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National Joint Registry

18th Annual Report 2021

Surgical data to 31 December 2020

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Additional data and information can also be found as outlined on pages 4-6.

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 data collection of its kind in the world, the NJR has been described in UK Parliament as a global exemplar of an implantable medical devices registry.

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

We produce this Annual Report, summarising our 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. The report illustrates how the number of elective joint procedures has been heavily impacted throughout this past year by COVID-19; many joint procedures have had to be cancelled or postponed. There has been a major impact on people awaiting surgery for all joint types in a climate of continued uncertainty for their future surgical dates, with increasingly extended waiting lists. We have covered this impact, both on the orthopaedic sector and with a patient perspective on those who are facing long waiting times, in a special feature in this year's report, you can find this on page 341.

Registry data for the surgery that has taken place this past year have again been analysed by expert statisticians and the results published with the continued aim of enhancing safety and improving clinical outcomes for the benefit of patients and the whole orthopaedic healthcare sector - device outcome results are also shared with implant manufacturers. The report also includes some short excerpts which showcase the NJR's contribution to orthopaedic research activity, illustrating 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 implant devices in the UK, is demonstrating the highest standards of patient safety with regard to their use. Patient representatives are actively involved in our workstreams and committees. With well over three million records, registry 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.

Our data collection and analysis work provides the evidence to drive continuous development and implementation of measures, to ensure implant safety and the enhancement of patient outcomes is always top of the agenda alongside a focus on reduced revision rates year on year; as well as improvements in standards in quality of care, whilst also addressing overall cost-effectiveness in joint replacement surgery.

We are very grateful to all patients, who having undergone a joint replacement, have provided their data to the NJR over the years, which has enabled us to collect and develop such a rich and valuable data source. The registry is also appreciative of the work of data entry staff in all participating hospitals, who willingly engage in our stringent data quality award programmes to ensure our information is of high quality, accurate and as complete as is 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 2020	Statistics on joint replacement activity for hip, knee, ankle, elbow and shoulder activity for the period 1 January to 31 December 2020	reports.njrcentre.org.uk through interactive reporting
Outcomes after joint replacement surgery 2003-2020	Detailed statistical analyses on hip and knee replacement surgery using data from 1 April 2003 to 31 December 2020. Analysis of primary ankles and shoulders representing data collected since 1 January 2010 and 1 April 2012 respectively. Analyses on 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 2021	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	In this report and via reports.njrcentre.org.uk and download area

NJR Reports online

Clinical activity 2020 overview

The interactive portion of our 18th 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 2020 calendar year. This includes information on the volumes and surgical techniques in relation to procedures submitted to the registry, with the most recent data being for the period 1 January 2020 to 31 December 2020. To be included in these tables and graphs, all procedures must have been entered into the registry by 28 February 2021.

This year's printed report includes a paper illustrating how the volume of joint procedures has been heavily impacted by COVID-19, along with a patient perspective on those who are now facing even longer waiting times. Supplementary data analyses information for this work can be found online at **reports.njrcentre.org.uk/COVID19**.

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 2020 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
- 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
- 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 registry.

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 ten years, which means, following good governance standards, it is time for me to make way for a new person in the NJR chair.

In each of the past ten 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 - the NJR nonetheless delivered a number of important developments. This NJR 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 18th edition of our Annual Report.

Our work and developments

Managing the impact of the COVID-19 crisis: In 2020/21 the NJR undertook a radical review of our proposed annual work plan and budget to reflect the impact of the COVID-19 crisis. We considered how resources could be conserved until we could re-engage in collecting, processing and analysing data for our work and reinstating income collection via trust subscription payments. As a result, our development plans and expenditure programme last year were significantly reduced. We will continue to monitor our activity and finance in 2021/22, to ensure the impact of reduced elective surgery and its effect on trust subscription income continues to be managed.

NJR/BOA plans for implementation of a Musculoskeletal [MSK] Registry: This year we have continued to pursue the proposal to develop a national MSK registry, bringing the seven registries forming the BOA Trauma and Orthopaedic Registries Unifying Structure (TORUS) together with the NJR, under a single governance body. This proposal has gained support in principle from NHS leadership following publication of the Cumberlege report, which identified the need for more comprehensive implant device registries and cited the NJR as a 'global exemplar' of such a registry. This provided the opportunity for us to propose the MSK registry be considered as a useful pilot for plans to develop appropriate options for implementation of larger integrated data sets for implantable devices. We will pursue this objective in the coming year and ensure that we continue to align with national plans to deliver appropriate options for implementation of a centralised registries database.

Automating our Data Quality Audit: Data quality has continued to be a key priority for the NJR and our Data Quality Audit programme has been a unique initiative with considerable success in assessing the completeness and quality of the data submitted to the registry. However, the process of comparing local hospital records to those submitted to the NJR has been labour intensive for both hospital and NJR staff, so we began a national roll out of an enhanced, automated process. This has greatly reduced the burden involved in undertaking this work and enables units to check their data quality on a more frequent basis. Full roll out of this enhanced process in all joint types was completed in 2020/2021. In addition,

data quality exercises involving dual mobility hip replacements, reverse shoulder replacements and multi-compartmental knee replacements are now being developed in consultation with the relevant specialist societies.

PROMs and ePREMs: An important element of work continues to be the collection, analysis and reporting, of patient reported metrics and this year we have focused on a number of key areas. We have been examining the quality and representativeness of national PROMs for patients who have hip and knee replacement surgery, which will ensure that clinicians, hospital managers and regulators can have confidence in using patient reported metrics to assure quality. We have also been routinely including reporting of PROMs metrics in implant reports made available to manufacturers via the NJR Supplier Feedback service and developing a system that will make a library of these implant reports available to clinical teams via a new digital platform that will be launched in 2021/22. In conjunction with both BESS and GIRFT, we have been working to improve patient engagement with pre-operative PROMs submissions and in the coming year we will commence an electronic Patient Reported Experience Measures (ePREMs) pilot, halted this year due to the COVID crisis, where we hope that patients will share their experiences of joint surgery to help improve healthcare for patients.

Modernising our IT Platform – Launch of 'NJR CONNECT': Last year we commissioned the development of a cloud-ready, platform-based application framework for provision of future NJR services. The rationale for this included a focus on the need to develop an environment with the ability to move to a cloud-based infrastructure and have the capacity to extend to any additional registry alignment. This year the first phase of development launched and transferred the NJR Clinician Feedback services into the new environment, along with a more interactive reporting service, including the Consultant and Surgeon Level Report, Annual Clinical Report, Clinical Outcomes Publication Preview, Clinician Profile Edit, interactive outcomes and clinical practice reports, and a contacts database. Further development will continue during 2021/22 and include the NJR component database and supplier and management feedback systems, interactive reporting, availability of an implant data library, a new semantic layer to aid researcher secure access to NJR data, data entry and data quality tools, and the Data Access Portal.

Unique/innovative solutions to support patient safety: 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. The data entry system has been updated to enable it to detect potential 'never events' and warn the data entry user, also alerting the NJR team so that this can be investigated. We have also developed an Application Programming Interface, to allow hospital theatre systems to interface with NJR's checking rules and enable immediate identification of implant incompatibilities as 'never events' in real time, so these are identified before the implant is put in the patient. A smartphone version of this application is also being developed so clinical teams can undertake validation checks even if their hospital does not have a compatible front-end system. This work also supports the importance of the emphasis on patient safety as highlighted in the Cumberlege report.

Research and the NJR Data Access Portal (DAP): Research has been a huge part of the NJR's success and the output of peer-reviewed papers by the University of Bristol and by others using NJR data, has been truly extraordinary and ensures that NJR data can be best used to inform and improve practice. It has led to a large number of important and impactful publications, delivering valuable evidence about how joint replacement surgery works and with the key aim of being used to improve patient safety and outcomes. This year the NJR DAP has been developed to streamline research applications by providing a secure working environment, including analysis tools for researchers and users of NJR data, whilst enabling the NJR to manage and control our data more effectively. Providing access to the data without the need for datasets to be sent to third parties will significantly reduce the governance burden that research teams face.

The NJR Patient Decision Support Tool: A major initiative has been the launch of 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 University of Sheffield 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. We are continuing a collaboration with the University of Sheffield to enhance the tool to allow the most up-to-date NJR data to be used to calculate the projected risks and benefits of joint replacement surgery. This NJR initiative will continue to benefit healthcare economies through improved clinical outcomes and better resource utilisation.

Redevelopment of the NJR Website: Work has been ongoing to design and build the architecture for our new website. As our public-facing information portal, the aim of the upgrade is to develop increased functionality to make the website more engaging and enable us to develop new visual material to inform our stakeholders more imaginatively about the work we do and to clearly demonstrate how the NJR benefits the orthopaedic sector. The website is scheduled to launch during 2021/22.

NJR Component Database and International Benefits: Following work with the German Arthroplasty Registry (EPRD) to develop a common classification system for defining the attributes of hip and knee arthroplasty components, the classification has been adopted by both our registries, each of us managing our own local databases populated by industry implant suppliers. Use of this classification data for NJR reporting will commence in 2021/22. In addition, we have agreed to license the component classification system to the International Society of Arthroplasty Registers for their International Prosthesis Library platform, meaning the hip and knee components can be classified in the same way in registries across much of the world. This will provide the valuable international benefits of improving the comparability of data for identifying poor outcomes and of decreasing the burden on industry colleagues in data upload. In addition, the University of Oxford have proposed a new component classification for shoulder arthroplasty devices, which is planned to be published on open access and will be free to license and will further form the basis of a new shoulder component database, to be developed by the NJR in the coming year.

The people who make the NJR a success

This year has seen a number of changes to the NJRSC membership. I am delighted to welcome Derek Pegg as a co-opted member of the NJRSC, in his new role as Chairman of the NJR Regional Clinical Coordinators (RCC) and Data Quality Committees, succeeding Matthew Porteous. Derek has supported the NJR for many years as Vice Chairman of the RCC Committee and through membership of a number of NJR sub-committees. I thank him for his continued support and wish him well in his new roles. I am also very pleased to confirm the re-appointment for a further term of office, of both Peter Howard, NJRSC surgeon member and Robin Brittain, NJRSC patient representative member and to thank them for their continued hard work. My appreciation also goes to Bob Handley for his contribution as BOA President to the NJRSC this year, which has been important in continuing our valued relationship with the orthopaedic profession. We look forward to welcoming his successor John Skinner, who takes up post from September 2021.

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 (who will be known as NEC Software Solutions UK Ltd from July 2021) and the University of Bristol, for their excellent work throughout the year in supporting the NJR to deliver its work agenda and objectives. 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 for his interim chairmanship of the RCC and Data Quality committees, pending the appointment of Derek Pegg.

My sincere thanks also to the Chairmen of each of our sub-committees - Peter Howard, Mark Wilkinson, Mike Reed and Derek Pegg - for their hard work, vision and effort. 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 as ever to the NJR Management Team who in the past year have had to cope with an environment of uncertainty in how and where to work, with shifting priorities and compressed budgets. They have continued to support the NJR cheerfully and tirelessly, against a challenging background. I particularly want to thank Elaine Young, my partner in all things NJR for the past decade, whose dedication to what the NJR delivers has always been extraordinary.

I leave the NJR with mixed feelings: I am immensely proud to have been associated with so many talented, dedicated professionals and to have been a part of a truly extraordinary organisation. But I am also concerned about how the NJR we have all worked so hard to build will fare in the headwinds of a challenging NHS environment. Having said that, I know I leave our organisation in the capable and protective hands of my extraordinary Steering Committee colleagues…but I will be watching!

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

It will come as no surprise to anyone that the single most pronounced factor in this year's annual report compared to previous years is the massive impact of the COVID-19 pandemic on the volume of all joint procedures. This has meant not only that the number of cases performed in 2020 has been roughly halved across the whole spectrum of arthroplasty, but this fall in numbers occurred during the last nine months of the year. This means that actual loss of arthroplasty provision was closer to 70% during those nine months and it is clear that volume has not fully recovered during the first quarter of 2021. We can anticipate that the data for analysis will be distorted by this loss of throughput and the accompanying altered case-mix for some years to come. Our preliminary analysis suggests that simply recovering the 2020 deficit will take a decade if joint surgery can only be increased by 5% compared to 2019; and will take five years if a 10% increase can be achieved. Recovery will clearly take much longer at those rates when the further deficit in volumes that has continued into 2021 is factored in.

Readers will therefore have to interpret much of the data from all arthroplasty registries with great care over the coming years as there will have been multiple reasons why the outcome results may be different from previous years including: patients waiting longer, operation complexity changing, and alterations in readiness to perform both primary and revision procedures during the pandemic.

The pandemic has of course shaped our representation at both national and international meetings, but many have continued virtually. We supported both the BASK and BHS annual conferences this year with virtual presentations from our Medical Director Tim Wilton and Peter Howard, Chairman of our Implant and Surgical Performance sub-committees. Each session was followed by a lively open question session with delegates who were interested in hearing how the NJR is supporting the work of the orthopaedic sector.

Meanwhile the work of the NJR Editorial Board has continued. The 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 a patient perspective, clinicians from specialist societies and members of the NJR Management Team. Each year the Board aims to make progress in reporting on our rich data resource, making data easily accessible to improve patient outcomes. In addition to the section on COVID-19,

a key development for this report has been "volume plots" which show the number of specific procedures performed each year, but also demonstrate whether each procedure was performed by surgeons with higher or lower activity.

We hope to launch the report at the British Orthopaedic Association Congress meeting in Aberdeen in September – and at the time of going to press we are looking forward to this being a face-to-face meeting!

This year we will have a limited print run of the annual report to be issued on a first-come first-served basis at the report launch. Increasingly 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.

Commentary on findings

This year NJR's Annual Report is based on 2,895,368 records entered between 1 April 2003 and 31 December 2020, and the NJR maintains its position as the largest orthopaedic registry in the world. The report presents joint replacement up to 17 years of follow-up, with data on hips, knees, shoulders, elbows and ankle replacements. Due to the pandemic, approximately half as many records were added this year. In total the following numbers of linkable primary joint replacements are available for analysis: 1,251,164 hips, 1,357,077 knees, 7,084 ankles, 50,255 shoulders and 5,043 elbow replacements. There are further linkable revisions for each joint.

Hip replacement

There are new graphic representations of the proportions of different hip operation types performed by surgeons according to their annual throughput of those cases, and these give a fascinating insight into how things have changed over the years. Bearing in mind the concerns over minimum numbers and low surgeon volumes, these graphs give useful information about the general level of surgeon experience. High proportions of most types of hip replacement can be seen to be performed by surgeons doing quite high numbers per year. More than half of unipolar hip replacements are performed by surgeons doing more than 97 such cases a year. Only a tiny number of resurfacing hips are performed by surgeons doing more than 97 such operations, but the proportion of resurfacing cases done by those surgeons is nevertheless very high. This indicates that surgeons who are performing such operations tend to be highly specialised in the procedure.

Dual mobility hips, although performed far less frequently, are on the rise with a steady climb – being almost unheard of in 2013. It is perhaps not surprising, given the more limited indications for the procedure, that even prior to the pandemic few surgeons were performing more than 25 dual mobility hip procedures per year, but most such operations are nevertheless performed by surgeons who do more than seven per annum.

For the first time, hybrid fixation has become the most popular choice for hip replacement. It is interesting to note that while for cemented and reverse hybrid fixation metal-on-polyethylene (MoP) remains the predominant bearing surface choice; in both uncemented and hybrid hips the favoured choice is ceramic-on-polyethylene (CoP). Over the years there has been little change in the choice of bearing surface for reverse hybrid hips, and a very gradual change from MoP towards CoP for cemented hips. In contrast the change to CoP has been much more marked for hybrid hips and the bearing choice in uncemented hips has seen far more pronounced variations over the years. The reasons for this greater variation for uncemented hips is unclear and deserves further research and clarification.

The temporal changes in total hip replacement (THR) revision (Figure 3.H4 (a)) indicate a deterioration in revision rates until 2008 followed by marked improvement at all time points. There may have been two phases in this recovery; a sharp improvement until 2010 followed by a more gradual improvement ever since. It is tempting to suggest the steeper improvement from 2008 to 2010 is due mainly to metal-on-metal (MoM) issues and the subsequent improvement is a secular trend which is also seen in knee revision rates. The reason for that secular trend may be multi-factorial, but coincides with the start of feedback of data on their own results to surgeons by the NJR. In Figure 3.H4 (b) the 13-year revision rates

are more clearly seen to be following the improving trends of earlier time points.

Revision rates for different revision indications are shown in Figure 3.H11 and it is perhaps no surprise that rates for aseptic loosening (and lysis) are highest for MoM bearings and resurfacing. Although very low rates for aseptic loosening are seen in cemented MoP and CoP these do seem to rise significantly after ten years. The very low rates seen in hybrid MoP and CoP up to ten years do also appear to cross over such that hybrid CoC have the lower rate for aseptic loosening after ten years. There appear to be few differences in infection rates according to bearing or fixation except for a higher rate in MoM hips at most lengths of follow-up. This data is unadjusted however and two separate analyses from registry data have shown reduced infection rates in ceramic bearings.

Interesting detail is available this year on revision rates by bearing surface stratified by age groups, and also for femoral head size; and surgeons will want to delve deeply into this information to check whether more or less "tailoring" of their procedures may be desirable according to the individual patient being treated.

Revision rates (PTIRs) for different hip constructs are presented in much more detail this year and should be of particular interest to both surgeons and patients alike. It can be seen that some apparently similar constructs have differing revision rates and surgeons will wish to reassure themselves that what they may believe about the construct they are using is indeed borne out by this extensive analysis. Readers should also be aware that these revision rates for constructs are not adjusted for age and other case-mix variables, but some of the constructs may be specifically indicated in younger patients or for some specific indication, so it is necessary to look carefully at the age, gender and other factors presented.

The median age and interquartile range are often quite different between cemented, hybrid and uncemented constructs, and this is most marked when considering resurfacing constructs.

In 2020 there was a marked reduction in THR for hip fracture and this might be the group where we would have expected numbers to hold up despite the pandemic. The reasons for this will need to be examined in more detail to see if there may have been a real drop in such fractures, or whether other factors such as altered case-mix or altered threshold for certain treatments were responsible. Revision rates for THR performed for hip fracture seem to track those for THR in osteoarthritis to a remarkable extent out to 15 years, albeit with increased rates of revision for the former in the first year.

Knee replacement

There are many areas this year in which there is either new information in the report or the previous information is expanded to give much more detail. There has been controversy for years about the possibility that surgeons doing small numbers of certain operations may be systematically giving rise to higher failure rates than those performing higher numbers. This relationship seems particularly clear in the case of unicondylar knee replacements and this year's data show that the median number of such cases performed over the past three years is 19 (per surgeon) or 49 per unit. These figures show that, on average, surgeons are still not reaching the target numbers set by the British Association for Surgery of the Knee (BASK) which will be of concern to many. Nevertheless, over recent years we can see that over two-thirds of unicondylar procedures are performed by surgeons doing 25 cases or more per year.

Although the case numbers per surgeon have been greatly distorted by the impact of COVID-19 in 2020, we can see that over recent years prior to 2020, virtually no procedures were carried out by surgeons performing fewer than seven total knee replacements (TKRs) per year and that about 75% of such cases each year were by surgeons performing more than 49 cases per year.

Table 3.K1 shows that over the life of the registry roughly 25% of all TKRs are performed using a posterior stabilised (PS) implant and these consistently show higher revision rates than operations performed with unconstrained implants. While it is sometimes argued that this could reflect PS usage by many surgeons when they encounter a particularly difficult or complicated case, the evidence from the registry seems to show that the choice is mostly based on surgeon preference. This is therefore an area where surgeons may wish to reflect on whether they are really making the safest and most appropriate choice.

The revision rates for PS and cruciate retaining (CR) knees of each implant brand are now shown in the report separately and are also stratified according to whether the patella is resurfaced or not. These data show that the above finding of higher revision rates in PS knees may in fact be seen in the majority of, but not all, implant brands. It is therefore worthwhile for surgeons to look at Figures 3.K7 to 3.K10 in detail to ascertain the precise differences between the sub-types of implant available to them in their units, and in the market in general.

Although unicondylar knees are seen to have typically involved the use of a mobile bearing over the last 18 years, this has been changing recently towards a fixed bearing. There is still controversy about the pros and cons of performing unicondylar knee procedures, and caution needs to be used in interpreting the revision data since there are clear case-mix differences between those suitable for a unicondylar and those who are not. The statistics reported here have not been adjusted for such case-mix differences, which may be of particular relevance in certain implants which have been marketed as suitable for a particular patient grouping such as younger, more active patients or a particular gender.

As predicted in the last two years, Figure 3.K3 (b) shows that the improvement in revision rates shown previously up to ten years, is now reflected at 13 and 15 years as well, starting as before with the 2008 cohort.

While revision rates for uncemented unicondylar procedures appear lower than those for cemented at many time points, it is important to view this in the context of a gradual improvement in unicondylar results in general, which has been occurring over 15 years. Thus the uncemented unicondylar implants, which have mostly been inserted over the last ten years, would be expected to have slightly better results than cemented unicondylars with similar follow-up but performed on average more than ten years ago.

Re-revision rates continue to be seen to be much higher than those revised after primary operations across all sub-groups of knee replacement. Figures for re-revision of around 16% at ten years are seen this year, which is several times higher than those for a standard primary TKR and therefore continue to be a cause for concern. The time to first revision has a huge impact on the likelihood of subsequent revision procedures, but it remains uncertain whether this is wholly, or only in part, due to the different indications for first revision which predominate in the early and late post-operative periods.

Elbow replacement

There are now over 5,000 elbow replacements available for analysis including total replacement (with or without radial head replacement), distal humeral hemiarthroplasty, lateral resurfacing and radial head replacement. Over 40% of these were performed for a trauma indication.

With the exception of 2020, the number of elbow replacements being registered has increased but the numbers of surgeons performing one to two per year has fallen, and those performing more than 13 has increased. Revision rates differ by indication, with primary total elbow replacement (with or without a radial head replacement) for acute trauma being less than 4% at eight years, with elective indications being less than 10% at eight years, although few cases have that length of follow-up.

Shoulder replacement

A rigorous review of the shoulder data has been performed. Consequently, new classifications and component attributes are now used within the report to define the primary groupings throughout the whole of the shoulder section. The report has now moved to whole construct validation, ensuring all relevant elements required to build a construct are present in every procedure being reported on in our analysis. Over 50,000 primary shoulder replacements are available for analysis. The proportion of reverse polarity total shoulder replacement continues to increase (see Table 3.S1) albeit tending towards use in somewhat older patients (Table 3.S4). The median, interquartile range, and number of procedures performed by units and consultants has remained static for the last few years, apart from 2020 due to the impact of COVID-19.

Ankle replacement

This report focuses on primary procedures performed, and also on revision and mortality, with over 7,000 procedures being available for analysis. As noted previously, all ankle replacements recorded use uncemented implants although cement was listed in the

component data in less than 5% and in the context of poor bone stock and low-demand patients.

The proportion of fixed-bearing ankle replacements continue to increase, and most procedures are done by surgeons performing more than seven cases per year. In 2019, the average number of procedures performed per consultant across all ankle replacements was 6.4 dropping to 4.0 in 2020.

In 2020 the Infinity ankle replacement implant dominated at 65.2% of all total ankle replacements, although it was only introduced in 2014. It is reassuring to see that the short term implant survival has improved.

Overall revision rates appear to be just less than 9% at ten years, although we believe there is incomplete reporting of conversion to fusion which remains mandatory. Both the Star and the Infinity ankle implant are running at revision rates of less than 3% at five years, albeit running into low numbers with longer follow-up. Other implants are failing at varying, and some at concerning, rates.

Patient Reported Outcome Measures (PROMs)

Our annual report includes the failure rates of all the different brands used in hip and knee replacements, however revision surgery is not a complete marker of success. A device may well be classified as successful if it survives for 15 years, but an implanted patient may disagree should they have experienced persistent pain and disability and around 20% of patients report persistent pain following joint replacement surgery. Analysis of revision rates alone fails to identify these patients with persistent pain or disability. Therefore, there have been calls for methods to measure pain that can subsequently be used in conjunction with revision rates for accurately monitoring outcomes in hip and knee replacement surgery. See also the Independent Medicines and Medical Devices Safety Review, chaired by Baroness Julia Cumberlege, published report titled “First Do No Harm” (Cumberlege, 2020).

Patient reported measures of hip and knee pain and function have been collected nationally by NHS Digital since 2009 for all patients receiving a primary hip or knee replacement operation. This information, to date, has not been reported in our annual report. We aim to address this gap in implant outcome reporting by incorporating national PROMs analyses within our future annual reports.

Data will be analysed separately for hip and knee joints. Analyses will be repeated according to indication for surgery, primary and revision operations, where surgery was carried out and how it was funded. Descriptive analyses will be used to look at how the proportion of any missing PROMs data varies over time, by looking at trends for each year of data. We will further explore geographical variation in patterns of missing data by hospital trust, and operating surgeon, and use caterpillar plots to visually display hospitals and surgeons with the most and least amount of missing PROMs data.

We will present descriptive statistics to look at the association of patient characteristics according to completion of PROMs scores. We will do these analyses overall, and then repeat them for individual years of the data, as the influence of patient characteristics on missing PROMs outcomes and the quality of data may change over time. Caterpillar plots will describe the variation in PROMs outcomes within and between implant brands and constructs. Initial analyses will be descriptive about the actual variation in observed PROMs outcomes, with stratification of analyses by age and gender groups. More formal modelling methods will then be considered, for ‘within and between group’ variation between implant brands and constructs.

Having assessed data quality, our aim is to then compare and scrutinise the differing performances between the implant brands of different prostheses for associated pain and functional outcomes. By selecting a hip or knee brand with a highest improvement in pain and functional outcome as a reference group, we will perform statistical analyses to directly compare the performance of all the stem and cup combinations used in hip replacement and all the knee brands used in knee replacement against this reference. This will demonstrate if any brands are performing poorly in comparison to the best performing implants, and thus enable patients and surgeons to make better informed decisions about the relative performance, as judged by patient reported pain and functional outcome of the construct of each brand.

Cumberlege J. First Do No Harm: The report of the Independent Medicines and Medical Devices Safety Review. 2020 Jul 8. https://www.immdsreview.org.uk/Report.html

Concluding acknowledgements

The NJR continues to work collaboratively with our many stakeholders; the most important, of course, are the patients we serve, and whom we would like to thank for allowing us to use their data. The NJR operational collaboration is a huge team effort – this year managed almost exclusively by work performed virtually. Elaine Young, NJR Director of Operations has demonstrated the great versatility of her leadership and her team.

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 and Improvement
- NHS Digital
- 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)
- NEC Software Solutions UK Ltd (previously known as Northgate Public Services UK Ltd)
- University of Bristol
- University of Oxford
- Confidentiality Advisory Group (CAG)
- Association of British HealthTech Industries (ABHI)

We are most grateful to our contractors for their very valuable input into the NJR Annual Report, and many other functions. NEC Software Solutions, University of Bristol and University of Oxford teams help us refine and improve each year. This year's report is the biggest and best report yet. We offer our personal thanks to Vicky McCormack, Report Project Manager and Deirdra Taylor, Associate Director of Communication and Stakeholder Engagement for the NJR, for getting the final report into shape in the face of challenging circumstances.

On a personal note, we would particularly like to thank Laurel Powers-Freeling, Chairman of the NJR. Laurel's leadership over the last ten years has seen the NJR grow in terms of size, quality, stature, and utility. Laurel brought huge insight to the NJR from her many other areas of expertise and her guidance has enabled the organisation to grow in ways we would simply not have been able to develop without those insights. We owe her a great deal and wish her every success in her future endeavours, followed by a long and happy retirement.

Professor Mike Reed
Chairman of the NJR Editorial Board

and

Mr Tim Wilton
NJR Medical Director

3. Outcomes after joint replacement 2003 to 2020

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 2020 inclusive, whose records had been submitted to the registry before 1 March 2021.

Information governance and patient confidentiality:

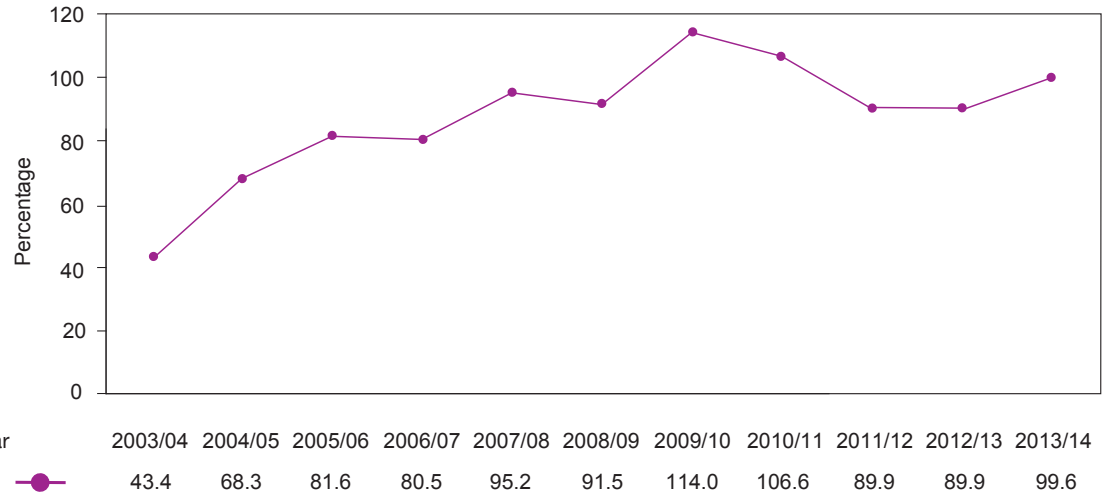
Data are collected via a secure web-based data entry application and stored and processed in NEC Software Solutions' (NEC) data centre. NEC is ISO 27001 and ISO 9001 accredited, and compliant with the NHS's Data Security and Protection Toolkit. Data linkage to other datasets is approved by the Health 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 are the foundation of any joint replacement registry and the National Joint Registry fully understands and endorses this. From inception, it was mandatory to record hip and knee arthroplasty procedures for 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 (NHS) procedures into the registry.

When the NJR was established, 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 we could compare sales to uploads into the registry. This process gave a crude estimate of compliance and for the first four years of the registry, compliance could have been improved. Post-2008 the compliance rate was in excess of 95% and on occasion greater than 100% (see Figure 3.D1). When compliance was over 100%, this was indicative of the practice of stockpiling prostheses.

Figure 3.D1 Compliance rates from 2003 to 2014.

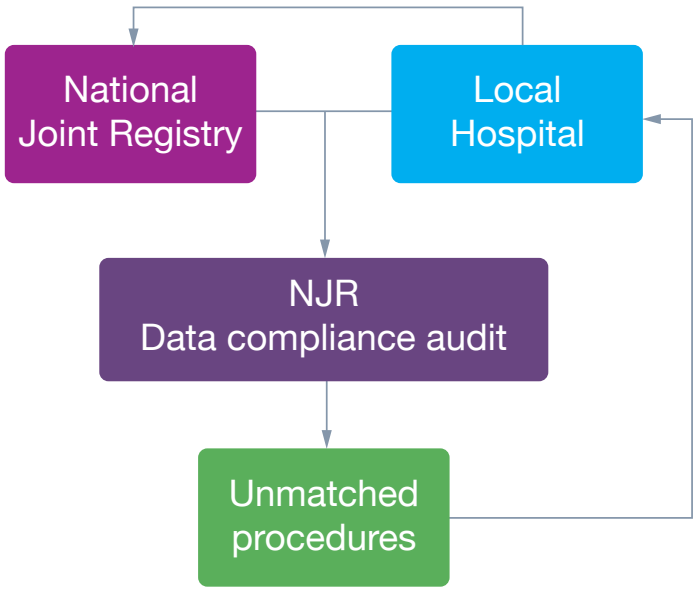


Comparing procedures to a levy had utility, however it was not sufficiently refined to distinguish within-year compliance and differential-compliance in the upload of primary and revision procedures. An additional comparator was therefore needed to properly assess compliance, and the Hospital Episode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

The comparison of data entry onto the registry and HES data gave a clear indication of the degree to which data might be missing or of any anomalies in data-entry, but does not itself supply or correct the missing data. For this reason a formal audit cycle, capable of reconciling the 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 registry 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 registry, see Figure 3.D2. Records that were found on the local hospital PAS but not on the registry were subsequently uploaded 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 registry 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 registry 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 registry. It is important to note that nearly all unmatched procedures identified by the audit were subsequently uploaded into the registry.

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 data quality audit compliance.

	Percentage missing NJR records (%)				
Procedure	2014/15	2015/16	2016/17	2017/18	2018/19
Hip primary	4.3	5.4	4.19	4.16	2.38
Hip revision	8.1	11.42	8.74	9.15	5.02
Knee primary	3.5	4.86	3.83	3.41	1.52
Knee revision	8.8	12.45	9.25	8.77	4.79

Note: Percentages for years prior to 2018/19 are pre-audit figures prior to introduction of the automated audit process. Percentages for the 2018/19 audit are as at 10 August 2021 using the automated process.

The recording of revision procedures in the registry has noticeably improved since the audit has been in place. In the most recently completed audit for years 2018/19, 97.87% of NJR hip and knee records could be matched to HES and local PAS systems.

During this last year we have undertaken a national roll out of an automated process enabling units to check their data quality on a monthly or quarterly basis. This is underway for hip, knee, elbow, ankle and shoulder data and the pilot suggested that this will rapidly become part of normal workflow and greatly reduce the number of mismatches between registry and hospital data. We anticipate that compliance and data accuracy will exceed 99% when the process is fully embedded.

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 registry 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.

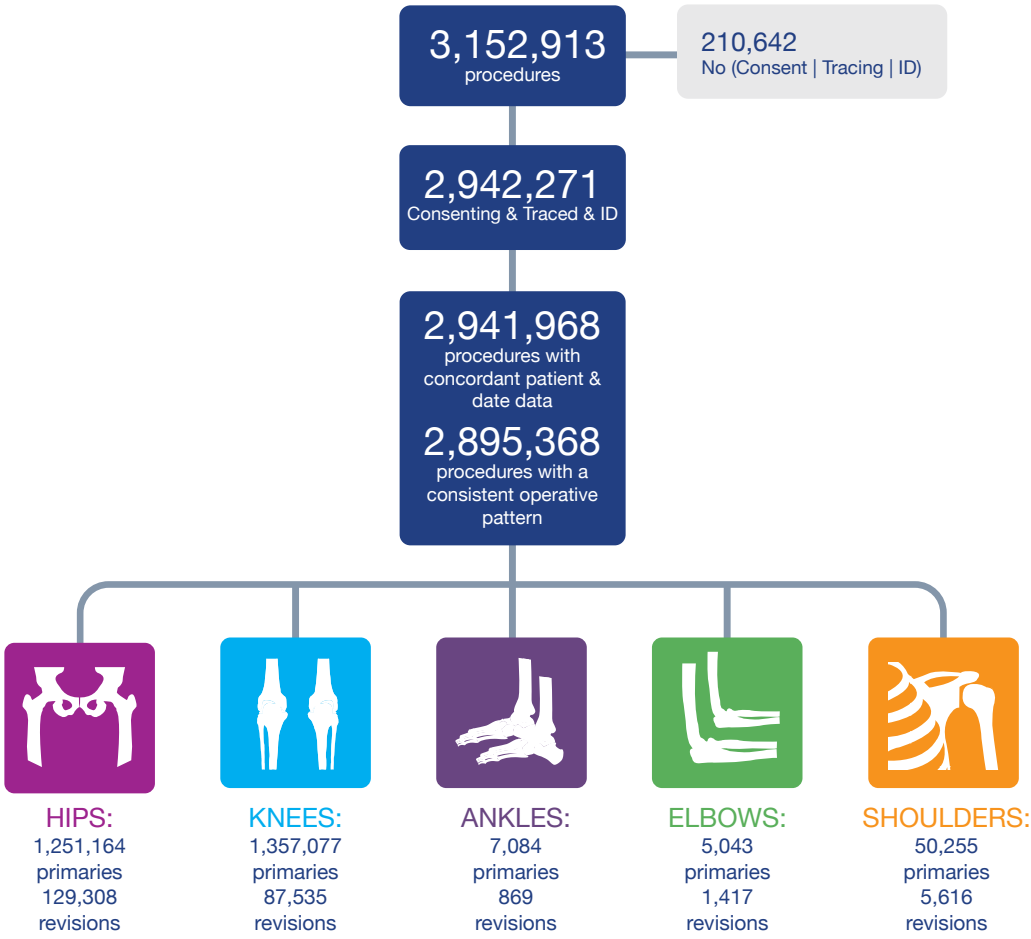
We believe that missing data within the registry can be considered missing completely at random. We propose that this missing data mechanism will ensure that the quality assurance process of prostheses entered into the registry, consultant and units is statistically valid.

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 for the same individual.

Starting with a total of 3,152,913 NJR sourced records, 6.7% were excluded 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 and the States of Guernsey were also excluded because of as yet 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 2,670,623 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 registry. 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.

A revision is defined as any operation where one or more components are added to, removed from or modified in a joint replacement, or if a Debridement And Implant Retention (DAIR) with or without modular exchange is performed. Capturing DAIR with or without modular exchange commenced with the introduction of MDSv7. Prior to this DAIR with modular exchange was included as a single-stage revision but DAIR without modular exchange was not captured. Within the annual report, each of these procedure types is included in the analyses as a revision episode. This is distinct from the analyses in the surgeon, unit, and implant performance workstreams where DAIR without modular exchange is not currently included as a revision outcome.

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

Debridement And Implant Retention (DAIR) without modular exchange has been included in the registry 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 categories 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 currently 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 registry 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 procedure (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.

We now distinguish 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) i.e. those prior to MDSv7.

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 recorded within the registry 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 registry 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 17 years, whilst patient data collected last year will have one year of follow-up or

less. Survival analyses methods enable 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' 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

Prosthesis Time Incidence Rates (PTIR) 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 registries 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 smaller intervals and calculating PTIRs for each smaller interval.

3.2 Outcomes after hip replacement

3.2.1 Overview of primary hip replacement surgery

In this section we address revision and mortality outcomes for all primary hip operations performed between 1 April 2003 and 31 December 2020. Patients operated on at the commencement of the registry therefore had a potential 17.75 years of follow-up. This year, follow-up is reported at a maximum of 17 years in the tables and figures, although beyond 15 years the numbers at risk are particularly low in some categories.

Figure 3.H1 (a) (page 46) describes the data cleaning applied to produce the total of 1,251,164 hip procedures included in the analyses presented in this section.

Over the lifetime of the registry, the 1,251,164 primary hip replacement procedures contributing to our revision analyses were carried out by a total of 3,821 unique consultant surgeons working across 478 units. Over the last three years (1 January 2018 to 31 December 2020), 250,278 primary hip procedures (representing 20.0% of the current registry volume) were performed by 2,164 consultant surgeons working across 424 units.

Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 60 (interquartile range (IQR) 4 to 183) and the median number of procedures per unit was 525 (IQR 263 to 814). A proportion of surgeons will have commenced practice as a consultant during this period, some may have retired, and some surgeons may have periods of surgical inactivity within the time of coverage of the registry, 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 1,142,684 cases (91.3% of the cohort) and was the sole indication given in 1,102,840 (88.1%) primary hip replacements.

Figure 3.H1 (a) Hip cohort flow diagram.

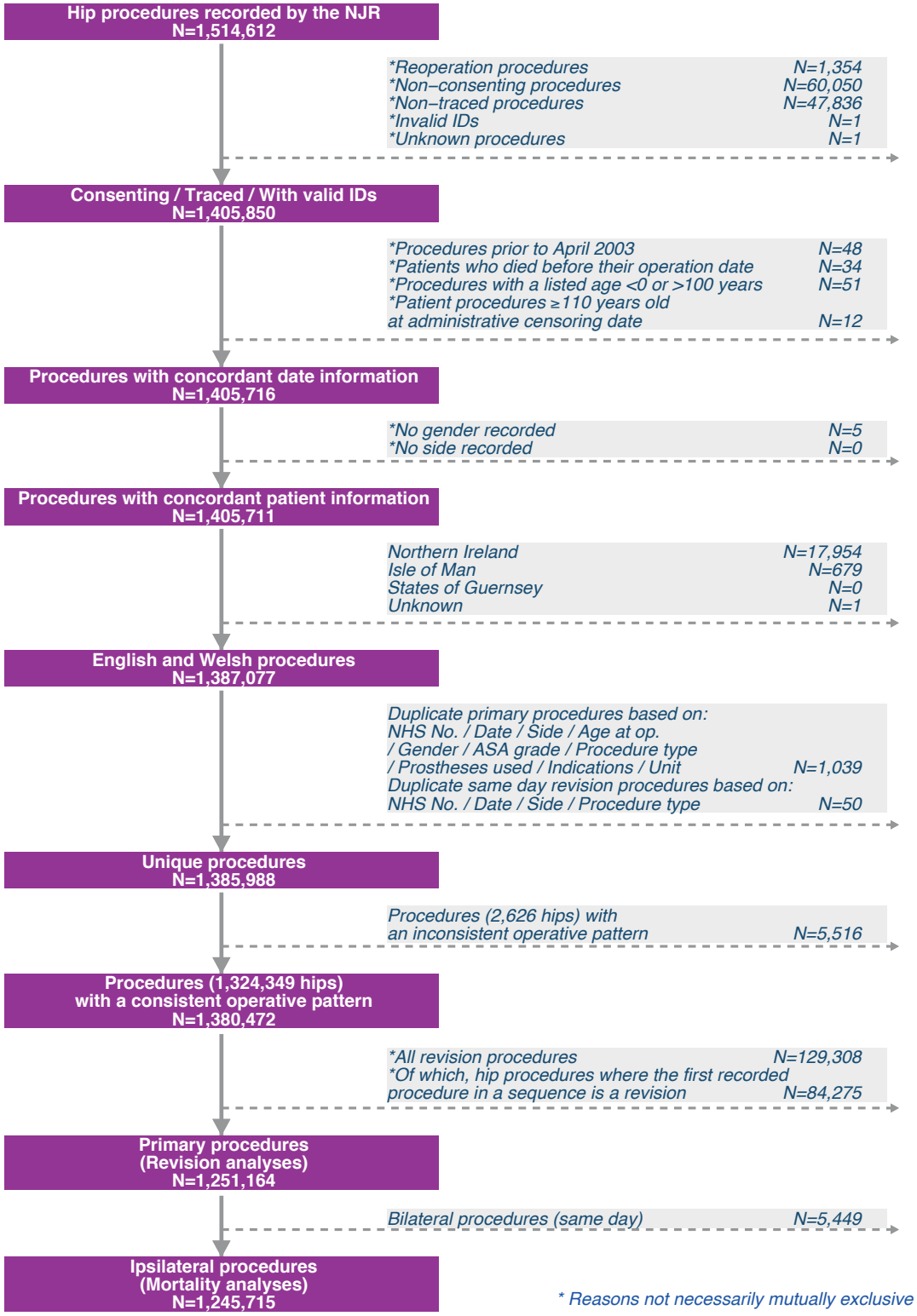
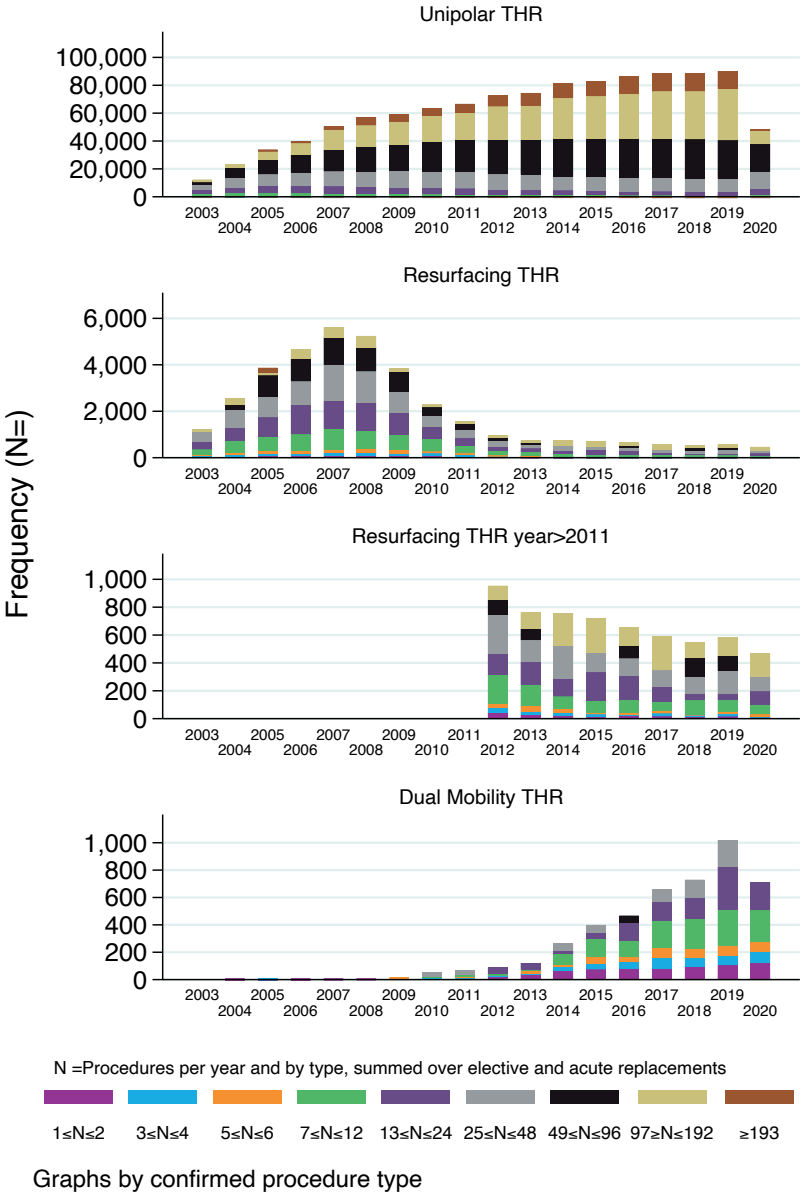


Table 3.H1 Number and percentage of primary hip replacements by fixation and bearing.

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		1,251,164		100.0
All cemented		391,414		31.3
	MoP	338,744	86.5	27.1
	MoM	407	0.1	<0.1
	CoP	49,677	12.7	4.0
	MoPoM	2,340	0.6	0.2
	Others	246	0.1	<0.1
All uncemented		465,982		37.2
	MoP	181,446	38.9	14.5
	MoM	29,028	6.2	2.3
	CoP	118,388	25.4	9.5
	CoC	133,721	28.7	10.7
	CoM	2,153	0.5	0.2
	MoPoM	725	0.2	0.1
	CoPoM	406	0.1	<0.1
	Others	115	<0.1	<0.1
All hybrid		284,326		22.7
	MoP	159,609	56.1	12.8
	MoM	2,722	1.0	0.2
	CoP	90,769	31.9	7.3
	CoC	26,961	9.5	2.2
	MoPoM	3,236	1.1	0.3
	CoPoM	862	0.3	0.1
	Others	166	0.1	<0.1
All reverse hybrid		32,596		2.6
	MoP	22,231	68.2	1.8
	CoP	10,141	31.1	0.8
	Others	224	0.7	<0.1
All resurfacing		40,081		3.2
	MoM	39,883	99.5	3.2
	Others	198	0.5	<0.1
Unclassified		36,765		2.9

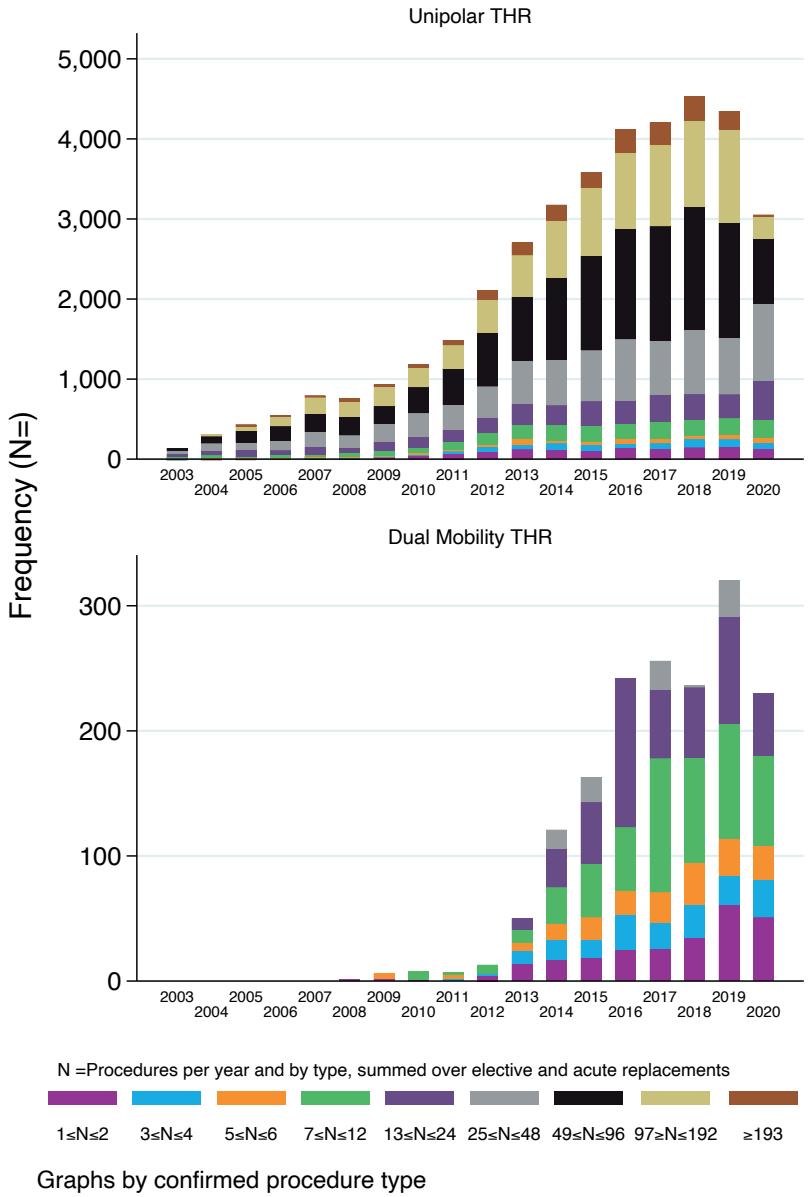
Table 3.H1 shows the breakdown of cases by the method of fixation and within each fixation sub-group, by bearing surfaces. Bearing surface combinations are reported as a separate group where there were more than 250 cases. The most commonly used operation type overall remains as cemented metal-on-polyethylene (86.5% of all cemented primaries, 27.1% of all primaries). 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.

Figure 3.H1 (b) Frequency of primary **hip** replacements within **elective** cases stratified by procedure **type**. Consultants have been placed in groups by the **volume** of cases they undertake per annum. Each colour represents total volume of cases undertaken by all the consultants in that grouping.



Graphs by confirmed procedure type

Figure 3.H1 (c) Frequency of primary hip replacements within acute trauma cases stratified by procedure type. Consultants have been placed in groups by the volume of cases they undertake per annum. Each colour represents total volume of cases undertaken by all the consultants in that grouping.



Graphs by confirmed procedure type

Figure 3.H1 (b) and Figure 3.H1 (c) show the yearly number of primary total hip replacements performed for elective and acute trauma indications respectively. Elective procedures have been stratified by unipolar, resurfacing and dual mobility total hip replacements. Acute trauma procedures have been stratified by unipolar and dual mobility total hip replacements, please note the difference in scale of the y-axis between each sub-plot.

Each bar is further stratified by the volume of procedures that the consultant conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 25 elective unipolar THR procedures and 25 acute trauma unipolar elective procedures their annual total volume would be 50 procedures. Those 50 procedures would contribute to the black sub-division in both elective and acute trauma figures.

Figure 3.H1 (b) shows the annual rates of elective unipolar THR increasing, (with the exception of 2020 due to the COVID-19 pandemic), with the majority of additional procedures contributed by higher volume surgeons i.e. those performing more than 49 procedures a year. A similar result is also observed in the acute trauma setting with a rapid expansion of unipolar THRs being recorded in the registry after 2011.

Figure 3.H1 (b) also shows that after declining substantially in popularity, resurfacing has only declined marginally in the past five years. The procedure has declined more among surgeons who undertook low volumes of resurfacing. In 2020 over half of the resurfacing procedures were performed by consultants who used it in more than 25 cases per year.

Figure 3.H1 (b) and Figure 3.H1 (c) also illustrate the emerging use of dual mobility THR in the elective and acute trauma setting. Prior to 2013 dual mobility THR was relatively rare but since 2013 its use has increased in both settings, and it is now more common than hip resurfacing. Over half of dual mobility operations are performed by consultants who conduct seven or more replacements per year.

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

Fixation/ bearing	2004 n= 42,578	2005 n= 40,662	2006 n= 48,511	2007 n= 60,895	2008 n= 67,434	2009 n= 68,599	2010 n= 71,119	2011 n= 74,076	2012 n= 78,282	2013 n= 80,438	2014 n= 87,682	2015 n= 89,840	2016 n= 94,346	2017 n= 96,424	2018 n= 96,771	2019 n= 98,649	2020 n= 54,858
All cemented	53.6	46.0	40.3	37.4	31.9	30.0	29.5	30.2	31.8	32.1	31.1	30.1	28.5	27.4	26.9	25.7	22.4
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	23.4	22.0	21.7	20.3	17.3
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	0
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	5.1	4.8
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	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	0.1
All uncemented	18.3	24.2	28.3	31.5	37.3	40.8	43.2	42.8	44.1	41.9	40.3	39.0	38.2	37.5	36.5	35.1	34.8
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	16.8	16.2	15.9	15.6	15.2	13.6	12.5
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	<0.1
CoP	5.0	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	14.9	15.9	17.1
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	5.3	4.8
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	<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	0.2
CoPoM	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	0.1	0.2
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	0
All hybrid	12.7	13.9	15.1	14.8	14.7	15.4	15.8	16.7	17.4	19.9	22.8	25.3	27.7	29.8	31.6	34.8	37.9
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	14.9	15.5	15.2	16.5	16.2
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	<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	19.4
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	0.7
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	1.0
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	0.4
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	<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)

Fixation/ bearing	2004 n= 42,578	2005 n= 40,662	2006 n= 48,511	2007 n= 60,895	2008 n= 67,434	2009 n= 68,599	2010 n= 71,119	2011 n= 74,076	2012 n= 78,282	2013 n= 80,438	2014 n= 87,682	2015 n= 89,840	2016 n= 94,346	2017 n= 96,424	2018 n= 96,771	2019 n= 98,649	2020 n= 54,858
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	2.2
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	2.1	1.6	1.5
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	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	<0.1
All resurfacing	9.8	10.3	10.3	9.7	8.3	6.1	3.7	2.4	1.4	1.1	0.9	0.9	0.7	0.7	0.6	0.6	0.9
Resurfacing by bearing surface:																	
MoM	9.8	10.3	10.3	9.7	8.3	6.1	3.7	2.4	1.4	1.1	0.9	0.9	0.7	0.6	0.5	0.6	0.9
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	0.1
Unclassified	4.9	4.7	4.9	5.0	5.4	5.0	5.1	4.7	2.3	2.0	1.8	1.6	1.6	1.4	1.5	1.4	1.8
All	100	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. The proportion of all hips that are cemented has nearly halved between 2006 and 2020. The percentage of hybrid implants used has gone up by over 2.5 times over the same period. The percentage of uncemented implants used increased from 18% to 44% in the first nine years of the registry, but since then has steadily declined to 35% over the last eight years. Figure 3.H2 (a) illustrates the temporal changes in fixation and type of primary hip replacements. Figure 3.H2 (b) overleaf 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 and type by **year** of primary hip replacement.

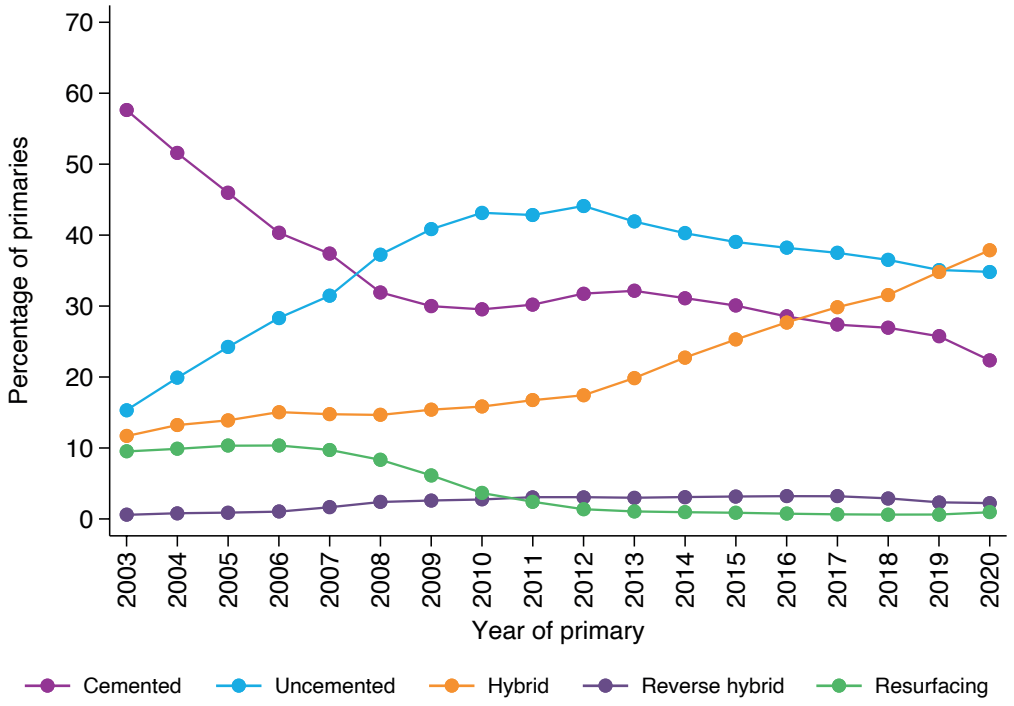


Figure 3.H2 (b) Unipolar **THR fixation** and main bearing type by **year** of primary hip replacement.

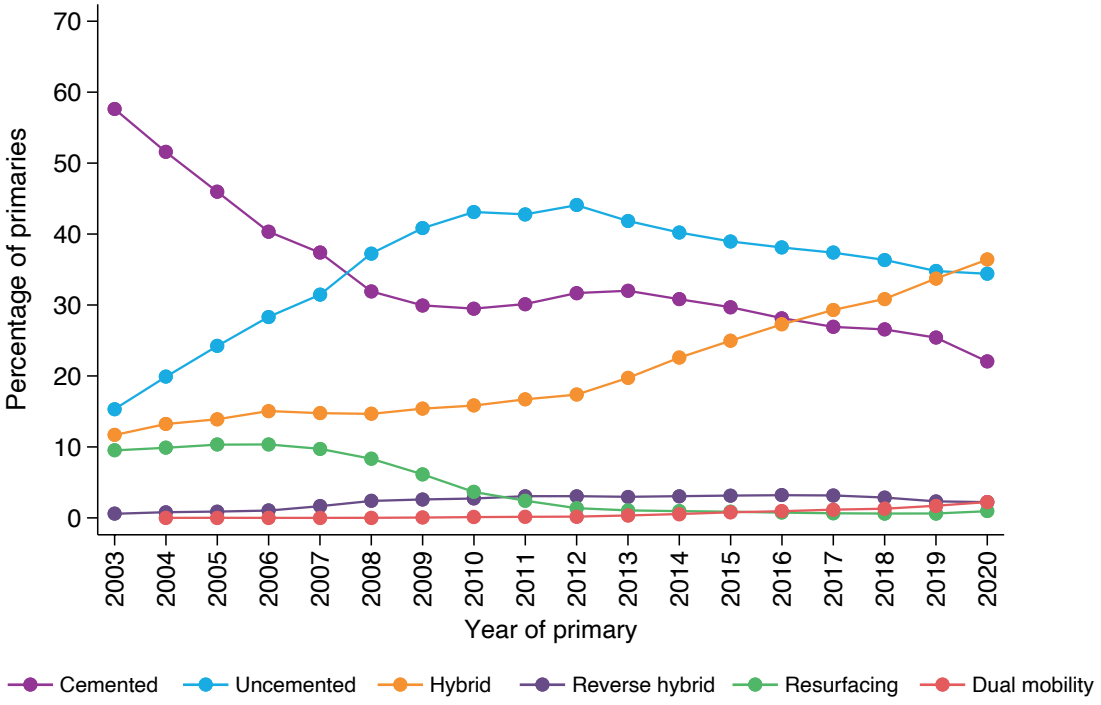
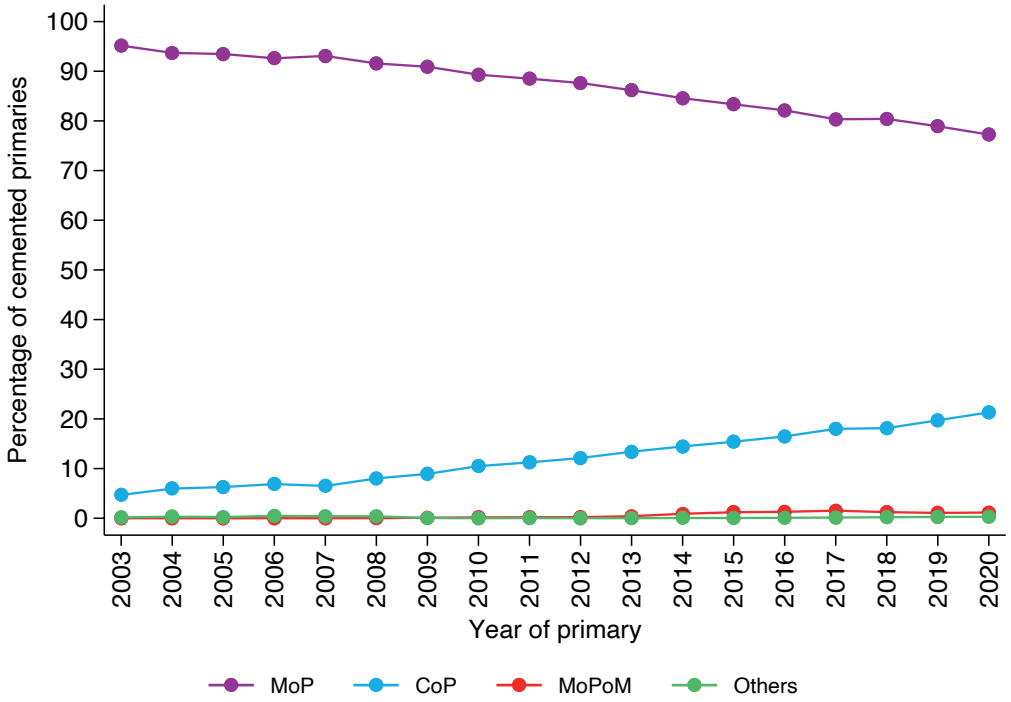


Figure 3.H3 (a) Cemented primary hip replacement bearing surface by year.



Figures 3.H3 (a) to (d) illustrate the temporal changes in the bearing surface combinations used by the type of total hip replacement fixation. 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. The greatest variation in bearing use is noted in the uncemented fixation group.

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

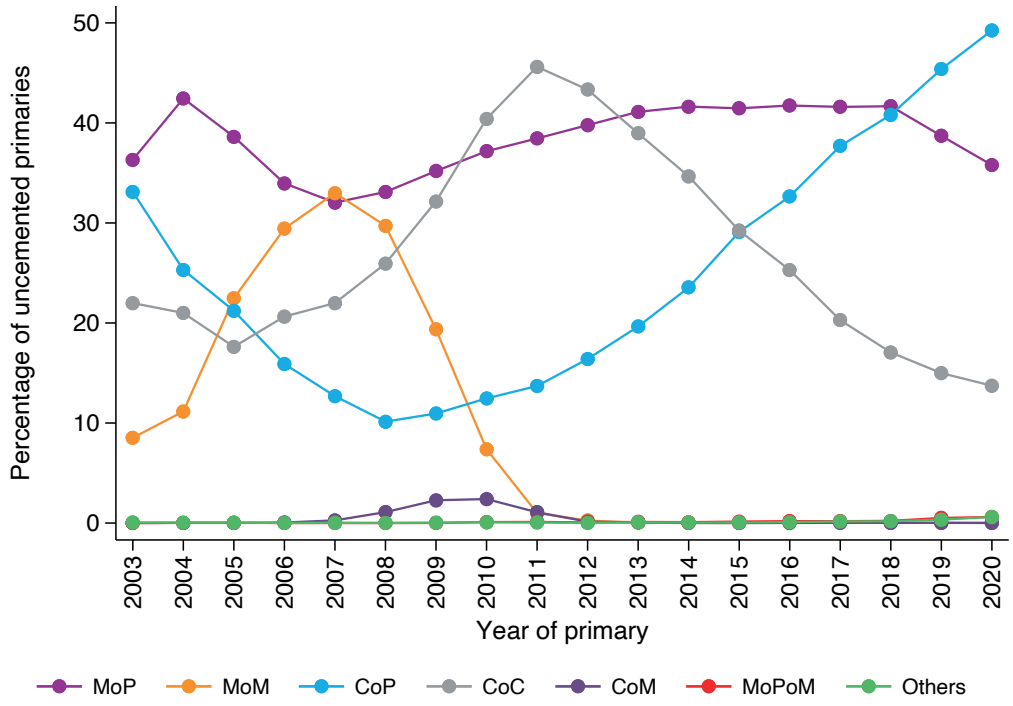


Figure 3.H3 (c) Hybrid primary hip replacement bearing surface by year.

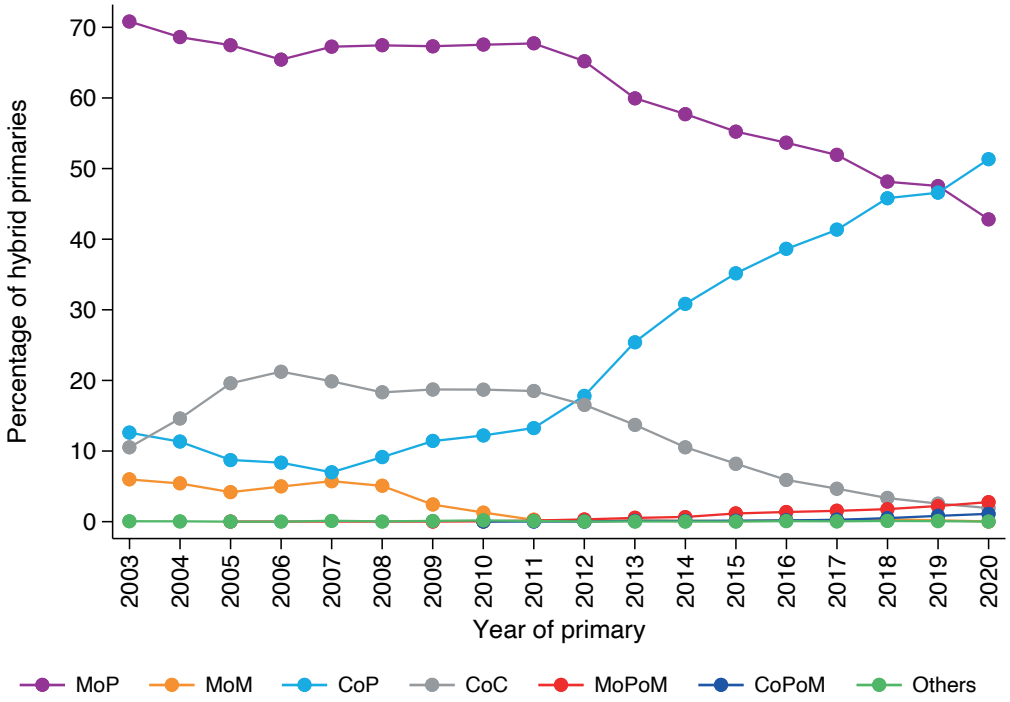


Figure 3.H3 (d) Reverse hybrid primary hip replacement bearing surface by year.

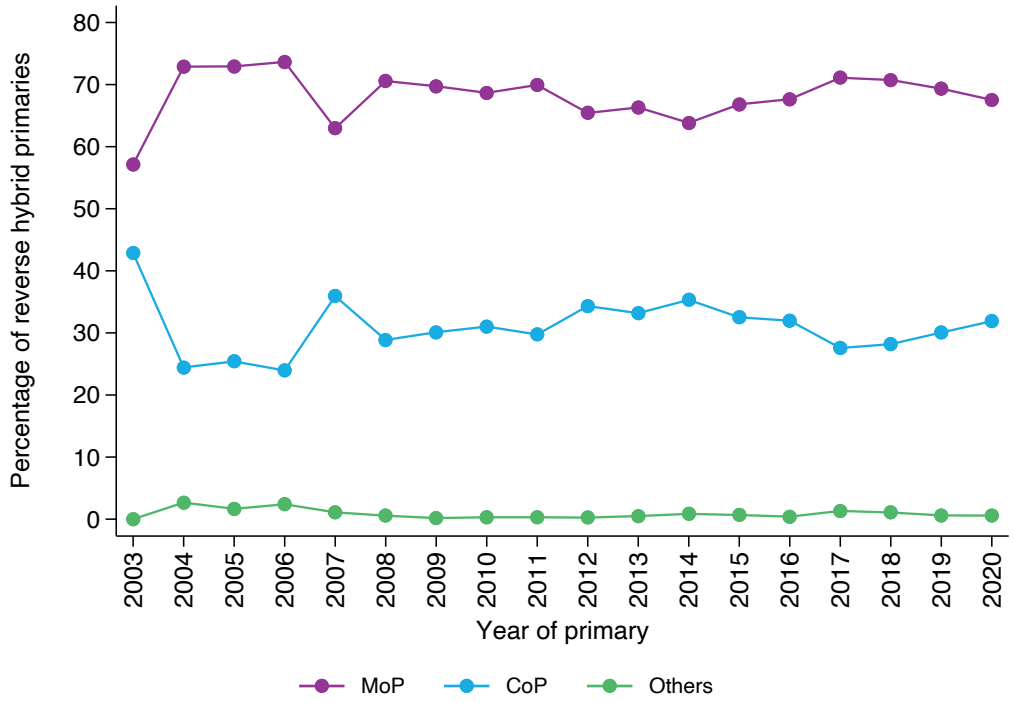
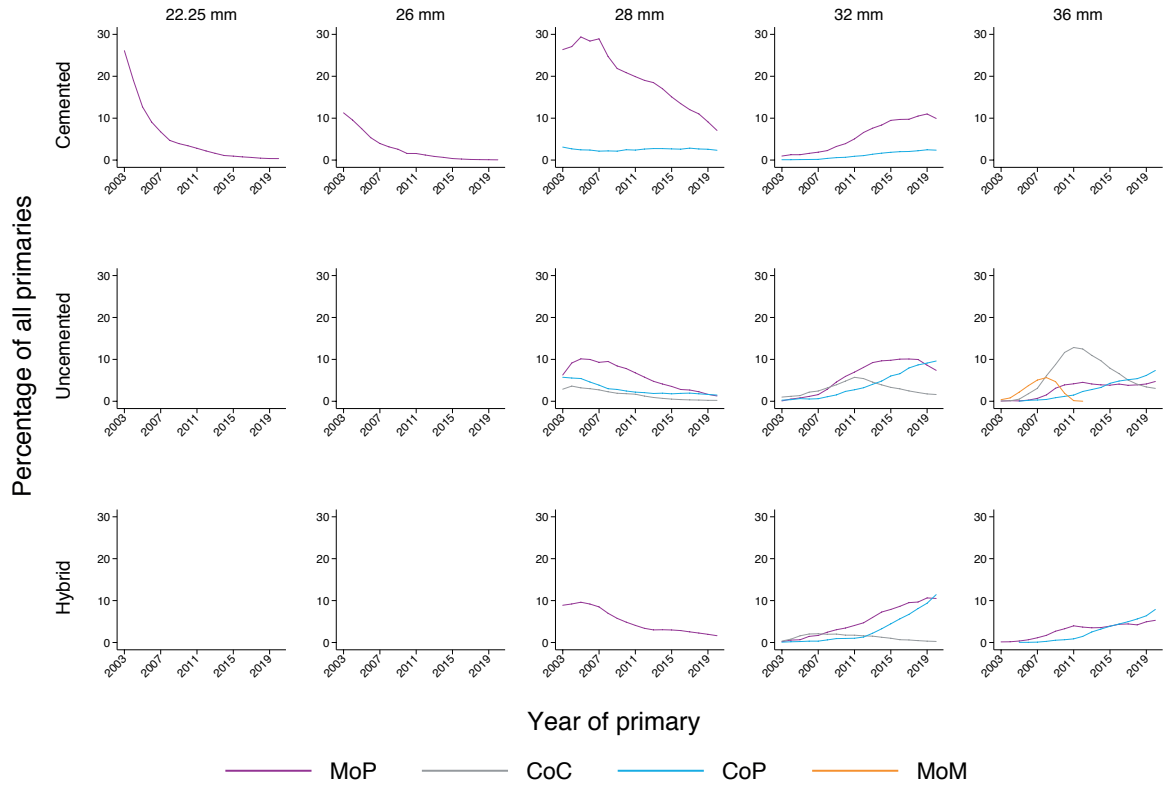


Figure 3.H3 (e) Trends in **fixation**, **bearing** and **head size** in primary unipolar total hip replacement by **year**.



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 2020, as 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 2020 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 tended to be older than those in the other groups. Those receiving resurfacings were more likely to be younger 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		**1,251,164**	**69 (61 to 76)**	**68.1 (11.4)**	**40.1**
All cemented		**391,414**	**74 (68 to 79)**	**73.1 (9.1)**	**33.5**
Cemented and					
	MoP	338,744	75 (69 to 80)	74.3 (8.2)	32.8
	MoM	407	72 (65 to 78)	71.1 (9.5)	33.7
	CoP	49,677	65 (59 to 71)	64.6 (10.4)	37.9
	MoPoM	2,340	77 (70 to 83)	75.5 (10.7)	30.9
	Others	246	75 (66 to 83)	72.5 (12.9)	29.7
All uncemented		**465,982**	**65 (58 to 72)**	**64.4 (11.3)**	**45.0**
Uncemented and					
	MoP	181,446	71 (64 to 76)	69.9 (9.5)	41.5
	MoM	29,028	63 (57 to 70)	63.0 (11.1)	50.8
	CoP	118,388	64 (57 to 70)	62.9 (10.1)	46.3
	CoC	133,721	60 (52 to 66)	58.6 (11.3)	47.2
	CoM	2,153	63 (56 to 69)	62.0 (10.6)	42.1
	MoPoM	725	71 (61 to 79)	69.0 (13.4)	38.9
	CoPoM	406	59 (52 to 69)	60.4 (13.0)	59.1
	Others	115	62 (52 to 71)	61.0 (13.7)	45.2
All hybrid		**284,326**	**70 (63 to 77)**	**69.1 (10.9)**	**37.3**
Hybrid and					
	MoP	159,609	74 (68 to 79)	73.2 (8.7)	34.8
	MoM	2,722	65 (57 to 74)	64.6 (12.4)	46.4
	CoP	90,769	66 (59 to 72)	65.0 (10.6)	40.5
	CoC	26,961	60 (53 to 66)	59.0 (11.3)	40.8
	MoPoM	3,236	76 (68 to 82)	73.8 (11.2)	33.3
	CoPoM	862	69 (59 to 77)	67.4 (12.9)	46.1
	Others	166	67 (58 to 75)	65.8 (12.8)	48.8
All reverse hybrid		**32,596**	**71 (64 to 77)**	**69.7 (9.8)**	**37.0**
Reverse hybrid and					
	MoP	22,231	73 (68 to 78)	72.8 (8.0)	35.7
	CoP	10,141	64 (58 to 69)	63.0 (9.7)	40.0
	Others	224	72 (57 to 81)	68.0 (15.8)	30.8
All resurfacing		**40,081**	**55 (48 to 60)**	**53.9 (9.1)**	**73.4**
Resurfacing and					
	MoM	39,883	55 (48 to 60)	53.9 (9.1)	73.5
	Others	198	54 (48 to 60)	53.4 (10.8)	55.1
Unclassified		**36,765**	**69 (61 to 77)**	**68.0 (12.5)**	**38.5**

*IQR=interquartile range.

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

		Males N (%)		Females N (%)		All N (%)
Total		**502,239**		**748,925**		**1,251,164**
ASA 1		90,190 (18.0)		104,495 (14.0)		194,685 (15.6)
ASA 2		326,480 (65.0)		519,514 (69.4)		845,994 (67.6)
ASA 3		82,248 (16.4)		120,953 (16.2)		203,201 (16.2)
ASA 4		3,258 (0.6)		3,877 (0.5)		7,135 (0.6)
ASA 5		63 (<0.1)		86 (<0.1)		149 (<0.1)
Osteoarthritis as the sole reason for primary		450,019 (89.6)		652,821 (87.2)		1,102,840 (88.1)
Osteoarthritis as a reason for primary		465,099 (92.6)		677,585 (90.5)		1,142,684 (91.3)
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)

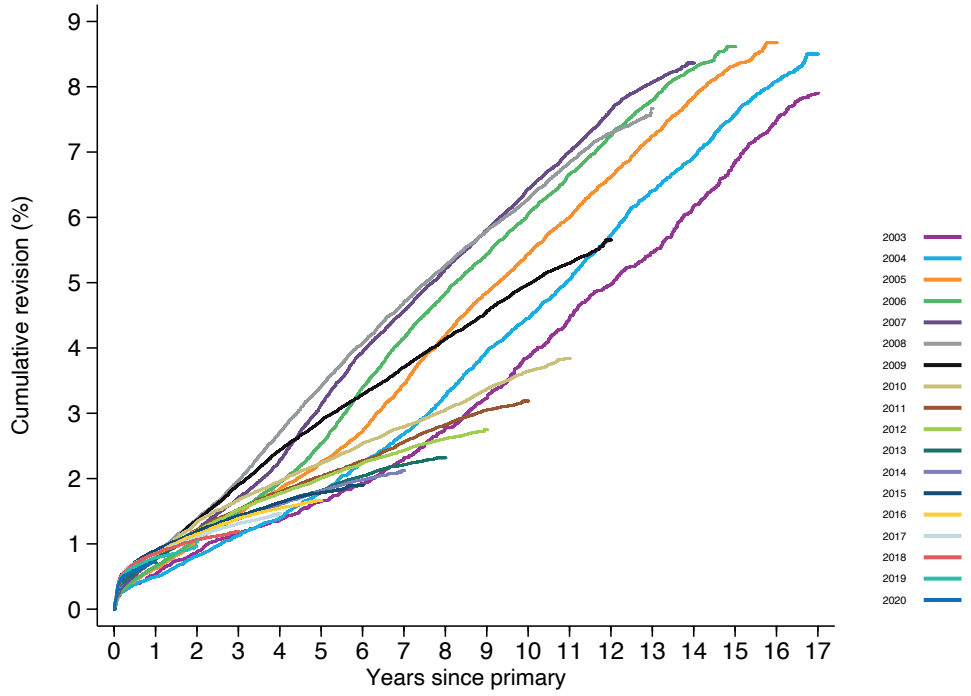
Table 3.H4 shows the American Society of Anesthesiologists (ASA) grade and indication for primary hip replacement by gender. A greater number of females than males undergo primary hip replacement and two-thirds of patients are ASA grade 2. Only a small number of patients with a grade greater than ASA 3 undergo a primary hip replacement. The majority of cases are performed for osteoarthritis. A total of 1,102,840 (88.1%) primary hip replacements have been recorded in the registry where the sole indication was osteoarthritis.

3.2.2 First revisions after primary hip surgery

A total of 37,444 first revisions of a hip prosthesis have been linked to a previous primary hip replacement recorded in the registry between 2003 and 2020.

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 2020.

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



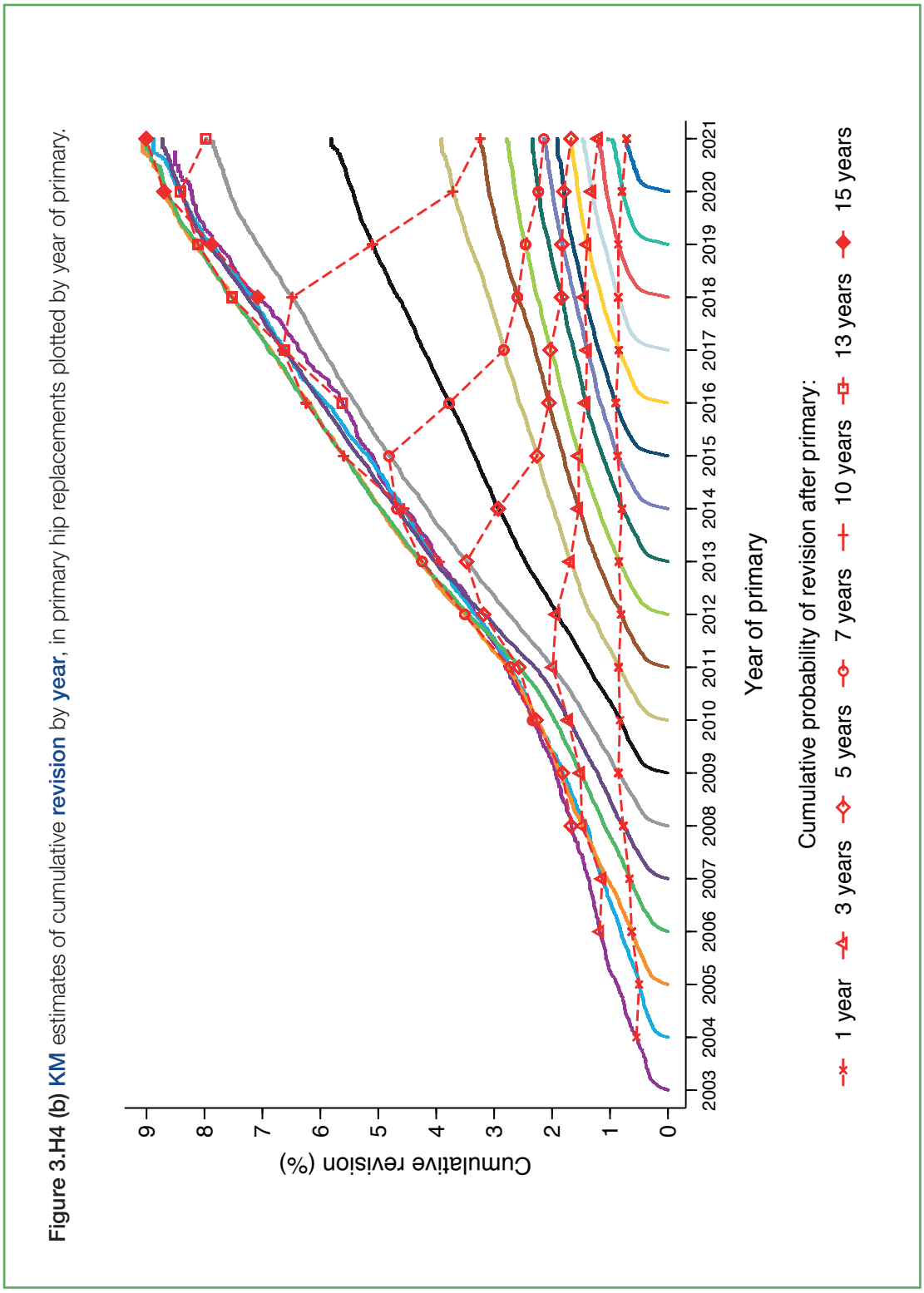


Figure 3.H4 (b) KM estimates of cumulative **revision** by **year**, in primary hip replacements plotted by year of primary.

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, we have highlighted the revision rate at 1, 3, 5, 7, 10, 13 and 15 years. Figure 3.H4 (b) separates each year, enabling 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, 10 and 13-year rate of revision increases for operations occurring between 2003 and 2008 and then reduces for operations occurring between 2008 and 2020. The early increases may be partly a result of under-reporting in the earlier years of the registry as this wasn't mandatory at that time, but is also contributed to by the usage of metal-on-metal bearings, which peaked in 2008 and then fell (see Table 3.H2 on page 51).

A similar pattern, although smaller in effect, is also observed in knees. Knees were not affected by the high revision rates of metal-on-metal bearings, and thus the decreases observed since 2009 indicate a broader improvement in outcomes overall. It appears that this secular decline in revision rates is still ongoing. This improvement suggests the adoption of evidence-based practice to which the NJR's clinician feedback has contributed. For example, for a primary hip replacement performed in 2010, the 10-year revision rate is 3.7% (95% CI 3.5% - 3.8%) which is below the current NICE recommended threshold of 5% at ten years (NICE: Total hip replacement and resurfacing arthroplasty for end-stage arthritis of the hip. Technology appraisal guidance [TA304] Published: 26 February 2014). Prior to 2014, the revision threshold recommended by NICE was 10% at ten years (NICE: Guidance on the Selection of Prostheses for Primary Total Hip Replacement. Technology appraisal guidance [TA2] Published: 26 April 2000).

Table 3.H5 (page 65) 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, 15 and 17 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 blue 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.

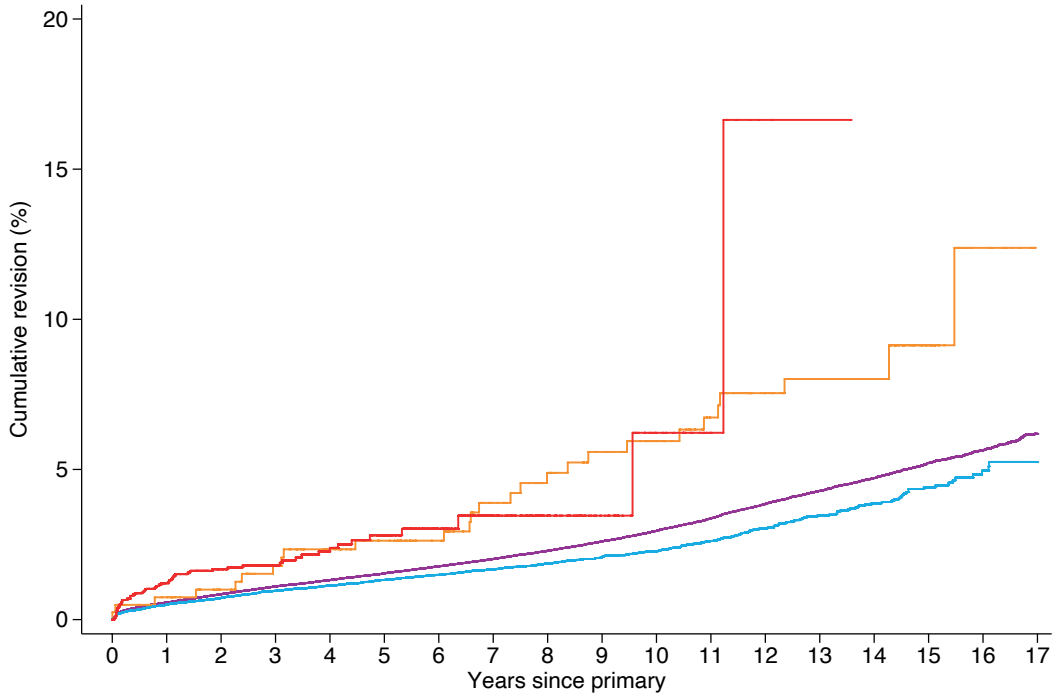
The revision rate of dual mobility bearings appears higher up to five years across all fixation types than that of most of the unipolar bearing combinations, except metal-on-metal. The CoPoM dual mobility bearings show lower revision estimates than the MoPoM combinations but with overlapping confidence intervals. The relatively small numbers at risk in the dual mobility groups make it difficult to draw firm conclusions 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	15 years	17 years
All cases*		**1,251,164**	**0.81 (0.79-0.83)**	**1.49 (1.47-1.51)**	**2.16 (2.13-2.19)**	**4.28 (4.23-4.33)**	**6.89 (6.78-6.99)**	**7.78 (7.62-7.95)**
All cemented		**391,414**	**0.57 (0.54-0.59)**	**1.09 (1.06-1.12)**	**1.52 (1.48-1.56)**	**2.90 (2.82-2.97)**	**5.15 (4.99-5.31)**	**6.12 (5.85-6.39)**
Cemented and	MoP	338,744	0.57 (0.55-0.60)	1.10 (1.07-1.14)	1.54 (1.50-1.59)	2.96 (2.88-3.03)	5.21 (5.05-5.38)	6.19 (5.91-6.47)
	MoM	407	0.74 (0.24-2.29)	1.80 (0.86-3.73)	2.63 (1.42-4.84)	5.94 (3.86-9.10)	*9.13 (6.04-13.69)*	
	CoP	49,677	0.50 (0.44-0.57)	0.96 (0.87-1.05)	1.32 (1.21-1.44)	2.28 (2.10-2.48)	4.41 (3.93-4.95)	*5.25 (4.52-6.10)*
	MoPoM	2,340	*1.21 (0.83-1.77)*	*1.81 (1.32-2.49)*	2.81 (2.06-3.84)	*6.22 (2.56-14.73)*		
	Others	246**	*0.87 (0.22-3.43)*	*1.47 (0.47-4.57)*	*1.47 (0.47-4.57)*			
All uncemented		**465,982**	**0.96 (0.93-0.99)**	**1.75 (1.71-1.79)**	**2.54 (2.49-2.59)**	**5.06 (4.97-5.15)**	**7.89 (7.70-8.09)**	**8.81 (8.48-9.16)**
Uncemented and	MoP	181,446	1.03 (0.98-1.07)	1.64 (1.58-1.71)	2.07 (2.00-2.14)	3.63 (3.51-3.76)	6.23 (5.91-6.58)	7.66 (7.00-8.39)
	MoM	29,028	1.07 (0.95-1.19)	3.50 (3.29-3.72)	7.73 (7.43-8.05)	17.74 (17.28-18.20)	22.48 (21.87-23.09)	*23.31 (22.54-24.11)*
	CoP	118,388	0.82 (0.77-0.87)	1.35 (1.28-1.42)	1.75 (1.66-1.83)	2.86 (2.70-3.02)	4.46 (4.12-4.83)	5.22 (4.62-5.90)
	CoC	133,721	0.96 (0.91-1.01)	1.75 (1.68-1.83)	2.28 (2.20-2.36)	3.44 (3.32-3.56)	5.16 (4.86-5.48)	5.55 (5.14-5.99)
	CoM	2,153	0.56 (0.32-0.98)	2.74 (2.13-3.53)	4.80 (3.96-5.80)	8.11 (6.99-9.39)		
	MoPoM	725	2.73 (1.75-4.26)	3.38 (2.22-5.13)	*3.38 (2.22-5.13)*	*3.38 (2.22-5.13)*		
	CoPoM	406	0.79 (0.26-2.43)	*2.46 (0.90-6.61)*	*2.46 (0.90-6.61)*			
	Others	115**	*3.48 (1.32-9.00)*	*7.02 (3.57-13.55)*	*8.07 (4.27-14.95)*	*17.09 (10.33-27.54)*		
All hybrid		**284,326**	**0.79 (0.76-0.83)**	**1.30 (1.26-1.34)**	**1.76 (1.71-1.82)**	**3.21 (3.11-3.31)**	**5.10 (4.88-5.34)**	**5.87 (5.49-6.26)**
Hybrid and	MoP	159,609	0.83 (0.79-0.88)	1.34 (1.28-1.40)	1.79 (1.72-1.86)	3.09 (2.97-3.22)	4.97 (4.68-5.27)	5.64 (5.19-6.14)
	MoM	2,722	0.81 (0.53-1.23)	2.61 (2.06-3.30)	5.76 (4.90-6.76)	16.08 (14.59-17.69)	21.45 (19.50-23.55)	*22.48 (20.13-25.06)*
	CoP	90,769	0.76 (0.70-0.82)	1.21 (1.13-1.29)	1.53 (1.44-1.63)	2.38 (2.19-2.59)	4.12 (3.48-4.88)	*5.81 (4.52-7.46)*
	CoC	26,961	0.60 (0.52-0.70)	1.09 (0.97-1.23)	1.59 (1.45-1.76)	2.73 (2.51-2.97)	3.92 (3.56-4.32)	*4.04 (3.62-4.51)*
	MoPoM	3,236	1.30 (0.95-1.77)	1.90 (1.42-2.54)	2.29 (1.67-3.13)			
	CoPoM	862	1.02 (0.51-2.03)	*1.34 (0.66-2.69)*	*1.34 (0.66-2.69)*			
	Others	166**	*1.81 (0.59-5.51)*	*2.68 (1.00-7.09)*	*2.68 (1.00-7.09)*	*2.68 (1.00-7.09)*		
All reverse hybrid		**32,596**	**0.85 (0.76-0.96)**	**1.47 (1.34-1.62)**	**1.96 (1.80-2.13)**	**3.44 (3.15-3.75)**	**6.39 (5.37-7.60)**	*6.68 (5.55-8.03)*
Reverse hybrid and	MoP	22,231	0.87 (0.76-1.01)	1.46 (1.30-1.63)	1.90 (1.72-2.11)	3.53 (3.16-3.94)	*6.39 (5.21-7.83)*	*6.39 (5.21-7.83)*
	CoP	10,141	0.77 (0.62-0.96)	1.48 (1.25-1.74)	1.97 (1.70-2.29)	3.06 (2.63-3.56)	*5.92 (4.24-8.23)*	*6.76 (4.63-9.84)*
	Others	224**	*2.33 (0.97-5.50)*	*2.99 (1.34-6.61)*	*9.10 (5.06-16.08)*	*19.06 (11.74-30.09)*		
All resurfacing		**40,081**	**1.20 (1.10-1.31)**	**2.96 (2.80-3.14)**	**5.20 (4.98-5.43)**	**10.41 (10.10-10.73)**	**13.96 (13.55-14.38)**	**14.79 (14.30-15.29)**
Resurfacing and	MoM	39,883	1.20 (1.10-1.31)	2.97 (2.80-3.14)	5.20 (4.99-5.43)	10.41 (10.10-10.73)	13.96 (13.56-14.38)	14.79 (14.31-15.29)
	Others	198**	*1.17 (0.29-4.60)*	*2.61 (0.98-6.85)*				

* Includes 36,765 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.

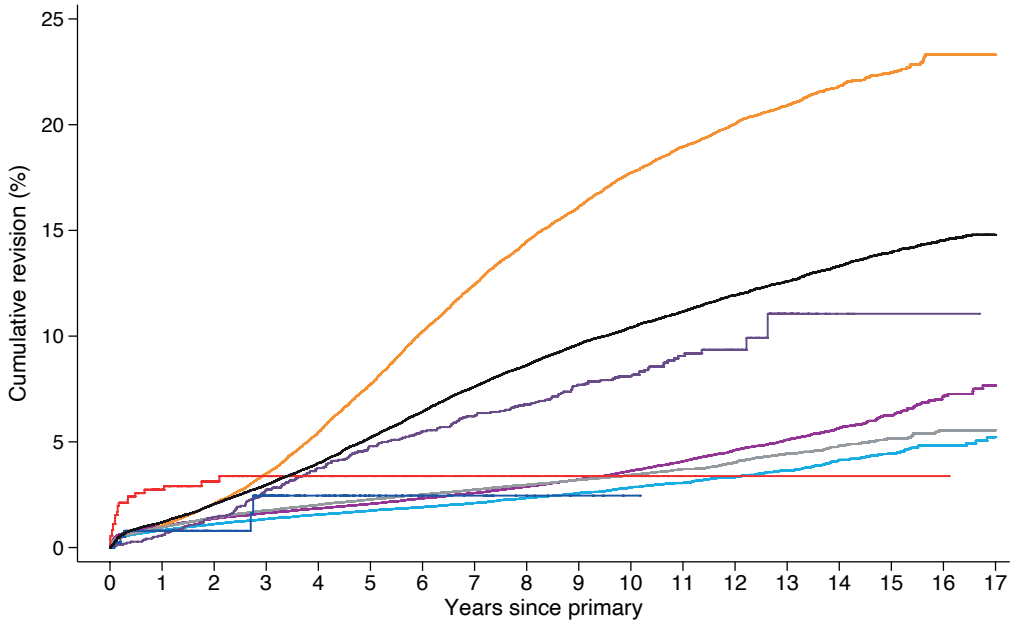
Figure 3.H5 KM estimates of cumulative **revision** in **cemented** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk								
MoP	338,744	293,203	236,590	179,817	127,413	84,596	51,896	25,621	8,167
MoM	407	379	346	318	280	251	*205*	*91*	*19*
CoP	49,677	40,948	30,750	21,805	14,347	8,844	5,082	2,475	736
MoPoM	2,340	1,621	836	289	*73*	*23*	*<4*		

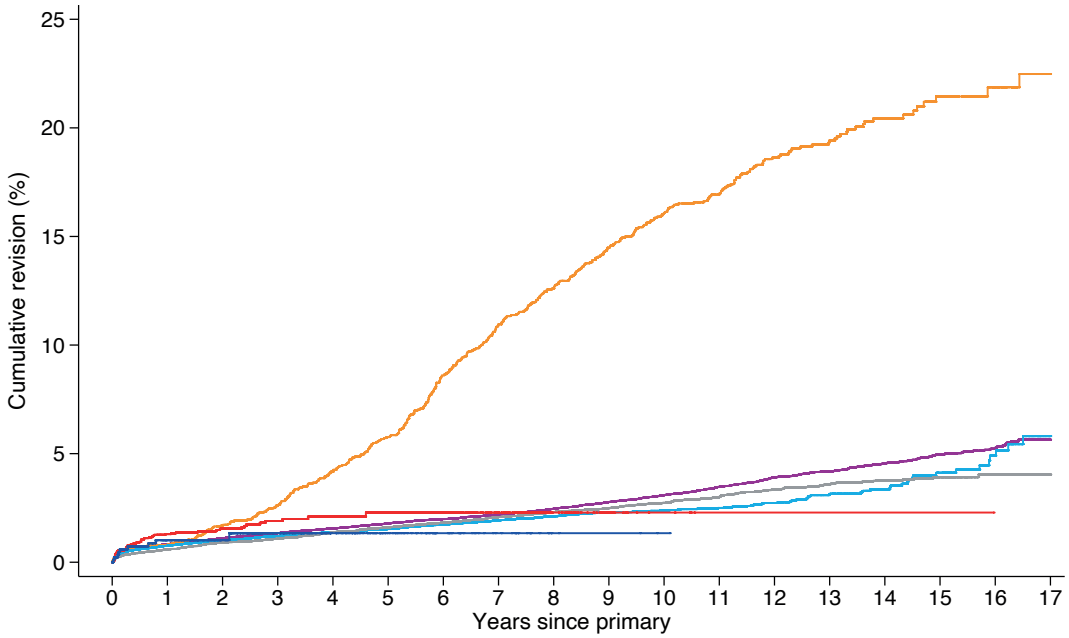
Figures 3.H5 to 3.H8 (pages 66 to 69) illustrate the differences between the various bearing surface sub-groups for cemented, uncemented, hybrid and reverse hybrid hips, respectively. Metal-on-metal bearings continue to perform worse than all other options regardless of fixation, apart from in cemented fixation where the results of the rarely used metal-on-metal combination are similar to metal-on-polyethylene-on-metal dual mobility. The failure rates for ceramic-on-polyethylene bearings remain consistently low or equivalent to alternatives across all fixation options out to ten years and it is encouraging that these are becoming more widely used with time. The trajectory of the revision rates for polyethylene-containing bearings do appear to differ beyond ten years, which may represent the increased use of highly cross-linked polyethylene over time. The long-term impacts of such changes will continue to be monitored. Dual mobility bearings have higher early revision rates than other options for cemented and uncemented fixation, this effect appears to persist in cemented fixation. Although a similar pattern is seen in hybrid fixation, the difference compared to alternatives is smaller. 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	181,446	154,373	119,481	86,352	56,766	32,946	16,100	6,357	1,503
MoM	29,028	27,841	26,089	23,826	21,633	19,256	12,694	3,990	451
CoP	118,388	90,874	61,656	39,163	24,184	14,475	8,205	4,197	1,288
CoC	133,721	122,816	107,359	86,417	60,638	32,781	13,831	4,826	1,174
CoM	2,153	2,083	1,969	1,873	1,768	1,346	*249*	*6*	*<4*
MoPoM	725	396	*245*	*135*	*75*	*27*	*<4*	*<4*	*<4*
CoPoM	406	*163*	*60*	*22*	*7*	*<4*			
Resurfacing	40,081	37,969	35,779	33,177	30,467	26,824	20,057	10,288	3,165

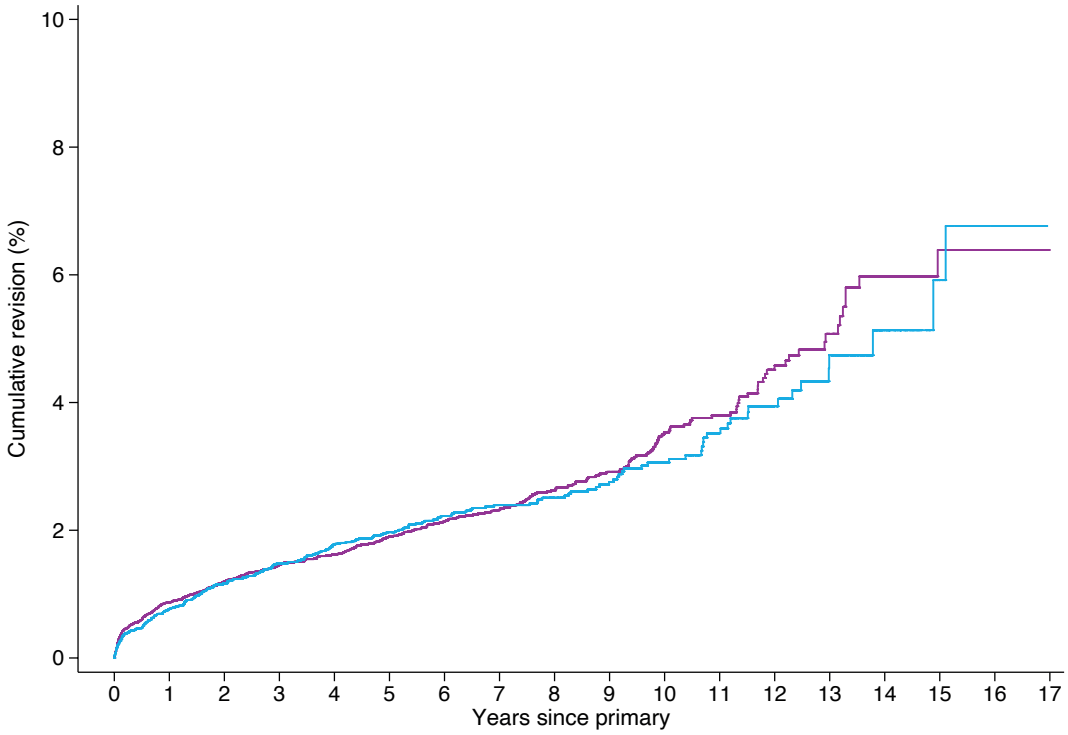
Figure 3.H7 KM estimates of cumulative **revision** in **hybrid** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk								
MoP	159,609	127,678	93,373	64,110	42,377	26,243	14,722	6,481	1,827
MoM	2,722	2,527	2,211	1,977	1,758	1,534	1,175	524	*171*
CoP	90,769	62,384	36,021	18,163	8,500	4,778	2,513	1,207	398
CoC	26,961	25,146	22,340	18,629	14,189	9,706	5,856	2,761	588
MoPoM	3,236	1,704	717	*210*	*50*	*5*	*<4*	*<4*	
CoPoM	862	331	*111*	*37*	*4*	*<4*			

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 13 years. After 13 years the numbers at risk are very low and therefore it is difficult to interpret survivorship at greater than 13 years.

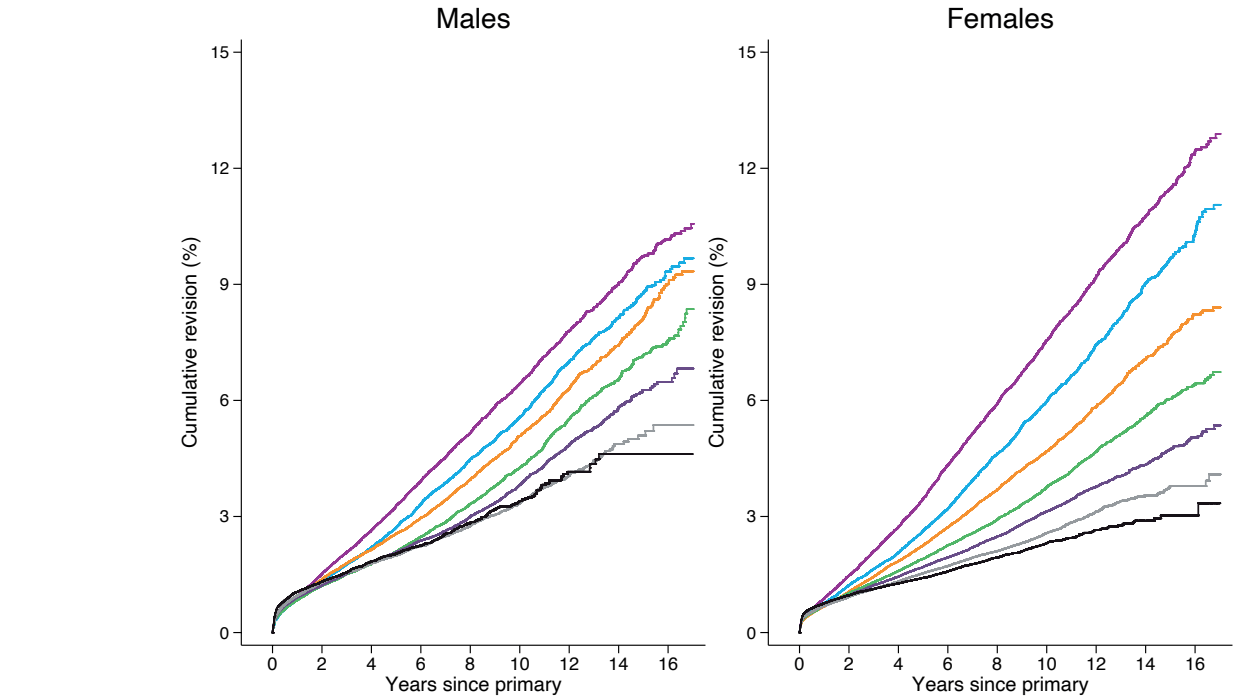
Figure 3.H8 KM estimates of cumulative **revision** in **reverse hybrid** primary hip replacements by **bearing**.
Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.



Key:	Numbers at risk								
MoP	22,231	18,815	13,919	9,498	6,055	3,279	1,381	390	*91*
CoP	10,141	8,795	6,964	4,968	3,202	1,795	839	*199*	*57*

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**.

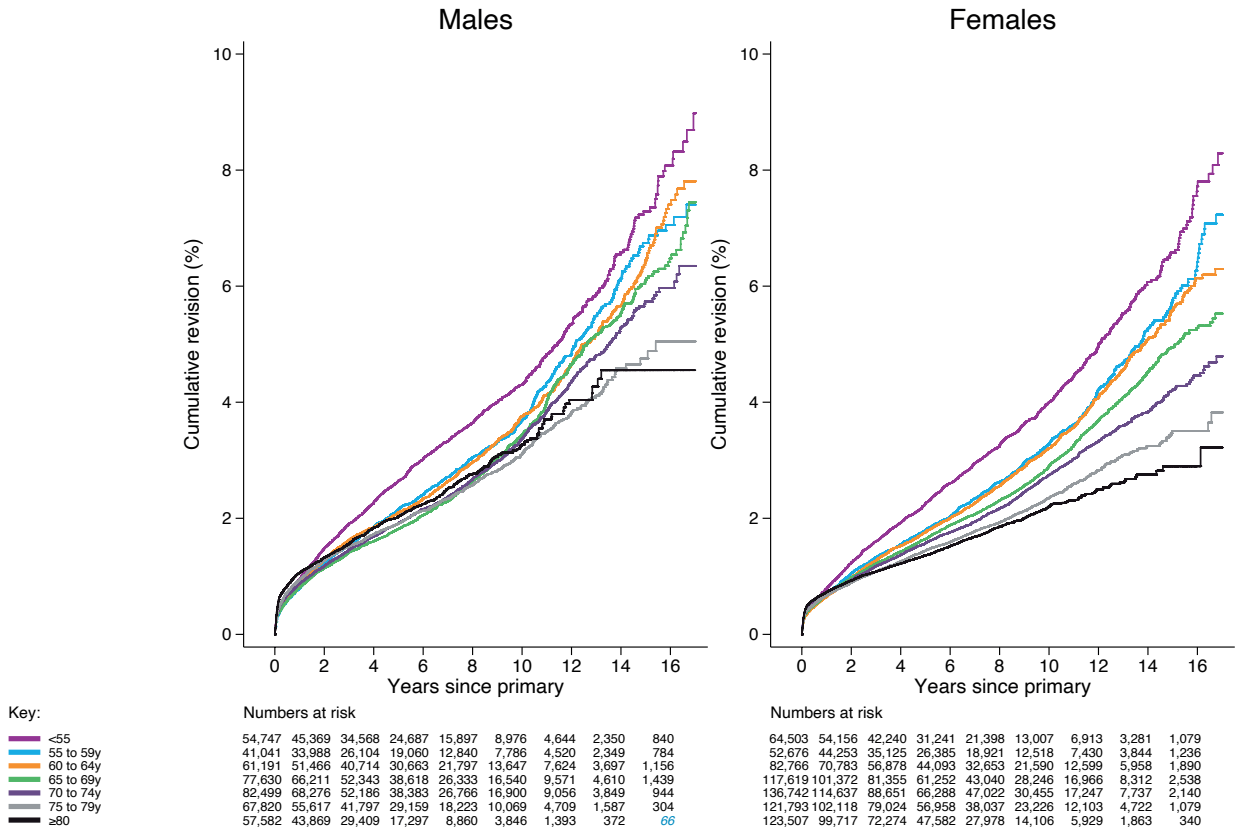


Table 3.H6 (page 72) further expands Table 3.H5 to show separate estimates for males and females within each of four age bands, <55, 55 to 64, 65 to 74 and ≥75 years. Estimates are shown at 1, 3, 5, 10, 15 and 17 years after the primary operation. These estimates refine results shown in earlier reports, 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 15 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All cases	<55	74,837	0.94 (0.87-1.01)	2.09 (1.98-2.20)	3.29 (3.15-3.43)	6.45 (6.22-6.68)	9.72 (9.32-10.14)	10.56 (10.01-11.15)	75,417	0.89 (0.83-0.96)	2.11 (2.00-2.22)	3.47 (3.32-3.61)	7.56 (7.31-7.82)	11.48 (11.04-11.94)	12.89 (12.23-13.58)
All cemented	<55	5,303	0.75 (0.55-1.02)	1.77 (1.43-2.18)	2.40 (1.99-2.89)	4.37 (3.68-5.20)	8.73 (7.24-10.52)	*11.95 (9.31-15.27)*	8,178	0.67 (0.52-0.88)	1.46 (1.21-1.76)	2.17 (1.85-2.54)	4.60 (4.00-5.27)	8.20 (7.05-9.52)	*9.93 (8.29-11.88)*
MoP	<55	2,162	0.94 (0.61-1.46)	2.26 (1.69-3.00)	3.08 (2.39-3.95)	5.65 (4.53-7.03)	11.47 (9.31-14.08)	*14.58 (11.35-18.62)*	3,727	0.85 (0.60-1.21)	1.82 (1.42-2.32)	2.52 (2.03-3.11)	5.41 (4.56-6.41)	9.15 (7.72-10.84)	*11.14 (9.11-13.58)*
MoM	<55	7							12			*0*			
CoP	<55	3,079	0.60 (0.38-0.94)	1.42 (1.04-1.94)	1.89 (1.43-2.51)	3.13 (2.40-4.08)	*4.88 (3.38-7.00)*	*7.34 (4.31-12.35)*	4,349	0.47 (0.30-0.72)	1.10 (0.82-1.48)	1.84 (1.44-2.35)	3.66 (2.90-4.61)	*7.11 (5.19-9.70)*	*8.12 (5.63-11.64)*
MoPoM	<55	41	*2.50 (0.36-16.45)*	*2.50 (0.36-16.45)*	*2.50 (0.36-16.45)*				75	*4.67 (1.53-13.83)*	*4.67 (1.53-13.83)*	*4.67 (1.53-13.83)*			
Others	<55	14	*0*	*0*					15	*0*					
All uncemented	<55	40,368	0.97 (0.88-1.07)	2.17 (2.03-2.32)	3.38 (3.19-3.58)	6.64 (6.31-7.00)	9.71 (9.05-10.41)	*10.17 (9.39-11.02)*	42,543	0.90 (0.81-0.99)	2.00 (1.87-2.14)	3.18 (3.01-3.37)	6.42 (6.10-6.75)	9.71 (9.08-10.38)	*11.76 (10.36-13.34)*
MoP	<55	5,140	0.99 (0.75-1.31)	1.94 (1.58-2.39)	2.78 (2.31-3.33)	4.88 (4.10-5.82)	*8.34 (6.64-10.45)*	*8.34 (6.64-10.45)*	6,234	0.95 (0.74-1.23)	1.80 (1.49-2.18)	2.48 (2.09-2.95)	4.22 (3.55-5.02)	*8.07 (6.42-10.13)*	*11.51 (8.46-15.56)*
MoM	<55	3,304	0.76 (0.51-1.12)	3.61 (3.03-4.31)	7.74 (6.87-8.72)	17.58 (16.30-18.95)	21.57 (20.00 - 23.24)	*21.57 (20.00 - 23.24)*	2,386	1.85 (1.38-2.48)	5.82 (4.95-6.84)	12.77 (11.48-14.18)	26.66 (24.91-28.51)	*32.50 (30.42-34.68)*	*33.25 (30.96-35.67)*
CoP	<55	11,092	1.00 (0.82-1.20)	1.82 (1.57-2.12)	2.51 (2.18-2.89)	3.48 (2.93-4.13)	*5.50 (4.13-7.29)*	*7.31 (5.15-10.33)*	11,437	0.88 (0.72-1.07)	1.46 (1.24-1.72)	2.02 (1.74-2.35)	3.31 (2.76-3.96)	*5.42 (4.20-6.97)*	*9.79 (6.13-15.45)*
CoC	<55	20,504	0.98 (0.86-1.13)	2.09 (1.90-2.30)	2.91 (2.68-3.17)	4.39 (4.06-4.75)	6.45 (5.56-7.48)	*6.76 (5.71-7.99)*	22,093	0.79 (0.68-0.92)	1.77 (1.60-1.96)	2.46 (2.25-2.68)	4.16 (3.84-4.50)	5.55 (4.95-6.21)	*5.91 (5.03-6.94)*
CoM	<55	197	*1.02 (0.25-4.00)*	*4.61 (2.42-8.67)*	*7.84 (4.80-12.67)*	*12.39 (8.40-18.07)*			270	0	*4.93 (2.90-8.35)*	*8.79 (5.93-12.93)*	*11.99 (8.58-16.61)*		
MoPoM	<55	42	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*				59	*1.72 (0.24-11.62)*	*1.72 (0.24-11.62)*	*1.72 (0.24-11.62)*			
CoPoM	<55	74	*0*	*0*	*0*				47	*2.17 (0.31-14.45)*	*8.70 (1.89-35.15)*				
Others	<55	15	*0*	*7.14 (1.04-40.92)*	*7.14 (1.04-40.92)*				17	*5.88 (0.85-34.98)*	*11.76 (3.08-39.40)*	*11.76 (3.08-39.40)*			
All hybrid	<55	11,787	0.93 (0.77-1.12)	1.61 (1.39-1.87)	2.22 (1.93-2.54)	4.80 (4.23-5.45)	9.04 (7.75-10.54)	*10.27 (8.59-12.26)*	15,124	0.72 (0.60-0.87)	1.32 (1.14-1.53)	1.91 (1.68-2.18)	3.93 (3.49-4.42)	6.72 (5.78-7.80)	*7.60 (6.38-9.03)*
MoP	<55	1,842	1.55 (1.07-2.23)	2.57 (1.91-3.44)	3.36 (2.56-4.40)	5.95 (4.62-7.65)	*10.68 (7.83-14.47)*	*13.01 (9.15-18.32)*	2,623	0.82 (0.54-1.26)	1.80 (1.34-2.43)	2.37 (1.81-3.10)	4.31 (3.39-5.48)	*9.95 (7.47-13.21)*	*11.47 (8.44-15.50)*
MoM	<55	312	0	2.28 (1.09-4.73)	4.32 (2.53-7.33)	*16.58 (12.76-21.40)*	*26.71 (21.24-33.26)*		223	*1.80 (0.68-4.72)*	*3.18 (1.53-6.56)*	*7.97 (5.03-12.51)*	*21.55 (16.50-27.88)*	*25.78 (19.61-33.45)*	

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
CoP	<55	6,203	0.97 (0.75-1.25)	1.49 (1.20-1.86)	1.91 (1.53-2.38)	3.27 (2.48-4.29)	*6.58 (3.87-11.09)*	*8.49 (4.66-15.19)*	7,444	0.73 (0.56-0.96)	1.22 (0.98-1.52)	1.52 (1.22-1.88)	3.09 (2.38-4.01)	*3.88 (2.72-5.52)*	*5.34 (2.96-9.55)*
CoC	<55	3,241	0.59 (0.38-0.92)	1.17 (0.85-1.62)	1.75 (1.34-2.28)	3.26 (2.61-4.07)	*5.48 (4.22-7.10)*	*5.48 (4.22-7.10)*	4,645	0.56 (0.38-0.83)	1.06 (0.80-1.41)	1.66 (1.32-2.09)	3.01 (2.48-3.65)	4.81 (3.86-6.00)	*5.29 (4.05-6.90)*
MoPoM	<55	93	*2.16 (0.55-8.37)*	*3.91 (1.23-12.02)*	*3.91 (1.23-12.02)*				120	*1.86 (0.47-7.24)*	*1.86 (0.47-7.24)*	*1.86 (0.47-7.24)*			
CoPoM	<55	80	*0*	*0*	*0*				57	*0*					
Others	<55	16		*0*					12	*8.33 (1.22-46.10)*					
All reverse hybrid	**<55**	**914**	**1.21 (0.67-2.18)**	**2.33 (1.51-3.60)**	**2.83 (1.88-4.25)**	*5.83 (3.87-8.73)*	*13.47 (8.25-21.58)*		**1,299**	**1.18 (0.71-1.94)**	**1.88 (1.25-2.82)**	**3.02 (2.14-4.24)**	*5.12 (3.73-7.03)*	*7.57 (4.87-11.66)*	
MoP	<55	179	*0.58 (0.08-4.08)*	*3.84 (1.74-8.36)*	*3.84 (1.74-8.36)*	*8.67 (4.25-17.28)*	*20.55 (10.26-38.68)*		275	0.38 (0.05-2.70)	*0.84 (0.21-3.35)*	*1.95 (0.73-5.17)*	*3.62 (1.57-8.23)*	*9.11 (3.71-21.43)*	
CoP	<55	722	1.39 (0.75-2.58)	2.01 (1.20-3.38)	2.64 (1.64-4.24)	*5.07 (3.08-8.27)*	*11.54 (5.75-22.41)*		988	1.33 (0.78-2.29)	2.01 (1.29-3.14)	2.74 (1.83-4.08)	*3.98 (2.62-6.04)*	*4.77 (2.97-7.63)*	
Others	<55	13		*0*					36	*2.78 (0.40-18.13)*	*5.82 (1.48-21.35)*	*18.31 (7.91-39.11)*	*40.96 (24.15-63.39)*		
All resurfacing	**<55**	**14,148**	**0.83 (0.70-1.00)**	**2.17 (1.94-2.43)**	**3.85 (3.54-4.19)**	**7.38 (6.93-7.86)**	**10.21 (9.58-10.87)**	**10.53 (9.84-11.26)**	**5,610**	**1.25 (0.99-1.58)**	**4.99 (4.45-5.60)**	**9.23 (8.50-10.02)**	**19.67 (18.64-20.75)**	**24.75 (23.54-26.01)**	*25.85 (24.46-27.29)*
MoM	<55	14,087	0.84 (0.70-1.00)	2.17 (1.94-2.43)	3.85 (3.54-4.19)	7.38 (6.93-7.86)	10.21 (9.58-10.87)	10.52 (9.84-11.25)	5,567	1.24 (0.98-1.57)	5.00 (4.46-5.61)	9.24 (8.51-10.03)	19.68 (18.64-20.76)	24.76 (23.55-26.02)	*25.85 (24.47-27.30)*
Others	<55	61	*0*	*2.63 (0.37-17.25)*					43	*2.56 (0.37-16.84)*	*2.56 (0.37-16.84)*				
All cases	**55 to 64**	**123,273**	**0.90 (0.85-0.95)**	**1.78 (1.71-1.86)**	**2.63 (2.53-2.73)**	**5.29 (5.12-5.45)**	**8.41 (8.10-8.72)**	**9.46 (9.02-9.92)**	**149,576**	**0.72 (0.68-0.76)**	**1.53 (1.46-1.59)**	**2.41 (2.33-2.50)**	**5.20 (5.05-5.35)**	**8.44 (8.17-8.73)**	**9.50 (9.10-9.92)**
All cemented	**55 to 64**	**17,813**	**0.67 (0.56-0.80)**	**1.47 (1.29-1.66)**	**2.01 (1.80-2.24)**	**4.05 (3.69-4.44)**	**7.62 (6.91-8.39)**	**9.06 (8.07-10.17)**	**29,700**	**0.47 (0.40-0.56)**	**1.06 (0.95-1.19)**	**1.63 (1.48-1.79)**	**3.40 (3.14-3.68)**	**6.69 (6.17-7.25)**	**7.86 (7.15-8.64)**
MoP	55 to 64	11,200	0.71 (0.57-0.89)	1.73 (1.50-2.00)	2.36 (2.08-2.67)	4.75 (4.29-5.26)	8.65 (7.82-9.57)	10.05 (8.93-11.29)	19,797	0.52 (0.43-0.63)	1.22 (1.07-1.39)	1.88 (1.69-2.09)	3.80 (3.49-4.14)	7.25 (6.66-7.88)	8.48 (7.69-9.36)
MoM	55 to 64	26		*0*	*0*	*0*			53	*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	*8.56 (3.29-21.28)*		
CoP	55 to 64	6,489	0.61 (0.45-0.84)	0.99 (0.77-1.27)	1.37 (1.09-1.72)	2.36 (1.90-2.94)	*4.39 (3.29-5.84)*	*5.52 (3.83-7.91)*	9,689	0.37 (0.26-0.51)	0.72 (0.57-0.92)	1.07 (0.86-1.32)	2.21 (1.81-2.70)	4.58 (3.55-5.91)	*5.20 (3.94-6.87)*
MoPoM	55 to 64	90	*0*	*1.49 (0.21-10.13)*	*1.49 (0.21-10.13)*				141	*0.81 (0.11-5.63)*	*0.81 (0.11-5.63)*	*2.10 (0.51-8.43)*			
Others	55 to 64	8							20	*0*					

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All uncemented	**55 to 64**	**64,239**	**0.89 (0.82-0.97)**	**1.82 (1.71-1.93)**	**2.69 (2.56-2.83)**	**5.72 (5.48-5.98)**	**8.98 (8.47-9.51)**	*10.02 (9.22-10.87)*	**72,851**	**0.78 (0.72-0.85)**	**1.64 (1.55-1.74)**	**2.56 (2.43-2.68)**	**5.45 (5.24-5.68)**	**8.55 (8.11-9.01)**	**9.36 (8.70-10.07)**
MoP	55 to 64	15,649	0.95 (0.81-1.12)	1.87 (1.66-2.11)	2.44 (2.19-2.71)	4.58 (4.13-5.07)	8.13 (7.08-9.32)	*10.43 (8.53-12.71)*	19,710	0.74 (0.62-0.87)	1.55 (1.38-1.74)	1.95 (1.75-2.17)	3.70 (3.36-4.06)	6.44 (5.70-7.28)	*8.41 (6.75-10.44)*
MoM	55 to 64	5,177	0.85 (0.64-1.14)	3.06 (2.62-3.57)	6.65 (6.00-7.37)	16.56 (15.55-17.63)	21.01 (19.74-22.35)	*22.05 (20.19-24.06)*	4,847	0.93 (0.70-1.24)	3.87 (3.36-4.45)	9.44 (8.65-10.31)	22.54 (21.37-23.77)	28.25 (26.78-29.79)	*28.83 (27.17-30.56)*
CoP	55 to 64	19,285	0.81 (0.69-0.95)	1.37 (1.20-1.56)	1.79 (1.58-2.02)	3.00 (2.62-3.43)	5.09 (4.19-6.17)	*5.09 (4.19-6.17)*	21,872	0.64 (0.55-0.76)	1.22 (1.07-1.39)	1.64 (1.46-1.84)	2.94 (2.60-3.33)	4.38 (3.69-5.21)	*4.56 (3.80-5.46)*
CoC	55 to 64	23,648	0.93 (0.81-1.06)	1.78 (1.62-1.96)	2.32 (2.13-2.53)	3.62 (3.34-3.92)	5.61 (4.84-6.49)	*6.14 (5.13-7.34)*	25,815	0.90 (0.79-1.02)	1.56 (1.41-1.72)	2.03 (1.86-2.22)	3.04 (2.80-3.29)	4.89 (4.26-5.61)	*5.26 (4.48-6.18)*
CoM	55 to 64	317	0.63 (0.16-2.50)	2.87 (1.50-5.44)	5.18 (3.21-8.32)	*7.40 (4.93-11.04)*			465	0.43 (0.11-1.71)	1.95 (1.02-3.72)	3.28 (1.99-5.38)	6.85 (4.87-9.60)		
MoPoM	55 to 64	66	*0*	*0*	*0*				72	*2.88 (0.73-11.05)*	*2.88 (0.73-11.05)*	*2.88 (0.73-11.05)*			
CoPoM	55 to 64	80	*0*	*0*					53	*2.00 (0.28-13.36)*	*2.00 (0.28-13.36)*				
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*	*7.14 (1.04-40.92)*			
All hybrid	**55 to 64**	**23,177**	**0.84 (0.73-0.97)**	**1.50 (1.34-1.67)**	**2.05 (1.86-2.27)**	**3.69 (3.34-4.07)**	**6.15 (5.44-6.95)**	*6.86 (5.84-8.06)*	**34,174**	**0.60 (0.52-0.69)**	**1.17 (1.05-1.30)**	**1.68 (1.53-1.84)**	**3.50 (3.22-3.80)**	**5.33 (4.84-5.87)**	*6.27 (5.45-7.19)*
MoP	55 to 64	6,866	1.01 (0.80-1.28)	1.77 (1.47-2.13)	2.39 (2.03-2.82)	3.94 (3.38-4.60)	6.41 (5.34-7.68)	*7.18 (5.76-8.92)*	11,413	0.77 (0.62-0.95)	1.30 (1.10-1.53)	1.86 (1.61-2.15)	3.72 (3.29-4.20)	6.06 (5.29-6.93)	*7.23 (6.02-8.66)*
MoM	55 to 64	388	0.77 (0.25-2.38)	4.25 (2.63-6.85)	7.32 (5.08-10.50)	16.08 (12.63-20.35)	*21.57 (17.15-26.93)*	*25.93 (17.79-36.87)*	426	0.71 (0.23-2.18)	3.40 (2.03-5.68)	8.07 (5.77-11.22)	22.48 (18.58-27.05)	*28.16 (23.70-33.27)*	*28.16 (23.70-33.27)*
CoP	55 to 64	11,345	0.79 (0.64-0.97)	1.31 (1.10-1.56)	1.60 (1.35-1.91)	2.77 (2.17-3.52)	*5.98 (4.05-8.80)*	*5.98 (4.05-8.80)*	15,740	0.53 (0.43-0.66)	1.04 (0.88-1.23)	1.33 (1.13-1.56)	2.23 (1.81-2.74)	*4.05 (2.82-5.80)*	*6.05 (3.61-10.04)*
CoC	55 to 64	4,323	0.67 (0.47-0.97)	1.16 (0.88-1.53)	1.73 (1.37-2.18)	2.79 (2.28-3.41)	4.13 (3.30-5.16)	*4.13 (3.30-5.16)*	6,279	0.42 (0.28-0.61)	1.00 (0.78-1.28)	1.43 (1.16-1.77)	2.59 (2.18-3.08)	3.03 (2.54-3.62)	*3.03 (2.54-3.62)*
MoPoM	55 to 64	134	*2.51 (0.81-7.61)*	*2.51 (0.81-7.61)*	*2.51 (0.81-7.61)*				208	*1.48 (0.48-4.54)*	*2.64 (0.91-7.53)*	*2.64 (0.91-7.53)*			
CoPoM	55 to 64	97	*1.09 (0.15-7.47)*	*1.09 (0.15-7.47)*					91	*1.15 (0.16-7.88)*	*1.15 (0.16-7.88)*	*1.15 (0.16-7.88)*			
Others	55 to 64	24	*0*	*6.67 (0.97-38.74)*					17	*5.88 (0.85-34.98)*	*5.88 (0.85-34.98)*	*5.88 (0.85-34.98)*			

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All reverse hybrid	**55 to 64**	**2,596**	**0.95 (0.64-1.41)**	**1.84 (1.37-2.47)**	**2.44 (1.87-3.19)**	**4.00 (3.01-5.31)**	*9.68 (5.79-15.95)*		**4,054**	**0.90 (0.65-1.25)**	**1.69 (1.32-2.15)**	**2.36 (1.91-2.93)**	**4.08 (3.30-5.03)**	*8.78 (6.17-12.42)*	*8.78 (6.17-12.42)*
MoP	55 to 64	1,020	0.80 (0.40-1.60)	1.37 (0.80-2.35)	2.17 (1.36-3.47)	*4.56 (2.81-7.37)*	*11.43 (6.67-19.21)*		1,722	1.18 (0.76-1.82)	1.91 (1.35-2.71)	2.78 (2.05-3.78)	5.05 (3.76-6.77)	*11.45 (7.54-17.20)*	
CoP	55 to 64	1,566	1.04 (0.64-1.70)	2.15 (1.52-3.05)	2.63 (1.90-3.65)	3.67 (2.62-5.12)	*10.31 (3.54-28.05)*		2,306	0.71 (0.43-1.15)	1.54 (1.10-2.16)	2.03 (1.49-2.75)	3.18 (2.35-4.30)	*4.61 (3.15-6.71)*	
Others	55 to 64	10							26	*0*	*0*	*5.56 (0.80-33.36)*	*14.14 (3.59-47.09)*		
All resurfacing	**55 to 64**	**11,949**	**1.20 (1.02-1.42)**	**2.35 (2.09-2.64)**	**3.75 (3.42-4.12)**	**6.95 (6.48-7.45)**	**9.62 (8.98-10.29)**	**10.49 (9.69-11.35)**	**4,289**	**1.66 (1.32-2.09)**	**4.48 (3.90-5.14)**	**8.53 (7.72-9.41)**	**17.33 (16.21-18.52)**	**22.54 (21.20-23.95)**	*23.99 (22.39-25.69)*
MoM	55 to 64	11,911	1.20 (1.02-1.41)	2.34 (2.08-2.63)	3.74 (3.41-4.10)	6.94 (6.47-7.43)	9.60 (8.97-10.28)	10.48 (9.68-11.34)	4,263	1.67 (1.32-2.10)	4.50 (3.91-5.16)	8.55 (7.74-9.43)	17.35 (16.23-18.54)	22.56 (21.22-23.97)	*24.01 (22.40-25.71)*
Others	55 to 64	38	*2.94 (0.42-19.10)*						26	*0*	*0*				
All cases	**65 to 74**	**172,746**	**0.88 (0.84-0.93)**	**1.52 (1.46-1.58)**	**2.09 (2.02-2.17)**	**4.05 (3.92-4.18)**	**6.75 (6.48-7.03)**	**7.70 (7.23-8.21)**	**267,445**	**0.70 (0.67-0.73)**	**1.26 (1.22-1.31)**	**1.80 (1.75-1.86)**	**3.44 (3.35-3.54)**	**5.39 (5.20-5.58)**	*6.05 (5.76-6.36)*
All cemented	**65 to 74**	**50,718**	**0.67 (0.60-0.74)**	**1.26 (1.16-1.36)**	**1.76 (1.64-1.89)**	**3.59 (3.38-3.81)**	**6.40 (5.98-6.84)**	**7.72 (6.97-8.55)**	**95,088**	**0.48 (0.43-0.52)**	**1.02 (0.96-1.09)**	**1.47 (1.38-1.55)**	**2.80 (2.66-2.94)**	**4.81 (4.54-5.08)**	**5.47 (5.08-5.89)**
MoP	65 to 74	43,851	0.69 (0.62-0.77)	1.30 (1.19-1.41)	1.82 (1.69-1.96)	3.74 (3.52-3.98)	6.60 (6.16-7.06)	8.00 (7.21-8.87)	83,075	0.47 (0.42-0.52)	1.03 (0.96-1.10)	1.49 (1.40-1.58)	2.88 (2.74-3.03)	4.87 (4.60-5.16)	5.54 (5.14-5.98)
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)*			101	*0.99 (0.14-6.82)*	*0.99 (0.14-6.82)*	*3.09 (1.01-9.27)*	*5.33 (2.25-12.34)*	*7.98 (3.86-16.11)*	
CoP	65 to 74	6,606	0.49 (0.35-0.70)	0.90 (0.69-1.17)	1.27 (1.00-1.61)	2.15 (1.71-2.69)	*4.17 (3.03-5.72)*	*4.17 (3.03-5.72)*	11,468	0.51 (0.39-0.66)	1.00 (0.82-1.21)	1.24 (1.03-1.48)	1.90 (1.58-2.29)	4.05 (3.17-5.16)	*4.70 (3.34-6.59)*
MoPoM	65 to 74	180	*1.73 (0.56-5.28)*	*3.29 (1.36-7.84)*	*3.29 (1.36-7.84)*				409	0.76 (0.25-2.35)	*0.76 (0.25-2.35)*	*1.50 (0.49-4.56)*			
Others	65 to 74	23	*0*						35	*3.13 (0.45-20.18)*					
All uncemented	**65 to 74**	**70,471**	**0.95 (0.88-1.03)**	**1.65 (1.56-1.75)**	**2.28 (2.16-2.40)**	**4.44 (4.23-4.66)**	**7.63 (7.09-8.21)**	*8.14 (7.45-8.89)*	**89,920**	**0.89 (0.83-0.96)**	**1.54 (1.46-1.63)**	**2.25 (2.14-2.35)**	**4.40 (4.22-4.59)**	**6.43 (6.08-6.80)**	*7.02 (6.51-7.56)*
MoP	65 to 74	31,387	0.92 (0.82-1.03)	1.57 (1.44-1.72)	1.95 (1.80-2.13)	3.76 (3.47-4.09)	6.90 (6.07-7.83)	*7.36 (6.35-8.53)*	44,045	0.92 (0.84-1.02)	1.46 (1.35-1.58)	1.87 (1.74-2.02)	3.26 (3.04-3.50)	5.05 (4.56-5.58)	*5.77 (5.01-6.64)*
MoM	65 to 74	4,569	1.08 (0.82-1.42)	2.97 (2.51-3.51)	6.10 (5.43-6.85)	13.58 (12.57-14.67)	*18.61 (17.01-20.34)*		4,646	1.12 (0.86-1.47)	3.57 (3.07-4.15)	8.69 (7.90-9.55)	19.17 (18.02-20.38)	*23.08 (21.65-24.59)*	
CoP	65 to 74	18,656	0.82 (0.70-0.96)	1.25 (1.10-1.43)	1.50 (1.32-1.71)	2.28 (1.98-2.64)	4.25 (3.34-5.40)	*4.56 (3.51-5.90)*	22,446	0.74 (0.64-0.86)	1.21 (1.07-1.37)	1.54 (1.37-1.73)	2.63 (2.32-2.98)	3.90 (3.32-4.59)	*3.90 (3.32-4.59)*
CoC	65 to 74	15,428	1.13 (0.98-1.31)	1.79 (1.59-2.01)	2.25 (2.02-2.50)	3.02 (2.72-3.36)	*4.77 (3.95-5.77)*	*5.57 (4.03-7.67)*	18,196	0.92 (0.79-1.07)	1.52 (1.35-1.71)	1.80 (1.61-2.01)	2.42 (2.17-2.69)	3.47 (2.96-4.06)	*3.47 (2.96-4.06)*

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
CoM	65 to 74	304	1.32 (0.50-3.49)	3.71 (2.07-6.61)	5.14 (3.13-8.38)	*8.56 (5.82-12.52)*			379	0.53 (0.13-2.11)	1.60 (0.72-3.53)	3.51 (2.05-5.96)	*7.69 (5.34-11.03)*		
MoPoM	65 to 74	72	*0*	*0*	*0*				139	*4.45 (2.02-9.63)*	*6.44 (3.24-12.58)*	*6.44 (3.24-12.58)*			
CoPoM	65 to 74	46	*0*						45	*0*	*0*				
Others	65 to 74	9							24	*8.33 (2.15-29.39)*	*12.50 (4.21-33.92)*	*12.50 (4.21-33.92)*			
All hybrid	**65 to 74**	**39,092**	**0.90 (0.81-1.00)**	**1.46 (1.34-1.59)**	**1.92 (1.77-2.08)**	**3.57 (3.29-3.88)**	**5.46 (4.89-6.09)**	*6.17 (5.12-7.43)*	**66,330**	**0.75 (0.69-0.82)**	**1.19 (1.11-1.28)**	**1.63 (1.53-1.75)**	**2.81 (2.63-3.02)**	**4.16 (3.79-4.56)**	*4.65 (4.06-5.33)*
MoP	65 to 74	22,101	0.89 (0.78-1.03)	1.47 (1.31-1.65)	1.95 (1.76-2.17)	3.64 (3.29-4.02)	5.74 (5.04-6.54)	*6.21 (5.13-7.50)*	40,403	0.77 (0.69-0.86)	1.24 (1.13-1.36)	1.69 (1.56-1.84)	2.88 (2.66-3.13)	4.14 (3.73-4.59)	*4.22 (3.78-4.71)*
MoM	65 to 74	335	1.20 (0.45-3.16)	2.16 (1.04-4.48)	4.26 (2.49-7.23)	*14.48 (10.76-19.33)*	*17.44 (13.13-22.97)*		411	0.97 (0.37-2.57)	2.01 (1.01-3.99)	5.92 (3.94-8.87)	*13.13 (9.95-17.23)*	*17.76 (13.41-23.33)*	
CoP	65 to 74	13,369	0.88 (0.74-1.06)	1.34 (1.15-1.57)	1.58 (1.35-1.85)	2.45 (1.94-3.08)	*3.11 (1.98-4.87)*	*5.66 (2.27-13.74)*	20,878	0.70 (0.59-0.82)	1.10 (0.96-1.26)	1.37 (1.19-1.57)	1.89 (1.61-2.20)	*3.46 (2.35-5.07)*	*6.01 (3.21-11.11)*
CoC	65 to 74	2,844	0.74 (0.49-1.14)	1.42 (1.04-1.94)	1.98 (1.51-2.59)	2.84 (2.21-3.64)	*4.02 (3.07-5.27)*		3,848	0.71 (0.49-1.03)	0.93 (0.67-1.29)	1.33 (1.00-1.76)	2.25 (1.76-2.88)	*3.03 (2.27-4.04)*	
MoPoM	65 to 74	313	*3.16 (1.66-6.00)*	*4.48 (2.39-8.29)*	*4.48 (2.39-8.29)*				620	1.76 (0.95-3.24)	*2.45 (1.36-4.39)*	*3.34 (1.70-6.52)*			
CoPoM	65 to 74	108	*2.20 (0.55-8.52)*	*4.48 (1.35-14.26)*					136	*0.74 (0.10-5.10)*	*0.74 (0.10-5.10)*	*0.74 (0.10-5.10)*			
Others	65 to 74	22		*0*					33		*0*	*0*	*0*		
All reverse hybrid	**65 to 74**	**4,810**	**1.00 (0.75-1.32)**	**1.71 (1.37-2.14)**	**2.08 (1.68-2.56)**	**3.48 (2.78-4.34)**	*6.17 (4.20-9.00)*		**8,184**	**0.53 (0.40-0.72)**	**0.96 (0.77-1.21)**	**1.44 (1.18-1.75)**	**2.78 (2.28-3.38)**	*3.57 (2.78-4.58)*	
MoP	65 to 74	3,389	1.23 (0.91-1.67)	1.94 (1.51-2.49)	2.43 (1.92-3.07)	4.08 (3.17-5.24)	*7.43 (4.84-11.32)*		6,083	0.55 (0.39-0.77)	0.98 (0.75-1.27)	1.39 (1.11-1.76)	2.91 (2.32-3.65)	*3.25 (2.53-4.16)*	
CoP	65 to 74	1,408	0.43 (0.19-0.96)	1.17 (0.71-1.94)	1.27 (0.78-2.06)	*2.09 (1.32-3.30)*	*3.17 (1.53-6.51)*		2,072	0.39 (0.20-0.78)	0.82 (0.50-1.34)	1.43 (0.97-2.13)	2.29 (1.52-3.46)	*4.23 (2.41-7.37)*	
Others	65 to 74	13	*0*						29	*6.90 (1.77-24.86)*	*6.90 (1.77-24.86)*	*12.07 (3.94-33.73)*			
All resurfacing	**65 to 74**	**3,097**	**1.98 (1.54-2.54)**	**2.98 (2.44-3.65)**	**4.31 (3.64-5.11)**	**7.29 (6.37-8.33)**	**9.05 (7.93-10.32)**	*9.38 (8.12-10.83)*	**744**	**1.48 (0.82-2.66)**	**2.98 (1.97-4.49)**	**5.76 (4.29-7.72)**	**13.86 (11.50-16.65)**	*19.69 (16.47-23.44)*	
MoM	65 to 74	3,088	1.99 (1.55-2.54)	2.99 (2.44-3.66)	4.32 (3.65-5.12)	7.30 (6.38-8.34)	9.06 (7.94-10.33)	*9.39 (8.13-10.84)*	727	1.52 (0.84-2.72)	3.04 (2.01-4.58)	5.84 (4.35-7.82)	13.95 (11.58-16.76)	*19.80 (16.57-23.57)*	
Others	65 to 74	9							17	*0*					

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All cases	≥75	131,383	1.00 (0.95-1.06)	1.56 (1.49-1.63)	2.02 (1.94-2.11)	3.37 (3.22-3.53)	5.01 (4.63-5.43)	*5.23 (4.75-5.76)*	256,487	0.72 (0.69-0.76)	1.13 (1.09-1.17)	1.48 (1.43-1.53)	2.46 (2.37-2.55)	3.52 (3.32-3.73)	3.82 (3.43-4.25)
All cemented	≥75	57,121	0.84 (0.77-0.92)	1.36 (1.26-1.46)	1.81 (1.69-1.94)	3.08 (2.87-3.31)	4.67 (4.16-5.23)	*5.00 (4.34-5.76)*	127,493	0.46 (0.42-0.50)	0.85 (0.80-0.90)	1.15 (1.09-1.22)	1.97 (1.87-2.08)	*2.88 (2.65-3.13)*	2.88 (2.65-3.13)
MoP	≥75	53,965	0.83 (0.76-0.92)	1.35 (1.25-1.45)	1.79 (1.67-1.92)	3.08 (2.87-3.31)	4.72 (4.20-5.31)	*5.06 (4.39-5.84)*	120,967	0.46 (0.42-0.50)	0.85 (0.79-0.90)	1.15 (1.08-1.22)	1.98 (1.87-2.09)	2.89 (2.65-3.14)	2.89 (2.65-3.14)
MoM	≥75	46		*0*	*2.56 (0.37-16.84)*	*11.07 (3.59-31.36)*			104	*0*	*3.22 (1.05-9.65)*	*3.22 (1.05-9.65)*	*6.16 (2.58-14.37)*		
CoP	≥75	2,670	0.82 (0.53-1.25)	1.41 (1.00-1.98)	1.79 (1.29-2.48)	2.37 (1.64-3.44)	*2.37 (1.64-3.44)*		5,327	0.40 (0.26-0.62)	0.70 (0.49-0.98)	0.92 (0.66-1.27)	1.39 (1.01-1.92)	*2.21 (1.38-3.52)*	*2.21 (1.38-3.52)*
MoPoM	≥75	412	1.82 (0.87-3.78)	*2.76 (1.49-5.08)*	*5.04 (2.69-9.35)*				992	0.94 (0.49-1.79)	1.56 (0.92-2.62)	*2.60 (1.57-4.28)*			
Others	≥75	28	*0*						103	*0.99 (0.14-6.82)*	*0.99 (0.14-6.82)*				
All uncemented	≥75	34,418	1.31 (1.19-1.43)	1.88 (1.74-2.04)	2.33 (2.16-2.51)	3.85 (3.55-4.17)	*5.39 (4.71-6.17)*	*5.39 (4.71-6.17)*	51,172	1.23 (1.14-1.33)	1.69 (1.58-1.81)	2.12 (1.99-2.26)	3.64 (3.41-3.88)	5.64 (4.94-6.43)	*8.34 (5.26-13.09)*
MoP	≥75	23,118	1.37 (1.23-1.53)	1.95 (1.77-2.14)	2.31 (2.11-2.53)	3.36 (3.04-3.72)	*5.35 (4.33-6.62)*		36,163	1.23 (1.12-1.35)	1.62 (1.49-1.76)	1.99 (1.84-2.15)	3.28 (3.02-3.56)	5.34 (4.37-6.53)	*8.05 (4.12-15.41)*
MoM	≥75	1,700	1.02 (0.63-1.63)	1.91 (1.34-2.70)	3.74 (2.90-4.83)	8.55 (7.11-10.28)	*10.14 (8.33-12.31)*		2,399	1.34 (0.95-1.89)	3.05 (2.42-3.83)	4.94 (4.12-5.92)	9.54 (8.31-10.96)	*12.16 (10.54-14.02)*	
CoP	≥75	5,816	1.07 (0.83-1.37)	1.50 (1.21-1.87)	1.88 (1.52-2.32)	2.91 (2.23-3.79)	*3.28 (2.37-4.53)*		7,784	1.04 (0.84-1.30)	1.44 (1.19-1.74)	1.75 (1.45-2.09)	2.77 (2.27-3.37)	*3.37 (2.60-4.37)*	*7.97 (2.58-23.21)*
CoC	≥75	3,543	1.31 (0.99-1.75)	1.93 (1.52-2.45)	2.11 (1.67-2.65)	3.51 (2.79-4.41)	*4.06 (3.09-5.32)*		4,494	1.50 (1.18-1.90)	1.88 (1.52-2.33)	2.07 (1.69-2.54)	3.03 (2.44-3.76)	*5.59 (3.72-8.37)*	
CoM	≥75	88	*0*	*0*	*2.76 (0.70-10.59)*	*4.26 (1.39-12.63)*			133	*0*	*0.77 (0.11-5.33)*	*0.77 (0.11-5.33)*	*1.88 (0.46-7.50)*		
MoPoM	≥75	102	*5.08 (2.14-11.77)*	*5.08 (2.14-11.77)*	*5.08 (2.14-11.77)*				173	*2.50 (0.94-6.53)*	*3.57 (1.46-8.61)*	*3.57 (1.46-8.61)*	*3.57 (1.46-8.61)*		
CoPoM	≥75	40	*2.63 (0.37-17.25)*						21	*0*					
All hybrid	≥75	32,107	0.94 (0.84-1.05)	1.50 (1.36-1.65)	1.95 (1.78-2.13)	3.25 (2.92-3.63)	*4.77 (3.97-5.74)*		62,535	0.77 (0.71-0.84)	1.14 (1.05-1.23)	1.52 (1.41-1.63)	2.23 (2.05-2.43)	2.93 (2.49-3.43)	*3.72 (2.40-5.74)*
MoP	≥75	24,748	0.92 (0.81-1.05)	1.51 (1.36-1.68)	1.96 (1.77-2.18)	3.20 (2.84-3.60)	*4.86 (3.96-5.96)*		49,613	0.78 (0.70-0.86)	1.16 (1.06-1.26)	1.49 (1.38-1.62)	2.21 (2.02-2.43)	3.00 (2.52-3.57)	*3.87 (2.44-6.12)*
MoM	≥75	228	*0.88 (0.22-3.48)*	*1.41 (0.46-4.33)*	*1.97 (0.74-5.20)*	*10.12 (5.85-17.19)*			399	0.50 (0.13-2.00)	1.61 (0.73-3.56)	*4.24 (2.46-7.25)*	*8.93 (5.96-13.27)*		

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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
CoP	≥75	5,865	1.06 (0.82-1.37)	1.50 (1.19-1.89)	1.98 (1.59-2.47)	*2.62 (1.97-3.49)*	*2.62 (1.97-3.49)*		9,925	0.77 (0.61-0.97)	1.04 (0.84-1.28)	1.56 (1.27-1.90)	1.64 (1.33-2.01)	*1.64 (1.33-2.01)*	
CoC	≥75	596	1.20 (0.57-2.49)	1.38 (0.69-2.75)	1.62 (0.84-3.10)	*2.61 (1.33-5.09)*			1,185	0.51 (0.23-1.13)	0.80 (0.41-1.53)	1.17 (0.66-2.08)	*1.82 (1.05-3.15)*		
MoPoM	≥75	539	0.42 (0.11-1.67)	*0.96 (0.36-2.56)*	*0.96 (0.36-2.56)*				1,209	0.70 (0.35-1.39)	1.04 (0.54-2.00)	*1.58 (0.83-2.97)*			
CoPoM	≥75	112	*0*	*0*					181	*1.85 (0.60-5.68)*	*1.85 (0.60-5.68)*				
Others	≥75	19	*0*						23	*4.35 (0.62-27.07)*	*4.35 (0.62-27.07)*				
All reverse hybrid	**≥75**	**3,732**	**1.12 (0.83-1.52)**	**1.91 (1.50-2.43)**	**2.42 (1.93-3.04)**	**3.85 (2.93-5.05)**			**7,007**	**0.81 (0.62-1.05)**	**1.24 (1.00-1.54)**	**1.52 (1.24-1.87)**	**2.67 (2.14-3.33)**	*3.40 (2.63-4.40)*	
MoP	≥75	3,338	1.17 (0.85-1.60)	1.97 (1.53-2.53)	2.45 (1.93-3.12)	4.04 (3.01-5.40)			6,225	0.80 (0.60-1.05)	1.25 (0.99-1.57)	1.49 (1.20-1.85)	2.68 (2.11-3.42)	*2.97 (2.30-3.83)*	
CoP	≥75	361	0.85 (0.28-2.62)	1.53 (0.64-3.66)	*2.30 (1.10-4.80)*	*2.83 (1.40-5.67)*			718	0.70 (0.29-1.68)	1.02 (0.49-2.13)	1.40 (0.73-2.68)	*2.28 (1.24-4.16)*		
Others	≥75	33	*0*	*0*					64	*3.36 (0.85-12.80)*	*3.36 (0.85-12.80)*				
All resurfacing	**≥75**	**212**	*1.91 (0.72-5.00)*	*2.43 (1.02-5.74)*	*4.19 (2.11-8.23)*	*6.97 (3.99-12.05)*	*6.97 (3.99-12.05)*		**32**	*3.13 (0.45-20.18)*	*6.58 (1.68-23.91)*	*6.58 (1.68-23.91)*	*12.42 (3.95-35.37)*		
MoM	≥75	211	*1.92 (0.72-5.03)*	*2.44 (1.02-5.76)*	*4.20 (2.11-8.25)*	*6.98 (3.99-12.06)*	*6.98 (3.99-12.06)*		29	*3.45 (0.49-22.05)*	*7.16 (1.84-25.75)*	*7.16 (1.84-25.75)*	*12.96 (4.19-36.23)*		

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 looks at the effect of head size on the probability of revision following primary hip replacement. Fixation and bearing combinations with greater than 10,000 uses are included, and head sizes with less than 500 implantations within each group were excluded.

This gave us 12 groups:

a) Metal-on-polyethylene cemented hip constructs n=338,706

b) Ceramic-on-polyethylene cemented hip constructs n=49,676

c) Metal-on-polyethylene uncemented hip constructs n=180,942

d) Metal-on-metal uncemented hip constructs n=28,528

e) Ceramic-on-polyethylene uncemented hip constructs n=117,853

f) Ceramic-on-ceramic uncemented hip constructs n=133,478

g) Metal-on-polyethylene hybrid hip constructs n=159,417

h) Ceramic-on-polyethylene hybrid hip constructs n=90,583

i) Ceramic-on-ceramic hybrid hip constructs n=26,447

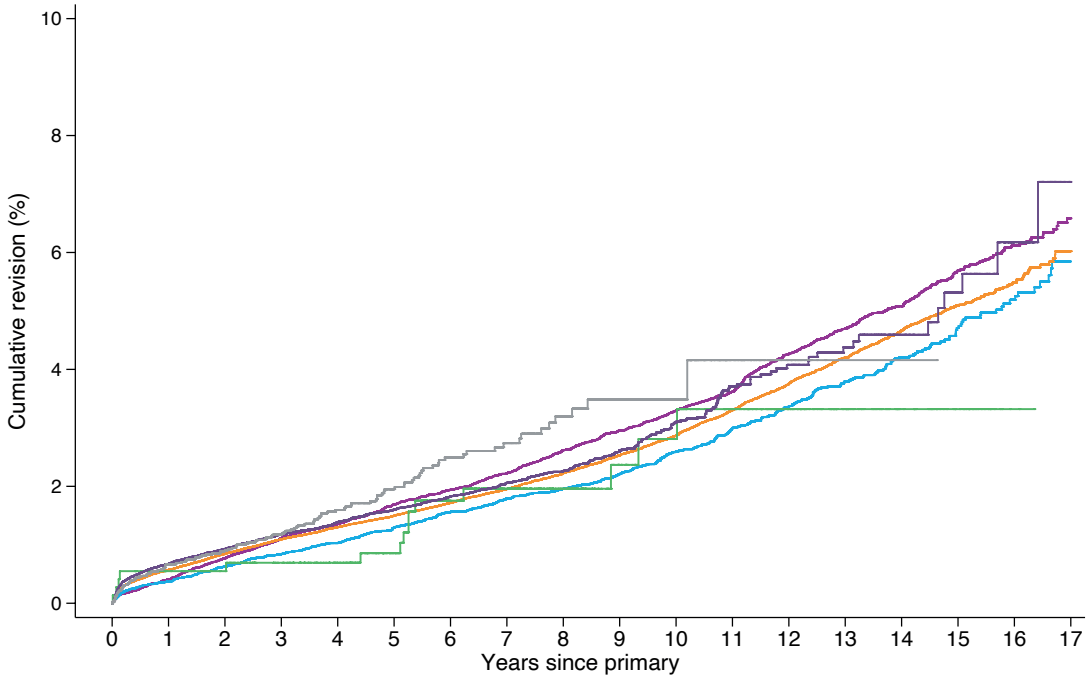
j) Metal-on-polyethylene reverse hybrid hip constructs n=21,541

k) Ceramic-on-polyethylene reverse hybrid hip constructs n=9,672

l) Metal-on-metal resurfacing n=39,271

Figures 3.H10 (a) to 3.H10 (l) (on pages 80 to 91) show respective percentage cumulative probabilities of revision (Kaplan-Meier estimates) for various head sizes, for each of the groups with follow-up up to 17 years following the primary hip replacement.

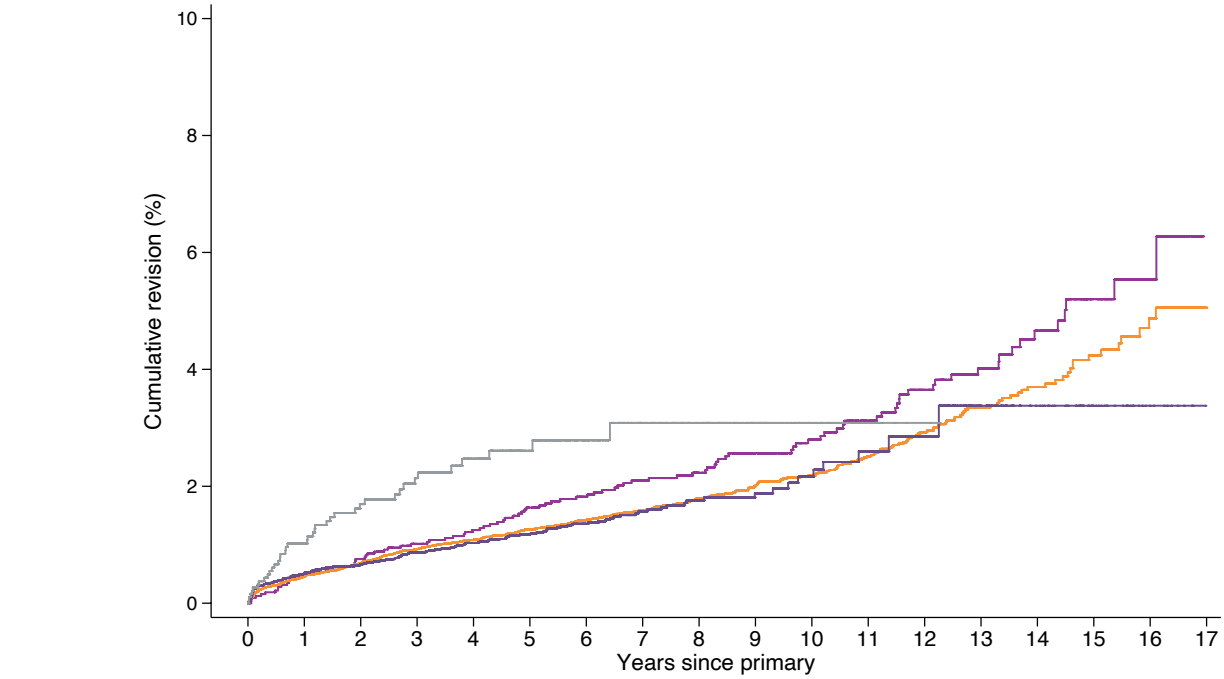
Figure 3.H10 (a) KM estimates of cumulative **revision** of primary **cemented MoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
22.25	34,815	32,659	29,819	26,301	22,186	17,270	12,271	7,498	3,116
26	18,689	17,736	16,470	14,739	12,411	9,655	6,877	4,045	1,487
28	198,010	176,816	146,941	114,103	81,021	52,947	30,985	13,484	3,427
30	730	692	629	494	293	*190*	*108*	*42*	*<4*
32	78,963	59,838	39,240	22,178	10,675	4,356	1,641	551	*134*
36	7,499	5,433	3,469	1,984	814	*177*	*14*	*<4*	

In Figure 3.H10 (a), for cemented metal-on-polyethylene (MoP) hips, 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 22.25mm 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 nine years of follow-up. The numbers at risk for patients who received 36mm heads after nine years are too small for meaningful comparison.

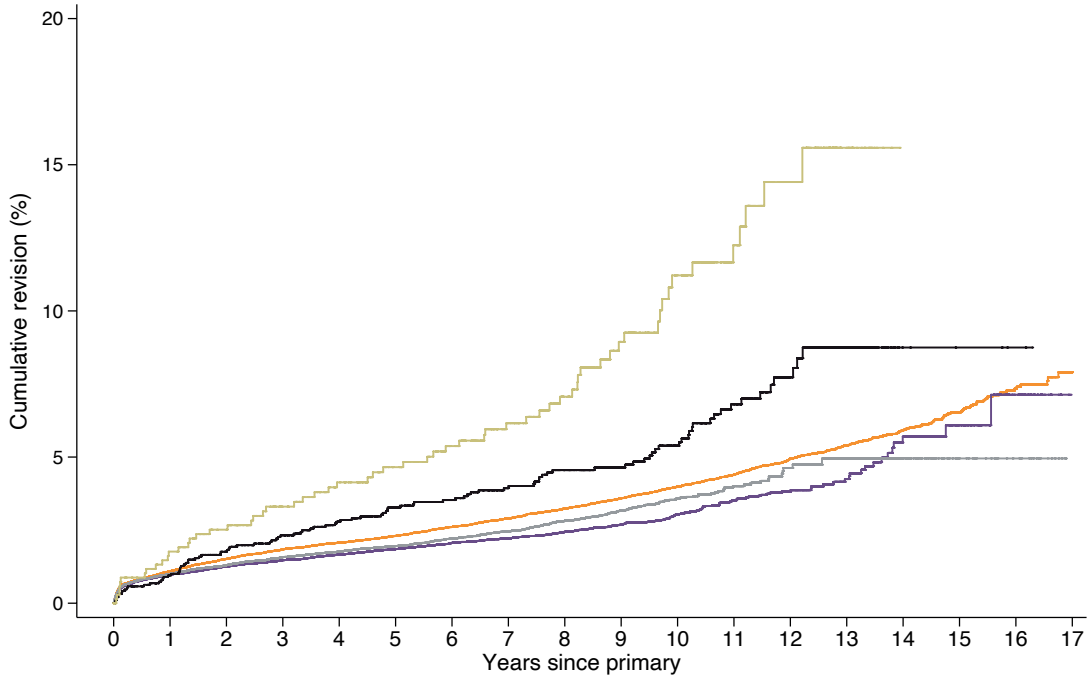
Figure 3.H10 (b) KM estimates of cumulative **revision** of primary **cemented CoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
22.25	3,206	3,084	2,892	2,566	2,104	1,597	1,154	638	*157*
28	28,888	24,739	19,295	14,441	9,957	6,370	3,690	1,780	565
32	15,708	11,853	7,788	4,419	2,089	827	*235*	*56*	*14*
36	1,874	1,271	774	378	*196*	*49*	*<4*		

Figure 3.H10 (b) shows revision rates for different head sizes for cemented ceramic-on-polyethylene (CoP) hips. There was a statistically significant effect of head size (overall P<0.001) with 36mm heads having the highest revision rates, followed by 22.25mm heads. The lowest revision rates were achieved with 28mm and 32mm heads.

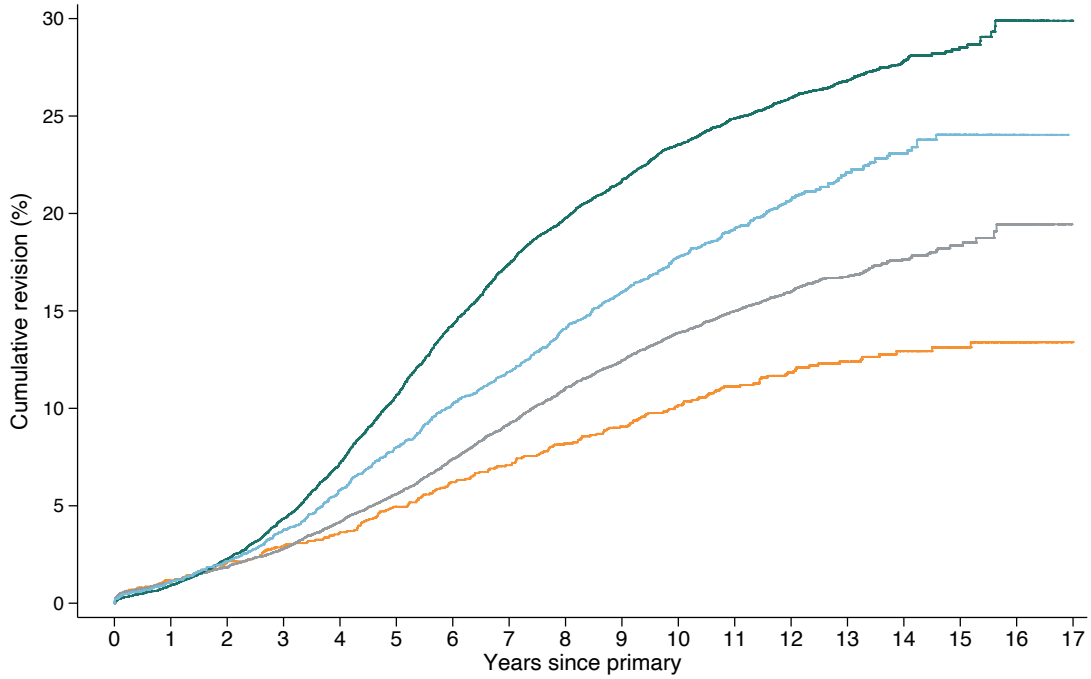
Figure 3.H10 (c) KM estimates of cumulative **revision** of primary **uncemented MoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	58,112	53,505	46,791	39,223	30,536	21,366	12,803	5,730	1,398
32	82,081	67,566	47,696	29,858	15,614	6,617	1,966	466	*51*
36	38,148	30,461	22,420	14,993	8,835	3,851	848	*85*	*20*
40	1,916	1,776	1,641	1,458	1,181	770	294	*6*	*<4*
44	685	637	569	513	384	*213*	*84*		

Figure 3.H10 (c) shows revision rates for uncemented metal-on-polyethylene (MoP) hips. Head sizes above 36mm had the highest revision rates.

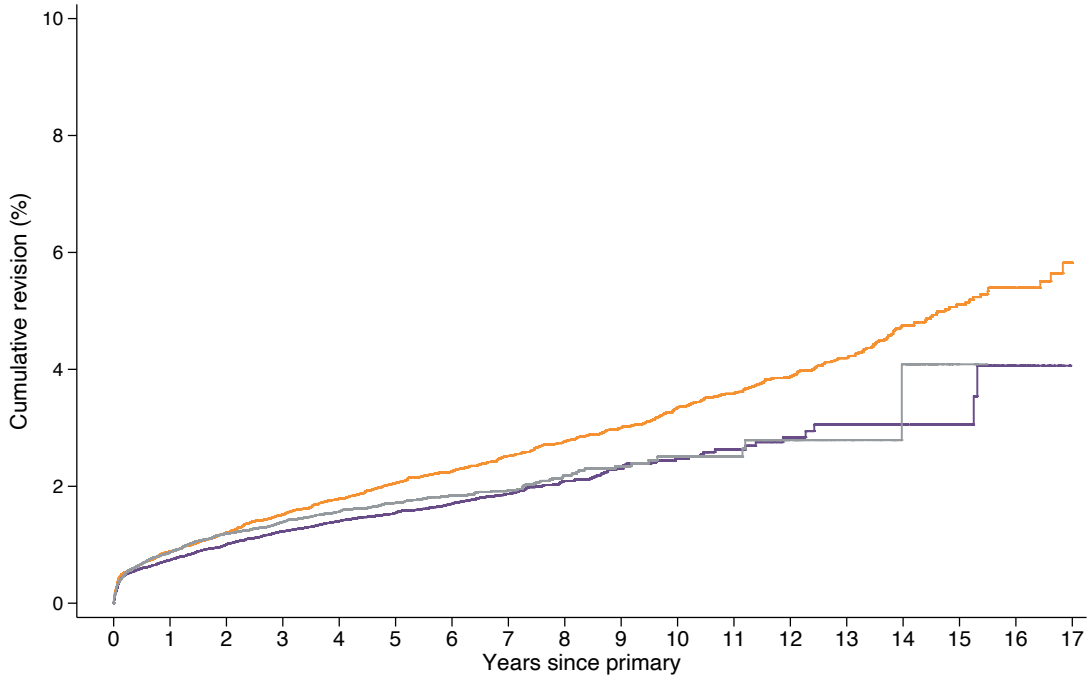
Figure 3.H10 (d) KM estimates of cumulative **revision** of primary **uncemented MoM** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	1,871	1,799	1,719	1,620	1,542	1,350	1,016	516	*175*
36	12,297	11,735	11,059	10,170	9,183	8,131	4,967	1,379	*125*
38 to 48	10,682	10,296	9,548	8,557	7,699	6,913	4,839	1,535	*110*
50 to 54	3,678	3,537	3,314	3,055	2,820	2,519	1,646	509	*37*

Figure 3.H10 (d) shows revision rates for uncemented metal-on-metal (MoM) hips, with a statistically significant difference between the head sizes overall ($P<0.001$) with the lowest failure rates achieved with the smallest head sizes.

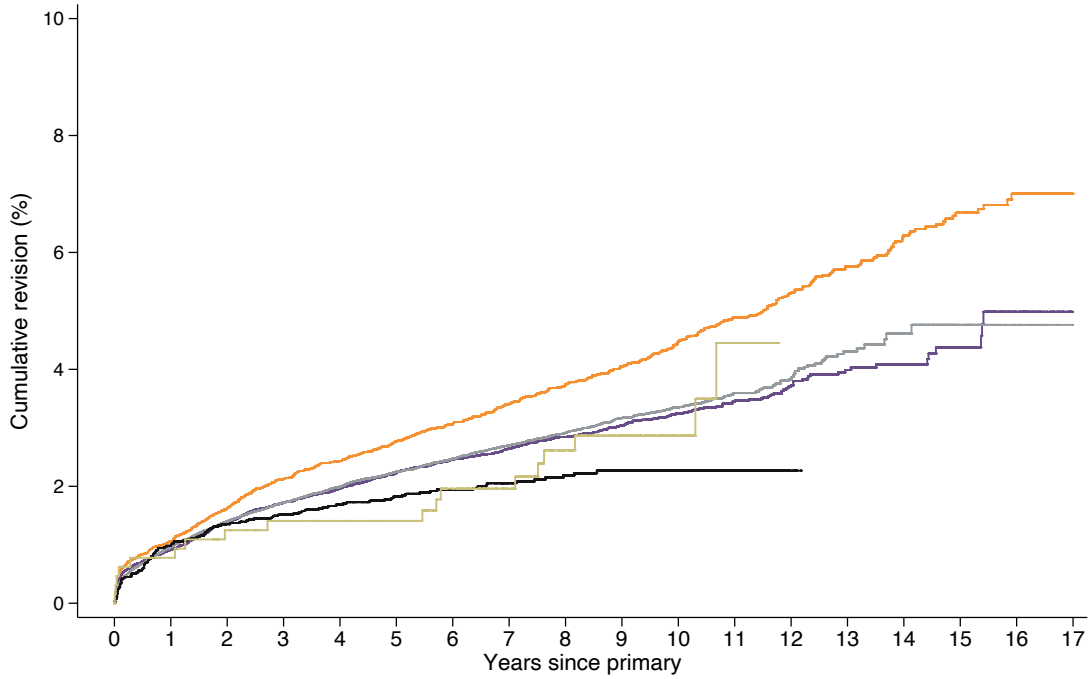
Figure 3.H10 (e) KM estimates of cumulative **revision** of primary **uncemented CoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	27,353	24,367	20,379	16,669	13,216	9,960	6,762	3,719	1,197
32	54,335	40,097	24,739	13,804	6,928	3,021	1,064	405	*90*
36	36,165	25,933	16,130	8,325	3,785	1,402	378	*72*	

For uncemented ceramic-on-polyethylene (CoP) hips (Figure 3.H10 (e)), there was a statistically significant difference between the three head sizes shown ($P<0.001$) with 28mm heads having higher revision rates than 32mm and 36mm heads.

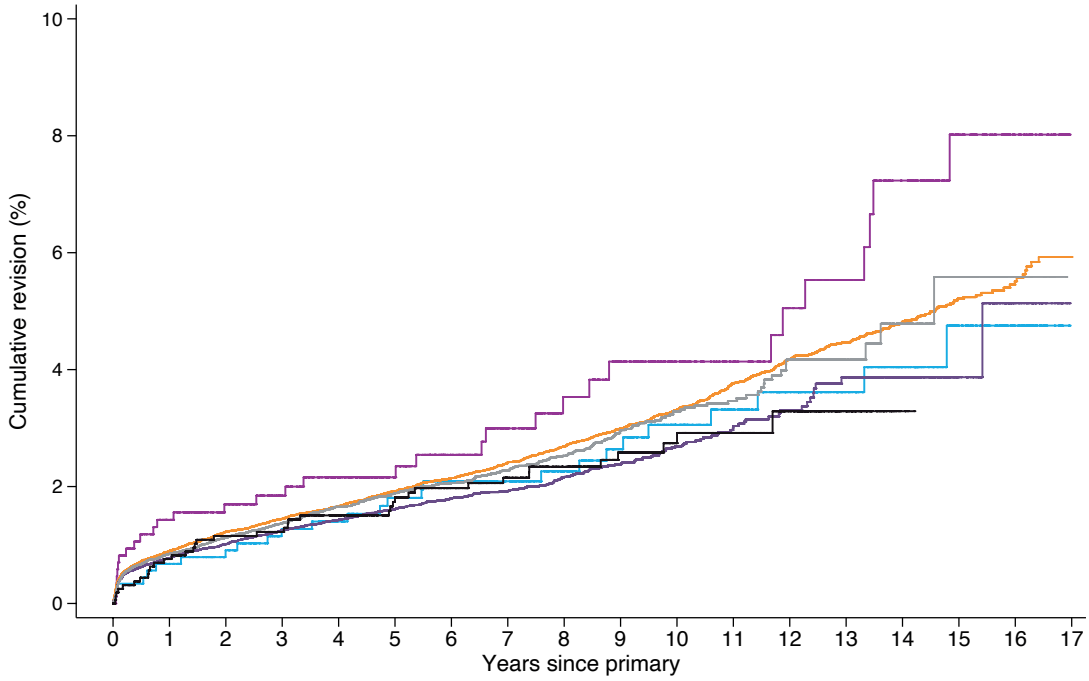
Figure 3.H10 (f) KM estimates of cumulative **revision** of primary **uncemented CoC** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	13,445	12,799	11,965	10,957	9,489	7,357	5,142	2,770	859
32	36,485	33,246	28,610	22,827	16,054	8,682	3,906	1,331	285
36	77,544	70,976	61,496	48,127	31,867	15,461	4,769	725	*30*
40	5,361	4,938	4,487	3,796	2,680	1,017	*14*		
44	643	627	594	520	400	*203*			

Figure 3.H10 (f) shows revision rates for uncemented ceramic-on-ceramic (CoC) hip replacements by head size. There are statistically significant differences between all five head sizes shown (P<0.001). The larger the head size, the lower the revision rate of the construct.

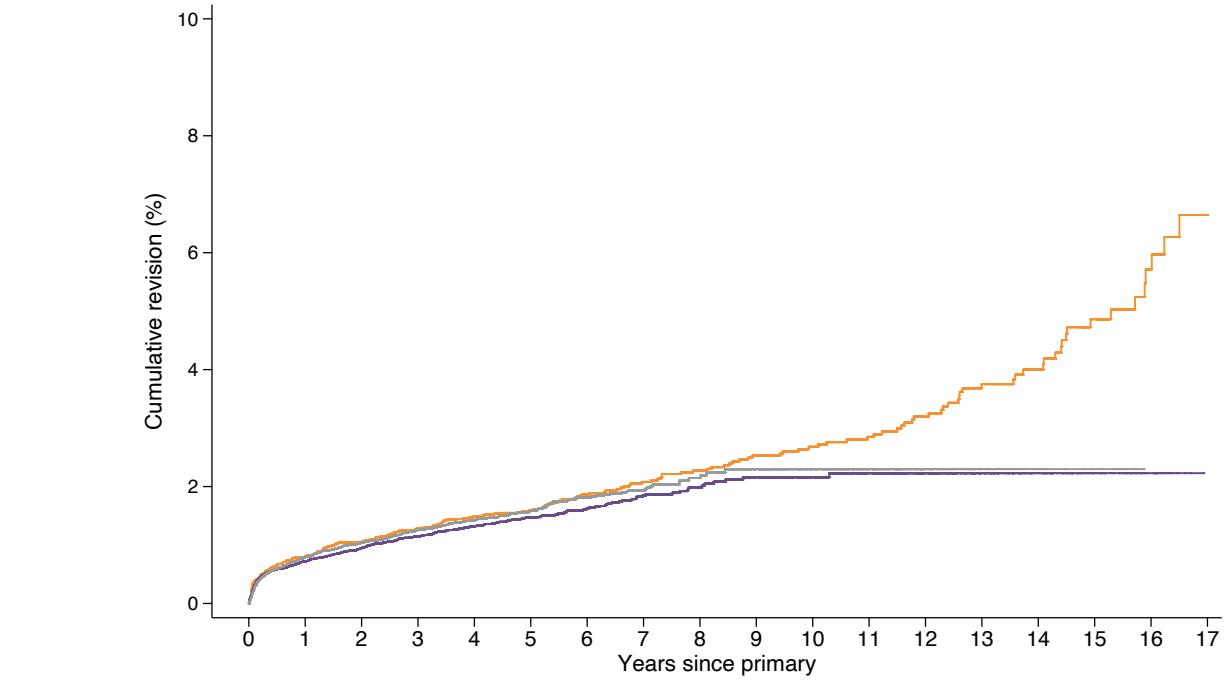
Figure 3.H10 (g) KM estimates of cumulative **revision** of primary **hybrid MoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
22.25	862	706	581	462	342	259	*203*	*149*	*69*
26	886	845	749	667	545	411	296	*178*	*62*
28	46,852	42,277	36,096	29,322	23,193	17,175	11,363	5,589	1,636
32	70,542	52,754	34,011	19,381	9,582	4,371	1,602	360	*41*
36	38,674	29,454	20,443	12,973	7,641	3,405	1,017	*201*	*19*
40	1,601	1,468	1,335	1,170	975	561	*220*	*4*	

Figure 3.H10 (g) shows revision rate for hybrid MoP hip replacements by head size. There was a statistically significant difference between the six head sizes shown (P<0.001) with 22.25mm heads having higher revision rates than the other heads. Beyond ten years the numbers at risk are low so apparent differences should be interpreted with caution.

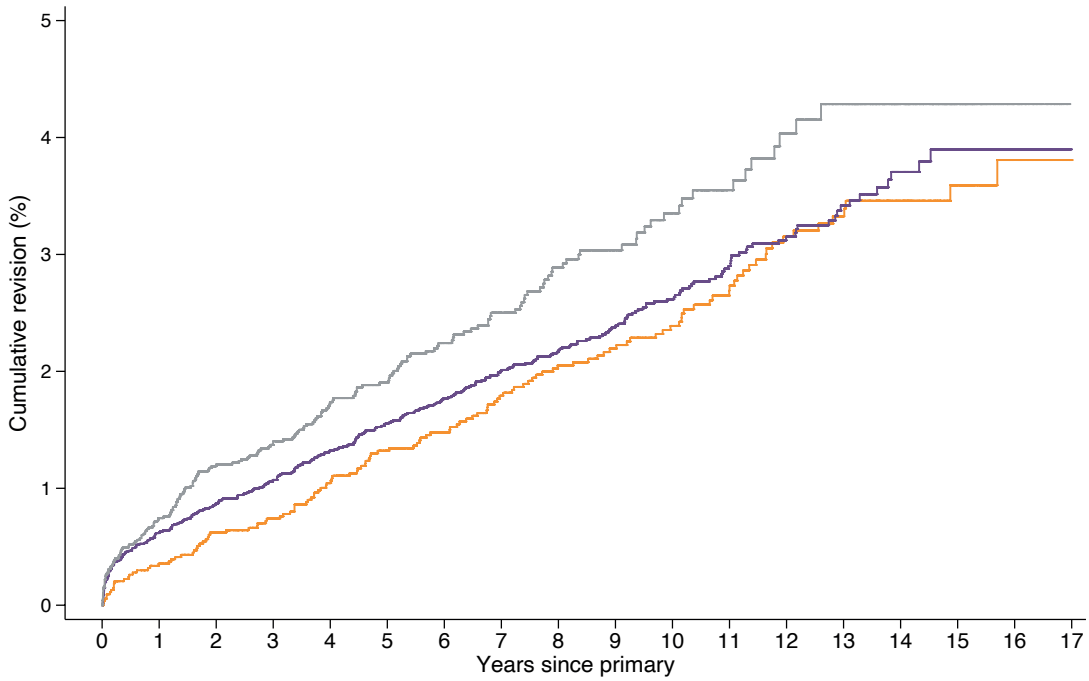
Figure 3.H10 (h) KM estimates of cumulative **revision** of primary **hybrid CoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	12,275	9,856	6,885	4,635	3,278	2,453	1,773	1,036	372
32	44,540	29,340	15,808	7,222	3,059	1,566	577	*151*	*25*
36	33,768	23,048	13,257	6,267	2,138	746	*157*	*16*	

Figure 3.H10 (h) shows revision rates for hybrid ceramic-on-polyethylene hip replacements by head size. There were no statistically significant differences in revision rates between 28mm, 32mm and 36mm heads (P=0.06).

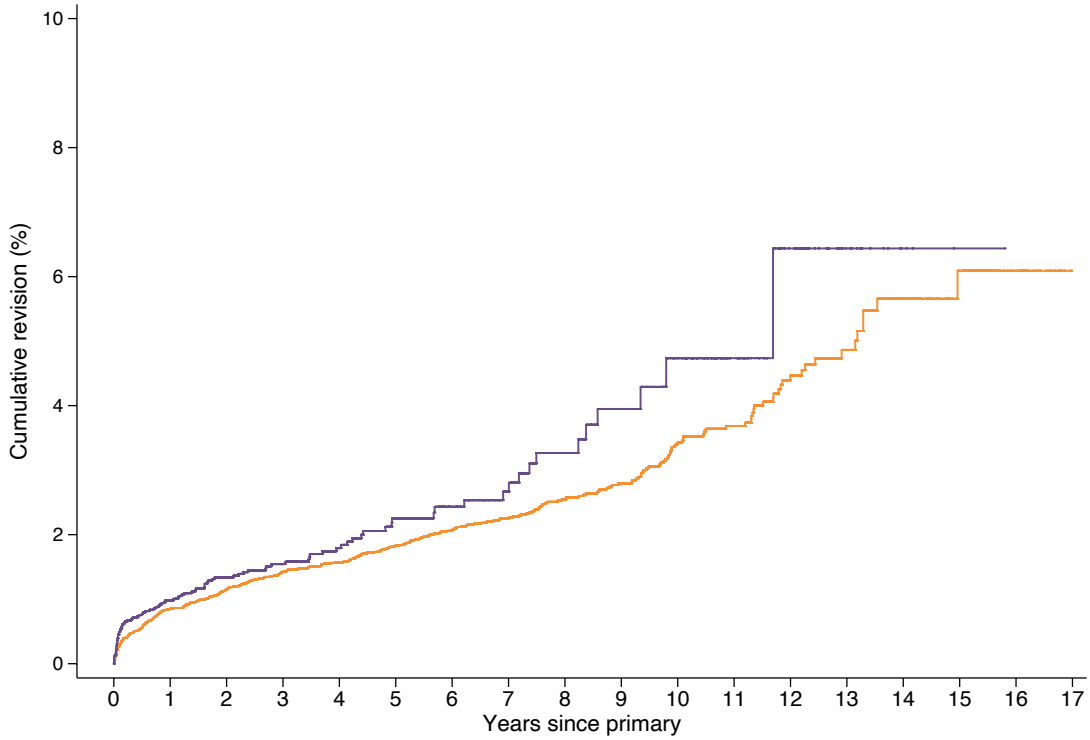
Figure 3.H10 (i) KM estimates of cumulative **revision** of primary **hybrid CoC** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	5,367	5,148	4,777	4,247	3,623	2,793	1,879	1,066	349
32	13,341	12,664	11,494	9,886	7,630	5,312	3,134	1,294	*184*
36	7,739	6,843	5,652	4,156	2,750	1,556	843	401	*55*

Figure 3.H10 (i) shows revision rates for hybrid ceramic-on-ceramic hip replacements by head size. Bearings with 36mm heads had a higher revision rate than 32mm and 28mm heads (P=0.009).

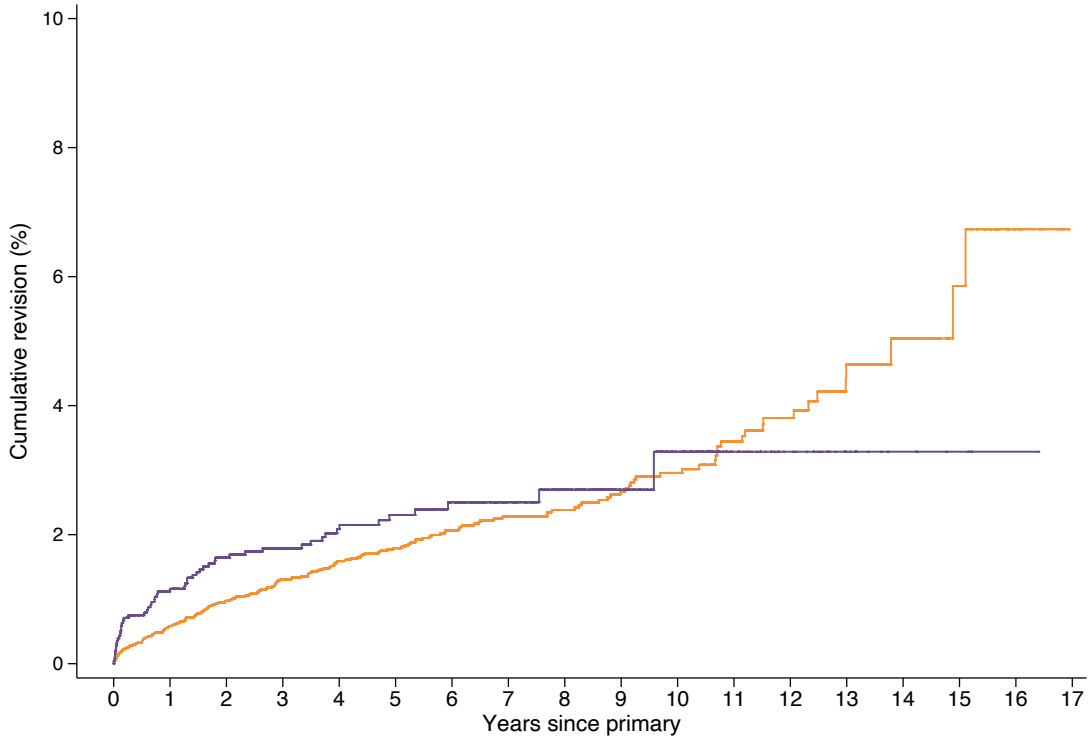
Figure 3.H10 (j) KM estimates of cumulative **revision** of primary **reverse hybrid MoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	16,452	14,476	11,461	8,135	5,302	2,957	1,277	374	*88*
32	5,089	3,757	2,000	998	507	*193*	*44*	*4*	

Figure 3.H10 (j) shows revision rates for reverse hybrid metal-on-polyethylene hip replacements by head size. There were no statistically significant differences in revision rates between head sizes (P=0.09).

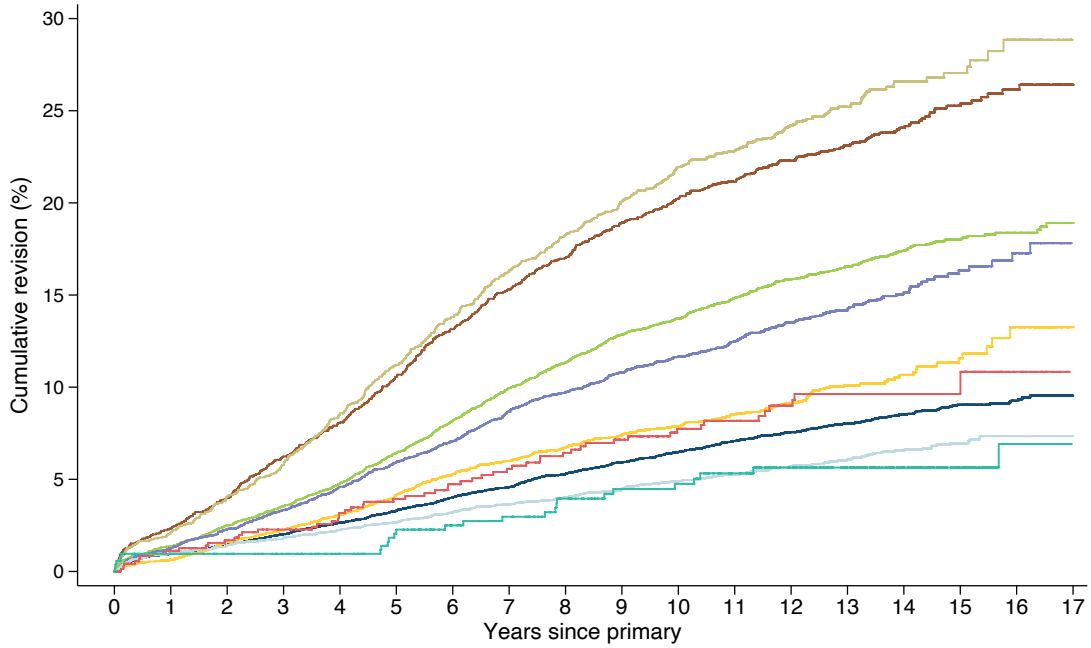
Figure 3.H10 (k) KM estimates of cumulative **revision** of primary **reverse hybrid CoP** hip replacement by **head size (mm)**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
28	7,120	6,353	5,213	3,948	2,710	1,634	805	*192*	*56*
32	2,552	2,117	1,534	875	423	*137*	*31*	*7*	*<4*

Figure 3.H10 (k) shows revision rates for reverse hybrid ceramic-on-polyethylene hip replacements by head size. There were no statistically significant differences in revision rates between head sizes (P=0.24).

Figure 3.H10 (l) KM estimates of cumulative **revision** of primary **resurfacing MoM** hip replacement 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								
42	2,234	2,136	2,028	1,896	1,784	1,654	1,408	804	283
44	2,236	2,141	2,024	1,881	1,744	1,553	1,135	460	*93*
46	6,198	6,020	5,830	5,540	5,157	4,707	3,751	2,099	693
48	4,789	4,542	4,307	4,001	3,645	3,122	2,088	819	*184*
50	11,722	11,095	10,455	9,671	8,894	7,833	5,961	3,206	1,064
52	5,014	4,689	4,376	3,965	3,545	2,913	1,787	653	*134*
54	5,833	5,460	5,107	4,712	4,323	3,825	3,019	1,760	590
56	724	679	644	587	529	457	289	*140*	*27*
58	521	490	464	421	389	341	272	*180*	*52*

Figure 3.H10 (l) shows revision rates for resurfacing metal-on-metal hip replacements by head size. There is a strong trend to better implant survivorship with larger head sizes.

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

As in previous reports, we only include 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. 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	15 years	17 years
Cemented									
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	3,380	75 (70 to 79)	31	0.63 (0.41-0.96)	1.25 (0.92-1.70)	1.55 (1.17-2.05)	2.75 (2.13-3.55)		
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	4,794	77 (72 to 81)	33	0.32 (0.19-0.53)	0.95 (0.69-1.30)	1.31 (0.99-1.74)	2.11 (1.60-2.79)		
C-Stem AMT Cemented Stem[St] : Marathon[C]	14,107	75 (70 to 80)	32	0.50 (0.39-0.63)	0.98 (0.81-1.18)	1.27 (1.06-1.53)	*2.05 (1.41-2.99)*		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	6,036	72 (66 to 77)	39	0.39 (0.26-0.58)	0.88 (0.66-1.16)	1.19 (0.93-1.52)	2.71 (2.21-3.31)	4.61 (3.70-5.74)	*5.30 (3.86-7.24)*
C-Stem Cemented Stem[St] : Marathon[C]	9,649	68 (60 to 75)	41	0.44 (0.33-0.60)	0.89 (0.71-1.11)	1.28 (1.05-1.56)	2.13 (1.73-2.63)		
CPT CoCr Stem[St] : Elite Plus Ogee[C]	2,518	73 (67 to 79)	36	0.60 (0.36-1.00)	1.51 (1.10-2.08)	2.23 (1.71-2.91)	3.92 (3.12-4.93)	*6.04 (4.51-8.08)*	
CPT CoCr Stem[St] : ZCA[C]	17,237	77 (71 to 81)	31	0.92 (0.79-1.08)	1.52 (1.34-1.73)	2.19 (1.96-2.45)	4.09 (3.66-4.58)	5.48 (4.71-6.37)	*6.26 (4.74-8.24)*
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	4,623	72 (66 to 78)	38	0.33 (0.20-0.54)	1.14 (0.87-1.50)	1.83 (1.47-2.28)	3.65 (3.10-4.30)	6.21 (5.32-7.23)	*6.99 (5.91-8.27)*
Charnley Cemented Stem[St] : Charnley Ogee[C]	10,495	73 (67 to 78)	38	0.38 (0.27-0.51)	1.21 (1.02-1.45)	1.87 (1.62-2.16)	3.71 (3.32-4.14)	6.16 (5.51-6.88)	6.88 (6.07-7.79)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	6,979	74 (68 to 79)	29	0.38 (0.26-0.55)	0.76 (0.58-1.00)	1.16 (0.93-1.46)	2.47 (2.09-2.93)	3.95 (3.34-4.66)	*4.93 (3.85-6.31)*
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 (1.55-2.70)	2.75 (2.14-3.54)	4.72 (3.66-6.08)	*5.16 (3.87-6.85)*
Exeter V40[St] : Charnley and Elite Plus LPW[C]	5,447	73 (68 to 79)	31	0.65 (0.47-0.91)	1.25 (0.98-1.59)	1.49 (1.19-1.87)	2.19 (1.76-2.72)	*3.44 (2.44-4.85)*	*4.75 (2.63-8.51)*

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	15 years	17 years
Exeter V40[St] : Elite Plus Cemented Cup[C]	5,221	73 (67 to 79)	33	0.33 (0.20-0.53)	0.65 (0.46-0.91)	0.87 (0.65-1.17)	1.50 (1.16-1.93)	3.30 (2.40-4.52)	*3.59 (2.58-5.00)*
Exeter V40[St] : Elite Plus Ogee[C]	26,380	74 (69 to 80)	35	0.40 (0.33-0.48)	0.86 (0.75-0.98)	1.20 (1.07-1.35)	2.18 (1.97-2.41)	3.29 (2.90-3.73)	*3.82 (3.22-4.53)*
Exeter V40[St] : Exeter Contemporary Flanged[C]	94,901	74 (69 to 79)	34	0.57 (0.52-0.62)	1.02 (0.95-1.09)	1.39 (1.31-1.47)	2.40 (2.26-2.54)	4.13 (3.79-4.51)	*5.42 (4.47-6.57)*
Exeter V40[St] : Exeter Contemporary Hooded[C]	29,111	75 (70 to 80)	32	0.95 (0.84-1.06)	1.62 (1.48-1.78)	2.14 (1.97-2.32)	3.95 (3.67-4.26)	7.43 (6.74-8.18)	*8.69 (7.54-10.02)*
Exeter V40[St] : Exeter Duration[C]	16,880	73 (67 to 79)	32	0.60 (0.49-0.73)	1.19 (1.04-1.37)	1.64 (1.45-1.85)	3.78 (3.46-4.14)	6.67 (6.06-7.33)	*8.10 (6.92-9.48)*
Exeter V40[St] : Exeter X3 Rimfit[C]	39,370	71 (63 to 78)	34	0.49 (0.43-0.57)	0.87 (0.78-0.98)	1.27 (1.15-1.41)	*1.90 (1.55-2.33)*		
Exeter V40[St] : Marathon[C]	8,599	71 (64 to 78)	35	0.47 (0.35-0.65)	0.86 (0.67-1.10)	1.11 (0.88-1.41)	1.68 (1.27-2.21)		
Exeter V40[St] : Opera[C]	2,815	74 (68 to 80)	32	0.40 (0.22-0.71)	0.85 (0.56-1.27)	1.29 (0.92-1.80)	3.10 (2.41-3.98)	*7.54 (5.61-10.10)*	*8.27 (6.01-11.32)*
MS-30[St] : Original ME Muller Low Profile Cup[C]	4,064	74 (68 to 80)	32	0.25 (0.13-0.46)	0.53 (0.34-0.82)	0.76 (0.52-1.11)	1.53 (1.10-2.12)	*2.40 (1.55-3.72)*	*3.15 (1.78-5.56)*
Muller Straight Stem[St] : Original ME Muller Low Profile Cup[C]	2,907	75 (70 to 80)	28	0.38 (0.21-0.69)	0.79 (0.52-1.20)	1.15 (0.80-1.64)	2.47 (1.85-3.29)	*5.43 (3.64-8.06)*	*9.02 (4.94-16.17)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	5,436	75 (70 to 80)	29	0.45 (0.30-0.66)	1.09 (0.84-1.40)	1.51 (1.21-1.89)	2.42 (1.99-2.94)	4.45 (3.51-5.64)	*5.66 (4.14-7.71)*
Uncemented									
Accolade[St] : Trident[SL]	27,158	66 (59 to 73)	44	0.94 (0.83-1.06)	1.89 (1.73-2.06)	2.53 (2.34-2.72)	4.10 (3.83-4.39)	*5.68 (4.97-6.47)*	*5.68 (4.97-6.47)*
Accolade II[St] : Trident[SL]	13,042	65 (57 to 72)	46	0.85 (0.70-1.03)	1.38 (1.17-1.64)	1.81 (1.45-2.27)			
Anthology[St] : R3 Cementless[SL]	4,924	62 (53 to 69)	42	1.11 (0.85-1.45)	1.74 (1.41-2.16)	2.18 (1.78-2.66)	*3.68 (2.75-4.92)*		
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)	23.56 (22.00-25.22)	43.87 (41.97-45.82)	*48.52 (46.42-50.66)*	
Corail[St] : Duraloc Cementless Cup[SL]	4,001	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 (4.74-6.25)	11.02 (9.74-12.46)	*12.89 (10.96-15.13)*
Corail[St] : Pinnacle Gription[SL]	10,711	66 (58 to 74)	41	0.93 (0.76-1.13)	1.55 (1.32-1.83)	2.21 (1.87-2.61)	*2.85 (2.36-3.45)*		
Corail[St] : Pinnacle[SL]	170,277	66 (59 to 73)	45	0.77 (0.73-0.81)	1.47 (1.41-1.53)	2.14 (2.07-2.22)	4.55 (4.41-4.70)	7.39 (7.00-7.81)	
Corail[St] : Trilogy[SL]	3,281	67 (61 to 74)	40	0.59 (0.37-0.92)	1.09 (0.79-1.52)	1.64 (1.24-2.16)	2.94 (2.34-3.68)	*3.71 (2.79-4.91)*	*4.65 (3.25-6.65)*
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	5,133	62 (52 to 70)	39	1.33 (1.04-1.69)	1.83 (1.48-2.25)	2.13 (1.74-2.60)			

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	15 years	17 years
Furlong HAC Stem[St] : CSF[SL]	17,104	69 (63 to 76)	40	1.11 (0.96-1.28)	1.83 (1.64-2.05)	2.23 (2.01-2.46)	3.60 (3.31-3.92)	5.17 (4.73-5.64)	5.79 (5.17-6.49)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	24,545	66 (59 to 73)	45	1.10 (0.98-1.24)	1.75 (1.59-1.92)	2.03 (1.86-2.22)	2.68 (2.45-2.93)		
M/L Taper Cementless[St] : Continuum[SL]	6,203	61 (53 to 68)	50	1.23 (0.99-1.54)	1.78 (1.47-2.14)	2.15 (1.80-2.56)	*2.64 (2.21-3.15)*		
M/L Taper Cementless[St] : Trilogy IT[SL]	5,443	64 (55 to 71)	51	1.26 (1.00-1.60)	2.05 (1.69-2.48)	2.32 (1.93-2.80)			
Metafix Stem[St] : Trinity[SL]	6,949	64 (56 to 70)	46	0.77 (0.59-1.01)	1.11 (0.88-1.40)	1.39 (1.10-1.74)	*2.21 (1.60-3.06)*		
Polarstem Cementless[St] : R3 Cementless[SL]	19,140	66 (58 to 72)	46	0.75 (0.63-0.88)	1.00 (0.86-1.17)	1.20 (1.03-1.40)	*1.77 (1.42-2.20)*		
SL-Plus Cementless Stem[St] : EP-Fit Plus[SL]	3,797	66 (59 to 74)	43	1.46 (1.12-1.89)	3.13 (2.62-3.74)	4.49 (3.87-5.22)	7.34 (6.47-8.32)	*9.07 (7.91-10.39)*	
Synergy Cementless Stem[St] : R3 Cementless[SL]	3,871	65 (57 to 71)	52	0.88 (0.63-1.24)	1.29 (0.98-1.71)	1.71 (1.33-2.20)	3.26 (2.35-4.52)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	26,557	65 (58 to 72)	44	1.10 (0.98-1.23)	1.50 (1.36-1.66)	1.76 (1.61-1.94)	2.32 (2.11-2.55)		
Taperloc Complete Cementless Stem[St] : Exceed ABT[SL]	3,737	63 (56 to 70)	49	0.86 (0.61-1.21)	1.34 (1.01-1.78)	1.60 (1.23-2.10)			
miniHip[St] : Trinity[SL]	2,501	56 (49 to 63)	45	1.37 (0.98-1.92)	2.12 (1.61-2.78)	2.42 (1.86-3.15)	*3.55 (2.17-5.78)*		
Hybrid									
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	18,567	71 (65 to 77)	38	0.67 (0.56-0.80)	1.16 (1.00-1.34)	1.56 (1.36-1.80)	2.90 (2.37-3.55)	*3.03 (2.46-3.74)*	
CPCS[St] : R3 Cementless[SL]	4,834	74 (68 to 79)	32	0.81 (0.59-1.11)	1.39 (1.06-1.83)	1.70 (1.28-2.27)			
CPT CoCr Stem[St] : Continuum[SL]	11,159	70 (62 to 77)	36	1.49 (1.28-1.74)	2.17 (1.90-2.48)	2.56 (2.24-2.93)	*4.29 (3.21-5.73)*		
CPT CoCr Stem[St] : Trabecular Metal Modular Cementless Cup[SL]	2,771	72 (64 to 79)	31	1.14 (0.80-1.62)	1.89 (1.43-2.49)	2.43 (1.88-3.14)	4.56 (3.50-5.94)	*5.69 (4.02-8.04)*	
CPT CoCr Stem[St] : Trilogy IT[SL]	11,497	69 (62 to 76)	37	1.24 (1.05-1.46)	1.81 (1.57-2.09)	2.28 (1.98-2.63)			
CPT CoCr Stem[St] : Trilogy[SL]	24,410	71 (65 to 78)	36	0.90 (0.79-1.03)	1.45 (1.30-1.61)	2.18 (1.98-2.39)	3.86 (3.51-4.26)	5.28 (4.68-5.96)	*5.28 (4.68-5.96)*
Exeter V40[St] : ABG II Cementless Cup[SL]	2,633	65 (59 to 73)	34	0.27 (0.13-0.56)	0.74 (0.47-1.15)	1.20 (0.84-1.71)	2.25 (1.70-2.97)	3.98 (3.08-5.13)	*3.98 (3.08-5.13)*
Exeter V40[St] : Pinnacle[SL]	9,540	72 (65 to 78)	38	0.79 (0.63-0.99)	1.16 (0.95-1.40)	1.43 (1.19-1.71)	2.64 (2.13-3.27)	*3.48 (2.65-4.57)*	
Exeter V40[St] : R3 Cementless[SL]	3,092	72 (65 to 78)	31	0.73 (0.48-1.11)	1.23 (0.88-1.72)	1.53 (1.10-2.13)	*2.09 (1.27-3.43)*		

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	15 years	17 years
Exeter V40[St] : Trident[SL]	110,306	69 (61 to 76)	40	0.62 (0.58-0.67)	1.07 (1.01-1.14)	1.41 (1.33-1.49)	2.43 (2.28-2.59)	3.56 (3.25-3.89)	*4.06 (3.34-4.93)*
Exeter V40[St] : Trilogy[SL]	14,776	70 (63 to 76)	40	0.57 (0.46-0.70)	0.89 (0.75-1.06)	1.24 (1.07-1.44)	2.20 (1.94-2.49)	3.38 (2.94-3.90)	*4.18 (3.31-5.27)*
Exeter V40[St] : Tritanium[SL]	6,520	68 (60 to 75)	45	1.09 (0.86-1.38)	1.66 (1.35-2.03)	2.13 (1.75-2.60)	*3.24 (2.56-4.08)*		
Taperfit Cemented Stem[St] : Trinity[SL]	6,727	71 (65 to 77)	34	0.90 (0.70-1.16)	1.39 (1.12-1.73)	1.64 (1.31-2.04)			
Reverse hybrid									
Corail[St] : Elite Plus Ogee[C]	3,143	72 (65 to 77)	37	0.64 (0.41-0.99)	1.44 (1.07-1.93)	1.85 (1.41-2.42)	2.97 (2.31-3.82)	*5.18 (3.74-7.16)*	
Corail[St] : Marathon[C]	16,069	70 (64 to 76)	39	0.63 (0.52-0.77)	1.08 (0.92-1.26)	1.33 (1.14-1.54)	2.12 (1.74-2.59)		
Resurfacing									
ASR Resurfacing Cup	2,918	55 (49 to 60)	69	1.65 (1.24-2.18)	5.88 (5.08-6.80)	13.30 (12.12-14.60)	26.27 (24.70-27.93)	30.30 (28.60-32.08)	
Adept Resurfacing Cup	3,806	54 (47 to 59)	75	1.09 (0.80-1.48)	2.41 (1.96-2.96)	4.40 (3.77-5.13)	7.90 (7.03-8.87)	*11.93 (10.11-14.06)*	
BHR Resurfacing Cup	22,740	55 (48 to 60)	76	1.02 (0.89-1.16)	2.31 (2.12-2.51)	3.55 (3.31-3.81)	7.45 (7.09-7.83)	10.60 (10.12-11.10)	11.30 (10.74-11.88)
Conserve Plus Resurfacing Cup	1,320	56 (50 to 61)	63	2.05 (1.41-2.97)	5.17 (4.10-6.51)	8.31 (6.94-9.94)	14.11 (12.32-16.13)	*17.04 (14.82-19.57)*	*18.32 (15.18-22.02)*
Cormet 2000 Resurfacing Cup	3,610	55 (48 to 60)	65	1.53 (1.17-1.98)	3.78 (3.20-4.45)	7.73 (6.90-8.66)	16.86 (15.67-18.14)	22.86 (21.35-24.45)	*24.68 (22.89-26.58)*
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)	8.48 (7.24-9.92)	10.38 (8.93-12.04)	
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)	10.21 (8.84-11.78)	*13.73 (11.58-16.25)*	

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	15 years	17 years
Cemented										
C-Stem AMT Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	3,352	75 (71 to 79)	31	0.63 (0.41-0.97)	1.26 (0.93-1.72)	1.56 (1.18-2.07)	2.78 (2.15-3.59)		
C-Stem AMT Cemented Stem[St] : Elite Plus Ogee[C]	MoP	4,165	77 (73 to 82)	33	0.32 (0.18-0.55)	0.94 (0.67-1.31)	1.30 (0.96-1.76)	2.17 (1.62-2.90)		
C-Stem AMT Cemented Stem[St] : Marathon[C]	MoP	11,533	77 (72 to 81)	31	0.46 (0.35-0.61)	0.99 (0.81-1.22)	1.34 (1.10-1.63)	*1.83 (1.36-2.45)*		
C-Stem AMT Cemented Stem[St] : Marathon[C]	CoP	2,574	66 (60 to 71)	37	0.67 (0.42-1.08)	0.90 (0.58-1.38)	1.00 (0.64-1.53)	*2.42 (0.99-5.82)*		
C-Stem Cemented Stem[St] : Elite Plus Ogee[C]	MoP	5,077	73 (68 to 78)	38	0.44 (0.29-0.67)	0.98 (0.73-1.31)	1.30 (1.01-1.68)	2.97 (2.41-3.67)	5.07 (4.01-6.39)	*6.05 (4.17-8.73)*
C-Stem Cemented Stem[St] : Marathon[C]	MoP	5,467	73 (68 to 78)	37	0.36 (0.23-0.56)	0.76 (0.55-1.04)	1.12 (0.85-1.49)	2.06 (1.53-2.78)		
C-Stem Cemented Stem[St] : Marathon[C]	CoP	4,182	59 (52 to 65)	46	0.56 (0.37-0.84)	1.06 (0.78-1.45)	1.48 (1.12-1.96)	2.23 (1.67-2.99)		
CPT CoCr Stem[St] : ZCA[C]	MoP	16,290	77 (72 to 82)	30	0.96 (0.82-1.12)	1.57 (1.38-1.78)	2.26 (2.01-2.53)	4.19 (3.74-4.69)	5.42 (4.65-6.31)	*6.20 (4.68-8.19)*
Charnley Cemented Stem[St] : Charnley Cemented Cup[C]	MoP	4,623	72 (66 to 78)	38	0.33 (0.20-0.54)	1.14 (0.87-1.50)	1.83 (1.47-2.28)	3.65 (3.10-4.30)	6.21 (5.32-7.23)	*6.99 (5.91-8.27)*
Charnley Cemented Stem[St] : Charnley Ogee[C]	MoP	10,495	73 (67 to 78)	38	0.38 (0.27-0.51)	1.21 (1.02-1.45)	1.87 (1.62-2.16)	3.71 (3.32-4.14)	6.16 (5.51-6.88)	6.88 (6.07-7.79)
Charnley Cemented Stem[St] : Charnley and Elite Plus LPW[C]	MoP	6,979	74 (68 to 79)	29	0.38 (0.26-0.55)	0.76 (0.58-1.00)	1.16 (0.93-1.46)	2.47 (2.09-2.93)	3.95 (3.34-4.66)	*4.93 (3.85-6.31)*
Exeter V40[St] : Charnley and Elite Plus LPW[C]	MoP	4,297	75 (71 to 80)	28	0.68 (0.48-0.98)	1.24 (0.94-1.64)	1.49 (1.15-1.93)	2.39 (1.88-3.05)	*3.91 (2.73-5.57)*	*5.24 (2.98-9.13)*
Exeter V40[St] : Elite Plus Cemented Cup[C]	MoP	4,926	74 (68 to 79)	32	0.35 (0.22-0.56)	0.63 (0.44-0.89)	0.82 (0.59-1.12)	1.42 (1.08-1.86)	2.80 (2.00-3.91)	*3.12 (2.18-4.47)*
Exeter V40[St] : Elite Plus Ogee[C]	MoP	23,869	75 (70 to 80)	34	0.38 (0.31-0.47)	0.86 (0.74-0.99)	1.20 (1.06-1.35)	2.18 (1.97-2.42)	3.31 (2.90-3.78)	*3.88 (3.24-4.65)*
Exeter V40[St] : Elite Plus Ogee[C]	CoP	2,511	67 (61 to 72)	42	0.54 (0.31-0.93)	0.86 (0.56-1.34)	1.26 (0.86-1.84)	2.16 (1.54-3.04)	*2.98 (2.06-4.29)*	*2.98 (2.06-4.29)*

*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	15 years	17 years
Exeter V40[St] : Exeter Contemporary Flanged[C]	MoP	87,622	75 (70 to 80)	34	0.57 (0.52-0.62)	1.02 (0.95-1.09)	1.39 (1.31-1.47)	2.41 (2.27-2.56)	4.17 (3.81-4.57)	*5.30 (4.34-6.48)*
Exeter V40[St] : Exeter Contemporary Flanged[C]	CoP	7,279	66 (61 to 72)	37	0.59 (0.43-0.79)	1.04 (0.83-1.32)	1.39 (1.12-1.72)	2.24 (1.81-2.78)	*3.56 (2.74-4.63)*	
Exeter V40[St] : Exeter Contemporary Hooded[C]	MoP	27,198	76 (70 to 81)	32	0.96 (0.85-1.08)	1.62 (1.48-1.78)	2.14 (1.97-2.33)	3.93 (3.64-4.24)	7.39 (6.68-8.17)	*8.57 (7.39-9.93)*
Exeter V40[St] : Exeter Duration[C]	MoP	15,907	74 (68 to 79)	32	0.61 (0.50-0.75)	1.22 (1.06-1.41)	1.68 (1.49-1.90)	3.84 (3.50-4.20)	6.75 (6.12-7.44)	*8.36 (7.06-9.89)*
Exeter V40[St] : Exeter X3 Rimfit[C]	MoP	28,050	74 (68 to 79)	33	0.50 (0.43-0.60)	0.87 (0.76-1.00)	1.26 (1.11-1.43)	*1.99 (1.52-2.59)*		
Exeter V40[St] : Exeter X3 Rimfit[C]	CoP	11,320	63 (56 to 69)	38	0.46 (0.35-0.61)	0.88 (0.71-1.08)	1.29 (1.07-1.56)	*1.71 (1.35-2.15)*		
Exeter V40[St] : Marathon[C]	MoP	6,026	75 (70 to 80)	34	0.56 (0.40-0.79)	0.95 (0.72-1.26)	1.16 (0.89-1.52)	1.85 (1.32-2.57)		
Exeter V40[St] : Marathon[C]	CoP	2,573	62 (56 to 67)	40	0.28 (0.13-0.58)	0.63 (0.37-1.07)	1.01 (0.63-1.61)	*1.30 (0.80-2.11)*		
Exeter V40[St] : Opera[C]	MoP	2,682	75 (69 to 80)	31	0.38 (0.20-0.70)	0.85 (0.56-1.29)	1.32 (0.94-1.85)	3.15 (2.44-4.05)	*7.38 (5.48-9.91)*	*8.11 (5.88-11.14)*
MS-30[St] : Original ME Muller Low Profile Cup[C]	CoP	2,609	71 (66 to 76)	32	0.19 (0.08-0.47)	0.53 (0.31-0.92)	0.68 (0.42-1.12)	1.23 (0.80-1.91)	*2.18 (1.21-3.93)*	*3.31 (1.53-7.07)*
Stanmore Modular Stem[St] : Stanmore-Arcom Cup[C]	MoP	4,966	75 (70 to 81)	30	0.41 (0.26-0.63)	1.09 (0.83-1.42)	1.56 (1.24-1.96)	2.50 (2.04-3.06)	4.16 (3.23-5.37)	*5.17 (3.65-7.29)*
Uncemented										
Accolade[St] : Trident[SL]	MoP	12,474	71 (64 to 76)	41	0.97 (0.81-1.15)	1.96 (1.73-2.22)	2.71 (2.43-3.01)	5.01 (4.56-5.51)	*7.86 (6.14-10.05)*	
Accolade[St] : Trident[SL]	CoP	7,269	61 (55 to 67)	46	0.83 (0.64-1.07)	1.57 (1.30-1.89)	1.88 (1.59-2.24)	2.56 (2.12-3.09)	*2.80 (2.20-3.55)*	
Accolade[St] : Trident[SL]	CoC	7,361	62 (55 to 68)	46	1.01 (0.80-1.26)	2.05 (1.75-2.40)	2.78 (2.43-3.18)	3.84 (3.41-4.33)	*4.93 (4.06-5.97)*	*4.93 (4.06-5.97)*
Accolade II[St] : Trident[SL]	MoP	4,633	70 (64 to 76)	43	0.93 (0.69-1.25)	1.49 (1.14-1.96)	1.78 (1.33-2.38)			
Accolade II[St] : Trident[SL]	CoP	7,740	62 (55 to 69)	48	0.85 (0.66-1.09)	1.38 (1.10-1.74)	1.76 (1.24-2.50)			
Anthology[St] : R3 Cementless[SL]	MoP	3,912	63 (55 to 70)	39	1.17 (0.87-1.56)	1.82 (1.44-2.30)	2.11 (1.68-2.65)	*2.45 (1.95-3.09)*		
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)	23.56 (22.00-25.22)	43.87 (41.97-45.82)	*48.52 (46.42-50.66)*	
Corail[St] : Duraloc Cementless Cup[SL]	MoP	3,679	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 (4.60-6.16)	10.63 (9.27-12.17)	*12.33 (10.38-14.62)*
Corail[St] : Pinnacle Gription[SL]	MoP	3,909	74 (68 to 79)	37	1.08 (0.80-1.47)	1.63 (1.26-2.12)	2.22 (1.70-2.88)	*3.16 (2.28-4.38)*		

*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	15 years	17 years
Corail[St] : Pinnacle Gription[SL]	CoP	4,406	63 (57 to 70)	43	0.64 (0.44-0.94)	1.27 (0.94-1.71)	1.71 (1.24-2.36)			
Corail[St] : Pinnacle[SL]	MoP	68,083	71 (65 to 77)	41	0.79 (0.73-0.86)	1.27 (1.19-1.36)	1.56 (1.46-1.66)	2.77 (2.59-2.96)	4.55 (4.02-5.14)	
Corail[St] : Pinnacle[SL]	MoM	11,884	67 (60 to 74)	47	0.88 (0.73-1.06)	2.45 (2.18-2.74)	5.20 (4.80-5.62)	13.33 (12.69-13.99)	17.76 (16.84-18.73)	
Corail[St] : Pinnacle[SL]	CoP	44,886	64 (57 to 69)	47	0.66 (0.59-0.74)	1.06 (0.97-1.17)	1.43 (1.30-1.56)	2.42 (2.14-2.75)	*3.51 (2.55-4.83)*	
Corail[St] : Pinnacle[SL]	CoC	43,589	59 (52 to 66)	49	0.83 (0.75-0.92)	1.78 (1.65-1.91)	2.42 (2.28-2.57)	3.77 (3.56-3.99)	5.84 (5.14-6.64)	
Furlong Evolution Cementless[St] : Furlong HAC CSF Plus[SL]	CoC	4,422	60 (50 to 69)	39	1.24 (0.95-1.62)	1.66 (1.31-2.10)	2.01 (1.61-2.53)			
Furlong HAC Stem[St] : CSF[SL]	MoP	8,079	73 (67 to 78)	39	1.37 (1.14-1.65)	2.19 (1.89-2.53)	2.54 (2.21-2.91)	4.24 (3.77-4.76)	5.67 (4.96-6.47)	*7.48 (5.68-9.81)*
Furlong HAC Stem[St] : CSF[SL]	CoP	7,374	67 (61 to 73)	41	0.79 (0.61-1.02)	1.36 (1.12-1.66)	1.77 (1.49-2.10)	2.74 (2.37-3.17)	4.30 (3.72-4.97)	4.64 (3.98-5.40)
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	MoP	5,877	74 (69 to 79)	39	1.66 (1.37-2.03)	2.32 (1.96-2.74)	2.82 (2.41-3.30)	3.98 (3.38-4.69)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoP	3,347	67 (62 to 72)	46	0.91 (0.63-1.29)	1.58 (1.20-2.07)	1.83 (1.41-2.37)	2.72 (2.09-3.55)		
Furlong HAC Stem[St] : Furlong HAC CSF Plus[SL]	CoC	15,321	63 (56 to 69)	47	0.93 (0.79-1.10)	1.57 (1.38-1.78)	1.78 (1.58-2.01)	2.23 (1.99-2.51)		
Metafix Stem[St] : Trinity[SL]	CoP	3,077	64 (57 to 70)	47	0.68 (0.44-1.05)	0.91 (0.61-1.36)	1.13 (0.77-1.67)	*1.13 (0.77-1.67)*		
Metafix Stem[St] : Trinity[SL]	CoC	2,778	60 (52 to 66)	45	0.77 (0.50-1.18)	1.14 (0.80-1.63)	1.38 (0.98-1.94)	*2.22 (1.51-3.27)*		
Polarstem Cementless[St] : R3 Cementless[SL]	MoP	17,313	66 (59 to 73)	46	0.78 (0.66-0.92)	1.04 (0.89-1.22)	1.26 (1.07-1.49)	*2.11 (1.56-2.85)*		
Synergy Cementless Stem[St] : R3 Cementless[SL]	MoP	3,099	66 (58 to 72)	51	0.91 (0.63-1.31)	1.20 (0.86-1.66)	1.45 (1.07-1.96)	*1.90 (1.40-2.55)*		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	MoP	8,493	72 (66 to 77)	40	1.29 (1.07-1.56)	1.80 (1.53-2.11)	2.04 (1.75-2.38)	2.73 (2.33-3.21)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoP	5,726	65 (58 to 70)	45	0.81 (0.61-1.08)	1.02 (0.79-1.33)	1.16 (0.90-1.49)	1.77 (1.33-2.34)		
Taperloc Cementless Stem[St] : Exceed ABT[SL]	CoC	12,325	61 (54 to 67)	47	1.09 (0.92-1.29)	1.52 (1.32-1.76)	1.84 (1.61-2.10)	2.30 (2.01-2.63)		

*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	15 years	17 years
Hybrid										
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	MoP	9,735	75 (71 to 80)	34	0.70 (0.55-0.89)	1.27 (1.04-1.54)	1.71 (1.42-2.06)	2.73 (2.04-3.64)		
C-Stem AMT Cemented Stem[St] : Pinnacle[SL]	CoP	7,022	67 (61 to 72)	42	0.65 (0.49-0.88)	0.97 (0.75-1.25)	1.06 (0.82-1.39)	*1.44 (0.93-2.21)*		
CPCS[St] : R3 Cementless[SL]	MoP	4,447	74 (69 to 80)	31	0.79 (0.56-1.10)	1.40 (1.05-1.87)	1.58 (1.17-2.13)			
CPT CoCr Stem[St] : Continuum[SL]	MoP	5,721	75 (70 to 80)	34	1.61 (1.31-1.97)	2.22 (1.84-2.66)	2.67 (2.20-3.22)	*4.66 (3.05-7.07)*		
CPT CoCr Stem[St] : Continuum[SL]	CoP	3,947	65 (59 to 71)	39	1.38 (1.06-1.81)	2.12 (1.68-2.68)	2.35 (1.85-2.98)			
CPT CoCr Stem[St] : Trilogy IT[SL]	MoP	5,530	74 (69 to 79)	34	1.49 (1.20-1.85)	2.12 (1.75-2.56)	2.70 (2.23-3.26)			
CPT CoCr Stem[St] : Trilogy IT[SL]	CoP	4,617	65 (59 to 71)	40	1.03 (0.77-1.37)	1.61 (1.26-2.05)	2.10 (1.63-2.69)			
CPT CoCr Stem[St] : Trilogy[SL]	MoP	14,615	73 (67 to 79)	35	0.88 (0.74-1.04)	1.47 (1.28-1.69)	2.29 (2.04-2.56)	4.13 (3.71-4.60)	5.51 (4.86-6.26)	*5.51 (4.86-6.26)*
CPT CoCr Stem[St] : Trilogy[SL]	CoP	9,272	69 (62 to 75)	37	0.95 (0.77-1.17)	1.43 (1.20-1.71)	2.00 (1.69-2.37)	*2.57 (2.14-3.09)*		
Exeter V40[St] : Pinnacle[SL]	MoP	6,265	75 (70 to 80)	31	0.83 (0.63-1.09)	1.21 (0.96-1.53)	1.50 (1.21-1.86)	2.48 (1.95-3.14)	*3.33 (2.44-4.53)*	
Exeter V40[St] : Pinnacle[SL]	CoP	3,006	65 (59 to 71)	53	0.62 (0.39-0.98)	0.88 (0.59-1.31)	1.05 (0.71-1.54)	*2.82 (1.66-4.77)*		
Exeter V40[St] : Trident[SL]	MoP	56,398	74 (68 to 79)	37	0.66 (0.59-0.73)	1.13 (1.04-1.23)	1.45 (1.34-1.56)	2.52 (2.31-2.76)	3.68 (3.22-4.20)	
Exeter V40[St] : Trident[SL]	CoP	38,664	65 (58 to 71)	42	0.58 (0.50-0.66)	0.93 (0.83-1.04)	1.19 (1.06-1.33)	1.85 (1.58-2.18)	*2.68 (1.58-4.50)*	
Exeter V40[St] : Trident[SL]	CoC	13,021	59 (53 to 65)	44	0.54 (0.43-0.68)	1.06 (0.90-1.25)	1.56 (1.36-1.79)	2.69 (2.40-3.01)	3.83 (3.38-4.34)	*4.08 (3.45-4.84)*
Exeter V40[St] : Trident[SL]*	MoPoM	1,442	75 (67 to 81)	33	1.14 (0.69-1.89)	1.88 (1.18-2.99)	*2.11 (1.32-3.35)*			
Exeter V40[St] : Trilogy[SL]	MoP	11,878	71 (65 to 77)	40	0.56 (0.44-0.71)	0.88 (0.72-1.07)	1.27 (1.07-1.49)	2.23 (1.94-2.56)	3.46 (2.95-4.05)	*3.84 (3.15-4.68)*
Exeter V40[St] : Trilogy[SL]	CoP	2,758	63 (58 to 69)	43	0.55 (0.33-0.90)	0.93 (0.63-1.37)	1.14 (0.80-1.63)	2.00 (1.49-2.67)	*3.07 (2.22-4.25)*	*4.92 (2.77-8.69)*
Exeter V40[St] : Tritanium[SL]	CoP	3,536	64 (57 to 70)	47	1.08 (0.79-1.49)	1.66 (1.26-2.19)	2.15 (1.64-2.83)	*3.54 (2.32-5.37)*		
Taperfit Cemented Stem[St] : Trinity[SL]	MoP	3,386	75 (70 to 80)	33	1.00 (0.71-1.40)	1.57 (1.18-2.09)	1.74 (1.31-2.33)			
Taperfit Cemented Stem[St] : Trinity[SL]	CoP	2,584	68 (62 to 74)	36	0.91 (0.61-1.37)	1.38 (0.96-1.97)	1.68 (1.18-2.40)			
Reverse hybrid										
Corail[St] : Marathon[C]	MoP	11,242	73 (68 to 78)	38	0.64 (0.51-0.81)	1.07 (0.88-1.29)	1.31 (1.10-1.57)	2.12 (1.67-2.70)		
Corail[St] : Marathon[C]	CoP	4,827	62 (56 to 68)	41	0.59 (0.41-0.86)	1.10 (0.83-1.46)	1.35 (1.04-1.75)	2.14 (1.49-3.07)		

*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, 37,444 (3.0%) of the 1,251,164 primary hip replacements had an associated first revision. The most common indications for revision were aseptic loosening (9,190), dislocation / subluxation (6,503), adverse soft tissue reaction to particulate debris (5,698, a figure that is likely to be an underestimate due to changes in MDS collection, see later), periprosthetic fracture (5,696), infection (5,660) and pain (4,916). Pain was not usually cited alone; in 3,342 out of the 4,916 instances (68.0%), it was cited together with one or more other indications. Associated PTIRs for these and the other indications are shown in Table 3.H9. Here, implant wear denotes 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 requested (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 a small number of revisions associated with a few primaries as late as 2011 still 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 2,648 of the 5,698 instances (46.5%) of adverse reactions to particulate debris would thus be included, i.e. 3,050 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 but ceramic-on-metal has similar rates. Metal-on-metal bearings have the highest incidence of adverse reaction to particulate debris. Although the numbers are relatively small in comparison to other groups, dual mobility bearings appear to have high PTIRs for revision for periprosthetic fracture and infection.

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: All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	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*	8,159.6	4.59 (4.54-4.64)	1.13 (1.10-1.15)	0.60 (0.59-0.62)	0.80 (0.78-0.82)	0.69 (0.68-0.71)	0.70 (0.68-0.72)	0.31 (0.30-0.32)	0.27 (0.26-0.28)	0.25 (0.24-0.27)	0.14 (0.14-0.15)	0.03 (0.03-0.03)	0.70 (0.68-0.72)	5,913.6	0.45 (0.43-0.47)
All cemented	2,660.6	3.22 (3.15-3.29)	1.05 (1.01-1.09)	0.25 (0.23-0.27)	0.80 (0.77-0.84)	0.66 (0.63-0.70)	0.53 (0.50-0.56)	0.18 (0.16-0.20)	0.21 (0.19-0.23)	0.18 (0.17-0.20)	0.08 (0.07-0.09)	0.01 (0.01-0.02)	0.03 (0.03-0.04)	1,730.7	0.03 (0.02-0.03)
Cemented and															
MoP	2,348.8	3.27 (3.19-3.34)	1.08 (1.04-1.13)	0.25 (0.23-0.27)	0.82 (0.79-0.86)	0.65 (0.62-0.69)	0.54 (0.51-0.57)	0.18 (0.17-0.20)	0.22 (0.20-0.24)	0.19 (0.17-0.21)	0.07 (0.06-0.08)	0.01 (0.01-0.02)	0.03 (0.02-0.04)	1,488.7	0.02 (0.02-0.03)
MoM	4.2	6.49 (4.45-9.46)	2.16 (1.12-4.16)	0.24 (0.03-1.71)	1.20 (0.50-2.89)	0.72 (0.23-2.23)	0.96 (0.36-2.56)	0	0.96 (0.36-2.56)	0.48 (0.12-1.92)	0.96 (0.36-2.56)	0	0.72 (0.23-2.23)	0.9	0
CoP	299.0	2.70 (2.52-2.89)	0.78 (0.69-0.89)	0.20 (0.16-0.26)	0.62 (0.54-0.72)	0.70 (0.61-0.80)	0.38 (0.32-0.46)	0.15 (0.11-0.20)	0.14 (0.10-0.19)	0.11 (0.08-0.16)	0.10 (0.07-0.15)	0	0.04 (0.02-0.07)	232.5	0.04 (0.02-0.07)
MoPoM	7.9	6.45 (4.90-8.49)	0.76 (0.34-1.69)	0.13 (0.02-0.90)	1.01 (0.51-2.02)	2.15 (1.34-3.46)	2.15 (1.34-3.46)	0.13 (0.02-0.90)	0.13 (0.02-0.90)	0	0	0	0	7.9	0
All uncemented	3,047.5	5.37 (5.29-5.45)	1.31 (1.27-1.35)	0.73 (0.70-0.76)	0.80 (0.77-0.83)	0.69 (0.66-0.72)	0.68 (0.66-0.71)	0.42 (0.39-0.44)	0.28 (0.26-0.30)	0.34 (0.32-0.36)	0.19 (0.17-0.20)	0.05 (0.04-0.06)	1.13 (1.09-1.17)	2,443.9	0.73 (0.70-0.77)
Uncemented and															
MoP	1,125.8	4.20 (4.08-4.32)	1.03 (0.98-1.10)	0.40 (0.36-0.44)	0.97 (0.92-1.03)	0.65 (0.60-0.70)	0.87 (0.82-0.93)	0.38 (0.35-0.42)	0.22 (0.19-0.25)	0.42 (0.39-0.46)	0.09 (0.08-0.11)	0.04 (0.03-0.06)	0.19 (0.17-0.22)	920.9	0.19 (0.17-0.22)
MoM	300.5	18.06 (17.59-18.55)	3.46 (3.26-3.68)	3.40 (3.20-3.62)	0.80 (0.71-0.91)	1.41 (1.28-1.55)	0.84 (0.74-0.95)	0.73 (0.64-0.83)	1.36 (1.23-1.50)	0.61 (0.52-0.70)	0.17 (0.13-0.22)	0.08 (0.06-0.12)	9.98 (9.63-10.34)	150.3	9.53 (9.05-10.03)
CoP	604.5	3.53 (3.38-3.68)	0.87 (0.80-0.95)	0.32 (0.27-0.36)	0.91 (0.84-0.99)	0.62 (0.56-0.69)	0.52 (0.47-0.58)	0.35 (0.30-0.40)	0.12 (0.10-0.15)	0.27 (0.24-0.32)	0.09 (0.07-0.12)	0.03 (0.02-0.05)	0.06 (0.05-0.09)	493.1	0.06 (0.04-0.08)
CoC	991.8	3.89 (3.77-4.01)	1.19 (1.12-1.26)	0.54 (0.49-0.58)	0.53 (0.49-0.58)	0.54 (0.49-0.58)	0.52 (0.48-0.57)	0.39 (0.36-0.43)	0.11 (0.09-0.13)	0.20 (0.18-0.23)	0.36 (0.33-0.40)	0.05 (0.03-0.06)	0.13 (0.11-0.16)	855.5	0.13 (0.11-0.15)
CoM	20.8	8.58 (7.40-9.93)	3.08 (2.41-3.94)	1.30 (0.89-1.90)	0.53 (0.29-0.96)	1.06 (0.70-1.61)	0.58 (0.33-1.02)	0.67 (0.40-1.14)	0.63 (0.36-1.08)	0.53 (0.29-0.96)	0.14 (0.05-0.45)	0.19 (0.07-0.51)	2.12 (1.58-2.85)	20.1	2.04 (1.50-2.77)
MoPoM	2.4	9.06 (5.97-13.76)	2.06 (0.86-4.95)	0.82 (0.21-3.29)	1.65 (0.62-4.39)	1.65 (0.62-4.39)	2.47 (1.11-5.50)	0.82 (0.21-3.29)	0	0.41 (0.06-2.92)	0	0	0.82 (0.21-3.29)	2.4	0.84 (0.21-3.35)

*Including 36,765 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: All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	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 hybrid	1,528.5	3.69 (3.60-3.79)	0.51 (0.47-0.54)	0.28 (0.26-0.31)	0.93 (0.88-0.98)	0.79 (0.75-0.84)	0.89 (0.85-0.94)	0.24 (0.21-0.26)	0.16 (0.14-0.19)	0.20 (0.18-0.22)	0.14 (0.12-0.16)	0.02 (0.01-0.03)	0.20 (0.18-0.22)	1,202.1	0.12 (0.10-0.14)
Hybrid and															
MoP	910.2	3.60 (3.48-3.73)	0.53 (0.48-0.58)	0.23 (0.20-0.26)	1.02 (0.95-1.09)	0.77 (0.71-0.83)	0.97 (0.91-1.04)	0.24 (0.21-0.28)	0.17 (0.14-0.20)	0.23 (0.20-0.26)	0.09 (0.07-0.11)	0.02 (0.01-0.03)	0.07 (0.05-0.09)	700.2	0.06 (0.05-0.08)
MoM	26.5	15.97 (14.52-17.57)	2.98 (2.39-3.72)	2.83 (2.26-3.55)	1.25 (0.89-1.75)	1.17 (0.82-1.66)	1.81 (1.37-2.40)	0.49 (0.28-0.85)	1.62 (1.20-2.19)	0.34 (0.18-0.65)	0.34 (0.18-0.65)	0.08 (0.02-0.30)	7.48 (6.50-8.59)	10.0	6.38 (4.99-8.15)
CoP	355.3	3.46 (3.27-3.65)	0.26 (0.21-0.32)	0.15 (0.11-0.20)	0.98 (0.89-1.09)	0.98 (0.89-1.09)	0.82 (0.73-0.92)	0.18 (0.14-0.23)	0.08 (0.05-0.11)	0.15 (0.11-0.20)	0.10 (0.07-0.14)	0.02 (0.01-0.04)	0.04 (0.02-0.06)	324.8	0.03 (0.02-0.06)
CoC	225.4	2.89 (2.68-3.12)	0.51 (0.43-0.62)	0.42 (0.34-0.52)	0.41 (0.34-0.51)	0.49 (0.40-0.59)	0.52 (0.44-0.63)	0.29 (0.23-0.37)	0.11 (0.07-0.16)	0.15 (0.10-0.21)	0.38 (0.31-0.47)	0.02 (0.01-0.05)	0.13 (0.09-0.19)	156.2	0.13 (0.09-0.21)
MoPoM	8.4	6.21 (4.73-8.15)	0.72 (0.32-1.60)	0	1.08 (0.56-2.07)	2.03 (1.26-3.27)	1.79 (1.08-2.97)	0.12 (0.02-0.85)	0.12 (0.02-0.85)	0.36 (0.12-1.11)	0.12 (0.02-0.85)	0	0.12 (0.02-0.85)	8.4	0.12 (0.02-0.85)
CoPoM	1.8	5.11 (2.66-9.83)	0.57 (0.08-4.03)	0	1.14 (0.28-4.54)	1.14 (0.28-4.54)	2.84 (1.18-6.82)	0	0	0	0	0.57 (0.08-4.03)	0	1.8	0
All reverse hybrid	193.4	3.90 (3.63-4.19)	1.27 (1.12-1.44)	0.31 (0.24-0.40)	0.84 (0.72-0.98)	0.73 (0.62-0.87)	0.65 (0.54-0.77)	0.28 (0.22-0.37)	0.20 (0.14-0.27)	0.23 (0.17-0.31)	0.05 (0.03-0.10)	0.02 (0.01-0.06)	0.10 (0.07-0.16)	169.1	0.07 (0.04-0.12)
Reverse hybrid and															
MoP	128.8	3.89 (3.56-4.25)	1.20 (1.03-1.41)	0.21 (0.14-0.31)	0.89 (0.74-1.07)	0.74 (0.60-0.90)	0.72 (0.59-0.89)	0.25 (0.18-0.35)	0.21 (0.14-0.31)	0.22 (0.15-0.31)	0.05 (0.02-0.10)	0	0.08 (0.04-0.14)	112.9	0.06 (0.03-0.13)
CoP	63.6	3.69 (3.25-4.20)	1.37 (1.11-1.69)	0.49 (0.34-0.69)	0.71 (0.53-0.95)	0.72 (0.54-0.97)	0.49 (0.34-0.69)	0.31 (0.20-0.49)	0.16 (0.08-0.29)	0.27 (0.17-0.43)	0.05 (0.02-0.15)	0.03 (0.01-0.13)	0.03 (0.01-0.13)	55.6	0
All resurfacing	435.5	10.38 (10.08-10.68)	2.19 (2.06-2.34)	3.06 (2.90-3.23)	0.25 (0.20-0.30)	0.46 (0.40-0.53)	1.10 (1.01-1.20)	0.57 (0.51-0.65)	0.90 (0.81-0.99)	0.25 (0.20-0.30)	0.23 (0.19-0.28)	0.06 (0.04-0.08)	3.73 (3.55-3.91)	182.1	3.04 (2.80-3.31)
Resurfacing and															
MoM	435.0	10.38 (10.08-10.69)	2.19 (2.06-2.34)	3.07 (2.91-3.24)	0.25 (0.20-0.30)	0.46 (0.40-0.53)	1.10 (1.00-1.20)	0.57 (0.51-0.65)	0.90 (0.81-0.99)	0.24 (0.20-0.29)	0.23 (0.19-0.28)	0.06 (0.04-0.09)	3.73 (3.55-3.92)	181.7	3.05 (2.81-3.31)

*Including 36,765 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: All causes	Aseptic loosening	Pain	Dislocation/ Subluxation	Infection	Peripros-thetic fracture	Malalign-ment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	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	8,159.6	4.59 (4.54-4.64)	1.13 (1.10-1.15)	0.60 (0.59-0.62)	0.80 (0.78-0.82)	0.69 (0.68-0.71)	0.70 (0.68-0.72)	0.31 (0.30-0.32)	0.27 (0.26-0.28)	0.25 (0.24-0.27)	0.14 (0.14-0.15)	0.03 (0.03-0.03)	0.70 (0.68-0.72)	5,913.6	0.45 (0.43-0.47)
<1 year	1,207.3	8.24 (8.08-8.41)	0.99 (0.93-1.05)	0.50 (0.46-0.54)	2.47 (2.38-2.56)	1.97 (1.89-2.05)	1.70 (1.63-1.77)	0.70 (0.66-0.75)	0.07 (0.05-0.08)	0.30 (0.27-0.34)	0.20 (0.18-0.23)	0.10 (0.08-0.12)	0.09 (0.07-0.11)	1,017.3	0.10 (0.09-0.12)
1 to 3 years	2,105.8	3.45 (3.37-3.53)	0.93 (0.89-0.97)	0.66 (0.62-0.69)	0.60 (0.56-0.63)	0.68 (0.65-0.72)	0.38 (0.35-0.41)	0.31 (0.28-0.33)	0.13 (0.11-0.14)	0.12 (0.10-0.13)	0.11 (0.10-0.13)	0.03 (0.02-0.04)	0.20 (0.18-0.22)	1,737.1	0.23 (0.21-0.26)
3 to 5 years	1,651.7	3.40 (3.31-3.49)	0.89 (0.84-0.93)	0.71 (0.67-0.75)	0.44 (0.41-0.47)	0.42 (0.39-0.45)	0.44 (0.41-0.47)	0.22 (0.20-0.25)	0.19 (0.17-0.22)	0.17 (0.15-0.19)	0.10 (0.09-0.12)	0.02 (0.01-0.02)	0.65 (0.61-0.69)	1,301.7	0.51 (0.47-0.55)
5 to 7 years	1,231.7	4.01 (3.90-4.12)	1.06 (1.01-1.12)	0.72 (0.68-0.77)	0.42 (0.38-0.46)	0.35 (0.32-0.38)	0.55 (0.51-0.59)	0.22 (0.20-0.25)	0.29 (0.26-0.32)	0.22 (0.20-0.25)	0.13 (0.12-0.16)	0.02 (0.01-0.03)	1.16 (1.10-1.22)	904.9	0.69 (0.64-0.74)
7 to 10 years	1,187.1	4.58 (4.46-4.70)	1.39 (1.32-1.46)	0.53 (0.49-0.58)	0.50 (0.46-0.54)	0.35 (0.32-0.39)	0.64 (0.59-0.68)	0.21 (0.19-0.24)	0.48 (0.44-0.52)	0.31 (0.28-0.35)	0.16 (0.14-0.18)	0.01 (0.01-0.02)	1.35 (1.29-1.42)	747.3	0.84 (0.78-0.91)
10 to 13 years	579.2	5.49 (5.30-5.68)	2.00 (1.88-2.11)	0.31 (0.27-0.36)	0.55 (0.50-0.62)	0.40 (0.35-0.45)	0.90 (0.82-0.98)	0.18 (0.15-0.22)	0.73 (0.66-0.80)	0.59 (0.53-0.66)	0.20 (0.17-0.24)	0.01 (0.01-0.03)	1.46 (1.36-1.56)	205.3	1.09 (0.95-1.24)
13 to 15 years	150.4	5.57 (5.21-5.96)	2.28 (2.05-2.54)	0.29 (0.22-0.39)	0.60 (0.49-0.74)	0.39 (0.30-0.50)	0.85 (0.72-1.01)	0.17 (0.12-0.25)	0.94 (0.80-1.11)	0.92 (0.78-1.09)	0.25 (0.18-0.35)	0	1.30 (1.13-1.50)		
15 to 17 years	44.1	5.13 (4.50-5.84)	2.56 (2.13-3.08)	0.20 (0.11-0.39)	0.52 (0.35-0.78)	0.27 (0.15-0.48)	0.98 (0.72-1.31)	0.23 (0.12-0.42)	1.02 (0.76-1.37)	1.02 (0.76-1.37)	0.23 (0.12-0.42)	0	0.61 (0.42-0.89)		
≥17 years*	2.2	4.98 (2.76-8.99)	2.72 (1.22-6.04)	0	1.36 (0.44-4.21)	0	1.36 (0.44-4.21)	0	0.45 (0.06-3.21)	1.36 (0.44-4.21)	0	0	0		

*Current maximum observed follow-up is 17.75 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 (page 103), 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, 15 to 17, and ≥17 years after surgery (the maximum follow-up for any implant is now 17.75 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 at around seven years. Adverse reaction to particulate debris increased with time, as did lysis.

Figures 3.H11 (a) to 3.H11 (g) (pages 105 to 108) 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 bearings. In uncemented metal-on-metal, they rose and then fell. 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 and resurfacing (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**.

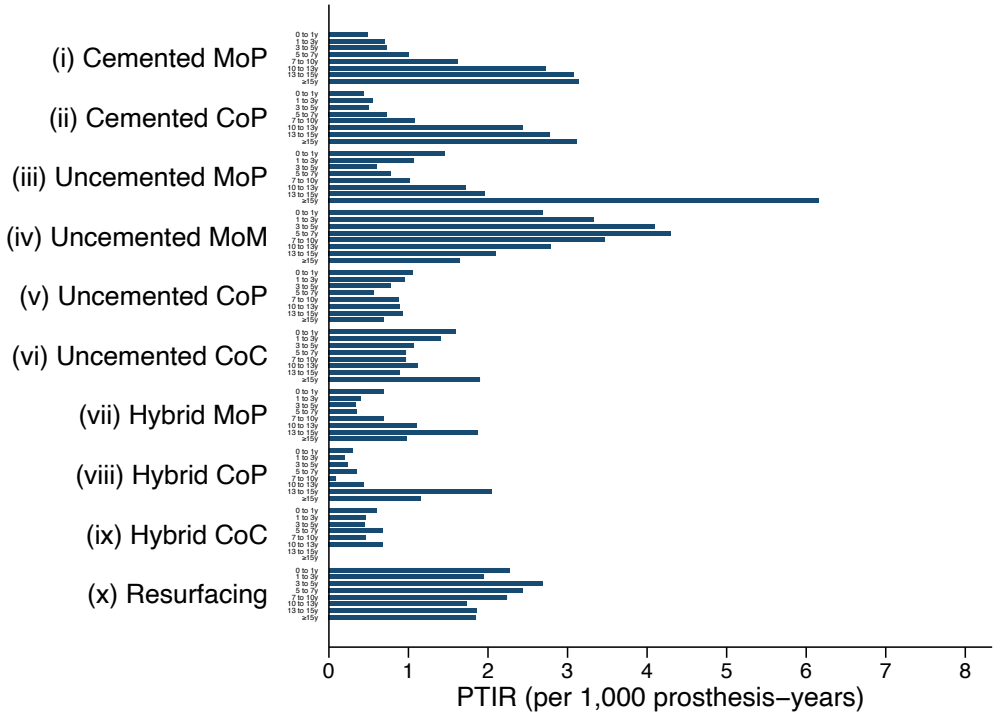


Figure 3.H11 (b) PTIR estimates of **pain** by **fixation** and **bearing**.

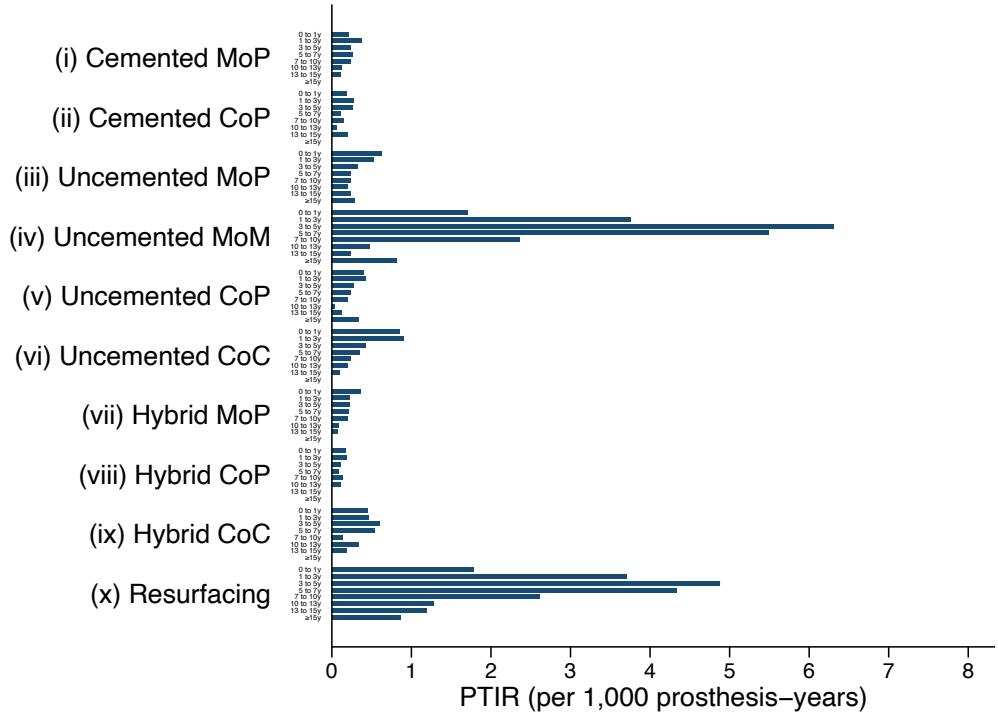


Figure 3.H11 (c) PTIR estimates of dislocation / subluxation by fixation and bearing.

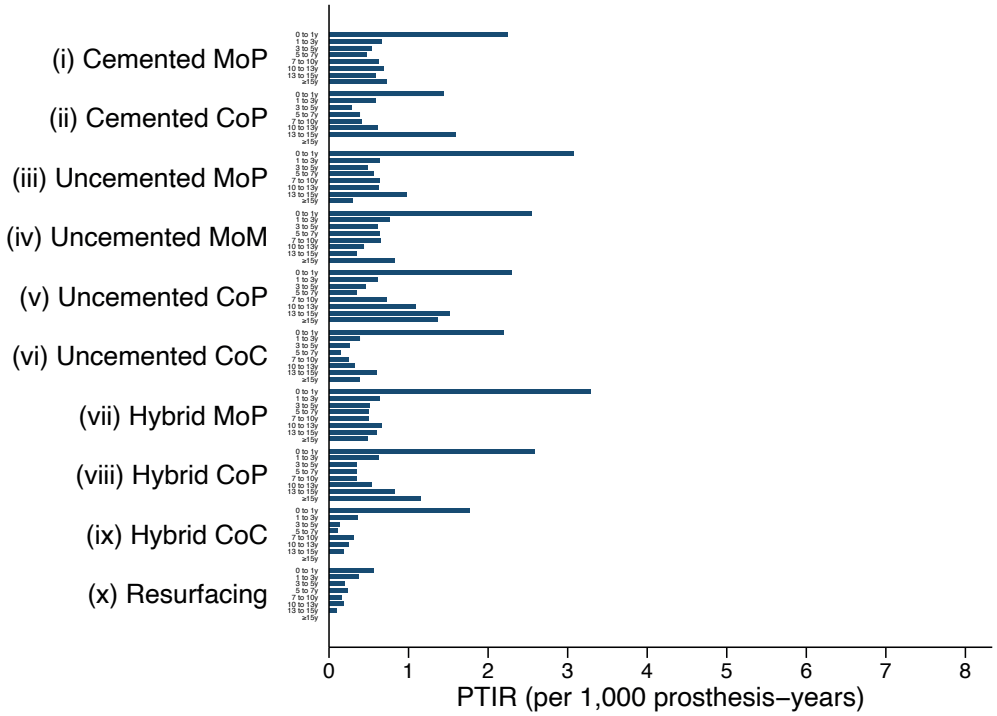


Figure 3.H11 (d) PTIR estimates of infection by fixation and bearing.

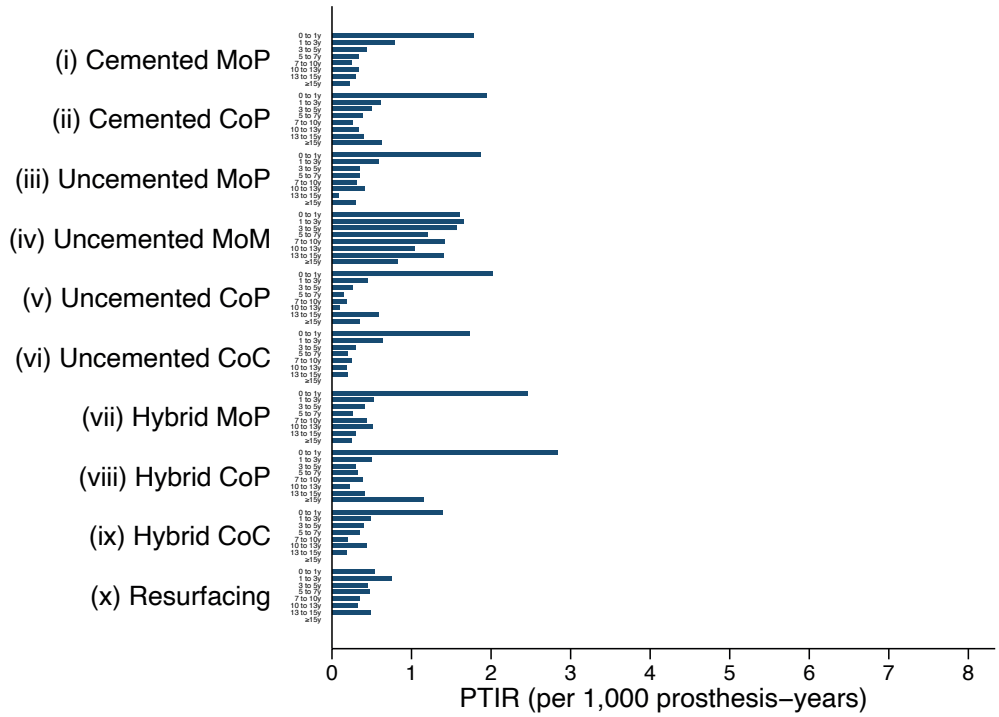


Figure 3.H11 (e) PTIR estimates of lysis by fixation and bearing.

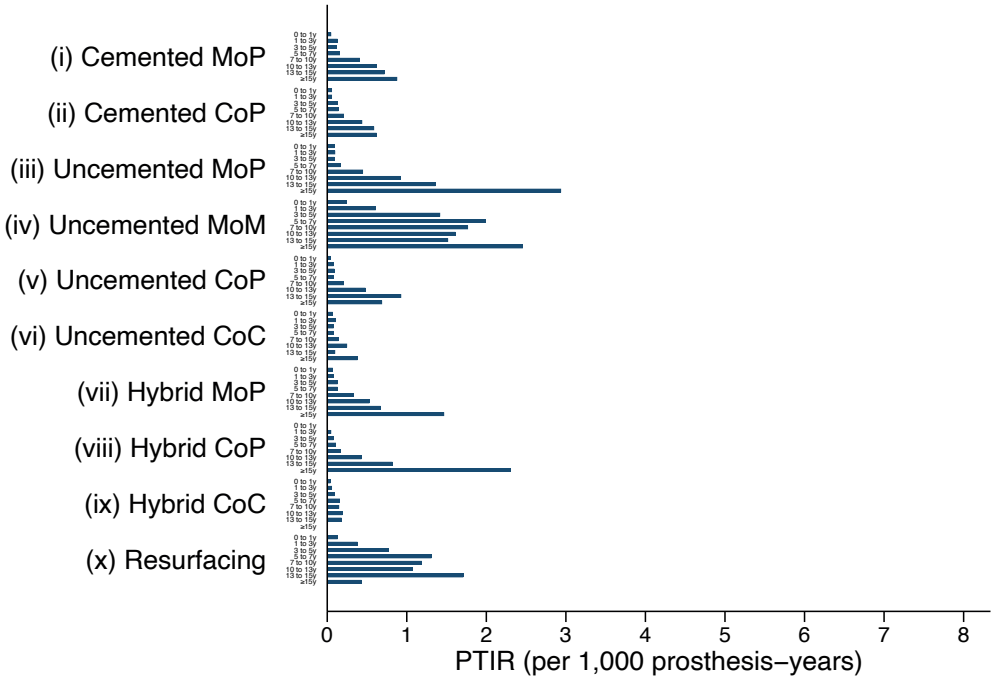


Figure 3.H11 (f) PTIR estimates of adverse soft tissue reaction by fixation and bearing.

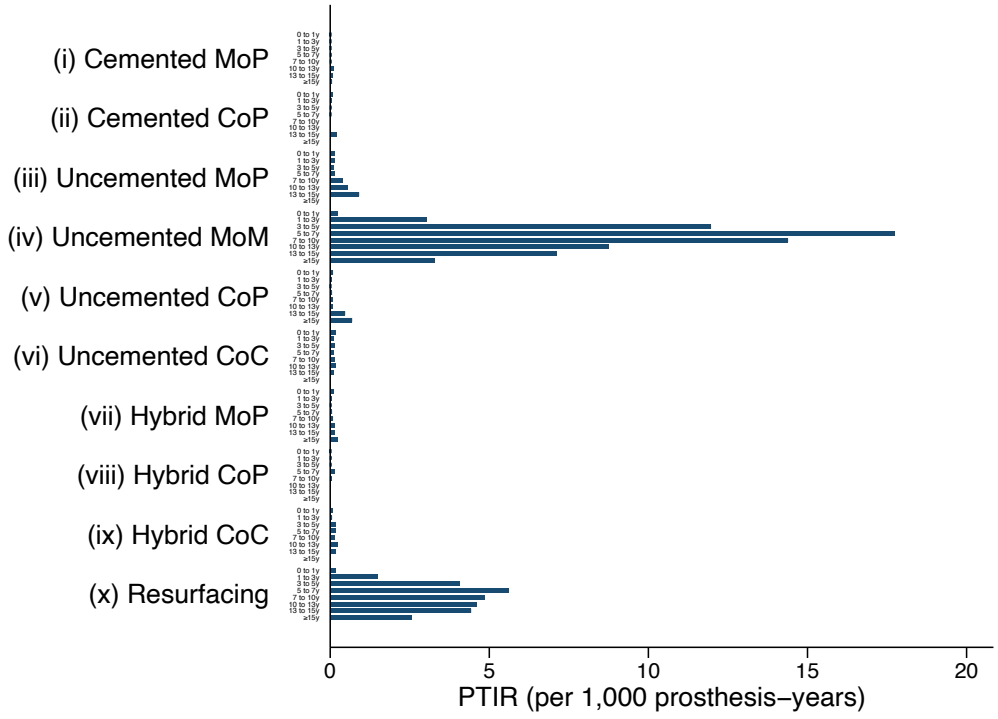
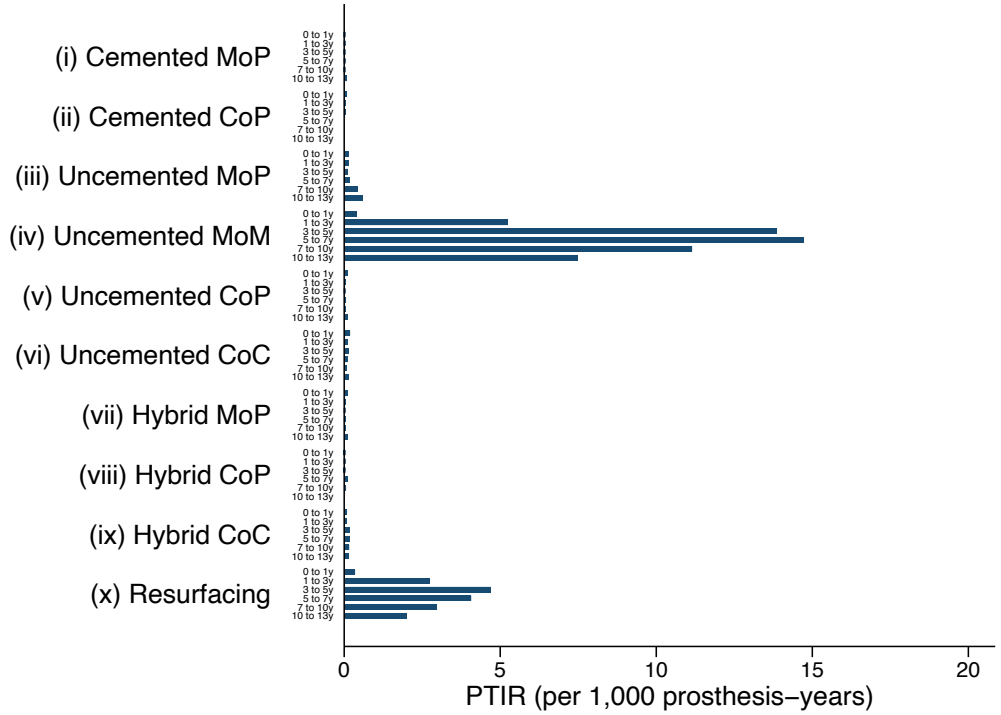


Figure 3.H11 (g) PTIR estimates of **adverse soft tissue reaction** by **fixation** and **bearing**, since 2008.



3.2.6 Mortality after primary hip replacement surgery

In this section we describe the mortality of the cohort up to 15 years from primary hip replacement, according to gender and age group. Deaths recorded after 31 December 2020 were not included in the analysis. For simplicity, we have 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. While 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). Among the 1,251,164 primary hip replacements, there were 5,449 bilateral operations, with the left and right side operated on the same day; here the second of the two has been excluded, leaving 1,245,715 primary hip replacements, of whom 235,188 had died before the end of 2020.

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	N	Time since primary					
		30 days	90 days	1 year	5 years	10 years	15 years
All cases	1,245,715*	0.21 (0.21-0.22)	0.46 (0.45-0.48)	1.46 (1.44-1.48)	9.57 (9.52-9.63)	25.46 (25.36-25.57)	43.96 (43.77-44.16)
Males							
<55 years	73,838	0.07 (0.06-0.10)	0.16 (0.14-0.19)	0.53 (0.48-0.58)	2.32 (2.20-2.44)	5.28 (5.07-5.49)	9.73 (9.30-10.17)
55 to 59 years	51,033	0.06 (0.04-0.08)	0.20 (0.16-0.24)	0.62 (0.55-0.69)	3.37 (3.20-3.55)	8.83 (8.50-9.17)	17.01 (16.35-17.70)
60 to 64 years	71,285	0.11 (0.09-0.14)	0.24 (0.21-0.28)	0.83 (0.76-0.90)	4.73 (4.57-4.91)	12.21 (11.90-12.54)	24.85 (24.16-25.54)
65 to 69 years	84,761	0.16 (0.13-0.19)	0.35 (0.32-0.40)	1.10 (1.03-1.18)	6.85 (6.66-7.04)	18.90 (18.54-19.27)	38.74 (37.99-39.49)
70 to 74 years	87,367	0.20 (0.18-0.24)	0.44 (0.40-0.49)	1.60 (1.52-1.68)	10.50 (10.27-10.73)	29.49 (29.06-29.92)	56.49 (55.71-57.26)
75 to 79 years	70,989	0.38 (0.34-0.43)	0.75 (0.69-0.82)	2.49 (2.38-2.61)	16.68 (16.37-16.99)	46.45 (45.91-46.99)	77.97 (77.13-78.80)
80 to 84 years	42,049	0.73 (0.65-0.82)	1.41 (1.30-1.53)	4.05 (3.86-4.25)	26.82 (26.34-27.32)	66.99 (66.28-67.70)	*92.14 (91.36-92.87)*
≥85 years	18,174	1.61 (1.44-1.80)	2.93 (2.70-3.19)	7.63 (7.25-8.03)	43.37 (42.53-44.22)	86.32 (85.48-87.12)	*98.29 (97.67-98.77)*
Females							
<55 years	74,702	0.06 (0.05-0.08)	0.20 (0.17-0.24)	0.64 (0.59-0.70)	2.50 (2.38-2.63)	5.14 (4.94-5.36)	8.54 (8.14-8.95)
55 to 59 years	59,053	0.06 (0.05-0.09)	0.18 (0.15-0.22)	0.58 (0.53-0.65)	2.99 (2.84-3.15)	7.15 (6.88-7.43)	13.11 (12.58-13.67)
60 to 64 years	89,645	0.07 (0.05-0.09)	0.18 (0.15-0.21)	0.61 (0.56-0.66)	3.68 (3.55-3.82)	9.33 (9.08-9.59)	18.85 (18.30-19.42)
65 to 69 years	123,960	0.08 (0.07-0.10)	0.21 (0.19-0.24)	0.74 (0.69-0.79)	4.83 (4.70-4.97)	13.74 (13.48-14.02)	29.16 (28.58-29.74)
70 to 74 years	142,679	0.11 (0.10-0.13)	0.27 (0.24-0.29)	0.94 (0.89-0.99)	7.04 (6.89-7.19)	21.68 (21.37-21.99)	45.25 (44.63-45.88)
75 to 79 years	126,850	0.21 (0.19-0.24)	0.44 (0.40-0.47)	1.47 (1.40-1.53)	11.41 (11.21-11.61)	34.58 (34.20-34.96)	66.53 (65.86-67.19)
80 to 84 years	85,360	0.34 (0.30-0.38)	0.76 (0.71-0.82)	2.44 (2.34-2.55)	18.47 (18.18-18.77)	53.87 (53.38-54.37)	85.47 (84.84-86.09)
≥85 years	43,970	0.80 (0.72-0.89)	1.74 (1.62-1.87)	4.76 (4.56-4.96)	32.28 (31.78-32.78)	75.25 (74.64-75.86)	*95.76 (95.19-96.27)*

*Some patients had operations on the left and right side on the same day. The second of 5,449 pairs of simultaneous bilateral operations were excluded.

Table 3.H11 (page 109) 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 almost four 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 over twice the risk of death in the older group. It is worthy of note that for all cases in the registry, 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

Total hip replacement is an increasingly utilised treatment option for fractured neck of femur and in this section we 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 45,144 (3.6%) 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 a fractured neck of femur has continued to increase with time to a maximum of 7% in 2020, 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 2020. The most striking feature is the marked drop in 2020 in the total annual number of THRs performed for a fractured NOF (3,847 compared to 5,383 in 2019). This is certainly due to the impact of the COVID-19 pandemic, but how much is due to fewer fractures occurring during lockdown and how much is due to less provision of care because of the impact on services by the pandemic is not discernible from these figures.

†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. 201,204 implants entered using MDSv1 and v2) and 42,917 cases with indications including acute trauma neck of femur in the later phase (i.e. 1,049,960 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	14,472	139 (1.0)	0 (0.0)	139 (100.0)
2004	28,106	292 (1.0)	0 (0.0)	292 (100.0)
2005	40,662	390 (1.0)	0 (0.0)	390 (100.0)
2006	48,511	528 (1.1)	0 (0.0)	528 (100.0)
2007	60,895	780 (1.3)	0 (0.0)	780 (100.0)
2008	67,434	867 (1.3)	<4 (0.1)	866 (99.9)
2009	68,599	1,083 (1.6)	11 (1.0)	1,072 (99.0)
2010	71,119	1,370 (1.9)	8 (0.6)	1,362 (99.4)
2011	74,076	1,721 (2.3)	19 (1.1)	1,702 (98.9)
2012	78,282	2,439 (3.1)	21 (0.9)	2,418 (99.1)
2013	80,438	3,122 (3.9)	71 (2.3)	3,051 (97.7)
2014	87,682	3,725 (4.2)	144 (3.9)	3,581 (96.1)
2015	89,840	4,206 (4.7)	187 (4.4)	4,019 (95.6)
2016	94,346	4,872 (5.2)	292 (6.0)	4,580 (94.0)
2017	96,424	5,011 (5.2)	308 (6.1)	4,703 (93.9)
2018	96,771	5,369 (5.5)	328 (6.1)	5,041 (93.9)
2019	98,649	5,383 (5.5)	426 (7.9)	4,957 (92.1)
2020	54,858	3,847 (7.0)	324 (8.4)	3,523 (91.6)
Total	1,251,164	45,144 (3.6)	2,140 (4.7)	43,004 (95.3)

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

	Reason for primary hip replacement		Comparison
	Fractured neck of femur (n=45,144)	Osteoarthritis only (n=1,102,840)	
% Females	72.4%	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	42.6	32.3	Overall P<0.001 (Chi-squared test)
All uncemented	19.6	39.0	
All hybrid	35.5	22.6	
All reverse hybrid	2.2	2.7	
All resurfacing	<0.1	3.4	

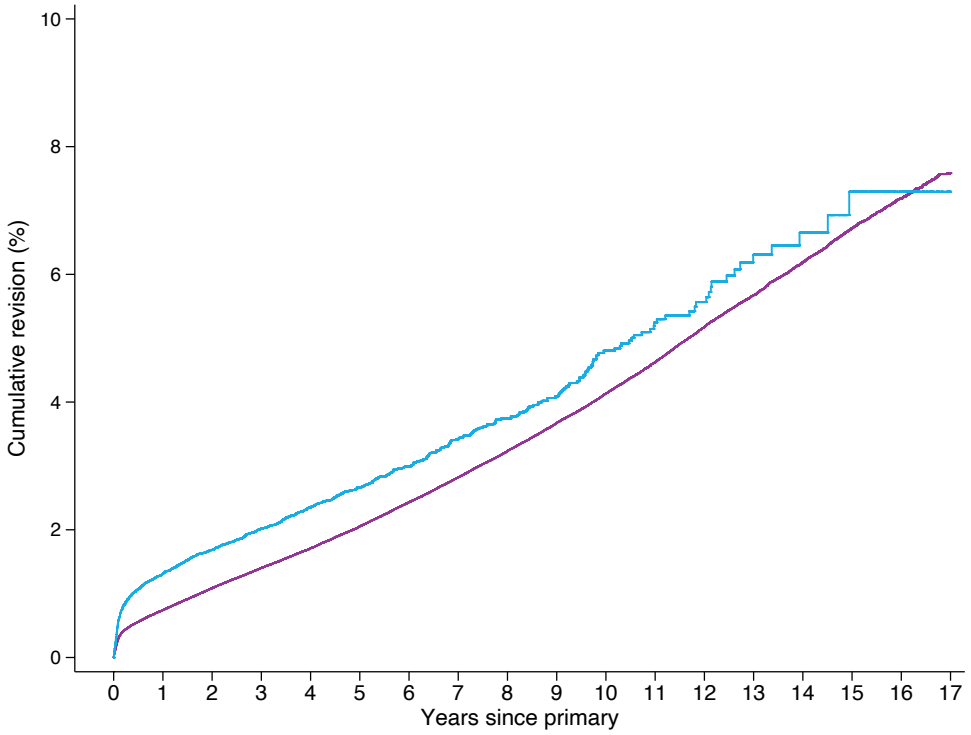
*Excludes 103,180 cases who had other reasons in addition to osteoarthritis.

Table 3.H13 compares the fractured NOF 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 NOF cases, compared with the remainder, were women (72.4% versus 59.2%: P<0.001, Chi-squared test).

The fractured NOF cases were significantly older (median age 73 years versus 70 years at operation: P<0.001 by Mann-Whitney U-test). We found that cemented and hybrid hips were used more commonly in fractured NOF 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 NOF 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 114) 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. While the difference here is not significant, it is interesting that this is a different pattern seen to that for 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 115) shows a markedly worse overall mortality in the fractured NOF cases compared to cases implanted for other indications (P<0.001, logrank test). As in the overall mortality section, the second of 5,449 simultaneous bilateral procedures were excluded. Gender and 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.

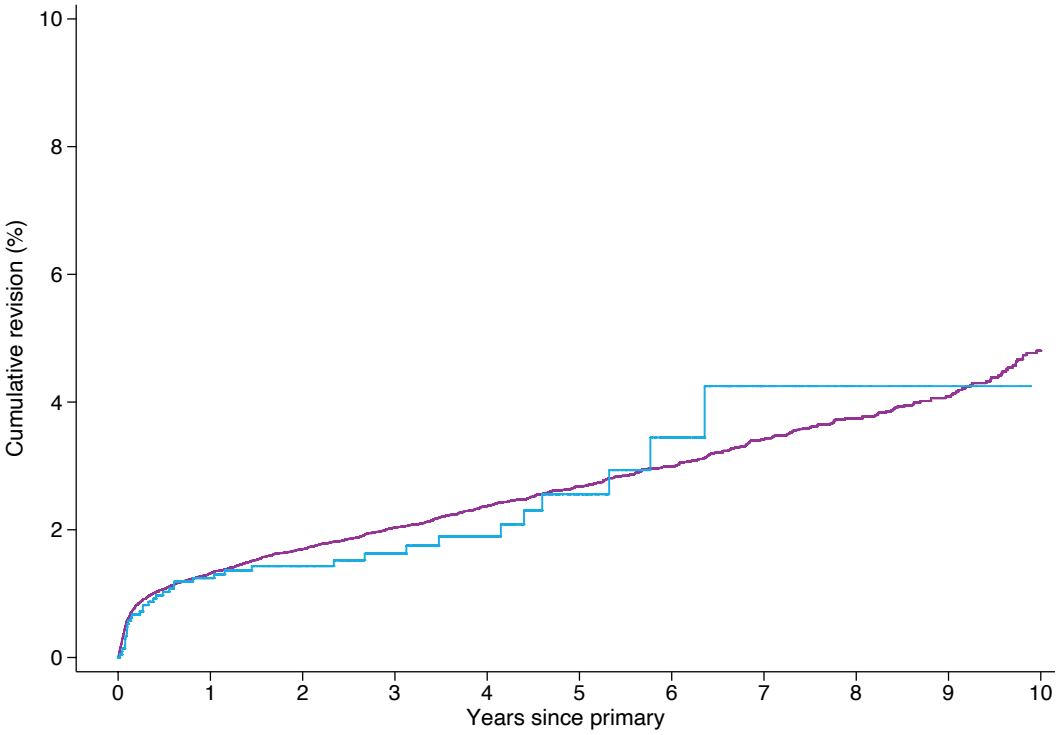
Figure 3.H12 (a) KM estimates of cumulative **revision** for **fractured NOF** and **OA only** cases for primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

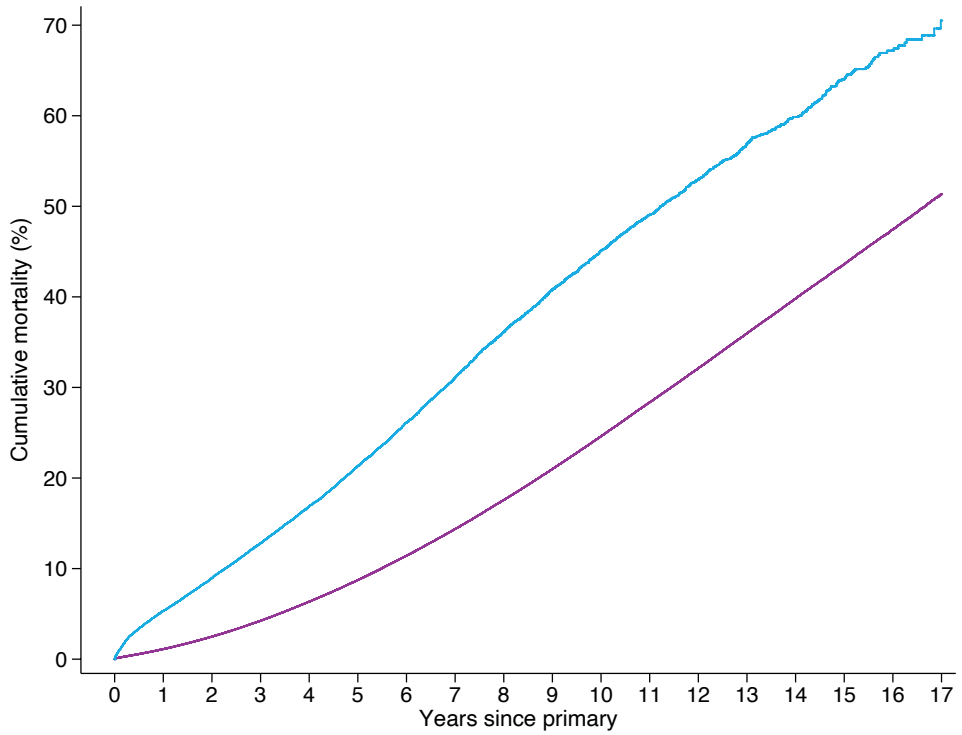
	Numbers at risk								
Osteoarthritis only	1,102,840	936,776	739,438	554,511	392,798	256,759	147,681	66,104	18,585
Fractured neck of femur	45,144	32,080	20,503	11,499	5,672	2,711	1,230	448	*110*

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	43,004	30,871	19,958	11,336	5,648	2,706
Dual mobility	2,140	1,209	545	*163*	*24*	*5*

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.*



Key:	Numbers at risk								
Osteoarthritis only	1,098,083	942,744	748,882	566,282	405,672	269,415	158,076	71,406	20,125
Fractured neck of femur	45,115	32,581	20,953	11,828	5,910	2,875	1,331	493	*124*

3.2.8 Overview of hip revision procedures

In this section we look at all hip revision procedures performed since the start of the registry, 1 April 2003, up to 31 December 2020, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total, there were 129,308 revisions on 110,629 individual patient sides (103,984 actual patients). In addition to the 37,444 first revised primary hip replacements described in section 3.2.2 of this report, there were 84,275 revision procedures for which no primary hip replacement had been recorded in the registry.

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 registry 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. We have made an attempt to do this later in this section.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

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*	16 (1.1)	0 (0.0)	1,418 (98.9)	1,434
2004	1,795 (65.8)	119 (4.4)	816 (29.9)	2,730
2005	3,460 (87.3)	202 (5.1)	303 (7.6)	3,965
2006	4,200 (86.8)	269 (5.6)	372 (7.7)	4,841
2007	5,563 (87.4)	339 (5.3)	460 (7.2)	6,362
2008	6,043 (86.2)	421 (6.0)	550 (7.8)	7,014
2009	6,319 (84.3)	517 (6.9)	661 (8.8)	7,497
2010	7,048 (86.5)	502 (6.2)	598 (7.3)	8,148
2011	7,978 (87.5)	530 (5.8)	611 (6.7)	9,119
2012	9,248 (88.1)	604 (5.8)	650 (6.2)	10,502
2013	8,536 (87.8)	567 (5.8)	623 (6.4)	9,726
2014	8,409 (87.0)	666 (6.9)	592 (6.1)	9,667
2015	8,018 (86.0)	709 (7.6)	597 (6.4)	9,324
2016	7,729 (87.3)	587 (6.6)	539 (6.1)	8,855
2017	7,697 (87.2)	614 (7.0)	517 (5.9)	8,828
2018	7,355 (87.7)	557 (6.6)	472 (5.6)	8,384
2019	7,076 (87.5)	546 (6.8)	465 (5.7)	8,087
2020	4,151 (86.0)	388 (8.0)	286 (5.9)	4,825
Total	110,641 (85.6)	8,137 (6.3)	10,530 (8.1)	129,308

*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=110,641)	Stage one of two-stage N(%) (n=8,137)	Stage two of two-stage N(%) (n=10,530)
Aseptic loosening	51,525 (46.6)	954 (11.7)	2,270 (21.6)
Dislocation / Subluxation	18,205 (16.5)	326 (4.0)	536 (5.1)
Pain	18,188 (16.4)	819 (10.1)	908 (8.6)
Lysis	16,332 (14.8)	732 (9.0)	691 (6.6)
Implant wear	15,441 (14.0)	336 (4.1)	413 (3.9)
Periprosthetic fracture	13,292 (12.0)	323 (4.0)	466 (4.4)
Other indication	7,684 (6.9)	274 (3.4)	823 (7.8)
Malalignment	5,989 (5.4)	114 (1.4)	115 (1.1)
Infection	5,428 (4.9)	6,686 (82.2)	6,470 (61.4)
Implant fracture	4,017 (3.6)	83 (1.0)	162 (1.5)
Head-socket size mismatch	750 (0.7)	21 (0.3)	26 (0.2)
Adverse reaction to particulate debris*	10,217 (10.8) n=94,586	238 (3.3) n=7,132	169 (2.4) n=7,096

*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=34,008)	Stage one of two-stage N(%) (n=2,692)	Stage two of two-stage N(%) (n=2,279)
Aseptic loosening	13,080 (38.5)	203 (7.5)	167 (7.3)
Dislocation / Subluxation	6,431 (18.9)	106 (3.9)	75 (3.3)
Periprosthetic fracture	5,768 (17.0)	126 (4.7)	121 (5.3)
Implant wear	4,595 (13.5)	99 (3.7)	55 (2.4)
Lysis	4,337 (12.8)	195 (7.2)	92 (4.0)
Adverse reaction to particulate debris	3,722 (10.9)	108 (4.0)	65 (2.9)
Infection	2,632 (7.7)	2,349 (87.3)	1,823 (80.0)
Other indication	1,610 (4.7)	70 (2.6)	137 (6.0)
Malalignment	1,603 (4.7)	29 (1.1)	14 (0.6)
Pain	1,535 (4.5)	46 (1.7)	35 (1.5)
Implant fracture	1,292 (3.8)	19 (0.7)	15 (0.7)
Head-socket size mismatch	134 (0.4)	<4 (0.1)	<4 (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 16.4% to 4.5% of single-stage revisions. There is also a higher proportion of cases revised for periprosthetic fracture in the last five years (17.0% compared to 12.0%) and a higher proportion of cases revised due to infection (7.7% compared to 4.9%). The ratio of stage two of two-stage, stage one of two-stage and single-stage revisions overall (1:0.77:10.5) is different compared to those performed in the last five years (1:1.18:14.9).

3.2.9 Rates of hip re-revision

In most instances (89.8% of 110,629 individual patient-sides), the first revision procedure was a single-stage revision, however in the remaining 10.2% 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 registry (n=37,444) 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 4,253 re-revisions and, for 5,936 cases, the patient died without having been re-revised. The censoring date for the remainder was the end of 2020.

Figure 3.H14 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision between 1 and 17 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.*

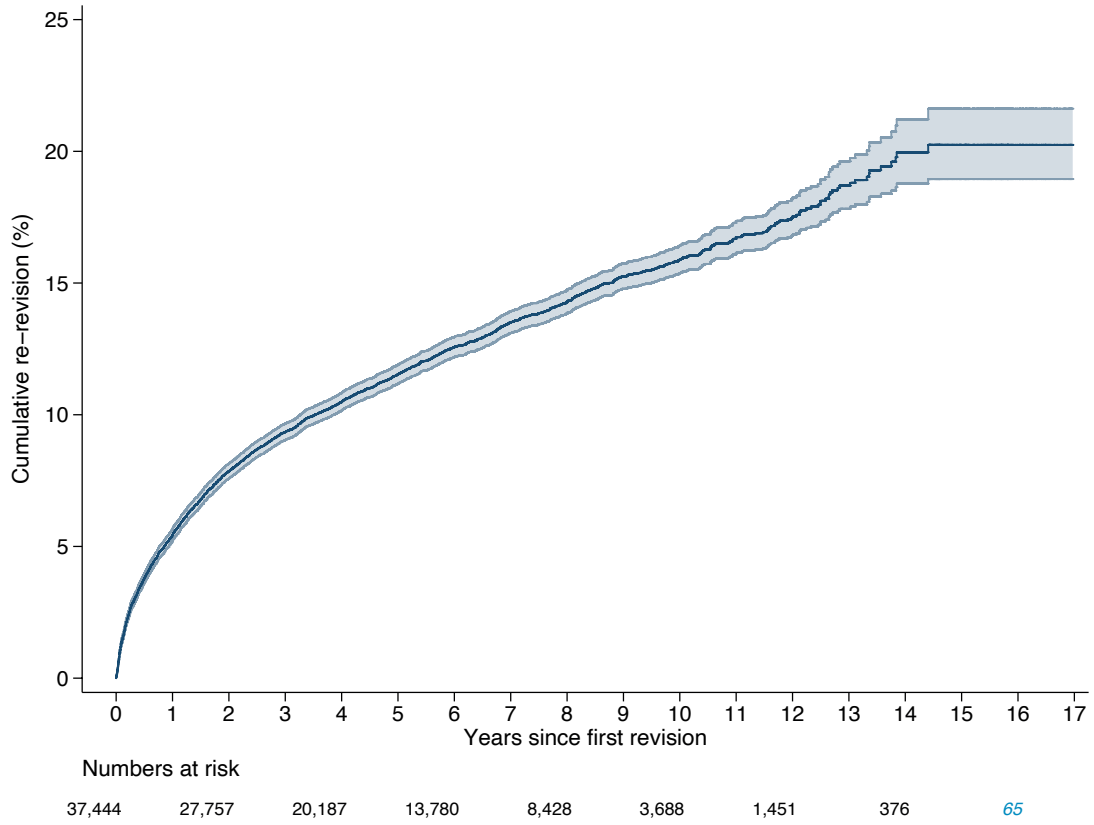
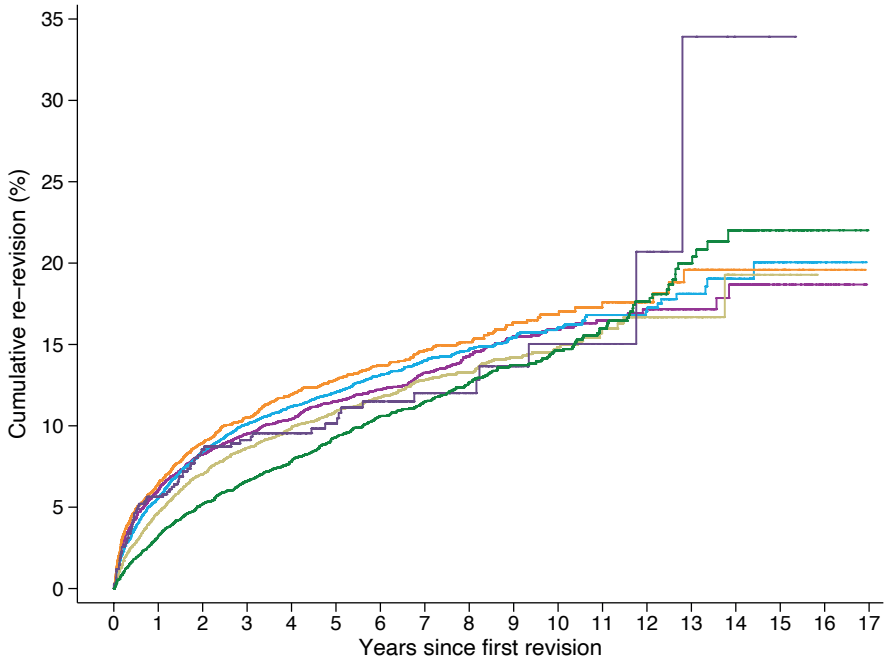


Figure 3.H14 (b) KM estimates of cumulative **re-revision** by **primary fixation** in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

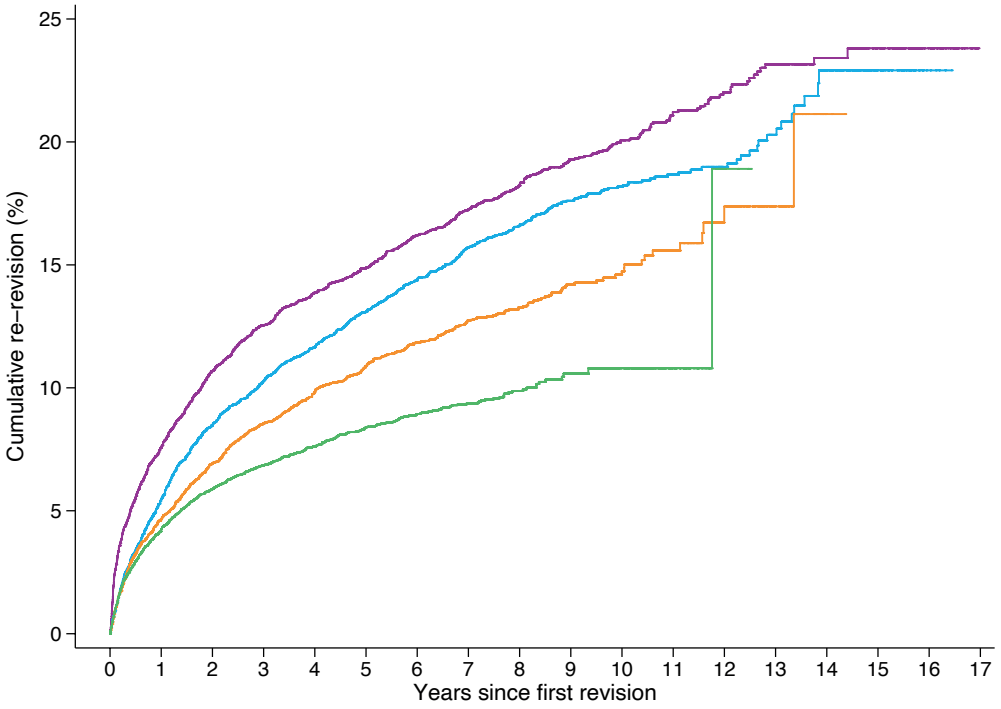


Key:	Numbers at risk								
Cemented	8,564	5,863	3,906	2,442	1,426	679	307	*86*	*18*
Uncemented without MoM	10,935	7,936	5,571	3,577	2,090	970	367	*106*	*17*
Uncemented MoM	5,427	4,568	3,737	2,837	1,697	526	*156*	*19*	*<4*
Hybrid	5,647	3,757	2,429	1,448	845	407	*157*	*49*	*10*
Reverse hybrid	755	528	351	*219*	*114*	*43*	*13*	*<4*	
Resurfacing	4,519	3,943	3,295	2,623	1,827	856	362	*91*	*12*

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 12 years the numbers at risk are low and should therefore be interpreted with caution.

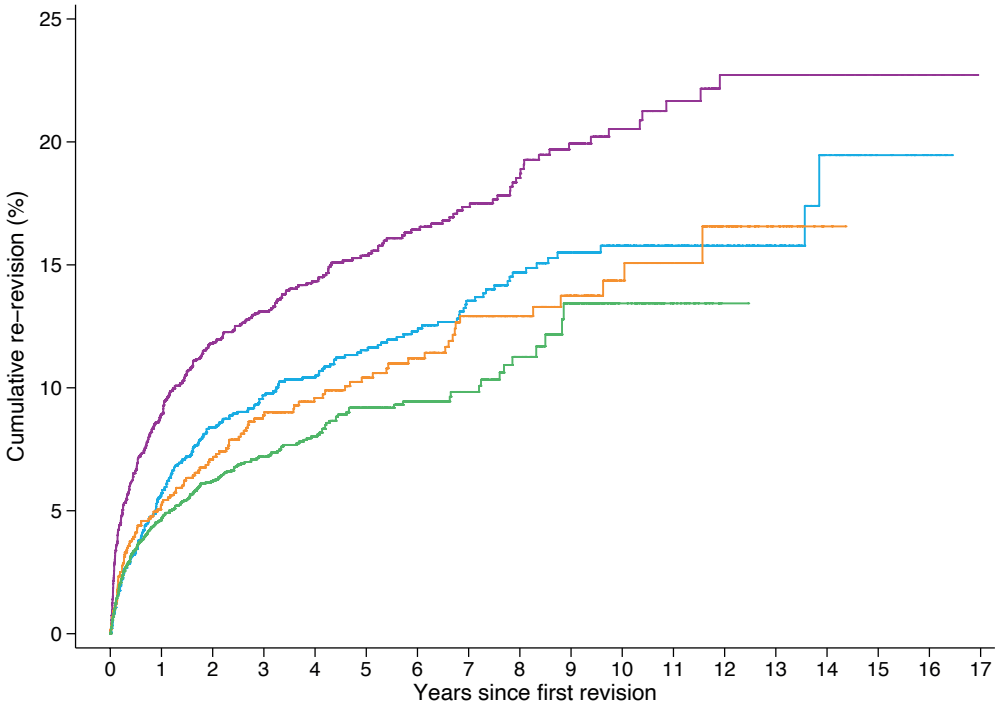
Figure 3.H14 (c) shows the relationship between time to first revision and the risk of subsequent revision. The earlier the primary hip replacement is revised, the higher the risk of a second revision. There is a relationship between the indication for first revision and time to first revision; earlier in this report (section 3.2.5) we show, 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	9,951	7,287	5,312	3,698	2,514	1,485	749	255	*60*
First rev. 1 to 3y	7,256	5,689	4,499	3,405	2,476	1,381	573	*119*	*5*
First rev. 3 to 5y	5,617	4,504	3,669	2,917	1,949	620	*125*	*<4*	
First rev. ≥5y	14,620	10,277	6,707	3,760	1,489	*202*	*4*		

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.*



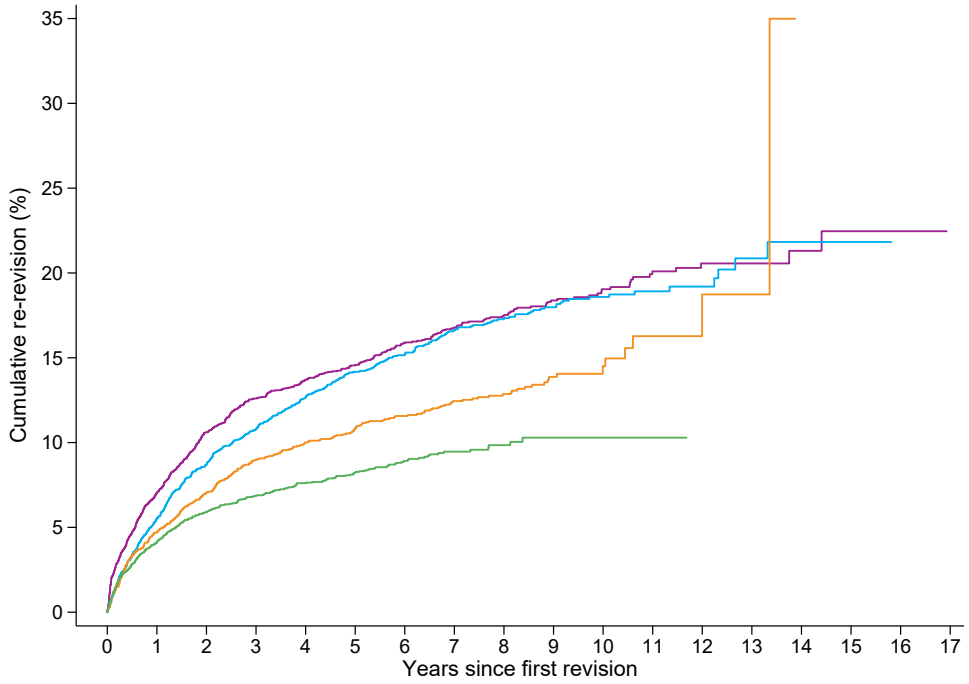
Key:

Numbers at risk

First rev. <1y	2,175	1,795	1,516	1,281	1,057	870	709	567	448	328	*236*	*184*	*130*	*86*	*51*	*25*	*13*	*<4*
First rev. 1 to 3y	1,783	1,544	1,349	1,174	1,018	872	724	584	476	355	277	*194*	*139*	*79*	*33*	*12*	*5*	
First rev. 3 to 5y	1,175	986	837	703	597	499	406	335	255	*177*	*121*	*74*	*37*	*15*	*<4*			
First rev. ≥5y	3,431	2,774	2,161	1,652	1,234	879	603	394	*247*	*116*	*45*	*16*	*<4*					

For those with a documented primary hip replacement within the registry, 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.

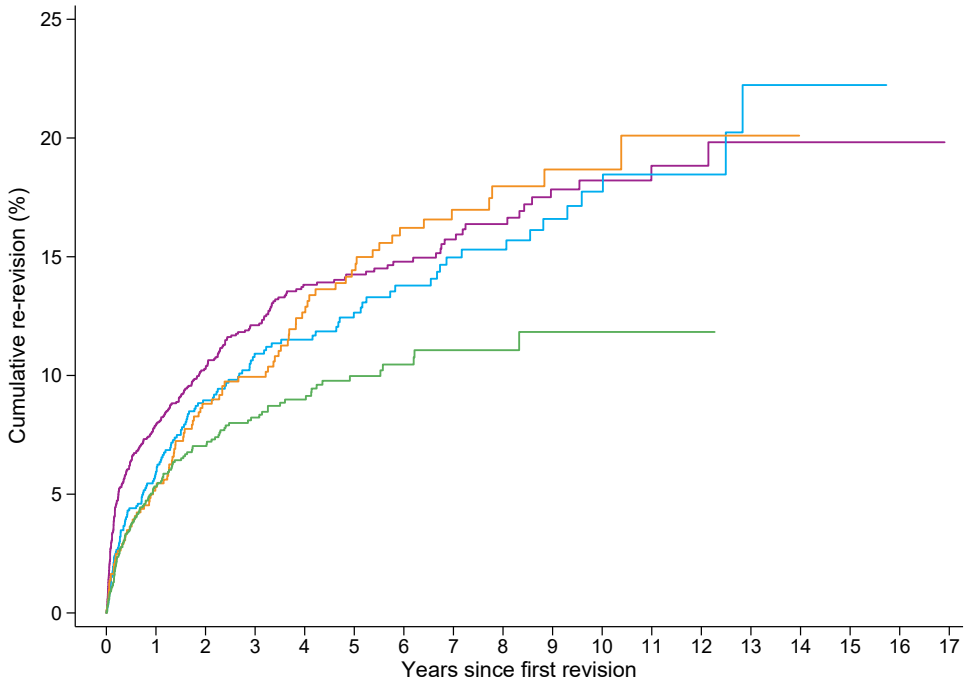
Figure 3.H15 (b) KM estimates of cumulative **re-revision** in **uncemented** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																
First rev. <1y	4,406	3,839	3,354	2,929	2,550	2,202	1,800	1,486	1,211	908	666	480	296	*162*	*86*	*47*	*18*	*5*
First rev. 1 to 3y	3,208	2,897	2,592	2,350	2,094	1,864	1,608	1,377	1,150	893	598	347	*194*	*97*	*39*	*13*	*0*	
First rev. 3 to 5y	2,553	2,320	2,116	1,931	1,763	1,603	1,423	1,212	904	498	*191*	*84*	*33*	*11*	*0*			
First rev. ≥5y	6,195	5,293	4,442	3,598	2,901	2,221	1,583	999	522	*166*	*41*	*7*	*0*					

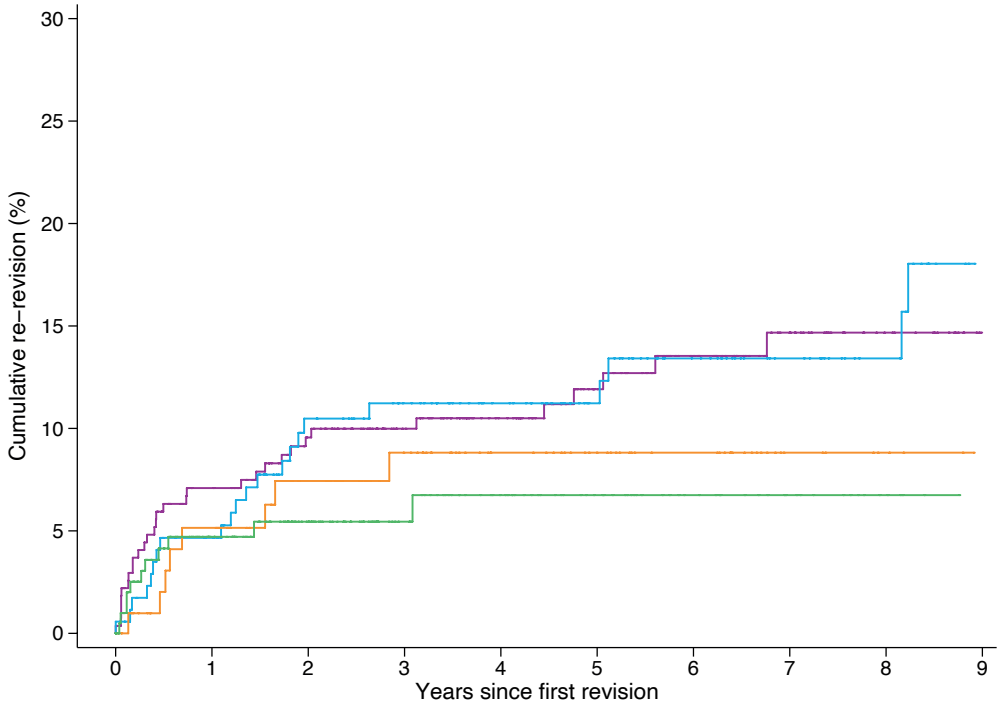
Figure 3.H15 (c) KM estimates of cumulative **re-revision** in **hybrid** primary hip replacement by **years to first revision**, in linked primary hip replacements. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

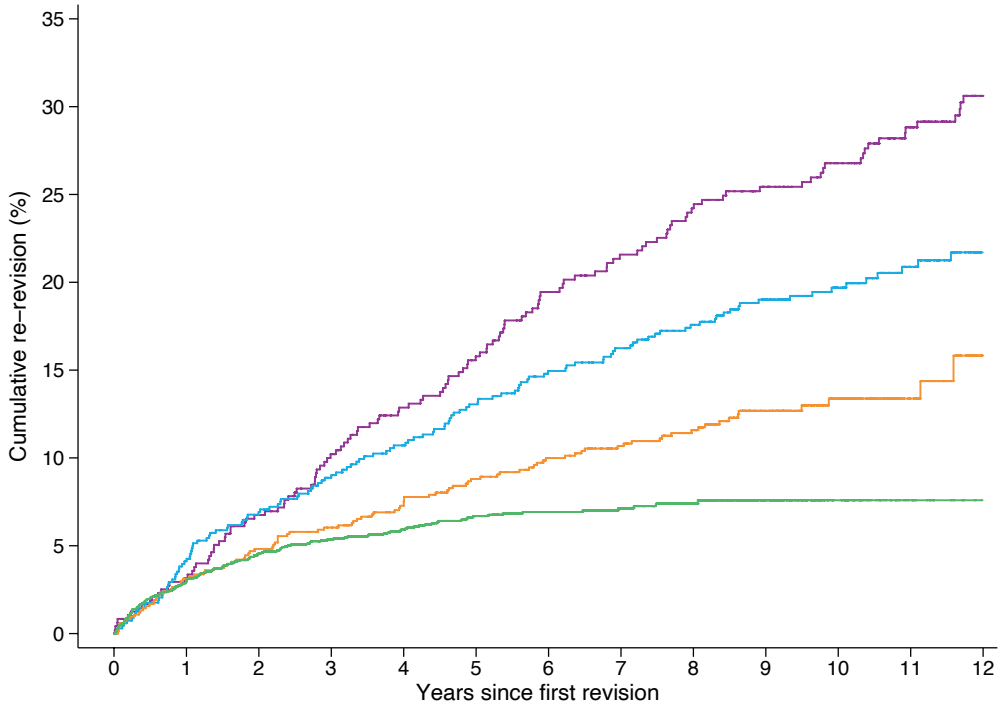
	Numbers at risk																	
First rev. <1y	2,201	1,798	1,468	1,189	924	731	541	405	324	*247*	*186*	*131*	*85*	*56*	*32*	*19*	*10*	*<4*
First rev. 1 to 3y	1,136	946	772	630	532	421	332	267	*219*	*170*	*114*	*81*	*57*	*37*	*17*	*7*	*0*	
First rev. 3 to 5y	737	610	505	436	362	310	258	*200*	*153*	*110*	*72*	*38*	*13*	*5*	*0*			
First rev. ≥5y	1,573	1,250	1,012	782	611	438	317	*224*	*149*	*69*	*35*	*9*	*<4*					

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	273	*237*	*211*	*178*	*146*	*113*	*95*	*71*	*51*	*36*
First rev. 1 to 3y	*175*	*160*	*129*	*115*	*99*	*81*	*64*	*51*	*39*	*26*
First rev. 3 to 5y	*103*	*91*	*78*	*65*	*49*	*40*	*32*	*17*	*13*	*9*
First rev. ≥5y	*204*	*149*	*110*	*75*	*57*	*41*	*28*	*19*	*11*	*6*

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	478	459	437	412	390	373	346	329	314	290	268	*226*	*176*
First rev. 1 to 3y	684	652	627	599	577	556	531	514	480	418	317	*221*	*151*
First rev. 3 to 5y	833	804	785	766	743	700	669	633	537	372	*205*	*100*	*34*
First rev. ≥5y	2,524	2,338	2,094	1,838	1,585	1,310	1,077	784	496	*205*	*66*	*16*	*<4*

Table 3.H16 (a) shows the re-revision rate of the 37,444 primary hip replacements in the registry that were revised. Of these, 4,253 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	15 years	17 years
Primary recorded in the NJR	37,444	5.44 (5.21-5.68)	9.34 (9.03-9.66)	11.53 (11.18-11.89)	15.89 (15.37-16.42)	*20.24 (18.94-21.61)*	*20.24 (18.94-21.61)*

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	13 years
<1 year after primary	9,951	7.59 (7.08-8.14)	12.53 (11.86-13.23)	14.85 (14.11-15.64)	17.25 (16.40-18.13)	20.05 (19.03-21.12)	23.13 (21.72-24.62)
1 to 3 years after primary	7,256	5.48 (4.98-6.04)	10.28 (9.57-11.03)	13.10 (12.28-13.96)	15.71 (14.78-16.69)	18.18 (17.11-19.31)	20.29 (18.81-21.86)
3 to 5 years after primary	5,617	4.68 (4.15-5.27)	8.55 (7.82-9.34)	10.88 (10.04-11.79)	12.73 (11.79-13.74)	14.74 (13.60-15.97)	*17.38 (15.24-19.78)*
≥5 years after primary	14,620	4.23 (3.91-4.58)	6.86 (6.43-7.31)	8.39 (7.89-8.93)	9.37 (8.79-9.98)	*10.80 (9.90-11.76)*	

Note: Maximum interval was 17.6 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 at 15 years due to low numbers.

Table 3.H16 (c) KM estimates of cumulative **re-revision** (95% CI) by **fixation** and **bearing used in primary hip replacement**. *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	13 years
All	All	37,444	5.44 (5.21-5.68)	9.34 (9.03-9.66)	11.53 (11.18-11.89)	13.51 (13.10-13.93)	15.89 (15.37-16.42)	18.69 (17.81-19.61)
All cemented		8,564	6.08 (5.59-6.62)	9.52 (8.87-10.21)	11.48 (10.74-12.28)	13.25 (12.37-14.19)	15.90 (14.73-17.16)	*17.17 (15.69-18.77)*
	MoP	7,674	6.08 (5.55-6.65)	9.36 (8.69-10.08)	11.21 (10.43-12.04)	13.04 (12.12-14.02)	15.65 (14.43-16.97)	*16.56 (15.12-18.12)*
	CoP	808	5.96 (4.49-7.88)	11.19 (9.02-13.84)	13.99 (11.40-17.12)	*15.20 (12.35-18.64)*	*18.53 (14.55-23.44)*	*24.06 (16.76-33.82)*
All uncemented		16,362	5.28 (4.95-5.64)	9.58 (9.11-10.06)	11.66 (11.14-12.21)	13.61 (13.01-14.24)	15.63 (14.87-16.42)	17.65 (16.44-18.95)
	MoP	4,729	5.39 (4.77-6.09)	9.89 (9.02-10.85)	11.37 (10.40-12.42)	13.95 (12.75-15.24)	15.82 (14.32-17.45)	*17.09 (14.89-19.57)*
	MoM	5,427	4.63 (4.10-5.23)	8.60 (7.87-9.40)	10.85 (10.01-11.76)	12.77 (11.83-13.79)	14.79 (13.61-16.06)	*16.62 (14.88-18.55)*
	CoP	2,131	6.07 (5.12-7.20)	10.90 (9.55-12.42)	12.66 (11.15-14.37)	13.58 (11.93-15.45)	*15.57 (13.39-18.08)*	*17.50 (14.22-21.43)*
	CoC	3,855	5.49 (4.80-6.27)	9.72 (8.78-10.75)	12.15 (11.07-13.33)	13.94 (12.72-15.27)	16.05 (14.53-17.71)	*18.91 (16.37-21.79)*
All hybrid		5,647	6.47 (5.84-7.16)	10.54 (9.70-11.44)	12.85 (11.88-13.90)	14.63 (13.50-15.86)	16.83 (15.37-18.42)	*19.59 (16.94-22.59)*
	MoP	3,277	6.64 (5.82-7.57)	10.23 (9.17-11.41)	12.32 (11.09-13.68)	13.80 (12.40-15.35)	*15.69 (13.92-17.66)*	*17.44 (14.76-20.56)*
	MoM	423	4.38 (2.78-6.87)	10.42 (7.77-13.89)	*13.60 (10.48-17.55)*	*16.03 (12.52-20.39)*	*19.48 (15.11-24.91)*	*19.48 (15.11-24.91)*
	CoP	1,228	6.83 (5.51-8.45)	10.92 (9.12-13.06)	*14.12 (11.79-16.87)*	*15.14 (12.50-18.29)*	*15.14 (12.50-18.29)*	
	CoC	652	5.97 (4.38-8.11)	10.69 (8.45-13.47)	12.14 (9.69-15.14)	*14.93 (11.92-18.61)*	*18.09 (14.09-23.08)*	*27.12 (17.92-39.77)*
All reverse hybrid		755	5.64 (4.18-7.58)	9.12 (7.17-11.57)	10.14 (8.00-12.80)	*12.01 (9.45-15.20)*	*15.03 (11.15-20.11)*	
	MoP	501	5.88 (4.10-8.41)	9.21 (6.85-12.33)	*9.98 (7.45-13.30)*	*12.94 (9.60-17.32)*	*16.52 (11.28-23.83)*	
All resurfacing		4,519	3.21 (2.73-3.77)	6.60 (5.90-7.39)	9.31 (8.45-10.25)	11.49 (10.51-12.56)	14.61 (13.37-15.96)	*19.99 (17.70-22.52)*
Unclassified		1,597	6.38 (5.26-7.72)	9.69 (8.27-11.34)	12.14 (10.49-14.03)	15.08 (13.13-17.29)	*16.99 (14.74-19.53)*	*17.97 (15.15-21.26)*

Note: Maximum interval was 17.6 years.
Note: Data has not been presented at 15 years due to low numbers.

Table 3.H16 (c) shows cumulative re-revision rates at 1, 3, 5, 7, 10 and 13 years following the first revision for those with documented primary hip replacements within the registry, broken down by fixation types and bearing surfaces used in the primary hip replacement.

The failure rates for revisions following resurfacings were comparatively low, but Figure 3.H14 (b) (page 120) shows that after ten years the failure rate is becoming higher than those for 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 (please note the indications are not mutually exclusive). Table 3.H17 (a) shows the indications for recorded revisions in the registry 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. In the final column in Table 3.H17 (b), we report the indications for all the second linked revisions e.g. 888 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 for a 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, N(%)
Aseptic loosening	54,749 (42.3)
Pain	19,915 (15.4)
Dislocation / Subluxation	19,067 (14.7)
Infection	18,584 (14.4)
Lysis	17,755 (13.7)
Implant wear	16,190 (12.5)
Periprosthetic fracture	14,081 (10.9)
Malalignment	6,218 (4.8)
Implant fracture	4,262 (3.3)
Head/socket size mismatch	797 (0.6)
Other indication	8,781 (6.8)
Adverse reaction to particulate debris*	10,624 (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 108,814 revisions as opposed to 129,308 revisions for the other reasons.

Table 3.H17 (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	9,190	874 (9.5)	888
Dislocation / Subluxation	6,503	762 (11.7)	1,057
Periprosthetic fracture	5,696	589 (10.3)	351
Infection	5,660	991 (17.5)	1,343
Pain	4,916	620 (12.6)	414
Malalignment	2,524	242 (9.6)	204
Lysis	2,209	181 (8.2)	171
Implant wear	2,078	187 (9.0)	205
Implant fracture	1,167	127 (10.9)	121
Head/socket size mismatch	245	37 (15.1)	15
Other indication	3,098	416 (13.4)	269
Adverse reaction to particulate debris*	2,575	246 (9.6)	121

*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 23,977 revisions as opposed to 37,444 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 registry increased with time. Approximately 57% of revisions performed in 2020 had a linked primary in the registry. 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 data capture began or being outside the coverage of the registry.

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	1,411	43 (3.0)
2004	2,639	142 (5.4)
2005	3,748	304 (8.1)
2006	4,482	462 (10.3)
2007	5,858	811 (13.8)
2008	6,314	1,155 (18.3)
2009	6,561	1,512 (23.0)
2010	7,073	1,949 (27.6)
2011	7,945	2,655 (33.4)
2012	9,026	3,338 (37.0)
2013	8,224	3,041 (37.0)
2014	8,085	3,092 (38.2)
2015	7,655	3,231 (42.2)
2016	7,273	3,227 (44.4)
2017	7,178	3,333 (46.4)
2018	6,817	3,466 (50.8)
2019	6,518	3,489 (53.5)
2020	3,822	2,194 (57.4)
Total	110,629	37,444 (33.8)

*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	16	0	1,352	43
2004	1,668	94	829	48
2005	3,117	249	327	55
2006	3,645	374	375	88
2007	4,603	683	444	128
2008	4,688	954	471	201
2009	4,571	1,250	478	262
2010	4,712	1,718	412	231
2011	4,899	2,387	391	268
2012	5,310	3,011	378	327
2013	4,869	2,742	314	299
2014	4,644	2,798	349	294
2015	4,116	2,907	308	324
2016	3,810	2,940	236	287
2017	3,598	3,059	247	274
2018	3,126	3,217	225	249
2019	2,852	3,220	177	269
2020	1,497	1,997	131	197
Total	65,741	33,600	7,444	3,844

*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 registry compared with the remainder (Kaplan-Meier estimates 1.42 (95% CI 1.30-1.54) versus 1.90 (1.80- 2.00)), which may reflect the fact that this patients in this 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 registry who had a median age of 74 (IQR 66 to 80) years. The percentage of males to females was similar in both groups (44.2% versus 42.5% respectively).

3.2.12 Conclusions

As in previous annual reports, our analysis of implants has been 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 younger women and the lowest among older women. When data on metal-on-metal is excluded, younger women have similar revision rates to younger 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 the resulting greater participation in society. The data clearly show that constructs failing at different rates is associated with the age and gender of the recipients.

Overall, the number of primary hip replacements recorded annually in the registry continues to increase with 1,369,888 now recorded, of which 1,251,164 were eligible for analysis. The COVID-19 pandemic has had a marked impact on the provision of hip replacement with primary THR decreasing from 98,649 in 2019 to 54,858 in 2020 and revision THR from 8,087 in 2019 to 4,825 in 2020. This represents a massive under-provision with significant implications for morbidity among patients and we examine this impact further in our COVID-19 section of the report (see page 341). Similarly, the provision of THR for a fractured neck of femur has decreased markedly from 5,383 in 2019 to 3,847 in 2020.

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 2019 uncemented fixation was the most common, with hybrid fixation increasing steadily from 2012 to become the most commonly used fixation for the first time in 2020.

Since 2011, the use of ceramic-on-ceramic bearings has declined while the use of ceramic-on-polyethylene bearings has increased markedly, with ceramic-on-polyethylene hybrid total hip replacements being the most utilised construct in 2020 (19.4% of all THRs), followed by cemented metal-on-polyethylene (17.3%) and then uncemented ceramic-on-polyethylene (17.1%). This is our second year reporting on dual mobility; this is used in different bearing combinations and the numbers this year enable us to report on metal-on-polyethylene-on-metal and ceramic-on-polyethylene-on-metal within some sub-groups and 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 the sub-groups described. It is possible that this is a case mix selection effect and our annual report will continue to report on these patterns, particularly if adoption continues to increase. We observed a different pattern when dual mobility is used for patients with a fractured neck of femur without this early higher rate of revision.

Since the 12th NJR Annual Report in 2015, our 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 aged 55 to 64 years, at 15 years post-surgery, hybrid and uncemented ceramic-on-polyethylene and ceramic-on-ceramic constructs as well as cemented ceramic-on-polyethylene constructs have similarly low revision rates of approximately 5%, while cemented metal-on-polyethylene constructs have revision rates of 8.65% (95% CI 7.82-9.57) and uncemented metal-on-polyethylene bearings 8.13% (95% CI 7.08-9.32). Resurfacings in this group have an even higher revision rate at 15 years of 10.49% (95% CI 9.69-11.35). Women aged 55 to 64 years have lower revision rates than men for all fixation/bearing combinations at 15 years, except for those with metal-on-metal bearings, such as resurfacings, where the revision rates are markedly higher for women than men and markedly higher than alternatives. For example, 15-year revision rates with hybrid ceramic-on-ceramic constructs in this group are 3.03% (95% CI 2.54-3.62) compared to metal-on-metal hip resurfacing of 22.56% (95% CI 21.22-23.97).

For patients over 75 years, 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. The risk of revision at 15 years in this group is very small, males 5.01% (95% CI 4.63-5.43) and females 3.52% (95% CI 3.32-3.73). The 15-year mortality rate in men aged 75 to 79 years is 77.97% (95% CI 77.13-78.80) and in women aged 75 to 79 years is 66.53% (95% CI 65.86-67.19). 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, only 61% of males and 71% of females are still alive 15 years later.

We have also examined outcomes of different head sizes (bearing diameters) with alternative fixation and bearing types 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 uncemented fixation. Ceramic-on-ceramic bearings have lower failure rates with larger bearings when used with uncemented fixation, as predicted by Alison Smith's flexible parametric survival models published in the Lancet in 2012 (Smith et al., 2012). However, this does not appear to hold true with ceramic-on-ceramic hybrid fixations. This demonstrates how important it is to examine the entire construct, not just the individual variables such as fixation, composition of bearing and head size.

With regard to specific branded stem / cup combinations, some of the best implant survivorships have still been found to be achieved by mix and match cemented hard-on-soft bearing constructs, although this practice remains contrary to both the MHRA and implant 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. It is important to note that there is variability in brand level constructs with variation in outcome according to factors such as the bearing combination used. It is therefore important to consider the construct when selecting implants for specific outcomes. We encourage all readers to view Table 3.H8 for fine details of construct performance.

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 11.30% (95% CI 10.74-11.88) at 17 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.

We note that revision rates by year of surgery for the entire cohort increased dramatically from 2003 to 2008 and then began to decline and continue to do so. The peak rate matches that for 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 is also present after knee replacement, although with a lesser magnitude, it is likely that

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.

other factors also contribute to the decline in revision rates. For example, the decline coincides with the commencement of the NJR's clinician feedback activity. It is noteworthy that this decline appears to be ongoing, which is undoubtedly very good news.

Consistent with results from previous years' annual reports, we observed similar revision rates for total hip replacement performed as a result of a fractured neck of femur and those carried out 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 registry increased to a peak of 10,502 in 2012 and since then has declined steadily to 8,087 in 2019, with a marked drop to 4,825 in 2020 due to the impact of the COVID-19 pandemic. Please note that there may be late registrations for 2020 procedures and thus the figure for this year may be revised upwards 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; 20.05% (95% CI 19.03-21.12) of hips revised within a year of primary surgery are re-revised within ten years. In contrast, when the primary lasts at least five years the re-revision rate is 10.80% (95% CI 9.90-11.76) at ten years. Re-revision rates up to ten years appear to be independent of the fixation and bearing of the primary hip replacement, except for resurfacing procedures which are initially associated with lower re-revision rates, but this pattern appears to wane between seven and ten years after the re-revision.

Overall, this report is good news for patients, clinicians and the healthcare sector. Provision of hip replacement increased up to 2019, revision rates continued to decline and clinicians are increasingly utilising constructs with proven longevity. In contrast, in 2020 there was a massive under-provision of both primary and revision hip replacement with over 47,000 fewer hip replacements performed than in 2019. As hip replacement is undertaken to treat severe pain and functional limitation, this deficit represents considerable suffering for a large cohort of people nationally. (See our patient perspective in the COVID section of the report on page 341).

3.3 Outcomes after knee replacement

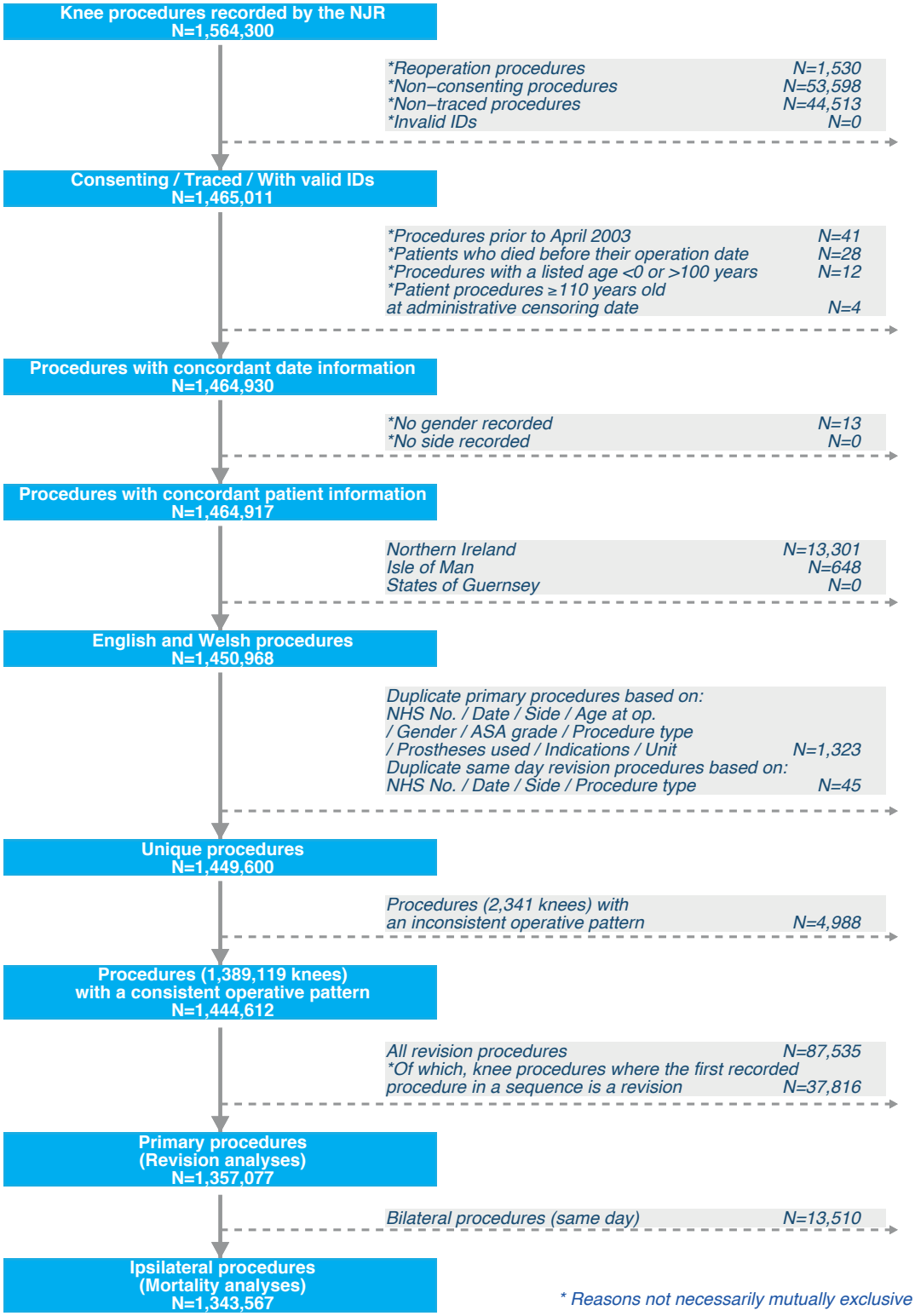
3.3.1 Overview of primary knee replacement surgery

In this section of the report we address revision and mortality outcomes for all primary knee operations performed between 1 April 2003 and 31 December 2020. The very first patients who were entered into the registry therefore had a potential 17.75 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. We note here 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 MDSv7 forms but not in 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 forms with the introduction of our 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 i.e. one patellofemoral and one unicondylar, or one patellofemoral and two unicondylar.

Figure 3.K1 (a) describes the data cleaning processes applied to produce the total of 1,357,077 primary knee procedures included in the analyses we present in this section.

Figure 3.K1 (a) Knee cohort flow diagram.



Over the lifetime of the registry, the 1,357,077 primary knee joint replacement procedures contributing to our revision analyses were carried out by a total of 3,446 unique consultant surgeons working across 469 units.

Over the last three years (1 January 2018 to 31 December 2020), 260,620 primary knee procedures (representing 19.2% of the current registry) were performed by 1,864 consultant surgeons working across 406 units. Looking at caseload over this three year period, the median number of primary procedures per consultant surgeon was 107 (IQR 39 to 198) and the median number of procedures per unit was 576 (IQR 284 to 860). A proportion of surgeons will have commenced practice as a consultant during this period, some may have retired, and some surgeons may have periods of surgical inactivity within the coverage of the NJR, therefore their apparent caseload would be lower.

Over this three year period, there have been 226,350 primary total knee replacements performed by 1,852 surgeons (median=96 cases per surgeon; IQR 37 to 171) in 403 separate units (median=580 cases per unit; IQR 298 to 877). In the same time period, there have been 30,068 primary unicondylar knee procedures performed by 794 consultant surgeons (median=19 cases per surgeon; IQR 5 to 50) in 364 units (median=49 cases per unit; IQR 17 to 103).

The majority of primary knee replacements were carried out on women (females 56.3%; males 43.7%). 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 146) and commentary later for discussion of age at primary by type of knee replacement. Osteoarthritis was given as a documented indication for surgery in 1,321,874 procedures (97.4% of the cohort) and was the sole indication given in 1,310,663 (96.6%) primary knee procedures.

Table 3.K1 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 (9.3% of the total) with the remainder being patellofemoral (1.2%).

More than half of all operations (57.6%) were TKRs which were all cemented and unconstrained (cruciate retaining) with a fixed bearing, followed by 19.9% 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. However, while uncemented are almost equally likely to have a mobile or fixed bearing, hybrid knees are more likely to utilise a fixed bearing. Approximately two-thirds (68.8%) of cemented TKRs are unconstrained and have a fixed bearing. Unicondylar knee surgery typically involves the use of a mobile bearing (61.5%). A number of primary knee replacements could not be classified according to their bearing / constraint (approximately 1.6% 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		1,357,077		100.0
Total knee replacement				
All cemented		1,136,212		83.7
Cemented and	unconstrained, fixed	781,402	68.8	57.6
	unconstrained, mobile	40,231	3.5	3.0
	posterior-stabilised, fixed	270,635	23.8	19.9
	posterior-stabilised, mobile	12,886	1.1	0.9
	constrained condylar	10,698	0.9	0.8
	monobloc polyethylene tibia	18,296	1.6	1.3
	pre-assembled/hinged/linked	2,064	0.2	0.2
All uncemented		47,061		3.5
Uncemented and	unconstrained, fixed	18,187	38.6	1.3
	unconstrained, mobile	25,152	53.4	1.9
	posterior-stabilised, fixed	3,428	7.3	0.3
	other constraints	294	0.6	<0.1
All hybrid		9,851		0.7
Hybrid and	unconstrained, fixed	6,468	65.7	0.5
	unconstrained, mobile	2,156	21.9	0.2
	posterior-stabilised, fixed	819	8.3	0.1
	other constraints	408	4.1	<0.1
Unicompartmental knee replacement				
All unicondylar, cemented		96,187		7.1
Cemented and	fixed	40,281	41.9	3.0
	mobile	49,610	51.6	3.7
	monobloc polyethylene tibia	6,296	6.5	0.5
All unicondylar, uncemented/hybrid		29,268		2.2
Uncemented/hybrid and	fixed	1,259	4.3	0.1
	mobile	27,606	94.3	2.0
	monobloc polyethylene tibia	403	1.4	<0.1
Patellofemoral		15,639		1.2
Multicompartmental		586		<0.1
Unclassified		22,273		1.6

Figure 3.K1 (b) Frequency of primary **TKR** within **elective** cases stratified by procedure **type**. Consultants have been placed in groups by the **volume** of cases they undertake per annum. Each colour represents total volume of cases undertaken by all the consultants in that grouping.

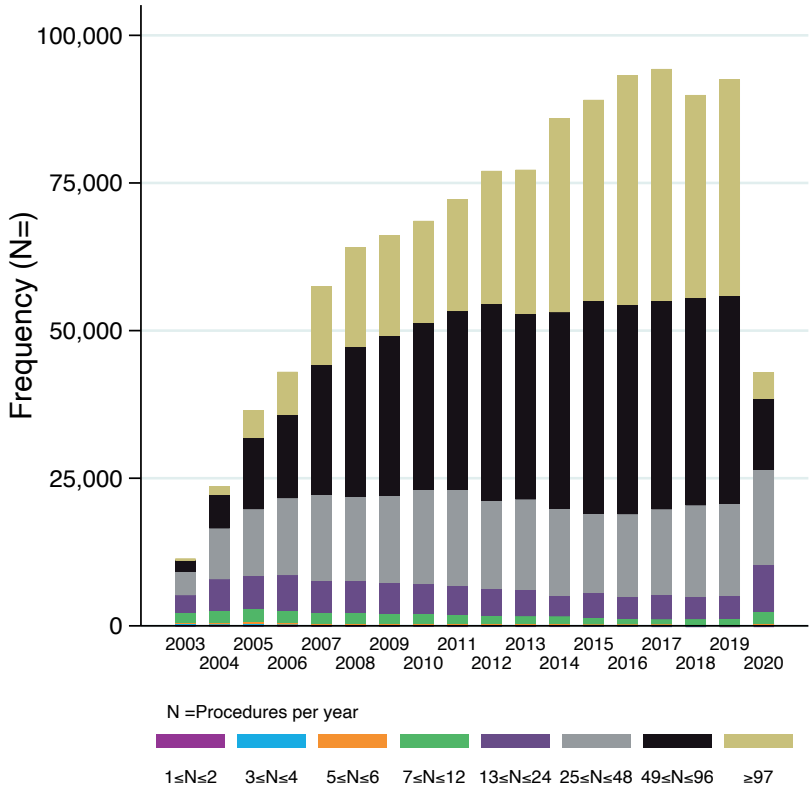


Figure 3.K1 (c) Frequency of primary **UKR** within **elective** cases stratified by procedure **type**. Consultants have been placed in groups by the **volume** of cases they undertake per annum. Each colour represents total volume of cases undertaken by all the consultants in that grouping.

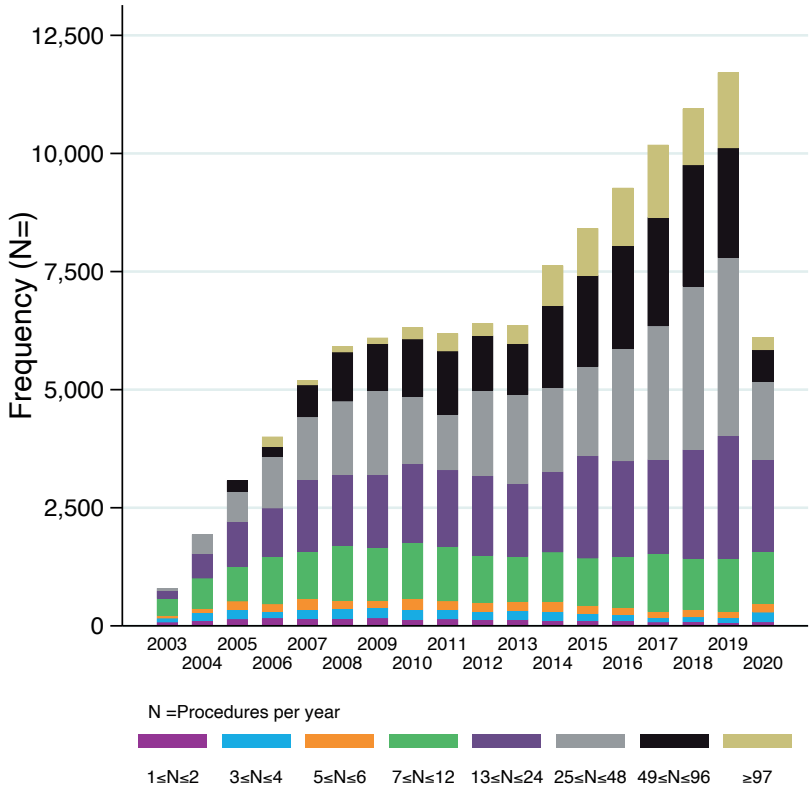
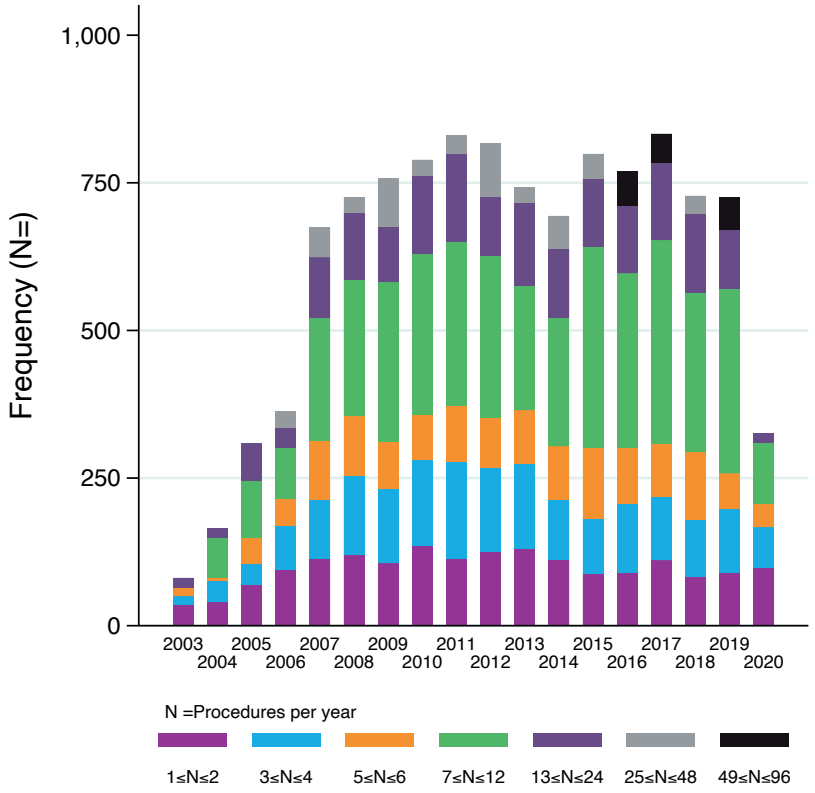


Figure 3.K1 (d) Frequency of primary **patellofemoral** knee replacements within **elective** cases stratified by procedure **type**. Consultants have been placed in groups by the **volume** of cases they undertake per annum. Each colour represents total volume of cases undertaken by all the consultants in that grouping.



Figures 3.K1 (b) to (d) show the yearly number of primary knee replacements performed for all indications. Procedures have been stratified by total knee, unicondylar and patellofemoral joint replacements. Please note the difference in scale of the y-axis between each plot.

Each bar in the figure is further stratified by the volume of procedures that the consultant conducted in that year within that joint replacement type i.e. if a surgeon performed 25 elective total knee replacement procedures, 25 unicondylar knee replacements and 25 patellofemoral joint replacement procedures, their annual total volume would be 75 procedures. However, each 25 procedures are not aggregated and only contribute to the grey sub-division in each figure respectively.

Figure 3.K1 (b) (page 140) shows that the volume of total knee replacements has increased since data collection started. Prior to 2020 the majority of additional procedures were contributed by higher volume surgeons i.e. those performing over 49 procedures annually.

Figure 3.K1 (c) (page 141) shows that the volume of unicondylar knee replacements has increased rapidly since 2014. Prior to 2020 the majority of additional procedures were contributed by higher volume consultants i.e. those performing over 25 procedures annually. Only a very small proportion of consultants contributed less than seven unicondylar knee replacements per year.

Figure 3.K1 (d) shows that the volume of patellofemoral knee replacements has remained fairly constant over the last ten years. Prior to 2020 the majority of procedures recorded in the registry were contributed to by consultants who performed more than seven procedures annually.

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

Fixation/bearing/ constraint	2004 n= 41,585	2005 n= 42,517	2006 n= 50,345	2007 n= 67,032	2008 n= 74,468	2009 n= 76,654	2010 n= 79,247	2011 n= 82,826	2012 n= 86,720	2013 n= 86,440	2014 n= 96,242	2015 n= 100,081	2016 n= 105,164	2017 n= 107,136	2018 n= 103,144	2019 n= 106,572	2020 n= 50,904
Total knee replacement																	
All cemented	**78.4**	**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**	**84.8**	**83.2**
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	61.3	61.4	60.3
unconstrained, mobile	4.1	5.6	6.5	6.4	5.7	4.7	4.0	2.9	2.4	2.1	1.9	1.7	1.7	1.6	1.6	1.5	1.7
posterior-stabilised, fixed	20.3	19.3	19.6	19.8	20.4	20.8	21.2	21.1	20.8	20.9	20.2	19.9	19.3	19.5	19.1	18.6	17.9
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	0.4
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	1.6
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	1.1
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	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**	**1.9**	**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	1.0	1.1
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	0.8	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	0.1	0.2	0.2	0.1	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	<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**	**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	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	<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	0.2
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	0

Note: Data from 2003 has been included in 2004, since 2003 was not a complete year.
Note: A zero represents no procedures of this bearing type.

Table 3.K2 (continued)

Fixation/bearing/ constraint	2004 n= 41,585	2005 n= 42,517	2006 n= 50,345	2007 n= 67,032	2008 n= 74,468	2009 n= 76,654	2010 n= 79,247	2011 n= 82,826	2012 n= 86,720	2013 n= 86,440	2014 n= 96,242	2015 n= 100,081	2016 n= 105,164	2017 n= 107,136	2018 n= 103,144	2019 n= 106,572	2020 n= 50,904
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	5.8	6.0	6.7	7.1	7.9
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	5.7	6.7
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	1.1
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	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	5.1
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	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	4.8
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	<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	1.0	1.0
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	<0.1
Unclassified	3.5	3.1	3.1	3.6	3.2	2.9	2.7	2.6	1.2	1.0	0.8	0.7	0.8	0.7	0.7	0.6	0.7
All	100	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.
Note: A zero represents no procedures of this bearing type.

Table 3.K2 (page 143) shows the annual rates for the usage of the different types of primary knee replacements. Overall, more than 90% 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.

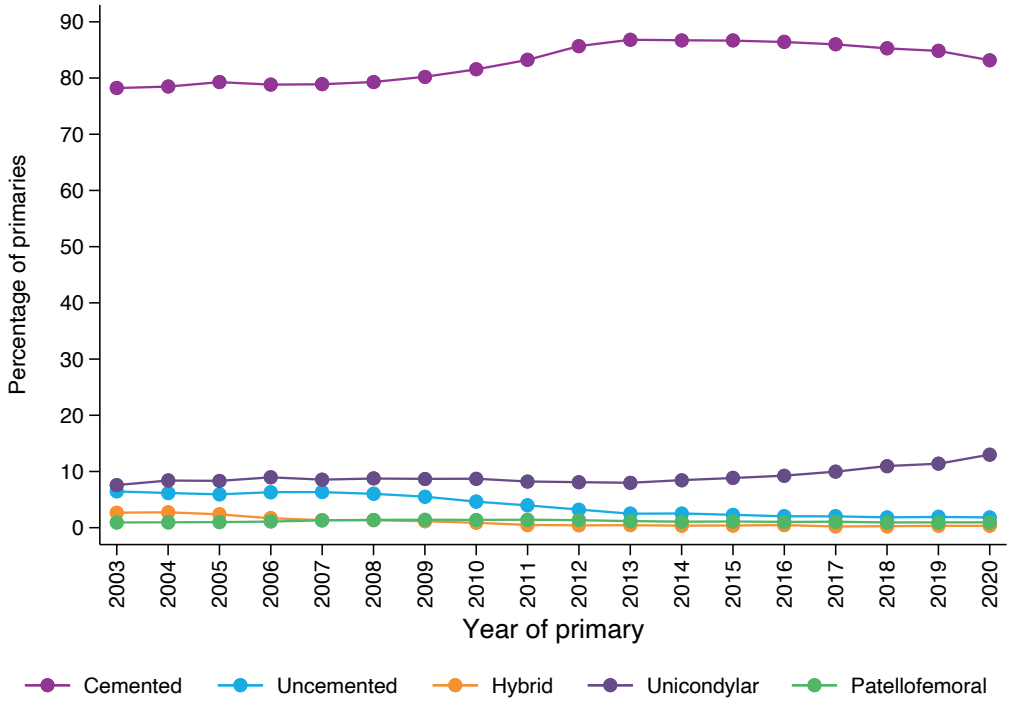


Table 3.K3 Age at primary knee replacement by **fixation**, **constraint** and **bearing** type.

Fixation	Constraint and bearing type	N	Age of patient (years)		Percentage male (%)[3]
			Median (IQR)[1]	Mean (SD)[2]	
All types		**1,357,077**	**70 (63 to 76)**	**68.9 (9.6)**	**43.4**
All cemented		**1,136,212**	**70 (64 to 76)**	**69.7 (9.3)**	**42.4**
Cemented and	unconstrained, fixed	781,402	70 (64 to 76)	69.6 (9.1)	42.9
	unconstrained, mobile	40,231	69 (62 to 76)	68.7 (9.6)	42.0
	posterior-stabilised, fixed	270,635	70 (64 to 77)	69.8 (9.4)	41.1
	posterior-stabilised, mobile	12,886	66 (60 to 74)	66.5 (10.1)	44.7
	constrained condylar	10,698	71 (63 to 78)	69.9 (10.4)	36.2
	monobloc polyethylene tibia	18,296	74 (69 to 79)	73.5 (8.2)	40.8
	pre-assembled/hinged/linked	2,064	75 (66 to 82)	73.1 (12.6)	27.3
All uncemented		**47,061**	**69 (62 to 75)**	**68.2 (9.6)**	**48.6**
Uncemented and	unconstrained, fixed	18,187	69 (61 to 75)	68.0 (9.8)	50.0
	unconstrained, mobile	25,152	69 (62 to 75)	68.5 (9.2)	46.7
	posterior-stabilised, fixed	3,428	67 (59 to 75)	66.7 (10.6)	53.0
	other constraints	294	67 (60 to 73)	66.4 (9.0)	73.5
All hybrid		**9,851**	**69 (62 to 76)**	**68.7 (9.8)**	**44.4**
Hybrid and	unconstrained, fixed	6,468	70 (63 to 76)	69.1 (9.5)	45.2
	unconstrained, mobile	2,156	69 (62 to 76)	68.6 (9.8)	38.3
	posterior-stabilised, fixed	819	68 (60 to 75)	67.0 (10.6)	46.4
	other constraints	408	66 (58.5 to 75)	65.8 (10.7)	58.8
All unicondylar, cemented		**96,187**	**64 (57 to 71)**	**63.8 (9.8)**	**53.3**
Unicondylar, cemented and	fixed	40,281	63 (56 to 70)	63.3 (10.0)	55.3
	mobile	49,610	64 (57 to 71)	64.2 (9.5)	51.6
	monobloc polyethylene tibia	6,296	64 (57 to 71)	64.0 (10.1)	53.4
All unicondylar, uncemented/hybrid		**29,268**	**65 (58 to 72)**	**64.7 (9.6)**	**55.0**
Unicondylar, uncemented/hybrid and	fixed	1,259	66 (57 to 73)	65.2 (11.1)	43.8
	mobile	27,606	65 (58 to 71)	64.7 (9.5)	55.7
	monobloc polyethylene tibia	403	65 (59 to 72)	65.6 (9.1)	42.9
Patellofemoral		**15,639**	**58 (50 to 67)**	**58.6 (11.7)**	**22.6**
Multicompartmental		**586**	**60 (53 to 67)**	**60.5 (10.1)**	**46.9**
Unclassified		**22,273**	**69 (61 to 75)**	**68.0 (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 cemented unicondylar prostheses were typically six years younger (median age 64 years; IQR 57 to 71) compared to all types of knee replacement while those receiving uncemented/hybrid unicondylar prostheses were five years younger (median age 65 years; IQR 58 to 72). The patellofemoral group were typically 12 years younger (median age 58 years; IQR 50 to 67) compared to all types of knee replacement. Those receiving multicompartmental knee replacements were typically ten years younger (median age 60 years; IQR 53 to 67) compared to all types of knee replacement.

Women were more likely to have a primary TKR; they received 57.6%, 51.4% and 55.6% of cemented, uncemented and hybrid type procedures respectively. Conversely, cemented and uncemented unicondylar surgery was performed on a higher proportion of males (53.3% and 55.0% respectively). Patellofemoral surgery was 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. ASA 2 is the most common ASA grade and only a small number of patients with a grade greater than ASA 3 undergo knee replacement. The majority of cases are performed with osteoarthritis as the sole indication; 1,310,663 (96.6%) of all 1,357,077 knee replacements.

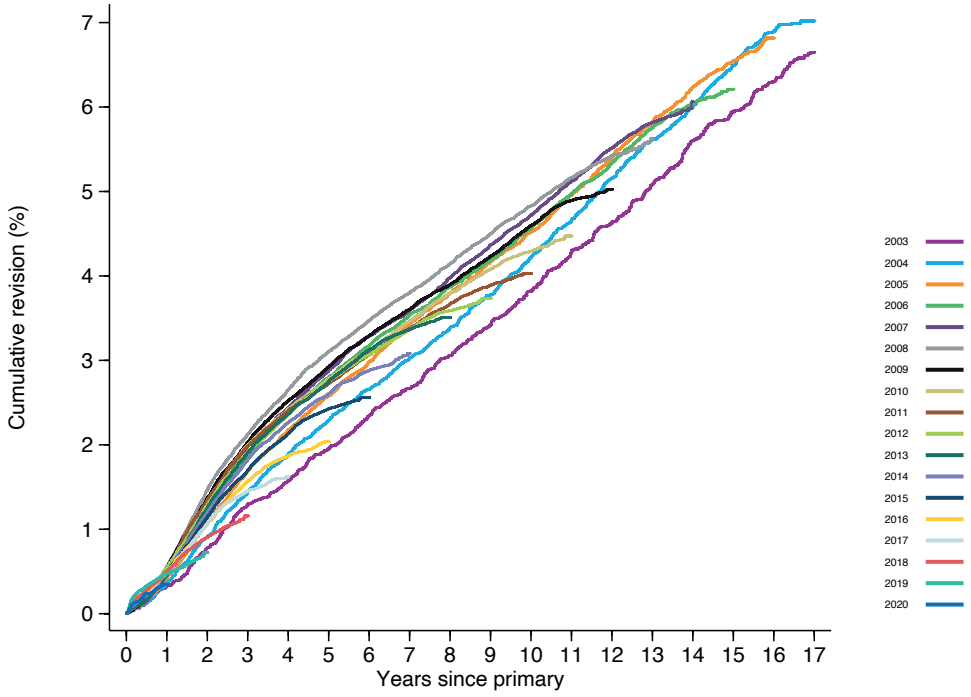
Table 3.K4 Primary knee replacement patient **demographics**.

	Males N (%)		Females N (%)		All N (%)	
Total		**589,539**		**767,538**		**1,357,077**
ASA 1		78,045 (13.2)		77,191 (10.1)		155,236 (11.4)
ASA 2		414,999 (70.4)		562,076 (73.2)		977,075 (72.0)
ASA 3		94,373 (16.0)		125,918 (16.4)		220,291 (16.2)
ASA 4		2,068 (0.4)		2,275 (0.3)		4,343 (0.3)
ASA 5		54 (<0.1)		78 (<0.1)		132 (<0.1)
Osteoarthritis as a reason for primary		578,694 (98.2)		743,180 (96.8)		1,321,874 (97.4)
Osteoarthritis as the sole reason for primary		573,703 (97.3)		736,960 (96.0)		1,310,663 (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.



In this section, estimates of cumulative revision in the tables are presented at 1, 3, 5, 10, 15 and 17 years. A total of 40,451 first revisions of a knee prosthesis have been linked to registry primary knee replacement surgery records of operations undertaken between 2003 and 2020. 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) overleaf shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. It separates each year enabling changes in failure rates to be clearly identified. In addition, the revision rates at 1, 3, 5, 7, 10, 13 and 15 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 knee 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 2020. 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 registry 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 timeline of when NJR clinician feedback and performance analyses were introduced, it is likely that these patterns represent improved survivorship as a result of clinician feedback and the 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.

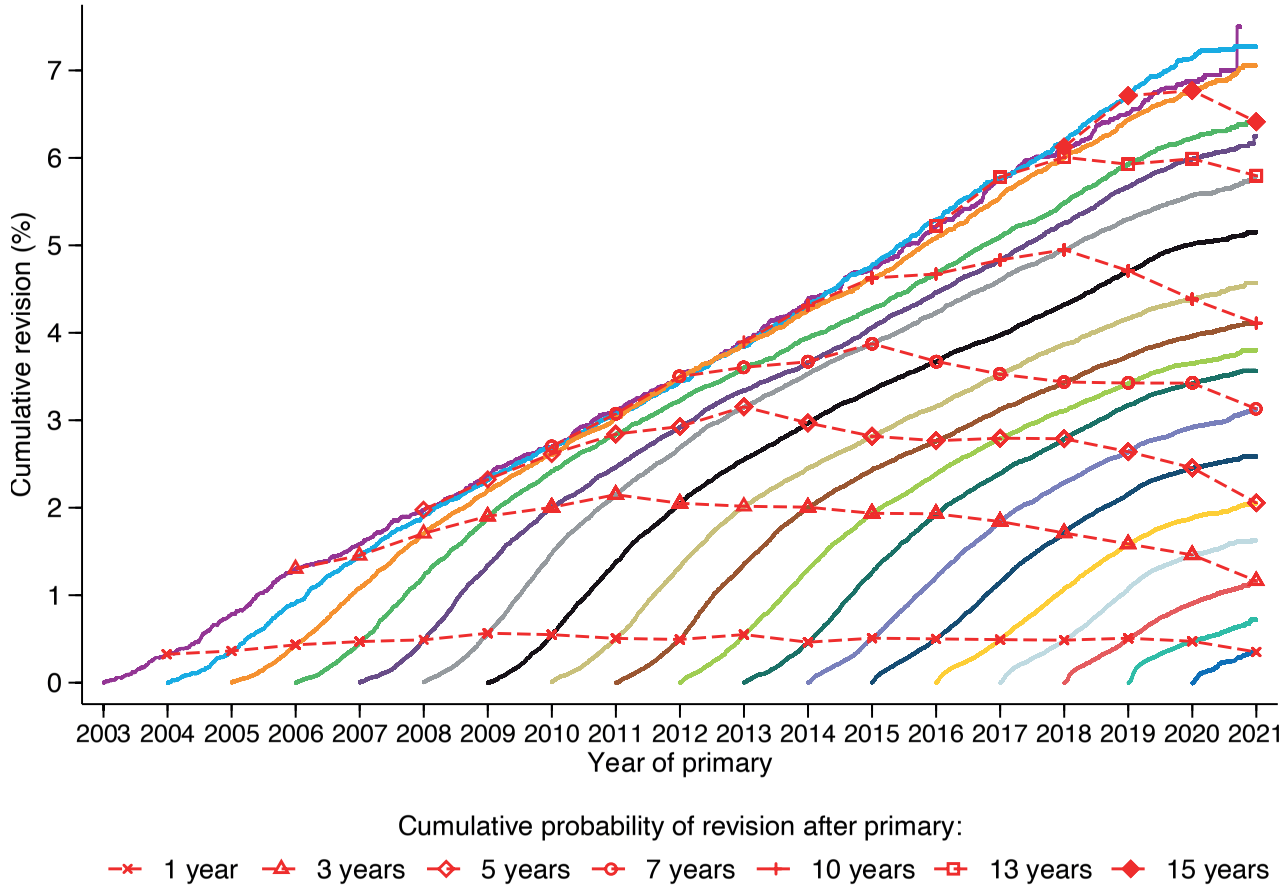


Table 3.K5 KM estimates of cumulative **revision** (95% CI) by **fixation**, **constraint** and **bearing**, in primary knee replacements. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation/constraint/ bearing type	N	Time since primary					
		1 year	3 years	5 years	10 years	15 years	17 years
All types	1,357,077	0.49 (0.48-0.51)	1.75 (1.73-1.77)	2.54 (2.51-2.57)	4.13 (4.08-4.17)	5.84 (5.75-5.93)	6.43 (6.29-6.57)
Unclassified	22,273	*0.73 (0.63-0.86)*	*2.23 (2.04-2.44)*	*3.16 (2.93-3.41)*	*5.35 (5.02-5.70)*	*7.15 (6.63-7.71)*	*8.23 (7.32-9.25)*
All cemented	1,136,212	0.42 (0.41-0.43)	1.48 (1.45-1.50)	2.11 (2.08-2.14)	3.23 (3.19-3.27)	4.41 (4.33-4.50)	4.82 (4.69-4.96)
unconstrained, fixed	781,402	0.38 (0.37-0.39)	1.36 (1.34-1.39)	1.92 (1.89-1.96)	2.91 (2.86-2.96)	4.09 (3.99-4.19)	4.49 (4.33-4.64)
unconstrained, mobile	40,231	0.51 (0.44-0.58)	1.81 (1.68-1.95)	2.67 (2.51-2.84)	4.09 (3.87-4.31)	5.25 (4.92-5.61)	*5.37 (5.00-5.76)*
posterior-stabilised, fixed	270,635	0.48 (0.45-0.50)	1.69 (1.64-1.74)	2.50 (2.43-2.56)	3.89 (3.80-3.99)	5.09 (4.92-5.26)	5.63 (5.32-5.96)
posterior-stabilised, mobile	12,886	0.63 (0.51-0.78)	2.10 (1.87-2.37)	2.86 (2.57-3.17)	4.21 (3.84-4.62)	5.47 (4.86-6.16)	*5.47 (4.86-6.16)*
constrained condylar	10,698	0.90 (0.74-1.10)	2.09 (1.81-2.40)	2.71 (2.36-3.10)	4.02 (3.33-4.84)	*5.39 (3.81-7.59)*	*6.49 (4.19-9.98)*
monobloc polyethylene tibia	18,296	0.36 (0.28-0.46)	1.29 (1.13-1.48)	1.76 (1.56-1.98)	2.31 (2.05-2.61)	*2.80 (2.37-3.31)*	*2.80 (2.37-3.31)*
pre-assembled/hinged/linked	2,064	1.91 (1.39-2.63)	4.26 (3.41-5.32)	5.86 (4.79-7.16)	*8.99 (7.17-11.25)*	*10.65 (8.21-13.75)*	
All uncemented	47,061	0.56 (0.50-0.64)	2.09 (1.96-2.23)	2.84 (2.68-3.00)	4.06 (3.86-4.27)	5.35 (5.05-5.68)	5.65 (5.23-6.10)
unconstrained, fixed	18,187	0.64 (0.53-0.76)	2.28 (2.06-2.51)	2.97 (2.72-3.24)	4.18 (3.86-4.53)	5.38 (4.91-5.89)	*5.50 (4.98-6.07)*
unconstrained, mobile	25,152	0.50 (0.42-0.60)	1.92 (1.76-2.11)	2.69 (2.49-2.90)	3.78 (3.52-4.05)	5.02 (4.60-5.46)	*5.34 (4.75-6.00)*
posterior-stabilised, fixed	3,428	0.62 (0.40-0.95)	2.33 (1.86-2.91)	3.30 (2.72-4.00)	5.71 (4.83-6.75)	*7.90 (6.57-9.48)*	*8.81 (6.79-11.40)*
other constraints	294	0.68 (0.17-2.71)	*2.27 (1.02-5.00)*	*2.68 (1.28-5.55)*	*3.17 (1.59-6.26)*		
All hybrid	9,851	0.52 (0.39-0.68)	1.70 (1.46-1.99)	2.37 (2.08-2.71)	3.58 (3.19-4.02)	4.34 (3.85-4.90)	*4.56 (3.93-5.28)*
unconstrained, fixed	6,468	0.45 (0.32-0.65)	1.61 (1.33-1.96)	2.23 (1.88-2.63)	3.24 (2.81-3.74)	4.04 (3.49-4.68)	*4.30 (3.59-5.14)*
unconstrained, mobile	2,156	0.89 (0.57-1.39)	1.77 (1.29-2.44)	2.37 (1.78-3.14)	4.06 (3.06-5.39)	*4.72 (3.45-6.43)*	*4.72 (3.45-6.43)*
posterior-stabilised, fixed	819	0	2.14 (1.24-3.68)	3.67 (2.37-5.67)	5.77 (3.98-8.33)	*6.23 (4.29-8.99)*	
other constraints	408	0.49 (0.12-1.96)	2.24 (1.17-4.26)	3.00 (1.71-5.22)	*5.06 (3.19-7.98)*	*5.65 (3.57-8.88)*	
All unicondylar, cemented	96,187	0.98 (0.92-1.04)	3.71 (3.58-3.84)	5.62 (5.46-5.78)	10.41 (10.16-10.66)	15.74 (15.28-16.22)	17.59 (16.85-18.36)
fixed	40,281	0.63 (0.56-0.71)	2.62 (2.45-2.80)	4.04 (3.81-4.28)	7.55 (7.10-8.02)	11.38 (10.37-12.48)	*12.17 (10.73-13.79)*
mobile	49,610	1.28 (1.18-1.38)	4.37 (4.19-4.56)	6.49 (6.27-6.72)	11.67 (11.35-12.00)	17.30 (16.75-17.87)	19.30 (18.43-20.20)
monobloc polyethylene tibia	6,296	0.72 (0.54-0.97)	4.38 (3.89-4.94)	6.52 (5.90-7.19)	10.84 (9.98-11.78)	15.36 (14.03-16.80)	*16.82 (14.94-18.91)*
All unicondylar, uncemented/hybrid	29,268	1.21 (1.09-1.35)	2.73 (2.53-2.94)	3.89 (3.63-4.18)	7.61 (6.95-8.32)	*11.52 (9.88-13.42)*	
fixed	1,259	0.25 (0.08-0.78)	2.87 (1.99-4.14)	5.93 (4.46-7.86)	*10.18 (7.89-13.10)*	*13.76 (10.43-18.04)*	
mobile	27,606	1.27 (1.14-1.41)	2.73 (2.53-2.95)	3.79 (3.52-4.07)	7.55 (6.82-8.35)	*11.38 (9.41-13.74)*	
monobloc polyethylene tibia	403	0.50 (0.13-1.99)	2.29 (1.20-4.35)	3.36 (1.97-5.72)	*6.73 (4.49-10.03)*		
Patellofemoral	15,639	1.05 (0.90-1.23)	5.75 (5.38-6.15)	9.42 (8.93-9.94)	18.23 (17.45-19.05)	25.36 (23.94-26.85)	*26.71 (24.86-28.66)*
Multicompartmental	586	1.04 (0.47-2.29)	7.19 (5.32-9.67)	9.84 (7.60-12.69)	*14.02 (11.07-17.67)*		

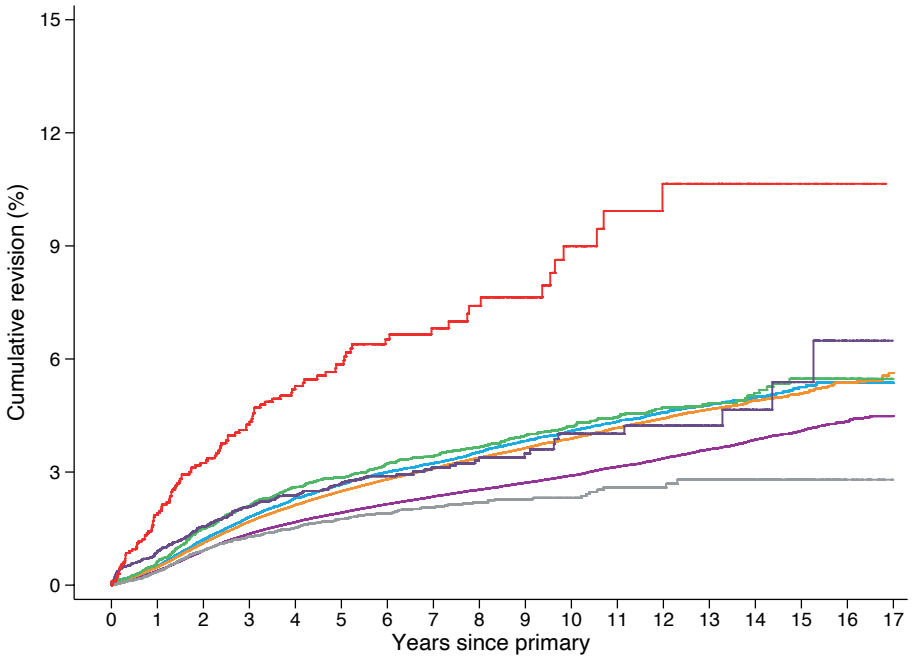
Note: Blank cells indicate the number at risk is below ten and thus estimates have been omitted as they are highly unreliable.

Table 3.K5 on the previous page 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 fixation type and bearing mobility (fixed or mobile). The table shows updated estimates at 1, 3, 5, 10, 15 and 17 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 TKRs and cemented TKRs 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 TKRs, this is most marked in the patellofemoral replacement and multicompartmental groups.

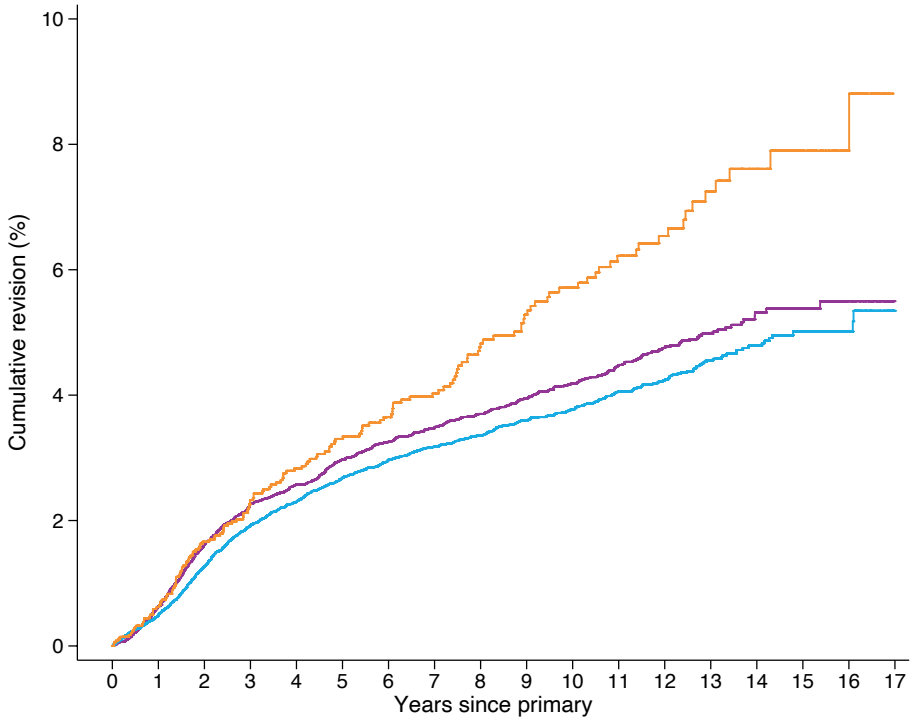
Figure 3.K4 (a) KM estimates of cumulative **revision** in **primary total cemented** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk								
Unconstrained, fixed	781,402	663,507	513,082	371,029	253,363	157,388	85,943	35,810	9,248
Unconstrained, mobile	40,231	36,435	31,549	26,687	21,866	16,616	10,262	3,991	736
Posterior–stabilised, fixed	270,635	232,924	183,470	136,590	95,517	60,572	32,828	13,416	3,548
Posterior–stabilised, mobile	12,886	11,986	10,731	9,023	6,835	4,802	2,867	1,259	*245*
Constrained condylar	10,698	7,939	5,161	2,829	1,261	630	360	*159*	*41*
Monobloc polyethylene tibia	18,296	15,524	11,605	8,112	4,548	2,070	1,004	307	*52*
Pre–assembled/hinged/linked	2,064	1,528	1,092	715	408	*238*	*123*	*48*	*12*

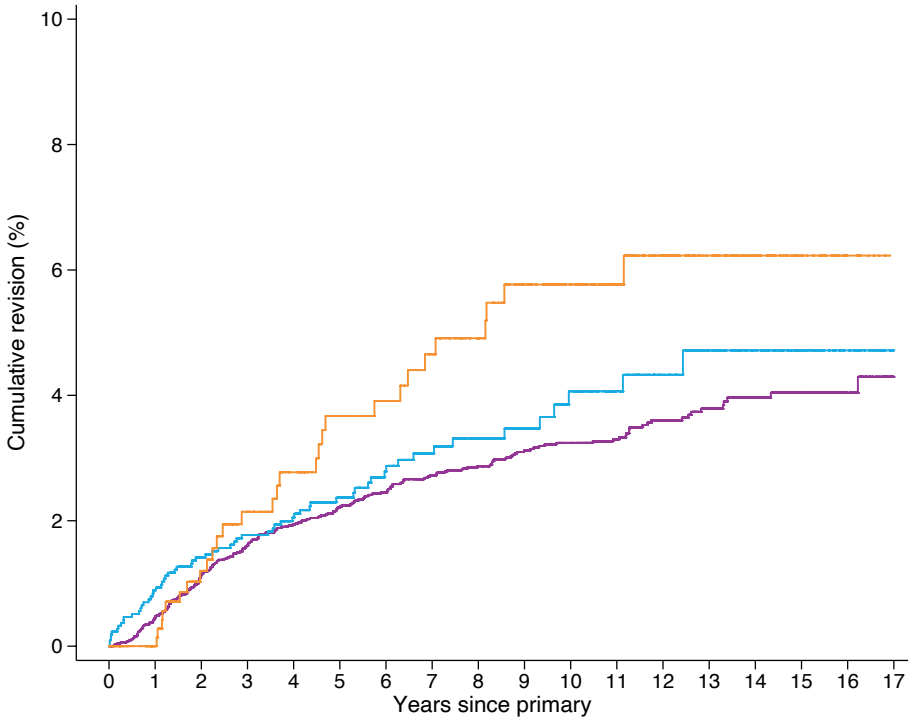
Figure 3.K4 (b) KM estimates of cumulative **revision** in **primary total uncemented** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk								
Unconstrained, fixed	18,187	16,001	13,623	11,543	9,811	7,467	4,492	1,715	450
Unconstrained, mobile	25,152	23,158	20,338	16,925	13,370	9,411	5,765	2,497	626
Posterior–stabilised, fixed	3,428	3,093	2,571	2,114	1,573	1,213	774	368	*102*

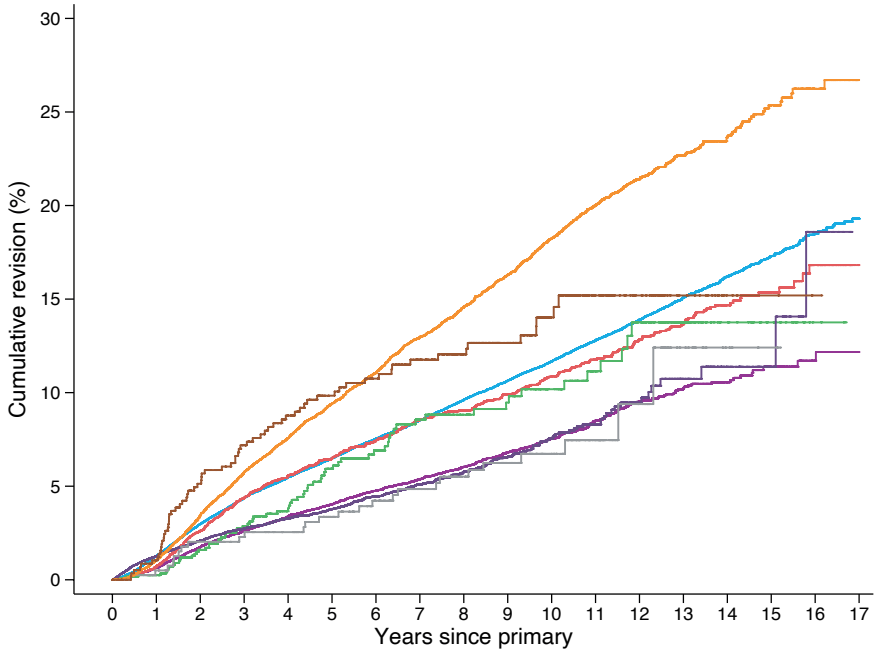
Figure 3.K4 (c) KM estimates of cumulative **revision** in **primary total hybrid** knee replacements by **constraint** and **bearing**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																
Unconstrained, fixed	6,468	6,288	6,056	5,800	5,582	5,325	5,072	4,791	4,457	4,134	3,747	3,135	2,434	1,809	1,333	926	462	*123*
Unconstrained, mobile	2,156	2,100	1,989	1,860	1,679	1,355	1,068	858	692	564	456	377	284	*201*	*146*	*92*	*56*	*14*
Posterior–stabilised, fixed	819	726	562	487	451	420	396	376	342	307	263	*213*	*160*	*121*	*80*	*45*	*18*	*7*

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	40,281	29,922	19,895	12,669	7,514	4,156	1,977	807	*190*
Cemented, mobile	49,610	45,876	40,751	34,697	27,704	19,975	11,956	5,082	1,365
Cemented, monobloc polyethylene tibia	6,296	5,716	4,891	4,076	3,250	2,408	1,596	755	*151*
Uncemented/hybrid, fixed	1,259	925	640	422	311	*212*	*112*	*34*	*6*
Uncemented/hybrid, mobile	27,606	20,124	11,598	5,581	2,721	1,146	340	*89*	*13*
Uncemented/hybrid, monobloc polyethylene tibia	403	383	367	323	270	*145*	*39*	*5*	
Patellofemoral	15,639	13,490	10,769	8,196	5,987	3,808	2,078	776	*193*
Multicompartmental	586	517	445	371	288	*152*	*43*	*8*	*4*

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

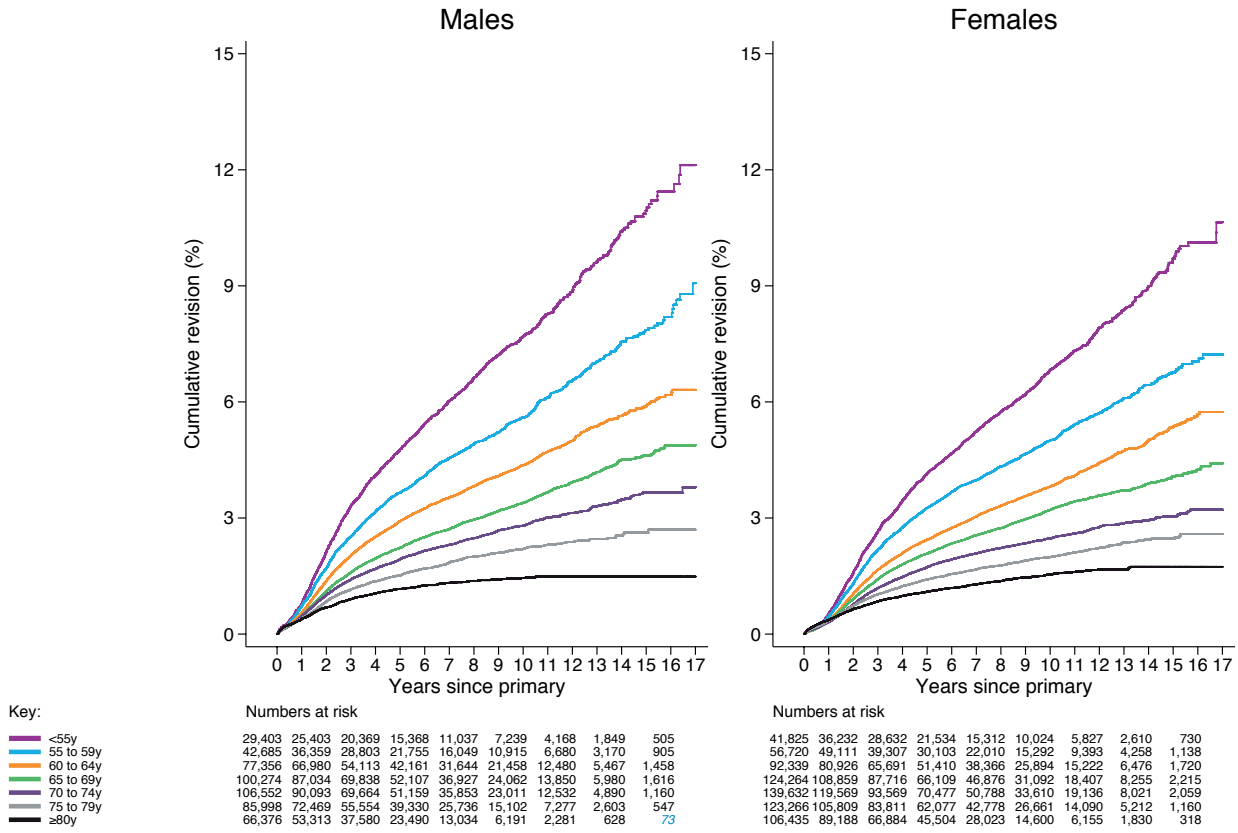
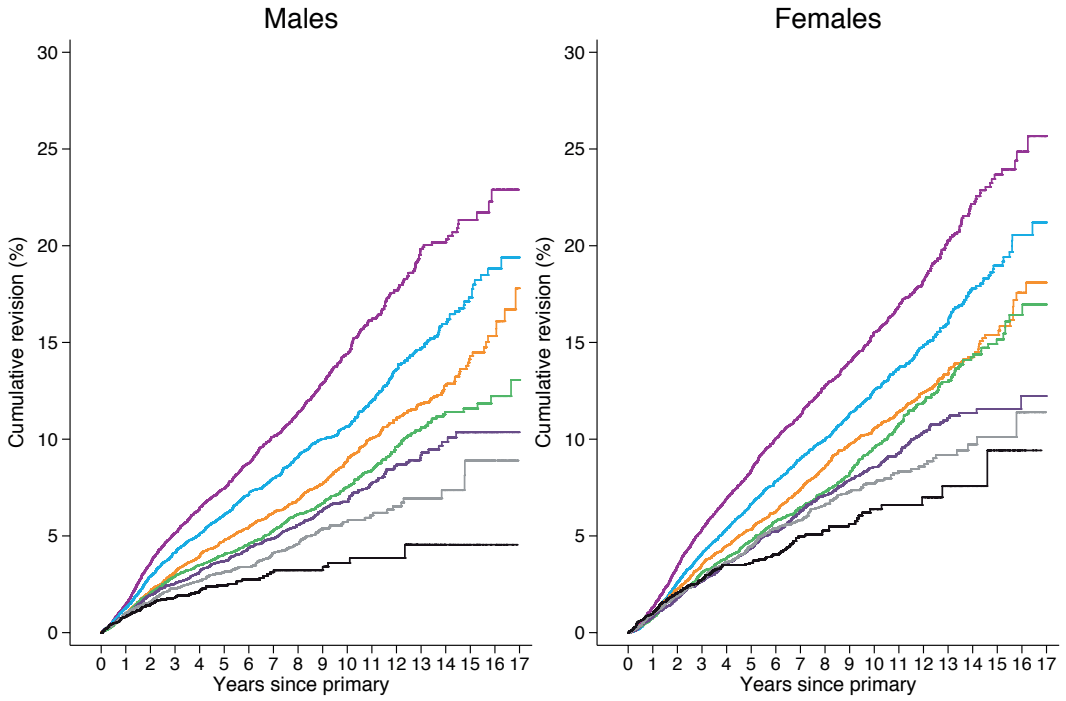


Figure 3.K5 (a) shows that the chance of revision after primary TKR is far higher in younger patient cohorts and that men were slightly more likely, overall, to have a first revision compared to women of comparable grouped age, if they were under the age of 70 when they underwent primary surgery.

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



Key:

	Numbers at risk								
<55y	10,410	8,674	6,670	4,902	3,468	2,232	1,184	477	*116*
55 to 59y	10,528	8,552	6,449	4,777	3,495	2,466	1,492	687	*192*
60 to 64y	13,329	11,058	8,626	6,653	5,018	3,533	2,098	870	*233*
65 to 69y	12,880	10,773	8,293	6,098	4,357	2,857	1,665	709	*198*
70 to 74y	10,132	8,091	5,804	4,153	2,927	1,931	1,028	404	*90*
75 to 79y	6,256	4,927	3,611	2,549	1,684	986	509	*193*	*50*
≥80y	3,820	2,849	1,887	1,169	731	383	*159*	*38*	*11*

Numbers at risk

11,711	9,797	7,483	5,498	3,880	2,557	1,419	596	*130*
9,498	7,884	6,107	4,646	3,486	2,481	1,531	745	*191*
10,095	8,518	6,785	5,274	4,022	2,774	1,652	660	*170*
9,752	8,136	6,369	4,739	3,462	2,384	1,331	589	*156*
8,302	6,708	4,898	3,562	2,609	1,799	1,051	468	*128*
5,325	4,277	3,217	2,370	1,725	1,166	672	267	*52*
3,417	2,702	1,943	1,378	906	493	*229*	*69*	*8*

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; please note the differences in the vertical axes between Figures 3.K5 (a) and (b).

Table 3.K6 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, 15 and 17 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All cases	**<55**	**41,956**	**1.02 (0.93-1.13)**	**4.00 (3.81-4.20)**	**5.77 (5.53-6.02)**	**9.91 (9.54-10.29)**	**14.21 (13.54-14.90)**	***15.45 (14.47-16.49)***	**59,858**	**0.74 (0.67-0.81)**	**3.55 (3.39-3.71)**	**5.58 (5.38-5.79)**	**9.83 (9.52-10.16)**	**14.17 (13.58-14.78)**	**15.20 (14.33-16.11)**
Unclassified	**<55**	**927**	**1.64 (0.99-2.71)**	**5.15 (3.87-6.84)**	**7.57 (5.95-9.60)**	**13.63 (11.27-16.44)**	***16.53 (13.65-19.95)***	***18.43 (14.16-23.79)***	**1,246**	**1.54 (0.99-2.40)**	**4.95 (3.86-6.34)**	**8.20 (6.75-9.95)**	**12.81 (10.88-15.05)**	***18.16 (14.85-22.12)***	***18.16 (14.85-22.12)***
All cemented	**<55**	**27,144**	**0.80 (0.70-0.91)**	**3.28 (3.06-3.51)**	**4.70 (4.43-4.98)**	**7.61 (7.21-8.03)**	**10.94 (10.17-11.77)**	***12.35 (11.09-13.74)***	**39,381**	**0.53 (0.46-0.61)**	**2.61 (2.45-2.78)**	**4.08 (3.87-4.31)**	**6.79 (6.47-7.14)**	**9.70 (9.07-10.37)**	***10.79 (9.71-11.98)***
unconstrained, fixed	<55	17,934	0.76 (0.64-0.90)	2.98 (2.73-3.26)	4.18 (3.87-4.51)	6.86 (6.38-7.37)	10.12 (9.14-11.19)	*12.18 (10.38-14.28)*	26,425	0.44 (0.37-0.53)	2.25 (2.07-2.45)	3.67 (3.42-3.93)	6.03 (5.65-6.44)	9.04 (8.25-9.89)	*9.69 (8.74-10.73)*
unconstrained, mobile	<55	1,362	1.04 (0.62-1.75)	4.14 (3.18-5.37)	6.08 (4.89-7.55)	8.60 (7.11-10.39)	*11.88 (9.61-14.65)*	*11.88 (9.61-14.65)*	1,747	0.75 (0.44-1.29)	2.96 (2.24-3.89)	4.93 (3.96-6.12)	7.58 (6.29-9.11)	*10.11 (7.97-12.78)*	*10.95 (8.40-14.20)*
posterior-stabilised, fixed	<55	6,562	0.70 (0.52-0.93)	3.66 (3.21-4.17)	5.61 (5.03-6.25)	9.36 (8.47-10.33)	*13.21 (11.55-15.09)*	*13.77 (11.84-15.98)*	9,553	0.62 (0.48-0.80)	3.27 (2.91-3.66)	4.84 (4.39-5.34)	8.57 (7.84-9.36)	11.61 (10.29-13.08)	*13.95 (10.84-17.85)*
posterior-stabilised, mobile	<55	706	1.29 (0.67-2.46)	4.26 (2.98-6.08)	5.52 (4.03-7.54)	7.87 (5.98-10.32)	*10.05 (7.14-14.06)*		786	1.29 (0.70-2.39)	4.58 (3.31-6.32)	5.94 (4.47-7.88)	8.27 (6.43-10.61)	*10.22 (7.52-13.80)*	
constrained condylar	<55	343	2.09 (1.00-4.33)	*4.63 (2.76-7.72)*	*5.71 (3.49-9.28)*	*7.60 (4.61-12.42)*			498	0.42 (0.10-1.65)	2.26 (1.22-4.17)	*2.64 (1.45-4.77)*	*4.51 (1.87-10.69)*		
monobloc polyethylene tibia	<55	169	*0.61 (0.09-4.27)*	*4.52 (2.18-9.25)*	*4.52 (2.18-9.25)*	*6.66 (3.44-12.68)*			277	1.11 (0.36-3.40)	*3.57 (1.87-6.76)*	*5.24 (2.98-9.14)*	*5.24 (2.98-9.14)*		
pre-assembled/hinged/ linked	<55	68	*2.94 (0.74-11.25)*	*4.59 (1.50-13.58)*	*8.75 (3.68-20.01)*	*13.46 (6.53-26.63)*			95	*4.28 (1.63-11.00)*	*9.24 (4.71-17.69)*	*12.28 (6.73-21.83)*			
All uncemented	**<55**	**1,895**	**0.70 (0.40-1.20)**	**3.94 (3.12-4.96)**	**5.67 (4.66-6.90)**	**8.82 (7.44-10.44)**	***11.87 (9.85-14.27)***	***11.87 (9.85-14.27)***	**1,993**	**0.71 (0.42-1.20)**	**3.70 (2.93-4.66)**	**5.33 (4.37-6.48)**	**7.75 (6.52-9.20)**	***10.76 (8.88-13.00)***	***10.76 (8.88-13.00)***
unconstrained, fixed	<55	816	0.87 (0.41-1.81)	4.21 (2.98-5.95)	5.74 (4.24-7.77)	8.48 (6.49-11.03)	*11.86 (9.04-15.50)*		811	1.01 (0.51-2.01)	3.09 (2.06-4.62)	4.16 (2.90-5.95)	6.84 (5.03-9.28)	*9.76 (6.97-13.58)*	
unconstrained, mobile	<55	830	0.74 (0.33-1.63)	3.92 (2.78-5.54)	5.77 (4.32-7.68)	9.03 (7.05-11.54)	*11.29 (8.45-15.01)*	*11.29 (8.45-15.01)*	982	0.61 (0.28-1.36)	3.70 (2.67-5.11)	5.56 (4.25-7.26)	7.64 (6.01-9.67)	*11.23 (8.63-14.55)*	
posterior-stabilised, fixed	<55	224	*0*	*2.82 (1.27-6.16)*	*4.51 (2.36-8.52)*	*9.27 (5.40-15.67)*	*13.95 (8.32-22.88)*		194	*0*	*6.03 (3.38-10.62)*	*8.50 (5.20-13.72)*	*11.92 (7.67-18.28)*	*11.92 (7.67-18.28)*	
other constraints	<55	25		*5.26 (0.76-31.88)*	*10.84 (2.82-36.85)*				6						
All hybrid	**<55**	**364**	**0.55 (0.14-2.19)**	**3.38 (1.93-5.88)**	**5.84 (3.81-8.92)**	***8.30 (5.75-11.91)***	***10.30 (7.16-14.71)***		**451**	**0.67 (0.22-2.06)**	**2.81 (1.60-4.89)**	**4.79 (3.12-7.34)**	***7.44 (5.22-10.57)***	***8.76 (6.06-12.58)***	***8.76 (6.06-12.58)***
unconstrained, fixed	<55	206	*0.49 (0.07-3.40)*	*2.95 (1.34-6.46)*	*5.55 (3.11-9.80)*	*6.63 (3.90-11.15)*	*9.59 (5.82-15.57)*		267	0.75 (0.19-2.96)	*3.49 (1.83-6.60)*	*5.08 (2.98-8.60)*	*6.87 (4.32-10.84)*	*8.74 (5.45-13.88)*	
unconstrained, mobile	<55	71		*2.82 (0.71-10.80)*	*4.62 (1.50-13.76)*	*11.94 (5.27-25.82)*			103	*0.98 (0.14-6.76)*	*2.00 (0.50-7.77)*	*3.20 (1.04-9.63)*	*7.62 (3.02-18.57)*		
posterior-stabilised, fixed	<55	48	*0*	*0*	*2.86 (0.41-18.60)*	*9.61 (3.18-27.09)*			55	*0*	*2.44 (0.35-16.08)*	*7.32 (2.42-21.00)*	*9.76 (3.78-23.94)*		

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
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)*			26			*3.85 (0.55-24.31)*	*11.54 (3.87-31.64)*		
All unicondylar, cemented	**<55**	**8,229**	**1.46 (1.22-1.75)**	**5.55 (5.05-6.09)**	**8.12 (7.51-8.79)**	**15.12 (14.13-16.18)**	**21.85 (20.14-23.69)**	*23.44 (21.04-26.07)*	**9,284**	**1.32 (1.11-1.58)**	**5.72 (5.25-6.24)**	**8.91 (8.30-9.57)**	**16.25 (15.31-17.25)**	**24.43 (22.64-26.34)**	*25.97 (23.47-28.68)*
fixed	<55	4,091	1.06 (0.79-1.43)	3.86 (3.27-4.55)	5.72 (4.94-6.60)	9.79 (8.44-11.35)	*13.34 (10.99-16.14)*		4,187	0.75 (0.52-1.07)	4.01 (3.41-4.72)	6.19 (5.38-7.11)	13.26 (11.56-15.19)	*17.77 (14.89-21.14)*	
mobile	<55	3,581	1.80 (1.41-2.29)	6.92 (6.13-7.82)	9.78 (8.83-10.83)	17.69 (16.31-19.16)	*25.10 (22.91-27.48)*	*26.30 (23.62-29.23)*	4,523	1.85 (1.49-2.28)	6.78 (6.07-7.56)	10.57 (9.68-11.53)	18.15 (16.92-19.47)	*26.32 (24.20-28.60)*	*27.69 (24.84-30.81)*
monobloc polyethylene tibia	<55	557	2.18 (1.24-3.80)	7.72 (5.74-10.34)	12.06 (9.50-15.24)	*21.11 (17.43-25.45)*	*26.28 (21.75-31.56)*		574	1.23 (0.59-2.56)	8.38 (6.35-11.04)	11.64 (9.19-14.70)	*17.57 (14.34-21.43)*	*29.83 (23.35-37.63)*	
All unicondylar, uncemented/hybrid	**<55**	**2,181**	**1.52 (1.08-2.15)**	**3.45 (2.72-4.38)**	**4.32 (3.44-5.41)**	*10.32 (8.06-13.17)*			**2,427**	**1.32 (0.93-1.88)**	**3.79 (3.04-4.72)**	**6.01 (4.93-7.32)**	*10.87 (8.51-13.84)*		
fixed	<55	103	*0*	*3.49 (1.12-10.53)*	*6.81 (2.83-15.91)*	*14.77 (7.28-28.67)*			131	*0*	*5.38 (2.26-12.50)*	*7.10 (3.18-15.43)*	*14.47 (6.53-30.37)*		
mobile	<55	2,057	1.61 (1.14-2.28)	3.43 (2.68-4.38)	4.17 (3.29-5.29)	*9.79 (7.45-12.82)*			2,273	1.41 (0.99-2.00)	3.76 (2.99-4.72)	5.94 (4.83-7.30)	*10.30 (7.88-13.40)*		
monobloc polyethylene tibia	<55	21		*5.00 (0.72-30.53)*	*5.00 (0.72-30.53)*				23			*4.35 (0.62-27.07)*			
Patellofemoral	**<55**	**1,151**	**2.58 (1.80-3.69)**	**9.71 (8.06-11.67)**	**14.04 (11.99-16.40)**	**23.29 (20.29-26.65)**	*34.94 (28.80-41.95)*		**4,970**	**0.84 (0.62-1.14)**	**6.24 (5.56-6.99)**	**10.01 (9.12-10.97)**	**20.30 (18.81-21.89)**	*27.90 (25.33-30.68)*	*28.61 (25.74-31.73)*
Multicompartmental	**<55**	**65**	*0*	*8.00 (3.41-18.16)*	*9.64 (4.45-20.21)*	*9.64 (4.45-20.21)*			**106**	*0.96 (0.14-6.63)*	*9.74 (5.36-17.35)*	*15.04 (9.34-23.72)*	*21.15 (13.34-32.60)*		
All cases	**55 to 64**	**147,781**	**0.71 (0.67-0.75)**	**2.48 (2.39-2.56)**	**3.60 (3.50-3.70)**	**5.73 (5.58-5.89)**	**8.22 (7.95-8.50)**	**9.28 (8.82-9.77)**	**175,504**	**0.47 (0.44-0.51)**	**2.17 (2.10-2.25)**	**3.27 (3.18-3.36)**	**5.42 (5.28-5.55)**	**7.66 (7.43-7.91)**	**8.45 (8.10-8.81)**
Unclassified	**55 to 64**	**2,649**	**1.00 (0.68-1.46)**	**3.02 (2.42-3.77)**	**3.78 (3.09-4.61)**	**6.51 (5.53-7.65)**	*8.77 (7.44-10.33)*	*9.93 (7.58-12.95)*	**3,046**	**0.63 (0.40-0.99)**	**2.72 (2.19-3.38)**	**3.49 (2.87-4.23)**	**6.06 (5.19-7.07)**	**8.25 (6.95-9.79)**	*10.44 (7.84-13.85)*
All cemented	**55 to 64**	**112,614**	**0.62 (0.58-0.67)**	**2.21 (2.12-2.30)**	**3.18 (3.07-3.29)**	**4.77 (4.61-4.93)**	**6.58 (6.31-6.86)**	**7.26 (6.81-7.73)**	**141,747**	**0.39 (0.35-0.42)**	**1.83 (1.76-1.91)**	**2.71 (2.62-2.80)**	**4.20 (4.07-4.34)**	**5.82 (5.59-6.07)**	**6.29 (5.97-6.62)**
unconstrained, fixed	55 to 64	78,517	0.55 (0.50-0.61)	2.05 (1.94-2.15)	2.91 (2.79-3.05)	4.27 (4.09-4.46)	6.09 (5.76-6.43)	6.71 (6.24-7.21)	98,177	0.36 (0.32-0.40)	1.69 (1.61-1.78)	2.43 (2.33-2.54)	3.73 (3.58-3.89)	5.41 (5.12-5.71)	5.97 (5.57-6.40)
unconstrained, mobile	55 to 64	4,584	0.77 (0.55-1.07)	2.66 (2.23-3.18)	3.76 (3.23-4.38)	5.75 (5.05-6.53)	7.47 (6.40-8.72)	*7.47 (6.40-8.72)*	5,553	0.47 (0.32-0.69)	2.09 (1.74-2.52)	3.12 (2.67-3.63)	5.00 (4.40-5.68)	6.46 (5.60-7.45)	*6.76 (5.75-7.95)*
posterior-stabilised, fixed	55 to 64	25,706	0.76 (0.66-0.88)	2.59 (2.39-2.80)	3.82 (3.57-4.08)	5.94 (5.59-6.32)	8.00 (7.42-8.63)	*9.05 (7.87-10.40)*	33,215	0.44 (0.37-0.51)	2.19 (2.03-2.36)	3.40 (3.20-3.62)	5.26 (4.97-5.57)	6.76 (6.28-7.26)	*7.05 (6.43-7.72)*
posterior-stabilised, mobile	55 to 64	1,882	0.86 (0.53-1.40)	2.47 (1.85-3.29)	3.06 (2.35-3.96)	4.81 (3.84-6.01)	*5.46 (4.25-6.99)*	*5.46 (4.25-6.99)*	2,141	0.33 (0.16-0.69)	1.79 (1.30-2.47)	3.03 (2.36-3.87)	4.63 (3.76-5.70)	*6.65 (5.26-8.39)*	*6.65 (5.26-8.39)*

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
constrained condylar	55 to 64	936	0.87 (0.44-1.74)	1.99 (1.21-3.24)	3.68 (2.47-5.47)	*4.30 (2.76-6.67)*	*4.30 (2.76-6.67)*		1,287	0.57 (0.27-1.19)	1.87 (1.20-2.89)	2.29 (1.52-3.46)	*6.56 (3.87-11.02)*	*7.78 (4.54-13.14)*	
monobloc polyethylene tibia	55 to 64	887	0.81 (0.39-1.70)	1.97 (1.21-3.19)	3.26 (2.19-4.85)	*4.16 (2.79-6.20)*	*4.16 (2.79-6.20)*		1,168	0.26 (0.08-0.80)	1.55 (0.95-2.53)	2.35 (1.54-3.57)	*3.76 (2.45-5.74)*	*5.58 (3.49-8.85)*	
pre-assembled/hinged/ linked	55 to 64	102	*5.07 (2.14-11.75)*	*12.01 (6.81-20.74)*	*14.95 (8.89-24.56)*	*21.35 (12.44-35.23)*			206	*2.52 (1.06-5.95)*	*3.11 (1.41-6.80)*	*4.44 (2.23-8.73)*	*8.45 (4.35-16.07)*		
All uncemented	**55 to 64**	**6,333**	**0.59 (0.43-0.81)**	**2.33 (1.98-2.74)**	**3.29 (2.86-3.79)**	**5.15 (4.56-5.80)**	**6.53 (5.76-7.40)**	*7.54 (6.08-9.32)*	**6,023**	**0.62 (0.45-0.86)**	**2.56 (2.18-3.00)**	**3.66 (3.19-4.19)**	**5.32 (4.73-5.99)**	**7.33 (6.40-8.38)**	*7.33 (6.40-8.38)*
unconstrained, fixed	55 to 64	2,557	0.52 (0.30-0.89)	2.52 (1.96-3.24)	3.44 (2.76-4.29)	5.70 (4.74-6.85)	*7.14 (5.84-8.71)*	*7.14 (5.84-8.71)*	2,263	0.68 (0.41-1.12)	2.90 (2.26-3.71)	3.73 (2.98-4.65)	5.47 (4.52-6.62)	*7.26 (5.91-8.89)*	*7.26 (5.91-8.89)*
unconstrained, mobile	55 to 64	3,108	0.52 (0.32-0.85)	2.21 (1.74-2.81)	3.34 (2.74-4.07)	4.56 (3.83-5.44)	*5.99 (5.00-7.17)*	*6.99 (5.08-9.59)*	3,323	0.55 (0.34-0.86)	2.29 (1.83-2.87)	3.53 (2.93-4.25)	4.94 (4.18-5.82)	6.71 (5.48-8.21)	*6.71 (5.48-8.21)*
posterior-stabilised, fixed	55 to 64	613	1.15 (0.55-2.40)	2.01 (1.15-3.51)	2.39 (1.42-4.00)	5.97 (4.07-8.72)	*7.11 (4.82-10.43)*		408	0.99 (0.37-2.61)	3.06 (1.75-5.33)	4.47 (2.80-7.10)	*7.97 (5.50-11.48)*	*12.48 (8.73-17.68)*	
other constraints	55 to 64	55	*1.82 (0.26-12.21)*	*3.95 (1.00-14.97)*	*3.95 (1.00-14.97)*	*6.48 (2.11-18.98)*			29	*0*	*0*	*0*			
All hybrid	**55 to 64**	**1,093**	**0.37 (0.14-0.98)**	**1.62 (1.01-2.60)**	**3.06 (2.16-4.32)**	**4.71 (3.51-6.30)**	*7.05 (5.28-9.39)*	*8.36 (5.66-12.27)*	**1,289**	**0.55 (0.26-1.15)**	**2.26 (1.57-3.26)**	**3.23 (2.37-4.40)**	**5.10 (3.94-6.60)**	*5.47 (4.22-7.08)*	*5.47 (4.22-7.08)*
unconstrained, fixed	55 to 64	686	0.29 (0.07-1.17)	1.50 (0.81-2.76)	2.89 (1.86-4.50)	4.29 (2.96-6.20)	*6.41 (4.49-9.12)*	*7.92 (4.95-12.55)*	812	0.87 (0.42-1.81)	2.64 (1.73-4.03)	3.70 (2.59-5.28)	5.29 (3.90-7.14)	*5.76 (4.26-7.76)*	*5.76 (4.26-7.76)*
unconstrained, mobile	55 to 64	221	*0.45 (0.06-3.17)*	*0.45 (0.06-3.17)*	*2.03 (0.76-5.33)*	*2.03 (0.76-5.33)*	*3.81 (1.34-10.62)*		324	0	1.29 (0.48-3.39)	*1.64 (0.69-3.90)*	*5.99 (2.82-12.49)*	*5.99 (2.82-12.49)*	
posterior-stabilised, fixed	55 to 64	110	*0*	*2.46 (0.61-9.59)*	*4.03 (1.30-12.15)*	*7.67 (3.20-17.75)*			100	*0*	*2.50 (0.63-9.64)*	*5.33 (2.03-13.61)*	*8.43 (3.86-17.89)*		
other constraints	55 to 64	76	*1.32 (0.19-8.97)*	*5.28 (2.02-13.46)*	*6.62 (2.81-15.17)*	*12.75 (6.34-24.71)*			53		*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*	*1.92 (0.27-12.88)*		
All unicondylar, cemented	**55 to 64**	**18,434**	**0.95 (0.81-1.10)**	**3.78 (3.50-4.08)**	**5.68 (5.32-6.06)**	**10.07 (9.53-10.64)**	**16.06 (15.02-17.16)**	*18.78 (16.91-20.83)*	**15,364**	**0.90 (0.76-1.07)**	**3.99 (3.68-4.33)**	**6.29 (5.89-6.72)**	**11.89 (11.27-12.55)**	**17.60 (16.52-18.74)**	*20.10 (18.46-21.87)*
fixed	55 to 64	7,970	0.52 (0.38-0.71)	2.25 (1.92-2.65)	3.83 (3.35-4.39)	6.97 (6.08-7.99)	*12.42 (9.98-15.41)*	*12.42 (9.98-15.41)*	6,002	0.61 (0.44-0.85)	3.09 (2.63-3.62)	4.80 (4.18-5.50)	8.66 (7.57-9.90)	*13.53 (10.91-16.71)*	
mobile	55 to 64	9,297	1.32 (1.11-1.58)	4.75 (4.33-5.21)	6.78 (6.27-7.32)	11.50 (10.80-12.25)	17.70 (16.45-19.03)	*20.89 (18.67-23.35)*	8,308	1.17 (0.96-1.43)	4.49 (4.06-4.96)	7.08 (6.53-7.67)	13.14 (12.35-13.98)	19.23 (17.95-20.59)	*21.90 (20.00-23.95)*
monobloc polyethylene tibia	55 to 64	1,167	0.69 (0.35-1.38)	4.75 (3.64-6.19)	6.91 (5.53-8.63)	11.63 (9.68-13.95)	*16.29 (13.62-19.43)*		1,054	0.39 (0.14-1.02)	4.59 (3.45-6.08)	6.47 (5.09-8.21)	11.86 (9.82-14.29)	*15.25 (12.52-18.50)*	

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All unicondylar, uncemented/hybrid	55 to 64	5,423	1.55 (1.25-1.93)	2.73 (2.30-3.24)	3.84 (3.27-4.51)	6.98 (5.69-8.54)	*10.75 (7.31-15.65)*		4,229	1.09 (0.81-1.47)	2.95 (2.44-3.58)	4.29 (3.59-5.11)	9.38 (7.61-11.55)	*11.55 (8.96-14.84)*	
fixed	55 to 64	181	*0*	*1.33 (0.33-5.25)*	*7.13 (3.59-13.92)*	*10.15 (5.43-18.57)*			172	*0*	*2.12 (0.69-6.46)*	*4.98 (2.24-10.90)*	*12.17 (6.29-22.82)*		
mobile	55 to 64	5,189	1.63 (1.31-2.02)	2.81 (2.37-3.34)	3.74 (3.17-4.40)	6.72 (5.36-8.41)	*10.19 (6.40-16.02)*		3,969	1.14 (0.85-1.53)	2.98 (2.45-3.63)	4.25 (3.53-5.10)	*9.30 (7.37-11.71)*	*9.78 (7.69-12.41)*	
monobloc polyethylene tibia	55 to 64	53	*0*	*0*	*0*	*7.11 (2.35-20.48)*			88	*1.15 (0.16-7.88)*	*3.48 (1.13-10.39)*	*4.67 (1.78-11.96)*	*8.00 (3.57-17.41)*		
Patellofemoral	55 to 64	1,124	1.82 (1.18-2.81)	5.83 (4.56-7.45)	10.66 (8.84-12.82)	22.38 (19.30-25.86)	*28.95 (24.61-33.87)*		3,701	0.85 (0.60-1.21)	5.41 (4.70-6.23)	9.43 (8.46-10.51)	17.63 (16.14-19.24)	*24.70 (22.24-27.38)*	*27.44 (23.59-31.77)*
Multicompartmental	55 to 64	111	*0*	*6.45 (3.13-13.05)*	*8.35 (4.43-15.43)*	*12.69 (7.26-21.67)*			105	*1.94 (0.49-7.54)*	*8.14 (4.15-15.63)*	*10.54 (5.79-18.76)*	*18.01 (10.52-29.84)*		
All cases	65 to 74	234,380	0.53 (0.50-0.56)	1.65 (1.60-1.71)	2.30 (2.23-2.37)	3.57 (3.47-3.67)	4.90 (4.72-5.08)	5.24 (4.98-5.52)	288,646	0.36 (0.34-0.38)	1.44 (1.40-1.49)	2.12 (2.07-2.18)	3.36 (3.28-3.45)	4.41 (4.27-4.55)	4.74 (4.54-4.95)
Unclassified	65 to 74	3,710	0.60 (0.40-0.91)	1.90 (1.49-2.40)	2.85 (2.34-3.46)	4.41 (3.72-5.21)	*5.93 (4.81-7.30)*	*7.89 (5.69-10.90)*	4,376	0.65 (0.45-0.94)	1.79 (1.43-2.24)	2.49 (2.06-3.02)	4.28 (3.65-5.00)	5.31 (4.42-6.38)	*5.31 (4.42-6.38)*
All cemented	65 to 74	196,147	0.47 (0.44-0.50)	1.49 (1.43-1.55)	2.08 (2.01-2.15)	3.09 (2.99-3.19)	4.17 (3.99-4.36)	4.40 (4.15-4.66)	252,964	0.32 (0.29-0.34)	1.27 (1.22-1.31)	1.86 (1.80-1.92)	2.79 (2.71-2.88)	3.51 (3.38-3.65)	3.76 (3.57-3.97)
unconstrained, fixed	65 to 74	138,398	0.45 (0.42-0.49)	1.38 (1.31-1.44)	1.90 (1.82-1.98)	2.75 (2.64-2.87)	3.81 (3.59-4.03)	4.02 (3.71-4.35)	174,033	0.27 (0.24-0.29)	1.16 (1.11-1.22)	1.68 (1.61-1.75)	2.53 (2.44-2.63)	3.29 (3.12-3.46)	3.51 (3.26-3.77)
unconstrained, mobile	65 to 74	6,578	0.48 (0.34-0.68)	1.82 (1.52-2.18)	2.63 (2.26-3.07)	4.00 (3.49-4.57)	4.96 (4.24-5.80)	*4.96 (4.24-5.80)*	8,531	0.43 (0.31-0.59)	1.64 (1.39-1.94)	2.37 (2.06-2.74)	3.62 (3.20-4.10)	4.29 (3.74-4.91)	*4.29 (3.74-4.91)*
posterior-stabilised, fixed	65 to 74	44,770	0.53 (0.46-0.60)	1.72 (1.59-1.85)	2.43 (2.28-2.59)	3.83 (3.61-4.07)	4.99 (4.61-5.41)	*5.28 (4.79-5.81)*	61,065	0.40 (0.35-0.45)	1.42 (1.32-1.52)	2.20 (2.07-2.33)	3.29 (3.11-3.47)	3.93 (3.69-4.19)	4.32 (3.95-4.72)
posterior-stabilised, mobile	65 to 74	2,025	0.45 (0.23-0.86)	1.91 (1.39-2.63)	2.59 (1.97-3.42)	3.37 (2.59-4.38)	*4.05 (3.08-5.31)*		2,431	0.58 (0.34-0.98)	1.90 (1.43-2.54)	2.57 (1.99-3.30)	3.79 (3.01-4.77)	*4.85 (3.52-6.66)*	*4.85 (3.52-6.66)*
constrained condylar	65 to 74	1,442	0.80 (0.45-1.45)	2.32 (1.60-3.35)	3.22 (2.30-4.49)	*4.85 (3.16-7.42)*	*11.04 (4.90-23.84)*		2,455	0.88 (0.57-1.34)	2.13 (1.59-2.84)	2.78 (2.11-3.66)	*3.01 (2.28-3.96)*	*3.01 (2.28-3.96)*	
monobloc polyethylene tibia	65 to 74	2,769	0.11 (0.04-0.34)	1.49 (1.08-2.06)	1.99 (1.48-2.66)	2.54 (1.92-3.37)	*2.95 (2.05-4.22)*		4,107	0.35 (0.21-0.59)	1.48 (1.14-1.92)	2.01 (1.59-2.54)	2.60 (2.07-3.28)	*2.84 (2.17-3.70)*	
pre-assembled/hinged/ linked	65 to 74	165	*3.12 (1.31-7.34)*	*8.22 (4.74-14.06)*	*10.34 (6.18-17.04)*	*13.83 (8.67-21.70)*			342	1.23 (0.46-3.25)	*3.44 (1.86-6.34)*	*5.23 (3.11-8.73)*	*6.60 (3.71-11.61)*	*6.60 (3.71-11.61)*	
All uncemented	65 to 74	8,955	0.57 (0.43-0.75)	1.81 (1.55-2.12)	2.31 (2.01-2.67)	3.35 (2.95-3.82)	4.25 (3.67-4.92)	*4.25 (3.67-4.92)*	8,926	0.48 (0.35-0.64)	2.24 (1.95-2.58)	2.97 (2.62-3.36)	3.82 (3.40-4.28)	4.54 (4.00-5.16)	*5.07 (4.20-6.12)*
unconstrained, fixed	65 to 74	3,501	0.61 (0.40-0.94)	2.13 (1.69-2.70)	2.78 (2.25-3.42)	3.79 (3.13-4.60)	*4.26 (3.49-5.19)*	*4.26 (3.49-5.19)*	3,221	0.47 (0.29-0.78)	2.54 (2.03-3.17)	3.12 (2.54-3.82)	4.01 (3.33-4.84)	*4.80 (3.93-5.85)*	*5.29 (4.10-6.83)*

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
unconstrained, mobile	65 to 74	4,749	0.47 (0.31-0.71)	1.55 (1.23-1.95)	1.92 (1.55-2.37)	3.00 (2.48-3.62)	*4.15 (3.33-5.17)*	*4.15 (3.33-5.17)*	5,161	0.51 (0.35-0.74)	2.09 (1.73-2.53)	2.91 (2.47-3.43)	3.71 (3.18-4.32)	4.23 (3.59-4.97)	*4.84 (3.64-6.42)*
posterior-stabilised, fixed	65 to 74	613	0.99 (0.45-2.19)	2.05 (1.17-3.58)	2.89 (1.77-4.69)	*3.81 (2.41-6.01)*	*5.28 (3.15-8.81)*		512	0.20 (0.03-1.38)	2.13 (1.15-3.93)	2.86 (1.67-4.88)	*3.94 (2.39-6.46)*	*6.05 (3.23-11.20)*	
other constraints	65 to 74	92	*1.09 (0.15-7.47)*	*2.32 (0.58-9.00)*	*2.32 (0.58-9.00)*	*2.32 (0.58-9.00)*			32	*0*	*0*	*0*			
All hybrid	**65 to 74**	**1,724**	**0.41 (0.20-0.86)**	**1.65 (1.13-2.40)**	**1.93 (1.36-2.73)**	**2.83 (2.08-3.85)**	*3.18 (2.32-4.34)*	*3.18 (2.32-4.34)*	**2,006**	**0.55 (0.31-1.00)**	**1.67 (1.18-2.35)**	**1.90 (1.37-2.63)**	**2.69 (2.02-3.58)**	**3.28 (2.44-4.39)**	*3.28 (2.44-4.39)*
unconstrained, fixed	65 to 74	1,208	0.25 (0.08-0.78)	1.55 (0.98-2.46)	1.84 (1.20-2.80)	2.65 (1.83-3.82)	*2.82 (1.95-4.07)*	*2.82 (1.95-4.07)*	1,322	0.31 (0.11-0.81)	1.25 (0.77-2.03)	1.25 (0.77-2.03)	2.09 (1.41-3.08)	2.81 (1.91-4.14)	*2.81 (1.91-4.14)*
unconstrained, mobile	65 to 74	317	1.28 (0.48-3.39)	1.97 (0.89-4.33)	*2.35 (1.13-4.88)*	*3.53 (1.80-6.84)*	*5.54 (2.43-12.38)*		479	1.47 (0.70-3.05)	3.23 (1.96-5.30)	4.06 (2.57-6.39)	*4.87 (3.13-7.56)*	*4.87 (3.13-7.56)*	
posterior-stabilised, fixed	65 to 74	132	*0*	*2.71 (0.88-8.17)*	*2.71 (0.88-8.17)*	*4.65 (1.64-12.81)*			162	*0*	*1.00 (0.14-6.89)*	*2.13 (0.53-8.25)*	*2.13 (0.53-8.25)*	*2.13 (0.53-8.25)*	
other constraints	65 to 74	67	*0*	*0*	*0*	*0*			43			*0*	*0*		
All unicondylar, cemented	**65 to 74**	**17,189**	**0.86 (0.73-1.01)**	**2.89 (2.63-3.16)**	**4.09 (3.77-4.42)**	**7.48 (6.97-8.02)**	**11.33 (10.43-12.30)**	*12.36 (10.85-14.06)*	**13,598**	**0.76 (0.62-0.92)**	**2.95 (2.67-3.27)**	**4.69 (4.31-5.09)**	**9.25 (8.63-9.91)**	**13.73 (12.68-14.85)**	*15.05 (13.60-16.65)*
fixed	65 to 74	7,134	0.60 (0.45-0.82)	2.12 (1.78-2.53)	2.86 (2.42-3.37)	5.00 (4.18-5.98)	*8.03 (6.15-10.45)*		5,282	0.44 (0.29-0.67)	1.93 (1.56-2.40)	2.98 (2.47-3.61)	5.80 (4.73-7.12)	*6.84 (5.44-8.59)*	
mobile	65 to 74	8,952	1.10 (0.91-1.34)	3.35 (2.99-3.75)	4.66 (4.23-5.13)	8.52 (7.87-9.22)	12.50 (11.43-13.66)	*13.81 (11.94-15.94)*	7,472	1.03 (0.82-1.28)	3.53 (3.13-3.98)	5.56 (5.05-6.13)	10.75 (9.97-11.59)	15.74 (14.47-17.10)	*16.96 (15.34-18.74)*
monobloc polyethylene tibia	65 to 74	1,103	0.46 (0.19-1.11)	3.22 (2.30-4.50)	5.34 (4.09-6.96)	7.00 (5.48-8.92)	*10.66 (8.17-13.85)*	*10.66 (8.17-13.85)*	844	0.24 (0.06-0.96)	3.18 (2.16-4.67)	4.62 (3.34-6.38)	7.11 (5.36-9.39)	*10.71 (8.09-14.10)*	
All unicondylar, uncemented/hybrid	**65 to 74**	**5,823**	**1.13 (0.88-1.45)**	**2.38 (1.99-2.84)**	**3.27 (2.75-3.89)**	**5.46 (4.39-6.79)**			**4,456**	**0.97 (0.71-1.31)**	**2.75 (2.26-3.34)**	**4.18 (3.48-5.03)**	*8.25 (6.45-10.51)*		
fixed	65 to 74	176	*0.60 (0.08-4.15)*	*5.37 (2.71-10.48)*	*8.39 (4.66-14.85)*	*11.57 (6.59-19.87)*			216	*0*	*2.13 (0.69-6.50)*	*6.26 (2.99-12.87)*	*8.91 (4.62-16.81)*		
mobile	65 to 74	5,583	1.14 (0.89-1.47)	2.24 (1.85-2.70)	3.01 (2.50-3.61)	*5.23 (4.08-6.71)*			4,154	1.03 (0.76-1.40)	2.78 (2.27-3.39)	4.03 (3.32-4.88)	*9.11 (6.76-12.22)*		
monobloc polyethylene tibia	65 to 74	64	*1.56 (0.22-10.58)*	*4.74 (1.55-13.97)*	*6.44 (2.46-16.27)*	*8.20 (3.49-18.63)*			86	*0*	*2.41 (0.61-9.29)*	*3.64 (1.19-10.88)*	*3.64 (1.19-10.88)*		

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
Patellofemoral	65 to 74	762	1.87 (1.11-3.14)	6.42 (4.83-8.51)	9.70 (7.64-12.28)	*18.12 (14.77-22.13)*	*20.76 (15.32-27.81)*		2,245	0.81 (0.51-1.29)	5.19 (4.31-6.23)	8.17 (7.04-9.48)	16.68 (14.83-18.73)	*24.85 (21.07-29.17)*	*26.08 (21.76-31.06)*
Multicompartmental	65 to 74	70	*2.86 (0.72-10.94)*	*5.90 (2.25-14.97)*	*9.59 (4.39-20.24)*	*13.44 (6.90-25.27)*			75	*1.35 (0.19-9.21)*	*6.80 (2.89-15.56)*	*8.46 (3.88-17.93)*	*10.15 (4.95-20.23)*		
All cases	≥75	165,422	0.43 (0.40-0.47)	1.12 (1.07-1.18)	1.47 (1.41-1.54)	2.14 (2.04-2.24)	2.64 (2.43-2.86)	*2.69 (2.46-2.95)*	243,530	0.39 (0.37-0.42)	1.02 (0.98-1.07)	1.40 (1.35-1.45)	2.04 (1.97-2.12)	2.53 (2.40-2.66)	2.66 (2.48-2.85)
Unclassified	≥75	2,438	0.34 (0.17-0.67)	0.98 (0.65-1.49)	1.59 (1.13-2.23)	2.97 (2.24-3.94)	*3.12 (2.35-4.14)*		3,881	0.63 (0.42-0.93)	1.28 (0.96-1.70)	1.77 (1.38-2.27)	2.64 (2.11-3.30)	*3.09 (2.39-3.99)*	*3.09 (2.39-3.99)*
All cemented	≥75	145,501	0.40 (0.36-0.43)	1.04 (0.99-1.10)	1.36 (1.29-1.42)	1.90 (1.81-2.00)	2.27 (2.09-2.46)	*2.34 (2.12-2.58)*	220,714	0.35 (0.33-0.38)	0.93 (0.89-0.97)	1.26 (1.21-1.31)	1.79 (1.72-1.86)	2.16 (2.05-2.29)	2.27 (2.11-2.44)
unconstrained, fixed	≥75	100,707	0.37 (0.33-0.41)	0.99 (0.92-1.05)	1.27 (1.19-1.35)	1.78 (1.67-1.90)	2.15 (1.93-2.39)	*2.26 (1.97-2.59)*	147,211	0.32 (0.29-0.35)	0.88 (0.83-0.93)	1.17 (1.11-1.23)	1.69 (1.60-1.78)	2.02 (1.89-2.16)	*2.07 (1.91-2.24)*
unconstrained, mobile	≥75	4,367	0.38 (0.23-0.61)	1.00 (0.74-1.37)	1.51 (1.16-1.96)	1.96 (1.52-2.52)	*2.18 (1.61-2.94)*		7,509	0.42 (0.30-0.60)	0.94 (0.74-1.19)	1.37 (1.11-1.68)	1.86 (1.53-2.27)	*2.21 (1.77-2.76)*	*2.21 (1.77-2.76)*
posterior-stabilised, fixed	≥75	34,252	0.47 (0.40-0.55)	1.17 (1.06-1.30)	1.56 (1.42-1.71)	2.23 (2.02-2.45)	2.66 (2.30-3.08)	*2.66 (2.30-3.08)*	55,512	0.38 (0.33-0.43)	1.02 (0.94-1.11)	1.42 (1.32-1.53)	1.99 (1.85-2.15)	2.50 (2.22-2.81)	*2.77 (2.33-3.30)*
posterior-stabilised, mobile	≥75	1,147	0.53 (0.24-1.18)	1.39 (0.84-2.29)	1.52 (0.93-2.47)	1.84 (1.15-2.95)	*1.84 (1.15-2.95)*		1,768	0.52 (0.27-0.99)	1.01 (0.63-1.62)	1.37 (0.91-2.09)	1.99 (1.33-2.98)	*2.61 (1.65-4.11)*	
constrained condylar	≥75	1,157	0.82 (0.43-1.56)	1.79 (1.11-2.88)	2.01 (1.25-3.25)	*2.59 (1.46-4.58)*			2,580	1.13 (0.78-1.63)	1.76 (1.29-2.41)	1.94 (1.42-2.65)	*2.27 (1.63-3.18)*		
monobloc polyethylene tibia	≥75	3,643	0.28 (0.15-0.52)	1.02 (0.73-1.44)	1.25 (0.91-1.72)	1.57 (1.15-2.15)			5,276	0.45 (0.30-0.67)	0.83 (0.61-1.12)	1.10 (0.83-1.46)	1.43 (1.07-1.91)	*1.43 (1.07-1.91)*	
pre-assembled/hinged/ linked	≥75	228	*0.46 (0.07-3.23)*	*2.54 (1.06-6.00)*	*3.26 (1.46-7.20)*	*4.43 (2.03-9.52)*			858	1.39 (0.77-2.51)	2.82 (1.82-4.35)	3.79 (2.52-5.69)	*6.04 (3.69-9.81)*		
All uncemented	≥75	5,684	0.52 (0.36-0.75)	1.30 (1.03-1.65)	1.71 (1.38-2.11)	2.26 (1.86-2.76)	*2.26 (1.86-2.76)*	*2.26 (1.86-2.76)*	7,252	0.55 (0.40-0.75)	1.30 (1.05-1.59)	1.61 (1.33-1.95)	1.95 (1.62-2.33)	*2.74 (2.17-3.47)*	*2.74 (2.17-3.47)*
unconstrained, fixed	≥75	2,227	0.61 (0.35-1.04)	1.02 (0.67-1.56)	1.47 (1.01-2.13)	1.83 (1.28-2.60)	*1.83 (1.28-2.60)*		2,791	0.77 (0.50-1.18)	1.59 (1.18-2.15)	2.01 (1.53-2.64)	2.01 (1.53-2.64)	*2.71 (1.94-3.79)*	
unconstrained, mobile	≥75	3,047	0.50 (0.30-0.83)	1.34 (0.98-1.84)	1.69 (1.27-2.25)	2.34 (1.79-3.04)	*2.34 (1.79-3.04)*		3,952	0.41 (0.25-0.67)	1.15 (0.85-1.54)	1.33 (1.01-1.76)	1.81 (1.40-2.35)	*2.52 (1.81-3.51)*	*2.52 (1.81-3.51)*
posterior-stabilised, fixed	≥75	366	0.28 (0.04-1.95)	2.48 (1.24-4.90)	*3.22 (1.74-5.92)*	*4.29 (2.42-7.55)*			498	0.41 (0.10-1.61)	0.84 (0.32-2.23)	1.80 (0.85-3.81)	*3.11 (1.63-5.89)*	*5.32 (2.18-12.66)*	
other constraints	≥75	44	*0*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*			11		*0*				

Note: Total sample on which results are based is 1,357,077 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	15 years	17 years		1 year	3 years	5 years	10 years	15 years	17 years
All hybrid	≥75	**1,189**	**0.43 (0.18-1.03)**	**0.89 (0.48-1.66)**	**1.28 (0.74-2.21)**	**2.17 (1.34-3.52)**	*2.17 (1.34-3.52)*		**1,735**	**0.65 (0.36-1.16)**	**1.27 (0.83-1.95)**	**1.50 (1.00-2.23)**	**1.99 (1.37-2.87)**	*1.99 (1.37-2.87)*	*1.99 (1.37-2.87)*
unconstrained, fixed	≥75	825	0.38 (0.12-1.16)	0.91 (0.43-1.89)	1.42 (0.76-2.63)	2.35 (1.37-4.01)	*2.35 (1.37-4.01)*		1,142	0.62 (0.30-1.30)	1.18 (0.69-2.03)	1.50 (0.92-2.44)	2.01 (1.30-3.12)	*2.01 (1.30-3.12)*	*2.01 (1.30-3.12)*
unconstrained, mobile	≥75	216	*0.93 (0.23-3.66)*	*0.93 (0.23-3.66)*	*0.93 (0.23-3.66)*	*0.93 (0.23-3.66)*			425	0.96 (0.36-2.53)	1.23 (0.51-2.93)	1.23 (0.51-2.93)	*1.83 (0.77-4.33)*		
posterior-stabilised, fixed	≥75	90	*0*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*			122	*0*	*3.70 (1.19-11.22)*	*3.70 (1.19-11.22)*	*3.70 (1.19-11.22)*		
other constraints	≥75	58	*0*	*0*	*0*	*3.03 (0.43-19.63)*			46	*0*	*0*	*0*	*0*		
All unicondylar, cemented	≥75	**7,404**	**0.81 (0.63-1.05)**	**2.12 (1.80-2.50)**	**2.98 (2.57-3.46)**	**5.17 (4.49-5.95)**	*7.91 (6.02-10.37)*	*7.91 (6.02-10.37)*	**6,685**	**1.10 (0.87-1.38)**	**2.96 (2.55-3.42)**	**4.44 (3.92-5.02)**	**7.60 (6.80-8.48)**	*10.16 (8.70-11.85)*	*11.24 (8.89-14.17)*
fixed	≥75	3,094	0.51 (0.31-0.84)	1.26 (0.89-1.79)	2.00 (1.44-2.77)	*3.17 (2.10-4.76)*	*5.77 (2.87-11.43)*		2,521	0.72 (0.45-1.16)	2.33 (1.74-3.11)	3.43 (2.62-4.47)	*5.21 (3.93-6.88)*	*5.21 (3.93-6.88)*	
mobile	≥75	3,778	1.10 (0.81-1.49)	2.75 (2.26-3.35)	3.65 (3.07-4.34)	5.95 (5.09-6.95)	*8.99 (6.73-11.95)*	*8.99 (6.73-11.95)*	3,699	1.34 (1.02-1.77)	3.44 (2.89-4.10)	5.12 (4.43-5.92)	8.61 (7.61-9.74)	*11.89 (10.04-14.06)*	*13.15 (10.34-16.66)*
monobloc polyethylene tibia	≥75	532	0.38 (0.10-1.51)	1.60 (0.80-3.18)	2.62 (1.49-4.60)	*5.91 (3.60-9.61)*	*5.91 (3.60-9.61)*		465	1.10 (0.46-2.61)	2.03 (1.06-3.87)	3.05 (1.78-5.20)	*5.56 (3.57-8.62)*	*5.56 (3.57-8.62)*	
All unicondylar, uncemented/hybrid	≥75	**2,672**	**1.34 (0.96-1.87)**	**2.10 (1.59-2.78)**	**2.53 (1.90-3.37)**	*4.46 (2.80-7.06)*			**2,057**	**0.70 (0.42-1.19)**	**1.90 (1.35-2.68)**	**2.83 (2.07-3.87)**	*4.59 (3.14-6.70)*		
fixed	≥75	91	*1.19 (0.17-8.15)*	*1.19 (0.17-8.15)*	*1.19 (0.17-8.15)*				189	*0.55 (0.08-3.82)*	*2.12 (0.68-6.56)*	*3.24 (1.19-8.66)*	*4.82 (1.91-11.89)*		
mobile	≥75	2,546	1.36 (0.97-1.91)	2.17 (1.64-2.88)	2.64 (1.97-3.52)	*4.65 (2.78-7.72)*			1,835	0.73 (0.43-1.26)	1.93 (1.35-2.76)	2.88 (2.07-4.01)	*5.04 (3.20-7.91)*		
monobloc polyethylene tibia	≥75	35		*0*	*0*				33			*0*	*0*		
Patellofemoral	≥75	**505**	**0.42 (0.11-1.67)**	**2.81 (1.60-4.90)**	**3.76 (2.27-6.20)**	*6.85 (4.16-11.18)*			**1,181**	**0.51 (0.23-1.14)**	**2.72 (1.90-3.89)**	**5.77 (4.45-7.46)**	*9.42 (7.44-11.89)*	*9.42 (7.44-11.89)*	
Multicompartmental	≥75	**29**	*0*	*4.35 (0.62-27.07)*	*4.35 (0.62-27.07)*				**25**	*0*	*0*	*0*			

Note: Total sample on which results are based is 1,357,077 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 151). The revision rate for cemented unicondylar (medial or lateral UKR) knee replacements is 3.2 times higher than the observed rate for cemented TKR at ten years and 3.6 times higher at 17 years. The revision rate for uncemented unicondylar (medial or lateral UKR) knee replacements is 2.4 times higher than for cemented TKR at ten years and 2.6 times higher at 15 years, although the numbers for the last estimate are small and so we suggest should be treated with caution. The revision rate for patellofemoral replacement is 5.6 times higher than for cemented TKR at ten years and 5.5 times higher at 17 years although again, we advise a degree of caution since the number of patellofemoral replacements at risk at 17 years is small. Multicompartmental knee replacements have relatively small numbers, and at five years the risk of revision is 4.5 times higher than for cemented TKR, 1.8 times higher than for cemented unicondylar knee replacements and 2.5 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 in 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 159). Conversely, female patients are more likely to have a unicondylar implant revised in the longer term compared to their male, age-equivalent counterparts, except for when 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 that for 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 page 174)). 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 175) 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 179) 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 where the number had fallen below ten cases. We have made no attempt 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	15 years	17 years
All total knee replacements	**1,193,125**	**70 (63 to 76)**	**43**	**0.43 (0.41-0.44)**	**1.50 (1.48-1.53)**	**2.15 (2.12-2.18)**	**3.27 (3.23-3.31)**	**4.45 (4.37-4.53)**	**4.85 (4.72-4.97)**
ACS PC[Fem]ACS[Tib]	1,159	68 (61 to 73)	50	0.78 (0.41-1.50)	2.70 (1.89-3.84)	3.29 (2.38-4.54)	*4.72 (3.48-6.40)*		
Advance MP Stature[Fem] Advance[Tib]	1,502	69 (62 to 75)	13	0.07 (0.01-0.47)	1.67 (1.12-2.48)	2.53 (1.82-3.51)	3.38 (2.40-4.76)		
Advance MP[Fem] Advance[Tib]	8,926	70 (64 to 76)	48	0.58 (0.44-0.76)	2.08 (1.80-2.40)	2.95 (2.60-3.34)	4.24 (3.78-4.76)	4.99 (4.33-5.73)	*6.47 (4.08-10.19)*
Advance PS[Fem] Advance[Tib]	1,438	72 (66 to 77)	45	0.56 (0.28-1.12)	2.64 (1.90-3.67)	3.36 (2.50-4.51)	5.97 (4.57-7.77)	*7.24 (5.48-9.53)*	
AGC V2[Fem:Tib]	39,003	71 (65 to 77)	43	0.31 (0.26-0.37)	1.52 (1.40-1.65)	2.19 (2.05-2.35)	3.49 (3.29-3.69)	5.62 (5.25-6.01)	6.43 (5.85-7.06)
AGC[Fem]AGC V2[Tib]	28,816	71 (64 to 77)	42	0.30 (0.24-0.37)	1.59 (1.45-1.74)	2.23 (2.06-2.41)	3.57 (3.33-3.83)	5.83 (5.28-6.44)	*6.98 (5.63-8.64)*
AS Columbus Cemented[Fem] Columbus CR/PS[Tib]	1,260	65 (59 to 71.5)	52	0.41 (0.17-0.99)	1.50 (0.88-2.54)	2.42 (1.46-3.98)			
Attune[Fem] Attune FB[Tib]	28,721	69 (62 to 76)	43	0.40 (0.33-0.48)	1.50 (1.34-1.67)	2.10 (1.88-2.35)			
Attune[Fem] Attune RP[Tib]	4,953	69 (62 to 76)	44	0.19 (0.10-0.37)	0.90 (0.64-1.27)	1.34 (0.96-1.88)			
Columbus Cemented[Fem] Columbus CR/PS[Tib]	15,909	70 (64 to 76)	43	0.43 (0.34-0.55)	1.48 (1.29-1.69)	2.05 (1.82-2.32)	3.00 (2.63-3.43)	*3.71 (3.06-4.50)*	
E-Motion Bicondylar Knee[Fem] E-Motion FP[Tib]	3,339	68 (61 to 74)	45	0.66 (0.44-1.00)	2.35 (1.88-2.93)	3.33 (2.75-4.02)	4.56 (3.82-5.45)	*5.45 (4.48-6.61)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	1,338	76 (68 to 83)	28	1.27 (0.78-2.07)	3.30 (2.41-4.51)	5.05 (3.86-6.58)	*7.95 (5.98-10.54)*	*9.91 (7.19-13.58)*	
EvolutionMP[Fem:Tib]	1,815	70 (63 to 76)	45	0.46 (0.23-0.93)	1.64 (1.07-2.49)	2.11 (1.39-3.20)			
Genesis II Oxinium[Fem] Genesis II[Tib]	11,362	59 (54 to 65)	40	0.58 (0.46-0.74)	2.43 (2.15-2.75)	3.57 (3.21-3.97)	6.06 (5.50-6.67)	7.67 (6.78-8.67)	*7.67 (6.78-8.67)*
Genesis II[Fem:Tib]	85,534	71 (65 to 77)	42	0.46 (0.42-0.51)	1.50 (1.42-1.59)	2.05 (1.95-2.16)	3.02 (2.86-3.18)	3.49 (3.21-3.79)	*3.83 (3.30-4.44)*
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)	5.14 (4.21-6.28)	7.07 (5.88-8.49)	*7.74 (6.38-9.38)*
Journey II BCS Oxinium[Fem] Journey[Tib]	4,057	66 (59 to 73)	41	0.58 (0.38-0.87)	2.42 (1.90-3.08)	2.60 (2.04-3.31)			
Kinemax[Fem:Tib]	10,915	71 (64 to 77)	43	0.25 (0.17-0.36)	1.74 (1.51-2.01)	2.70 (2.40-3.03)	4.73 (4.32-5.17)	6.68 (6.15-7.25)	7.20 (6.60-7.85)
LCS Complete[Fem] M.B.T.[Tib]	29,139	70 (63 to 76)	44	0.43 (0.36-0.51)	1.69 (1.54-1.84)	2.49 (2.31-2.69)	3.64 (3.40-3.90)	4.22 (3.90-4.57)	
LCS[Fem:Tib]	2,001	70 (63 to 76)	41	0.65 (0.38-1.12)	1.78 (1.28-2.48)	2.32 (1.74-3.09)	3.00 (2.31-3.88)	3.80 (2.98-4.83)	*4.08 (3.19-5.20)*

[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	15 years	17 years
Legion CR COCR[Fem] Genesis II[Tib]	1,045	71 (65 to 77)	44	0.48 (0.20-1.15)	1.61 (0.99-2.62)	2.13 (1.37-3.29)			
Maxim[Fem:Tib]	1,744	70 (63 to 77)	43	0.41 (0.19-0.85)	1.77 (1.24-2.53)	2.77 (2.08-3.68)	5.47 (4.41-6.77)	*9.03 (7.33-11.10)*	*12.39 (8.95-17.03)*
MRK[Fem:Tib]	15,118	70 (64 to 77)	44	0.32 (0.24-0.42)	1.17 (1.00-1.37)	1.63 (1.42-1.86)	2.70 (2.36-3.09)	*3.23 (2.69-3.87)*	*3.23 (2.69-3.87)*
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)	4.02 (3.31-4.88)	*6.85 (5.55-8.44)*	*7.25 (5.79-9.08)*
Nexgen LCCK[Fem] Nexgen[Tib]	1,091	71 (64 to 79)	36	1.13 (0.65-1.99)	2.65 (1.79-3.91)	3.33 (2.30-4.81)	*4.93 (3.23-7.48)*	*9.65 (4.28-20.94)*	
Nexgen[Fem:Tib]	174,049	70 (64 to 76)	42	0.38 (0.35-0.41)	1.29 (1.24-1.35)	2.03 (1.96-2.11)	3.44 (3.33-3.56)	4.55 (4.34-4.78)	4.93 (4.61-5.28)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet)[Tib]	3,239	67 (59 to 74)	46	0.47 (0.28-0.77)	1.90 (1.47-2.44)	2.60 (2.09-3.24)	4.39 (3.65-5.29)	*6.24 (5.02-7.74)*	*6.24 (5.02-7.74)*
Nexgen[Fem] TM Monoblock[Tib]	4,273	64 (58 to 71)	57	0.61 (0.42-0.90)	2.64 (2.19-3.18)	3.33 (2.82-3.93)	4.38 (3.77-5.08)	4.95 (4.23-5.78)	*4.95 (4.23-5.78)*
Optetrak CR[Fem] Optetrak[Tib]	1,639	70 (63 to 76)	43	0.86 (0.51-1.45)	3.45 (2.66-4.46)	4.90 (3.94-6.09)	8.06 (6.71-9.67)	*9.29 (7.23-11.89)*	
Persona CR[Fem] Persona[Tib]	4,722	70 (63 to 76)	46	0.25 (0.13-0.46)	0.74 (0.43-1.26)	1.68 (0.95-2.94)			
Persona PS[Fem] Persona[Tib]	1,446	70 (63 to 76)	42	0.44 (0.20-0.97)	1.63 (1.02-2.60)	3.11 (2.05-4.72)			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	17,259	65 (58 to 72)	47	0.63 (0.52-0.76)	2.00 (1.80-2.23)	2.78 (2.54-3.04)	3.96 (3.65-4.29)	4.97 (4.50-5.49)	*5.15 (4.58-5.79)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	170,400	70 (64 to 76)	43	0.39 (0.36-0.42)	1.29 (1.23-1.35)	1.78 (1.71-1.85)	2.51 (2.43-2.60)	3.28 (3.16-3.42)	3.55 (3.36-3.76)
PFC Sigma Bicondylar Knee[Fem] PFC Sigma Bicondylar[Tib]	192,189	70 (64 to 77)	42	0.37 (0.34-0.40)	1.41 (1.36-1.47)	1.96 (1.90-2.03)	2.66 (2.56-2.75)	*2.89 (2.73-3.07)*	
Profix[Fem:Tib]	3,956	73 (67 to 78)	44	0.41 (0.25-0.67)	1.37 (1.05-1.79)	1.87 (1.48-2.35)	2.72 (2.23-3.31)	3.76 (2.95-4.78)	*4.11 (3.12-5.40)*
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)	6.49 (5.43-7.74)	8.54 (7.21-10.10)	*8.54 (7.21-10.10)*
Rotaglide[Fem:Tib]	1,449	71 (63 to 77)	39	0.56 (0.28-1.11)	2.41 (1.73-3.35)	3.79 (2.89-4.96)	4.34 (3.34-5.62)	*6.25 (4.60-8.47)*	
Saiph[Fem:Tib]	1,855	69 (63 to 75)	39	0.55 (0.29-1.05)	1.29 (0.81-2.06)	1.42 (0.89-2.25)			
Scorpio NRG[Fem:Tib]	14,101	70 (64 to 76)	43	0.41 (0.32-0.53)	1.59 (1.40-1.82)	2.43 (2.18-2.70)	3.69 (3.35-4.06)		
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)	4.69 (3.98-5.51)	6.06 (5.03-7.28)	*6.06 (5.03-7.28)*
Scorpio[Fem] Scorpio NRG[Tib]	21,689	71 (64 to 77)	42	0.44 (0.36-0.54)	1.83 (1.66-2.02)	2.63 (2.42-2.85)	4.02 (3.76-4.31)	5.15 (4.81-5.52)	*5.34 (4.94-5.77)*
Sphere[Fem] GMK[Tib]	1,698	69 (62 to 75)	44	0.81 (0.47-1.39)	2.10 (1.46-3.03)	2.98 (2.10-4.22)			

[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	15 years	17 years
TC Plus[Fem:Tib]	16,030	70 (64 to 76)	45	0.68 (0.57-0.82)	1.79 (1.60-2.01)	2.38 (2.15-2.63)	3.52 (3.23-3.84)	4.80 (4.35-5.30)	*5.21 (4.58-5.93)*
Triathlon[Fem:Tib]	145,056	70 (63 to 76)	43	0.49 (0.46-0.53)	1.47 (1.40-1.54)	2.06 (1.97-2.15)	3.04 (2.90-3.19)	*4.38 (3.55-5.40)*	
Unity Knee[Fem] Unity[Tib]	1,458	70 (63 to 76)	45	0.28 (0.11-0.75)	0.80 (0.43-1.50)	1.06 (0.59-1.88)			
Vanguard[Fem:Tib]	82,502	70 (63 to 76)	42	0.39 (0.35-0.43)	1.44 (1.36-1.53)	2.04 (1.94-2.16)	2.98 (2.78-3.20)		

[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	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	17 years
All total knee replacements	With Patella	458,640	70 (63 to 76)	38	0.41 (0.39-0.43)	1.27 (1.24-1.31)	1.84 (1.80-1.88)	2.88 (2.82-2.95)	4.00 (3.87-4.13)	4.28 (4.10-4.47)
	Without Patella	734,485	70 (63 to 76)	45	0.43 (0.42-0.45)	1.64 (1.61-1.67)	2.33 (2.29-2.37)	3.49 (3.44-3.55)	4.71 (4.61-4.81)	5.18 (5.01-5.34)
ACS PC[Fem] ACS[Tib]	With Patella	90	68 (61 to 74)	28	*2.25 (0.57-8.69)*	*3.57 (1.16-10.70)*	*3.57 (1.16-10.70)*			
	Without Patella	1,069	68 (61 to 73)	52	0.66 (0.31-1.38)	2.61 (1.80-3.79)	3.24 (2.32-4.54)	*4.72 (3.44-6.46)*		
Advance MP Stature[Fem] Advance[Tib]	With Patella	508	69 (62 to 75)	12	0	0.62 (0.20-1.93)	1.72 (0.82-3.60)	*2.07 (1.03-4.14)*		
	Without Patella	994	69 (62 to 75)	14	0.10 (0.01-0.72)	2.19 (1.43-3.34)	2.96 (2.05-4.26)	*4.00 (2.72-5.86)*		
Advance MP[Fem] Advance[Tib]	With Patella	3,048	70 (63 to 76)	43	0.53 (0.32-0.86)	1.52 (1.14-2.03)	2.10 (1.63-2.71)	3.34 (2.66-4.18)	*3.95 (3.02-5.17)*	
	Without Patella	5,878	70 (64 to 76)	50	0.60 (0.43-0.84)	2.37 (2.00-2.80)	3.39 (2.94-3.91)	4.68 (4.09-5.36)	*5.52 (4.71-6.46)*	*8.67 (4.23-17.31)*
Advance PS[Fem] Advance[Tib]	With Patella	252	71 (66 to 76)	36	*0.80 (0.20-3.17)*	*3.99 (2.09-7.54)*	*5.00 (2.79-8.86)*	*8.78 (5.32-14.31)*	*8.78 (5.32-14.31)*	
	Without Patella	1,186	72 (66 to 78)	48	0.51 (0.23-1.13)	2.36 (1.61-3.45)	3.02 (2.14-4.25)	5.37 (3.92-7.33)	*6.92 (4.99-9.55)*	
AGC V2[Fem:Tib]	With Patella	12,157	71 (65 to 77)	35	0.25 (0.17-0.36)	1.24 (1.06-1.46)	1.84 (1.61-2.10)	3.01 (2.70-3.37)	4.68 (4.08-5.35)	*4.85 (4.18-5.61)*
	Without Patella	26,846	71 (65 to 77)	46	0.34 (0.28-0.42)	1.65 (1.50-1.81)	2.35 (2.17-2.55)	3.69 (3.46-3.95)	5.99 (5.55-6.47)	7.02 (6.29-7.83)
AGC[Fem] AGC V2[Tib]	With Patella	9,725	71 (64 to 77)	37	0.25 (0.17-0.37)	1.19 (0.99-1.43)	1.69 (1.44-1.98)	2.98 (2.61-3.40)	6.00 (5.04-7.14)	*6.00 (5.04-7.14)*
	Without Patella	19,091	71 (64 to 77)	45	0.33 (0.26-0.42)	1.79 (1.61-1.99)	2.50 (2.28-2.74)	3.87 (3.57-4.20)	5.53 (4.94-6.19)	*7.57 (5.43-10.50)*

[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	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	17 years
AS Columbus Cemented[Fem] Columbus CR/PS[Tib]	With Patella	792	65 (59 to 71)	51	0.13 (0.02-0.95)	1.20 (0.57-2.53)	1.96 (0.97-3.93)			
	Without Patella	468	64 (58 to 72)	52	0.89 (0.34-2.37)	*2.04 (0.95-4.36)*	*3.32 (1.61-6.76)*			
Attune[Fem] Attune FB[Tib]	With Patella	13,599	70 (63 to 76)	39	0.35 (0.26-0.47)	1.24 (1.04-1.47)	1.86 (1.54-2.24)			
	Without Patella	15,122	69 (62 to 76)	47	0.45 (0.35-0.57)	1.72 (1.50-1.98)	2.32 (2.02-2.67)			
Attune[Fem] Attune RP[Tib]	With Patella	3,190	69 (62 to 76)	40	0.20 (0.09-0.43)	0.80 (0.51-1.26)	*1.08 (0.68-1.70)*			
	Without Patella	1,763	69 (62 to 76)	52	0.19 (0.06-0.59)	1.07 (0.63-1.81)	*1.78 (1.10-2.88)*			
Columbus Cemented[Fem] Columbus CR/PS[Tib]	With Patella	4,695	70 (64 to 76)	37	0.61 (0.42-0.88)	1.32 (1.02-1.71)	1.65 (1.29-2.09)	3.19 (2.25-4.50)	*5.85 (3.48-9.76)*	
	Without Patella	11,214	71 (65 to 77)	45	0.36 (0.26-0.49)	1.54 (1.32-1.80)	2.21 (1.93-2.54)	3.03 (2.63-3.50)	*3.32 (2.81-3.92)*	
E-Motion Bicondylar Knee[Fem] E-Motion FP[Tib]	With Patella	289	66 (60 to 73)	33	1.05 (0.34-3.21)	5.63 (3.49-9.03)	7.97 (5.31-11.87)	*7.97 (5.31-11.87)*		
	Without Patella	3,050	68 (61 to 74)	46	0.63 (0.40-0.98)	2.03 (1.58-2.61)	2.87 (2.32-3.56)	4.16 (3.42-5.05)	*5.06 (4.09-6.24)*	
Endo-Model Standard Rotating Hinge[Fem:Tib]	With Patella	271	75 (66 to 82)	28	*1.55 (0.58-4.07)*	*3.04 (1.45-6.31)*	*4.69 (2.53-8.61)*	*7.34 (3.79-13.98)*		
	Without Patella	1,067	76 (69 to 83)	28	1.20 (0.69-2.11)	3.37 (2.38-4.76)	5.14 (3.82-6.90)	*8.11 (5.91-11.09)*	*9.49 (6.79-13.19)*	
EvolutionMP [Fem:Tib]	With Patella	686	71 (65 to 77)	46	0.63 (0.24-1.68)	*1.55 (0.71-3.36)*	*1.55 (0.71-3.36)*			
	Without Patella	1,129	68 (62 to 75)	45	0.36 (0.14-0.97)	1.64 (0.98-2.71)	2.25 (1.39-3.63)			
Genesis II Oxinium[Fem] Genesis II[Tib]	With Patella	6,130	59 (54 to 65)	36	0.50 (0.35-0.71)	1.77 (1.45-2.16)	2.37 (1.98-2.83)	4.21 (3.57-4.95)	*5.51 (4.35-6.97)*	
	Without Patella	5,232	59 (54 to 65)	44	0.68 (0.49-0.94)	3.18 (2.72-3.72)	4.90 (4.30-5.58)	8.03 (7.14-9.03)	*9.90 (8.60-11.37)*	
Genesis II[Fem:Tib]	With Patella	39,672	71 (65 to 77)	38	0.46 (0.40-0.53)	1.25 (1.14-1.37)	1.63 (1.50-1.78)	2.38 (2.18-2.60)	2.78 (2.44-3.16)	*3.26 (2.39-4.44)*
	Without Patella	45,862	71 (65 to 77)	46	0.47 (0.41-0.54)	1.71 (1.59-1.84)	2.39 (2.24-2.55)	3.50 (3.28-3.74)	4.01 (3.62-4.45)	*4.22 (3.67-4.84)*
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)	4.51 (3.36-6.05)	*6.37 (4.89-8.27)*	*7.24 (5.45-9.60)*
	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)	*7.90 (6.11-10.17)*	*8.36 (6.42-10.85)*
Journey II BCS Oxinium[Fem] Journey[Tib]	With Patella	3,348	66 (59 to 73)	41	0.45 (0.26-0.75)	1.48 (1.05-2.08)	1.59 (1.12-2.24)			

[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	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	17 years
	Without Patella	709	65 (57 to 72)	43	1.15 (0.58-2.29)	5.69 (4.08-7.92)	*6.10 (4.36-8.51)*			
Kinemax [Fem:Tib]	With Patella	4,381	71 (64 to 77)	37	0.25 (0.14-0.46)	1.24 (0.95-1.62)	1.76 (1.41-2.21)	3.68 (3.12-4.33)	5.56 (4.80-6.44)	*5.98 (5.13-6.96)*
	Without Patella	6,534	71 (64 to 77)	47	0.25 (0.15-0.40)	2.07 (1.75-2.45)	3.32 (2.90-3.80)	5.44 (4.88-6.05)	7.42 (6.71-8.20)	8.02 (7.21-8.92)
LCS Complete[Fem] M.B.T.[Tib]	With Patella	1,437	69 (62 to 76)	33	0.56 (0.28-1.12)	2.08 (1.43-3.02)	3.41 (2.52-4.62)	5.05 (3.83-6.64)	*5.83 (4.31-7.87)*	
	Without Patella	27,702	70 (63 to 76)	45	0.42 (0.35-0.50)	1.67 (1.52-1.83)	2.45 (2.27-2.65)	3.58 (3.33-3.84)	4.15 (3.82-4.50)	
LCS[Fem:Tib]	With Patella	220	69.5 (63 to 76)	37	*1.36 (0.44-4.17)*	*4.64 (2.52-8.45)*	*5.13 (2.87-9.07)*	*5.66 (3.25-9.77)*	*7.15 (4.25-11.91)*	*7.15 (4.25-11.91)*
	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)	3.38 (2.57-4.44)	*3.70 (2.81-4.87)*
Legion CR COCR[Fem] Genesis II[Tib]	With Patella	170	69 (62 to 76)	34	*1.18 (0.30-4.65)*	*2.41 (0.91-6.30)*	*3.08 (1.29-7.25)*			
	Without Patella	875	71 (66 to 78)	46	0.34 (0.11-1.06)	1.46 (0.83-2.56)	1.95 (1.17-3.23)			
Maxim[Fem:Tib]	With Patella	513	71 (63 to 76)	33	0.59 (0.19-1.83)	1.62 (0.81-3.21)	2.26 (1.26-4.04)	4.95 (3.19-7.64)	*7.32 (4.85-10.96)*	
	Without Patella	1,231	70 (63 to 77)	47	0.33 (0.12-0.88)	1.84 (1.21-2.78)	2.98 (2.15-4.13)	5.70 (4.46-7.28)	*9.62 (7.59-12.17)*	*12.46 (8.68-17.71)*
MRK[Fem:Tib]	With Patella	5,325	71 (64 to 77)	38	0.27 (0.16-0.45)	1.06 (0.80-1.40)	1.55 (1.22-1.96)	2.46 (1.96-3.08)	*2.99 (2.23-4.00)*	*2.99 (2.23-4.00)*
	Without Patella	9,793	70 (64 to 76)	48	0.34 (0.24-0.48)	1.23 (1.02-1.49)	1.66 (1.41-1.97)	2.84 (2.41-3.36)	*3.29 (2.67-4.06)*	
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)	4.34 (3.37-5.59)	*7.83 (5.68-10.75)*	
	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)	3.62 (2.67-4.91)	*6.00 (4.46-8.05)*	*6.63 (4.79-9.14)*
Nexgen LCCK[Fem] Nexgen[Tib]	With Patella	515	71 (63 to 78)	37	0.40 (0.10-1.60)	1.75 (0.83-3.67)	*1.75 (0.83-3.67)*	*4.89 (2.16-10.86)*		
	Without Patella	576	72 (64 to 79)	36	1.78 (0.96-3.29)	3.44 (2.18-5.42)	4.65 (3.05-7.06)	*5.11 (3.36-7.75)*	*11.24 (4.73-25.44)*	
Nexgen [Fem:Tib]	With Patella	51,137	70 (63 to 76)	37	0.41 (0.36-0.47)	1.34 (1.24-1.45)	2.14 (2.00-2.29)	3.72 (3.49-3.96)	4.77 (4.39-5.19)	*5.11 (4.51-5.79)*
	Without Patella	122,912	70 (64 to 76)	44	0.36 (0.33-0.40)	1.27 (1.21-1.34)	1.99 (1.90-2.08)	3.34 (3.20-3.48)	4.47 (4.21-4.75)	4.87 (4.50-5.27)
Nexgen[Fem] LPS (Legacy Posterior Stabilised ZimmerBiomet)[Tib]	With Patella	1,077	67 (59 to 74)	37	0.47 (0.20-1.13)	2.38 (1.60-3.53)	3.31 (2.35-4.65)	6.28 (4.79-8.20)	*8.65 (6.40-11.64)*	*8.65 (6.40-11.64)*
	Without Patella	2,162	67 (59 to 75)	51	0.47 (0.25-0.86)	1.67 (1.20-2.32)	2.27 (1.71-3.03)	3.49 (2.70-4.50)	*4.87 (3.64-6.52)*	*4.87 (3.64-6.52)*
Nexgen[Fem] TM Monoblock[Tib]	With Patella	415	62 (56 to 69)	55	0.73 (0.24-2.24)	2.51 (1.36-4.61)	3.30 (1.93-5.63)	*5.55 (3.60-8.52)*	*7.07 (4.46-11.12)*	
	Without Patella	3,858	64 (58 to 71)	57	0.60 (0.40-0.90)	2.66 (2.19-3.22)	3.33 (2.80-3.97)	4.25 (3.63-4.98)	4.75 (4.02-5.61)	*4.75 (4.02-5.61)*
Optetrak CR[Fem] Optetrak[Tib]	With Patella	646	70 (64 to 76)	43	0.94 (0.42-2.08)	2.40 (1.45-3.94)	3.76 (2.51-5.61)	7.00 (5.06-9.64)	*7.41 (5.36-10.20)*	

[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	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	17 years
	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)	8.74 (6.99-10.90)	*10.26 (7.55-13.85)*	
Persona CR[Fem] Persona[Tib]	With Patella	1,865	69 (62 to 75)	41	0.32 (0.13-0.77)	0.65 (0.27-1.55)	*0.93 (0.40-2.18)*			
	Without Patella	2,857	70 (63 to 76)	49	0.20 (0.08-0.49)	0.79 (0.40-1.53)	*2.00 (1.04-3.85)*			
Persona PS[Fem] Persona[Tib]	With Patella	552	69 (62 to 75)	36	0.41 (0.10-1.64)	*1.08 (0.39-2.95)*	*2.48 (1.14-5.33)*			
	Without Patella	894	70 (64 to 76)	46	0.46 (0.17-1.22)	1.93 (1.14-3.26)	3.36 (2.07-5.42)			
PFC Sigma Bicondylar Knee[Fem] M.B.T.[Tib]	With Patella	8,720	65 (58 to 72)	43	0.45 (0.33-0.62)	1.70 (1.44-2.00)	2.39 (2.08-2.74)	3.50 (3.11-3.94)	*4.66 (3.98-5.46)*	*5.09 (4.08-6.35)*
	Without Patella	8,539	65 (58 to 73)	50	0.81 (0.64-1.03)	2.32 (2.01-2.66)	3.17 (2.81-3.58)	4.43 (3.98-4.94)	5.31 (4.68-6.03)	*5.31 (4.68-6.03)*
PFC Sigma Bicondylar Knee[Fem] PFC Bicondylar[Tib]	With Patella	66,318	71 (64 to 77)	38	0.36 (0.32-0.41)	1.09 (1.01-1.18)	1.55 (1.45-1.65)	2.17 (2.04-2.30)	2.85 (2.67-3.04)	3.14 (2.83-3.49)
	Without Patella	104,082	70 (64 to 76)	46	0.41 (0.37-0.45)	1.41 (1.34-1.49)	1.93 (1.84-2.02)	2.73 (2.62-2.85)	3.57 (3.40-3.76)	3.82 (3.59-4.08)
PFC Sigma Bicondylar Knee[Fem] PFC Sigma Bicondylar[Tib]	With Patella	82,688	71 (64 to 77)	38	0.36 (0.33-0.41)	1.17 (1.10-1.26)	1.67 (1.57-1.77)	2.33 (2.19-2.47)	*2.56 (2.26-2.90)*	
	Without Patella	109,501	70 (64 to 77)	45	0.38 (0.34-0.41)	1.59 (1.51-1.67)	2.18 (2.09-2.28)	2.89 (2.77-3.03)		
Profix[Fem:Tib]	With Patella	82	73 (65 to 78)	30	*0*	*0*	*1.37 (0.19-9.33)*	*4.13 (1.35-12.26)*		
	Without Patella	3,874	73 (67 to 78)	44	0.42 (0.26-0.68)	1.40 (1.07-1.83)	1.88 (1.49-2.37)	2.69 (2.20-3.28)	3.64 (2.84-4.64)	*3.99 (3.01-5.29)*
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)	6.12 (4.81-7.77)	*8.11 (6.47-10.16)*	*8.11 (6.47-10.16)*
	Without Patella	822	71 (64 to 77)	45	0.37 (0.12-1.13)	3.51 (2.44-5.04)	4.44 (3.21-6.13)	7.01 (5.37-9.11)	*9.09 (7.07-11.67)*	*9.09 (7.07-11.67)*
Rotaglide [Fem:Tib]	With Patella	1,430	71 (63 to 77)	39	0.49 (0.24-1.03)	2.37 (1.69-3.32)	3.77 (2.87-4.95)	4.33 (3.32-5.62)	*6.26 (4.60-8.50)*	
	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	1,025	69 (62 to 75)	33	0.54 (0.22-1.29)	0.72 (0.32-1.63)	*0.95 (0.43-2.06)*			
	Without Patella	830	70 (63 to 76)	47	0.56 (0.21-1.49)	2.03 (1.14-3.59)	*2.03 (1.14-3.59)*			
Scorpio NRG[Fem:Tib]	With Patella	7,127	71 (64 to 77)	39	0.45 (0.32-0.64)	1.30 (1.06-1.59)	1.99 (1.68-2.35)	3.13 (2.69-3.64)		
	Without Patella	6,974	70 (64 to 76)	46	0.37 (0.25-0.55)	1.89 (1.60-2.25)	2.88 (2.50-3.31)	4.25 (3.75-4.82)		
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 (1.57-3.57)	3.85 (2.76-5.36)	*5.16 (3.50-7.59)*	*5.16 (3.50-7.59)*

[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	Male (%)	Time since primary					
					1 year	3 years	5 years	10 years	15 years	17 years
	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)	5.04 (4.18-6.07)	*6.36 (5.19-7.77)*	*6.36 (5.19-7.77)*
Scorpio[Fem] Scorpio NRG[Tib]	With Patella	8,115	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 (2.88-3.70)	4.19 (3.72-4.73)	*4.30 (3.79-4.88)*
	Without Patella	13,574	71 (64 to 77)	44	0.51 (0.41-0.65)	2.12 (1.89-2.38)	2.98 (2.70-3.28)	4.47 (4.12-4.85)	5.73 (5.27-6.24)	*5.98 (5.42-6.60)*
Sphere[Fem] GMK[Tib]	With Patella	387	69 (61 to 75)	36	0.59 (0.15-2.36)	*1.32 (0.49-3.49)*	*2.18 (0.82-5.69)*			
	Without Patella	1,311	69 (62 to 75)	47	0.87 (0.48-1.56)	2.29 (1.54-3.39)	3.18 (2.18-4.61)			
TC Plus[Fem:Tib]	With Patella	890	71 (64 to 76)	37	0.34 (0.11-1.05)	1.38 (0.79-2.42)	2.36 (1.53-3.64)	3.79 (2.63-5.43)	*5.17 (3.61-7.38)*	*6.34 (3.98-10.01)*
	Without Patella	15,140	70 (64 to 76)	45	0.70 (0.58-0.85)	1.82 (1.61-2.05)	2.38 (2.14-2.64)	3.51 (3.21-3.83)	4.79 (4.32-5.32)	*5.11 (4.47-5.84)*
Triathlon [Fem:Tib]	With Patella	64,214	70 (63 to 76)	39	0.49 (0.44-0.54)	1.27 (1.18-1.37)	1.78 (1.67-1.91)	2.67 (2.48-2.89)		
	Without Patella	80,842	70 (63 to 76)	46	0.50 (0.45-0.55)	1.62 (1.53-1.72)	2.27 (2.15-2.40)	3.33 (3.13-3.55)	*4.61 (3.75-5.67)*	
Unity Knee[Fem] Unity[Tib]	With Patella	1,123	70 (63 to 76)	43	0.28 (0.09-0.85)	0.93 (0.48-1.79)	*1.22 (0.67-2.22)*			
	Without Patella	335	69 (62 to 75)	52	0.31 (0.04-2.19)	*0.31 (0.04-2.19)*	*0.31 (0.04-2.19)*			
Vanguard [Fem:Tib]	With Patella	34,878	70 (63 to 76)	37	0.37 (0.31-0.45)	1.09 (0.98-1.22)	1.63 (1.48-1.79)	2.63 (2.23-3.10)		
	Without Patella	47,624	70 (63 to 76)	45	0.39 (0.34-0.46)	1.68 (1.56-1.81)	2.33 (2.18-2.48)	3.26 (3.01-3.52)		
Vanguard[Fem] Maxim[Tib]	With Patella	688	68 (61 to 75)	34	0.30 (0.07-1.18)	0.54 (0.17-1.72)	1.04 (0.42-2.54)	*2.63 (1.39-4.94)*		

[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.

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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
All unicompartmental knee replacements	141,094	63 (56 to 71)	50	1.03 (0.98-1.09)	3.77 (3.67-3.88)	5.80 (5.67-5.94)	11.04 (10.81-11.27)	16.59 (16.16-17.04)	18.42 (17.74-19.13)
Unicondylar									
AMC/Uniglide [Fem:Tib]	3,011	64 (57 to 72)	51	2.36 (1.88-2.97)	6.06 (5.25-6.98)	7.69 (6.78-8.71)	12.60 (11.35-13.97)	*17.04 (15.17-19.11)*	
Journey Uni Oxinium[Fem] Journey Uni[Tib]	1,465	62 (56 to 69)	55	1.31 (0.83-2.08)	3.53 (2.58-4.82)	5.46 (4.08-7.29)			
MG Uni[Fem:Tib]	2,262	63 (57 to 70)	55	0.84 (0.54-1.32)	4.01 (3.28-4.91)	6.07 (5.16-7.15)	10.29 (9.08-11.66)	13.36 (11.85-15.06)	*13.69 (12.07-15.52)*
Oxford Cementless Partial Knee[Fem:Tib]	24,975	65 (58 to 71)	56	1.18 (1.05-1.33)	2.38 (2.18-2.59)	3.37 (3.10-3.67)	5.85 (5.10-6.72)		
Oxford Cementless Partial Knee[Fem] Oxford Partial Knee[Tib]	1,895	66 (57 to 73)	46	1.16 (0.76-1.78)	3.73 (2.90-4.79)	5.32 (4.26-6.63)	9.22 (7.48-11.34)		
Oxford Single Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	43,046	64 (58 to 71)	52	1.23 (1.13-1.34)	4.38 (4.18-4.58)	6.52 (6.28-6.76)	11.72 (11.39-12.07)	17.28 (16.71-17.87)	19.34 (18.42-20.29)
Oxford Twin Peg Cemented Partial Knee[Fem] Oxford Partial Knee[Tib]	5,401	65 (57 to 72)	48	0.82 (0.61-1.11)	2.47 (2.06-2.96)	3.71 (3.17-4.35)	7.01 (5.95-8.26)		
Persona Partial Knee[Fem:Tib]	2,631	65 (58 to 72)	58	0.21 (0.09-0.50)	*0.72 (0.36-1.42)*				
*Physica ZUK [Fem:Tib]	19,083	63 (56 to 70)	55	0.33 (0.26-0.43)	1.86 (1.66-2.08)	2.91 (2.63-3.22)	5.87 (5.25-6.57)	*8.68 (6.02-12.41)*	
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)	17.79 (15.90-19.88)	23.54 (21.26-26.02)	*24.65 (22.10-27.43)*
Sigma HP (Uni)[Fem] Sigma HP[Tib]	12,787	63 (56 to 70)	58	0.74 (0.60-0.90)	2.89 (2.59-3.23)	4.07 (3.69-4.48)	6.43 (5.76-7.17)		
Triathlon Uni[Fem] Triathlon[Tib]	1,518	62 (55 to 69)	56	1.21 (0.77-1.92)	4.26 (3.28-5.51)	6.86 (5.48-8.58)	*8.76 (6.98-10.95)*		
Patellofemoral									
Avon[Fem]	6,378	58 (50 to 67)	22	0.69 (0.51-0.92)	4.18 (3.70-4.73)	7.31 (6.65-8.04)	14.74 (13.68-15.88)	21.92 (20.13-23.83)	*23.11 (20.89-25.52)*
FPV[Fem]	1,649	59 (52 to 68)	23	0.91 (0.55-1.51)	7.04 (5.89-8.40)	10.31 (8.91-11.90)	19.31 (17.24-21.59)		
Journey PFJ Oxinium[Fem]	2,187	58 (50 to 67)	23	1.79 (1.30-2.45)	7.34 (6.26-8.59)	12.59 (11.11-14.24)	21.97 (19.80-24.33)		
Sigma HP (PF)[Fem]	1,302	58 (50 to 66)	23	2.70 (1.94-3.74)	9.36 (7.89-11.08)	13.71 (11.91-15.75)	*25.24 (22.14-28.70)*		
Zimmer PFJ[Fem]	3,224	56 (49 to 65)	23	0.61 (0.39-0.96)	4.48 (3.75-5.35)	7.13 (6.12-8.30)	*14.26 (12.03-16.88)*		

*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) 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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed	37,070	71 (65 to 77)	43	0.26 (0.22-0.32)	1.42 (1.30-1.55)	2.08 (1.94-2.24)	3.33 (3.13-3.53)	5.42 (5.05-5.82)	6.27 (5.67-6.92)
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed	28,092	71 (64 to 77)	42	0.31 (0.25-0.38)	1.58 (1.44-1.73)	2.22 (2.05-2.40)	3.51 (3.27-3.76)	5.80 (5.23-6.42)	*6.32 (5.54-7.19)*
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed	8,748	70 (64 to 76)	48	0.56 (0.43-0.75)	2.03 (1.75-2.35)	2.83 (2.49-3.22)	4.14 (3.67-4.66)	4.90 (4.24-5.66)	*6.38 (3.99-10.12)*
Attune CR[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed	18,550	69 (62 to 75)	44	0.37 (0.29-0.47)	1.43 (1.25-1.64)	1.90 (1.65-2.18)			
Attune CR[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile	3,493	70 (63 to 77)	42	0.15 (0.06-0.36)	0.88 (0.57-1.36)	1.47 (0.93-2.33)			
Attune PS[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed	10,159	70 (63 to 76)	42	0.45 (0.34-0.61)	1.62 (1.36-1.93)	2.48 (2.07-2.99)			
Columbus Cemented[Fem]Columbus CR/PS[Tib]									
Cemented, unconstrained, fixed	13,101	70 (64 to 76)	44	0.43 (0.33-0.56)	1.49 (1.29-1.72)	2.06 (1.81-2.35)	2.97 (2.58-3.41)	*3.72 (3.04-4.56)*	
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed	7,654	59 (54 to 65)	40	0.56 (0.41-0.75)	2.11 (1.79-2.48)	3.07 (2.67-3.53)	5.03 (4.42-5.72)	*6.67 (5.68-7.82)*	
Cemented, posterior-stabilised, fixed	3,454	58 (53 to 64)	40	0.65 (0.43-0.98)	3.19 (2.63-3.87)	4.78 (4.06-5.62)	8.37 (7.22-9.69)	*9.87 (8.20-11.85)*	
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed	62,064	71 (65 to 77)	43	0.40 (0.35-0.46)	1.35 (1.26-1.45)	1.84 (1.73-1.96)	2.71 (2.54-2.89)	3.05 (2.80-3.31)	*3.49 (2.87-4.23)*
Cemented, posterior-stabilised, fixed	21,688	71 (65 to 77)	39	0.64 (0.54-0.75)	1.82 (1.64-2.02)	2.51 (2.28-2.75)	3.67 (3.32-4.04)	*5.06 (3.54-7.20)*	
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed	4,049	66 (59 to 73)	41	0.58 (0.38-0.88)	2.40 (1.88-3.05)	2.57 (2.01-3.28)			

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
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)	6.59 (6.06-7.16)	7.12 (6.52-7.77)
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	12,390	70 (64 to 76)	41	0.41 (0.31-0.54)	1.51 (1.31-1.75)	2.48 (2.21-2.79)	3.94 (3.56-4.36)	*4.41 (3.96-4.90)*	
Uncemented, unconstrained, mobile	15,831	69 (62 to 75)	47	0.42 (0.33-0.54)	1.83 (1.63-2.06)	2.53 (2.28-2.80)	3.43 (3.12-3.77)	4.11 (3.67-4.61)	
MRK[Fem:Tib]									
Cemented, unconstrained, fixed	14,877	70 (64 to 76)	44	0.31 (0.24-0.42)	1.16 (0.99-1.36)	1.61 (1.40-1.85)	2.69 (2.35-3.08)	*3.22 (2.68-3.86)*	*3.22 (2.68-3.86)*
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)	3.88 (3.17-4.76)	*6.65 (5.30-8.33)*	*7.12 (5.56-9.09)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed	89,051	70 (63 to 76)	43	0.31 (0.27-0.35)	1.03 (0.96-1.10)	1.52 (1.43-1.61)	2.41 (2.27-2.56)	3.19 (2.88-3.53)	*3.34 (2.92-3.82)*
Cemented, posterior-stabilised, fixed	82,171	70 (64 to 77)	41	0.45 (0.41-0.50)	1.57 (1.49-1.66)	2.57 (2.45-2.69)	4.42 (4.24-4.61)	5.76 (5.45-6.08)	6.23 (5.79-6.70)
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed	4,002	64 (58 to 71)	58	0.61 (0.41-0.90)	2.62 (2.16-3.17)	3.33 (2.81-3.96)	4.39 (3.76-5.12)	4.98 (4.24-5.84)	*4.98 (4.24-5.84)*
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile	8,377	64 (58 to 72)	47	0.59 (0.45-0.78)	1.91 (1.64-2.24)	2.66 (2.33-3.04)	3.84 (3.42-4.31)	5.25 (4.49-6.14)	*5.66 (4.62-6.91)*
Cemented, posterior-stabilised, mobile	7,135	65 (59 to 72)	46	0.66 (0.50-0.88)	2.18 (1.86-2.55)	3.02 (2.64-3.45)	4.22 (3.75-4.76)	4.79 (4.21-5.45)	*4.79 (4.21-5.45)*
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed	132,331	70 (64 to 76)	43	0.39 (0.36-0.42)	1.23 (1.17-1.29)	1.70 (1.62-1.77)	2.36 (2.26-2.45)	3.02 (2.88-3.17)	3.19 (3.01-3.37)
Cemented, posterior-stabilised, fixed	36,344	71 (64 to 77)	41	0.40 (0.34-0.47)	1.49 (1.37-1.62)	2.05 (1.91-2.21)	2.99 (2.80-3.19)	4.03 (3.75-4.33)	4.54 (4.02-5.13)
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed	122,269	70 (63 to 76)	42	0.35 (0.32-0.38)	1.34 (1.27-1.41)	1.87 (1.79-1.95)	2.50 (2.39-2.62)		
Cemented, posterior-stabilised, fixed	55,012	71 (64 to 77)	41	0.42 (0.37-0.48)	1.61 (1.50-1.72)	2.22 (2.09-2.36)	3.08 (2.90-3.27)		
Cemented, monobloc polyethylene tibia	14,312	74 (69 to 79)	42	0.35 (0.27-0.46)	1.30 (1.11-1.51)	1.72 (1.50-1.97)	2.10 (1.83-2.42)	*2.21 (1.88-2.60)*	
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed	4,404	70 (63 to 76)	46	0.26 (0.14-0.49)	0.77 (0.45-1.30)	1.59 (0.89-2.85)			

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed	8,584	70 (64 to 76)	42	0.36 (0.26-0.52)	1.45 (1.22-1.73)	2.36 (2.05-2.71)	3.55 (3.12-4.03)		
Cemented, posterior-stabilised, fixed	4,734	70 (63 to 77)	43	0.45 (0.29-0.68)	1.70 (1.37-2.12)	2.43 (2.02-2.92)	3.83 (3.27-4.47)		
Scorpio[Fem]Scorpio NRG[Tib]									
Cemented, unconstrained, fixed	10,455	71 (64 to 77)	42	0.44 (0.33-0.59)	1.85 (1.60-2.13)	2.58 (2.29-2.91)	3.89 (3.52-4.30)	5.13 (4.62-5.69)	*5.21 (4.68-5.79)*
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)	4.17 (3.67-4.74)	5.35 (4.74-6.03)	*5.77 (4.96-6.70)*
Uncemented, unconstrained, fixed	3,733	70 (64 to 76)	47	0.62 (0.41-0.93)	1.93 (1.53-2.43)	2.61 (2.14-3.18)	3.93 (3.33-4.63)	*4.74 (4.02-5.58)*	*4.74 (4.02-5.58)*
TC Plus[Fem:Tib]									
Cemented, unconstrained, fixed	7,929	70 (64 to 76)	46	0.81 (0.63-1.03)	2.01 (1.72-2.34)	2.63 (2.30-3.01)	3.75 (3.34-4.21)	4.89 (4.30-5.55)	*5.51 (4.52-6.71)*
Cemented, unconstrained, mobile	5,266	70 (64 to 76)	44	0.53 (0.37-0.77)	1.55 (1.25-1.92)	2.09 (1.73-2.52)	3.25 (2.78-3.80)	4.29 (3.62-5.08)	
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed	113,969	70 (63 to 76)	43	0.46 (0.42-0.50)	1.39 (1.31-1.46)	1.93 (1.84-2.03)	2.89 (2.72-3.06)	*4.24 (3.38-5.32)*	
Cemented, posterior-stabilised, fixed	24,445	70 (63 to 77)	41	0.62 (0.53-0.73)	1.75 (1.58-1.94)	2.56 (2.34-2.80)	3.64 (3.30-4.00)		
Uncemented, unconstrained, fixed	4,190	68 (61 to 75)	51	0.61 (0.41-0.91)	1.70 (1.30-2.23)	2.15 (1.64-2.82)	*3.07 (2.07-4.54)*		
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed	67,485	70 (64 to 76)	42	0.35 (0.31-0.40)	1.36 (1.27-1.46)	1.95 (1.84-2.08)	2.86 (2.64-3.10)		
Cemented, posterior-stabilised, fixed	10,208	70 (63 to 77)	40	0.61 (0.48-0.79)	2.12 (1.84-2.44)	2.87 (2.53-3.27)	4.17 (3.49-4.97)		
Cemented, constrained condylar	3,380	70 (63 to 76)	36	0.47 (0.28-0.77)	1.28 (0.92-1.78)	1.56 (1.14-2.13)			
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,087	67 (59 to 75)	50	0.28 (0.09-0.86)	3.04 (2.16-4.27)	4.62 (3.49-6.11)	8.35 (6.61-10.52)	*12.74 (9.97-16.22)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,314	62 (56 to 69)	54	1.47 (0.93-2.32)	3.29 (2.34-4.62)	4.75 (3.41-6.58)			
MG Uni[Fem:Tib]									
Cemented, fixed	1,481	62 (56 to 69)	56	0.95 (0.56-1.59)	4.36 (3.43-5.54)	6.59 (5.43-7.99)	11.45 (9.89-13.24)	14.36 (12.45-16.54)	*14.36 (12.45-16.54)*
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	24,975	65 (58 to 71)	56	1.18 (1.05-1.33)	2.38 (2.18-2.59)	3.37 (3.10-3.67)	5.85 (5.10-6.72)		

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,496	65 (58 to 73)	50	1.43 (0.94-2.19)	4.22 (3.27-5.42)	5.79 (4.63-7.22)	9.68 (7.88-11.86)		
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	43,021	64 (58 to 71)	52	1.23 (1.13-1.33)	4.38 (4.18-4.58)	6.52 (6.28-6.76)	11.72 (11.39-12.07)	17.28 (16.71-17.88)	19.34 (18.42-20.29)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	5,148	65 (57 to 72)	49	0.80 (0.59-1.09)	2.45 (2.04-2.95)	3.72 (3.17-4.37)	7.02 (5.95-8.28)		
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	2,631	65 (58 to 72)	58	0.21 (0.09-0.50)	*0.72 (0.36-1.42)*				
***Physica ZUK[Fem:Tib]**									
Cemented, fixed	17,078	63 (56 to 70)	54	0.35 (0.27-0.45)	1.71 (1.51-1.95)	2.74 (2.45-3.06)	5.61 (4.96-6.36)	*8.48 (5.82-12.28)*	
Cemented, monobloc polyethylene tibia	2,005	64 (56 to 71)	55	0.21 (0.08-0.55)	2.93 (2.24-3.83)	4.14 (3.27-5.24)	*7.61 (5.94-9.73)*		
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	12,479	63 (56 to 70)	58	0.75 (0.61-0.92)	2.82 (2.52-3.15)	3.94 (3.56-4.35)	6.30 (5.61-7.07)		
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,518	62 (55 to 69)	56	1.21 (0.77-1.92)	4.26 (3.28-5.51)	6.86 (5.48-8.58)	*8.76 (6.98-10.95)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,378	58 (50 to 67)	22	0.69 (0.51-0.92)	4.18 (3.70-4.73)	7.31 (6.65-8.04)	14.74 (13.68-15.88)	21.92 (20.13-23.83)	*23.11 (20.89-25.52)*
FPV[Fem]									
Patellofemoral	1,649	59 (52 to 68)	23	0.91 (0.55-1.51)	7.04 (5.89-8.40)	10.31 (8.91-11.90)	19.31 (17.24-21.59)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,187	58 (50 to 67)	23	1.79 (1.30-2.45)	7.34 (6.26-8.59)	12.59 (11.11-14.24)	21.97 (19.80-24.33)		
Sigma HP (PF)[Fem]									
Patellofemoral	1,302	58 (50 to 66)	23	2.70 (1.94-3.74)	9.36 (7.89-11.08)	13.71 (11.91-15.75)	*25.24 (22.14-28.70)*		
Zimmer PFJ[Fem]									
Patellofemoral	3,224	56 (49 to 65)	23	0.61 (0.39-0.96)	4.48 (3.75-5.35)	7.13 (6.12-8.30)	*14.26 (12.03-16.88)*		

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Total knee replacements									
AGC V2[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	11,769	71 (65 to 77)	35	0.23 (0.16-0.34)	1.21 (1.03-1.43)	1.81 (1.58-2.08)	2.96 (2.64-3.32)	4.63 (4.03-5.32)	*4.80 (4.13-5.59)*
Cemented, unconstrained, fixed, without patella	25,301	71 (65 to 77)	46	0.28 (0.22-0.35)	1.52 (1.37-1.68)	2.21 (2.03-2.40)	3.49 (3.25-3.75)	5.74 (5.29-6.23)	6.82 (6.06-7.67)
AGC[Fem]AGC V2[Tib]									
Cemented, unconstrained, fixed, with patella	9,479	71 (64 to 77)	37	0.26 (0.17-0.38)	1.20 (1.00-1.45)	1.70 (1.45-1.99)	2.99 (2.61-3.42)	6.16 (5.16-7.35)	*6.16 (5.16-7.35)*
Cemented, unconstrained, fixed, without patella	18,613	71 (64 to 77)	45	0.34 (0.26-0.43)	1.77 (1.59-1.97)	2.48 (2.26-2.72)	3.77 (3.47-4.10)	5.37 (4.78-6.03)	*6.32 (5.21-7.65)*
Advance MP[Fem]Advance[Tib]									
Cemented, unconstrained, fixed, with patella	3,000	70 (63 to 76)	43	0.50 (0.30-0.83)	1.48 (1.10-1.99)	2.03 (1.56-2.63)	3.28 (2.61-4.13)	*3.90 (2.97-5.13)*	
Cemented, unconstrained, fixed, without patella	5,748	70 (64 to 76)	50	0.60 (0.43-0.83)	2.32 (1.95-2.75)	3.25 (2.81-3.77)	4.56 (3.97-5.24)	*5.42 (4.60-6.39)*	*8.57 (4.15-17.26)*
Attune CR[Fem]Attune FB[Tib]									
Cemented, unconstrained, fixed, with patella	7,413	70 (62 to 76)	38	0.24 (0.15-0.39)	1.13 (0.88-1.46)	1.54 (1.20-1.97)			
Cemented, unconstrained, fixed, without patella	11,137	69 (62 to 75)	48	0.46 (0.35-0.60)	1.62 (1.38-1.91)	2.12 (1.79-2.51)			
Attune CR[Fem]Attune RP[Tib]									
Cemented, unconstrained, mobile, with patella	2,140	70 (63 to 77)	37	0.19 (0.07-0.52)	0.86 (0.49-1.50)	*1.32 (0.70-2.49)*			
Cemented, unconstrained, mobile, without patella	1,353	70 (63 to 77)	49	0.08 (0.01-0.59)	0.89 (0.44-1.80)	*1.64 (0.85-3.18)*			
Attune PS[Fem]Attune FB[Tib]									
Cemented, posterior-stabilised, fixed, with patella	6,183	70 (63 to 76)	41	0.47 (0.33-0.69)	1.36 (1.07-1.74)	2.22 (1.69-2.90)			
Cemented, posterior-stabilised, fixed, without patella	3,976	70 (62 to 76)	44	0.42 (0.26-0.68)	2.03 (1.57-2.61)	2.92 (2.27-3.76)			
Columbus Cemented[Fem]Columbus CR/PS[Tib]									
Cemented, unconstrained, fixed, with patella	3,881	70 (63 to 76)	37	0.58 (0.38-0.88)	1.30 (0.98-1.73)	1.57 (1.20-2.05)	3.02 (2.08-4.37)	*5.76 (3.34-9.84)*	
Cemented, unconstrained, fixed, without patella	9,220	71 (65 to 76)	46	0.37 (0.27-0.52)	1.56 (1.32-1.85)	2.25 (1.94-2.61)	3.05 (2.62-3.55)	*3.35 (2.82-3.99)*	

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Genesis II Oxinium[Fem]Genesis II[Tib]									
Cemented, unconstrained, fixed, with patella	4,317	59 (54 to 64)	38	0.50 (0.32-0.76)	1.55 (1.20-1.99)	2.06 (1.64-2.59)	3.61 (2.92-4.44)	*5.02 (3.72-6.75)*	
Cemented, unconstrained, fixed, without patella	3,337	59 (54 to 65)	43	0.64 (0.42-0.98)	2.81 (2.27-3.46)	4.31 (3.61-5.13)	6.74 (5.73-7.92)	*8.59 (7.15-10.31)*	
Cemented, posterior-stabilised, fixed, with patella	1,698	59 (54 to 65)	34	0.54 (0.28-1.04)	2.36 (1.71-3.27)	3.21 (2.41-4.27)	5.94 (4.52-7.78)		
Cemented, posterior-stabilised, fixed, without patella	1,756	57 (52 to 63)	47	0.75 (0.43-1.28)	3.95 (3.10-5.02)	6.20 (5.09-7.55)	10.46 (8.79-12.42)		
Genesis II[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	28,007	71 (66 to 77)	39	0.39 (0.32-0.47)	1.04 (0.92-1.18)	1.37 (1.23-1.54)	2.03 (1.82-2.28)	2.36 (2.02-2.76)	*2.90 (1.97-4.27)*
Cemented, unconstrained, fixed, without patella	34,057	71 (65 to 77)	46	0.41 (0.35-0.49)	1.59 (1.45-1.73)	2.20 (2.03-2.38)	3.22 (2.97-3.48)	3.56 (3.23-3.92)	*3.84 (3.24-4.55)*
Cemented, posterior-stabilised, fixed, with patella	11,388	71 (65 to 77)	35	0.63 (0.50-0.80)	1.73 (1.49-2.01)	2.24 (1.95-2.57)	3.27 (2.83-3.79)	*4.07 (3.10-5.34)*	
Cemented, posterior-stabilised, fixed, without patella	10,300	71 (65 to 77)	44	0.64 (0.50-0.82)	1.92 (1.66-2.22)	2.77 (2.44-3.15)	4.02 (3.53-4.58)	*5.66 (3.57-8.92)*	
Journey II BCS Oxinium[Fem]Journey[Tib]									
Cemented, posterior-stabilised, fixed, with patella	3,342	66 (59 to 73)	41	0.45 (0.26-0.75)	1.48 (1.05-2.08)	1.59 (1.13-2.24)			
Cemented, posterior-stabilised, fixed, without patella	707	65 (57 to 72)	43	1.15 (0.58-2.29)	5.55 (3.96-7.77)	*5.96 (4.24-8.37)*			
Kinemax[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	4,291	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)	5.47 (4.72-6.34)	*5.89 (5.05-6.87)*
Cemented, unconstrained, fixed, without patella	6,475	71 (64 to 77)	47	0.23 (0.14-0.39)	2.07 (1.75-2.46)	3.30 (2.88-3.78)	5.41 (4.86-6.03)	7.33 (6.62-8.11)	7.94 (7.13-8.83)
LCS Complete[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	781	70 (63 to 77)	31	0.64 (0.27-1.54)	2.19 (1.34-3.55)	3.80 (2.60-5.54)	*6.37 (4.59-8.81)*	*6.94 (4.94-9.71)*	
Cemented, unconstrained, mobile, without patella	11,609	71 (64 to 76)	42	0.39 (0.29-0.52)	1.47 (1.26-1.71)	2.40 (2.12-2.71)	3.79 (3.40-4.21)	*4.25 (3.80-4.75)*	
Uncemented, unconstrained, mobile, with patella	567	68 (61 to 74)	34	0.54 (0.17-1.66)	1.87 (0.97-3.57)	2.69 (1.52-4.72)	*3.01 (1.74-5.19)*	*4.19 (2.13-8.16)*	

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Uncemented, unconstrained, mobile, without patella	15,264	69 (62 to 75)	47	0.42 (0.33-0.53)	1.83 (1.62-2.06)	2.52 (2.27-2.80)	3.44 (3.13-3.79)	4.10 (3.65-4.60)	
MRK[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	5,256	71 (64 to 77)	38	0.25 (0.15-0.43)	1.01 (0.76-1.34)	1.50 (1.18-1.92)	2.42 (1.92-3.05)	*2.95 (2.20-3.96)*	*2.95 (2.20-3.96)*
Cemented, unconstrained, fixed, without patella	9,621	70 (63 to 76)	48	0.35 (0.25-0.49)	1.24 (1.03-1.50)	1.66 (1.40-1.97)	2.85 (2.41-3.37)	*3.30 (2.67-4.07)*	
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)	4.39 (3.40-5.64)	*7.84 (5.63-10.87)*	
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)	3.21 (2.28-4.51)	*5.45 (3.90-7.58)*	*6.21 (4.25-9.02)*
Nexgen[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	23,958	70 (63 to 76)	38	0.30 (0.23-0.37)	0.99 (0.86-1.13)	1.45 (1.29-1.63)	2.36 (2.09-2.66)	3.13 (2.59-3.79)	*3.13 (2.59-3.79)*
Cemented, unconstrained, fixed, without patella	65,093	70 (63 to 76)	45	0.31 (0.27-0.36)	1.04 (0.96-1.13)	1.54 (1.44-1.65)	2.43 (2.27-2.60)	3.20 (2.83-3.61)	*3.41 (2.89-4.03)*
Cemented, posterior-stabilised, fixed, with patella	26,330	70 (63 to 76)	36	0.52 (0.44-0.62)	1.67 (1.52-1.85)	2.77 (2.55-3.00)	4.83 (4.49-5.20)	6.07 (5.54-6.64)	*6.50 (5.71-7.40)*
Cemented, posterior-stabilised, fixed, without patella	55,841	71 (64 to 77)	43	0.42 (0.37-0.48)	1.52 (1.42-1.63)	2.48 (2.34-2.63)	4.24 (4.03-4.46)	5.63 (5.25-6.03)	*6.12 (5.61-6.67)*
Nexgen[Fem]TM Monoblock[Tib]									
Uncemented, unconstrained, fixed, with patella	379	63 (57 to 69)	58	0.53 (0.13-2.11)	2.21 (1.11-4.38)	3.09 (1.72-5.52)	*5.20 (3.25-8.27)*	*6.87 (4.16-11.25)*	
Uncemented, unconstrained, fixed, without patella	3,623	65 (58 to 72)	58	0.61 (0.40-0.93)	2.66 (2.18-3.25)	3.36 (2.80-4.02)	4.31 (3.66-5.07)	4.82 (4.06-5.71)	*4.82 (4.06-5.71)*
PFC Sigma Bicondylar Knee[Fem]M.B.T.[Tib]									
Cemented, unconstrained, mobile, with patella	3,192	64 (58 to 72)	41	0.47 (0.29-0.78)	2.12 (1.67-2.70)	2.88 (2.34-3.53)	4.32 (3.63-5.14)	*6.34 (5.02-7.99)*	
Cemented, unconstrained, mobile, without patella	5,185	64 (58 to 71)	51	0.66 (0.47-0.92)	1.79 (1.46-2.19)	2.52 (2.12-3.00)	3.51 (3.01-4.11)	*4.51 (3.66-5.57)*	
Cemented, posterior-stabilised, mobile, with patella	5,153	64 (59 to 72)	45	0.45 (0.30-0.67)	1.45 (1.15-1.82)	2.10 (1.73-2.53)	2.98 (2.52-3.52)	*3.46 (2.82-4.23)*	
Cemented, posterior-stabilised, mobile, without patella	1,982	66 (58 to 73)	49	1.22 (0.82-1.82)	4.11 (3.31-5.09)	5.45 (4.51-6.57)	7.47 (6.31-8.82)	*8.23 (6.95-9.73)*	

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
PFC Sigma Bicondylar Knee[Fem]PFC Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	44,282	71 (64 to 77)	37	0.35 (0.30-0.41)	1.02 (0.92-1.12)	1.48 (1.36-1.60)	2.04 (1.89-2.20)	2.68 (2.45-2.92)	2.79 (2.52-3.09)
Cemented, unconstrained, fixed, without patella	88,049	70 (64 to 76)	46	0.41 (0.37-0.45)	1.34 (1.26-1.42)	1.80 (1.71-1.90)	2.51 (2.39-2.64)	3.19 (3.02-3.38)	3.39 (3.17-3.63)
Cemented, posterior-stabilised, fixed, with patella	21,410	71 (64 to 77)	39	0.40 (0.32-0.49)	1.23 (1.09-1.39)	1.68 (1.51-1.87)	2.39 (2.17-2.63)	3.13 (2.83-3.47)	3.71 (3.05-4.50)
Cemented, posterior-stabilised, fixed, without patella	14,934	71 (64 to 77)	45	0.40 (0.31-0.52)	1.86 (1.65-2.09)	2.59 (2.34-2.87)	3.84 (3.51-4.20)	5.32 (4.80-5.88)	*5.74 (4.93-6.67)*
PFC Sigma Bicondylar Knee[Fem]PFC Sigma Bicondylar[Tib]									
Cemented, unconstrained, fixed, with patella	43,503	70 (63 to 76)	36	0.35 (0.30-0.41)	1.16 (1.05-1.27)	1.64 (1.51-1.78)	2.24 (2.05-2.45)		
Cemented, unconstrained, fixed, without patella	78,766	70 (63 to 76)	46	0.35 (0.31-0.39)	1.43 (1.35-1.52)	1.99 (1.88-2.10)	2.63 (2.49-2.78)		
Cemented, posterior-stabilised, fixed, with patella	36,282	71 (65 to 77)	40	0.38 (0.32-0.45)	1.20 (1.09-1.32)	1.69 (1.55-1.84)	2.43 (2.23-2.65)		
Cemented, posterior-stabilised, fixed, without patella	18,730	70 (63 to 77)	45	0.51 (0.42-0.62)	2.38 (2.16-2.62)	3.21 (2.95-3.50)	4.26 (3.93-4.63)		
Cemented, monobloc polyethylene tibia, with patella	2,785	76 (71 to 81)	37	0.41 (0.23-0.73)	1.10 (0.75-1.60)	1.61 (1.16-2.24)	1.80 (1.30-2.51)	*2.10 (1.41-3.13)*	
Cemented, monobloc polyethylene tibia, without patella	11,527	74 (69 to 79)	43	0.34 (0.25-0.46)	1.34 (1.14-1.58)	1.74 (1.49-2.03)	2.18 (1.87-2.55)		
Persona CR[Fem]Persona[Tib]									
Cemented, unconstrained, fixed, with patella	1,790	69 (62 to 75)	42	0.33 (0.14-0.80)	0.66 (0.28-1.57)	*0.66 (0.28-1.57)*			
Cemented, unconstrained, fixed, without patella	2,614	70 (63 to 76)	49	0.22 (0.09-0.52)	0.83 (0.42-1.60)	*2.04 (1.07-3.90)*			
Scorpio NRG[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	3,787	70 (64 to 76)	38	0.42 (0.26-0.69)	1.23 (0.92-1.64)	2.01 (1.60-2.53)	3.39 (2.75-4.18)		
Cemented, unconstrained, fixed, without patella	4,797	70 (64 to 76)	46	0.31 (0.19-0.52)	1.63 (1.30-2.03)	2.63 (2.20-3.14)	3.71 (3.16-4.35)		
Cemented, posterior-stabilised, fixed, with patella	3,109	71 (64 to 77)	42	0.49 (0.29-0.80)	1.31 (0.96-1.78)	1.90 (1.47-2.46)	2.85 (2.27-3.57)		
Cemented, posterior-stabilised, fixed, without patella	1,625	69 (63 to 76)	47	0.37 (0.17-0.82)	2.45 (1.80-3.34)	3.43 (2.64-4.46)	5.62 (4.52-6.96)		

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 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)	3.35 (2.73-4.10)	4.24 (3.46-5.18)	*4.51 (3.60-5.63)*
Cemented, unconstrained, fixed, without patella	7,397	70 (64 to 77)	43	0.48 (0.34-0.66)	2.10 (1.79-2.46)	2.86 (2.50-3.28)	4.12 (3.67-4.62)	5.49 (4.87-6.20)	*5.49 (4.87-6.20)*
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)	3.05 (2.50-3.72)	4.13 (3.44-4.96)	*4.13 (3.44-4.96)*
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)	5.69 (4.82-6.71)	7.00 (5.97-8.20)	*7.89 (6.40-9.72)*
Uncemented, unconstrained, fixed, with patella	813	71 (63 to 77)	39	0.37 (0.12-1.15)	1.75 (1.04-2.94)	2.53 (1.64-3.89)	3.26 (2.21-4.80)	*4.02 (2.74-5.88)*	
Uncemented, unconstrained, fixed, without patella	2,920	70 (64 to 76)	49	0.69 (0.44-1.07)	1.98 (1.53-2.56)	2.63 (2.10-3.29)	4.11 (3.42-4.94)	*4.94 (4.12-5.91)*	*4.94 (4.12-5.91)*
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)	3.91 (2.53-6.01)	*5.43 (3.56-8.26)*	*5.43 (3.56-8.26)*
Cemented, unconstrained, fixed, without patella	7,373	70 (64 to 76)	46	0.86 (0.67-1.10)	2.05 (1.75-2.40)	2.64 (2.29-3.03)	3.74 (3.31-4.21)	4.83 (4.22-5.53)	*5.62 (4.45-7.09)*
Cemented, unconstrained, mobile, with patella	237	72 (65 to 77)	35	*0*	*0.47 (0.07-3.29)*	*1.47 (0.48-4.49)*	*1.47 (0.48-4.49)*		
Cemented, unconstrained, mobile, without patella	5,029	70 (64 to 76)	44	0.56 (0.39-0.81)	1.60 (1.28-1.99)	2.12 (1.75-2.56)	3.31 (2.83-3.88)	4.37 (3.69-5.17)	
Triathlon[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	45,449	70 (63 to 76)	39	0.44 (0.38-0.50)	1.17 (1.07-1.28)	1.59 (1.46-1.74)	2.46 (2.23-2.71)		
Cemented, unconstrained, fixed, without patella	68,520	70 (63 to 76)	46	0.47 (0.42-0.53)	1.53 (1.43-1.63)	2.15 (2.02-2.28)	3.16 (2.95-3.40)	*4.43 (3.54-5.53)*	
Cemented, posterior-stabilised, fixed, with patella	16,102	70 (63 to 76)	40	0.57 (0.46-0.70)	1.50 (1.31-1.72)	2.27 (2.01-2.55)	3.20 (2.83-3.61)		
Cemented, posterior-stabilised, fixed, without patella	8,343	70 (63 to 77)	44	0.71 (0.55-0.92)	2.23 (1.91-2.60)	3.13 (2.72-3.60)	4.56 (3.90-5.32)		
Uncemented, unconstrained, fixed, with patella	1,215	68 (60 to 75)	47	0.83 (0.43-1.60)	1.51 (0.85-2.68)	*1.51 (0.85-2.68)*	*1.51 (0.85-2.68)*		
Uncemented, unconstrained, fixed, without patella	2,975	69 (61 to 75)	52	0.53 (0.32-0.88)	1.76 (1.30-2.39)	2.28 (1.69-3.06)	*3.26 (2.17-4.90)*		

*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	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
Vanguard[Fem:Tib]									
Cemented, unconstrained, fixed, with patella	27,202	70 (64 to 76)	38	0.33 (0.26-0.40)	0.96 (0.84-1.09)	1.44 (1.28-1.62)	2.52 (2.05-3.09)		
Cemented, unconstrained, fixed, without patella	40,283	70 (63 to 76)	45	0.37 (0.32-0.44)	1.61 (1.49-1.75)	2.27 (2.11-2.44)	3.14 (2.88-3.41)		
Cemented, posterior-stabilised, fixed, with patella	5,703	70 (63 to 76)	38	0.56 (0.39-0.79)	1.68 (1.35-2.08)	2.48 (2.05-2.99)	*3.24 (2.64-3.98)*		
Cemented, posterior-stabilised, fixed, without patella	4,505	70 (63 to 77)	44	0.68 (0.48-0.97)	2.67 (2.21-3.22)	3.36 (2.82-4.01)	*5.11 (4.01-6.50)*		
Cemented, constrained condylar, with patella	1,732	70 (63 to 76)	32	0.54 (0.28-1.03)	1.19 (0.75-1.88)	1.60 (1.05-2.45)			
Cemented, constrained condylar, without patella	1,648	70 (63 to 76)	40	0.39 (0.17-0.86)	1.38 (0.87-2.19)	1.52 (0.96-2.40)			
Unicondylar knee replacements									
AMC/Uniglide[Fem:Tib]									
Cemented, monobloc polyethylene tibia	1,087	67 (59 to 75)	50	0.28 (0.09-0.86)	3.04 (2.16-4.27)	4.62 (3.49-6.11)	8.35 (6.61-10.52)	*12.74 (9.97-16.22)*	
Journey Uni Oxinium[Fem]Journey Uni[Tib]									
Cemented, fixed	1,314	62 (56 to 69)	54	1.47 (0.93-2.32)	3.29 (2.34-4.62)	4.75 (3.41-6.58)			
MG Uni[Fem:Tib]									
Cemented, fixed	1,481	62 (56 to 69)	56	0.95 (0.56-1.59)	4.36 (3.43-5.54)	6.59 (5.43-7.99)	11.45 (9.89-13.24)	14.36 (12.45-16.54)	*14.36 (12.45-16.54)*
Oxford Cementless Partial Knee[Fem:Tib]									
Uncemented/Hybrid, mobile	24,975	65 (58 to 71)	56	1.18 (1.05-1.33)	2.38 (2.18-2.59)	3.37 (3.10-3.67)	5.85 (5.10-6.72)		
Oxford Cementless Partial Knee[Fem]Oxford Partial Knee[Tib]									
Uncemented/Hybrid, mobile	1,496	65 (58 to 73)	50	1.43 (0.94-2.19)	4.22 (3.27-5.42)	5.79 (4.63-7.22)	9.68 (7.88-11.86)		
Oxford Single Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	43,021	64 (58 to 71)	52	1.23 (1.13-1.33)	4.38 (4.18-4.58)	6.52 (6.28-6.76)	11.72 (11.39-12.07)	17.28 (16.71-17.88)	19.34 (18.42-20.29)
Oxford Twin Peg Cemented Partial Knee[Fem]Oxford Partial Knee[Tib]									
Cemented, mobile	5,148	65 (57 to 72)	49	0.80 (0.59-1.09)	2.45 (2.04-2.95)	3.72 (3.17-4.37)	7.02 (5.95-8.28)		
Persona Partial Knee[Fem:Tib]									
Cemented, fixed	2,631	65 (58 to 72)	58	0.21 (0.09-0.50)	*0.72 (0.36-1.42)*				

*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 (b) (continued)

Brand[1]	N	Median (IQR) age at primary	Male (%)	Time since primary					
				1 year	3 years	5 years	10 years	15 years	17 years
*Physica ZUK[Fem:Tib]									
Cemented, fixed	17,078	63 (56 to 70)	54	0.35 (0.27-0.45)	1.71 (1.51-1.95)	2.74 (2.45-3.06)	5.61 (4.96-6.36)	*8.48 (5.82-12.28)*	
Cemented, monobloc polyethylene tibia	2,005	64 (56 to 71)	55	0.21 (0.08-0.55)	2.93 (2.24-3.83)	4.14 (3.27-5.24)	*7.61 (5.94-9.73)*		
Sigma HP (Uni)[Fem]Sigma HP[Tib]									
Cemented, fixed	12,479	63 (56 to 70)	58	0.75 (0.61-0.92)	2.82 (2.52-3.15)	3.94 (3.56-4.35)	6.30 (5.61-7.07)		
Triathlon Uni[Fem]Triathlon[Tib]									
Cemented, fixed	1,518	62 (55 to 69)	56	1.21 (0.77-1.92)	4.26 (3.28-5.51)	6.86 (5.48-8.58)	*8.76 (6.98-10.95)*		
Patellofemoral knee replacements									
Avon[Fem]									
Patellofemoral	6,378	58 (50 to 67)	22	0.69 (0.51-0.92)	4.18 (3.70-4.73)	7.31 (6.65-8.04)	14.74 (13.68-15.88)	21.92 (20.13-23.83)	*23.11 (20.89-25.52)*
FPV[Fem]									
Patellofemoral	1,649	59 (52 to 68)	23	0.91 (0.55-1.51)	7.04 (5.89-8.40)	10.31 (8.91-11.90)	19.31 (17.24-21.59)		
Journey PFJ Oxinium[Fem]									
Patellofemoral	2,187	58 (50 to 67)	23	1.79 (1.30-2.45)	7.34 (6.26-8.59)	12.59 (11.11-14.24)	21.97 (19.80-24.33)		
Sigma HP (PF)[Fem]									
Patellofemoral	1,302	58 (50 to 66)	23	2.70 (1.94-3.74)	9.36 (7.89-11.08)	13.71 (11.91-15.75)	*25.24 (22.14-28.70)*		
Zimmer PFJ[Fem]									
Patellofemoral	3,224	56 (49 to 65)	23	0.61 (0.39-0.96)	4.48 (3.75-5.35)	7.13 (6.12-8.30)	*14.26 (12.03-16.88)*		

*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 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.

In Table 3.K11 (page 190), 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, 15 to 17 and ≥17 years after surgery (the maximum follow-up for any implant is now 17.75 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	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening / Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalignment	Other indication[2]	Stiffness[3] Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years	Progressive arthritis[4] Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
All cases	8,921.4	4.53 (4.49-4.58)	0.68 (0.66-0.70)	0.16 (0.16-0.17)	0.87 (0.85-0.89)	1.21 (1.18-1.23)	0.17 (0.16-0.18)	0.29 (0.28-0.30)	0.64 (0.63-0.66)	0.32 (0.31-0.34)	0.50 (0.48-0.51)	8,665.1	0.29 (0.27-0.30)	6,503.2	0.73 (0.71-0.75)
Total knee replacement															
All cemented	7,353.0	3.62 (3.58-3.66)	0.48 (0.47-0.50)	0.10 (0.09-0.11)	0.94 (0.92-0.96)	0.98 (0.96-1.01)	0.16 (0.15-0.17)	0.18 (0.17-0.19)	0.60 (0.59-0.62)	0.29 (0.27-0.30)	0.35 (0.33-0.36)	7,155.1	0.29 (0.28-0.31)	5,453.7	0.34 (0.33-0.36)
unconstrained, fixed, with patella	1,708.7	2.86 (2.78-2.94)	0.31 (0.28-0.33)	0.08 (0.07-0.09)	0.90 (0.85-0.94)	0.82 (0.78-0.87)	0.13 (0.11-0.14)	0.18 (0.16-0.20)	0.57 (0.54-0.61)	0.26 (0.23-0.28)	0.22 (0.20-0.25)	1,657.4	0.26 (0.23-0.28)	1,287.0	0.03 (0.02-0.04)
unconstrained, fixed, without patella	3,249.2	3.55 (3.48-3.61)	0.56 (0.53-0.58)	0.09 (0.08-0.10)	0.84 (0.81-0.87)	0.81 (0.78-0.84)	0.13 (0.12-0.14)	0.16 (0.15-0.17)	0.57 (0.54-0.59)	0.28 (0.27-0.30)	0.39 (0.37-0.41)	3,168.7	0.30 (0.28-0.32)	2,438.1	0.53 (0.51-0.56)
unconstrained, mobile, with patella	82.1	5.03 (4.57-5.54)	0.52 (0.39-0.71)	0.33 (0.23-0.48)	1.27 (1.05-1.54)	1.67 (1.41-1.97)	0.15 (0.08-0.26)	0.44 (0.32-0.61)	1.12 (0.91-1.38)	0.40 (0.29-0.57)	0.29 (0.20-0.44)	78.7	0.58 (0.44-0.78)	49.2	0
unconstrained, mobile, without patella	254.3	3.92 (3.69-4.18)	0.71 (0.61-0.82)	0.15 (0.11-0.21)	0.77 (0.67-0.89)	1.28 (1.15-1.43)	0.16 (0.12-0.21)	0.28 (0.22-0.35)	0.70 (0.60-0.81)	0.37 (0.31-0.46)	0.35 (0.28-0.43)	248.0	0.36 (0.30-0.45)	150.4	0.32 (0.24-0.42)
posterior-stabilised, fixed, with patella	900.3	3.62 (3.50-3.75)	0.32 (0.29-0.36)	0.09 (0.07-0.11)	1.19 (1.12-1.26)	1.20 (1.13-1.27)	0.23 (0.20-0.26)	0.17 (0.15-0.20)	0.58 (0.54-0.64)	0.28 (0.25-0.31)	0.25 (0.22-0.28)	874.9	0.26 (0.23-0.30)	672.4	0.03 (0.02-0.04)
posterior-stabilised, fixed, without patella	887.6	4.94 (4.79-5.08)	0.62 (0.57-0.68)	0.10 (0.08-0.12)	1.07 (1.01-1.15)	1.59 (1.51-1.67)	0.23 (0.20-0.27)	0.21 (0.18-0.24)	0.73 (0.67-0.78)	0.33 (0.29-0.37)	0.50 (0.45-0.54)	860.2	0.31 (0.28-0.35)	645.4	0.64 (0.58-0.71)
posterior-stabilised, mobile, with patella	71.1	3.50 (3.09-3.96)	0.44 (0.31-0.62)	0.07 (0.03-0.17)	0.93 (0.73-1.18)	0.96 (0.75-1.21)	0.18 (0.11-0.31)	0.18 (0.11-0.31)	0.76 (0.58-0.99)	0.24 (0.15-0.38)	0.38 (0.26-0.55)	69.9	0.47 (0.34-0.66)	49.4	0
posterior-stabilised, mobile, without patella	37.5	6.19 (5.44-7.04)	1.07 (0.78-1.46)	0.24 (0.12-0.46)	0.75 (0.52-1.08)	1.31 (0.99-1.73)	0.32 (0.18-0.56)	0.43 (0.26-0.70)	1.01 (0.74-1.39)	0.19 (0.09-0.39)	1.23 (0.92-1.64)	36.4	0.60 (0.40-0.92)	20.7	1.16 (0.78-1.73)
constrained condylar, with patella	20.7	4.39 (3.57-5.39)	0.19 (0.07-0.51)	0.34 (0.16-0.71)	2.22 (1.66-2.96)	0.68 (0.40-1.14)	0.29 (0.13-0.64)	0.05 (0.01-0.34)	0.63 (0.36-1.08)	0.05 (0.01-0.34)	0.43 (0.23-0.83)	20.5	0.24 (0.10-0.59)	18.2	0.11 (0.03-0.44)
constrained condylar, without patella	26.4	5.94 (5.08-6.94)	0.38 (0.20-0.70)	0.30 (0.15-0.60)	2.61 (2.06-3.30)	0.91 (0.61-1.35)	0.49 (0.29-0.85)	0.34 (0.18-0.65)	0.76 (0.49-1.17)	0.38 (0.20-0.70)	0.45 (0.26-0.80)	26.1	0.35 (0.18-0.66)	22.4	0.67 (0.40-1.11)
monobloc polyethylene tibia, with patella	22.8	2.37 (1.81-3.09)	0.26 (0.12-0.59)	0.04 (0.01-0.31)	0.70 (0.43-1.15)	0.57 (0.33-0.98)	0.18 (0.07-0.47)	0.09 (0.02-0.35)	0.66 (0.40-1.09)	0.35 (0.18-0.70)	0.18 (0.07-0.47)	22.7	0.26 (0.12-0.59)	20.9	0
monobloc polyethylene tibia, without patella	81.9	3.16 (2.80-3.57)	0.48 (0.35-0.65)	0.10 (0.05-0.20)	0.81 (0.63-1.03)	0.78 (0.61-1.00)	0.21 (0.13-0.33)	0.06 (0.03-0.15)	0.45 (0.33-0.62)	0.26 (0.17-0.39)	0.33 (0.23-0.48)	81.4	0.25 (0.16-0.38)	71.9	0.21 (0.13-0.35)
pre-assembled/ hinged/linked, with patella	2.0	13.60 (9.33-19.84)	0.50 (0.07-3.58)	1.51 (0.49-4.69)	7.05 (4.18-11.91)	1.51 (0.49-4.69)	1.01 (0.25-4.03)	0.50 (0.07-3.58)	0.50 (0.07-3.58)	1.01 (0.25-4.03)	1.51 (0.49-4.69)	2.0	0.51 (0.07-3.60)	1.4	1.45 (0.36-5.79)

[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	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening / Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalignment	Other indication[2]	Stiffness[3] Prosthesis-years at risk (x1,000)	Stiffness[3] Revisions per 1,000 prosthesis-years	Progressive arthritis[4] Prosthesis-years at risk (x1,000)	Progressive arthritis[4] Revisions per 1,000 prosthesis-years
pre-assembled/ hinged/linked, without patella	8.4	10.29 (8.33-12.71)	0.36 (0.12-1.11)	0.84 (0.40-1.76)	3.83 (2.71-5.42)	2.15 (1.36-3.42)	0.84 (0.40-1.76)	0.60 (0.25-1.44)	0.48 (0.18-1.28)	0.84 (0.40-1.76)	0.96 (0.48-1.91)	8.1	0.37 (0.12-1.14)	6.4	0.79 (0.33-1.89)
All uncemented	**386.8**	**4.35 (4.14-4.56)**	**0.82 (0.73-0.91)**	**0.16 (0.12-0.20)**	**0.60 (0.53-0.69)**	**1.51 (1.39-1.64)**	**0.15 (0.12-0.20)**	**0.32 (0.27-0.39)**	**0.73 (0.65-0.82)**	**0.38 (0.32-0.45)**	**0.57 (0.50-0.65)**	**369.4**	**0.36 (0.30-0.42)**	**230.3**	**0.42 (0.34-0.51)**
unconstrained, fixed, with patella	18.4	4.50 (3.63-5.58)	0.33 (0.15-0.72)	0.22 (0.08-0.58)	0.76 (0.45-1.28)	1.79 (1.27-2.52)	0.33 (0.15-0.72)	0.22 (0.08-0.58)	1.19 (0.79-1.81)	0.71 (0.41-1.21)	0.16 (0.05-0.50)	18.2	0.22 (0.08-0.59)	13.9	0.07 (0.01-0.51)
unconstrained, fixed, without patella	130.1	4.45 (4.10-4.83)	0.78 (0.65-0.95)	0.08 (0.04-0.14)	0.59 (0.47-0.74)	1.71 (1.50-1.95)	0.15 (0.10-0.24)	0.32 (0.24-0.44)	0.67 (0.54-0.83)	0.37 (0.28-0.49)	0.62 (0.49-0.77)	123.2	0.35 (0.26-0.47)	75.7	0.50 (0.37-0.69)
unconstrained, mobile, with patella	9.0	5.78 (4.41-7.59)	0.89 (0.45-1.78)	0.22 (0.06-0.89)	0.89 (0.45-1.78)	2.22 (1.44-3.45)	0.11 (0.02-0.79)	1.22 (0.68-2.21)	1.78 (1.09-2.91)	1.00 (0.52-1.92)	0.78 (0.37-1.63)	8.1	0.61 (0.26-1.47)	4.1	0
unconstrained, mobile, without patella	200.2	3.98 (3.71-4.27)	0.81 (0.69-0.94)	0.17 (0.13-0.24)	0.56 (0.46-0.67)	1.28 (1.13-1.45)	0.11 (0.08-0.17)	0.26 (0.20-0.35)	0.64 (0.54-0.76)	0.29 (0.22-0.37)	0.50 (0.42-0.61)	192.2	0.33 (0.26-0.42)	119.1	0.45 (0.35-0.59)
posterior-stabilised, fixed, with patella	5.3	8.16 (6.05-11.00)	1.33 (0.63-2.79)	0.76 (0.28-2.02)	1.33 (0.63-2.79)	3.04 (1.86-4.96)	0.95 (0.39-2.28)	0.57 (0.18-1.77)	1.71 (0.89-3.28)	0.76 (0.28-2.02)	0.57 (0.18-1.77)	4.9	1.03 (0.43-2.46)	2.8	0
posterior-stabilised, fixed, without patella	21.8	5.46 (4.56-6.53)	1.24 (0.85-1.81)	0.23 (0.10-0.55)	0.60 (0.35-1.03)	1.60 (1.15-2.23)	0.18 (0.07-0.49)	0.55 (0.31-0.97)	0.96 (0.63-1.48)	0.69 (0.41-1.14)	1.10 (0.74-1.64)	20.8	0.48 (0.26-0.90)	12.9	0.23 (0.08-0.72)
other constraints, with patella	0.2	0	0	0	0	0	0	0	0	0	0	0.2	0	0.1	0
other constraints, without patella	1.9	4.17 (2.08-8.33)	2.60 (1.08-6.26)	0.52 (0.07-3.70)	1.56 (0.50-4.84)	0.52 (0.07-3.70)	0	0	0.52 (0.07-3.70)	0	0.52 (0.07-3.70)	1.9	1.06 (0.26-4.22)	1.8	0
All hybrid	**89.0**	**3.54 (3.17-3.95)**	**0.58 (0.45-0.77)**	**0.15 (0.08-0.25)**	**0.83 (0.66-1.04)**	**1.09 (0.89-1.33)**	**0.13 (0.08-0.24)**	**0.31 (0.22-0.46)**	**0.58 (0.45-0.77)**	**0.31 (0.22-0.46)**	**0.27 (0.18-0.40)**	**81.5**	**0.20 (0.12-0.32)**	**42.5**	**0.28 (0.16-0.50)**
unconstrained, fixed, with patella	23.2	2.63 (2.05-3.38)	0.43 (0.23-0.80)	0.13 (0.04-0.40)	0.69 (0.42-1.13)	0.86 (0.56-1.34)	0.17 (0.06-0.46)	0.39 (0.20-0.75)	0.65 (0.39-1.07)	0.04 (0.01-0.31)	0.13 (0.04-0.40)	21.1	0.09 (0.02-0.38)	7.9	0
unconstrained, fixed, without patella	41.6	3.44 (2.92-4.05)	0.60 (0.41-0.89)	0.12 (0.05-0.29)	0.84 (0.60-1.17)	0.99 (0.73-1.34)	0.10 (0.04-0.26)	0.29 (0.16-0.51)	0.39 (0.24-0.63)	0.39 (0.24-0.63)	0.34 (0.20-0.57)	37.2	0.19 (0.09-0.39)	19.9	0.25 (0.10-0.61)
unconstrained, mobile, with patella	2.3	5.22 (2.96-9.19)	0	0.43 (0.06-3.09)	0.43 (0.06-3.09)	2.61 (1.17-5.81)	0.43 (0.06-3.09)	0	0	0.43 (0.06-3.09)	0	2.1	0.94 (0.24-3.76)	1.8	0
unconstrained, mobile, without patella	12.6	4.06 (3.09-5.35)	0.56 (0.27-1.17)	0.24 (0.08-0.74)	0.80 (0.43-1.48)	1.51 (0.97-2.37)	0	0.48 (0.21-1.06)	0.88 (0.49-1.58)	0.72 (0.37-1.38)	0.48 (0.21-1.06)	11.9	0.17 (0.04-0.67)	8.7	0.46 (0.17-1.22)

[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	Prosthesis-years at risk (x1,000)	Number of revisions per 1,000 prosthesis-years for: All causes	Pain	Dislocation/ Subluxation	Infection	Aseptic loosening / Lysis	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalignment	Other indication[2]	Stiffness[3] Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years	Progressive arthritis[4] Prosthesis-years at risk (x1,000)	Revisions per 1,000 prosthesis-years
posterior-stabilised, fixed, with patella	2.0	6.92 (4.10-11.68)	1.98 (0.74-5.27)	0	1.98 (0.74-5.27)	2.97 (1.33-6.60)	0.99 (0.25-3.95)	0	0.49 (0.07-3.51)	0	0	1.9	0.52 (0.07-3.71)	1.2	0
posterior-stabilised, fixed, without patella	3.4	4.47 (2.70-7.42)	0.30 (0.04-2.12)	0	1.49 (0.62-3.58)	1.19 (0.45-3.18)	0	0	1.19 (0.45-3.18)	0	0	3.2	0	1.7	0.58 (0.08-4.10)
other constraints, with patella	2.5	4.00 (2.15-7.44)	1.60 (0.60-4.27)	0	0.80 (0.20-3.20)	0	0.40 (0.06-2.84)	0.40 (0.06-2.84)	0.80 (0.20-3.20)	0	0.40 (0.06-2.84)	2.5	0.40 (0.06-2.84)	0.4	0
other constraints, without patella	1.5	5.88 (3.06-11.29)	0.65 (0.09-4.63)	0.65 (0.09-4.63)	0.65 (0.09-4.63)	0.65 (0.09-4.63)	0	0	1.96 (0.63-6.07)	0.65 (0.09-4.63)	0	1.5	0.67 (0.09-4.75)	0.9	2.30 (0.57-9.18)
Unicompartmental knee replacement															
All unicondylar, cemented	**670.4**	**11.33 (11.08-11.59)**	**2.12 (2.02-2.24)**	**0.61 (0.56-0.68)**	**0.46 (0.41-0.52)**	**3.14 (3.01-3.28)**	**0.20 (0.17-0.24)**	**1.12 (1.04-1.20)**	**0.91 (0.84-0.98)**	**0.54 (0.49-0.60)**	**1.50 (1.41-1.59)**	**649.6**	**0.17 (0.14-0.21)**	**465.7**	**3.46 (3.29-3.63)**
fixed	194.1	8.14 (7.75-8.55)	1.56 (1.39-1.75)	0.09 (0.06-0.15)	0.54 (0.44-0.65)	2.22 (2.02-2.44)	0.19 (0.14-0.26)	0.72 (0.61-0.85)	0.53 (0.43-0.64)	0.39 (0.31-0.48)	0.94 (0.82-1.09)	191.8	0.15 (0.11-0.22)	169.9	2.72 (2.49-2.98)
mobile	424.4	12.72 (12.39-13.07)	2.29 (2.15-2.44)	0.91 (0.82-1.00)	0.43 (0.37-0.50)	3.46 (3.29-3.64)	0.19 (0.15-0.23)	1.29 (1.19-1.41)	1.08 (0.99-1.19)	0.61 (0.54-0.69)	1.81 (1.69-1.94)	407.3	0.17 (0.14-0.22)	266.1	3.90 (3.67-4.14)
monobloc polyethylene tibia	51.9	11.85 (10.95-12.82)	2.89 (2.46-3.39)	0.15 (0.08-0.31)	0.46 (0.31-0.69)	4.01 (3.50-4.59)	0.37 (0.23-0.57)	1.19 (0.93-1.53)	0.87 (0.65-1.16)	0.60 (0.42-0.85)	1.02 (0.78-1.34)	50.5	0.24 (0.14-0.42)	29.6	3.68 (3.05-4.44)
All unicondylar, uncemented/hybrid	**120.3**	**8.53 (8.03-9.07)**	**0.92 (0.77-1.11)**	**1.30 (1.12-1.53)**	**0.49 (0.38-0.63)**	**1.45 (1.25-1.68)**	**0.61 (0.49-0.77)**	**0.84 (0.69-1.02)**	**0.76 (0.62-0.94)**	**0.42 (0.32-0.56)**	**1.22 (1.04-1.44)**	**120.1**	**0.12 (0.07-0.20)**	**115.6**	**2.12 (1.87-2.40)**
fixed	6.6	10.81 (8.56-13.64)	1.67 (0.93-3.02)	0.15 (0.02-1.08)	0	5.02 (3.57-7.07)	0.15 (0.02-1.08)	1.37 (0.71-2.63)	1.07 (0.51-2.24)	0.46 (0.15-1.42)	1.98 (1.15-3.41)	6.4	0.31 (0.08-1.24)	5.3	2.64 (1.56-4.46)
mobile	110.3	8.43 (7.91-8.99)	0.83 (0.68-1.02)	1.41 (1.21-1.65)	0.53 (0.41-0.69)	1.22 (1.03-1.45)	0.66 (0.53-0.83)	0.79 (0.64-0.97)	0.76 (0.61-0.94)	0.44 (0.33-0.58)	1.20 (1.01-1.42)	110.2	0.09 (0.05-0.17)	107.2	2.09 (1.83-2.38)
monobloc polyethylene tibia	3.4	7.54 (5.14-11.08)	2.32 (1.16-4.64)	0	0	1.74 (0.78-3.88)	0	1.45 (0.60-3.49)	0.29 (0.04-2.06)	0	0.58 (0.15-2.32)	3.4	0.58 (0.15-2.32)	3.2	2.21 (1.05-4.63)
Patellofemoral	**106.2**	**19.63 (18.81-20.50)**	**4.23 (3.85-4.64)**	**0.64 (0.50-0.81)**	**0.43 (0.32-0.58)**	**2.32 (2.04-2.62)**	**0.16 (0.10-0.26)**	**1.64 (1.41-1.90)**	**0.91 (0.75-1.11)**	**1.15 (0.96-1.37)**	**2.99 (2.68-3.34)**	**103.7**	**0.43 (0.32-0.58)**	**78.9**	**9.62 (8.96-10.32)**
Multi Unicompartmental	**4.2**	**16.31 (12.88-20.65)**	**3.31 (1.96-5.59)**	**0.71 (0.23-2.20)**	**0.47 (0.12-1.89)**	**1.42 (0.64-3.16)**	**0.24 (0.03-1.68)**	**1.42 (0.64-3.16)**	**0.95 (0.35-2.52)**	**0.95 (0.35-2.52)**	**3.31 (1.96-5.59)**	**4.2**	**0**	**3.9**	**6.67 (4.54-9.79)**
Unclassified															
	191.4	5.50 (5.17-5.84)	0.77 (0.66-0.91)	0.19 (0.14-0.26)	0.86 (0.74-1.00)	1.60 (1.43-1.79)	0.18 (0.13-0.25)	0.45 (0.37-0.56)	0.80 (0.68-0.94)	0.35 (0.28-0.44)	0.76 (0.65-0.90)	181.7	0.30 (0.23-0.39)	112.5	1.06 (0.88-1.27)

[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)	Pros-thesis-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	Peri-prosthetic fracture	Implant wear[1]	Instability	Malalign-ment	Other indication[2]	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe sis-years	Prosthe-sis-years at risk (x1,000)	Revisions per 1,000 prosthe sis-years
All cases	8,921.4	4.53 (4.49-4.58)	0.68 (0.66-0.70)	0.16 (0.16-0.17)	0.87 (0.85-0.89)	1.21 (1.18-1.23)	0.17 (0.16-0.18)	0.29 (0.28-0.30)	0.64 (0.63-0.66)	0.32 (0.31-0.34)	0.50 (0.48-0.51)	8,665.1	0.29 (0.27-0.30)	6,503.2	0.73 (0.71-0.75)
<1	1,323.7	4.95 (4.83-5.07)	0.48 (0.44-0.52)	0.38 (0.35-0.42)	1.95 (1.87-2.02)	0.61 (0.57-0.65)	0.30 (0.27-0.33)	0.18 (0.16-0.20)	0.53 (0.49-0.57)	0.31 (0.28-0.34)	0.57 (0.53-0.61)	1,303.4	0.30 (0.27-0.33)	1,114.6	0.26 (0.24-0.30)
1 to 3	2,319.7	6.39 (6.29-6.49)	1.30 (1.25-1.34)	0.19 (0.17-0.21)	1.19 (1.14-1.23)	1.51 (1.46-1.56)	0.12 (0.11-0.13)	0.19 (0.18-0.21)	0.95 (0.92-1.00)	0.55 (0.52-0.58)	0.77 (0.73-0.80)	2,280.4	0.54 (0.51-0.57)	1,915.0	0.91 (0.87-0.96)
3 to 5	1,820.1	4.06 (3.97-4.16)	0.73 (0.69-0.77)	0.10 (0.08-0.11)	0.61 (0.58-0.65)	1.26 (1.21-1.31)	0.12 (0.10-0.13)	0.20 (0.18-0.22)	0.60 (0.57-0.64)	0.32 (0.29-0.34)	0.44 (0.41-0.47)	1,783.0	0.26 (0.24-0.29)	1,437.1	0.72 (0.68-0.77)
5 to 7	1,352.0	3.37 (3.27-3.47)	0.43 (0.39-0.46)	0.09 (0.08-0.11)	0.48 (0.45-0.52)	1.14 (1.09-1.20)	0.13 (0.11-0.15)	0.26 (0.24-0.29)	0.48 (0.44-0.52)	0.22 (0.20-0.25)	0.36 (0.32-0.39)	1,317.6	0.15 (0.13-0.17)	994.3	0.77 (0.72-0.83)
7 to 10	1,299.4	3.23 (3.13-3.33)	0.28 (0.25-0.31)	0.10 (0.08-0.12)	0.34 (0.31-0.37)	1.16 (1.10-1.22)	0.18 (0.16-0.21)	0.42 (0.39-0.46)	0.47 (0.44-0.51)	0.17 (0.14-0.19)	0.30 (0.27-0.33)	1,253.3	0.10 (0.09-0.12)	819.2	0.89 (0.83-0.96)
10 to 13	616.7	3.67 (3.52-3.82)	0.18 (0.15-0.22)	0.13 (0.10-0.16)	0.35 (0.31-0.40)	1.37 (1.28-1.46)	0.25 (0.21-0.29)	0.75 (0.69-0.83)	0.58 (0.52-0.64)	0.15 (0.12-0.18)	0.29 (0.25-0.33)	578.2	0.08 (0.06-0.11)	220.1	0.75 (0.64-0.87)
13 to 15	148.2	3.50 (3.21-3.82)	0.14 (0.09-0.22)	0.10 (0.06-0.17)	0.28 (0.20-0.38)	1.44 (1.26-1.65)	0.26 (0.19-0.35)	0.86 (0.73-1.03)	0.51 (0.41-0.64)	0.11 (0.07-0.18)	0.21 (0.15-0.30)	126.9	0.10 (0.06-0.18)	2.3	0.43 (0.06-3.05)
15 to 17	39.8	3.56 (3.02-4.20)	0.28 (0.15-0.50)	0.15 (0.07-0.34)	0.28 (0.15-0.50)	1.51 (1.17-1.94)	0.28 (0.15-0.50)	1.10 (0.82-1.48)	0.58 (0.38-0.87)	0.08 (0.02-0.23)	0.30 (0.17-0.53)	22.4	0	0.5	0
≥17	1.8	2.74 (1.14-6.58)	0	0	0	1.64 (0.53-5.10)	0	0.55 (0.08-3.89)	0.55 (0.08-3.89)	0	0.55 (0.08-3.89)	0.0	0	0.0	0

[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.

3.3.5 Mortality after primary knee surgery

In this section we describe the mortality of the cohort up to 15 years from primary operation, according to gender and age group. Deaths recorded after 31 December 2020 have not been included in the analysis. For simplicity, we have 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 1,357,077 records of a primary knee replacement, 22,272 unknown knee type records were excluded and there were 13,510 bilateral operations in which the patient had both knees replaced on the same day; here the second of the two has been excluded, leaving 1,184,306 TKR procedures (of whom 226,710 had died before the end of 2020) and 137,399 UKR procedures (of whom 12,895 died before the end of 2020).

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	1,184,306	0.16 (0.15-0.17)	0.30 (0.29-0.31)	1.03 (1.01-1.05)	8.71 (8.65-8.77)	26.08 (25.96-26.19)	48.11 (47.89-48.33)
Males							
<55	28,934	0.04 (0.02-0.07)	0.08 (0.05-0.12)	0.29 (0.23-0.36)	2.09 (1.91-2.28)	6.10 (5.72-6.50)	11.99 (11.11-12.93)
55 to 59	42,028	0.05 (0.03-0.08)	0.10 (0.07-0.14)	0.36 (0.31-0.42)	2.92 (2.75-3.11)	8.74 (8.36-9.13)	17.77 (16.95-18.62)
60 to 64	76,325	0.07 (0.06-0.10)	0.13 (0.11-0.16)	0.47 (0.43-0.52)	4.06 (3.91-4.22)	11.74 (11.43-12.06)	25.53 (24.80-26.27)
65 to 69	99,210	0.10 (0.08-0.12)	0.18 (0.15-0.21)	0.67 (0.62-0.73)	5.84 (5.68-6.00)	17.78 (17.44-18.12)	37.61 (36.88-38.36)
70 to 74	105,714	0.14 (0.12-0.16)	0.27 (0.24-0.30)	1.05 (0.99-1.11)	9.29 (9.10-9.49)	28.46 (28.07-28.86)	56.57 (55.82-57.32)
75 to 79	85,513	0.29 (0.25-0.32)	0.52 (0.47-0.57)	1.79 (1.70-1.88)	15.03 (14.76-15.30)	44.70 (44.22-45.18)	76.74 (76.02-77.46)
80 to 84	47,792	0.58 (0.51-0.65)	0.99 (0.90-1.08)	3.02 (2.87-3.18)	24.04 (23.61-24.48)	63.97 (63.32-64.61)	*91.38 (90.65-92.07)*
≥85	18,358	1.10 (0.95-1.26)	1.93 (1.75-2.15)	5.71 (5.38-6.05)	38.80 (37.99-39.61)	82.53 (81.64-83.39)	*97.30 (96.40-98.03)*
Females							
<55	41,309	0.03 (0.01-0.05)	0.06 (0.04-0.08)	0.21 (0.17-0.26)	1.61 (1.48-1.75)	4.58 (4.30-4.88)	9.50 (8.80-10.24)
55 to 59	56,179	0.03 (0.02-0.05)	0.06 (0.04-0.08)	0.26 (0.22-0.30)	2.08 (1.95-2.22)	6.29 (6.01-6.57)	14.11 (13.44-14.81)
60 to 64	91,581	0.03 (0.02-0.05)	0.08 (0.07-0.11)	0.31 (0.27-0.35)	2.74 (2.62-2.86)	8.70 (8.45-8.96)	19.48 (18.86-20.12)
65 to 69	123,453	0.07 (0.05-0.08)	0.12 (0.10-0.14)	0.43 (0.39-0.47)	3.90 (3.78-4.02)	12.81 (12.54-13.08)	29.85 (29.22-30.49)
70 to 74	138,945	0.09 (0.08-0.11)	0.18 (0.16-0.20)	0.63 (0.59-0.68)	6.00 (5.86-6.14)	20.66 (20.35-20.97)	46.23 (45.57-46.90)
75 to 79	122,809	0.16 (0.14-0.18)	0.30 (0.27-0.34)	1.12 (1.06-1.18)	10.20 (10.01-10.39)	33.99 (33.62-34.37)	66.72 (66.06-67.37)
80 to 84	75,160	0.27 (0.24-0.31)	0.55 (0.50-0.60)	1.88 (1.78-1.98)	16.43 (16.13-16.73)	51.83 (51.31-52.35)	84.72 (84.05-85.38)
≥85	30,996	0.58 (0.50-0.67)	1.19 (1.08-1.32)	3.49 (3.29-3.70)	28.67 (28.10-29.24)	73.36 (72.62-74.10)	*95.14 (94.45-95.78)*

Note: Excludes 8,819 bilateral operations performed on the same day.

Table 3.K12 (a) on page 191 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. While such surgery may have contributed to the overall mortality, the impact of this is not investigated in this report. Furthermore, exclusions for unknown knee type and same-day bilateral operations were not mutually exclusive; there was an overlap of 410 cases of unknown knee types with same day bilateral procedures.

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	**121,986**	**0.03 (0.03-0.05)**	**0.08 (0.06-0.09)**	**0.39 (0.36-0.43)**	**4.16 (4.04-4.30)**	**13.31 (13.04-13.60)**	**27.45 (26.85-28.07)**
Males							
<55	10,128	0.01 (0.00-0.07)	0.03 (0.01-0.09)	0.18 (0.11-0.29)	1.23 (1.02-1.50)	3.65 (3.14-4.23)	8.30 (6.91-9.97)
55 to 59	10,182	0.03 (0.01-0.09)	0.04 (0.01-0.11)	0.20 (0.13-0.31)	1.71 (1.44-2.03)	5.95 (5.30-6.68)	12.42 (11.02-13.99)
60 to 64	12,844	0.05 (0.03-0.11)	0.09 (0.05-0.16)	0.34 (0.26-0.46)	2.94 (2.62-3.29)	8.69 (8.03-9.40)	20.47 (18.81-22.26)
65 to 69	12,426	0.01 (0.00-0.06)	0.05 (0.02-0.11)	0.34 (0.25-0.46)	4.34 (3.94-4.77)	14.54 (13.65-15.50)	29.69 (27.74-31.75)
70 to 74	9,822	0.02 (0.01-0.08)	0.07 (0.03-0.15)	0.59 (0.46-0.77)	7.26 (6.66-7.90)	22.57 (21.32-23.89)	*48.23 (45.58-50.96)*
75 to 79	6,100	0.05 (0.02-0.15)	0.17 (0.09-0.31)	1.00 (0.78-1.29)	11.28 (10.36-12.26)	37.85 (35.97-39.78)	*71.13 (67.94-74.25)*
80 to 84	2,801	0.11 (0.03-0.33)	0.25 (0.12-0.53)	1.81 (1.37-2.38)	20.02 (18.27-21.90)	53.90 (50.99-56.86)	*85.85 (82.09-89.18)*
≥85	905	0.55 (0.23-1.33)	0.78 (0.37-1.62)	3.56 (2.52-5.03)	33.80 (30.15-37.76)	*80.10 (75.32-84.48)*	*97.55 (90.97-99.67)*

Note: Excludes 4,281 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 peri-operative 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	11,464	0.02 (0.00-0.07)	0.03 (0.01-0.08)	0.06 (0.03-0.13)	0.78 (0.62-0.99)	2.64 (2.24-3.11)	4.71 (3.89-5.71)
55 to 59	9,267	0.01 (0.00-0.08)	0.01 (0.00-0.08)	0.07 (0.03-0.15)	1.02 (0.80-1.29)	3.85 (3.32-4.46)	7.90 (6.78-9.19)
60 to 64	9,846	0.01 (0.00-0.07)	0.01 (0.00-0.07)	0.13 (0.07-0.22)	1.76 (1.48-2.08)	5.84 (5.22-6.53)	13.91 (12.36-15.63)
65 to 69	9,524	0.03 (0.01-0.10)	0.08 (0.04-0.17)	0.26 (0.17-0.38)	2.52 (2.19-2.91)	8.46 (7.68-9.33)	21.18 (19.14-23.41)
70 to 74	8,122	0.05 (0.02-0.13)	0.09 (0.04-0.18)	0.34 (0.23-0.50)	3.96 (3.48-4.50)	13.95 (12.83-15.17)	34.39 (31.90-37.02)
75 to 79	5,201	0	0.06 (0.02-0.18)	0.34 (0.21-0.54)	6.44 (5.70-7.28)	24.59 (22.89-26.39)	*54.23 (50.92-57.61)*
80 to 84	2,482	0.12 (0.04-0.37)	0.33 (0.16-0.65)	1.12 (0.77-1.62)	12.12 (10.69-13.73)	42.46 (39.64-45.40)	*75.24 (70.93-79.34)*
≥85	872	0.34 (0.11-1.07)	0.93 (0.46-1.84)	2.95 (2.01-4.34)	20.13 (17.13-23.57)	*61.67 (56.41-66.95)*	*97.60 (90.10-99.76)*
All patellofemoral	**14,852**	**0.04 (0.02-0.09)**	**0.13 (0.08-0.20)**	**0.38 (0.29-0.49)**	**3.71 (3.39-4.06)**	**11.67 (10.99-12.39)**	**23.37 (21.80-25.02)**
All multicompartmental	**561**	*0*	*0*	*0.36 (0.09-1.43)*	*2.57 (1.50-4.39)*	*7.88 (5.53-11.17)*	*25.94 (11.44-52.40)*

Note: Excludes 4,281 bilateral operations performed on the same day.

3.3.6 Overview of knee revisions

In this section we look at all recorded knee revision procedures performed since the registry began on 1 April 2003 up to the end of December 2020, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total there were 87,535 revisions recorded on 72,493 individual patient-sides (68,973 actual patients). In addition to the 40,451 revised primaries described previously in this section, there were 32,042 additional revisions for a patient-side for which there is no associated primary operation recorded in the registry.

We have classified revisions 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. 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. We have attempted to address this later in this section.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion

to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

Table 3.K13 below gives an overview of all knee revision procedures carried out each year since April 2003. There were a maximum number of 14 documented revision procedures associated with any individual patient-side. The increase in the number of operations over time, until 2020 when rates were impacted by COVID-19, 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*	7 (1.1)	<4 (0.2)	625 (98.7)	633
2004	702 (57.3)	78 (6.4)	445 (36.3)	1,225
2005	1,475 (73.7)	209 (10.4)	318 (15.9)	2,002
2006	1,947 (75.3)	282 (10.9)	356 (13.8)	2,585
2007	2,641 (75.1)	386 (11.0)	491 (14.0)	3,518
2008	3,324 (75.6)	474 (10.8)	596 (13.6)	4,394
2009	3,715 (76.3)	527 (10.8)	630 (12.9)	4,872
2010	4,182 (77.1)	573 (10.6)	670 (12.4)	5,425
2011	4,339 (77.4)	620 (11.1)	649 (11.6)	5,608
2012	5,009 (78.5)	631 (9.9)	740 (11.6)	6,380
2013	4,704 (78.4)	633 (10.6)	662 (11.0)	5,999
2014	5,078 (78.0)	736 (11.3)	700 (10.7)	6,514
2015	5,353 (79.1)	743 (11.0)	675 (10.0)	6,771
2016	5,562 (80.6)	698 (10.1)	643 (9.3)	6,903
2017	5,667 (80.6)	700 (10.0)	666 (9.5)	7,033
2018	5,601 (82.2)	618 (9.1)	598 (8.8)	6,817
2019	5,847 (83.5)	613 (8.8)	545 (7.8)	7,005
2020	3,067 (79.6)	426 (11.1)	358 (9.3)	3,851
Total	68,220	8,948	10,367	87,535

*Incomplete year.

Table 3.K14 (a) below 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 in approximately 80% 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=68,220)	Stage one of two-stage N(%) (n=8,948)	Stage two of two-stage N(%) (n=10,367)
Aseptic loosening / Lysis	26,072 (38.2)	1,565 (17.5)	1,750 (16.9)
Instability	11,850 (17.4)	353 (3.9)	506 (4.9)
Pain	10,137 (14.9)	364 (4.1)	529 (5.1)
Implant wear	9,542 (14.0)	288 (3.2)	314 (3.0)
Other indication	7,672 (11.2)	324 (3.6)	612 (5.9)
Infection	5,180 (7.6)	7,628 (85.2)	7,719 (74.5)
Malalignment	5,018 (7.4)	113 (1.3)	175 (1.7)
Periprosthetic fracture	3,071 (4.5)	126 (1.4)	161 (1.6)
Dislocation / Subluxation	2,776 (4.1)	141 (1.6)	138 (1.3)
Stiffness*	3,904 (5.7) n=68,220	200 (2.2) n=8,948	165 (1.7) n=9,461
Progressive arthritis*	9,078 (14.9) n=60,989	62 (0.8) n=7,920	89 (1.1) n=8,034

*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.
Note: Indications listed are not mutually exclusive.

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=25,744)	Stage one of two-stage N(%) (n=3,055)	Stage two of two-stage N(%) (n=2,810)
Aseptic loosening / Lysis	8,467 (32.9)	412 (13.5)	296 (10.5)
Progressive arthritis	5,177 (20.1)	27 (0.9)	53 (1.9)
Instability	4,426 (17.2)	94 (3.1)	73 (2.6)
Implant wear	3,353 (13.0)	69 (2.3)	41 (1.5)
Infection	2,857 (11.1)	2,715 (88.9)	2,347 (83.5)
Pain	2,412 (9.4)	48 (1.6)	40 (1.4)
Other indication	2,370 (9.2)	91 (3.0)	123 (4.4)
Malalignment	1,580 (6.1)	28 (0.9)	28 (1.0)
Periprosthetic fracture	1,470 (5.7)	38 (1.2)	52 (1.9)
Stiffness	1,435 (5.6)	43 (1.4)	40 (1.4)
Dislocation / Subluxation	961 (3.7)	49 (1.6)	27 (1.0)

Note: Indications listed are not mutually exclusive.

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 registry (n=40,451) 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 14). In cases where a stage one of two procedure was followed by a stage two of two procedure within 365 days, we have treated this as a single distinct episode. This definition allows multiple stage one procedures to occur before a new revision episode is triggered. In situations where the first stage one procedure is not followed by a stage two procedure within a 365-day period, the next occurrence of a stage one procedure was considered as a new revision episode.

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were calculated. There were 4,501 re-revisions and for 5,169 cases the patient died without having been re-revised. The censoring date for the remainder was the end of 2020.

Figure 3.K6 (a) plots Kaplan-Meier estimates of the cumulative probability of a subsequent revision in linked revised primary knee replacements as between 1 and 17 years since the primary operation.

Figure 3.K6 (a) KM estimates of cumulative **re-revision**, in linked 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.*

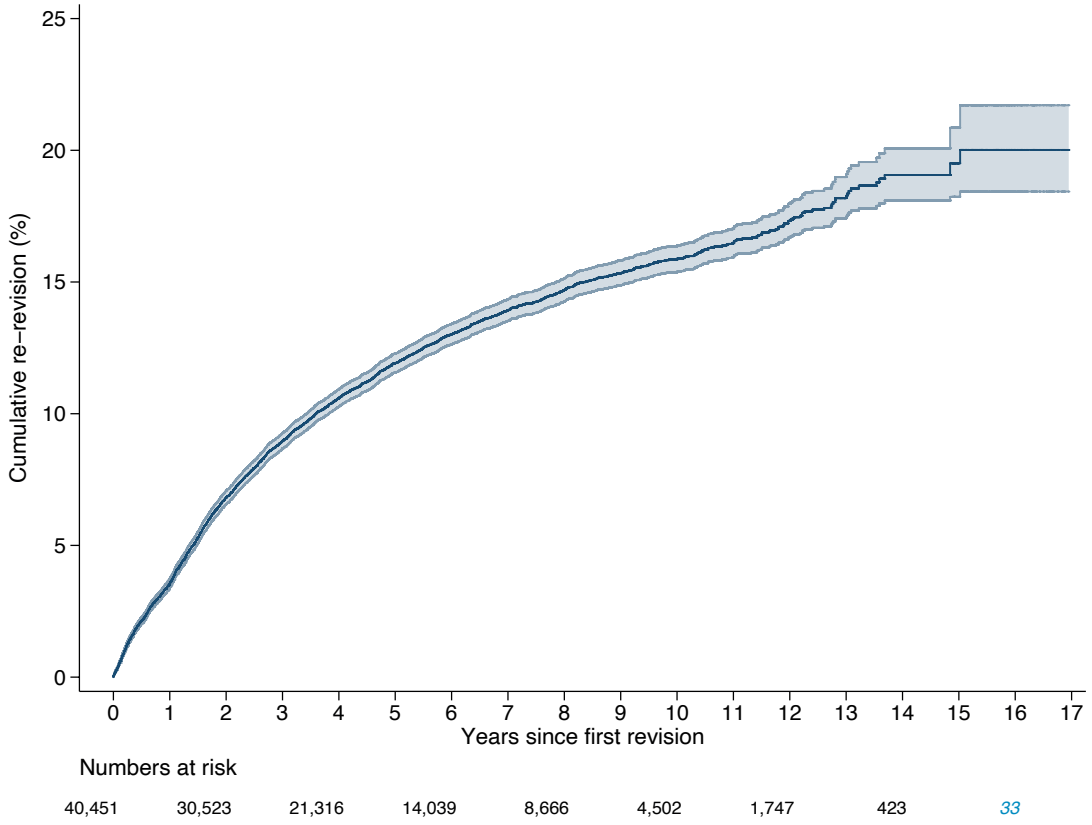
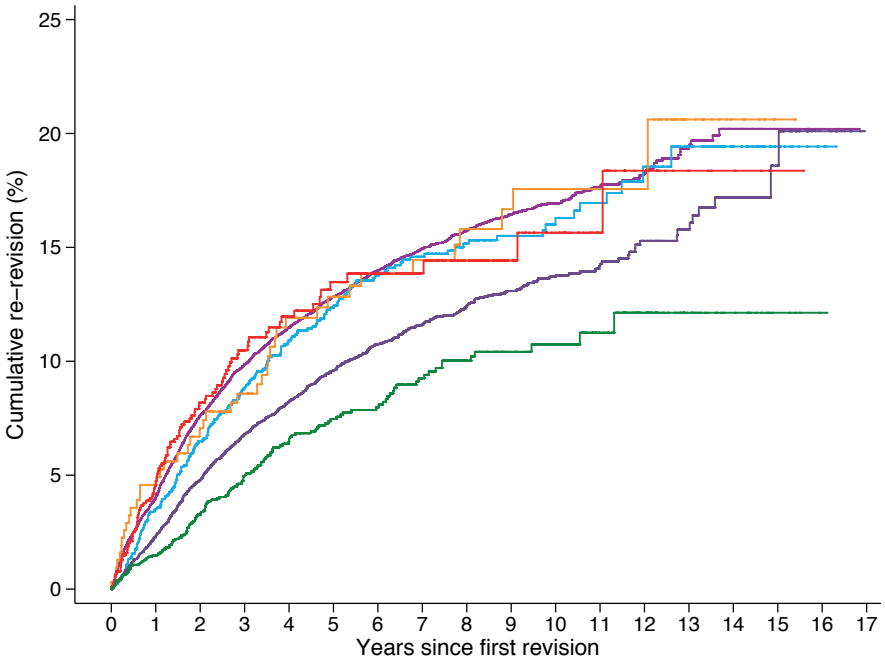


Figure 3.K6 (b) shows estimates of re-revision by type of primary knee replacement. Revised patellofemoral knee replacements have the lowest risk of re-revision until ten years, after which the numbers at risk fall below 250 and should be interpreted with caution. Revised cemented unicondylar knee replacements have the next lowest risk of re-revision until 14 years when again, the numbers at risk become small.

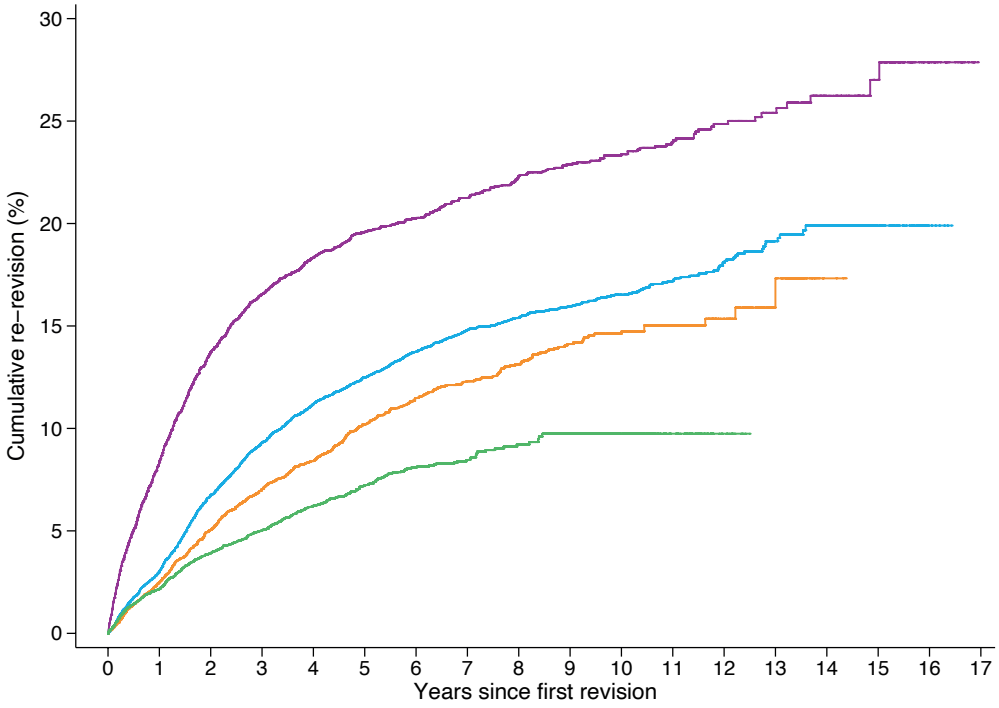
Revised uncemented / hybrid unicondylar knee replacements appear to have a higher risk of re-revision than their cemented counterparts and are equivalent to the rates seen for revised cemented total knee replacements until five years, after which the numbers in the revised uncemented unicondylar group 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	26,625	19,587	13,305	8,473	5,007	2,543	971	*208*	*12*
Uncemented	1,681	1,387	1,064	784	543	298	*123*	*32*	*<4*
Hybrid	315	253	*206*	*159*	*118*	*71*	*27*	*7*	
Unicondylar, cemented	7,596	6,124	4,531	3,186	2,087	1,148	483	*143*	*15*
Unicondylar, uncemented/hybrid	1,027	638	355	*193*	*121*	*55*	*17*	*6*	
Patellofemoral	2,086	1,659	1,200	777	484	*229*	*64*	*14*	*<4*

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:

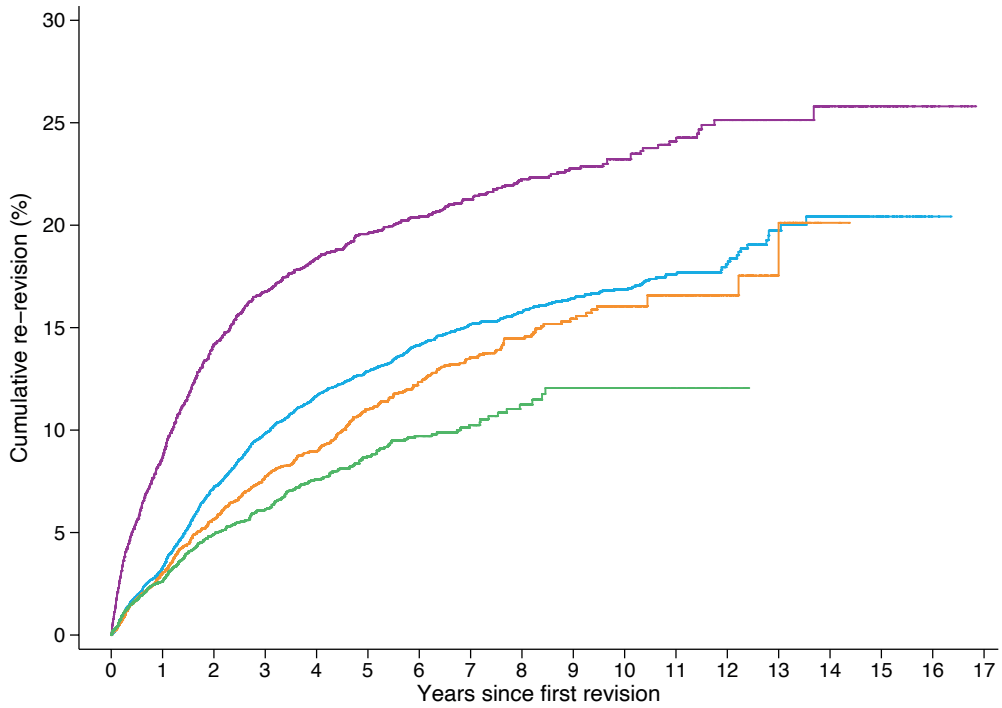
Numbers at risk

First rev. <1y	6,547	5,634	4,721	4,069	3,470	2,954	2,487	2,086	1,706	1,355	1,081	784	529	316	*177*	*86*	*27*	*<4*
First rev. 1 to 3y	14,826	13,722	12,010	10,533	9,128	7,777	6,515	5,371	4,389	3,359	2,514	1,667	1,012	538	*243*	*74*	*6*	
First rev. 3 to 5y	7,396	6,739	5,794	4,929	4,127	3,401	2,813	2,241	1,716	1,147	725	408	*195*	*57*	*<4*			
First rev. ≥5y	11,682	10,100	7,998	6,183	4,591	3,284	2,224	1,413	855	434	*182*	*65*	*11*					

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 19.6% 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 2.2% at one year following the first revision, rising to 7.2% by five years.

For those with documented primary knee replacements within the registry, Figures 3.K7 (a) to (f) show cumulative re-revision rates following the first revision, according to the main type of primary knee replacement. We have further sub-divided each sub-group 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 three to five years of the initial primary knee replacement. However, the numbers at risk were small in the hybrid group and therefore we advise that 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.*

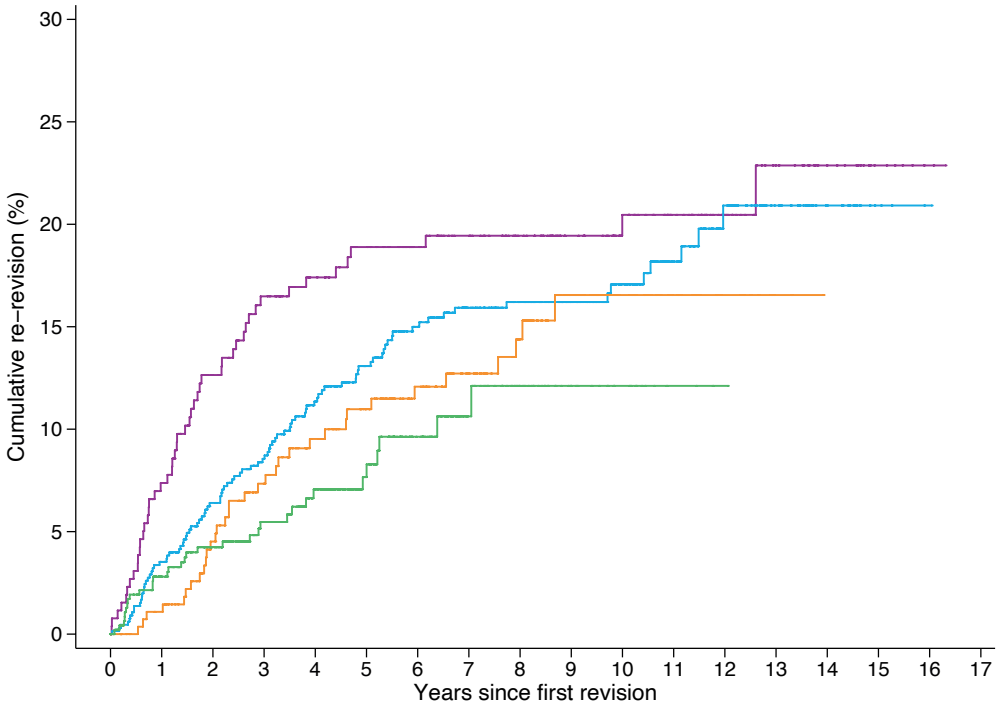


Key:

Numbers at risk

First rev. <1y	4,651	3,964	3,286	2,797	2,344	1,946	1,595	1,300	1,029	797	609	421	279	*159*	*85*	*38*	*10*	*<4*
First rev. 1 to 3y	10,419	9,544	8,242	7,095	6,011	5,041	4,119	3,311	2,622	1,972	1,467	958	579	293	*121*	*39*	*<4*	
First rev. 3 to 5y	4,971	4,447	3,729	3,082	2,525	2,008	1,628	1,260	949	627	385	*219*	*108*	*30*	*<4*			
First rev. ≥5y	6,584	5,554	4,330	3,300	2,425	1,706	1,131	690	407	*204*	*82*	*30*	*5*					

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.*

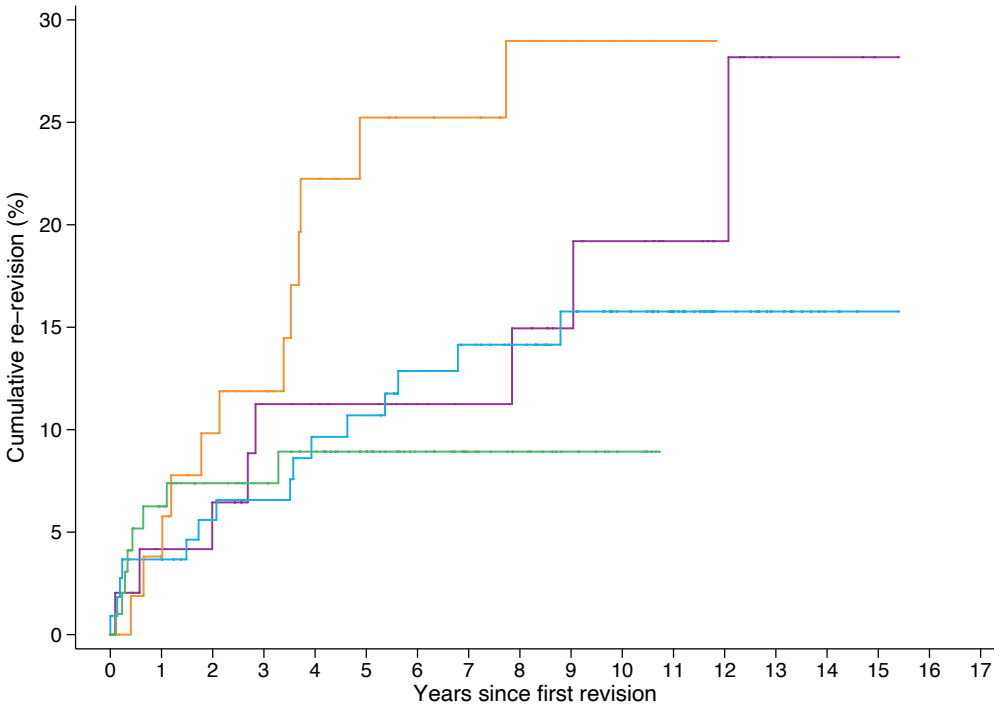


Key:

Numbers at risk

First rev. <1y	261	*234*	*209*	*192*	*173*	*162*	*149*	*135*	*118*	*96*	*78*	*62*	*42*	*27*	*16*	*7*	*<4*	*0*
First rev. 1 to 3y	661	623	572	540	483	426	378	331	294	*237*	*175*	*117*	*70*	*40*	*16*	*4*	*<4*	
First rev. 3 to 5y	282	272	*244*	*217*	*195*	*174*	*151*	*124*	*93*	*58*	*34*	*20*	*10*	*<4*	*0*			
First rev. ≥5y	477	426	362	291	*213*	*149*	*106*	*60*	*38*	*19*	*11*	*<4*	*<4*					

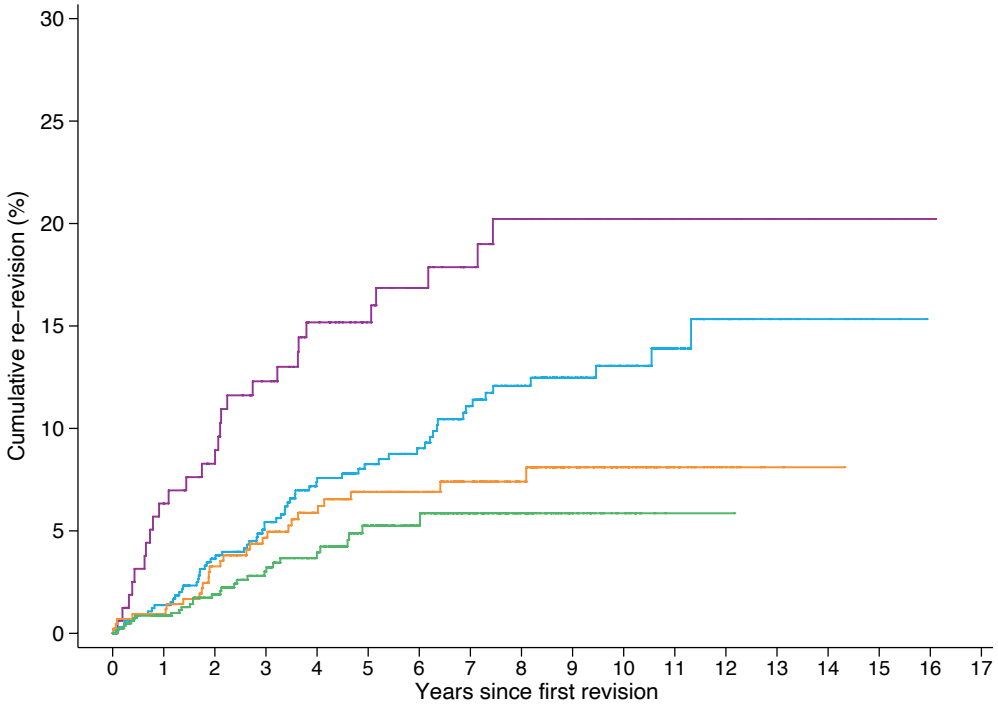
Figure 3.K7 (c) KM estimates of cumulative **re-revision** in primary **hybrid TKRs** by **years to first revision.** *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																	
First rev. <1y	*50*	*44*	*41*	*36*	*34*	*32*	*27*	*25*	*23*	*20*	*17*	*13*	*9*	*<4*	*<4*	*<4*	*0*	*0*
First rev. 1 to 3y	*109*	*103*	*97*	*94*	*86*	*85*	*77*	*66*	*61*	*52*	*43*	*33*	*18*	*11*	*4*	*<4*	*0*	
First rev. 3 to 5y	*55*	*49*	*44*	*38*	*30*	*25*	*23*	*22*	*16*	*11*	*6*	*4*	*0*	*0*	*0*			
First rev. ≥5y	*101*	*85*	*71*	*63*	*56*	*45*	*32*	*23*	*18*	*11*	*5*	*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.*

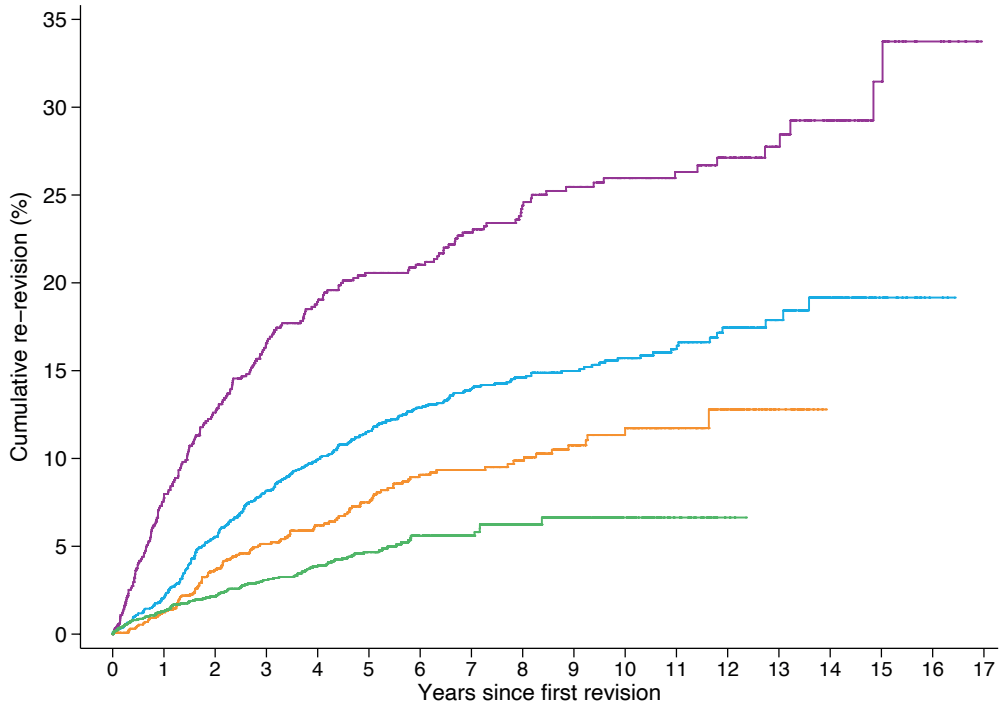


Key:

Numbers at risk

First rev. <1y	*161*	*146*	*138*	*127*	*114*	*103*	*87*	*74*	*61*	*47*	*38*	*26*	*15*	*8*	*4*	*<4*	*<4*	*0*
First rev. 1 to 3y	657	633	573	509	460	391	331	277	*228*	*173*	*129*	*70*	*39*	*18*	*9*	*<4*	*0*	
First rev. 3 to 5y	429	406	359	325	285	*241*	*203*	*166*	*135*	*83*	*50*	*23*	*9*	*<4*	*<4*			
First rev. ≥5y	839	756	589	459	341	*248*	*156*	*104*	*60*	*26*	*12*	*<4*	*<4*					

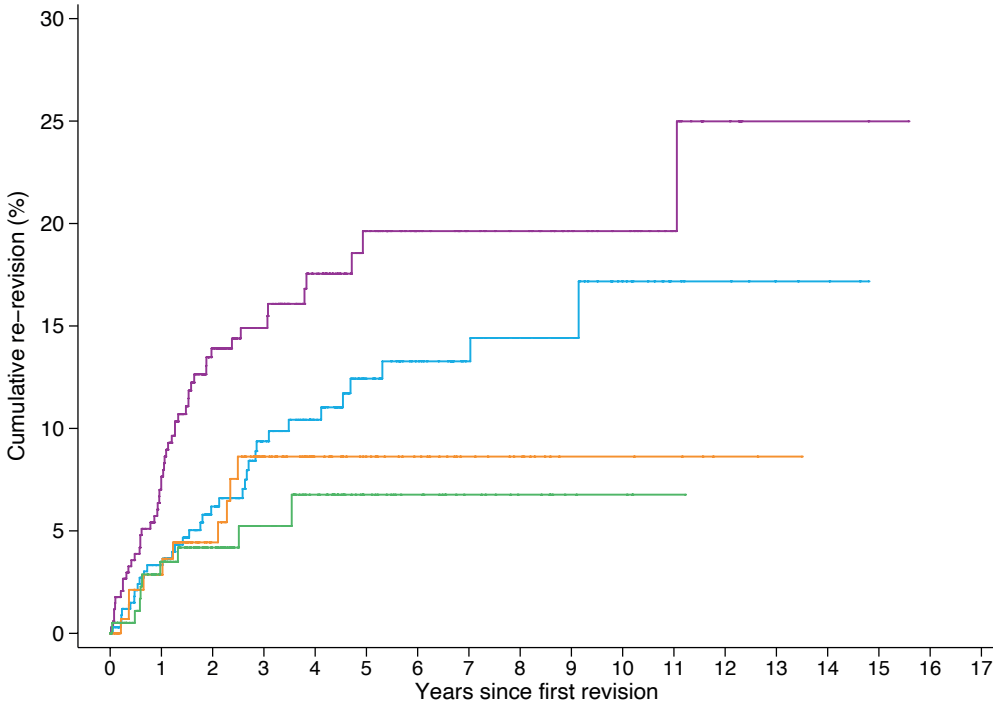
Figure 3.K7 (e) KM estimates of cumulative **re-revision** in primary **cemented unicondylar** knee replacements by **years to first revision**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:

	Numbers at risk																
First rev. <1y	917	817	728	659	602	549	495	436	374	314	270	*212*	*155*	*103*	*61*	*31*	*12*	*0*
First rev. 1 to 3y	2,297	2,192	1,999	1,837	1,679	1,481	1,303	1,122	962	770	593	421	265	*155*	*82*	*24*	*<4*	
First rev. 3 to 5y	1,322	1,263	1,152	1,041	911	803	694	582	464	332	*224*	*125*	*60*	*20*	*0*			
First rev. ≥5y	3,060	2,738	2,245	1,766	1,339	986	694	461	287	*150*	*61*	*25*	*<4*					

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	340	285	*198*	*147*	*107*	*73*	*53*	*44*	*40*	*30*	*25*	*16*	*7*	*<4*	*<4*	*<4*	*0*	*0*
First rev. 1 to 3y	340	303	*233*	*183*	*149*	*112*	*92*	*76*	*58*	*33*	*20*	*10*	*8*	*5*	*4*	*0*	*0*	
First rev. 3 to 5y	*152*	*125*	*97*	*69*	*47*	*33*	*25*	*17*	*13*	*6*	*6*	*5*	*<4*	*<4*	*0*			
First rev. ≥5y	*195*	*154*	*110*	*73*	*52*	*31*	*23*	*15*	*10*	*5*	*4*	*<4*	*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	10 years	15 years	17 years
Primary recorded in the NJR	40,451	3.56 (3.38-3.75)	8.97 (8.68-9.28)	11.92 (11.56-12.28)	15.89 (15.40-16.39)	*19.51 (18.23-20.86)*	*20.01 (18.43-21.71)*

Note: The number at risk for the 17 year estimate is only 2.

Table 3.K15 (a) shows the re-revision rate of the 40,451 revised primary knee replacements (39,399 (97.4%) with known knee type at primary procedure) that are registered in the registry. Of these, 4,501 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	10 years	15 years
<1 year after primary	6,547	8.33 (7.68-9.04)	16.56 (15.64-17.54)	19.60 (18.58-20.67)	23.39 (22.16-24.67)	*27.01 (24.75-29.44)*
1 to 3 years after primary	14,826	3.04 (2.77-3.33)	9.32 (8.84-9.82)	12.49 (11.92-13.09)	16.52 (15.78-17.29)	*19.90 (18.59-21.29)*
3 to 5 years after primary	7,396	2.50 (2.16-2.89)	7.04 (6.44-7.69)	10.19 (9.43-11.01)	14.74 (13.61-15.95)	
≥5 years after primary*	11,682	2.18 (1.93-2.47)	5.04 (4.61-5.50)	7.21 (6.64-7.83)	*9.74 (8.79-10.79)*	

*The maximum of this interval was 17.5 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 not presented for 17 years due to low numbers.

Table 3.K15 (c) shows cumulative re-revision rates at 1, 3, 5, 10 and 15 years following the first revision for those with documented primary knee replacements within the registry, 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 an 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	10 years	15 years
All types		40,451	3.56 (3.38-3.75)	8.97 (8.68-9.28)	11.92 (11.56-12.28)	15.89 (15.40-16.39)	*19.51 (18.23-20.86)*
Unclassified		1,052	3.29 (2.36-4.58)	9.43 (7.73-11.47)	12.37 (10.35-14.75)	*14.48 (12.06-17.33)*	
Cemented		26,625	4.04 (3.81-4.29)	9.87 (9.49-10.26)	12.84 (12.38-13.30)	16.91 (16.28-17.57)	*20.20 (18.89-21.59)*
	unconstrained, fixed, with patella	4,893	5.02 (4.43-5.68)	11.21 (10.30-12.21)	13.92 (12.85-15.08)	17.57 (16.13-19.11)	*19.74 (17.60-22.10)*
	unconstrained, fixed, without patella	11,525	3.52 (3.19-3.87)	9.25 (8.69-9.84)	12.40 (11.72-13.11)	15.97 (15.05-16.95)	*18.78 (17.01-20.71)*
	unconstrained, mobile, without patella	998	3.51 (2.52-4.88)	9.46 (7.73-11.54)	12.73 (10.65-15.17)	*19.28 (16.30-22.73)*	
	posterior-stabilised, fixed, with patella	3,260	4.78 (4.08-5.59)	10.36 (9.28-11.55)	13.50 (12.19-14.93)	17.20 (15.41-19.16)	
	posterior-stabilised, fixed, without patella	4,381	3.51 (3.00-4.11)	9.13 (8.25-10.10)	11.65 (10.61-12.79)	16.14 (14.62-17.82)	*18.43 (15.64-21.65)*
Uncemented		1,681	3.52 (2.73-4.52)	8.81 (7.50-10.34)	12.35 (10.75-14.18)	16.29 (14.22-18.63)	*19.43 (16.29-23.08)*
	unconstrained, mobile, without patella	797	4.11 (2.93-5.77)	7.89 (6.17-10.08)	10.56 (8.50-13.09)	*14.97 (12.17-18.34)*	
Hybrid		315	4.57 (2.73-7.60)	*8.58 (5.87-12.45)*	*12.84 (9.36-17.48)*	*17.56 (13.03-23.44)*	
Unicondylar, cemented		7,596	2.34 (2.02-2.71)	6.81 (6.24-7.44)	9.60 (8.88-10.37)	13.78 (12.77-14.87)	*18.59 (15.48-22.25)*
	fixed	1,580	2.29 (1.65-3.18)	8.05 (6.71-9.66)	11.07 (9.38-13.04)	*15.83 (13.44-18.61)*	
	mobile	5,401	2.46 (2.08-2.92)	6.65 (5.98-7.38)	9.25 (8.43-10.15)	13.50 (12.33-14.78)	*17.67 (14.24-21.82)*
Unicondylar, uncemented/ hybrid		1,027	4.75 (3.58-6.29)	10.49 (8.55-12.82)	13.48 (11.04-16.40)	*15.65 (12.27-19.84)*	
	mobile	930	5.02 (3.76-6.69)	10.62 (8.59-13.10)	*13.94 (11.28-17.17)*	*15.16 (12.12-18.87)*	
Patellofemoral		2,086	1.47 (1.03-2.09)	4.95 (4.04-6.06)	7.47 (6.27-8.88)	*10.74 (9.02-12.76)*	

Note: Maximum interval was 17 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	29,387 (33.6)
Infection	20,527 (23.5)
Instability	12,709 (14.5)
Pain	11,030 (12.6)
Implant wear	10,144 (11.6)
Malalignment	5,306 (6.1)
Periprosthetic fracture	3,358 (3.8)
Dislocation / Subluxation	3,055 (3.5)
Other indication	8,608 (9.8)
Stiffness*	4,269 (4.9)
Progressive Arthritis**	9,229 (12.0)

*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 86,629 revisions as opposed to 87,535 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 76,943 revisions, as opposed to 87,535 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	10,759	1,057 (9.8)	1,115
Infection	7,799	1,443 (18.5)	1,750
Pain	6,052	680 (11.2)	461
Instability	5,730	602 (10.5)	781
Malalignment	2,883	262 (9.1)	247
Implant wear	2,587	243 (9.4)	183
Periprosthetic fracture	1,497	107 (7.1)	112
Dislocation / Subluxation	1,468	212 (14.4)	185
Other indication	4,421	443 (10.0)	336
Stiffness*	2,474	289 (11.7)	281
Progressive Arthritis**	4,744	230 (4.8)	115

*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 39,374 linked revisions as opposed to 40,451 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 29,572 linked revisions, as opposed to 40,451 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 (please note the indications are not mutually exclusive). Table 3.K16 (a) shows the indications for all knee revisions recorded in the registry 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 for a first revision. This reflects the roles that infection, surgical complexity and soft tissue elements 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	625	12 (1.9)
2004	1,168	83 (7.1)
2005	1,844	280 (15.2)
2006	2,340	509 (21.8)
2007	3,141	882 (28.1)
2008	3,810	1,390 (36.5)
2009	4,193	1,832 (43.7)
2010	4,611	2,202 (47.8)
2011	4,690	2,358 (50.3)
2012	5,296	2,977 (56.2)
2013	4,912	2,845 (57.9)
2014	5,248	3,225 (61.5)
2015	5,417	3,521 (65.0)
2016	5,504	3,770 (68.5)
2017	5,607	3,982 (71.0)
2018	5,448	4,036 (74.1)
2019	5,653	4,280 (75.7)
2020	2,986	2,267 (75.9)
Total	72,493	40,451 (55.8)

*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	5	<4	608	10
2004	647	47	438	36
2005	1,235	202	329	78
2006	1,493	385	338	124
2007	1,861	667	398	215
2008	2,036	1,091	384	299
2009	1,984	1,504	377	328
2010	2,060	1,809	349	393
2011	2,039	1,930	293	428
2012	2,061	2,510	258	467
2013	1,827	2,411	240	434
2014	1,812	2,728	211	497
2015	1,711	3,042	185	479
2016	1,572	3,331	162	439
2017	1,484	3,520	141	462
2018	1,314	3,596	98	440
2019	1,281	3,868	92	412
2020	650	1,995	69	272
Total	27,072	34,638	4,970	5,813

Tables 3.K17 (a) and (b) show that the numbers of revisions and the relative proportion of revisions with an associated primary in the registry increased with time. Approximately 75% of those revisions performed in 2020 had a linked primary in the registry. We propose that 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 having been performed before registry data capture began or are outside the coverage of the registry.

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 registry compared with the remainder (Kaplan-Meier estimates 0.72 (95% CI 0.65-0.81) versus 1.00 (0.90-1.12)), 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 registry who had a median age of 73 (IQR 65 to 79) years. The percentage of males was similar in both groups (45.1% versus 46.9% respectively).

3.3.10 Conclusions

There are now over 1.3 million primary knee replacements recorded in the registry with a maximum follow-up of 17.75 years, making this the largest dataset of its kind in the world. Of these, 96.6% of the procedures were 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, reaching approximately 10% for the first time in 2017 and rising to 11.5% in 2020. 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%, that is 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. Both TKR and patellofemoral replacement are more likely to be performed on females, whereas unicondylar knee replacement is more likely to be performed on males.

TKRs with a monobloc polyethylene tibia consistently show some of the lowest crude revision rates, although the numbers at risk in later years are 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. We present results divided by gender and age group and these show the risk of revision of a cemented unicondylar knee replacement is at least two times higher in males and 2.4 times higher in females at ten years than a cemented TKR. The distinction of uncemented unicondylar knee replacements 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 2.9 times higher in males and females than a cemented TKR across all age groups at ten years 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 was 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 revision knee replacement. 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. Approximately 8% of revisions for infection that have been recorded in the registry 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 knee revision surgery potentially more challenging than that 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 exercised when proposing that a UKR may be considered as 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. We consider this to be an area that requires further research to fully 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 specific indication for revision. This suggests that not all of the processes that lead to revision are the same and that some are more aggressive than others with consequences beyond the initial revision.

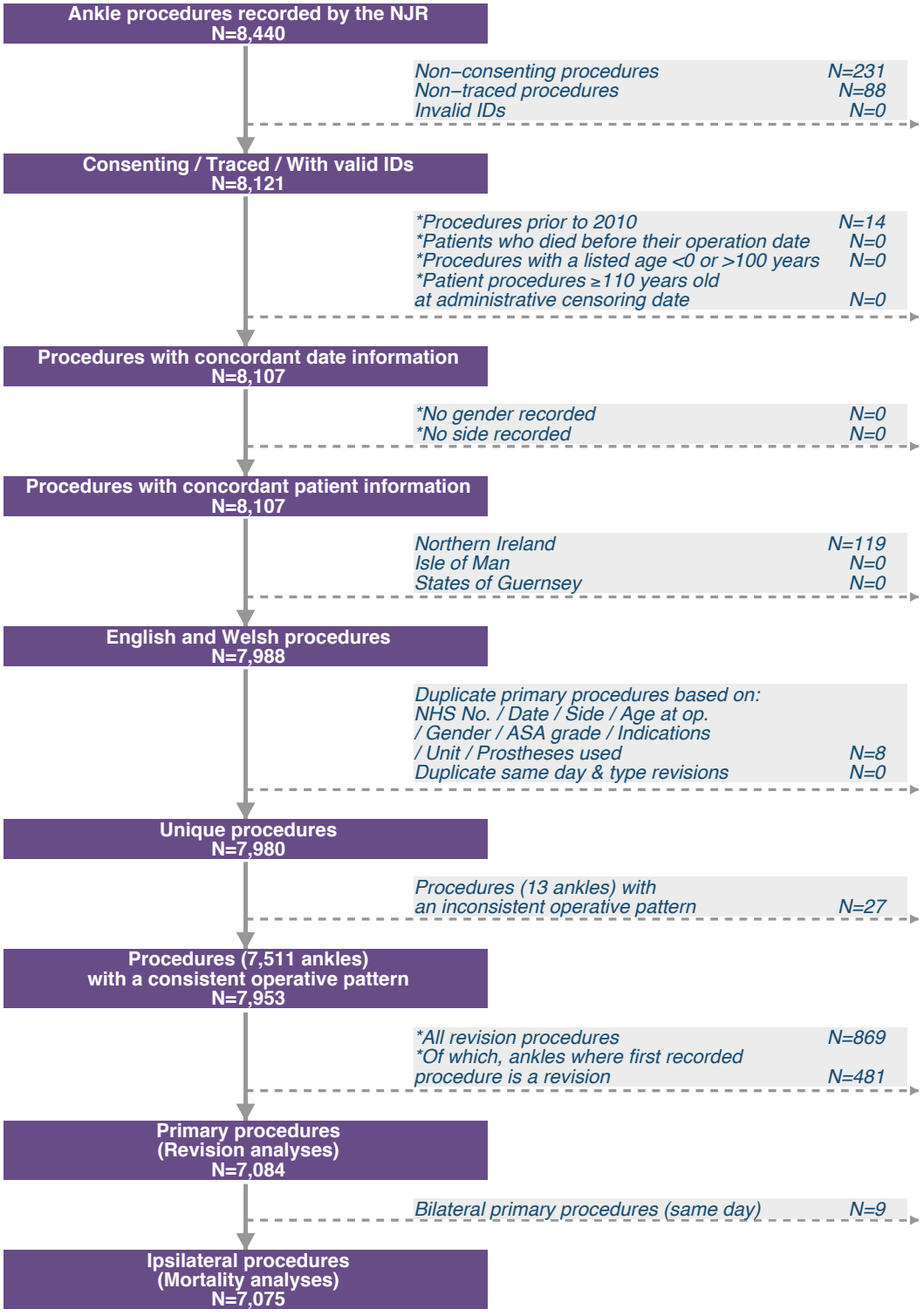
Knee replacement remains a safe procedure with low rates of peri-operative mortality. The rates of mortality are higher for males than those for females. The average age of a patient undergoing a TKR is approximately 70 years, just over 55% of males and 45% of females in the 70 to 74 age bracket will have died within 15 years of 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

In this section of the report, we look at revision and mortality for all primary ankle operations submitted to the registry from 1 January 2010 up to 31 December 2020. There were, after data cleaning, 7,084 primary ankle operations available for analysis on 6,744 patients. A total of 340 patients had bilateral operations (nine had both sides operated on the same date), which can be seen in the patient flow diagram in Figure 3.A1.

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.

All ankle replacement brands recorded in the registry are uncemented implants, but cement can be used occasionally by surgeons in circumstances such as poor bone stock or low demand patients. Of the 7,084 primary procedures, a total of 6,757 (95.4%) procedures were implanted without cement being listed in the component data. Cement was listed in 327 (4.6%) of primary procedures. Of all total ankle replacement (TAR) procedures, 184 (2.6%) were defined as unconfirmed. Procedures were defined as unconfirmed when they either had insufficient elements to form a coherent construct or they 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.

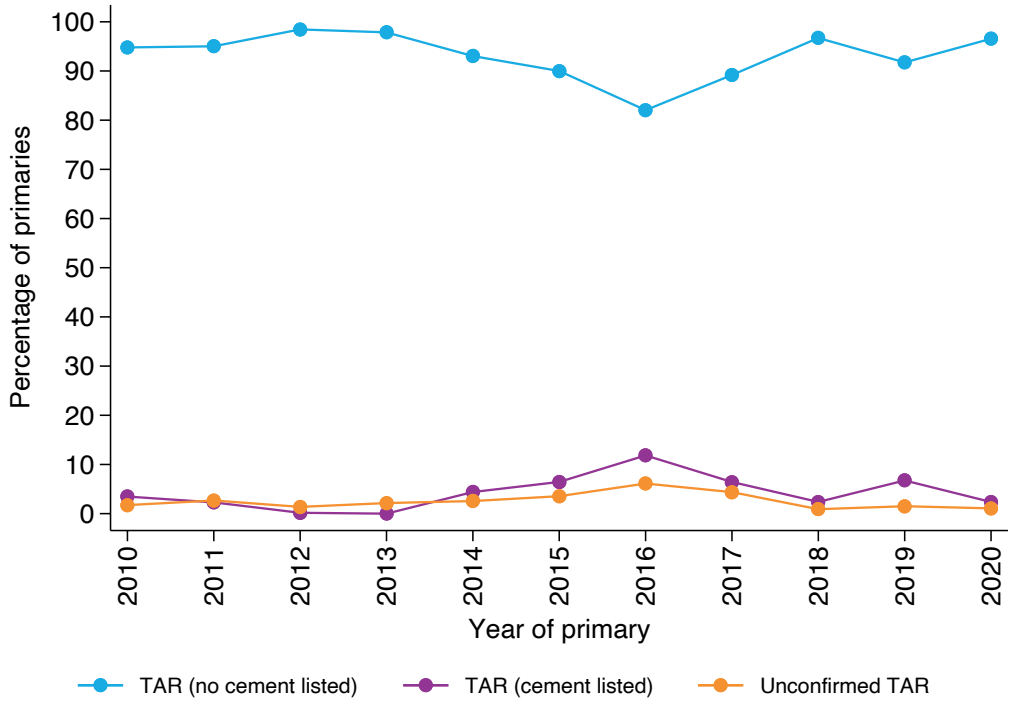


Figure 3.A3 and Figure 3.A4 show the yearly number of primary ankle replacements performed for all indications and ankle replacements stratified by fixed and mobile bearings, please note the difference in scale of the y-axis between each plot. Each bar in the figure is further stratified by the volume of procedures that the surgeon conducted in that year, and when procedures are stratified by fixed and mobile bearings the volume of procedures is calculated separately. For example, if a surgeon performed 25 primary ankle replacements procedures, their procedures would have contributed to the grey sub-division in Figure 3.A3. If those procedures consisted of 12 fixed bearings and 13 mobile bearings, those procedures would be represented by green and purple bars respectively (Figure 3.A4).

Figure 3.A3 shows the volume of primary ankle replacements recorded in the registry increasing since 2015 (except for 2020 due to the impact of COVID-19). The majority of additional procedures were contributed to the registry by higher volume ankle surgeons i.e. surgeons who perform more than 13 TAR procedures annually. Figure 3.A4 overleaf illustrates that the expansion of TAR procedures has largely been of a fixed bearing design and that the use of mobile bearing has steadily been decreasing. Many of the changes in bearing use are due to the voluntary withdrawal of the Mobility implant in 2014 and the introduction of the Infinity in the same year.

Figure 3.A3 **Frequency** of primary **ankle** replacements, bars stacked by **volume** per consultant per year.

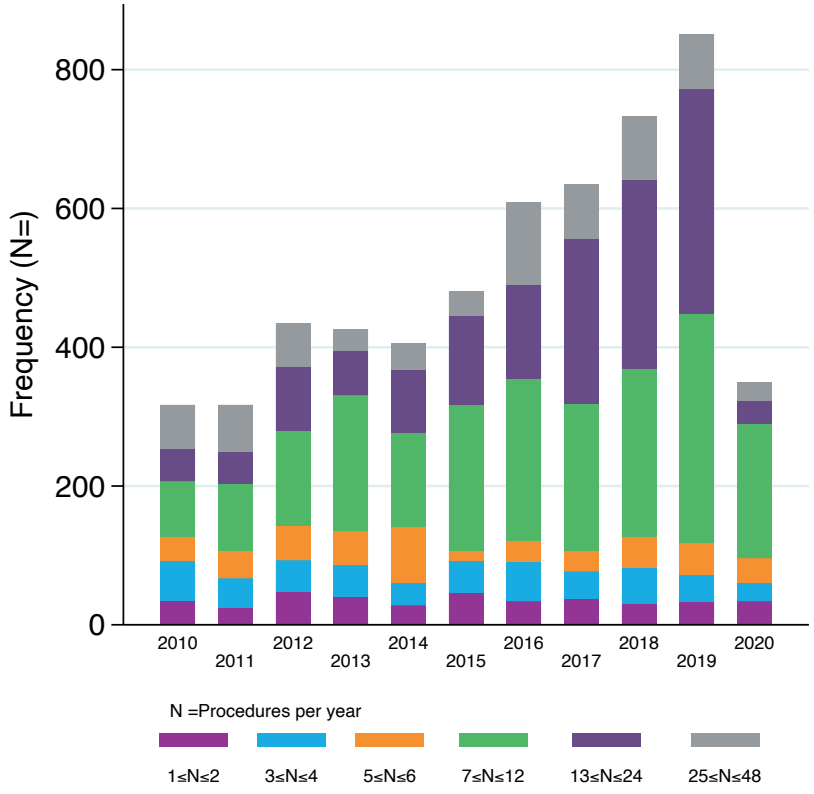


Figure 3.A4 Frequency of primary **ankle** replacements stratified by **fixed** and **mobile** bearings, bars stacked by **volume** per consultant per year.

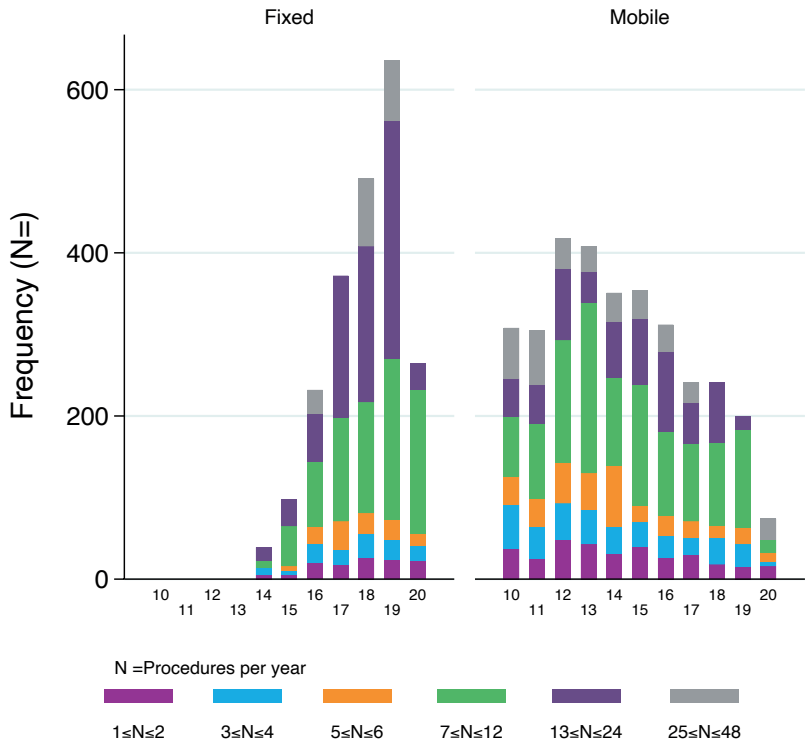


Table 3.A1 Descriptive statistics of ankle procedures performed by consultant and unit by year of surgery.

Number of primary replacements during each year	Year of surgery										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of procedures in year	403	523	582	558	546	620	735	777	882	993	465
Units (N)	104	127	145	134	138	143	144	146	149	160	125
Mean number of primary replacements per unit	3.9	4.1	4.0	4.2	4.0	4.3	5.1	5.3	5.9	6.2	3.7
Median (IQR) number of any primary replacements per unit	2 (1 to 4)	2 (1 to 5)	2 (1 to 4)	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)	2 (1 to 5)
Units who entered ≥10 operations (N)	10	9	13	12	11	10	20	18	24	31	9
Units who entered ≥20 operations (N)	3	3	4	4	4	6	7	6	8	6	2
Consultants providing operation (N)	107	126	143	133	126	142	137	141	148	155	116
Mean number of primary replacements per consultant	3.8	4.2	4.1	4.2	4.3	4.4	5.4	5.5	6.0	6.4	4.0
Median (IQR) number of any primary replacements per consultant	2 (1 to 4)	3 (2 to 5)	2 (1 to 5)	3 (1 to 5)	3 (2 to 5)	2 (1 to 6)	3 (2 to 8)	3 (1 to 8)	3.5 (2 to 8)	5 (2 to 9)	2 (1 to 5.5)
Consultants who entered ≥10 operations (N)	10	10	12	13	10	16	20	27	32	36	8
Consultants who entered ≥20 operations (N)	2	3	2	2	2	4	5	7	6	5	1

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 282 consultants carried out the 7,084 reported primary procedures over the ten year period. The annual mean number of procedures per consultant was 3.8 in 2010, and has gradually increased to 6.4 in 2019, although reduced to 4.0 in 2020 due to COVID-19. Only 1.9% of all consultants performed more than 20 primary ankle replacements in 2010 and this number slowly increased to 3.2% of consultants by 2019, although in 2020 only 0.9% of all consultants performed more than 20 primary ankle replacements. The percentage of units submitting 20 or more ankle primary operations per year does not exceed 5% (2018) (1.6 % in 2020). Of the 276 units who submitted data to the registry, 11 (4%) carried out 20 or more procedures since the start of ankle data collection in 2010. The mean number of primary ankle replacements per unit per year rose steadily from 3.9 in 2010 to 6.2 in 2019, although this fell to 3.7 in 2020 due to COVID-19.

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

Brand	Number of primaries (%)	Number (%) of each brand, for each year of operation										
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Akile	45 (0.6)	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 (1.2)	8 (0.8)	<4 (0.2)
Box	796 (11.2)	22 (5.5)	27 (5.2)	45 (7.7)	51 (9.1)	81 (14.8)	134 (21.6)	126 (17.1)	109 (14.0)	102 (11.6)	80 (8.1)	19 (4.1)
CCI	<4 (0.0)	0 (0.0)	0 (0.0)	<4 (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)
Cadence	59 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.4)	6 (0.8)	15 (1.7)	24 (2.4)	11 (2.4)
Hintegra	296 (4.2)	9 (2.2)	17 (3.3)	35 (6.0)	67 (12.0)	47 (8.6)	54 (8.7)	33 (4.5)	9 (1.2)	14 (1.6)	11 (1.1)	0 (0.0)
Inbone	124 (1.8)	0 (0.0)	0 (0.0)	<4 (0.3)	4 (0.7)	16 (2.9)	<4 (0.5)	24 (3.3)	22 (2.8)	26 (2.9)	17 (1.7)	10 (2.2)
Inbone[Talar] Infinity[Tibial]	198 (2.8)	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)	49 (4.9)	34 (7.3)
Infinity	2,120 (29.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	28 (5.1)	95 (15.3)	212 (28.8)	377 (48.5)	489 (55.4)	616 (62.0)	303 (65.2)
Infinity[Talar] Inbone[Tibial]	<4 (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)	<4 (0.1)	<4 (0.2)	0 (0.0)
Mobility	1,117 (15.8)	252 (62.5)	295 (56.4)	284 (48.8)	201 (36.0)	85 (15.6)	0 (0.0)	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)	<4 (0.1)	0 (0.0)	0 (0.0)
Salto	323 (4.6)	22 (5.5)	29 (5.5)	40 (6.9)	45 (8.1)	55 (10.1)	55 (8.9)	44 (6.0)	9 (1.2)	11 (1.2)	9 (0.9)	4 (0.9)
Star	656 (9.3)	14 (3.5)	28 (5.4)	30 (5.2)	34 (6.1)	58 (10.6)	74 (11.9)	84 (11.4)	100 (12.9)	95 (10.8)	88 (8.9)	51 (11.0)
Trabecular Metal Total	6 (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)	<4 (0.1)	0 (0.0)	0 (0.0)
Vantage	19 (0.3)	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 (0.0)	16 (1.6)	<4 (0.6)
Zenith	1,076 (15.2)	77 (19.1)	109 (20.8)	124 (21.3)	131 (23.5)	151 (27.7)	159 (25.6)	109 (14.8)	61 (7.9)	73 (8.3)	58 (5.8)	24 (5.2)
Unconfirmed	**184 (2.6)**	**7 (1.7)**	**14 (2.7)**	**8 (1.4)**	**12 (2.2)**	**14 (2.6)**	**22 (3.5)**	**45 (6.1)**	**34 (4.4)**	**8 (0.9)**	**15 (1.5)**	**5 (1.1)**
Total	**7,084 (100)**	**403 (100)**	**523 (100)**	**582 (100)**	**558 (100)**	**546 (100)**	**620 (100)**	**735 (100)**	**777 (100)**	**882 (100)**	**993 (100)**	**465 (100)**

Table 3.A2 shows the number of replacements by implant brand and year of primary operation. The most frequently used brand is the fixed bearing, Infinity[Tal:Tib] (Stryker), which represented 65.2% of primary ankle replacements performed in 2020. The use of this brand has risen steeply from its introduction in 2014.

We are identifying 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 Stryker, were designed to be interchangeable with a matched articulating surface. This combination represented 7.3% of primary ankle replacements in 2020. Prior to the introduction of the Infinity, the Mobility (DePuy) had been the market leader before it was voluntarily withdrawn.

In 2020, the three most common brands were Infinity[Tal:Tib] (65.2%), Star[Tal:Tib] (11.0%) and Inbone[Tal]Infinity[Tib] (7.3%). It was not possible to identify the brand implanted in five procedures in 2020.

3.4.2 Revisions after primary ankle surgery

A total of 339 out of the 7,084 primary procedures had a linkable A2 MDS form completed to indicate a revision before the end of 2020. The first revisions shown here include 43 conversions to arthrodesis, 238 single-stage procedures, 52 two-stage procedures, six DAIRs, four with modular exchange and two without. 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 years	5 years	7 years	10 years
All cases	7,084	0.76 (0.58-1.00)	3.23 (2.80-3.71)	5.80 (5.16-6.52)	7.29 (6.50-8.16)	8.52 (7.55-9.60)
Female	2,855	0.84 (0.56-1.26)	3.59 (2.91-4.43)	6.31 (5.31-7.49)	8.00 (6.75-9.47)	*9.41 (7.88-11.22)*
<65	1,052	0.89 (0.46-1.70)	4.87 (3.64-6.50)	8.97 (7.10-11.30)	11.25 (8.98-14.05)	*12.58 (9.96-15.81)*
65 to 74	1,123	0.84 (0.44-1.61)	3.58 (2.55-5.01)	6.10 (4.61-8.06)	8.09 (6.14-10.62)	*10.00 (7.49-13.29)*
≥75	680	0.76 (0.32-1.82)	1.55 (0.80-2.99)	2.04 (1.12-3.71)	*2.04 (1.12-3.71)*	*2.66 (1.39-5.04)*
Male	4,229	0.71 (0.50-1.03)	2.97 (2.46-3.60)	5.45 (4.66-6.38)	6.77 (5.81-7.88)	*7.86 (6.67-9.24)*
<65	1,343	0.85 (0.47-1.54)	4.44 (3.38-5.83)	7.50 (5.95-9.43)	8.93 (7.13-11.16)	*10.12 (7.97-12.79)*
65 to 74	1,775	0.64 (0.35-1.15)	2.65 (1.95-3.61)	5.32 (4.16-6.80)	7.22 (5.72-9.09)	*8.43 (6.60-10.74)*
≥75	1,111	0.66 (0.32-1.38)	1.64 (0.98-2.72)	2.94 (1.90-4.52)	*2.94 (1.90-4.52)*	*3.43 (2.15-5.45)*

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

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

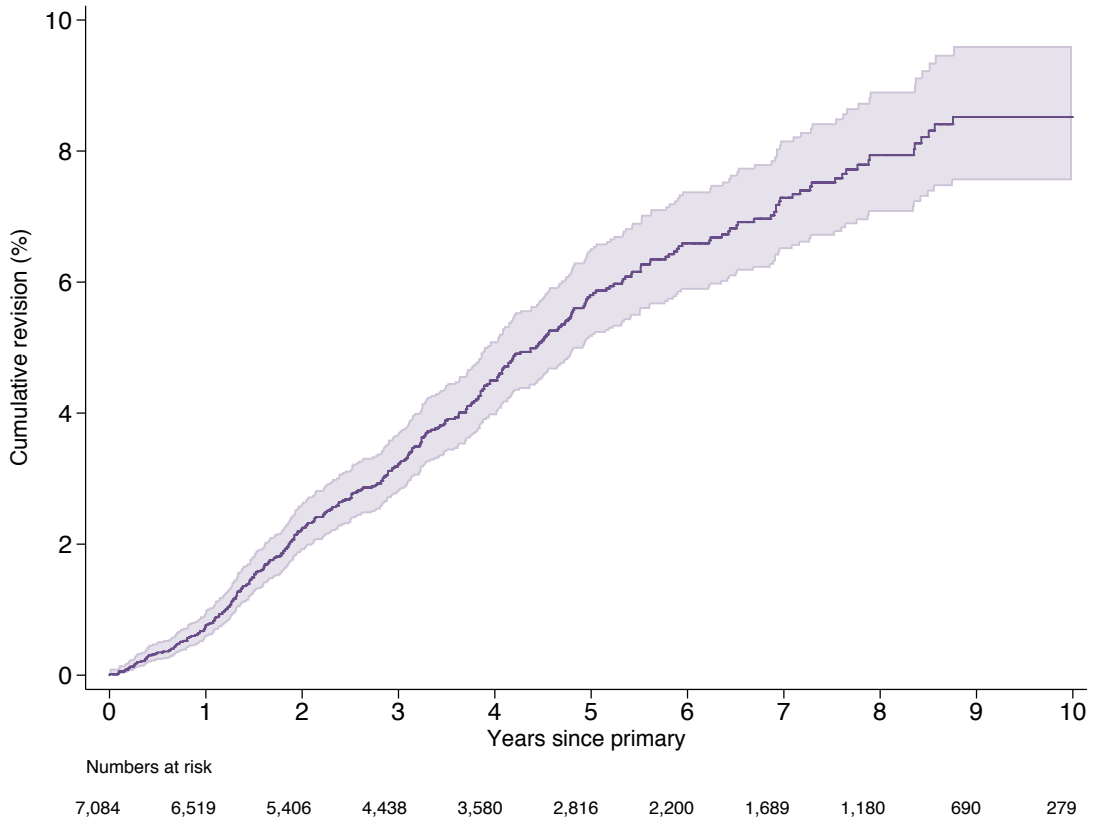


Figure 3.A5 and Table 3.A3 show the overall estimated cumulative percentage probability of (first) revision. Results are also stratified by gender and age.

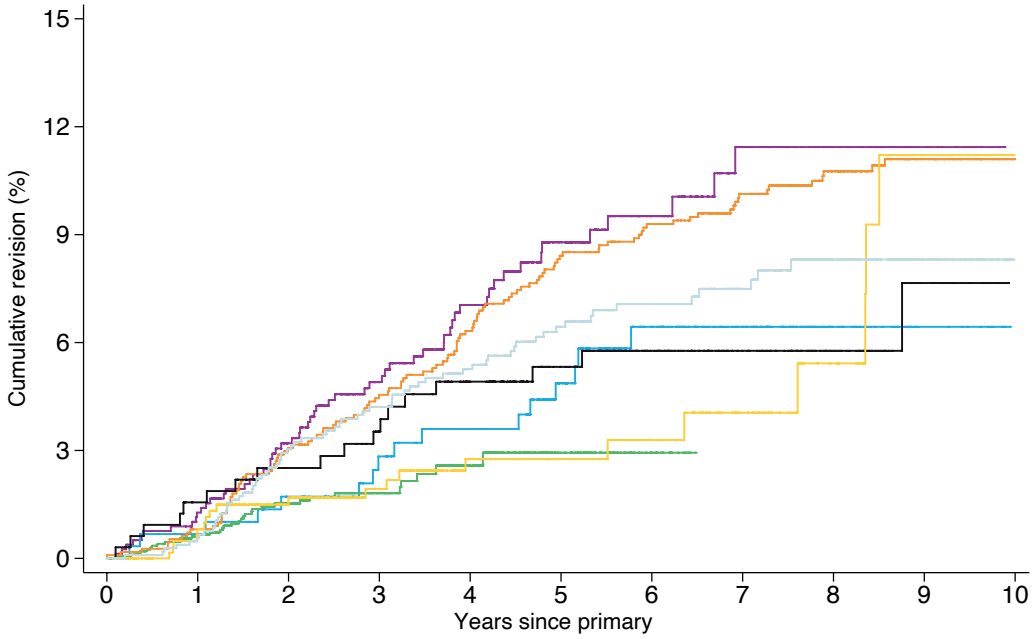
Table 3.A4 and Figure 3.A6 on page 224, show the estimated cumulative percentage probability of (first) revision by implant brand with at least 250 uses. Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time-period. At one year post-operation rates of revision were heterogeneous between brands, varying from 0.57 (95% CI 0.26-1.26) to 1.56 (0.65-3.70). Larger variations between brands were observed for later post-operative periods, with rates varying from 2.76 (95% CI 1.62-4.69) to 8.79 (95% CI 6.72-11.45) at five years post-operation. The large relative differences between the lowest and highest rates seem to be related to the implant brand and are unlikely to be entirely due to patient age and gender case mix. At ten 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	10 years
Box	796	67 (60 to 73)	65	1.28 (0.69-2.36)	4.90 (3.54-6.77)	8.79 (6.72-11.45)	*11.43 (8.55-15.20)*	*11.43 (8.55-15.20)*
Hintegra	296	70 (63 to 75)	66	0.68 (0.17-2.67)	2.83 (1.43-5.59)	*4.87 (2.85-8.26)*	*6.44 (3.96-10.38)*	
Infinity	2,120	69 (62 to 75)	59	0.67 (0.39-1.15)	1.81 (1.25-2.63)	*2.94 (1.93-4.45)*		
Mobility	1,117	68 (61 to 75)	56	0.81 (0.42-1.55)	4.55 (3.47-5.96)	8.42 (6.91-10.24)	10.13 (8.46-12.11)	*11.10 (9.32-13.20)*
Salto	323	69 (62 to 74)	59	1.56 (0.65-3.70)	3.53 (1.97-6.28)	*5.32 (3.29-8.56)*	*5.77 (3.62-9.15)*	*7.66 (4.23-13.66)*
Star	656	69 (63 to 76)	66	0.82 (0.34-1.96)	1.93 (1.07-3.47)	*2.76 (1.62-4.69)*	*4.05 (2.28-7.15)*	
Zenith	1,076	69 (63 to 75)	58	0.57 (0.26-1.26)	4.21 (3.13-5.66)	6.44 (5.02-8.23)	7.49 (5.90-9.50)	*8.31 (6.53-10.55)*

Note: 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 registry.

Figure 3.A6 KM estimates of cumulative **revision** of primary ankle replacement by **brand**. *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										
Zenith	1,076	1,037	943	848	764	644	496	367	*242*	*141*	*61*
Star	656	594	499	402	300	*218*	*147*	*94*	*61*	*32*	*7*
Salto	323	313	295	279	261	*219*	*168*	*116*	*76*	*44*	*18*
Mobility	1,117	1,100	1,064	1,031	993	954	919	821	639	398	*164*
Infinity	2,120	1,787	1,166	678	309	*108*	*25*				
Hintegra	296	292	278	259	*243*	*205*	*146*	*102*	*45*	*16*	*5*
Box	796	766	665	549	428	308	*190*	*118*	*75*	*40*	*19*

Table 3.A5 Indications for the 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	**92**	**0.28 (0.23-0.35)**
Aseptic loosening	**157**	**0.49 (0.42-0.57)**
Aseptic loosening of tibial component only	40	0.12 (0.09-0.17)
Aseptic loosening of talar component only	48	0.15 (0.11-0.20)
Aseptic loosening of both tibial and talar components	69	0.21 (0.17-0.27)
Lysis	**65**	**0.20 (0.16-0.26)**
Lysis of tibial component only	14	0.04 (0.03-0.07)
Lysis of talar component only	25	0.08 (0.05-0.11)
Lysis of both tibial and talar components	26	0.08 (0.05-0.12)
Malalignment	**60**	**0.19 (0.14-0.24)**
Implant fracture	**12**	**0.04 (0.02-0.07)**
Implant fracture of tibial component only	0	0
Implant fracture of talar component only	<4	0.01 (0.00-0.02)
Implant fracture of meniscal component only	8	0.02 (0.01-0.05)
Implant fracture of tibial and talar components	<4	0.01 (0.00-0.02)
Meniscal insert dislocation	**11**	**0.03 (0.02-0.06)**
Wear of polyethylene component	**34**	**0.11 (0.08-0.15)**
Component migration/dissociation	**25**	**0.08 (0.05-0.11)**
Pain	**70**	**0.22 (0.17-0.27)**
Stiffness	**36**	**0.11 (0.08-0.15)**
Soft tissue impingement	**30**	**0.09 (0.06-0.13)**
Other indication for revision	**43**	**0.13 (0.10-0.18)**

Note: Two revision procedures recorded no reason for that revision and were removed from the analysis.
Note: In MDSv4 pain was referred to as Pain (undiagnosed) and from MDSv6 onwards pain is 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.

Of the revisions for infection, 23 (25.0%) 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/histo). Out of the 157 revisions for aseptic loosening, 43.9% were performed because of loosening of both the tibial and talar components. Of patients revised for an indication of lysis, 40.0% had lysis of both tibial and talar components. Of the 12 revisions for implant fracture, eight (66.7%) were performed for a fractured meniscal insert and two (16.7%) 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 NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

3.4.3 Mortality after primary ankle replacement

In this analysis, the second of each of the nine (same day) bilateral procedures were excluded. Among the remaining 7,075, a total of 556 patients had died before the end of 2020, 189 of these were female and 367 were male.

Figure 3.A7 KM estimates of cumulative **mortality** after primary ankle replacement (shaded area indicates point-wise 95% CI).

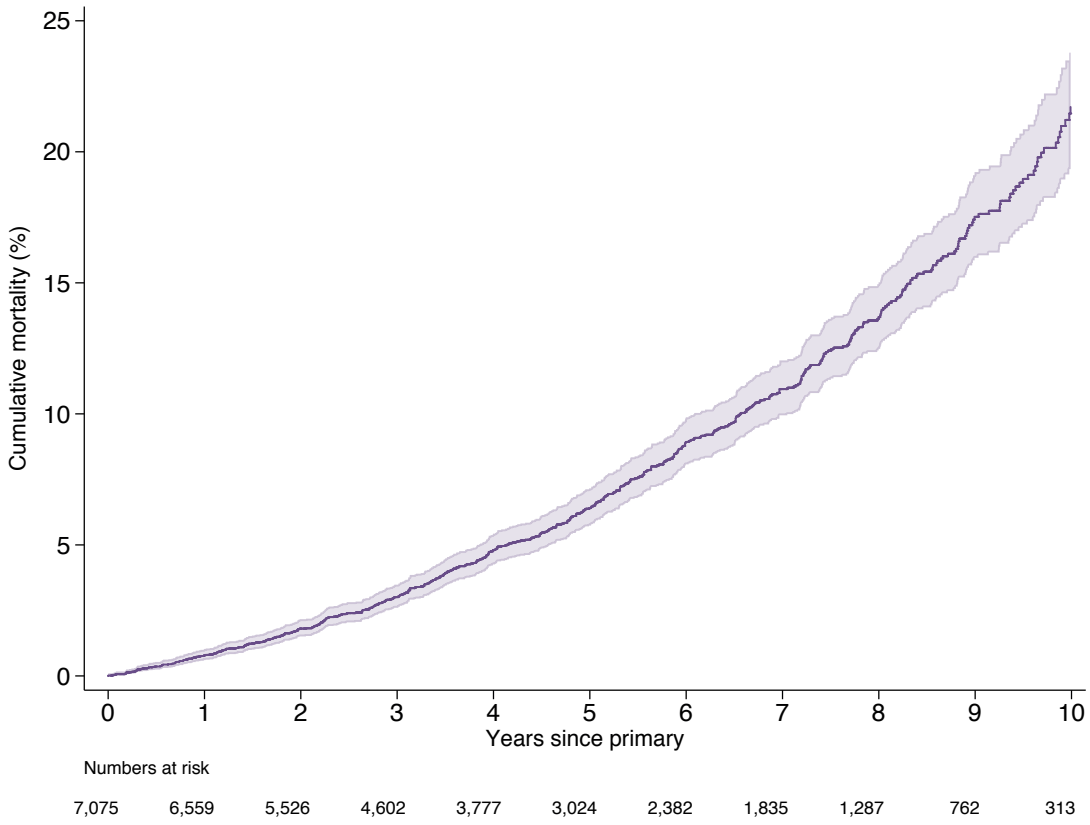


Table 3.A6 KM estimates of cumulative **mortality** (95% CI) after primary ankle replacement, by gender and age.
Blue italics signify that fewer than 250 cases remained at risk at these time points.

Age at primary (years)	Number of primaries	Time since primary						
		30 days	90 days	1 year	3 years	5 years	7 years	10 years
All cases	7,075	0.07 (0.03-0.17)	0.16 (0.09-0.28)	0.79 (0.61-1.03)	3.01 (2.60-3.48)	6.41 (5.74-7.16)	10.95 (9.95-12.04)	21.71 (19.55-24.08)
Female	2,853	0.04 (0.00-0.25)	0.14 (0.05-0.38)	0.66 (0.41-1.04)	2.49 (1.93-3.21)	5.25 (4.32-6.36)	9.41 (8.00-11.07)	*17.26 (14.47-20.52)*
<65	1,050	0	0.19 (0.05-0.77)	0.39 (0.15-1.04)	1.19 (0.66-2.15)	2.37 (1.48-3.79)	4.97 (3.40-7.23)	*7.47 (5.27-10.54)*
65 to 74	1,123	0.09 (0.01-0.63)	0.18 (0.05-0.72)	0.65 (0.31-1.35)	2.13 (1.38-3.30)	4.56 (3.26-6.36)	8.07 (6.07-10.69)	*14.35 (10.45-19.55)*
≥75	680	0	0	1.08 (0.52-2.26)	5.24 (3.63-7.52)	11.28 (8.59-14.73)	*19.28 (15.33-24.10)*	*39.20 (30.47-49.40)*
Male	4,222	0.09 (0.04-0.25)	0.17 (0.08-0.35)	0.88 (0.64-1.22)	3.36 (2.81-4.01)	7.20 (6.29-8.24)	12.00 (10.66-13.50)	*25.11 (22.02-28.55)*
<65	1,342	0	0	0.08 (0.01-0.54)	1.43 (0.88-2.33)	3.29 (2.31-4.68)	4.44 (3.14-6.25)	*9.98 (6.54-15.07)*
65 to 74	1,771	0.17 (0.05-0.52)	0.23 (0.09-0.60)	0.93 (0.57-1.51)	2.78 (2.05-3.75)	6.21 (4.95-7.77)	9.61 (7.85-11.73)	*18.47 (14.90-22.77)*
≥75	1,109	0.09 (0.01-0.64)	0.28 (0.09-0.85)	1.79 (1.14-2.79)	6.77 (5.29-8.64)	13.92 (11.53-16.74)	*26.02 (22.29-30.25)*	*59.42 (50.25-68.80)*

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.A7 and Table 3.A6 on the previous pages show the estimated cumulative percentage probability of death at different times after surgery, by gender and age at primary. Male patients and patients of older age were more likely to have died.

3.4.4 Conclusions

Compared to the other joint types included in the annual report, primary ankle replacement is a low volume procedure, and linked revisions are 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.

Although there has been a trend towards an increasing volume of replacements by unit, the mean number per unit has only risen from 3.9 to 6.2 per year between 2010 to 2019, with an expected fall off in numbers in 2020 due to COVID-19. Only 7.2% of units conducting ankle replacements performed more than ten per year in 2020 and, in the same year, just 1.6% of units performed more than 20 primary procedures. BOFAS encourages surgeons to pool resources and create networks, where practicable, to ensure the sharing of best practice in the achievement of the highest standards of care and outcome quality for patients.

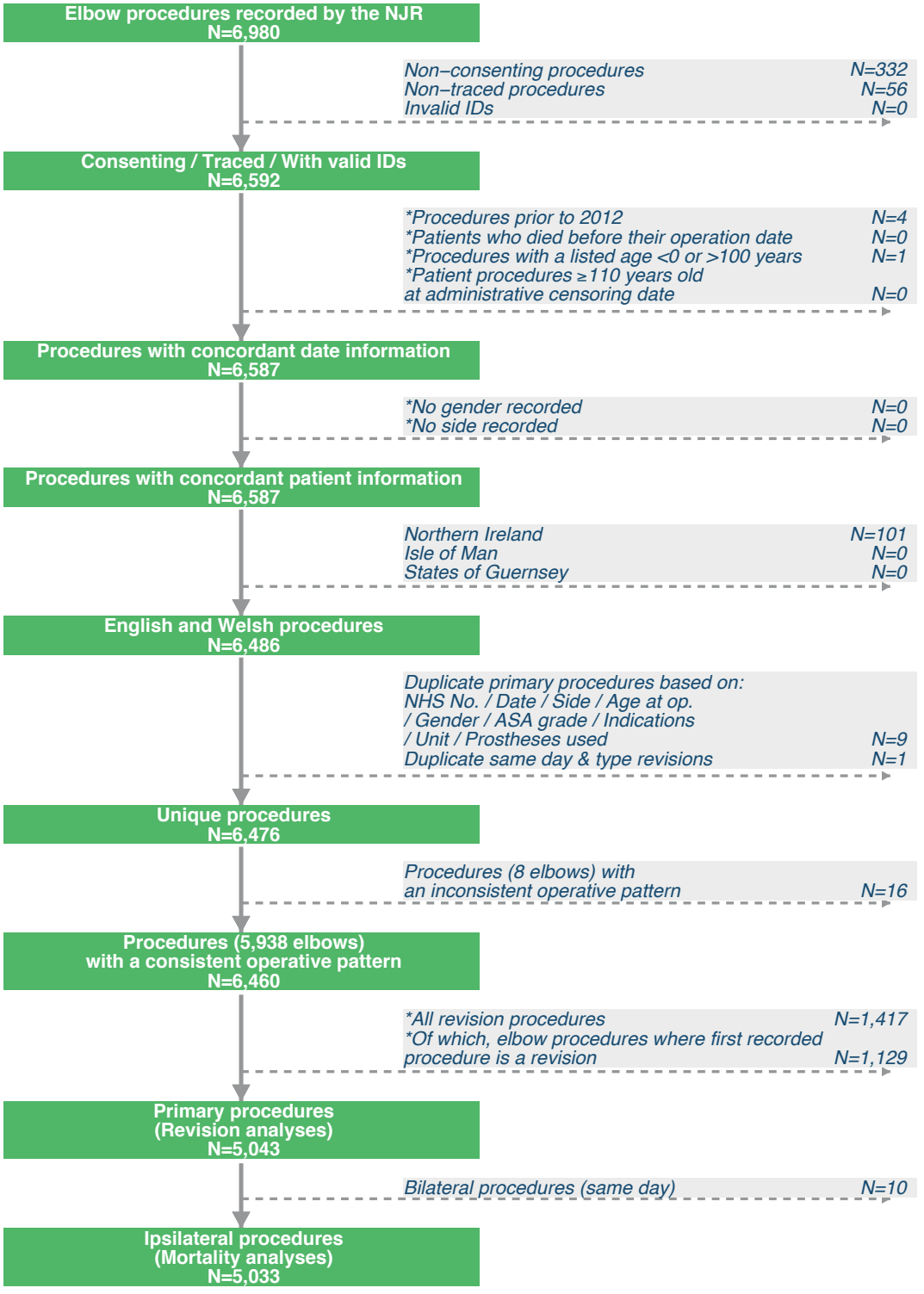
The cumulative percentage probability of 90-day mortality following primary ankle surgery is very low (0.16% (95% CI 0.09-0.28)) and the cumulative percentage of revision at ten years following a primary ankle replacement is found to be 8.52% (95% CI 7.55-9.60). Substantial heterogeneity in the rates 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

In this section we detail the primary elbow replacements entered into the registry since recording began (1 April 2012) up to the end of 31 December 2020. 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. We conducted an extended review of the component labels reported on the primary elbow (E1) MDS form. Our analysis has been able to identify total replacements with a radial head replacement (n=29) and investigate inconsistencies between the type of procedure reported on the MDS form and the component label data uploaded to the registry. Procedures where the reported type of surgery did not match the components listed on the MDS form are classified as unconfirmed in the elbow section of the report.

Figure 3.E1 Elbow cohort flow diagram.



** Reasons not necessarily mutually exclusive*

A total of 5,043 primary replacements were available for analysis for a total of 4,861 patients (Figure 3.E1). Of these patients, 182 had documented elbow replacements on both left and right sides, and in ten patients these were both performed on the same day (bilateral).

The majority of replacements were performed on women (69.1%) and the median age at the time of primary operation was 67 years (IQR 56 to 76), with an overall range of 14 to 99 years. Cement was listed in the component data in 66.0% of the primary elbow procedures.

Table 3.E1 shows that the annual number of primary elbow replacements entered into the registry has increased since 2012. While the increase in the early years is in part due to improvement in data capture, the consistent increase observed year after year from 2015 to 2019 mostly reflects an increase in the volume of procedures, improved reporting of radial head replacement and distal humeral hemiarthroplasties, or a combination of these factors. There is a decrease from 2019 to 2020 due to the impact of COVID-19.

Table 3.E1 provides a breakdown by the stated type of replacement. Of all procedures, including the unconfirmed, 68.3% were classified as a total replacement. A total of 454 (9%) primary elbow replacements had an unconfirmed status.

Table 3.E2 (page 234) details the type of primary operation in each year and we show that 2,135 (42.3%) elbow replacements were carried out for acute trauma. These have been separated from the remaining 2,908 cases performed for elective indications in the rest of this section. Nearly half (49.1%) of the elbow procedures performed for trauma were confirmed radial head replacements.

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 (%)	2020 N (%)
All cases	5,043	258 (100.0)	451 (100.0)	449 (100.0)	545 (100.0)	577 (100.0)	658 (100.0)	710 (100.0)	834 (100.0)	561 (100.0)
Confirmed elbow replacements	**4,589**	**198 (76.7)**	**370 (82.0)**	**408 (90.9)**	**486 (89.2)**	**515 (89.3)**	**600 (91.2)**	**661 (93.1)**	**806 (96.6)**	**545 (97.1)**
Total elbow replacement	3,031	170 (65.9)	329 (72.9)	351 (78.2)	390 (71.6)	384 (66.6)	433 (65.8)	381 (53.7)	381 (45.7)	212 (37.8)
Total elbow replacement inc. radial head replacement	29	0 (0.0)	0 (0.0)	<4 (0.7)	<4 (0.2)	<4 (0.5)	<4 (0.3)	8 (1.1)	9 (1.1)	<4 (0.5)
Radial head replacement	1,286	23 (8.9)	36 (8.0)	53 (11.8)	94 (17.2)	128 (22.2)	163 (24.8)	220 (31.0)	316 (37.9)	253 (45.1)
Lateral resurfacing	13	5 (1.9)	5 (1.1)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.2)
Distal humeral hemiarthroplasty	230	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	<4 (0.2)	52 (7.3)	100 (12.0)	76 (13.5)
Unconfirmed elbow replacements	**454**	**60 (23.3)**	**81 (18.0)**	**41 (9.1)**	**59 (10.8)**	**62 (10.7)**	**58 (8.8)**	**49 (6.9)**	**28 (3.4)**	**16 (2.9)**
Unconfirmed total elbow replacement	383	53 (20.5)	78 (17.3)	36 (8.0)	54 (9.9)	53 (9.2)	49 (7.4)	40 (5.6)	14 (1.7)	6 (1.1)
Unconfirmed radial head replacement	47	<4 (0.8)	<4 (0.4)	5 (1.1)	5 (0.9)	7 (1.2)	6 (0.9)	5 (0.7)	9 (1.1)	6 (1.1)
Unconfirmed lateral resurfacing	12	5 (1.9)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.2)	<4 (0.3)	<4 (0.3)	0 (0.0)	<4 (0.2)
Unconfirmed distal humeral hemiarthroplasty	12	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	<4 (0.2)	<4 (0.3)	5 (0.6)	<4 (0.5)

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.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 (%)	2020 N (%)
Acute trauma	All cases	2,135	66 (100.0)	120 (100.0)	122 (100.0)	202 (100.0)	214 (100.0)	246 (100.0)	331 (100.0)	455 (100.0)	379 (100.0)
	Confirmed elbow replacements	1,925	48 (72.7)	95 (79.2)	108 (88.5)	180 (89.1)	183 (85.5)	205 (83.3)	301 (90.9)	438 (96.3)	367 (96.8)
	Total elbow replacement	673	33 (50.0)	65 (54.2)	62 (50.8)	104 (51.5)	85 (39.7)	81 (32.9)	77 (23.3)	85 (18.7)	81 (21.4)
	Total elbow replacement inc. radial head replacement	<4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)
	Radial head replacement	1,048	15 (22.7)	30 (25.0)	46 (37.7)	75 (37.1)	98 (45.8)	123 (50.0)	182 (55.0)	261 (57.4)	218 (57.5)
	Lateral resurfacing	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 (0.0)
	Distal humeral hemiarthroplasty	203	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.5)	0 (0.0)	<4 (0.4)	42 (12.7)	91 (20.0)	68 (17.9)
	Unconfirmed elbow replacements	210	18 (27.3)	25 (20.8)	14 (11.5)	22 (10.9)	31 (14.5)	41 (16.7)	30 (9.1)	17 (3.7)	12 (3.2)
	Unconfirmed total elbow replacement	163	16 (24.2)	24 (20.0)	9 (7.4)	19 (9.4)	26 (12.1)	34 (13.8)	25 (7.6)	6 (1.3)	4 (1.1)
	Unconfirmed radial head replacement	37	<4 (3.0)	<4 (0.8)	5 (4.1)	<4 (1.5)	5 (2.3)	5 (2.0)	<4 (0.9)	7 (1.5)	6 (1.6)
	Unconfirmed lateral resurfacing	<4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.4)	<4 (0.3)	0 (0.0)	0 (0.0)
	Unconfirmed distal humeral hemiarthroplasty	8	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.4)	<4 (0.3)	4 (0.9)	<4 (0.5)
Elective	All cases	2,908	192 (100.0)	331 (100.0)	327 (100.0)	343 (100.0)	363 (100.0)	412 (100.0)	379 (100.0)	379 (100.0)	182 (100.0)
	Confirmed elbow replacements	2,664	150 (78.1)	275 (83.1)	300 (91.7)	306 (89.2)	332 (91.5)	395 (95.9)	360 (95.0)	368 (97.1)	178 (97.8)
	Total elbow replacement	2,358	137 (71.4)	264 (79.8)	289 (88.4)	286 (83.4)	299 (82.4)	352 (85.4)	304 (80.2)	296 (78.1)	131 (72.0)
	Total elbow replacement inc. radial head replacement	28	0 (0.0)	0 (0.0)	<4 (0.9)	<4 (0.3)	<4 (0.8)	<4 (0.5)	8 (2.1)	8 (2.1)	<4 (1.6)
	Radial head replacement	238	8 (4.2)	6 (1.8)	7 (2.1)	19 (5.5)	30 (8.3)	40 (9.7)	38 (10.0)	55 (14.5)	35 (19.2)
	Lateral resurfacing	13	5 (2.6)	5 (1.5)	<4 (0.3)	0 (0.0)	0 (0.0)	<4 (0.2)	0 (0.0)	0 (0.0)	<4 (0.5)
	Distal humeral hemiarthroplasty	27	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	10 (2.6)	9 (2.4)	8 (4.4)
	Unconfirmed elbow replacements	244	42 (21.9)	56 (16.9)	27 (8.3)	37 (10.8)	31 (8.5)	17 (4.1)	19 (5.0)	11 (2.9)	4 (2.2)
	Unconfirmed total elbow replacement	220	37 (19.3)	54 (16.3)	27 (8.3)	35 (10.2)	27 (7.4)	15 (3.6)	15 (4.0)	8 (2.1)	<4 (1.1)
	Unconfirmed radial head replacement	10	0 (0.0)	<4 (0.3)	0 (0.0)	<4 (0.6)	<4 (0.6)	<4 (0.2)	<4 (0.5)	<4 (0.5)	0 (0.0)
	Unconfirmed lateral resurfacing	10	5 (2.6)	<4 (0.3)	0 (0.0)	0 (0.0)	<4 (0.3)	<4 (0.2)	<4 (0.3)	0 (0.0)	<4 (0.5)
	Unconfirmed distal humeral hemiarthroplasty	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<4 (0.3)	0 (0.0)	<4 (0.3)	<4 (0.3)	<4 (0.5)

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.

Figure 3.E2 and Figure 3.E3 show the yearly number of primary elbow replacements performed for elective and acute trauma indications respectively. Elective and acute trauma procedures have been stratified by total elbow replacements (with or without a radial head replacement), radial head replacements and distal humeral hemi-arthroplasty, please note the difference in scale of the y-axis between each sub-plot. Each bar in the figure is further stratified by the volume of procedures that the surgeon conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 12 elective primary total elbow replacement procedures and 12 acute trauma primary total elbow replacement procedures, their annual total volume would be 24 procedures. Those 24 procedures would contribute to the dark purple sub-division in both elective and acute trauma figures shown here.

Figure 3.E2 shows that the volume of primary total elbow replacements has marginally increased over the last five years (except for 2020 due to the impact of COVID-19), with the number of surgeons performing one or two procedures annually falling. Elective radial head replacements are increasingly being recorded in the registry, however the majority of consultants only perform one or two procedures annually. Figure 3.E3 overleaf shows the volume of primary total elbow replacements staying relatively constant over the last five years. In the last three years there has been an increasing proportion of primary total elbow replacements performed by higher volume elbow surgeons i.e. those performing more than 13 procedures a year. Radial head replacements for acute trauma have been steadily increasing in volume and the proportion of consultants performing three or more procedures per year has also been increasing, indicating a degree of specialisation among a minority of consultants.

Figure 3.E2 **Frequency** of primary elbow replacements within **elective** cases stratified by procedure **type**, bars stacked by **volume** per consultant per year.

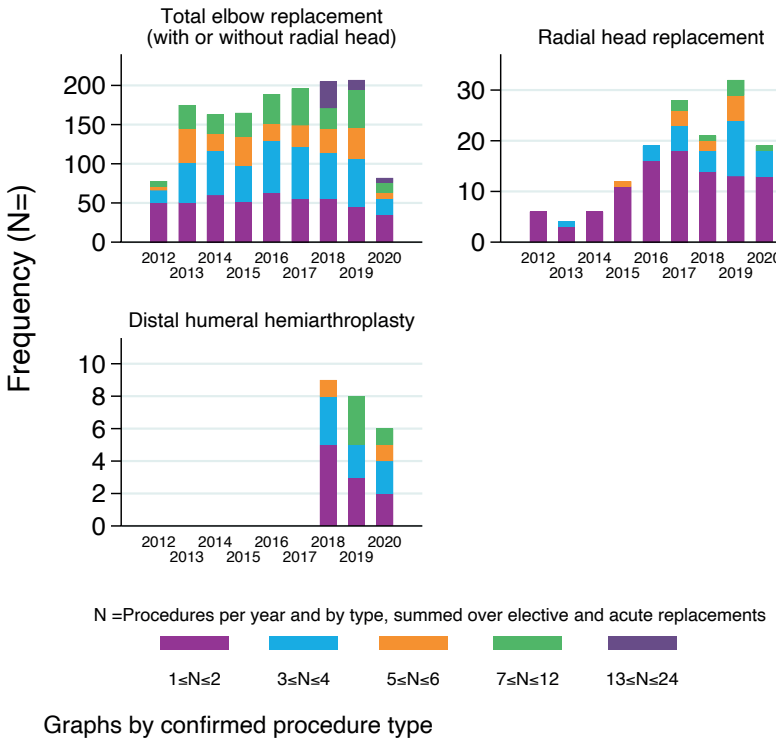


Figure 3.E3 Frequency of primary elbow replacements within **acute trauma** cases stratified by procedure **type**, bars stacked by **volume** per consultant per year.

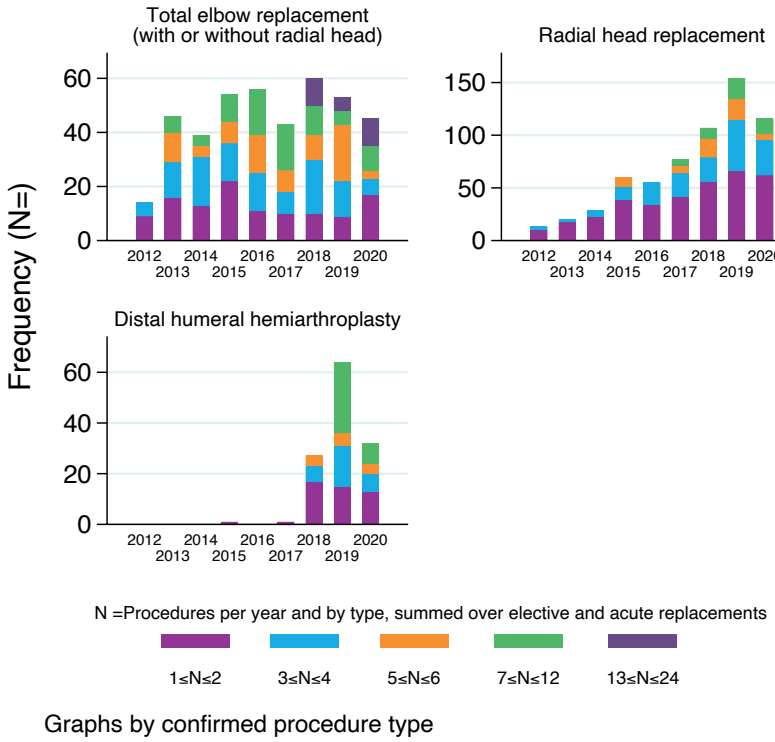


Table 3.E3 Indications for main confirmed types of primary elbow replacements, by year and type of primary operation.

	Year of primary	Number of primaries	Acute trauma	Elective						
			Number of cases (%)	Number of cases (%)	Number (%)* for each indication (amongst elective cases only)					
					Osteoarthritis	Inflammatory arthropathy	Trauma sequelae	Essex Lopresti	Avascular necrosis	Other indication
Total elbow replacement	All cases	3,031	673 (22.2)	2,358 (77.8)	798 (33.8)	1,164 (49.4)	400 (17.0)	4 (0.2)	4 (0.2)	109 (4.6)
	2012	170	33 (19.4)	137 (80.6)	44 (32.1)	65 (47.4)	28 (20.4)	<4 (0.7)	0 (0.0)	7 (5.1)
	2013	329	65 (19.8)	264 (80.2)	94 (35.6)	134 (50.8)	30 (11.4)	<4 (0.4)	<4 (0.4)	15 (5.7)
	2014	351	62 (17.7)	289 (82.3)	105 (36.3)	146 (50.5)	38 (13.1)	0 (0.0)	0 (0.0)	15 (5.2)
	2015	390	104 (26.7)	286 (73.3)	99 (34.6)	148 (51.7)	39 (13.6)	0 (0.0)	<4 (0.7)	16 (5.6)
	2016	384	85 (22.1)	299 (77.9)	100 (33.4)	150 (50.2)	52 (17.4)	0 (0.0)	0 (0.0)	12 (4.0)
	2017	433	81 (18.7)	352 (81.3)	115 (32.7)	179 (50.9)	60 (17.0)	<4 (0.3)	<4 (0.3)	13 (3.7)
	2018	381	77 (20.2)	304 (79.8)	103 (33.9)	159 (52.3)	50 (16.4)	<4 (0.3)	0 (0.0)	10 (3.3)
	2019	381	85 (22.3)	296 (77.7)	98 (33.1)	136 (45.9)	62 (20.9)	0 (0.0)	0 (0.0)	14 (4.7)
	2020	212	81 (38.2)	131 (61.8)	40 (30.5)	47 (35.9)	41 (31.3)	0 (0.0)	0 (0.0)	7 (5.3)
Radial head replacement	All cases	1,286	1,048	238	43	<4	163	21	4	13
	2012	23	15	8	<4	0	4	0	0	<4
	2013	36	30	6	<4	0	4	0	0	0
	2014	53	46	7	0	<4	5	<4	0	0
	2015	94	75	19	4	0	14	0	<4	0
	2016	128	98	30	5	0	24	<4	<4	<4
	2017	163	123	40	6	0	27	4	0	4
	2018	220	182	38	9	0	24	4	0	<4
	2019	316	261	55	7	<4	41	4	<4	<4
	2020	253	218	35	7	0	20	7	0	<4
Distal humeral hemiarthroplasty	All cases	230	203	27	5	<4	19	0	0	<4
	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	<4	<4	0	0	0	0	0	0	0
	2016	0	0	0	0	0	0	0	0	0
	2017	<4	<4	0	0	0	0	0	0	0
	2018	52	42	10	<4	<4	6	0	0	0
	2019	100	91	9	<4	<4	8	0	0	0
	2020	76	68	8	<4	0	5	0	0	<4

*Percentages are not presented where numbers are too few for meaningful percentages; please note the listed reasons are not mutually exclusive as more than one reason could have been stated.
Note: Procedures with unconfirmed prostheses, confirmed lateral resurfacing and confirmed total elbow replacements including a radial head replacement were 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 since more than one indication could have been provided. Only one indication for surgery, as defined in Table 3.E3, was given for all 1,925 acute trauma cases with a confirmed type of primary procedure. In 132 (5%) of the 2,664 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 the last three years, 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														
	2018					2019					2020				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)
All regions	710	172	2 (1 to 5)	231	5 (2 to 8)	834	172	3 (1 to 7)	249	6 (3 to 10)	561	138	2 (1 to 6)	213	4 (2 to 8)
East Midlands	77	15	5 (1 to 7)	30	7 (5 to 7)	65	12	3 (2 to 8.5)	24	6 (3 to 11.5)	42	8	3 (2.5 to 7.5)	18	4 (3 to 15)
East of England	72	13	4 (2 to 8)	17	8 (5 to 9)	70	13	2 (1 to 8)	18	10 (7 to 12)	41	9	6 (2 to 6)	17	6 (4 to 6)
London	62	24	2 (1 to 2.5)	30	2 (1 to 5)	88	25	3 (1 to 4)	33	3 (2 to 8)	82	27	2 (1 to 3)	36	2 (1 to 7)
North East	79	12	6 (4 to 9)	16	8.5 (5 to 10)	73	12	6.5 (4 to 8)	18	7.5 (7 to 9)	64	14	4 (1 to 7)	21	6 (4 to 8)
North West	121	27	2 (1 to 5)	42	4 (2 to 8)	145	27	2 (1 to 8)	40	8 (3 to 10)	64	16	2.5 (1.5 to 5.5)	32	3 (2 to 7)
South Central	29	5	6 (5 to 8)	11	6 (5 to 8)	38	6	7.5 (4 to 8)	13	8 (7 to 9)	33	7	3 (1 to 8)	10	4.5 (2 to 12)
South East Coast	55	25	2 (1 to 3)	18	2.5 (1 to 4)	76	19	3 (1 to 7)	23	5 (3 to 8)	73	19	2 (1 to 6)	22	4 (2 to 11)
South West	56	15	2 (1 to 5)	22	5 (2 to 9)	99	15	3 (1 to 13)	24	13 (3 to 16)	59	8	6.5 (2.5 to 10)	20	7 (6 to 9)
Wales	37	9	3 (1 to 4)	6	5 (3 to 6)	43	12	3.5 (1.5 to 4)	10	4 (3 to 4)	9	5	1 (1 to 3)	4	2 (1 to 3)
West Midlands	49	13	3 (2 to 3)	19	3 (2 to 15)	54	14	3 (2 to 4)	26	3 (3 to 10)	34	11	3 (2 to 4)	16	3 (3 to 4)
Yorkshire and the Humber	73	14	4 (1 to 7)	20	5 (4 to 7.5)	83	17	3 (1 to 5)	20	4 (2 to 10)	60	14	2 (1 to 6)	17	5 (2 to 6)

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

Table 3.E4 Number of units and consultant surgeons (cons) providing primary elbow replacements during each year from the last three years, by region.

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

Region	Year of primary														
	2018					2019					2020				
	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)	Number of primaries	Number of units	Median number of primaries per unit (IQR)	Number of cons.	Median number of primaries per cons. (IQR)
All regions	389	125	2 (1 to 4)	151	3 (2 to 6)	390	121	2 (1 to 4)	142	3 (2 to 6)	215	88	1 (1 to 3)	101	2 (1 to 5)
East Midlands	45	10	3 (2 to 5)	18	5 (3 to 5)	39	8	4 (2 to 6.5)	14	6 (3 to 7)	15	5	3 (1 to 3)	8	3 (2 to 5)
East of England	45	10	5 (4 to 6)	14	6 (5 to 6)	32	10	2.5 (1 to 5)	11	3 (2 to 6)	18	8	1.5 (1 to 3.5)	9	2 (1 to 4)
London	32	12	2 (1 to 3.5)	18	3.5 (2 to 8)	34	13	2 (1 to 3)	15	3 (2 to 5)	26	9	1 (1 to 2)	15	2 (1 to 9)
North East	28	11	2 (2 to 3)	12	2 (2 to 4)	32	11	3 (1 to 5)	11	4 (1 to 5)	26	11	1 (1 to 4)	12	3 (1 to 6)
North West	52	17	1 (1 to 3)	20	1 (1 to 3.5)	53	17	2 (1 to 3)	22	2 (1 to 4)	23	10	1.5 (1 to 3)	14	2 (1 to 3)
South Central	16	4	3.5 (2.5 to 5.5)	6	3.5 (3 to 4)	19	5	2 (2 to 6)	9	6 (2 to 6)	12	5	2 (1 to 3)	5	3 (3 to 5)
South East Coast	31	17	2 (1 to 2)	12	2.5 (2 to 3.5)	30	11	2 (1 to 4)	11	4 (2 to 4)	28	11	1 (1 to 5)	8	2 (1 to 4)
South West	32	14	1.5 (1 to 4)	16	2.5 (1 to 4)	46	12	2.5 (1.5 to 5)	10	4 (2 to 7)	9	5	2 (1 to 2)	7	2 (1 to 3)
Wales	22	8	2.5 (1 to 4)	6	4 (3 to 6)	20	8	2 (1.5 to 3.5)	7	3 (2 to 4)	7	5	1 (1 to 1)	4	1 (1 to 2)
West Midlands	37	10	2 (1 to 3)	15	3 (2 to 15)	35	12	2 (1 to 3.5)	17	3 (2 to 5)	20	8	2 (1 to 2.5)	9	2 (2 to 8)
Yorkshire and the Humber	49	12	3 (1 to 5)	14	4 (2 to 11)	50	14	2 (1 to 4)	15	3 (2 to 6)	31	11	1 (1 to 4)	10	1.5 (1 to 4)

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

Over the last three years (from 2018 to 2020) 2,105 primary elbow replacements were entered into the registry, of which 994 had confirmed components consistent with a total elbow replacement (with or without radial head replacement).

On the previous pages Tables 3.E4 (a) and (b) show the number of all types of elbow replacement by year and NJR geographical region over this time period, together with the number of units and consultants. A list of units within 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 6.5 replacements per unit in the South West region and as low as one replacement per unit in Wales in 2020. These figures are subject to change, as some units may not have submitted all data for all 2020 procedures by the time of data analysis.

Table 3.E5 below 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	Elective	Acute trauma
Total elbow replacement	All cases	3,031	2,358	673
	Linked:			
	Coonrad Morrey	1,563	1,182	381
	Discovery	777	615	162
	GSB III	43	40	<4
	Latitude EV Stem[Hum:Ulna]	179	151	28
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]	51	42	9
	Latitude EV Stem[Hum]Latitude Legacy Stem[Ulna]	<4	<4	0
	Latitude Legacy Stem[Hum:Ulna]	31	25	6
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]	38	31	7
	MUTARS Stem Cementless[Hum]MUTARS[Ulna]	<4	<4	0
	Nexel	240	170	70
	Unlinked:			
	IBP	8	8	0
	Latitude EV Stem[Hum:Ulna]	38	33	5
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]	25	24	<4
	Latitude Legacy Stem[Hum:Ulna]	9	9	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]	20	20	0
	NES	<4	<4	0

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.
Note: [Hum]=Humeral, [Ulna]=Ulna, [Rad]=Radial Head, [LHR]=Lateral humeral resurfacing, [LRR]=Lateral radial resurfacing, [DHH]=Distal humeral hemiarthroplasty.

Table 3.E5 (continued)

		Number of primaries	Elective	Acute trauma
Total elbow replacement inc. radial head replacement	All cases	29	28	<4
	Linked:			
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude (Legacy | EV)[Rad]	6	5	<4
	Latitude Legacy Stem[Hum]Latitude EV Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Unlinked:			
	Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	<4	<4	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude (Legacy | EV)[Rad]	6	6	0
	Latitude EV Stem[Hum]Latitude EV Stem[Ulna] Latitude EV[Rad]	<4	<4	0
	Latitude Legacy Stem[Hum]Latitude Legacy Short Stem[Ulna]Latitude (Legacy | EV)[Rad]	6	6	0
	Latitude Legacy Stem[Hum]Latitude Legacy Stem[Ulna]Latitude (Legacy | EV)[Rad]	4	4	0
Radial head replacement	All cases	1,286	238	1,048
	Bipolar:			
	Latitude (Legacy | EV)[Rad]	<4	0	<4
	RHS[Rad]	35	19	16
	rHead Recon[Rad]	6	<4	<4
	Monopolar:			
	Anatomic[Rad]	723	121	602
	Ascension[Rad]	79	21	58
	Corin[Rad]	26	5	21
	Evolve Proline[Rad]	276	43	233
	ExploR[Rad]	104	16	88
	Liverpool[Rad]	4	<4	<4
	MoPyC[Rad]	9	<4	7
	Uni-Radial Elbow[Rad]	6	<4	4
Lateral resurfacing	All cases	13	13	0
	LRE[LHR:LRR]	12	12	0
	Uni-Elbow[LHR:LRR]	<4	<4	0
Distal humeral hemiarthroplasty	All cases	230	27	203
	Latitude EV Stem[DHH]	213	23	190
	Latitude Legacy Stem[DHH]	17	4	13

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.
Note: [Hum]=Humeral, [Ulna]=Ulna, [Rad]=Radial Head, [LHR]=Lateral humeral resurfacing, [LRR]=Lateral radial resurfacing, [DHH]=Distal humeral hemiarthroplasty.

The top five constructs (Coonrad Morrey[Hum:Ulna], Discovery[Hum:Ulna], Nexel[Hum:Ulna], Latitude EV Stem[Hum:Ulna], Latitude EV Stem[Hum]Latitude EV Short Stem[Ulna]) account for nearly 93.9% of total elbow replacements performed. All total elbow replacements with radial head replacement were performed using the Latitude family of implants. One implant, (RHS[Rad]), accounts for 83.3% of the bipolar radial head replacements and two implants, (Anatomic[Rad] and Evolve Proline[Rad]), account for 81.4% of the monopolar radial head replacements. Nearly all (92.3%) lateral resurfacing procedures have been performed using the LRE[LHR:LRR] brand. The Latitude EV Stem[DHH] was used for 92.6% of distal humeral hemiarthroplasty procedures.

3.5.2 Revisions after primary elbow replacement surgery

We found that a total of 219 elbow primaries in the registry (48 acute trauma cases and 171 elective) had linked revision procedures recorded up to the end of 2020, including six excision procedures, 130 single-stage revisions, nine DAIRs (seven with modular exchange and two without modular exchange) and 63 stage one of a two-stage procedure.

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	7 years	8 years
All acute trauma and elective cases		5,043	67 (56 to 76)	31	1.32 (1.03-1.69)	2.74 (2.29-3.28)	4.13 (3.54-4.82)	5.39 (4.67-6.22)	5.97 (5.18-6.88)	7.04 (6.09-8.14)	7.53 (6.49-8.74)	*7.76 (6.64-9.06)*
Acute trauma	All acute trauma cases	2,135	66 (52 to 77)	30	1.09 (0.72-1.66)	2.03 (1.46-2.81)	2.38 (1.74-3.25)	2.90 (2.12-3.96)	3.29 (2.39-4.53)	*3.89 (2.76-5.47)*	*3.89 (2.76-5.47)*	*3.89 (2.76-5.47)*
	Total elbow replacement	673	77 (71 to 83)	17	1.27 (0.63-2.52)	2.42 (1.44-4.07)	3.35 (2.11-5.30)	4.29 (2.77-6.60)	*5.13 (3.34-7.83)*	*6.40 (4.14-9.85)*	*6.40 (4.14-9.85)*	*6.40 (4.14-9.85)*
	Total elbow replacement inc. radial head replacement	<4	79 (79 to 79)	0								
	Radial head replacement	1,048	53 (40.5 to 63)	42	0.30 (0.10-0.95)	0.59 (0.24-1.44)	0.59 (0.24-1.44)	0.89 (0.37-2.13)	*0.89 (0.37-2.13)*	*0.89 (0.37-2.13)*	*0.89 (0.37-2.13)*	*0.89 (0.37-2.13)*
	Distal humeral hemiarthroplasty	203	71 (65 to 79)	18	*3.96 (1.89-8.19)*	*7.67 (3.84-15.01)*						
	Unconfirmed total elbow replacement	163	75 (66 to 83)	20	*1.23 (0.31-4.85)*	*1.95 (0.63-5.93)*	*1.95 (0.63-5.93)*	*1.95 (0.63-5.93)*	*1.95 (0.63-5.93)*	*1.95 (0.63-5.93)*	*1.95 (0.63-5.93)*	
	Unconfirmed radial head replacement	37	48 (37 to 59)	51	*2.70 (0.39-17.68)*	*5.95 (1.51-21.89)*	*5.95 (1.51-21.89)*	*5.95 (1.51-21.89)*	*5.95 (1.51-21.89)*			
	Unconfirmed lateral resurfacing	<4	74.5 (74 to 75)	50								
	Unconfirmed distal humeral hemiarthroplasty	8	74 (63 to 80.5)	38								

Note: 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 (continued)

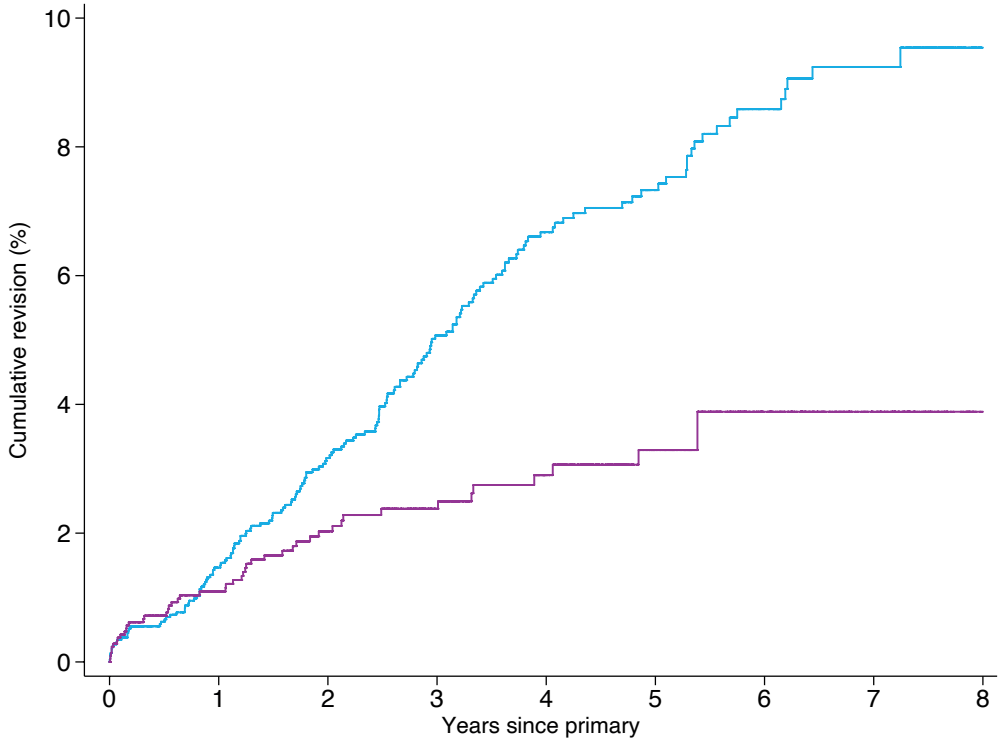
		Number of primaries	Age (Median, IQR)	Male (%)	Time since primary							
					1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
Elective	All elective cases	2,908	68 (58 to 75)	31	1.46 (1.08-1.98)	3.17 (2.56-3.91)	5.07 (4.25-6.05)	6.68 (5.68-7.83)	7.33 (6.26-8.58)	8.59 (7.32-10.05)	9.24 (7.86-10.85)	*9.54 (8.06-11.27)*
	Total elbow replacement	2,358	69 (60 to 76)	29	1.14 (0.78-1.67)	2.97 (2.33-3.79)	4.74 (3.87-5.80)	6.34 (5.28-7.61)	7.16 (5.98-8.56)	8.45 (7.06-10.11)	8.86 (7.37-10.62)	*9.28 (7.63-11.25)*
	Total elbow replacement inc. radial head replacement	28	64 (55 to 71)	36	*3.57 (0.51-22.76)*	*8.93 (2.24-32.08)*						
	Radial head replacement	238	51 (41 to 62)	49	*3.26 (1.56-6.72)*	*3.26 (1.56-6.72)*	*4.88 (2.50-9.40)*	*5.92 (3.10-11.14)*	*5.92 (3.10-11.14)*	*5.92 (3.10-11.14)*	*5.92 (3.10-11.14)*	
	Lateral resurfacing	13	57 (52 to 61)	46	*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)*	*8.33 (1.22-46.10)*		
	Distal humeral hemiarthroplasty	27	71 (67 to 81)	30	*3.70 (0.53-23.51)*							
	Unconfirmed total elbow replacement	220	67.5 (57.5 to 75)	30	*2.31 (0.97-5.46)*	*3.77 (1.90-7.39)*	*6.92 (4.15-11.43)*	*9.15 (5.86-14.16)*	*9.15 (5.86-14.16)*	*10.73 (7.00-16.26)*	*11.82 (7.73-17.84)*	*11.82 (7.73-17.84)*
	Unconfirmed radial head replacement	10	60 (48 to 77)	40								
	Unconfirmed lateral resurfacing	10	59.5 (45 to 68)	40								
	Unconfirmed distal humeral hemiarthroplasty	4	75.5 (66 to 80.5)	0								

Note: 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 eight years after the primary operation, together with 95% confidence intervals for all cases and for acute trauma and elective cases separately.

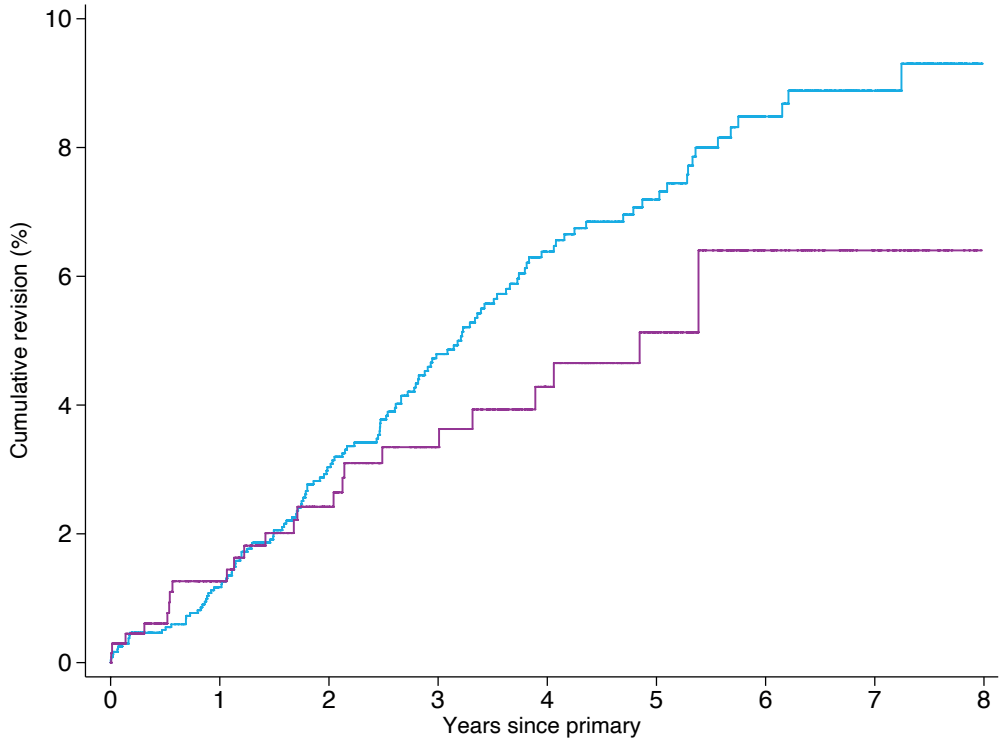
There is a higher cumulative revision rate for all elbow arthroplasty for elective indications compared to trauma. Figure 3.E4 shows Kaplan-Meier estimates of the cumulative percentage probability of revision after primary elbow replacement, divided into acute trauma and elective cases. It should be noted that there are substantial differences in the proportions of different types of elbow replacement in the elective and trauma group that are likely to account for the differences observed. Total elbow replacement makes up a higher proportion of procedures in elective cases (82.0%) than trauma (31.6%), whereas isolated radial head replacement is more commonly performed in trauma cases (49.1%) than elective (8.2%).

Figure 3.E4 KM estimates of cumulative **revision** of primary **elbow 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	2,135	1,687	1,203	848	607	393	*225*	*131*	*38*
Elective	2,908	2,637	2,178	1,733	1,302	926	626	376	*130*

Figure 3.E5 KM estimates of cumulative **revision** of primary **total elbow replacement (with or without a radial head 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	674	553	444	344	264	*183*	*103*	*67*	*19*
Elective	2,386	2,183	1,804	1,433	1,061	745	494	280	*95*

For the sub-group of total elbow replacement, shown in Figure 3.E5, we found that the survival of total replacements was comparable for trauma and elective indications up to two years. From two 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 lateral resurfacing, distal humeral hemiarthroplasty and the other unconfirmed types of primary procedure between elective and trauma indications.

Figure 3.E6 KM estimates of cumulative **revision** of **primary radial head 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.*

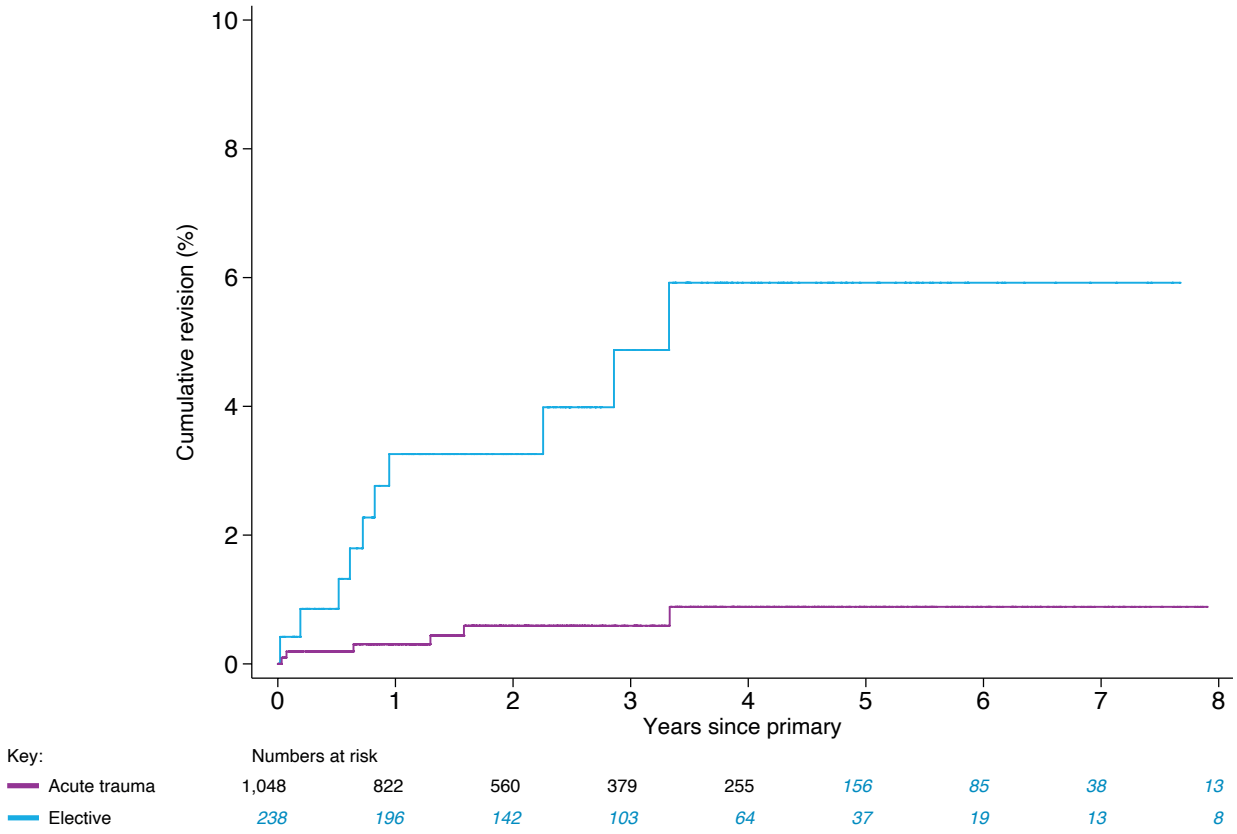


Figure 3.E6 shows Kaplan-Meier estimates of the cumulative percentage probability of revision by acute trauma and the elective cases in radial head replacements. Revision of radial head replacement appears to be under-reported as they are frequently revised to an excision arthroplasty which is often poorly recorded by units.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

Figure 3.E7 KM estimates of cumulative **revision** of **total elbow replacements** and **distal humeral hemiarthroplasty** within the **acute trauma** cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*

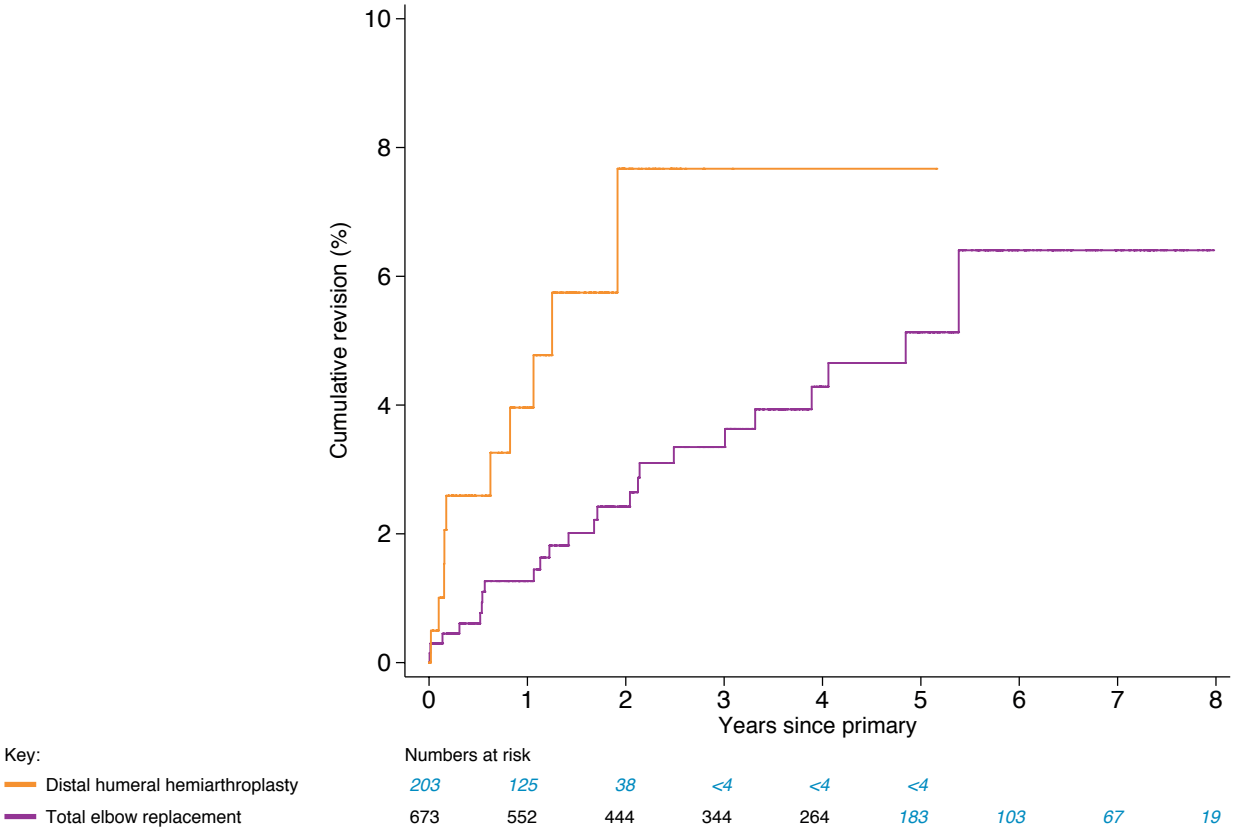
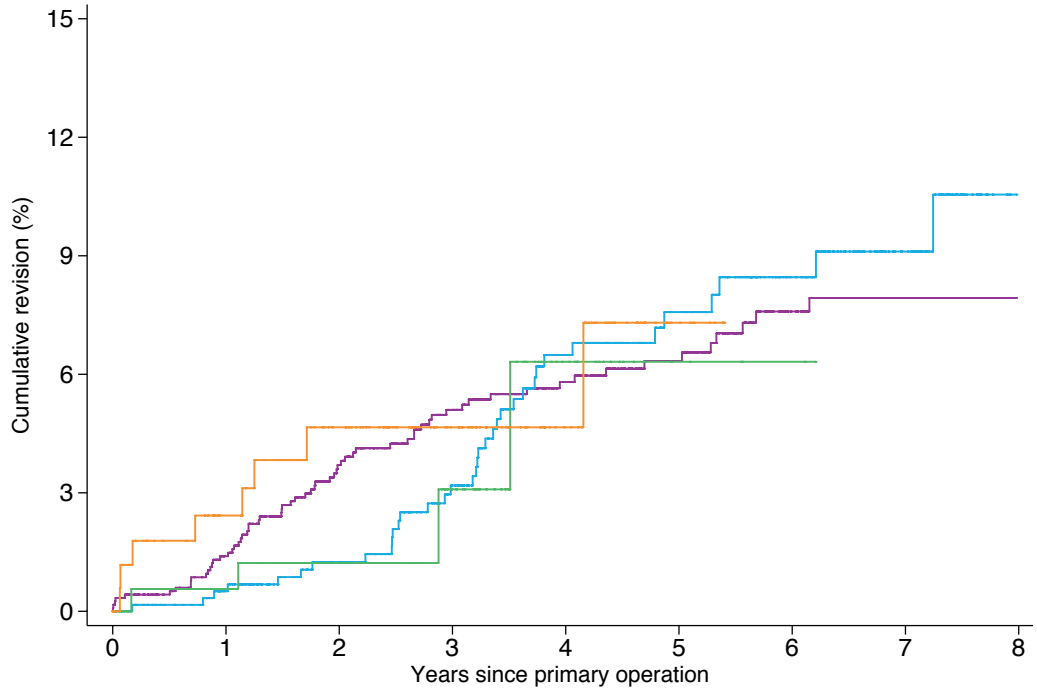


Figure 3.E7 shows cumulative rates of revision within the acute trauma cases. These differences remain uncertain as the number of procedures and the number of revisions within these groups remain low and excisions of radial head replacements are likely to have been under-reported.

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

Figure 3.E8 KM estimates of cumulative **revision** of **total elbow replacements** by implant **brand** within the **elective** cases. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points (elbow replacements with less than 100 procedures are excluded).*



Key:	Numbers at risk								
Nexel	*170*	*143*	*109*	*74*	*39*	*10*			
Latitude EV Stem	*184*	*155*	*95*	*45*	*19*	*5*	*<4*		
Discovery	615	570	506	425	307	*230*	*157*	*86*	*26*
Coonrad Morrey	1,182	1,095	917	747	589	431	288	*162*	*57*

Table 3.E7 overleaf 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 0.5% to 2.2% in the first post-operative year. At five years post-operation, the rates still varied between brands from 5.9% to 9.0%. However, we note that as numbers are small, this may simply be due to chance. For radial head replacement, the cumulative revision rates varied between brands from 0.4% to 2.1% in the first post-operative year.

Figure 3.E8 shows the rate of revision by implant brand within the elective cases. 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 all 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	7 years	8 years
Total elbow replacement	Linked brands	Coonrad Morrey	1,563	72 (64 to 78)	26	1.39 (0.91-2.13)	3.40 (2.57-4.48)	4.71 (3.69-6.00)	5.36 (4.24-6.76)	5.90 (4.69-7.41)	7.07 (5.61-8.90)	*7.35 (5.82-9.27)*	*7.35 (5.82-9.27)*
		Discovery	777	70 (61 to 78)	28	0.54 (0.20-1.42)	1.41 (0.76-2.61)	3.18 (2.06-4.91)	5.92 (4.22-8.27)	7.14 (5.16-9.82)	*8.26 (6.02-11.28)*	*8.79 (6.39-12.04)*	*9.96 (6.94-14.20)*
		Latitude EV Stem	179	71 (63 to 77)	24	*1.19 (0.30-4.67)*	*1.90 (0.61-5.80)*	*3.86 (1.24-11.67)*	*7.07 (2.42-19.70)*				
		Nexel	240	71 (62 to 79)	28	*2.21 (0.92-5.23)*	*3.98 (1.99-7.88)*	*3.98 (1.99-7.88)*	*6.92 (3.37-13.95)*	*9.04 (4.44-17.92)*			
Radial head replacement	Mono-polar brands	Anatomic	723	52 (41 to 63)	44	0.75 (0.31-1.81)	0.95 (0.42-2.11)	*1.34 (0.60-2.97)*	*1.34 (0.60-2.97)*	*1.34 (0.60-2.97)*	*1.34 (0.60-2.97)*	*1.34 (0.60-2.97)*	*1.34 (0.60-2.97)*
		Evolve Proline	276	54 (41.5 to 64)	44	*0.37 (0.05-2.58)*	*0.37 (0.05-2.58)*	*0.37 (0.05-2.58)*	*0.37 (0.05-2.58)*	*0.37 (0.05-2.58)*	*0.37 (0.05-2.58)*		
		ExploR	104	50.5 (40 to 61.5)	38	*2.12 (0.53-8.20)*	*2.12 (0.53-8.20)*	*2.12 (0.53-8.20)*	*2.12 (0.53-8.20)*	*2.12 (0.53-8.20)*			
Distal humeral hemiarthroplasty		Latitude EV Stem	213	71 (65 to 79)	21	*4.28 (2.15-8.43)*	*9.03 (4.78-16.70)*						

Note: 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 aseptic loosening and infection. The indications for revision were not mutually exclusive; in 26 of the 219 first revisions more than one indication was stated. A few cases (n=56) had gone on to have further revision procedures. The numbers are too small for any further analysis nor to draw any reliable 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					
				Aseptic loosening	Failed hemi-arthroplasty	Infection	Instability	Other indication for revision	Peripros-thetic fracture
All acute trauma and elective cases		5,043	219	85	11	73	29	17	32
Acute trauma	Confirmed elbow replacements	1,925	41	13	<4	14	7	5	4
	Total elbow replacement	673	25	11	0	11	<4	<4	4
	Total elbow replacement inc. radial head replacement	<4	0	0	0	0	0	0	0
	Radial head replacement	1,048	6	<4	0	<4	<4	<4	0
	Lateral resurfacing	0	0	0	0	0	0	0	0
	Distal humeral hemiarthroplasty	203	10	0	<4	<4	5	<4	0
	Unconfirmed elbow replacements	210	7	<4	<4	<4	<4	<4	0
	Unconfirmed total elbow replacement	163	<4	<4	<4	0	<4	<4	0
	Unconfirmed radial head replacement	37	<4	<4	0	0	<4	0	0
	Unconfirmed lateral resurfacing	<4	0	0	0	0	0	0	0
	Unconfirmed distal humeral hemiarthroplasty	8	<4	0	<4	<4	<4	0	0

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.E8 (continued)

Type of primary procedure		Number of primaries	Total revised	Indication for first revision procedure					
				Aseptic loosening	Failed hemi-arthroplasty	Infection	Instability	Other indication for revision	Peripros-thetic fracture
Elective	**Confirmed elbow replacements**	**2,664**	**148**	**59**	**4**	**50**	**15**	**10**	**27**
	Total elbow replacement	2,358	133	57	0	48	11	7	26
	Total elbow replacement inc. radial head replacement	28	<4	0	0	0	0	<4	<4
	Radial head replacement	238	10	<4	<4	<4	<4	<4	0
	Lateral resurfacing	13	<4	0	0	0	0	<4	0
	Distal humeral hemiarthroplasty	27	<4	0	<4	0	<4	0	0
	Unconfirmed elbow replacements	**244**	**23**	**11**	**<4**	**8**	**4**	**<4**	**<4**
	Unconfirmed total elbow replacement	220	21	11	<4	8	<4	<4	0
	Unconfirmed radial head replacement	10	0	0	0	0	0	0	0
	Unconfirmed lateral resurfacing	10	<4	0	0	0	<4	0	<4
	Unconfirmed distal humeral hemiarthroplasty	4	0	0	0	0	0	0	0

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 231). Among the remaining 5,033 procedures, 606 of the recipients had died by the end of December 2020.

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	7 years	8 years
All acute trauma and elective cases		5,033	67 (56 to 76)	31	0.22 (0.12-0.40)	0.58 (0.41-0.84)	2.24 (1.86-2.70)	4.83 (4.23-5.51)	8.22 (7.39-9.14)	11.57 (10.52-12.71)	16.03 (14.71-17.47)	19.93 (18.33-21.65)	23.09 (21.22-25.09)	*27.16 (24.68-29.85)*
Acute trauma	All acute trauma cases	2,128	66 (52 to 77)	30	0.43 (0.22-0.82)	0.81 (0.51-1.30)	2.93 (2.27-3.79)	5.99 (4.96-7.23)	10.10 (8.63-11.82)	13.69 (11.83-15.81)	17.85 (15.52-20.48)	*22.46 (19.50-25.79)*	*25.81 (22.24-29.84)*	*29.33 (24.54-34.81)*
	Total elbow replacement	672	77 (71 to 83)	17	0.75 (0.31-1.79)	1.66 (0.92-2.97)	5.97 (4.37-8.11)	11.27 (8.97-14.12)	17.47 (14.50-20.97)	23.22 (19.71-27.25)	*28.53 (24.50-33.05)*	*34.49 (29.73-39.78)*	*37.39 (32.10-43.23)*	*39.87 (33.87-46.51)*
	Total elbow replacement inc. radial head replacement	<4	79 (79 to 79)	0										
	Radial head replacement	1,042	53 (41 to 63)	42	0.19 (0.05-0.78)	0.29 (0.09-0.90)	0.75 (0.36-1.57)	1.42 (0.81-2.51)	1.86 (1.08-3.20)	2.50 (1.46-4.27)	*2.99 (1.72-5.16)*	*4.59 (2.51-8.33)*	*9.53 (4.87-18.19)*	*9.53 (4.87-18.19)*
	Distal humeral hemiarthroplasty	203	71 (65 to 79)	18	*0*	*0.53 (0.07-3.70)*	*3.21 (1.35-7.58)*	*7.97 (4.28-14.59)*						
	Unconfirmed total elbow replacement	163	75 (66 to 83)	20	*1.23 (0.31-4.82)*	*1.23 (0.31-4.82)*	*4.31 (2.08-8.84)*	*9.40 (5.78-15.12)*	*18.83 (13.47-25.98)*	*23.63 (17.36-31.69)*	*32.85 (24.75-42.76)*	*38.35 (29.06-49.40)*	*40.55 (30.76-52.08)*	
	Unconfirmed radial head replacement	37	48 (37 to 59)	51			*0*	*0*	*0*	*0*	*0*			
	Unconfirmed lateral resurfacing	<4	74.5 (74 to 75)	50										
	Unconfirmed distal humeral hemiarthroplasty	8	74 (63 to 80.5)	38										

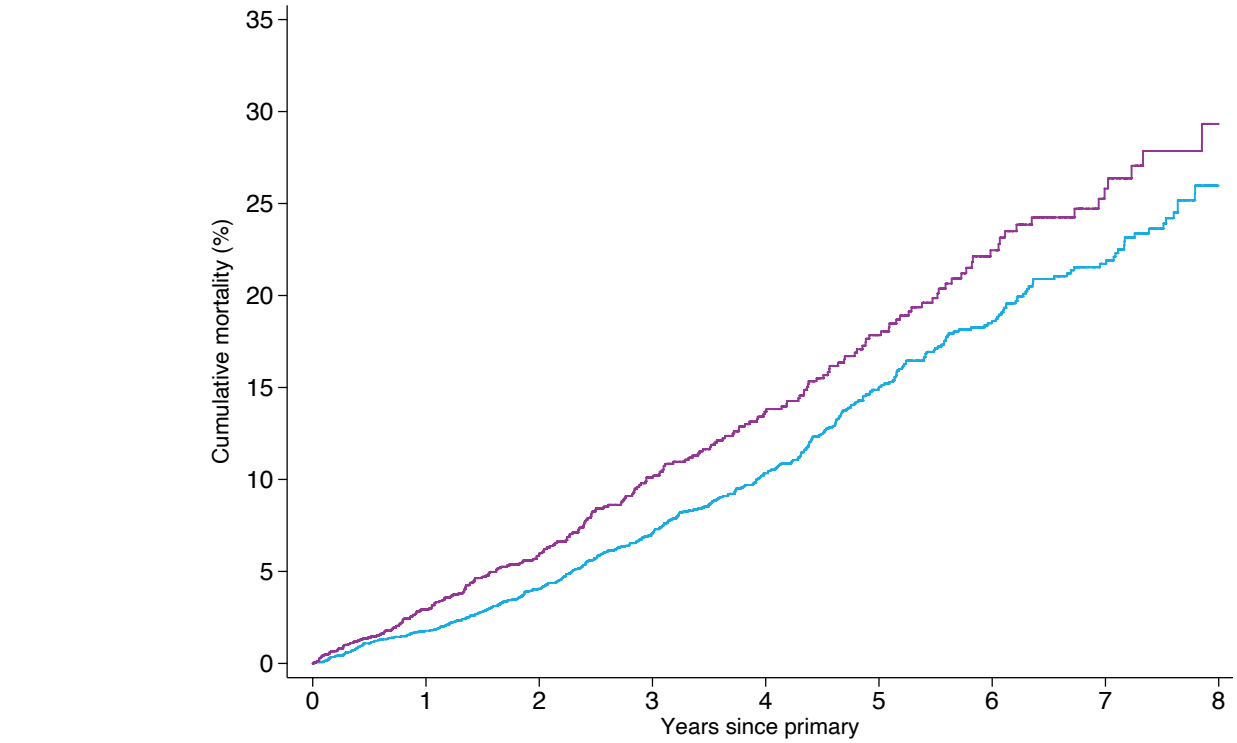
Note: Rates are not reported when there are less than ten primary procedures at risk of revision for the considered time period.
Note: Elbow replacements with a mismatch between the type of procedure reported by the surgeon on the MDS form and the recorded component labels on the MDS form or with no 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 (continued)

		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	7 years	8 years
Elective	All elective cases	2,905	68 (58 to 75)	31	0.07 (0.02-0.28)	0.42 (0.24-0.73)	1.77 (1.35-2.33)	4.07 (3.38-4.90)	7.10 (6.14-8.20)	10.34 (9.12-11.71)	14.96 (13.38-16.70)	18.61 (16.75-20.66)	21.72 (19.56-24.09)	*25.98 (23.12-29.12)*
	Total elbow replacement	2,356	69 (60 to 76)	29	0.08 (0.02-0.34)	0.43 (0.23-0.79)	1.87 (1.39-2.51)	4.53 (3.73-5.49)	7.91 (6.79-9.19)	11.55 (10.14-13.15)	16.59 (14.78-18.61)	20.62 (18.47-22.98)	23.76 (21.30-26.46)	*27.58 (24.33-31.18)*
	Total elbow replacement inc. radial head replacement	28	64 (55 to 71)	36		*0*	*0*	*0*						
	Radial head replacement	237	51 (41 to 62)	49	*0*	*0*	*0.49 (0.07-3.44)*	*0.49 (0.07-3.44)*	*0.49 (0.07-3.44)*	*2.85 (0.85-9.36)*	*2.85 (0.85-9.36)*	*2.85 (0.85-9.36)*	*2.85 (0.85-9.36)*	
	Lateral resurfacing	13	57 (52 to 61)	46			*0*	*0*	*0*	*0*	*0*	*0*	*0*	
	Distal humeral hemiarthroplasty	27	71 (67 to 81)	30		*0*	*0*	*0*						
	Unconfirmed total elbow replacement	220	67.5 (57.5 to 75)	30		*0.91 (0.23-3.59)*	*2.73 (1.24-5.98)*	*4.13 (2.17-7.78)*	*6.10 (3.59-10.29)*	*7.17 (4.38-11.63)*	*11.18 (7.48-16.53)*	*13.96 (9.66-19.96)*	*16.86 (11.83-23.72)*	*24.52 (17.50-33.74)*
	Unconfirmed radial head replacement	10	60 (48 to 77)	40										
	Unconfirmed lateral resurfacing	10	59.5 (45 to 68)	40										
	Unconfirmed distal humeral hemiarthroplasty	4	75.5 (66 to 80.5)	0										

Note: 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.

Figure 3.E9 KM estimates of cumulative **mortality** of primary **elbow 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	2,128	1,702	1,222	865	623	404	*231*	*133*	*38*
Elective	2,905	2,674	2,246	1,819	1,394	1,004	689	417	*143*

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

The mortality rate at four years after primary total elbow replacement for trauma is 101.0% higher than the rate in elective total elbow arthroplasty, with a four-year mortality rate of 23.2%.

3.5.4 Conclusions

The annual number of primary elbow replacement procedures entered into the registry has increased since 2012, other than in 2020 which was profoundly affected by COVID-19. The NJR has one of the largest datasets of elbow arthroplasty globally. It is not yet known how accurate or complete the dataset is, and an independent audit of elbow replacement data is underway.

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, i.e. the components entered do not match the procedure type recorded or in the case where there is no component data at all in the data entry record, the procedure type is reported as unconfirmed. Further work is required to reconcile these unconfirmed procedures and reduce their 'unconfirmed' status. This will enhance the comprehensiveness and utility of the data moving forward.

Distal humeral hemiarthroplasty was not included in the MDS until June 2018. Despite this, their use appears to be increasing overall, 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 elective total elbow replacement has been consistent over the five years of data entry with inflammatory arthropathy accounting for 41.7% of cases. In 2020 there were 215 confirmed elective and acute trauma primary total elbow replacements (including three with radial head replacements) performed in 88 units by 101 consultants. The volume of procedures does not show large variation, however the number of units performing elbow replacements has declined, from 125 in 2018, and the number of consultants from 151 in 2018. It has been the intention of the NHSE/I GIRFT programme to centralise total elbow replacement surgery across fewer specialist centres, so this data is encouraging, although this comparison may have been affected by the impact of COVID-19 on the 2020 figures. It should be noted that the median numbers of primary procedures per unit and per surgeon have not changed significantly from 2018 to those reported in 2020.

The Kaplan-Meier estimate of cumulative revision of total elbow replacement at four years was 4.29 (95% CI 2.77-6.60) for trauma patients and 6.34 (95% CI 5.28-7.61) for elective cases. Disparities in the rate of revision were observed between implant brands. Brand comparisons will become more evident and reliable as the size of the elbow cohort increases over time. We note that the main indications for revision were infection and aseptic loosening and this is observed for both acute trauma and elective cases.

The 5-year mortality rate for elbow replacement in all cases is 16.03 (95% CI 14.71-17.47) with differences seen between trauma and elective surgery. The 1-year mortality rate following total elbow replacement remains higher in the trauma patient population than in those having elective surgery, however this is likely to represent a difference in the demographics of these two patient groups.

3.6 Outcomes after shoulder replacement

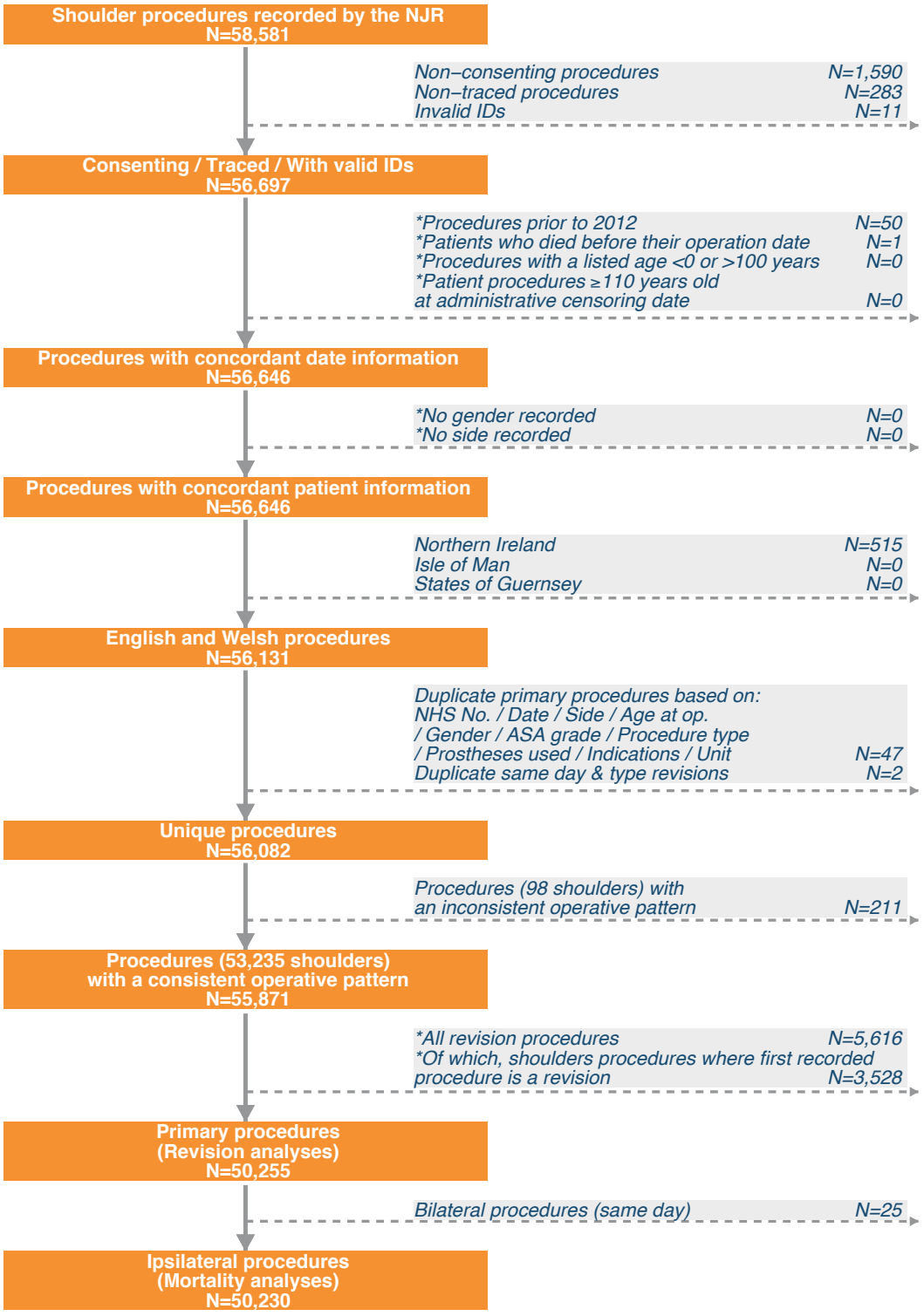
3.6.1 Overview of primary shoulder replacement surgery

Shoulder replacements have been recorded in the registry since 2012. In this section we address an overview of the (data-linked) primary shoulder replacements performed up to 31 December 2020 and also document 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 report 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. We have 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 of 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 4,774 (9.5%) procedures are unconfirmed; although the volume is expected to improve in future reports, with the development of more rigorous checks.

We define 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.



** Reasons not necessarily mutually exclusive*

A total of 50,255 primary shoulder replacements were available for our analysis in a total of 46,277 patients. Of these patients, 3,978 had documented replacements on both left and right sides, 25 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 (%)	2020 N (%)
All cases	**50,255 (100.0)**	**2,545 (100.0)**	**4,412 (100.0)**	**5,309 (100.0)**	**5,734 (100.0)**	**6,537 (100.0)**	**7,002 (100.0)**	**7,223 (100.0)**	**7,660 (100.0)**	**3,833 (100.0)**
Proximal humeral hemiarthroplasty	**8,064 (16.0)**	**885 (34.8)**	**1,303 (29.5)**	**1,287 (24.2)**	**1,060 (18.5)**	**1,015 (15.5)**	**836 (11.9)**	**707 (9.8)**	**679 (8.9)**	**292 (7.6)**
Resurfacing	2,906 (5.8)	476 (18.7)	594 (13.5)	537 (10.1)	375 (6.5)	368 (5.6)	220 (3.1)	146 (2.0)	130 (1.7)	60 (1.6)
Stemless	1,227 (2.4)	70 (2.8)	132 (3.0)	164 (3.1)	139 (2.4)	164 (2.5)	171 (2.4)	175 (2.4)	167 (2.2)	45 (1.2)
Stemmed	3,931 (7.8)	339 (13.3)	577 (13.1)	586 (11.0)	546 (9.5)	483 (7.4)	445 (6.4)	386 (5.3)	382 (5.0)	187 (4.9)
Total shoulder replacement	**13,734 (27.3)**	**632 (24.8)**	**1,178 (26.7)**	**1,534 (28.9)**	**1,770 (30.9)**	**1,897 (29.0)**	**1,983 (28.3)**	**1,892 (26.2)**	**1,933 (25.2)**	**915 (23.9)**
Resurfacing	486 (1.0)	49 (1.9)	99 (2.2)	82 (1.5)	88 (1.5)	78 (1.2)	45 (0.6)	24 (0.3)	15 (0.2)	6 (0.2)
Stemless	4,915 (9.8)	137 (5.4)	256 (5.8)	390 (7.3)	505 (8.8)	631 (9.7)	733 (10.5)	855 (11.8)	937 (12.2)	471 (12.3)
Stemmed	8,333 (16.6)	446 (17.5)	823 (18.7)	1,062 (20.0)	1,177 (20.5)	1,188 (18.2)	1,205 (17.2)	1,013 (14.0)	981 (12.8)	438 (11.4)
Reverse polarity total shoulder replacement	**23,678 (47.1)**	**686 (27.0)**	**1,351 (30.6)**	**1,907 (35.9)**	**2,328 (40.6)**	**3,008 (46.0)**	**3,609 (51.5)**	**3,969 (54.9)**	**4,512 (58.9)**	**2,308 (60.2)**
Stemless	186 (0.4)	5 (0.2)	14 (0.3)	15 (0.3)	25 (0.4)	25 (0.4)	21 (0.3)	38 (0.5)	23 (0.3)	20 (0.5)
Stemmed	23,492 (46.7)	681 (26.8)	1,337 (30.3)	1,892 (35.6)	2,303 (40.2)	2,983 (45.6)	3,588 (51.2)	3,931 (54.4)	4,489 (58.6)	2,288 (59.7)
Interpositional arthroplasty	**5 (<0.1)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**0 (0)**	**<4 (<0.1)**	**<4 (<0.1)**	**0 (0)**
Unconfirmed	**4,774 (9.5)**	**342 (13.4)**	**580 (13.1)**	**581 (10.9)**	**576 (10.0)**	**617 (9.4)**	**574 (8.2)**	**653 (9.0)**	**533 (7.0)**	**318 (8.3)**
Unconfirmed HHA	346 (0.7)	21 (0.8)	59 (1.3)	40 (0.8)	42 (0.7)	40 (0.6)	34 (0.5)	45 (0.6)	42 (0.5)	23 (0.6)
Unconfirmed TSR	1,853 (3.7)	201 (7.9)	312 (7.1)	304 (5.7)	258 (4.5)	271 (4.1)	205 (2.9)	166 (2.3)	79 (1.0)	57 (1.5)
Unconfirmed RTSR	2,570 (5.1)	120 (4.7)	209 (4.7)	237 (4.5)	276 (4.8)	306 (4.7)	335 (4.8)	438 (6.1)	411 (5.4)	238 (6.2)
Unconfirmed IPA	5 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0.1)	<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 have changed 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 (HHA), conventional total shoulder replacement (TSR) and reverse polarity total shoulder replacement (RTSR). There is a continued increasing preference for reverse polarity total 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 and Figure 3.S3 overleaf show the yearly number of primary shoulder replacements performed for elective and acute trauma indications respectively. Elective and acute trauma procedures have been stratified by procedure type. Please note the difference in scale of the y-axis between each sub-plot. Each bar is further stratified by the volume of procedures that the surgeon conducted in that year across both elective and acute trauma settings i.e. if a surgeon performed 24 elective primary stemmed humeral hemiarthroplasty procedures and 24 acute stemmed humeral hemiarthroplasty procedures their annual total volume would be 48 procedures. Those 48 procedures would contribute to the grey sub-division in both elective and acute trauma figures.

Figure 3.S2 shows a complex pattern of increasing and decreasing treatment preferences. Resurfacing humeral hemiarthroplasty and total shoulder replacements have declined since the start of data collection, stemless total shoulder replacements have steadily increased, the volume of stemmed reverse polarity total shoulder replacement has increased substantially, and stemmed humeral hemiarthroplasty and total shoulder replacements have fallen. In the more common procedures (stemless total shoulder replacements, stemmed total shoulder replacements and stemmed reverse polarity total shoulder replacements), the growth in procedures appears to be occurring in higher volume shoulder surgeons.

Figure 3.S3 shows the popularity of stemmed humeral hemiarthroplasty has reduced over the last few years while the popularity of stemmed reverse polarity total shoulder replacements has been steadily increasing. Stemmed reverse polarity total shoulder replacements are increasingly conducted by higher volume surgeons.

Figure 3.S2 Frequency of primary **shoulder replacements** within **elective** patients stratified by procedure **type**, bars stacked by **volume** per consultant per year.

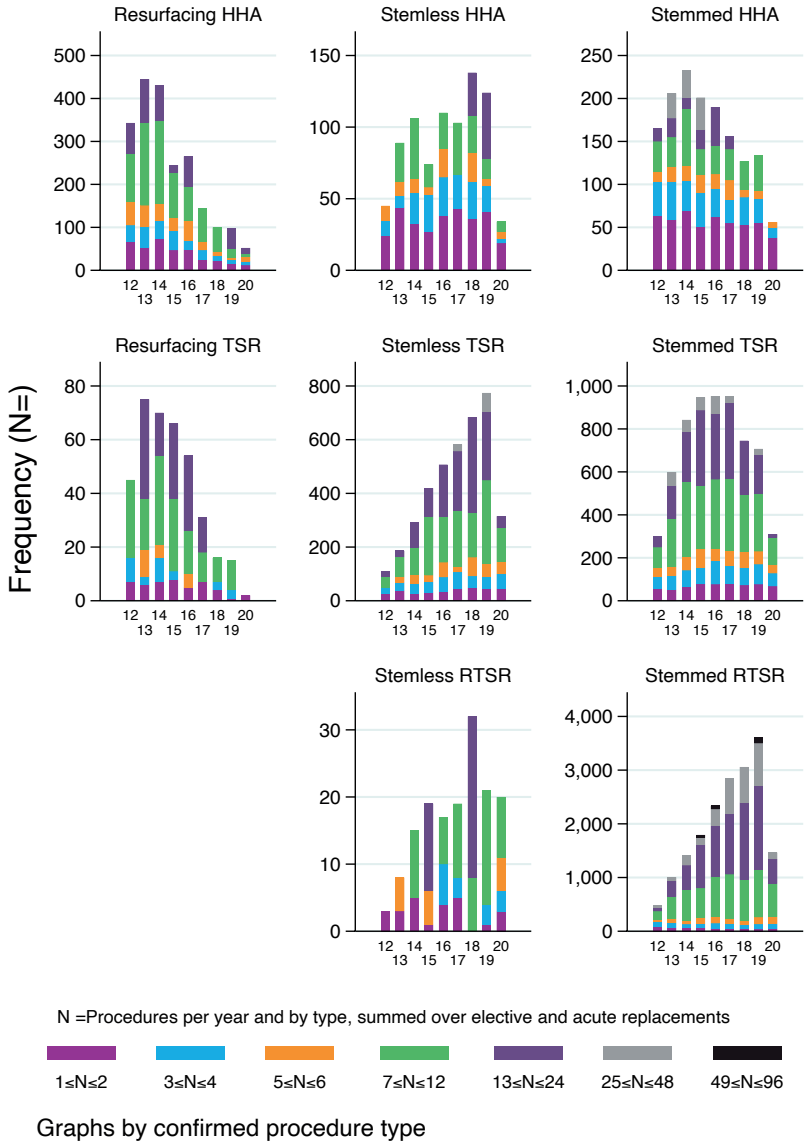


Figure 3.S3 Frequency of primary **shoulder replacements** within **acute trauma** patients stratified by procedure **type**, bars stacked by **volume** per consultant per year.

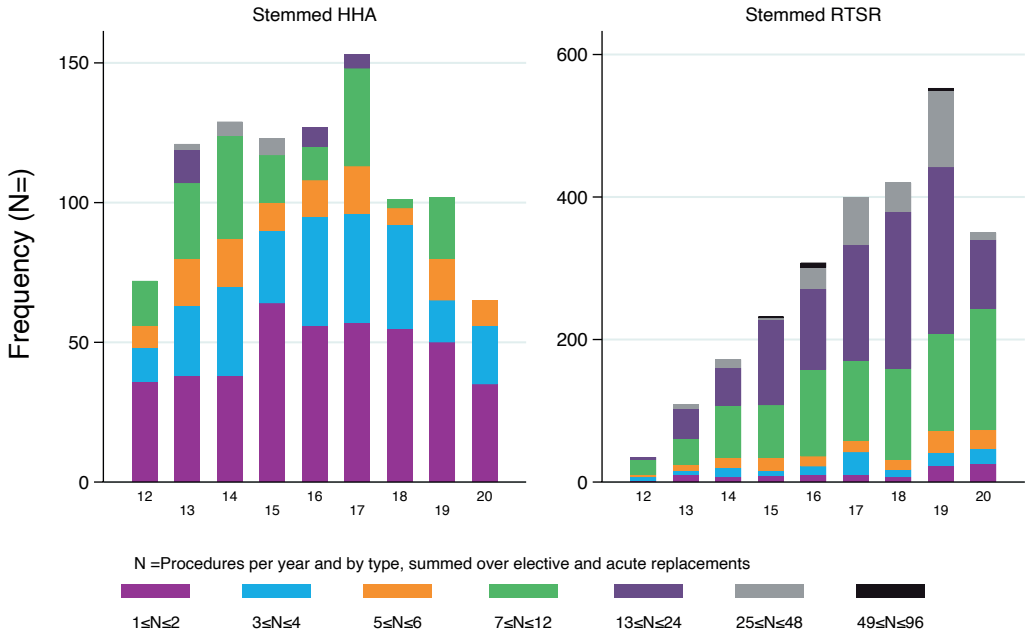
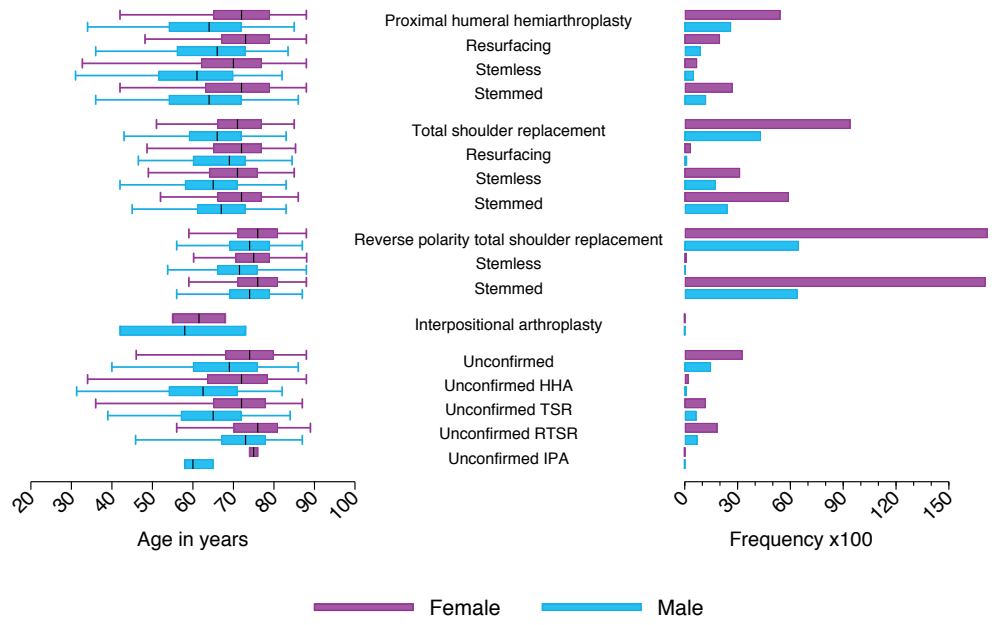


Figure 3.S4 Age (Box and whiskers*) and **frequency** of primary shoulder replacements by **gender** and **type** of shoulder replacement.



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

Figure 3.S4 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 the points 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.S4 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	5,143	1,180 (22.9)	74 (67 to 80) 27 to 99
	Proximal humeral hemiarthroplasty	1,648	499 (30.3)	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	3,011	577 (19.2)	76 (70 to 81) 48 to 99
	Interpositional arthroplasty	0	0 (0.0)	0 (0 to 0) 0 to 0
	Unconfirmed	470	96 (20.4)	74 (68 to 80) 35 to 95
Elective	All cases	45,112	13,761 (30.5)	73 (67 to 79) 17 to 100
	Proximal humeral hemiarthroplasty	6,416	2,137 (33.3)	70 (61 to 77) 17 to 95
	Resurfacing	2,900	897 (30.9)	71 (64 to 78) 20 to 95
	Stemless	1,217	514 (42.2)	67 (56 to 75) 17 to 93
	Stemmed	2,299	726 (31.6)	70 (60 to 78) 19 to 95
	Total shoulder replacement	13,720	4,319 (31.5)	70 (64 to 76) 18 to 99
	Resurfacing	486	140 (28.8)	71 (63 to 76) 29 to 95
	Stemless	4,911	1,763 (35.9)	69 (62 to 75) 18 to 99
	Stemmed	8,323	2,416 (29.0)	71 (65 to 76) 24 to 96
	Reverse polarity total shoulder replacement	20,667	5,902 (28.6)	76 (71 to 80) 17 to 100
	Stemless	186	70 (37.6)	73 (69 to 78) 49 to 89
	Stemmed	20,481	5,832 (28.5)	76 (71 to 80) 17 to 100
	Interpositional arthroplasty	5	<4 (60.0)	58 (55 to 68) 42 to 73
	Unconfirmed	4,304	1,400 (32.5)	73 (66 to 78) 18 to 96
	Unconfirmed HHA	292	109 (37.3)	69 (59 to 76) 18 to 92
	Unconfirmed TSR	1,814	644 (35.5)	69 (61 to 76) 20 to 96
	Unconfirmed RTSR	2,195	644 (29.3)	75 (69 to 80) 18 to 95
	Unconfirmed IPA	<4	<4 (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.S4, 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	50,255	409	80 (28 to 172)	880	19 (2 to 85)
Last 5 years	32,255	399	56 (21 to 114)	700	28 (4 to 72.5)
2012	2,545	262	6 (3 to 12)	379	4 (2 to 9)
2013	4,412	312	9 (4 to 18)	432	7 (2 to 15)
2014	5,309	338	10 (4 to 21)	456	8 (3 to 17)
2015	5,734	347	11 (4 to 23)	486	8 (3 to 17)
2016	6,537	348	14 (5 to 26)	490	10 (4 to 19)
2017	7,002	364	14 (5 to 27)	492	11 (5 to 21)
2018	7,223	367	14 (5 to 28)	506	11 (4 to 21)
2019	7,660	374	14 (6 to 29)	518	11 (4 to 21)
2020	3,833	350	7 (3 to 15)	471	6 (3 to 12)

Table 3.S3 illustrates the number of primary shoulder replacements and the number of units and consultants conducting shoulder replacements within the registry. 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, with the exception of 2020 and COVID-19, it has now fallen to 7 (3 to 15) and 6 (3 to 12) procedures respectively.

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	5,143 (100.0)	45,112 (100.0)	27,297 (100.0)	12,584 (100.0)	3,182 (100.0)	1,819 (100.0)	1,447 (100.0)	1,046 (100.0)	584 (100.0)
Proximal humeral hemiarthroplasty	1,648 (32.0)	6,416 (14.2)	4,809 (17.6)	353 (2.8)	557 (17.5)	392 (21.6)	521 (36.0)	181 (17.3)	7 (1.2)
Resurfacing	6 (0.1)	2,900 (6.4)	2,465 (9.0)	166 (1.3)	70 (2.2)	160 (8.8)	102 (7.0)	50 (4.8)	<4 (0.3)
Stemless	10 (0.2)	1,217 (2.7)	984 (3.6)	18 (0.1)	81 (2.5)	61 (3.4)	122 (8.4)	36 (3.4)	0 (0)
Stemmed	1,632 (31.7)	2,299 (5.1)	1,360 (5.0)	169 (1.3)	406 (12.8)	171 (9.4)	297 (20.5)	95 (9.1)	5 (0.9)
Total shoulder replacement	14 (0.3)	13,720 (30.4)	12,746 (46.7)	34 (0.3)	277 (8.7)	497 (27.3)	347 (24.0)	174 (16.6)	4 (0.7)
Resurfacing	0 (0)	486 (1.1)	464 (1.7)	0 (0)	4 (0.1)	22 (1.2)	<4 (0.1)	4 (0.4)	0 (0)
Stemless	4 (0.1)	4,911 (10.9)	4,539 (16.6)	11 (0.1)	107 (3.4)	183 (10.1)	114 (7.9)	80 (7.6)	<4 (0.3)
Stemmed	10 (0.2)	8,323 (18.4)	7,743 (28.4)	23 (0.2)	166 (5.2)	292 (16.1)	231 (16.0)	90 (8.6)	<4 (0.3)
Reverse polarity total shoulder replacement	3,011 (58.5)	20,667 (45.8)	7,346 (26.9)	10,961 (87.1)	1,978 (62.2)	723 (39.7)	452 (31.2)	474 (45.3)	531 (90.9)
Stemless	0 (0)	186 (0.4)	74 (0.3)	103 (0.8)	6 (0.2)	<4 (0.1)	4 (0.3)	0 (0)	6 (1.0)
Stemmed	3,011 (58.5)	20,481 (45.4)	7,272 (26.6)	10,858 (86.3)	1,972 (62.0)	721 (39.6)	448 (31.0)	474 (45.3)	525 (89.9)
Interpositional arthroplasty	0 (0)	5 (<0.1)	5 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unconfirmed	470 (9.1)	4,304 (9.5)	2,391 (8.8)	1,236 (9.8)	370 (11.6)	207 (11.4)	127 (8.8)	217 (20.7)	42 (7.2)
Unconfirmed HHA	54 (1.0)	292 (0.6)	174 (0.6)	49 (0.4)	26 (0.8)	16 (0.9)	24 (1.7)	27 (2.6)	0 (0)
Unconfirmed TSR	39 (0.8)	1,814 (4.0)	1,459 (5.3)	127 (1.0)	77 (2.4)	79 (4.3)	48 (3.3)	92 (8.8)	<4 (0.2)
Unconfirmed RTSR	375 (7.3)	2,195 (4.9)	755 (2.8)	1,060 (8.4)	267 (8.4)	112 (6.2)	55 (3.8)	98 (9.4)	41 (7.0)
Unconfirmed IPA	<4 (<0.1)	<4 (<0.1)	<4 (<0.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

*Percentages are based on the total number of elective cases; please 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 =16,280.
***Includes 80 metastatic cancer/malignancies documented since MDSv6 (N=40,241), together with 182 dislocations documented since MDSv7 (N=16,280).
Note: HHA=Proximal humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity total shoulder replacement, IPA=Interpositional arthroplasty.

Table 3.S4 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 registry 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 registry are not mutually exclusive; 84.7% of procedures list a single indication for the cause of surgery, with the remainder recording more than one indication.

Table 3.S5 (a) Number of resurfacing proximal humeral hemiarthroplasty replacements between 2012 and 2020 and within the last year by brand construct.

			Primary operations all years			Primary operations in 2020		
	Manufacturer(s)	Shoulder construct	All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing HHA	Wright	Aequalis Resurfacing[HH.Resurf]	251	0	251	0	0	0
	FH	Arrow[HH.Resurf]	35	0	35	0	0	0
	Zimmer Biomet	Copeland[HH.Resurf]	1,620	<4	1,617	30	0	30
	DePuy	Epoca[HH.Resurf]	112	<4	111	0	0	0
	Exactech	Equinoxe[HH.Resurf:H.RPeg]	42	0	42	6	0	6
	DePuy	Global CAP[HH.Resurf]	609	<4	607	14	0	14
	Lima	SMR[HH.Resurf:H.RPeg]	110	0	110	0	0	0
	Lima	SMR[HH.Resurf]	23	0	23	0	0	0
	JRI	Vaios[HH.Resurf]	100	0	100	10	0	10

Table 3.S5 (b) Number of stemless proximal humeral hemiarthroplasty replacements between 2012 and 2020 and within the last year by brand construct.

			Primary operations all years			Primary operations in 2020		
	Manufacturer(s)	Shoulder construct	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]	56	<4	55	<4	0	<4
	Mathys	Affinis[HH.Stand:H.Stemless]	586	5	581	26	<4	25
	Arthrex	Eclipse[HH.Stand:H.Stemless]	129	<4	128	<4	0	<4
	DePuy	Global ICON[HH.Stand:H. Stemless]	19	0	19	<4	0	<4
	Lima	SMR[HH.Stand:H.Stemless]	30	0	30	4	0	4
	Zimmer Biomet	Sidus[HH.Stand:H.Stemless]	170	<4	169	6	0	6
	Wright	Simpliciti[HH.Stand:H.Stemless]	159	0	159	<4	0	<4
	Zimmer Biomet	TESS[HH.Stand:H.Stemless]	75	<4	73	0	0	0

Table 3.S5 (c) Number of stemmed proximal humeral hemiarthroplasty replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			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]	217	184	33	14	11	<4
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	22	<4	19	0	0	0
	Wright	Aequalis[HH.Stand]: Ascend Flex[H.Standard]	251	6	245	27	0	27
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	143	8	135	6	0	6
	Zimmer Biomet	Bio-Modular[HH.Stand]: Comprehensive Fracture[H.Standard]	19	15	4	0	0	0
	Zimmer Biomet	Versa-Dial[HH.Stand]: Comprehensive Fracture[H.Standard]	184	146	38	19	16	<4
	DePuy	Global Unite[HH.Stand]: Global AP[H.Mod]	10	0	10	<4	0	<4
	DePuy	Global Advantage[HH.Stand]: Global FX[H.Standard]	210	169	41	<4	<4	0
	Zimmer Biomet	Bigliani/Flatow[HH.Stand]: TM[H.Dia]	24	<4	23	0	0	0
	Wright	Aequalis[HH.Stand:H.Standard]	196	4	192	0	0	0
	Mathys	Affinis[HH.Stand:H.NeckBody:H.Dia]	208	175	33	13	12	<4
	Mathys	Affinis[HH.Stand:H.Standard]	66	<4	63	<4	<4	<4
	Zimmer Biomet	Anatomical[HH.Stand:H.Mod]	22	<4	20	<4	0	<4
	Zimmer Biomet	Anatomical Fracture[HH.Stand:H.Mod]	46	35	11	0	0	0
	FH	Arrow[HH.Stand:H.Standard]	33	5	28	<4	<4	0
	Wright	Ascend Flex[HH.Stand:H.Standard]	162	5	157	11	<4	10
	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	<4	39	0	0	0
	DePuy	Epoca[HH.Stand:H.Mod]	115	51	64	0	0	0
	Exactech	Equinoxe[HH.Stand:H.Standard]	223	191	32	25	22	<4
	Exactech	Equinoxe[HH.Stand:H.Mod]	125	<4	122	9	<4	8
	DePuy	Global AP[HH.Stand:H.Mod]	252	5	247	<4	0	<4
	DePuy	Global Advantage[HH.Stand:H.Standard]	321	66	255	<4	<4	0
	DePuy	Global Unite[HH.Stand:H.Mod]	29	17	12	0	0	0
	DePuy	Global Unite[HH.Stand:H.NeckBody:H.Mod]	319	239	80	24	22	<4
	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	<4	73	0	0	0
	Lima	SMR[HH.Stand:H.Dia]	13	8	5	0	0	0
	Lima	SMR[HH.Stand:H.NeckBody:H.Dia]	298	166	132	17	13	4
	JRI	Vaios[HH.Stand:H.NeckBody:H.Dia]	86	43	43	5	5	0

Table 3.S5 (d) Number of resurfacing total shoulder replacement replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Resurfacing TSR	Wright	Aequalis[G.Ana]: Aequalis Resurfacing[HH.Resurf]	25	0	25	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Aequalis Resurfacing[HH.Resurf]	14	0	14	4	0	4
	FH	Arrow[G.Ana:HH.Resurf]	15	0	15	0	0	0
	DePuy	Epoca[G.Ana:HH.Resurf]	126	0	126	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Resurf]	54	0	54	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Resurf]	204	0	204	0	0	0
	Exactech	Equinoxe[G.Ana:HH.Resurf:H.RPeg]	31	0	31	<4	0	<4

Table 3.S5 (e) Number of stemless conventional total shoulder replacement replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			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]	39	0	39	0	0	0
	Arthrex:DePuy	Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	16	0	16	0	0	0
	Arthrex:Wright	Aequalis[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	77	0	77	0	0	0
	Arthrex	Universal[G.BP]: Universal[G.Lin]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	63	0	63	12	0	12
	Arthrex:DePuy	Global Anchor Peg[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	11	0	11	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.BP]: Epoca[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	51	0	51	0	0	0
	Arthrex	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	416	0	416	39	0	39
	DePuy	Global[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	13	0	13	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global ICON[HH.Stand]: Global ICON[H.Stemless]	229	0	229	51	0	51
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	554	<4	553	56	0	56
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	33	0	33	0	0	0
	Zimmer Biomet	TM[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	100	<4	99	0	0	0
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	135	0	135	31	0	31
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Sidus[H.Stemless]	18	0	18	0	0	0
	Zimmer Biomet	Anatomical[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	65	0	65	7	0	7
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Sidus[HH.Stand]: Sidus[H.Stemless]	27	0	27	0	0	0
	Wright	Aequalis[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	85	0	85	<4	0	<4
	Wright	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	654	<4	653	69	0	69
	Wright	Affiniti[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	10	0	10	0	0	0
	Mathys	Affinis[G.Ana:HH.Stand:H.Stemless]	1,997	0	1,997	166	0	166
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.Stemless]	150	0	150	17	0	17
	Lima	SMR[G.Ana:HH.Stand:H.Stemless]	46	0	46	20	0	20
	Zimmer Biomet	TESS[G.Ana:HH.Stand:H.Stemless]	69	0	69	0	0	0

Table 3.S5 (f) Number of stemmed conventional total shoulder replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			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]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	116	0	116	<4	0	<4
	Zimmer Biomet	TM Reverse[G.BP]: TM[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	18	0	18	0	0	0
	Zimmer Biomet	Anatomical[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	24	0	24	0	0	0
	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: Anatomical[H.Mod]	69	0	69	0	0	0
	Zimmer Biomet	TM[G.Ana]: Anatomical[HH.Stand]: Anatomical[H.Mod]	12	<4	11	0	0	0
	Wright	Aequalis[G.Ana]: Ascend[HH.Stand]: Ascend[H.Standard]	24	0	24	0	0	0
	Wright	Aequalis[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	19	0	19	0	0	0
	Wright	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,317	0	1,317	143	0	143
	Zimmer Biomet	Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	14	0	14	<4	0	<4
	Zimmer Biomet	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	892	<4	890	73	0	73
	DePuy	Global[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	59	0	59	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global AP[H.Mod]	139	0	139	35	0	35
	DePuy	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,051	0	1,051	9	0	9
	DePuy	Global Anchor Peg[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	241	0	241	13	0	13
	DePuy	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	535	0	535	17	0	17
	Arthrex:DePuy	Univers II[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	19	0	19	<4	0	<4
	DePuy	Global[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	37	0	37	0	0	0
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.Mod]	26	0	26	<4	0	<4
	DePuy	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	497	<4	496	21	0	21
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Lin]: SMR[HH.Stand]: SMR[H.NeckBody]: SMR[H.Dia]	32	0	32	0	0	0
	Zimmer Biomet	TM[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	47	0	47	0	0	0

Table 3.S5 (f) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed TSR	Zimmer Biomet	Bigliani/Flatow[G.Ana]: Bigliani/Flatow[HH.Stand]: TM[H.Dia]	30	0	30	0	0	0
	Wright	Aequalis[G.Ana:HH.Stand:H.Standard]	193	0	193	0	0	0
	Mathys	Affinis[G.Ana:HH.Stand:H.Standard]	102	<4	101	<4	0	<4
	Zimmer Biomet	Anatomical[G.Ana:HH.Stand:H.Mod]	85	0	85	0	0	0
	FH	Arrow[G.Ana:HH.Stand:H.Standard]	165	0	165	<4	0	<4
	FH	Arrow[G.BP:G.Lin:HH.Stand:H.Standard]	14	0	14	<4	0	<4
	Zimmer Biomet	Bigliani/Flatow[G.Ana:HH.Stand:H.Dia]	58	0	58	0	0	0
	DePuy	Epoca[G.BP:G.Ana:HH.Stand:H.Mod]	62	<4	60	0	0	0
	DePuy	Epoca[G.Ana:HH.Stand:H.Mod]	315	0	315	0	0	0
	DePuy	Epoca[G.Peg:G.Ana:HH.Stand:H.Mod]	156	0	156	0	0	0
	Exactech	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,158	<4	1,156	89	0	89
	Medacta	Medacta[G.Ana:HH.Stand:H.NeckBody:H.Standard]	18	0	18	<4	0	<4
	Lima	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	407	0	407	6	0	6
	Lima	SMR[G.Ana:HH.Stand:H.NeckBody:H.Dia]	50	0	50	5	0	5
	JRI	Vaios[G.BP:G.Ana:HH.Stand:H.NeckBody:H.Dia]	125	0	125	<4	0	<4

Table 3.S5 (g) Number of stemless reverse polarity total shoulder replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			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]	37	0	37	0	0	0
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.Stemless]	137	0	137	20	0	20
	Zimmer Biomet	TESS[G.BP:G.Sph:H.RevBear:H.Stemless]	11	0	11	0	0	0

Table 3.S5 (h) Number of stemmed reverse polarity total shoulder replacement replacements between 2012 and 2020 and within the last year by brand construct.

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	37	25	12	15	9	6
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis Reversed Fracture[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	57	39	18	7	5	<4
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	372	285	87	44	39	5
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Standard]	85	67	18	38	36	<4
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Aequalis-Reversed II[H.RevBear]: Aequalis Reversed Fracture[H.Spacer]: Aequalis Reversed Fracture[H.Standard]	10	8	<4	<4	<4	0
	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]	122	8	114	28	<4	24
	Zimmer Biomet	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	1,082	37	1,045	63	<4	61
	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 Fracture[H.Mod]	131	107	24	17	17	0
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.Standard]	12	<4	11	0	0	0
	Wright	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,441	17	1,424	157	4	153
	Wright	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,051	35	1,016	273	16	257
	Wright	Aequalis Perform Reversed[G.BP]: Unbranded[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	21	0	21	8	0	8
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial Glenosphere[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	12	<4	11	<4	0	<4
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	2,408	90	2,318	213	12	201
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive Fracture[H.Standard]	475	378	97	66	53	13
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive Segmental Revision[H.NeckBody]: Comprehensive Segmental Revision[H.Dia]	19	5	14	<4	<4	0

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.S5 (h) (continued)

	Manufacturer(s)	Shoulder construct	Primary operations all years			Primary operations in 2020		
			All cases N	Acute trauma N	Elective N	All cases N	Acute trauma N	Elective N
Stemmed RTSR	DePuy	Delta Xtend[G.BP]: Delta Xtend[G.Sph]: Delta Xtend[H.RevBear]: Delta Xtend[H.RevCup]: Global Unite[H.Mod]	94	59	35	18	11	7
	Lima	Axioma[G.Peg]: Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	101	<4	99	10	0	10
	Lima	Axioma[G.BP]: SMR[G.Sph]: SMR[H.RevBear]: SMR[H.RevCup]: SMR[H.Dia]	94	<4	91	0	0	0
	Zimmer Biomet	Comprehensive[G.BP]: Versa-Dial[G.Sph]: TM Reverse[H.RevBear]: TM Reverse[H.Mod]	39	0	39	<4	0	<4
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.RevCup]: Univers Reverse[H.Standard]	47	7	40	7	<4	5
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Spacer]: Univers Reverse[H.Standard]	11	<4	10	0	0	0
	Arthrex	Universal[G.BP]: Univers Reverse[G.Sph]: Univers Reverse[H.RevBear]: Univers Reverse[H.Standard]	184	18	166	14	<4	12
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	16	0	16	<4	0	<4
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.Dia]	19	0	19	<4	0	<4
	Wright	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,173	25	1,148	46	<4	43
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	817	31	786	57	<4	56
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Dia]	173	134	39	20	17	<4
	Mathys	Affinis[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	15	<4	13	0	0	0
	FH	Arrow[G.BP:G.Sph:H.RevBear:H.Standard]	169	24	145	9	<4	8
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Mod]	22	<4	19	0	0	0
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,620	64	2,556	189	14	175
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	2,972	538	2,434	180	54	126
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	84	32	52	<4	0	<4
	DePuy	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Mod]	43	4	39	<4	<4	<4
	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Standard]	415	329	86	65	52	13
	Exactech	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	2,772	50	2,722	287	11	276
	Stanmore	METS[G.Sph:H.RevBear:H.Mod]	11	0	11	0	0	0
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Mod]	28	<4	25	0	0	0
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	451	38	413	79	6	73
	DJO	RSP[G.BP:G.Sph:H.RevBear:H.Spacer:H.Standard]	9	<4	8	5	<4	4
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,806	332	1,474	198	57	141
	Lima	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Spacer:H.Dia]	154	35	119	9	<4	6
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Spacer:H.Mod]	10	<4	7	0	0	0
	Zimmer Biomet	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	656	65	591	48	7	41
	JRI	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	357	28	329	11	<4	9
	Innovative	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	615	39	576	69	<4	68

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 (h) on the previous pages 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 occasions overall or five occasions within the last year respectively. Results illustrate the frequency of all implanted constructs across all years of data collection within the registry i.e. between 2012 and 2020. 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. While 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

We present results in this section 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 are presented up to eight years which is the last full year of data collection within the registry. Figures also include an 'at-risk table' which presents the number of individuals at risk of revision at the time indicated.

Figure 3.S5 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.*

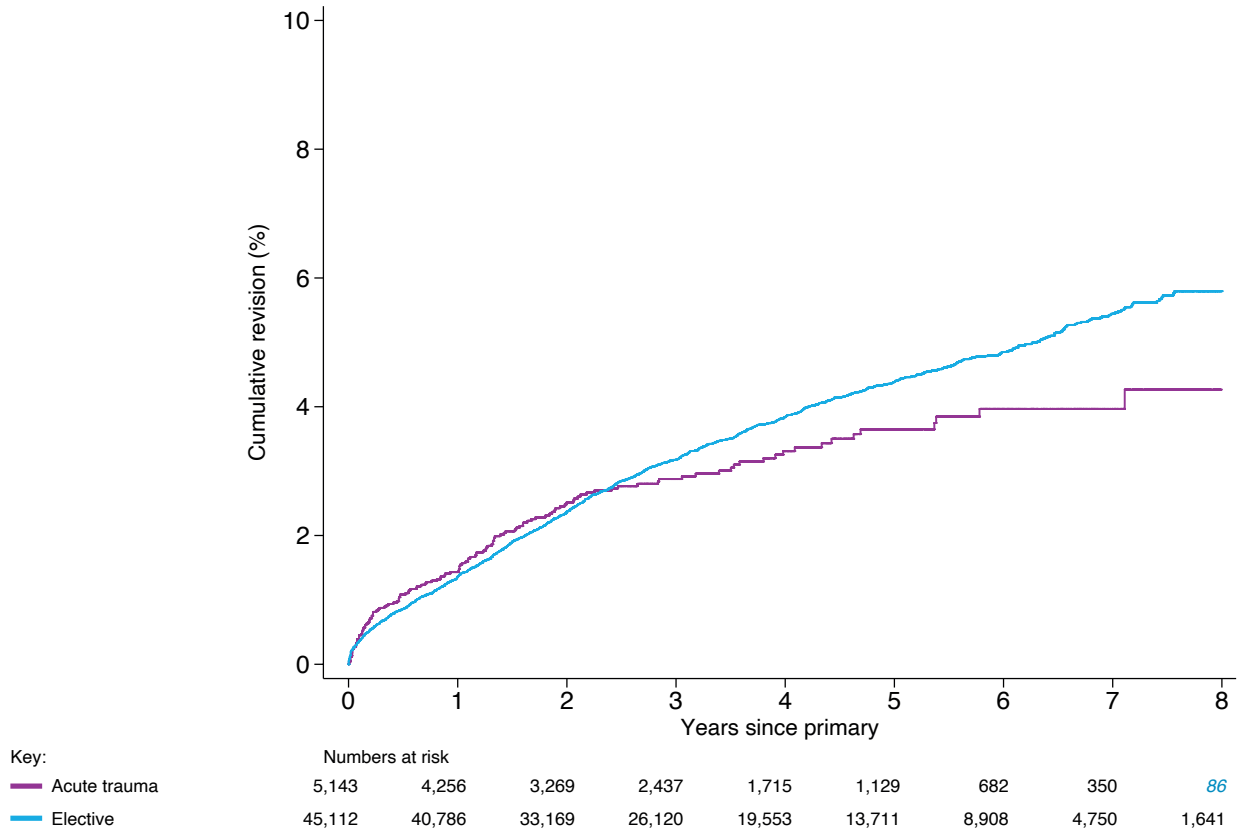


Table 3.S6 KM estimates of cumulative **revision** (95% CI) for primary shoulder replacement for **all cases**, **acute trauma** and **elective** cases. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

		Age at primary Median (IQR)	Percentage male (%)	Time since primary							
				1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
All cases	50,255	73 (67 to 79)	30	1.37 (1.27-1.48)	2.39 (2.25-2.53)	3.15 (2.99-3.33)	3.80 (3.61-4.00)	4.32 (4.11-4.55)	4.78 (4.54-5.03)	5.33 (5.04-5.64)	5.68 (5.35-6.04)
Acute trauma	5,143	74 (67 to 80)	23	1.43 (1.14-1.81)	2.51 (2.09-3.02)	2.88 (2.41-3.43)	3.31 (2.78-3.95)	3.65 (3.05-4.36)	3.97 (3.29-4.78)	3.97 (3.29-4.78)	*4.27 (3.42-5.32)*
Elective	45,112	73 (67 to 79)	31	1.36 (1.26-1.48)	2.37 (2.23-2.53)	3.18 (3.00-3.36)	3.84 (3.64-4.05)	4.38 (4.16-4.62)	4.85 (4.60-5.12)	5.44 (5.14-5.77)	5.80 (5.44-6.17)

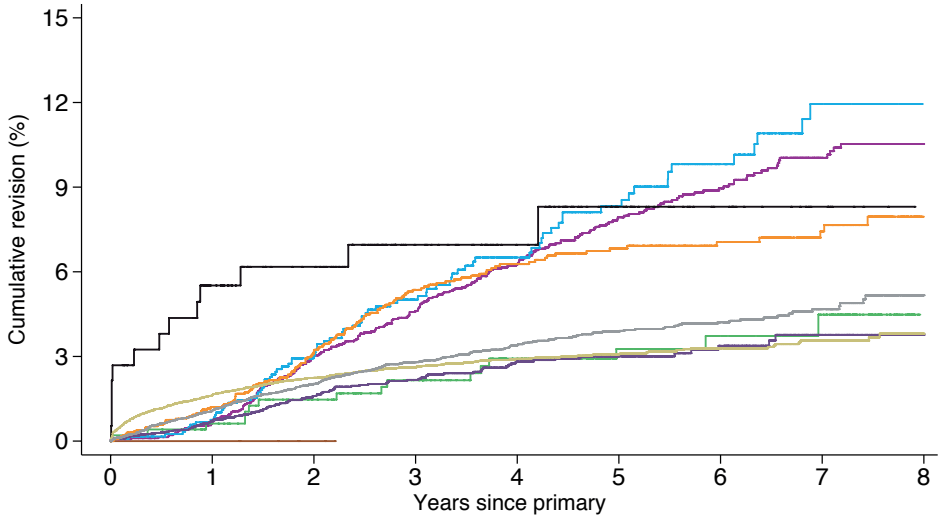
Figure 3.S5 and Table 3.S6 illustrate the cumulative revision of primary shoulder procedures performed overall (shown in Table 3.S6 only) and by acute trauma and elective procedures. Our results indicate that the risk of revision is comparable for the first two years following surgery, at which point 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 eight 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	8 years
Female	All	31,351	0.98 (0.87-1.10)	1.88 (1.73-2.05)	2.60 (2.42-2.80)	3.15 (2.93-3.38)	3.65 (3.40-3.91)	4.08 (3.80-4.38)	4.57 (4.23-4.93)	5.00 (4.59-5.45)
	<55	1,146	2.42 (1.67-3.51)	4.82 (3.68-6.29)	7.50 (6.00-9.35)	8.78 (7.11-10.80)	10.07 (8.21-12.32)	10.40 (8.46-12.76)	*11.91 (9.47-14.92)*	*13.27 (10.35-16.93)*
	55 to 64	3,263	1.37 (1.02-1.84)	2.80 (2.26-3.47)	4.04 (3.36-4.86)	5.10 (4.29-6.05)	6.40 (5.42-7.54)	7.63 (6.47-8.98)	8.72 (7.38-10.29)	*9.20 (7.74-10.93)*
	65 to 74	11,559	1.01 (0.84-1.21)	2.02 (1.77-2.31)	2.84 (2.53-3.19)	3.41 (3.05-3.81)	3.89 (3.49-4.34)	4.38 (3.93-4.90)	4.96 (4.41-5.58)	5.54 (4.84-6.34)
	≥75	15,383	0.76 (0.64-0.92)	1.35 (1.18-1.56)	1.72 (1.51-1.96)	2.05 (1.81-2.33)	2.30 (2.03-2.61)	2.47 (2.17-2.81)	2.59 (2.27-2.97)	2.77 (2.37-3.22)
Male	All	13,761	2.24 (2.00-2.50)	3.50 (3.19-3.84)	4.50 (4.13-4.89)	5.46 (5.03-5.91)	6.09 (5.62-6.59)	6.65 (6.13-7.22)	7.49 (6.85-8.20)	7.64 (6.97-8.37)
	<55	1,479	2.63 (1.92-3.60)	5.39 (4.31-6.74)	7.36 (6.04-8.95)	9.73 (8.12-11.63)	11.25 (9.45-13.38)	12.60 (10.56-15.00)	*14.83 (12.27-17.87)*	*15.31 (12.63-18.51)*
	55 to 64	2,614	2.03 (1.55-2.66)	3.49 (2.82-4.32)	4.84 (4.01-5.84)	5.84 (4.88-6.97)	6.39 (5.36-7.62)	7.47 (6.24-8.93)	8.19 (6.76-9.90)	*8.19 (6.76-9.90)*
	65 to 74	5,241	2.09 (1.73-2.52)	3.09 (2.64-3.62)	3.78 (3.27-4.38)	4.68 (4.07-5.38)	5.48 (4.77-6.28)	5.81 (5.06-6.68)	6.50 (5.59-7.55)	*6.50 (5.59-7.55)*
	≥75	4,427	2.41 (1.99-2.91)	3.33 (2.82-3.93)	4.12 (3.53-4.82)	4.56 (3.91-5.32)	4.63 (3.97-5.40)	4.75 (4.06-5.55)	5.13 (4.29-6.13)	*5.46 (4.45-6.68)*

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.S6 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	2,900	2,802	2,571	2,321	2,019	1,599	1,229	773	322
Stemless HHA	1,217	1,155	955	753	575	408	282	*149*	*46*
Stemmed HHA	2,299	2,155	1,852	1,572	1,296	1,004	694	417	*162*
Resurfacing TSR	486	474	449	412	358	280	*200*	*124*	*37*
Stemless TSR	4,911	4,378	3,391	2,521	1,767	1,156	680	328	*110*
Stemmed TSR	8,323	7,745	6,635	5,507	4,246	3,076	1,989	1,027	346
Stemless RTSR	*186*	*154*	*130*	*91*	*71*	*47*	*25*	*11*	*<4*
Stemmed RTSR	20,481	18,004	13,810	10,196	7,037	4,527	2,709	1,279	386
IPA	*5*	*5*	*<4*						

Note: HHA=Humeral hemiarthroplasty, TSR=Total shoulder replacement, RTSR=Reverse polarity 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	8 years
Proximal humeral hemiarthroplasty	**6,416**	**70 (61 to 77)**	**33**	**0.87 (0.67-1.14)**	**3.10 (2.69-3.57)**	**4.95 (4.41-5.55)**	**6.32 (5.70-7.00)**	**7.65 (6.94-8.42)**	**8.48 (7.71-9.32)**	**9.47 (8.60-10.42)**	**9.91 (8.99-10.93)**
Resurfacing	2,900	71 (64 to 78)	31	0.66 (0.42-1.04)	3.04 (2.46-3.75)	4.61 (3.88-5.48)	6.25 (5.38-7.26)	7.93 (6.92-9.09)	8.96 (7.85-10.21)	10.04 (8.81-11.43)	10.53 (9.23-12.00)
Stemless	1,217	67 (56 to 75)	42	0.76 (0.39-1.45)	3.04 (2.18-4.23)	5.01 (3.84-6.54)	6.51 (5.10-8.29)	8.32 (6.61-10.46)	9.81 (7.81-12.29)	*11.95 (9.38-15.16)*	*11.95 (9.38-15.16)*
Stemmed	2,299	70 (60 to 78)	32	1.21 (0.83-1.75)	3.18 (2.51-4.03)	5.36 (4.45-6.45)	6.27 (5.26-7.47)	6.83 (5.75-8.09)	7.05 (5.94-8.36)	7.43 (6.23-8.86)	*7.95 (6.59-9.59)*
Total shoulder replacement	**13,720**	**70 (64 to 76)**	**31**	**0.94 (0.79-1.12)**	**1.86 (1.64-2.11)**	**2.56 (2.29-2.86)**	**3.19 (2.87-3.55)**	**3.58 (3.22-3.97)**	**3.93 (3.53-4.37)**	**4.40 (3.92-4.94)**	**4.74 (4.17-5.39)**
Resurfacing	486	71 (63 to 76)	29	0.62 (0.20-1.91)	1.47 (0.70-3.06)	2.16 (1.17-3.97)	2.92 (1.70-5.00)	3.27 (1.93-5.49)	*3.73 (2.22-6.22)*	*4.48 (2.61-7.64)*	*4.48 (2.61-7.64)*
Stemless	4,911	69 (62 to 75)	36	0.73 (0.52-1.02)	1.60 (1.26-2.02)	2.17 (1.75-2.68)	2.81 (2.30-3.44)	3.01 (2.45-3.68)	3.38 (2.71-4.20)	3.76 (2.95-4.79)	*3.76 (2.95-4.79)*
Stemmed	8,323	71 (65 to 76)	29	1.09 (0.88-1.34)	2.04 (1.74-2.38)	2.80 (2.44-3.20)	3.41 (3.00-3.88)	3.88 (3.42-4.39)	4.21 (3.71-4.77)	4.68 (4.08-5.35)	5.17 (4.43-6.02)
Reverse polarity total shoulder replacement	**20,667**	**76 (71 to 80)**	**29**	**1.67 (1.50-1.86)**	**2.28 (2.07-2.50)**	**2.66 (2.43-2.90)**	**2.95 (2.70-3.23)**	**3.13 (2.86-3.42)**	**3.34 (3.04-3.67)**	**3.61 (3.23-4.02)**	**3.85 (3.36-4.41)**
Stemless	186	73 (69 to 78)	38	*5.52 (3.00-10.01)*	*6.18 (3.46-10.89)*	*6.96 (3.99-11.99)*	*6.96 (3.99-11.99)*	*8.31 (4.75-14.33)*	*8.31 (4.75-14.33)*	*8.31 (4.75-14.33)*	
Stemmed	20,481	76 (71 to 80)	28	1.64 (1.47-1.82)	2.24 (2.04-2.46)	2.62 (2.39-2.86)	2.92 (2.66-3.19)	3.08 (2.81-3.37)	3.29 (2.99-3.62)	3.56 (3.19-3.98)	3.81 (3.32-4.37)
Interpositional arthroplasty	**5**	**58 (55 to 68)**	**60**								
Unconfirmed	**4,304**	**73 (66 to 78)**	**33**	**1.96 (1.58-2.42)**	**3.12 (2.62-3.71)**	**4.16 (3.56-4.85)**	**4.97 (4.29-5.74)**	**5.57 (4.82-6.42)**	**6.30 (5.46-7.27)**	**7.07 (6.10-8.19)**	*7.45 (6.37-8.71)*
Unconfirmed HHA	292	69 (58.5 to 75.5)	37	1.03 (0.33-3.17)	*3.86 (2.09-7.07)*	*5.29 (3.09-8.97)*	*5.84 (3.48-9.73)*	*5.84 (3.48-9.73)*	*6.65 (3.99-10.97)*	*8.06 (4.70-13.65)*	*8.06 (4.70-13.65)*
Unconfirmed TSR	1,814	69 (61 to 76)	36	1.12 (0.73-1.74)	2.72 (2.05-3.61)	4.19 (3.33-5.27)	5.29 (4.29-6.51)	6.30 (5.17-7.67)	7.19 (5.92-8.72)	8.01 (6.59-9.73)	*8.40 (6.83-10.30)*
Unconfirmed RTSR	2,195	75 (69 to 80)	29	2.78 (2.16-3.58)	3.27 (2.59-4.14)	3.80 (3.03-4.76)	4.29 (3.43-5.36)	4.43 (3.54-5.54)	4.92 (3.91-6.18)	*5.44 (4.25-6.95)*	*5.91 (4.49-7.76)*
Unconfirmed IPA	<4	60 (58 to 65)	100								

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

Table 3.S8 and Figure 3.S6 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.S6 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 eight 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	8 years
Resurfacing HHA	Aequalis Resurfacing[HH.Resurf]	251	*0.40 (0.06-2.81)*	*2.43 (1.10-5.33)*	*3.69 (1.94-6.97)*	*4.59 (2.57-8.14)*	*6.17 (3.68-10.24)*	*6.82 (4.14-11.14)*	*8.60 (5.30-13.79)*	*8.60 (5.30-13.79)*
	Copeland[HH.Resurf]	1,617	0.44 (0.21-0.92)	2.26 (1.63-3.13)	3.66 (2.82-4.74)	5.10 (4.08-6.37)	6.89 (5.65-8.39)	7.76 (6.41-9.37)	9.12 (7.58-10.95)	*9.89 (8.22-11.89)*
	Global CAP[HH.Resurf]	607	1.00 (0.45-2.21)	3.67 (2.41-5.57)	5.21 (3.65-7.41)	7.30 (5.38-9.87)	8.74 (6.58-11.57)	*10.34 (7.88-13.52)*	*10.73 (8.18-14.01)*	*10.73 (8.18-14.01)*
Stemless HHA	Affinis[HH.Stand:H.Stemless]	581	0.35 (0.09-1.41)	2.84 (1.72-4.66)	3.07 (1.89-4.96)	*4.66 (3.02-7.17)*	*6.55 (4.33-9.85)*	*8.04 (5.28-12.15)*	*9.32 (5.95-14.44)*	*9.32 (5.95-14.44)*
Stemmed HHA	Global Advantage[HH.Stand:H.Standard]	255	1.18 (0.38-3.62)	*1.60 (0.60-4.20)*	*4.21 (2.28-7.68)*	*4.69 (2.62-8.31)*	*5.20 (2.98-8.99)*	*5.76 (3.37-9.75)*	*5.76 (3.37-9.75)*	*5.76 (3.37-9.75)*
Stemless TSR	Univers II[G.Ana]: Eclipse[HH.Stand]: Eclipse[H.Stemless]	416	0.24 (0.03-1.69)	1.40 (0.58-3.34)	*2.49 (1.24-4.95)*	*3.00 (1.54-5.79)*	*3.00 (1.54-5.79)*	*3.00 (1.54-5.79)*	*3.00 (1.54-5.79)*	*3.00 (1.54-5.79)*
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Nano[H.Stemless]	553	1.13 (0.51-2.49)	2.05 (1.11-3.80)	2.92 (1.69-5.02)	*3.74 (2.22-6.27)*	*4.99 (2.96-8.36)*	*4.99 (2.96-8.36)*	*4.99 (2.96-8.36)*	
	Aequalis Perform+[G.Ana]: Simpliciti[HH.Stand]: Simpliciti[H.Stemless]	653	0.50 (0.16-1.54)	1.69 (0.88-3.23)	1.95 (1.04-3.61)	*1.95 (1.04-3.61)*	*1.95 (1.04-3.61)*	*1.95 (1.04-3.61)*		
	Affinis[G.Ana:HH.Stand:H.Stemless]	1,997	0.37 (0.17-0.77)	0.79 (0.47-1.34)	1.17 (0.74-1.84)	1.39 (0.89-2.16)	1.54 (0.99-2.38)	1.82 (1.13-2.94)	*2.28 (1.32-3.93)*	*2.28 (1.32-3.93)*
Stemmed TSR	Aequalis Perform+[G.Ana]: Ascend Flex[HH.Stand]: Ascend Flex[H.Standard]	1,317	0.24 (0.08-0.76)	0.72 (0.36-1.44)	1.39 (0.80-2.41)	2.27 (1.36-3.78)	*2.27 (1.36-3.78)*	*2.27 (1.36-3.78)*		
	Comprehensive[G.Peg]: Comprehensive[G.Ana]: Versa-Dial[HH.Stand]: Comprehensive[H.Standard]	890	1.52 (0.89-2.61)	2.85 (1.90-4.27)	4.42 (3.13-6.23)	4.88 (3.48-6.83)	*4.88 (3.48-6.83)*	*5.32 (3.75-7.52)*	*5.32 (3.75-7.52)*	*5.32 (3.75-7.52)*
	Global Anchor Peg[G.Ana]: Global AP[HH.Stand]: Global AP[H.Mod]	1,051	0.29 (0.09-0.89)	0.78 (0.39-1.55)	1.08 (0.60-1.95)	1.43 (0.85-2.41)	1.59 (0.95-2.63)	2.12 (1.32-3.39)	2.12 (1.32-3.39)	*2.12 (1.32-3.39)*
	Global[G.Ana]: Global Advantage[HH.Stand]: Global Advantage[H.Standard]	535	0.57 (0.18-1.76)	0.98 (0.41-2.34)	1.43 (0.68-2.99)	1.97 (1.02-3.77)	2.60 (1.43-4.71)	*2.60 (1.43-4.71)*	*2.60 (1.43-4.71)*	*2.60 (1.43-4.71)*
	Global Anchor Peg[G.Ana]: Global Unite[HH.Stand]: Global Unite[H.NeckBody]: Global Unite[H.Mod]	496	0.82 (0.31-2.17)	1.73 (0.87-3.43)	1.73 (0.87-3.43)	*1.73 (0.87-3.43)*	*2.30 (1.13-4.66)*	*2.30 (1.13-4.66)*		
	Epoca[G.Ana:HH.Stand:H.Mod]	315	0.32 (0.04-2.23)	0.65 (0.16-2.56)	1.30 (0.49-3.44)	*2.03 (0.92-4.47)*	*2.03 (0.92-4.47)*	*2.03 (0.92-4.47)*	*2.84 (1.28-6.23)*	*2.84 (1.28-6.23)*
	Equinoxe[G.Ana:HH.Stand:H.Mod]	1,156	1.18 (0.68-2.02)	2.22 (1.48-3.33)	3.10 (2.17-4.42)	3.99 (2.85-5.58)	4.42 (3.17-6.15)	*4.42 (3.17-6.15)*	*5.62 (3.78-8.31)*	*5.62 (3.78-8.31)*
	SMR[G.BP:G.Lin:HH.Stand:H.NeckBody:H.Dia]	407	2.98 (1.70-5.19)	5.60 (3.72-8.38)	7.94 (5.61-11.18)	*9.01 (6.47-12.48)*	*9.95 (7.19-13.68)*	*9.95 (7.19-13.68)*	*9.95 (7.19-13.68)*	*14.56 (8.97-23.17)*

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 (continued)

	Shoulder construct	N	Time since primary							
			1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
Stemmed RTSR	TM Reverse[G.BP]: TM Reverse[G.Sph]: Anatomical I/R[H.RevBear]: Anatomical[H.Mod]	1,045	1.85 (1.19-2.89)	2.41 (1.62-3.58)	3.26 (2.28-4.65)	3.61 (2.54-5.10)	4.17 (2.92-5.92)	*4.17 (2.92-5.92)*	*4.17 (2.92-5.92)*	*4.17 (2.92-5.92)*
	Aequalis Perform Reversed[G.BP]: Aequalis Perform Reversed[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,016	1.58 (0.95-2.61)	2.00 (1.21-3.29)	*2.47 (1.43-4.25)*					
	Aequalis-Reversed II[G.BP]: Aequalis-Reversed II[G.Sph]: Ascend Flex[H.RevBear]: Ascend Flex[H.RevCup]: Ascend Flex[H.Standard]	1,424	1.31 (0.83-2.08)	1.91 (1.29-2.82)	2.02 (1.38-2.96)	2.02 (1.38-2.96)	*2.02 (1.38-2.96)*	*3.44 (1.84-6.39)*	*5.41 (2.40-11.97)*	
	Comprehensive[G.BP]: Versa-Dial[G.Sph]: Comprehensive[H.RevBear]: Comprehensive[H.Standard]	2,318	1.20 (0.82-1.74)	1.46 (1.04-2.06)	1.68 (1.20-2.34)	1.77 (1.27-2.46)	1.89 (1.35-2.65)	*1.89 (1.35-2.65)*	*1.89 (1.35-2.65)*	*1.89 (1.35-2.65)*
	Aequalis-Reversed II[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,148	1.25 (0.74-2.10)	1.72 (1.10-2.68)	1.94 (1.27-2.97)	2.09 (1.37-3.16)	2.09 (1.37-3.16)	2.09 (1.37-3.16)	*2.69 (1.56-4.62)*	*3.97 (1.91-8.15)*
	Affinis[G.BP:G.Sph:H.RevBear:H.Standard]	786	3.14 (2.11-4.64)	4.24 (3.00-5.99)	4.86 (3.48-6.76)	5.48 (3.93-7.63)	*6.26 (4.47-8.75)*	*6.26 (4.47-8.75)*	*7.64 (4.89-11.85)*	*7.64 (4.89-11.85)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.RevCup:H.Mod]	2,556	1.13 (0.78-1.63)	1.62 (1.19-2.21)	1.73 (1.28-2.35)	1.73 (1.28-2.35)	1.73 (1.28-2.35)	1.87 (1.36-2.57)	2.18 (1.48-3.21)	*2.18 (1.48-3.21)*
	Delta Xtend[G.BP:G.Sph:H.RevBear:H.Standard]	2,434	1.21 (0.84-1.74)	1.51 (1.08-2.10)	1.51 (1.08-2.10)	1.58 (1.14-2.19)	1.79 (1.28-2.49)	2.30 (1.60-3.28)	*2.30 (1.60-3.28)*	*2.30 (1.60-3.28)*
	Equinoxe[G.BP:G.Sph:H.RevBear:H.Mod]	2,722	1.39 (1.00-1.92)	2.10 (1.59-2.77)	2.69 (2.08-3.49)	3.74 (2.92-4.79)	4.22 (3.27-5.44)	4.47 (3.44-5.82)	*4.95 (3.65-6.68)*	*4.95 (3.65-6.68)*
	RSP[G.BP:G.Sph:H.RevBear:H.Standard]	413	1.58 (0.71-3.49)	*2.25 (1.13-4.47)*	*2.25 (1.13-4.47)*	*2.25 (1.13-4.47)*	*2.25 (1.13-4.47)*	*2.25 (1.13-4.47)*		
	SMR[G.BP:G.Sph:H.RevBear:H.RevCup:H.Dia]	1,474	1.73 (1.18-2.56)	2.74 (1.99-3.77)	3.19 (2.35-4.33)	3.32 (2.45-4.50)	3.32 (2.45-4.50)	*3.32 (2.45-4.50)*	*3.32 (2.45-4.50)*	*3.32 (2.45-4.50)*
	TM Reverse[G.BP:G.Sph:H.RevBear:H.Mod]	591	1.06 (0.48-2.34)	1.46 (0.73-2.90)	1.97 (1.06-3.67)	*2.68 (1.49-4.78)*	*2.68 (1.49-4.78)*	*2.68 (1.49-4.78)*	*2.68 (1.49-4.78)*	
	Vaios[G.BP:G.Sph:H.RevBear:H.NeckBody:H.Dia]	329	2.77 (1.45-5.26)	4.12 (2.41-6.99)	*4.87 (2.96-7.97)*	*4.87 (2.96-7.97)*	*4.87 (2.96-7.97)*	*4.87 (2.96-7.97)*	*4.87 (2.96-7.97)*	*4.87 (2.96-7.97)*
	Verso[G.BP:G.Sph:H.RevBear:H.Standard]	576	2.34 (1.36-3.99)	3.23 (2.01-5.16)	3.50 (2.21-5.53)	*3.97 (2.49-6.30)*	*3.97 (2.49-6.30)*	*3.97 (2.49-6.30)*	*3.97 (2.49-6.30)*	*3.97 (2.49-6.30)*

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 after. 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 2020.

Acute trauma	Events 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	**141**	**164.3**	**0.86 (0.73-1.01)**	**0.11 (0.07-0.17)**	**0.27 (0.20-0.36)**	**0.24 (0.17-0.32)**	**0.07 (0.04-0.12)**	**0.05 (0.02-0.10)**	**0.09 (0.06-0.15)**
Proximal humeral hemiarthroplasty	83	64.6	1.28 (1.04-1.59)	0.15 (0.08-0.29)	0.23 (0.14-0.38)	0.56 (0.40-0.77)	0.05 (0.01-0.14)	0.02 (0.00-0.11)	0.19 (0.11-0.33)
Total shoulder replacement	0	0.6	0	0	0	0	0	0	0
Reverse polarity total shoulder replacement	45	85.0	0.53 (0.40-0.71)	0.08 (0.04-0.17)	0.27 (0.18-0.41)	0	0.07 (0.03-0.16)	0.05 (0.02-0.13)	0.02 (0.01-0.09)
Unconfirmed	13	14.0	0.93 (0.54-1.60)	0.07 (0.01-0.51)	0.43 (0.19-0.96)	0.21 (0.07-0.67)	0.14 (0.04-0.57)	0.21 (0.07-0.67)	0.07 (0.01-0.51)

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 2020, 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, dislocation, or infection are the leading causes 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 18.4%, 69.5%, and 9.9% recorded none, one and two indications for revision respectively.

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	Events 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	Component dissociation	Native glenoid surface erosion	Implant fracture	Dislocation	Unexplained pain
All cases	35	26.7	1.31 (0.94-1.83)	0.11 (0.04-0.35)	0.04 (0.01-0.27)	0.07 (0.02-0.30)	0.04 (0.01-0.27)	0.04 (0.01-0.27)	0.04 (0.01-0.27)	0.34 (0.18-0.65)	0.04 (0.01-0.27)
Proximal humeral hemiarthroplasty	12	5.6	2.15 (1.22-3.79)	0.36 (0.09-1.43)	0	0.36 (0.09-1.43)	0.18 (0.03-1.27)	0.18 (0.03-1.27)	0	0.36 (0.09-1.43)	0.18 (0.03-1.27)
Total shoulder replacement	0	0.0	0	0	0	0	0	0	0	0	0
Reverse polarity total shoulder replacement	18	18.4	0.98 (0.62-1.56)	0.05 (0.01-0.39)	0.05 (0.01-0.39)	0	0	0	0.05 (0.01-0.39)	0.33 (0.15-0.73)	0
Unconfirmed	5	2.7	1.85 (0.77-4.45)	0	0	0	0	0	0	0.37 (0.05-2.63)	0

Note: These have been suppressed due to zero events: impingement, glenoid implant wear, lysis humerus, lysis glenoid.

Table 3.S12 PTIR estimates of indications for shoulder **revision** (95% CI) for **elective** procedures by **type** of shoulder replacement between 2012 and 2020.

Elective	Events 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	**1,597**	**1,707.30**	**0.94 (0.89-0.98)**	**0.13 (0.11-0.14)**	**0.24 (0.22-0.27)**	**0.23 (0.21-0.25)**	**0.12 (0.10-0.13)**	**0.05 (0.04-0.06)**	**0.11 (0.10-0.13)**
Proximal humeral hemiarthroplasty	**446**	**302.9**	**1.47 (1.34-1.62)**	**0.07 (0.05-0.11)**	**0.11 (0.08-0.16)**	**0.50 (0.42-0.58)**	**0.10 (0.07-0.15)**	**0.01 (0.00-0.04)**	**0.38 (0.31-0.45)**
Resurfacing	229	150.8	1.52 (1.33-1.73)	0.07 (0.04-0.12)	0.09 (0.05-0.16)	0.54 (0.44-0.68)	0.11 (0.07-0.18)	0.03 (0.01-0.07)	0.36 (0.27-0.47)
Stemless	84	49.3	1.70 (1.38-2.11)	0.04 (0.01-0.16)	0.08 (0.03-0.22)	0.53 (0.36-0.77)	0.08 (0.03-0.22)	0	0.53 (0.36-0.77)
Stemmed	133	102.9	1.29 (1.09-1.53)	0.10 (0.05-0.18)	0.16 (0.10-0.25)	0.41 (0.30-0.55)	0.10 (0.05-0.18)	0	0.33 (0.24-0.46)
Total shoulder replacement	**399**	**540.0**	**0.74 (0.67-0.81)**	**0.06 (0.04-0.08)**	**0.25 (0.21-0.30)**	**0.36 (0.31-0.41)**	**0.11 (0.09-0.15)**	**0.02 (0.01-0.04)**	**0.08 (0.06-0.11)**
Resurfacing	16	25.8	0.62 (0.38-1.01)	0.04 (0.01-0.28)	0.12 (0.04-0.36)	0.39 (0.21-0.72)	0.04 (0.01-0.28)	0.04 (0.01-0.28)	0
Stemless	108	167.7	0.64 (0.53-0.78)	0.05 (0.03-0.10)	0.24 (0.18-0.33)	0.32 (0.24-0.41)	0.07 (0.04-0.12)	0.02 (0.01-0.06)	0.09 (0.05-0.15)
Stemmed	275	346.6	0.79 (0.70-0.89)	0.06 (0.04-0.09)	0.26 (0.21-0.32)	0.38 (0.32-0.45)	0.14 (0.11-0.19)	0.02 (0.01-0.05)	0.09 (0.06-0.12)
Reverse polarity total shoulder replacement	**537**	**685.3**	**0.78 (0.72-0.85)**	**0.20 (0.17-0.24)**	**0.28 (0.24-0.32)**	**0.01 (0.01-0.03)**	**0.11 (0.08-0.13)**	**0.07 (0.05-0.09)**	**0.03 (0.02-0.05)**
Stemless	13	6.2	2.09 (1.22-3.60)	0.32 (0.08-1.29)	0.32 (0.08-1.29)	0.16 (0.02-1.14)	0.80 (0.34-1.93)	0.16 (0.02-1.14)	0
Stemmed	524	679.1	0.77 (0.71-0.84)	0.20 (0.17-0.24)	0.28 (0.24-0.32)	0.01 (0.01-0.03)	0.10 (0.08-0.13)	0.07 (0.05-0.09)	0.03 (0.02-0.05)
Interpositional arthroplasty	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Unconfirmed	**215**	**178.9**	**1.20 (1.05-1.37)**	**0.14 (0.09-0.21)**	**0.29 (0.22-0.38)**	**0.20 (0.15-0.28)**	**0.18 (0.13-0.26)**	**0.09 (0.05-0.15)**	**0.07 (0.04-0.12)**
Unconfirmed HHA	16	12.3	1.30 (0.79-2.12)	0.16 (0.04-0.65)	0.08 (0.01-0.58)	0.32 (0.12-0.86)	0.16 (0.04-0.65)	0.16 (0.04-0.65)	0.08 (0.01-0.58)
Unconfirmed TSR	111	87.8	1.26 (1.05-1.52)	0.06 (0.02-0.14)	0.23 (0.15-0.35)	0.32 (0.22-0.46)	0.20 (0.13-0.33)	0.05 (0.02-0.12)	0.10 (0.05-0.20)
Unconfirmed RTSR	88	78.6	1.12 (0.91-1.38)	0.23 (0.14-0.36)	0.39 (0.28-0.56)	0.05 (0.02-0.14)	0.17 (0.10-0.28)	0.13 (0.07-0.24)	0.03 (0.01-0.10)
Unconfirmed IPA	0	0.1	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	Events 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	Implant fracture	Dislocation	Unexplained pain
All cases	217	21.5	10.09 (8.83-11.52)	0.23 (0.10-0.56)	0.79 (0.49-1.27)	0.23 (0.10-0.56)	0.19 (0.07-0.50)	0.98 (0.64-1.50)	0.23 (0.10-0.56)	0.33 (0.16-0.68)	0.05 (0.01-0.33)	1.72 (1.25-2.37)	0.51 (0.28-0.92)
Proximal humeral hemiarthroplasty	19	1.7	11.41 (7.28-17.89)	0.60 (0.08-4.26)	0	1.80 (0.58-5.59)	0	0.60 (0.08-4.26)	0.60 (0.08-4.26)	4.20 (2.00-8.82)	0	3.00 (1.25-7.21)	2.40 (0.90-6.40)
Resurfacing	5	0.4	11.19 (4.66-26.88)	0	0	4.48 (1.12-17.89)	0	0	2.24 (0.32-15.88)	4.48 (1.12-17.89)	0	0	6.71 (2.16-20.81)
Stemless	4	0.6	7.13 (2.68-19.00)	0	0	0	0	0	0	1.78 (0.25-12.66)	0	0	1.78 (0.25-12.66)
Stemmed	10	0.7	15.21 (8.18-28.26)	1.52 (0.21-10.80)	0	1.52 (0.21-10.80)	0	1.52 (0.21-10.80)	0	6.08 (2.28-16.21)	0	7.60 (3.16-18.27)	0
Total shoulder replacement	37	6.2	6.00 (4.35-8.29)	0	0.65 (0.24-1.73)	0.32 (0.08-1.30)	0.32 (0.08-1.30)	0.49 (0.16-1.51)	0.49 (0.16-1.51)	0	0	1.14 (0.54-2.38)	0.32 (0.08-1.30)
Resurfacing	0	0.1	0	0	0	0	0	0	0	0	0	0	0
Stemless	17	2.9	5.82 (3.62-9.37)	0	0.34 (0.05-2.43)	0	0	0.69 (0.17-2.74)	0.34 (0.05-2.43)	0	0	0.69 (0.17-2.74)	0.34 (0.05-2.43)
Stemmed	20	3.2	6.30 (4.07-9.77)	0	0.95 (0.30-2.93)	0.63 (0.16-2.52)	0.63 (0.16-2.52)	0.32 (0.04-2.24)	0.63 (0.16-2.52)	0	0	1.58 (0.66-3.79)	0.32 (0.04-2.24)
Reverse polarity total shoulder replacement	132	12.0	10.98 (9.26-13.03)	0.25 (0.08-0.77)	0.92 (0.51-1.65)	0	0.17 (0.04-0.67)	1.08 (0.63-1.86)	0.08 (0.01-0.59)	0	0.08 (0.01-0.59)	1.83 (1.21-2.78)	0.42 (0.17-1.00)
Stemless	<4	0.1	22.84 (5.71-91.33)	11.42 (1.61-81.08)	11.42 (1.61-81.08)	0	0	0	0	0	0	0	0
Stemmed	130	11.9	10.90 (9.18-12.94)	0.17 (0.04-0.67)	0.84 (0.45-1.56)	0	0.17 (0.04-0.67)	1.09 (0.63-1.88)	0.08 (0.01-0.60)	0	0.08 (0.01-0.60)	1.84 (1.21-2.80)	0.42 (0.17-1.01)
Interpositional arthroplasty	0	0.0	0	0	0	0	0	0	0	0	0	0	0
Unconfirmed	29	1.7	17.46 (12.14-25.13)	0.60 (0.08-4.27)	1.20 (0.30-4.82)	0	0	2.41 (0.90-6.42)	0	0	0	1.81 (0.58-5.60)	0
Unconfirmed HHA	<4	0.1	8.03 (1.13-57.03)	0	0	0	0	0	0	0	0	0	0
Unconfirmed TSR	<4	0.4	7.66 (2.47-23.75)	0	0	0	0	2.55 (0.36-18.12)	0	0	0	0	0
Unconfirmed RTSR	25	1.1	21.98 (14.85-32.53)	0.88 (0.12-6.24)	1.76 (0.44-7.03)	0	0	2.64 (0.85-8.18)	0	0	0	2.64 (0.85-8.18)	0
Unconfirmed IPA	0	0.0	0	0	0	0	0	0	0	0	0	0	0

Note: These have been suppressed due to zero events: 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 on the previous pages 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 2020. 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.

We have shown that 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 22.2%, 64.7%, and 11.1% recorded none, one and two indications for revision respectively.

The NJR asks surgeons and those responsible for healthcare delivery to ensure that when primary and revision joint replacement procedures of the hip, knee, ankle, elbow or shoulder are performed, that the relevant MDS form is completed and data entered into the registry. This is a requirement mandated by the Department of Health and Social Care. For the purposes of the annual report, revision procedures include any addition, removal or modification of the implants and procedures such as debridement and implant retention with or without implant exchange, excision arthroplasty, amputation and conversion to arthrodesis. For the avoidance of confusion, completing a revision MDS form is also mandatory for a procedure involving modification of a joint by adding another implant to another part of the joint. For the analyses of surgeon performance, hospital performance and implant performance, debridement and implant retention without implant exchange is currently excluded.

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

The OSS is a validated patient reported outcome measure for use in shoulder surgery. It consists of 12 pain and function items which address problems that the patient may have 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	5,143	(100.0)		4,725	(100.0)		2,510	(100.0)		1,178	(100.0)	
	All responders	487	(9.5)	(100.0)	2,103	(44.5)	(100.0)	256	(10.2)	(100.0)	340	(28.9)	(100.0)
	All complete* within window of interest	347	(6.7)	(71.3)	1,539	(32.6)	(73.2)	249	(9.9)	(97.3)	335	(28.4)	(98.5)
	OSS collected before window of interest	<4	(<0.1)	(0.2)	5	(0.1)	(0.2)	<4	(<0.1)	(0.4)	<4	(0.1)	(0.3)
	1 to 9 Items completed	<4	(<0.1)	(0.2)	0	(0)	(0)	0	(0)	(0)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	0	(0)	(0)	<4	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)	<4	(0.1)	(0.3)
	12 Items completed	0	(0)	(0)	4	(0.1)	(0.2)	<4	(<0.1)	(0.4)	0	(0)	(0)
	OSS collected within window of interest	357	(6.9)	(73.3)	1,550	(32.8)	(73.7)	253	(10.1)	(98.8)	337	(28.6)	(99.1)
	1 to 9 Items completed	10	(0.2)	(2.1)	11	(0.2)	(0.5)	4	(0.2)	(1.6)	<4	(0.2)	(0.6)
	10 to 11 Items completed	22	(0.4)	(4.5)	85	(1.8)	(4.0)	6	(0.2)	(2.3)	10	(0.8)	(2.9)
	12 Items completed	325	(6.3)	(66.7)	1,454	(30.8)	(69.1)	243	(9.7)	(94.9)	325	(27.6)	(95.6)
	OSS collected after window of interest	129	(2.5)	(26.5)	525	(11.1)	(25.0)	<4	(0.1)	(0.8)	<4	(0.2)	(0.6)
	1 to 9 Items completed	19	(0.4)	(3.9)	<4	(0.1)	(0.1)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	8	(0.2)	(1.6)	35	(0.7)	(1.7)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	12 Items completed	102	(2.0)	(20.9)	487	(10.3)	(23.2)	<4	(0.1)	(0.8)	<4	(0.2)	(0.6)
Elective	All eligible cases	45,112	(100.0)		43,145	(100.0)		27,045	(100.0)		14,417	(100.0)	
	All responders	16,940	(37.6)	(100.0)	21,288	(49.3)	(100.0)	3,045	(11.3)	(100.0)	4,409	(30.6)	(100.0)
	All complete* within window of interest	11,405	(25.3)	(67.3)	14,992	(34.7)	(70.4)	2,989	(11.1)	(98.2)	4,333	(30.1)	(98.3)
	OSS collected before window of interest	1,006	(2.2)	(5.9)	110	(0.3)	(0.5)	7	(<0.1)	(0.2)	15	(0.1)	(0.3)
	1 to 9 Items completed	5	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)	0	(<0.1)	(<0.1)
	10 to 11 Items completed	25	(0.1)	(0.1)	10	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)
	12 Items completed	976	(2.2)	(5.8)	99	(0.2)	(0.5)	6	(<0.1)	(0.2)	14	(0.1)	(0.3)
	OSS collected within window of interest	11,462	(25.4)	(67.7)	15,093	(35.0)	(70.9)	3,018	(11.2)	(99.1)	4,382	(30.4)	(99.4)
	1 to 9 Items completed	57	(0.1)	(0.3)	101	(0.2)	(0.5)	29	(0.1)	(1.0)	49	(0.3)	(1.1)
	10 to 11 Items completed	458	(1.0)	(2.7)	856	(2.0)	(4.0)	212	(0.8)	(7.0)	288	(2.0)	(6.5)
	12 Items completed	10,947	(24.3)	(64.6)	14,136	(32.8)	(66.4)	2,777	(10.3)	(91.2)	4,045	(28.1)	(91.7)
	OSS collected after window of interest	4,472	(9.9)	(26.4)	5,892	(13.7)	(27.7)	20	(0.1)	(0.7)	12	(0.1)	(0.3)
	1 to 9 Items completed	130	(0.3)	(0.8)	38	(0.1)	(0.2)	0	(<0.1)	(<0.1)	<4	(<0.1)	(<0.1)
	10 to 11 Items completed	375	(0.8)	(2.2)	300	(0.7)	(1.4)	0	(<0.1)	(<0.1)	<4	(<0.1)	(0.1)
	12 Items completed	3,967	(8.8)	(23.4)	5,554	(12.9)	(26.1)	20	(0.1)	(0.7)	8	(0.1)	(0.2)

*Complete corresponds to ten or more items completed.
Note: The windows of interest are: 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 PROMs. 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 by hospital trusts is therefore 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 month N (% of Pre-op)	3 year N (% of Pre-op)	5 year N (% of Pre-op)
Acute trauma & elective	All years	50,255	11,752 (23.4)	16,531 (34.5)	3,238 (11.0)	4,668 (29.9)
	2012	2,545	673 (26.4)	345 (13.7)	0 (0)	1,130 (51.5)
	2013	4,412	1,077 (24.4)	1,883 (43.1)	0 (0)	1,354 (35.5)
	2014	5,309	1,414 (26.6)	299 (5.7)	2,067 (41.7)	1,839 (39.9)
	2015	5,734	1,489 (26.0)	857 (15.0)	729 (13.6)	345 (6.9)
	2016	6,537	1,476 (22.6)	26 (0.4)	263 (4.3)	0
	2017	7,002	1,486 (21.2)	4,672 (67.3)	179 (2.7)	0
	2018	7,223	1,429 (19.8)	5,024 (70.1)	0	0
	2019	7,660	1,781 (23.3)	3,360 (44.2)	0	0
	2020	3,833	927 (24.2)	65 (3.6)	0	0
Acute trauma	All years	5,143	347 (6.7)	1,539 (32.6)	249 (9.9)	335 (28.4)
	2012	160	11 (6.9)	17 (11.0)	0 (0)	52 (40.9)
	2013	387	42 (10.9)	149 (39.4)	0 (0)	100 (33.3)
	2014	473	36 (7.6)	33 (7.2)	162 (40.8)	145 (42.3)
	2015	532	31 (5.8)	92 (17.7)	76 (16.4)	38 (9.3)
	2016	598	41 (6.9)	7 (1.2)	9 (1.7)	0
	2017	713	35 (4.9)	441 (63.4)	<4 (0.3)	0
	2018	768	50 (6.5)	471 (62.3)	0	0
	2019	864	53 (6.1)	323 (38.2)	0	0
	2020	648	48 (7.4)	6 (1.8)	0	0
Elective	All years	45,112	11,405 (25.3)	14,992 (34.7)	2,989 (11.1)	4,333 (30.1)
	2012	2,385	662 (27.8)	328 (13.9)	0 (0)	1,078 (52.1)
	2013	4,025	1,035 (25.7)	1,734 (43.4)	0 (0)	1,254 (35.7)
	2014	4,836	1,378 (28.5)	266 (5.5)	1,905 (41.8)	1,694 (39.7)
	2015	5,202	1,458 (28.0)	765 (14.8)	653 (13.3)	307 (6.7)
	2016	5,939	1,435 (24.2)	19 (0.3)	254 (4.5)	0
	2017	6,289	1,451 (23.1)	4,231 (67.8)	177 (3.0)	0
	2018	6,455	1,379 (21.4)	4,553 (71.0)	0	0
	2019	6,796	1,728 (25.4)	3,037 (45.0)	0	0
	2020	3,185	879 (27.6)	59 (4.0)	0	0

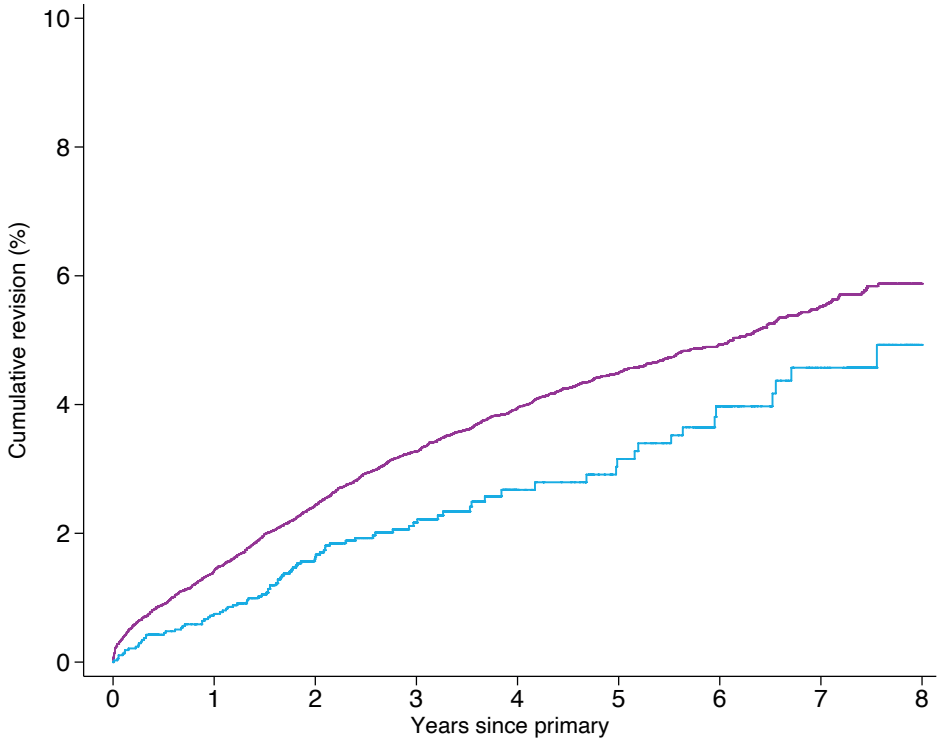
Table 3.S15 provides a detailed description of the number of patients reporting complete OSS within the window of interest pre-operatively and at 6 months, 3 years and 5 years by the year of surgery for patients undergoing primary shoulder replacement for acute trauma or elective indications. The denominator 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	50,255	11,752	3,863 (32.9)	1,141 (9.7)	1,372 (11.7)	355 (3.0)	118 (1.0)
	2012	2,545	673	92 (13.7)	0 (0)	345 (51.3)	0 (0)	0 (0)
	2013	4,412	1,077	527 (48.9)	0 (0)	369 (34.3)	0 (0)	0 (0)
	2014	5,309	1,414	83 (5.9)	614 (43.4)	561 (39.7)	62 (4.4)	49 (3.5)
	2015	5,734	1,489	239 (16.1)	201 (13.5)	97 (6.5)	185 (12.4)	69 (4.6)
	2016	6,537	1,476	5 (0.3)	197 (13.3)	0 (0)	<4 (0.2)	0 (0)
	2017	7,002	1,486	1,048 (70.5)	129 (8.7)	0 (0)	105 (7.1)	0 (0)
	2018	7,223	1,429	1,054 (73.8)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	7,660	1,781	762 (42.8)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	3,833	927	53 (5.7)	0 (0)	0 (0)	0 (0)	0 (0)
Acute trauma	All years	5,143	347	102 (29.4)	25 (7.2)	29 (8.4)	<4 (0.6)	<4 (0.3)
	2012	160	11	<4 (9.1)	0 (0)	4 (36.4)	0 (0)	0 (0)
	2013	387	42	17 (40.5)	0 (0)	13 (31.0)	0 (0)	0 (0)
	2014	473	36	<4 (2.8)	14 (38.9)	11 (30.6)	0 (0)	0 (0)
	2015	532	31	<4 (9.7)	<4 (6.5)	<4 (3.2)	<4 (3.2)	<4 (3.2)
	2016	598	41	0 (0)	7 (17.1)	0 (0)	0 (0)	0 (0)
	2017	713	35	21 (60.0)	<4 (5.7)	0 (0)	<4 (2.9)	0 (0)
	2018	768	50	33 (66.0)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	864	53	20 (37.7)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	648	48	6 (12.5)	0 (0)	0 (0)	0 (0)	0 (0)
Elective	All years	45,112	11,405	3,761 (33.0)	1,116 (9.8)	1,343 (11.8)	353 (3.1)	117 (1.0)
	2012	2,385	662	91 (13.7)	0 (0)	341 (51.5)	0 (0)	0 (0)
	2013	4,025	1,035	510 (49.3)	0 (0)	356 (34.4)	0 (0)	0 (0)
	2014	4,836	1,378	82 (6.0)	600 (43.5)	550 (39.9)	62 (4.5)	49 (3.6)
	2015	5,202	1,458	236 (16.2)	199 (13.6)	96 (6.6)	184 (12.6)	68 (4.7)
	2016	5,939	1,435	5 (0.3)	190 (13.2)	0 (0)	<4 (0.2)	0 (0)
	2017	6,289	1,451	1,027 (70.8)	127 (8.8)	0 (0)	104 (7.2)	0 (0)
	2018	6,455	1,379	1,021 (74.0)	0 (0)	0 (0)	0 (0)	0 (0)
	2019	6,796	1,728	742 (42.9)	0 (0)	0 (0)	0 (0)	0 (0)
	2020	3,185	879	47 (5.3)	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 on page 289, 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. While the proportion of patients with pre-operative and 6-month OSS has increased in recent years, this still only represents 14.6% of all eligible primary replacements.

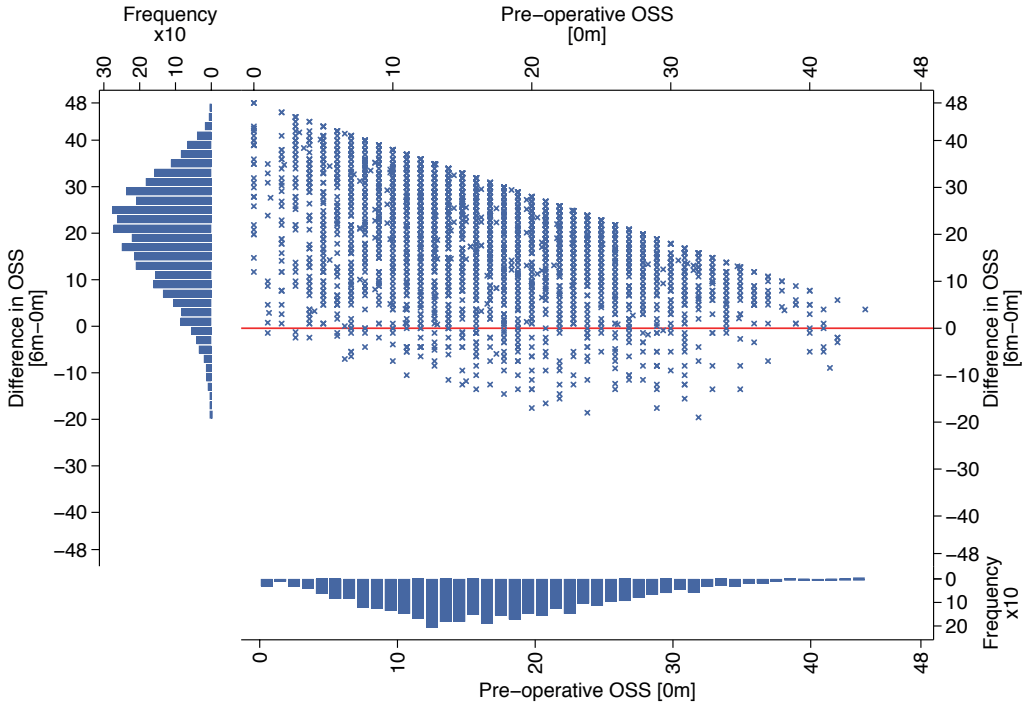
Figure 3.S7 KM estimates of cumulative **revision** for primary **elective** shoulder replacements for patients **with** and **without** valid **PROMs**. *Blue italics in the numbers at risk table signify that fewer than 250 cases remained at risk at these time points.*



Key:	Numbers at risk								
Non PROMs cohort	41,351	37,117	30,304	24,279	18,722	12,912	8,341	4,285	1,569
PROMs cohort	3,761	3,669	2,865	1,841	831	799	567	465	*72*

Figure 3.S7 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.S8 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=3,761.

Figure 3.S8 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. While 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 PROMs 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 6 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 Score [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Acute trauma & elective	All years	3,863	16.7 (8.4)	[11, 16, 22]	35.7 (10.4)	[30, 39, 44]	19.0 (11.6)	[12, 20, 27]
	2012	92	17.6 (7.9)	[12, 16, 23]	33.8 (11.7)	[28, 37, 43]	16.2 (11.7)	[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	1,048	16.8 (8.4)	[11, 16, 22]	36.0 (10.2)	[30, 39, 44]	19.2 (11.6)	[12, 20, 28]
	2018	1,054	16.4 (8.5)	[10, 16, 22]	36.2 (10.4)	[30, 39, 44]	19.8 (11.7)	[13, 21, 28]
	2019	762	16.8 (8.4)	[11, 16, 22]	36.7 (10.0)	[31, 40, 44]	19.9 (11.1)	[13, 21, 28]
	2020	53	15.4 (9.5)	[9, 14, 24]	36.9 (9.0)	[31, 40, 44]	21.5 (9.5)	[17, 22, 28]
Acute trauma	All years	102	13.5 (15.9)	[1, 8, 23]	31.4 (11.7)	[22, 34, 42]	17.8 (20.3)	[6, 22, 33]
	2012	<4						
	2013	17	11.9 (14.7)	[2, 8, 12]	33.3 (13.8)	[25, 41, 44]	21.3 (23.8)	[17, 27, 40]
	2014	<4						
	2015	<4						
	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	20	9.9 (15.6)	[0, 1, 15]	33.7 (12.7)	[25, 40, 44]	23.8 (17.7)	[15, 26, 39]
	2020	6	6.3 (15.0)	[0, 0, 1]	33.1 (11.3)	[22, 35, 43]	26.8 (14.2)	[20, 25, 42]
Elective	All years	3,761	16.8 (8.1)	[11, 16, 22]	35.8 (10.4)	[30, 39, 44]	19.0 (11.3)	[12, 20, 27]
	2012	91	17.4 (7.5)	[12, 16, 23]	33.8 (11.7)	[28, 36, 43]	16.4 (11.6)	[9, 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	1,027	16.8 (8.2)	[11, 16, 22]	36.1 (10.2)	[30, 39, 44]	19.2 (11.4)	[12, 20, 28]
	2018	1,021	16.4 (8.2)	[11, 16, 22]	36.4 (10.3)	[31, 39, 44]	20.1 (11.3)	[13, 21, 28]
	2019	742	17.0 (8.0)	[11, 16, 22]	36.8 (9.9)	[31, 40, 44]	19.8 (10.8)	[13, 21, 28]
	2020	47	16.5 (8.0)	[10, 15, 25]	37.4 (8.7)	[31, 40, 44]	20.9 (8.8)	[16, 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 6 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 Score [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Acute trauma & elective	**Proximal humeral hemiarthroplasty**	**404**	**17.8 (9.2)**	**[11, 17, 23]**	**31.3 (11.8)**	**[23, 34, 41]**	**13.5 (12.4)**	**[6, 14, 23]**
	Resurfacing	185	18.4 (8.4)	[12, 18, 23]	32.2 (11.3)	[26, 35, 41]	13.8 (11.3)	[7, 14, 23]
	Stemless	80	19.9 (8.4)	[16, 19, 23]	33.2 (11.3)	[26, 36, 42]	13.4 (10.5)	[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	**1,237**	**17.6 (8.0)**	**[12, 17, 23]**	**38.5 (9.2)**	**[35, 41, 45]**	**20.9 (10.5)**	**[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	547	18.0 (8.1)	[12, 17, 24]	38.9 (9.0)	[36, 41, 45]	20.9 (10.3)	[15, 22, 29]
	Stemmed	634	17.2 (8.0)	[11, 17, 23]	38.1 (9.6)	[34, 41, 45]	20.9 (10.8)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**1,974**	**15.9 (8.4)**	**[10, 15, 21]**	**34.9 (10.5)**	**[29, 37, 43]**	**19.0 (11.7)**	**[12, 20, 27]**
	Stemless	31	16.9 (7.1)	[9, 17, 23]	36.4 (10.1)	[28, 40, 45]	19.5 (12.3)	[7, 21, 29]
	Stemmed	1,943	15.9 (8.4)	[10, 15, 21]	34.9 (10.5)	[29, 37, 43]	19.0 (11.7)	[12, 20, 27]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**248**	**16.8 (8.9)**	**[10, 16, 24]**	**34.6 (10.3)**	**[28, 37, 43]**	**17.7 (11.2)**	**[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	114	17.3 (8.7)	[10, 18, 24]	35.6 (10.6)	[29, 39, 44]	18.3 (11.5)	[11, 19, 27]
	Unconfirmed RTSR	121	16.3 (9.2)	[10, 16, 22]	34.2 (9.3)	[28, 36, 41]	17.9 (10.5)	[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	**<4**						
	Resurfacing	0						
	Stemless	<4						
	Stemmed	0						
	Reverse polarity total shoulder replacement	**75**	**13.4 (15.8)**	**[0, 8, 24]**	**32.1 (11.3)**	**[24, 34, 42]**	**18.8 (18.7)**	**[7, 22, 34]**
	Stemless	0						
	Stemmed	75	13.4 (15.8)	[0, 8, 24]	32.1 (11.3)	[24, 34, 42]	18.8 (18.7)	[7, 22, 34]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**4**	**1.8 (3.5)**	**[0, 0, 4]**	**29.8 (9.6)**	**[22, 30, 38]**	**28.0 (12.0)**	**[18, 30, 38]**
	Unconfirmed HHA	0						
	Unconfirmed TSR	0						
	Unconfirmed RTSR	4	1.8 (3.5)	[0, 0, 4]	29.8 (9.6)	[22, 30, 38]	28.0 (12.0)	[18, 30, 38]
	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 Score [0 min, 48 max]					
			Pre-op		6 month		(6 month - Pre-op)	
			Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th	Mean (SD)	[25,50,75]th
Elective	**Proximal humeral hemiarthroplasty**	**382**	**17.9 (8.5)**	**[12, 17, 23]**	**31.5 (11.7)**	**[24, 34, 41]**	**13.6 (11.3)**	**[6, 14, 22]**
	Resurfacing	185	18.4 (8.4)	[12, 18, 23]	32.2 (11.3)	[26, 35, 41]	13.8 (11.3)	[7, 14, 23]
	Stemless	80	19.9 (8.4)	[16, 19, 23]	33.2 (11.3)	[26, 36, 42]	13.4 (10.5)	[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	**1,236**	**17.6 (8.0)**	**[12, 17, 23]**	**38.5 (9.2)**	**[35, 41, 45]**	**20.9 (10.5)**	**[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	546	18.0 (8.1)	[12, 18, 24]	38.9 (9.0)	[36, 41, 45]	20.9 (10.3)	[15, 22, 29]
	Stemmed	634	17.2 (8.0)	[11, 17, 23]	38.1 (9.6)	[34, 41, 45]	20.9 (10.8)	[14, 21, 29]
	Reverse polarity total shoulder replacement	**1,899**	**16.0 (7.9)**	**[10, 15, 21]**	**35.0 (10.4)**	**[29, 37, 43]**	**19.0 (11.3)**	**[12, 20, 27]**
	Stemless	31	16.9 (7.1)	[9, 17, 23]	36.4 (10.1)	[28, 40, 45]	19.5 (12.3)	[7, 21, 29]
	Stemmed	1,868	16.0 (8.0)	[10, 15, 21]	35.0 (10.4)	[29, 37, 43]	19.0 (11.3)	[12, 20, 27]
	Interpositional arthroplasty	**0**						
	Unconfirmed	**244**	**17.1 (8.7)**	**[10, 17, 24]**	**34.7 (10.3)**	**[28, 37, 43]**	**17.6 (11.1)**	**[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	114	17.3 (8.7)	[10, 18, 24]	35.6 (10.6)	[29, 39, 44]	18.3 (11.5)	[11, 19, 27]
	Unconfirmed RTSR	117	16.8 (8.9)	[11, 16, 23]	34.4 (9.3)	[28, 36, 41]	17.6 (10.3)	[11, 18, 25]
	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 6 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.

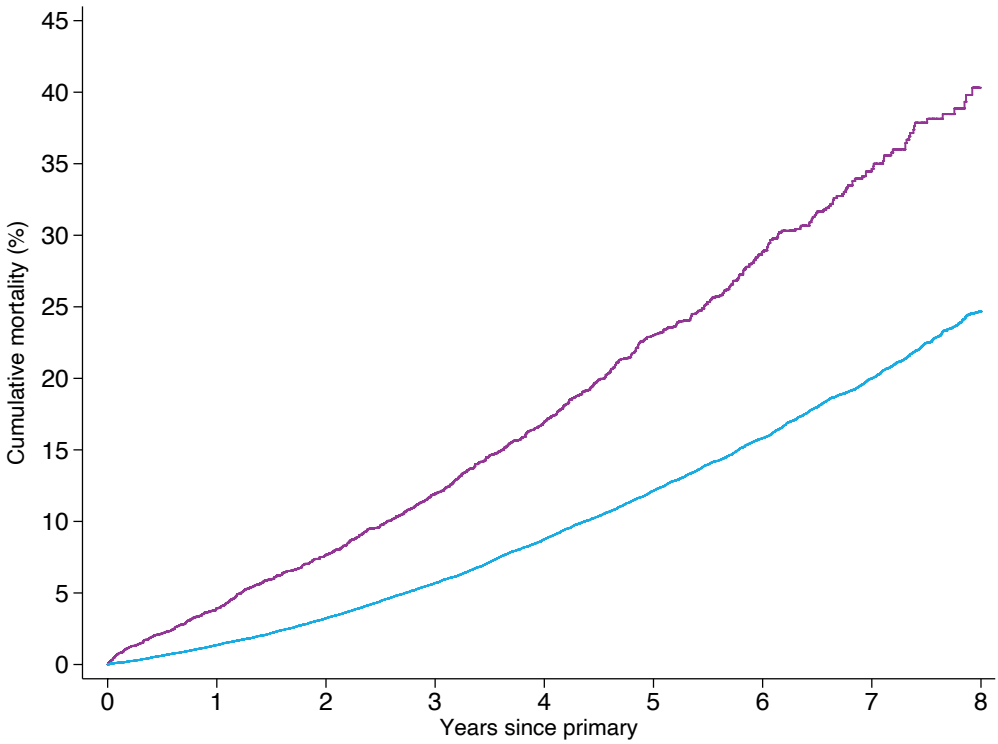
Table 3.S18 clearly illustrates that the change between pre-operative and 6-month assessment of OSS while positive, is still substantially less for patients receiving a proximal humeral hemiarthroplasty compared to either a conventional total or reverse polarity total shoulder replacement. The change 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=25), see Figure 3.S1 (page 259), they were excluded from the analysis to avoid double counting. This results in 45,765 patient procedures being included in the analysis, with 5,512 observed deaths.

Figure 3.S9 and Table 3.S19 describe the mortality of patients receiving a primary shoulder replacement up to eight 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 eighth 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 on page 265.

Figure 3.S9 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*.

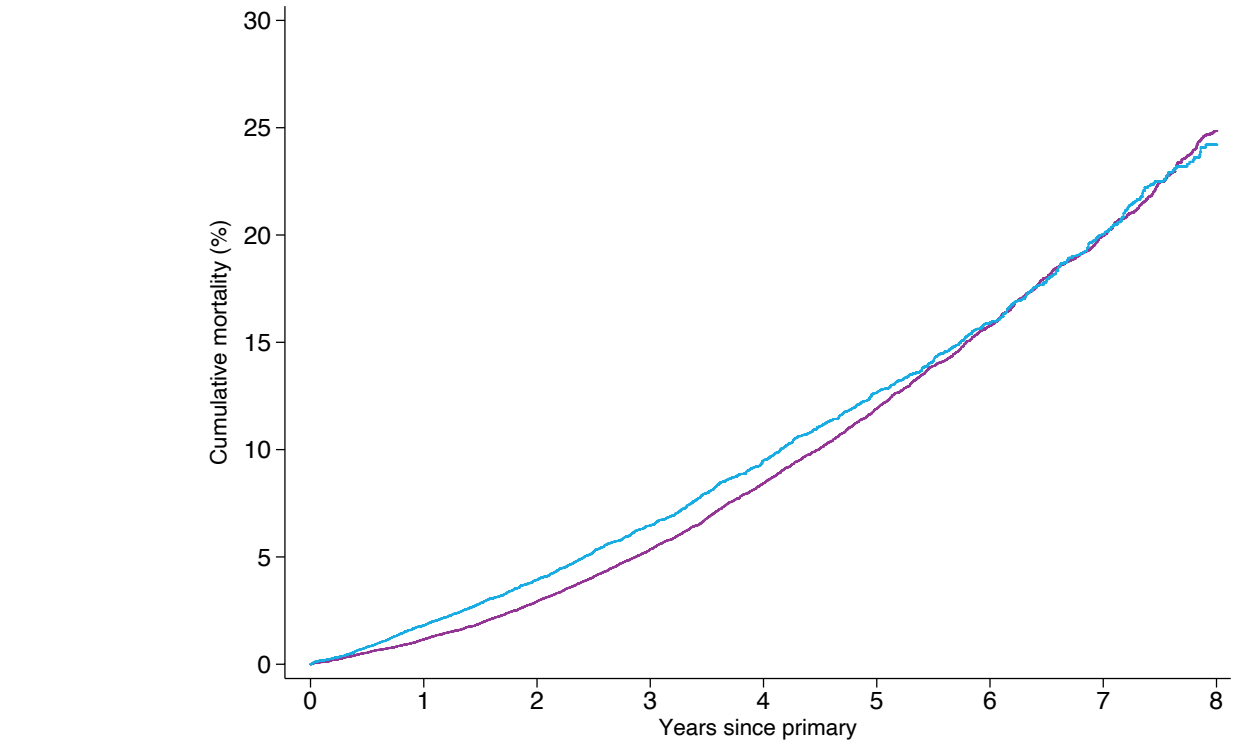


Key:	Numbers at risk								
Acute trauma	5,131	4,307	3,344	2,504	1,775	1,175	710	367	*93*
Elective	45,099	41,342	33,989	27,037	20,411	14,411	9,447	5,099	1,786

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.*

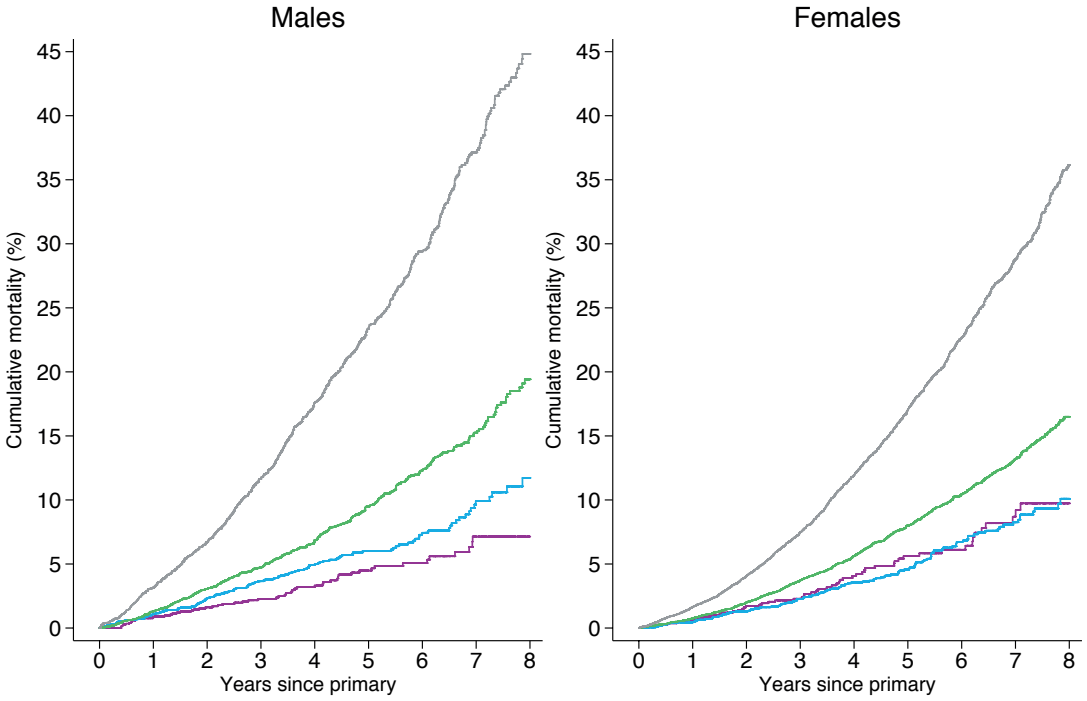
	N	Age at primary Median (IQR)	Male (%)	Time since primary									
				30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
All cases	50,230	73 (67 to 79)	30	0.17 (0.14-0.21)	0.38 (0.33-0.44)	1.61 (1.50-1.73)	3.67 (3.50-3.85)	6.30 (6.06-6.54)	9.54 (9.23-9.85)	13.14 (12.76-13.54)	17.00 (16.52-17.49)	21.31 (20.70-21.93)	26.04 (25.20-26.90)
Acute trauma	5,131	74 (67 to 80)	23	0.69 (0.49-0.95)	1.30 (1.02-1.66)	3.93 (3.42-4.51)	7.68 (6.93-8.51)	11.97 (10.98-13.03)	17.00 (15.75-18.34)	23.03 (21.45-24.70)	28.85 (26.91-30.89)	34.64 (32.24-37.17)	*40.31 (37.05-43.76)*
Elective	45,099	73 (67 to 79)	31	0.12 (0.09-0.15)	0.28 (0.23-0.33)	1.36 (1.25-1.47)	3.24 (3.07-3.42)	5.70 (5.46-5.94)	8.76 (8.45-9.08)	12.14 (11.75-12.55)	15.83 (15.34-16.33)	20.00 (19.38-20.64)	24.67 (23.81-25.56)

Figure 3.S10 KM estimates of cumulative **mortality** for primary **elective** shoulder replacement by **gender**.



Key:	Numbers at risk								
Female	31,339	28,829	23,760	18,981	14,365	10,206	6,680	3,595	1,257
Male	13,760	12,513	10,229	8,056	6,046	4,205	2,767	1,504	529

Figure 3.S11 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								
<55y	1,479	1,370	1,164	955	752	539	370	*220*	*91*
55 to 64y	2,613	2,371	1,948	1,557	1,198	857	583	330	*106*
65 to 74y	5,241	4,813	3,988	3,150	2,371	1,675	1,113	609	*212*
≥75y	4,427	3,959	3,129	2,394	1,725	1,134	701	345	*120*

Numbers at risk									
1,145	1,077	935	786	637	453	305	*176*	*74*
3,263	2,997	2,473	2,020	1,574	1,190	802	476	*187*
11,551	10,717	8,892	7,184	5,491	3,986	2,662	1,453	510
15,380	14,038	11,460	8,991	6,663	4,577	2,911	1,490	486

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	8 years
Female	All	31,339	0.10 (0.07-0.14)	0.24 (0.20-0.31)	1.15 (1.04-1.28)	2.93 (2.74-3.13)	5.36 (5.09-5.65)	8.44 (8.07-8.82)	11.91 (11.44-12.39)	15.77 (15.19-16.37)	19.97 (19.23-20.74)	24.85 (23.81-25.92)
	<55	1,145	0	0.18 (0.04-0.70)	0.63 (0.30-1.31)	1.72 (1.08-2.71)	2.29 (1.52-3.43)	4.06 (2.93-5.62)	5.61 (4.18-7.52)	6.11 (4.56-8.16)	*8.69 (6.45-11.66)*	*9.74 (7.19-13.12)*
	55 to 64	3,263	0.03 (0.00-0.22)	0.06 (0.02-0.25)	0.45 (0.26-0.75)	1.30 (0.95-1.78)	2.27 (1.76-2.92)	3.56 (2.87-4.41)	4.56 (3.73-5.58)	6.72 (5.57-8.10)	8.26 (6.85-9.94)	*10.09 (8.22-12.36)*
	65 to 74	11,551	0.08 (0.04-0.15)	0.18 (0.12-0.28)	0.75 (0.61-0.93)	2.00 (1.75-2.29)	3.75 (3.38-4.16)	5.65 (5.16-6.17)	8.00 (7.38-8.67)	10.43 (9.65-11.26)	13.21 (12.21-14.28)	16.49 (15.09-18.00)
	≥75	15,380	0.13 (0.08-0.20)	0.33 (0.25-0.44)	1.65 (1.45-1.86)	4.07 (3.75-4.41)	7.48 (7.03-7.97)	11.96 (11.35-12.60)	17.02 (16.24-17.84)	22.69 (21.71-23.71)	28.81 (27.57-30.10)	36.15 (34.38-37.98)
Male	All	13,760	0.16 (0.11-0.24)	0.34 (0.26-0.46)	1.82 (1.60-2.06)	3.95 (3.62-4.31)	6.46 (6.02-6.94)	9.50 (8.93-10.10)	12.68 (11.97-13.43)	15.93 (15.06-16.84)	20.05 (18.93-21.23)	24.21 (22.70-25.80)
	<55	1,479	0	0	0.84 (0.48-1.47)	1.62 (1.07-2.45)	2.27 (1.58-3.27)	3.33 (2.41-4.58)	4.49 (3.34-6.03)	5.07 (3.79-6.77)	*7.14 (5.24-9.70)*	*7.14 (5.24-9.70)*
	55 to 64	2,613	0.15 (0.06-0.41)	0.31 (0.15-0.62)	1.12 (0.77-1.61)	2.33 (1.78-3.03)	3.66 (2.93-4.56)	5.00 (4.09-6.09)	6.01 (4.96-7.27)	7.44 (6.13-9.02)	9.91 (8.08-12.14)	*11.72 (9.30-14.73)*
	65 to 74	5,241	0.04 (0.01-0.15)	0.19 (0.10-0.36)	1.31 (1.03-1.66)	3.07 (2.61-3.60)	4.73 (4.14-5.41)	6.85 (6.08-7.71)	9.49 (8.50-10.58)	12.36 (11.12-13.73)	15.25 (13.68-16.97)	*19.42 (17.16-21.94)*
	≥75	4,427	0.36 (0.22-0.59)	0.66 (0.46-0.95)	3.16 (2.68-3.73)	6.75 (6.01-7.58)	11.68 (10.65-12.80)	17.56 (16.23-18.98)	23.47 (21.84-25.21)	29.40 (27.41-31.50)	37.13 (34.59-39.81)	*44.83 (41.41-48.40)*

Table 3.S20, Figure 3.S10 and Figure 3.S11 describe the mortality of patients receiving a primary shoulder replacement up to eight 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 eighth year. Mortality differences between the genders are small and while males have higher mortality within the first five years following surgery, mortality in the longer term appears more comparable, see Figure 3.S10. When mortality is further divided by age (see Figure 3.S11), 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, we provide new and extensive insight into the use and performance of shoulder constructs used in primary shoulder replacements and also give 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, we have extensively revised shoulder implant data processing 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 registry, such as the unconfirmed procedures that are now reported. These are procedures where the reported patient procedure disagrees with the implanted prostheses or there are insufficient elements recorded to verify 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 consistently 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 one of the core functions of the registry, which is to provide a comprehensive record of all implanted prostheses.

There are now 50,255 shoulder replacements eligible for analysis after the application of our data cleaning processes. Patterns of use and the completeness of data are becoming clearer and revision rates out to eight years can be analysed. PROMs data continue 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 60.2% 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 NJR's operational geographical areas, 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 11.3% and 10.1% in males and females respectively at five years. These revision figures should be addressed in clinical discussions with younger patients wishing to undergo shoulder replacement surgery.

At present, reverse polarity total shoulder replacement demonstrates the lowest revision rates at eight years. However, it is worth highlighting that these procedures 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. While it may be argued that the higher revision rate is mediated by the ease of the revision procedure, the PROMs data evidenced 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 report less positive outcome measures with the primary operation compared to others.

We suggest that more in-depth analysis which accounts for case-mix should be conducted as, while 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 replacement 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 registry and other clinically relevant factors may help surgeons select different treatment modalities for patients.

This year we have presented a detailed description of PROMs data with reference to not only those who have responded, but the entire cohort of patients receiving a primary shoulder replacement. The pre-operative scores are administered and collected by hospital trusts and our analysis demonstrates that hospital trust compliance is poor. Better collection strategies need to be developed nationally to improve this low compliance. The post-operative PROMs are administered directly to patients on the NJR's behalf by their authorised contractor, NEC Software Solutions, and consideration of how many people respond and the timing of when they respond is now also being addressed. 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 3,761 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 PROMs, that shoulder replacement surgery results in substantial improvement in both pain and function for patients. However, it is less clear how those who do not complete the PROMs fare, and the revision rate of those who do not respond to the PROMs questionnaires does appear to be different and higher, when it is compared to those who do respond.

The largest gains by elective patients can be observed in those patients receiving a conventional total shoulder replacement, followed closely by those receiving a reverse polarity shoulder replacement, which is thereafter followed by those receiving a proximal humeral hemiarthroplasty.

Overall, in this section of the report we have shown that the volume of shoulder replacement surgery in the registry continues to grow rapidly and now presents an opportunity for outcomes to be assessed both by revision rates and by PROMs, although careful consideration of the latter in respect 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 interested stakeholders.

3.7 In-depth studies

3.7.1 The effect of surgical approach in total hip replacement on outcomes: an analysis of 723,904 elective operations from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man

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Background

Total hip replacement (THR) is both clinically and cost-effective. The surgical approach that is employed influences the outcome, however there is little generalisable and robust evidence to guide practice.

Methods

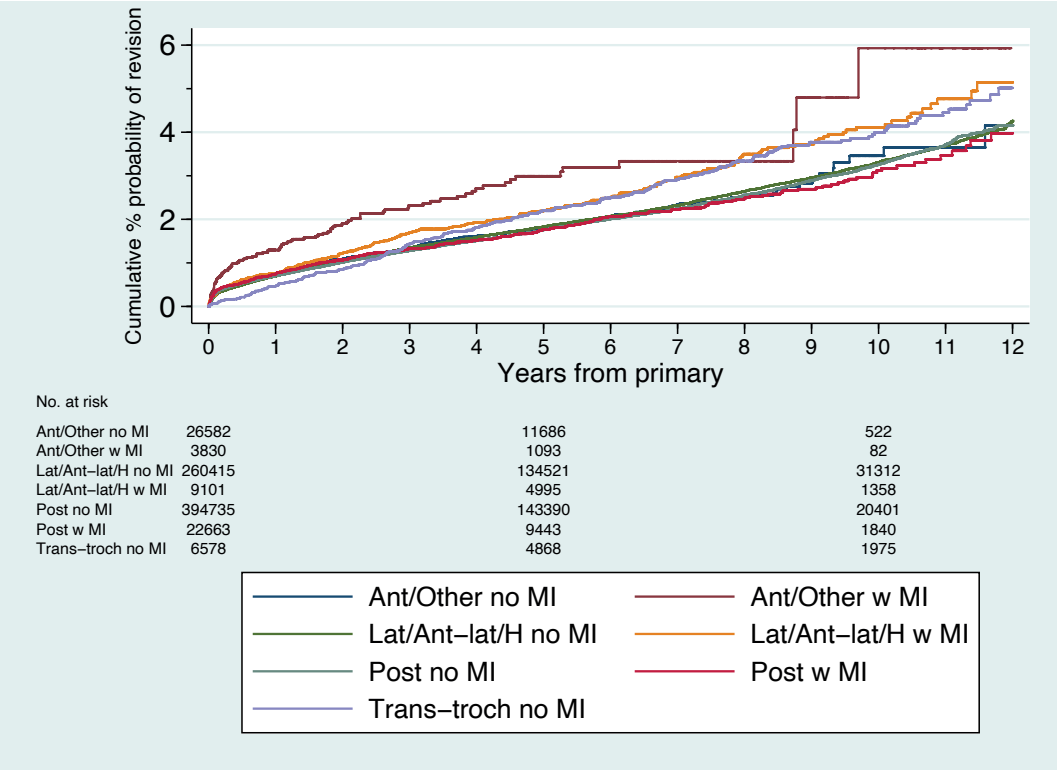
A total of 723,904 primary THRs captured in the National Joint Registry, linked to hospital inpatient, mortality and patient reported outcome measures (PROMs) data with up to 13.75 years follow-up were analysed. There were seven surgical approach groups: conventional posterior, lateral, anterior and trans-trochanteric groups and minimally invasive posterior, lateral and anterior. Operations with metal-on-metal bearings were excluded from analysis.

Survival methods were used to compare revision rates and 90-day mortality. Groups were compared using Cox proportional hazards and Flexible Parametric Survival Modelling (FPM). Confounders included age at surgery, sex, risk group (indications additional to osteoarthritis), ASA grade, THR fixation, thromboprophylaxis, anaesthetic, body mass index and deprivation. PROMs were analysed with regression modelling or non-parametric methods.

Findings

A total of 12,989 (1.8%) of 723,904 implants were revised during follow-up; 84,294 (11.6%) died without undergoing revision. Figure 3.1 shows the estimated cumulative percentage revised (Kaplan-Meier) up to 12 years for the seven groups.

Figure 3.1 Cumulative percentage revised (Kaplan-Meier) up to 12 years for the seven surgical approach groups.



Unadjusted analysis showed a higher revision risk than the referent conventional posterior for the conventional lateral, minimally invasive lateral, minimally invasive anterior and trans-trochanteric groups. This persisted with all adjusted FPM and adjusted Cox models (see Table 3.1 overleaf), except in the Cox model including BMI where the higher revision rate persisted for the conventional lateral approach (HRR 1.12 [95% CI 1.06,1.17] P<0.001). PROMs demonstrated statistically, but not clinically, significant differences. Self-reported complications were more frequent with the conventional lateral approach.

Table 3.1 Regression models to compare approach groups for revision risk (n=723,747 with complete information).

(i) Cox proportional hazards regression models, with stratification by age/sex/risk groups.

Approach	Minimally invasive procedure used	HRR [95% CI]	With adjustment for fixation and ASA HRR [95% CI]	With adjustment for fixation, ASA and BMI sub-group (n=443,657) HRR [95% CI]
Posterior	No	1 [Referent]	1 [Referent]	1 [Referent]
Posterior	Yes	0.99 [0.89,1.10] P=0.864	0.92 [0.83,1.02] P=0.110	0.89 [0.77,1.02] P=0.097
Lat/Ant-Lat/Hard	No	1.05 [1.01,1.09] P=0.009	1.07 [1.03,1.11] P=0.001	1.12 [1.06,1.17] P<0.001
Lat/Ant-Lat/Hard	Yes	1.31 [1.16,1.50] P<0.001	1.28 [1.13,1.46] P<0.001	1.02 [0.80,1.30] P=0.861
Ant/Other	No	1.04 [0.95,1.14] P=0.431	1.03 [0.94,1.13] P=0.561	1.01 [0.88,1.15] P=0.921
Ant/Other	Yes	1.67 [1.36,2.05] P<0.001	1.48 [1.21,1.82] P<0.001	1.03 [0.71,1.51] P=0.870
Trans-trochanteric	No	1.22 [1.07,1.40] P=0.004	1.40 [1.22,1.60] P<0.001	1.48 [1.14,1.91] P=0.003
Additional pairwise comparisons:				
Lat/Ant-Lat/Hard	No vs. Yes	P=0.001	P=0.005	P=0.475
Ant/Other	No vs. Yes	P<0.001	P=0.001	P=0.902

Note: Lat/Ant-Lat/Hard = Lateral / Anterolateral / Hardinge. Ant/Other = Anterior / Other. ASA = American Society of Anesthesiologists Physical Status. BMI = body mass index.

(ii) FPM models, with adjustment for time-varying effects of age, sex, risk group.

Approach	Minimally invasive procedure used	Coefficent [95% CI]	With adjustment for fixation and ASA, as time-varying effects Coefficient [95% CI]
Posterior	No	0 [Referent]	0 [Referent]
Posterior	Yes	-0.006 [-0.109,0.096] P=0.903	-0.081 [-0.183,0.022] P=0.125
Lat/Ant-Lat/Hard	No	0.056 [0.019,0.093] P=0.003	0.069 [0.031,0.106] P<0.001
Lat/Ant-Lat/Hard	Yes	0.282 [0.154,0.411] P<0.001	0.264 [0.135,0.392] P<0.001
Ant/Other	No	0.031 [-0.063,0.126] P=0.516	0.019 [-0.075,0.114] P=0.688
Ant/Other	Yes	0.516 [0.311,0.721] P<0.001	0.380 [0.174,0.585] P<0.001
Trans-trochanteric	No	0.213 [0.075,0.350] P=0.002	0.309 [0.170,0.448] P<0.001
Additional pairwise comparisons:			
Lat/Ant-Lat/Hard	No vs. Yes	P=0.001	P=0.003
Ant/Other	No vs. Yes	P<0.001	P=0.002

Note: Lat/Ant-Lat/Hard = Lateral / Anterolateral / Hardinge. Ant/Other = Anterior / Other. ASA = American Society of Anesthesiologists Physical Status.

Our previous work on mortality after hip replacement had identified confounding factors and a series of univariable analyses confirmed these. Thus, in our analysis shown in Table 3.2, we have adjusted for these factors. In all models, the conventional lateral approach was associated with a higher risk of mortality than the conventional posterior approach (HRR 1.15 [95% CI 1.01-1.30] P=0.029 in the fully adjusted model). There were no other significant differences in mortality compared to the referent conventional posterior approach group.

Table 3.2 Cox 'proportional hazards' regression model to compare 90-day mortality between the seven approach sub-groups.

Approach	Minimally invasive procedure used	Number for analysis	(i) Unadjusted model (n=723,747; 2,673 deaths) HRR [95% CI]	(ii) With covariate adjustment for sex, age, ASA and year of primary, stratified by 'risk group' (n=723,747; 2,673 deaths) HRR [95% CI]	(iii) With covariate adjustment for sex, age, ASA, year of primary and fixation, stratified by 'risk group' (n=723,747; 2,673 deaths) HRR [95% CI]	(iv) With covariate adjustment for sex, age, ASA, year of primary, fixation, mechanical and chemical thromboprophylaxis and anaesthetic group, stratified by 'risk group' (n=713,994 with complete information; 2,621 deaths) HRR [95% CI]	(v) With covariate adjustment for sex, age, ASA, year of primary, fixation, mechanical and chemical thromboprophylaxis, anaesthetic group and quintile of area deprivation, stratified by 'risk group' (n=572,719 with complete information; 2,192 deaths) HRR [95% CI]	(vi) With covariate adjustment for sex, age, ASA, year of primary, fixation, mechanical and chemical thromboprophylaxis, anaesthetic group, quintile of area deprivation and BMI subgroup, stratified by 'risk group' (n=359,883 with complete information; 1,148 deaths) HRR [95% CI]
Posterior	No	394,655	1 [referent]	1 [referent]	1 [referent]	1 [referent]	1 [referent]	1 [referent]
Posterior	Yes	22,655	0.80 [0.62-1.04] P=0.101	0.88 [0.68-1.14] P=0.344	0.90 [0.69-1.17] P=0.447	0.91 [0.70-1.18] P=0.475	0.93 [0.68-1.27] P=0.644	0.87 [0.57-1.34] P=0.525
Lat/Ant-Lat/Hard	No	260,353	1.38 [1.27-1.49] P<0.001	1.14 [1.05-1.24] P=0.002	1.14 [1.05-1.23] P=0.002	1.16 [1.06-1.26] P=0.001	1.11 [1.01-1.21] P=0.027	1.15 [1.01-1.30] P=0.029
Lat/Ant-Lat/Hard	Yes	9,099	1.21 [0.87-1.69] P=0.252	1.02 [0.73-1.43] P=0.896	1.03 [0.74-1.44] P=0.847	0.91 [0.63-1.31] P=0.605	0.87 [0.58-1.31] P=0.512	0.80 [0.41-1.55] P=0.507
Ant/Other	No	26,578	1.03 [0.83-1.28] P=0.793	0.96 [0.77-1.19] P=0.703	0.96 [0.77-1.19] P=0.715	0.96 [0.78-1.20] P=0.732	0.94 [0.75-1.19] P=0.620	0.89 [0.63-1.26] P=0.509
Ant/Other	Yes	3,829	0.80 [0.43-1.50] P=0.493	0.88 [0.47-1.65] P=0.697	0.91 [0.49-1.71] P=0.780	0.92 [0.49-1.71] P=0.787	1.23 [0.61-2.47] P=0.563	1.01 [0.32-3.15] P=0.986
Trans-trochanteric	No	6,578	1.49 [1.05-2.11] P=0.026	1.19 [0.83-1.69] P=0.342	1.16 [0.81-1.65] P=0.412	1.16 [0.81-1.67] P=0.409	1.12 [0.75-1.68] P=0.571	1.12 [0.52-2.41] P=0.771
Additional pairwise comparisons:								
Lat/Ant-Lat/Hard	No vs. Yes		P=0.452	P=0.517	P=0.573	P=0.195	P=0.250	P=0.283
Ant/Other	No vs. Yes		P=0.460	P=0.807	P=0.884	P=0.885	P=0.447	P=0.833

Note: Lat/Ant-Lat/Hard = Lateral / Anterolateral / Hardinge. Ant/Other = Anterior / Other. ASA = American Society of Anesthesiologists Physical Status. BMI = body mass index.

Interpretation

Lateral approaches for THR are associated with worse outcomes, including more deaths and revisions, than the posterior approach. The conventional lateral approach (36.0%) is the second most popular approach and is currently used annually in over 20,000 primary THRs in the registry. This approach was associated with worse outcomes in all measures than the commonest approach, the conventional posterior (54.5%). The data presented here does not support its continued use over alternatives.

It would be difficult and perhaps unwise to attempt conversion of experienced surgeons to an approach with which they may be unfamiliar. However, surgeons in training should be taught alternative approaches to the lateral associated with better outcomes. The data does support continued use of minimally invasive approaches, with acceptable mortality and PROMs outcomes, although minimally invasive lateral and anterior approaches may be associated with higher revision rates than their corresponding conventional approaches.

3.7.2 What are the inpatient and day case costs following primary total hip replacement of patients treated for prosthetic joint infection: a matched cohort study using linked data from the National Joint Registry and Hospital Episode Statistics

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Background

Following total hip replacement (THR), a small percentage of patients develop a periprosthetic joint infection (PJI). PJI is a serious and debilitating complication which is associated with a negative impact on morbidity and quality of life and an increased risk of mortality. Compared to primary THR and aseptic revision, revision procedures for PJI are associated with an increased burden on healthcare providers due to longer operating times, higher readmission rates, costly repeat procedures, extended hospital admissions, more hospital outpatient appointments, and prolonged use of intravenous and oral antibiotics. Our aim was to estimate the cost to the English NHS of inpatient and day case admissions, in the five years following primary THR, of patients who were treated with a one- or two-stage revision for PJI following primary THR (revised PJI patients hereinafter), compared to patients whose THR was either not revised or revised for reasons not related to PJI (comparator patients hereinafter).

Methods

This matched cohort study utilised linked NJR and Hospital Episodes Statistics (HES) inpatient and day case admission data, from 1 April 2003 until 1 December 2014. HES data includes admissions in England funded by the English NHS, as such the analysis was limited to patients receiving NHS funded treatment in England. Eligibility criteria for inclusion in the revised PJI group included: infection as an indication for revision recorded in the NJR; a one-stage revision or at least part one of a two-stage revision for PJI, between 2006 and 2009, that occurred within five years of the primary THR; first revision for PJI on the index side; no revision PJI surgery on the non-index side during the follow-up period and complete matching variables. Eligibility criteria for inclusion in the comparator group included: a primary THR between the dates of the primary THRs of revised PJI patients; no revision for PJI on the index side reported in the NJR; no revision surgery for PJI on the non-index side during the follow-up period and complete matching variables.

Patients were matched using a combination of exact and radius (close) matching, using a one to five ratio of revised PJI to comparator patients. Patient characteristics and primary THR surgery factors that were considered to potentially impact the likelihood of PJI following THR were included. Exact matching was used for sex, ASA grade, type of replacement (total or resurfacing) and hospital. Radius matching was used for date of primary THR (one year radius) and age (ten year radius).

All inpatient and day case admissions (not limited to orthopaedic admissions) reported in HES during the five years following primary were included. HES data was cleaned and costs were estimated for each

admission using Healthcare Resource Groups and corresponding NHS reference costs, which are based on average unit costs of NHS providers.

A two-part model, which accounted for clustering of revised PJI and comparator patients within their matching group and excess zeros, was used to estimate the difference in number of stays and costs between revised PJI and comparator patients. Age, sex, ASA grade, diagnosis of osteoarthritis, operation date, Charlson Comorbidity Index, bearing surface and procedure were controlled for within the model.

Results

Between 2006 and 2009, 1,914 one- or two-stage revisions for PJI were identified in the NJR. From these, 422 patients met the inclusion criteria, had NJR data that could be linked to HES data and were matched to 1,923 comparator patients. There was balance between revised and comparator patients for variables where exact matching was employed (see Table 3.3). Other variables were moderately balanced between the two groups and were subsequently adjusted for in the analysis model.

Table 3.3 Characteristics of matched patients revised and not revised for PJI following primary THR.

Characteristics	Revised PJI group (n=422) Number (%)	Comparator group (n=1,923) Number (%)
Date of primary – range	16/05/03 - 02/12/09	28/04/03 - 01/12/09
Age - mean (range)	66 (21-95)	67 (23-92)
Female	191 (45)	891 (46)
Osteoarthritis diagnosis	398 (94)	1,862 (97)
ASA grade		
P1	69 (16)	302 (16)
P2	298 (71)	1,399 (73)
P3	55 (13)	222 (12)
Charlson		
0	275 (65)	1,415 (74)
1	97 (23)	333 (17)
2	31 (7)	104 (5)
3 or above	19 (5)	71 (4)
Procedure		
Cemented	164 (39)	782 (41)
Uncemented	158 (37)	668 (35)
Hybrid/Reverse hybrid	64 (15)	324 (17)
Resurfacing	36 (9)	149 (8)
Bearing type		
Metal-on-plastic	254 (60)	1,179 (61)
Metal-on-metal	99 (23)	354 (18)
Ceramic-on-ceramic	41 (10)	199 (10)
Ceramic-on-plastic/ metal-on-ceramic/ ceramic-on-metal	28 (7)	191 (10)
Matches per revised PJI patient		
5 matching comparator patients	358 (85)	
4 matching comparator patients	13 (3)	
3 matching comparator patients	9 (2)	
2 matching comparator patients	12 (3)	
1 matching comparator patients	30 (7)	

During the five years following primary THR, revised PJI patients had eight admissions on average, compared to an average of three admissions for comparator patients. The average cost of inpatient and day case admissions in the five years following primary THR was £41,633 (95% CI £39,079 to £44,187) for revised PJI patients and £8,181 (95% CI £7614 to £8748) for comparator patients, equating to a difference in costs of £33,452 (95% CI £30,828 to 36,077; $p < 0.00$) (see Table 3.4).

Table 3.4 Average total and annual inpatient and day case hospital admission costs over the five years following THR, by revised PJI and comparator patients.

Years	Revised PJI group (n=422) Adjusted cost £ Mean (SE)	Comparator group (n=1,923) Adjusted cost £ Mean (SE)	Adjusted difference in costs £ (95% CI)
1st year post-primary	14,686 (816)	1,959 (111)	12,727 (11,094 to 14,360)
2nd year post-primary	10,575 (682)	1,503 (91)	9,071 (7,719 to 10,424)
3rd year post-primary	6,974 (580)	1,512 (97)	5,462 (4,306 to 6,618)
4th year post-primary	5,168 (501)	1,584 (131)	3,584 (2,611 to 4,557)
5th year post-primary	4,427 (431)	1,568 (101)	2,859 (1,999 to 3,720)
Total over five years	41,633 (1,303)	8,181 (289)	33,452 (30,828 to 36,077)

Note: Marginal means after adjusting for excess zero; adjusted for age, sex, ASA grade, diagnosis of osteoarthritis, operation date, Charlson Comorbidity Index, bearing surface and procedure.
Note: SE = Standard Error.

Discussion

Over the five years following primary THR, patients who had a one- or two-stage revision THR for PJI had more hospital admissions than comparator patients on average, at an estimated additional cost of £33,452. Relative to other studies exploring the costs of PJI treatment, the sample size was large.

The inclusion criteria meant that a minority of comparator patients may have developed a PJI and received alternative treatments. The estimated cost burden therefore does not compare infected with uninfected patients but compares those revised for PJI with a one- or two-stage revision compared to those not revised for PJI. As the indication for revision is defined at the time of revision, revisions attributed to infection could be an under- or overestimate, as intraoperative results may alter the opinion of the treating surgeon.

We were able to match 94% of revised PJI patients to comparator patients. Most revision PJI patients were matched to five comparator patients; however, to maximise the sample size, revision PJI patients were still included if less than five matches were identified. The richness of the NJR dataset meant that most known confounders were included as matching variables or controlled for within the regression. The exception was body mass index, which was not included due in part to it not being included in earlier NJR data collection forms.

Inpatient and day case admissions for any indication were included, as it was acknowledged that PJI may affect other areas of patients' lives, leading to admissions for reasons not directly related to the PJI. Including outpatient, primary and community care, prescribed medications and admissions funded by the NHS outside of England would result in increased estimates of the financial burden of treating PJI.

Conclusion

This study showed that patients who develop PJI and have revision surgery cost approximately £33,000 (over five-fold) more than patients not revised for PJI, based on their hospital admissions alone. As demand for primary and revision THR is predicted to rise in future, future research should focus on finding ways to reduce the incidence of PJI following THR and finding cost-effective treatments for PJI.

3.7.3 Effect of Bearing Surface on Survival of Cementless and Hybrid Total Hip Arthroplasty: Study of Data in the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man

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Background

The effect of the bearing surface on total hip replacement (THR) survival has received a lot of attention over the last two decades and features in every report of the National Joint Registry (NJR) and other registries around the world. Polyethylene-based bearings have traditionally been associated with particle-related osteolysis which led to the development and more widespread use of hard on hard bearings. The development of cross-linked polyethylene (XLPE) has led to a marked reduction in the risk of revision of THRs utilising this bearing. In the annual NJR reports, the type of polyethylene is not stratified which leads to XLPE being merged with conventional PE and presented as a single group.

Methods

The NJR dataset and data on polyethylene manufacturing characteristics were used for the study. Primary THRs implanted between 1 January 2004 and 28 July 2016 were eligible for analysis.

Polyethylene irradiated with an irradiation dose of five or more Mrad was classified as crosslinked (XLPE). The bearing combinations analysed were: ceramic on polyethylene (CoP), metal on polyethylene (MoP), ceramic on cross-linked polyethylene (CoXLPE), metal on cross-linked polyethylene (MoXLPE), ceramicized metal on cross-linked polyethylene (CMoXLPE), and ceramic on ceramic (CoC). The primary endpoint was revision for any reason. Additional analyses were performed to investigate specific reasons for revision, such as infection, aseptic loosening, wear, dislocation, periprosthetic fracture, pain and implant fracture.

Statistical analysis

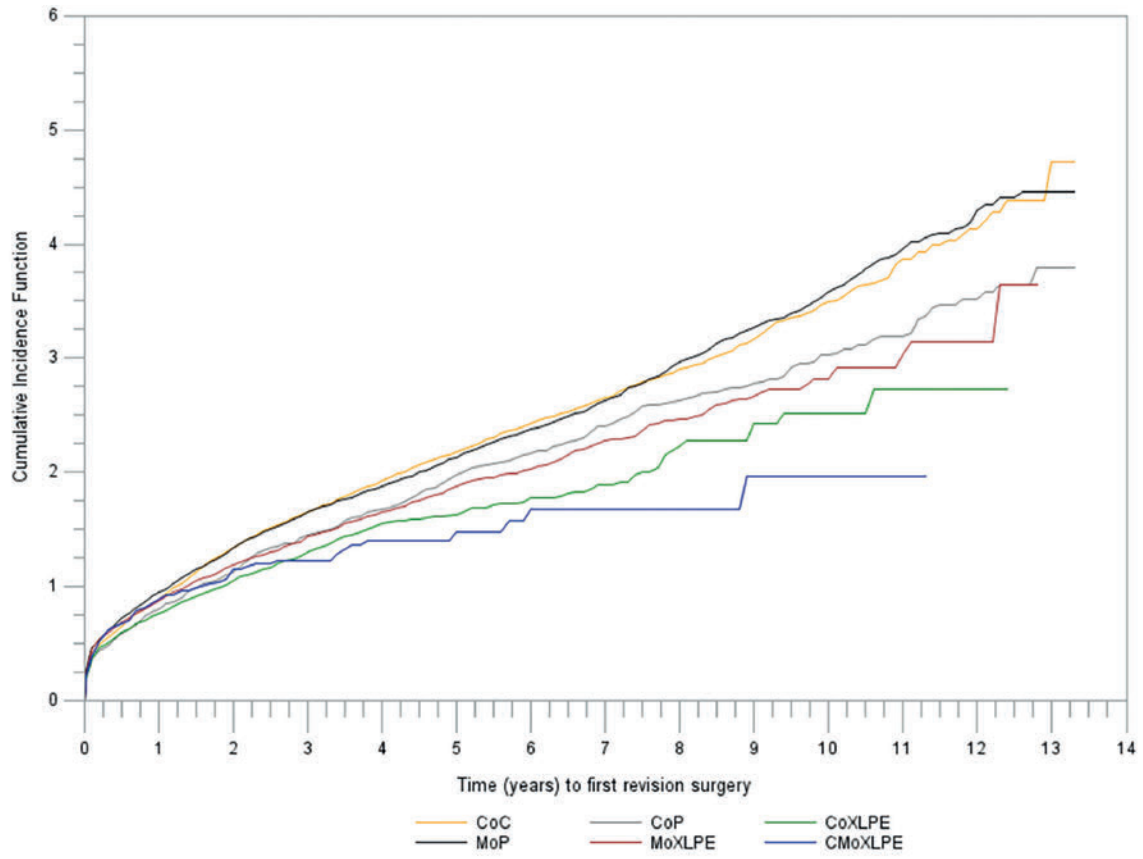
Kaplan-Meier analysis adjusted for the competing risk of death was used for overall and cause-specific revisions. Revisions for other reasons were treated as a competing risk in cause-specific analyses. A Cox proportional hazards regression model was used to obtain hazard ratios accounting for a competing risk of death.

Results

Overall risk of revision

When all patients were analysed (adjusted for a competing risk of death), the lowest cumulative incidence of revision for any reason at ten years of follow-up was 1.96% for CMoXLPE (95% CI 1.35-2.76), followed by 2.52% (95% CI 2.14-2.95) for CoXLPE, 2.81% (95% CI 2.58-3.05) for MoXLPE, 3.03% (95% CI 2.75-3.33) for CoP, 3.47% (95% CI 3.29-3.65) for CoC, and 3.53% (95% CI 3.37-3.70) for MoP (see Figure 3.2).

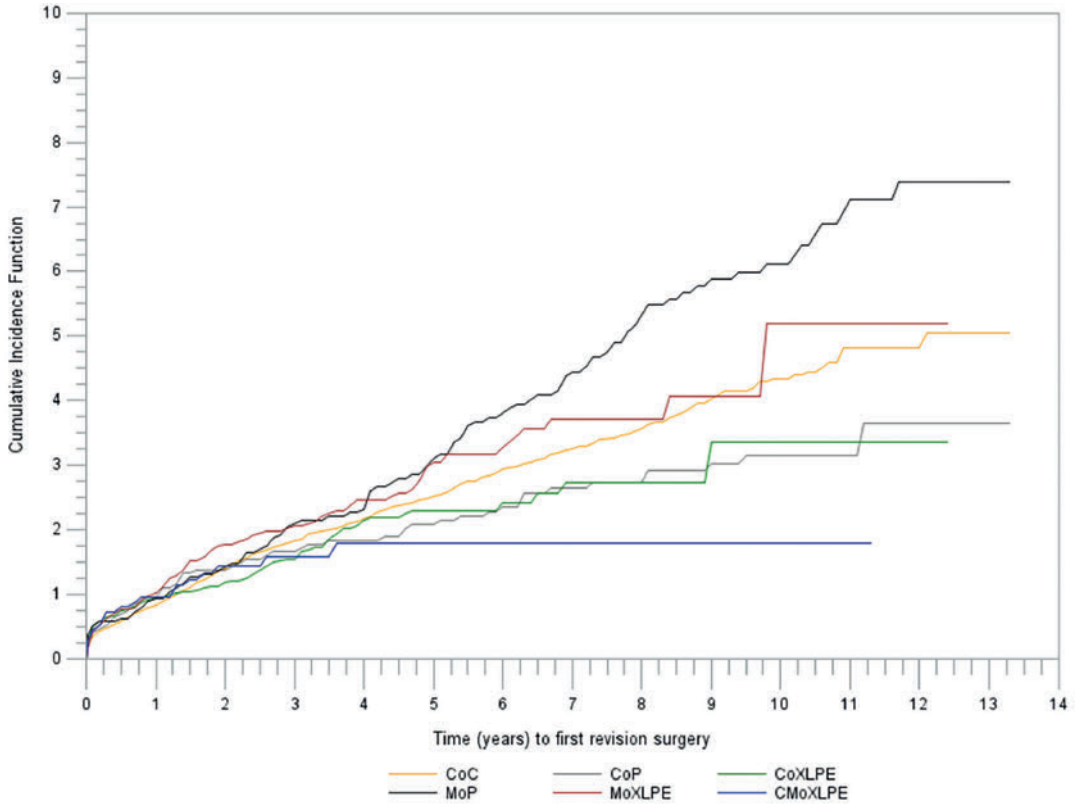
Figure 3.2 Cumulative incidence of revision for any reason by bearing combination (P<0.0001).



Patients under the age of 55

When patients under the age of 55 at the time of implantation were analysed independently, the cumulative incidence of revision at ten years was 1.80% (95% CI 1.11-2.78) for CMoXLPE, 3.16% (95% CI 2.36-4.13) for CoP, 3.35% (95% CI 2.16-4.95) for CoXLPE, 4.34% (95% CI 3.95-4.76) for CoC, 5.20% (95% CI 3.11-8.05) for MoXLPE, and 6.12% (95% CI 4.97-7.42) for MoP (see Figure 3.3 overleaf).

Figure 3.3 Cumulative incidence of revision for any reason by bearing combination in patients aged less than 55 years of age at the time of primary THR (P<0.0001).



Reasons for revision

THRs with CMoXLPE and CoXLPE bearings demonstrated the lowest risk of revision due to aseptic loosening. When revision for infection was analysed, CoP and CoC THRs had a lower risk of revision when compared to MoP THRs as the reference. A total of 1.3/1000 implants with a ceramic bearing were revised for a ceramic liner fracture.

Multivariate analysis

The Cox regression model revealed CMoXLPE and CoXLPE as the bearings with the biggest reduction in the risk of revision (see Table 3.5). A similar trend was observed when patients under the age of 55 were analysed independently. An additional Cox model was built to include head size. Due to low numbers of THRs with large heads and conventional PE, the bearings analysed were limited to CMoXLPE, CoXLPE, MoXLPE and CoC (see Table 3.6 on page 318). The lowest risk of revision for any reason was seen in THRs with CMoXLPE and CoXLPE in the model.

Table 3.5 Cox regression hazard ratios of risk of any revision by bearing combination.

Characteristic/Level	All ages (HR)	<55 years (HR)
Age		
55 to <64 years	0.85 (0.79-0.91)	
65 years to <75 years	0.73 (0.68-0.79)	
75 years and more	0.68 (0.62-0.73)	
<55 years	1.0 (reference)	
Gender		
Male	1.18 (1.13-1.23)	1.20 (1.08-1.34)
Female	1.0 (reference)	1.0 (reference)
Bearing combination		
CoC	0.77 (0.72-0.82)	0.64 (0.52-0.78)
CoP	0.74 (0.66-0.82)	0.50 (0.36-0.70)
CoXLPE	0.66 (0.60-0.72)	0.61 (0.47-0.78)
MoXLPE	0.81 (0.76-0.87)	0.77 (0.59-1.01)
CMoXLPE	0.58 (0.48-0.71)	0.47 (0.30-0.76)
MoP	1.0 (reference)	1.0 (reference)
Stem fixation		
Cementless	1.35 (1.28-1.42)	1.45 (1.26-1.68)
Cemented	1.0 (reference)	1.0 (reference)

Table 3.6 Cox regression hazard ratios of risk of any revision by bearing combination and head size.

Characteristic/Level	All causes (HR)	Dislocation (HR)	Aseptic loosening (HR)
Age			
55 to <64 years	0.82 (0.76-0.89)	0.84 (0.70-1.02)	0.79 (0.68-0.91)
65 years to <75 years	0.76 (0.70-0.82)	0.86 (0.71-1.04)	0.61 (0.52-0.71)
75 years and older	0.76 (0.69-0.84)	1.01 (0.82-1.26)	0.43 (0.35-0.53)
<55 years	1.0 (reference)	1.0 (reference)	1.0 (reference)
Gender			
Male	1.16 (1.10-1.23)	1.05 (0.93-1.19)	1.34 (1.19-1.50)
Female	1.0 (reference)	1.0 (reference)	1.0 (reference)
Bearing combination			
CoC	0.99 (0.93-1.07)	0.84 (0.72-0.99)	1.05 (0.90-1.21)
CoXLPE	0.84 (0.77-0.92)	0.90 (0.61-1.34)	0.85 (0.70-1.03)
CMoXLPE	0.75 (0.62-0.92)	0.90 (0.61-1.34)	0.52 (0.32-0.860
MoXLPE	1.0 (reference)	1.0 (reference)	1.0 (reference)
Stem fixation			
Cementless	1.33 (1.25-1.42)	1.03 (0.91-1.18)	2.26 (1.93-2.65)
Cemented	1.0 (reference)	1.0 (reference)	1.0 (reference)
Head size			
≤28 mm	1.07 (0.99-1.15)	2.13 (1.82-2.48)	0.85 (0.73-1.00)
32 mm	0.92 (0.86-0.98)	1.27 (1.09-1.47)	0.79 (0.69-0.91)
≥36 mm	1.0 (reference)	1.0 (reference)	1.0 (reference)

Discussion

Our analysis revealed that XLPE bearing THRs had a significantly lower risk of revision when compared to conventional PE (MoP). Ceramicized metal on XLPE and ceramic on XLPE were associated with the lowest risk of revision for any reason in our multivariate analysis. Due to the marked difference in the risk of revision between conventional polyethylene and crosslinked polyethylene we recommend stratification of the polyethylene-based bearings when comparing survival of THRs.

Conclusion

XLPE-based bearing THRs were associated with a marked reduction in the risk of revision at a maximum follow-up of 13 years.

3.7.4 Provision of revision knee surgery and calculation of the effect of a network service reconfiguration: An analysis from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man

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Background

Revision knee replacement (KR) is expensive, technically challenging and patients are at risk of significant complications and poor outcomes. It is well-established in primary knee surgery (total and partial) that higher surgeon volume is associated with lower complication rates, lower revision rates and lower mortality rates. Evidence is becoming available for revision surgery; analysis of >17,000 revision hip cases showed that low volume centres (<13 cases per year) had significantly worse 90-day mortality and 1-year re-revision rates than high-volume centres and analysis of ~25,000 revision knee cases showed decreased re-revision rates in high volume centres. Analysis of >30,000 hip and knee revision cases showed lower complication rates and lower 90-day re-admission rates in high volume centres. Although these reports point towards a volume-outcome relationship in revision KR, the precise level remains a research question.

Centralisation of complex services has occurred within and beyond orthopaedics. Major trauma care has been organised into specialist trauma units and major trauma centres, and in England the 'Getting It Right First Time' (GIRFT) initiative has delivered recommendations on service organisation and infrastructure for units undertaking complex, specialist orthopaedic work. In response to GIRFT recommendations, the British Association for Surgery of the Knee (BASK) set up a working group in revision KR surgery. Part of the group's remit was to undertake an exploratory analysis using summary NJR data to 1) describe the current provision of revision KR in England and Wales at the individual surgeon and unit level; and 2) investigate the effect on workload of case distribution in a network model.

Methods

A data extract was obtained from the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man containing all knee procedures coded on a K2 form during 2016, 2017 and 2018 (three years total data). To calculate individual surgeon workload, procedures performed at both NHS and independent sites were combined.

The effect of service re-organisation into a network model was undertaken by assigning each NHS site to one of 13 geographical regions, corresponding to regions used by the NJR. Based on their current annual revision workload, units within each region were categorised as either a Major Revision Centre (MRC), Revision Unit (RU) or Primary Arthroplasty Unit (PAU). MRCs were defined as those undertaking >210 revisions over three years (>70 revision KR per year). Revision Units were defined as units undertaking an average of ≥70 procedures over three years, giving an average minimum volume of >20 per year. These thresholds were set based on 1) analysis of literature examining the relationship between volume and outcome that suggests units undertaking <25 KR per year have increased early complication rates, higher 90-day readmission rates and higher re-revision rates; and 2) a need to have at least one MRC and several RUs in each region. For this analysis the threshold was reduced to 20 per unit to allow an increase in unit volume after workload re-allocation to boost units above 25 cases per year. Primary Arthroplasty Units were all other units (<20 revision KR/year).

In total 25 MRCs, 82 RUs and 125 PAUs were identified and used for calculations. Work currently done by PAUs was re-assigned to MRCs and RUs evenly (number of units in a region divided by re-

allocated cases). For example, 100 cases at PAUs in a region with ten revision centres (two MRCs and eight RUs) would result in 10 additional cases per MRC/RU per year.

Main findings

There were 20,857 revision KR procedures recorded on the NJR between 2016 and 2018 (three years) across 232 NHS (18,355 cases, 88%) and 167 independent healthcare provider sites (2,502 cases, 12%). In total 1,353 surgeons performed at least one revision KR procedure over this time period.

The median annual surgeon volume was 2.3±0.2 cases per year (Range 0-56) (see Figure 3.4). The majority of surgeons performed small numbers of revision procedures with 1,020 (75%) surgeons performing <7 revisions per year (see Table 3.7). Overall, 209 of 1,353 surgeons performed ≥10/year (56% of total work, 15.8% of surgeons) and 100 surgeons performed ≥15/year (36% of total work, 7% of surgeons). A total of 64 surgeons performed ≥20/year and 19 performed ≥30/year. Overall, the highest volume 397 (29%) surgeons performed 75% of the revision KR workload.

Figure 3.4 Individual surgeon volume.
Surgeons' individual volume, including procedures undertaken at NHS and independent sites, over three years. More than 1,300 surgeons undertook at least one revision KR procedure; 100 surgeons carried out >44 procedures over three years, accounting for 37% of national procedure volume (indicated by the black arrow).

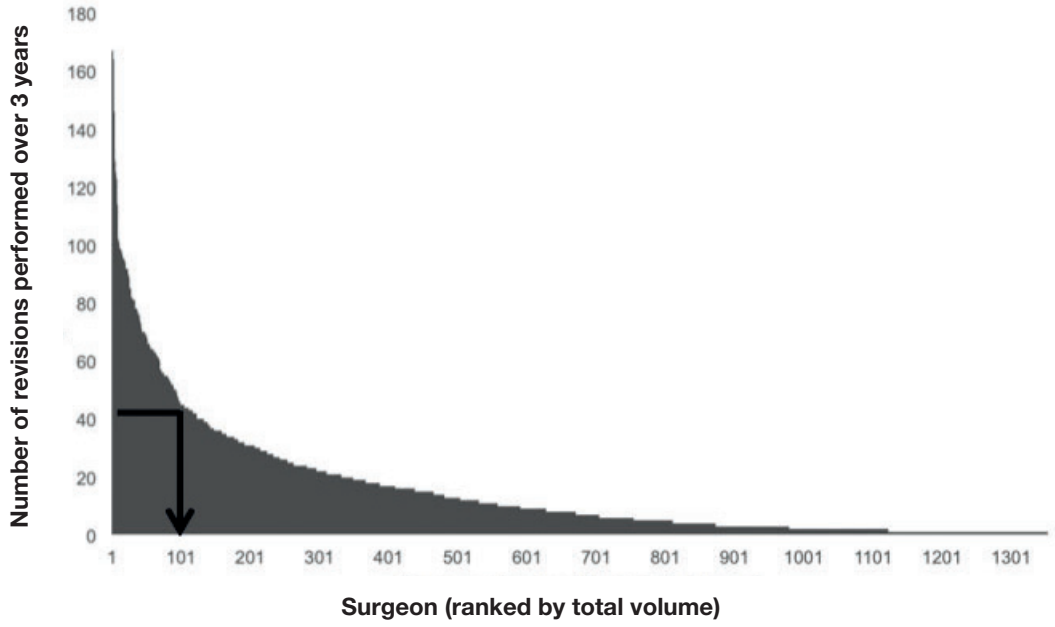
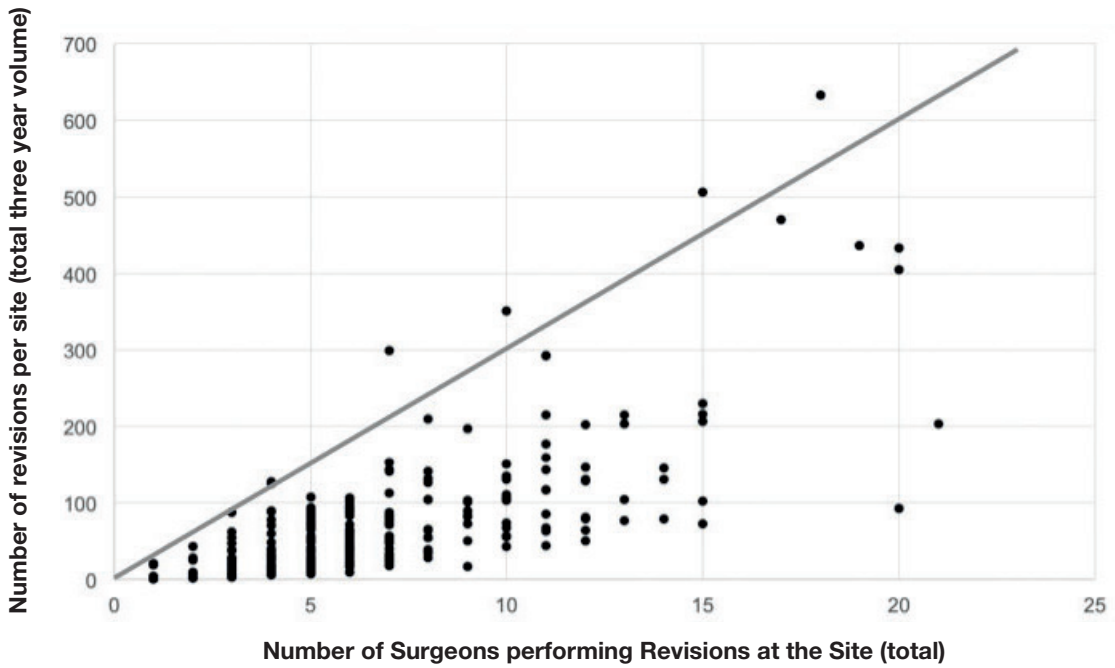


Table 3.7 Revision surgeon volume, average annual number of revisions (2016-2018).

Annual volume	Number of surgeons
0 – 4	872
5 – 9	257
10 – 14	113
15 – 19	41
20 – 24	29
25 – 29	16
30 – 39	18
40+	7
Total	1,353

The median NHS site annual volume over three years was 51 cases, equating to a mean of 18.3±1.3 cases (range 1-211) per year. Overall 15 sites performed ≥70/year, 92 performed 20-69 and 125 performed <20/year. Comparing surgeon number against revision volume for each site (see Figure 3.5) shows that most centres had a large number of surgeons undertaking a small number of procedures. Five sites were identified (of 232, 2%) where mean surgeon volume across all revision surgeons was >10 cases per year.

Figure 3.5 Site versus surgeon volume.
The number of surgeons undertaking revision KR procedures at each site (NHS only) versus total site volume (three years total data). The black line plots a threshold at an average of ten procedures for each surgeon per year; 5/232 sites hit this threshold and sit above the line.



Even redistribution of caseload from PAUs to MRCs/RUs is shown in Table 3.8. Ten mid-volume units were made MRCs to allow each region to have at least one MRC unit for the purpose of the model, giving 25 MRC units for calculations. In total 1,235 revisions (21%) were reallocated from PAUs (for each individual region the range was 19-174, 18%-36%). Amongst 25 MRCs and 85 RUs there was an average increase in MRC workload of 11 procedures (range 6-14) per year. All MRCs and RUs had a revision rate for their primary knee arthroplasties 'as expected' or 'better than expected' (2014-2019).

Table 3.8 The effect of MRC-RU reconfiguration on centre volume.

Region	Total revisions in region (annual)	Percentage of region in Primary Arthroplasty Units	No. of revisions to be absorbed (annual)	No. of Major Revision Centres (MRC)	No. of Revision Units (RU)	No. of Primary Arthroplasty Units (PAU)	Average additional revisions per unit (annual)
East Midlands	445	22%	80	1	5	7	13
Eastern	484	34%	124	2	8	8	12
London	627	29%	141	3	10	21	11
Mid and West Wales	88	27%	19	1	2	3	6
North East	397	21%	70	2	7	7	8
North West	654	36%	174	3	13	21	11
South Central	610	26%	126	2	7	8	14
South East Coast	500	25%	98	2	8	10	10
South East Wales	200	22%	36	1	2	4	12
South West	611	18%	94	2	8	7	9
West Midlands	746	20%	124	3	7	12	12
Yorkshire	594	33%	148	3	8	14	13
Total	**5,956**	**21%**	**1,235**	**25**	**85**	**122**	**11**

Discussion

Revision KR surgery is expensive for healthcare providers and challenging for the clinical team. It is well established that increasing surgeon and centre volume improves cost-effectiveness and outcomes. Here we report the current provision of revision KR in England, Wales and Northern Ireland using descriptive data from the NJR and describe the effect of implementing GIRFT ideals and moving revision KR from low volume centres to higher volume units.

We found many surgeons performing a small number of procedures; more than 1,000 surgeons performed <7 procedures per year. In addition to a large number of low volume surgeons there were a large number of low volume units. This finding is similar to work published almost ten years ago describing volumes of revision knee procedures using NJR data and demonstrates little has changed over the last decade despite the introduction of clinical networks and the GIRFT initiative.

To help further the discussion around service reconfiguration we developed a hypothetical model using thresholds for unit volume to investigate the effect of a network model for revision KR work. This had the aim of minimising the number of procedures performed in low volume centres by low volume surgeons and was achieved by distributing these complex cases across the regional network. The estimated alteration in work resulting from creation of 122 PAUs (with current volumes <20-30 cases per year) was, on average, 11 cases for MRC/RUs. An additional effect of this change was that all revision units would reach a volume threshold of 30 cases per year. Although this would appear to be a manageable additional workload, representing an approximate 20% increase in revision KR procedures across the system for centres that continue to perform knee revisions, the precise redistribution of cases between MRCs and RUs will depend on case complexity.

There are limitations to the study. The NJR does not allow stratification by case complexity; we are unable to distinguish between the conversion of a unicompartmental replacement to a total knee replacement, from a complex revision for infection requiring stems, augments and extensor mechanism reconstruction. We therefore do not understand the case-mix for these low volume surgeons and units.

Conclusions

Data presented here demonstrates that currently in England and Wales a number of surgeons undertake a small number of revision KR procedures in a large number of low volume units. High volume surgeons and centres do already exist, creating a pre-fabricated network for the implementation of a network model of care. Creating referral centres from low volume units and redistributing this work showed that the scale of the uplift would be manageable and would have the positive effect of raising centres above a 30/year threshold.

3.7.5 The association between surgical volume and failure of primary total hip replacement in England and Wales: Findings from a prospective national joint replacement register

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BMJ Open 2020;10:e033045 DOI: **https://doi.org/10.1136/bmjopen-2019-033045**

Background

Centralisation and specialisation in medical care are advocated to optimise a theorised volume-outcome relationship i.e. higher volume surgeons and units are associated with better outcomes. Despite the prevailing wisdom of such an association, evidence to support the volume-outcome relationship in total hip arthroplasty (THA) is sparse. In addition, investigating the volume-outcome relationship is technically difficult due to the computationally intensive methods required to calculate a time varying volume exposure.

Differentiating between-consultant and within-consultant effects is crucial to interpreting the data. A between-consultant effect is essentially a cross-sectional analysis that compares the performance of one consultant against another and is highly likely to be confounded by centre level effects. A within-consultant effect is based on individual time series data and compares changes of volume across time within the same consultant. Correspondingly, within-consultant effects can be interpreted more strongly, as the effect of changing a consultant's personal volume, assuming centre-level factors remain relatively constant over the short-term analysis period. The concept of between-effect and within-effects is well known in epidemiology, and often referred to as the ecological fallacy.

The aim of this research is to investigate the between-consultant and within-consultant (surgeon) effect of the volume of primary THA for osteoarthritis (OA) and the risk of subsequent revision.

Methods

Using data from the National Joint Registry of England, Wales, Northern Ireland and the Isle of Man (NJR), we investigated the association between consultant surgical volume in the year (365 days) prior to the index operation of interest, and the risk of revision in patients undergoing elective primary THA between 1 April 2003 and 22 February 2017.

The primary outcome of interest was all cause revision after a primary THA.

The primary exposure of interest in this study was the consultant surgical volume of any primary THA recorded in the NJR in the preceding 365 days prior to the index procedure in consenting patients i.e. time varying volume.

Models were incrementally adjusted for patient factors (age, gender, ASA grade, funder), operation factors (fixation, approach, position, anaesthetic type, thrombo-prophylaxis, bearing, year of surgery), centre factors (private or public, centre surgical volume), consultant factors (training status, proportion of NHS THA conducted in previous year, proportion of THAs performed compared to all other joints), and deprivation (English and Welsh IMD).

Statistical analysis was performed using a multi-level parametric (Weibull) survival model. Volume effect was parametrised using restricted cubic splines. Analyses were performed in Stata 15.1.

Results

Of the 579,858 patients undergoing primary THA (mean baseline age 69.8 years [SD 10.2]), 61.1% were female. Figure 3.6 illustrates the distribution of within-consultant and between-consultant volume across the NJR. Figure 3.7 illustrates individual consultant and unit level variation in volume of procedures recorded by the NJR. Figures 3.8 and 3.9 show the results from multi-level survival models, they demonstrate differing results for between-consultant and within-consultant effects. There was a strong volume-revision association between consultants (a cross-sectional association) with a near linear 43.3% (95% CI 29.1%-57.4%) reduction of the risk of revision comparing consultants with volumes between 1 and 200 procedures annually. Changes in individual surgeons (within-consultant) case volume showed no evidence of an association with revision. Adjustment for confounding factors made little difference to the reported associations.

Figure 3.6 Empirical cumulative distribution and frequency distribution of (between) mean consultant volume and (within) individual centred volume of hip arthroplasty in the previous 365 days. Grey horizontal hashed lines indicate the 2.5th, 25th, 50th, 75th and 97.5th centiles of the distribution, vertical hashed lines indicate mean and centred consultant volume at 2.5th, 25th, 50th, 75th and 97.5th centiles, respectively.

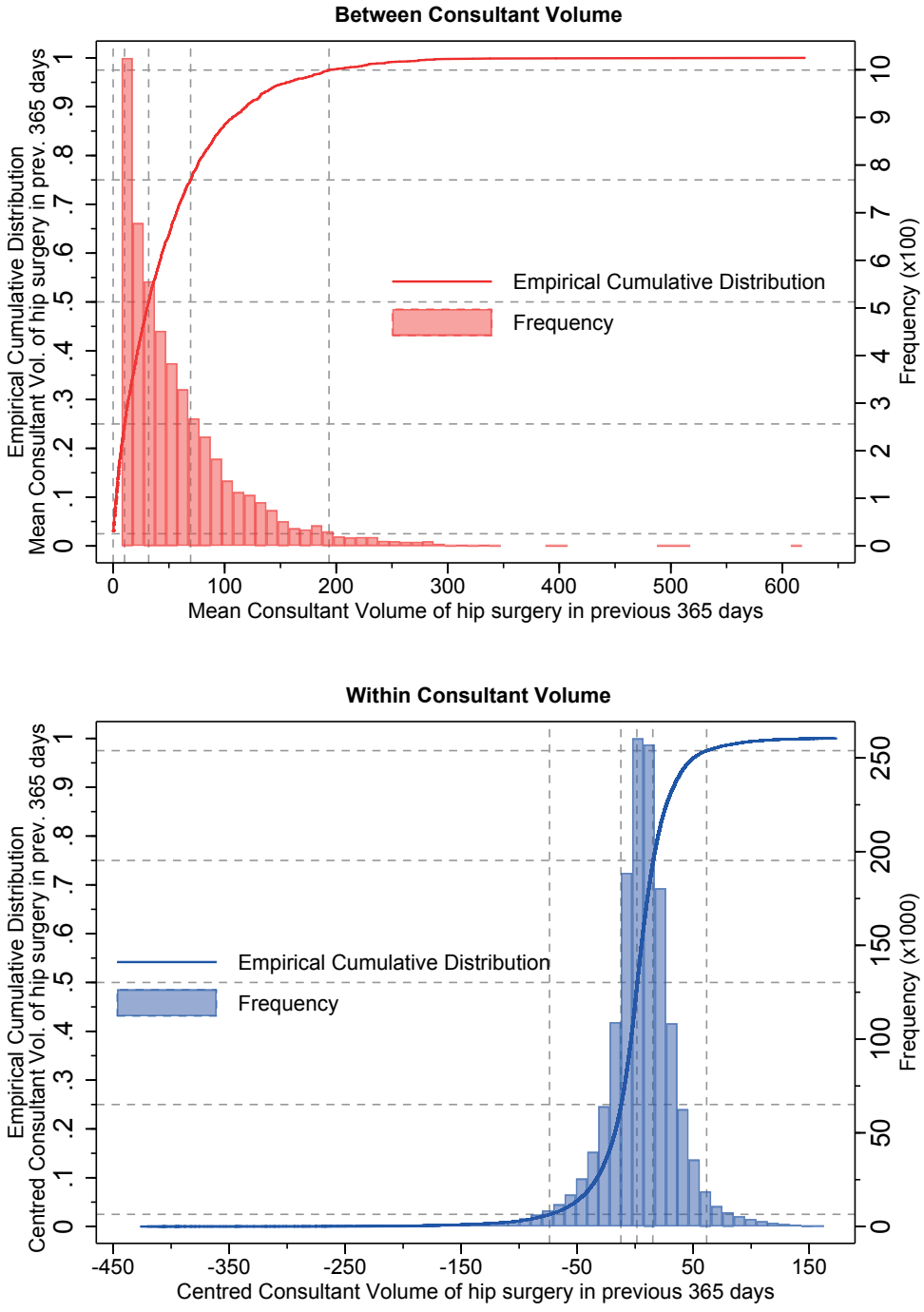


Figure 3.7 Mean, IQR and 95th centile range of consultant and centre volume of hip arthroplasty in the previous 365 days recorded in the NJR by individual consultant and individual unit, respectively.

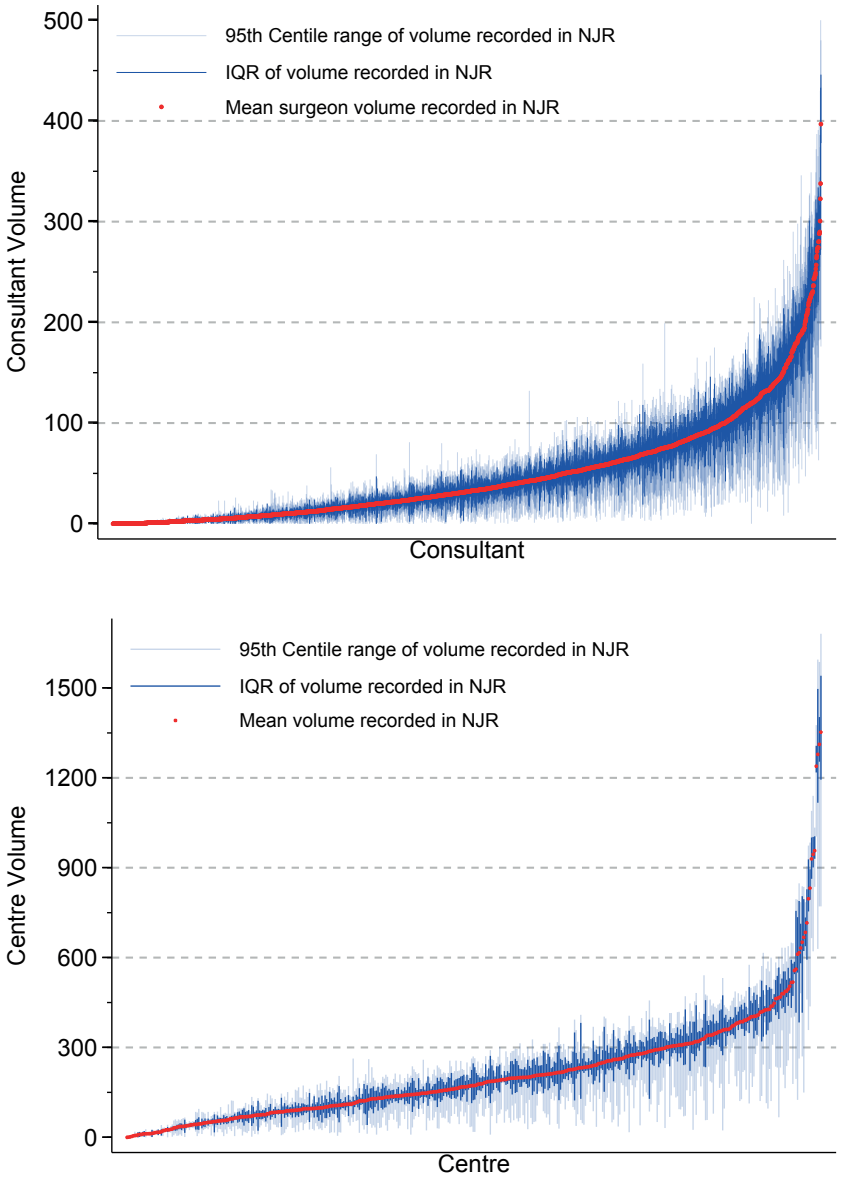


Figure 3.8 Between-consultant marginal association of hip surgical volume in the preceding 365 days and hazard of revision arthroplasty unadjusted (M1) and adjusted (M5) for confounding factors in a multilevel model (MLM). Patient factors include sex, American Society of Anesthesiologists grade and funder. Operation confounding factors include fixation, approach, position, anaesthetic, mechanical and chemical thromboprophylaxis, bearing and year of operation. Centre confounding factors include hospital location and centre volume in the preceding 365 days. Surgeon confounding factors include lead operating surgeon, listing of a surgeon within National Joint Registry prior to 2008, the proportion of National Health Service cases in the preceding year and proportion hip arthroplasty procedures undertaken in the previous year.

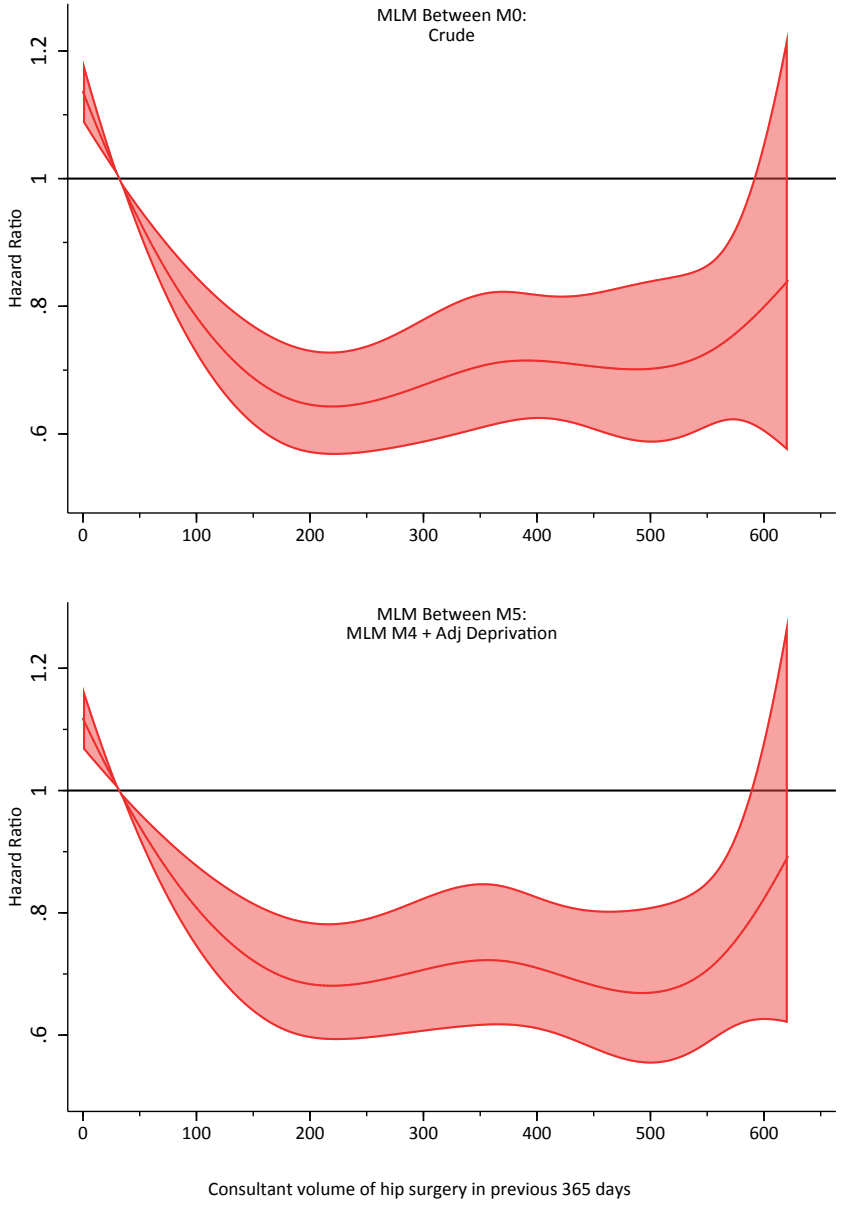
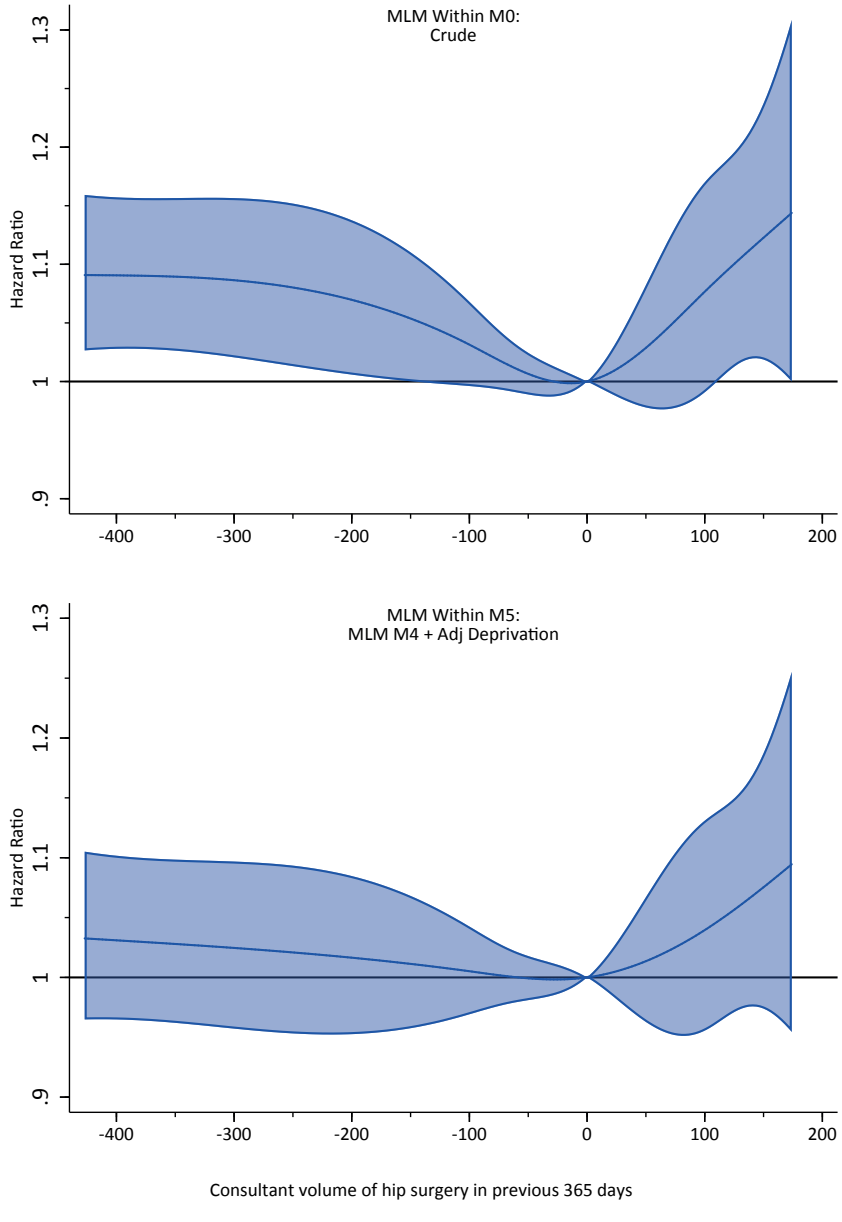


Figure 3.9 Within-consultant marginal association of hip surgical volume in the preceding 365 days and hazard of revision arthroplasty unadjusted (M1) and adjusted (M5) for confounding factors in a multilevel model (MLM). Patient factors include sex, American Society of Anesthesiologists grade and funder. Operation confounding factors include fixation, approach, position, anaesthetic, mechanical and chemical thromboprophylaxis, bearing and year of operation. Centre confounding factors include hospital location and centre volume in the preceding 365 days. Surgeon confounding factors include lead operating surgeon, listing of a surgeon within National Joint Registry prior to 2008, the proportion of National Health Service cases in the preceding year and proportion hip arthroplasty procedures undertaken in the previous year.



Discussion

We provide novel insights into the volume-outcome relationship of 579,858 elective THA patients using a between-decomposition and within-decomposition to analyse the association of consultant volumes on revision. Uniquely, we use a time-varying volume specification that facilitates the decomposition of between-consultant and within-consultant effects. We suggest the within-consultant effect is much closer to the causal interpretation desired by many policymakers, and failure of research to recognise the difference amongst between-effects and within-effects may lead to erroneous policy decisions and unintended consequences.

We demonstrate that optimal between-consultant results are reached when the consultant volumes in the previous year are approximately 200 procedures. We suggest these factors are not causally related to volume, but rather due to unmeasured surgeon, patient and/or centre factors. There is no evidence to suggest that consultants should change their personal volume in the hope of improving their outcomes or that there is an arbitrary threshold where the outcome of results become good.

We suggest the within-consultant effect from the multi-level regression is much closer to the causal interpretation required by consultants, patients, and policymakers i.e. what is the effect of changes in personal volume on the hazard of revision THA? This is not to say the between-effect is not of interest to policy makers, but to say that the between-effect suggests that there are intrinsic differences between high and low volume consultants i.e. expertise, where higher volume consultants tend to have better outcomes, but these differences cannot be attributed to volume per se. We suggest our analyses illustrate "state vs. trait" behaviour. Where between-consultant association illustrates the "traits" of surgeons, and within-consultant associations illustrate their "state". This is to say, traits of experienced high-volume surgeons with good outcomes are unaffected by changes to their personal volume. Conversely, low volume arthroplasty consultants who transiently increase their personal volume do not improve their outcomes.

Conclusion

In summary, using data from the largest arthroplasty register in the world, we have demonstrated that there is no within-consultant association between surgical volume in the previous year and the risk of revision in patients undergoing primary THA for OA. Whereas there is strong evidence to suggest higher volume consultants tend to have better outcomes for reasons that are unlikely to be due to the volume of arthroplasty performed by the individual consultant in the previous year per se.

The results from this study have profound implications for quality improvement within healthcare. Encouraging consultants to undertake a minimum number of procedures under the guise of raising standards could be counterproductive and may only serve to expose patients to increased risk of revision by low or previously low volume consultants. Centralisation and specialisation of THA in consultants who, for reasons not including volume, can undertake a greater number of procedures is likely to benefit patients and reduce the revision burden overall. Encouraging or training low volume consultants to use prosthesis combinations with better outcomes may be a more effective method of improving outcomes for patients.

Published papers 2020-2021

Details of published analyses that have been sanctioned by the NJR Research Committee between April 2020 and March 2021. NJR data is available for research purposes following approval by the NJR Research Committee. For further details please visit the NJR website at **www.njrcentre.org.uk**.

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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 2020 calendar year. Outcomes analysis after hip and knee replacement surgery is also provided for the period 2011 to 2021.

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 NJR Implant Scrutiny Committee reports Level 1 outlier implants to the MHRA. There are currently 11 hip stems, nine hip acetabular (cup) components and 29 hip stem / cup combinations reported. A total of 14 knee brands are currently reported. Knee implants with and without patella resurfacing are now 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	2.11	2011	2009
S-ROM Cementless stem*	3,647	1.21	2013	Still in use
Adept Cementless stem*	228	1.89	2017	2010
Freeman Cementless	330	1.24	2019	2010
DePuy Proxima	341	1.31	2019	2014
Twinsys Cementless Stem	1,065	1.11	2019	2018
Alloclassic Cementless Stem	265	1.17	June 2020	Still in use
ESOP Stem	100	1.39	June 2020	2017
Bimetric Cementless Stem	4,947	0.87	February 2021	2019
SP II Cemented Revision	116	1.53	February 2021	Still in use

*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*	6,279	3.68	2010	2010
Ultima MoM cup*	194	1.68	2010	2006
R3 with metal liner**	151	2.88	2011	2011
M2A38*	1,489	1.67	2014	2011
Delta One TT	519	1.40	2015	Still in use
Trabecular Metal Revision Shell	419	1.43	2017	Still in use
seleXys TH+	184	1.70	2018	2011
Pinnacle with metal liner**	15,601	1.32	2018	2013
MIHR cup*	257	1.82	2019	2011

*Inclusion here is mainly due to metal-on-metal combinations.
**Metal-on-metal.

Table 4.3 Level 1 outlier stem / cup combinations reported to MHRA.

Combination	Number implanted	Latest PTIR	Notified as outlier	Last implanted
ASR Resurfacing Head / ASR Resurfacing Cup*	2,919	2.58	2010	2010
Metafix Stem / Cormet 2000 Resurfacing Cup*	173	2.50	2010	2011
CPT CoCr Stem / Adept Resurfacing Cup*	268	3.01	2011	2010
Corail / ASR Resurfacing Cup*	2,745	5.06	2011	2010
CPT CoCr Stem / BHR Resurfacing Cup*	117	2.42	2011	2010
Accolade / Mitch TRH Cup*	274	2.56	2011	2011
Summit Cementless Stem / ASR Resurfacing Cup*	128	4.42	2012	2009
CPT CoCr Stem / Durom Resurfacing Cup*	185	2.22	2012	2009
S-Rom Cementless Stem / ASR Resurfacing Cup*	148	3.66	2012	2010
CPCS / BHR Resurfacing Cup*	256	1.43	2012	2010
Anthology / BHR Resurfacing Cup*	513	2.71	2012	2011
SL-Plus Cementless Stem / Cormet 2000 Resurfacing Cup*	628	2.18	2013	2010
Profemur L Modular / Conserve Plus Resurfacing Cup*	164	2.40	2013	2010
Bimetric Cementless Stem / M2A 38*	1,303	1.70	2014	2011
Corin Proxima / Cormet 2000 Resurfacing Cup*	102	2.19	2015	2009
Synergy Cementless Stem / BHR Resurfacing Cup*	1,590	2.02	2016	2011
Adept Cementless Stem / Adept Resurfacing Cup*	201	2.01	2017	2010
Exeter V40 / Trabecular Metal Revision Shell	211	1.26	2017	2017
CLS Spotorno Cementless Stem / Adept Resurfacing Cup*	218	2.54	2017	2011
Spectron / Opera	216	1.06	2018	2014
Exeter V40 / Mitch TRH Cup*	121	1.54	2018	2010
Twinsys Cementless Stem / Adept Resurfacing Cup*	130	2.04	2018	2010
CLS Spotorno Cementless Stem / Durom Resurfacing Cup*	929	1.59	2018	2018
S-Rom Cementless Stem / Pinnacle*	2,085	1.24	2018	Still in use
S-Rom Cementless Stem / Ultima Mom Cup	105	1.46	2019	2005
Taperloc Cementless Stem / M2A 38*	138	1.47	2019	2010
Versys FMT Cementless Stem / Durom Resurfacing Cup*	182	1.43	2019	2010
Restoration Cementless Stem / Tritanium	119	2.87	June 2020	Still in use
Furlong HAC Stem / MIHR Cup	134	1.40	June 2020	2010

© National Joint Registry 2021

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	248	1.68	2009	2008
Tack	231	1.57	2009	2008
St Leger	104	1.64	2011	2005
Journey Deuce	151	2.44	2014	2013
SLK Evo	103	1.72	2016	2013
ACS	203	1.57	2017	Still in use
Journey Oxinium	832	0.99	2017	2014
Smiles (METS hinged/linked knee)*	842	1.45	2018	Still in use
Endo-Model Modular Rotating Hinge*	245	2.04	2019	Still in use
Journey II BCS Oxinium without primary patella	713	1.50	June 2020	Still in use
E-Motion Bicondylar Knee with primary patella	329	1.24	June 2020	Still in use
Genesis II Oxinium without primary patella	5,346	0.83	February 2021	Still in use
LCS PFJ	223	4.81	February 2021	2010
RHK without primary patella	185	1.30	February 2021	2018
Genesis II Oxinium posterior stabilised	3,544	0.89	July 2021	Still in use

*Hinged knee prostheses are more often used in complex primaries, when compared to all total knee replacements.
Note: Analysis of knee replacements with and without patella resurfacing commenced in March 2020. Analysis by constraint (CR/PS/Constrained) commenced in March 2021.

Best performing knee implants

There are no knee implants performing statistically less than half their expected PTIR.

4.2 Clinical activity

Overall in 2020, 141 NHS trusts and local health boards (comprising 256 separate hospitals) and 177 independent hospitals were open and eligible to report patient procedures to the registry. Data were not submitted in 2020 by five NHS hospitals (including two trauma units) and two independent hospitals. Due to the COVID-19 pandemic, hospitals were directed at the end of March 2020 to cease inputting records to audits and to divert staff to higher priority tasks, therefore a number of elective procedures were not initially reported as data entry activity wasn't then resumed until July that year. It is expected that these procedures will be identified by units and entered retrospectively or submitted as part of our ongoing audit programme.

Compliance is measured by comparing the proportion of all joint replacements entered into the registry, with those submitted to the Hospital Episodes Statistics (HES) and Patient Episode Database Wales (PEDW) services. These data rely on submissions by hospitals and are only available by NHS trust. No data are currently available from private providers and figures also exclude units in Northern Ireland as compliance data are not available.

- 37% of NHS hospitals in England and Wales reported 95% or more of the joint replacements they undertook
- 37% reported between 80% to 95%
- 26% reported less than 80%

Of those hospitals submitting data, the proportion of patients who gave permission (consent) for their details to be entered into the registry were:

NHS hospitals

- 33% of NHS hospitals achieved a consent rate of greater than 95%
- 36% achieved a consent rate of 80% to 95%
- 31% recorded a consent rate of less than 80%

Independent hospitals

- 57% of independent hospitals achieved a consent rate greater than 95%
- 30% achieved a consent rate of 80% to 95%
- 13% recorded a consent rate of less than 80%

There has been a decrease in recorded consent for all submitting units when compared to the previous year, with those achieving a higher than 95% rate falling to 43% from 56% in 2019. The proportion of all units achieving a higher than 80% consent rate, has increased slightly. This reduction in consent rate can be related to the ratio of elective to trauma cases, which changed significantly during 2020, having a higher proportion of trauma cases compared to previous years. There was a significant reduction in elective cases due to COVID-19 and trauma cases have a higher rate where NJR consent is not obtained.

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

- 81% achieved a proportion of patients with a linkable NHS number greater than 95%
- 17% achieved a proportion of 80% to 95%
- 2% recorded a proportion of less than 80%

Independent hospitals

- 68% achieved a proportion of patients with a linkable NHS number greater than 95%
- 25% achieved a proportion of 80% to 95%
- 7% recorded a proportion of less than 80%

There has been a drop in linkability from 2019, with the percentage of submitting units achieving over 95% in 2020 falling from 80% to 76%. The proportion achieving a greater than 80% linkability rate has increased slightly to 20% compared with 17% in 2019. The drop in linkability is related to the fall in consent rate.

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 2011 to 2021

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 34 hospitals reported higher than expected rates of revision for knee replacement, and 23 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 13 hospitals reporting higher than expected rates for knees, and 11 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, we reported outlying hospitals based on all cases submitted to the registry since 1 April 2003. To reflect changes in hospital practices and component use, we now report outlying hospitals based on the last ten years (13 February 2011 to 13 February 2021) and five years of data (13 February 2016 to 13 February 2021 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 2016[2].

Hospital name
None identified

Table 4.6 Outliers for knee mortality rates since 2016[2].

Hospital name
None identified

Table 4.7 Outliers for hip revision rates, all linked primaries from 2011[1].

Hospital name
BMI Clementine Churchill Hospital (Middlesex)
BMI The Meriden Hospital (West Midlands)
Bradford Royal Infirmary
Broadgreen Hospital
Chorley and South Ribble Hospital
Colchester General Hospital
Fitzwilliam Hospital (Cambridgeshire)
Homerton University Hospital
Hospital of St Cross
Milton Keynes Hospital
North Downs Hospital (Surrey)
Nuffield Orthopaedic Centre
Orthopaedics and Spine Specialist Hospital (Cambridgeshire)
Salisbury District Hospital
South Tyneside District Hospital
Southampton General Hospital
Spire Hartswood Hospital (Essex)
St Richard's Hospital
Sussex Orthopaedic NHS Treatment Centre
The Tunbridge Wells Hospital
Wansbeck Hospital
Watford General Hospital
Weston General Hospital

Table 4.8 Outliers for hip revision rates, all linked primaries from 2016[2].

Hospital name
Castle Hill Hospital
Clifton Park Hospital (North Yorkshire)
Darent Valley
Fulwood Hall Hospital (Lancashire)
Hexham General Hospital
Milton Keynes Hospital
North Tyneside General Hospital
Nuffield Orthopaedic Centre
Southampton General Hospital
Wansbeck Hospital
Weston General Hospital

Table 4.9 Outliers for knee revision rates, all linked primaries from 2011[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
County Hospital Louth
Ealing Hospital
Guy's Hospital
Heatherwood Hospital
Hillingdon Hospital
Hinchingbrooke Hospital
King Edward VII's Hospital Sister Agnes (Greater London)
Mount Vernon Treatment Centre
Nevill Hall Hospital
Nuffield Health Chichester Hospital (West Sussex)
Nuffield Orthopaedic Centre
Orthopaedics and Spine Specialist Hospital (Cambridgeshire)
Peterborough City Hospital
Queen Elizabeth The Queen Mother Hospital
Southampton General Hospital
Southmead Hospital
Spire Hull and East Riding Hospital (East Yorkshire)
Spire Southampton Hospital (Hampshire)
Springfield Hospital (Essex)
St Mary's Hospital (Isle of Wight)
St Richard's Hospital
Sussex Orthopaedic NHS Treatment Centre
The Royal National Orthopaedic Hospital (Stanmore)
Torbay Hospital
University College Hospital
University Hospital Llandough
York Hospital

Table 4.10 Outliers for knee revision rates, all linked primaries from 2016[2].

Hospital name
BMI Bath Clinic (Avon)
BMI The South Cheshire Private Hospital (Cheshire)
Guy's Hospital
Hillingdon Hospital
King Edward VII's Hospital Sister Agnes (Greater London)
Nuffield Orthopaedic Centre
Practice Plus Group Hospital - Barlborough (Derbyshire)
Queen Elizabeth The Queen Mother Hospital
Southmead Hospital
Spire Bushey Hospital (Hertfordshire)
Springfield Hospital (Essex)
The Royal National Orthopaedic Hospital (Stanmore)
Yeovil District Hospital

Note: 1 Date range 13 February 2011 to 13 February 2021 inclusive. 2 Date range 13 February 2016 to 13 February 2021 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 hip revision rates, all linked primaries from 2011[1].

Hospital name
Calderdale Royal Hospital
Ipswich Hospital
Musgrave Park Hospital
Royal Derby Hospital
Royal Devon and Exeter Hospital (Wonford)
Royal Surrey County Hospital
Sunderland Royal Hospital

Table 4.12 Better than expected hip revision rates, all linked primaries from 2016[2].

Hospital name
Calderdale Royal Hospital
Musgrave Park Hospital
Ulster Independent Clinic (Belfast)

Table 4.13 Better than expected knee revision rates, all linked primaries from 2011[1].

Hospital name
Bishop Auckland Hospital
Burnley General Hospital
Claremont Hospital (South Yorkshire)
Craigavon Area Hospital
Hexham General Hospital
Ipswich Hospital
Musgrave Park Hospital
Norfolk and Norwich Hospital
North Tyneside General Hospital
Nottingham Woodthorpe Hospital (Nottinghamshire)
Nuffield Health Cambridge Hospital (Cambridgeshire)
Nuffield Health Derby Hospital (Derbyshire)
Nuffield Health Ipswich Hospital (Suffolk)
Princess Alexandra Hospital
Spire Norwich Hospital (Norfolk)
Stepping Hill Hospital
The Elective Orthopaedic Centre

Table 4.14 Better than expected knee revision rates, all linked primaries from 2016[2].

Hospital name
Ipswich Hospital
Musgrave Park Hospital
Nottingham Woodthorpe Hospital (Nottinghamshire)

Note: 1 Date range 13 February 2011 to 13 February 2021 inclusive. 2 Date range 13 February 2016 to 13 February 2021 inclusive.

The effects of the COVID-19 pandemic on joint replacement surgery volumes and waiting lists

The COVID-19 induced joint replacement deficit in England, Wales and Northern Ireland

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Summary

Background

The COVID-19 pandemic has impacted health, economies and the functioning of societies globally. In addition to direct health effects, it has indirectly impacted population health by limiting access to non-COVID treatments, including joint replacements. The pandemic has necessitated re-organisation of healthcare with the private-sector providing support to public hospitals in some areas. The full impact is therefore difficult to ascertain from public data sources alone.

Methods

We used a mandatory prospective national register of private and publicly funded hip, knee, shoulder, elbow and ankle replacements in England, Wales and Northern Ireland. Descriptive analysis of the provision of joint replacement comparing data from 2019 to 2020 and predicted deficit recovery.

Findings

There was a substantial deficit in the provision of joint replacement in 2020 compared to 2019 with 106,922 (48.8%) fewer procedures performed; resulting in 45,116 (44%) fewer hip replacements, 57,115 (52%) fewer knee replacements, 3,878 (50%) fewer shoulder replacements, 280 (33%) fewer elbow replacements and 533 (53%) fewer ankle replacements performed. Wales and Northern Ireland were disproportionately affected with an overall reduction of 8,001 (67%) and 2,833 (64%) respectively compared to 96,088 (47%) in England.

An immediate 5% expansion in provision from the 2019 baseline will eliminate the deficit over approximately 10 years (by 2031), whilst a 10% expansion will address the deficit by 2026.

Interpretation

This large national analysis of both private and publicly funded joint replacements illustrates a substantial accumulated deficit of surgery, equivalent to six months of normal activity across England, Wales and Northern Ireland, due to the indirect effects of COVID-19. As the pandemic evolves, further waves of infection are likely to restrict surgery and see the deficit increase, therefore projections of time taken to address the deficit must thus be regarded as the best-case scenario. A significant expansion of joint replacement services compared to 2019 is urgently required to address this deficit.

Funding

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Supplementary Material

Additional graphs and tables mentioned in this paper can be found online either by scanning the following QR Code or visiting the link below:

https://reports.njrcentre.org.uk/COVID19

Introduction

Joint replacement is a common and important surgical procedure used to treat a variety of musculoskeletal problems including osteoarthritis and acute trauma. It is a highly successful procedure that reduces pain and disability enabling participation in and contribution to society. The Lancet described joint replacement as the operation of the 20th century.[1] Over 200,000 primary hip and knee replacements were performed in England, Wales and Northern Ireland in 2019.[2] Joint replacements are long-lasting, with over half of hip and knee replacements lasting in excess of 25 years[3,4] and 90% of shoulder replacements lasting in excess of 10 years.[5] For very many people it is a curative procedure for the debilitating effects of end-stage arthritis.
The COVID-19 pandemic has had an unprecedented impact on populations around the world. The first patient with COVID-19 in the UK was identified on the 23rd January 2020[6] and the first UK national lockdown commenced on 23rd March 2020.[7] The pandemic has impacted our lives widely and has inevitably required a massive and rapid re-organisation of healthcare provision in order to provide care for patients with severe acute respiratory distress due to SARS-Cov2 infection.

Less urgent medical procedures have been forgone or deferred due to competing pandemic demands. We have seen a re-organisation of services from the public to the private sector and some hospitals have specialised in "COVID care", whereas others have attempted to remain "COVID free" in an effort to provide more routine services. Early reports have suggested that mortality is persistently high (20.4%) following the acquisition of COVID-19 in the perioperative period after elective surgery.[8] Reports from around the world have suggested a wide variety of consequences of healthcare reorganisation including a reduction in the volume of joint replacement,[9-13] an increased number of patients with symptoms "worse than death" whilst waiting for joint replacement,[14] increased waiting lists[15] and economic hardship.[16] However, the majority of these reports have been based on single centres with small sample sizes. Assessing the impact of COVID-19 on the provision of joint replacement is difficult due to the shift in surgeries from the public to the private sector and the effective commandeering of private hospitals by NHS trusts. The analysis of single centres, public sector or private sector databases may be misleading as they are unable to consider the totality of a healthcare system that has become increasingly integrated during this pandemic. A comprehensive analysis of both private and public sector provision is required to understand the impact of COVID-19 and plan the recovery of joint replacement capacity. Fortunately, England, Wales and Northern Ireland have an integrated mandatory register, the National Joint Registry, for all hip, knee, shoulder, elbow and ankle joint replacements.

We aim to describe the impact of the COVID-19 pandemic on joint replacement services in England, Wales and Northern Ireland and quantify the expansion of services required in order to address the accumulated deficit of joint replacement surgery and return joint replacement service provision back to pre-pandemic levels.

Methods

Data Source

In this prospective observational registry-based study we analysed data from the National Joint Registry (NJR).[2] We collected data on hip, knee, shoulder, elbow and ankle primary joint replacement procedures entered into the registry from hospitals in England, Wales and Northern Ireland since its inception in April 2003 through to the end of December 2020. A data quality audit in 2017/18 showed over a 95% and 96% capture of all primary hip and knee data respectively (though this has subsequently been significantly improved by national audits).[2]

The NJR data was prepared for this analysis in the same manner as described in the NJR 2020 17th Annual Report.[2] Data were cleaned by removing records with missing information, removing duplicate procedures, and removing records where we were unable to ascertain a logical sequence of revision procedures. The cleaning process resulted in 2,789,980 primary procedures for analysis (see Supplementary Figures 1 to 5, see online for all supplementary figures).

Statistical Analysis

We used descriptive statistics to illustrate the impact

of COVID-19 on the provision of joint replacement since the start of data collection for each type of joint replacement, dividing procedures into acute (those performed for trauma) and elective indications, where possible.

We present weekly counts of procedures in 2019 compared to 2020 by each joint, dividing procedures into acute and elective indications where possible, and include a 21-day weekly rolling average.

The time-to-recovery and expansion in services required compared to 2019 was also calculated. We assume the years-to-recovery is estimated by deficit in procedures expressed as a percentage expansion of services compared to 2019 i.e. a 50,000 procedure deficit will take 5 years to recover assuming a baseline provision of 100,000 patients and a 10% expansion in surgical provision. We have simplistically assumed a static baseline (2019) though the secular patterns prior to this suggest the need for increasing service provision (with the possible exception of knee replacement) so these estimates are likely to be conservative.

$$years\ to\ recovery = \frac{N_{2019} - N_{2020}}{\frac{N_{2019}}{100} \cdot \%expansion}$$

Time-to-recovery was calculated for England, Wales and Northern Ireland overall and for each nation separately.

Sensitive Analysis

Weekly frequencies were also calculated for all English sub-regions for all joints in 2020, dividing procedures into acute and elective indications where possible. Time-to-recovery was also calculated for all English sub-regions for all joints comparing provision to 2019. All analyses were conducted in Stata 15.1 StataCorp. College Station, TX.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. AS, KD, EL had full access to all the data in the study and all authors had the final responsibility for the decision to submit for publication.

Results

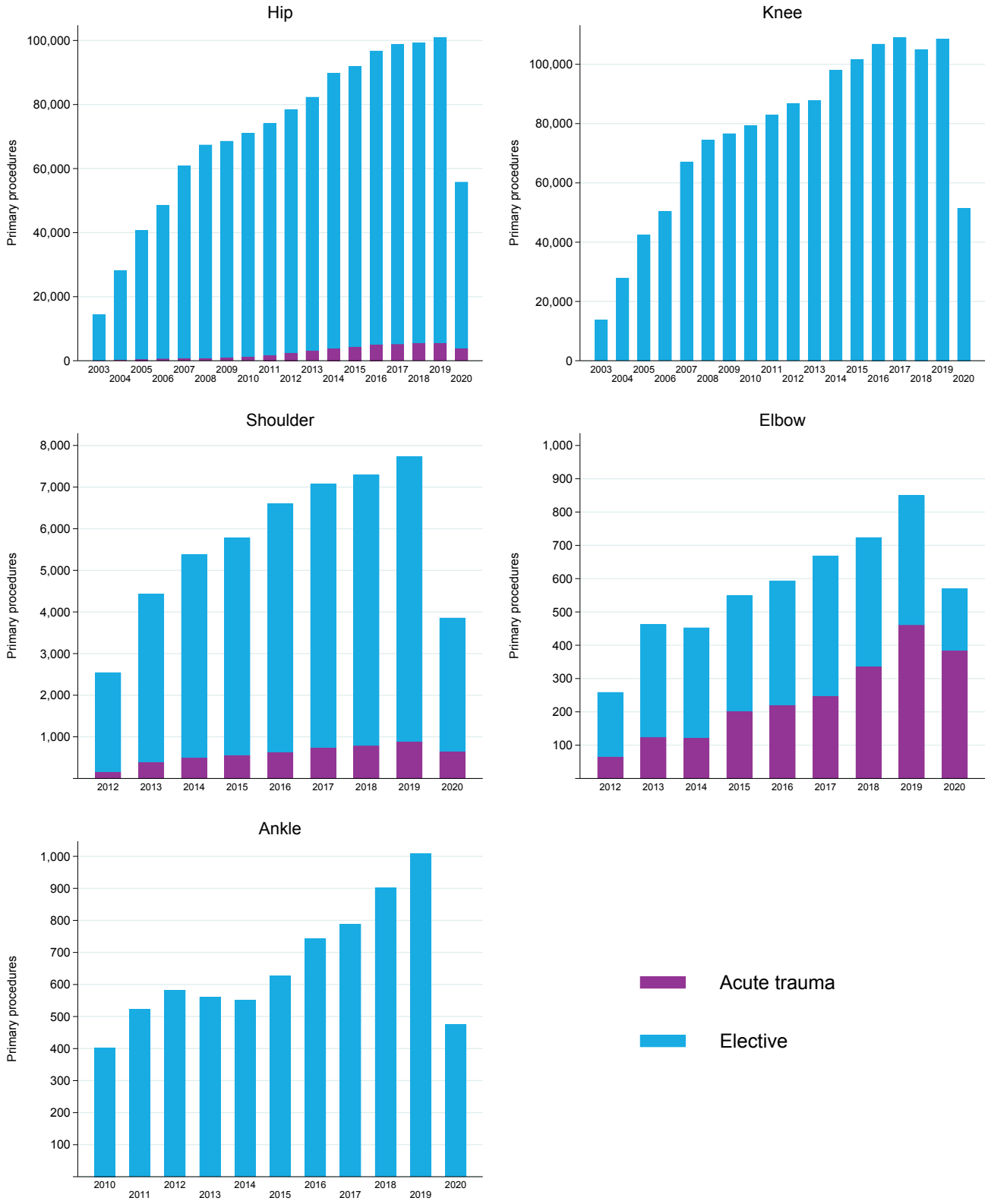
Overall, 106,922 (48.8%) fewer joint (hip, knee, shoulder, elbow, ankle) replacements were performed in 2020 compared to 2019. Knee replacements showed the largest reduction in absolute numbers followed by hip replacements, see Table 1. Wales and Northern Ireland have recorded 67% and 64% fewer joint replacement procedures respectively compared to 2019, which is substantially greater than the deficit of 47% experienced by England.

Table 1: Descriptive statistics of provision and change of joint replacement by joint and nation.

Joint	N(2019)	N(2020)	N(Change)	%(Change)
England, Wales and Northern Ireland				
Hip	100,940	55,824	-45,116	-44.7
Knee	108,607	51,492	-57,115	-52.6
Shoulder	7,737	3,859	-3,878	-50.1
Elbow	850	570	-280	-32.9
Ankle	1,009	476	-533	-52.8
Total	**219,143**	**112,221**	**-106,922**	**-48.8**
England				
Hip	93,148	52,818	-40,330	-43.3
Knee	100,547	49,169	-51,378	-51.1
Shoulder	7,373	3,736	-3,637	-49.3
Elbow	791	552	-239	-30.2
Ankle	961	457	-504	-52.4
Total	**202,820**	**106,732**	**-96,088**	**-47.4**
Wales				
Hip	5,501	2,039	-3,462	-62.9
Knee	6,025	1,734	-4,291	-71.2
Shoulder	287	97	-190	-66.2
Elbow	43	9	-34	-79.1
Ankle	32	8	-24	-75.0
Total	**11,888**	**3,887**	**-8,001**	**-67.3**
Northern Ireland				
Hip	2,291	967	-1,324	-57.8
Knee	2,035	589	-1,446	-71.1
Shoulder	77	26	-51	-66.2
Elbow	16	9	-7	-43.8
Ankle	16	11	-5	-31.3
Total	**4,435**	**1,602**	**-2,833**	**-63.9**

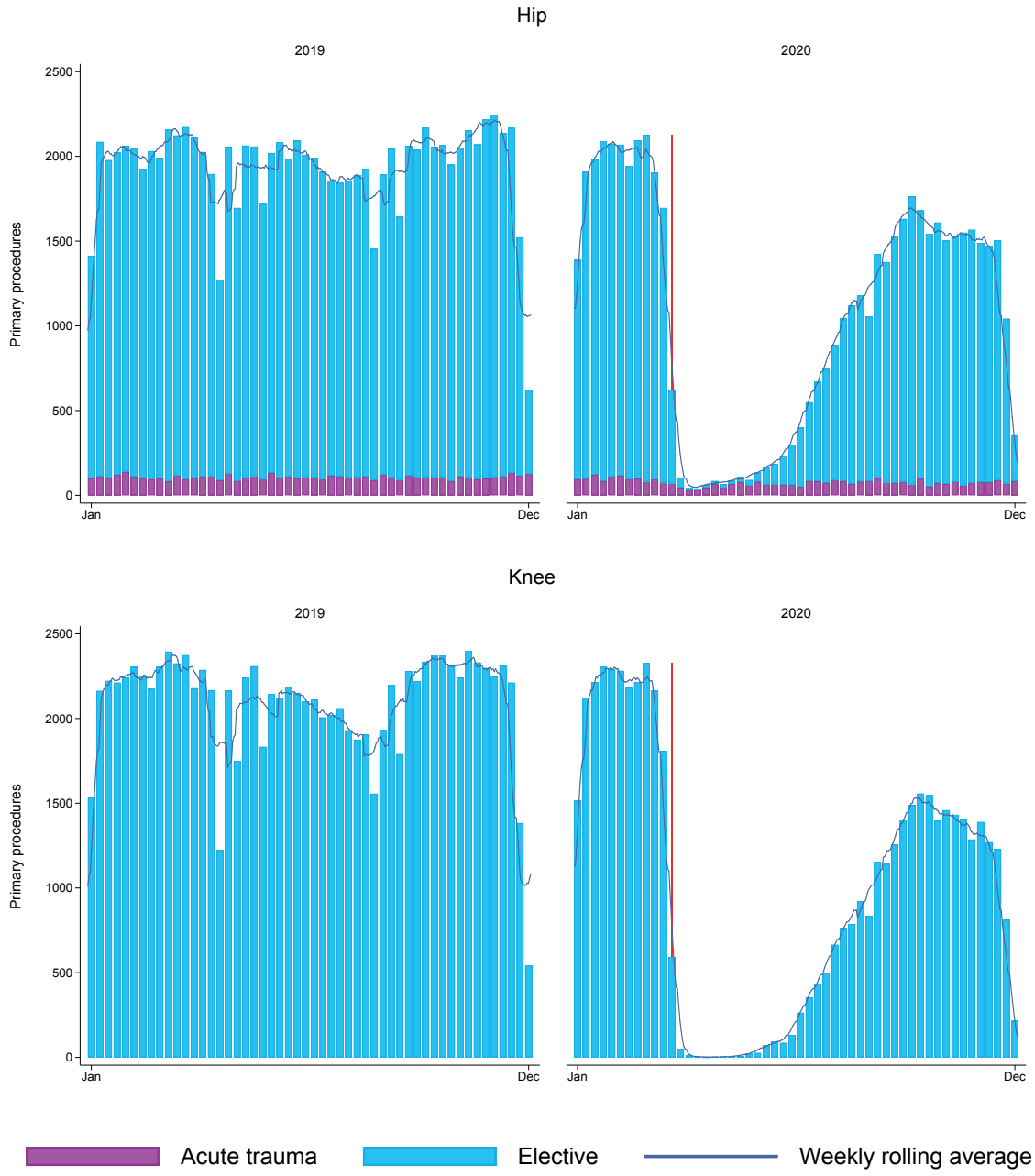
Figure 1 illustrates the difference in accrual of primary joint replacements since the start of data collection for each joint. Data have illustrated that provision of joint replacement has increased year on year since data collection started.

Figure 1: Annual number of primary hip, knee, shoulder, elbow and ankle replacements performed in England, Wales and Northern Ireland.



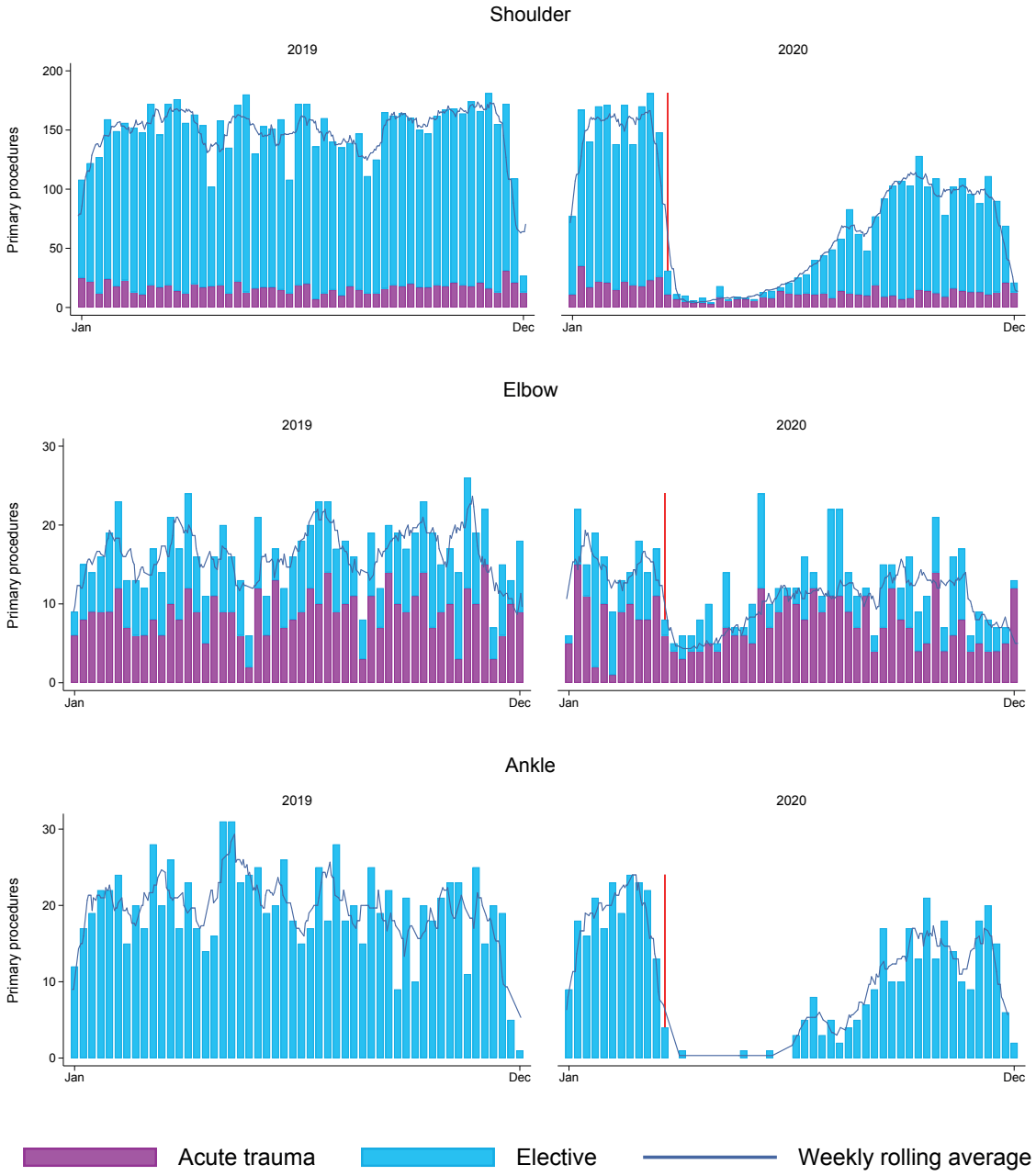
Figures 2 and 3 illustrate weekly counts of primary hip, knee, shoulder, elbow and ankle replacements in 2019 compared to 2020. These show a rapid decline in the number of procedures prior to the start of the first national lockdown. A very small number of elective joint replacements were performed in the first eight weeks following the first national lockdown. The volumes of acute procedures (those performed for trauma) recorded in hip, shoulder and elbow replacements were also reduced in 2020 compared to 2019.

Figure 2: Weekly number of primary hip and knee replacements performed in England, Wales, and Northern Ireland in 2019 and 2020.



Graphs by year of primary operation
Red line indicates first national lockdown
Weekly (centred) rolling average based over 21 days

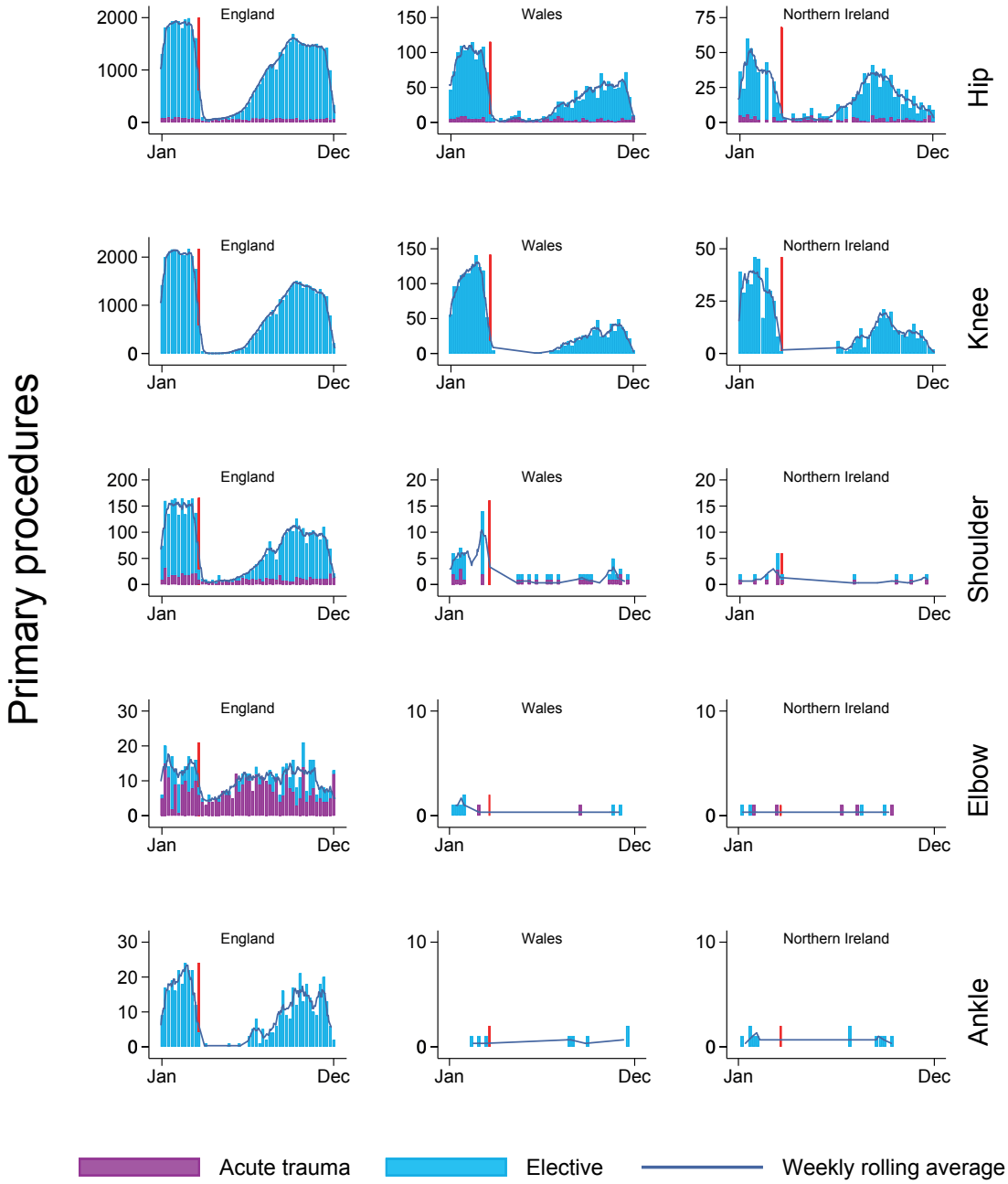
Figure 3: Weekly number of primary shoulder, elbow and ankle replacements performed in England, Wales, and Northern Ireland in 2019 and 2020.



Graphs by year of primary operation
Red line indicates first national lockdown
Weekly (centred) rolling average based over 21 days

Figure 4 shows a breakdown of weekly counts of primary hip, knee, shoulder, elbow and ankle replacements in 2020 stratified by each nation. This shows that the reduced volume of joint replacements is not evenly distributed across England, Wales and Northern Ireland. The volume of procedures recorded in Wales and Northern Ireland in the second quarter of the year (2020) is negligible compared to those recorded in England. This pattern is even more pronounced for shoulder, elbow and ankle procedures in the 2nd, 3rd and 4th quarters of 2020.

Figure 4: Weekly number of primary shoulder, elbow and ankle replacements performed in England,Wales, and Northern Ireland in 2020 by nation.



Supplementary Figures 6 through to 10 and Supplementary Table 1 illustrate regional breakdown of weekly counts of primary hip, knee, shoulder, elbow and ankle replacements in 2020. Supplementary Figure 6 and 7 demonstrate heterogeneity in the recovery of hip and knee replacements from the first wave of COVID-19 infections, with some regions beginning restoring provision more rapidly, and to a greater extent, than others.

Figure 5 illustrates the years-to-recovery following expansion of provision compared to 2019 rates across England, Wales and Northern Ireland stratified by joint. This figure illustrates that an immediate 5% expansion in provision of hip, knee, shoulder, elbow and ankle replacement compared to 2019 may address the deficit in procedures, within approximately 10 years. A 10% expansion in provision is projected to address the current deficit in approximately five years.

Figure 5: Predicted years-to-recovery of the 2020 deficit of joint replacement procedures following expansion of joint replacement provision compared to 2019 in England, Wales and Northern Ireland.

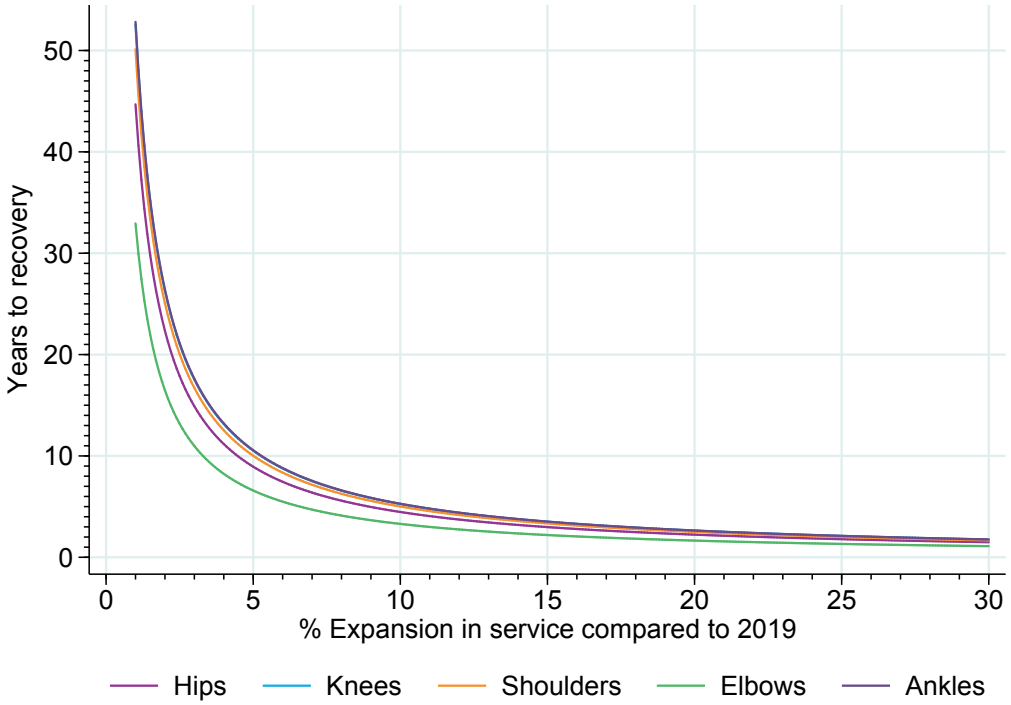
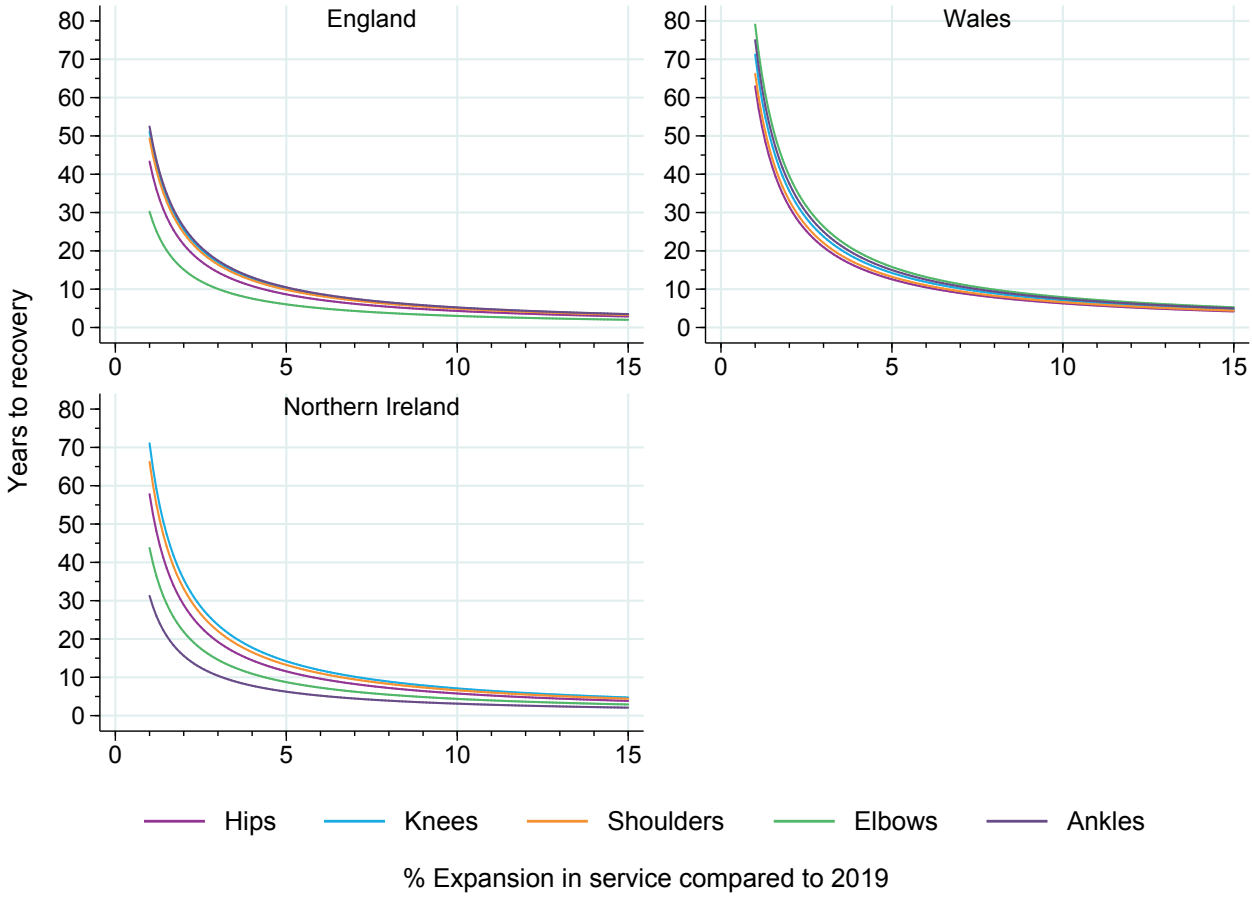


Figure 6 illustrates the years-to-recovery following expansion of provision compared to 2019 stratified by England, Wales and Northern Ireland and joint type. Figure 6 and data in Table 2 illustrate that the recovery in Wales and Northern Ireland will take longer for an equivalent expansion in services.

Figure 6: Predicted years-to-recovery of the 2020 deficit of joint replacement procedures following expansion of joint replacement provision compared to 2019 stratified by nation.



Supplementary Figure 11 and Supplementary Table 2 illustrates years-to-recovery following expansion of provision compared to 2019 stratified by region and joint type. These data illustrate heterogeneity in provision of joint replacement during 2020 and different recovery profiles in the 3rd and 4th quarters of 2020.

Table 2: Predicted years-to-recovery of 2020 deficit following expansion of joint replacement provision compared to 2019 by joint type and nation.

Expansion compared to 2019 (%)	Years to recovery				
	Hip	Knee	Shoulder	Elbow	Ankle
England, Wales and Northern Ireland					
5	8.9	10.5	10.0	6.6	10.6
10	4.5	5.3	5.0	3.3	5.3
15	3.0	3.5	3.3	2.2	3.5
20	2.2	2.6	2.5	1.6	2.6
25	1.8	2.1	2.0	1.3	2.1
30	1.5	1.8	1.7	1.1	1.8
England					
5	8.7	10.2	9.9	6.0	10.5
10	4.3	5.1	4.9	3.0	5.2
15	2.9	3.4	3.3	2.0	3.5
20	2.2	2.6	2.5	1.5	2.6
25	1.7	2.0	2.0	1.2	2.1
30	1.4	1.7	1.6	1.0	1.7
Wales					
5	12.6	14.2	13.2	15.8	15.0
10	6.3	7.1	6.6	7.9	7.5
15	4.2	4.7	4.4	5.3	5.0
20	3.1	3.6	3.3	4.0	3.8
25	2.5	2.8	2.6	3.2	3.0
30	2.1	2.4	2.2	2.6	2.5
Northern Ireland					
5	11.6	14.2	13.2	8.8	6.3
10	5.8	7.1	6.6	4.4	3.1
15	3.9	4.7	4.4	2.9	2.1
20	2.9	3.6	3.3	2.2	1.6
25	2.3	2.8	2.6	1.8	1.3
30	1.9	2.4	2.2	1.5	1.0

Discussion

We present the first comprehensive assessment of the provision of joint replacement across the entire health service (private and public) in England, Wales and Northern Ireland. The COVID-19 pandemic has had a profound impact on patients due to reduced service delivery of joint replacement surgery. Provision of joint replacement surgery in 2020 was reduced by approximately 50% compared to 2019. Patients requiring elective joint replacement have been impacted the most with acute trauma provision being largely preserved throughout 2020. The impact of COVID-19 has not been uniform across or within the nations covered by the NJR. Wales and Northern Ireland have seen the greatest reduction in capacity with surgery for patients requiring elective shoulder, elbow and ankle replacements effectively being halted.

We illustrate that to recover the accumulated deficit in joint replacement that has occurred in 2020 a significant expansion in pre-pandemic service provision is needed, even if it is assumed that demand remains static at 2019 levels, which is unlikely to be true given the year-on-year secular increase in the provision of most procedures except possibly knee replacement. The deficit in 2020 is equivalent to six months of normal activity across England, Wales and Northern Ireland. Without expansion in provision, waiting lists for joint replacement will be, at a minimum six months longer compared to pre-pandemic levels based on the assumption that services have been restored since January 2021. However, as provision had not recovered to pre-pandemic levels by the end of 2020, it is likely that the pandemic will continue to impact patients due to reduced provision of joint replacement services for at least the first half of 2021. Waiting lists will therefore continue to lengthen as the deficit increases.

Expanding provision in the post-pandemic NHS system will be challenging. Either greater productivity, equivalent to every hospital providing an additional 2.5 or 5 weeks of joint replacement provision per year, must be achieved which is unlikely to be feasible. An alternative strategy would be a 5% or 10% expansion in services crudely represents 10 or 20 new high volume treatment centres each providing 500 hip and 500 knee joint replacements per year. Staffing such facilities and providing all the ancillary care would also be extremely challenging. Any additional theatre capacity developed will require consultant orthopaedic surgeons, anaesthetic staff, theatre staff, nurses, physiotherapists and all the other ancillary services. Expanding staff capacity cannot take place overnight and presents the most serious challenge. Utilisation and efficiency solutions are likely to offer only a partial answer. Caution must also be exercised when attempting to expand capacity within existing staff, ensuring they are retained and supported in order that work-related "burn-out" due to COVID-19 is not exacerbated. Similarly, the increased volume of post discharge care will have significant resource implications and impact on already stretched community-based services.

The removal of barriers to increasing capacity, such as annual[17] and lifetime pension allowances,[18] will be as important as incentivising 7-day a week operating, asking senior orthopaedic surgeons and anaesthetists to delay their retirement or asking recently retired surgeons and anaesthetists to return from retirement to assist in the provision of joint replacement are all strategies to be considered. Expanding bed capacity will be particularly difficult during winter months when, even prior to the pandemic, elective surgery is already routinely curtailed. Minimising seasonal variation in the volume of primary procedures performed will be essential in maximising service delivery; the role of private sector service provision is likely to be increasingly important in restoring provision of joint replacement.

The selection of evidence based joint replacement[19,20] and rehabilitation strategies which are cost-effective[21] and minimise the national healthcare and revision burden will be essential in maximising capacity of primary procedures, with NHS initiatives such as "Getting It Right First Time"[22] playing an important role. The rapid assessment of the clinical and cost-effectiveness of new treatment modalities, such as day case joint replacement,[23] and enhanced recovery programmes[24] are required if the capacity for primary joint replacement is to be maximised.

Strengths and limitations

This analysis has a number of strengths. Importantly the data included in this analysis covers both private and publicly-funded joint replacement procedures. Contribution to the registry is mandatory and primary case ascertainment is in excess of 95% for hip and knee replacements.[2]

We assume the latent demand for joint replacement will be the same as 2019, we have not accounted for the increased demand in joint replacement we have seen historically, which is approximately 5% per year.[2] We have not factored in the reduced demand for joint replacement due to the higher expected mortality in 2020; similarly we have also not accounted for the observed modest reduction in trauma related procedures in 2020, which we assume will have been treated using alternative strategies, e.g. hemiarthroplasty rather than total hip replacement as was recommended by NHS England in March 2020, in response to the demands of the pandemic,[25] for patients with intracapsular hip fractures[26] or conservative management.

We are underestimating the impact on elective hip, shoulder and elbow joint replacement, as surgery for traumatic indications has been largely preserved throughout 2020. We also expect a modest lag in data entry, which principally reduces volume estimates in the 4th-quarter of 2020 (typically there is less than 5% late data entry beyond three months). There may also be a reduction in compliance in reporting procedures to the NJR because of indirect effects of the allocation of administrative staff during the COVID-19 pandemic response in individual hospitals. The model used to predict time-to-recovery is simplistic and has not accounted for demographic changes including an increasingly elderly population nor increasing life expectancy that we have historically observed. This analysis only considers the impact of the pandemic on activity in 2020; the pandemic principally impacted provision in the last three quarters of 2020 and has continued to affect provision in 2021 and is likely to make predictions very conservative.

Conclusion

We have been able to reliably assess the impact on patients waiting for joint replacement, created by the effects of COVID-19 in 2020, using a nationally representative data source. The provision of primary joint replacement declined by approximately 106,000 cases (50%) in 2020 in England, Wales and Northern Ireland. This will inevitably lead to a large number of patients enduring unnecessary pain, disability and secondary decline in mental and overall physical well-being.

The impact on waiting times, in an already overstretched healthcare system, is extremely concerning and likely to deteriorate further in 2021. Returning to pre-pandemic provision is not sufficient, as this will not address the deficit in joint replacement and even with a rapid expansion in service provision to address this deficit in provision, our study indicates it will take many years to resolve this joint replacement crisis.

Declaration of interests

- AS, KD, EL, AJ, CLG, EMC, JLR, AP, YBS, MRW, AWB are members of the National Joint Registry analysis team and contracted to conduct routine data analysis for the National Joint Registry for quality assurance purposes and routine report generation.
- AS reports funding from the MRC to his institution unrelated to this work.
- EL reports funding from CeramTec to his institution unrelated to this work.
- JLR reports funding from The National Joint Registry unrelated to this work.
- AJ reports personal fees from Freshfields, Bruckhaus, Derringer and Anthera Pharmaceuticals Ltd unrelated to this work.
- CLG reports grants from GCRF, ORUK, EBI, Wellcome, EDTCP, Versus Arthritis, Chartered Society of Physiotherapists unrelated to this work.
- EMC reports grants from Versus Arthritis and NIHR unrelated to this work.
- MR reports grants from Zimmer, The Health Foundation, Heraeus, 3m Healthcare, Sheulke, Aquilant, Biocomposites, Stryker, Depuy, Smith and Nephew, Bone Support, NIHR, Ethicon, Convatec unrelated to this work.
- DJP reports no conflict of interests.
- JMW reports reimbursement for role as Chairman of the NJR Research Committee and as member of the NJR Executive Committee. Grant income from Helmholtz Institute, Munich, Germany; Amgen, Inc; Versus Arthritis; Wellcome Sanger Institute; Medical Research Council; Health Quality Improvement Partnership; NIHR Academic Clinical Fellowship Programme; NIHR Health Technology Assessment Programme; NIHR Research Policy Programme unrelated to this work
- AP reports grant funding from NIHR unrelated to this work and teaching fees from Zimmer Biomet unrelated to this work.
- TW reports reimbursement from the National Joint Registry and honoraria from Smith and Nephew, and Pfizer unrelated to this work.
- MRW reports institutional funding from NIHR, Stryker, Ceramtec, Depuy, Heraeus unrelated to this work and royalties from Taylor Francis in relation to a textbook “Apley & Solomon’s System of Orthopaedics and Trauma 10th Edition”.
- AWB reports institutional funding from NIHR, Stryker and Ceramtec unrelated to this work and royalties from Taylor Francis in relation to a textbook “Apley & Solomon’s System of Orthopaedics and Trauma 10th Edition”.

Contributors

- AS was responsible for study concept, data analysis, and writing – original draft of the article – review & editing.
- KD and EL were responsible for data analysis, writing – review & editing.
- SKK was responsible for searching literature, writing – review & editing.
- AWB, MRW, AJ, YBS, CLG, EMC, JLR, AP, were responsible for study concept, funding acquisition, and writing – review & editing.
- MR, TW, MRW, DJP were responsible for study concept, project administration, and writing – review & editing.
- AS, KD, EL have accessed and verified the underlying data.

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The effects of the COVID-19 pandemic on joint replacement surgery

The patient perspective

By Robin Brittain - Patient Representative, NJR Editorial Board and NJR Steering Committee Member.

Coronavirus (COVID-19) has had a detrimental effect on joint replacement surgery waiting times. During the first wave, NHS hospitals were told to suspend all non-urgent elective surgery for at least three months from 15 April 2020 to help the service deal with the COVID-19 pandemic.[1] Although elective surgeries resumed in the UK in mid-2020, most hospitals were subsequently functioning at a much reduced capacity. And with further lockdowns, surgery has been impacted with further restrictions and reductions in services and cancellations.

All of this has had an impact on surgical waiting times. Other related services have also been affected and impacted during this time. Inpatient and critical care capacity were freed up and prioritised for COVID-19 patients during the first and subsequent waves. Access to physiotherapy and occupational therapy which people can be referred to, and which many of them will benefit from to help with their recovery and aid mobility following surgery, has additionally been affected with reduced services throughout this time.

Waiting times for treatment and care have been an issue throughout the history of the NHS with challenges such as increasing demand. Guarantees on waiting times in several key areas of health care were introduced as part of the Patient Charter in 1991, which included admission for treatment by a specific date no later than two years from the day someone was placed on a waiting list. By 1995 the guarantee was shortened to a maximum wait for admission to hospital of 18 months.

From 2000, progressively tougher targets were introduced. Targets could be seen at times as arbitrary and did not always reflect the reality of how long people waited. In 2004 a more holistic target was introduced, setting an 18-week right under the NHS Constitution on the total waiting time between GP or other healthcare professional referral and consultant-led treatment in outpatients (non-admitted care) or inpatients (admitted care). This was one of NHS England's significant achievements in the 2000s.[2,3,4]

1 Iacobucci, G. (2020) 'Covid-19: all non-urgent elective surgery is suspended for at least three months in England', BMJ (Clinical research ed.), 368, p. m1106. doi: 10.1136/bmj.m1106.

2 Charlesworth, A., Watt, T. and Gardner, T. (2020) Returning NHS waiting times to 18 weeks for routine treatment. The scale of the challenge pre-COVID-19, The Health Foundation. Available at: https://www.health.org.uk/publications/long-reads/returning-nhs-waiting-times-to-18-weeks (Accessed: 24 June 2021).

3 Appleby, J. (2010) The waiting game: what's happening to hospital waiting times?, The King's Fund. Available at: https://www.kingsfund.org.uk/blog/2010/12/waiting-game-whats-happening-hospital-waiting-times (Accessed: 24 June 2021).

4 Tudor Edwards, R. (1997) NHS Waiting Lists: Towards The Elusive Solution, Office of Health Economics. Available at: https://www.ohe.org/system/files/private/publications/228 - 1997_NHS_Waiting_Lists_Edwards.pdf (Accessed: 24 June 2021).

However, despite this change, increasing waiting times for elective joint replacement surgery before the pandemic had already become a reality, not just in England, but across the UK. There were already issues to meet and satisfy patient needs and expectations with GPs not always referring those for consideration for joint replacement. This had been despite indicators to do so, such as pain, and functional limitations and variations in referral criteria depending on severity of symptoms and after trying non-surgical treatments such as physical therapies, weight control and pain relief.

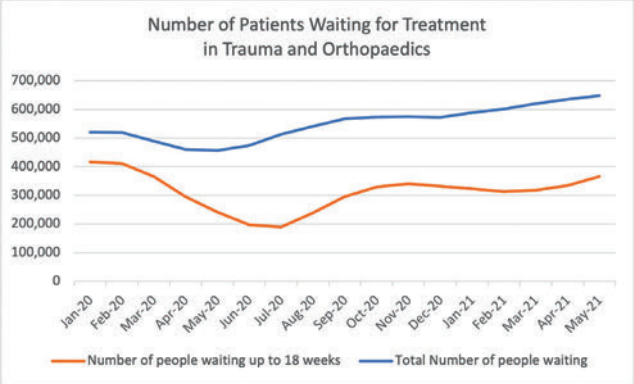
There were also issues pre-pandemic with increasing waiting times in accessing certain services, such as therapy services for rehabilitation to aid recovery post-surgery. The pandemic exacerbated these issues, for example, by increasing limitations on getting to see a GP, let alone requesting them to refer, or for them to be able to refer due to the reduction or suspension of services.

The COVID-19 virus reached the UK in late January 2020, and the waiting times, reduction and recovery of surgery can be observed subsequent to this time using different available information.

Publicly accessible data relating to waiting times is available and can be useful to assess joint replacement surgery waiting times but this can be limited or have shortcomings.

NHS England collects and publishes monthly consultant-led, referral to treatment (RTT) data to monitor meeting the 18-week waiting time target. This is recorded by clinical specialities. However, a drawback is that waiting times cannot be observed specifically for joint replacement surgery as this is included within trauma and orthopaedics (T&O) data. This data is often referenced in regards to joint replacement surgery (which does make up a reasonable proportion of the data), but it is more of a general indicator of waiting time trends.

RTT data show how during the pandemic, trauma and orthopaedic waiting times (including joint replacement surgery), has been steadily increasing across England, other than the dip we see below in the Spring and Summer of 2020.



Data Source:
Consultant-led Referral to Treatment Waiting Times Data in England. Incomplete Commissioner Pathway, NHS England. https://www.england.nhs.uk/statistics/statistical-work-areas/rtt-waiting-times/rtt-data-2020-21

It's not specifically clear why there is a dip. One contributor is understood to be a reduction of trauma referrals, and a factor identified being social distancing and lockdown measures resulting in less accidents taking place.[5,6]

Finished admission episodes (FAEs), for hip and knee joint replacement surgery in England covering a 10-year period were released by NHS Digital due to media interest. It covers NHS hospitals and commissioned activity in the independent sector. It only relates to hip and knee joint replacement surgery, but as these are the most commonly performed implant procedures it's a useful indicator of waiting times for joint replacement surgery as a whole. For the three most recent years, it shows that surgery waiting times have steadily been increasing.

5 Park, C. et al. (2020) 'Impact of the COVID-19 pandemic on orthopedic trauma workload in a London level 1 trauma center: the "golden month"', Acta Orthopaedica, 91(5), pp. 556–561. doi: 10.1080/17453674.2020.1783621.

6 Sephton, B. M. et al. (2021) 'The effect of COVID-19 on a Major Trauma Network. An analysis of mechanism of injury pattern, referral load and operative case-mix', Injury, 52(3), pp. 395–401. doi: 10.1016/j.injury.2021.02.035.

With those waiting 18 weeks or more:

- 2016-2017 = 43,787 people
- 2017-2018 = 45,716 people
- 2018-2019 = 55,251 people

With those waiting 52 weeks or more:

- 2016-2017 = 1,320 people
- 2017-2018 = 1,863 people
- 2018-2019 = 2,889 people

Data Source:
Waiting times for hip and knee surgery in England, NHS Digital. Count of Finished Admission Episodes (FAEs) with a main operative procedure of hip or knee replacement with a treatment waiting times of
a) 18 weeks or more, by hospital provider
b) 52 weeks and more, by hospital provider.
Using Hospital Episode Statistics (HES) data.
https://digital.nhs.uk/data-and-information/supplementary-information/2020/waiting-times-for-hip-and-knee-surgery

The National Joint Registry (NJR) collects and records all joint procedures undertaken, with surgical details, which can be statistically analysed retrospectively and collectively to see surgical activity, patterns and trends, such as those within the timeline of the pandemic.

The section preceding this piece illustrates how the COVID-19 pandemic has affected surgical activity with joint replacement procedures undertaken in 2020.

Figure 1 uses NJR acute trauma and elective data for England, Wales and Northern Ireland, to show surgical activity for a range of past consecutive years, with procedures undertaken steadily increasing until 2020 when they decline with the start of the pandemic and, as previously mentioned, waiting times also increase leading up to 2020, increasing more with the effects of the pandemic.

Figures 2 to 4 use NJR acute trauma and elective data for England, Wales and Northern Ireland, with a focus on 2020, and with weekly surgical activity and breakdowns between surgical specialities and also between nations. This highlights the effects of the first national lockdown on reductions in volume due to cancelled joint replacement surgery.

It is generally recognised that joint replacement surgery has one of the longest waiting times[7] for treatment of any speciality. NHS England Referral to Treatment (RTT) historical data indeed show that trauma and orthopaedics consistently have the longest waiting times, with joint replacement surgery being included in this. This is then reflected by how many people are in need of, and receive, such surgery.

The NJR identifies that the primary reason for joint replacement surgery is arthritis, of which osteoarthritis is the most common form of peripheral joint arthritis and cause of disability in the UK.[8] The exact incidence and prevalence of osteoarthritis is difficult to fully determine. Around 8.75 million people aged 45 years and over (33%) in the UK were identified in 2013 by Versus Arthritis, the leading musculoskeletal support charity, as seeking treatment for osteoarthritis.[9] In the absence of any cure, the impact of the national burden of osteoarthritis is increasing.

Therefore, with already rising joint replacement surgery waiting times compounded by the increasing incidence of osteoarthritis, COVID-19 has had a further detrimental effect on accessing surgery and on surgery waiting times.

Beyond waiting time data, indicators of joint replacement surgery waiting times can include the use of anecdotal information, including the testimonials of those waiting for surgery, survey work, and data analysis, which can be part of research and reporting work by charities, patient groups, institutions and

7 National Health Service England (no date) Consultant-led Referral to Treatment Waiting Times. Available at: https://www.england.nhs.uk/statistics/statistical-work-areas/rtt-waiting-times (Accessed: 16 June 2021).

8 Swain, S. et al. (2020) 'Trends in incidence and prevalence of osteoarthritis in the United Kingdom: findings from the Clinical Practice Research Datalink (CPRD)', Osteoarthritis and Cartilage, 28(6), pp. 792–801. doi: 10.1016/j.joca.2020.03.004.

9 Versus Arthritis (2019) The State of Musculoskeletal Health 2019. Arthritis and other musculoskeletal conditions in numbers. Available at: https://www.versusarthritis.org/media/14594/state-of-musculoskeletal-health-2019.pdf.

academics.[10] Additionally, modelling of the various sources of data can take place, such as by Mishra et al.[11] and Oussedik et al.[12]

It can be just as important to make use of a variety of resources and not just pure statistical data to understand the waiting time landscape. And in particular, the personal stories of those waiting for surgery can highlight the physical, mental, emotional and occupational and social effects that waiting for joint replacement surgery has on them, and which data doesn't typically show or reflect.

The resulting impact on patients

People in need of joint replacement surgery report symptoms of pain, even when at rest, alongside aches following activity, and limited or loss of function which include joint stiffness, limited range of movement and mobility, difficulty with sleep due to the pain and associated tiredness and fatigue.

There can be knock-on effects of increased difficulty with undertaking and carrying out tasks and activities with normal daily living, socially and with work, all which can have a resulting financial toll and implications. There are those who because of their poor health-state can simply have difficulty even leaving their homes.

This all has a negative effect on their quality of life.

Timely access to joint replacement surgery is important to ensure that people can benefit from the easing of symptoms, leading to a better quality of life. COVID-19 has exacerbated the severity of the situation with increasing issues and painful symptoms for people waiting for surgery.

> *"Physically on a day-to-day basis it's really changed my life completely. I can't just get up and walk out of the house and go wherever I want to go. I have to live with a pain threshold and it's there, it affects my walking, my sitting, my standing. My sleeping is impacted by it, I don't have a full night's sleep anymore. It's horrible, it's just a nagging pain. No medication has helped me. It's basically only surgery that will fix me now."*
>
> - Rob Martinez, June 2020.

Rob was put on the waiting list in October 2019 for double knee joint replacement surgery and was due to have his first knee replaced in April 2020, but was notified in March that his operation had been cancelled. He had his right knee replaced in October 2020.[13,14]

There can be increased resulting disability due to worsening function, decreased mobility and pain.

The risk related to delaying joint replacement surgery is that it may lead to the deterioration of the joint, with damage inside and outside of the joint, or even deformity. Additionally, there can be risks to muscles, ligaments and other structures becoming weak and losing function and strength, for example with muscle wasting and deficit. Prolonged delays may result in reduced surgical options and joint replacement may become a more complicated process with possible longer surgery than is normal and with increased anaesthesia use. All of this has implications with various risk and effects, including the resulting impact on recovery time.

With delays, there can be an inability for a patient to manage and cope with pain, and with limited pain management options being offered or available, there

10 Versus Arthritis (2021) Supporting People with Arthritis Waiting for Surgery. A six-part package to support people with arthritis waiting for joint replacement surgery in England. Available at: https://www.versusarthritis.org/media/23694/joint-replacement-support-package-june2021.pdf.

11 Mishra, B., BODS Collaborators and Roy, B. (2020) 'BODS/BOA Survey of impact of COVID-19 on UK orthopaedic practice and implications on restoration of elective services - Part 2', The Transient Journal.

12 Oussedik, S. et al. (2021) 'Elective orthopaedic cancellations due to the COVID-19 pandemic: where are we now, and where are we heading?', Bone & Joint Open, 2(2), pp. 103–110. doi: 10.1302/2633-1462.22.bjo-2020-0161.r1.

13 Life 'on hold' for Berkshire man waiting for knee replacement (2020) ITV News. Available at: https://www.itv.com/news/meridian/2020-06-19/life-on-hold-for-berkshire-man-waiting-for-knee-replacement (Accessed: 21 May 2021).

14 Chalmers, V. (2021) UNITED IN PAIN Feeling suicidal, plagued by stabbing pains – we are the faces behind record NHS waiting lists, The Sun. Available at: https://www.thesun.co.uk/fabulous/14942694/faces-behind-record-nhs-waiting-lists-suicidal-pain-arthritis (Accessed: 26 May 2021).

can be a reliance on the use of strong pain relief medication such as opioids. This brings with it the potential risks and effects of experiencing drowsiness, clouded thinking or 'brain fog', and anxiety amongst other possible issues, as well as the potential risk of over-prescribing and/or misuse which can lead to adverse events.

On top of all of this, there have also been COVID-19 lockdown rules to adhere to and cope with, and for those identified as clinically extremely vulnerable due to having certain health conditions, undergoing certain treatments and taking certain drug medication which can suppress immune systems, there has been the added burden of following advice for protective shielding.

If one is less active and more sedentary, particularly over a long period of time, there is the potential risk of other health issues, co-morbidities and complications developing such as weight gain leading to obesity, type 2 diabetes, cardiovascular and respiratory disorders, which in turn might have implications, such as risk for undergoing joint replacement surgery.

The waiting, the not knowing when surgery might happen, and feelings of being abandoned, isolated and trapped, combined with dealing with pain, limited and even loss of function and mobility, sleep issues, tiredness and fatigue, mood swings with frustration, irritability and anger, and ultimately reduced quality of life can additionally have an effect on mental health and wellbeing resulting in worry, anxiety and depression.

"If I hadn't had that operation I don't think I'd be talking to you today because I could not have carried on the way things were…"

"My whole life was just basically gone. I had no life left."

"The pain was just getting more and more excruciating. I couldn't even stand up - it got to the stage where I couldn't put weight on it."

"It was like somebody was just constantly sawing into my hip, groin and then that just completely knocks your mental health."

"I just felt that I couldn't go on any more. I didn't want to be here any more. What was the point because all in front of me all I could see was this waiting list going on and on and on."

- Liz McLucas, 25th February 2021.

Liz was having to take painkillers, including morphine, to control the pain.

"No matter how much pain killers they gave me it wasn't enough."

"It took the edge of it but it took the edge off everything else".

"It got to the stage where getting out of bed was nearly too much."

Liz took the decision to pay for private surgery, despite being against private healthcare in principle, due to being on a waiting list for over two years. It cost her £10,800, borrowing money from her two sons to pay for it. She had hip replacement surgery in January 2021, after chronic pain had confined her to bed for much of the previous 12 months.

"What mother wants to turn round and ask her children for money?"[15]

A multi-centre cross-sectional study in 2020 by Scott et al. concluded that one-third of patients waiting for total hip arthroplasty and nearly one-quarter waiting for a knee arthroplasty procedure were categorised in a state "worse than death" (patients scoring less than zero for their EQ-5D score). And that every increasing six-month period a patient waited for surgery was associated with a clinically significant deterioration in the quality of their life.[16]

"My mobility is nearly zero as a result of the excessive pain. It never stops; it is just constant ... I've begun to feel like life is not worth living."

- Christopher Bulteel, age 72, October 2020.

15 McKeown, L.-A. (2021) Liz McLucas: 'I had to borrow money from my sons for surgery', BBC News. Available at: https://www.bbc.co.uk/news/uk-northern-ireland-56195209 (Accessed: 21 May 2021).

16 Clement, N. D. et al. (2021) 'The number of patients "worse than death" while waiting for a hip or knee arthroplasty has nearly doubled during the COVID-19 pandemic', The bone & joint journal, 103-B(4), pp.672–680. doi: 10.1302/0301-620X.103B.BJJ-2021-0104.R1.

Christopher was due to have a hip replacement in March 2020 after being on a waiting list for a year, but the operation was cancelled due to the coronavirus outbreak, leaving him virtually housebound.[17,18] The NJR was in contact with Christopher in early August 2021 and he said that when he had been feeling low, thinking about his family and others worse off than himself had helped him. He had still not had surgery.

When surgery has been able to take place, for some there have been concerns, worry and being anxious and apprehensive about not only being safe going into hospital, but also while having surgery and being cared for, with the risk of contracting COVID-19. A study of 102 patients who were on the waiting list of a single high-volume procedure surgeon, having previously been given a date for surgery for an elective hip or knee procedure during the COVID-19 pandemic, identified the number of patients wanting to proceed with their planned elective surgery in the COVID-19 environment. Overall, 58 patients (56.8%) preferred to continue with planned surgery upon resumption of elective orthopaedic services, in spite of additional risks posed by COVID-19. This leaves nearly half who were not willing or wanting to have surgery.[19]

Patient groups, charities and representative bodies including Versus Arthritis and the Arthritis and Musculoskeletal Alliance (ARMA), the umbrella body for organisations providing musculoskeletal services, have for a number of years been calling for improved access to joint replacement surgery.

Campaigns have addressed not only long waiting lists but also the restrictions and rationing that has been taking place, for example, overweight or obese patients being told to lose weight or others to stop smoking in order to be a suitable candidate for surgery, as opposed to clinical need.[20,21,22] And the practice of what can been seen as a barrier to receiving surgery was already taking place long before the arrival of the COVID-19 pandemic.

Versus Arthritis launched their 'Right on Time' campaign in February 2020 calling for improved access to joint replacement surgery due to increasing waiting times. The campaign was paused with the arrival of the pandemic. They then launched their 'Impossible to Ignore' campaign in July 2020 to ensure the wider needs of those with arthritis are recognised and addressed by the government and policy makers so that they are not left behind, for example being in pain, and that people with arthritis and related conditions:

- can access healthcare services throughout the pandemic;
- know that there will be a commitment to their ongoing involvement in shaping the future of services and treatment;
- have timely and clear communication and access to advice and support to manage their pain.

Also, with regards to joint replacement surgery, that it is able to continue wherever it is safe to do so throughout the pandemic, and that there is a national plan with action to bring down joint replacement waiting lists.

With the resumption of elective surgery there is a backlog of procedures that need to be undertaken. The NJR has an important role to play. There is an even greater emphasis and focus for the registry to monitor joint replacement surgery to ensure that the highest quality of outcome standards in terms of surgeon and implant performance, alongside patient outcomes and safety that have come to be expected, continue despite the volume and hospital pressures that will co-exist to reduce these waiting list times.

17 Tanner, C. (2020) 'I've begun to feel like life is not worth living' says man, 71, who has waited 21 months for hip replacement, inews.co.uk. Available at: https://inews.co.uk/news/real-life/waiting-lists-nhs-figures-routine-operations-arthritis-knee-hip-replacements-790201 (Accessed: 21 May 2021).

18 Durkin, J. (2021) Former mayor living in constant pain after op cancelled, Bournemouth Echo. Available at: https://www.bournemouthecho.co.uk/news/19047434.former-mayor-living-constant-pain-op-cancelled (Accessed: 21 May 2021).

19 Chang, J. et al. (2020) 'Restarting elective orthopaedic services during the COVID-19 pandemic. Do patients want to have surgery?', Bone & Joint Open, 1(6), pp. 267–271. doi: 10.1302/2633-1462.16.bjo-2020-0057.

20 Arthritis and Musculoskeletal Alliance (ARMA) (2017) Policy Position Paper. 'Rationing' Access to Joint Replacement Surgery and Impact on People with Arthritis and Musculoskeletal Condition. Available at: http://arma.uk.net/wp-content/uploads/2017/08/Policy-Position-Paper-Surgery_v5_Interactive.pdf.

21 The Association of British HealthTech Industries (ABHI) (2017) Hip and Knee Replacement: The Hidden Barriers. Available at: https://www.abhi.org.uk/media/1379/hip-and-knee-replacement-the-hidden-barriers.pdf.

22 Dodd, L. et al. (2015) 'Rationing of orthopaedic surgery in the UK', Bone & Joint 360, 4(6), pp. 2–5. doi: 10.1302/2048-0105.45.360391.

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 Anesthesiologists 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 surgical specialty association for trauma and orthopaedics 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' because 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.
Coverage	Scope of inclusion criteria for the registry. Data submission has been mandatory for independent organisations since 1 April 2003 and for NHS organisations since 1 April 2011. See also NJR definition.
COVID-19	Coronavirus disease following infection from the SARS-CoV-2 virus.
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. The NJR does not collect data on Antibiotic use and therefore DAIR in our context focuses on implant and procedure data.
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 2020 inclusive. Hospital (unit) level analyses present data for hip and knee procedures undertaken between 1 January and 31 December 2020 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 2021.
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 2020) 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 (E – England, I – Improvement, X – Digital).
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	The National Joint Registry (NJR), which covers England, Wales, Northern Ireland, the Isle of Man and the States of Guernsey, has collected and analysed information from both the NHS and independent healthcare sectors on hip and knee replacements since 1 April 2003, ankle replacements since 1 April 2010, and elbow and shoulder replacements since April 2012.
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.
PROM(s)	Patient Reported Outcome Measure(s).
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 (knee)	See Patellar resurfacing.
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	A revision is defined as any operation where one or more components are added to, removed from or modified in a joint replacement or if a Debridement And Implant Retention (DAIR) with or without modular exchange is performed. Capturing DAIR with or without modular exchange commenced with the introduction of MDSv7. Prior to this DAIR with modular exchange was included as a single-stage revision but DAIR without modular exchange was not captured. Within the annual report, each of these procedure types is included in the analyses as a revision episode. This is distinct from the analyses in the surgeon, unit, and implant performance work streams where DAIR without modular exchange is not currently included as a revision outcome.

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 2020 calendar year

Hips

recorded on the NJR since April 2003

2020

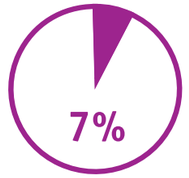
54,858 primary replacement procedures

60% ♀

average ages:

♂ 66.7 ♀ 69.1

Data:



Acute trauma

Osteoarthritis

average BMI **28.5** = ‘overweight’

Knees

recorded on the NJR since April 2003

2020

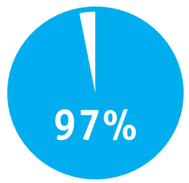
50,904 primary replacement procedures

55% ♀

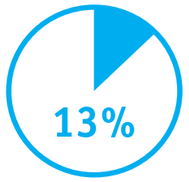
average ages:

♂ 68.6 ♀ 69.0

Data:



Osteoarthritis



Unicondylar knee replacements

average BMI **30.6** = ‘obese’

Ankles

recorded on the NJR since April 2010

2020

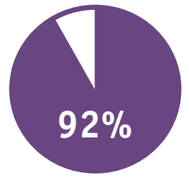
465 primary replacement procedures

41% ♀

average ages:

♂ 68.8 ♀ 67.1

Data:



Osteoarthritis

Rheumatoid arthritis and other inflammatory joint problems

average BMI **29.0** = ‘overweight’

Elbows

recorded on the NJR since April 2012

2020

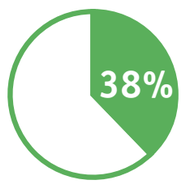
561 primary replacement procedures

64% ♀

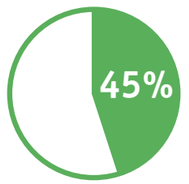
average ages:

♂ 55.0 ♀ 67.0

Data:



Total elbow replacement (with or without a radial head)



Radial head replacements

Distal humeral hemiarthroplasty

Shoulders

recorded on the NJR since April 2012

2020

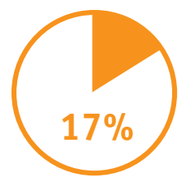
3,833 primary replacement procedures

70% ♀

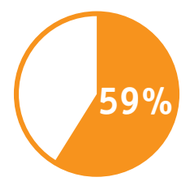
average ages:

♂ 68.9 ♀ 73.3

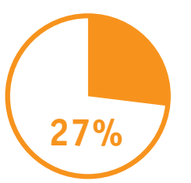
Data:



Acute trauma



Osteoarthritis



Elective cuff tear arthropathy

For more data on clinical activity during the 2020 calendar year visit reports.njrcentre.org.uk

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 NEC Software Solutions (NEC) data centre. NEC is accredited to ISO/IEC 27001:2013, ISO/IEC 9001:2015, ISO/IEC 20000, Cyber Essentials Plus, and Healthcare Data Storage (HDS). NEC is also registered on the NHS Data Security and Protection Toolkit with a status of 'Exceeds Standards'.

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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