92 (0.29-2.86)*	*3.07 (1.29-7.25)*			
	Without Patella	815	70 (64 to 76)	46	0.52 (0.20-1.39)	2.19 (1.27-3.79)	*4.22 (2.51-7.06)*			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	With Patella	8,661	65 (58 to 72)	43	0.46 (0.33-0.62)	1.73 (1.47-2.03)	2.43 (2.12-2.79)	3.60 (3.19-4.06)	4.24 (3.73-4.82)	*5.12 (3.90-6.71)*
	Without Patella	8,493	65 (58 to 73)	50	0.80 (0.63-1.01)	2.34 (2.04-2.69)	3.24 (2.87-3.65)	4.48 (4.01-5.00)	5.27 (4.65-5.97)	*5.67 (4.73-6.79)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	With Patella	64,757	71 (64 to 77)	38	0.36 (0.32-0.41)	1.12 (1.03-1.20)	1.58 (1.48-1.69)	2.22 (2.09-2.35)	2.67 (2.50-2.84)	3.02 (2.80-3.26)
	Without Patella	101,833	70 (64 to 76)	46	0.41 (0.38-0.46)	1.45 (1.38-1.53)	1.98 (1.89-2.08)	2.81 (2.69-2.94)	3.34 (3.19-3.50)	3.76 (3.55-3.98)
PFC Sigma Bicondylar Knee[Fem] PFC Sigma Bicondylar[Tib]	With Patella	78,762	71 (64 to 77)	38	0.37 (0.33-0.42)	1.21 (1.13-1.30)	1.72 (1.62-1.83)	2.48 (2.31-2.65)	*2.52 (2.35-2.71)*	
	Without Patella	106,052	70 (64 to 77)	45	0.38 (0.34-0.42)	1.64 (1.56-1.72)	2.25 (2.15-2.35)	3.03 (2.89-3.18)	*3.26 (3.07-3.46)*	
Profix[Fem:Tib]	With Patella	78	73 (66 to 78)	27	*0*	*0*	*1.45 (0.21-9.84)*	*4.37 (1.43-12.94)*	*4.37 (1.43-12.94)*	

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K7 (b) (continued)

Brand[1]	Patella status	N	Median (IQR) age at primary	Time since primary						
				Percentage (%) male	1 year	3 years	5 years	10 years	13 years	15 years
	Without Patella	3,771	73 (67 to 78)	43	0.43 (0.26-0.70)	1.39 (1.05-1.82)	1.79 (1.40-2.27)	2.63 (2.14-3.23)	3.04 (2.47-3.74)	*4.17 (3.00-5.79)*
Rotaglide+ [Fem:Tib]	With Patella	1,177	69 (63 to 76)	42	0.86 (0.46-1.59)	2.70 (1.91-3.82)	3.52 (2.59-4.77)	6.17 (4.85-7.83)	7.53 (5.96-9.49)	*8.44 (6.64-10.69)*
	Without Patella	822	71 (64 to 77)	45	0.37 (0.12-1.13)	3.51 (2.44-5.05)	4.44 (3.21-6.13)	6.85 (5.24-8.92)	8.06 (6.24-10.37)	*9.23 (7.09-11.96)*
Rotaglide [Fem:Tib]	With Patella	1,430	71 (63 to 77)	39	0.42 (0.19-0.94)	2.33 (1.65-3.28)	3.84 (2.91-5.06)	4.33 (3.31-5.67)	*6.59 (4.57-9.46)*	*6.59 (4.57-9.46)*
	Without Patella	19	67 (60 to 75)	37	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*			
Saiph[Fem:Tib]	With Patella	821	69 (62 to 75)	32	0.56 (0.21-1.50)	0.56 (0.21-1.50)	*0.89 (0.35-2.31)*			
	Without Patella	663	70 (63 to 76)	44	0.76 (0.29-2.02)	2.75 (1.55-4.84)	*2.75 (1.55-4.84)*			
Scorpio NRG[Fem:Tib]	With Patella	7,127	71 (64 to 77)	39	0.45 (0.32-0.64)	1.26 (1.03-1.56)	2.00 (1.69-2.37)	3.21 (2.74-3.76)	*3.67 (3.04-4.43)*	
	Without Patella	6,967	70 (64 to 76)	46	0.37 (0.26-0.55)	1.94 (1.63-2.30)	2.94 (2.55-3.38)	4.32 (3.78-4.92)		
Scorpio [Fem:Tib]	With Patella	959	68 (60 to 75)	40	0.21 (0.05-0.84)	1.71 (1.05-2.77)	2.37 (1.57-3.58)	3.86 (2.77-5.37)	3.86 (2.77-5.37)	*4.95 (3.00-8.13)*
	Without Patella	2,296	68 (62 to 75)	47	0.44 (0.24-0.81)	2.37 (1.81-3.09)	3.44 (2.76-4.29)	5.01 (4.15-6.04)	6.17 (5.07-7.51)	*6.17 (5.07-7.51)*
Scorpio[Fem] Scorpio NRG[Tib]	With Patella	8,114	71 (65 to 77)	38	0.32 (0.22-0.47)	1.35 (1.12-1.63)	2.05 (1.76-2.39)	3.27 (2.89-3.71)	4.04 (3.58-4.57)	4.13 (3.64-4.68)
	Without Patella	13,568	71 (64 to 77)	44	0.51 (0.41-0.65)	2.13 (1.89-2.39)	2.98 (2.70-3.28)	4.50 (4.15-4.88)	5.49 (5.07-5.96)	5.77 (5.30-6.29)
Sphere[Fem] GMK[Tib]	With Patella	297	69 (61 to 75)	34	*0.80 (0.20-3.17)*	*1.82 (0.68-4.81)*	*2.88 (1.12-7.35)*			
	Without Patella	1,188	69 (62 to 75)	47	0.95 (0.51-1.76)	2.43 (1.57-3.75)	3.14 (2.06-4.77)			
TC Plus[Fem:Tib]	With Patella	888	71 (64 to 76)	37	0.34 (0.11-1.05)	1.40 (0.80-2.46)	2.40 (1.56-3.70)	3.76 (2.59-5.43)	*4.44 (3.10-6.33)*	*4.99 (3.40-7.30)*
	Without Patella	15,116	70 (64 to 76)	45	0.71 (0.59-0.85)	1.83 (1.62-2.06)	2.40 (2.16-2.66)	3.52 (3.22-3.84)	4.23 (3.86-4.64)	*5.04 (4.32-5.88)*
Triathlon [Fem:Tib]	With Patella	58,972	70 (63 to 76)	39	0.51 (0.45-0.57)	1.33 (1.23-1.44)	1.89 (1.76-2.04)	2.92 (2.68-3.18)	*3.41 (2.98-3.91)*	
	Without Patella	74,757	70 (63 to 76)	46	0.51 (0.46-0.56)	1.72 (1.62-1.83)	2.43 (2.29-2.57)	3.73 (3.46-4.02)	*4.27 (3.81-4.79)*	
Unity Knee[Fem] Unity[Tib]	With Patella	1,063	70 (64 to 76)	43	0.31 (0.10-0.94)	0.82 (0.39-1.73)	*1.38 (0.65-2.89)*			
	Without Patella	301	69 (62 to 75)	51	*0*	*0*	*0*			
Vanguard [Fem:Tib]	With Patella	32,925	70 (63 to 76)	37	0.38 (0.32-0.46)	1.12 (1.00-1.25)	1.69 (1.52-1.87)	2.86 (2.36-3.46)	*3.65 (2.57-5.17)*	
	Without Patella	47,123	70 (63 to 76)	45	0.39 (0.34-0.45)	1.79 (1.67-1.93)	2.49 (2.33-2.66)	3.54 (3.26-3.84)	*3.75 (3.39-4.14)*	

[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Tables 3.K7 (a) and (b) and Table 3.K8 show the Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any indication, of a primary TKR (Tables 3.K7 (a) and (b)) and primary UKR (Table 3.K8) by implant brand.

Table 3.K8 KM estimates of cumulative **revision** (95% CI) by **unicompartmental knee** replacement **brands**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
All unicompartmental knee replacements	**133,399**	**63 (56 to 71)**	**50**	**1.06 (1.00-1.12)**	**4.01 (3.90-4.13)**	**6.19 (6.04-6.35)**	**11.80 (11.55-12.06)**	**15.86 (15.48-16.25)**	**18.46 (17.89-19.05)**
Unicondylar									
AMC/ Uniglide[Fem:Tib]	3,002	64 (57 to 72)	51	2.38 (1.89-2.99)	6.07 (5.26-7.00)	7.66 (6.74-8.70)	12.79 (11.48-14.24)	*17.83 (15.74-20.17)*	*18.34 (16.07-20.89)*
Journey Uni Oxinium[Fem] Journey Uni[Tib]	1,285	62 (55 to 69)	55	1.33 (0.80-2.20)	3.62 (2.54-5.13)	*6.36 (4.54-8.89)*			
MG Uni[Fem:Tib]	2,263	63 (57 to 70)	55	0.84 (0.54-1.32)	4.01 (3.28-4.91)	6.07 (5.15-7.15)	10.33 (9.11-11.71)	12.45 (11.03-14.04)	*14.23 (12.49-16.18)*
Oxford Cementless Partial Knee[Fem:Tib]	21,786	65 (58 to 71)	55	1.15 (1.01-1.30)	2.53 (2.29-2.78)	3.63 (3.29-4.00)	*5.90 (5.03-6.92)*		
Oxford Cementless Partial Knee [Fem]Oxford Partial Knee[Tib]	1,728	66 (57 to 73)	48	1.23 (0.79-1.89)	3.95 (3.04-5.11)	5.50 (4.36-6.93)	*9.72 (7.73-12.19)*	*14.23 (10.04-19.97)*	
Oxford Single Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	42,822	64 (58 to 71)	52	1.22 (1.12-1.33)	4.41 (4.21-4.61)	6.60 (6.36-6.85)	12.01 (11.65-12.37)	15.88 (15.39-16.40)	18.86 (18.10-19.64)
Oxford Twin Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	5,005	65 (57 to 72)	48	0.80 (0.58-1.10)	2.53 (2.09-3.06)	3.75 (3.16-4.46)	6.99 (5.80-8.43)	*12.36 (8.61-17.58)*	
Persona Partial Knee[Fem:Tib]	1,990	65 (57 to 72)	57	0.14 (0.03-0.56)					
*Physica ZUK[Fem:Tib]	17,527	63 (56 to 70)	55	0.36 (0.28-0.47)	2.06 (1.83-2.32)	3.29 (2.97-3.66)	6.70 (5.92-7.58)	*8.80 (6.90-11.21)*	
Preservation[Fem:Tib]	1,487	63 (56 to 69)	55	2.56 (1.87-3.51)	8.09 (6.80-9.60)	11.63 (10.09-13.39)	17.73 (15.83-19.81)	22.73 (20.51-25.15)	*23.99 (21.55-26.65)*
Sigma HP (Uni)[Fem] Sigma HP[Tib]	11,907	63 (56 to 70)	58	0.80 (0.65-0.98)	3.18 (2.85-3.56)	4.49 (4.06-4.97)	7.03 (6.27-7.87)		
Triathlon Uni[Fem] Triathlon[Tib]	1,455	62 (55 to 69)	56	1.29 (0.80-2.06)	4.54 (3.46-5.95)	7.42 (5.85-9.39)	9.87 (7.73-12.57)		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.

Table 3.K8 (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Patellofemoral									
Avon[Fem]	6,203	58 (50 to 67)	22	0.67 (0.49-0.91)	4.31 (3.80-4.88)	7.64 (6.94-8.41)	15.49 (14.35-16.70)	20.39 (18.86-22.04)	*23.54 (21.29-25.98)*
FPV[Fem]	1,638	59 (52 to 68)	23	0.92 (0.56-1.52)	7.10 (5.94-8.46)	10.41 (9.00-12.03)	20.18 (17.89-22.72)		
Journey PFJ Oxinium[Fem]	2,097	58 (50 to 67)	23	1.82 (1.31-2.51)	7.71 (6.56-9.06)	13.16 (11.59-14.92)	23.10 (20.73-25.69)	*26.78 (22.25-32.03)*	
Sigma HP (PF)[Fem]	1,299	58 (50 to 66)	23	2.70 (1.95-3.74)	9.45 (7.96-11.20)	14.27 (12.38-16.42)	*28.28 (24.25-32.83)*		
Zimmer PFJ[Fem]	2,974	56 (49 to 65)	22	0.67 (0.42-1.06)	4.96 (4.12-5.95)	7.82 (6.67-9.16)	*15.98 (12.92-19.67)*		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 1,000 primary total knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.

Table 3.K9 (a) (page 157) shows Kaplan-Meier estimates of the cumulative percentage probability of first revision of a primary TKR or primary UKR by implant brand and bearing / constraint type for those brands / bearing types which were implanted on at least 1,000 occasions for UKR and 2,500 occasions for TKR. Patient summaries of age and gender by brand are also given.

Table 3.K9 (a) KM estimates of cumulative **revision** (95% CI) by **fixation**, **constraint** and **brand**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed	34,464	71 (65 to 77)	38	0.27 (0.22-0.33)	1.44 (1.32-1.57)	2.10 (1.95-2.26)	3.39 (3.18-3.61)	4.60 (4.30-4.93)	5.72 (5.24-6.24)
AGC V2[Fem]AGC[Tib]									
Cemented, unconstrained, fixed	2,607	70 (64 to 76)	99	0.15 (0.06-0.41)	1.28 (0.90-1.80)	1.88 (1.41-2.50)	3.36 (2.66-4.24)	5.52 (4.29-7.09)	*7.27 (5.34-9.85)*
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed	26,189	71 (64 to 77)	38	0.28 (0.22-0.35)	1.55 (1.40-1.71)	2.20 (2.02-2.39)	3.47 (3.21-3.75)	4.64 (4.24-5.09)	6.21 (5.44-7.08)
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed	8,682	70 (64 to 76)	48	0.57 (0.43-0.75)	2.09 (1.80-2.43)	2.93 (2.57-3.34)	4.36 (3.86-4.93)	5.03 (4.34-5.82)	*5.35 (4.46-6.40)*
Attune CR[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed	16,533	69 (62 to 75)	44	0.37 (0.29-0.48)	1.58 (1.36-1.84)	2.38 (1.94-2.92)			
Attune CR[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile	2,964	70 (63 to 76)	42	0.19 (0.08-0.46)	1.08 (0.68-1.72)	*2.08 (1.19-3.64)*			
Attune PS[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed	9,181	70 (62 to 76)	42	0.49 (0.36-0.66)	1.89 (1.55-2.30)	3.28 (2.59-4.15)			
Columbus Cemented[Fem]Columbus[Tib]									
Cemented, unconstrained, fixed	12,129	71 (65 to 77)	45	0.47 (0.36-0.61)	1.55 (1.33-1.80)	2.20 (1.93-2.52)	3.23 (2.78-3.75)	*3.52 (2.93-4.24)*	3.52 (2.93-4.24)
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed	7,385	59 (54 to 65)	40	0.53 (0.39-0.73)	2.17 (1.83-2.56)	3.15 (2.72-3.64)	5.17 (4.51-5.93)	6.14 (5.26-7.17)	*6.95 (5.75-8.39)*
Cemented, posterior-stabilised, fixed	3,327	58 (53 to 64)	41	0.63 (0.40-0.97)	3.19 (2.61-3.90)	4.76 (4.00-5.65)	9.03 (7.69-10.60)	*11.89 (8.97-15.68)*	
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed	59,383	71 (65 to 77)	43	0.41 (0.36-0.46)	1.42 (1.32-1.53)	1.93 (1.81-2.06)	2.85 (2.65-3.05)	3.13 (2.87-3.40)	*3.21 (2.91-3.53)*
Cemented, posterior-stabilised, fixed	20,740	71 (65 to 77)	39	0.63 (0.53-0.75)	1.87 (1.67-2.08)	2.58 (2.33-2.84)	3.86 (3.46-4.30)	4.25 (3.56-5.07)	*5.99 (3.35-10.61)*
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed	3,481	66 (59 to 72)	41	0.62 (0.39-0.97)	2.91 (2.19-3.85)	*3.24 (2.43-4.33)*			
Kinemax[Fem:Tib]									
Cemented, unconstrained, fixed	10,766	71 (64 to 77)	43	0.24 (0.17-0.36)	1.74 (1.51-2.01)	2.68 (2.39-3.01)	4.71 (4.30-5.15)	6.07 (5.57-6.60)	6.66 (6.11-7.26)
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	12,146	70 (64 to 76)	41	0.41 (0.31-0.54)	1.55 (1.33-1.79)	2.52 (2.24-2.84)	4.05 (3.65-4.50)	4.56 (4.06-5.12)	*4.56 (4.06-5.12)*
Uncemented, unconstrained, mobile	15,462	69 (62 to 75)	47	0.43 (0.34-0.55)	1.85 (1.64-2.08)	2.54 (2.29-2.82)	3.49 (3.16-3.85)	4.21 (3.74-4.73)	*4.61 (3.91-5.42)*

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[†]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
MRK[Fem:Tib]									
Cemented, unconstrained, fixed	14,363	70 (64 to 76)	44	0.31 (0.23-0.41)	1.19 (1.01-1.40)	1.67 (1.45-1.94)	2.86 (2.48-3.29)	3.17 (2.70-3.73)	*3.53 (2.76-4.50)*
Natural Knee II[Fem]NK2[Tib]									
Cemented, unconstrained, fixed	2,684	70 (64 to 76)	41	0.34 (0.18-0.65)	1.41 (1.02-1.94)	2.20 (1.70-2.84)	3.89 (3.16-4.78)	6.05 (4.91-7.44)	*6.93 (5.38-8.90)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed	85,250	70 (63 to 76)	43	0.30 (0.27-0.34)	1.08 (1.01-1.16)	1.59 (1.50-1.69)	2.57 (2.42-2.74)	3.09 (2.85-3.35)	3.55 (3.00-4.21)
Cemented, posterior-stabilised, fixed	79,767	70 (64 to 77)	41	0.46 (0.41-0.51)	1.63 (1.54-1.73)	2.67 (2.55-2.80)	4.60 (4.40-4.81)	5.59 (5.31-5.88)	6.02 (5.65-6.42)
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed	3,975	64 (58 to 71)	58	0.59 (0.39-0.89)	2.59 (2.13-3.15)	3.33 (2.79-3.96)	4.38 (3.75-5.12)	4.95 (4.21-5.81)	*5.25 (4.35-6.34)*
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	8,350	64 (58 to 72)	47	0.57 (0.43-0.76)	1.92 (1.65-2.25)	2.69 (2.36-3.08)	3.88 (3.45-4.37)	4.72 (4.13-5.39)	*5.83 (4.39-7.71)*
Cemented, posterior-stabilised, mobile	7,102	65 (59 to 72)	46	0.67 (0.50-0.89)	2.21 (1.89-2.59)	3.06 (2.68-3.50)	4.30 (3.80-4.86)	4.82 (4.24-5.48)	*5.08 (4.34-5.93)*
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed	128,890	70 (64 to 76)	43	0.39 (0.36-0.43)	1.26 (1.20-1.33)	1.74 (1.67-1.82)	2.43 (2.33-2.53)	2.88 (2.76-3.01)	3.17 (3.00-3.34)
Cemented, posterior-stabilised, fixed	35,978	71 (64 to 77)	41	0.39 (0.33-0.46)	1.51 (1.38-1.64)	2.08 (1.93-2.24)	3.02 (2.83-3.23)	3.60 (3.37-3.85)	4.26 (3.91-4.64)
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed	117,292	70 (63 to 76)	42	0.35 (0.32-0.39)	1.37 (1.30-1.45)	1.93 (1.84-2.02)	2.62 (2.49-2.76)	*2.76 (2.60-2.93)*	
Cemented, posterior-stabilised, fixed	53,116	71 (64 to 77)	42	0.43 (0.38-0.49)	1.65 (1.54-1.77)	2.27 (2.13-2.41)	3.24 (3.02-3.46)		
Cemented, monobloc polyethylene tibia	13,818	74 (69 to 79)	42	0.38 (0.28-0.50)	1.39 (1.19-1.62)	1.85 (1.61-2.13)	2.29 (1.97-2.66)	*2.29 (1.97-2.66)*	
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed	3,174	70 (63 to 76)	46	0.20 (0.08-0.48)	0.55 (0.25-1.21)	*2.14 (0.82-5.50)*			
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed	8,576	70 (64 to 76)	42	0.36 (0.26-0.52)	1.47 (1.23-1.75)	2.42 (2.10-2.79)	3.67 (3.22-4.20)		
Cemented, posterior-stabilised, fixed	4,735	70 (63 to 77)	43	0.45 (0.29-0.68)	1.70 (1.37-2.12)	2.44 (2.03-2.94)	3.83 (3.25-4.51)	*4.29 (3.48-5.28)*	
Scorpio[Fem]Scorpio NRG[Tib]									
Cemented, unconstrained, fixed	10,450	71 (64 to 77)	42	0.44 (0.33-0.59)	1.85 (1.60-2.13)	2.58 (2.29-2.91)	3.92 (3.55-4.34)	4.79 (4.34-5.29)	5.07 (4.56-5.63)
Cemented, posterior-stabilised, fixed	6,058	71.5 (65 to 77)	40	0.22 (0.13-0.37)	1.67 (1.37-2.03)	2.58 (2.20-3.02)	4.16 (3.66-4.73)	5.15 (4.56-5.82)	5.34 (4.70-6.06)
Uncemented, unconstrained, fixed	3,731	70 (64 to 76)	47	0.62 (0.41-0.93)	1.93 (1.53-2.43)	2.61 (2.14-3.18)	3.97 (3.36-4.69)	4.93 (4.13-5.89)	*4.93 (4.13-5.89)*
TC Plus[Fem:Tib]									
Cemented, unconstrained, fixed	7,930	70 (64 to 76)	46	0.81 (0.63-1.03)	2.01 (1.72-2.34)	2.63 (2.30-3.01)	3.74 (3.33-4.20)	4.66 (4.12-5.27)	*5.02 (4.36-5.77)*
Cemented, unconstrained, mobile	5,261	70 (64 to 76)	44	0.54 (0.37-0.78)	1.57 (1.26-1.95)	2.11 (1.75-2.55)	3.28 (2.80-3.85)	3.70 (3.17-4.33)	*4.10 (3.42-4.90)*

*Denotes that this brand is now marketed by Lima.
[†]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed	105,047	70 (63 to 76)	43	0.47 (0.43-0.52)	1.47 (1.39-1.56)	2.05 (1.95-2.16)	3.21 (3.00-3.44)	3.58 (3.27-3.92)	
Cemented, posterior-stabilised, fixed	22,903	70 (63 to 77)	41	0.62 (0.52-0.73)	1.78 (1.60-1.98)	2.67 (2.43-2.94)	3.87 (3.49-4.30)		
Uncemented, unconstrained, fixed	3,600	69 (61 to 75)	51	0.64 (0.41-0.99)	2.04 (1.54-2.71)	2.65 (1.99-3.52)	*3.91 (2.40-6.36)*		
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed	65,568	70 (63 to 76)	42	0.36 (0.32-0.41)	1.45 (1.35-1.56)	2.09 (1.96-2.23)	3.08 (2.83-3.35)	*3.38 (3.00-3.80)*	
Cemented, posterior-stabilised, fixed	9,965	70 (63 to 77)	40	0.56 (0.43-0.73)	2.17 (1.88-2.51)	2.99 (2.62-3.41)	4.65 (3.89-5.57)	*5.11 (4.02-6.47)*	
Cemented, constrained condylar	3,110	70 (63 to 76)	36	0.46 (0.27-0.79)	1.29 (0.91-1.84)	1.53 (1.08-2.17)			
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,084	67 (59 to 75)	50	0.28 (0.09-0.86)	3.13 (2.22-4.40)	4.60 (3.45-6.12)	8.65 (6.77-11.01)	*13.80 (10.57-17.92)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,144	62 (55 to 69)	54	1.51 (0.91-2.50)	3.58 (2.44-5.22)	*5.64 (3.83-8.27)*			
†MG Uni[Fem:Tib]									
Cemented, fixed	1,482	62 (56 to 69)	56	0.95 (0.56-1.59)	4.36 (3.43-5.53)	6.58 (5.42-7.98)	11.51 (9.94-13.31)	13.81 (11.99-15.89)	*14.96 (12.85-17.39)*
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	21,786	65 (58 to 71)	55	1.15 (1.01-1.30)	2.53 (2.29-2.78)	3.63 (3.29-4.00)	*5.90 (5.03-6.92)*		
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,430	65 (57 to 73)	51	1.44 (0.93-2.22)	4.32 (3.33-5.60)	5.80 (4.59-7.31)	*10.00 (7.98-12.51)*	*14.50 (10.29-20.22)*	
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	42,798	64 (58 to 71)	52	1.22 (1.12-1.33)	4.40 (4.21-4.61)	6.60 (6.36-6.85)	12.01 (11.66-12.37)	15.88 (15.39-16.40)	18.86 (18.10-19.64)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	4,780	65 (57 to 72)	49	0.81 (0.59-1.12)	2.57 (2.12-3.12)	3.81 (3.20-4.52)	7.05 (5.84-8.49)	*12.41 (8.65-17.63)*	
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	1,990	65 (57 to 72)	57	0.14 (0.03-0.56)					
***Physica ZUK[Fem:Tib]**									
Cemented, fixed	15,591	63 (56 to 70)	55	0.38 (0.29-0.50)	1.92 (1.68-2.19)	3.16 (2.82-3.55)	6.44 (5.62-7.38)	*8.51 (6.57-10.99)*	
Cemented, monobloc polyethylene tibia	1,936	64 (56 to 71)	56	0.22 (0.08-0.59)	3.08 (2.33-4.05)	4.21 (3.29-5.40)	*8.33 (6.26-11.05)*		
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	11,603	63 (56 to 70)	58	0.81 (0.66-1.00)	3.10 (2.76-3.47)	4.34 (3.91-4.82)	*6.86 (6.09-7.72)*		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (a) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,455	62 (55 to 69)	56	1.29 (0.80-2.06)	4.54 (3.46-5.95)	7.42 (5.85-9.39)	*9.87 (7.73-12.57)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,203	58 (50 to 67)	22	0.67 (0.49-0.91)	4.31 (3.80-4.88)	7.64 (6.94-8.41)	15.49 (14.35-16.70)	20.39 (18.86-22.04)	*23.54 (21.29-25.98)*
FPV[Fem]									
Patellofemoral	1,638	59 (52 to 68)	23	0.92 (0.56-1.52)	7.10 (5.94-8.46)	10.41 (9.00-12.03)	20.18 (17.89-22.72)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,097	58 (50 to 67)	23	1.82 (1.31-2.51)	7.71 (6.56-9.06)	13.16 (11.59-14.92)	23.10 (20.73-25.69)	*26.78 (22.25-32.03)*	
Sigma HP (PF)[Fem]									
Patellofemoral	1,299	58 (50 to 66)	23	2.70 (1.95-3.74)	9.45 (7.96-11.20)	14.27 (12.38-16.42)	*28.28 (24.25-32.83)*		
Zimmer PFJ[Fem]									
Patellofemoral	2,974	56 (49 to 65)	22	0.67 (0.42-1.06)	4.96 (4.12-5.95)	7.82 (6.67-9.16)	*15.98 (12.92-19.67)*		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) KM estimates of cumulative **revision** (95% CI) by **fixation**, **constraint**, **brand** and whether a **patella** component was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	11,075	71 (65 to 77)	31	0.24 (0.16-0.35)	1.21 (1.02-1.44)	1.81 (1.57-2.08)	2.90 (2.57-3.28)	3.93 (3.43-4.51)	4.84 (4.07-5.75)
Cemented, unconstrained, fixed, without patella	23,389	71 (65 to 77)	42	0.29 (0.23-0.37)	1.55 (1.39-1.72)	2.23 (2.05-2.44)	3.60 (3.35-3.88)	4.89 (4.52-5.29)	6.07 (5.49-6.72)
AGC V2[Fem]AGC[Tib]									
Cemented, unconstrained, fixed, with patella	695	70 (64 to 75)	99	0.14 (0.02-1.02)	1.51 (0.81-2.78)	1.84 (1.05-3.22)	*4.21 (2.78-6.34)*	*5.42 (3.44-8.47)*	*5.42 (3.44-8.47)*
Cemented, unconstrained, fixed, without patella	1,912	70 (64 to 76)	99	0.16 (0.05-0.49)	1.19 (0.79-1.80)	1.89 (1.35-2.63)	3.07 (2.31-4.06)	5.49 (4.07-7.38)	*7.74 (5.40-11.04)*
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed, with patella	8,862	71 (64 to 77)	33	0.23 (0.15-0.35)	1.18 (0.97-1.44)	1.71 (1.45-2.02)	3.02 (2.62-3.48)	4.39 (3.74-5.15)	*6.57 (5.31-8.11)*
Cemented, unconstrained, fixed, without patella	17,327	71 (64 to 77)	41	0.31 (0.24-0.40)	1.73 (1.54-1.94)	2.44 (2.21-2.69)	3.69 (3.37-4.05)	4.73 (4.23-5.28)	5.78 (4.89-6.82)
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed, with patella	2,988	70 (63 to 76)	43	0.48 (0.28-0.80)	1.50 (1.11-2.02)	2.04 (1.56-2.66)	3.42 (2.70-4.33)	3.84 (2.96-4.96)	*4.36 (3.15-6.02)*
Cemented, unconstrained, fixed, without patella	5,694	70 (64 to 76)	50	0.61 (0.44-0.86)	2.40 (2.02-2.85)	3.40 (2.93-3.94)	4.81 (4.17-5.54)	5.74 (4.73-6.96)	*5.74 (4.73-6.96)*
Attune CR[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed, with patella	6,480	70 (62 to 76)	38	0.27 (0.17-0.45)	1.24 (0.94-1.64)	1.85 (1.34-2.54)			
Cemented, unconstrained, fixed, without patella	10,053	69 (62 to 75)	48	0.43 (0.32-0.59)	1.79 (1.50-2.14)	2.70 (2.09-3.47)			
Attune CR[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile, with patella	1,809	70 (63 to 76)	37	0.24 (0.09-0.64)	1.12 (0.62-2.02)	*1.77 (0.79-3.94)*			
Cemented, unconstrained, mobile, without patella	1,155	70 (63 to 77)	49	0.11 (0.02-0.77)	1.01 (0.48-2.12)	*2.39 (1.08-5.24)*			
Attune PS[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed, with patella	5,516	70 (63 to 76)	40	0.49 (0.33-0.73)	1.61 (1.23-2.11)	2.93 (2.06-4.17)			
Cemented, posterior-stabilised, fixed, without patella	3,665	70 (62 to 76)	44	0.48 (0.29-0.79)	2.34 (1.76-3.11)	*3.85 (2.82-5.24)*			

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Columbus Cemented[Fem]Columbus[Tib]									
Cemented, unconstrained, fixed, with patella	3,343	71 (64 to 77)	39	0.69 (0.45-1.04)	1.29 (0.95-1.77)	1.60 (1.19-2.14)	*3.28 (2.12-5.05)*	*4.91 (2.79-8.55)*	
Cemented, unconstrained, fixed, without patella	8,786	71 (65 to 76)	47	0.39 (0.27-0.54)	1.63 (1.37-1.94)	2.41 (2.07-2.80)	3.31 (2.83-3.87)	*3.31 (2.83-3.87)*	
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed, with patella	4,139	59 (54 to 64)	38	0.44 (0.27-0.70)	1.56 (1.19-2.03)	2.06 (1.62-2.62)	3.66 (2.91-4.60)	*4.56 (3.45-6.01)*	*5.99 (4.04-8.83)*
Cemented, unconstrained, fixed, without patella	3,246	59 (54 to 65)	43	0.65 (0.42-1.01)	2.91 (2.35-3.61)	4.47 (3.73-5.36)	6.96 (5.87-8.24)	7.99 (6.65-9.57)	*8.41 (6.89-10.24)*
Cemented, posterior-stabilised, fixed, with patella	1,603	59 (54 to 65)	34	0.45 (0.22-0.95)	2.47 (1.77-3.44)	3.34 (2.48-4.49)	*6.09 (4.52-8.17)*	*7.09 (5.15-9.73)*	
Cemented, posterior-stabilised, fixed, without patella	1,724	57 (52 to 62.5)	47	0.78 (0.46-1.35)	3.84 (2.98-4.95)	6.01 (4.87-7.40)	11.38 (9.41-13.72)	*15.20 (10.89-21.00)*	
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	26,354	71 (66 to 77)	39	0.39 (0.32-0.48)	1.10 (0.97-1.25)	1.45 (1.30-1.63)	2.08 (1.84-2.35)	2.37 (2.04-2.74)	*2.56 (2.09-3.13)*
Cemented, unconstrained, fixed, without patella	33,029	71 (65 to 77)	46	0.42 (0.36-0.50)	1.66 (1.52-1.82)	2.29 (2.11-2.48)	3.40 (3.13-3.70)	3.68 (3.32-4.08)	*3.68 (3.32-4.08)*
Cemented, posterior-stabilised, fixed, with patella	10,725	71 (65 to 77)	35	0.65 (0.51-0.83)	1.79 (1.53-2.09)	2.23 (1.92-2.58)	3.31 (2.80-3.90)	*4.38 (2.67-7.15)*	
Cemented, posterior-stabilised, fixed, without patella	10,015	71 (65 to 77)	44	0.61 (0.47-0.79)	1.94 (1.67-2.26)	2.91 (2.55-3.32)	4.33 (3.76-4.99)	*4.47 (3.85-5.19)*	*6.86 (3.45-13.40)*
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed, with patella	2,801	66 (59 to 72)	41	0.44 (0.25-0.80)	1.78 (1.20-2.64)	*1.98 (1.32-2.97)*			
Cemented, posterior-stabilised, fixed, without patella	680	65 (57 to 72)	43	1.23 (0.61-2.44)	*6.77 (4.52-10.08)*	*7.75 (5.05-11.81)*			
Kinemax[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	4,292	71 (64 to 77)	37	0.26 (0.14-0.47)	1.24 (0.95-1.63)	1.75 (1.39-2.20)	3.64 (3.08-4.29)	5.01 (4.31-5.83)	5.51 (4.73-6.41)
Cemented, unconstrained, fixed, without patella	6,474	71 (64 to 77)	47	0.23 (0.14-0.39)	2.07 (1.75-2.46)	3.30 (2.88-3.78)	5.42 (4.86-6.03)	6.77 (6.11-7.49)	7.43 (6.69-8.25)
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	765	70 (63 to 77)	31	0.66 (0.27-1.57)	2.29 (1.41-3.72)	4.02 (2.74-5.86)	*6.85 (4.92-9.50)*	*6.85 (4.92-9.50)*	

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Cemented, unconstrained, mobile, without patella	11,381	70 (64 to 76)	42	0.40 (0.29-0.53)	1.50 (1.28-1.75)	2.43 (2.14-2.75)	3.87 (3.47-4.32)	4.42 (3.91-5.00)	*4.42 (3.91-5.00)*
Uncemented, unconstrained, mobile, with patella	526	68 (61 to 73)	33	0.58 (0.19-1.80)	2.11 (1.10-4.04)	3.01 (1.71-5.28)	*3.38 (1.96-5.82)*	*5.02 (2.41-10.32)*	
Uncemented, unconstrained, mobile, without patella	14,936	69 (62 to 75)	47	0.43 (0.33-0.55)	1.84 (1.63-2.08)	2.53 (2.28-2.81)	3.49 (3.16-3.86)	4.17 (3.71-4.68)	*4.59 (3.87-5.43)*
MRK[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	5,067	71 (64 to 77)	38	0.25 (0.14-0.43)	1.05 (0.79-1.41)	1.56 (1.21-2.00)	2.57 (2.02-3.26)	2.89 (2.22-3.76)	*3.40 (2.35-4.89)*
Cemented, unconstrained, fixed, without patella	9,296	70 (63 to 76)	47	0.34 (0.24-0.48)	1.26 (1.04-1.54)	1.74 (1.45-2.07)	3.03 (2.54-3.62)	*3.30 (2.71-4.01)*	*3.30 (2.71-4.01)*
Natural Knee II[Fem]NK2[Tib]									
Cemented, unconstrained, fixed, with patella	1,517	70 (64 to 76)	41	0.46 (0.22-0.97)	1.68 (1.14-2.47)	2.67 (1.96-3.64)	4.31 (3.33-5.59)	*6.56 (5.00-8.59)*	*8.00 (5.28-12.03)*
Cemented, unconstrained, fixed, without patella	1,167	70 (64 to 76)	40	0.17 (0.04-0.69)	1.05 (0.60-1.85)	1.59 (1.01-2.52)	3.34 (2.37-4.70)	*5.40 (3.88-7.48)*	*6.04 (4.22-8.62)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	22,816	70 (63 to 76)	37	0.30 (0.24-0.38)	1.04 (0.90-1.19)	1.53 (1.35-1.73)	2.55 (2.24-2.90)	2.95 (2.52-3.45)	*3.27 (2.69-3.98)*
Cemented, unconstrained, fixed, without patella	62,434	70 (63 to 76)	45	0.30 (0.26-0.35)	1.10 (1.01-1.19)	1.62 (1.50-1.74)	2.58 (2.40-2.78)	3.15 (2.86-3.45)	*3.66 (2.95-4.55)*
Cemented, posterior-stabilised, fixed, with patella	25,234	70 (63 to 76)	36	0.51 (0.43-0.61)	1.73 (1.57-1.92)	2.87 (2.64-3.12)	4.97 (4.60-5.38)	5.85 (5.36-6.38)	6.08 (5.53-6.67)
Cemented, posterior-stabilised, fixed, without patella	54,533	71 (64 to 77)	43	0.43 (0.38-0.49)	1.58 (1.48-1.70)	2.59 (2.44-2.74)	4.44 (4.21-4.69)	5.48 (5.14-5.84)	6.01 (5.53-6.53)
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed, with patella	377	63 (57 to 69)	58	0.28 (0.04-1.94)	1.72 (0.78-3.79)	2.63 (1.38-4.99)	*4.91 (2.96-8.08)*	*7.08 (3.98-12.43)*	
Uncemented, unconstrained, fixed, without patella	3,598	65 (58 to 72)	58	0.62 (0.41-0.94)	2.68 (2.19-3.28)	3.40 (2.83-4.07)	4.33 (3.68-5.10)	4.78 (4.04-5.64)	*5.11 (4.18-6.24)*
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	3,177	64 (58 to 72)	41	0.48 (0.29-0.79)	2.15 (1.69-2.73)	2.92 (2.37-3.59)	4.44 (3.72-5.28)	5.50 (4.59-6.60)	*6.94 (4.52-10.58)*
Cemented, unconstrained, mobile, without patella	5,173	64 (58 to 71)	51	0.62 (0.44-0.88)	1.78 (1.45-2.19)	2.55 (2.14-3.04)	3.51 (2.99-4.11)	4.17 (3.44-5.04)	*5.07 (3.46-7.41)*
Cemented, posterior-stabilised, mobile, with patella	5,134	64 (59 to 71)	45	0.45 (0.30-0.68)	1.46 (1.16-1.84)	2.12 (1.75-2.56)	3.07 (2.58-3.64)	3.33 (2.79-3.98)	*3.87 (2.83-5.27)*

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[†]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Cemented, posterior-stabilised, mobile, without patella	1,968	66 (58 to 73)	49	1.24 (0.83-1.84)	4.20 (3.38-5.21)	5.56 (4.61-6.71)	7.48 (6.31-8.87)	8.44 (7.08-10.04)	*8.44 (7.08-10.04)*
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	42,959	71 (64 to 77)	37	0.35 (0.29-0.41)	1.05 (0.95-1.15)	1.52 (1.40-1.66)	2.10 (1.94-2.27)	2.52 (2.32-2.74)	2.80 (2.54-3.10)
Cemented, unconstrained, fixed, without patella	85,931	70 (64 to 76)	46	0.42 (0.38-0.46)	1.37 (1.29-1.46)	1.85 (1.76-1.96)	2.59 (2.47-2.72)	3.06 (2.90-3.23)	3.35 (3.14-3.57)
Cemented, posterior-stabilised, fixed, with patella	21,173	71 (64 to 77)	39	0.39 (0.31-0.48)	1.24 (1.09-1.40)	1.69 (1.51-1.88)	2.41 (2.19-2.66)	2.91 (2.64-3.21)	3.36 (2.99-3.78)
Cemented, posterior-stabilised, fixed, without patella	14,805	71 (64 to 77)	45	0.39 (0.30-0.51)	1.89 (1.68-2.13)	2.63 (2.38-2.92)	3.89 (3.55-4.26)	4.59 (4.19-5.03)	5.56 (4.91-6.29)
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	41,157	70 (63 to 76)	36	0.36 (0.30-0.42)	1.19 (1.08-1.31)	1.71 (1.57-1.87)	2.36 (2.14-2.60)		
Cemented, unconstrained, fixed, without patella	76,135	70 (63 to 76)	45	0.35 (0.31-0.39)	1.47 (1.38-1.56)	2.04 (1.93-2.16)	2.75 (2.59-2.93)		
Cemented, posterior-stabilised, fixed, with patella	34,827	71 (65 to 77)	40	0.38 (0.32-0.45)	1.24 (1.12-1.37)	1.72 (1.58-1.88)	2.60 (2.36-2.87)		
Cemented, posterior-stabilised, fixed, without patella	18,289	70 (63 to 77)	45	0.52 (0.42-0.63)	2.42 (2.19-2.67)	3.26 (2.99-3.55)	4.37 (3.99-4.78)		
Cemented, monobloc polyethylene tibia, with patella	2,660	76 (71 to 81)	37	0.44 (0.24-0.79)	1.15 (0.78-1.69)	1.70 (1.22-2.37)	*1.95 (1.38-2.75)*	*1.95 (1.38-2.75)*	
Cemented, monobloc polyethylene tibia, without patella	11,158	74 (69 to 79)	43	0.36 (0.26-0.50)	1.44 (1.22-1.71)	1.88 (1.61-2.19)	2.38 (2.00-2.82)		
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed, with patella	1,197	69 (62 to 75)	41	0.29 (0.09-0.89)	*0.62 (0.19-1.97)*	*0.62 (0.19-1.97)*			
Cemented, unconstrained, fixed, without patella	1,977	70 (63 to 76)	49	0.15 (0.04-0.58)	0.51 (0.17-1.47)	*2.44 (0.90-6.56)*			
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	3,786	70 (64 to 76)	38	0.42 (0.26-0.69)	1.22 (0.91-1.63)	2.07 (1.64-2.61)	3.73 (2.99-4.66)		
Cemented, unconstrained, fixed, without patella	4,790	70 (64 to 76)	46	0.31 (0.19-0.52)	1.67 (1.33-2.08)	2.69 (2.25-3.22)	3.71 (3.14-4.39)		
Cemented, posterior-stabilised, fixed, with patella	3,110	71 (64 to 77)	42	0.49 (0.29-0.80)	1.28 (0.93-1.74)	1.88 (1.45-2.44)	2.73 (2.15-3.46)	*3.03 (2.27-4.05)*	
Cemented, posterior-stabilised, fixed, without patella	1,625	69 (63 to 76)	47	0.37 (0.17-0.82)	2.52 (1.85-3.42)	3.51 (2.70-4.55)	5.82 (4.64-7.30)		

*Denotes that this brand is now marketed by Lima.
[†]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Scorpio[Fem]Scorpio NRG[Tib]									
Cemented, unconstrained, fixed, with patella	3,058	72 (65 to 77)	38	0.36 (0.20-0.65)	1.23 (0.89-1.70)	1.89 (1.46-2.46)	3.39 (2.77-4.15)	4.19 (3.41-5.13)	*4.19 (3.41-5.13)*
Cemented, unconstrained, fixed, without patella	7,392	70 (64 to 77)	43	0.48 (0.34-0.66)	2.10 (1.80-2.46)	2.87 (2.50-3.28)	4.14 (3.69-4.65)	5.04 (4.50-5.65)	*5.43 (4.80-6.13)*
Cemented, posterior-stabilised, fixed, with patella	3,473	71 (65 to 77)	38	0.15 (0.06-0.35)	1.16 (0.85-1.58)	1.81 (1.41-2.32)	3.02 (2.47-3.68)	3.89 (3.23-4.68)	*4.06 (3.34-4.95)*
Cemented, posterior-stabilised, fixed, without patella	2,585	72 (65 to 77)	42	0.31 (0.16-0.63)	2.36 (1.83-3.03)	3.61 (2.94-4.43)	5.70 (4.83-6.73)	6.88 (5.86-8.07)	*7.08 (6.00-8.34)*
Uncemented, unconstrained, fixed, with patella	812	71 (63 to 77)	39	0.37 (0.12-1.15)	1.75 (1.04-2.94)	2.53 (1.64-3.90)	3.33 (2.26-4.91)	*3.58 (2.43-5.26)*	*3.58 (2.43-5.26)*
Uncemented, unconstrained, fixed, without patella	2,919	70 (64 to 76)	49	0.69 (0.44-1.07)	1.98 (1.53-2.56)	2.63 (2.10-3.29)	4.15 (3.45-4.99)	5.27 (4.34-6.39)	*5.27 (4.34-6.39)*
TC Plus[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	556	71 (64 to 76)	38	0.18 (0.03-1.27)	1.45 (0.73-2.89)	2.58 (1.53-4.31)	3.94 (2.55-6.06)	*4.49 (2.96-6.78)*	*5.26 (3.34-8.23)*
Cemented, unconstrained, fixed, without patella	7,374	70 (64 to 76)	47	0.86 (0.67-1.10)	2.05 (1.75-2.40)	2.64 (2.29-3.03)	3.73 (3.30-4.20)	4.69 (4.12-5.34)	*4.98 (4.30-5.77)*
Cemented, unconstrained, mobile, with patella	235	72 (65 to 77)	35	*0*	*0.50 (0.07-3.46)*	*1.57 (0.51-4.79)*	*1.57 (0.51-4.79)*	*1.57 (0.51-4.79)*	
Cemented, unconstrained, mobile, without patella	5,026	70 (64 to 76)	44	0.56 (0.39-0.81)	1.61 (1.30-2.01)	2.14 (1.77-2.59)	3.34 (2.85-3.91)	3.76 (3.22-4.40)	*4.16 (3.47-4.99)*
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	41,691	70 (63 to 76)	39	0.45 (0.39-0.53)	1.25 (1.13-1.37)	1.70 (1.55-1.86)	2.76 (2.46-3.09)	*3.16 (2.68-3.71)*	
Cemented, unconstrained, fixed, without patella	63,356	70 (63 to 76)	46	0.48 (0.43-0.54)	1.62 (1.51-1.74)	2.28 (2.14-2.43)	3.51 (3.22-3.82)	*3.86 (3.47-4.30)*	
Cemented, posterior-stabilised, fixed, with patella	15,041	70 (63 to 76)	40	0.59 (0.48-0.73)	1.51 (1.31-1.74)	2.35 (2.07-2.66)	3.29 (2.88-3.76)		
Cemented, posterior-stabilised, fixed, without patella	7,862	70 (63 to 77)	44	0.67 (0.50-0.88)	2.31 (1.97-2.72)	3.32 (2.86-3.85)	5.10 (4.30-6.04)		
Uncemented, unconstrained, fixed, with patella	973	68 (60 to 75)	48	0.65 (0.27-1.56)	*1.79 (0.85-3.75)*	*1.79 (0.85-3.75)*			
Uncemented, unconstrained, fixed, without patella	2,627	69 (62 to 75)	52	0.64 (0.38-1.06)	2.15 (1.58-2.92)	2.81 (2.07-3.79)	*4.18 (2.52-6.87)*		
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	25,665	70 (63 to 76)	37	0.34 (0.28-0.42)	0.99 (0.86-1.14)	1.51 (1.34-1.72)	2.56 (2.06-3.18)	*3.54 (2.29-5.46)*	

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[†]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Cemented, unconstrained, fixed, without patella	39,903	70 (63 to 76)	45	0.37 (0.32-0.44)	1.72 (1.59-1.87)	2.43 (2.26-2.61)	3.41 (3.11-3.73)	*3.57 (3.21-3.96)*	
Cemented, posterior-stabilised, fixed, with patella	5,430	70 (63 to 77)	38	0.49 (0.33-0.72)	1.61 (1.28-2.03)	2.44 (1.99-3.00)	*4.20 (2.88-6.11)*		
Cemented, posterior-stabilised, fixed, without patella	4,535	70 (63 to 77)	43	0.64 (0.45-0.93)	2.81 (2.33-3.39)	3.61 (3.03-4.30)	*5.29 (4.36-6.41)*	*5.92 (4.52-7.73)*	
Cemented, constrained condylar, with patella	1,598	70 (63 to 76)	32	0.62 (0.32-1.19)	1.32 (0.82-2.14)	1.60 (1.00-2.53)			
Cemented, constrained condylar, without patella	1,512	70 (63 to 76)	40	0.30 (0.11-0.79)	1.25 (0.74-2.12)	1.45 (0.85-2.44)			
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,084	67 (59 to 75)	50	0.28 (0.09-0.86)	3.13 (2.22-4.40)	4.60 (3.45-6.12)	8.65 (6.77-11.01)	*13.80 (10.57-17.92)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,144	62 (55 to 69)	54	1.51 (0.91-2.50)	3.58 (2.44-5.22)	*5.64 (3.83-8.27)*			
MG Uni[Fem:Tib]									
Cemented, fixed	1,482	62 (56 to 69)	56	0.95 (0.56-1.59)	4.36 (3.43-5.53)	6.58 (5.42-7.98)	11.51 (9.94-13.31)	13.81 (11.99-15.89)	*14.96 (12.85-17.39)*
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	21,786	65 (58 to 71)	55	1.15 (1.01-1.30)	2.53 (2.29-2.78)	3.63 (3.29-4.00)	*5.90 (5.03-6.92)*		
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,430	65 (57 to 73)	51	1.44 (0.93-2.22)	4.32 (3.33-5.60)	5.80 (4.59-7.31)	*10.00 (7.98-12.51)*	*14.50 (10.29-20.22)*	
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	42,798	64 (58 to 71)	52	1.22 (1.12-1.33)	4.40 (4.21-4.61)	6.60 (6.36-6.85)	12.01 (11.66-12.37)	15.88 (15.39-16.40)	18.86 (18.10-19.64)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	4,780	65 (57 to 72)	49	0.81 (0.59-1.12)	2.57 (2.12-3.12)	3.81 (3.20-4.52)	7.05 (5.84-8.49)	*12.41 (8.65-17.63)*	
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	1,990	65 (57 to 72)	57	0.14 (0.03-0.56)					
***Physica ZUK[Fem:Tib]**									
Cemented, fixed	15,591	63 (56 to 70)	55	0.38 (0.29-0.50)	1.92 (1.68-2.19)	3.16 (2.82-3.55)	6.44 (5.62-7.38)	*8.51 (6.57-10.99)*	
Cemented, monobloc polyethylene tibia	1,936	64 (56 to 71)	56	0.22 (0.08-0.59)	3.08 (2.33-4.05)	4.21 (3.29-5.40)	*8.33 (6.26-11.05)*		
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	11,603	63 (56 to 70)	58	0.81 (0.66-1.00)	3.10 (2.76-3.47)	4.34 (3.91-4.82)	*6.86 (6.09-7.72)*		

*Denotes that this brand is now marketed by Lima.
[†]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

Table 3.K9 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Percentage (%) male	Time since primary					
				1 year	3 years	5 years	10 years	13 years	15 years
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,455	62 (55 to 69)	56	1.29 (0.80-2.06)	4.54 (3.46-5.95)	7.42 (5.85-9.39)	*9.87 (7.73-12.57)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,203	58 (50 to 67)	22	0.67 (0.49-0.91)	4.31 (3.80-4.88)	7.64 (6.94-8.41)	15.49 (14.35-16.70)	20.39 (18.86-22.04)	*23.54 (21.29-25.98)*
FPV[Fem]									
Patellofemoral	1,638	59 (52 to 68)	23	0.92 (0.56-1.52)	7.10 (5.94-8.46)	10.41 (9.00-12.03)	20.18 (17.89-22.72)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,097	58 (50 to 67)	23	1.82 (1.31-2.51)	7.71 (6.56-9.06)	13.16 (11.59-14.92)	23.10 (20.73-25.69)	*26.78 (22.25-32.03)*	
Sigma HP (PF)[Fem]									
Patellofemoral	1,299	58 (50 to 66)	23	2.70 (1.95-3.74)	9.45 (7.96-11.20)	14.27 (12.38-16.42)	*28.28 (24.25-32.83)*		
Zimmer PFJ[Fem]									
Patellofemoral	2,974	56 (49 to 65)	22	0.67 (0.42-1.06)	4.96 (4.12-5.95)	7.82 (6.67-9.16)	*15.98 (12.92-19.67)*		

*Denotes that this brand is now marketed by Lima.
[1]Brands shown have been used in at least 2,500 total primary knee replacement operations for that type of fixation and bearing type and at least 1,000 for unicondylar and patellofemoral knee replacement operations.
Note: Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable.
Note: Femoral brand precedes [Fem], tibial brand precedes [Tib]. [Fem:Tib] indicates the same brand for both femoral and tibial component.

3.3.4 Revisions for different indications after primary knee replacement

Table 3.K10 (page 169) shows the revision incidence rates for each indication recorded on data collection forms for knee revision surgery, for all cases and then sub-divided by fixation type and whether the primary procedure was a TKR or a UKR.

For all knee replacements, the highest PTIRs for the five most common indications for revision in descending order, were for: aseptic loosening / lysis, infection, progressive arthritis, pain and instability. For cemented TKR, the highest PTIRs in descending order were aseptic loosening / lysis, infection, instability, pain and 'other' indication. Revision incidences for pain and aseptic loosening / lysis, wear and 'other' indications were slightly higher for TKRs which were uncemented, compared to prosthesis implanted using a cemented fixation, but revision for infection was lower for uncemented.

For cemented unicondylar knee replacements (medial and lateral UKR), the highest three incidence rates for indications for revising the implant were for: progressive arthritis, aseptic loosening / lysis and pain, respectively. For uncemented / hybrid unicondylar knee replacements (medial and lateral UKR) the highest rates were for: progressive arthritis, aseptic loosening / lysis and dislocation / subluxation. The incidence of revision for pain, aseptic loosening / lysis, implant wear and progressive arthritis were lower for uncemented / hybrid fixation than for cemented but the incidence was higher for dislocation / subluxation and periprosthetic fracture. For patellofemoral replacements, the top three indications for revision were: progressive arthritis, pain and 'other' indication. Similarly, for multicompartmental knee replacements, the highest incidence for revision was for progressive arthritis, pain and 'other' indication. These indications had higher incidences than all of the other knee types.

In Table 3.K11 (page 172), the PTIRs for each indication are shown separately for different time periods from the primary knee replacement, within the first year from primary operation, and between 1 to 3, 3 to 5, 5 to 7, 7 to 10, 10 to 13, 13 to 15 and ≥15 years after surgery (the maximum follow-up for any implant is now 16.75 years). It is clear that most of the PTIRs for a particular indication do vary, especially for infection, aseptic loosening / lysis, pain and progressive arthritis for different time intervals after surgery. Infection is most likely to be the reason that a joint is revised in the first year but after seven years or more, is comparatively less likely than some of the other reasons. Conversely, revision between one and three years after surgery is more likely for aseptic loosening / lysis and pain, with incidence rates dropping off for pain later on but rising again for aseptic loosening / lysis. Aseptic loosening / lysis PTIRs continue to remain relatively higher than other indicated reasons for revision for implants surviving for longer periods after surgery.

Table 3.K10 PTIR estimates of indications for revision (95% CI) by fixation, constraint, bearing type and whether a patella component was recorded.

Fixation, constraint and bearing sub-groups	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation / sub-luxation	Infection	Aseptic loosening / lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Stiffness[3] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Progressive arthritis[4] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
All cases	7,840.7	4.82 (4.77-4.87)	0.75 (0.73-0.77)	0.17 (0.17-0.18)	0.92 (0.90-0.94)	1.29 (1.26-1.31)	0.17 (0.16-0.18)	0.30 (0.29-0.31)	0.68 (0.66-0.70)	0.35 (0.34-0.36)	0.54 (0.52-0.55)	7,592.8	0.31 (0.29-0.32)	5,533.0	0.78 (0.76-0.80)
Total knee replacement															
All cemented	6,446.5	3.84 (3.80-3.89)	0.53 (0.51-0.55)	0.11 (0.10-0.11)	0.98 (0.96-1.01)	1.05 (1.02-1.07)	0.16 (0.15-0.17)	0.19 (0.18-0.20)	0.64 (0.62-0.66)	0.31 (0.30-0.32)	0.38 (0.36-0.39)	6,254.6	0.32 (0.30-0.33)	4,632.6	0.37 (0.35-0.38)
unconstrained, fixed, with patella	1,478.7	3.05 (2.96-3.14)	0.34 (0.31-0.37)	0.08 (0.07-0.10)	0.95 (0.90-1.00)	0.88 (0.84-0.93)	0.13 (0.11-0.15)	0.18 (0.16-0.20)	0.60 (0.56-0.64)	0.28 (0.25-0.30)	0.24 (0.22-0.26)	1,429.0	0.27 (0.25-0.30)	1,075.8	0.03 (0.02-0.04)
unconstrained, fixed, without patella	2,848.5	3.77 (3.70-3.84)	0.61 (0.58-0.64)	0.10 (0.09-0.11)	0.88 (0.84-0.91)	0.87 (0.83-0.90)	0.13 (0.11-0.14)	0.17 (0.15-0.18)	0.60 (0.57-0.63)	0.31 (0.29-0.33)	0.42 (0.40-0.45)	2,770.4	0.32 (0.30-0.34)	2,073.6	0.56 (0.53-0.59)
unconstrained, mobile, with patella	74.1	5.32 (4.82-5.87)	0.58 (0.43-0.78)	0.35 (0.24-0.52)	1.30 (1.06-1.58)	1.71 (1.44-2.04)	0.13 (0.07-0.25)	0.45 (0.32-0.63)	1.20 (0.98-1.48)	0.43 (0.31-0.61)	0.31 (0.21-0.47)	70.9	0.63 (0.47-0.85)	42.8	0
unconstrained, mobile, without patella	232.1	4.07 (3.82-4.34)	0.75 (0.65-0.87)	0.16 (0.12-0.22)	0.78 (0.67-0.90)	1.32 (1.18-1.48)	0.17 (0.12-0.23)	0.27 (0.21-0.35)	0.70 (0.60-0.82)	0.40 (0.32-0.49)	0.36 (0.29-0.45)	226.0	0.38 (0.30-0.47)	133.3	0.33 (0.25-0.44)
posterior-stabilised, fixed, with patella	789.0	3.79 (3.65-3.92)	0.36 (0.32-0.40)	0.10 (0.08-0.12)	1.22 (1.15-1.30)	1.24 (1.16-1.32)	0.23 (0.20-0.27)	0.17 (0.15-0.21)	0.62 (0.57-0.68)	0.31 (0.27-0.35)	0.27 (0.23-0.31)	764.4	0.28 (0.24-0.32)	571.1	0.03 (0.02-0.05)
posterior-stabilised, fixed, without patella	788.2	5.22 (5.06-5.38)	0.68 (0.62-0.74)	0.11 (0.09-0.13)	1.12 (1.05-1.20)	1.66 (1.58-1.76)	0.22 (0.19-0.26)	0.22 (0.19-0.25)	0.77 (0.71-0.83)	0.35 (0.31-0.39)	0.54 (0.49-0.60)	761.7	0.33 (0.29-0.37)	556.3	0.68 (0.62-0.76)
posterior-stabilised, mobile, with patella	64.0	3.78 (3.33-4.29)	0.48 (0.34-0.69)	0.08 (0.03-0.19)	1.00 (0.78-1.28)	1.02 (0.80-1.30)	0.19 (0.11-0.33)	0.20 (0.12-0.35)	0.84 (0.65-1.10)	0.25 (0.15-0.41)	0.44 (0.30-0.63)	62.8	0.49 (0.35-0.70)	43.5	0
posterior-stabilised, mobile, without patella	34.4	6.56 (5.76-7.48)	1.16 (0.85-1.58)	0.26 (0.14-0.50)	0.81 (0.56-1.18)	1.39 (1.05-1.85)	0.29 (0.16-0.54)	0.46 (0.28-0.76)	1.07 (0.78-1.48)	0.20 (0.10-0.43)	1.31 (0.98-1.75)	33.4	0.66 (0.43-1.00)	18.5	1.24 (0.83-1.87)
constrained condylar, with patella	16.6	5.11 (4.13-6.32)	0.24 (0.09-0.64)	0.42 (0.20-0.88)	2.65 (1.97-3.56)	0.72 (0.41-1.27)	0.36 (0.16-0.80)	0.06 (0.01-0.43)	0.72 (0.41-1.27)	0.06 (0.01-0.43)	0.54 (0.28-1.04)	16.4	0.31 (0.13-0.73)	14.4	0.14 (0.03-0.56)
constrained condylar, without patella	21.7	6.28 (5.30-7.42)	0.46 (0.25-0.86)	0.32 (0.15-0.68)	2.81 (2.19-3.62)	1.02 (0.67-1.54)	0.32 (0.15-0.68)	0.32 (0.15-0.68)	0.78 (0.49-1.26)	0.42 (0.22-0.80)	0.37 (0.18-0.74)	21.3	0.38 (0.19-0.75)	17.9	0.84 (0.50-1.39)
monobloc polyethylene tibia, with patella	19.5	2.46 (1.86-3.27)	0.26 (0.11-0.62)	0.05 (0.01-0.36)	0.77 (0.46-1.28)	0.56 (0.31-1.02)	0.21 (0.08-0.55)	0.10 (0.03-0.41)	0.67 (0.39-1.15)	0.31 (0.14-0.69)	0.15 (0.05-0.48)	19.4	0.26 (0.11-0.62)	17.7	0
monobloc polyethylene tibia, without patella	70.5	3.52 (3.10-3.98)	0.55 (0.40-0.76)	0.11 (0.06-0.23)	0.89 (0.70-1.14)	0.84 (0.65-1.08)	0.23 (0.14-0.37)	0.07 (0.03-0.17)	0.50 (0.36-0.69)	0.30 (0.19-0.46)	0.37 (0.25-0.54)	70.0	0.29 (0.18-0.44)	61.0	0.25 (0.15-0.41)
pre-assembled/ hinged/linked, with patella	1.8	14.27 (9.65-21.13)	0.57 (0.08-4.05)	1.71 (0.55-5.31)	7.42 (4.31-12.78)	1.71 (0.55-5.31)	1.14 (0.29-4.57)	0.57 (0.08-4.05)	0.57 (0.08-4.05)	0.57 (0.08-4.05)	1.71 (0.55-5.31)	1.7	0.58 (0.08-4.09)	1.2	0.86 (0.12-6.12)
pre-assembled/ hinged/linked, without patella	7.4	11.10 (8.94-13.78)	0.41 (0.13-1.26)	0.81 (0.36-1.81)	4.33 (3.06-6.12)	2.30 (1.43-3.70)	0.81 (0.36-1.81)	0.54 (0.20-1.44)	0.54 (0.20-1.44)	0.95 (0.45-1.99)	0.95 (0.45-1.99)	7.2	0.42 (0.13-1.29)	5.5	0.92 (0.38-2.20)

[1] The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2] Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3] Stiffness was asked in versions MDSv2, v3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4] Progressive arthritis was asked in versions MDSv3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K10 (continued)

Fixation, constraint and bearing sub-groups	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation / sub-luxation	Infection	Aseptic loosening / lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Stiffness[3] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Progressive arthritis[4] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
All uncemented	**351.8**	**4.59 (4.37-4.82)**	**0.90 (0.80-1.00)**	**0.17 (0.13-0.22)**	**0.64 (0.56-0.73)**	**1.60 (1.47-1.74)**	**0.15 (0.12-0.20)**	**0.33 (0.27-0.39)**	**0.77 (0.68-0.86)**	**0.40 (0.34-0.47)**	**0.61 (0.53-0.69)**	**335.0**	**0.38 (0.32-0.45)**	**202.7**	**0.43 (0.35-0.53)**
unconstrained, fixed, with patella	16.0	4.62 (3.68-5.80)	0.37 (0.17-0.83)	0.19 (0.06-0.58)	0.62 (0.34-1.16)	1.94 (1.36-2.75)	0.25 (0.09-0.67)	0.19 (0.06-0.58)	1.31 (0.86-2.01)	0.81 (0.47-1.40)	0.19 (0.06-0.58)	15.7	0.25 (0.10-0.68)	11.7	0.09 (0.01-0.61)
unconstrained, fixed, without patella	119.1	4.74 (4.37-5.15)	0.86 (0.71-1.04)	0.08 (0.05-0.16)	0.64 (0.51-0.80)	1.86 (1.63-2.12)	0.14 (0.09-0.23)	0.34 (0.25-0.47)	0.72 (0.58-0.89)	0.39 (0.29-0.52)	0.66 (0.53-0.83)	112.4	0.36 (0.27-0.50)	67.2	0.51 (0.36-0.71)
unconstrained, mobile, with patella	8.2	6.12 (4.64-8.07)	0.98 (0.49-1.96)	0.24 (0.06-0.98)	0.98 (0.49-1.96)	2.32 (1.48-3.64)	0.12 (0.02-0.87)	1.35 (0.75-2.43)	1.96 (1.20-3.19)	1.10 (0.57-2.12)	0.73 (0.33-1.63)	7.4	0.68 (0.28-1.63)	3.5	0
unconstrained, mobile, without patella	182.2	4.18 (3.89-4.49)	0.88 (0.75-1.03)	0.19 (0.14-0.27)	0.60 (0.50-0.72)	1.34 (1.19-1.52)	0.13 (0.08-0.19)	0.26 (0.19-0.34)	0.65 (0.54-0.78)	0.30 (0.23-0.39)	0.53 (0.44-0.65)	174.5	0.34 (0.26-0.44)	105.0	0.48 (0.36-0.63)
posterior-stabilised, fixed, with patella	4.6	9.29 (6.89-12.53)	1.73 (0.86-3.46)	0.86 (0.32-2.30)	1.73 (0.86-3.46)	3.24 (1.95-5.38)	1.08 (0.45-2.60)	0.65 (0.21-2.01)	1.94 (1.01-3.74)	0.86 (0.32-2.30)	0.65 (0.21-2.01)	4.2	1.18 (0.49-2.83)	2.3	0
posterior-stabilised, fixed, without patella	19.9	5.74 (4.77-6.89)	1.36 (0.93-1.98)	0.25 (0.10-0.60)	0.60 (0.34-1.06)	1.56 (1.10-2.22)	0.20 (0.08-0.54)	0.50 (0.27-0.94)	0.96 (0.61-1.50)	0.70 (0.42-1.19)	1.21 (0.81-1.80)	18.9	0.53 (0.29-0.99)	11.3	0.26 (0.09-0.82)
other constraints, with patella	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0
other constraints, without patella	1.7	4.62 (2.31-9.24)	2.89 (1.20-6.94)	0.58 (0.08-4.10)	1.73 (0.56-5.37)	0.58 (0.08-4.10)	0	0	0.58 (0.08-4.10)	0	0.58 (0.08-4.10)	1.7	1.17 (0.29-4.69)	1.6	0
All hybrid	**82.2**	**3.63 (3.24-4.06)**	**0.61 (0.46-0.80)**	**0.15 (0.08-0.26)**	**0.86 (0.68-1.09)**	**1.12 (0.91-1.37)**	**0.12 (0.07-0.23)**	**0.34 (0.24-0.49)**	**0.61 (0.46-0.80)**	**0.33 (0.23-0.48)**	**0.28 (0.19-0.42)**	**74.9**	**0.19 (0.11-0.32)**	**37.7**	**0.32 (0.18-0.56)**
unconstrained, fixed, with patella	21.8	2.75 (2.13-3.54)	0.46 (0.25-0.85)	0.14 (0.04-0.43)	0.73 (0.45-1.20)	0.92 (0.59-1.42)	0.14 (0.04-0.43)	0.41 (0.21-0.79)	0.69 (0.41-1.14)	0.05 (0.01-0.32)	0.14 (0.04-0.43)	19.8	0.10 (0.03-0.40)	7.2	0
unconstrained, fixed, without patella	38.8	3.53 (2.99-4.18)	0.62 (0.42-0.92)	0.13 (0.05-0.31)	0.88 (0.63-1.23)	1.01 (0.74-1.38)	0.08 (0.02-0.24)	0.31 (0.18-0.55)	0.39 (0.23-0.64)	0.41 (0.25-0.67)	0.34 (0.19-0.58)	34.6	0.20 (0.10-0.42)	18.0	0.28 (0.12-0.67)
unconstrained, mobile, with patella	2.0	4.53 (2.36-8.70)	0	0	0.50 (0.07-3.57)	2.51 (1.05-6.04)	0.50 (0.07-3.57)	0	0	0.50 (0.07-3.57)	0	1.8	0.55 (0.08-3.90)	1.5	0
unconstrained, mobile, without patella	11.1	4.14 (3.10-5.53)	0.63 (0.30-1.32)	0.27 (0.09-0.84)	0.72 (0.36-1.44)	1.53 (0.95-2.46)	0	0.54 (0.24-1.20)	0.99 (0.55-1.79)	0.72 (0.36-1.44)	0.54 (0.24-1.20)	10.5	0.10 (0.01-0.68)	7.5	0.54 (0.20-1.43)
posterior-stabilised, fixed, with patella	1.7	7.78 (4.52-13.40)	1.80 (0.58-5.57)	0	2.39 (0.90-6.38)	3.59 (1.61-7.99)	1.20 (0.30-4.79)	0	0.60 (0.08-4.25)	0	0	1.6	0.64 (0.09-4.53)	0.9	0
posterior-stabilised, fixed, without patella	3.1	4.86 (2.93-8.06)	0.32 (0.05-2.30)	0	1.62 (0.67-3.89)	1.30 (0.49-3.45)	0	0	1.30 (0.49-3.45)	0	0	2.9	0	1.5	0.65 (0.09-4.61)
other constraints, with patella	2.3	4.26 (2.29-7.92)	1.70 (0.64-4.54)	0	0.85 (0.21-3.41)	0	0.43 (0.06-3.02)	0.43 (0.06-3.02)	0.85 (0.21-3.41)	0	0.43 (0.06-3.02)	2.3	0.43 (0.06-3.02)	0.4	0
other constraints, without patella	1.4	5.79 (2.90-11.58)	0.72 (0.10-5.14)	0.72 (0.10-5.14)	0.72 (0.10-5.14)	0.72 (0.10-5.14)	0	0	1.45 (0.36-5.79)	0.72 (0.10-5.14)	0	1.3	0.74 (0.10-5.28)	0.8	2.66 (0.67-10.63)

[1] The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2] Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3] Stiffness was asked in versions MDSv2, v3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4] Progressive arthritis was asked in versions MDSv3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K10 (continued)

Fixation, constraint and bearing sub-groups	Pros-thesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation / sub-luxation	Infection	Aseptic loosening / lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Stiffness[3] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe-sis-years	Progressive arthritis[4] Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
Unicompartmental knee replacement															
All unicondylar, cemented	**591.9**	**12.13 (11.85-12.42)**	**2.34 (2.22-2.46)**	**0.64 (0.58-0.71)**	**0.49 (0.44-0.56)**	**3.40 (3.26-3.55)**	**0.22 (0.18-0.26)**	**1.17 (1.08-1.26)**	**0.98 (0.90-1.06)**	**0.60 (0.54-0.67)**	**1.62 (1.52-1.72)**	**571.9**	**0.19 (0.16-0.23)**	**397.5**	**3.68 (3.49-3.87)**
fixed	158.4	9.22 (8.76-9.70)	1.84 (1.64-2.06)	0.11 (0.07-0.17)	0.61 (0.50-0.75)	2.46 (2.22-2.71)	0.20 (0.14-0.29)	0.79 (0.66-0.94)	0.62 (0.51-0.75)	0.47 (0.38-0.59)	1.05 (0.90-1.22)	156.1	0.18 (0.12-0.26)	135.5	3.08 (2.80-3.39)
mobile	386.5	13.27 (12.92-13.64)	2.45 (2.29-2.61)	0.92 (0.83-1.02)	0.45 (0.39-0.52)	3.68 (3.49-3.88)	0.20 (0.16-0.25)	1.32 (1.21-1.44)	1.13 (1.03-1.24)	0.65 (0.58-0.74)	1.91 (1.77-2.05)	370.0	0.19 (0.15-0.24)	236.2	4.01 (3.76-4.27)
monobloc polyethylene tibia	47.1	12.56 (11.58-13.61)	3.12 (2.66-3.67)	0.17 (0.08-0.34)	0.49 (0.32-0.74)	4.29 (3.74-4.93)	0.40 (0.26-0.63)	1.19 (0.92-1.55)	0.96 (0.71-1.28)	0.64 (0.45-0.91)	1.13 (0.86-1.47)	45.7	0.26 (0.15-0.46)	25.9	3.82 (3.14-4.65)
All unicondylar, uncemented/hybrid	**94.2**	**9.38 (8.78-10.02)**	**1.14 (0.94-1.37)**	**1.40 (1.18-1.66)**	**0.54 (0.41-0.71)**	**1.61 (1.38-1.89)**	**0.67 (0.52-0.86)**	**0.83 (0.66-1.03)**	**0.84 (0.67-1.05)**	**0.50 (0.37-0.66)**	**1.36 (1.14-1.62)**	**94.0**	**0.15 (0.09-0.25)**	**89.7**	**2.35 (2.06-2.69)**
fixed	5.5	11.91 (9.36-15.17)	1.99 (1.10-3.59)	0.18 (0.03-1.28)	0	5.78 (4.09-8.17)	0.18 (0.03-1.28)	1.44 (0.72-2.89)	0.90 (0.38-2.17)	0.54 (0.17-1.68)	2.17 (1.23-3.81)	5.4	0.37 (0.09-1.48)	4.3	3.00 (1.74-5.17)
mobile	85.5	9.28 (8.66-9.95)	1.03 (0.84-1.27)	1.53 (1.29-1.82)	0.60 (0.45-0.78)	1.34 (1.12-1.61)	0.73 (0.57-0.93)	0.76 (0.60-0.97)	0.85 (0.68-1.07)	0.51 (0.38-0.69)	1.33 (1.11-1.60)	85.4	0.12 (0.06-0.22)	82.5	2.34 (2.03-2.69)
monobloc polyethylene tibia	3.1	7.38 (4.91-11.11)	2.57 (1.28-5.14)	0	0	1.61 (0.67-3.86)	0	1.61 (0.67-3.86)	0.32 (0.05-2.28)	0	0.64 (0.16-2.57)	3.1	0.64 (0.16-2.57)	2.9	1.75 (0.73-4.21)
Patellofemoral	**94.1**	**20.87 (19.97-21.81)**	**4.61 (4.20-5.07)**	**0.69 (0.54-0.88)**	**0.44 (0.32-0.59)**	**2.45 (2.15-2.78)**	**0.17 (0.10-0.28)**	**1.73 (1.49-2.02)**	**0.99 (0.81-1.21)**	**1.22 (1.02-1.47)**	**3.24 (2.90-3.63)**	**91.6**	**0.46 (0.34-0.62)**	**68.1**	**10.31 (9.58-11.10)**
Multicompartmental	**3.7**	**16.85 (13.16-21.56)**	**3.74 (2.22-6.32)**	**0.80 (0.26-2.49)**	**0.53 (0.13-2.14)**	**1.60 (0.72-3.57)**	**0**	**1.34 (0.56-3.21)**	**0.80 (0.26-2.49)**	**1.07 (0.40-2.85)**	**3.74 (2.22-6.32)**	**3.7**	**0**	**3.4**	**6.71 (4.46-10.09)**
Unclassified															
	176.3	5.73 (5.39-6.09)	0.82 (0.70-0.97)	0.19 (0.13-0.26)	0.90 (0.77-1.05)	1.65 (1.47-1.85)	0.17 (0.12-0.24)	0.47 (0.37-0.58)	0.85 (0.72-0.99)	0.38 (0.30-0.48)	0.78 (0.66-0.92)	167.2	0.31 (0.24-0.41)	101.3	1.11 (0.92-1.33)

[1] The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2] Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3] Stiffness was asked in versions MDSv2, v3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.
[4] Progressive arthritis was asked in versions MDSv3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis-years at risk.

Table 3.K11 PTIR estimates of **indications** for **revision** (95% CI) by **years** following primary knee replacement.

Time since primary (years)	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for:										Stiffness[3]		Progressive arthritis[4]	
		All causes	Pain	Dislocation / subluxation	Infection	Aseptic loosening / lysis	Periprosthetic fracture	Implant wear[1]	Instability	Malalignment	Other indication[2]	Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years	Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
All cases	7,840.7	4.82 (4.77-4.87)	0.75 (0.73-0.77)	0.17 (0.17-0.18)	0.92 (0.90-0.94)	1.29 (1.26-1.31)	0.17 (0.16-0.18)	0.30 (0.29-0.31)	0.68 (0.66-0.70)	0.35 (0.34-0.36)	0.54 (0.52-0.55)	7,592.8	0.31 (0.29-0.32)	5,533.0	0.78 (0.76-0.80)
<1	1,241.0	4.98 (4.86-5.11)	0.50 (0.46-0.54)	0.39 (0.36-0.43)	1.93 (1.85-2.01)	0.63 (0.58-0.67)	0.29 (0.26-0.32)	0.18 (0.16-0.21)	0.54 (0.50-0.58)	0.32 (0.29-0.35)	0.58 (0.53-0.62)	1,220.7	0.30 (0.27-0.34)	1,031.9	0.28 (0.25-0.31)
1 to 3	2,113.1	6.72 (6.61-6.83)	1.39 (1.34-1.45)	0.20 (0.18-0.22)	1.22 (1.18-1.27)	1.60 (1.55-1.65)	0.12 (0.11-0.14)	0.20 (0.18-0.22)	1.00 (0.96-1.04)	0.58 (0.55-0.62)	0.82 (0.78-0.86)	2,073.8	0.57 (0.53-0.60)	1,708.4	0.95 (0.91-1.00)
3 to 5	1,624.6	4.28 (4.18-4.38)	0.78 (0.74-0.83)	0.10 (0.08-0.11)	0.63 (0.59-0.67)	1.34 (1.28-1.39)	0.12 (0.11-0.14)	0.21 (0.19-0.23)	0.63 (0.59-0.67)	0.33 (0.31-0.36)	0.48 (0.45-0.51)	1,587.5	0.27 (0.25-0.30)	1,241.6	0.78 (0.73-0.83)
5 to 7	1,186.4	3.56 (3.45-3.67)	0.47 (0.43-0.51)	0.10 (0.08-0.12)	0.50 (0.46-0.54)	1.20 (1.14-1.27)	0.13 (0.11-0.15)	0.28 (0.26-0.32)	0.50 (0.47-0.55)	0.24 (0.21-0.27)	0.38 (0.35-0.42)	1,152.0	0.16 (0.14-0.19)	828.7	0.84 (0.78-0.90)
7 to 10	1,101.5	3.48 (3.37-3.59)	0.30 (0.27-0.34)	0.10 (0.09-0.13)	0.36 (0.32-0.39)	1.27 (1.20-1.33)	0.19 (0.16-0.22)	0.45 (0.42-0.50)	0.50 (0.46-0.54)	0.18 (0.16-0.21)	0.33 (0.30-0.37)	1,055.4	0.11 (0.09-0.13)	621.8	1.02 (0.94-1.10)
10 to 13	468.5	4.15 (3.97-4.34)	0.20 (0.17-0.25)	0.14 (0.11-0.18)	0.38 (0.33-0.44)	1.56 (1.45-1.68)	0.26 (0.21-0.31)	0.87 (0.79-0.96)	0.67 (0.60-0.75)	0.18 (0.14-0.22)	0.33 (0.28-0.38)	430.0	0.09 (0.07-0.13)	99.4	1.01 (0.83-1.22)
13 to 15	91.3	4.31 (3.91-4.76)	0.18 (0.11-0.29)	0.12 (0.07-0.22)	0.26 (0.18-0.39)	1.90 (1.64-2.21)	0.25 (0.17-0.38)	1.15 (0.95-1.39)	0.66 (0.51-0.85)	0.14 (0.08-0.25)	0.23 (0.15-0.35)	70.1	0.13 (0.07-0.25)	1.1	0.88 (0.12-6.28)
≥15	14.3	4.97 (3.94-6.27)	0.56 (0.28-1.12)	0.21 (0.07-0.65)	0.28 (0.11-0.75)	2.17 (1.53-3.09)	0.28 (0.11-0.75)	1.33 (0.85-2.09)	0.77 (0.43-1.39)	0.14 (0.04-0.56)	0.49 (0.23-1.03)	3.5	0.00	0.2	0.00

[1] The indication implant failure, as reported in annual reports up to 2013, has been renamed implant wear as this reflects the wearing down of the implant but distinguishes from the implant itself breaking.
[2] Other indication now includes other indications not listed, implant fracture and incorrect sizing.
[3] Stiffness was asked in versions MDSv2, v3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis to years at risk.
[4] Progressive arthritis was asked in versions MDSv3, v6 and v7 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer prosthesis to years at risk.

3.3.5 Mortality after primary knee surgery

This section describes the mortality of the cohort up to 15 years from primary operation, according to gender and age group. Deaths recorded after 31 December 2019 were not included in the analysis. For simplicity, it is not taken into account whether the patient had a first (or further) joint revision after the primary operation when calculating the cumulative probability of death (see survival analysis methods note in section 3.1). Of the 1,300,897 records of a primary knee replacement, 21,466 unknown knee type records were excluded and there were 13,058 bilateral operations in which the patient had both knees replaced on the same day; here the second of the two has been excluded, leaving 1,136,497 TKR procedures (of whom 188,452 had died before the end of 2019) and 129,876 UKR procedures (of whom 10,499 died before the end of 2019).

Table 3.K12 (a) KM estimates of cumulative **mortality** (95% CI) by **age** and **gender**, in primary **TKR**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age group (years)	N	Time since primary					
		30 days	90 days	1 year	5 years	10 years	15 years
All primary TKR cases	1,136,497	0.16 (0.15-0.17)	0.30 (0.29-0.31)	1.03 (1.01-1.04)	8.66 (8.60-8.72)	25.85 (25.73-25.97)	47.43 (47.16-47.70)
Males							
<55	27,761	0.04 (0.02-0.08)	0.08 (0.05-0.12)	0.28 (0.22-0.35)	2.11 (1.92-2.31)	6.00 (5.59-6.43)	11.79 (10.68-13.00)
55 to 59	40,131	0.05 (0.03-0.08)	0.10 (0.08-0.14)	0.35 (0.30-0.42)	2.91 (2.73-3.11)	8.53 (8.12-8.95)	16.88 (15.92-17.88)
60 to 64	73,224	0.07 (0.06-0.10)	0.13 (0.11-0.16)	0.47 (0.43-0.53)	4.00 (3.85-4.17)	11.53 (11.20-11.87)	24.88 (23.98-25.81)
65 to 69	95,357	0.10 (0.08-0.12)	0.18 (0.16-0.21)	0.67 (0.62-0.72)	5.75 (5.58-5.92)	17.45 (17.09-17.82)	36.64 (35.74-37.57)
70 to 74	101,147	0.14 (0.12-0.16)	0.27 (0.24-0.31)	1.05 (0.99-1.12)	9.20 (8.99-9.41)	28.08 (27.66-28.50)	55.86 (54.92-56.80)
75 to 79	82,060	0.29 (0.25-0.33)	0.51 (0.46-0.56)	1.78 (1.69-1.88)	14.93 (14.65-15.22)	44.21 (43.69-44.74)	75.80 (74.87-76.71)
80 to 84	45,891	0.59 (0.52-0.66)	1.00 (0.91-1.10)	3.04 (2.88-3.20)	23.81 (23.36-24.27)	63.46 (62.76-64.16)	*91.98 (91.02-92.87)*
≥85	17,600	1.10 (0.96-1.27)	1.94 (1.75-2.16)	5.66 (5.32-6.02)	38.67 (37.82-39.53)	82.43 (81.45-83.38)	*97.06 (95.66-98.10)*
Females							
<55	39,610	0.03 (0.01-0.05)	0.06 (0.04-0.08)	0.20 (0.16-0.25)	1.58 (1.45-1.73)	4.51 (4.20-4.83)	9.25 (8.42-10.16)
55 to 59	53,782	0.03 (0.02-0.05)	0.06 (0.04-0.08)	0.26 (0.22-0.31)	2.07 (1.93-2.21)	6.22 (5.92-6.53)	13.76 (12.94-14.63)
60 to 64	88,006	0.03 (0.02-0.05)	0.08 (0.07-0.10)	0.31 (0.28-0.35)	2.75 (2.63-2.87)	8.61 (8.34-8.89)	18.64 (17.89-19.42)
65 to 69	118,885	0.07 (0.05-0.08)	0.12 (0.10-0.14)	0.43 (0.39-0.47)	3.89 (3.77-4.02)	12.57 (12.29-12.87)	28.67 (27.90-29.45)
70 to 74	132,950	0.09 (0.08-0.11)	0.18 (0.16-0.20)	0.63 (0.59-0.67)	5.96 (5.82-6.12)	20.34 (20.02-20.68)	45.25 (44.42-46.09)
75 to 79	117,919	0.16 (0.14-0.18)	0.30 (0.27-0.33)	1.12 (1.06-1.19)	10.17 (9.97-10.37)	33.86 (33.45-34.27)	65.86 (65.03-66.69)
80 to 84	72,359	0.27 (0.24-0.31)	0.55 (0.50-0.60)	1.87 (1.77-1.97)	16.36 (16.05-16.68)	51.43 (50.87-51.99)	83.70 (82.83-84.55)
≥85	29,815	0.58 (0.50-0.67)	1.17 (1.05-1.30)	3.45 (3.24-3.66)	28.60 (28.00-29.20)	72.99 (72.18-73.79)	*94.37 (93.36-95.28)*

Note: Excludes 8,555 bilateral operations performed on the same day.

Table 3.K12 (a) shows Kaplan-Meier estimates of cumulative percentage mortality at 30 days, 90 days and at 1, 5, 10 and 15 years from the primary knee replacement, for all cases and by age and gender. Fewer men than women have had a primary knee replacement and, proportionally, more women than men undergo surgery above the age of 75. Males, particularly in the older age groups, had a higher cumulative percentage probability of dying in the short or longer term after their primary knee replacement operation than females in the equivalent age group. The mortality rates are lower in males and females following UKR than TKR, but these figures do not adjust for selection and hence do not account for residual confounding (Hunt et al., 2018).

Note: These cases were not censored when further revision surgery was undertaken. Whilst such surgery may have contributed to the overall mortality, the impact of this is not investigated in this report.

Table 3.K12 (b) KM estimates of cumulative **mortality** (95% CI) by **age** and **gender**, in primary **unicompartmental** replacements. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age group (years)	N	Time since primary					
		30 days	90 days	1 year	5 years	10 years	15 years
All unicondylar	115,012	0.03 (0.02-0.05)	0.08 (0.06-0.10)	0.39 (0.35-0.43)	4.11 (3.98-4.25)	13.17 (12.87-13.48)	26.74 (26.00-27.50)
Males							
<55	9,654	0.01 (0.00-0.07)	0.03 (0.01-0.10)	0.17 (0.11-0.28)	1.16 (0.94-1.43)	3.39 (2.87-4.01)	*7.41 (5.76-9.50)*
55 to 59	9,565	0.03 (0.01-0.10)	0.04 (0.02-0.11)	0.20 (0.13-0.32)	1.78 (1.49-2.14)	6.00 (5.30-6.79)	12.04 (10.41-13.90)
60 to 64	12,142	0.05 (0.02-0.11)	0.08 (0.04-0.15)	0.35 (0.25-0.47)	2.85 (2.52-3.22)	8.72 (8.01-9.49)	20.64 (18.56-22.93)
65 to 69	11,759	0.01 (0.00-0.06)	0.05 (0.02-0.12)	0.34 (0.25-0.47)	4.33 (3.91-4.79)	14.48 (13.51-15.52)	*28.92 (26.53-31.47)*
70 to 74	9,167	0.02 (0.01-0.09)	0.08 (0.04-0.16)	0.62 (0.48-0.81)	7.34 (6.70-8.03)	22.47 (21.12-23.90)	*48.10 (44.80-51.52)*
75 to 79	5,691	0.05 (0.02-0.16)	0.16 (0.08-0.31)	0.96 (0.73-1.27)	10.89 (9.94-11.93)	37.69 (35.64-39.81)	*69.41 (65.26-73.47)*
80 to 84	2,614	0.08 (0.02-0.31)	0.23 (0.10-0.52)	1.78 (1.32-2.39)	20.14 (18.28-22.17)	52.78 (49.67-55.97)	*82.10 (77.43-86.30)*
≥85	847	0.47 (0.18-1.26)	0.71 (0.32-1.58)	3.59 (2.49-5.16)	34.04 (30.14-38.29)	*79.77 (74.33-84.71)*	

Note: Excludes 4,095 bilateral operations performed on the same day.

Hunt LP, Whitehouse MR, Howard PW, Ben-Shlomo Y, Blom AW. Using long term mortality to determine which perioperative risk factors of mortality following hip and knee replacement may be causal. Sci Rep. 2018 Oct 9;8(1):15026.

Table 3.K12 (b) (continued)

Age group (years)	N	Time since primary					
		30 days	90 days	1 year	5 years	10 years	15 years
Females							
<55	10,908	0.02 (0.00-0.07)	0.03 (0.01-0.09)	0.07 (0.03-0.14)	0.79 (0.61-1.02)	2.81 (2.36-3.35)	*4.76 (3.76-6.02)*
55 to 59	8,724	0.01 (0.00-0.08)	0.01 (0.00-0.08)	0.07 (0.03-0.16)	1.05 (0.82-1.34)	3.77 (3.22-4.42)	7.18 (5.95-8.66)
60 to 64	9,365	0.01 (0.00-0.08)	0.01 (0.00-0.08)	0.14 (0.08-0.24)	1.77 (1.48-2.11)	5.69 (5.04-6.42)	*13.32 (11.52-15.37)*
65 to 69	9,001	0.03 (0.01-0.10)	0.09 (0.04-0.18)	0.28 (0.19-0.41)	2.54 (2.18-2.94)	8.23 (7.40-9.15)	*18.84 (16.44-21.54)*
70 to 74	7,604	0.05 (0.02-0.14)	0.08 (0.04-0.18)	0.31 (0.20-0.47)	3.84 (3.34-4.41)	13.78 (12.58-15.08)	*32.30 (29.49-35.31)*
75 to 79	4,831	0	0.06 (0.02-0.20)	0.35 (0.22-0.57)	6.41 (5.62-7.30)	23.77 (21.98-25.67)	*52.70 (48.42-57.10)*
80 to 84	2,327	0.13 (0.04-0.40)	0.35 (0.17-0.70)	1.13 (0.76-1.66)	11.99 (10.49-13.68)	42.72 (39.67-45.90)	*76.50 (71.17-81.47)*
≥85	813	0.37 (0.12-1.14)	0.99 (0.50-1.98)	3.27 (2.22-4.80)	20.02 (16.84-23.71)	*63.03 (57.01-69.05)*	
All patellofemoral	**14,317**	**0.04 (0.02-0.09)**	**0.13 (0.09-0.21)**	**0.37 (0.29-0.49)**	**3.70 (3.37-4.07)**	**11.73 (11.00-12.51)**	**24.51 (22.42-26.77)**
All multicompartmental	**547**		**0**	**0.37 (0.09-1.49)**	**2.72 (1.59-4.65)**	*8.02 (5.26-12.13)*	*12.89 (7.06-22.91)*

Note: Excludes 4,095 bilateral operations performed on the same day.

3.3.6 Overview of knee revisions

This section looks at all recorded knee revision procedures performed since the registry began on 1 April 2003 up to the end of December 2019, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total there were 83,042 revisions recorded on 69,053 individual patient-sides (65,721 actual patients). In addition to the 37,794 revised primaries described previously in this section, there were 31,259 additional revisions for a patient-side for which there is no associated primary operation recorded in the NJR.

Revisions are classified as single-stage, stage one of two-stage or stage two of two-stage revisions. Information on stage one and stage two of two-stage revisions are entered into the registry separately, whereas stage one and stage two revisions in practice are typically linked. Debridement and implant retention (DAIR) with or without modular exchange are included as single-stage procedures. With the introduction of distinct indicators for the DAIR procedures in MDSv7, it may be possible to report these as distinct categories in future reports. Although not all patients who undergo stage one of a two-stage revision will undergo a stage two of two-stage revision. In some cases, stage one revisions have been entered without stage two, and vice versa, making identification of entire patient revision episodes difficult. An attempt has been made to do this later in this section.

Table 3.K13 (page 176) gives an overview of all knee revision procedures carried out each year since April 2003. There were a maximum number of 13 documented revision procedures associated with any individual patient-side. The increase in the number of operations over time reflects the increasing number of at-risk implants prevailing in the dataset.

Table 3.K13 Number and percentage of revisions by procedure type and year.

Year of revision surgery	Type of revision procedure			Total revision joint operations
	Single-stage N(%)	Stage one of two-stage N(%)	Stage two of two-stage N(%)	
2003*	522 (82.6)	1 (0.2)	109 (17.2)	632
2004	933 (76.2)	78 (6.4)	214 (17.5)	1,225
2005	1,477 (73.7)	209 (10.4)	317 (15.8)	2,003
2006	1,947 (75.3)	282 (10.9)	356 (13.8)	2,585
2007	2,639 (75.1)	386 (11.0)	491 (14.0)	3,516
2008	3,325 (75.7)	473 (10.8)	595 (13.5)	4,393
2009	3,710 (76.2)	526 (10.8)	630 (12.9)	4,866
2010	4,180 (77.1)	570 (10.5)	669 (12.3)	5,419
2011	4,331 (77.4)	619 (11.1)	649 (11.6)	5,599
2012	5,004 (78.5)	630 (9.9)	740 (11.6)	6,374
2013	4,702 (78.4)	631 (10.5)	662 (11.0)	5,995
2014	5,078 (78.0)	736 (11.3)	700 (10.7)	6,514
2015	5,349 (79.0)	744 (11.0)	674 (10.0)	6,767
2016	5,536 (80.7)	688 (10.0)	639 (9.3)	6,863
2017	5,575 (80.5)	690 (10.0)	663 (9.6)	6,928
2018	5,464 (82.1)	599 (9.0)	592 (8.9)	6,655
2019	5,605 (83.6)	574 (8.6)	529 (7.9)	6,708
Total	65,377	8,436	9,229	83,042

*Incomplete year.

Table 3.K14 (a) (page 177) shows the stated indications for the revision knee surgery. As more than one indication can be selected, the indications are not mutually exclusive and therefore column percentages do not add up to 100%. Aseptic loosening / lysis is the most common indication for revision, accounting for approximately 40% of single-stage revision operations, while instability, pain, wear and other indications account for between 10 and 20% each. Of the two-stage revision operations, infection is the main indication recorded for revision surgery in approximately four-fifths of either stage one or stage two procedures. Table 3.K14 (b) presents these results, restricted to the last five years.

Table 3.K14 (a) Number and percentage of knee revision by indication and procedure type.

Reason for revision	Type of revision procedure		
	Single-stage N(%) (n=65,377)	Stage one of two-stage N(%) (n=8,436)	Stage two of two-stage N(%) (n=9,229)
Aseptic loosening / lysis	25,300 (38.7)	1,504 (17.8)	1,382 (15.0)
Instability	11,397 (17.4)	342 (4.1)	363 (3.9)
Pain	10,051 (15.4)	362 (4.3)	359 (3.9)
Implant wear	9,170 (14.0)	281 (3.3)	204 (2.2)
Other indication	7,455 (11.4)	314 (3.7)	504 (5.5)
Malalignment	4,892 (7.5)	112 (1.3)	134 (1.5)
Infection	4,729 (7.2)	7,167 (85.0)	7,257 (78.6)
Periprosthetic fracture	2,802 (4.3)	123 (1.5)	137 (1.5)
Dislocation / subluxation	2,651 (4.1)	137 (1.6)	107 (1.2)
Stiffness*	3,739 (5.8) n=64,629	196 (2.3) n=8,436	159 (1.8) n=9,071
Progressive arthritis*	8,423 (14.7) n=57,397	59 (0.8) n=7,407	80 (1.0) n=7,644

*These reasons were not recorded in the earliest phase of the registry; only in MDSv2 onwards for stiffness and MDSv3 onwards for progressive arthritis.
Note: The number of joints on which these two percentages are based is stated beside the percentage figure.

Table 3.K14 (b) Number and percentage of knee revision by indication and procedure type in the last five years.

Reason for revision	Type of revision procedure		
	Single-stage N(%) (n=27,535)	Stage one of two-stage N(%) (n=3,295)	Stage two of two-stage N(%) (n=3,097)
Aseptic loosening / lysis	9,215 (33.5)	457 (13.9)	361 (11.7)
Progressive arthritis	5,503 (20.0)	33 (1.0)	49 (1.6)
Instability	4,778 (17.4)	114 (3.5)	93 (3.0)
Implant wear	3,532 (12.8)	82 (2.5)	44 (1.4)
Pain	2,802 (10.2)	69 (2.1)	55 (1.8)
Other indication	2,711 (9.8)	115 (3.5)	143 (4.6)
Infection	2,695 (9.8)	2,893 (87.8)	2,562 (82.7)
Malalignment	1,784 (6.5)	36 (1.1)	35 (1.1)
Stiffness	1,569 (5.7)	57 (1.7)	46 (1.5)
Periprosthetic fracture	1,429 (5.2)	52 (1.6)	59 (1.9)
Dislocation / subluxation	988 (3.6)	58 (1.8)	28 (0.9)

3.3.7 Rates of knee re-revision

In most instances (86%), the first revision procedure was a single-stage revision, in the remaining 14% it was part of a two-stage procedure. For a given patient-side, the survival following the first documented revision procedure linked to a primary in the NJR (n=37,794) has been analysed. This analysis is restricted to patients with a linked primary procedure so that there is confidence that the next observed procedure on the same joint is the first revision episode. If there is no linked primary record in the dataset, it cannot be determined if the first observed revision is the first revision or has been preceded by other revision episodes. The time from the first documented revision procedure (of any type) to the time at which a second revision procedure was undertaken has been determined. For this purpose, an initial stage one followed by either a stage one or a stage two of a two-stage procedure have been considered to be the same revision episode and these were disregarded, looking instead for the start of a second revision episode. (The maximum number of distinct revision episodes for any patient-side was determined to be 13).

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were calculated. There were 4,099 re-revisions and, for 4,057 cases, the patient died without having been re-revised. The censoring date for the remainder was the end of 2019.

Figure 3.K6 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision in linked revised primary knee replacements between 1 and 15 years since the primary operation.

Figure 3.K6 (a) KM estimates of cumulative **re-revision**, in linked revised primary knee replacements (shaded area indicates point-wise 95% CI). *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

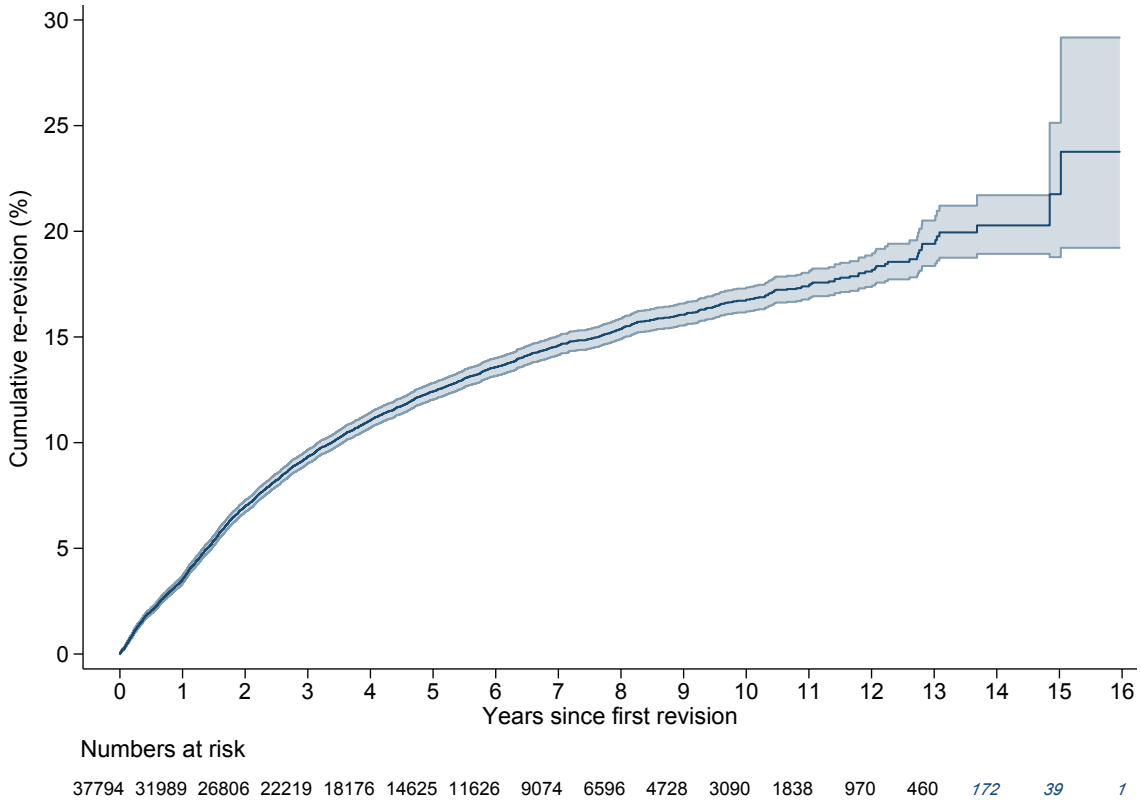
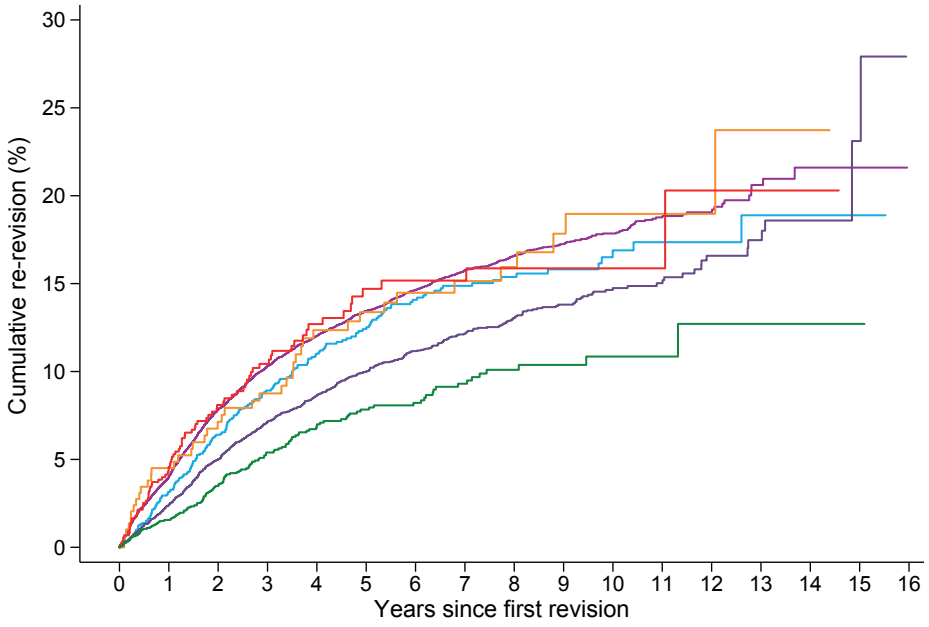


Figure 3.K6 (b) shows estimates of re-revision by type of primary knee replacement. Revised patellofemoral knee replacements have the lowest risk of re-revision until eight years, after which the numbers at risk fall below 250 and should be interpreted with caution. Revised cemented unicondylar knee replacements have the next lowest risk of re-revision until 12 years when again, the numbers at risk become small.

Revised uncemented / hybrid unicondylar knee replacements appear to have a higher risk of re-revision than their cemented counterparts and are equivalent to the rates seen for revised cemented total knee replacements until four years, after which the numbers in the revised uncemented unicondylar group become small.

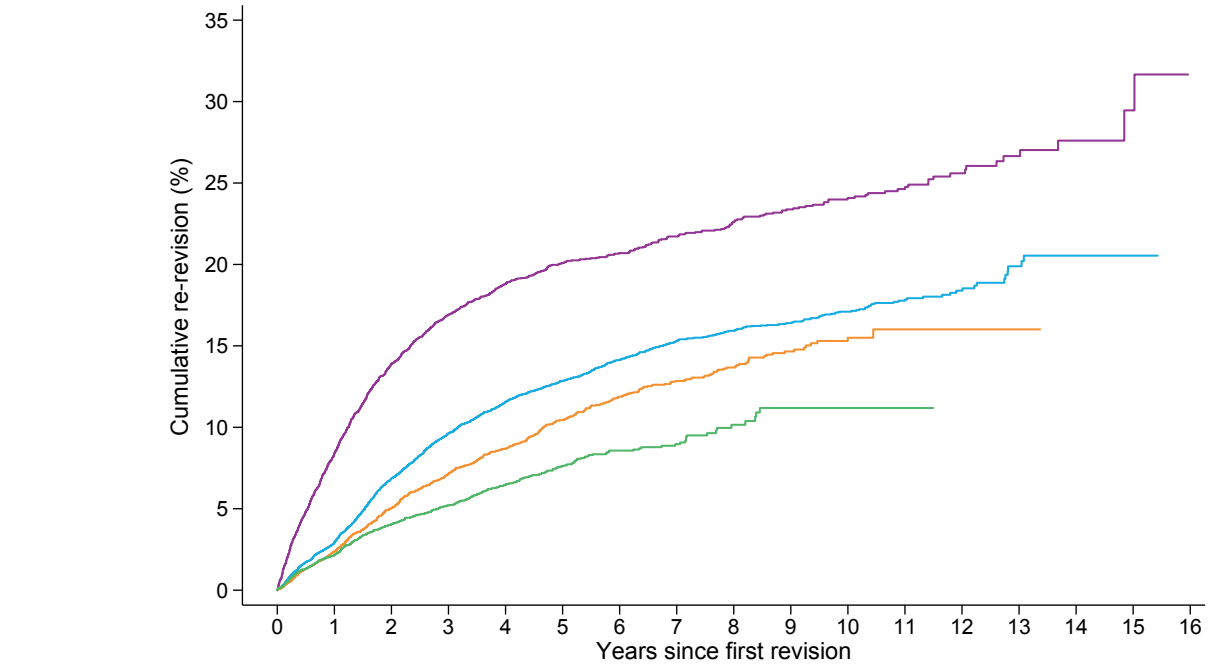
Figure 3.K6 (b) KM estimates of cumulative **re-revision** by primary fixation, in linked primary knee replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk															
Cemented	24780	20662	17064	13937	11238	8896	6922	5291	3791	2706	1744	1030	522	*232*	*86*	*16*	*1*
Uncemented	1616	1454	1292	1116	946	826	687	563	436	313	*212*	*130*	*74*	*34*	*11*	*4*	*0*
Hybrid	298	265	*239*	*218*	*190*	*165*	*144*	*124*	*100*	*73*	*52*	*28*	*17*	*7*	*2*	*0*	*0*
Unicondylar, cemented	7181	6323	5462	4662	3945	3267	2679	2157	1619	1184	813	502	287	*153*	*59*	*16*	*0*
Unicondylar, uncemented/hybrid	883	657	488	367	254	*193*	*155*	*122*	*78*	*56*	*32*	*19*	*8*	*6*	*1*	*0*	*0*
Patellofemoral	1963	1698	1459	1232	1008	788	636	493	334	*234*	*124*	*66*	*28*	*14*	*5*	*1*	*0*

Figure 3.K6 (c) KM estimates of cumulative **re-revision** by **years to first revision**, in linked primary knee replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

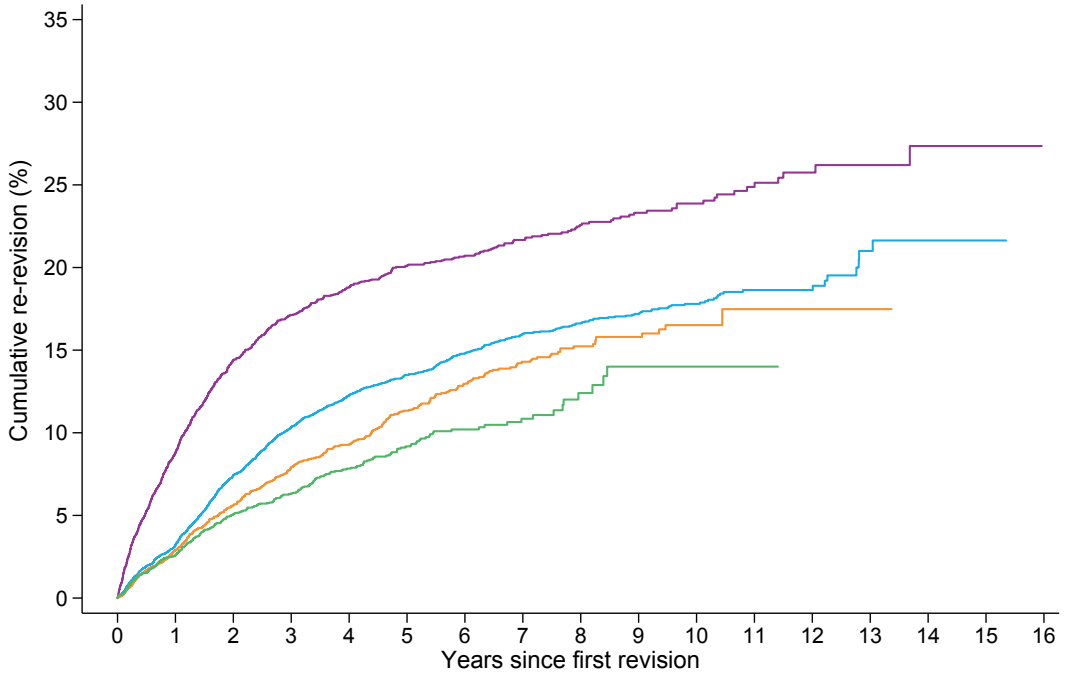
Numbers at risk

First rev. <1y	6186	5069	4298	3651	3097	2583	2195	1804	1431	1130	822	558	336	*198*	*95*	*32*	*1*
First rev. 1 to 3y	14195	12595	10978	9478	8066	6785	5609	4563	3496	2633	1766	1067	573	258	*77*	*7*	*0*
First rev. 3 to 5y	6950	6031	5120	4301	3567	2922	2336	1798	1217	767	435	*202*	*61*	*4*	*0*	*0*	*0*
First rev. ≥5y	10463	8294	6410	4789	3446	2335	1486	909	452	*198*	*67*	*11*	*0*	*0*	*0*	*0*	*0*

Figure 3.K6 (c) shows the relationship between time to first revision and risk of subsequent revision. The earlier the primary knee replacement fails, the higher the risk of second revision. For example, if a primary knee replacement is revised within the first year of the primary replacement being performed, there is an 8.3% re-revision rate at one year following the first revision, rising to 20.1% by five years; if a primary knee replacement is not revised until five years or more after the primary procedure, the re-revision rate is approximately 2% at one year following the first revision, rising to 7.6% by five years.

For those with documented primary knee replacements within the NJR, Figures 3.K7 (a) to (f) (pages 181 to 186) show cumulative re-revision rates following the first revision, according to the main type of primary knee replacement. Each sub-group has been further sub-divided according to the time interval from the primary to the first revision, i.e. less than 1 year, 1 to 3, 3 to 5 and greater than or equal to 5 years. For cemented TKRs, uncemented TKRs, unicondylar and patellofemoral knee replacements, those who had their first revision within one year of the initial primary knee replacement experienced the worst re-revision rates. However, for hybrid TKRs, the worst re-revision rates were experienced by those who had their first revision within 3 to 5 years of the initial primary knee replacement; however, the numbers at risk were small in the hybrid group and therefore the results should be interpreted with caution.

Figure 3.K7 (a) KM estimates of cumulative **re-revision** in primary **cemented TKRs** by **years to first revision**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

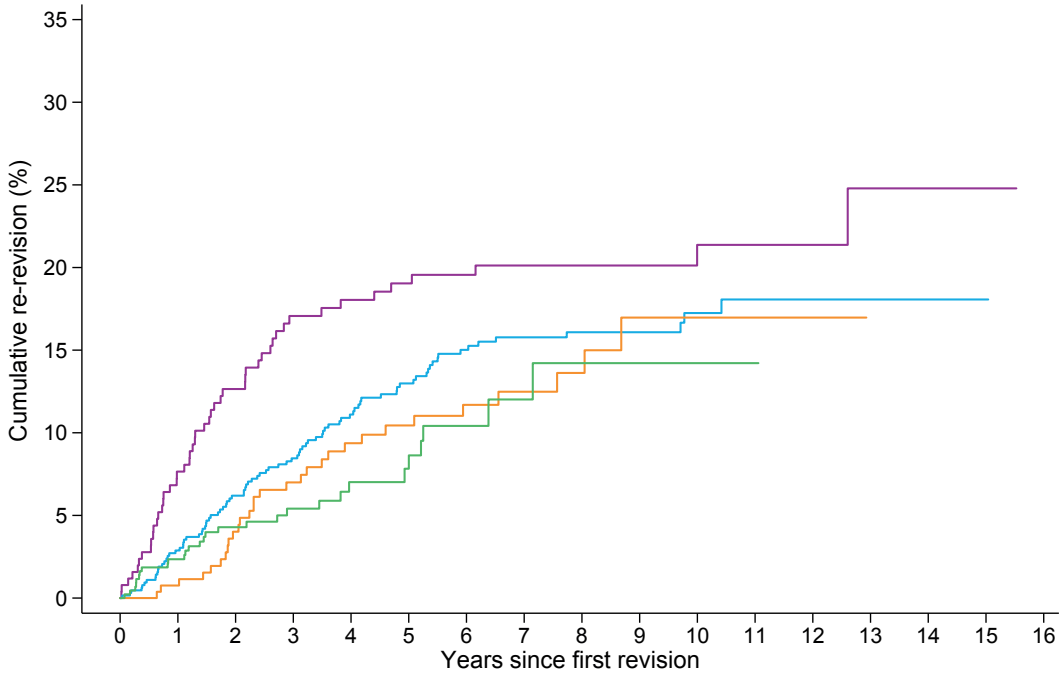


Key:

Numbers at risk

First rev. <1y	4386	3541	2959	2476	2055	1666	1376	1098	842	647	450	300	*170*	*101*	*43*	*13*	*1*
First rev. 1 to 3y	9922	8682	7422	6270	5251	4322	3475	2755	2061	1555	1029	614	320	*129*	*43*	*3*	*0*
First rev. 3 to 5y	4624	3900	3222	2635	2130	1701	1330	998	671	411	*234*	*111*	*32*	*2*	*0*	*0*	*0*
First rev. ≥5y	5848	4539	3461	2556	1802	1207	741	440	*217*	*93*	*31*	*5*	*0*	*0*	*0*	*0*	*0*

Figure 3.K7 (b) KM estimates of cumulative **re-revision** in primary **uncemented TKRs** by **years to first revision.** *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

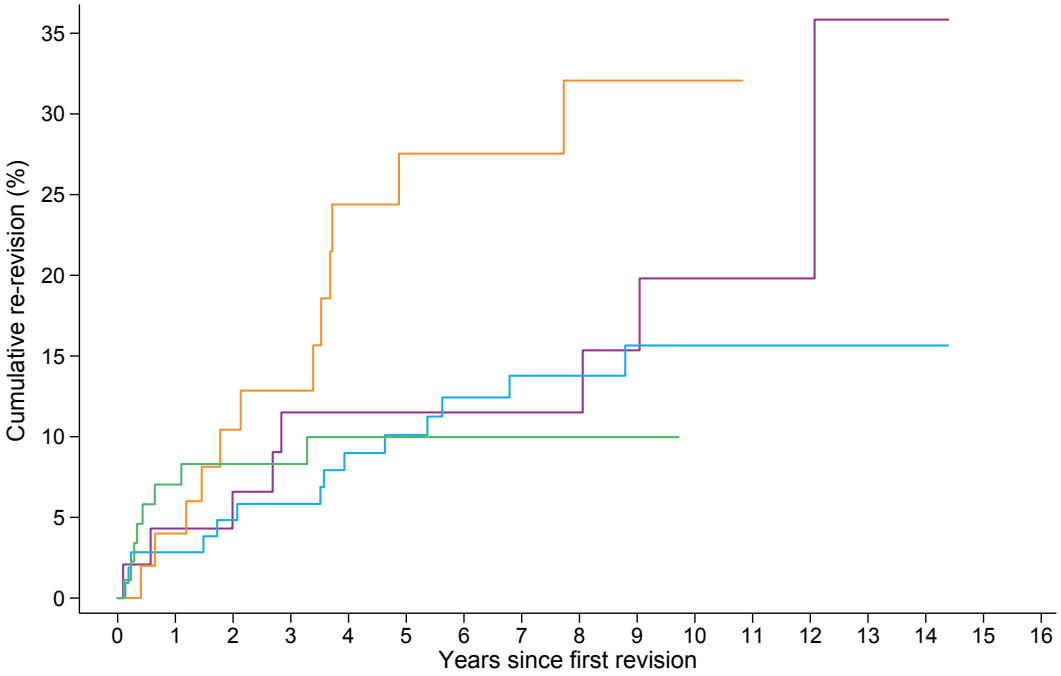


Key:

Numbers at risk

First rev. <1y	255	*224*	*204*	*181*	*167*	*159*	*142*	*125*	*105*	*85*	*63*	*43*	*29*	*16*	*7*	*3*	*0*
First rev. 1 to 3y	646	593	556	504	441	397	348	299	*248*	*181*	*124*	*75*	*42*	*18*	*4*	*1*	*0*
First rev. 3 to 5y	272	257	*229*	*204*	*180*	*156*	*130*	*97*	*63*	*36*	*22*	*11*	*3*	*0*	*0*	*0*	*0*
First rev. ≥5y	443	380	303	*227*	*158*	*114*	*67*	*42*	*20*	*11*	*3*	*1*	*0*	*0*	*0*	*0*	*0*

Figure 3.K7 (c) KM estimates of cumulative **re-revision** in primary **hybrid TKRs** by **years to first revision.** *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

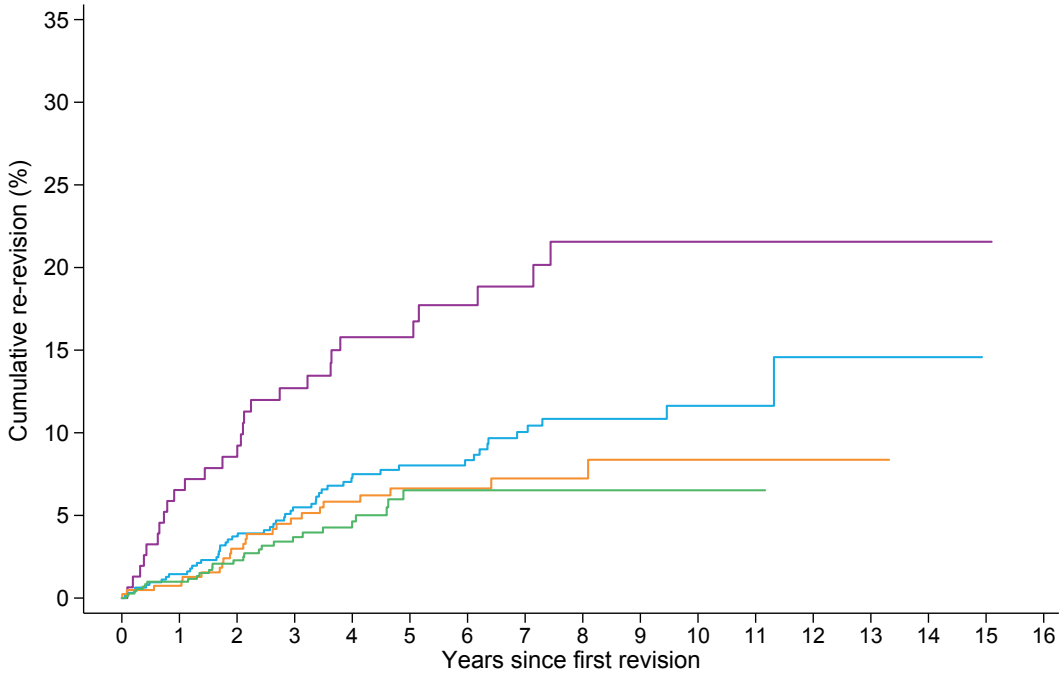


Key:

Numbers at risk

First rev. <1y	*49*	*43*	*41*	*34*	*32*	*29*	*26*	*25*	*23*	*19*	*14*	*9*	*5*	*3*	*1*	*0*	*0*
First rev. 1 to 3y	*106*	*101*	*95*	*91*	*86*	*80*	*72*	*63*	*53*	*43*	*34*	*19*	*12*	*4*	*1*	*0*	*0*
First rev. 3 to 5y	*51*	*48*	*39*	*35*	*26*	*23*	*22*	*18*	*12*	*6*	*4*	*0*	*0*	*0*	*0*	*0*	*0*
First rev. ≥5y	*92*	*73*	*64*	*58*	*46*	*33*	*24*	*18*	*12*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Figure 3.K7 (d) KM estimates of cumulative **re-revision** in primary **patellofemoral** knee replacements by **years to first revision.** *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

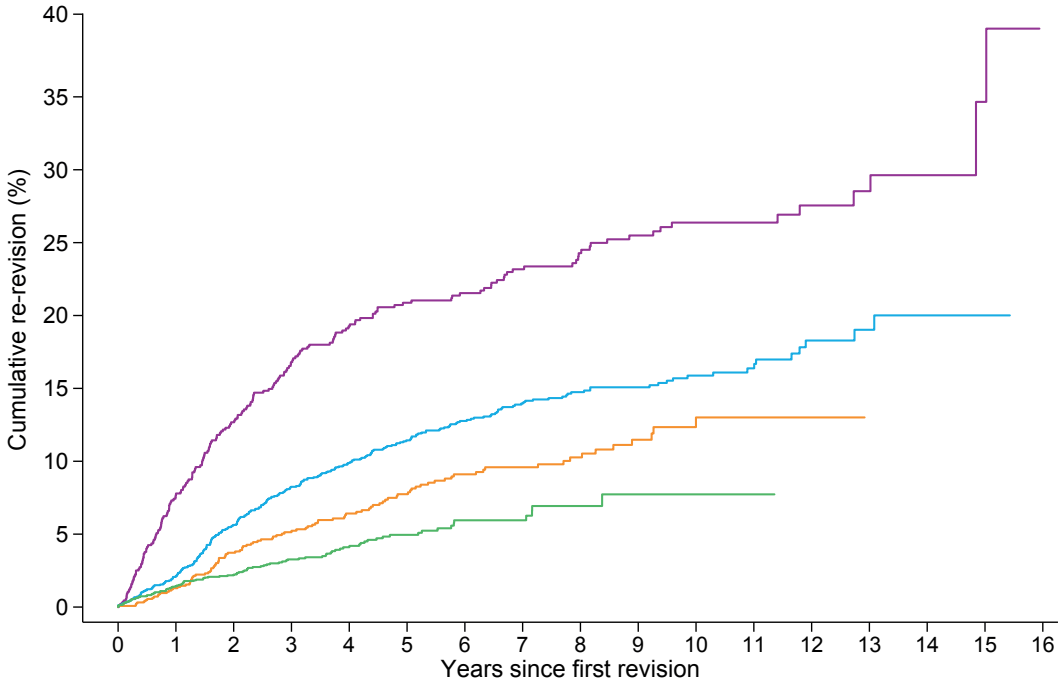


Key:

Numbers at risk

First rev. <1y	*154*	*141*	*134*	*118*	*105*	*89*	*76*	*62*	*48*	*37*	*25*	*15*	*8*	*4*	*3*	*1*	*0*
First rev. 1 to 3y	640	587	523	469	395	334	284	*233*	*175*	*133*	*74*	*41*	*18*	*9*	*2*	*0*	*0*
First rev. 3 to 5y	413	369	332	292	*249*	*206*	*169*	*137*	*85*	*52*	*24*	*9*	*2*	*1*	*0*	*0*	*0*
First rev. ≥5y	756	601	470	353	259	*159*	*107*	*61*	*26*	*12*	*1*	*1*	*0*	*0*	*0*	*0*	*0*

Figure 3.K7 (e) KM estimates of cumulative **re-revision** in primary **cemented unicondylar** knee replacements by **years to first revision**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

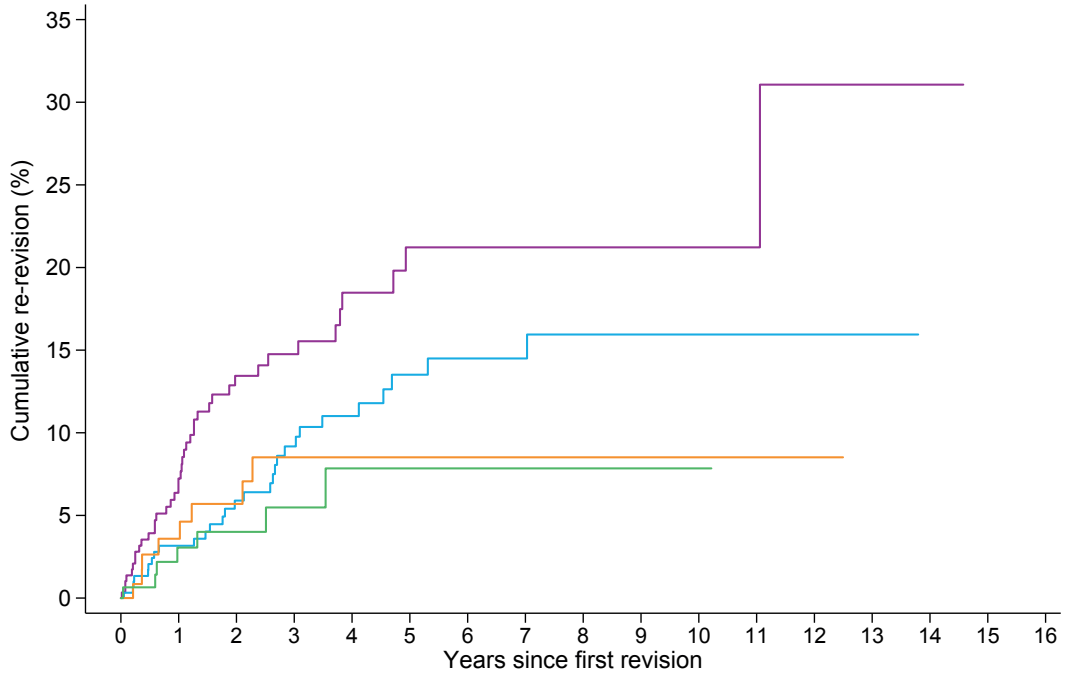


Key:

Numbers at risk

First rev. <1y	885	771	696	630	570	504	459	391	329	273	*218*	*161*	*106*	*65*	*35*	*13*	*0*
First rev. 1 to 3y	2233	2080	1903	1719	1526	1335	1155	982	794	611	438	277	*160*	*88*	*24*	*3*	*0*
First rev. 3 to 5y	1281	1188	1063	942	825	713	596	482	344	*235*	*131*	*61*	*21*	*0*	*0*	*0*	*0*
First rev. ≥5y	2782	2284	1800	1371	1024	715	469	302	*152*	*65*	*26*	*3*	*0*	*0*	*0*	*0*	*0*

Figure 3.K7 (f) KM estimates of cumulative **re-revision** in primary **uncemented / hybrid unicondylar** knee replacements by **years to first revision**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key: Numbers at risk

First rev. <1y	296	*214*	*150*	*112*	*77*	*53*	*44*	*41*	*31*	*25*	*16*	*8*	*2*	*2*	*1*	*0*	*0*
First rev. 1 to 3y	310	*238*	*191*	*155*	*114*	*93*	*78*	*59*	*36*	*21*	*10*	*8*	*5*	*4*	*0*	*0*	*0*
First rev. 3 to 5y	*123*	*93*	*71*	*47*	*32*	*24*	*17*	*12*	*6*	*6*	*5*	*3*	*1*	*0*	*0*	*0*	*0*
First rev. ≥5y	*154*	*112*	*76*	*53*	*31*	*23*	*16*	*10*	*5*	*4*	*1*	*0*	*0*	*0*	*0*	*0*	*0*

Table 3.K15 (a) KM estimates of cumulative **re-revision** (95% CI). *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Number of first revised joints at risk of re-revision	Time since first revision					
		1 year	3 years	5 years	7 years	10 years	15 years
Primary recorded in the NJR	37,794	3.52 (3.33-3.71)	9.32 (9.00-9.65)	12.44 (12.05-12.84)	16.77 (16.21-17.35)	19.38 (18.34-20.48)	*21.73 (18.75-25.11)*

Note: The number at risk for the 15 year estimate is only 40.

Table 3.K15 (a) shows the re-revision rate of the 37,794 revised primary knee replacements (36,784 (93.7%) with known knee type at primary procedure) registered in the NJR. Of these, 4,099 were re-revised.

Table 3.K15 (b) shows that primary knee replacements that fail within the first year after surgery have approximately two to four times the chance of needing re-revision at each time point compared with primaries that last more than five years.

Table 3.K15 (b) KM estimates of cumulative **re-revision** (95% CI) by **years since first revision**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Primary in the NJR where the first revision took place:	Number of first revised joints at risk of re-revision	Time since first revision					
		1 year	3 years	5 years	7 years	10 years	13 years
<1 year after primary	6,186	8.25 (7.57-8.98)	16.90 (15.92-17.92)	20.10 (19.02-21.24)	21.72 (20.56-22.94)	24.08 (22.75-25.48)	*26.63 (24.79-28.58)*
1 to 3 years after primary	14,195	2.95 (2.68-3.25)	9.61 (9.11-10.15)	12.88 (12.27-13.51)	15.30 (14.60-16.02)	17.11 (16.30-17.95)	19.88 (18.42-21.44)
3 to 5 years after primary	6,950	2.41 (2.06-2.81)	7.14 (6.50-7.84)	10.46 (9.63-11.34)	12.83 (11.86-13.88)	15.48 (14.15-16.92)	
≥5 years after primary*	10,463	2.17 (1.90-2.48)	5.20 (4.73-5.72)	7.61 (6.94-8.34)	8.98 (8.15-9.90)	*11.18 (9.74-12.81)*	

*The maximum of this interval was 16.5 years.
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K15 (c) shows cumulative re-revision rates at 1, 3, 5, 7 and 10 years following the first revision for those with documented primary knee replacements within the NJR, broken down by type of knee replacement, constraint, mobility and whether a patella component was recorded. Overall, the worst re-revision rates were demonstrated in those where the initial primary had been a cemented TKR, hybrid TKR or uncemented unicondylar although the confidence intervals broadly overlap after five years in the cemented TKR group and earlier in the other groups.

Table 3.K15 (c) KM estimates of cumulative **re-revision** (95% CI) by **fixation** and **constraint** and whether a **patella component** was recorded. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Knee type	Constraint	N	Time since first revision					
			1 year	3 years	5 years	7 years	10 years	13 years
All types		**37,794**	**3.52 (3.34-3.72)**	**9.33 (9.02-9.66)**	**12.42 (12.03-12.82)**	**14.60 (14.15-15.06)**	**16.77 (16.21-17.35)**	**19.41 (18.36-20.51)**
Unclassified		**1,010**	**2.93 (2.03-4.21)**	**9.51 (7.74-11.67)**	**12.43 (10.32-14.93)**	**13.53 (11.26-16.21)**	*14.93 (12.27-18.10)*	*14.93 (12.27-18.10)*
Cemented		**24,780**	**4.01 (3.77-4.27)**	**10.31 (9.89-10.73)**	**13.44 (12.94-13.95)**	**15.77 (15.19-16.37)**	**17.85 (17.13-18.60)**	*20.61 (19.17-22.13)*
	unconstrained, fixed, with patella	4,509	5.06 (4.44-5.76)	11.70 (10.70-12.79)	14.45 (13.28-15.72)	16.88 (15.49-18.37)	18.71 (17.03-20.53)	*21.11 (18.68-23.80)*
	unconstrained, fixed, without patella	10,740	3.52 (3.17-3.90)	9.77 (9.16-10.41)	13.15 (12.40-13.94)	15.09 (14.23-15.99)	16.68 (15.66-17.77)	*19.61 (17.57-21.86)*
	unconstrained, mobile, without patella	944	3.69 (2.65-5.13)	9.76 (7.95-11.95)	12.95 (10.78-15.52)	16.41 (13.80-19.46)	*20.00 (16.68-23.89)*	*20.00 (16.68-23.89)*
	posterior-stabilised, fixed, with patella	2,987	4.65 (3.94-5.50)	10.87 (9.70-12.18)	14.37 (12.92-15.96)	16.67 (14.97-18.55)	*18.06 (16.07-20.26)*	*20.24 (16.65-24.49)*
	posterior-stabilised, fixed, without patella	4,114	3.41 (2.88-4.04)	9.42 (8.47-10.47)	12.10 (10.97-13.34)	14.50 (13.14-15.98)	17.39 (15.59-19.36)	*19.63 (15.82-24.21)*
Uncemented		**1,616**	**3.14 (2.39-4.14)**	**8.92 (7.55-10.51)**	**12.41 (10.74-14.33)**	**14.88 (12.97-17.04)**	*16.89 (14.58-19.53)*	*18.89 (15.31-23.19)*
	unconstrained, mobile, without patella	762	3.52 (2.41-5.12)	7.88 (6.10-10.15)	10.47 (8.34-13.10)	13.37 (10.82-16.47)	*15.28 (12.24-18.98)*	*18.30 (12.63-26.11)*
Hybrid		**298**	**4.51 (2.64-7.64)**	*8.76 (5.95-12.80)*	*13.38 (9.71-18.29)*	*15.15 (11.13-20.43)*	*18.97 (13.94-25.52)*	
Unicondylar, cemented		**7,181**	**2.42 (2.08-2.81)**	**7.14 (6.52-7.81)**	**10.00 (9.22-10.83)**	**12.15 (11.24-13.12)**	**14.75 (13.58-16.00)**	*17.47 (15.50-19.67)*
	fixed	1,460	2.37 (1.68-3.34)	8.20 (6.74-9.95)	11.03 (9.21-13.18)	14.26 (11.94-16.97)	*16.40 (13.65-19.63)*	*26.88 (16.97-40.98)*
	mobile	5,130	2.54 (2.14-3.02)	7.04 (6.33-7.84)	9.73 (8.85-10.70)	11.68 (10.65-12.79)	14.57 (13.22-16.04)	*16.62 (14.60-18.88)*
Unicondylar, uncemented/ hybrid		**883**	**4.57 (3.31-6.29)**	**10.44 (8.28-13.11)**	*14.70 (11.76-18.30)*	*15.18 (12.13-18.90)*	*15.87 (12.62-19.86)*	
	mobile	794	4.82 (3.46-6.69)	10.67 (8.37-13.56)	*15.61 (12.28-19.73)*	*16.22 (12.75-20.52)*	*17.11 (13.35-21.79)*	
Patellofemoral		**1,963**	**1.56 (1.08-2.23)**	**5.39 (4.39-6.62)**	**7.84 (6.53-9.39)**	**9.31 (7.78-11.12)**	*10.85 (8.93-13.16)*	*12.71 (9.14-17.54)*

Note: Maximum interval was 15.0 years.

3.3.8 Reason for knee re-revision

Table 3.K16 (a) Number of revisions by indication for all revisions.

Reason for revision	All recorded revisions, N(%)
Aseptic loosening / lysis	28,186 (33.9)
Infection	19,153 (23.1)
Instability	12,102 (14.6)
Pain	10,772 (13.0)
Implant wear	9,655 (11.6)
Malalignment	5,138 (6.2)
Periprosthetic fracture	3,062 (3.7)
Dislocation / subluxation	2,895 (3.5)
Other indication	8,273 (10.0)
Stiffness*	4,094 (5.0)
Progressive arthritis**	8,562 (11.8)

*Stiffness as a reason for revision was not recorded in MDSv1 and as such was only a potential reason for revision among a total of 82,136 revisions as opposed to 83,042 revisions for the other reasons.
**Progressive arthritis as a reason for revision was not recorded in MDSv1 or MDSv2 and as such was only a potential reason for revision among a total of 72,448 revisions, as opposed to 83,042 revisions for the other reasons.

Table 3.K16 (b) Number of revisions by indication for first linked revision and second linked re-revision.

	First linked revision		Second linked revision
Reason for revision	N	Subsequently re-revised, N(%)	N
Aseptic loosening / lysis	10,084	962 (9.5)	1,012
Infection	7,188	1,298 (18.1)	1,556
Pain	5,854	650 (11.1)	441
Instability	5,335	555 (10.4)	723
Malalignment	2,754	246 (8.9)	236
Implant wear	2,360	218 (9.2)	160
Dislocation / subluxation	1,369	197 (14.4)	171
Periprosthetic fracture	1,324	92 (6.9)	96
Other indication	4,214	411 (9.8)	312
Stiffness*	2,330	267 (11.5)	263
Progressive arthritis**	4,308	192 (4.5)	100

*Stiffness as a reason for revision was not recorded in MDSv1 and as such was only a potential reason for revision among a total of 36,743 linked revisions as opposed to 37,794 linked revisions for the other reasons.
**Progressive arthritis as a reason for revision was not recorded in MDSv1 or MDSv2 and as such was only a potential reason for revision among a total of 27,196 linked revisions, as opposed to 37,794 linked revisions for the other reasons.

Tables 3.K16 (a) and (b) show a breakdown of the stated indications for the first revision and for any second revision (note the indications are not mutually exclusive). Table 3.K16 (a) shows the indications for all knee revisions recorded in the NJR and Table 3.K16 (b) reports the indications for the first linked revision and the number and percentage of first recorded revisions that were subsequently re-revised. The final column reports the indications for all the second linked revisions. It is interesting to note that infection, dislocation / subluxation, instability and stiffness are more common indications for second revision than first revision. This reflects the complexity and soft tissue elements that contribute to the outcome of revision knee replacement.

Table 3.K17 (a) Number of revisions by year.

Year of first revision in the NJR*	Number of first revisions	Number of first revisions (%) with the associated primary recorded in the NJR
2003	624	12 (1.9)
2004	1,168	83 (7.1)
2005	1,845	280 (15.2)
2006	2,340	509 (21.8)
2007	3,139	881 (28.1)
2008	3,811	1,387 (36.4)
2009	4,188	1,829 (43.7)
2010	4,608	2,201 (47.8)
2011	4,681	2,352 (50.2)
2012	5,294	2,974 (56.2)
2013	4,908	2,840 (57.9)
2014	5,251	3,226 (61.4)
2015	5,412	3,515 (64.9)
2016	5,479	3,745 (68.4)
2017	5,541	3,927 (70.9)
2018	5,331	3,935 (73.8)
2019	5,433	4,098 (75.4)
Total	69,053	37,794 (54.7)

*First documented revision in the NJR.

Table 3.K17 (b) Number of revisions by year, stage, and whether or not primary is in the NJR.

Year of (first) revision	Single-stage		First documented stage of two-stage	
	Primary not in the NJR total per year	Primary in the NJR total per year	Primary not in the NJR total per year	Primary in the NJR total per year
2003	509	6	103	6
2004	858	60	227	23
2005	1,237	202	328	78
2006	1,493	385	338	124
2007	1,859	667	399	214
2008	2,040	1,088	384	299
2009	1,982	1,501	377	328
2010	2,059	1,808	348	393
2011	2,040	1,924	289	428
2012	2,060	2,507	260	467
2013	1,828	2,408	240	432
2014	1,814	2,727	211	499
2015	1,712	3,036	185	479
2016	1,574	3,311	160	434
2017	1,473	3,467	141	460
2018	1,298	3,496	98	439
2019	1,248	3,698	87	400
Total	27,084	32,291	4,175	5,503

Tables 3.K17 (a) and (b) show that the numbers of revisions and the relative proportion of revisions with an associated primary in the NJR increased with time. Approximately 75% of revisions performed in 2019 had a linked primary in the NJR. This is likely to reflect improved data capture over time, improved linkability of records and the longevity of knee replacements, with a proportion of primaries being revised being performed before NJR data capture began or are outside the coverage of the NJR.

3.3.9 90-day mortality after knee revision

The overall cumulative percentage probability of mortality at 90 days after knee revision was lower in the cases with their primaries documented in the NJR compared with the remainder (Kaplan-Meier estimates 0.65 (95% CI 0.58-0.74) versus 0.96 (0.85-1.07)), which may reflect the fact that this patient group was younger at the time of their first revision, with a median age of 68 (IQR 61 to 75) years, compared to the group without primaries documented in the NJR who had a median age of 72 (IQR 65 to 79) years. The percentage of males was similar in both groups (45.1% versus 47.0% respectively).

3.3.10 Conclusions

There are now over 1.3 million primary knee replacements with a maximum follow-up of 16.75 years recorded in the NJR, making this the largest dataset of its kind in the world. Of these, 96.6% of the procedures are performed for osteoarthritis as the only indication. Approximately 90% of the procedures are TKRs, 9% medial or lateral unicondylar knee replacements and 1% patellofemoral replacements. These proportions have remained relatively constant over time but the proportion of unicondylar knee replacements has risen slightly, hitting approximately 10% for the first time in 2017, rising to 11.5% in 2019. The popularity of uncemented unicondylar replacements has risen relatively rapidly. These made up less than 1% of knee replacements in 2010 and now account for 4.3%, over a third of the unicondylar knee replacements performed. Cemented, unconstrained (cruciate retaining), fixed bearing

TKR remains by far the most common type of knee replacement followed by cemented, posterior stabilised, fixed bearing TKR. Patients who received unicondylar or patellofemoral knee replacement were typically younger than those receiving a TKR. TKR and patellofemoral replacement are more likely to be performed in females whereas unicondylar knee replacement is more likely to be performed in males.

TKRs with a monobloc polyethylene tibia consistently show some of the lowest crude revision rates although the numbers at risk in later years is small so the results must be interpreted with caution. Cemented TKRs that are unconstrained with a fixed bearing, as well as being the most common type of TKR, consistently show low revision rates in comparison to alternatives; crude revision rates are approximately one percentage point lower in comparison to cemented unconstrained TKRs with a mobile bearing and cemented TKRs that are posterior stabilised with either a fixed or mobile bearing at ten years.

Age and gender influence the risk of revision surgery, with younger patients and males being more likely to undergo revision; and it has previously been felt that this may explain the higher revision rates observed in UKR. Results are presented divided by gender and age-band and these show the risk of revision of a cemented unicondylar knee replacement is at least 1.9 times higher in males and 2.3 times higher in females at ten years than a cemented TKR. The distinction of uncemented unicondylar knee replacements this year shows that revision rates are lower than for cemented unicondylar replacements but remain higher than for cemented TKR. The risk of revision of a patellofemoral replacement is at least 2.8 times higher in males and females than a cemented TKR across all age groups and the results of multicompartmental knee replacements show similarly high revision rates. The difference in revision rates rises from the under 55 age group up to the 65 to 74 age group, and then declines again in the over 75s.

The most common causes of revision across all primary knee replacements were for aseptic loosening / lysis, infection, progressive arthritis, pain and instability. For uncemented TKRs, the incidence of revision for pain and aseptic loosening / lysis, wear and 'other' indications were higher but the risk of revision for infection lower than for cemented TKR. For cemented unicondylar knee replacements, the highest risk of revision was for progressive arthritis, aseptic loosening / lysis and pain. For uncemented unicondylar knee replacements, the third most common indication was dislocation / subluxation rather than pain. The incidence of revision for indications such as pain and aseptic loosening / lysis was lower for uncemented unicondylar than for cemented but higher for dislocation / subluxation and periprosthetic fractures. Progression of osteoarthritis elsewhere in the knee is also the fourth most common indication selected by surgeons for TKR. The risk of revision for progressive arthritis, aseptic loosening / lysis and pain were all higher for UKRs than TKRs but the risk of revision for infection was lower.

Infection accounts for the majority of the two-stage revision procedures performed. Only approximately 7% of revisions for infection that have been recorded in the NJR to date have been single-stage procedures, indicating low usage and take-up of this technique in the treatment of knee prosthetic joint infection. The soft tissue envelope makes single-stage revision surgery potentially more challenging than in the hip, which may explain the differences in utilisation of a single-stage approach.

The risk of re-revision following a revision procedure is higher than for the risk of revision of a primary TKR across all types of knee replacement. The risk of re-revision of a revised patellofemoral replacement is slightly lower than the other types of knee with the rest being broadly similar. This suggests that caution should be used when suggesting that UKR may be considered an interim procedure or a lesser intervention than a TKR as the crude re-revision rates are worse than the revision rates for primary TKR and are broadly similar regardless of the type of the knee replacement implanted at the primary procedure. This area requires further research to explore the risk of revision in light of the different demographics in these groups. The risk of re-revision is higher for those revised after a shorter period of time following the primary and is associated with the indication for revision. This suggests that not all of the processes that lead to revision are the same and some are more aggressive than others with consequences beyond the initial revision.

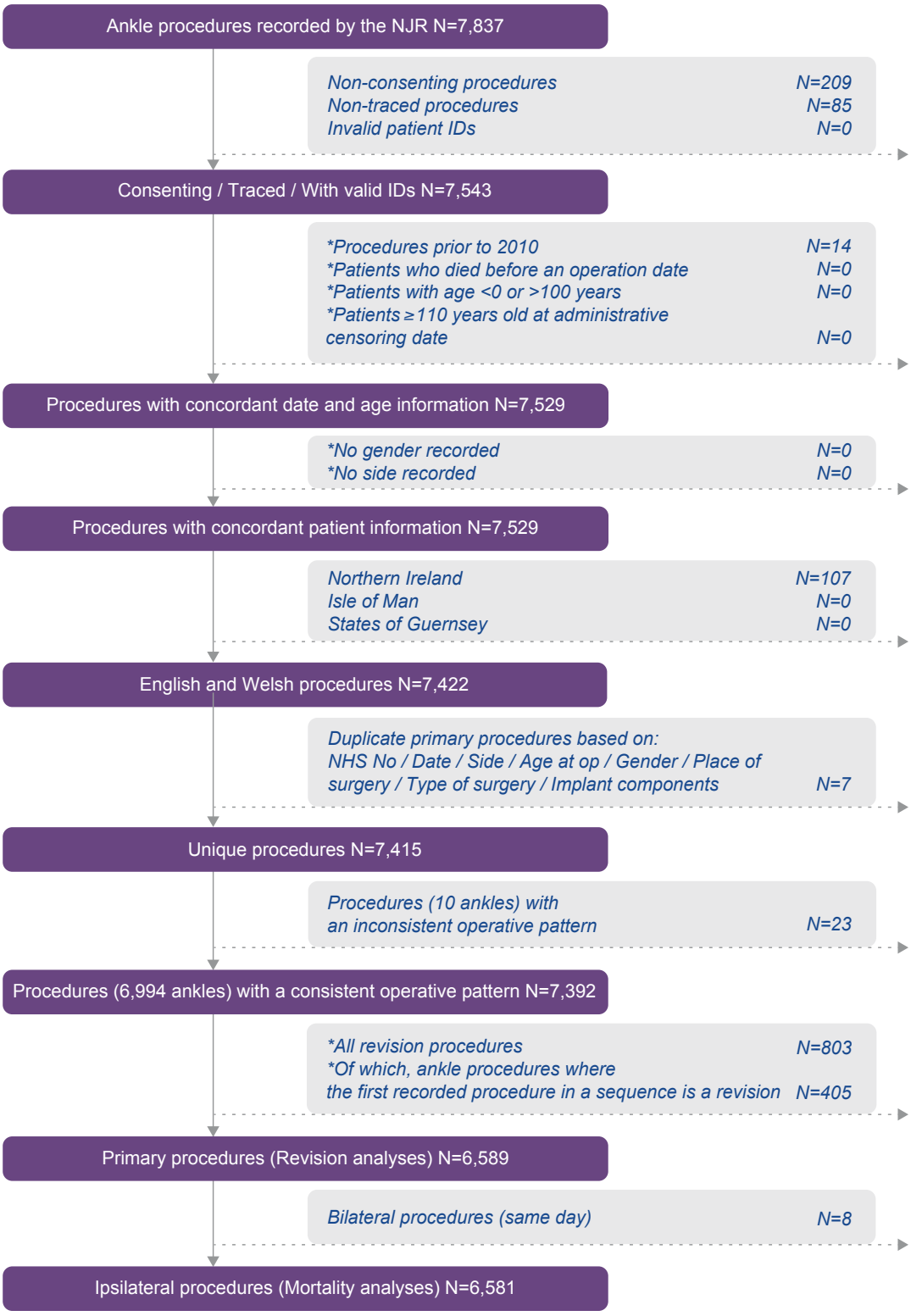
Knee replacement remains a safe procedure with low rates of perioperative mortality. The rates of mortality are higher for males than for females. The average age of a patient undergoing TKR is approximately 70 years, just over 55% of males and 45% of females in the 70 to 74 age bracket will have died 15 years after their knee replacement. This means that for the average patient undergoing a knee replacement, their knee replacement should last them for the rest of their life, without the need for revision surgery.

3.4 Outcomes after ankle replacement

3.4.1 Overview of primary ankle replacement surgery

This section looks at revision and mortality for all primary ankle operations submitted to the NJR from 1 January 2010 up to 31 December 2019. There were 7,837 procedures entered into the NJR and, after data cleaning, 6,589 primary ankle operations were available for analysis. This includes eight bilateral operations (both sides operated on the same date), which can be seen in the patient flow diagram in Figure 3.A1 (page 195).

Figure 3.A1 Ankle cohort flow diagram.



** Reasons not necessarily mutually exclusive*

The median age at primary surgery was 69 years (IQR 62 to 75 years), with an overall range of 17 to 97 years. More procedures were performed in men (59.7%) than in women.

This year the NJR has conducted an extended review of the component data recorded on the primary ankle data entry form (MDS A1). Previously, construct fixation was defined based only on the listed fixation method of the tibial component. By improved handling of component level data, we have identified both talar and tibial component fixation, as well as when cement is included within the recorded component data for a procedure.

All ankle replacement brands recorded in the NJR are uncemented implants, but cement can be used occasionally by surgeons in circumstances such as poor bone stock or low demand patients. Of the 6,589 primary procedures, a total of 5,810 (88.2%) procedures were implanted without cement being listed in the component data. In 601 (9.1%) primary procedures, cement was listed in the component data and 178 (2.7%) primary procedures are defined as unconfirmed. Procedures were determined to be unconfirmed when they either had insufficient elements to form a coherent construct or contained custom-made prostheses. Figure 3.A2 illustrates the temporal changes in fixation of primary ankle replacements.

Figure 3.A2 Fixation by year of primary ankle replacement.

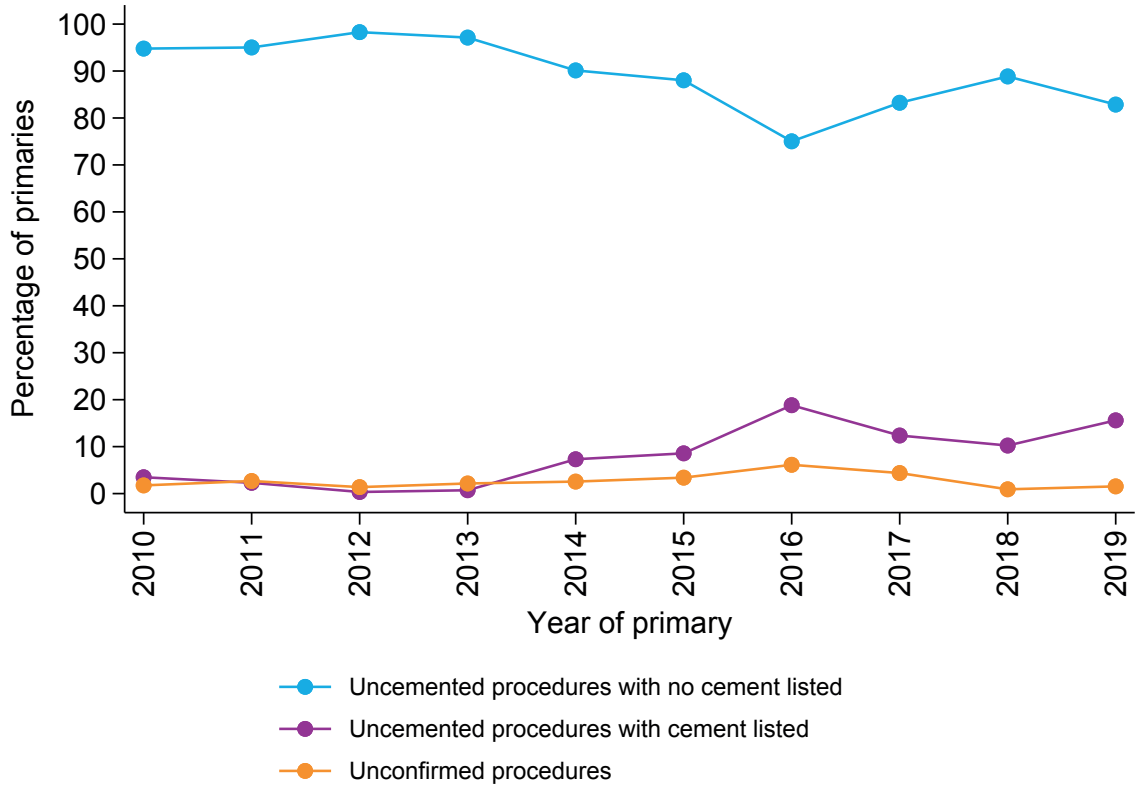


Table 3.A1 Descriptive statistics of ankle procedures performed by consultant and unit by year of surgery.

Number of primary replacements during each year	Year of surgery									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of procedures in year	**402**	**522**	**581**	**557**	**547**	**618**	**733**	**776**	**879**	**974**
Units (N)	104	127	144	133	138	142	144	146	147	155
Mean number of primary replacements per unit	3.9	4.1	4	4.2	4	4.4	5.1	5.3	6	6.3
Median (IQR) number of any primary replacements per unit	2 (1 to 4)	2 (1 to 5)	2 (1 to 4.5)	2 (1 to 5)	2 (1 to 4)	2 (1 to 5)	2 (1 to 6.5)	3 (1 to 6)	3 (1 to 7)	3 (2 to 8)
Units who entered ≥ 10 operations (N)	10	7	10	10	9	10	16	16	22	28
Units who entered ≥ 20 operations (N)	3	3	3	3	4	5	5	6	6	6
Consultants providing operation (N)	107	126	142	132	126	142	137	141	148	156
Mean number of operations per consultant	3.8	4.1	4.1	4.2	4.3	4.4	5.4	5.5	5.9	6.2
Median (IQR) number of operations per consultant	2 (1 to 4)	3 (2 to 5)	2.5 (1 to 5)	3 (1 to 5.5)	3 (2 to 5)	2 (1 to 6)	3 (1 to 8)	3 (1 to 8)	3.5 (2 to 8)	5 (1.5 to 9)
Consultant who entered ≥ 10 operations (N)	9	10	10	11	8	13	17	22	27	25
Consultant who entered ≥ 20 operations (N)	2	2	2	2	2	4	5	5	5	5

Table 3.A1 shows an increasing number of annually reported cases over the ten-year observation period. This could represent improved compliance or the reporting of a true increase in caseload.

A total of 276 consultants carried out the 6,589 reported primary procedures over the ten-year period, with the annual mean number of procedures per consultant rising from 3.8 in 2010 to 6.2 in 2019. Although this is an improvement, only 3.2% of consultants performed 20 or more primary ankle replacements in 2019 and a further 12.9% performed between 10 and 19 primary ankle replacements.

Of the 269 units which submitted data to the NJR, 82 (30.5%) carried out 20 or more procedures over the ten-year period. However, the percentage of units submitting 20 or more ankle primary operations each year does not exceed 5% (3.9% in 2019). The number of units submitting more than 20 primary ankle procedures per year has risen from three in 2010 to six in 2019 and the mean number of primary replacements per unit has also risen from 3.9 to 6.3 respectively across the same period.

Table 3.A2 Number and percentage of primary ankle replacements by ankle brand.

Brand	Number of primaries (%)	Number (%) of each brand, for each year of operation									
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AKILE	44 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.6)	9 (1.2)	12 (1.5)	11 (1.3)	8 (0.8)
BOX	771 (11.7)	22 (5.5)	27 (5.2)	45 (7.7)	51 (9.2)	81 (14.8)	134 (21.7)	126 (17.2)	109 (14.0)	102 (11.6)	74 (7.6)
CCI	1 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Cadence	47 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.4)	6 (0.8)	15 (1.7)	23 (2.4)
Hintegra	297 (4.5)	9 (2.2)	17 (3.3)	35 (6.0)	67 (12.0)	48 (8.8)	54 (8.7)	33 (4.5)	9 (1.2)	14 (1.6)	11 (1.1)
INBONE	113 (1.7)	0 (0.0)	0 (0.0)	2 (0.3)	4 (0.7)	16 (2.9)	3 (0.5)	24 (3.3)	22 (2.8)	26 (3.0)	16 (1.6)
INBONE [Talar component] INFINITY [Tibial component]	163 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.9)	16 (2.6)	28 (3.8)	31 (4.0)	35 (4.0)	48 (4.9)
INFINITY	1,805 (27.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (5.1)	95 (15.4)	211 (28.8)	376 (48.5)	486 (55.3)	609 (62.5)
INFINITY [Talar component] INBONE [Tibial component]	3 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)	2 (0.2)
Mobility	1,115 (16.9)	251 (62.4)	294 (56.3)	284 (48.9)	201 (36.1)	85 (15.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Rebalance	61 (0.9)	0 (0.0)	4 (0.8)	13 (2.2)	13 (2.3)	6 (1.1)	4 (0.6)	13 (1.8)	7 (0.9)	1 (0.1)	0 (0.0)
Salto	318 (4.8)	22 (5.5)	29 (5.6)	40 (6.9)	45 (8.1)	55 (10.1)	55 (8.9)	44 (6.0)	9 (1.2)	10 (1.1)	9 (0.9)
STAR	602 (9.1)	14 (3.5)	28 (5.4)	29 (5.0)	34 (6.1)	58 (10.6)	74 (12.0)	84 (11.5)	100 (12.9)	96 (10.9)	85 (8.7)
Trabecular Metal	5 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)
Vantage	16 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	16 (1.6)
Zenith	1,049 (15.9)	77 (19.2)	109 (20.9)	124 (21.3)	130 (23.3)	151 (27.6)	158 (25.6)	108 (14.7)	61 (7.9)	73 (8.3)	58 (6.0)
Unconfirmed	**179 (2.7)**	**7 (1.7)**	**14 (2.7)**	**8 (1.4)**	**12 (2.2)**	**14 (2.6)**	**21 (3.4)**	**45 (6.1)**	**34 (4.4)**	**9 (1.0)**	**15 (1.5)**
Total	**6,589 (100)**	**402 (100)**	**522 (100)**	**581 (100)**	**557 (100)**	**547 (100)**	**618 (100)**	**733 (100)**	**776 (100)**	**879 (100)**	**974 (100)**

Table 3.A2 shows the number of replacements by implant brand, and by brand and year of primary operation. The most frequently used brand is the fixed bearing INFINITY (Wright Medical), which represented 62.5% of primary ankle replacements performed in 2019. The use of this brand has risen steeply from its introduction in 2014.

The NJR can now identify when components, within primary ankle replacements, come from different brands and/or manufacturers. There are no examples of mix and match between manufacturers within ankle replacements. The INFINITY and INBONE implants, both manufactured by Wright Medical, were designed to be interchangeable with a matched articulating surface. This combination represented 4.9% of primary ankle replacements in 2019. Prior to the introduction of the INFINITY, Mobility (DePuy) was the market leader but was voluntarily withdrawn from the market in 2014.

In 2019, other common brands include STAR (8.7%), followed by BOX (7.6%). As defined previously, it was not possible to identify the type of constructs implanted in 179 procedures.

3.4.2 Revisions after primary ankle surgery

A total of 311 out of the 6,589 primary procedures had a linkable A2 MDS form completed to indicate a revision before the end of 2019. The first revisions shown here include 41 conversions to arthrodesis, 225 single-stage procedures, 42 two-stage procedures (including seven for which the second stage was a conversion to arthrodesis) and three DAIRs. No amputations have been recorded, and given the low rate reported for conversion to arthrodesis, we believe that these small numbers are likely to be a reflection of under-reporting.

Table 3.A3 KM estimates of cumulative **revision** (95% CI) of primary ankle replacement, by **gender** and **age**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Age at primary (years)	Number of primaries	Time since primary				
		1 year	3 year	5 years	7 years	9 years
All cases	6,589	0.73 (0.54-0.98)	3.56 (3.08-4.12)	6.38 (5.65-7.20)	8.18 (7.25-9.22)	9.72 (8.50-11.10)
Male	3,931	0.73 (0.50-1.07)	3.32 (2.73-4.04)	5.97 (5.06-7.03)	7.57 (6.44-8.89)	*8.81 (7.36-10.54)*
<65	1,248	0.99 (0.55-1.77)	5.00 (3.78-6.60)	8.42 (6.63-10.65)	*10.19 (8.08-12.82)*	*12.11 (9.28-15.73)*
65 to 74	1,660	0.58 (0.30-1.12)	2.90 (2.10-4.00)	5.79 (4.46-7.50)	8.04 (6.27-10.28)	*9.15 (7.08-11.77)*
≥75	1,023	0.64 (0.29-1.41)	1.82 (1.07-3.09)	2.90 (1.82-4.61)	*2.90 (1.82-4.61)*	*2.90 (1.82-4.61)*
Female	2,658	0.74 (0.47-1.17)	3.90 (3.14-4.85)	6.97 (5.82-8.33)	9.01 (7.53-10.76)	*10.88 (8.94-13.22)*
≥65	986	0.77 (0.37-1.60)	5.26 (3.89-7.09)	10.02 (7.87-12.71)	*12.82 (10.16-16.12)*	*14.97 (11.57-19.26)*
65 to 74	1,039	0.96 (0.50-1.83)	4.08 (2.89-5.74)	6.93 (5.21-9.20)	*9.28 (6.94-12.35)*	*11.34 (8.29-15.41)*
≥75	633	0.32 (0.08-1.28)	1.29 (0.57-2.92)	*1.59 (0.75-3.38)*	*1.59 (0.75-3.38)*	*2.50 (1.06-5.82)*

Note: Arthrodesis and amputation revision procedures may be under-reported in the NJR.

Figure 3.A3 KM estimates of cumulative **revision** of primary ankle replacement (shaded area indicates point-wise 95% CI).

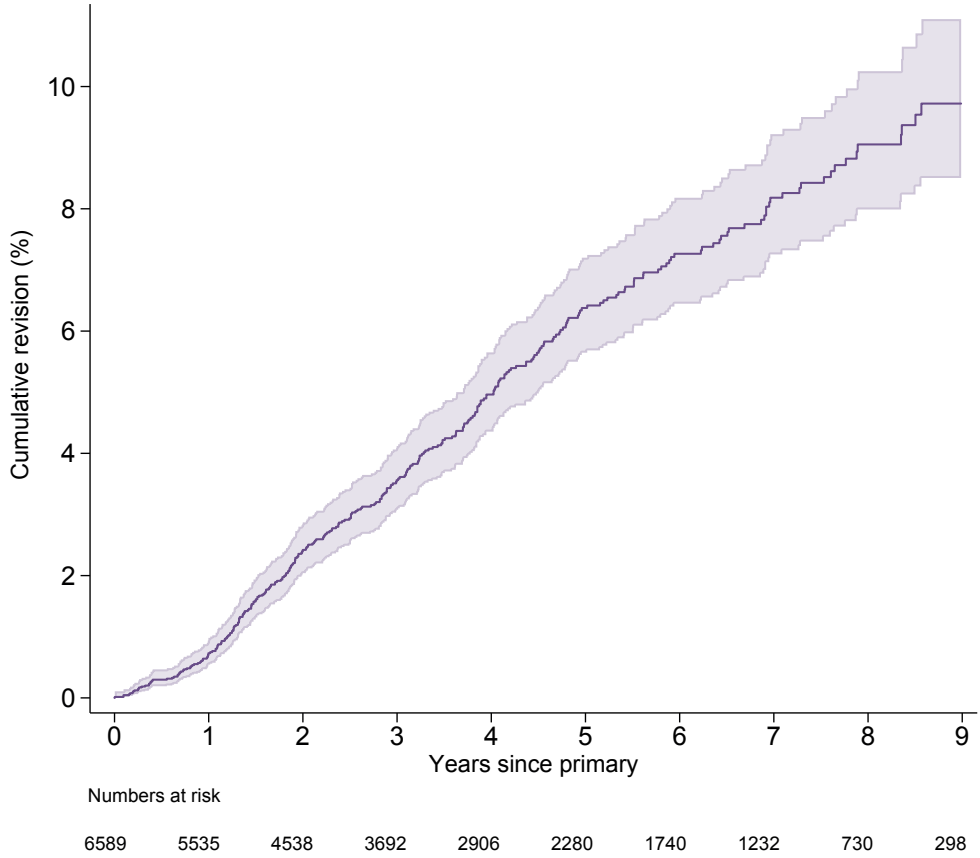


Figure 3.A3 and Table 3.A3 show the overall estimated cumulative percentage probability of (first) revision. Results are also stratified by gender and age.

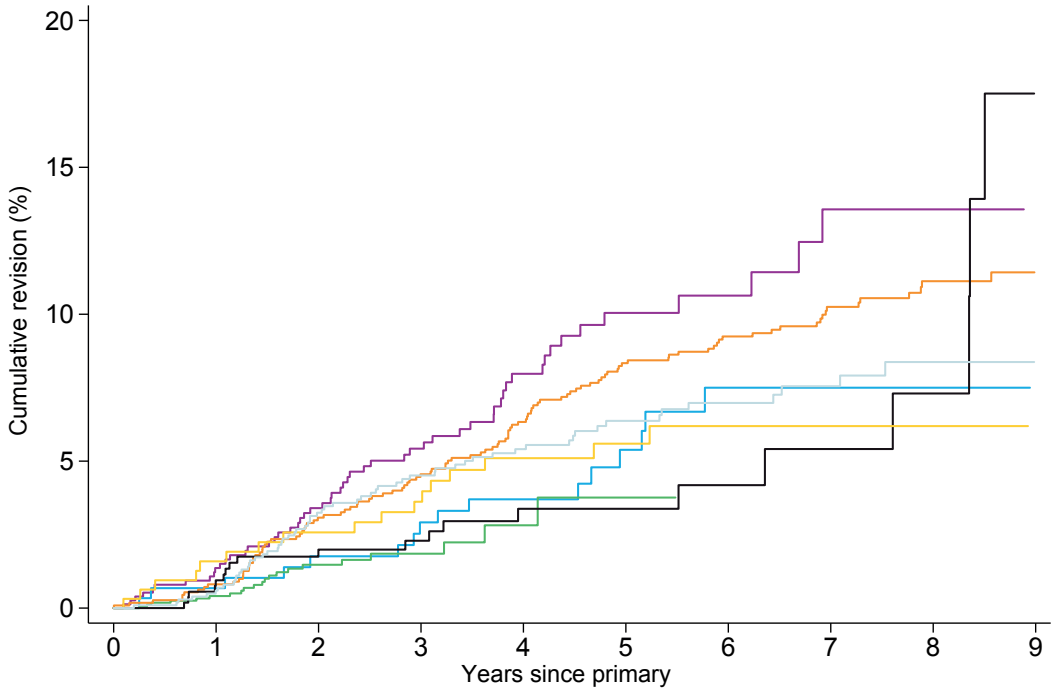
Table 3.A4 and Figure 3.A4 (pages 201 and 202) show the estimated cumulative percentage probability of (first) revision by implant brand with at least 250 uses. Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period. The early rates of revision were heterogeneous between brands, varying from 0.4% to 1.6% in the first post-operative year. Similar variations between brands were observed for later post-operative periods, with rates varying from 3.4% to 10.1% at five years post-operation. The large relative differences between the lowest and highest rates seem to be related to the implant's brand and are unlikely to be entirely due to patient age and gender case mix. At nine years post-operation, the 95% confidence intervals are large, overlapping each other, and no robust comparison between brands can be performed until the size of the cohort becomes larger.

Table 3.A4 KM estimates of cumulative **revision** (95% CI) of primary ankle replacement by **brand**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Brand	Number of primaries	Age (Median, IQR)	Male (%)	Time since primary				
				1 year	3 years	5 years	7 years	9 years
BOX	771	67 (60 to 73)	65	1.36 (0.74-2.52)	5.43 (3.89-7.54)	*10.05 (7.57-13.27)*	*13.57 (9.76-18.70)*	*13.57 (9.76-18.70)*
Hintegra	297	70 (63 to 75)	66	0.68 (0.17-2.68)	2.92 (1.47-5.76)	*5.39 (3.12-9.21)*	*7.50 (4.55-12.23)*	*
INFINITY	1,805	69 (62 to 75)	59	0.41 (0.18-0.92)	1.85 (1.14-3.01)	*3.76 (1.96-7.17)*	*	*
Mobility	1,115	68 (61 to 75)	55	0.81 (0.42-1.55)	4.56 (3.47-5.97)	8.34 (6.83-10.15)	10.25 (8.55-12.27)	*11.43 (9.52-13.68)*
Salto	318	69 (62 to 74)	59	1.59 (0.67-3.78)	3.62 (2.02-6.45)	*5.60 (3.45-9.01)*	*6.19 (3.86-9.88)*	*6.19 (3.86-9.88)*
STAR	602	68.5 (62 to 75)	66	0.95 (0.39-2.26)	2.29 (1.27-4.13)	*3.38 (1.97-5.78)*	*5.41 (2.89-10.01)*	*
Zenith	1,049	69 (63 to 75)	58	0.59 (0.27-1.32)	4.51 (3.35-6.06)	6.37 (4.91-8.25)	7.55 (5.83-9.74)	*8.37 (6.40-10.92)*

*Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period.
Note: Brands with less than 250 procedures are not reported.
Note: Arthrodesis and amputation revision procedures may be under-reported in the NJR.

Figure 3.A4 KM estimates of cumulative **revision** of primary ankle replacement by **brand**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk									
Zenith	1049	976	869	786	666	513	381	261	*147*	*62*
Salto	318	303	285	270	*223*	*172*	*117*	*78*	*47*	*20*
STAR	602	508	406	306	*223*	*149*	*96*	*63*	*35*	*8*
Mobility	1115	1098	1062	1029	991	953	849	662	422	*177*
INFINITY	1805	1180	686	317	*114*	*26*	*0*	*0*	*0*	*0*
Hintegra	297	283	265	251	*212*	*158*	*103*	*49*	*19*	*6*
BOX	771	687	566	447	316	*197*	*123*	*76*	*40*	*19*

Table 3.A5 Indications for the 311 (first) **revisions** following primary ankle replacement. Note: These are not mutually exclusive.

Indication	Total number revised	Number of revisions per 100 prosthesis-years (95% CI)
Infection	**79**	**0.30 (0.24-0.38)**
Aseptic loosening	**146**	**0.56 (0.47-0.65)**
Aseptic loosening of tibial component only	34	0.13 (0.09-0.18)
Aseptic loosening of talar component only	45	0.17 (0.13-0.23)
Aseptic loosening of both tibial and talar components	67	0.26 (0.20-0.32)
Lysis	**62**	**0.24 (0.18-0.30)**
Lysis of tibial component only	14	0.05 (0.03-0.09)
Lysis of talar component only	25	0.10 (0.06-0.14)
Lysis of both tibial and talar components	23	0.09 (0.06-0.13)
Malalignment	**57**	**0.22 (0.17-0.28)**
Implant fracture	**12**	**0.05 (0.03-0.08)**
Implant fracture of tibial component only	2	0.01 (0.00-0.03)
Implant fracture of meniscal component only	8	0.03 (0.02-0.06)
Implant fracture of tibial and talar components	2	0.01 (0.00-0.03)
Meniscal insert dislocation	**10**	**0.04 (0.02-0.07)**
Wear of polyethylene component	**33**	**0.13 (0.09-0.18)**
Component migration/dissociation	**23**	**0.09 (0.06-0.13)**
Pain	**63**	**0.24 (0.19-0.31)**
Stiffness	**31**	**0.12 (0.08-0.17)**
Soft tissue impingement	**25**	**0.10 (0.06-0.14)**
Other indication for revision	**40**	**0.15 (0.11-0.21)**

Note: In MDSv4 pain was referred to as Pain (undiagnosed) and in MDSv6 onwards pain was referred to as Unexplained pain.

Table 3.A5 shows the indications for revision of ankle replacements, with aseptic loosening and infection as the most commonly cited indications. Around 22% of the revisions for infection were recorded as having a high suspicion of infection (e.g. pus or confirmed micro) and the remaining revisions for infection had a low suspicion (awaiting micro/histology). Out of the 146 revisions for aseptic loosening, 46% were performed because of loosening of both the tibial and talar components. Around 37% of patients revised for an indication of lysis had lysis of both tibial and talar components. Of the 12 revisions for implant fracture, eight (67%) were performed for a fractured meniscal insert and two were performed to treat implant fracture of both tibial and talar components.

There is concern that there may be under-reporting of revisions of ankle replacement, in particular when the revision is to an ankle arthrodesis or amputation. The British Orthopaedic Foot and Ankle Society (BOFAS), in alignment with the NJR, encourages surgeons to complete A2 MDS forms where relevant and reminds surgeons and hospitals that this is a mandated requirement by the Department of Health and Social Care. All revisions, conversion of an ankle replacement to an arthrodesis, and amputations, require the completion of an NJR A2 MDS form.

3.4.3 Mortality after primary ankle replacement

In this analysis, the second of each of the eight (same day) bilateral procedures were excluded. Among the remaining 6,581 procedures, a total of 398 patients had died before the end of 2019, 139 of these were female and 259 were male.

Figure 3.A5 KM estimates of cumulative **mortality** after primary ankle replacement (shaded area indicates point-wise 95% CI).

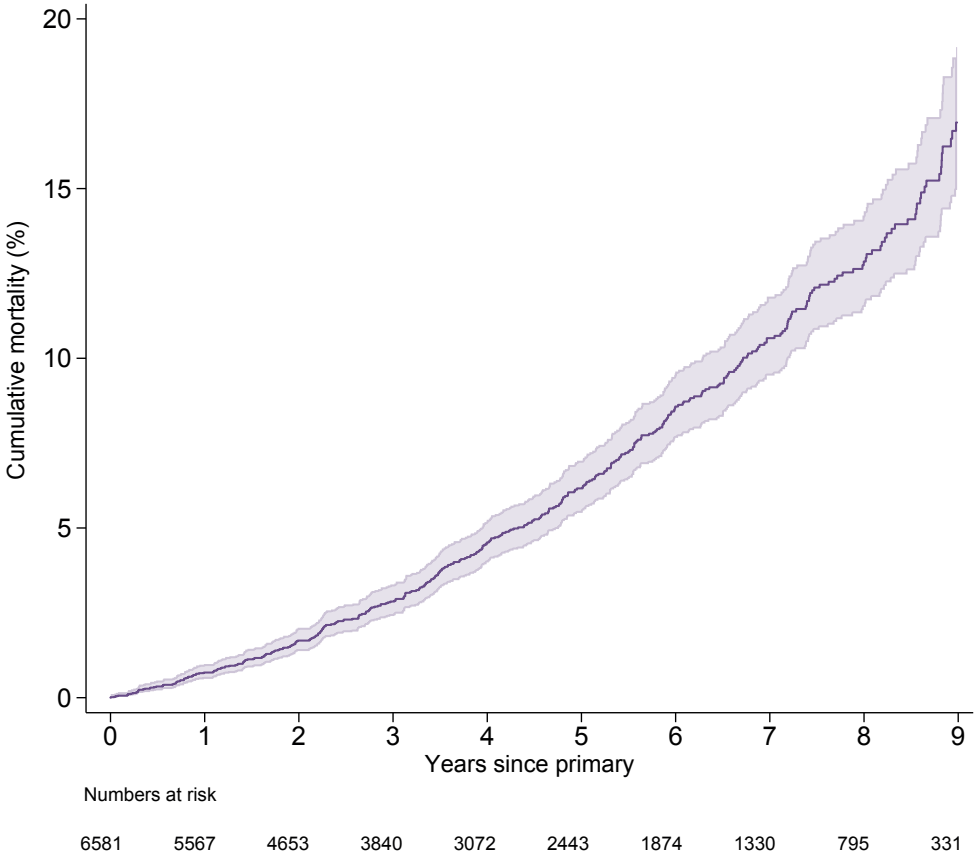


Table 3.A6 KM estimates of cumulative **mortality** (95% CI) after primary ankle replacement, by gender and age.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Age at primary	Number of primaries	Time since primary						
		30 days	90 days	1 year	3 years	5 years	7 years	9 years
All cases	**6,581**	**0.06 (0.02-0.16)**	**0.14 (0.07-0.27)**	**0.74 (0.55-0.99)**	**2.83 (2.41-3.34)**	**6.17 (5.44-6.98)**	**10.59 (9.49-11.82)**	**16.95 (14.96-19.17)**
Males	**3,925**	**0.10 (0.04-0.27)**	**0.18 (0.09-0.38)**	**0.82 (0.58-1.18)**	**3.11 (2.54-3.81)**	**6.70 (5.74-7.82)**	**11.66 (10.17-13.36)**	*19.13 (16.33-22.33)*
<65	1,247	0	0	0.08 (0.01-0.59)	1.23 (0.70-2.16)	2.94 (1.94-4.44)	4.44 (2.97-6.63)	*5.80 (3.64-9.20)*
65 to 74	1,657	0.18 (0.06-0.56)	0.24 (0.09-0.65)	0.71 (0.39-1.28)	2.41 (1.70-3.43)	5.29 (4.04-6.93)	8.36 (6.54-10.67)	*15.97 (11.85-21.35)*
≥75	1,021	0.10 (0.01-0.69)	0.30 (0.10-0.93)	1.92 (1.21-3.03)	6.72 (5.13-8.79)	13.97 (11.35-17.12)	*26.87 (22.60-31.76)*	*44.12 (36.37-52.74)*
Females	**2,656**	**0**	**0.08 (0.02-0.31)**	**0.62 (0.37-1.03)**	**2.42 (1.83-3.20)**	**5.38 (4.36-6.64)**	**9.09 (7.56-10.92)**	*14.05 (11.44-17.18)*
<65	984	0	0.21 (0.05-0.83)	0.43 (0.16-1.13)	1.24 (0.66-2.30)	2.47 (1.49-4.09)	4.58 (2.97-7.03)	*7.23 (4.74-10.95)*
65 to 74	1,039	0	0	0.54 (0.22-1.28)	2.14 (1.33-3.44)	4.51 (3.11-6.49)	*7.74 (5.60-10.66)*	*10.30 (7.46-14.14)*
≥75	633	0	0	1.08 (0.49-2.39)	4.92 (3.25-7.42)	*11.90 (8.88-15.85)*	*19.17 (14.82-24.61)*	*33.07 (24.04-44.37)*

Note: Some patients had operations on the left and right side on the same day. The second of bilateral operations performed on the same day were excluded.

Figure 3.A5 and Table 3.A6 show the estimated cumulative percentage probability of death at different times after surgery, by gender and age at primary. Earlier death was associated with the male gender and older age.

3.4.4 Conclusions

Compared to the other joint types included in the annual report, ankle primary replacement is a low volume procedure. The numbers of linked first revisions is even lower, it is likely that there is significant under-reporting of revision to arthrodesis procedures, or revision to amputation, making outcome analysis difficult.

Since the withdrawal of the Mobility implant in 2014, the fixed bearing INFINITY implant has rapidly gained popularity to become the market leader and survivorship data is encouraging at present.

Only 18.1% of units doing ankle replacements performed more than ten per year in 2019 and, in the same year, just 3.9% of units performed more than 20 primary procedures. BOFAS encourages surgeons to pool resources and create networks, where practicable, to ensure the highest standards of care and quality for patients.

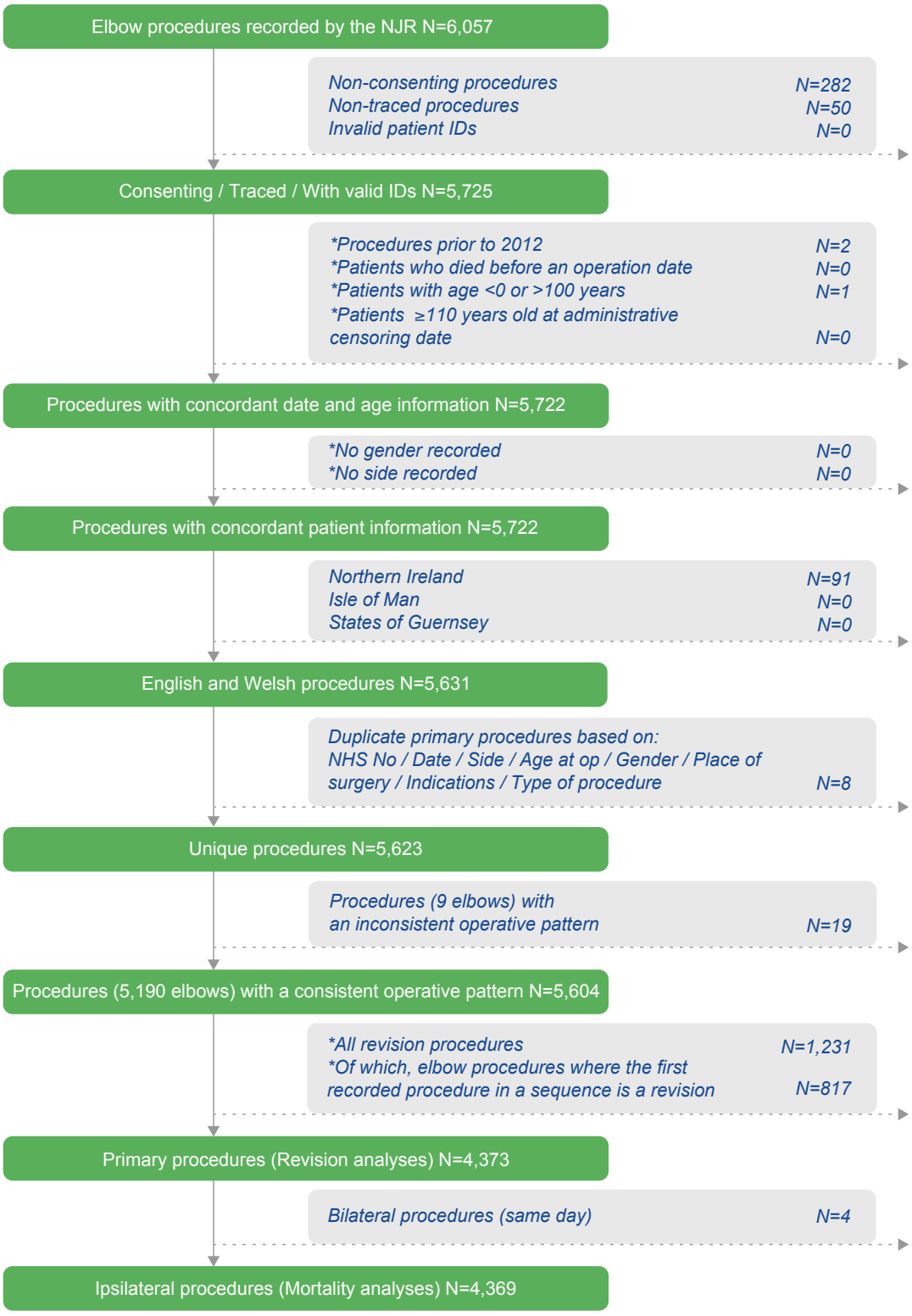
The cumulative percentage probability of 90-day mortality following primary ankle surgery is very low and the cumulative percentage of revision at nine years following a primary ankle replacement is 9.72 (95% CI 8.50-11.10). Substantial heterogeneity in the rates of revision was observed between the implant brands used in primary ankle replacement surgery.

3.5 Outcomes after elbow replacement

3.5.1 Overview of primary elbow replacement surgery

This section details the primary elbow replacements entered into the registry since recording began (1 April 2012) up to the end of 31 December 2019. Data on linked first revision episodes and linked mortality data are presented. Primary elbow replacement in this section refers to total replacement (with or without radial head replacement), distal humeral hemiarthroplasty, lateral resurfacing and radial head replacement. This year the NJR conducted an extended review of the component labels reported on the primary elbow (E1) MDS form. The analysis has been able to identify total replacements with a radial head replacement (n=21) and investigate inconsistencies between the type of procedure reported on the E1 MDS form and the component label data uploaded to the NJR. Procedures where the reported type of surgery did not match the components listed on the E1 MDS form are classified as unconfirmed in the rest of this section.

Figure 3.E1 Elbow cohort flow diagram



A total of 4,373 primary replacements were available for analysis for a total of 4,207 patients (Figure 3.E1). Of these patients, 166 had documented elbow replacements on both left and right sides, and in four patients these were both performed on the same day (bilateral).

The majority of replacements were performed on women (70%) and the median age at the primary operation was 68 years (IQR 56 to 76), with an overall range of 14 to 99 years. Cement was listed in the component data in 68.7% of the primary elbow procedures.

Table 3.E1 Number of primary elbow replacements by year and percentage of each type of procedure.

	Number of primaries	Year of primary							
		2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)
All cases	4,373	260 (100.0)	449 (100.0)	449 (100.0)	545 (100.0)	568 (100.0)	654 (100.0)	691 (100.0)	757 (100.0)
All cases with confirmed procedure type	**3,926**	**199 (76.5)**	**370 (82.4)**	**404 (90.0)**	**483 (88.6)**	**502 (88.4)**	**595 (91.0)**	**641 (92.8)**	**732 (96.7)**
Total elbow replacements	2,788	171 (65.8)	331 (73.7)	349 (77.7)	390 (71.6)	377 (66.4)	430 (65.7)	377 (54.6)	363 (48.0)
Total elbow replacements inc. radial head replacement	21	0 (0.0)	0 (0.0)	2 (0.4)	0 (0.0)	2 (0.4)	2 (0.3)	7 (1.0)	8 (1.1)
Radial head replacements	956	23 (8.8)	34 (7.6)	52 (11.6)	92 (16.9)	123 (21.7)	161 (24.6)	204 (29.5)	267 (35.3)
Lateral resurfacings	12	5 (1.9)	5 (1.1)	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)
Distal humeral hemiarth-roplasties	149	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	1 (0.2)	53 (7.7)	94 (12.4)
All cases with unconfirmed procedure type	**447**	**61 (23.5)**	**79 (17.6)**	**45 (10.0)**	**62 (11.4)**	**66 (11.6)**	**59 (9.0)**	**50 (7.2)**	**25 (3.3)**
Unconfirmed elbow prosthetic replacements	276	47 (18.1)	65 (14.5)	31 (6.9)	48 (8.8)	30 (5.3)	24 (3.7)	20 (2.9)	11 (1.5)
Unconfirmed radial head replacements	44	1 (0.4)	1 (0.2)	5 (1.1)	4 (0.7)	10 (1.8)	7 (1.1)	7 (1.0)	9 (1.2)
Unconfirmed lateral resurfacings	8	5 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.2)	1 (0.1)	0 (0.0)
Unconfirmed distal humeral hemiarth-roplasties	119	8 (3.1)	13 (2.9)	9 (2.0)	10 (1.8)	25 (4.4)	27 (4.1)	22 (3.2)	5 (0.7)

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no component data in the record are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E1 shows that the annual number of primary elbow replacements entered into the NJR has increased since 2012. Whilst the increase in the early years is in part due to improvement in data capture, the consistent increase observed year-after-year since 2015 likely reflects an increase in the volume of procedures, improved reporting of radial head replacement and distal humeral hemiarthroplasties, or a combination of these factors.

Table 3.E1 gives a breakdown by the stated type of replacement. Of all procedures, including the unconfirmed, 64% were classified as a total replacement. A total of 447 (9.7%) primary elbow replacements had an unconfirmed status.

Table 3.E2 (page 211) details the type of primary operation in each year and shows that 1,668 (38.2%) elbow replacements were carried out for acute trauma. These have been separated from the remaining 2,705 elective cases in the rest of this section. Over half (51.8%) of the elbow procedures performed for trauma were radial head replacements.

Table 3.E2 Types of primary elbow procedures used in **acute trauma** and **elective** cases by year and **type of primary operation**.

		Number of primaries	Year of primary							
			2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)
Acute trauma	All cases	1,668	65 (100.0)	117 (100.0)	122 (100.0)	203 (100.0)	210 (100.0)	244 (100.0)	314 (100.0)	393 (100.0)
	All cases with confirmed procedure type	1,469	48 (73.8)	92 (78.6)	107 (87.7)	180 (88.7)	175 (83.3)	203 (83.2)	285 (90.8)	379 (96.4)
	Total elbow replacements	577	33 (50.8)	64 (54.7)	61 (50.0)	104 (51.2)	81 (38.6)	81 (33.2)	76 (24.2)	77 (19.6)
	Total elbow replacements inc. radial head replacement	1	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)
	Radial head replacements	761	15 (23.1)	28 (23.9)	46 (37.7)	75 (36.9)	94 (44.8)	121 (49.6)	166 (52.9)	216 (55.0)
	Lateral resurfacings	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Distal humeral hemiarthroplasties	130	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	1 (0.4)	43 (13.7)	85 (21.6)
	All cases with unconfirmed procedure type	199	17 (26.2)	25 (21.4)	15 (12.3)	23 (11.3)	35 (16.7)	41 (16.8)	29 (9.2)	14 (3.6)
	Unconfirmed elbow prosthetic replacements	62	9 (13.8)	15 (12.8)	3 (2.5)	11 (5.4)	7 (3.3)	10 (4.1)	4 (1.3)	3 (0.8)
	Unconfirmed radial head replacements	33	1 (1.5)	0 (0.0)	5 (4.1)	3 (1.5)	7 (3.3)	5 (2.0)	5 (1.6)	7 (1.8)
	Unconfirmed lateral resurfacings	0	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Unconfirmed distal humeral hemiarthroplasties	104	7 (10.8)	10 (8.5)	7 (5.7)	9 (4.4)	21 (10.0)	26 (10.7)	20 (6.4)	4 (1.0)
Elective	All cases	2,705	195 (100.0)	332 (100.0)	327 (100.0)	342 (100.0)	358 (100.0)	410 (100.0)	377 (100.0)	364 (100.0)
	All cases with confirmed procedure type	2,457	151 (77.4)	278 (83.7)	297 (90.8)	303 (88.6)	327 (91.3)	392 (95.6)	356 (94.4)	353 (97.0)
	Total elbow replacements	2,211	138 (70.8)	267 (80.4)	288 (88.1)	286 (83.6)	296 (82.7)	349 (85.1)	301 (79.8)	286 (78.6)
	Total elbow replacements inc. radial head replacement	20	0 (0.0)	0 (0.0)	2 (0.6)	0 (0.0)	2 (0.6)	2 (0.5)	7 (1.9)	7 (1.9)
	Radial head replacements	195	8 (4.1)	6 (1.8)	6 (1.8)	17 (5.0)	29 (8.1)	40 (9.8)	38 (10.1)	51 (14.0)
	Lateral resurfacings	12	5 (2.6)	5 (1.5)	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)
	Distal humeral hemiarthroplasties	19	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (2.7)	9 (2.5)
	All cases with unconfirmed procedure type	248	44 (22.6)	54 (16.3)	30 (9.2)	39 (11.4)	31 (8.7)	18 (4.4)	21 (5.6)	11 (3.0)
	Unconfirmed elbow prosthetic replacements	214	38 (19.5)	50 (15.1)	28 (8.6)	37 (10.8)	23 (6.4)	14 (3.4)	16 (4.2)	8 (2.2)
	Unconfirmed radial head replacements	11	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)	3 (0.8)	2 (0.5)	2 (0.5)	2 (0.5)
	Unconfirmed lateral resurfacings	8	5 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	1 (0.2)	1 (0.3)	0 (0.0)
	Unconfirmed distal humeral hemiarthroplasties	15	1 (0.5)	3 (0.9)	2 (0.6)	1 (0.3)	4 (1.1)	1 (0.2)	2 (0.5)	1 (0.3)

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no component data in the record are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E3 Indications for main confirmed types of primary elbow replacements, by year and type of primary operation.

	Year of primary	Number of primaries	Acute trauma	Elective						
			Number of cases	Number of cases	Number (%)* for each indication (amongst elective cases only)					
					Osteoarthritis	Other inflammatory arthropathy	Trauma sequelae	Essex Lopresti	Avascular necrosis	Other indication
Total elbow replacements	All cases	2,788	577	2,211	750 (33.9)	1,112 (50.3)	356 (16.1)	4 (0.2)	4 (0.2)	100 (4.5)
	2012	171	33	138	44 (31.9)	66 (47.8)	27 (19.6)	1 (0.7)	0 (0.0)	8 (5.8)
	2013	331	64	267	94 (35.2)	137 (51.3)	30 (11.2)	1 (0.4)	1 (0.4)	15 (5.6)
	2014	349	61	288	105 (36.5)	145 (50.3)	38 (13.2)	0 (0.0)	0 (0.0)	15 (5.2)
	2015	390	104	286	99 (34.6)	148 (51.7)	39 (13.6)	0 (0.0)	2 (0.7)	15 (5.2)
	2016	377	81	296	99 (33.4)	148 (50.0)	52 (17.6)	0 (0.0)	0 (0.0)	12 (4.1)
	2017	430	81	349	113 (32.4)	179 (51.3)	60 (17.2)	1 (0.3)	1 (0.3)	12 (3.4)
	2018	377	76	301	101 (33.6)	159 (52.8)	49 (16.3)	1 (0.3)	0 (0.0)	9 (3.0)
	2019	363	77	286	95 (33.2)	130 (45.5)	61 (21.3)	0 (0.0)	0 (0.0)	14 (4.9)
Radial head replacements	All cases	956	761	195	36	3	135	14	4	11
	2012	23	15	8	2	0	4	0	0	2
	2013	34	28	6	3	0	4	0	0	0
	2014	52	46	6	0	1	4	1	0	0
	2015	92	75	17	4	0	12	0	1	0
	2016	123	94	29	5	0	23	1	2	1
	2017	161	121	40	6	0	27	4	0	4
	2018	204	166	38	9	0	24	4	0	2
	2019	267	216	51	7	2	37	4	1	2
Distal humeral hemiarthroplasties	All cases	149	130	19	3	3	14	0	0	0
	2012	0	0	0	0	0	0	0	0	0
	2013	0	0	0	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0
	2015	1	1	0	0	0	0	0	0	0
	2016	0	0	0	0	0	0	0	0	0
	2017	1	1	0	0	0	0	0	0	0
	2018	53	43	10	2	2	6	0	0	0
	2019	94	85	9	1	1	8	0	0	0

*Percentages are not presented where numbers are too few for meaningful percentages.
Note: Procedures of unconfirmed type and with confirmed types but small numbers are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.

Table 3.E3 describes the indications for the primary operation separately by type of primary elbow replacement. Primary operations with an unconfirmed procedure type are excluded from this table.

Please note that the indications for primary elbow replacement are not mutually exclusive as more than one indication could have been stated. Only one indication for surgery, as defined in Table 3.E3, was given for all 1,469 acute trauma cases with a confirmed type of primary procedure. In 124 (5%) of the 2,457 elective cases with a confirmed type of primary, more than one indication was given.

Table 3.E4 **Number** of **units** and **consultant surgeons** (cons) providing primary elbow replacements **during each year** from 2017-2019, by **region**.

(a) All primary elbow replacements (including the confirmed and unconfirmed total, radial head, lateral resurfacing and distal humeral hemiarthroplasty replacements).

Region	Year of primary														
	2017					2018					2019				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)
Total	654	168	3 (1 to 5)	229	2 (1 to 4)	691	171	2 (1 to 5)	225	2 (1 to 4)	757	169	3 (1 to 6)	231	2 (1 to 4)
North East	76	14	4 (2 to 7)	20	3 (1 to 5)	75	12	5.5 (3 to 9)	16	4 (2 to 8)	69	12	5.5 (4 to 7.5)	17	4 (1 to 7)
Yorkshire and the Humber	64	17	3 (2 to 5)	18	3 (2 to 5)	73	14	4 (1 to 7)	20	3 (1 to 4)	78	17	3 (1 to 5)	20	2.5 (1 to 5)
North West	96	25	2 (1 to 4)	33	2 (1 to 4)	121	28	2 (1 to 5)	42	1 (1 to 3)	134	27	2 (1 to 8)	39	2 (1 to 3)
West Midlands	48	17	2 (1 to 3)	24	1.5 (1 to 3)	49	13	3 (2 to 3)	19	2 (1 to 3)	42	13	3 (1 to 3)	21	1 (1 to 2)
East Midlands	75	11	5 (3 to 11)	26	1.5 (1 to 4)	75	15	3 (1 to 7)	29	2 (1 to 3)	59	11	3 (2 to 8)	22	2 (1 to 4)
East of England	62	14	3 (1 to 6)	20	2 (1.5 to 4)	71	13	4 (2 to 7)	18	2 (1 to 5)	68	13	2 (1 to 7)	18	3 (2 to 6)
London	51	20	2 (1 to 3)	27	2 (1 to 2)	58	22	2 (1 to 2)	28	2 (1 to 3)	83	26	2 (1 to 4)	33	1 (1 to 3)
South West	65	13	3 (2 to 6)	20	2 (1 to 3.5)	50	15	2 (1 to 5)	19	2 (1 to 3)	83	15	2 (1 to 8)	18	2 (2 to 6)
South Central	29	8	2 (1.5 to 5.5)	11	1 (1 to 5)	27	5	6 (5 to 7)	11	1 (1 to 3)	38	6	7.5 (4 to 8)	13	2 (1 to 4)
South East Coast	63	20	3 (1 to 4)	22	2 (1 to 3)	55	25	2 (1 to 3)	18	2 (1 to 4)	68	18	3 (1 to 7)	24	1 (1 to 3.5)
Wales	25	9	3 (1 to 3)	8	3 (1.5 to 4)	37	9	3 (1 to 4)	6	5 (3 to 7)	35	11	3 (1 to 4)	7	5 (3 to 7)

Note: Wales region combines North, Mid and West, South East.

Table 3.E4 Number of units and consultant surgeons (cons) providing primary elbow replacements during each year from 2017-2019, by region.

(b) All confirmed primary total elbow replacements (with or without radial head replacement).

Region	Year of primary														
	2017					2018					2019				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons	Median number of primaries per consultant (IQR)
Total	**432**	**144**	**2 (1 to 3.5)**	**174**	**2 (1 to 3)**	**384**	**126**	**2 (1 to 4)**	**149**	**2 (1 to 3)**	**371**	**117**	**2 (1 to 4)**	**135**	**2 (1 to 4)**
North East	45	13	3 (2 to 4)	16	2 (2 to 4)	28	11	2 (2 to 3)	12	1.5 (1 to 2.5)	32	11	3 (1 to 5)	11	3 (1 to 4)
Yorkshire and the Humber	46	15	2 (1 to 5)	15	2 (2 to 3)	49	12	3 (1 to 5)	14	3 (2 to 4)	49	14	2 (1 to 4)	15	2 (1 to 4)
North West	62	20	2 (1 to 3.5)	26	2 (1 to 3)	53	18	1 (1 to 3)	20	1 (1 to 2.5)	49	16	2 (1 to 3)	20	1 (1 to 2)
West Midlands	34	15	2 (1 to 3)	18	1.5 (1 to 3)	37	10	2 (1 to 3)	15	2 (1 to 3)	30	10	2 (1 to 3)	14	2 (1 to 3)
East Midlands	45	11	2 (1 to 6)	16	1.5 (1 to 4)	43	10	3 (2 to 4)	17	3 (1 to 3)	37	8	3 (2 to 6.5)	14	3 (1 to 3)
East of England	47	14	2 (1 to 5)	18	2 (1 to 3)	44	10	5 (4 to 6)	15	1 (1 to 5)	31	10	2.5 (1 to 5)	11	3 (1 to 4)
London	34	15	2 (1 to 3)	19	1 (1 to 2)	30	12	2 (1 to 3)	17	1 (1 to 3)	31	13	1 (1 to 3)	14	1.5 (1 to 3)
South West	46	12	2.5 (1.5 to 5.5)	16	2 (1.5 to 2.5)	31	14	1.5 (1 to 3)	16	1.5 (1 to 2.5)	44	12	2 (1.5 to 4.5)	10	4.5 (2 to 6)
South Central	18	5	2 (2 to 3)	7	1 (1 to 5)	16	4	3.5 (2.5 to 5.5)	6	2 (2 to 2)	19	5	2 (2 to 6)	9	2 (1 to 3)
South East Coast	42	16	2 (1 to 4)	17	2 (1 to 3)	31	17	2 (1 to 2)	12	2 (1 to 4)	30	11	2 (1 to 4)	11	2 (1 to 3)
Wales	13	8	1 (1 to 2.5)	6	2 (2 to 3)	22	8	2.5 (1 to 4)	6	3 (3 to 5)	19	7	2 (2 to 4)	6	3 (2 to 4)

Note: Wales region combines North, Mid and West, South East.

Over the last three years (from 2017 to 2019), 2,102 primary elbow replacements were entered into the registry, of which 1,187 had confirmed components consistent with a total elbow replacement (with or without radial head replacement).

Table 3.E4 (a) shows the number of all types of elbow replacement by year and NJR region over this time period, together with the number of units and consultants. A list of units in each NJR region is provided in the downloads section of **reports.njrcentre.org.uk** and further information can be found on **https://surgeonprofile.njrcentre.org.uk**

The median number of elbow replacements per unit and consultant has changed very little over the last three years and remains around two to three per annum with up to 5.5 replacements per unit in the North East region and 7.5 replacements per unit in the South Central region in 2019. The median number of replacements per year appears to increase over time in the South Central region. These figures are subject to change, as some units may not have submitted all data for this period by the time of data analysis. Table 3.E4 (b) shows the number of total primary replacement by year and by region. There does appear to be a reduction in the total number of consultants and units performing primary total elbow arthroplasty over this time period.

Table 3.E5 lists the brands used in elbow replacement by confirmed procedure type, with sub-division by acute trauma and elective cases.

Table 3.E5 Brands used in elbow replacement by confirmed procedure type.

		Number of primaries	Acute trauma	Elective
Total elbow replacements	All cases	2,788	577	2,211
	Unlinked brands:			
	IBP	9	0	9
	K-elbow	4	0	4
	Latitude	88	5	83
	NES	2	0	2
	Linked brands:			
	Comprehensive SRS [Hum] Nexel [Ulna]	3	1	2
	Coonrad Morrey	1,472	342	1,130
	Coonrad Morrey [Hum] Undefined/Custom [Ulna]	1	0	1
	Discovery	715	143	572
	Discovery [Hum] Undefined/Custom [Ulna]	1	0	1
	GSB III	43	3	40
	Latitude	256	39	217
	Mutars	2	0	2
	Nexel	190	43	147
	Other	2	1	1
Total elbow replacements inc. radial head replacement	All cases	21	1	20
	Unlinked brands:			
	Latitude	16	0	16
	Linked brands:			
	Latitude	5	1	4

Note: Procedures of unconfirmed type are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.

Table 3.E5 (continued)

		Number of primaries	Acute trauma	Elective
Radial head replacements	All cases	956	761	195
	Bipolar brands:			
	Latitude	1	1	0
	RHS	31	14	17
	rHead Recon	6	3	3
	Monopolar brands:			
	Anatomic	531	434	97
	Ascension	66	46	20
	Corin	26	21	5
	Evolve Proline	197	163	34
	ExploR	80	66	14
	Liverpool	4	3	1
	MoPyC	8	6	2
	Uni-Radial Elbow	6	4	2
Lateral resurfacings	All cases	12	0	12
	LRE	11	0	11
	Uni-Elbow	1	0	1
Distal humeral hemiarthroplasties	All cases	149	130	19
	Latitude	149	130	19

Note: Procedures of unconfirmed type are not reported in this table.
Note: Distal humeral hemiarthroplasty started to be reported in MDSv7 released in June 2018.

Four implants (Coonrad-Morrey, Discovery, Latitude and Nexel) account for nearly 98% of total elbow replacements performed. There is no separation of Latitude Legacy and Latitude EV at this point. All total elbow replacements with radial head replacement were done using the Latitude implant. One implant (RHS) accounts for nearly 82% of the bipolar radial head replacements and two implants (Anatomic and Evolve Proline) account for nearly 79% of the monopolar radial head replacements. Nearly all lateral resurfacing procedures have been performed using the LRE brand. Latitude implants were used for all distal humeral hemiarthroplasty procedures.

3.5.2 Revisions after primary elbow replacement surgery

A total of 180 elbow primaries in the registry (36 acute trauma cases and 144 elective) had linked revision procedures recorded up to the end of 2019, including five excision, 104 single-stage, eight DAIRs (seven with modular exchange and one without modular exchange) and 63 two-stage arthroplasties.

The NJR also includes revision procedures for which a primary has not been recorded; including those procedures without a linked primary. A total of 1,231 revision procedures have been entered by 221 consultant surgeons working across 151 units. This total counts stage one of two and stage two of two operations as separate procedures. Over the last year, 197 revision procedures were entered into the NJR by 74 consultants working across 54 units.

Table 3.E6 KM estimates of cumulative **revision** (95% CI) by primary elbow procedures for **acute trauma** and **elective** cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

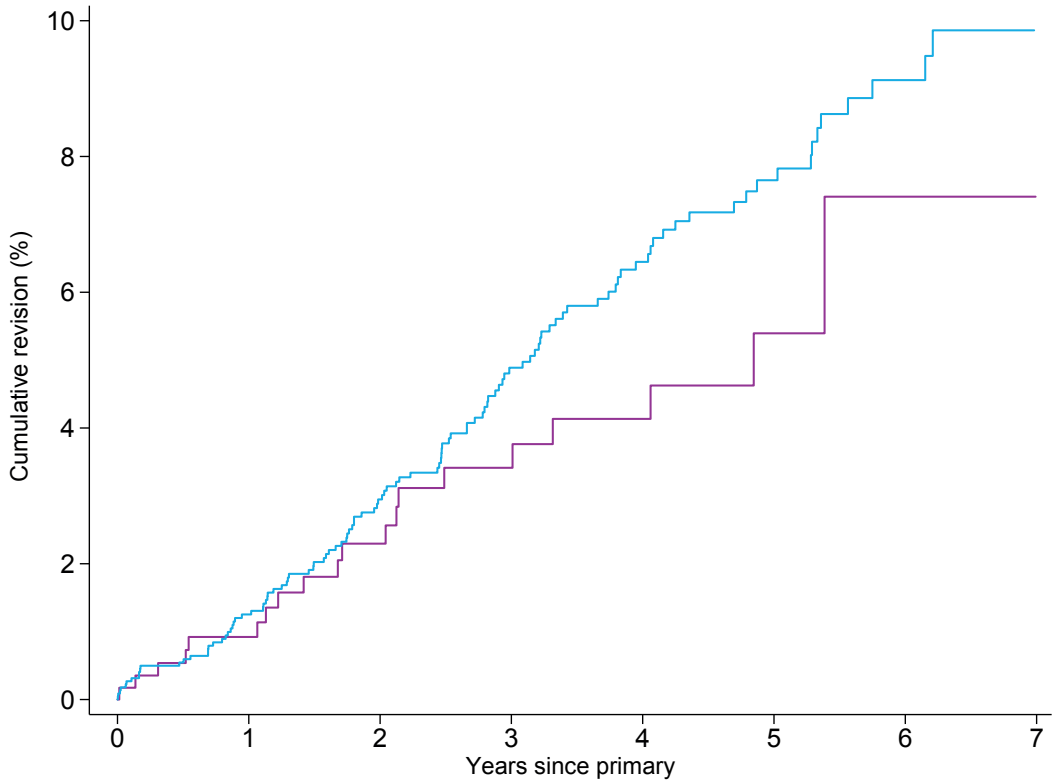
		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary					
					1 year	2 years	3 years	4 years	5 years	6 years
All acute trauma and elective cases		4,373	68 (56 to 76)	30	1.30 (0.99-1.70)	2.64 (2.16-3.23)	4.27 (3.60-5.07)	5.53 (4.71-6.48)	6.40 (5.45-7.50)	7.64 (6.47-9.01)
Acute trauma	All acute trauma cases	1,668	67 (53 to 78)	28	0.91 (0.54-1.53)	1.92 (1.29-2.85)	2.39 (1.65-3.46)	2.90 (2.01-4.16)	*3.51 (2.38-5.16)*	*4.51 (2.94-6.90)*
	Total elbow replacements	577	77 (71 to 83)	16	0.92 (0.38-2.20)	2.30 (1.27-4.13)	3.41 (2.06-5.64)	*4.13 (2.56-6.65)*	*5.40 (3.30-8.77)*	*7.41 (4.43-12.27)*
	Total elbow replacements inc. radial head replacement	1	79 (79 to 79)	0	*	*	*	*	*	*
	Radial head replacements	761	53 (41 to 64)	40	0.16 (0.02-1.15)	0.60 (0.19-1.88)	0.60 (0.19-1.88)	*1.05 (0.36-3.02)*	*1.05 (0.36-3.02)*	*1.05 (0.36-3.02)*
	Distal humeral hemiarthroplasties	130	70 (65 to 79)	18	*4.30 (1.53-11.81)*	*	*	*	*	*
	Unconfirmed elbow prosthetic replacements	62	78.5 (73 to 84)	16	*1.61 (0.23-10.90)*	*3.62 (0.91-13.83)*	*3.62 (0.91-13.83)*	*3.62 (0.91-13.83)*	*3.62 (0.91-13.83)*	*3.62 (0.91-13.83)*
	Unconfirmed radial head replacements	33	51 (40 to 60)	42	*3.03 (0.43-19.63)*	*7.07 (1.79-25.81)*	*7.07 (1.79-25.81)*	*	*	*
	Unconfirmed distal humeral hemiarthroplasties	104	73 (66 to 82)	24	*1.94 (0.49-7.54)*	*3.00 (0.98-9.01)*	*3.00 (0.98-9.01)*	*3.00 (0.98-9.01)*	*3.00 (0.98-9.01)*	*3.00 (0.98-9.01)*
Elective	All elective cases	2,705	68 (58 to 75)	31	1.52 (1.11-2.08)	3.02 (2.39-3.81)	5.18 (4.28-6.27)	6.75 (5.65-8.05)	7.72 (6.48-9.17)	9.03 (7.56-10.78)
	Total elbow replacements	2,211	69 (60 to 76)	29	1.22 (0.82-1.80)	2.86 (2.19-3.73)	4.81 (3.86-5.98)	6.37 (5.20-7.79)	7.58 (6.21-9.22)	9.05 (7.38-11.08)
	Total elbow replacements inc. radial head replacement	20	64 (55 to 71.5)	40	*5.56 (0.80-33.36)*	*	*	*	*	*
	Radial head replacements	195	51 (41 to 61)	49	*3.13 (1.31-7.38)*	*3.13 (1.31-7.38)*	*4.58 (1.95-10.56)*	*6.38 (2.81-14.13)*	*6.38 (2.81-14.13)*	*6.38 (2.81-14.13)*
	Lateral resurfacings	12	57.5 (53 to 62.5)	50	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*	*
	Distal humeral hemiarthroplasties	19	74 (67 to 83)	21	*	*	*	*	*	*
	Unconfirmed elbow prosthetic replacements	214	68 (58 to 76)	30	*1.47 (0.48-4.48)*	*2.53 (1.06-5.98)*	*6.55 (3.77-11.27)*	*8.39 (5.13-13.57)*	*8.39 (5.13-13.57)*	*9.43 (5.81-15.12)*
	Unconfirmed radial head replacements	11	58 (48 to 65)	45	*	*	*	*	*	*
	Unconfirmed lateral resurfacings	8	59.5 (50 to 71.5)	38	*	*	*	*	*	*
	Unconfirmed distal humeral hemiarthroplasties	15	66 (57 to 75)	20	*13.33 (3.51-43.61)*	*13.33 (3.51-43.61)*	*	*	*	*

*Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no component data in the record are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E6 shows Kaplan-Meier estimates of the cumulative percentage probability of revision up to six years after the primary operation, together with 95% confidence intervals for all cases and for acute trauma and elective cases separately.

There is a higher cumulative revision rate for all elbow arthroplasty for elective indications compared to trauma. Figure 3.E2 shows Kaplan-Meier estimates of the cumulative percentage probability of revision after primary total elbow replacement, divided into acute trauma and elective cases. Total elbow replacement makes up a higher proportion of procedures in elective cases (81.7%) than trauma (34.6%), whereas isolated radial head replacement is more commonly performed in trauma cases (45.6%) than elective (7.2%).

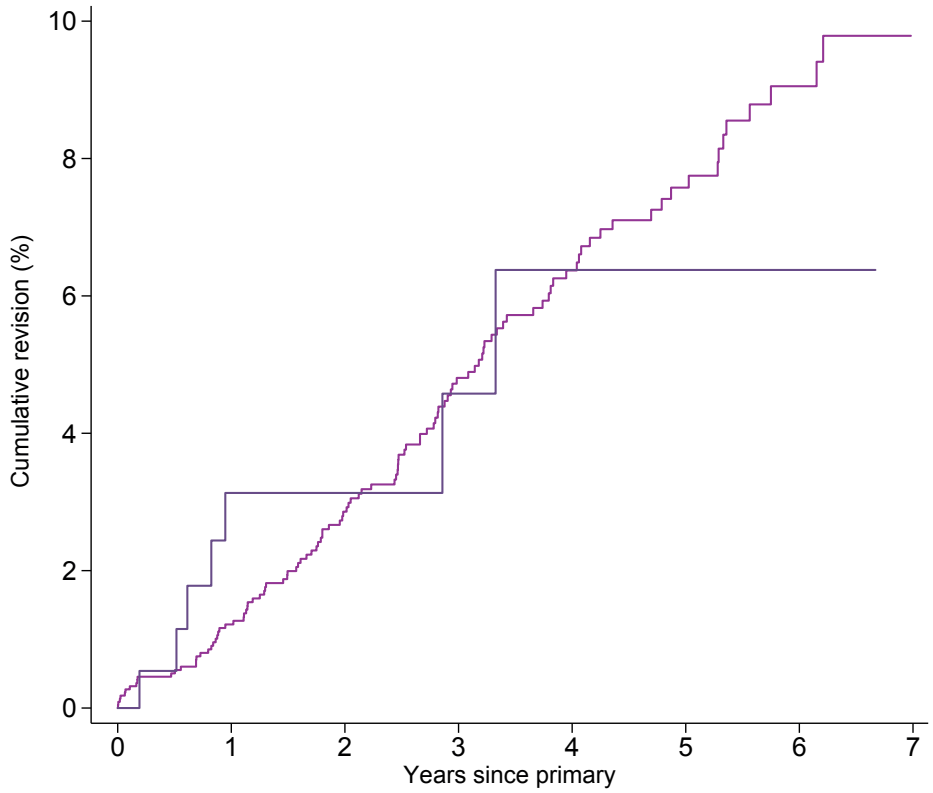
Figure 3.E2 KM estimates of cumulative **revision** of primary **total elbow replacement** by **acute trauma** and **elective cases**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk							
Elective	2231	1881	1511	1124	808	534	294	*101*
Acute trauma	578	469	371	278	*199*	*112*	*69*	*21*

For the sub-group of total elbow replacement, the survival of total replacements was comparable for trauma and elective indications up to two years. From three years post-operation onwards, the revision rates were higher for the elective total elbow replacements, but the data for acute trauma is less certain due to the low numbers in the registry and because the confidence intervals of the estimates in both groups overlap. There is insufficient data to compare radial head replacement, lateral resurfacing, distal humeral hemiarthroplasty and the other unconfirmed types of primary procedure between elective and trauma indications.

Figure 3.E3 KM estimates of cumulative **revision** by confirmed type of primary **elbow replacement** within the **elective cases**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

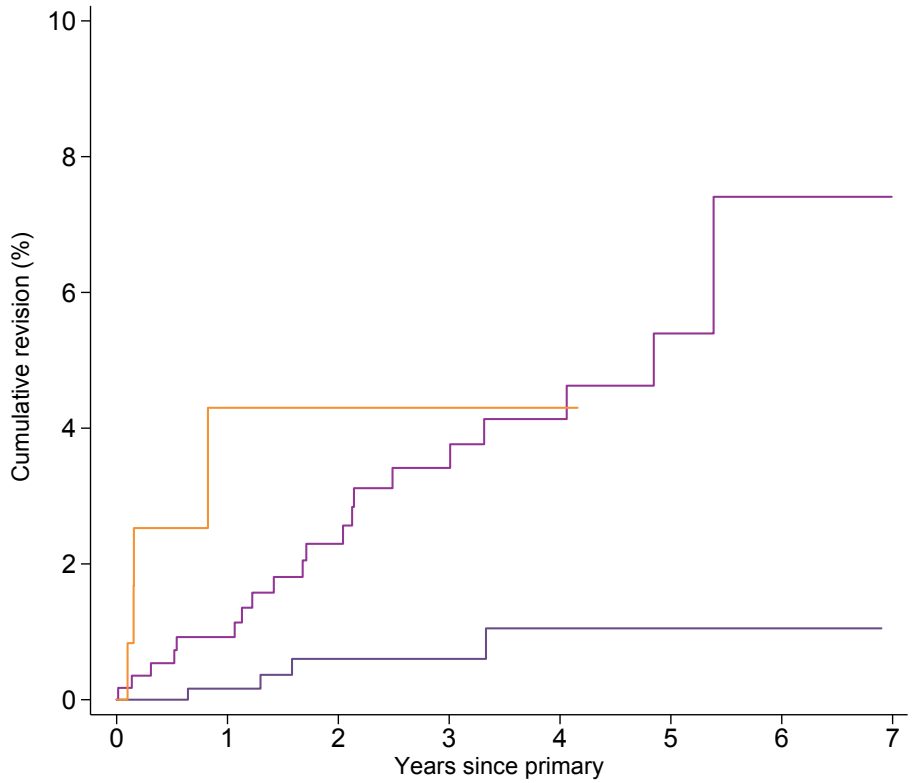


Key:	Numbers at risk							
Radial head replacements	*195*	*138*	*101*	*63*	*35*	*19*	*13*	*8*
Total elbow replacements	2211	1869	1506	1121	807	533	294	*101*

Figure 3.E3 shows Kaplan-Meier estimates of the cumulative percentage probability of revision by confirmed type of primary total elbow replacement within the elective cases. As shown in Table 3.E6 (page 217), no clear difference can be identified between the different types of primary procedures performed on an elective basis.

Figure 3.E4 shows these cumulative rates within the acute trauma cases. These differences remain uncertain as the number of procedures and the number of revisions within these groups remain low and the excisions of radial heads are likely to have been under-reported.

Figure 3.E4 KM estimates of cumulative **revision** by confirmed **type of primary elbow replacement** within the **acute trauma** cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk							
Distal humeral hemiarthroplasties	*130*	*42*	*2*	*1*	*1*	*0*	*0*	*0*
Radial head replacements	761	541	372	252	*155*	*84*	*38*	*13*
Total elbow replacements	577	469	371	278	*199*	*112*	*69*	*21*

There are too few cases for further sub-division into age/gender sub-groups.

Table 3.E7 shows the cumulative probability of revision for brands used in at least 100 primary elbow replacements with a confirmed procedure type. For total elbow replacement, the cumulative revision rates varied between brands from 0.6% to 2.8% in the first post-operative year. At four years post-operation, the rates were still varying between brands from 5.3% to 8.1%, however numbers are small and this may simply be due to chance. For radial head replacement, the revisions were all nested in one brand.

Brand comparisons will become more reliable as the size of the elbow cohort increases over time, and allow further stratification by patient characteristics, acute/elective status and indication for primary surgery.

Table 3.E7 KM estimates of cumulative **revision** (95% CI) for primary elbow procedures by **implant brand**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

			Number of primaries	Age (Median, IQR)	Male (%)	Time since primary					
						1 year	2 years	3 years	4 years	5 years	6 years
Total elbow replacements	Linked brands	Coonrad Morrey	1,472	71 (64 to 78)	25	1.38 (0.88-2.16)	3.09 (2.26-4.21)	4.53 (3.47-5.91)	5.32 (4.12-6.86)	6.03 (4.68-7.74)	*7.43 (5.72-9.62)*
		Discovery	714	69 (61 to 77)	28	0.60 (0.22-1.58)	1.44 (0.75-2.75)	3.55 (2.27-5.55)	5.93 (4.10-8.55)	*7.87 (5.54-11.10)*	*9.57 (6.76-13.45)*
		Latitude	256	70 (61.5 to 77)	28	*0.85 (0.21-3.36)*	*4.13 (1.96-8.59)*	*8.07 (4.17-15.32)*	*8.07 (4.17-15.32)*	*8.07 (4.17-15.32)*	*
		Nexel	190	70 (62 to 79)	29	*2.81 (1.18-6.65)*	*4.30 (2.05-8.88)*	*4.30 (2.05-8.88)*	*6.21 (2.83-13.34)*	*	*
Radial head replacements	Mono-polar brands	Anatomic	531	52 (40 to 63)	44	0.45 (0.11-1.81)	*0.75 (0.24-2.35)*	*1.31 (0.45-3.76)*	*1.31 (0.45-3.76)*	*1.31 (0.45-3.76)*	*1.31 (0.45-3.76)*
		Evolve Proline	197	55 (44 to 64)	41	*0*	*0*	*0*	*0*	*0*	*
Distal humeral hemiarth-roplasties		Latitude	149	71 (65 to 79)	18	*4.37 (1.74-10.74)*	*	*	*	*	*

*Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period.
Note: Elbow replacements with less than 100 procedures are excluded from this table.

Table 3.E8 gives a breakdown of the indications for the first data linked revision procedure. The most common indications for revision remain as aseptic loosening and infection. The indications for revision were not mutually exclusive; in 20 of the 179 first revisions more than one indication was stated. A few cases (n=40) had gone on to have further revision procedures (two-stage revisions counted as one procedure). The numbers are too small for any further analysis or to draw any conclusions.

Table 3.E8 Indications for first data linked revision after any primary elbow replacement. Acute trauma and elective cases are shown separately, for total elbow replacement, lateral resurfacing and distal humeral hemiarthroplasty, and radial head replacement.

	Type of primary procedure	Number of primaries	Total revised	Indication for first revision procedure				
				Infection	Periprosthetic fracture	Instability	Aseptic loosening	Other indications
All acute trauma and elective cases		4,373	180	62	25	23	73	18
Acute trauma	All cases with confirmed procedure type	1,469	29	10	3	4	12	4
	Total elbow replacements	577	21	10	3	1	10	1
	Total elbow replacements inc. radial head replacement	1	0	0	0	0	0	0
	Radial head replacements	761	4	0	0	0	2	2
	Lateral resurfacings	0	0	0	0	0	0	0
	Distal humeral hemiarthroplasties	130	4	0	0	3	0	1
	Unconfirmed elbow prosthetic replacements	62	2	0	0	0	1	2
	Unconfirmed radial head replacements	33	2	0	0	1	1	0
	Unconfirmed lateral resurfacings	0	0	0	0	0	0	0
	Unconfirmed distal humeral hemiarthroplasties	104	3	1	0	2	0	1
	All cases with unconfirmed procedure type	199	7	1	0	3	2	3
Elective	All cases with confirmed procedure type	2,457	124	45	22	11	48	9
	Total elbow replacements	2,211	113	43	21	8	47	5
	Total elbow replacements inc. radial head replacement	20	2	0	1	0	0	1
	Radial head replacements	195	7	2	0	2	1	2
	Lateral resurfacings	12	1	0	0	0	0	1
	Distal humeral hemiarthroplasties	19	1	0	0	1	0	0
	Unconfirmed elbow prosthetic replacements	214	17	6	0	3	11	1
	Unconfirmed radial head replacements	11	0	0	0	0	0	0
	Unconfirmed lateral resurfacings	8	1	0	0	1	0	0
	Unconfirmed distal humeral hemiarthroplasties	15	2	0	0	1	0	1
	All cases with unconfirmed procedure type	248	20	6	0	5	11	2

Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no component data in the record are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

3.5.3 Mortality after primary elbow replacement surgery

For this analysis, the second procedure of a pair of bilateral operations performed on the same day were excluded (Figure 3.E1 on page 208). Among the remaining 4,369 procedures, 448 of the recipients had died by the end of December 2019.

Table 3.E9 KM estimates of cumulative **mortality** (95% CI) by time from primary elbow replacement, for **acute trauma** and **elective** cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary							
					30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years
All acute trauma and elective cases		4,369	68 (56 to 76)	30	0.23 (0.12-0.43)	0.53 (0.36-0.80)	2.24 (1.83-2.75)	4.84 (4.18-5.60)	8.21 (7.29-9.24)	11.61 (10.44-12.91)	16.42 (14.87-18.12)	19.99 (18.12-22.04)
Acute trauma	All acute trauma cases	1,666	67 (53 to 78)	28	0.48 (0.24-0.97)	0.67 (0.37-1.21)	3.01 (2.24-4.02)	6.07 (4.88-7.55)	10.23 (8.53-12.25)	13.63 (11.49-16.14)	*19.09 (16.16-22.48)*	*22.85 (19.25-27.00)*
	Total elbow replacements	576	77 (71 to 83)	16	0.87 (0.36-2.09)	1.23 (0.59-2.57)	5.75 (4.08-8.08)	10.75 (8.33-13.83)	17.20 (13.99-21.06)	*21.38 (17.68-25.72)*	*28.40 (23.73-33.76)*	*33.30 (27.81-39.54)*
	Total elbow replacements inc. radial head replacement	1	79 (79 to 79)	0	*	*	*	*	*	*	*	*
	Radial head replacements	760	53 (41 to 64)	40	0.13 (0.02-0.94)	0.27 (0.07-1.07)	0.61 (0.23-1.63)	1.07 (0.47-2.42)	1.43 (0.65-3.11)	*2.44 (1.16-5.06)*	*2.44 (1.16-5.06)*	*4.43 (1.68-11.37)*
	Distal humeral hemiarthroplasties	130	70 (65 to 79)	18	*0*	*0*	*2.78 (0.70-10.65)*	*	*	*	*	*
	Unconfirmed elbow prosthetic replacements	62	78.5 (73 to 84)	16	*1.61 (0.23-10.90)*	*1.61 (0.23-10.90)*	*6.53 (2.50-16.48)*	*14.91 (8.05-26.71)*	*22.24 (13.54-35.27)*	*32.93 (21.49-48.29)*	*39.11 (26.28-55.39)*	*39.11 (26.28-55.39)*
	Unconfirmed radial head replacements	33	51 (40 to 60)	42	*	*	*	*	*	*	*	*
	Unconfirmed distal humeral hemiarthroplasties	104	73 (66 to 82)	24	*0.96 (0.14-6.63)*	*0.96 (0.14-6.63)*	*2.92 (0.95-8.79)*	*6.16 (2.81-13.26)*	*13.16 (7.41-22.77)*	*16.38 (9.07-28.56)*	*31.52 (18.77-49.82)*	*37.23 (22.36-57.55)*
Elective	All elective cases	2,703	68 (58 to 75)	31	0.07 (0.02-0.30)	0.45 (0.26-0.79)	1.81 (1.36-2.41)	4.16 (3.41-5.06)	7.16 (6.11-8.37)	10.58 (9.22-12.12)	15.15 (13.37-17.15)	18.68 (16.53-21.08)
	Total elbow replacements	2,210	69 (60 to 76)	30	0.09 (0.02-0.36)	0.46 (0.25-0.85)	1.77 (1.28-2.43)	4.45 (3.60-5.49)	7.67 (6.49-9.06)	11.57 (10.01-13.36)	16.38 (14.34-18.67)	20.50 (18.00-23.29)
	Total elbow replacements inc. radial head replacement	20	64 (55 to 71.5)	40	*	*	*	*	*	*	*	*
	Radial head replacements	194	51 (41 to 61)	49	*0*	*0*	*0.67 (0.09-4.64)*	*0.67 (0.09-4.64)*	*0.67 (0.09-4.64)*	*3.28 (0.66-15.45)*	*3.28 (0.66-15.45)*	*3.28 (0.66-15.45)*
	Lateral resurfacings	12	57.5 (53 to 62.5)	50	*	*	*	*	*	*	*	*
	Distal humeral hemiarthroplasties	19	74 (67 to 83)	21	*	*	*	*	*	*	*	*
	Unconfirmed elbow prosthetic replacements	214	68 (58 to 76)	30	*0*	*0.93 (0.23-3.68)*	*3.32 (1.60-6.85)*	*4.81 (2.62-8.76)*	*6.95 (4.17-11.47)*	*8.13 (5.05-12.96)*	*12.36 (8.24-18.31)*	*14.17 (9.60-20.66)*
	Unconfirmed radial head replacements	11	58 (48 to 65)	45	*	*	*	*	*	*	*	*
	Unconfirmed lateral resurfacings	8	59.5 (50 to 71.5)	38	*	*	*	*	*	*	*	*
	Unconfirmed distal humeral hemiarthroplasties	15	66 (57 to 75)	20	*0*	*0*	*7.14 (1.04-40.92)*	*7.14 (1.04-40.92)*	*	*	*	*

*Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no component data in the record are described as unconfirmed and classified according to the procedure type indicated by the surgeon on the MDS form.

Table 3.E9 shows the overall cumulative percentage probability of mortality shown separately for acute trauma and the elective cases.

The mortality after primary total elbow replacement for trauma is more than double the rate in elective total elbow arthroplasty, with a five year mortality approaching 30%.

3.5.4 Conclusions

The annual number of primary elbow replacement procedures entered into the registry has increased since 2012 and is one of the largest datasets of elbow arthroplasty globally. It is not yet known how accurate or complete the dataset is, as an independent audit of elbow replacement data has yet to be undertaken.

The type of procedure reported is determined from two sources of information. The first is the procedure type recorded on the MDS data collection form by the surgeon or their deputy at the time of the procedure. The second source is the set of component labels attached to the MDS form and recorded at upload of the record. When there is a mismatch between these two sources, or when there is no component data in the record, the procedure type is reported as unconfirmed. Further work is required to reconcile these unconfirmed procedures and reduce the recording of such procedures to maximise the comprehensiveness and utility of the data.

Distal humeral hemiarthroplasty was not included in the MDS until June 2018. Despite this, an increasing number of hemiarthroplasty implants were registered between 2012 and 2019 but total numbers remain low, so it is not yet possible to compare the revision rates for this newer procedure against the data for total elbow replacement. Most distal humeral hemiarthroplasty and radial head replacement procedures are performed for acute trauma and trauma sequelae as expected.

The distribution of indications for total elbow replacement has been consistent over the five years of data entry with inflammatory arthropathy accounting for half of cases. In 2019 there were 371 confirmed primary total elbow replacements (including eight with radial head replacements) performed in 117 units by 135 consultants. The volume of procedures does not show large variation, however the number of units performing elbow replacements has declined from 144 in 2017 and the number of consultants from 174 in 2017. It is the intention of the NHSI GIRFT programme to centralise total elbow replacement surgery into fewer specialist centres so this data is encouraging, but it should be noted that the median numbers of primary procedures per unit and per surgeon have not changed from 2017 to 2019.

The Kaplan-Meier estimate of cumulative revision of total elbow replacement at four years was 4.1 (95% CI 2.6-6.7) for trauma patients and 6.4 (95% CI 5.2-7.8) for elective cases. Disparities in the rate of revision were observed between implant brands. Brand comparisons will become more reliable as the size of the elbow cohort increases over time. The main indications for revision were infection and aseptic loosening and this is observed for both acute trauma and elective cases.

Five year mortality for all elbow replacement is 16.4% with differences seen between trauma and elective surgery. The one-year mortality rate following total elbow replacement remains higher in the trauma population than in those having elective surgery, however this is likely to represent a difference in the demographics of these two groups.

3.6 Outcomes after shoulder replacement

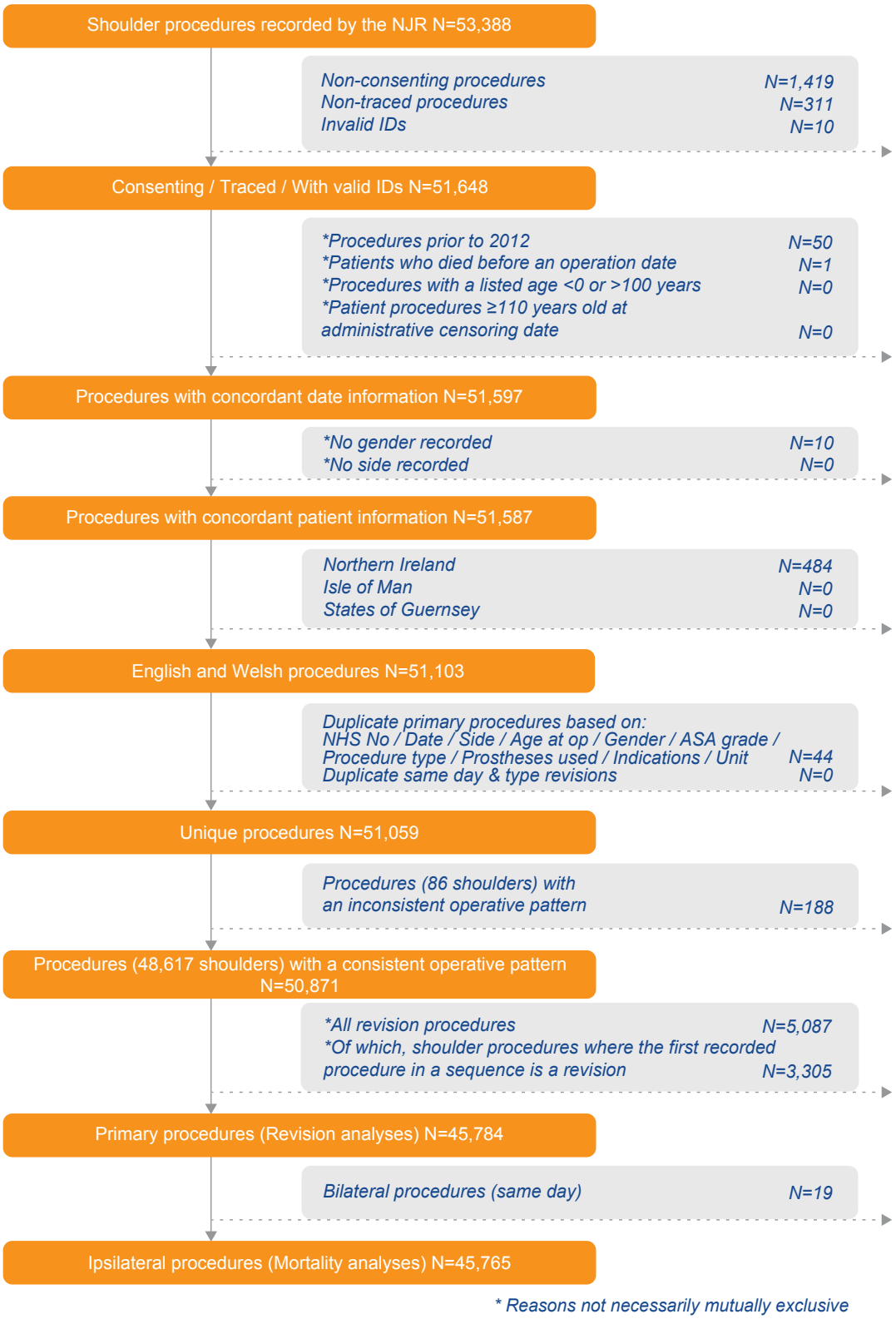
3.6.1 Overview of primary shoulder replacement surgery

The NJR has recorded shoulder replacements since 2012. This section contains an overview of the (data linked) primary shoulder replacements performed up to 31 December 2019 and documents the first revision and mortality, when these events had occurred following a primary shoulder replacement.

In 2018 and 2019 a rigorous review of the shoulder data was undertaken due to the rapid expansion of shoulder implant types available. As a consequence of this review, new classifications and component attributes are now used within the NJR to define the primary groupings throughout the whole of this section. The report has now moved to whole construct validation, ensuring all relevant elements required to build a construct are present in a procedure. The NJR has cross-checked the implanted construct with the indicated procedure at the time of the surgery and positively confirmed the implanted construct matches the reported procedure. This has led to the definition of unconfirmed constructs in which there are either insufficient implants listed to make up a complete construct, or the implants used do not match the indicated procedure. A total of 6,109 (13.3%) procedures are unconfirmed; although this is expected to improve in future reports, with more rigorous checks to be imposed at the point of data entry.

The NJR defines a stemmed humeral component as a humeral component in which any part enters the humeral diaphysis, while a stemless humeral component is defined as being completely confined to the metaphysis with no part entering the diaphysis.

Figure 3.S1 Shoulder cohort flow diagram.



A total of 45,784 primary shoulder replacements were available for analysis in a total of 42,285 patients. Of these patients, 3,499 had documented replacements on both left and right sides, 19 of which were bilateral simultaneous operations (left and right on the same day). See Figure 3.S1 for a detailed description of patients included in this section.

Table 3.S1 Number and percentage of primary shoulder replacements (elective or acute trauma), by year and type of shoulder replacement.

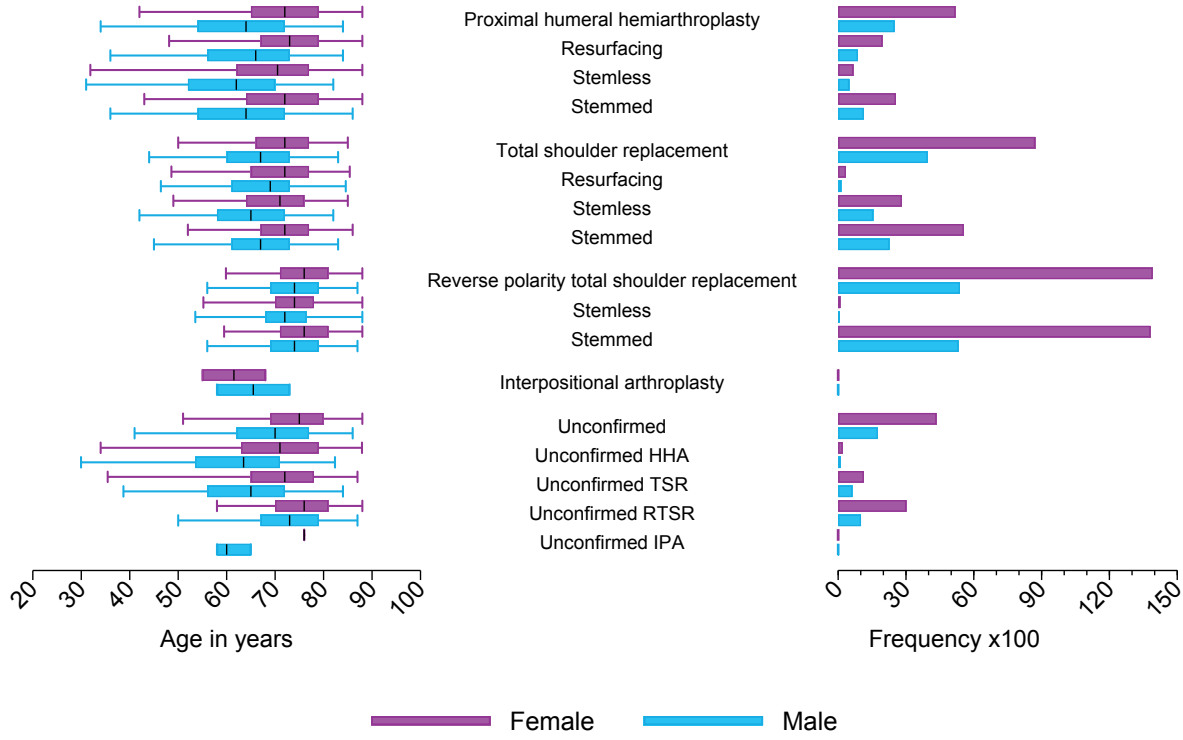
	All years N (%)	Year of primary							
		2012 N (%)	2013 N (%)	2014 N (%)	2015 N (%)	2016 N (%)	2017 N (%)	2018 N (%)	2019 N (%)
All cases	**45,784 (100.0)**	**2,527 (100.0)**	**4,394 (100.0)**	**5,278 (100.0)**	**5,709 (100.0)**	**6,510 (100.0)**	**6,968 (100.0)**	**7,104 (100.0)**	**7,294 (100.0)**
Proximal humeral hemiarthroplasty	**7,695 (16.8)**	**880 (34.8)**	**1,296 (29.5)**	**1,283 (24.3)**	**1,055 (18.5)**	**1,010 (15.5)**	**830 (11.9)**	**694 (9.8)**	**647 (8.9)**
Resurfacing	2,836 (6.2)	474 (18.8)	592 (13.5)	536 (10.2)	375 (6.6)	368 (5.7)	219 (3.1)	146 (2.1)	126 (1.7)
Stemless	1,166 (2.5)	70 (2.8)	132 (3.0)	164 (3.1)	137 (2.4)	163 (2.5)	170 (2.4)	170 (2.4)	160 (2.2)
Stemmed	3,693 (8.1)	336 (13.3)	572 (13.0)	583 (11.0)	543 (9.5)	479 (7.4)	441 (6.3)	378 (5.3)	361 (4.9)
Total shoulder replacement	**12,676 (27.7)**	**627 (24.8)**	**1,177 (26.8)**	**1,526 (28.9)**	**1,764 (30.9)**	**1,891 (29.0)**	**1,971 (28.3)**	**1,870 (26.3)**	**1,850 (25.4)**
Resurfacing	479 (1.0)	49 (1.9)	99 (2.3)	81 (1.5)	88 (1.5)	78 (1.2)	45 (0.6)	24 (0.3)	15 (0.2)
Stemless	4,367 (9.5)	135 (5.3)	255 (5.8)	386 (7.3)	501 (8.8)	626 (9.6)	729 (10.5)	847 (11.9)	888 (12.2)
Stemmed	7,830 (17.1)	443 (17.5)	823 (18.7)	1,059 (20.1)	1,175 (20.6)	1,187 (18.2)	1,197 (17.2)	999 (14.1)	947 (13.0)
Reverse polarity total shoulder replacement	**19,300 (42.2)**	**678 (26.8)**	**1,344 (30.6)**	**1,853 (35.1)**	**2,125 (37.2)**	**2,742 (42.1)**	**3,268 (46.9)**	**3,485 (49.1)**	**3,805 (52.2)**
Stemless	155 (0.3)	5 (0.2)	14 (0.3)	15 (0.3)	22 (0.4)	18 (0.3)	20 (0.3)	38 (0.5)	23 (0.3)
Stemmed	19,145 (41.8)	673 (26.6)	1,330 (30.3)	1,838 (34.8)	2,103 (36.8)	2,724 (41.8)	3,248 (46.6)	3,447 (48.5)	3,782 (51.9)
Interpositional arthroplasty	**4 (<0.1)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**2 (<0.1)**	**2 (<0.1)**
Unconfirmed	**6,109 (13.3)**	**342 (13.5)**	**577 (13.1)**	**616 (11.7)**	**765 (13.4)**	**867 (13.3)**	**899 (12.9)**	**1,053 (14.8)**	**990 (13.6)**
Unconfirmed HHA	314 (0.7)	21 (0.8)	59 (1.3)	40 (0.8)	42 (0.7)	39 (0.6)	33 (0.5)	41 (0.6)	39 (0.5)
Unconfirmed TSR	1,764 (3.9)	201 (8.0)	311 (7.1)	302 (5.7)	255 (4.5)	268 (4.1)	201 (2.9)	160 (2.3)	66 (0.9)
Unconfirmed RTSR	4,027 (8.8)	120 (4.7)	207 (4.7)	274 (5.2)	468 (8.2)	560 (8.6)	665 (9.5)	848 (11.9)	885 (12.1)
Unconfirmed IPA	4 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0.1)	0 (0)

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S1 illustrates the number of shoulder replacements and how they change across time. There is a steady increase in the number of primary shoulder replacements year on year. It also illustrates relative proportions of proximal humeral hemiarthroplasty, conventional total shoulder replacement and reverse polarity shoulder replacement. There is a continued increasing preference for reverse polarity shoulder replacement year on year.

The number of unconfirmed procedures contained within the registry is illustrated. Using more evolved methods of construct and procedure cross-validation, procedures with insufficient prostheses elements to build a unique construct or a construct that disagrees with the procedure indicated at the time of surgery are identified. It is noted that entering all the elements of reverse polarity total shoulder replacements appears to be particularly challenging and so it is urged that those completing the data entry forms and entering data should pay particular attention to these procedures.

Figure 3.S2 Age (Box and whiskers*) and **frequency** of primary shoulder replacements by **gender** and **type** of shoulder replacement.



*"Box and Whiskers" | represents median, box represent represent lower and upper interquartile range. Whiskers represent the 2.5th and 97.5th centile of the distribution.

Figure 3.S2 illustrates the age and gender difference between the different types and sub-types of shoulder replacements using a modified 'box and whisker' plot. The whiskers represent the 2.5th and 97.5th centile of the distribution. The figure also shows the frequency of procedures by gender and procedure type. The plots illustrate that women tend to be older than men at the time of operation and those receiving reverse polarity total shoulder replacements tend to be older than those receiving proximal humeral hemiarthroplasty or conventional total shoulder replacements. Figure 3.S2 also illustrates that the majority of procedures recorded within the registry are reverse polarity total shoulder replacements. It also clearly illustrates that the majority of unconfirmed procedures consist of reverse polarity total shoulder replacements.

Table 3.S2 Demographic characteristics of patients undergoing primary shoulder replacements, by acute or elective indications and type of shoulder replacement.

	Shoulder type	Number of cases	Male N (%)	Age in years at primary median (IQR*) range**
Acute trauma	All cases	4,364	1,014 (23.2)	74 (67 to 80) 27 to 99
	Proximal humeral hemiarthroplasty	1,506	452 (30.0)	68 (60 to 77) 27 to 96
	Total shoulder replacement	14	8 (57.1)	69 (53 to 74) 43 to 79
	Reverse polarity total shoulder replacement	2,191	430 (19.6)	76 (71 to 81) 48 to 99
	Interpositional arthroplasty	0	0 (0.0)	0 (0 to 0) 0 to 0
	Unconfirmed	653	124 (19.0)	75 (69 to 80) 35 to 96
Elective	All cases	41,420	12,592 (30.4)	73 (67 to 79) 17 to 99
	Proximal humeral hemiarthroplasty	6,189	2,050 (33.1)	70 (61 to 77) 17 to 95
	Resurfacing	2,831	870 (30.7)	71 (64 to 78) 20 to 95
	Stemless	1,157	487 (42.1)	67 (56 to 75) 17 to 93
	Stemmed	2,201	693 (31.5)	70 (61 to 78) 19 to 95
	Total shoulder replacement	12,662	3,952 (31.2)	70 (64 to 76) 18 to 99
	Resurfacing	479	136 (28.4)	71 (64 to 76) 29 to 95
	Stemless	4,363	1,548 (35.5)	69 (62 to 75) 18 to 99
	Stemmed	7,820	2,268 (29.0)	71 (65 to 76) 24 to 96
	Reverse polarity total shoulder replacement	17,109	4,957 (29.0)	76 (71 to 80) 17 to 99
	Stemless	155	60 (38.7)	73 (69 to 78) 49 to 89
	Stemmed	16,954	4,897 (28.9)	76 (71 to 80) 17 to 99
	Interpositional arthroplasty	4	2 (50.0)	63 (57 to 71) 55 to 73
	Unconfirmed	5,456	1,631 (29.9)	74 (67 to 79) 18 to 96
	Unconfirmed HHA	271	103 (38.0)	69 (59 to 76) 18 to 92
	Unconfirmed TSR	1,729	614 (35.5)	69 (61 to 76) 20 to 96
	Unconfirmed RTSR	3,453	911 (26.4)	75 (70 to 80) 18 to 95
	Unconfirmed IPA	3	3 (100.0)	60 (58 to 65) 58 to 65

*IQR: Interquartile range, i.e. 25th and 75th centile.
**Range: Lowest and highest observed values.
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S2 displays similar information to Figure 3.S2, except results are divided by acute trauma and elective procedures.

Table 3.S3 Numbers of units and consultant surgeons providing primary shoulder replacements and median and interquartile range of procedures performed by unit and consultant, by year, last five years and overall.

Year of primary	Primary replacements N	Units providing primary replacements in each year N	Primary replacements per unit Median (IQR)	Consultants providing primary replacements in each year N	Primary replacements per consultant Median (IQR)
All years	45,784	404	75.5 (24 to 159)	842	21 (2 to 81)
Last 5 years	33,585	394	57 (19 to 122)	719	27 (3 to 70)
2012	2,527	261	5 (3 to 12)	379	4 (2 to 9)
2013	4,394	311	9 (4 to 18)	432	7 (2 to 15)
2014	5,278	337	9 (4 to 21)	454	8 (3 to 17)
2015	5,709	347	11 (4 to 23)	485	8 (3 to 17)
2016	6,510	348	14 (5 to 26)	490	10 (4 to 19)
2017	6,968	363	14 (5 to 27)	491	10 (5 to 21)
2018	7,104	364	13.5 (5 to 28)	504	11 (4 to 21)
2019	7,294	370	14 (6 to 29)	511	11 (4 to 21)

Table 3.S3 illustrates the number of primary shoulder replacements and the number of units and consultants conducting shoulder replacements within the NJR. The table also illustrates the median and interquartile range of the number of replacements performed within each unit or by each consultant. This is displayed overall, aggregated by the last five years of data, and by year of data collection. The results illustrate that the median, and interquartile range, number of procedures performed by units and consultants has remained static for the last few years at 14 (6 to 29) and 11 (4 to 21) procedures respectively.

Table 3.S4 (page 233) illustrates the number and percentage of primary shoulder procedures by the type and sub-type of shoulder replacement for both acute trauma and elective procedures. The indication for surgery in elective procedures is also illustrated. The majority of proximal humeral hemiarthroplasty and conventional total shoulder replacement procedures recorded in the NJR are for an indication of osteoarthritis, whereas cuff tear arthropathy is the predominant indication for reverse polarity total shoulder replacements. It is important to note that the indications for surgery recorded in the NJR are not mutually exclusive; 85.3% of procedures list a single indication for surgery with the remainder recording more than one indication.

Table 3.S4 Number and percentage of primary shoulder replacements by indication and type of shoulder replacement.

	Acute trauma	Elective							
			N (%)* for each indication in elective procedures only						
	Number of cases N (%)	Number of cases N (%)	Osteoarthritis	Cuff tear arthropathy	Trauma sequelae	Other inflamatory arthropathy	Avascular necrosis	Other causes***	Cuff tear without arthropathy**
All cases	4,364 (100.0)	41,420 (100.0)	25,085 (100.0)	11,608 (100.0)	2,899 (100.0)	1,708 (100.0)	1,336 (100.0)	946 (100.0)	463 (100.0)
Proximal humeral hemiarthroplasty	1,506 (34.5)	6,189 (14.9)	4,646 (18.5)	349 (3.0)	534 (18.4)	383 (22.4)	497 (37.2)	165 (17.4)	6 (1.3)
Resurfacing	5 (0.1)	2,831 (6.8)	2,405 (9.6)	165 (1.4)	68 (2.3)	157 (9.2)	98 (7.3)	48 (5.1)	2 (0.4)
Stemless	9 (0.2)	1,157 (2.8)	931 (3.7)	17 (0.1)	80 (2.8)	60 (3.5)	118 (8.8)	34 (3.6)	0 (0)
Stemmed	1,492 (34.2)	2,201 (5.3)	1,310 (5.2)	167 (1.4)	386 (13.3)	166 (9.7)	281 (21.0)	83 (8.8)	4 (0.9)
Total shoulder replacement	14 (0.3)	12,662 (30.6)	11,769 (46.9)	33 (0.3)	256 (8.8)	461 (27.0)	313 (23.4)	156 (16.5)	4 (0.9)
Resurfacing	0 (0)	479 (1.2)	457 (1.8)	0 (0)	4 (0.1)	22 (1.3)	2 (0.1)	4 (0.4)	0 (0)
Stemless	4 (0.1)	4,363 (10.5)	4,031 (16.1)	11 (0.1)	98 (3.4)	164 (9.6)	98 (7.3)	69 (7.3)	2 (0.4)
Stemmed	10 (0.2)	7,820 (18.9)	7,281 (29.0)	22 (0.2)	154 (5.3)	275 (16.1)	213 (15.9)	83 (8.8)	2 (0.4)
Reverse polarity total shoulder replacement	2,191 (50.2)	17,109 (41.3)	5,887 (23.5)	9,364 (80.7)	1,636 (56.4)	607 (35.5)	369 (27.6)	378 (40.0)	382 (82.5)
Stemless	0 (0)	155 (0.4)	56 (0.2)	93 (0.8)	4 (0.1)	2 (0.1)	2 (0.1)	0 (0)	5 (1.1)
Stemmed	2,191 (50.2)	16,954 (40.9)	5,831 (23.2)	9,271 (79.9)	1,632 (56.3)	605 (35.4)	367 (27.5)	378 (40.0)	377 (81.4)
Interpositional arthroplasty	0 (0)	4 (<0.1)	4 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unconfirmed	653 (15.0)	5,456 (13.2)	2,779 (11.1)	1,862 (16.0)	473 (16.3)	257 (15.0)	157 (11.8)	247 (26.1)	71 (15.3)
Unconfirmed HHA	43 (1.0)	271 (0.7)	159 (0.6)	49 (0.4)	23 (0.8)	16 (0.9)	23 (1.7)	23 (2.4)	0 (0)
Unconfirmed TSR	35 (0.8)	1,729 (4.2)	1,385 (5.5)	122 (1.1)	75 (2.6)	78 (4.6)	46 (3.4)	90 (9.5)	1 (0.2)
Unconfirmed RTSR	574 (13.2)	3,453 (8.3)	1,232 (4.9)	1,691 (14.6)	375 (12.9)	163 (9.5)	88 (6.6)	134 (14.2)	70 (15.1)
Unconfirmed IPA	1 (<0.1)	3 (<0.1)	3 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

*Percentages are based on the total number of elective cases; note the listed reasons are not mutually exclusive as more than one reason could have been stated.
**Only recorded in MDSv7 introduced in June 2018. Total cases recorded using MDSv7 =11,926.
***Includes 70 metastatic cancer/malignancies documented since MDSv6 (N=35,777), together with 132 dislocations documented since MDSv7 (N=11,926).
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S5 (a) Number of resurfacing proximal humeral hemiarthroplasty replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing HHA	Wright	Aequalis Resurfacing[HH.Resurf]	250	0	250	6	0	6
	FH	Arrow[HH.Resurf]	35	0	35	0	0	0
	Zimmer Biomet	Copeland[HH.Resurf]	1,586	3	1,583	50	0	50
	DePuy	Epoca[HH.Resurf]	111	0	111	0	0	0
	Exactech	Equinoxe[HH.Resurf:H.RPeg]	36	0	36	12	0	12
	DePuy	Global CAP[HH.Resurf]	592	2	590	33	0	33
	Lima	SMR[HH.Resurf:H.RPeg]	110	0	110	1	0	1
	Lima	SMR[HH.Resurf]	22	0	22	0	0	0
	JRI	Vaios[HH.Resurf]	90	0	90	21	0	21

Table 3.S5 (b) Number of stemless proximal humeral hemiarthroplasty replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless HHA	Zimmer Biomet	Versa-Dial[HH.Stand]: Nano[H. Stemless]	54	1	53	8	0	8
	Mathys	Affinis[HH.Stand:H.Stemless]	552	4	548	94	0	94
	Arthrex	Eclipse[HH.Stand:H.Stemless]	127	1	126	1	0	1
	DePuy	Global ICON[HH.Stand:H. Stemless]	14	0	14	4	0	4
	Lima	SMR[HH.Stand:H.Stemless]	26	0	26	7	0	7
	Zimmer Biomet	Sidus[HH.Stand:H.Stemless]	163	1	162	23	1	22
	Wright	Simpliciti[HH.Stand:H.Stemless]	152	0	152	21	0	21
	Zimmer Biomet	TESS[HH.Stand:H.Stemless]	75	2	73	1	0	1

Table 3.S5 (c) Number of stemmed proximal humeral hemiarthroplasty replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed HHA	Wright	Aequalis[HH.Stand]: Aequalis-Fracture[H.Standard]	202	172	30	19	15	4
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	21	3	18	0	0	0
	Wright	Aequalis[HH.Stand]: Ascend Flex[H.Standard]	220	6	214	61	2	59
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	135	8	127	18	0	18
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive Fracture[H.Standard]	164	129	35	22	18	4
	Zimmer Biomet	Bio-Modular[HH.Stand]: Comprehensive Fracture[H.Standard]	19	15	4	0	0	0
	DePuy	Global Advantage[HH.Stand]: Global FX[H.Standard]	206	165	41	3	2	1
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: TM[H.Dia]	24	1	23	5	0	5
	Wright	Aequalis[HH.Stand:H.Standard]	195	4	191	4	0	4
	Mathys	Affinis[HH.Stand:H.Standard]	62	1	61	5	1	4
	Mathys	Affinis[HH.Stand:H.NeckBody:H.Dia]	195	163	32	21	16	5
	Zimmer Biomet	Anatomical[HH.Stand:H.Mod]	21	2	19	0	0	0
	Zimmer Biomet	Anatomical Fracture[HH.Stand:H.Mod]	46	35	11	3	1	2
	FH	Arrow[HH.Stand:H.Standard]	32	4	28	3	1	2
	Wright	Ascend Flex[HH.Stand:H.Standard]	150	4	146	27	2	25
	Zimmer Biomet	Bigliani/Flatow[HH.Stand:H.Dia]	47	12	35	0	0	0
	Zimmer Biomet	Bio-Modular[HH.Stand:H.Standard]	11	6	5	0	0	0
	DePuy	Delta Xtend[HH.Stand:H.Standard]	41	2	39	2	1	1
	DePuy	Epoca[HH.Stand:H.Mod]	115	51	64	0	0	0
	Exactech	Equinoxe[HH.Stand:H.Mod]	115	2	113	10	1	9
	Exactech	Equinoxe[HH.Stand:H.Standard]	182	156	26	26	19	7
	DePuy	Global AP[HH.Stand:H.Mod]	250	5	245	6	0	6
	DePuy	Global Advantage[HH.Stand:H.Standard]	315	62	253	15	4	11
	DePuy	Global Unite[HH.Stand:H.NeckBody:H.Mod]	290	212	78	56	47	9
	DePuy	Global Unite[HH.Stand:H.Mod]	28	16	12	1	1	0
	Smith & Nephew	Neer[H.MBStem]	24	8	16	0	0	0
	Zimmer Biomet	Nottingham[HH.Stand:H.Standard]	38	18	20	0	0	0
	Corin	Oxford[HH.Stand:H.Standard]	76	3	73	0	0	0
	Lima	SMR[HH.Stand:H.NeckBody:H.Dia]	278	152	126	37	16	21
	Lima	SMR[HH.Stand:H.Dia]	13	8	5	0	0	0
	JRI	Vaios[HH.Stand:H.NeckBody:H.Dia]	79	37	42	4	1	3

Table 3.S5 (d) Number of resurfacing conventional total shoulder replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing TSR	Wright	Aequalis Perform+[G.Ana]: Aequalis Resurfacing[HH.Resurf]	10	0	10	2	0	2
	Wright	Aequalis[G.Ana]: Aequalis Resurfacing[HH.Resurf]	25	0	25	0	0	0
	FH	Arrow[G.Ana:HH.Resurf]	14	0	14	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Resurf]	204	0	204	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Resurf]	54	0	54	0	0	0
	DePuy	Epoca[G.Ana:HH.Resurf]	126	0	126	9	0	9
	Exactech	Equinoxe[G.Ana:HH.Resurf:H.RPeg]	29	0	29	4	0	4

Table 3.S5 (e) Number of stemless conventional total shoulder replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless TSR	DePuy:Mathys	Epoca[G.BP]: Epoca[G.Ana]: Affinis[HH.Stand]: Affinis[H.Stemless]	38	0	38	0	0	0
	Arthrex	Universal[G.BP]: Universal[G.Lin]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	51	0	51	20	0	20
	Arthrex	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	362	0	362	83	0	83
	Arthrex:DePuy	Epoca[G.BP]: Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	50	0	50	0	0	0
	Arthrex:DePuy	Global Anchor Peg[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	11	0	11	0	0	0
	Arthrex:Wright	Aequalis[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	77	0	77	0	0	0
	Arthrex:DePuy	Epoca[G.Peg]: Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	12	0	12	0	0	0
	Arthrex:DePuy	Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	16	0	16	0	0	0
	DePuy	Global[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	13	0	13	4	0	4
	DePuy	Global Anchor Peg[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	177	0	177	97	0	97
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	493	1	492	109	0	109
	Zimmer Biomet	Anatomical[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	58	0	58	13	0	13
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	18	0	18	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	27	0	27	2	0	2
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	33	0	33	3	0	3
	Zimmer Biomet	TM[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	100	1	99	1	0	1
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	96	0	96	38	0	38
	Wright	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	570	1	569	129	0	129
	Wright	Aequalis[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	84	0	84	1	0	1
	Wright	Affiniti[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	10	0	10	0	0	0
	Mathys	Affinis[G.Ana:HH.Stand:H.Stemless]	1,802	0	1,802	338	0	338
	Lima	SMR[G.Ana:HH.Stand:H.Stemless]	26	0	26	17	0	17
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.Stemless]	133	0	133	24	0	24
	Zimmer Biomet	TESS[G.Ana:HH.Stand:H.Stemless]	68	0	68	0	0	0

Table 3.S5 (f) Number of stemmed conventional total shoulder replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed TSR	Wright	Aequalis Perform+[G.Ana]: Aequalis[HH.Stand]: Aequalis[H.Standard]	50	0	50	0	0	0
	Wright	Aequalis[G.Ana]: Aequalis[HH.Stand]: Aequalis-Press-Fit[H.Standard]	10	0	10	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Affiniti[HH.Stand]: Affiniti[H.Standard]	12	0	12	0	0	0
	Zimmer Biomet	TM[G.Ana]: Anatomical[HH.Stand]: Anatomical[H.Mod]	12	1	11	1	0	1
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	69	0	69	4	0	4
	Zimmer Biomet	Anatomical[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	24	0	24	0	0	0
	Zimmer Biomet	TM Reverse[G.BP]: TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	18	0	18	0	0	0
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	111	0	111	9	0	9
	Wright	Aequalis[G.Ana]: Ascend[HH.Stand]: Ascend[H.Standard]	23	0	23	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,167	0	1,167	295	0	295
	Wright	Aequalis[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	19	0	19	0	0	0
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	817	2	815	146	0	146
	Zimmer Biomet	Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	12	0	12	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global AP[H.Mod]	102	0	102	39	0	39
	DePuy	Global[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	58	0	58	1	0	1
	DePuy	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,042	0	1,042	25	0	25
	DePuy	Global Anchor Peg[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	226	0	226	17	0	17
	DePuy	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	516	0	516	49	0	49
	DePuy	Global[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	37	0	37	0	0	0
	Arthrex:DePuy	Univers II[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	18	0	18	5	0	5
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.Mod]	24	0	24	4	0	4
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	462	1	461	77	0	77
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Lin]: SMR[HH.Stand]: SMR[H.NeckBody]: SMR[H.Dia]	32	0	32	3	0	3
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	47	0	47	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	30	0	30	4	0	4
	Arthrex	Universal[G.BP]: Universal[G.Lin]: Univers II[HH.Stand]: Univers II[H.Standard]	5	0	5	5	0	5
	Wright	Aequalis[G.Ana:HH.Stand:H.Standard]	193	0	193	5	0	5
	Mathys	Affinis[G.Ana:HH.Stand:H.Standard]	100	1	99	6	0	6
	Zimmer Biomet	Anatomical[G.Ana:HH.Stand:H.Mod]	85	0	85	1	0	1

Table 3.S5 (f) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed TSR	FH	Arrow[G.Ana:HH.Stand:H.Standard]	160	0	160	15	0	15
	FH	Arrow[G.BP:G.Lin:HH.Stand:H.Standard]	11	0	11	6	0	6
	Zimmer Biomet	Bigliani/Flatow[G.Ana:HH.Stand:H.Dia]	58	0	58	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Stand:H.Mod]	156	0	156	0	0	0
	DePuy	Epoca[G.Ana:HH.Stand:H.Mod]	314	0	314	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Stand:H.Mod]	60	2	58	0	0	0
	Exactech	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,051	2	1,049	174	0	174
	Medacta	Medacta[G.Ana:HH.Stand:H.NeckBody:H.Standard]	12	0	12	11	0	11
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	399	0	399	26	0	26
	Lima	SMR[G.Ana:HH.Stand:H.NeckBody:H.Dia]	45	0	45	6	0	6
	JRI	Vaios[G.BP:G.Ana:HH.Stand:H.NeckBody:H.Dia]	124	0	124	5	0	5

Table 3.S5 (g) Number of stemless reverse polarity total shoulder replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemless RTSR	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Nano[H.Stemless]	26	0	26	0	0	0
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.Stemless]	117	0	117	21	0	21
	Zimmer Biomet	TESS[G.BP:G.Sph:H.RevBear:H.Stemless]	11	0	11	2	0	2

Table 3.S5 (h) Number of stemmed reverse polarity total shoulder replacements between 2012 and 2019 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	49	33	16	16	10	6
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	21	15	6	12	9	3
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	322	241	81	67	46	21
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	46	30	16	34	23	11
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis-Reversed II[H.RevCup]: Aequalis-Reversed II[H.Dia]	94	4	90	48	1	47
	Zimmer Biomet	Anatomical I/R[G.BP]: Anatomical I/R[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	13	0	13	0	0	0
	Zimmer Biomet	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	1,009	35	974	148	2	146
	Zimmer Biomet	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical Fracture[H.Mod]	112	88	24	26	24	2
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	758	19	739	454	13	441
	Wright	Aequalis Perform Reversed[G.BP]: Unbranded[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	14	0	14	4	0	4
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.Standard]	12	1	11	3	0	3
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,275	13	1,262	286	2	284
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	766	23	743	66	0	66
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive Fracture[H.Standard]	119	89	30	13	13	0
	DePuy	Delta Xtend[G.BP]: Delta Xtend[G.Sph]: Delta Xtend[H.RevBear]: Delta Xtend[H.RevCup]: Global Unite[H.Mod]	73	46	27	30	22	8
	Lima	Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	94	3	91	0	0	0
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	88	2	86	39	2	37
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.RevCup]: Univers Reverse[H.Standard]	39	5	34	9	4	5
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Standard]	166	15	151	54	8	46
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Spacer]: Univers Reverse[H.Standard]	11	1	10	2	1	1

Table 3.S5 (h) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2019		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.Dia]	17	0	17	5	0	5
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	15	0	15	0	0	0
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,126	22	1,104	111	3	108
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Dia]	153	116	37	37	28	9
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	15	2	13	1	0	1
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	748	28	720	124	3	121
	FH	Arrow[G.BP:G.Sph:H.RevBear:H.Standard]	160	23	137	31	8	23
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Mod]	22	3	19	6	2	4
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,416	50	2,366	374	19	355
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Mod]	39	3	36	2	0	2
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	80	32	48	9	1	8
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	2,757	475	2,282	417	86	331
	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	2,446	39	2,407	593	7	586
	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Standard]	332	260	72	81	63	18
	Stanmore	METS[G.Sph:H.RevBear:H.Mod]	11	0	11	2	0	2
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Mod]	27	3	24	0	0	0
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	358	30	328	82	7	75
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,568	263	1,305	291	47	244
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	140	30	110	22	9	13
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Spacer:H.Mod]	10	3	7	1	0	1
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	594	55	539	102	8	94
	JRI	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	345	26	319	34	5	29
	Innovative	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	524	34	490	117	10	107

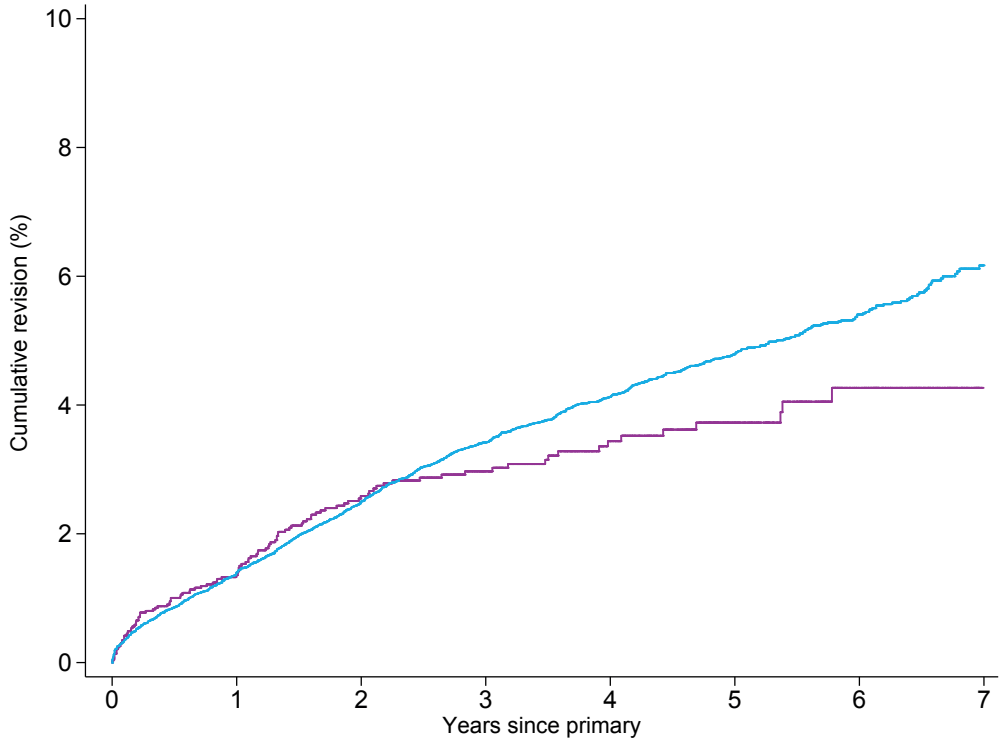
Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data is sorted by the brand of the humeral component.

Tables 3.S5 (a) to Table 3.S5 (h) (pages 234 to 241) illustrate the shoulder construct used by sub-type of the primary shoulder replacement for overall procedures and by acute and elective sub-divisions. They also show this data for the last year. Implants are only listed if they have been used on more than ten or five occasions overall or within the last year respectively. Results illustrate the frequency of all implanted constructs across all years of data collection within the NJR i.e. between 2012 and 2019. The frequency of shoulder constructs within the last year of the data collection is also illustrated to indicate contemporary practice. Constructs and prostheses elements are suffixed '[ ]' to indicate the implants that make up the construct. In the cases of within manufacturer and brand construct, this suffix is placed after the brand name; whereas within mix and match constructs, the suffix is placed immediately after the brand of the implanted element. Whilst the detail in reporting of constructs has become more granular, the complexity has necessarily increased to reflect the diversity of implanted elements and will facilitate improved implant scrutiny. Given the rapid evolution and heterogeneity of shoulder prostheses, it is expected that the classification system will evolve year-on-year with the introduction of new types of prostheses and the combinations in which these are used by surgeons.

3.6.2 Revisions after primary shoulder replacement surgery

Results in this section are presented as percentage cumulative revision of primary shoulder replacements. Results are estimated using the 1-Kaplan-Meier method; 95% CIs are shown within tables and when number at risk falls below 250, estimates are shown in blue italics to indicate that caution is required in interpreting the results. Data is presented up to seven years which is the last full year of data collection within the NJR. Figures also include an 'at-risk table' which presents the number of individuals at risk of revision at the time indicated.

Figure 3.S3 KM estimates of cumulative **revision** for primary shoulder replacement by **acute trauma** and **elective** cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk							
Acute trauma	4364	3378	2530	1799	1203	722	372	*94*
Elective	41420	33964	26949	20304	14275	9309	5032	1741

Table 3.S6 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for **all** cases, **acute trauma** and **elective** cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

		Age at primary Median (IQR*)	Percentage (%) male	Time since primary						
				1 year	2 years	3 years	4 years	5 years	6 years	7 years
All cases	45,784	73 (67 to 79)	30	1.39 (1.29-1.51)	2.51 (2.36-2.67)	3.38 (3.20-3.58)	4.07 (3.85-4.30)	4.70 (4.45-4.97)	5.32 (5.02-5.64)	6.03 (5.63-6.46)
Acute trauma	4,364	74 (67 to 80)	23	1.36 (1.04-1.76)	2.59 (2.11-3.17)	2.97 (2.44-3.61)	3.44 (2.83-4.18)	3.73 (3.05-4.55)	4.27 (3.40-5.35)	*4.27 (3.40-5.35)*
Elective	41,420	73 (67 to 79)	30	1.40 (1.29-1.52)	2.50 (2.34-2.67)	3.42 (3.22-3.63)	4.13 (3.90-4.37)	4.79 (4.52-5.07)	5.41 (5.09-5.74)	6.17 (5.74-6.62)

*IQR: Interquartile range, i.e. 25th and 75th centile.

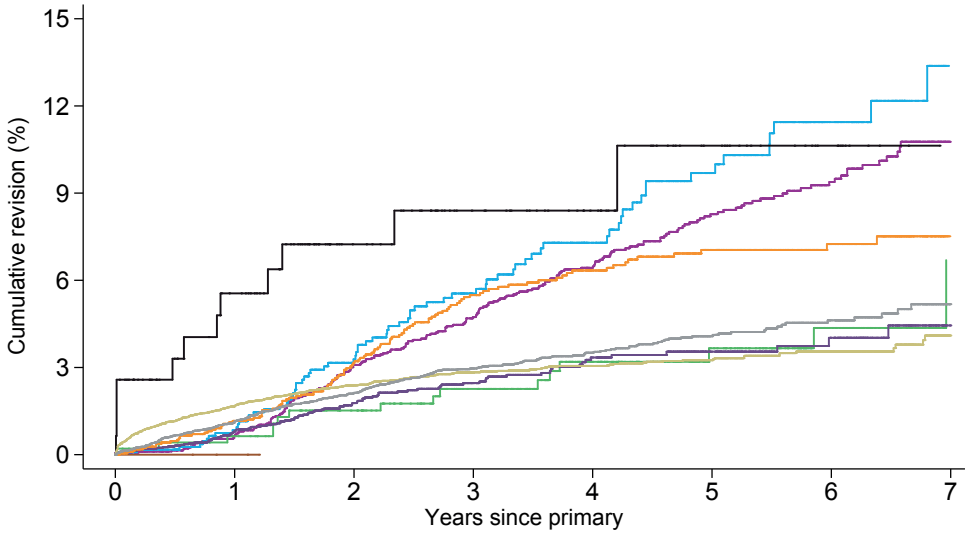
Figure 3.S3 and Table 3.S6 illustrate the cumulative revision of primary shoulder procedures performed overall (shown in Table 3.S6 only) and by acute trauma and elective procedures. Results indicate the risk of revision is comparable for the first two years following surgery, at which point it starts to diverge. The risk of revision for acute trauma patients tends to be lower, but the number of patients still at risk at seven years is small and therefore should be interpreted cautiously.

Table 3.S7 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for elective cases by **gender** and **age group**. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Gender	Age at primary (years)	N	Time since primary						
			1 year	2 years	3 years	4 years	5 years	6 years	7 years
Female	All	28,828	1.01 (0.90-1.14)	2.01 (1.84-2.19)	2.82 (2.60-3.05)	3.36 (3.12-3.63)	3.99 (3.70-4.30)	4.52 (4.17-4.89)	5.12 (4.67-5.62)
	<55	1,077	2.39 (1.61-3.55)	5.08 (3.84-6.72)	8.01 (6.35-10.09)	9.44 (7.57-11.74)	11.09 (8.90-13.77)	*11.62 (9.25-14.54)*	*13.57 (10.24-17.87)*
	55 to 64	2,960	1.36 (0.98-1.87)	2.97 (2.36-3.72)	4.33 (3.56-5.27)	5.56 (4.62-6.68)	7.15 (5.98-8.53)	8.68 (7.24-10.40)	*9.38 (7.78-11.30)*
	65 to 74	10,675	1.05 (0.87-1.27)	2.13 (1.85-2.45)	3.05 (2.69-3.45)	3.57 (3.16-4.02)	4.14 (3.68-4.67)	4.63 (4.09-5.24)	5.39 (4.66-6.23)
	≥75	14,116	0.80 (0.66-0.97)	1.46 (1.25-1.69)	1.87 (1.63-2.15)	2.20 (1.92-2.51)	2.52 (2.20-2.89)	2.80 (2.42-3.24)	3.04 (2.58-3.59)
Male	All	12,592	2.28 (2.03-2.57)	3.65 (3.31-4.02)	4.82 (4.41-5.27)	5.91 (5.42-6.44)	6.66 (6.11-7.26)	7.51 (6.85-8.23)	8.65 (7.74-9.67)
	<55	1,360	2.87 (2.09-3.94)	5.71 (4.51-7.21)	8.15 (6.64-9.98)	10.67 (8.83-12.87)	12.33 (10.24-14.81)	*14.41 (11.87-17.44)*	*17.67 (14.15-21.93)*
	55 to 64	2,368	1.97 (1.46-2.64)	3.71 (2.95-4.65)	5.34 (4.37-6.51)	6.49 (5.37-7.85)	7.14 (5.91-8.62)	8.44 (6.90-10.30)	*9.51 (7.50-12.04)*
	65 to 74	4,825	2.15 (1.76-2.61)	3.12 (2.64-3.69)	3.89 (3.32-4.55)	4.96 (4.26-5.77)	5.91 (5.08-6.88)	6.52 (5.58-7.62)	*7.25 (6.04-8.69)*
	≥75	4,039	2.42 (1.98-2.96)	3.50 (2.94-4.18)	4.41 (3.74-5.20)	4.87 (4.13-5.74)	4.97 (4.21-5.87)	5.17 (4.33-6.16)	*5.61 (4.49-7.00)*

Table 3.S7 further breaks down the cumulative revision of primary shoulder procedures for elective patients, by gender and age group. Results indicate that females have a lower risk of revision in the long term compared to males and that younger patients have an increased risk of revision compared to older patients.

Figure 3.S4 KM estimates of cumulative **revision** for primary **elective** shoulder replacement by **type** of shoulder replacement. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk							
Resurfacing HHA	2831	2670	2425	2120	1691	1282	823	343
Stemless HHA	1157	980	782	597	430	298	*158*	*47*
Stemmed HHA	2201	1934	1654	1365	1053	739	443	*175*
Resurfacing TSR	479	458	424	368	284	*205*	*128*	*40*
Stemless TSR	4363	3424	2548	1811	1176	693	336	*113*
Stemmed TSR	7820	6744	5633	4362	3162	2054	1079	360
Stemless RTSR	*155*	*123*	*84*	*63*	*48*	*28*	*13*	*3*
Stemmed RTSR	16954	13183	9933	6962	4590	2828	1381	412
IPA	*4*	*2*	*0*	*0*	*0*	*0*	*0*	*0*

Note: HHA=Humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S8 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for **elective** cases by shoulder **type**.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Elective	N	Age at primary Median (IQR*)	Percentage (%) male	Time since primary						
				1 year	2 years	3 years	4 years	5 years	6 years	7 years
Proximal humeral hemiarthroplasty	**6,189**	**70 (61 to 77)**	**33**	**0.87 (0.66-1.14)**	**3.15 (2.72-3.65)**	**5.13 (4.56-5.77)**	**6.55 (5.88-7.29)**	**8.10 (7.32-8.96)**	**9.02 (8.15-9.97)**	**10.11 (9.08-11.24)**
Resurfacing	2,831	71 (64 to 78)	31	0.65 (0.41-1.04)	3.09 (2.49-3.83)	4.73 (3.97-5.64)	6.43 (5.51-7.49)	8.28 (7.18-9.53)	9.38 (8.16-10.78)	10.77 (9.32-12.42)
Stemless	1,157	67 (56 to 75)	42	0.85 (0.44-1.62)	3.28 (2.32-4.65)	5.55 (4.20-7.32)	7.29 (5.65-9.39)	9.69 (7.61-12.30)	*11.44 (8.98-14.52)*	*13.38 (10.02-17.76)*
Stemmed	2,201	70 (61 to 78)	31	1.16 (0.78-1.73)	3.16 (2.46-4.05)	5.49 (4.52-6.67)	6.34 (5.26-7.62)	7.04 (5.87-8.44)	7.25 (6.02-8.71)	*7.51 (6.21-9.08)*
Total shoulder replacement	**12,662**	**70 (64 to 76)**	**31**	**1.01 (0.84-1.20)**	**1.98 (1.73-2.27)**	**2.77 (2.46-3.12)**	**3.42 (3.06-3.83)**	**3.90 (3.48-4.37)**	**4.44 (3.93-5.01)**	**5.10 (4.39-5.92)**
Resurfacing	479	71 (64 to 76)	28	0.64 (0.21-1.96)	1.52 (0.73-3.16)	2.26 (1.22-4.17)	3.20 (1.85-5.48)	*3.66 (2.15-6.22)*	*4.36 (2.53-7.48)*	*6.69 (3.11-14.09)*
Stemless	4,363	69 (62 to 75)	35	0.81 (0.57-1.15)	1.77 (1.38-2.29)	2.46 (1.96-3.09)	3.34 (2.68-4.16)	3.54 (2.84-4.42)	4.02 (3.11-5.19)	*4.45 (3.30-5.98)*
Stemmed	7,820	71 (65 to 76)	29	1.14 (0.92-1.41)	2.13 (1.81-2.50)	2.97 (2.57-3.42)	3.51 (3.06-4.02)	4.08 (3.56-4.66)	4.62 (4.01-5.33)	5.18 (4.39-6.10)
Reverse polarity total shoulder replacement	**17,109**	**76 (71 to 80)**	**29**	**1.71 (1.52-1.93)**	**2.43 (2.19-2.70)**	**2.88 (2.60-3.18)**	**3.10 (2.81-3.43)**	**3.32 (3.00-3.68)**	**3.62 (3.23-4.05)**	**4.16 (3.54-4.89)**
Stemless	155	73 (69 to 78)	39	*5.55 (2.81-10.82)*	*7.24 (3.94-13.09)*	*8.40 (4.68-14.83)*	*8.40 (4.68-14.83)*	*10.63 (5.76-19.17)*	*10.63 (5.76-19.17)*	
Stemmed	16,954	76 (71 to 80)	29	1.68 (1.49-1.89)	2.39 (2.15-2.65)	2.82 (2.55-3.12)	3.05 (2.76-3.38)	3.25 (2.93-3.61)	3.55 (3.17-3.98)	4.10 (3.48-4.83)
Interpositional arthroplasty	**4**	**63 (56.5 to 70.5)**	**50**							
Unconfirmed	**5,456**	**74 (67 to 79)**	**30**	**1.93 (1.59-2.35)**	**2.90 (2.46-3.43)**	**3.88 (3.33-4.51)**	**4.77 (4.12-5.53)**	**5.29 (4.56-6.13)**	**6.18 (5.28-7.23)**	*6.85 (5.77-8.13)*
Unconfirmed HHA	271	69 (59 to 76)	38	*1.12 (0.36-3.44)*	*4.04 (2.11-7.65)*	*5.68 (3.25-9.85)*	*6.35 (3.70-10.77)*	*6.35 (3.70-10.77)*	*7.49 (4.35-12.72)*	*7.49 (4.35-12.72)*
Unconfirmed TSR	1,729	69 (61 to 76)	36	1.12 (0.71-1.75)	2.81 (2.10-3.75)	4.33 (3.41-5.48)	5.66 (4.57-7.02)	6.64 (5.39-8.17)	7.73 (6.26-9.52)	*8.61 (6.89-10.73)*
Unconfirmed RTSR	3,453	75 (70 to 80)	26	2.43 (1.95-3.03)	2.69 (2.17-3.33)	3.14 (2.54-3.87)	3.64 (2.92-4.52)	3.64 (2.92-4.52)	*4.11 (3.20-5.28)*	*4.55 (3.39-6.09)*
Unconfirmed IPA	3	60 (58 to 65)	100							

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.
*IQR: Interquartile range, i.e. 25th and 75th centile.

Table 3.S8 and Figure 3.S4 report cumulative revision of primary shoulder procedures for elective patients, by type (Table 3.S8 only) and sub-type of shoulder construct.

Proximal humeral hemiarthroplasties undergo revision at a higher rate than either conventional total shoulder replacements or reverse polarity total shoulder replacements. The extent to which proximal humeral hemiarthroplasty procedures are seen as 'revisable' procedures compared to total shoulder replacements should be considered when interpreting the results. Furthermore, while Table 3.S8 and Figure 3.S4 suggest a stemmed proximal humeral hemiarthroplasty might be the better choice over a stemless or resurfacing humeral hemiarthroplasty, the latter group are more straightforward to revise than a stemmed implant and so caution is again needed interpreting these sub-group results.

The cumulative risk of revision of stemless reverse polarity total shoulder replacements is higher compared to stemmed versions. This needs careful interpretation as the number of stemless reverse polarity replacements is low, however, it is worth noting that some stemless reverse polarity brands have been withdrawn from the market. The performance of stemmed conventional total shoulder replacement compared to stemmed reverse polarity shoulder replacements is of particular interest. Reverse polarity total shoulder replacements tend to have an initially higher revision rate which then plateaus, whereas the conventional total shoulder replacements increase more slowly but at a constant rate and therefore exceed the cumulative risk of revision of reverse polarity total replacements and overall is 0.9% higher at seven years. The extent to which the different indications for surgery are confounding results is not clear and results should be interpreted cautiously.

Table 3.S9 KM estimates of cumulative revision (95% CI) for primary shoulder replacement for **elective cases** by **brand** construct in constructs with greater than 250 implantations. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Shoulder construct	N	Time since primary						
			1 year	2 years	3 years	4 years	5 years	6 years	7 years
Resurfacing HHA	Aequalis Resurfacing[HH.Resurf]	250	*0.41 (0.06-2.89)*	*2.49 (1.13-5.46)*	*3.80 (1.99-7.17)*	*4.27 (2.32-7.80)*	*5.47 (3.12-9.50)*	*6.36 (3.66-10.94)*	*9.28 (5.25-16.15)*
	Copeland[HH.Resurf]	1,583	0.45 (0.22-0.94)	2.29 (1.64-3.20)	3.71 (2.85-4.83)	5.23 (4.16-6.56)	7.33 (5.98-8.96)	8.44 (6.93-10.26)	*9.96 (8.16-12.14)*
	Global CAP[HH.Resurf]	590	1.05 (0.47-2.32)	3.92 (2.57-5.95)	5.54 (3.88-7.89)	7.90 (5.82-10.69)	*9.69 (7.28-12.84)*	*11.07 (8.33-14.64)*	*11.69 (8.77-15.51)*
Stemless HHA		548	0.40 (0.10-1.62)	3.08 (1.79-5.26)	3.38 (2.01-5.65)	*5.62 (3.53-8.89)*	*8.35 (5.38-12.86)*	*10.75 (6.82-16.73)*	*13.30 (7.90-21.91)*
Stemmed HHA	Global Advantage[HH.Stand:H.Standard]	253	*1.22 (0.40-3.74)*	*1.65 (0.62-4.34)*	*4.41 (2.40-8.06)*	*4.93 (2.76-8.75)*	*5.49 (3.15-9.50)*	*5.49 (3.15-9.50)*	*5.49 (3.15-9.50)*
Stemless TSR	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	362	0	*0.76 (0.19-3.03)*	*1.82 (0.68-4.84)*	*2.71 (1.08-6.73)*	*2.71 (1.08-6.73)*	*2.71 (1.08-6.73)*	*2.71 (1.08-6.73)*
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	492	1.08 (0.45-2.59)	2.33 (1.21-4.49)	*3.11 (1.71-5.65)*	*4.31 (2.41-7.64)*	*6.73 (3.61-12.37)*	*6.73 (3.61-12.37)*	
	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	569	0.67 (0.22-2.06)	1.73 (0.82-3.61)	*2.09 (1.04-4.17)*	*2.09 (1.04-4.17)*	*2.09 (1.04-4.17)*		
	Affinis[G.Ana:HH.Stand:H.Stemless]	1,802	0.44 (0.21-0.92)	0.98 (0.58-1.65)	1.48 (0.94-2.34)	1.80 (1.15-2.83)	1.80 (1.15-2.83)	*1.80 (1.15-2.83)*	*1.80 (1.15-2.83)*
Stemmed TSR	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,167	0.20 (0.05-0.82)	0.58 (0.24-1.40)	1.33 (0.68-2.59)	*2.42 (1.28-4.56)*	*2.42 (1.28-4.56)*		
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	815	1.73 (1.01-2.97)	3.22 (2.12-4.86)	5.38 (3.76-7.66)	*5.69 (4.00-8.07)*	*5.69 (4.00-8.07)*	*6.45 (4.38-9.45)*	*6.45 (4.38-9.45)*
	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,042	0.29 (0.09-0.91)	0.80 (0.40-1.59)	1.13 (0.63-2.04)	1.13 (0.63-2.04)	1.33 (0.74-2.36)	2.06 (1.19-3.54)	*2.06 (1.19-3.54)*
	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	516	0.62 (0.20-1.92)	1.08 (0.45-2.58)	1.60 (0.76-3.35)	2.23 (1.15-4.28)	*3.03 (1.66-5.52)*	*3.03 (1.66-5.52)*	*3.03 (1.66-5.52)*
	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	461	0.94 (0.35-2.48)	1.53 (0.69-3.40)	*1.53 (0.69-3.40)*	*1.53 (0.69-3.40)*	*2.94 (1.05-8.04)*		
	Epoca[G.Ana:HH.Stand:H.Mod]	314	0.32 (0.04-2.24)	0.65 (0.16-2.58)	1.33 (0.50-3.51)	*2.17 (0.98-4.80)*	*2.17 (0.98-4.80)*	*2.17 (0.98-4.80)*	*3.98 (1.48-10.47)*
	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,049	1.16 (0.64-2.09)	2.48 (1.62-3.79)	3.46 (2.37-5.04)	4.17 (2.89-6.00)	*4.51 (3.11-6.50)*	*4.51 (3.11-6.50)*	*5.41 (3.46-8.43)*
	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	399	3.13 (1.79-5.44)	5.71 (3.75-8.63)	*7.74 (5.35-11.11)*	*8.20 (5.70-11.72)*	*9.54 (6.62-13.64)*	*9.54 (6.62-13.64)*	*9.54 (6.62-13.64)*

Table 3.S9 (continued)

	Shoulder construct	N	Time since primary						
			1 year	2 years	3 years	4 years	5 years	6 years	7 years
Stemmed RTSR	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	974	1.94 (1.23-3.06)	2.47 (1.63-3.74)	3.58 (2.45-5.20)	3.58 (2.45-5.20)	*4.42 (2.95-6.60)*	*4.42 (2.95-6.60)*	*4.42 (2.95-6.60)*
	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	739	2.32 (1.36-3.94)	*2.32 (1.36-3.94)*					
	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,262	1.36 (0.84-2.22)	2.16 (1.43-3.25)	2.31 (1.54-3.46)	*2.31 (1.54-3.46)*	*2.31 (1.54-3.46)*	*3.53 (1.71-7.23)*	
	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	743	0.68 (0.28-1.62)	1.30 (0.68-2.49)	1.49 (0.80-2.75)	1.70 (0.94-3.06)	*2.00 (1.11-3.57)*	*2.00 (1.11-3.57)*	*2.00 (1.11-3.57)*
	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,104	1.34 (0.80-2.26)	1.86 (1.19-2.91)	2.13 (1.39-3.26)	2.32 (1.52-3.53)	2.32 (1.52-3.53)	*2.32 (1.52-3.53)*	*4.09 (1.70-9.71)*
	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	720	3.26 (2.16-4.92)	4.49 (3.11-6.47)	5.05 (3.52-7.22)	*5.05 (3.52-7.22)*	*6.39 (4.27-9.52)*	*6.39 (4.27-9.52)*	*10.14 (4.73-21.01)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	2,282	1.18 (0.80-1.73)	1.53 (1.08-2.17)	1.53 (1.08-2.17)	1.53 (1.08-2.17)	1.84 (1.27-2.65)	2.61 (1.71-3.98)	*2.61 (1.71-3.98)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,366	1.21 (0.83-1.76)	1.69 (1.22-2.35)	1.83 (1.33-2.51)	1.83 (1.33-2.51)	1.83 (1.33-2.51)	2.04 (1.44-2.88)	*2.70 (1.56-4.66)*
	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	2,407	1.36 (0.95-1.95)	2.27 (1.67-3.07)	2.81 (2.10-3.74)	3.70 (2.77-4.95)	3.91 (2.91-5.24)	*4.69 (3.34-6.57)*	*5.84 (3.65-9.29)*
	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	328	*1.71 (0.71-4.07)*	*2.16 (0.97-4.78)*	*2.16 (0.97-4.78)*	*2.16 (0.97-4.78)*	*2.16 (0.97-4.78)*		
	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,305	1.45 (0.92-2.30)	2.32 (1.58-3.40)	2.99 (2.06-4.32)	3.19 (2.21-4.61)	*3.19 (2.21-4.61)*	*3.19 (2.21-4.61)*	*3.19 (2.21-4.61)*
	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	539	1.22 (0.55-2.71)	1.72 (0.86-3.44)	*2.42 (1.28-4.55)*	*3.47 (1.89-6.32)*	*3.47 (1.89-6.32)*	*3.47 (1.89-6.32)*	
	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	319	2.96 (1.55-5.62)	*4.07 (2.33-7.07)*	*4.92 (2.93-8.18)*	*4.92 (2.93-8.18)*	*4.92 (2.93-8.18)*	*4.92 (2.93-8.18)*	*4.92 (2.93-8.18)*
	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	490	2.38 (1.32-4.26)	3.20 (1.90-5.37)	*3.20 (1.90-5.37)*	*3.20 (1.90-5.37)*	*3.20 (1.90-5.37)*	*3.20 (1.90-5.37)*	*3.20 (1.90-5.37)*

Note: HH.=Humeral head, H.=Humerus, G.=Glenoid, Resurf=Resurfacing, RPeg=Resurfacing peg, Ana=Anatomic, BP=Baseplate, Peg=Peg, Stand=Standard, Lin=Liner, Sph=Sphere, RevBear=Reverse bearing, Stand=Standard, NeckBody=Modular neck body, Mod=Modular Stem, MBStem=Monobloc stem, Dia=Diaphyseal stem, RevBear=Reverse bearing, RevCup=Reverse cup.
Note: Data is sorted by the brand of the humeral component.

Table 3.S9 reports cumulative revision of primary shoulder procedures for elective patients by shoulder construct. All constructs that have been used on more than 250 occasions are reported. Where the construct is solely built from within the same product line the elements used to build the construct are suffixed in [ ] following the brand. Where the construct is built from different product lines, the prosthesis is indicated in [ ] immediately. The description of constructs is necessarily complex, this reflects the extensive modularity of modern shoulder prostheses. All results should be viewed in the context of observational data and due consideration given to the volume of unconfirmed prostheses.

Table 3.S10 PTIR estimates of indications for shoulder revision (95% CI) for **acute trauma** by **type** of shoulder replacement between 2012 and 2019.

Acute trauma	N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for:						
			All causes	Infection	Instability | Dislocation	Cuff insufficiency	Aseptic loosening | Lysis	Peri-prosthetic fracture	Other indications
All cases	**115**	**122.1**	**0.94 (0.78-1.13)**	**0.10 (0.06-0.17)**	**0.29 (0.21-0.40)**	**0.29 (0.21-0.40)**	**0.07 (0.03-0.13)**	**0.06 (0.03-0.12)**	**0.09 (0.05-0.16)**
Proximal humeral hemiarthroplasty	72	51.5	1.40 (1.11-1.76)	0.16 (0.08-0.31)	0.27 (0.16-0.46)	0.62 (0.44-0.88)	0.06 (0.02-0.18)	0.02 (0.00-0.14)	0.16 (0.08-0.31)
Total shoulder replacement	0	0.5	0	0	0	0	0	0	0
Reverse polarity total shoulder replacement	30	54.2	0.55 (0.39-0.79)	0.06 (0.02-0.17)	0.33 (0.21-0.53)	0	0.06 (0.02-0.17)	0.02 (0.00-0.13)	0.04 (0.01-0.15)
Unconfirmed	13	15.9	0.82 (0.47-1.40)	0.06 (0.01-0.45)	0.19 (0.06-0.58)	0.19 (0.06-0.58)	0.13 (0.03-0.50)	0.31 (0.13-0.75)	0.06 (0.01-0.45)

Table 3.S11 PTIR estimates of indications for shoulder revision (95% CI) for acute trauma by type of shoulder replacement using reports from MDSv7.

Acute trauma	N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for:				
			All causes	Aseptic loosening humerus	Native glenoid surface erosion	Implant fracture	Dislocation
All cases	18	9.8	1.83 (1.15-2.91)	0.20 (0.05-0.81)	0.10 (0.01-0.72)	0.10 (0.01-0.72)	0.61 (0.27-1.36)
Proximal humeral hemiarthroplasty	5	2.2	2.24 (0.93-5.39)	0.45 (0.06-3.19)	0.45 (0.06-3.19)	0	0.45 (0.06-3.19)
Total shoulder replacement	0	0.0	0	0	0	0	0
Reverse polarity total shoulder replacement	9	5.7	1.58 (0.82-3.04)	0.18 (0.02-1.25)	0	0.18 (0.02-1.25)	0.70 (0.26-1.87)
Unconfirmed	4	1.9	2.12 (0.80-5.66)	0	0	0	0.53 (0.07-3.77)

Note: These have been suppressed due to zero events: aseptic loosening glenoid, stiffness, impingement, component dissociation, glenoid implant wear, lysis humerus, lysis glenoid, unexplained pain.

Table 3.S10 and Table 3.S11 describe the prosthesis time incidence rate (PTIR) per 100 years of follow-up for the reported indication for revision in acute trauma patients receiving a primary shoulder replacement. Table 3.S10 reports indications for all patients across the life of the registry i.e. between 2012 and 2019, this was achieved by aggregating indications for revision across the different minimum datasets. Table 3.S11 reports data for patients whose information was entered following the introduction of MDSv7.

Cuff insufficiency is the leading indication for revision for those who receive a proximal humeral hemiarthroplasty, whereas instability or dislocation is the leading cause in reverse polarity total shoulder replacements, see Table 3.S10. The low number of primary replacements and even lower frequency of revisions for patients whose data were entered using the most recent minimum dataset makes results difficult to interpret. It is important to note that the indications for revision are not mutually exclusive and 21.7%, 65.2%, and 10.4% recorded none, one and two indications for revision respectively.

Table 3.S12 PTIR estimates of indications for shoulder revision (95% CI) for **elective** procedures by **type** of shoulder replacement between 2012 and 2019.

Elective	N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for: All causes	Infection	Instability | Dislocation	Cuff insufficiency	Aseptic loosening | Lysis	Peri-prosthetic fracture	Other indications
All cases	**1,401**	**1317.4**	**1.06 (1.01-1.12)**	**0.13 (0.11-0.15)**	**0.27 (0.24-0.30)**	**0.27 (0.24-0.30)**	**0.12 (0.11-0.14)**	**0.05 (0.04-0.07)**	**0.11 (0.09-0.13)**
Proximal humeral hemiarthroplasty	**403**	**250.8**	**1.61 (1.46-1.77)**	**0.08 (0.05-0.13)**	**0.10 (0.06-0.14)**	**0.55 (0.47-0.65)**	**0.10 (0.07-0.15)**	**0.02 (0.01-0.04)**	**0.35 (0.29-0.44)**
Resurfacing	210	127.6	1.65 (1.44-1.88)	0.08 (0.04-0.15)	0.09 (0.05-0.16)	0.60 (0.48-0.75)	0.11 (0.06-0.19)	0.03 (0.01-0.08)	0.34 (0.25-0.45)
Stemless	75	38.7	1.94 (1.55-2.43)	0.05 (0.01-0.21)	0.08 (0.03-0.24)	0.59 (0.40-0.90)	0.05 (0.01-0.21)	0	0.47 (0.29-0.74)
Stemmed	118	84.5	1.40 (1.17-1.67)	0.11 (0.06-0.20)	0.12 (0.06-0.22)	0.46 (0.34-0.63)	0.11 (0.06-0.20)	0	0.33 (0.23-0.48)
Total shoulder replacement	**352**	**416.1**	**0.85 (0.76-0.94)**	**0.05 (0.03-0.08)**	**0.31 (0.26-0.36)**	**0.42 (0.36-0.49)**	**0.12 (0.09-0.16)**	**0.02 (0.01-0.04)**	**0.07 (0.05-0.10)**
Resurfacing	16	21.4	0.75 (0.46-1.22)	0.05 (0.01-0.33)	0.14 (0.05-0.43)	0.47 (0.25-0.87)	0.05 (0.01-0.33)	0.05 (0.01-0.33)	0
Stemless	94	122.4	0.77 (0.63-0.94)	0.07 (0.03-0.13)	0.30 (0.22-0.42)	0.38 (0.29-0.51)	0.07 (0.03-0.13)	0.02 (0.01-0.08)	0.08 (0.04-0.15)
Stemmed	242	272.2	0.89 (0.78-1.01)	0.04 (0.03-0.08)	0.32 (0.26-0.39)	0.43 (0.36-0.52)	0.15 (0.11-0.20)	0.02 (0.01-0.05)	0.07 (0.04-0.11)
Reverse polarity total shoulder replacement	**435**	**479.2**	**0.91 (0.83-1.00)**	**0.22 (0.18-0.27)**	**0.32 (0.27-0.37)**	**0.02 (0.01-0.04)**	**0.13 (0.10-0.16)**	**0.09 (0.06-0.12)**	**0.03 (0.01-0.04)**
Stemless	12	4.3	2.77 (1.57-4.88)	0.46 (0.12-1.85)	0.69 (0.22-2.15)	0.23 (0.03-1.64)	0.92 (0.35-2.46)	0.23 (0.03-1.64)	0
Stemmed	423	474.9	0.89 (0.81-0.98)	0.22 (0.18-0.26)	0.31 (0.27-0.37)	0.02 (0.01-0.03)	0.12 (0.09-0.15)	0.08 (0.06-0.11)	0.03 (0.01-0.04)
Interpositional arthroplasty	**0**	**0.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Unconfirmed	**211**	**171.3**	**1.23 (1.08-1.41)**	**0.12 (0.08-0.19)**	**0.30 (0.23-0.39)**	**0.19 (0.14-0.27)**	**0.16 (0.11-0.23)**	**0.08 (0.04-0.13)**	**0.06 (0.04-0.12)**
Unconfirmed HHA	14	9.9	1.42 (0.84-2.39)	0.20 (0.05-0.81)	0.10 (0.01-0.72)	0.41 (0.15-1.08)	0.20 (0.05-0.81)	0.10 (0.01-0.72)	0.10 (0.01-0.72)
Unconfirmed TSR	98	72.2	1.36 (1.11-1.66)	0.06 (0.02-0.15)	0.22 (0.14-0.36)	0.33 (0.22-0.50)	0.21 (0.13-0.34)	0.06 (0.02-0.15)	0.10 (0.05-0.20)
Unconfirmed RTSR	99	89.3	1.11 (0.91-1.35)	0.17 (0.10-0.28)	0.38 (0.27-0.53)	0.06 (0.02-0.13)	0.11 (0.06-0.21)	0.09 (0.04-0.18)	0.03 (0.01-0.10)
Unconfirmed IPA	0	0.0	0	0	0	0	0	0	0

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S13 PTIR estimates of indications for shoulder revision (95% CI) for **elective** procedures by **type** of shoulder replacement using reports from MDSv7.

Elective	N	Prosthesis-years at risk (x100)	Number of revisions per 100 prosthesis-years at risk for:									
			All causes	Aseptic loosening humerus	Aseptic loosening glenoid	Stiffness	Impingement	Component dissociation	Glenoid implant wear	Native glenoid surface erosion	Dislocation	Unexplained pain
All cases	130	8.8	14.82 (12.48-17.60)	0.34 (0.11-1.06)	1.03 (0.53-1.97)	0.57 (0.24-1.37)	0.46 (0.17-1.21)	1.37 (0.78-2.41)	0.34 (0.11-1.06)	0.46 (0.17-1.21)	2.17 (1.38-3.40)	0.57 (0.24-1.37)
Proximal humeral hemiarthroplasty	8	0.7	11.50 (5.75-23.00)	0	0	4.31 (1.39-13.37)	0	1.44 (0.20-10.21)	0	4.31 (1.39-13.37)	1.44 (0.20-10.21)	1.44 (0.20-10.21)
Resurfacing	3	0.2	15.86 (5.11-49.16)	0	0	10.57 (2.64-42.27)	0	0	0	5.29 (0.74-37.52)	0	5.29 (0.74-37.52)
Stemless	1	0.2	4.10 (0.58-29.09)	0	0	0	0	0	0	0	0	0
Stemmed	4	0.3	15.25 (5.72-40.64)	0	0	3.81 (0.54-27.07)	0	3.81 (0.54-27.07)	0	7.63 (1.91-30.49)	3.81 (0.54-27.07)	0
Total shoulder replacement	20	2.5	8.08 (5.21-12.52)	0	0.40 (0.06-2.87)	0.81 (0.20-3.23)	0.81 (0.20-3.23)	0	0.81 (0.20-3.23)	0	1.62 (0.61-4.30)	0
Resurfacing	0	0.0	0	0	0	0	0	0	0	0	0	0
Stemless	8	1.1	7.00 (3.50-13.99)	0	0	0	0	0	0	0	0	0
Stemmed	12	1.3	9.23 (5.24-16.25)	0	0.77 (0.11-5.46)	1.54 (0.38-6.15)	1.54 (0.38-6.15)	0	1.54 (0.38-6.15)	0	3.08 (1.15-8.20)	0
Reverse polarity total shoulder replacement	77	4.4	17.52 (14.01-21.90)	0.68 (0.22-2.12)	1.82 (0.91-3.64)	0	0.45 (0.11-1.82)	0.91 (0.34-2.42)	0.23 (0.03-1.62)	0	2.50 (1.39-4.52)	0.68 (0.22-2.12)
Stemless	2	0.0	58.97 (14.75-235.80)	29.49 (4.15-209.33)	29.49 (4.15-209.33)	0	0	0	0	0	0	0
Stemmed	75	4.4	17.20 (13.71-21.56)	0.46 (0.11-1.83)	1.60 (0.77-3.37)	0	0.46 (0.11-1.83)	0.92 (0.34-2.44)	0.23 (0.03-1.63)	0	2.52 (1.40-4.55)	0.69 (0.22-2.13)
Interpositional arthroplasty	0	0.0	0	0	0	0	0	0	0	0	0	0
Unconfirmed	25	1.2	20.78 (14.04-30.76)	0	0	0	0	5.82 (2.77-12.21)	0	0.83 (0.12-5.90)	2.49 (0.80-7.73)	0.83 (0.12-5.90)
Unconfirmed HHA	0	0.1	0	0	0	0	0	0	0	0	0	0
Unconfirmed TSR	0	0.2	0	0	0	0	0	0	0	0	0	0
Unconfirmed RTSR	25	1.0	25.55 (17.26-37.81)	0	0	0	0	7.15 (3.41-15.00)	0	1.02 (0.14-7.25)	3.07 (0.99-9.50)	1.02 (0.14-7.25)
Unconfirmed IPA	0	0.0	0	0	0	0	0	0	0	0	0	0

Note: These have been suppressed due to zero events: implant fracture, lysis humerus, lysis glenoid.
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S12 and Table 3.S13 describe the prosthesis time incidence rate (PTIR) per 100 years of follow-up for the reported indication for revision in elective patients receiving a primary shoulder replacement by type and sub-type of shoulder replacement.

Table 3.S12 reports indications for all patients across the life of the registry i.e. between 2012 and 2019. This was achieved by aggregating indications for revision across the different minimum datasets. Table 3.S13 reports data for patients whose information was entered following the introduction of MDSv7.

Cuff insufficiency is the leading indication for revision for those who receive a proximal humeral hemiarthroplasty or conventional total shoulder replacement, whereas instability or dislocation is the leading cause in reverse polarity total shoulder replacements, see Table 3.S12. The low number of primary replacements and even lower frequency of revisions for patients whose data were entered using the most recent minimum dataset makes results difficult to interpret. It is important to note the indications for revision are not mutually exclusive and 24.1%, 64.3%, and 10.1% recorded none, one and two indications for revision respectively.

3.6.3 Patient Reported Outcome Measures (PROMs) Oxford Shoulder Scores (OSS) associated with primary shoulder replacement surgery

The Oxford Shoulder Score (OSS) is a validated patient reported outcome measure for use in shoulder surgery. It consists of 12 pain and function items asking about problems that the patient encountered with their shoulder over the preceding four weeks (Dawson et al., 1996). The score is coded from 0 to 4 (from 'worst' to 'best') and then summed in line with updated OSS recommendations (Dawson et al., 2009). The final total score ranges from 0 to 48, with 48 representing the 'best' outcome and 0 the 'worst'. Where up to two items were missing, the average of the remaining items can be substituted for the missing values (Dawson et al., 2009). If more than two items were missing, the results have to be disregarded.

Dawson J, Fitzpatrick R, Carr A, JBJS, 1996: 78-B, 593-600.
Dawson J, Rogers K, Fitzpatrick R and Carr A, Arch Orthop Trauma Surg, 2009, 129:119-123.

Table 3.S14 Number and percentage of patients who completed an Oxford Shoulder Score by acute trauma and elective indications, by the collection window of interest at different time points.

		Pre-operative OSS			6 month OSS			3 year OSS			5 year OSS		
		N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)	N	Eligible (%)	Responders (%)
Acute trauma	All eligible cases	4,364	(100.0)		3,887	(100.0)		1,853	(100.0)		752	(100.0)	
	All responders	427	(9.8)	(100.0)	2,069	(53.2)	(100.0)	256	(13.8)	(100.0)	334	(44.4)	(100.0)
	All complete* within window of interest	293	(6.7)	(68.6)	1,516	(39.0)	(73.3)	249	(13.4)	(97.3)	329	(43.8)	(98.5)
	OSS collected before window of interest	1	(<0.1)	(0.2)	5	(0.1)	(0.2)	1	(0.1)	(0.4)	1	(0.1)	(0.3)
	1 to 9 Items completed	1	(<0.1)	(0.2)	0	(0)	(0)	0	(0)	(0)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	0	(0)	(0)	1	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)	1	(0.1)	(0.3)
	12 Items completed	0	(0)	(0)	4	(0.1)	(0.2)	1	(0.1)	(0.4)	0	(0)	(0)
	OSS collected within window of interest	302	(6.9)	(70.7)	1,527	(39.3)	(73.8)	253	(13.7)	(98.8)	331	(44.0)	(99.1)
	1 to 9 Items completed	9	(0.2)	(2.1)	11	(0.3)	(0.5)	4	(0.2)	(1.6)	2	(0.3)	(0.6)
	10 to 11 Items completed	20	(0.5)	(4.7)	83	(2.1)	(4.0)	6	(0.3)	(2.3)	10	(1.3)	(3.0)
	12 Items completed	273	(6.3)	(63.9)	1,433	(36.9)	(69.3)	243	(13.1)	(94.9)	319	(42.4)	(95.5)
	OSS collected after window of interest	124	(2.8)	(29.0)	514	(13.2)	(24.8)	2	(0.1)	(0.8)	2	(0.3)	(0.6)
	1 to 9 Items completed	19	(0.4)	(4.4)	3	(0.1)	(0.1)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	8	(0.2)	(1.9)	33	(0.8)	(1.6)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	12 Items completed	97	(2.2)	(22.7)	478	(12.3)	(23.1)	2	(0.1)	(0.8)	2	(0.3)	(0.6)
Elective	All eligible cases	41,420	(100.0)		37,989	(100.0)		21,040	(100.0)		9,806	(100.0)	
	All responders	15,836	(38.2)	(100.0)	20,952	(55.2)	(100.0)	3,016	(14.3)	(100.0)	4,355	(44.4)	(100.0)
	All complete* within window of interest	10,421	(25.2)	(65.8)	14,814	(39.0)	(70.7)	2,961	(14.1)	(98.2)	4,285	(43.7)	(98.4)
	OSS collected before window of interest	912	(2.2)	(5.8)	94	(0.2)	(0.4)	6	(<0.1)	(0.2)	14	(0.1)	(0.3)
	1 to 9 Items completed	5	(<0.1)	(<0.1)	0	(0)	(0)	0	(0)	(0)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	24	(0.1)	(0.2)	9	(<0.1)	(<0.1)	1	(<0.1)	(<0.1)	1	(<0.1)	(<0.1)
	12 Items completed	883	(2.1)	(5.6)	85	(0.2)	(0.4)	5	(<0.1)	(0.2)	13	(0.1)	(0.3)
	OSS collected within window of interest	10,474	(25.3)	(66.1)	14,915	(39.3)	(71.2)	2,990	(14.2)	(99.1)	4,330	(44.2)	(99.4)
	1 to 9 Items completed	53	(0.1)	(0.3)	101	(0.3)	(0.5)	29	(0.1)	(1.0)	45	(0.5)	(1.0)
	10 to 11 Items completed	427	(1.0)	(2.7)	834	(2.2)	(4.0)	211	(1.0)	(7.0)	284	(2.9)	(6.5)
	12 Items completed	9,994	(24.1)	(63.1)	13,980	(36.8)	(66.7)	2,750	(13.1)	(91.2)	4,001	(40.8)	(91.9)
	OSS collected after window of interest	4,450	(10.7)	(28.1)	5,750	(15.1)	(27.4)	20	(0.1)	(0.7)	11	(0.1)	(0.3)
	1 to 9 Items completed	129	(0.3)	(0.8)	36	(0.1)	(0.2)	0	(<0.1)	(<0.1)	1	(<0.1)	(<0.1)
	10 to 11 Items completed	374	(0.9)	(2.4)	286	(0.8)	(1.4)	0	(<0.1)	(<0.1)	3	(<0.1)	(0.1)
	12 Items completed	3,947	(9.5)	(24.9)	5,428	(14.3)	(25.9)	20	(0.1)	(0.7)	7	(0.1)	(0.2)

*Complete corresponds to ten or more items completed.
Note: The windows of interest: Pre-operative [-90 to 0 days], 6 months [5 to 8 months], 3 years [2 years 11 months to 3 years 6 months], 5 years [4 years 11 months to 5 years 6 months].

Table 3.S14 provides a detailed description of the number of patients reporting an OSS pre-operatively, 6 months, 3 years and 5 years following surgery for patients undergoing primary shoulder replacement for acute trauma or elective indications. The responses are further divided by how close to the time point of interest it was collected and the completeness of each PROM. The results are expressed absolutely (N) and as a percentage (%) of 'Eligible' participants and those who 'Responded' to the PROM. Eligibility is defined as being alive at the time point of interest and also having sufficient follow-up time following primary surgery.

How close the response was to the time point of interest is categorised by defining 'windows of interest'. The pre-operative window of interest is 90 days prior to the primary surgery until the day of the primary operation. The 6-month data collection window of interest ranges from 5 months to 8 months, i.e. spanning a 3-month window of interest. The 3 and 5 year data collections had windows of interest ranging from 1 month prior to 3 and 5 years respectively to 6 months after i.e. spanning a 7-month window of interest.

Ensuring data is collected pre-operatively by hospital trusts is very important. In order to assess the efficacy of a surgical technique or implantable construct, understanding where the patient started is critical in order to understand how the patient is likely to respond to surgery. Collecting a pre-operative PROM post-operatively is likely to induce recall bias and for this reason the end of the pre-operative window was strictly defined as the day of surgery. Table 3.S14 clearly illustrates only a small minority of eligible patients complete an OSS questionnaire prior to surgery and within the window of interest.

Given the low compliance in pre-operative score collection by hospitals delivering shoulder replacement surgery, the potential for bias in interpreting results is clear. Collection and compliance with reporting at 6 months, 3 and 5 years is substantially better than pre-operative rates, but the response rate of all eligible participants is still less than 50% in all instances. The British Elbow and Shoulder Society (BESS) have deemed shoulder PROMs essential in the assessment of patient outcomes and surveillance after shoulder replacement surgery. The low pre-operative compliance with PROMs data collection is particularly concerning.

Table 3.S15 **Number** and **percentage** of patients who completed cross-sectional **Oxford Shoulder Score** by **overall**, **acute trauma**, **elective** and by **year** of primary operation, within the collection window of interest, with valid measurements at the **time points** of interest.

	Year of primary	Potential cases N	Oxford Shoulder Scores completed at: Pre-Op N (% of Pre-Op)	6 months N (% of Pre-Op)	3 years N (% of Pre-Op)	5 years N (% of Pre-Op)
Acute trauma & elective	All years	45,784	10,714 (23.4)	16,332 (39.0)	3,211 (14.0)	4,616 (43.7)
	2012	2,527	670 (26.5)	346 (13.8)	0 (0)	1,129 (51.7)
	2013	4,394	1,074 (24.4)	1,883 (43.2)	0 (0)	1,355 (35.7)
	2014	5,278	1,411 (26.7)	300 (5.7)	2,067 (41.9)	1,837 (40.1)
	2015	5,709	1,486 (26.0)	857 (15.1)	729 (13.7)	295
	2016	6,510	1,472 (22.6)	26 (0.4)	261 (4.2)	0
	2017	6,968	1,488 (21.4)	4,673 (67.7)	154	0
	2018	7,104	1,408 (19.8)	5,030 (71.4)	0	0
	2019	7,294	1,705 (23.4)	3,217 (87.2)	0	0
Acute trauma	All years	4,364	293 (6.7)	1,516 (39.0)	249 (13.4)	329 (43.8)
	2012	154	11 (7.1)	17 (11.5)	0 (0)	52 (42.6)
	2013	378	42 (11.1)	149 (40.4)	0 (0)	100 (34.1)
	2014	466	35 (7.5)	33 (7.3)	162 (41.3)	145 (43.0)
	2015	528	31 (5.9)	92 (17.8)	76 (16.6)	32
	2016	588	41 (7.0)	7 (1.2)	9 (1.7)	0
	2017	706	35 (5.0)	441 (64.0)	2	0
	2018	747	49 (6.6)	473 (64.4)	0	0
	2019	797	49 (6.1)	304 (75.8)	0	0
Elective	All years	41,420	10,421 (25.2)	14,816 (39.0)	2,962 (14.1)	4,287 (43.7)
	2012	2,373	659 (27.8)	329 (14.0)	0 (0)	1,077 (52.3)
	2013	4,016	1,032 (25.7)	1,734 (43.5)	0 (0)	1,255 (35.8)
	2014	4,812	1,376 (28.6)	267 (5.6)	1,905 (42.0)	1,692 (39.9)
	2015	5,181	1,455 (28.1)	765 (14.8)	653 (13.4)	263
	2016	5,922	1,431 (24.2)	19 (0.3)	252 (4.5)	0
	2017	6,262	1,453 (23.2)	4,232 (68.1)	152	0
	2018	6,357	1,359 (21.4)	4,557 (72.2)	0	0
	2019	6,497	1,656 (25.5)	2,913 (88.6)	0	0

Table 3.S15 provides a detailed description of the number of patients reporting complete OSS within the window of interest pre-operatively and at 6 months, 3 years and 5 years by the year of surgery for patients undergoing primary shoulder replacement for acute trauma or elective indications. The denominator used to calculate percentages is the number of patients alive at the milestone of interest. Where numbers appear without a percentage in parentheses, the PROMs were collected prior to the target date but within the window of interest. The data illustrates that collection and submission of pre-operative PROMs by hospitals is consistently poor, with less than 30% of elective patients having their PROMs data submitted. In recent years the compliance with 6-month reporting has steadily improved.

Table 3.S16 Number and percentage of patients who completed longitudinal Oxford Shoulder Score by overall, acute trauma, elective and by year of primary operation, within the collection window of interest, with valid measurements at the time points of interest.

	Year of primary	Potential cases N	Oxford Shoulder Scores completed at: Pre-Op N	Pre-Op, 6m N (% of Pre-Op)	Pre-Op, 3y N (% of Pre-Op)	Pre-Op, 5y N (% of Pre-Op)	Pre-Op, 6m, 3y N (% of Pre-Op)	Pre-Op, 6m, 3y, 5y N (% of Pre-Op)
Acute trauma & elective	All years	45,784	10,714	3,765 (35.1)	1,124 (10.5)	1,358 (12.7)	341 (3.2)	111 (1.0)
	2012	2,527	670	93 (13.9)	0 (0)	345 (51.5)	0 (0)	0 (0)
	2013	4,394	1,074	527 (49.1)	0 (0)	369 (34.4)	0 (0)	0 (0)
	2014	5,278	1,411	83 (5.9)	614 (43.5)	560 (39.7)	62 (4.4)	49 (3.5)
	2015	5,709	1,486	239 (16.1)	201 (13.5)	84 (5.7)	185 (12.4)	62 (4.2)
	2016	6,510	1,472	5 (0.3)	196 (13.3)	0 (0)	3 (0.2)	0 (0)
	2017	6,968	1,488	1,049 (70.5)	113 (7.6)	0 (0)	91 (6.1)	0 (0)
	2018	7,104	1,408	1,051 (74.6)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	7,294	1,705	718 (42.1)	0 (0)	0 (0)	0 (0)	0 (0)
Acute trauma	All years	4,364	293	93 (31.7)	25 (8.5)	29 (9.9)	2 (0.7)	1 (0.3)
	2012	154	11	1 (9.1)	0 (0)	4 (36.4)	0 (0)	0 (0)
	2013	378	42	17 (40.5)	0 (0)	13 (31.0)	0 (0)	0 (0)
	2014	466	35	1 (2.9)	14 (40.0)	11 (31.4)	0 (0)	0 (0)
	2015	528	31	3 (9.7)	2 (6.5)	1 (3.2)	1 (3.2)	1 (3.2)
	2016	588	41	0 (0)	7 (17.1)	0 (0)	0 (0)	0 (0)
	2017	706	35	21 (60.0)	2 (5.7)	0 (0)	1 (2.9)	0 (0)
	2018	747	49	33 (67.3)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	797	49	17 (34.7)	0 (0)	0 (0)	0 (0)	0 (0)
Elective	All years	41,420	10,421	3,672 (35.2)	1,099 (10.5)	1,329 (12.8)	339 (3.3)	110 (1.1)
	2012	2,373	659	92 (14.0)	0 (0)	341 (51.7)	0 (0)	0 (0)
	2013	4,016	1,032	510 (49.4)	0 (0)	356 (34.5)	0 (0)	0 (0)
	2014	4,812	1,376	82 (6.0)	600 (43.6)	549 (39.9)	62 (4.5)	49 (3.6)
	2015	5,181	1,455	236 (16.2)	199 (13.7)	83 (5.7)	184 (12.6)	61 (4.2)
	2016	5,922	1,431	5 (0.3)	189 (13.2)	0 (0)	3 (0.2)	0 (0)
	2017	6,262	1,453	1,028 (70.8)	111 (7.6)	0 (0)	90 (6.2)	0 (0)
	2018	6,357	1,359	1,018 (74.9)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	6,497	1,656	701 (42.3)	0 (0)	0 (0)	0 (0)	0 (0)

Table 3.S16 describes the number and percentage of paired measurements available for longitudinal analyses for all patients undergoing primary shoulder replacement for acute trauma or elective indications. The denominator used to calculate percentages is the number of pre-operative measurements. The numerator is the number of responses within the window of interest, see Table 3.S14 (page 255), with no more than two items missing responses. The proportion of patients available for a paired longitudinal analysis at any time point is low, and the proportion of patients with serial measurements at any time point is even lower. Whilst the proportion of patients with pre-operative and 6-month OSS has increased in recent years, this still only represents 14.8% of all eligible primary replacements.

Figure 3.S5 KM estimates of cumulative **revision** for primary **elective** shoulder replacements for patients **with** and **without** valid **PROMs**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

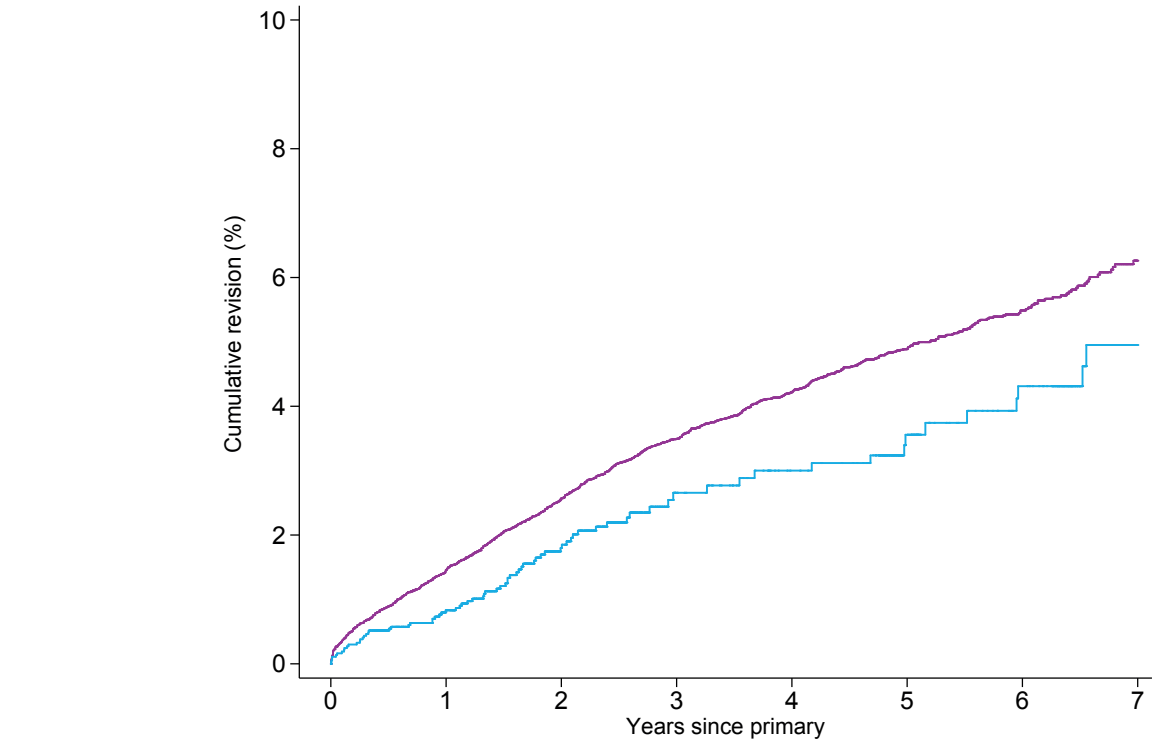
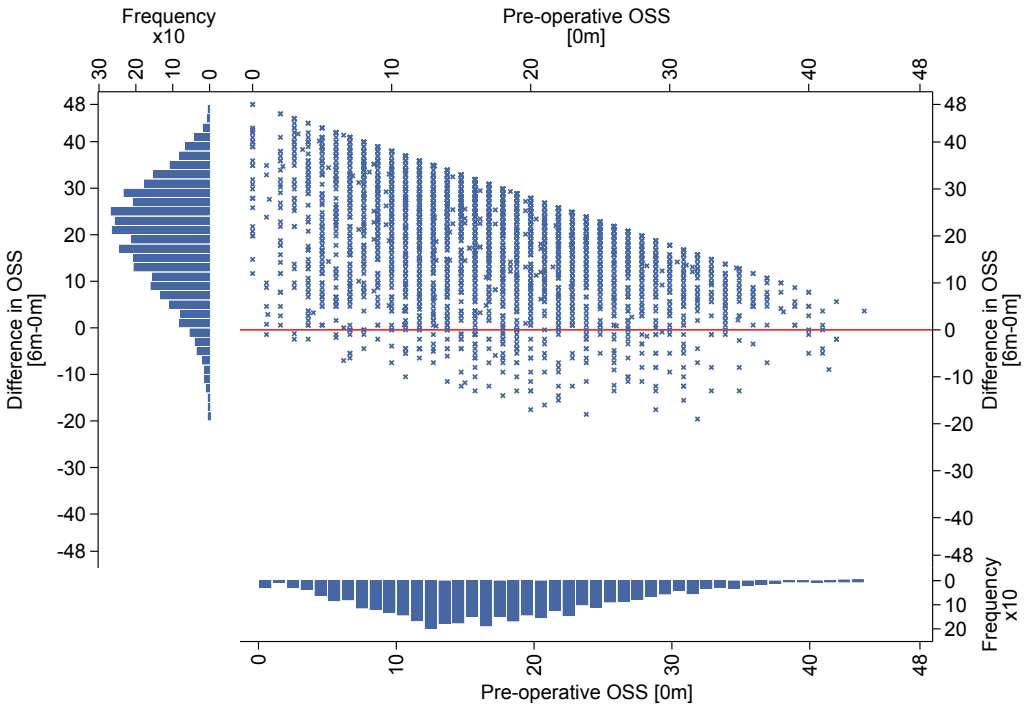


Figure 3.S5 reports the cumulative revision rate for elective patients undergoing primary shoulder replacements who completed pre-operative and 6-month PROMs assessments within the specified window of interest. Results indicate a different cumulative revision rate for patients who are included in the PROMs cohort versus those who are not. This difference suggests the group of patients responding to the PROMs questionnaires are different from those who are not responding and so are not representative of the larger population. This highlights the risk of using incomplete datasets to make inferences for the larger cohort and this PROMs data needs to be interpreted cautiously despite its relatively large size. If anything it indicates that the PROMs cohort is likely to be a more 'satisfied' group of patients as their revision rates are lower than the non-PROMs cohort.

Figure 3.S6 Distribution and scatter of **pre-operative OSS** and the **change in OSS** (post-pre) score for those receiving **elective** shoulder replacements for valid measurements within the collection window of interest.



Note: Elective patients with pre and 6 month presented only, N=3,672.

Figure 3.S6 illustrates the distribution of pre-operative OSS and change in OSS between the pre-operative and the 6-month assessment. Results are displayed for patients with elective indications for primary shoulder replacement only. It also illustrates the association between pre-operative OSS and the change in OSS. Whilst pre-operative and change in OSS are approximately normally distributed, this hides the profound ceiling effect within the assessment of the change score. This makes the interpretation of change in OSS particularly challenging and highlights the necessity of ascertaining a pre-operative PROM when assessing the efficacy of any intervention associated with a primary shoulder replacement. In the absence of specialist methods which account for floor and ceiling effects, a simple analysis of change scores is reported to be the most appropriate (Glymour et al., 2005). At six months following surgery, 5.3% of patients reported a score worse than they did pre-operatively. This figure is reduced compared to previous years due to the more refined inclusion/exclusion criteria of the PROMs cohort as defined previously.

Glymour M., et al. American Journal of Epidemiology, 2005: 162(3), 267-278.

Table 3.S17 Descriptive statistics of the pre-operative, 6 month and the change in OSS by overall, acute trauma, elective and by year of primary operation, within the collection window of interest, with valid measurements pre-operatively and 6 months post-operatively.

	Year of primary	Complete cases N	Oxford Shoulder Scores completed at: Pre-op Mean (SD)	Pre-op [25,50,75]th	6 months Mean (SD)	6 months [25, 50, 75]th	(6 months - Pre-op) Mean (SD)	(6 months - Pre-op) [25, 50, 75]th
Acute trauma & elective	All years	3,765	16.8 (8.4)	[11, 16, 22]	35.7 (10.5)	[30, 39, 44]	18.9 (11.6)	[12, 20, 27]
	2012	93	17.5 (7.9)	[12, 16, 23]	34.0 (11.7)	[28, 37, 43]	16.4 (11.9)	[9, 16, 25]
	2013	527	17.5 (8.6)	[11, 17, 23]	33.8 (10.7)	[27, 36, 43]	16.3 (12.0)	[8, 17, 25]
	2014	83	16.2 (8.0)	[10, 15, 22]	34.0 (11.1)	[25, 36, 42]	17.7 (10.2)	[12, 17, 25]
	2015	239	16.0 (7.7)	[11, 15, 21]	33.8 (11.1)	[28, 36, 43]	17.8 (11.0)	[10, 19, 26]
	2016	5	17.4 (9.3)	[9, 18, 26]	42.6 (6.1)	[37, 46, 47]	25.2 (11.4)	[22, 28, 29]
	2017	1,049	16.8 (8.4)	[11, 16, 22]	36.0 (10.3)	[30, 39, 44]	19.1 (11.6)	[12, 20, 28]
	2018	1,051	16.4 (8.5)	[10, 16, 22]	36.2 (10.4)	[30, 39, 44]	19.8 (11.7)	[13, 21, 28]
	2019	718	16.9 (8.3)	[11, 16, 22]	36.8 (9.9)	[31, 40, 44]	19.9 (11.1)	[13, 21, 28]
Acute trauma	All years	93	14.3 (16.1)	[2, 8, 24]	31.3 (11.8)	[22, 34, 41]	17.0 (20.7)	[5, 22, 32]
	2012	1						
	2013	17	11.9 (14.7)	[2, 8, 12]	33.3 (13.8)	[25, 41, 44]	21.3 (23.8)	[17, 27, 40]
	2014	1						
	2015	3	7.3 (4.9)	[4, 5, 13]	35.0 (11.5)	[22, 39, 44]	27.7 (16.4)	[9, 34, 40]
	2016	0						
	2017	21	15.4 (17.3)	[1, 8, 24]	31.4 (10.7)	[22, 34, 36]	16.0 (21.3)	[3, 22, 27]
	2018	33	16.6 (16.2)	[4, 11, 28]	28.7 (10.8)	[20, 30, 37]	12.1 (19.7)	[-3, 14, 29]
	2019	17	11.0 (16.7)	[0, 0, 17]	34.4 (13.0)	[27, 40, 44]	23.4 (19.1)	[13, 25, 39]
Elective	All years	3,672	16.8 (8.1)	[11, 16, 22]	35.8 (10.4)	[30, 39, 44]	19.0 (11.3)	[12, 20, 27]
	2012	92	17.3 (7.5)	[12, 16, 22]	33.9 (11.8)	[28, 37, 43]	16.7 (11.8)	[10, 16, 25]
	2013	510	17.7 (8.3)	[11, 17, 23]	33.8 (10.6)	[27, 36, 43]	16.2 (11.4)	[8, 17, 24]
	2014	82	16.3 (8.0)	[10, 15, 22]	34.2 (10.9)	[26, 37, 42]	17.9 (10.2)	[12, 17, 25]
	2015	236	16.1 (7.6)	[11, 16, 21]	33.8 (11.1)	[28, 36, 43]	17.7 (10.9)	[10, 19, 26]
	2016	5	17.4 (9.3)	[9, 18, 26]	42.6 (6.1)	[37, 46, 47]	25.2 (11.4)	[22, 28, 29]
	2017	1,028	16.8 (8.2)	[11, 16, 22]	36.1 (10.2)	[30, 39, 44]	19.2 (11.4)	[12, 20, 28]
	2018	1,018	16.4 (8.2)	[11, 16, 22]	36.5 (10.3)	[31, 39, 44]	20.1 (11.3)	[13, 21, 28]
	2019	701	17.1 (8.0)	[11, 17, 22]	36.9 (9.9)	[31, 40, 44]	19.8 (10.8)	[13, 21, 28]

Table 3.S17 presents descriptive statistics, mean and standard deviation, median and interquartile range, by year of primary shoulder replacements overall, and by those receiving shoulder replacements for acute trauma or elective indications. Results are presented only for those with measurements pre-operatively and at six months, within the window of interest and with no more than two items missing. The number of patients with valid OSS that receive primary shoulder replacements is relatively low, however, the results appear to be broadly concordant with those receiving primary shoulder replacement for elective indications. The change in OSS has tended to improve across the life of the registry, but the significance of this is very unclear given the potential for bias due to the lack of a representative sample.

Table 3.S18 Descriptive statistics of the pre-operative, 6 month and the change in OSS by overall, acute trauma, elective and by shoulder type, within the collection window of interest, with valid measurements pre-operatively and 6 months post-operatively.

	Primary procedure	Complete cases N	Oxford Shoulder Scores completed at: Pre-op Mean (SD)	Pre-op [25, 50, 75]th	6 months Mean (SD)	6 months [25, 50, 75]th	(6 months - Pre-op) Mean (SD)	(6 months - Pre-op) [25, 50, 75]th
Acute trauma & elective	**Proximal humeral hemiarthroplasty**	**401**	**17.8 (9.2)**	**[11, 17, 23]**	**31.3 (11.8)**	**[23, 34, 41]**	**13.5 (12.5)**	**[6, 14, 23]**
	Resurfacing	184	18.4 (8.3)	[13, 18, 24]	32.2 (11.4)	[26, 35, 41]	13.8 (11.3)	[7, 14, 23]
	Stemless	78	19.8 (8.5)	[16, 19, 23]	33.1 (11.3)	[25, 35, 42]	13.3 (10.6)	[6, 14, 21]
	Stemmed	139	15.8 (10.2)	[9, 14, 22]	29.1 (12.3)	[18, 32, 39]	13.3 (14.8)	[5, 14, 24]
	Total shoulder replacement	**1,210**	**17.6 (8.0)**	**[12, 17, 23]**	**38.5 (9.3)**	**[35, 41, 45]**	**20.9 (10.6)**	**[14, 22, 29]**
	Resurfacing	56	18.6 (8.2)	[12, 18, 25]	39.1 (7.1)	[36, 40, 45]	20.5 (9.3)	[14, 21, 26]
	Stemless	533	18.0 (8.2)	[12, 18, 24]	38.9 (9.0)	[36, 41, 45]	20.9 (10.4)	[14, 22, 29]
	Stemmed	621	17.1 (7.9)	[11, 16, 22]	38.1 (9.6)	[34, 41, 45]	21.0 (10.9)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**1,830**	**16.0 (8.3)**	**[10, 15, 21]**	**34.9 (10.5)**	**[29, 37, 43]**	**18.9 (11.7)**	**[11, 20, 27]**
	Stemless	31	16.8 (7.2)	[9, 17, 23]	36.8 (9.2)	[28, 40, 45]	20.0 (11.9)	[10, 21, 29]
	Stemmed	1,799	16.0 (8.3)	[10, 15, 21]	34.9 (10.5)	[29, 37, 43]	18.9 (11.7)	[11, 20, 27]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**323**	**16.7 (9.1)**	**[10, 16, 24]**	**34.8 (10.0)**	**[29, 37, 43]**	**18.1 (11.3)**	**[11, 18, 25]**
	Unconfirmed HHA	13	17.0 (7.3)	[11, 14, 23]	28.2 (14.1)	[18, 29, 42]	11.2 (14.2)	[4, 10, 21]
	Unconfirmed TSR	112	17.3 (8.7)	[10, 18, 24]	35.7 (10.5)	[30, 39, 44]	18.4 (11.5)	[11, 19, 27]
	Unconfirmed RTSR	198	16.4 (9.4)	[10, 15, 23]	34.8 (9.3)	[29, 37, 42]	18.4 (10.8)	[11, 18, 25]
	Unconfirmed IPA	0						
Acute trauma	**Proximal humeral hemiarthroplasty**	**22**	**16.3 (17.5)**	**[3, 10, 28]**	**28.5 (13.4)**	**[18, 30, 41]**	**12.2 (25.8)**	**[2, 17, 30]**
	Resurfacing	0						
	Stemless	0						
	Stemmed	22	16.3 (17.5)	[3, 10, 28]	28.5 (13.4)	[18, 30, 41]	12.2 (25.8)	[2, 17, 30]
	Total shoulder replacement	**1**						
	Resurfacing	0						
	Stemless	1						
	Stemmed	0						
	Reverse polarity total shoulder replacement	**57**	**16.2 (16.4)**	**[4, 10, 27]**	**31.4 (11.4)**	**[24, 34, 40]**	**15.2 (19.0)**	**[-1, 21, 27]**
	Stemless	0						
	Stemmed	57	16.2 (16.4)	[4, 10, 27]	31.4 (11.4)	[24, 34, 40]	15.2 (19.0)	[-1, 21, 27]
	Interpositional arthroplasty	0						
	Unconfirmed	13	3.0 (5.7)	[0, 0, 2]	34.8 (10.8)	[27, 39, 43]	31.9 (11.7)	[23, 37, 40]
	Unconfirmed HHA	0						
	Unconfirmed TSR	0						
	Unconfirmed RTSR	13	3.0 (5.7)	[0, 0, 2]	34.8 (10.8)	[27, 39, 43]	31.9 (11.7)	[23, 37, 40]
	Unconfirmed IPA	0						

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S18 (continued)

	Primary procedure	Complete cases N	Oxford Shoulder Scores completed at: Pre-op Mean (SD)	Pre-op [25, 50, 75]th	6 months Mean (SD)	6 months [25, 50, 75]th	(6 months - Pre-op) Mean (SD)	(6 months - Pre-op) [25, 50, 75]th
Elective	**Proximal humeral hemiarthroplasty**	**379**	**17.9 (8.5)**	**[12, 17, 23]**	**31.5 (11.7)**	**[23, 34, 41]**	**13.6 (11.3)**	**[6, 14, 22]**
	Resurfacing	184	18.4 (8.3)	[13, 18, 24]	32.2 (11.4)	[26, 35, 41]	13.8 (11.3)	[7, 14, 23]
	Stemless	78	19.8 (8.5)	[16, 19, 23]	33.1 (11.3)	[25, 35, 42]	13.3 (10.6)	[6, 14, 21]
	Stemmed	117	15.7 (8.3)	[10, 14, 22]	29.2 (12.2)	[21, 32, 39]	13.5 (11.8)	[5, 14, 22]
	Total shoulder replacement	**1,209**	**17.6 (8.0)**	**[12, 17, 23]**	**38.5 (9.3)**	**[35, 41, 45]**	**20.9 (10.6)**	**[14, 22, 29]**
	Resurfacing	56	18.6 (8.2)	[12, 18, 25]	39.1 (7.1)	[36, 40, 45]	20.5 (9.3)	[14, 21, 26]
	Stemless	532	18.0 (8.2)	[12, 18, 24]	38.9 (9.0)	[36, 41, 45]	20.8 (10.4)	[14, 22, 29]
	Stemmed	621	17.1 (7.9)	[11, 16, 22]	38.1 (9.6)	[34, 41, 45]	21.0 (10.9)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**1,773**	**16.0 (7.9)**	**[10, 15, 21]**	**35.0 (10.4)**	**[29, 37, 43]**	**19.0 (11.4)**	**[12, 20, 27]**
	Stemless	31	16.8 (7.2)	[9, 17, 23]	36.8 (9.2)	[28, 40, 45]	20.0 (11.9)	[10, 21, 29]
	Stemmed	1,742	16.0 (7.9)	[10, 15, 21]	35.0 (10.5)	[29, 37, 43]	19.0 (11.4)	[12, 20, 27]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**310**	**17.3 (8.8)**	**[11, 17, 24]**	**34.8 (10.0)**	**[29, 37, 43]**	**17.5 (10.9)**	**[10, 18, 25]**
	Unconfirmed HHA	13	17.0 (7.3)	[11, 14, 23]	28.2 (14.1)	[18, 29, 42]	11.2 (14.2)	[4, 10, 21]
	Unconfirmed TSR	112	17.3 (8.7)	[10, 18, 24]	35.7 (10.5)	[30, 39, 44]	18.4 (11.5)	[11, 19, 27]
	Unconfirmed RTSR	185	17.3 (8.9)	[11, 16, 24]	34.8 (9.2)	[29, 36, 41]	17.5 (10.2)	[11, 18, 24]
	Unconfirmed IPA	0						

Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S18 presents descriptive statistics, mean and standard deviation, median and interquartile range, by type and sub-type of primary shoulder replacements overall, and by those receiving shoulder replacements for acute trauma or elective indications. Results are presented only for those with measurements pre-operatively and at six months, within the window of interest and with no more than two items missing. The number of patients receiving a primary shoulder replacement for acute trauma indications is small.

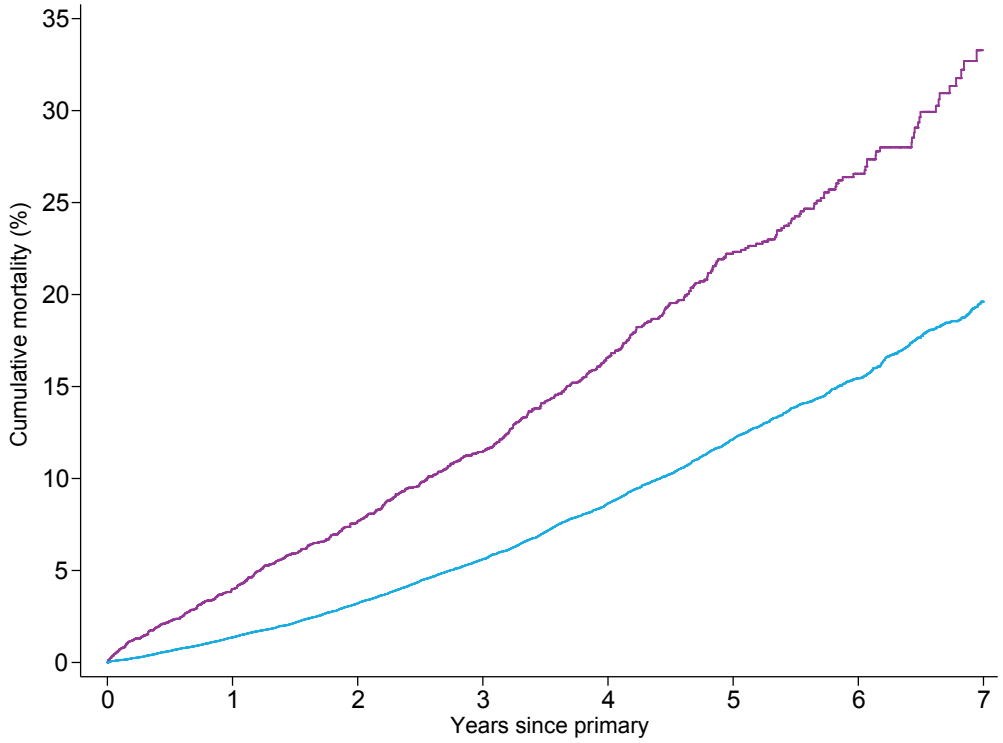
Table 3.S18 clearly illustrates that the change between pre-operative and 6-month assessment of OSS while positive, is still substantially less for patients receiving a proximal humeral hemiarthroplasty compared to either a conventional total or reverse polarity total shoulder replacement. The change in OSS between conventional total shoulder replacement versus reverse polarity total shoulder replacement and sub-type versus type of shoulder replacement is broadly similar.

3.6.4 Mortality after primary shoulder replacement surgery

This following section describes the mortality profile for patients receiving primary shoulder replacements. Where patients received same-day bilateral procedures (N=19), see Figure 3.S1 (page 228), they were excluded from the analysis to avoid double counting. This results in 45,765 patient procedures being included in the analysis, with 3,868 observed deaths.

Figure 3.S7 and Table 3.S19 (page 265) describe the mortality of patient receiving a primary shoulder replacement up to seven years following the primary procedure for all patients (Table 3.S19 only) and patients undergoing surgery for acute trauma and elective indications separately. Data is shown at 30 and 90 days following the primary procedure and then every year until the seventh year. Table 3.S19 indicates the importance of separating the data for patients receiving a primary shoulder replacement for acute trauma from the data for those with elective indications, due to the differences in the frailty of the patient population despite their similar age profile, see Table 3.S2 (page 231).

Figure 3.S7 KM estimates of cumulative **mortality** by **acute trauma** and **elective** indications for patients undergoing primary shoulder replacement. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



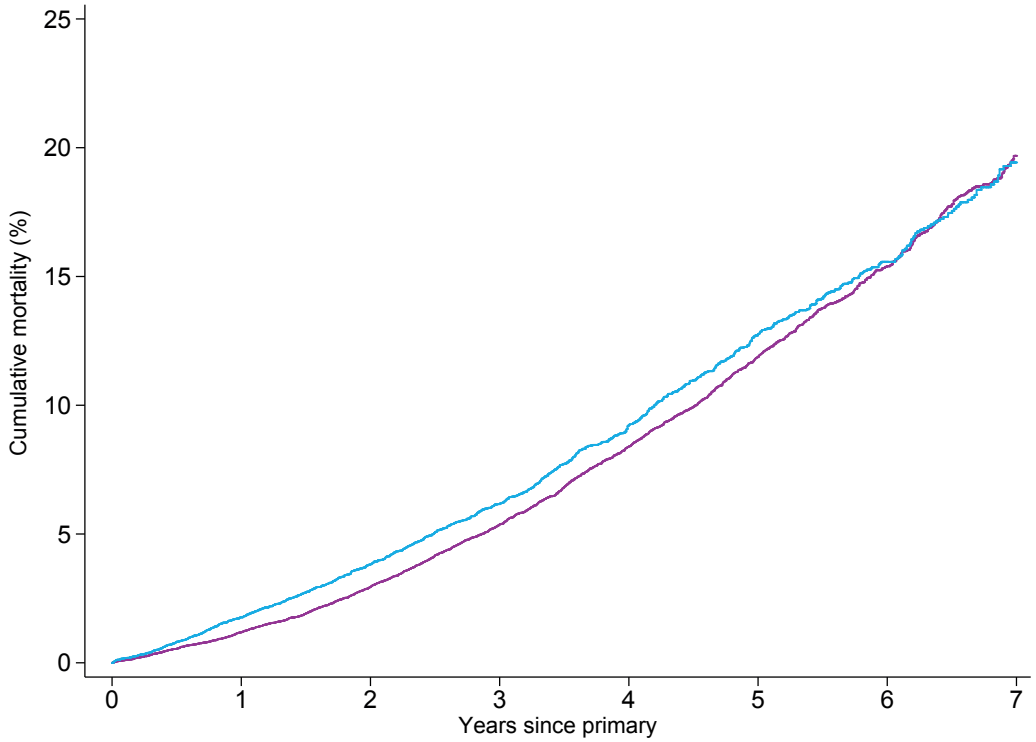
Key:	Numbers at risk							
Acute trauma	4355	3414	2589	1850	1245	749	389	*101*
Elective	41410	34427	27638	21033	14907	9802	5351	1877

Table 3.S19 KM estimates of cumulative mortality (95% CI) by **acute trauma** and **elective** indications for patients undergoing primary shoulder replacement. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	N	Age at primary Median (IQR*)	% male	Time since primary								
				30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years
All cases	45,765	73 (67 to 79)	30	0.16 (0.13-0.21)	0.37 (0.32-0.43)	1.61 (1.49-1.73)	3.64 (3.45-3.83)	6.16 (5.90-6.42)	9.37 (9.02-9.72)	13.04 (12.59-13.49)	16.42 (15.86-17.00)	20.76 (19.96-21.58)
Acute trauma	4,355	74 (67 to 80)	23	0.62 (0.43-0.91)	1.31 (1.01-1.70)	4.00 (3.43-4.65)	7.69 (6.86-8.61)	11.49 (10.41-12.67)	16.62 (15.19-18.16)	22.32 (20.50-24.28)	26.57 (24.33-28.97)	*33.28 (29.88-36.96)*
Elective	41,410	73 (67 to 79)	30	0.12 (0.09-0.15)	0.27 (0.23-0.33)	1.36 (1.25-1.48)	3.22 (3.04-3.41)	5.62 (5.36-5.89)	8.65 (8.31-9.01)	12.14 (11.69-12.61)	15.46 (14.88-16.05)	19.62 (18.80-20.46)

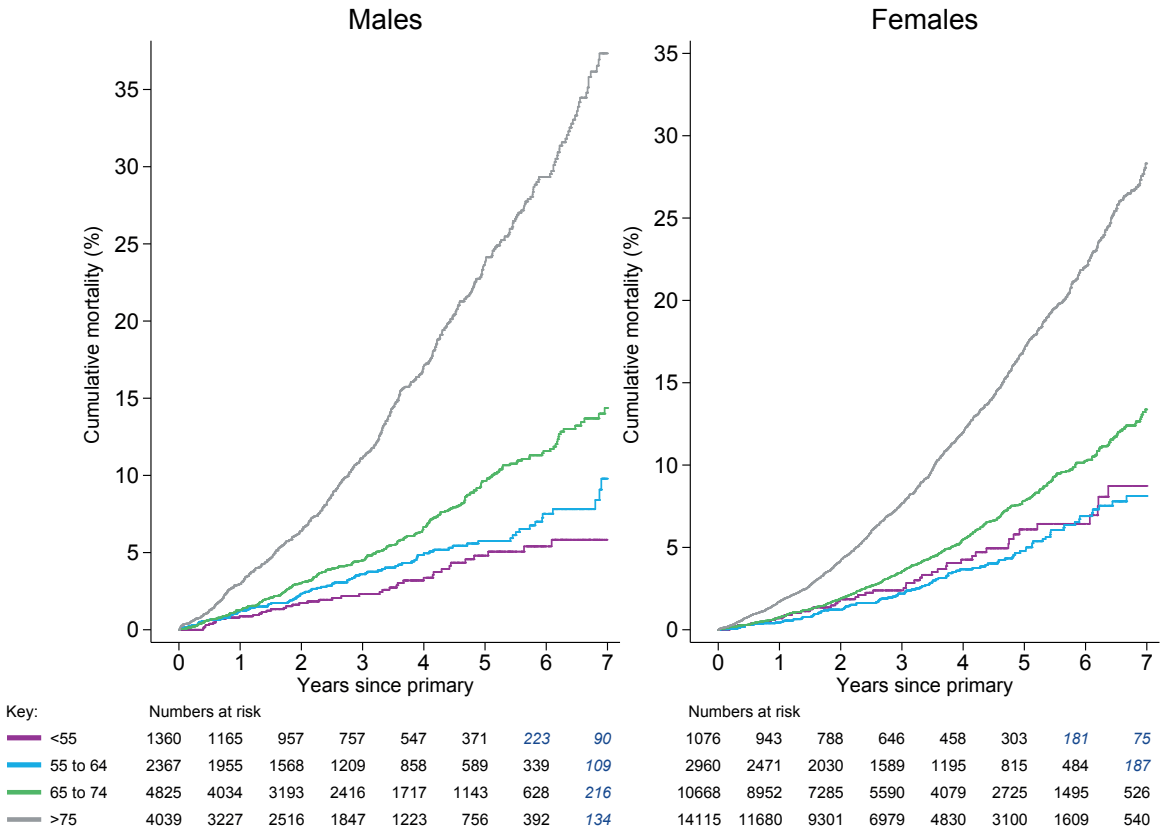
*IQR: Interquartile range, i.e. 25th and 75th centile.

Figure 3.S8 KM estimates of cumulative **mortality** for primary **elective** shoulder replacement by **gender**.



Key:	Numbers at risk							
Female	28819	24046	19404	14804	10562	6943	3769	1328
Male	12591	10381	8234	6229	4345	2859	1582	549

Figure 3.S9 KM estimates of cumulative **mortality** for primary **elective** shoulder replacement by **age group** and **gender**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk							
<55	1360	1165	957	757	547	371	*223*	*90*
55 to 64	2367	1955	1568	1209	858	589	339	*109*
65 to 74	4825	4034	3193	2416	1717	1143	628	*216*
>75	4039	3227	2516	1847	1223	756	392	*134*

Numbers at risk							
1076	943	788	646	458	303	*181*	*75*
2960	2471	2030	1589	1195	815	484	*187*
10668	8952	7285	5590	4079	2725	1495	526
14115	11680	9301	6979	4830	3100	1609	540

Table 3.S20 KM estimates of cumulative mortality (95% CI) for primary shoulder replacement for elective cases by **gender** and **age group**.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Gender	Age at primary (years)	N	Time since primary								
			30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Female	All	28,819	0.10 (0.07-0.14)	0.24 (0.19-0.31)	1.18 (1.06-1.32)	2.95 (2.75-3.18)	5.38 (5.08-5.70)	8.40 (8.00-8.83)	11.87 (11.33-12.42)	15.40 (14.71-16.11)	19.68 (18.71-20.71)
	<55	1,076	0	0.19 (0.05-0.75)	0.69 (0.33-1.45)	1.85 (1.15-2.97)	2.39 (1.56-3.65)	4.26 (3.00-6.03)	6.09 (4.39-8.43)	*6.43 (4.64-8.88)*	*8.73 (6.16-12.31)*
	55 to 64	2,960	0.03 (0.00-0.24)	0.07 (0.02-0.27)	0.44 (0.25-0.77)	1.22 (0.86-1.75)	2.20 (1.65-2.92)	3.67 (2.89-4.65)	4.78 (3.80-5.99)	6.90 (5.54-8.58)	*8.12 (6.47-10.18)*
	65 to 74	10,668	0.08 (0.04-0.15)	0.18 (0.12-0.28)	0.74 (0.59-0.93)	1.91 (1.64-2.22)	3.56 (3.17-4.01)	5.50 (4.96-6.09)	7.83 (7.12-8.60)	10.26 (9.35-11.26)	13.38 (12.03-14.86)
	≥75	14,115	0.13 (0.09-0.21)	0.33 (0.25-0.44)	1.71 (1.50-1.95)	4.21 (3.85-4.59)	7.69 (7.18-8.23)	12.01 (11.32-12.73)	17.04 (16.14-17.98)	22.08 (20.92-23.29)	28.32 (26.65-30.06)
Male	All	12,591	0.16 (0.10-0.25)	0.35 (0.26-0.47)	1.76 (1.54-2.02)	3.83 (3.48-4.22)	6.16 (5.69-6.68)	9.23 (8.59-9.91)	12.77 (11.94-13.65)	15.57 (14.55-16.65)	19.43 (17.99-20.97)
	<55	1,360	0	0	0.87 (0.48-1.57)	1.73 (1.12-2.67)	2.31 (1.56-3.41)	3.37 (2.37-4.80)	4.80 (3.45-6.67)	*5.40 (3.88-7.49)*	*5.83 (4.16-8.15)*
	55 to 64	2,367	0.17 (0.06-0.45)	0.30 (0.14-0.63)	1.24 (0.85-1.81)	2.33 (1.75-3.11)	3.60 (2.81-4.59)	4.96 (3.95-6.21)	5.74 (4.59-7.17)	7.51 (5.94-9.48)	*9.79 (7.29-13.08)*
	65 to 74	4,825	0.04 (0.01-0.17)	0.21 (0.11-0.39)	1.28 (0.99-1.66)	3.04 (2.55-3.62)	4.49 (3.86-5.23)	6.66 (5.81-7.63)	9.64 (8.49-10.95)	11.57 (10.19-13.14)	*14.37 (12.42-16.59)*
	≥75	4,039	0.35 (0.21-0.59)	0.65 (0.45-0.96)	2.96 (2.46-3.56)	6.43 (5.64-7.33)	11.10 (9.99-12.32)	17.04 (15.56-18.65)	23.83 (21.90-25.91)	29.34 (26.95-31.89)	*37.34 (33.90-41.01)*

Table 3.S20, Figure 3.S8 and Figure 3.S9 describe the mortality of patients receiving a primary shoulder replacement up to seven years following the primary procedure by gender and age group of the patients undergoing surgery for elective indications only. Data is shown at 30 and 90 days following the index procedure in Table 3.S20 and then every year until the seventh year. Mortality differences between the genders are small and whilst males have higher mortality within the first five years following surgery, mortality in the longer term appears more comparable, see Figure 3.S8. When mortality is further divided by age (see Figure 3.S9), it is clear that older males have higher mortality than females, this pattern first becomes evident after the age of 65.

3.6.5 Conclusions

In this year's report, new and extensive insight is provided into the use and performance of shoulder constructs used in primary shoulder replacements and provides a detailed description of revision rates by the indication for surgery. A detailed description of the longitudinal PROMs data collection is also provided for both elective and trauma patients.

The pattern of use of primary shoulder replacements has continued to be documented. This year, the shoulder implant data processing has been extensively revised and, building on the recent internal and external validation, it is now possible to report at the level of the construct. This detailed level of reporting has led to new and interesting insights, but it has also highlighted some inconsistencies within data recorded in the NJR. Unconfirmed procedures are now reported, these are procedures where the reported patient procedure disagrees with the implanted prostheses or there are insufficient elements reported to be implanted to form a coherent joint replacement construct. The volume of unconfirmed proximal humeral hemiarthroplasty is consistently low, and the volume of unconfirmed conventional total shoulder replacements has fallen since the start of the registry. However, the volume of unconfirmed reverse polarity total shoulder replacements is persistently high and has increased in recent years. The volume of unconfirmed reverse polarity total shoulder replacements is of concern as this now represents a significant proportion of all primary replacements. The lack of completeness hampers the core functions of the NJR, which is to provide a comprehensive record of all implanted prostheses.

There are now 45,784 shoulder replacements in the NJR after the application of our data cleaning processes. Patterns of use and the completeness of data are becoming clearer and revision rates out to seven years can be inspected. PROMs data continues to be collected so that patient outcomes in terms of pain and function can also be assessed alongside revision rates. It has previously been identified that some patients who have worse post-operative PROMs scores, i.e. a poor outcome, are not captured by the metric of revision surgery.

Confirmed reverse polarity total shoulder replacement made up 52.2% of all shoulder replacements in 2019 and the patterns of use observed in previous reports continue. This high level of use across indications indicates a growing confidence in this implant and a rapid change of practice in the UK despite limited high-level outcome evidence. Proximal humeral hemiarthroplasties, and to some extent conventional total shoulder replacements, are declining in numbers.

Revision rates this year do not alter the pattern observed last year. Revision rates in younger patients continue to be high and are now 12.3% and 11.1% in male and females respectively at five years. These revision figures should be made clear to younger patients wishing to undergo shoulder replacement surgery.

At present reverse polarity total shoulder replacement demonstrates the lowest revision rates at seven years. However, it is worth highlighting that they have a higher early revision rate compared to stemmed conventional total shoulder replacements, until approximately two years following surgery. After two years the revision rate of stemmed reverse polarity shoulder replacements falls below stemmed conventional total shoulder replacements. The observed non-proportionality between conventional and reverse bearings combined with the differing indications between the two procedures does not

necessarily mean that reverse polarity shoulder replacements should be favoured over conventional total shoulder replacement, particularly for indications that would normally indicate the latter.

More elective proximal humeral hemiarthroplasties are being revised after the first year of surgery, with stemmed hemiarthroplasty seeming to outperform either resurfacing or stemless hemiarthroplasty. Whilst it may be argued that the higher revision rate is mediated by the ease of the revision procedure, the PROMs data in this report does not support this. The change in PROMs score between the pre-operative and 6-month assessment following surgery suggests less improvement and that the group of patients that receive a hemiarthroplasty are less happy with the primary operation compared to others.

More in-depth analysis which accounts for case-mix must be conducted as, whilst the age and gender distribution is similar, the distribution of indications for which patients undergo proximal humeral hemiarthroplasty is different to that of either conventional total shoulder replacements or reverse polarity shoulder replacement, with a much higher proportion of patients indicating avascular necrosis. An in-depth analysis accounting for the variety of indications collected by the NJR and other clinically relevant factors may help surgeons select different treatment modalities for patients.

This year a detailed description of PROMs data has been presented with reference to, not only those who respond, but the entire cohort of patients receiving a primary shoulder replacement. The pre-operative scores are administered and collected by trusts and our analysis demonstrates that hospital trust compliance is poor. Strategies need to be developed nationally to improve this low compliance.

The post-operative PROMs are administered directly to patients by Northgate Public Services and how many people respond and when they respond is now considered. The completeness of measures cross-sectionally and importantly from a longitudinal perspective and how this has changed across the years has been described. A pre-operative and 6-month matched elective cohort of 3,672 patients is now available for analysis but the representative nature of this data compared to the whole cohort is not clear. It illustrates, in those who completed the PROM, shoulder replacement surgery results in substantial improvements in pain and function of patients. However, what is less clear is how those who do not complete the PROMs fare, and the revision rate of those who do not respond to the PROMs do appear to be different and higher compared to those who do respond.

The largest gains in elective patients can be observed in patients receiving a conventional total shoulder replacement, followed closely by those receiving a reverse polarity shoulder replacement, followed by those receiving a proximal humeral hemiarthroplasty.

Overall, the volume of shoulders in the NJR continues to grow rapidly and now presents an opportunity for outcomes to be assessed both by revision and by PROMs, although careful consideration with the latter in respects to its generalisability is required. Importantly, our new approach of whole construct validation using new classifications and component attributes will lead to more meaningful analysis and provision of useful information for patients, surgeons and other stakeholders.

3.7 In-depth studies

3.7.1 Risk factors for intraoperative periprosthetic femoral fractures during primary total hip arthroplasty

Full paper details

The research is supported by the National Institute for Health Research (NIHR) infrastructure at Leeds where co-author Professor Pandit is a NIHR Senior Investigator. The views expressed in this article are those of the author(s) and not necessarily those of the NHS, the NIHR, nor the Department of Health and Social Care.

Risk factors for intraoperative periprosthetic femoral fractures during primary total hip arthroplasty. An analysis from the National Joint Registry for England and Wales and the Isle of Man.

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Background

Intraoperative periprosthetic femoral fracture (IOPFF) is a significant complication of total hip replacement (THR) which may occur in 1–5% of cases. IOPFF is associated with an increased risk of post-operative periprosthetic fracture (PFF) and increased revision risk. Known risk factors for IOPFF include female sex, increasing age, poor bone quality, abnormal proximal femur morphology, cementless stem fixation and surgical approach (Direct Anterior and Hardinge approach). Risk factors and outcomes for specific anatomical sub-types of IOPFF are poorly understood. The aim of this study was to identify the predictors for all types of IOPFF, as well as for each anatomical sub-type using the National Joint Registry for England, Wales and the Isle of Man (NJR) dataset.

Methods

Participants

This study included all the primary THRs recorded in the NJR from 1 April 2004 to 30 September 2016 (n=793,823).

Outcome and variables

The study outcome was any IOPFF and included calcar crack, shaft fracture or trochanteric fracture. All variables relating to patient age, gender, ASA group, year of surgery, side of operation, surgical approach, computer guided surgery (CGS), minimally invasive surgery, surgeon grade, hospital type, indication and stem fixation type were included.

Statistical analysis

Analysis was conducted in two parts: firstly, prevalence and risk factors for any IOPFF and secondly risk factors for each IOPFF sub-type. A binary multi-variable logistic regression model estimated the relative risk (RR) of IOPFF for each variable compared to normal practice where applicable. Interactions were selected a priori and tested by the addition of a single interaction term to multi-variable models.

Results

Part one: All IOPFF

The prevalence of IOPFF during primary THR was 0.62% (4,938/793,823).

Risk factors for IOPFF

The relative risk of IOPFF almost doubled in females (RR 1.91, 95% CI 1.79-2.03) and was increased in both younger (age <50, RR 1.21, 95% CI 1.08-1.37) and older patients (age >80, RR 1.23, 95% CI 1.14-1.34) versus patients between 70 and 80 years (P<0.01).

All non-osteoarthritis indications significantly increased the risk of IOPFF apart from acute trauma and malignancy. Surgical predictors increasing the risk of IOPFF included the use of cementless

femoral implants (RR 2.40, 95% CI 2.26-2.55) and anterolateral approach (RR 1.09, 95% CI 1.03-1.16). The risk of IOPFF was significantly reduced when computer guided surgery was used (RR 0.51, 95% CI 0.41-0.65, P<0.01).

Part two: Risk factors for IOPFF by fracture sub-type

The relationship between age and risk of IOPFF varied by fracture sub-type. The risk of calcar crack significantly increased in the youngest age groups, while the risk of shaft fracture increased significantly in patients over 80. The risk of trochanteric fracture increased steadily with age.

Surgical indications for THR which increase IOPFF risk for all fracture locations included previous trauma and paediatric disease. Avascular necrosis of the hip and inflammatory hip disease increased the risk of calcar crack and trochanteric fractures, while infection increased the risk of femoral shaft fractures.

Cementless implants more than trebled the risk of calcar crack (RR 3.76, 95% CI 3.46-4.09, P<0.01) and doubled the risk of shaft fracture (RR 2.05, 95% CI 1.64-2.56, P<0.01). Posterior approach and CGS significantly decreased the risk of shaft fractures and trochanteric fractures.

Interactions between risk factors

The risk of IOPFF with a cementless stem did not increase with age. Risk of IOPFF was higher in younger versus older patients with NOF fracture. The increased risk of calcar crack associated with cementless stem use was greater in females than males. Risk of shaft fracture with a cemented stem was increased in older females.

Discussion

The risk of IOPFF is highest at extremes of age. Young patients may be at greater risk of calcar and shaft fractures because the proximal femoral canal is typically narrow and requires prolonged and forceful rasping during surgery. The risk of trochanteric fracture increased with age, perhaps because the metaphyseal bone of the trochanter may be vulnerable to age-related osteoporosis.

Worse ASA grade is strongly associated with an increased IOPFF risk. ASA is a surrogate marker for health conditions which can affect the integrity of the proximal femoral bone stock.

Anterolateral and 'other' approaches can increase the risk of trochanteric and shaft fractures versus a posterior approach. Increased rotational loading of the trochanter and shaft during anterolateral and other approaches may explain the specific increased risk of IOPFF.

Computer guided surgery (CGS) was associated with a significant reduction in the risk of any IOPFF and its effect appeared to affect all patients consistently without interaction with any other variable. This may suggest that CGS is an independent protective factor against any IOPFF. CGS typically requires pre-operative 3D imaging, which may allow more accurate planning of implant size and can give feedback on direction of femoral preparation and implantation.

Cementless stem use is associated with increased risk of calcar and shaft fractures. Cementless femoral stems appear to be an age independent risk factor for any IOPFF when adjusting for all other factors. In younger patients where it has been shown that cementless femoral stems may survive longer; the increased risk of IOPFF and associated sequelae must be weighed up against the potential benefit in stem survival.

This observational study benefits from large numbers of patients, which increases the statistical power of observations. However, we cannot confirm causal links and further work should be completed to test the hypotheses generated from this study. Large cumulative reduction in IOPFF risk may occur with use of cemented implants, posterior approach, and computer-guided surgery.

3.7.2 The effect of surgical approach on outcomes following total hip arthroplasty performed for displaced intracapsular hip fractures

Full paper details

The effect of surgical approach on outcomes following total hip arthroplasty performed for displaced intracapsular hip fractures: An analysis from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man.

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Published in The Journal of Bone and Joint Surgery: January 2, 2020 - Volume 102 - Issue 1 - p 21-28
DOI: **https://doi.org/10.2106/JBJS.19.00195**

Background

Existing studies suggest the anterolateral approach is preferable to the posterior approach when performing total hip arthroplasty (THA) for displaced intracapsular hip fractures, due to a reduced risk of reoperations and dislocations. However, these observations come from small studies with short follow-up (3 to 24 months). We assessed the effect of surgical approach on outcomes after THA performed for hip fractures.

Methods

A retrospective analysis of prospectively collected observational data was performed using the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. Anonymised patient data were extracted for all primary THAs implanted for hip fracture between April 2003 and December 2015.

The exposure was the surgical approach (posterior or anterolateral, with the latter including approaches coded as anterolateral, lateral, or Hardinge).

Outcomes of interest were implant survival at five years (all-cause revision, revision for dislocation / subluxation, and revision for periprosthetic fracture), patient survival (30 days, 1 year, and 5 years), and intraoperative complications (included calcar crack, pelvic and/or femoral shaft penetration, trochanteric and/or femoral shaft fracture).

Statistical analysis

The two surgical approach groups were matched (1:1 ratio) for multiple patient and surgical confounding factors (age, sex, date of surgery, American Society of Anesthesiologists grade, anaesthetic type, surgeon grade, and THA components implanted (including fixation, bearing surface, and femoral head size)) using propensity scores. The two approach groups were matched based on individual propensity scores.

Cumulative implant and patient survival rates following THA were determined using Kaplan-Meier estimates. Patients who were alive with a THA not requiring revision were censored on the study end date. Implant survival rates were compared between approach groups using Fine and Gray regression modelling (which accounted for the competing mortality risk). Patient survival rates were compared between approach groups using Cox regression, with the risk of intraoperative complications compared using logistic regression. Univariable regression models were used in all cases.

Results

The unmatched cohort included 18,887 THAs. Before matching, six covariates had imbalance between the two approach groups. After matching, 14,536 THAs were studied (7,268 posterior and 7,268 anterolateral). The mean age was 71.6 years and 74% were female. There was no covariate imbalance following matching, suggesting good performance of the matching process. The follow-up period in both approach groups was 4.0 years (range 1.0 to 13.0 years).

Following THA, 350 hips (2.4%) underwent revision surgery. The most common indications for revision

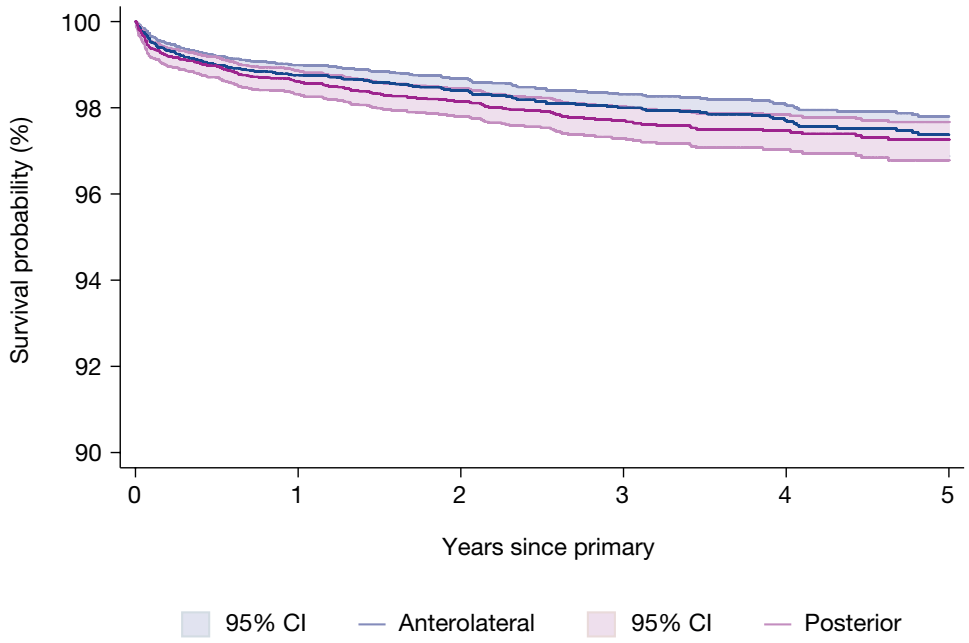
were dislocation / subluxation (33.7%), periprosthetic fracture (24.0%), aseptic loosening (15.7%), and infection (15.1%). The five year cumulative implant survival rates were similar between the posterior and anterolateral approach groups (97.3% vs. 97.4%; sub-hazard ratio (SHR) 1.15. 95% CI 0.93-1.42, P=0.185) (See Table 3.1 and Figure 3.1 (page 276)). Five-year implant survival rates free from revision for dislocation (SHR 1.28, 95% CI 0.89-1.84, P=0.188) and free from revision for periprosthetic fracture (SHR 1.03, 95% CI 0.68-1.56, P=0.879) were also comparable.

Table 3.1 Outcomes following THA performed for hip fracture by surgical approach.

Outcomes of interest	Percentage of cohort (%) (95% CI)			Univariable regression analysis
	Whole cohort (n=14,536)	Anterolateral (n=7,268)	Posterior (n=7,268)	
5-year implant survival rate free from all causes (350 revisions)	97.3 (97.0-97.6)	97.4 (96.9-97.8)	97.3 (96.8-97.7)	SHR=1.15 (0.93-1.42) p=0.185
5-year implant survival rate free from dislocation (118 revisions)	99.0 (98.8-99.2)	99.2 (98.9-99.4)	98.9 (98.6-99.2)	SHR=1.28 (0.89-1.84) p=0.188
5-year implant survival rate free from periprosthetic fracture (84 revisions)	99.4 (99.2-99.5)	99.4 (99.1-99.6)	99.4 (99.1-99.6)	SHR=1.03 (0.68-1.56) p=0.879
30-day patient survival (131 deaths)	99.1 (99.0-99.3)	98.8 (98.5-99.0)	99.5 (99.3-99.6)	HR=0.44 (0.30-0.64) p<0.001
1-year patient survival (857 deaths)	94.1 (93.7-94.5)	93.3 (92.7-93.8)	95.0 (94.5-95.5)	HR=0.73 (0.64-0.84) p<0.001
5-year patient survival (2,321 deaths)	78.0 (77.1-78.9)	76.8 (75.6-78.0)	79.2 (77.9-80.4)	HR=0.87 (0.81-0.94) p<0.001
Intraoperative complications (224 complications)	1.5% (n=224)	1.9% (n=140)	1.2% (n=84)	OR=0.59 (0.45-0.78) p<0.001

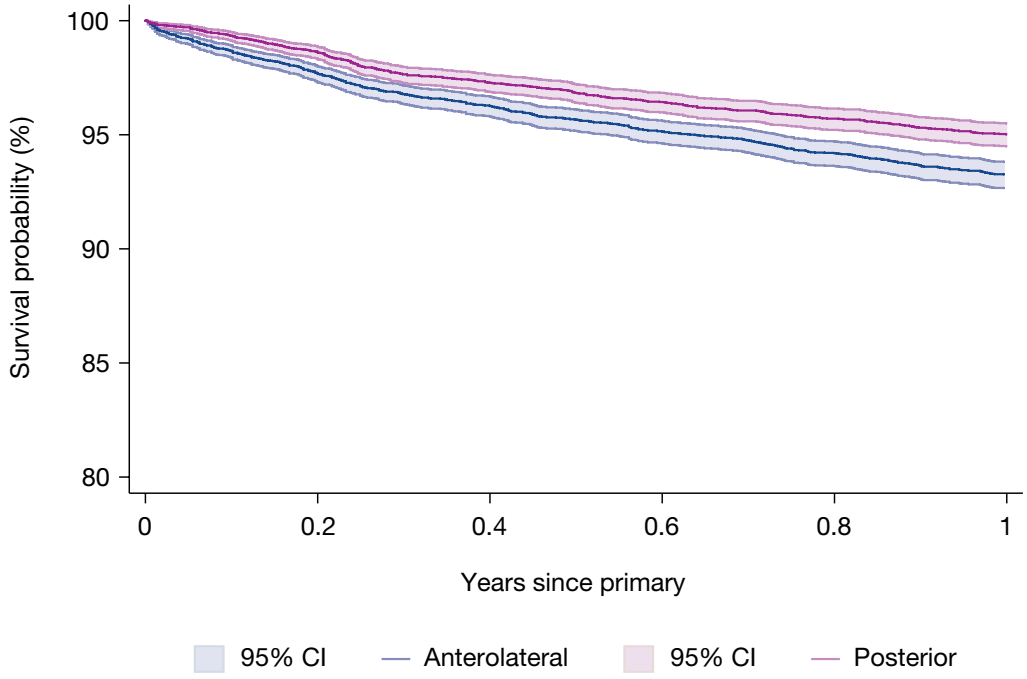
Note: HR=hazard ratio; OR=odds ratio; SHR=sub-hazard ratio.
Note: Hazard, odds, and sub-hazard ratios below one represent a reduced risk of the specified outcome in the posterior approach group.

Figure 3.1 Implant survival rate free from revision for all causes following THA for hip fracture by surgical approach.



Thirty-day patient survival rates were significantly higher in THAs implanted using a posterior approach (99.5% vs. 98.8%; hazard ratio (HR) 0.44, 95% CI 0.30-0.64, P<0.001), with this observation persisting at both one year (HR 0.73, 95% CI 0.64-0.84, P<0.001) and five years post-surgery (HR 0.87, 95% CI 0.81-0.94, P<0.001) (See Table 3.1 and Figure 3.2).

Figure 3.2 Patient survival rate following THA for hip fracture by surgical approach.



The most common intraoperative complications recorded were calcar (36%) and trochanteric (27%) fractures. The posterior approach had a significantly reduced risk of intraoperative complications compared with the anterolateral approach (1.2% vs. 1.9%; odds ratio 0.59, 95% CI 0.45-0.78, P<0.001).

Conclusions

This is the largest study assessing the effect of surgical approach on outcomes following THA for hip fracture. We observed that the posterior approach had a reduced risk of mortality and intraoperative complications compared with the anterolateral approach. Furthermore the posterior approach did not confer any increased risk of revision surgery, including revisions specifically for dislocation and periprosthetic fracture. We therefore propose that the posterior approach is safer than the anterolateral approach when performing THA for hip fractures, and should be preferred where possible.

3.7.3 Antibiotic-loaded bone cement is associated with a lower risk of revision following primary cemented total knee replacement

Full paper details:

Antibiotic-loaded bone cement (ALBC) is associated with a lower risk of revision following primary cemented total knee replacement (TKR): An analysis of 731,214 cases using National Joint Registry data.

Simon S. Jameson, Asaad Asaad, Marina Diament, Adetatyo Kasim, Theophile Bigirumurame, Paul Baker, James Mason, Paul Partington, Mike Reed.

Bone Joint J. 2019;101-B(11):1331-1347. DOI: **https://doi.org/10.1302/0301-620X.101B11.BJJ-2019-0196.R1**

Introduction

Prosthetic infection after total knee replacement (TKR) is a rare but potentially debilitating surgical complication. Its rate has been estimated to be between 1% and 2%. Patients with infected TKRs frequently require revision surgery, which in turn leads to poorer outcomes and significantly increased healthcare costs.

Adding antibiotics to cement has been advocated for many years as a means of reducing risk of prosthetic infection. Use of antibiotic-loaded bone cement (ALBC) in hip replacement is widely accepted, but the evidence in TKR is unclear, and has led to different practices globally. There are concerns that adding antibiotics may adversely affect mechanical properties of cement, may lead to the development of resistant organisms, and may cause bone cellular and renal toxicity.

We sought to evaluate the hypothesis that ALBC reduces the risk of revision following primary TKR.

Methods

A retrospective observational study was carried out using data from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man (NJR). All primary cemented TKRs performed and recorded on the NJR dataset between 2003 and 2016 were analysed to compare the revision rate when using ALBC versus plain cement.

The following endpoints were of interest: revision for infection, revision for a cause other than infection, and revision for any cause. The use of ALBC was compared with plain bone cement. For each endpoint, logrank tests, Kaplan Meier plots and Cox proportional hazards models were performed to compare the groups, both unadjusted for cement variables, and adjusted by stratification for patient, surgical and implant characteristics. The influence of timing of surgery (i.e. year of operation) was also explored in order to assess the influence of time dependent unknown variables (e.g. different generations of cementation techniques). Body mass index (BMI) data were only available in a sub-set of patients.

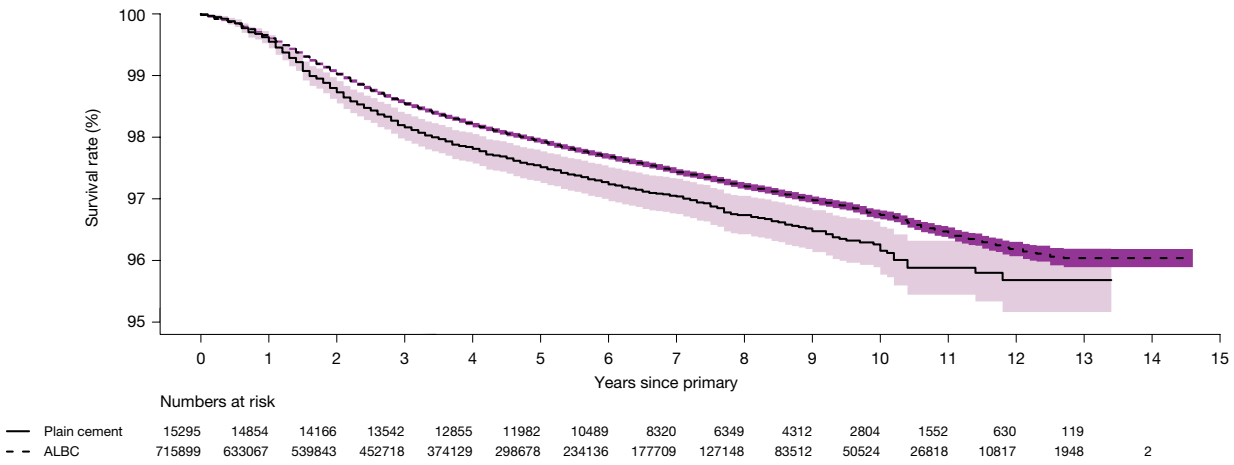
The analysis was performed on the entire dataset (excluding BMI data) and repeated for episodes with a valid BMI (range of $15 \leq BMI \leq 50$). A further sensitivity analysis was performed on the sub-group of cases where surgeons using ALBC during the entire data collection period were excluded.

Results

Of 731,214 TKRs, 15,295 (2.1%) were implanted with plain cement and 715,919 (97.9%) with ALBC. There were 13,391 revisions; 2,391 were performed for infection. There were 432,003 records with BMI data.

After adjusting for other variables, ALBC had a significantly lower risk of revision for any cause (Hazard Ratio (HR) 0.85, 95% Confidence Intervals (CI) 0.77-0.93, P<0.01) (see Figure 3.3 on the next page).

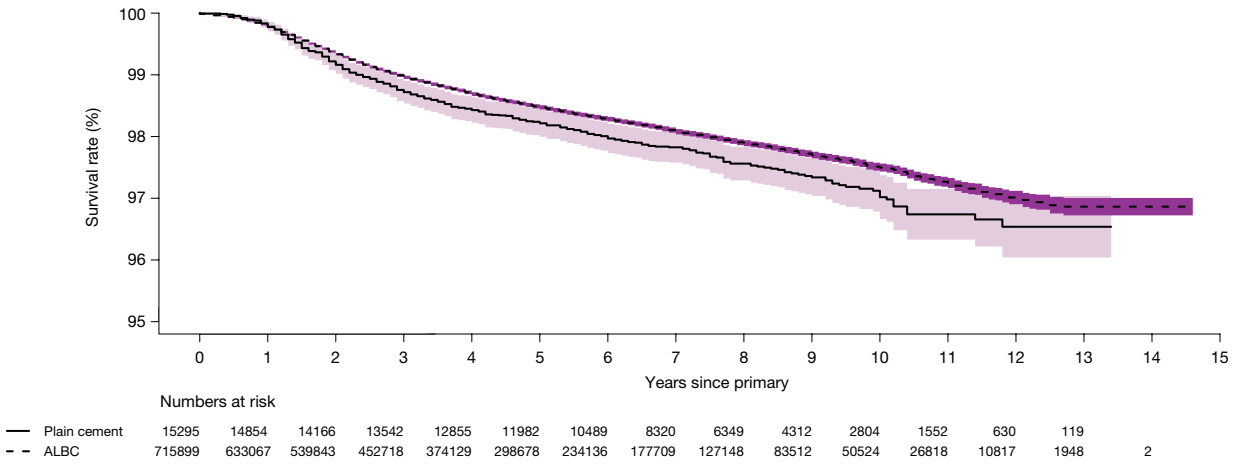
Figure 3.3 Prosthesis survival rates, using ALBC versus plain cement (n=13,391).



Log rank P= 0.001

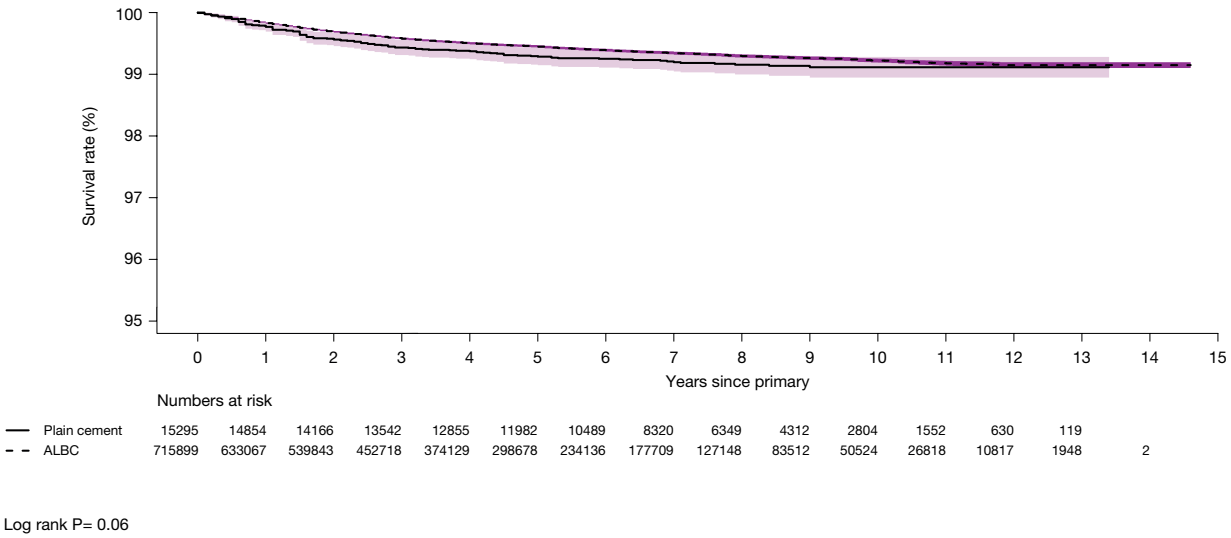
ALBC was associated with a lower risk of revision for all aseptic causes (HR 0.85, 95% CI 0.77-0.95, P<0.01) (Figure 3.4) and revisions for infection (HR 0.84, 95% CI 0.67-1.01, P=0.06) (Figure 3.5).

Figure 3.4 Prosthesis survival rates for aseptic cases, using ALBC versus plain cement (n=9,845).



Log rank P= 0.004

Figure 3.5 Prosthesis survival rates for cases of infection, using ALBC versus plain cement (n=3,546).



Log rank P= 0.06

The following factors were independently associated with a significantly increased risk of revision: male sex, younger age, lower ASA, indications other than osteoarthritis, un-resurfaced patella, employing posterior stabilised components and mobile bearings, the use of low viscosity and plain (non-antibiotic loaded) cement, and when a factor Xa inhibitor was used for venous thromboembolic (VTE) prophylaxis. Changes in rates of revision (hazard ratio) did not vary in a linear manner over time, irrespective of indication. Hazards of revision between the two groups varied across the operation years. In general, plain cement had a higher hazard of revision than ALBC, particularly after 2007.

The results were similar when BMI was added into the model, and in a sub-analysis where surgeons using only ALBC over the entire study period were excluded.

Prosthesis survival at ten years for TKRs implanted with ALBC was 96.3% (95% CI 96.3-96.4) compared with 95.5% (95% CI 95.0-95.9) in those implanted with plain cement. This equates to an absolute 10-year revision risk reduction of 0.87% and a relative risk reduction of 19.2% when ALBC was used. On a population level, where 100,000 TKRs are performed annually, this difference represents 870 fewer revisions at ten years in the ALBC group.

Discussion

After adjusting for a range of variables, ALBC was associated with a significantly lower risk of revision when compared with plain cement in this registry-based study of an entire nation of primary cemented TKRs. There were similar findings across a range of sensitivity analyses. Importantly, revision risk for aseptic causes was significantly lower when ALBC

was used, suggesting any concerns of mechanical instability when ALBC was used were unfounded.

There are limitations. Data on some proven risk factors for periprosthetic joint infection were unavailable in this study. BMI (which is known to influence risk of infection) data is incomplete within the NJR. Despite this, our analyses demonstrated little difference between the smaller cohort with BMI data and the full dataset (when BMI was excluded from the statistical models). ALBC was associated with a significant reduction in revisions, irrespective of BMI.

It is likely that infection as a cause of revision is under-reported in registry data. Moreover, the NJR does not record any information on superficial infections that are treated conservatively. While we were able to identify an association between ALBC and lower infection risk, we lacked detailed information on the type and dosage of local and systemic prophylactic antibiotics. Furthermore, we have no data on antimicrobial resistance profiles in those patients who were revised for infection, although several groups have found no change in the patterns of the infecting organisms where a prosthesis implanted with ALBC becomes infected.

Finally, the proportion of knee replacements implanted using plain cement in this study was only 2%, and most were implanted in the earlier years of the registry. Nevertheless, this still accounts for over 15,000 cases and differences in revision rates between cement types were significant despite the relative mismatched group sizes.

Whilst we believe this paper presents data to justify its use, there may be specific groups of patients who are more likely to benefit from ALBC than others, and further work on risk factors is needed to stratify risk and contain costs.

Conclusions

After adjusting for a range of variables, ALBC was associated with a 19% lower risk of revision in this large registry-based study of over 700,000 primary total knee replacements. Using ALBC decreases mid-term implant failure rates.

3.7.4 Choice of prosthetic implant combinations in total hip replacement: cost-effectiveness analysis using NJR and Swedish hip joint registries data

Full paper details:

This article summarises independent research funded by the National Institute for Health Research's Research for Patient Benefit Programme (grant no. PBPG-0613-31032). This was supported by the University of Bristol Musculoskeletal Research Unit, Department of Population Health Sciences, NIHR Bristol Biomedical Research Centre and the Department of Orthopaedics at Gothenburg University.

Choice of prosthetic implant combinations in total hip replacement: Cost-effectiveness analysis using UK and Swedish hip joint registries data.

Christopher G Fawsitt, Howard HZ Thom, Linda P Hunt, Szilard Nemes, Ashley W Blom, Nicky J Welton, William Hollingworth, Jóse López-López, Andrew D Beswick, Amanda Burston, Ola Rolfson, Goran Garellick, Elsa MR Marques.

Value in Health 2019;22:303-12. DOI: **https://doi.org/10.1016/j.jval.2018.08.013**

Background

Surgeons select from a constantly evolving range of implant components, combinations and techniques, to improve outcomes following arthroplasty. Different hip implant component materials and techniques are available at a range of costs to the healthcare provider and may have implications for how long the hip replacement will last and the quality of life of the patient after surgery. Our aim was to compare the lifetime cost-effectiveness of different implant combinations for men and women of different age groups undergoing total hip replacement in the UK.

Analyses of individual patients' data in joint registries assess the long-term survival of hip implants and when combined with cost and quality of life data, allows for the relative cost-effectiveness of different implant combinations to be compared, i.e. whether more expensive implants provide better value for money compared with the traditional less expensive combinations.

Methods

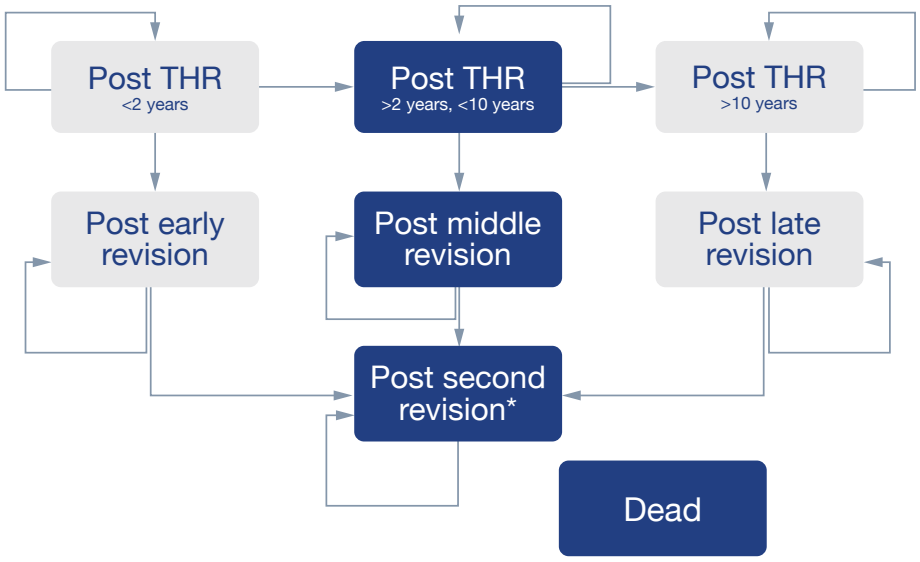
Twenty-four implant combinations defined by bearing surface (MoP, MoM, CoP, and CoC), fixation (cemented, uncemented, hybrid and reverse hybrid) and femoral head size (<36mm diameter=small; 36mm or more=large) were compared (see Table 3.2 on page 283). The reference combination in analyses was the small-head, cemented, MoP hip replacement.

We developed a Markov model with a life-time horizon and one-year cycle length, with tunnel states of ≤2 years, 2 to 10 years, and >10 years after primary hip replacement (see Figure 3.6). Time periods and outcomes were finalised in discussion with hip surgeons and patients. Piecewise constant hazard models were used to estimate the baseline hazard of revision for patients with the reference combination for each period, and hazard rate ratios calculated relative to the reference for the other implant combinations. This was done separately for each age and sex sub-group.

Table 3.2 Total hip replacement implant combinations.

Femoral head-on-acetabular bearing surface materials	Head size	Fixation
Metal-on-polyethylene (MoP)	Large ≥36mm Small <36mm	Cemented Uncemented Hybrid Reverse hybrid
Metal-on-metal (MoM)	Large ≥36mm Small <36mm	Uncemented Hybrid
Ceramic-on-polyethylene (CoP)	Large ≥36mm Small <36mm	Cemented Uncemented Hybrid Reverse hybrid
Ceramic-on-ceramic (CoC)	Large ≥36mm Small <36mm	Uncemented Hybrid

Figure 3.6 Markov model using tunnel states to model outcomes after hip replacement.



*Patients in post–second revision state can experience further revisions but return to the same state thereafter. THR indicates total hip replacement.

Data sources

Revision risks were calculated for primary total hip replacements recorded in the NJR from 2003 to 2016, potentially yielding >13 years of follow-up, and in the Swedish Hip Arthroplasty Register (SHAR) with 25 years of follow-up. NJR data were used for the early and middle periods. Where evidence was available from both registries, the SHAR estimates were calibrated to the NJR and used to predict longer-term NJR estimates and, if NJR information was limited for a sub-group, shorter-term estimates. Both registries provided data on the risk of revisions for men and women in five age groups (<55 years, 55-64 years, 65-74 years, 75-84 years and ≥85 years) across each time period.

Quality-adjusted life years (QALYs) were calculated using published UK utility estimates. All-cause mortality rates were obtained from the Office for National Statistics. Implant costs were obtained from the North Bristol NHS Trust, which were comparable to average prices nationally. The average cost of revision was calculated by weighting the Department of Health national reference costs for revision surgery. Ambulatory care costs for the first 12 months post-surgery were obtained from the literature. All unit costs were valued at 2015/2016 prices.

Estimated costs and QALYs were discounted at 3.5% per annum. The mean incremental net monetary benefit (INMB) statistic was calculated for each implant combination compared with the reference implant, at the National Institute for Health and Care Excellence's lower willingness-to-pay threshold of £20,000 per QALY gained. The implant combination with the highest mean INMB was the most cost-effective implant in each age/sex sub-group. In sensitivity analyses to the results, we varied the prices of implants and theatre time.

Results

In Table 3.3 (page 285), implant combinations are ranked by their expected mean INMB for each age and sex sub-group. In older age groups, small-head cemented MoP total hip replacements consistently had lower implant and lifetime costs, low revision rates, and the same or higher QALY gains than all other implant combinations. The probability that this was the most cost-effective implant combination was high, with more than 80% probability of being the most cost-effective choice for people older than 75 years. Negative mean INMBs, due to higher implant costs or higher revision rates, suggest that alternative implant combinations were not cost-effective.

For men and women younger than 65 years, small-head cemented CoP implants had the highest expected mean INMB, but evidence was uncertain with less than 50% probability of being the most cost-effective choice, driven by imprecise revision rate estimates. Uncemented, hybrid, reverse hybrid, and other bearing surface combinations were not cost-effective in these age groups, partly because of higher implant costs, but also because of poorer estimated revision rates. Across all sub-groups, large-head implant combinations were not cost-effective.

Table 3.3 Total hip replacement implant combinations by age and sex, ranked by mean INMB.

Age group	Top implants	Cost (95% CI)	QALYs (95% CI)	Mean INMB (95% CI)*	Probability most cost effective*
Males					
<55	CoP Cem S	£2,528 (£1,588 to £4,797)	14.10 (13.84 to 14.35)	£1,163 (£-1,147 to £3,356)	0.222
	MoP Cem S	£3,284 (£2,140 to £4,983)	14.08 (13.82 to 14.33)	0	0.002
	CoC Uncem S	£4,226 (£3,150 to £6,339)	14.08 (13.83 to 14.34)	-£754 (-£2,701 to £1,111)	0
55-64	CoP Cem S	£1,576 (£1,221 to £2,374)	10.73 (10.66 to 10.80)	£514 (-£313 to £1,807)	0.477
	MoP Cem S	£1,826 (£1,247 to £3,144)	10.72 (10.64 to 10.79)	0	0.033
	MoP Hyb S	£2,409 (£1,814 to £3,567)	10.72 (10.64 to 10.79)	-£577 (-£1,102 to -£33)	0
65-74	MoP Cem S	£1,300 (£1,112 to £1,510)	7.99 (7.94 to 8.04)	0	0.399
	CoP Cem S	£1,648 (£1,286 to £2,423)	7.99 (7.93 to 8.04)	-£358 (-£1,385 to £117)	0.054
	MoP Hyb S	£1,941 (£1,686 to £2,324)	7.98 (7.93 to 8.04)	-£673 (-£1,079 to -£438)	0
75-84	MoP Cem S	£986 (£907 to £1,071)	5.09 (5.05 to 5.14)	0	0.882
	CoP Cem S	£1,333 (£1,151 to £1,842)	5.09 (5.04 to 5.14)	-£370 (-£1,103 to -£115)	0
	MoP Hyb S	£1,676 (£1,518 to £1,954)	5.09 (5.04 to 5.13)	-£755 (-£-1,087 to -£604)	0
85+	MoP Cem S	£867 (£826 to £916)	2.43 (2.37 to 2.50)	0	0.901
	CoP Cem S	£1,197 (£1,064 to £1,630)	2.43 (2.37 to 2.50)	-£365 (-£1,111 to -£133)	0
	MoP Hyb S	£1,440 (£1,370 to £1,562)	2.43 (2.37 to 2.50)	-£575 (-£734 to -£475)	0
Females					
<55	CoP Cem S	£1,822 (£1,427 to £2,596)	14.48 (14.29 to 14.67)	£823 (£10 to £2,140)	0.499
	MoP Cem S	£2,374 (£1,635 to £3,623)	14.47 (14.28 to 14.66)	0	0.006
	MoP Hyb S	£2,749 (£2,058 to £3,928)	14.47 (14.28 to 14.66)	-£351 (-£1,150 to £520)	0
55-64	CoP Cem S	£1,673 (£1,324 to £2,513)	11.43 (11.36 to 11.49)	£104 (-£729 to £625)	0.281
	MoP Cem S	£1,692 (£1,344 to £2,118)	11.42 (11.36 to 11.49)	0	0.085
	MoP Hyb S	£2,033 (£1,734 to £2,455)	11.43 (11.36 to 11.49)	-£296 (-£582 to £30)	0.001

*At £20,000 willingness to pay threshold.
Note: Cem = cemented; CI = confidence interval; CoC = ceramic-on-ceramic; CoP = ceramic-on-polyethylene; Hyb = hybrid; INMB = incremental net monetary benefit; L = large; MoP = metal-on-polyethylene; QALY = quality-adjusted life-year; RevHyb = reverse hybrid; S = small; Uncem = uncemented.

Table 3.3 (continued)

Age group	Top implants	Cost (95% CI)	QALYs (95% CI)	Mean INMB (95% CI)*	Probability most cost effective*
65-74	MoP Cem S	£1,210 (£1,052 to £1,380)	8.66 (8.61 to 8.70)	0	0.838
	CoP Cem S	£1,452 (£1,233 to £1,982)	8.66 (8.61 to 8.70)	-£218 (-£746 to £14)	0.031
	MoP Hyb S	£1,973 (£1,704 to £2,361)	8.66 (8.61 to 8.70)	-£778 (-£1,103 to -£596)	0
75-84	MoP Cem S	£940 (£877 to £1,007)	5.51 (5.47 to 5.55)	0	0.935
	CoP Cem S	£1,319 (£1,148 to £1,870)	5.51 (5.47 to 5.55)	-£369 (-£879 to -£211)	0
	MoP Hyb S	£1,594 (£1,478 to £1,804)	5.51 (5.47 to 5.55)	-£660 (-£831 to -£587)	0
85+	MoP Cem S	£840 (£810 to £874)	2.75 (2.70 to 2.79)	0	0.99
	CoP Cem S	£1,191 (£1,067 to £1,530)	2.75 (2.71 to 2.79)	-£344 (-£687 to -£220)	0
	MoP Cem L	£1,433 (£900 to £2,200)	2.75 (2.71 to 2.80)	-£498 (-£1,219 to -£66)	0.002

*At £20,000 willingness to pay threshold.
Note: Cem = cemented; CI = confidence interval; CoC = ceramic-on-ceramic; CoP = ceramic-on-polyethylene; Hyb = hybrid; INMB = incremental net monetary benefit; L = large; MoP = metal-on-polyethylene; QALY = quality-adjusted life-year; RevHyb = reverse hybrid; S = small; Uncem = uncemented.

Discussion

For people 65 years and older, small-head cemented MoP total hip replacements are likely to be the most cost-effective. Since 2003, approximately 28.5% of patients with a total hip replacement registered in the NJR have received cemented MoP components. MoP implants are also the most commonly used bearing surface materials in Sweden, Norway, Australia, and the United States, although in some countries, such as the United States and Australia, they are more commonly fixed without cement. Our findings indicate that cemented hip implants are the most cost-effective fixation option, regardless of bearing size and surfaces. Limited availability of data led to imprecise hazard ratios for some implant combinations, particularly in younger patients.

Advantages of using joint registries over randomised controlled trials are large sample sizes, external validity, and longer-term follow-up. However, they may be subject to selection bias. While we stratified our analyses by possible predictors of revision risk: such as implant combination, patient age and sex, and time from surgery; surgeons may actually select patients to receive different implant combinations on the basis of their own surgical training and skills, personal preferences for implant types or brands, individual patient's bone anatomy or comorbidities, or local procurement decisions and costs. These factors are not routinely captured in joint registries and could not be considered in our analyses. We were also unable to evaluate different polyethylenes, since appropriate information was not available from the NJR.

Conclusion

In older patients, the least expensive total hip replacement with small-head, cemented, MoP implants, is likely the most cost-effective. We found no evidence that uncemented, hybrid, or reverse hybrid implants are cost-effective options for any patient group. Although we aimed to provide a comprehensive analysis of all possible implant combinations using the most up-to-date data available, the evidence is too limited to assess some implant combinations. Future research should assess the longer-term outcomes of newer implant combinations.

3.7.5 Geographical variation in outcomes of primary hip and knee replacement

Full paper details:

Geographical Variation in Outcomes of Primary Hip and Knee Replacement.

Cesar Garriga, José Leal, Maria T Sánchez-Santos, Nigel Arden, Andrew Price, Daniel Prieto-Alhambra, Andrew Carr, Amar Rangan, Cyrus Cooper, George Peat, Raymond Fitzpatrick, Karen Barker, Andrew Judge.

JAMA Network Open. 2019 Oct 2;2(10):e1914325. DOI: **https://doi.org/10.1001/jamanetworkopen.2019.14325**

Funding - NIHR Health Services and Delivery Research programme (project number 14/46/02).

Background

Commissioners of healthcare need to focus on quality improvement and reducing unwarranted variations in quality and outcome. In the United Kingdom (UK), the National Health Service Act 2006 (as amended by the Health and Social Care Act 2012), places duties on the NHS Commissioning Board and local clinical commissioning groups to reduce variations in access to, and outcomes from, healthcare services for patients. There are well known geographical variations in the provision of common surgical procedures including hip and knee replacement, as publicised through the NHS Atlas of Variation, but little is known about factors that can explain variation in health outcomes. Outcomes of surgery will vary across different hospitals and areas of the country. This may be explained by a hospital treating more complex and sicker patients, but also by how hospitals organise their services, such as bed availability, numbers of operating theatres and specialist surgeons, using new surgical techniques such as minimally invasive surgery, or centralising care into specialist high volume hospitals.

The aims of this study are: 1) to describe geographical variation in patient outcomes of hip and knee replacement across clinical commissioning groups (CCGs) in England, and 2) to explore whether patient case mix, surgical and hospital organisational factors can explain why such variation exists.

Study design and data source

We performed a retrospective observational cohort study using data obtained from the National Joint Registry (NJR). Primary operations were linked with Hospital Episode Statistics (HES) data and Patient Reported Outcome Measures (PROMs). Hospital organisational factors (workforce, bed availability and operating theatres) were retrieved and linked to HES from The Hospital and Community Health Service Workforce Statistics, the Quarterly Bed Availability and Occupancy and the Supporting Facilities datasets. Between 2014 and 2016 there were 173,107 primary hip replacements (THR) and 210,275 knee replacements (TKR).

Main outcome measures

Length of stay (LOS) was calculated as the number of days between the hospital admission and discharge date. We estimated the inpatient cost relating to the index episode using NHS reference costs from 2015/16. The mean cost per bed-day was based on the healthcare resource use for each patient and their LOS. We assessed absolute change in Oxford hip and knee scores (OHS and OKS) six months after the operation and at baseline. Higher positive values for OHS or OKS change represented greater improvement in pain and function. We defined post-operative complications as one or more events happening up to six months after primary replacement.

Predictor variables

We classified potential predictive variables according to whether they were patient, surgical or hospital organisational factors.

Statistical analysis

Multi-level regression models were used to describe the association of patient, hospital organisation and surgical factors on patient outcomes of surgery.

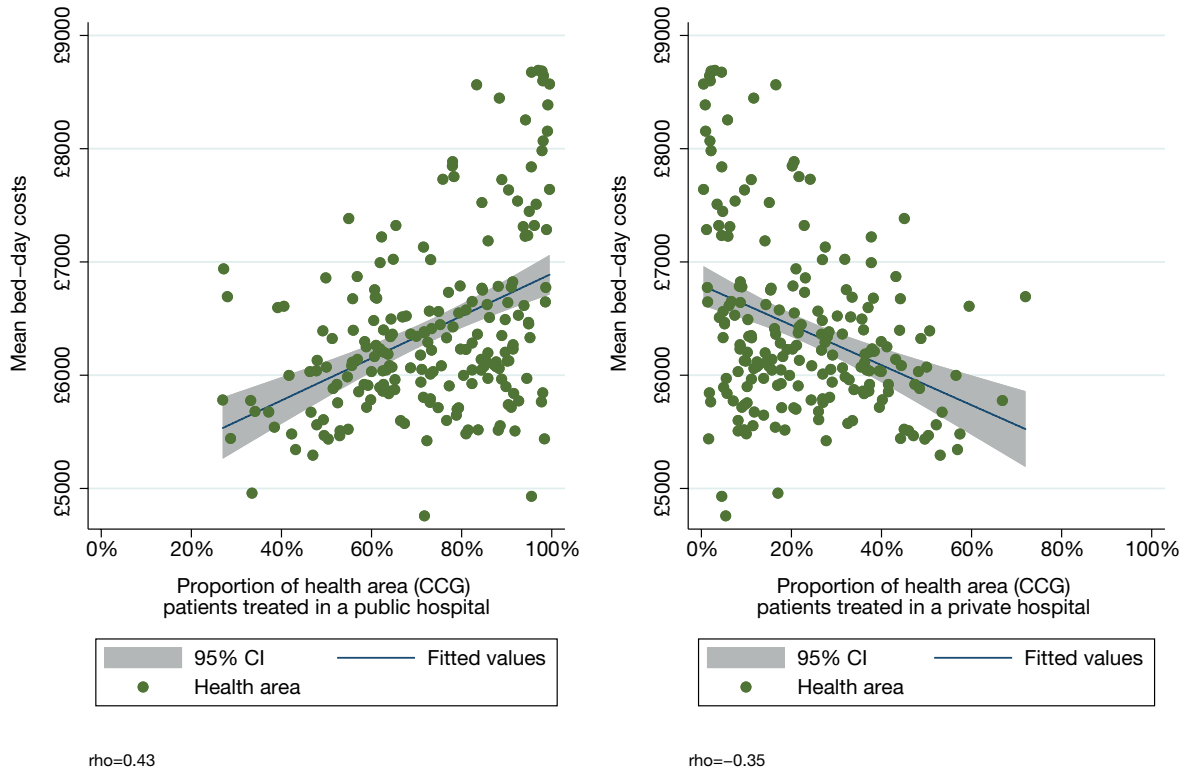
This controlled for evidence of clustering in the data, by allowing outcomes to vary across lower layer super output area (LSOA) and CCGs. We produced ecological correlations at health area level of hospital factors with predicted outcomes. Variation in outcomes was presented using maps of the 2017 CCG areas.

Predictive variables

LOS

Patients aged 80+, those with ASA grade 3+, and those with two or more co-morbidities were associated with longer LOS. Shorter LOS was seen in private hospitals or private treatment centres, in high-volume hospitals and lead surgeons, and among patients reporting better quality of life scores (EQ5D-3L) pre-operatively. Hospitals with 100 or more beds available overnight for trauma and orthopaedics were associated with longer LOS for THR than hospitals with fewer than 35 available beds. Patients undergoing TKR were associated with longer LOS than those having unicompartmental knee replacement. An ecological correlation was observed, where CCG areas with a higher percentage of NHS-funded patients being treated in public hospitals had higher bed-day costs, whereas CCG areas with a high proportion of patients treated in private hospitals had lower bed-day costs (see Figure 3.7). Observed mean bed-day costs by CCG ranged between £4,322 and £8,566 for THR; and £4,564 to £8,901 for TKR. Higher bed-day costs were found for older patients (80+), worse ASA grades, and more than three co-morbidities. Lower bed-day costs were seen in private hospitals or private treatment centres, high volume lead surgeons and hospitals, and a better pre-operative quality of life (EQ5D) score.

Figure 3.7 Bed-day costs vs TKR correlation in public and private hospitals by health area. England (2014-2016).



OHS and OKS change

Greater absolute change in OHS and OKS scores at six months was associated with private hospitals, high-volume hospitals and lead surgeons, better pre-operative EQ5D scores, lower Charlson Comorbidity Index scores, and better ASA grade (0-2). Greater change in OHS was associated with larger femoral head size (≥44 mm) and less deprived areas. Patients aged 60+ were related to a greater change in OKS score.

Complication at six months

Older patients (80+), with higher Charlson Comorbidity Index scores, with worse ASA grades, lower volume surgeons and hospitals, and treated in public hospitals were associated with a higher probability of developing complications in the following six months. Hospitals conducting more surgeries per year correlated ecologically at CCG level with a lower percentage of complications while hospitals with higher proportion of mid-grade or early career doctors correlated with higher percentage of complications. Thromboprophylaxis based on aspirin and less than 200 hip replacements per year in the hospital were also related to complications at six months. Fewer complications were associated with minimally invasive hip replacement surgery. For TKR, private treatment centres and unicompartmental implants were associated with a lower percentage of complications at six months.

Variation in outcomes

LOS

Observed mean LOS by CCG ranged between 2.5 to 6.2 days for THR; and 2.7 to 6.6 days for TKR. Fully adjusted models show that variability across CCGs remained high where 73 out of 207 had a shorter mean LOS and 86 CCGs had a longer mean LOS for THR than average (Figure 3.8 on page 290). For TKR, 87 CCGs had a shorter mean LOS and 75 CCGs had a longer mean LOS. Maps of England with CCG boundaries show the London region had longer mean LOSs while North England and the East showed shorter mean LOS estimates for both THR and TKR (Figure 3.9 on page 291). Mean bed-day costs ranged between £4,727 (SD £1,026) and £8,800 (SD £1,572) for THR. For TKR, mean bed-day costs ranged between £4,758 (SD £1,096) and £8,692 (SD £1,507).

Figure 3.8 Caterpillar plots of patient outcomes for primary hip replacement by health area in England (2014-2016).

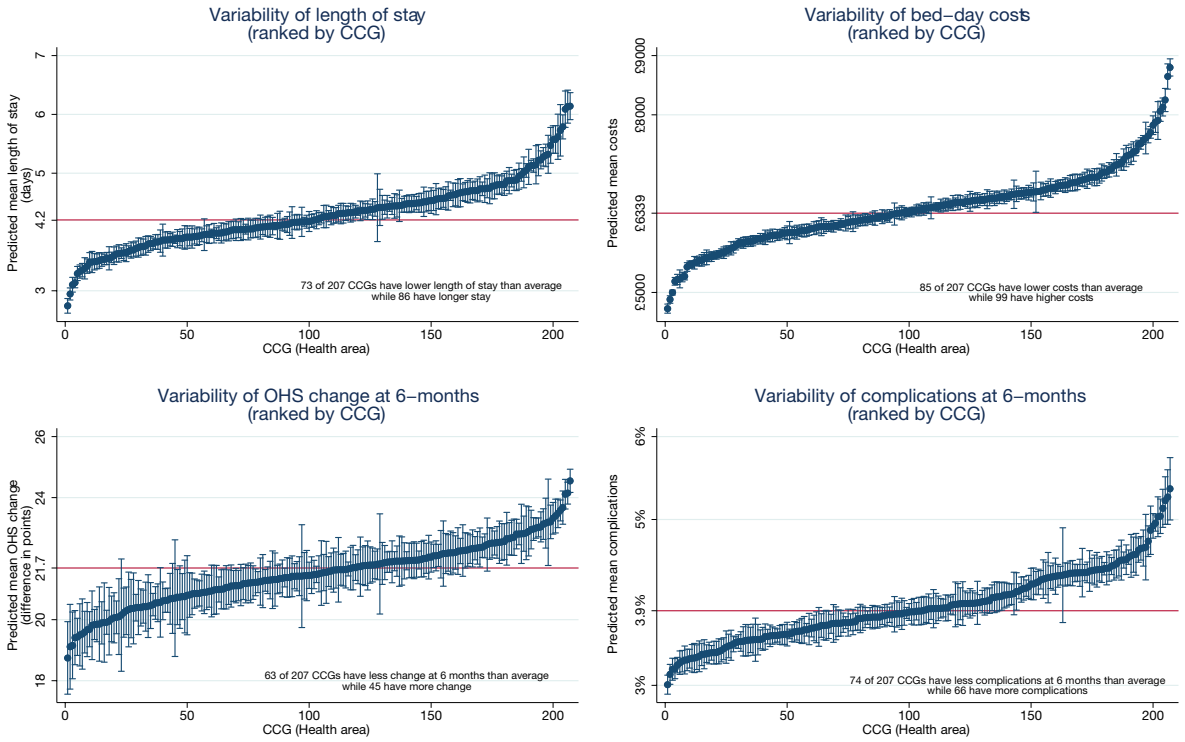
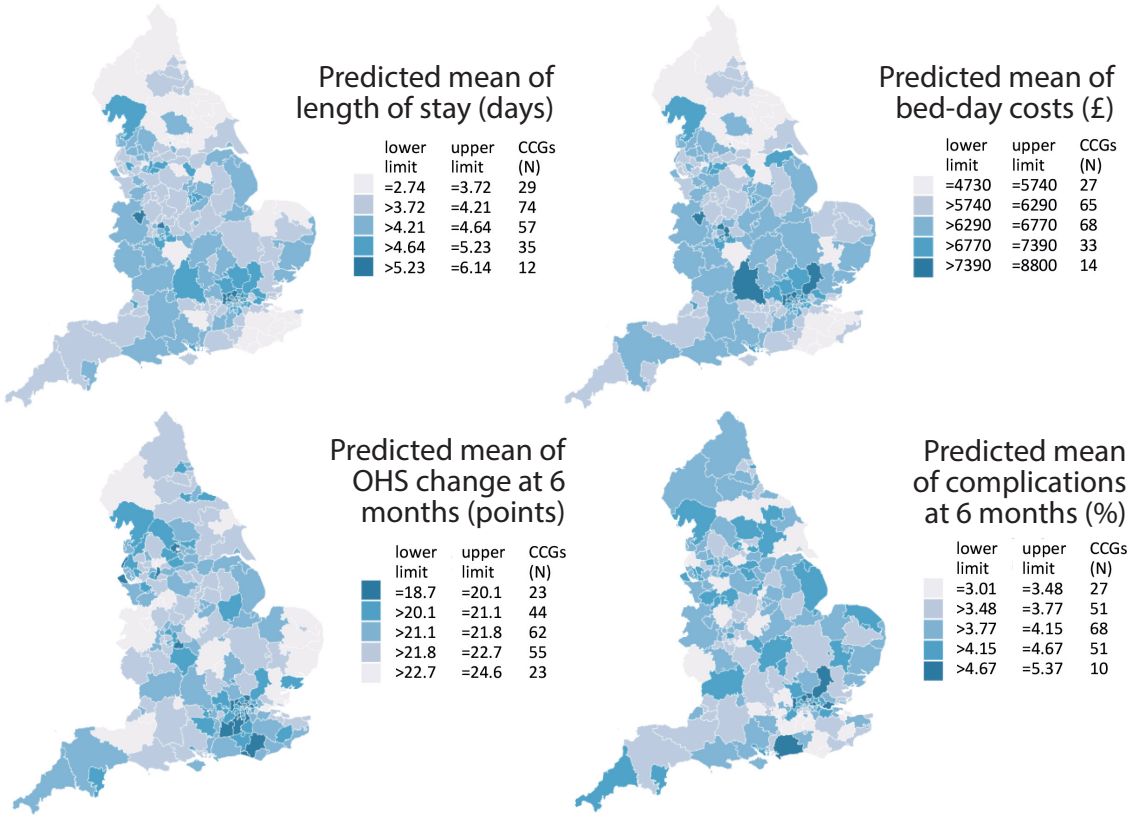


Figure 3.9 Maps of patient outcomes for primary hip replacement across 207 health areas in England (2014-2016).



OHS and OKS change

Observed mean OHS change by CCG ranged between 17.5 points and 24.9 points; and 11.2 points to 19.1 points for OKS. Caterpillar plots exploring the variability for OHS change (Figure 3.8) in fully adjusted models demonstrated less variability between CCGs, with 63 CCGs having lower OHS change and 45 having higher. Variation between CCGs was greater for OKS change with 78 CCGs having less OKS change and 55 having greater change.

Complication at six months

Observed complications at six months by CCG ranged between 2.0% and 8.6% for THR; and 1.5% to 8.4% for TKR. Fully adjusted models showed 66 CCGs having higher complications for patients undergoing THR (Figure 3.8). For TKR there was more variability where 81 CCGs had higher complications. The London region had a higher percentage of complications (Figure 3.9).

Discussion

There is substantial variation in patient outcomes of THR and TKR across CCG areas that remained after adjusting for patient case mix and surgical factors. Hospital organisational factors had some influence on explaining this variation. Variation in outcomes between CCGs was greater for TKR than for THR. LOS had high variation between CCGs. There was less variation between CCGs for OHS and OKS change outcomes, whilst there was relatively little CCG variation for 6-month complications. Of note was the substantial variation within each CCG for the OHS and OKS change outcomes.

Previous research has shown that public hospitals that had a private hospital close by experienced substantial reductions in pre-surgery length of stay for hip and knee replacement, where the authors suggested that hospitals exposed to competition from new private entrants became more efficient. However, the negative consequence was a worsening in the complexity and case mix of patients being treated in the public hospitals, with this contributing to an increase in public hospitals post-surgery LOS. Whilst policy makers may have intended this differential in healthier and sicker (straightforward and complex) patients between public and private hospitals, there has potentially been unintended consequences.

The ecological correlations at CCG level between public and private hospitals in bed-day costs could be explained by greater hospital efficiencies in the private setting. However, the changing case mix of public hospitals treating an increasing number of more complex, sicker, more obese, and elderly patients in those areas with competing private hospitals, could also explain regional variability. In addition, health areas with hospitals and lead surgeons performing a higher volume of joint replacement per year could explain variation between regions. Although we have shown that this is unlikely to be explained by our population is different as we have accounted for patient case mix factors, there will still be residual confounding and selection bias, particularly between public and private hospitals in respect of patient selection, that cannot be fully accounted for by adjustment in a regression model and observational study design.

4. Implant and unit-level activity and outcomes

This section of the annual report gives performance and data entry quality indicators for trusts and local health boards (many of whom comprise more than one hospital) and independent (private) providers in England, Wales, Northern Ireland and the Isle of Man for the 2019 calendar year. Outcomes analysis after hip and knee replacement surgery is also provided for the period 2010 to 2020.

This section also provides data for implant outliers since 2003 and further information on notification and last usage date.

The full analysis for units can be found in the document available in the downloads section at reports.njrcentre.org.uk

4.1 Implant performance

The Implant Scrutiny Committee reports Level 1 outlier implants to the MHRA. Since the committee's formation in 2009 there have been seven hip stems, ten hip acetabular (cup) components and 34 hip stem/cup combinations reported. A total of 12 knee brands have been notified. This year, knee implants with and without patella resurfacing are included in implant outlier analysis.

An implant is considered to be a Level 1 outlier when its Prosthesis Time Incident Rate (PTIR) is more than twice the PTIR of the group, allowing for confidence intervals. These are shown as the number of revisions per 100 prosthesis-years. As of March 2015, we have started to identify the best performing implants, these would have a PTIR less than half that of their group, allowing for confidence intervals. To date no implants have reached that level.

Components and constructs previously reported to MHRA, but no longer at Level 1, are not listed.

Hip implant performance

Table 4.1 Level 1 outlier stems reported to MHRA.

Stem name	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR	2,924	2.71	2010	2010
Corin Proxima*	105	2.23	2011	2009
S-ROM Cementless stem*	3,256	1.30	2013	Still in use
Adept Cementless stem*	227	1.93	2017	2010
Freeman cementless	330	1.33	October 2019	2010
DePuy Proxima	342	1.37	October 2019	2014
Twinsys cementless	1,065	1.18	October 2019	2018

*Inclusion here is mainly due to metal-on-metal combinations.

Table 4.2 Level 1 outlier acetabular components reported to MHRA.

Cup name	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR*	6,255	3.84	2010	2010
Ultima MoM cup*	193	1.76	2010	2006
R3 with metal liner**	150	3.02	2011	2011
M2A38*	1,484	1.74	2014	2011
Delta One TT	344	1.42	2015	Still in use
Trabecular Metal Revision Shell	399	1.42	2017	Still in use
seleXys TH+	184	1.84	2018	2011
Pinnacle with metal liner**	15,558	1.36	2018	2013
MIHR cup*	256	1.83	June 2019	2011

*Inclusion here is mainly due to metal-on-metal combinations.
**Metal-on-metal.

Table 4.3 Level 1 outlier stem/cup combinations.

Combination	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR Resurfacing Head / ASR Resurfacing Cup*	2,914	2.71	2010	2010
Metafix Stem / Cormet 2000 Resurfacing Cup*	173	2.68	2010	2011
CPT / Adept Resurfacing Cup*	268	3.11	2011	2010
Corail / ASR Resurfacing Cup*	2,729	5.23	2011	2010
CPT / BHR Resurfacing Cup*	116	2.40	2011	2010
Accolade / Mitch TRH Cup*	274	2.56	2011	2011
Summit Cementless Stem / ASR Resurfacing Cup*	128	4.61	2012	2009
CPT / Durom Resurfacing Cup*	184	2.30	2012	2009
S-Rom Cementless Stem / ASR Resurfacing Cup*	147	3.83	2012	2010
CPCS / BHR Resurfacing Cup*	255	1.52	2012	2010
Anthology / BHR Resurfacing Cup*	510	2.85	2012	2011
SL-Plus Cementless Stem / Cormet 2000 Resurfacing Cup*	627	2.18	2013	2010
Profemur L Modular / Conserve Plus Resurfacing Cup*	159	2.48	2013	2010
Bimetric Cementless Stem / M2A 38*	1,302	1.78	2014	2011
Corin Proxima / Cormet 2000 Resurfacing Cup*	102	2.32	2015	2009
Synergy Cementless Stem / BHR Resurfacing Cup*	1,584	2.10	2016	2011
Adept Cementless Stem / Adept Resurfacing Cup*	200	2.05	2017	2010
Exeter V40 / Trabecular Metal Revision Shell	172	1.47	2017	2017
CLS Cementless Stem / Adept Resurfacing Cup*	218	2.57	2017	2011
Spectron / Opera	216	1.07	2018	2014
Exeter V40 / Mitch*	121	1.33	2018	2010
Twinsys Cementless Stem / Adept Resurfacing Cup*	130	1.92	2018	2010
CLS Spotorno Cementless Stem / Durom Resurfacing Cup*	929	2.57	2018	2018
S-Rom Cementless Stem / Pinnacle*	2,044	1.33	2018	Still in use
S-Rom Cementless Stem / Ultima Mom Cup	105	1.52	October 2019	2005
Taperloc Cementless Stem / M2A 38*	138	1.49	October 2019	2010
Versys FMT Cementless Stem / Durom Resurfacing Cup*	182	1.47	October 2019	2010
Restoration Cementless Stem / Tritanium	109	3.51	June 2020	Still in use
Furlong HAC Stem / MIHR Cup	134	1.42	June 2020	2010

*Metal-on-metal.

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Best performing hip implants

There are no hip implants or combinations performing statistically less than half their expected PTIR.

Knee implant performance

Table 4.4 Level 1 outlier implants reported to MHRA.

Knee brand	Number implanted	Latest PTIR	Notified as outlier	Last implanted
JRI Bicondylar Knee	247	1.69	2009	2008
Tack	231	1.65	2009	2008
St Leger	104	1.69	2011	2005
Journey Deuce	151	2.64	2014	2013
SLK Evo	103	1.69	2016	2013
ACS	198	1.72	2017	2017
Journey Oxinium	825	1.03	2017	2014
Smiles hinged knee*	710	1.59	2018	Still in use
Endo-Model Modular Rotating Hinge*	230	2.22	June 2019	Still in use
Journey II BCS Oxinium without primary patella	691	1.72	June 2020	Still in use
E-Motion Bicondylar Knee with primary patella	329	1.44	June 2020	Still in use

*Hinged knee prostheses are more often used in complex primaries, when compared to all total knees replacements.
Note: Analysis of knee implant outliers with and without patella resurfacing commenced in 2020.

Best performing knee implants

There are no knee implants performing statistically less than half their expected PTIR.

4.2 Clinical activity

Overall in 2019, 145 NHS trusts and local health boards (comprising 251 separate hospitals) and 178 independent hospitals were open and eligible to report patient procedures to the NJR. All units except for one NHS trauma unit and two independent units submitted data in 2019. The proportion of all hip and knee joint replacements entered into the NJR compared to those entered in HES, is only available by NHS trust. No data on this is currently available from private providers and figures also exclude units in Northern Ireland as compliance data is not available.

At the time of publication, it has not been possible to produce compliance figures for the financial year 1 April 2019 to 31 March 2020 due to the unavailability of data from the Hospital Episodes Statistics (HES) service.

Of those hospitals submitting data, the proportion of patients who gave permission (consent) for their details to be entered into the NJR were:

NHS hospitals

- 45% of NHS hospitals achieved a consent rate of greater than 95%
- 34% achieved a consent rate of 80% to 95%
- 21% recorded a consent rate of less than 80%

Independent hospitals

- 71% of independent hospitals achieved a consent rate greater than 95%
- 25% achieved a consent rate of 80% to 95%
- 4% recorded a consent rate of less than 80%

There has been an increase in recorded consent for all submitting units when compared to the previous year, with those achieving a higher than 95% rate returning to 55% from 50% in 2018. The proportion of all units achieving a higher than 80% consent rate, has also increased.

Similarly, the proportion of entries in which there is significant data to enable the patient to be linked to an NHS number (linkability) is listed.

NHS hospitals

- 82% achieved a proportion of patients with a linkable NHS number greater than 95%
- 16% achieved a proportion of 80% to 95%
- 2% recorded a proportion of less than 80%

Independent hospitals

- 76% achieved a proportion of patients with a linkable NHS number greater than 95%
- 18% achieved a proportion of 80% to 95%
- 6% recorded a proportion of less than 80%

There has again been a drop in linkability from 2018, with the percentage of submitting units achieving over 95% in 2019 falling from 81% to 80%. The proportion achieving a greater than 80% linkability rate has remained the same at 96% compared with 2018.

Note: Independent hospitals might be expected to have lower linkability rates than NHS hospitals, as a proportion of their patients may come from overseas and do not have an NHS number.

4.3 Outlier units for 90-day mortality and revision rates for the period 2010 to 2020

The observed numbers of revisions of hip and knee replacements for each hospital were compared to the numbers expected, given the unit's case-mix in respect of age, gender and reason for primary surgery. Hospitals with a much higher than expected revision rate for hip and knee replacement have been identified. These hospitals had a revision rate that was above the upper of the 99.8% control limits (these limits approximate to +/-3 standard deviations). We would expect 0.2% (i.e. one in 500) to lie outside the control limits by chance, with approximately half of these (one in 1,000) to be above the upper limit.

When examined over the past ten years of the registry, a total of 40 hospitals reported higher than expected rates of revision for knee replacement, and 25 hospitals had higher than expected rates of revision for hip surgery. However, revisions taken only from the last five years of the registry showed only 15 hospitals reporting higher than expected rates for knees, and ten for hips.

The 90-day mortality rate for primary hip and knee replacement was calculated using the last five years of data for all hospitals by plotting standardised mortality ratios for each hospital against the expected number of deaths. No hospitals had higher than expected mortality rates for either hip or knee replacement.

Note: The case mix for mortality includes age, gender and ASA grade. Trauma cases have been excluded from both the hip and knee mortality analyses together with hips implanted for failed hemi-arthroplasty or for

metastatic cancer (the latter only from November 2014 when recording of this reason began). Also, where both left and right side joints were implanted on the same day, only one side was included in the analysis.

Note: Any units identified as potential outliers here have been notified. All units are provided with an NJR Annual Clinical Report and additionally have access to the online NJR Management Feedback system.

Important note about the outlier hospitals listed

In earlier annual reports, the NJR reported outlying hospitals based on all cases submitted to the NJR since 1 April 2003. To reflect changes in hospital practices and component use, the NJR now reports outlying hospitals based on the last ten years (15 February 2010 to 14 February 2020) and five years of data (15 February 2015 to 14 February 2020 inclusive, the latter date being when the dataset was cut). These cuts of data exclude the majority of withdrawn outlier implants and metal-on-metal total hip replacements from analysis, and thus better represent contemporary practice.

Table 4.5 Outliers for Hip mortality rates since 2015[2].

Hospital name
None identified

Table 4.6 Outliers for Knee mortality rates since 2015[2].

Hospital name
None identified

Table 4.7 Outliers for Hip revision rates, all linked primaries from 2010[1].

Hospital name
Ashtead Hospital (Surrey)
Basingstoke and North Hampshire Hospital
BMI Clementine Churchill Hospital (Middlesex)
BMI The Meriden Hospital (West Midlands)
Chesterfield Royal Hospital
Colchester General Hospital
Fitzwilliam Hospital (Cambridgeshire)
Hexham General Hospital
Homerton University Hospital
Milton Keynes Hospital
North Downs Hospital (Surrey)
North Tyneside General Hospital
Nuffield Orthopaedic Centre
Salisbury District Hospital
South Tyneside District Hospital
Southampton General Hospital
Spire Liverpool Hospital (Merseyside)
St Richard's Hospital
Sussex Orthopaedic NHS Treatment Centre
The Holly Private Hospital (Essex)
University Hospital (Coventry)
Wansbeck Hospital
Watford General Hospital
Weston General Hospital
Wrexham Maelor Hospital

Table 4.8 Outliers for Hip revision rates, all linked primaries from 2015[2].

Hospital name
BMI The Meriden Hospital (West Midlands)
Fitzwilliam Hospital (Cambridgeshire)
Hexham General Hospital
Milton Keynes Hospital
North Tyneside General Hospital
Nuffield Health Cheltenham Hospital (Gloucestershire)
Salisbury District Hospital
Southampton General Hospital
Wansbeck Hospital
Weston General Hospital

Table 4.9 Outliers for Knee revision rates, all linked primaries from 2010[1].

Hospital name
Abergele Hospital
Ashford Hospital
BMI Bishops Wood Hospital (Middlesex)
BMI Goring Hall Hospital (West Sussex)
BMI The London Independent Hospital (Greater London)
BMI The Meriden Hospital (West Midlands)
Broadgreen Hospital
Charing Cross Hospital
County Hospital Louth
Diana Princess of Wales Hospital
Ealing Hospital
Guy's Hospital
Heatherwood Hospital
Hillingdon Hospital
Hinchingbrooke Hospital
Homerton University Hospital
Horton NHS Treatment Centre (Oxfordshire)
King Edward VII Hospital Sister Agnes (Greater London)
Mount Vernon Treatment Centre
Nevill Hall Hospital
Nottingham City Hospital
Nuffield Health Chichester Hospital (West Sussex)
Orthopaedics and Spine Specialist Hospital (Cambridgeshire)
Queen Elizabeth The Queen Mother Hospital
Riverside Treatment Centre
South Tyneside District Hospital
Southampton General Hospital
Southmead Hospital
Spire Hull and East Riding Hospital (East Yorkshire)
Spire Southampton Hospital (Hampshire)
Springfield Hospital (Essex)
St Albans City Hospital
St Mary's Hospital
St Richard's Hospital
Sussex Orthopaedic NHS Treatment Centre
The Royal National Orthopaedic Hospital (Stanmore)
University College Hospital
University Hospital Aintree
University Hospital Llandough
York Hospital

Table 4.10 Outliers for Knee revision rates, all linked primaries from 2015[2].

Hospital name
Barlborough NHS Treatment Centre (Derbyshire)
BMI Bath Clinic (Avon)
BMI The Meriden Hospital (West Midlands)
Guy's Hospital
Heatherwood Hospital
Hillingdon Hospital
King Edward VII Hospital Sister Agnes (Greater London)
Nuffield Orthopaedic Centre
Ormskirk and District General Hospital
Southmead Hospital
Spire Southampton Hospital (Hampshire)
Springfield Hospital (Essex)
Sussex Orthopaedic NHS Treatment Centre
The Lister Hospital (London)
The North East NHS Surgery Centre

Note: 1 Date range 15 February 2010 to 14 February 2020 inclusive.
2 Date range 15 February 2015 to 14 February 2020 inclusive.

4.4 Better than expected performance

This year we have again listed hospitals where revision rates are statistically better than expected. The lists here show units that lie below the 99.8% control limit which also achieved greater than 90% compliance across all of the NJR data quality audits. Units with lower data quality compliance are automatically excluded from these lists.

Table 4.11 Better than expected for Hip revision rates, all linked primaries from 2010[1].

Hospital name
Calderdale Royal Hospital
Ipswich Hospital
Luton and Dunstable Hospital
Musgrave Park Hospital
Nuffield Health Derby Hospital (Derbyshire)
Queens Medical Centre Nottingham University Hospital
Royal Derby Hospital
Royal Devon and Exeter Hospital (Wonford)
Royal Surrey County Hospital

Table 4.12 Better than expected for Hip revision rates, all linked primaries from 2015[2].

Hospital name
Calderdale Royal Hospital
Ipswich Hospital
Royal Surrey County Hospital

Table 4.13 Better than expected for Knee revision rates, all linked primaries from 2010[1].

Hospital name
Bishop Auckland Hospital
BMI Alexandra Hospital Cheadle (Cheshire)
Burnley General Hospital
Calderdale Royal Hospital
Colchester General Hospital
Hexham General Hospital
Ipswich Hospital
Musgrave Park Hospital
Norfolk and Norwich Hospital
North Tyneside General Hospital
Nottingham Woodthorpe Hospital (Nottinghamshire)
Nuffield Health Derby Hospital (Derbyshire)
Nuffield Health Ipswich Hospital (Suffolk)
Princess Alexandra Hospital
Royal Derby Hospital
Spire Norwich Hospital (Norfolk)
Spire Parkway Hospital (West Midlands)
Stepping Hill Hospital
Worcestershire Royal Hospital

Table 4.14 Better than expected for Knee revision rates, all linked primaries from 2015[2].

Hospital name
Ipswich Hospital
Musgrave Park Hospital
Spire Norwich Hospital (Norfolk)
The Cheshire and Merseyside Treatment Centre
The Horder Centre (East Sussex)

Note: 1 Date range 15 February 2010 to 14 February 2020 inclusive.
2 Date range 15 February 2015 to 14 February 2020 inclusive.

Glossary

A	
ABHI	Association of British HealthTech Industries – the UK trade association of medical device suppliers.
Acetabular component	The portion of a total hip replacement prosthesis that is inserted into the acetabulum – the socket part of a ball and socket joint.
Acetabular cup	See Acetabular component.
Acetabular prosthesis	See Acetabular component.
Administrative censoring	Administrative censoring is the process of defining the end of the observation period for the cohort. All patients are assumed to have experienced either a revision, be dead or alive at the censoring date.
ALVAL	Aseptic Lymphocyte-dominated Vasculitis-Associated Lesion. This term is used in the Annual Report to describe the generality of adverse responses to metal debris, but in its strict sense refers to the delayed type-IV hypersensitivity response.
Amputation	The surgical removal of a limb.
Antibiotic-loaded bone cement	A bone cement which contains pre-mixed antibiotics, this is distinct from plain bone cement which contains no antibiotics. See Bone cement.
Arthrodesis	A procedure where the bones of a natural joint are fused together (stiffened).
Arthroplasty	A procedure where a native joint is surgically reconstructed or replaced with an artificial prosthesis.
ASA	American Society of Anaesthesiologists scoring system for grading the overall physical condition of the patient, as follows: P1 – fit and healthy; P2 – mild disease, not incapacitating; P3 – incapacitating systemic disease; P4 – life threatening disease; P5 – expected to die within 24 hrs without an operation.
B	
BASK	British Association for Surgery of the Knee.
Bearing type	The two surfaces that articulate together in a joint replacement. Options described in the report include metal-on-polyethylene, metal-on-metal, ceramic-on-polyethylene, ceramic-on-metal, ceramic-on-ceramic and in dual mobility hip replacements metal-on-polyethylene-on-metal and ceramic-on-polyethylene-on-metal.
BESS	British Elbow and Shoulder Society.
Beyond Compliance	A system of post market surveillance initiated in 2013. Under this system, Beyond Compliance collates NJR data, national PROMs and data from implanting surgeons, and monitors the usage and performance of implants which are new to the market.
BHS	British Hip Society.
Bilateral operation	Operation performed on both sides, e.g. left and right knee procedures, carried out on the same day or on different days.
BOA	British Orthopaedic Association – the professional body representing orthopaedic surgeons in the UK.
Body mass index (BMI).	A statistical tool used to estimate a healthy body weight based on an individual's height. The BMI is calculated by dividing a person's weight (kg) by the square of their height (m^2).
BOFAS	British Orthopaedic Foot and Ankle Society.
Bone cement	The material used to fix cemented joint replacements to bone – polymethyl methacrylate (PMMA).
Brand (of prosthesis)	The brand of a prosthesis (or implant) is the manufacturer's product name, e.g. the Exeter V40 brand for hips, the PFC Sigma brand for knees, the Zenith brand for ankles, the Delta Xtend brand for shoulders and the Coonrad Morrey for elbows.
C	
Case ascertainment	Proportion of all relevant joint replacement procedures performed that are entered into the NJR.
Case mix	Term used to describe variation in surgical practice, relating to factors such as indications for surgery, patient age and gender.
Cement	See Bone cement.
Cemented	Prostheses designed to be fixed into the bone using bone cement.

Cementless	See Uncemented.
Compliance	The percentage of total joint procedures that have been entered into the NJR where the denominator is defined as the number of all eligible procedures.
Confidence Interval (CI)	A 'Confidence Interval' (CI) illustrates the uncertainty of an estimated statistic. For example, a CI for the cumulative probability of revision tells us the probability that 'true' (population) probability of revision will fall between the range of values on a specified percentage, typically 95%, of occasions if the data collection was repeated.
Confounding	Confounding occurs when either a measured or unmeasured factor (variable) distorts the true relationship between the exposure and outcome of interest. For example, a comparison of the revision rates between two distinct types of implant may be 'confounded' by the virtue that one implant has been used on an older group of patients compared to the other. In this context, age may be a 'confounder' if it distorts the relationship between implant type and outcome i.e. revision rate. Statistical methods may help to 'adjust' for such confounding factors however residual confounding of an association may always persist.
Conventional total shoulder replacement	Replacement of the shoulder joint which replicates the normal anatomical features of a shoulder joint.
Cox 'proportional hazards' model	A type of multivariable regression model used in survival analysis to look at the effects of a number of variables ('exposures') on outcome (first revision or death). The effect of each variable is adjusted for the effects of all the other 'exposure' variables in the model. Some regression models used in survival modelling make assumptions about the way the hazard rate changes with time (see 'hazard rate'). The Cox model doesn't make any assumptions about how the hazard rate changes, however it does assume that the exposure variables affect the hazard rates in a 'proportional' way.
CQC	Care Quality Commission. Regulators of care provided by the NHS, local authorities, private companies and voluntary organisations.
Cumulative Incidence Function (CIF)	A different way of estimating failure compared to Kaplan-Meier, see Kaplan-Meier. Also known as observed or crude failure, as the estimate reflects what is seen in practice.
Cup	See Acetabular component.
D	
DAIR	Debridement And Implant Retention. In cases of infection, the surgeon may debride (surgically clean) the surgical site and retain the joint replacement implants.
DAIR with Modular Exchange	Debridement And Implant Retention with Modular Exchange. In cases of infection where the implants are modular, the surgeon may debride (surgically clean) the surgical site, exchange the modular components (e.g. head, acetabular liner) and retain the non-modular joint replacement implants.
Data collection periods for annual report analysis	Outcomes analyses present data for hip, knee, ankle, elbow and shoulder procedures that took place between 1 April 2003 and 31 December 2019 inclusive. Hospital (unit) level analyses present data for hip and knee procedures undertaken between 1 January and 31 December 2019 inclusive. Online interactive reporting presents data for each calendar year - 1 January to 31 December inclusive. Hospital (unit) outlier analysis is performed on the last five and ten years of data up to 14 February 2020.
DDH	Developmental dysplasia of the hip. A condition where the hip joint is malformed, usually with a shallow socket (acetabulum), which may cause instability.
Distal humeral hemiarthroplasty	A type of elbow replacement which only replaces the distal part of the humerus.
DHSC	Department of Health and Social Care.
Dual mobility	Dual mobility is a type of total hip replacement which contains two articulating bearing surfaces. The distal bearing surface consists of a standard femoral head which articulates within a large polyethylene bearing. The proximal bearing surface consists of an acetabular bearing which articulates against a large polyethylene bearing. The femoral head and acetabular bearing can be made of metal or ceramic.
DVT	Deep vein thrombosis. A blood clot that can form in the veins of the leg and is recognised as a significant risk after joint replacement surgery.

E	
Episode	An event involving a patient procedure such as a primary or revision total prosthetic replacement. An episode can also consist of two consecutive procedures, e.g. a stage one of two-stage revision, followed by a stage two of two-stage revision.
Excision arthroplasty	A procedure where the articular ends of the bones are simply excised, so that a gap is created between them, or when a joint replacement is removed and not replaced by another prosthesis.
F	
Femoral component (hip)	Part of a total hip joint that is inserted into the femur (thigh bone) of the patient. It normally consists of a stem and head (ball).
Femoral component (knee)	Portion of a knee prosthesis that is used to replace the articulating surface of the femur (thigh bone).
Femoral head	Spherical portion of the femoral component of the artificial hip replacement. May be modular or non-modular i.e. attached to the stem, see monobloc.
Femoral prosthesis	Portion of a total joint replacement used to replace damaged parts of the femur (thigh bone).
Femoral stem	The part of a modular femoral component inserted into the femur (thigh bone). It has a femoral head mounted on it to form the complete femoral component in hip replacement or may be added to the femoral component of a total knee replacement, usually in the revision setting.
Funnel plot	A graphical device to compare unit or surgeon performance. Measures of performance (e.g. a ratio of number of observed events to the expected number based on case-mix) are plotted against an interpretable measure of precision. Control limits are shown to indicate acceptable performance. Points outside of the control limits suggest 'special cause' as opposed to 'common cause' variation (see for example D Spiegelhalter, Stats in Medicine, 2005).
G	
Glenoid component	The portion of a total shoulder replacement prosthesis that is inserted into the scapula – the socket part of a ball and socket joint in conventional shoulder replacement or the ball part in reverse shoulder replacement.
H	
Hazard rate	Rate at which 'failures' occur at a given point in time after the operation conditional on 'survival' up to that point. In the case of first revision, for example, this is the rate at which new revisions occur in those previously unrevised.
Head	See Femoral head and/or Humeral head and/or Radial head component (elbow).
Healthcare provider	NHS or independent sector organisation that provides healthcare; in the case of the NJR, orthopaedic hip, knee, ankle, elbow or shoulder replacement surgery.
HES	Hospital Episode Statistics. A data source managed by NHS Digital which contains data on conditions (ICD-10 codes), procedures (OPCS-4 codes) in addition to other hospital statistics collected routinely by NHS hospitals in England.
Highly cross-linked polyethylene	See Modified Polyethylene.
HQIP	Healthcare Quality Improvement Partnership. Hosts the NJR on behalf of NHS England. Promotes quality in health and social care services and works to increase the impact that clinical audit has nationally.
Humeral component (elbow/distal)	Part of a total elbow joint that is inserted into the humerus (upper arm bone) of the patient to replace the articulating surface of the humerus.
Humeral component (shoulder/proximal)	Part of a total or partial shoulder replacement that is inserted into the humerus (upper arm bone) of the patient. It normally consists of a humeral stem and head (ball) in conventional shoulder replacement or a humeral stem and a humeral cup in a reverse shoulder replacement.
Humeral head	Domed head portion of the humeral component of the artificial shoulder replacement attached to the humeral stem.
Humeral prosthesis	Portion of a shoulder replacement used to replace damaged parts of the humerus (upper arm bone).

Humeral stem	The part of a modular humeral component inserted into the humerus (upper arm bone). Has a humeral head or humeral cup mounted on it to form the complete humeral implant.
Hybrid procedure	Joint replacement procedure in which cement is used to fix one prosthetic component while the other is cementless. For hip procedures, the term hybrid covers both reverse hybrid (uncemented stem, cemented socket) and hybrid (cemented stem, uncemented socket) unless separately defined.
I	
ID	A generic term for pseudo anonymised patient identification number, whether that be a pseudo anonymised NHS number, local hospital patient identifier or combination of personal characteristics.
Image/computer-guided surgery	Surgery performed by the surgeon, using real-time images and data computed from these to assist alignment and positioning of prosthetic components.
Inconsistent operative pattern	A sequence of operations where the primary operation is not the first operation in the sequence or where there are multiple primary operations.
Independent hospital	A hospital managed by a commercial company that predominantly treats privately-funded patients but does also treat NHS-funded patients.
Index joint	The primary joint replacement that is the subject of an NJR entry.
Indication (for surgery)	The reason for surgery. The NJR system allows for more than one indication to be recorded.
Ipsilateral procedure	An operation performed on one side, e.g. left or right knee procedures.
IQR	The interquartile range shows a range of values from the 25th (first quartile) and 75th (third quartile) centiles of a variables distribution.
ISTC	Independent sector treatment centre. See Treatment centre.
K	
Kaplan-Meier	Used to estimate the cumulative probability of 'failure' at various times from the primary operation, also known as Net Failure. 'Failure' may be either a first revision or a death, depending on the context. The method properly takes into account 'censored' data. Censorings arise from incomplete follow-up; for revision, for example, a patient may have died or reached the end of the analysis period (end of 2019) without having been revised.
L	
Lateral resurfacing (elbow)	Partial resurfacing of the elbow with a humeral surface replacement component used with a lateral resurfacing head inserted with or without cement.
LHMoM	Large head metal-on-metal. Where a metal femoral head of 36mm diameter or greater is used in conjunction with a femoral stem, and is articulating with either a metal resurfacing cup or a metal liner in a modular acetabular cup. Resurfacing hip replacements are excluded from this group.
Linkable percentage	Linkable percentage is the percentage of all relevant procedures that have been entered into the NJR, which may be linked via NHS number to other procedures performed on the same patient.
Linkable procedures	Procedures entered into the NJR database that are linkable to a patient's previous or subsequent procedures by the patient's NHS number.
Linked total elbow	Where the humeral and ulnar parts of a total elbow replacement are structurally coupled.
LMWH	Low molecular weight Heparin. A blood-thinning drug used in the prevention and treatment of deep vein thrombosis (DVT).
M	
MDS	Minimum dataset, the set of data fields collected by the NJR. Some of the data fields are mandatory (i.e. they must be filled in). Fields that relate to patients' personal details must only be completed where informed patient consent has been obtained.
MDSv1	Minimum dataset version one, used to collect data from 1 April 2003. MDSv1 closed to new data entry on 1 April 2005.
MDSv2	Minimum dataset version two, introduced on 1 April 2004. MDSv2 replaced MDSv1 as the official dataset on 1 June 2004.

MDSv3	Minimum dataset version three, introduced on 1 November 2007 replacing MDSv2 as the new official dataset.
MDSv4	Minimum dataset version four, introduced on 1 April 2010 replacing MDSv3 as the new official dataset. This dataset has the same hip and knee MDSv3 dataset but includes the data collection for total ankle replacement procedures.
MDSv5	Minimum dataset version five, introduced on 1 April 2012 replacing MDSv4 as the new official dataset. This dataset has the same hip, knee and ankle MDSv4 dataset but includes the data collection for total elbow and total shoulder replacement procedures.
MDSv6	Minimum dataset version six, introduced on 14 November 2014 replacing MDSv5 as the new official dataset. This dataset includes the data collection for hip, knee, ankle, elbow and shoulder replacement procedures.
MDSv7	Minimum dataset version seven, introduced on 4 June 2018 replacing MDSv6 as the new official dataset. This dataset includes reclassification and amendments to data collection for hip, knee, ankle, elbow and shoulder replacement procedures.
MHRA	Medicines and Healthcare products Regulatory Agency – the UK regulatory body for medical devices.
Minimally-invasive surgery	Surgery performed using small incisions (usually less than 10cm). This may require the use of special instruments.
Mix and match	Mix and match describes when the components of the joint construct come from different brands and/or manufacturers.
Modified Polyethylene (MP)	Any component made of polyethylene which has been modified in some way in order to improve its performance characteristics. Some of these processes involve chemical changes, such as increasing the cross-linking of the polymer chains or the addition of vitamin E and/or other antioxidants. Others are physical processes such as heat pressing or irradiation in a vacuum or inert gas.
Modular	Component composed of more than one piece, e.g. a modular acetabular cup shell component with a modular cup liner, or femoral stem coupled with a femoral head.
Monobloc	Component composed of, or supplied as, one piece, the antonym of modular e.g. a monobloc knee tibial component.
Multicompartmental knee replacement	More than one compartmental knee replacement within the same operation e.g. a unicondylar knee replacement and patellofemoral knee replacement, a medial and a lateral unicondylar knee replacement or a medial and a lateral and patellofemoral unicondylar knee replacement.
N	
NHS	National Health Service.
NHS No.	Pseudo anonymised National Health Service Number.
NICE	National Institute for Health and Care Excellence.
NICE benchmark	The NICE benchmark of performance is defined as a 5% prosthesis failure rate at 10 years.
NJR	National Joint Registry. The NJR has collected and analysed data on hip and knee replacements since 1 April 2003, on ankle replacements since 1 April 2010 and on elbow replacements and shoulder replacements since April 2012. It covers both the NHS and independent healthcare sectors to ensure complete recording of national activity in England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey.
NJR Centre	National coordinating centre for the NJR.
NJR Stats Online	Online facility for viewing and downloading NJR statistics on www.njrcentre.org.uk/njrcentre/Healthcare-providers/Accessing-the-data/StatsOnline/NJR-StatsOnline.
O	
ODEP	Orthopaedic Data Evaluation Panel of the NHS Supply Chain. www.odep.org.uk.
ODEP ratings	A letter and star rating awarded to implants based on their performance at specified time points. See www.odep.org.uk for more details.
OPCS-4	Office of Population, Censuses and Surveys: Classification of Interventions and Procedures, version 4 – a list of surgical procedures and codes.
Outlier	Data for a surgeon, unit or implant brand that falls outside of acceptable control limits. See also 'Funnel plot'. A Level One implant outlier is defined as having a PTIR of more than twice the group average. A Level Two implant outlier is defined as having a PTIR of 1.5 times the group average.

P	
Patellar resurfacing	Replacement of the surface of the patella (knee cap) with a prosthesis.
Patellofemoral knee replacement	Procedure involving replacement of the trochlear and replacement resurfacing of the patella.
Patellofemoral prosthesis	Two-piece knee prosthesis that provides a prosthetic (knee) articulation surface between the patella and trochlear.
Patient consent	Patient personal details may only be submitted to the NJR where explicit informed patient consent has been given or where patient consent has not been recorded. If a patient declines to give consent, only the anonymous operation and implant data may be submitted.
Patient physical status	See ASA.
PDS	The NHS Personal Demographics Service is the national electronic database of NHS patient demographic details. The NJR uses the PDS Demographics Batch Service (DBS) to source missing NHS numbers and to determine when patients recorded on the NJR have died.
PEDW	Patient Episode Database for Wales. The Welsh equivalent to Hospital Episode Statistics (HES) in England.
Primary hip/knee/ankle/elbow/ shoulder replacement	The first time a joint replacement operation is performed on any individual joint in a patient.
Procedure	A single operation. See also Primary hip/knee/ankle/elbow/shoulder replacement and Revision hip/ knee/ankle/elbow/shoulder replacement.
PROMs	Patient Reported Outcome Measures.
Prosthesis	Orthopaedic implant used in joint replacement procedures, e.g. a total hip, a unicondylar knee, a total ankle, a reverse shoulder or a radial head replacement.
Prosthesis-time	The total of the length of time a prosthesis was 'at risk' of revision. In the calculation of PTIRs for revision, for example, each individual prosthesis construct time is measured from the date of the primary operation to the date of first revision or, if there has been no revision, the date of patient's death or the administrative censoring date.
Proximal humeral hemiarthroplasty	A shoulder replacement procedure which replaces only the humeral side of the shoulder joint.
PTIR	Prosthesis-Time Incidence Rate. The total number of events (e.g. first revisions) divided by the total of the lengths of times the prosthesis was at risk (see 'Prosthesis-time').
Pulmonary embolism	A pulmonary embolism is a blockage in the pulmonary artery, which is the blood vessel that carries blood from the heart to the lungs.
R	
Radial head component (elbow)	Part of a partial elbow joint that is inserted into the radius (outer lower arm bone) of the patient to replace the articulating surface of the radial head. May be monobloc or modular.
Region	NJR regions are based on the former NHS Strategic Health Authority areas. These organisations were responsible for managing local performance and implementing national policy at a regional level until 2013.
Resurfacing (hip)	Resurfacing of the femoral head with a surface replacement femoral prosthesis and insertion of a monobloc acetabular cup, with or without cement.
Resurfacing (shoulder)	Resurfacing of the humeral head with a surface replacement humeral prosthesis inserted, with or without cement.
Reverse polarity total shoulder replacement	Replacement of the shoulder joint where a glenoid head is attached to the scapula and the humeral cup to the humerus.
Revision burden	The proportion of revision procedures carried out as a percentage of the total number of surgeries on that particular joint.
Revision hip/knee/ankle/elbow/ shoulder replacement	Any operation performed to add, remove or modify one or more components of a joint replacement or to perform a debridement and implant retention (DAIR) of a joint replacement.

S	
Shoulder humeral hemiarthroplasty	Replacement of the humeral head with a humeral stem and head or shoulder resurfacing component which articulates with the natural glenoid.
Single-stage revision	A complete revision procedure carried out in a single operation, i.e. components removed and replaced under one anaesthetic.
SOAL	Lower Layer Super Output Areas. Geographical areas for the collection and publication of small area statistics. These are designed to contain a minimum population of 1,000 and a mean population size of 1,500. Please also see Office for National Statistics at www.ons.gov.uk.
Stemless shoulder replacement	A shoulder replacement where the most distal element of humeral section does not project beyond the metaphyseal bone of the proximal humerus.
Stemmed shoulder replacement	A shoulder replacement where the most distal element of humeral section projects into the diaphysis of the proximal humerus.
Subtalar	The joints between the talus and the calcaneum, also known as the talocalcaneal joints.
Surgical approach	Method used by a surgeon to gain access to, and expose, the joint.
Survival (or failure) analysis	Statistical methods to look at time to a defined failure 'event' (for example either first revision or death); see Kaplan-Meier estimates and Cox 'proportional hazards' models. These methods can take into account cases with incomplete follow-up ('censored' observations).
T	
Talar component	Portion of an ankle prosthesis that is used to replace the articulating surface of the talus at the ankle joint.
TAR	Total ankle replacement (total ankle arthroplasty). Replacement of both tibial and talar surfaces, in most cases implanted without cement.
TED stockings	Thrombo embolic deterrent (TED) stockings. Elasticised stockings that can be worn by patients following surgery and which may help reduce the risk of deep vein thrombosis (DVT).
THR	Total hip replacement (total hip arthroplasty). Replacement of the femoral head with a stemmed femoral prosthesis and insertion of an acetabular cup, with or without cement.
Thromboprophylaxis	Drug or other post-operative regime prescribed to patients with the aim of preventing blood clot formation, usually deep vein thrombosis (DVT), in the post-operative period.
Tibial component (ankle)	Portion of an ankle prosthesis that is used to replace the articulating surface of the tibia (shin bone) at the ankle joint.
Tibial component (knee)	Portion of a knee prosthesis that is used to replace the articulating surface of the tibia (shin bone) at the knee joint. May be modular or monobloc (one piece).
TKR	Total knee replacement (total knee arthroplasty). Replacement of both tibial and femoral condyles (with or without resurfacing of the patella), with or without cement.
Total condylar knee	Type of knee prosthesis that replaces the complete contact area between the femur and the tibia of a patient's knee.
Total elbow replacement	Replacement of the elbow joint which consists of both humeral and ulna prostheses.
Treatment centre	Treatment centres are dedicated units that offer elective and short-stay surgery and diagnostic procedures in specialties such as ophthalmology, orthopaedic and other conditions. These include hip, knee, ankle, elbow, and shoulder replacements. Treatment centres may be privately funded (independent sector treatment centre – ISTC). NHS Treatment Centres exist but their data is included in those of the English NHS Trusts and Welsh Local Health Boards to which they are attached.
Trochanter	Bony protuberance of the femur, the greater trochanter is found on its upper outer aspect and is the site of attachment of the abductor muscles. The lesser trochanter is medial and inferior to this and is the site of attachment of the psoas tendon.
Trochanteric osteotomy	A procedure to temporarily remove and then reattach the greater trochanter, used to aid exposure of hip joint during some types of total hip replacement and now usually used only in complex procedures.
Two-stage revision	A revision procedure carried out as two operations, i.e. under two separate anaesthetics, most often used in the treatment of prosthetic joint infection.
Type (of prosthesis)	Type of prosthesis is the generic description of a prosthesis, e.g. modular cemented stem (hip), patellofemoral joint (knee), talar component (ankle), reverse shoulder (shoulder) and radial head replacement (elbow).

U	
Ulnar component (elbow)	Part of a total elbow joint that is inserted into the ulna (inner lower arm bone) of the patient to replace the articulating surface of the ulna. May be linked or unlinked.
Uncemented	Prostheses designed to be fixed into the bone by an initial press-fit and then bony ingrowth or ongrowth, without using cement.
Unconfirmed prostheses construct	A joint replacement which has been uploaded with either an insufficient number of elements to form a construct, or prostheses elements which are not concordant with the procedure indicated by the surgeon.
Unicompartmental knee replacement	Procedure where only one compartment of the knee joint is replaced, also known as partial knee replacement. The lateral (outside), medial (inside) and patellofemoral (under the knee cap) compartments are replaced individually.
Unicondylar arthroplasty	Replacement of one tibial condyle and one femoral condyle in the knee, with or without resurfacing of the patella.
Unicondylar knee replacement	See Unicondylar arthroplasty.
Unilateral operation	Operation performed on one side only, e.g. left hip.
Unlinked total elbow	Where the humeral and ulnar parts of a total elbow replacement are apposed but not structurally coupled.

Summary of key facts about joint replacement during the 2019 calendar year

Hips

recorded on the NJR since April 2003

2019

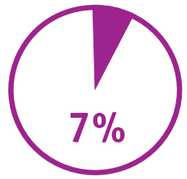
95,677 primary replacement procedures

60% ♀

average ages:

♂ 67.1 ♀ 69.4

Data:



Acute trauma

Elective osteoarthritis

average BMI **28.8** = ‘overweight’

Knees

recorded on the NJR since April 2003

2019

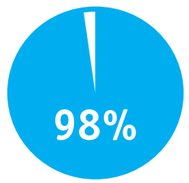
103,617 primary replacement procedures

56% ♀

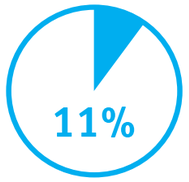
average ages:

♂ 68.8 ♀ 69.2

Data:



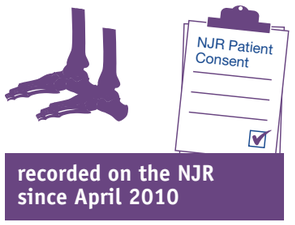
Osteoarthritis



Unicondylar knee replacements

average BMI **30.9** = ‘obese’

Ankles



recorded on the NJR since April 2010

2019

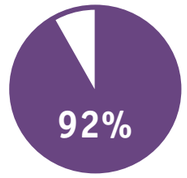
974 primary replacement procedures

40% ♀

average ages:

♂ 68.8 ♀ 68.1

Data:



Osteoarthritis

Rheumatoid arthritis and other inflammatory joint problems

average BMI **30.0** = ‘obese’

Elbows

recorded on the NJR since April 2012

2019

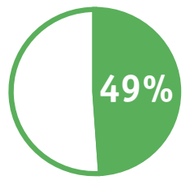
757 primary replacement procedures

68% ♀

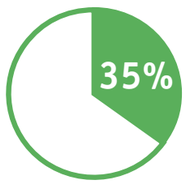
average ages:

♂ 57.6 ♀ 66.8

Data:



Total elbow replacement (with or without a radial head)



Radial head replacements

12% Distal humeral hemiarthroplasty

Shoulders

recorded on the NJR since April 2012

2019

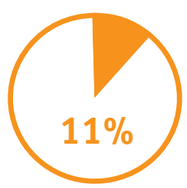
7,294 primary replacement procedures

70% ♀

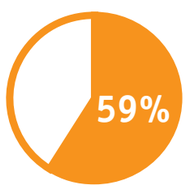
average ages:

♂ 69.5 ♀ 73.5

Data:



Acute trauma



Elective osteoarthritis

27% Elective cuff tear arthropathy

For more data on clinical activity during the 2019 calendar year visit reports.njrcentre.org.uk

Data collection

The National Joint Registry (NJR) produces this report using data collected, collated and provided by third parties. As a result of this the NJR takes no responsibility for the accuracy, currency, reliability and correctness of any data used or referred to in this report, nor for the accuracy, currency, reliability and correctness of links or references to other information sources and disclaims all warranties in relation to such data, links and references to the maximum extent permitted by legislation.

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Information governance and patient confidentiality

The NJR ensures that all patient data is processed and handled in line with international and UK standards and within UK and European legislation: protecting and applying strict controls on the use of patient data is of the highest importance.

NJR data is collected via a web-based data entry application and stored and processed in Northgate Public Services' (NPS) data centre. In addition to being accredited to ISO 27001 and ISO 9001, NPS is also compliant with the NHS Data Security and Protection Toolkit.

For research and analysis purposes, NJR data is annually linked to data from other healthcare systems using patient identifiers, principally a patient's NHS number. These other datasets include the Hospital Episodes Statistics (HES) service, data from the NHS England Patient Reported Outcomes Measures (PROMs) programme, and Civil Registration data (all provided by NHS Digital), and the Patient Episode Database Wales (PEDW) (provided by NHS Wales Informatics Service). The purpose of linking to these data sets is to expand and broaden the type of analyses that the NJR can undertake without having to collect additional data. This linkage has been approved by the Health Research Authority under Section 251 of the NHS Act 2006 on the basis of improving patient safety and patient outcomes: the support provides the legal basis for undertaking the linkage of NJR data to the health data sets listed above.

Once the datasets have been linked, patient identifiable data are removed from the new dataset so that it is not possible to identify any patient. This data is then made available to the NJR's statistics and analysis team at the University of Bristol whose processing of the data is compliant with the NHS Data Security and Protection Toolkit. The work undertaken by the University of Bristol is directed by the NJR's Steering Committee and the NJR's Editorial Board and the results of the analyses are published in the NJR's Annual Report and in professional journals. All published data is based on anonymised data, this means that no patient could be identified.

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Every effort has been made at the time of publication to ensure that the information contained in this report is accurate. If amendments or corrections are required after publication, they will be published on the NJR website at www.njrcentre.org.uk and on the dedicated NJR Reports website at reports.njrcentre.org.uk.

At reports.njrcentre.org.uk, this document is available to download in PDF format along with additional data and information on NJR progress and developments, clinical activity and implant and unit-level activity and outcomes.

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