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HIPS
KNEES
ANKLES
ELBOWS
SHOULDERS
PROMs

13th Annual Report 2016

National Joint Registry for England, Wales, Northern Ireland and the Isle of Man

Surgical data to 31 December 2015

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Chairman's foreword

Laurel Powers-Freeling, National Joint Registry Chairman

As Chairman of the National Joint Registry's Steering Committee [NJRSC] for the past four years, it is always a pleasure to offer a foreword to our Annual Report. This 13th edition, outlining the substantial progress and work of the NJR during the year 2015/16, showcases the Registry's significant developments, which continue apace in what has been another challenging and exciting year.

Key Work and Developments

The core purpose of the NJR, *to collect, manage and analyse data to provide early warning of issues related to patient safety and improve the quality of outcomes and cost effectiveness of joint replacement surgery*, remains as important as ever. This is particularly true as our maturing dataset now reaches 2.1 million records - maintaining our position as the largest arthroplasty register in the world.

The key focus for the NJR this year has been the implementation of an intensive national data quality audit across all NHS units, as part of the NJR's 'Supporting Data Quality Strategy.' The audit, designed to assess variation in local hospital and surgeon level data completeness and quality, has involved significant dedicated NJR resource. The outcome in year one of the audit, while indicating a low overall level of missing records, has highlighted a higher percentage of missing records for revision rather than primary procedures; this is a serious concern and is a matter we will thoroughly investigate and report upon. The audit will be rolled out again in 2016/17, with the inclusion of the independent healthcare sector, in a continued effort to validate NJR data quality and ensure it is robust.

Associated with the audit has also been the successful recruitment of a valuable network of NJR Data Quality and Clinical Leads at all hospitals, to support the NJR with this work, as well as the implementation of the NJR Quality Data Provider certification. Renewable

annually, the scheme rewards hospitals for completion of the audit as one of the NJR's six qualifying criteria designed to recognise quality data provision to the NJR and commitment to patient safety. This is a unique scheme which we have been proud to roll out, with 39 Trusts achieving the award during the year and hopefully many more to join during 2016/17.

Monitoring surgeon and implant performance continues to be a key function of the NJR and this year the surgeon outlier process has been reviewed to ensure it continues to be robust and facilitate our role in supporting surgeons and Trusts to review practice and performance.

The registry continues to underpin NHS England's openness and transparency programme through the orthopaedic clinical outcomes publication (COP) programme. Work has continued with the BOA and relevant specialist societies, to ensure the accurate reporting of consultant-level outcomes, which this year included patient case-mix information and surgeon-level NJR compliance rates for primary and revision procedures. Published on the public-facing NHS Choices, MyNHS and NJR's dedicated Surgeon and Hospital Profile websites, this work links directly to the NJR's efforts to improve data quality.

An additional area of national policy which the NJR continues to support is the work now gathering momentum surrounding Lord Carter's Efficiency and Procurement Review. Orthopaedic implants are used in significant volumes on a daily basis throughout the health service, and represent a high spend area with noticeable variation in pricing across organisations. With this in mind, reducing the cost burden to the NHS remains a focus of the NJR. We have now fully established a complimentary implant price-benchmarking service (INFORM) as part of Trusts', Local Health Boards' and providers' NJR subscription, which gives them the ability to benchmark the price they pay for orthopaedic implants against the 'best' national prices achieved.

Furthermore, for those NHS procurement and clinical teams wanting to examine local cost protocols and access reports by procedure type and patient case-mix, organisations can now take up the opportunity to register for the NJR's enhanced service (EMBED). This service, available for a reasonable, additional subscription charge, has the benefit of extended data reports to inform local dialogue and discussion about the relationship between implant cost and quality in outcome. (Please see the back of the Annual Report for further details.) The need to have such dialogue underpins the 'Getting It Right First Time' initiative. Moreover, these services remain an important source of evidence for the sustained impetus in the Department of Health's Quality, Innovation, Productivity and Prevention (QIPP) programme.

In July 2015, the NJR welcomed the Isle of Man and extended its data collection, reporting and information services to Noble's Hospital, which carries out hip and knee replacements across a population of more than 85,000 and will undoubtedly lead to benefits for patients.

As the largest arthroplasty registry in the world, our international collaboration continues with NJR's Medical Director, Martyn Porter, concluding a term of office as President of the International Society of Arthroplasty Registers (ISAR). This has become increasingly important as we continue to develop Unique Device Identifiers and complete a significant enhancement to the underlying component database. On this, working in close collaboration with EPRD, the German orthopaedic registry, the NJR has this year undertaken a project to define and capture increased classification data on each of the implants recorded. This will enable the NJR to better assess the performance of implants that share common characteristics and to also better understand if certain product characteristics demonstrate better or worse outcomes for patients. A consistent classification across NJR and EPRD and the ongoing work of ISAR supports the increased desire to move to a global standard across all orthopaedic registries. This is seen as a positive move to enable international registries to work together more closely in sharing intelligence on device surveillance across the globe. Opportunities for continued international collaboration and sharing best practice will continue to be a key strategic element for the NJR in the coming year.

Future Plans for the coming year 2016/2017

In addition to our core schedule of activities, we will:

- Refresh and update the NJR website (www.njrcentre.org.uk)
- Continue development of NJR information systems, including enhanced Clinician Feedback to aid surgeon appraisal, Supplier Feedback, Management Feedback and Trust Annual Clinical Reports
- Develop a dedicated NJR data access and research portal to allow researchers to access the NJR dataset via secure access
- Provide further analyses and investigation of NJR PROMs at 3 and 5 years

Acknowledgements

During this reporting period, there have been changes to the membership of the NJRSC. I would wish to convey my sincere thanks to outgoing independent healthcare sector member Dr Jean-Jacques de Gorter, for his valuable contribution to the NJR, which I have much appreciated, and to welcome his successor Mr David MacDonald, and also welcome new patient member Gillian Coward. I very much look forward to working with them. This year I have also appreciated the significant contribution made by Mr Tim Wilton. As BOA President, Tim joined the NJRSC

as a co-opted member from September 2015 and leaves the Steering Committee this September when a new president takes up post. I look forward to welcoming his successor.

The NJR Regional Clinical Coordinators Sub-committee has also seen a number of changes to its membership during this period. Regional Clinical Coordinators (RCC) underpin and champion the work and success of the NJR, as well as helping shape service delivery and direction. I offer my thanks to all members – both outgoing and incoming – who have supported this important committee, especially Mr Matthew Porteous for his significant contribution as RCC Sub-committee Chairman.

Finally, I would like to end by again thanking all remaining members of the NJRSC, and NJR sub-committees, for their valuable contribution and enthusiasm. In particular, my thanks to Mr Martyn Porter, NJR Vice Chair and Medical Director, and to the chairs of each of the NJR sub-committees for their valuable contribution, hard work and insight. I would encourage you to read and review the reports from each committee chairman at www.njrreports.org.uk where they provide strategic oversight and professional awareness into key work areas.

Also my thanks to the NJR management team, in particular our NJR Operations Director, Elaine Young. Thanks also go to our NJR contractors, the communications team based at the Healthcare Quality Improvement Partnership, Northgate Public Services (UK) Ltd and the University of Bristol, for all their hard work and efforts throughout the year in progressing the NJR work agenda.

Laurel Powers-Freeling

Chairman, National Joint Registry Steering Committee

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Executive summary

Mr Martyn Porter, NJR Medical Director and Chairman, Editorial Board

The National Joint Registry started collecting data in April 2003. The 'cut off' period for outcomes analysis for this report was December 2015, which gives a potential follow-up of 12.75 years for hip and knee replacements. Data on ankle replacement commenced in 2010 and shoulders in 2012 giving potential follow-up of 5.75 and 3.75 years respectively.

The registry now contains over 2 million procedure level records and during the financial year 2015/16 nearly 225,000 were added – which demonstrates the size and growth of this very large dataset.

Registries attempt to collect all possible records of procedures but clearly this is not achievable when dealing with such a high volume of activity. Compliance (the number of cases submitted compared to the number carried out) has grown over the lifetime of the registry, so missing data is more common in the first five years compared to the last eight years. We have monitored compliance by comparing submissions to routinely collected NHS data (Hospital Episode Statistics) but as this does not include privately funded work carried out in the independent sector we have monitored compliance by comparing submissions to the number of implants sold (up to 2 years ago). Both these methods are inexact and we have carried out a detailed national audit of data quality and compliance by comparing NJR submissions with locally collected hospital data for the year 2014/15 to explore this further. This audit is not yet complete and will be reported at a later date but preliminary analysis suggests that over 95% of primary operations and over 90% of revision operations have been captured.

Data quality is extremely important in terms of having confidence in the various outputs of the registry. Statistical methods that allow meaningful comparisons (risk adjustments) are also very important but complex tools. Nevertheless, the NJR is an extremely large dataset and despite missing data the conclusions

based on a large sample of activity are likely to be valid. Problems are more likely to be encountered when dealing with low volume activity. Further work and research are ongoing in these areas and will be reported as they mature.

It is important to reflect on the core objectives of the NJR which our Chairman reminded us of in her foreword, namely: to provide early warnings of issues related to patient safety. In this regard I would like to acknowledge the important work carried out by the Implant and Surgeon Outlier Committees, chaired previously by Mr Keith Tucker and Professor Paul Gregg respectively and recently by Mr Peter Howard. As a result of this work several orthopaedic implants have been identified as having potentially worse than expected performance when compared to similar devices. These anomalies have been investigated in considerable detail and shared with industry and the regulator, the Medicines & Healthcare Products Regulatory Agency. I would like to assure the public that the NJR has been instrumental in providing this high level of quality assurance which otherwise would not have been possible.

The format of the report has not changed from last year. Part 1 (annual progress) is a summary of the in year activities of the NJR and its sub-committees. Part 2 (clinical activity) relates to NJR descriptive data. Both these sections can be found online at www.njrreports.org.uk. Please note that information in Part 2 is available from 2005 in most cases and that the reports are interactive and filterable. So please visit the website and explore this information. Part 3 is the main body of the published report and relates to outcomes after joint replacement. This work has been produced by the highly experienced team at the University of Bristol under the leadership of Professor Ashley Blom and is now also supported by researchers from the University of Oxford. I would like to thank all the team for their excellent work and success in obtaining several high profile peer reviewed publications.

What are the main headlines for 2015?

Many of the trends reported last year continue. The revision estimates following primary total hip replacement are low (less than 5% for the majority of procedures at twelve years) and for some specific brand, bearing combinations can be extremely low (less than 2% at twelve years). These results are extremely impressive and underpin the enormous success and reliability of this operation. These sorts of results should drive confidence to the public and commissioners of healthcare that hip and knee replacement procedures are one of the most effective and cost effective interventions that the NHS has to offer.

As the dataset is so large it is possible for the most frequently used brands or types of replacement to be reported including details of fixation and bearing attributes. Patients and surgeons can therefore see what specific type of hip construct produces low revision rates. This is more relevant than just reporting on how the replacement is fixed to the bone. The good news is that many different types of replacement can produce good results at twelve years. There is not one specific implant that is out on its own at twelve years. In relation to bearing material the ceramic-on-polyethylene combination appear to have low revision rates, whereas metal-on-metal bearings have generally produced inferior results and are now very rarely used.

It is important to note that the patient has an important effect on how long a hip replacement will last. Revision estimates are much higher in younger patients under-55 compared to patients over-75 years of age. This presumably relates to patient activity. Younger patients should not be denied life changing surgery but they need to be advised that revision may be two or three times more likely at ten years compared to less active patients.

The outcomes of the revised hip are also reported this year. The ten year further revision risk is nearly 15% which is three times greater than the risk for the primary procedure. The message is that revision risk for most patients is low at ten years but if they do fail then the risk of further revision is substantially increased. The findings in the report reinforce the principles of the Department of Health's 'Getting It Right First Time' initiative.

The knee replacement data in many ways mirrors that of hip replacement. As reported previously partial or unicompartmental knee replacement have almost three times the revision risk of a full total replacement. This is where one needs to be cautious in interpreting registry data. Partial knee replacement is a less invasive operation with lower associated mortality and morbidity and therefore may confer advantages in other areas apart from the outcome measure of revision. It is important that surgeons discuss these differences with patients and set out the issues in question. The number of operations carried out by surgeons may be important in driving lower revision rates and there are professional initiatives to discourage surgeons from carrying out low volumes of partial replacement.

Data is presented on ankle and shoulder replacements and I would like to thank members of the British Elbow and Shoulder Society (BESS) and the British Orthopaedic Foot and Ankle Society (BOFAS) for assisting in analysing and understanding these relatively early but complex outputs.

What is also of particular interest for this year is our initial analysis of Patient Reported Outcome Measures (PROMs) in relation to shoulder replacement. The PROMs data highlights the substantial benefit and significant improvement of the elective patients sampled. These data are encouraging, especially given the large cohort being analysed.

Concluding acknowledgements

The Medical Advisory Committee (MAC) has been an extremely important forum for professional engagement and I would like to thank Mr Tim Wilton, president of the British Orthopaedic Association (BOA), and the specialist surgical societies, British Hip Society (BHS), British Association for Surgery of the Knee (BASK), BESS and BOFAS. Additionally, I would like to acknowledge and thank Professor Mark Wilkinson, Chair of the Research Sub-committee for establishing and developing the NJR research agenda, governance and data access platform, Mr Matthew Porteous, Chair of the Regional Clinical Coordinators Sub-committee, Elaine Young, NJR Director of Operations, and our Chairman, Laurel Powers-Freeling. The NJR continues to work with many stakeholders including patients, regulators, hospitals, industry, individual surgeons and procurement, to ensure accurate annual reporting. I would like to conclude by acknowledging the support and expertise of Northgate Public Services for providing the IT support to the NJR to achieve this.

Finally, I would like to thank all members of the NJR Steering Committee, sub-committees and indeed all the orthopaedic surgeons in hospitals that contribute data. The collective effort ensures that the National Joint Registry positions itself as the world-leading arthroplasty registry, driving patient safety across the field of joint replacement surgery.

Mr Martyn Porter

NJR Medical Director and Chairman,
Editorial Board

Part 1

Annual progress

1.1 Annual Report Introduction

The 13th Annual Report of the National Joint Registry for England, Wales, Northern Ireland and the Isle of Man (NJR) is the formal public report for the period 1 April 2015 to 31 March 2016 and comprises distinct parts, outlined in the summary table.

As part of the continued approach to sharing information about NJR progress, clinical activity and hospital and implant activity, the NJR has again refreshed and built upon its dedicated online annual report website, 'NJR Reports', to showcase annual report data and information.

Some of these data can be found in this printed report – namely the summaries and the full detailed, statistical analysis of outcomes following joint replacement surgery.

A short summary of the NJR's progress over 2015/16 is included below, in the Chairman's Foreword, and Annual Report Executive Summary.

More comprehensive detail is available online via 'NJR Reports' at: www.njrreports.org.uk.

1.2 Annual Progress

The total number of procedures recorded in the NJR now exceeds 2.09 million at 31 March 2016, with 224,470 procedures having been submitted in 2015/16. This is against a backdrop of sustained data quality, although a high degree of monitoring and support to orthopaedic units is still required. Overall key performance indicators demonstrated:

- Patient consent (to allow the recording of their details in the NJR) was recorded as 93.0%
- Linkability (the ability to link a patient's primary procedure to a revision procedure) was recorded as 94.5%

There have been changes in the NJR systems and processes that relate to these statistics and any comparison on the previous year will demonstrate variation – please see the data completeness and quality indicators section online for further detail.

The evolution of the NJR Steering Committee and the Regional Clinical Coordinator Sub-committee has continued, with a series of new appointments being made allowing for a number of long-standing members to conclude their final terms of office.

Data quality has been a primary focus for the NJR in 2015/16 with the undertaking of a data quality audit across all NHS units for the preceding submission year. The audit team were able to establish NJR Data Quality and Clinical Leads at all Trusts and Health Boards and work with them to extract, compare and validate local data against NJR records. The overall scale of missing records has been found to be low but the proportion of missing records was higher for revision procedures than primary procedures. Please visit www.njrreports.org.uk for further details of the audit.

This year also saw the five-year Patient Reported Outcome Measures (PROMs) follow up for hips and knees begin in April 2015 and the NJR also completed a third year of PROMs for shoulders.

Further enhancements to the NJR's reporting services have been made in 2015/16. Surgeons are now able to access more information through NJR Clinician Feedback, monitor their patients through a report on primary procedures and also, within subscribing Trusts and Health Boards, gain access to implant pricing reports. NJR Management Feedback continues to issue a report to summarise activity and outcomes at each hospital within a Trust, Health Board or organisation and offers a free reporting service to units providing implant pricing information.

Finally, the NJR remains committed to working for patient safety and driving forward quality in joint replacement surgery. Further progress and updates will be available at www.njrreports.org.uk and also via the main NJR website at www.njrcentre.org.uk.

1.3 Summary of content for the NJR Annual Report

Section	Summary	Content	Full information can be found
Part One	Executive summaries, annual progress and 2015/16 highlights	News and information in executive summaries, committee reports and highlights about the progress of the NJR to 31 March 2016	www.njrreports.org.uk
Part Two	Clinical activity 2015	Statistics on joint replacement activity for hip, knee, ankle, elbow and shoulder activity for the period 1 January to 31 December 2015	www.njrreports.org.uk through interactive reporting
Part Three	Outcomes after joint replacement surgery 2003-2015	Detailed statistical analyses on hip and knee replacement surgery using data from 1 April 2003 to 31 December 2015. Analyses on provisional data for ankles and shoulders is also included representing data collected since 1 April 2010 and 1 April 2012 respectively	In this printed report and via www.njrreports.org.uk
Part Four	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	www.njrreports.org.uk
Prostheses	Use of prostheses by brand (implants)	Prostheses used in joint replacement surgery 2015 for hip, knee, ankle, elbow and shoulder	www.njrreports.org.uk
Appendices	Information relating to the NJR's governance and operational structure Research	Composition, attendance, declarations of interest for the NJR Steering Committee, sub-committees and terms of reference Published and approved research papers using NJR data	www.njrreports.org.uk

Part 2

Clinical activity 2015 and using the dedicated NJR Reports website

2.1 Clinical activity 2015 overview

Part Two of the NJR's 13th Annual Report can now to be found online via the registry's dedicated NJR Reports website at: www.njrreports.org.uk.

Part Two presents data on clinical activity during the 2015 calendar year. This includes information on the volumes and surgical techniques in relation to procedures submitted to the NJR, with the most recent data being for the period 1 January 2015 to 31 December 2015. To be included in the report all procedures must have been entered into the NJR by 29 February 2016.

The information in Part Two 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, Wales and Northern Ireland able to participate in the NJR and the proportion actually participating
- Number of participating hospitals, according to number of procedures performed
- Procedure details, according to type of provider
- Patient characteristics for primary replacement procedures, according to procedure type
- Age and gender for primary replacement patients
- Patient's physical status classification (ASA grades) for primary replacement procedures
- Body Mass Index (BMI) for primary replacement patients
- Indications for primary procedure based on age group
- 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

2.2 Navigating the NJR Reports online facility

What can you find at NJR Reports online?

The total number of procedures recorded in the NJR now exceeds 2 million.

The NJR has refreshed and built upon its dedicated online annual report website – *NJR Reports* – to showcase annual report data and help users easily navigate the wealth of information collected about joint replacement procedures.

Part Two of the NJR's 13th Annual Report presents data on clinical activity during the 2015 calendar year. Simply navigate the left hand tabs via *NJR Reports* to view information on the volumes and surgical techniques in relation to procedures submitted to the NJR.

Left hand tabs: Here, the information is segregated by report and information type. A wealth of updates are available, from Executive Reports including from the NJR's Steering Committee Chairman, to Executive Summaries on clinical activity and outcomes data, and highlights from the year.

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 downloadable **patient guides** to make all the information as accessible as possible to all of our visitors.

Visit the NJR Reports website at: www.njrreports.org.uk

Part 3

Outcomes after joint replacement 2003 to 2015

3.1 Executive summary

Part Three of the 13th Annual Report provides outcome data in relation to hip, knee, shoulder, elbow and ankle replacements. It describes activity between 1 April 2003 and 31 December 2015.

There were 2,055,687 procedures recorded in this period and 10% of these were excluded because there were insufficient patient details to enable linkage. This relates predominantly to the early years of the registry and was less of a feature in recent years as data quality has improved.

The numbers of primary procedures available for analysis were 796,636 total hip replacements, 871,472 knee replacements, 3,174 ankle replacements, 17,199 shoulder replacements and 1,631 elbow replacements.

Hip replacement procedures

The potential follow-up for hip procedures was 12.75 years. A total of 60% of the primary procedures were carried out on women and the median age at primary across the entire group was 69 years. Osteoarthritis was the predominant diagnosis in 92% of cases. The most common form of fixation continues to be uncemented, but the percentage of total hip replacements that were uncemented has fallen to 39% from a peak of 46% in 2010. The trend for an increase in hybrid fixation seen over the last three reports has continued and now represents 26% of cases. The percentage of cemented total hip replacements performed has remained fairly static over the last seven years at just over 30%. Hip resurfacing remains at less than 1%. The most common articulation used in cemented, uncemented and hybrid prostheses continues to be metal-on-polyethylene. The trend in uncemented implantation showing a rise in ceramic-on-polyethylene and a decrease in ceramic-on-ceramic has continued with equal numbers now being used. With hybrid fixation, the increase in the use of ceramic-on-polyethylene reported last year has continued.

The Kaplan-Meier cumulative revision risk estimates are now reported at twelve years, with the lowest rates seen in the cemented fixation population at 3.93% (95% Confidence Interval 3.74-4.13), compared to 8.37% (95% CI 8.03-8.73) in the uncemented group. However, the uncemented group contained the majority of metal-on-metal articulations and when uncemented fixation was used with metal-on-polyethylene bearing, the twelve-year revision estimate was 5.46% (95% CI 4.92-6.06). The lowest revision risk in all categories was consistently seen with the ceramic-on-polyethylene bearing, the revision probability being 3.08% with the cemented fixation, 4.19% with uncemented and 3.29% with the hybrid fixation, although the latter was approximate as fewer than 250 were at risk at this point.

This year's analysis continues to show the increased risk of revision associated with younger patients. For example, in female patients less than 55 years of age undergoing cemented hip replacement, the ten-year revision risk estimate was 5.85%, compared with 2.02% in females over 75 years. Similar trends are seen across all groups and gender, with an inverse relationship between the probability of revision and the age of the patient.

Our analysis of the relationship between head size and revision rates in hard-on-soft bearings (metal-on-polyethylene and ceramic-on-polyethylene) appears to indicate an ideal head size of between 26 and 32mm. Head sizes of 36mm and above are associated with increasingly higher failure rates.

The common stem brand combinations are reported in terms of revision risk, with further sub-division into bearing type. Several brands had low revision risk at ten years and were essentially comparable. The most commonly used cemented Exeter V40 with a Contemporary Flanged cup with metal-on-polyethylene bearing produced a ten-year revision estimate of 2.23%; the most widely used uncemented prosthesis the Corail Pinnacle with a metal-on-polyethylene bearing had a ten-year revision risk of 3.16% and the most widely used hybrid the Exeter V40 and uncemented Trident cup with metal-on-polyethylene bearing produced a ten-year revision risk of 2.75%. The ASR resurfacing had a revision estimate of 27.05% at ten years, rising to 30.35% at twelve years. (Note the twelve year figure is an approximation as fewer than 250 cases remained at risk).

The cumulative mortality was examined up to twelve years following primary surgery and as expected increased with age. For example, this was low in men under 55 years of age at 6.15% (95% CI 5.64-6.71) but rose to 94.32% (95% CI 92.08-96.10) in men over 85 years. The comparative figures are 5.96% (95% CI 5.40-6.58) and 85.97% (95% CI 84.22-81.52) for women in the same age groups.

The six most common indications for revision after primary total hip replacement (listed in order of frequency) remains aseptic loosening, pain, adverse soft tissue reaction to particulate debris, dislocation, infection and peri-prosthetic fracture. The rate of revision for aseptic loosening, pain and adverse soft tissue reaction to particulate debris tended to increase over time, reaching a maximum beyond five years. The rate of revision for dislocation, infection and peri-prosthetic fracture are at their highest within the first year following surgery.

The percentage of primary hip replacements performed for fractured neck of femur has increased gradually over the last twelve years reaching 4.5% in 2015 (3,733 procedures). Comparing the cohort of 19,872 primary hip replacements performed to treat fractured neck of femur, with those performed for all other causes showed a slightly higher revision risk and a greatly increased mortality risk at each time point in the fracture group.

Revision total hip replacement has been studied for data collected between 1 April 2003 and 31 December 2015. A total of 88,822 revision procedures were reported of which 87.2% were single-stage revisions, 6.0% were stage one of two-stage procedures and 6.8% were stage two of two-stage procedures. From 2003 to 2012 the number of revisions recorded annually increased from 1,426 in the first recorded year to 10,497 in 2012. Over the last three years there has been a reduction in numbers recorded to 8,367 in 2015.

The 88,822 revision procedures included multiple revision procedures entered for the same individual person-joint. Out of these, 78,130 first recorded revision procedures were identified for a given patient-side; 20,926 of these were revisions of primary operations that could be identified in the registry whilst the remaining 57,204 related to unrecorded primaries (either pre-dating 2003, the primary had not been captured in the NJR or the procedures could not be linked). The ten-year risk of re-revision following these first revision procedures was 14.83% (95% CI 14.38-15.31), which is approximately three times higher than the risk of revision in the primary cohort. The top five most common indications for re-revision (in order of greatest frequency) were aseptic loosening, dislocation/subluxation, infection, pain and peri-prosthetic fracture.

Knee replacement procedures

Of the 871,472 primary knee replacements, osteoarthritis was the sole stated indication for surgery in 96% of cases. Of all primary knee replacements, 84.7% were all cemented total knee replacements, the majority of which were unconstrained fixed bearing knees, 4.4% were uncemented and 1.0% were hybrid. The utilisation of unicondylar knee replacements remains similar to previous years at 8.7% of all procedures while patellofemoral replacement made up 1.3% of all procedures. A total of 57% of primary knee replacement surgeries were performed on women. The median age for a patient undergoing primary cemented total knee replacement surgery was 70 years and was 64 years for unicondylar replacement.

When considering the temporal change in implant selection between 2003 and 2015, the use of all cemented total knee replacement has risen from 81.5% of all recorded surgeries in 2003 to 87.4% in 2015. There has been a decline in uncemented total knee replacements from 6.7% to 2.3% over the same time period. Unicondylar replacements remain between 8% and 9% of all primaries each year over the twelve-year period and patellofemoral replacements have continued to form just over 1% of all surgeries year on year.

The Kaplan-Meier cumulative revision risk estimates at twelve years were 3.82% (95% CI 3.71-3.94) for cemented total knee replacement, 4.74% (95% CI 4.34-5.17) for uncemented total knee replacement and 4.17% (95% CI 3.47-5.00) for hybrid total knee replacement.

As reported in previous years the corresponding twelve-year revision estimate for unicondylar replacements were higher than total knee replacements at 14.99% (95% CI 14.16-15.87) and for patellofemoral replacement the revision risk was 23.83% (95% CI 21.19-26.73). Revision estimates have been broken down according to level of constraint, for example the twelve-year estimate for cemented total knee replacement with an unconstrained, fixed bearing was 3.51% (95% CI 3.37-3.66) and the posterior-stabilised fixed bearing was 4.23% (95% CI 4.01-4.47). Further detailed breakdown in relation to fixation, bearing, constraint, gender and age show marked differences in outcomes. For example, when a cemented, unconstrained, fixed bearing total knee replacement was used in men over 75 years of age, the risk of revision at twelve years after the primary was just

2.14% (95% CI 1.79-2.56). In comparison, in men aged under 55, the revision risk estimate was 9.21% (95% CI 8.09-10.47).

The detailed breakdown of brands with a sub-division of fixation, bearing and constraint within brand continues to show that the ten-year revision estimates are low (less than 4% for many brands). For example looking at the most commonly used brands, at ten years the revision estimates were; 2.65% (95% CI 2.55-2.75) for the PFC Sigma, 3.62% (95% CI 3.43-3.82) for the Nexgen knee, 3.32% (2.83-3.90) for the Triathalon knee, 3.56% (95% CI 3.34-3.79) for the AGC and 2.78% (95% CI 2.51-3.07) for the Genesis 2.

Within the unicondylar brand group, the cumulative risk of revision at ten years varied from 6.31% (95% CI 5.16-7.70) seen with the Zimmer unicompartmental, to 12.02% (95% CI 11.51-12.54) with the Oxford prosthesis (the most commonly used) and 17.11% (95% CI 15.14-19.32) with the Preservation.

The cumulative mortality at twelve years after the primary knee replacement for women under 55 years of age was 5.46% (95% CI 4.62-6.44) but rose to 85.79% (95% CI 83.27-88.10) in women over 85. The corresponding figures for male patients were 7.92 (95% CI 6.62-9.47) and 91.24 (95% CI 88.68-93.42).

Outcomes of revision knee replacement surgery are also reported. There were a total of 54,153 revision operations recorded in the NJR. In 2015, 79% of revisions were single-stage; 10.5% were stage one of two-stage and 10.5% were stage two of two-stage. Looking at the outcomes following the first revision recorded in NJR for a given patient-side, the twelve-year cumulative percentage probability of re-revision was 15.99% (95% CI 14.96-17.09). The re-revision risks were higher when the primary was recorded in the NJR at 16.76% (95% CI 15.66-17.92), compared to 14.19% (95% CI 13.07-15.39) when the primary was not recorded in the NJR.

Ankle replacement procedures

A total of 3,174 primary ankle replacements have been recorded in the NJR up to 31 December 2015. Ankle replacements were entered routinely from 2010 although 13 primary operations performed in 2008-2009 were entered. The 3,174 procedures were carried out by a total of 214 consultants in 228 hospitals. A total of 44% of consultants entered ten or more procedures over the five year period, which means that two-thirds of consultants are carrying out very small numbers per year. The maximum number carried out by any one unit was 234.

The median age at primary surgery remains at 68 years and 59% of procedures were carried out in men. A total of 94% of the procedures were uncemented.

The Mobility was the most commonly used brand of replacement until 2013, but it was withdrawn from the market in 2014. In 2015 the most commonly used prosthesis was the Zenith ankle (25.6%) followed by the Box ankle (22.3%) and the Infinity ankle (15.5%).

A total of 105 implantations have been revised and the five-year cumulative revision risk was 6.83% (95% CI 5.47-8.52).

Shoulder replacement procedures

A total of 17,199 primary shoulder replacements were recorded on the NJR from 1 April 2012 until 31 December 2015. These were carried out by a total of 636 surgeons in 369 units. The median number reported for each surgeon was 13 (IQR 2-41). The median age at primary surgery remains at 73 years and 71.4% of procedures were carried out in women.

Over the last year there has been a continued decrease in the use of resurfacing arthroplasty and an increased use of the reverse polarity total shoulder replacement, which, in 2015, represented over 45% of cases.

There were 364 shoulder revisions overall and the cumulative revision estimate at three years was 3.44% (95% CI 3.07-3.86). The relatively small numbers and short follow-up continues to prevent a detailed breakdown of causes of revision or differences between brands.

A detailed analysis of pre- and post-operative Patient Reported Outcome Measures has been undertaken on a sample of patients who had a primary shoulder replacement after April 2012. Of the total number of responses, 3,331 elective patients had completed both pre- and post-operative questionnaires. The median pre-operative Oxford Shoulder Score (OSS) was 16, rising to 36 at six months, with a median change score of 18. Overall 90.8% of the elective patients had improvement in their OSS, with 8.3% worse and 0.9% staying the same after surgery.

Part 3

3.2 Summary of data sources and linkage

The main outcome analyses in this section relate to primary joint replacements. For these analyses we included all patients with at least one primary joint replacement carried out between 1 April 2003 and 31 December 2015 inclusive, whose records had been submitted to the NJR by 29 February 2016.

Data source:

In the early years of the registry, when reporting for publicly funded procedures was not mandated by the Department of Health, we know that a number of primary procedures were not recorded in the NJR, as indicated by discrepancies between implant levies and procedure rates. In the subsequent years, selective reporting of primary and revision operations may explain temporal increases in volume (primary and revision), and revision outcomes for hips and knees replacements (see sections 3.4 and 3.6).

More recently, primary procedures are less likely to have been missed; the recent 2014/15 NJR data completeness and accuracy audit across 39 trusts[1] suggests we may have missed about 3% of primaries during that period, although it is possible that these may, or will, have been subsequently entered as they were identified and uploaded at a later date.

What is of more serious consequence to our analyses is the differential and selective under-reporting of revision procedures associated with the primaries that have been entered. This could lead to reported revision outcomes looking better than they actually are and this issue is being addressed by the Data Quality Sub-commitee. The 2014/15 data completeness and accuracy audit suggested 5% and 7% of hip and knee revisions had been missed during this period respectively. Although, some of these may be entered at a later point in time.

Due to the large numbers of procedures recorded in this registry, we believe selective under-reporting of revisions would apply across all types of hip and knee replacements in a random pattern and therefore would not affect the group comparisons we make.

Patient-level data linkage:

Documentation of implant survivorship and mortality requires linkage of patient-level identifiers, this enables the identification of primary and revision operations on the same individual.

Starting with a total of 2,055,687 NJR source records, around 10% were lost because no suitable person-level identifier was found (see Figure 3.1). In around half of these 207,920 procedures (47.3%), the patient had declined to give consent for details to be held or consent was not obtained, the remainder being attributable to tracing and linkage difficulties. Cases from Northern Ireland and the Isle of Man were excluded at this step because there was no patient tracing service for them. Although a person-level identifier was available for 95% of operations since the beginning of 2008, in earlier years, the proportion had been much lower. In 2003/4, for example, it was only 59%, rising to 79% in 2006 and 90% in 2007. Therefore, patients with longer follow-up might be less representative of the whole cohort of patients undergoing primary joint replacement than those patients with shorter follow-up.

Among the patients with person-level identifiers, 5.9% only had revision operations recorded within the analysis period (2003 to 2015), i.e. there was no primary operation recorded for that patient. This would have been either because the primary had taken place at an earlier point in time (before the NJR data collection period began in 2003) or was not included for other reasons such as the operation being performed outside the geographical catchment area of the NJR, or consent for data linkage not being provided at the time of the primary procedure. At the joint level, some further revisions were excluded because they could not be matched to primary joint replacements, i.e. if a primary operation was recorded only for one side and there was only a documented revision for the other side, the latter was excluded. For hips and knees we have looked at these ‘unlinked’ revisions in our general overview of outcomes after revision, see Sections 3.4 and 3.6.

[1] Trusts that had completed the audit as of 25 March 2016

Linkage between primaries and any associated revisions:

A total of 1,421,133 patients had at least one record of a primary joint replacement within the NJR, i.e. hip, knee, ankle, elbow or shoulder. At this stage, information about the primary procedures were linked to subsequent associated revisions (i.e. for the same patient-joint-side). Further data cleaning was carried out at this step (for example, removal of duplicated primary information on the same side or revision dates that appeared to precede the primary procedure), leading to the final numbers for analysis shown in Tables 3.1 and 3.2.

In Table 3.2, of the 691,254 patients with primary hip operations, 15.3% had documented primaries for both hips (bilateral). Of the 719,985 patients with knee operations, 21.0% were bilateral.

Implant survivorship is mainly described with respect to the lifetime of the primary joint only, i.e. we have looked only at the time to first revision, not the time from a revision operation to any subsequent one. These analyses are described in Sections 3.3, 3.5, 3.7 and 3.8 for hips, knees, ankles and shoulders; the number of elbows remains too small for further breakdown.

In Sections 3.4 and 3.6, we provide an overview of further revisions following the first hip or knee revision procedure. We have also included revisions to a joint replacement where the associated primary had not been documented in the NJR.

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 did not have prior replacements recorded in the NJR. Established risk factors, such as age, are recorded at the time of primary operation and will therefore be different for the two procedures unless the two operations are performed at the same time. Patients may also have more than one type of implant.

Within the NJR a revision is defined as any operation in which any prosthesis or part of a prosthesis is either removed, exchanged or inserted for any reason into a joint in which there is an existing joint replacement. This therefore not only includes complete replacement of one or both of the main components of any joint replacement, but also, for example, liner and/or head exchange at washout for suspected infection and secondary patella resurfacing of an existing total or unicondylar knee replacement.

Figure 3.1

Initial numbers of procedures for analysis.

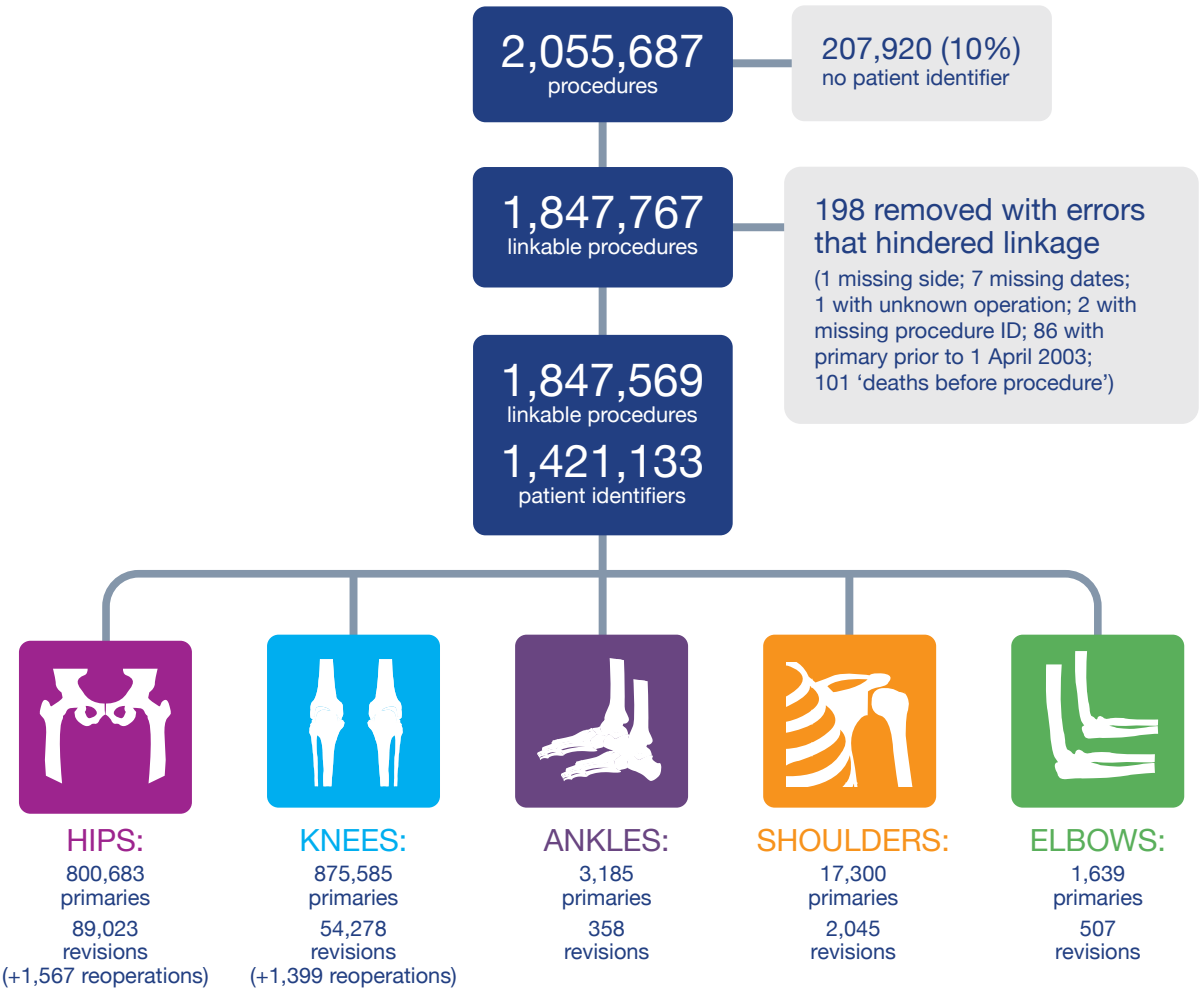


Table 3.1 Summary description of linked datasets used for main survivorship analyses.

Summary of data	NJR data (England and Wales only)				
Time period	All NJR procedure-level data restructured to person-level 1 April 2003 – 31 December 2015 (hips and knees) 1 April 2010* – 31 December 2015 (ankles) 1 April 2012* – 31 December 2015 (shoulders)				
Data exclusions	- Excludes data where person-level identifier is not present - Excludes patients where no primary operation is recorded in the NJR - Excludes any revisions after the first revision				
Number of primary operations	796,636 hips	871,472 knees	3,174 ankles	17,199 shoulders	1,631** elbows
Number of primaries that were subsequently revised	NJR identified primary-linked first revisions				
	20,926 hips	20,863 knees	105*** ankles	364**** shoulders	31 elbows

*These were the dates when data collection formally started however the analyses in this section include a small number of primaries in the database that took place before these time points.

**Figures for elbows are provisional.

***Includes 16 conversions to arthrodesis (no amputations recorded).

****Includes one excision.

Table 3.2 Composition of person-level datasets for main survivorship analysis.

	Joint				
	Hips	Knees	Ankles	Shoulders	Elbows*
Number of patients	**691,254**	**719,985**	**3,056**	**16,417**	**1,588**
Number (%) of patients with only one primary joint operation	585,872 (84.8%)	568,498 (79.0%)	2,938 (96.1%)	15,635 (95.2%)	1,545 (97.3%)
Number (%) of patients with both a left and right side primary operation but on different dates	101,389 (14.7%)	141,697 (19.7%)	114 (3.7%)	767 (4.7%)	42 (2.6%)
Number (%) of patients with both a left and a right side operation on the same date (bilateral operations)	3,993 (0.6%)	9,790 (1.4%)	4 (0.1%)	15 (0.1%)	1 (0.1%)
Total number of primary joints	**796,636**	**871,472**	**3,174**	**17,199**	**1,631**
Number with at least one revision operation linked to the primary	20,926	20,863	105**	364	31
Number with more than one revision procedure	3,040***	3,587***	7 (4)****	39 (25)****	5 (3)****

*Figures for elbows are provisional.

**Includes 16 conversions to arthrodesis (no amputations were recorded).

***Discussed more fully in a later section: the numbers shown include some stage two of two-stage revisions.

****In some cases the first revision was the stage one of a two-stage revision; the numbers in parenthesis exclude cases where a further revision procedure appeared to be either another stage one or the respective stage two.

Part 3

3.3 Outcomes after primary hip replacement

This section looks at revision and mortality outcomes for all primary hip operations performed between 1 April 2003 and 31 December 2015. Patients operated on at the beginning of the registry therefore had a potential 12.75 years of follow-up.

Details of the patient cohort are given in Tables 3.1 and 3.2 of the preceding section; a total of 796,636 hips were included in our analyses.

Osteoarthritis was given as a documented reason in 736,399 (92% of the cohort) and was the sole reason given in 711,014 (89%) hip procedures.

Methodological note

Survival analyses have been used throughout, first looking at the need for revision and then looking at mortality. Only the first revision has been considered in this section. The majority of implants did not require revision and survival analysis made use of the information that was available for them, i.e. that they had not been revised up to the end of the follow-up period (the end of 2015) or prior to their death; these observations being regarded as being 'censored' at those times. For mortality, the event was death, censoring only those cases that were still alive at the end of 2015 (and not for any revision procedure).

The survival tables in this report show 'Kaplan-Meier' estimates of the cumulative chance (probability) of revision, or death, at different times from the primary operation. Where possible, the numbers at risk at each anniversary have been added to the figures. These are particularly useful where a group has appeared to plateau; it may simply be because the number of cases fell so low that occurrence of further revisions/deaths became unlikely. The Kaplan-Meier estimates shown have been multiplied by 100, therefore they estimate the cumulative percentage probability.

In the case of revisions, no attempt has been made to adjust for the competing risk of death. The likely impact of mortality was reported in the 11th Annual Report (published September 2014).

Terminology note

The six 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) and resurfacing procedures. The metal-on-metal group in this section refers to patients with a stemmed prosthesis 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.

3.3.1 Overview of primary hip surgery

Table 3.3 (on the next page) shows the breakdown of cases by method of fixation and within each fixation sub-group, by bearing surface.

The most commonly used type overall remains cemented metal-on-polyethylene (87.5% of all cemented primaries, 31.0% of all primaries).

Table 3.3 Numbers and percentages of primary hip replacements of each type of fixation and within each fixation sub-group, by bearing surface.*

Fixation	Number (%)	Bearing surface within fixation group	Number (%)
All cases	796,636 (100%)		796,636 (100%)
All cemented	282,548 (35.5%)	MoP	247,093 (87.5%)
		MoM	1,084 (0.4%)
		CoP	28,562 (10.1%)
		Others/unsure	5,809 (2.1%)
All uncemented	311,456 (39.1%)	MoP	118,756 (38.1%)
		MoM	28,646 (9.2%)
		CoP	53,095 (17.0%)
		CoC	104,026 (33.4%)
		CoM	2,151 (0.7%)
		Others/unsure	4,782 (1.5%)
All hybrid	144,391 (18.1%)	MoP	91,077 (63.1%)
		MoM	2,147 (1.5%)
		CoP	27,533 (19.1%)
		CoC	21,485 (14.9%)
		Others/unsure	2,149 (1.5%)
All reverse hybrid	19,800 (2.5%)	MoP	13,415 (67.8%)
		CoP	6,291 (31.8%)
		Others/unsure	94 (0.5%)
All resurfacing	38,402 (4.8%)	(MoM)	38,402 (100%)
Unsure	39 (<0.1%)	Unsure	39 (not applicable)

*The percentages in the right-hand column have been calculated within each fixation group.

Table 3.4 and Figure 3.2 show the distributions across fixation groups for each year of primary operation and Figures 3.3 (a) to (d) show distributions across bearing surface of each fixation group. Trends of implant usage are interesting in that the decline in cemented implants between 2003 and 2009 has arrested and is now stable at around a third of cases. Conversely, although the use of uncemented implants has decreased since 2010, they still remain the most widely used compared to other implants. Hybrid implants continue to steadily increase in popularity and now account for a quarter of cases.

With regard to bearing surfaces, metal-on-polyethylene is still the most widely used, with ceramic-on-polyethylene following close behind; while the use of ceramic-on-ceramic is declining. The use of metal-on-metal stemmed implants has virtually ceased, with the proportion of metal-on-metal resurfacing implants decreasing from a peak of 10.8% in 2006 to account for only 0.9% of implants in 2015.

Table 3.4 Percentages of primary hip replacements in each calendar year that use each fixation type and for each fixation group, the percentages within each bearing surface.*

Fixation/ bearing	Percentage of hip replacements by fixation and bearing surface for each year of primary operation:												
	2003 n= 14,433	2004 n= 28,029	2005 n= 40,202	2006 n= 47,573	2007 n= 60,570	2008 n= 66,922	2009 n= 67,903	2010 n= 70,395	2011 n= 73,443	2012 n= 77,639	2013 n= 79,669	2014 n= 85,972	2015 n= 83,886
All cemented	60.4	53.8	48.3	42.5	39.5	34.0	31.7	31.3	32.2	32.9	33.0	31.9	31.0
Cemented by bearing surface:													
MoP	91.8	91.0	90.7	89.9	90.0	88.6	88.6	86.8	85.3	86.5	85.6	84.6	83.7
MoM	0.2	0.7	0.8	1.0	1.0	1.1	0.4	0.1	0.0(8)	0.0(1)	0.0	0.0(4)	0.0(5)
CoP	4.6	5.9	6.1	6.7	6.3	7.8	9.0	10.3	10.8	12.1	13.4	14.5	15.7
Others/ unsure	3.4	2.4	2.5	2.3	2.7	2.5	2.0	2.8	3.8	1.4	1.1	0.9	0.6
All uncemented	16.8	21.5	25.8	30.2	33.4	39.4	43.2	45.8	45.0	44.9	42.6	40.9	39.4
Uncemented by bearing surface:													
MoP	36.7	42.3	38.2	34.2	32.3	33.2	34.9	37.0	38.2	39.8	41.3	41.7	41.8
MoM	7.5	10.3	21.2	27.7	31.0	27.8	18.4	7.0	1.0	0.2	0.0(4)	0.0	0.0
CoP	29.9	23.8	20.0	14.6	11.9	9.9	10.8	12.3	13.5	16.3	19.5	23.5	29.0
CoC	20.9	19.7	17.1	20.4	21.9	25.7	31.6	39.5	44.7	42.9	38.6	34.3	28.8
CoM	0.0	0.0(1)	0.0(1)	0.0(6)	0.3	1.0	2.2	2.3	1.0	0.1	0.1	0.0(6)	0.0(1)
Others/ unsure	5.0	3.9	3.5	3.0	2.6	2.4	2.1	1.9	1.6	0.6	0.5	0.5	0.4
All hybrid	12.3	13.6	14.4	15.5	15.2	15.3	15.9	16.3	17.2	17.8	20.3	23.1	25.7
Hybrid by bearing surface:													
MoP	67.0	68.5	65.7	64.3	66.1	65.6	66.3	66.7	67.2	65.6	60.6	58.5	56.8
MoM	5.6	3.5	3.1	4.3	5.2	5.2	2.3	1.2	0.3	0.0(4)	0.0	0.0	0.0
CoP	12.0	11.1	8.6	8.0	6.8	8.7	11.2	12.0	13.1	17.5	25.2	30.6	34.8
CoC	9.9	14.3	19.1	20.3	19.3	17.8	18.3	18.4	18.1	16.2	13.5	10.4	8.0
Others/ unsure	5.5	2.6	3.5	3.1	2.7	2.7	2.0	1.8	1.4	0.7	0.7	0.6	0.4
All reverse hybrid	0.6	0.8	0.9	1.0	1.6	2.4	2.7	2.8	3.1	3.1	3.0	3.1	3.1
Reverse hybrid by bearing surface:													
MoP	58.1	72.7	74.4	76.4	63.7	70.6	69.6	68.2	70.2	65.5	66.9	64.5	67.4
CoP	40.7	24.7	24.8	22.1	35.3	28.5	29.7	31.0	29.6	34.4	32.9	35.3	32.5
Others/ unsure	1.2	2.7	0.8	1.4	1.0	0.9	0.8	0.8	0.3	0.1	0.2	0.2	0.1
All resurfacing (MoM)	9.8	10.2	10.6	10.8	10.3	8.9	6.6	3.9	2.5	1.4	1.1	0.9	0.9
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Percentages in each column shown with right-indentation have been calculated within each fixation group.

Figure 3.2

Temporal changes in percentages of each fixation method used in primary hip replacements.

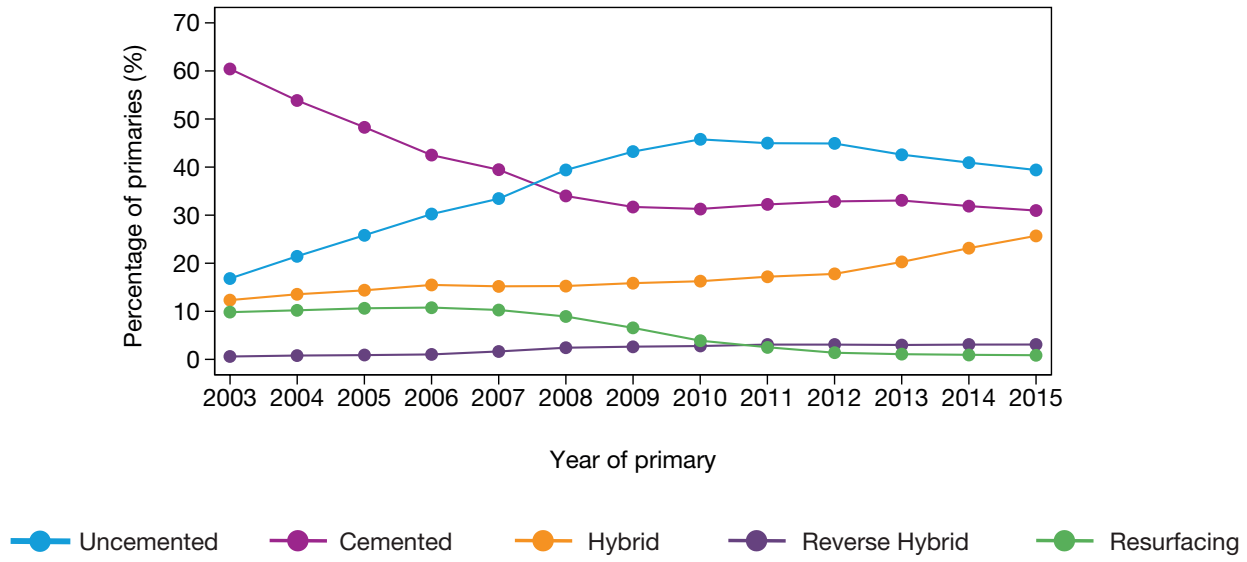


Figure 3.3 (a)

Temporal changes in percentages of each bearing surface used in **cemented** primary hip replacements.

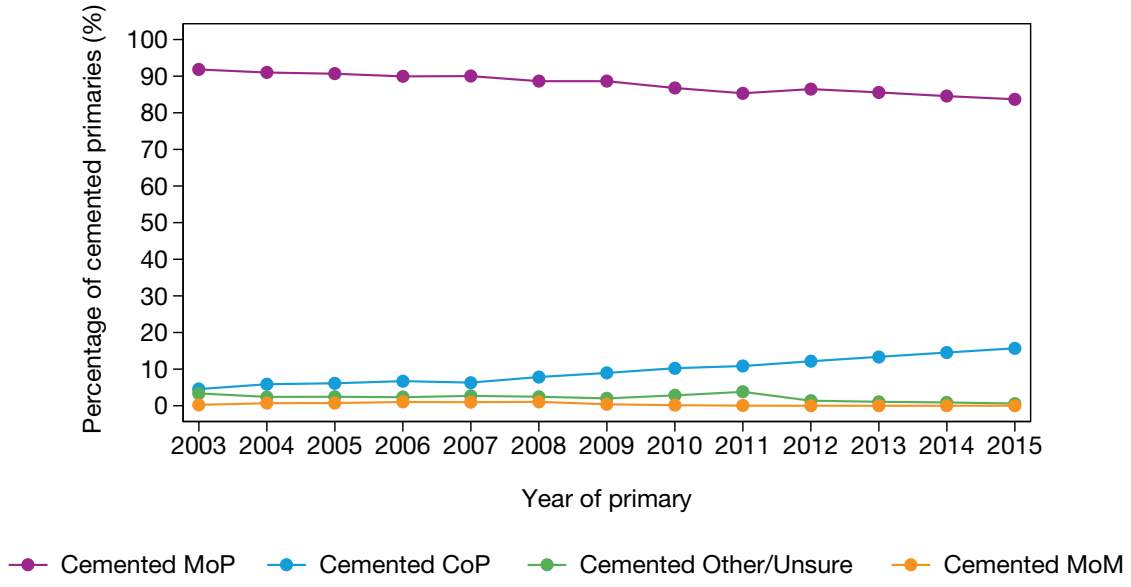


Figure 3.3 (b)

Temporal changes in percentages of each bearing surface used in **uncemented** primary hip replacements.

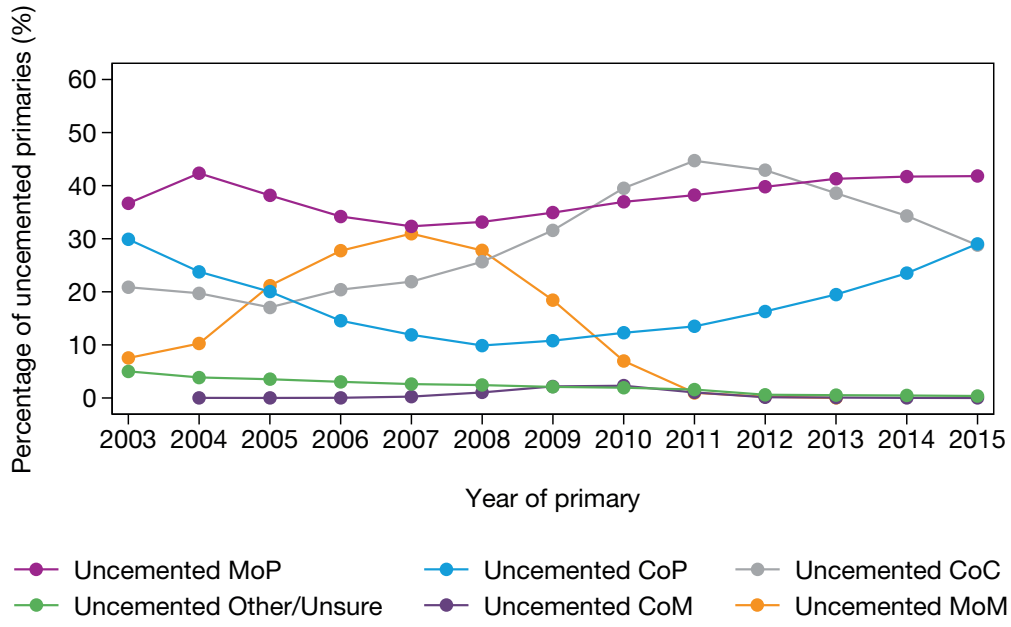


Figure 3.3 (c)

Temporal changes in percentages of each bearing surface used in **hybrid** primary hip replacements.

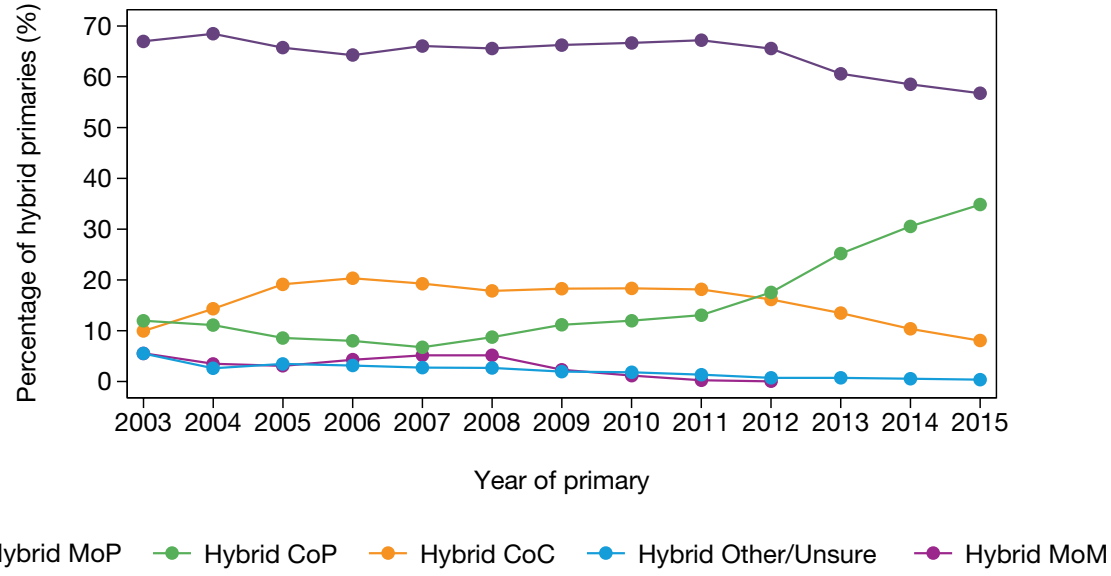
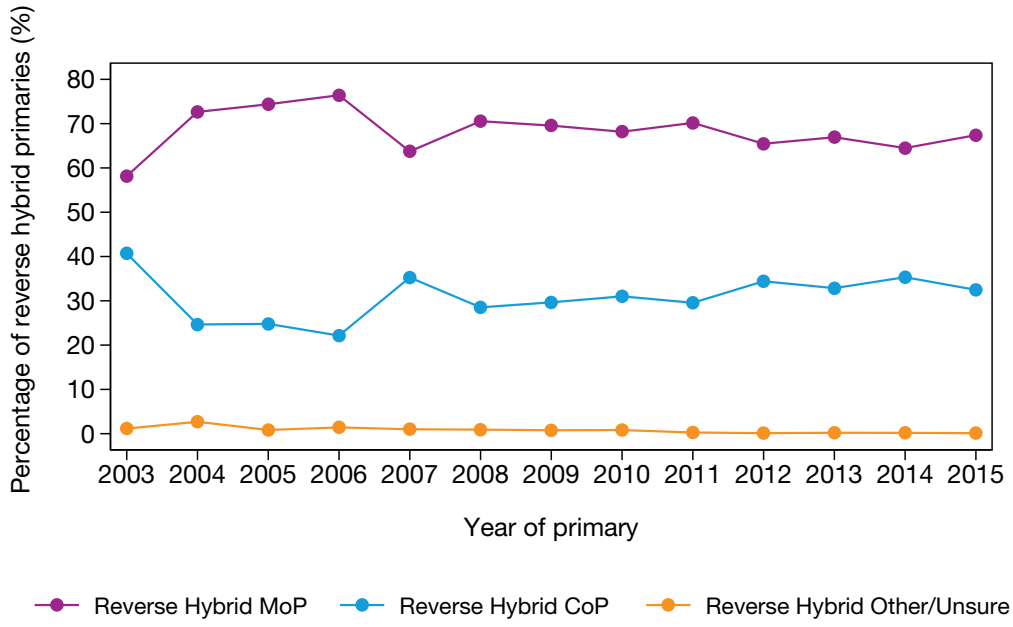


Figure 3.3 (d)

Temporal changes in percentages of each bearing surface used in **reverse hybrid** primary hip replacements.



Within the whole registry, all the 796,636 primary hip replacement procedures contributing to our analyses were carried out by a total of 3,185 consultant surgeons working across 466 units. Over the last three years (1 January 2013 to 31 December 2015), 249,527 primary hip procedures were performed by 2,176 consultant surgeons working across 409 units. Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 53 (inter-quartile range (IQR) 4-172) and the median number of procedures per unit was 514 (IQR 258-826). A proportion of consultants will have just qualified over this period, and some may have retired, therefore their apparent caseload would be lower.

The majority of hip primary procedures were carried out on women (males 40.2%: females 59.8%). The median age at primary operation was 69 (IQR 61-76) years[2], overall range 7-105 years.

Table 3.5 provides a breakdown of fixation type by age and gender with further division by bearing surfaces within each fixation sub-group.

Patients receiving resurfacing and ceramic-on-ceramic bearings tended to be younger than the other groups but the age ranges were wide. Those receiving resurfacings were more likely to be men.

[2] Omitting 226 cases where the NHS number was not traceable, therefore the age was not verifiable.

Table 3.5 Distribution of age at primary hip replacement (in years) and gender, for all procedures and for each type of fixation and bearing surface.

Fixation	By bearing surface within fixation group	n	Age (years)*			Percentage males**
			Median (IQR***)	Minimum	Maximum	
All cases		**796,636**	**69 (61-76)**	**7**	**105**	**40.2**
All cemented		**282,548**	**74 (68-79)**	**7**	**103**	**33.8**
Cemented and						
	MoP	247,093	74 (69-80)	15	103	33.1
	MoM	1,084	64 (57-73)	25	98	46.1
	CoP	28,562	65 (58-71)	14	101	39.0
	Others/unsure	5,809	72 (65-78)	7	102	36.3
All uncemented		**311,456**	**65 (58-72)**	**11**	**105**	**44.1**
Uncemented and						
	MoP	118,756	71 (65-77)	12	101	40.6
	MoM	28,646	64 (57-70)	13	105	50.6
	CoP	53,095	65 (58-70)	13	100	44.2
	CoC	104,026	60 (53-66)	11	100	46.4
	CoM	2,151	63 (56-69)	20	92	42.4
	Others/unsure	4,782	66 (58-73)	17	96	42.6
All hybrid		**144,391**	**70 (63-77)**	**12**	**100**	**36.9**
Hybrid and						
	MoP	91,077	73 (67-79)	12	100	35.0
	MoM	2,147	64 (56-72)	18	95	47.7
	CoP	27,533	66 (59-72)	14	97	39.0
	CoC	21,485	60 (53-66)	13	93	41.0
	Others/unsure	2,149	69 (61-76)	19	94	36.3
All reverse hybrid		**19,800**	**71 (64-77)**	**13**	**100**	**35.7**
Reverse hybrid and						
	MoP	13,415	73 (68-78)	13	100	34.1
	CoP	6,291	64 (58-70)	16	94	39.4
	Others/unsure	94	69 (61-76)	30	90	31.9
All resurfacing (MoM)		**38,402**	**55 (49-60)**	**12**	**95**	**70.8**
Unsure		**39**	**69 (56-75)**	**18**	**83**	**38.5**

*Excludes 226 cases with unverifiable ages (see previous page). **Excludes five with uncertain gender. ***IQR=inter-quartile range.

3.3.2 Revisions after primary hip surgery

Figures 3.4 (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 3.4 (a) plots each Kaplan-Meier survival curve with a common origin, i.e. time zero is equal to the year of operation. Figure 3.4 (b) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. In addition, the revision rate at 1, 3 and 5 years has also been highlighted. Figure 3.4 (b) separates each year allowing changes in failure rates to be clearly identified. If revision surgery and timing of revision surgery were static across time we would expect all failure curves to be the same shape and equally spaced, a departure from this would indicate a change in the number and timing of revision procedures. It is also very clear that the three- and five-year rate of revision increases for operations occurring between 2003 and 2008 and then reduces for operations occurring between 2009 and 2015. The differences may be partly a result of under-reporting in the earlier years of the registry, but most probably reflect the usage of metal-on-metal, which peaked in 2008 and then fell (see Table 3.4). Further investigation is needed of this phenomenon.

Table 3.6 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, 7 and 10 years from the primary operation together with 95% Confidence Intervals (95% CI). Results at 11 and 12 years have been added, but in general, the group sizes are too small for meaningful sub-division, hence many of these estimates are shown in *blue italics*. Estimates in *blue italics* indicate time points where fewer than 250 cases remained at risk, meaning that the estimates are less reliable. 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% Confidence Interval 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 we have here.) Kaplan-Meier estimates are not shown at all when the numbers at risk fell below ten.

Please note that the rates for resurfacing throughout Section 3.3 still include the ASR system unless explicitly stated otherwise.

Figures 3.5 to 3.8 illustrate the differences between the various bearing surface sub-groups for cemented, uncemented, hybrid and reverse hybrid hips, respectively. These continue to show the worse outcome for metal-on-metal bearings, which, in uncemented hips (Figure 3.6), fared worse than resurfacings. The failure rates for ceramic-on-polyethylene bearings were particularly low and it is encouraging that these are becoming more widely used with time.

In Table 3.6 and Figures 3.5 to 3.8, all age groups and genders were combined. In Figures 3.9 (a) and 3.9 (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 3.9 (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 rate. In Figure 3.9 (b), implants with metal-on-metal (or uncertain) bearing surfaces and resurfacings have been excluded. The revision rates for the younger women are much reduced; an age trend is seen in both genders but rates for women are lower than for men across the entire age spectrum.

Where group sizes permitted (overall group size>10,000), Table 3.7 further expands Table 3.6 to show separate estimates for males and females within each of four age bands: <55, 55-64, 65-74 and 75+ years. Estimates are shown at 1, 3, 5, 7 and 10 years after the primary operation. These refine results in our 2014 report, but now with larger numbers of cases therefore generally narrower Confidence Intervals. Results at 11 and 12 years are not shown here as the numbers at risk at these time points remain small in many of the sub-groups.

Figure 3.4 (a)

Temporal changes in revision rates after primary hip replacement: Kaplan-Meier estimates of cumulative percentage probability of revision for each year of primary operation.

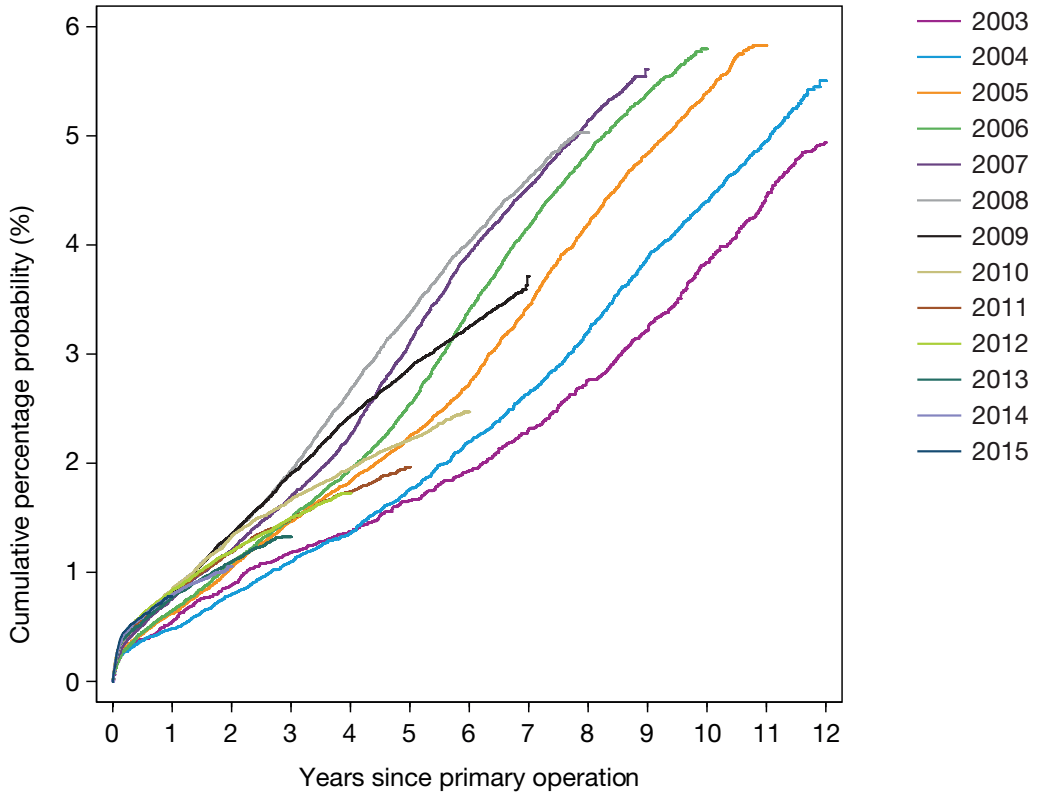


Figure 3.4 (b)

Temporal changes in revision rates after primary hip replacement: Kaplan-Meier estimates of cumulative percentage probability of revision for each year of primary operation with failure rates at 1, 3, and 5 years indicated.

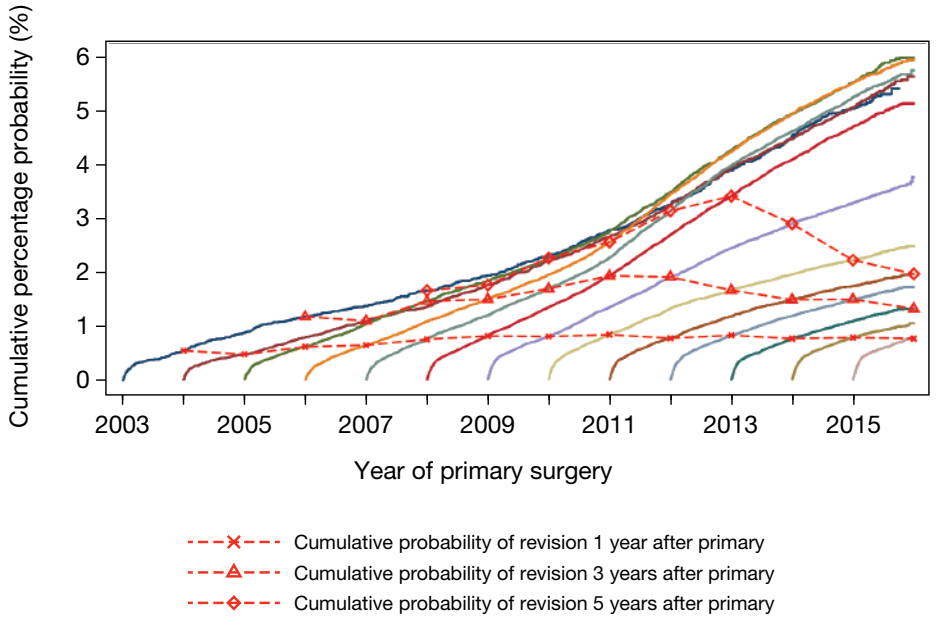


Table 3.6 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI) after primary hip replacement, by year from the primary operation, for all cases and by fixation and bearing surface. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

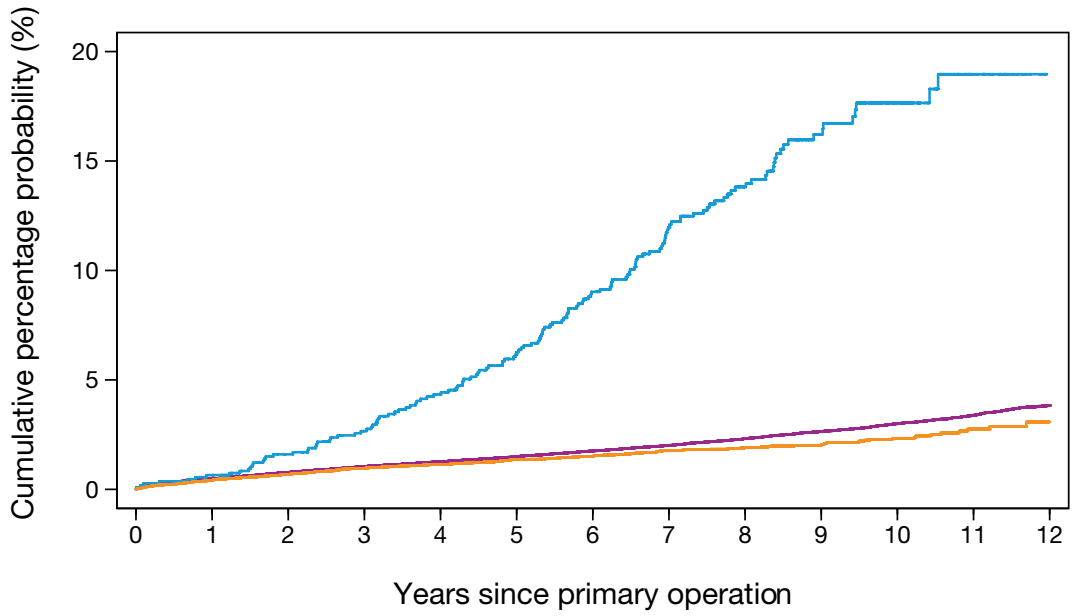
		Cumulative percentage probability of revision (95% CI) at:						
Fixation/ bearing types	n	1 year	3 years	5 years	7 years	10 years	11 years	12 years
All cases*	**796,636**	**0.77 (0.75-0.79)**	**1.59 (1.56-1.62)**	**2.51 (2.47-2.55)**	**3.67 (3.62-3.73)**	**5.39 (5.30-5.49)**	**5.95 (5.84-6.07)**	**6.46 (6.31-6.61)**
All cemented	**282,548**	**0.48 (0.46-0.51)**	**1.05 (1.01-1.09)**	**1.52 (1.47-1.57)**	**2.07 (2.00-2.14)**	**3.07 (2.96-3.18)**	**3.49 (3.35-3.64)**	**3.93 (3.74-4.13)**
Cemented by bearing surface								
MoP	247,093	0.48 (0.46-0.51)	1.05 (1.00-1.09)	1.50 (1.45-1.56)	2.01 (1.94-2.08)	3.00 (2.88-3.12)	3.39 (3.24-3.54)	3.84 (3.64-4.04)
MoM	1,084	0.65 (0.31-1.36)	2.66 (1.84-3.83)	6.27 (4.94-7.94)	11.98 (10.07-14.22)	*17.65 (15.02-20.68)*	*18.96 (15.90-22.54)*	*18.96 (15.90-22.54)*
CoP	28,562	0.42 (0.35-0.50)	0.96 (0.84-1.10)	1.37 (1.21-1.55)	1.77 (1.56-2.00)	2.33 (2.02-2.69)	2.75 (2.32-3.27)	3.08 (2.48-3.82)
Others/unsure	5,809	0.58 0.41-0.82)	1.15 (0.90-1.48)	1.67 (1.34-2.07)	2.38 (1.94-2.90)	3.39 (2.72-4.21)	4.74 (3.64-6.16)	*5.12 (3.85-6.77)*
All uncemented	**311,456**	**1.00 (0.96-1.03)**	**2.00 (1.94-2.05)**	**3.18 (3.11-3.26)**	**4.78 (4.68-4.89)**	**7.14 (6.95-7.33)**	**7.82 (7.57-8.07)**	**8.37 (8.03-8.73)**
Uncemented by bearing surface								
MoP	118,756	1.08 (1.02-1.14)	1.84 (1.76-1.92)	2.37 (2.27-2.48)	3.01 (2.88-3.15)	4.23 (4.00-4.47)	4.85 (4.51-5.21)	5.46 (4.92-6.06)
MoM	28,646	1.03 (0.92-1.15)	3.40 (3.19-3.62)	7.52 (7.21-7.83)	12.33 (11.93-12.74)	18.75 (18.07-19.45)	20.21 (19.30-21.16)	*22.14 (20.32-24.10)*
CoP	53,095	0.88 (0.80-0.96)	1.58 (1.47-1.71)	2.17 (2.01-2.33)	2.59 (2.40-2.79)	3.46 (3.17-3.78)	3.79 (3.43-4.18)	4.19 (3.70-4.73)
CoC	104,026	0.94 (0.88-1.00)	1.81 (1.72-1.90)	2.39 (2.29-2.50)	2.94 (2.80-3.08)	4.08 (3.80-4.38)	4.68 (4.25-5.14)	4.85 (4.32-5.44)
CoM	2,151	0.65 (0.39-1.10)	2.84 (2.21-3.64)	4.86 (4.01-5.89)	6.77 (5.56-8.24)			
Others/unsure	4,782	1.33 (1.04-1.70)	2.27 (1.88-2.75)	3.18 (2.69-3.75)	4.19 (3.59-4.88)	5.47 (4.67-6.41)	6.68 (5.44-8.20)	*7.60 (5.95-9.70)*
All hybrids	**144,391**	**0.72 (0.68-0.77)**	**1.28 (1.22-1.34)**	**1.89 (1.80-1.98)**	**2.55 (2.44-2.67)**	**3.67 (3.47-3.87)**	**4.17 (3.91-4.44)**	**4.55 (4.22-4.90)**
Hybrids by bearing surface								
MoP	91,077	0.76 (0.71-0.82)	1.32 (1.24-1.40)	1.86 (1.75-1.96)	2.35 (2.22-2.49)	3.40 (3.17-3.65)	4.09 (3.75-4.45)	4.32 (3.93-4.74)
MoM	2,147	0.70 (0.42-1.16)	2.95 (2.31-3.77)	6.54 (5.55-7.70)	11.44 (10.09-12.95)	16.57 (14.55-18.84)	*16.86 (14.78-19.20)*	*19.44 (16.36-23.00)*
CoP	27,533	0.66 (0.56-0.77)	1.11 (0.97-1.27)	1.48 (1.29-1.70)	1.82 (1.57-2.12)	2.41 (1.99-2.91)	2.55 (2.07-3.15)	*3.29 (2.43-4.45)*
CoC	21,485	0.59 (0.50-0.71)	1.03 (0.90-1.19)	1.56 (1.39-1.76)	2.02 (1.80-2.27)	2.72 (2.38-3.10)	2.94 (2.50-3.45)	*2.94 (2.50-3.45)*
Others/unsure	2,149	1.23 (0.84-1.80)	1.65 (1.18-2.30)	2.08 (1.54-2.83)	2.85 (2.14-3.77)	3.86 (2.89-5.13)	*3.86 (2.89-5.13)*	*3.86 (2.89-5.13)*
All reverse hybrids	**19,800**	**0.76 (0.64-0.89)**	**1.47 (1.30-1.67)**	**2.03 (1.80-2.28)**	**2.60 (2.29-2.94)**	**4.35 (3.45-5.47)**	*4.93 (3.79-6.41)*	*5.58 (4.03-7.71)*
Reverse hybrids by bearing surface								
MoP	13,415	0.79 (0.65-0.96)	1.42 (1.22-1.66)	2.02 (1.74-2.34)	2.57 (2.20-2.99)	4.48 (3.39-5.93)	*4.82 (3.59-6.45)*	*5.91 (3.83-9.07)*
CoP	6,291	0.66 (0.48-0.90)	1.52 (1.21-1.90)	1.98 (1.60-2.45)	2.51 (2.01-3.15)	*4.00 (2.59-6.15)*	*5.04 (2.97-8.50)*	*5.04 (2.97-8.50)*
Others/unsure	94**	*2.15 (0.54-8.33)*	*5.85 (2.47-13.53)*	*5.85 (2.47-13.53)*	*9.20 (4.43-18.61)*			
All resurfacing (MoM)	**38,402**	**1.26 (1.15-1.38)**	**3.12 (2.95-3.30)**	**5.59 (5.36-5.84)**	**8.38 (8.09-8.69)**	**11.84 (11.44-12.25)**	**12.75 (12.29-13.23)**	**13.57 (13.01-14.14)**

* Includes 39 with unsure fixation/bearing surface.

** Wide CI because based on very small group size (n=94).

Figure 3.5

Comparison of cumulative probability of revision (Kaplan-Meier estimates) for **cemented** primary hip replacements with different bearing surfaces.

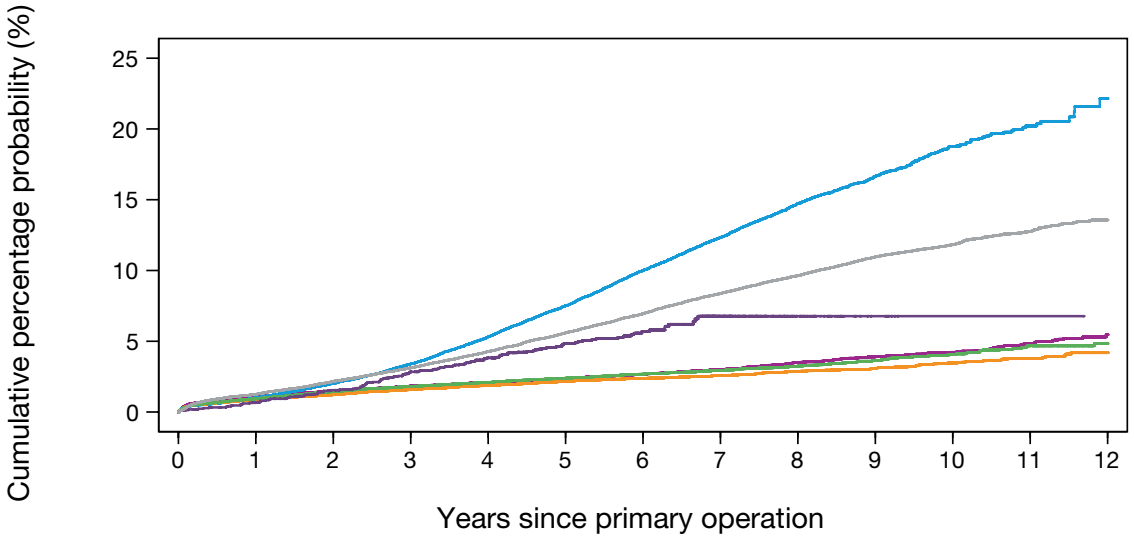


Numbers at risk

Cemented MoP	247,093	219,313	191,693	165,106	139,710	116,930	96,003	76,460	57,579	39,514	25,382	13,157	4,527
Cemented MoM	1,084	1,061	1,029	1,001	957	908	827	712	511	328	173	75	15
Cemented CoP	28,562	24,163	19,966	16,282	13,099	10,453	8,164	6,280	4,595	3,200	2,008	989	280

Figure 3.6

Comparison of cumulative probability of revision (Kaplan-Meier estimates) for **uncemented** primary hip replacements with different bearing surfaces.

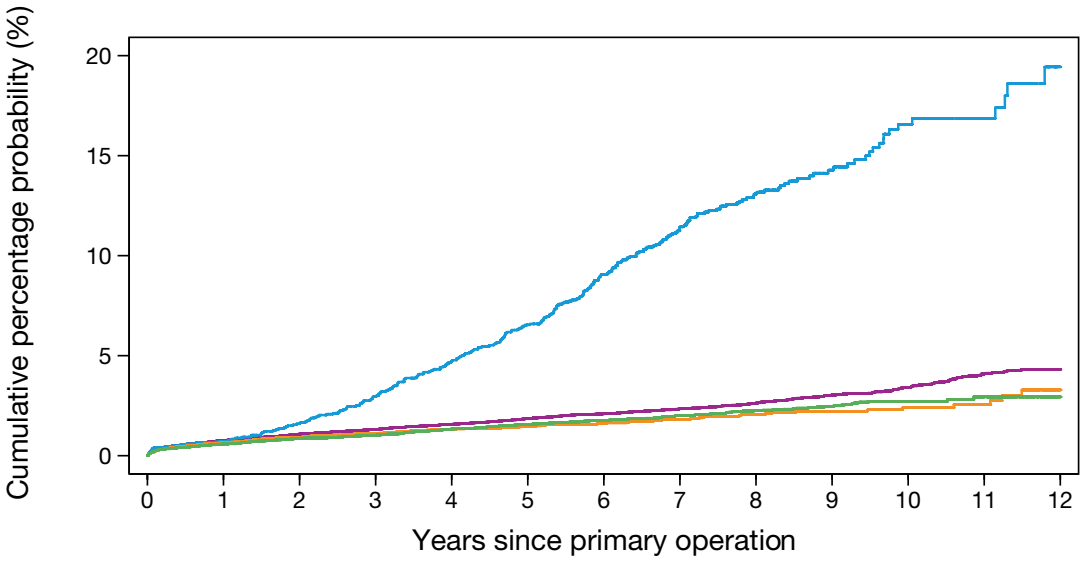


Numbers at risk

Uncemented MoP	118,756	102,239	86,122	70,988	56,290	43,550	31,973	22,347	14,638	9,199	5,272	2,343	583
Uncemented MoM	28,646	28,062	27,507	26,757	25,735	24,389	21,373	16,140	9,961	5,051	2,114	566	116
Uncemented CoP	53,095	42,765	34,175	27,309	21,441	16,865	12,907	9,850	7,381	5,165	3,329	1,660	548
Uncemented CoC	104,026	93,129	80,287	66,702	51,706	37,119	24,820	16,015	9,716	5,636	2,987	1,423	415
Uncemented CoM	2,151	2,122	2,079	2,006	1,910	1,551	863	293	49	7	1	1	0
Resurfacing	38,402	37,109	35,870	34,552	32,975	30,606	27,507	22,939	17,322	11,667	7,230	3,643	1,201

Figure 3.7

Comparison of cumulative probability of revision (Kaplan-Meier estimates) for **hybrid** primary hip replacements with different bearing surfaces.

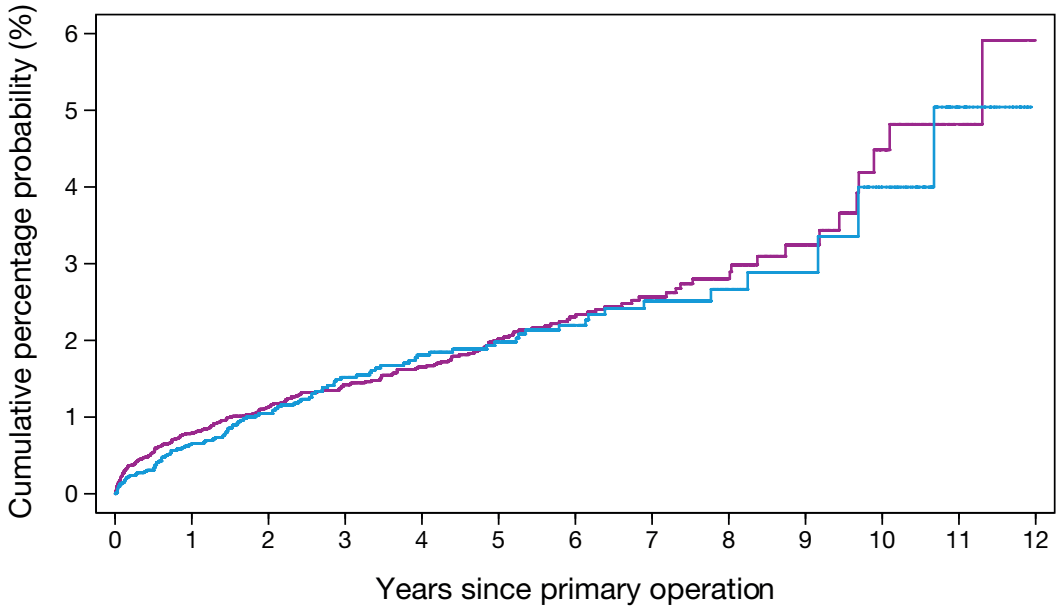


Numbers at risk

Hybrid MoP	91,077	76,724	63,866	53,042	43,235	34,407	26,773	20,085	14,105	9,029	5,330	2,573	789
Hybrid MoM	2,147	2,114	2,059	1,995	1,911	1,826	1,623	1,361	913	535	296	169	66
Hybrid CoP	27,533	19,733	13,563	9,456	7,024	5,378	4,050	2,865	2,017	1,435	917	504	162
Hybrid CoC	21,485	19,533	17,319	15,055	12,739	10,390	8,326	6,387	4,644	2,994	1,635	649	151

Figure 3.8

Comparison of cumulative probability of revision (Kaplan-Meier estimates) for **reverse hybrid** primary hip replacements with different bearing surfaces.



Numbers at risk

Rev. Hyb. MoP	13,415	11,318	9,416	7,651	5,997	4,418	3,135	2,015	1,067	569	303	130	29
Rev. Hyb. CoP	6,291	5,363	4,369	3,543	2,715	2,041	1,468	957	530	224	134	66	27

Figure 3.9 (a)

Cumulative probability of revision (Kaplan-Meier) for the whole cohort of primary hip replacements broken down by age separately for each gender.

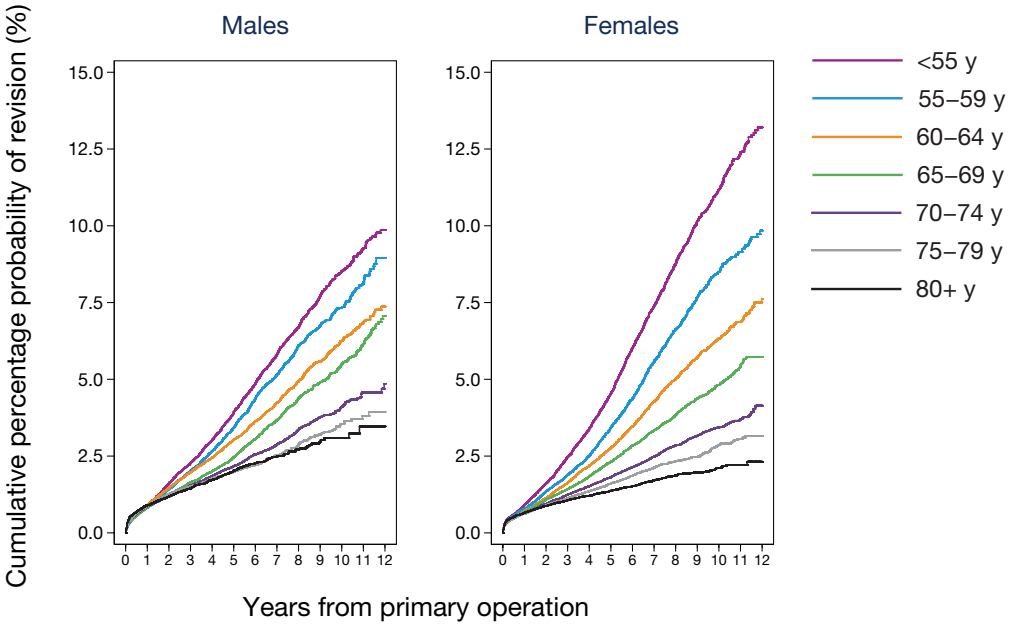


Figure 3.9 (b)

Cumulative probability of revision (Kaplan-Meier) for the whole cohort of primary hip replacements broken down by age separately for each gender, but excluding metal-on-metal total hip replacement and resurfacings.

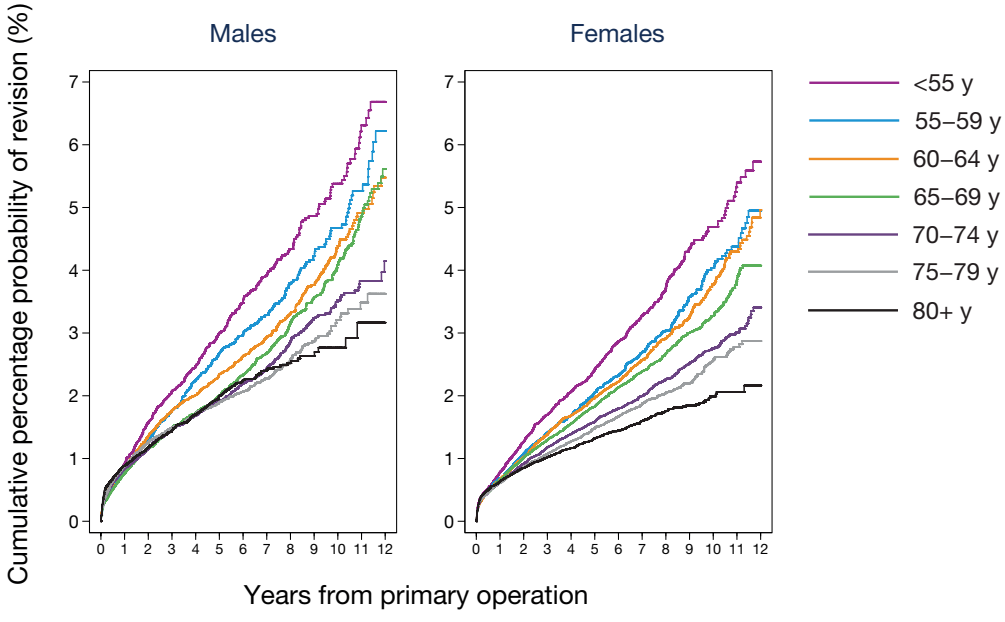


Table 3.7 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI), by gender and age, at 1, 3, 5, 7 and 10 years from the primary hip replacement, for each fixation group and main bearing surface. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

Fixation/ bearing types	Age at primary (years)	Males						Females					
		n	Years from primary operation					n	Years from primary operation				
			1 year	3 years	5 years	7 years	10 years		1 year	3 years	5 years	7 years	10 years
All cases*													
	<55	48,307	0.90 (0.82-0.99)	2.28 (2.14-2.43)	3.94 (3.74-4.16)	5.83 (5.56-6.12)	8.54 (8.11-8.98)	48,054	0.92 (0.84-1.01)	2.48 (2.33-2.63)	4.55 (4.33-4.79)	7.41 (7.09-7.74)	11.19 (10.69-11.72)
	55-64	80,419	0.90 (0.84-0.97)	2.00 (1.90-2.11)	3.20 (3.06-3.34)	4.62 (4.43-4.81)	6.72 (6.43-7.02)	97,348	0.74 (0.69-0.80)	1.73 (1.65-1.82)	3.04 (2.92-3.17)	4.80 (4.62-4.99)	7.21 (6.93-7.50)
	65-74	110,735	0.85 (0.79-0.90)	1.60 (1.52-1.68)	2.33 (2.23-2.44)	3.28 (3.14-3.43)	4.81 (4.58-5.05)	169,079	0.67 (0.63-0.71)	1.33 (1.28-1.40)	2.05 (1.98-2.14)	2.90 (2.79-3.01)	4.11 (3.94-4.28)
	75+	80,909	0.89 (0.83-0.96)	1.49 (1.40-1.59)	2.00 (1.89-2.12)	2.51 (2.36-2.67)	3.40 (3.14-3.69)	161,554	0.64 (0.60-0.68)	1.09 (1.04-1.15)	1.49 (1.43-1.57)	1.93 (1.84-2.03)	2.54 (2.39-2.70)
All Cemented													
	<55	3,920	0.65 (0.44-0.97)	1.88 (1.46-2.42)	3.09 (2.48-3.84)	4.70 (3.84-5.74)	7.07 (5.78-8.64)	5,841	0.72 (0.53-0.98)	1.72 (1.39-2.13)	2.62 (2.16-3.17)	4.16 (3.49-4.96)	5.85 (4.90-6.97)
	55-64	13,717	0.62 (0.50-0.77)	1.52 (1.31-1.76)	2.15 (1.89-2.45)	2.90 (2.56-3.27)	4.77 (4.22-5.38)	22,208	0.43 (0.35-0.53)	1.12 (0.98-1.28)	1.80 (1.61-2.02)	2.60 (2.35-2.89)	4.21 (3.80-4.66)
	65-74	38,117	0.56 (0.49-0.65)	1.16 (1.05-1.28)	1.67 (1.53-1.83)	2.36 (2.17-2.56)	3.62 (3.32-3.94)	68,991	0.40 (0.35-0.45)	1.00 (0.93-1.09)	1.48 (1.38-1.59)	1.97 (1.84-2.10)	2.81 (2.63-3.01)
	75+	39,770	0.68 (0.60-0.77)	1.18 (1.07-1.30)	1.62 (1.48-1.77)	2.05 (1.87-2.24)	2.75 (2.45-3.08)	89,910	0.39 (0.35-0.43)	0.81 (0.74-0.87)	1.12 (1.04-1.21)	1.47 (1.37-1.58)	2.02 (1.85-2.20)
Cemented by bearing surface													
MoP	<55	1,738	0.91 (0.55-1.50)	2.32 (1.66-3.24)	3.47 (2.58-4.65)	4.24 (3.20-5.60)	7.05 (5.37-9.24)	2,979	0.99 (0.68-1.43)	2.11 (1.62-2.76)	2.68 (2.10-3.43)	3.97 (3.16-4.99)	5.68 (4.54-7.10)
	55-64	9,091	0.65 (0.50-0.84)	1.76 (1.49-2.07)	2.49 (2.15-2.88)	3.21 (2.80-3.68)	5.16 (4.52-5.90)	15,672	0.47 (0.37-0.59)	1.18 (1.01-1.38)	1.78 (1.57-2.03)	2.49 (2.21-2.81)	4.01 (3.57-4.51)
	65-74	33,281	0.59 (0.51-0.68)	1.20 (1.08-1.33)	1.71 (1.56-1.88)	2.40 (2.20-2.61)	3.69 (3.37-4.03)	61,257	0.39 (0.34-0.44)	0.99 (0.91-1.08)	1.48 (1.37-1.59)	1.96 (1.83-2.11)	2.84 (2.65-3.05)
	75+	37,680	0.68 (0.60-0.77)	1.19 (1.08-1.32)	1.63 (1.48-1.79)	2.08 (1.90-2.29)	2.79 (2.48-3.14)	85,331	0.38 (0.34-0.43)	0.79 (0.73-0.86)	1.11 (1.03-1.20)	1.45 (1.35-1.56)	2.00 (1.83-2.19)
CoP	<55	1,846	0.47 (0.23-0.94)	1.28 (0.80-2.04)	2.13 (1.42-3.20)	3.22 (2.16-4.79)	*3.60 (2.39-5.42)*	2,539	0.42 (0.22-0.77)	1.16 (0.78-1.74)	2.10 (1.47-3.00)	3.04 (2.14-4.30)	*3.63 (2.51-5.22)*
	55-64	4,013	0.56 (0.37-0.86)	0.90 (0.63-1.28)	1.06 (0.75-1.49)	1.41 (0.98-2.01)	2.44 (1.58-3.75)	5,802	0.27 (0.17-0.45)	0.81 (0.58-1.12)	1.34 (1.01-1.78)	1.76 (1.33-2.33)	2.71 (1.93-3.81)
	65-74	3,935	0.38 (0.22-0.63)	0.86 (0.59-1.25)	1.20 (0.85-1.70)	1.47 (1.03-2.10)	2.00 (1.39-2.90)	6,261	0.46 (0.32-0.67)	1.12 (0.86-1.46)	1.32 (1.02-1.70)	1.59 (1.23-2.06)	1.80 (1.36-2.39)
	75+	1,334	0.57 (0.27-1.18)	1.12 (0.63-1.99)	1.49 (0.86-2.59)	1.49 (0.86-2.59)	*2.11 (1.06-4.17)*	2,824	0.37 (0.20-0.70)	0.72 (0.44-1.16)	1.10 (0.71-1.70)	1.38 (0.88-2.16)	*1.38 (0.88-2.16)*

*Includes cases with unknown fixation/bearing but excludes the 226 cases where the ages were unverifiable plus a further five with uncertain gender.

Continued >

Table 3.7 (continued)

Fixation/ bearing types	Age at primary (years)	Males						Females					
		n	Years from primary operation					n	Years from primary operation				
			1 year	3 years	5 years	7 years	10 years		1 year	3 years	5 years	7 years	10 years
All uncemented													
	<55	25,172	0.94 (0.83-1.07)	2.48 (2.28-2.71)	4.22 (3.92-4.55)	6.26 (5.83-6.72)	9.76 (8.98-10.60)	27,634	0.96 (0.85-1.08)	2.35 (2.16-2.55)	4.15 (3.87-4.45)	6.55 (6.13-7.00)	9.80 (9.07-10.57)
	55-64	42,018	0.94 (0.85-1.04)	2.14 (1.99-2.29)	3.49 (3.28-3.71)	5.33 (5.03-5.65)	7.81 (7.31-8.34)	49,590	0.86 (0.79-0.95)	1.92 (1.79-2.05)	3.33 (3.15-3.53)	5.41 (5.14-5.70)	8.16 (7.70-8.65)
	65-74	46,995	1.01 (0.92-1.10)	1.91 (1.78-2.05)	2.83 (2.66-3.02)	4.07 (3.83-4.33)	5.97 (5.53-6.44)	60,932	0.93 (0.86-1.01)	1.76 (1.65-1.88)	2.83 (2.68-2.99)	4.26 (4.04-4.49)	6.31 (5.91-6.73)
	75+	23,176	1.27 (1.13-1.43)	2.00 (1.82-2.21)	2.69 (2.45-2.95)	3.41 (3.08-3.77)	4.74 (4.12-5.45)	35,835	1.24 (1.13-1.36)	1.83 (1.69-1.98)	2.41 (2.23-2.60)	3.12 (2.88-3.38)	4.23 (3.79-4.73)
Uncemented by bearing surface													
MoP	<55	2,842	1.04 (0.72-1.50)	2.53 (1.95-3.27)	3.72 (2.92-4.73)	5.47 (4.34-6.90)	*7.19 (5.63-9.16)*	3,550	1.28 (0.95-1.72)	2.15 (1.69-2.74)	2.95 (2.34-3.70)	3.73 (2.95-4.70)	4.79 (3.71-6.17)
	55-64	9,859	0.99 (0.81-1.21)	2.20 (1.90-2.54)	2.93 (2.56-3.36)	3.81 (3.32-4.36)	5.43 (4.64-6.35)	13,026	0.87 (0.72-1.05)	1.86 (1.62-2.13)	2.41 (2.13-2.73)	3.27 (2.89-3.70)	4.88 (4.23-5.63)
	65-74	20,379	1.00 (0.87-1.15)	1.79 (1.60-2.00)	2.23 (2.00-2.48)	2.94 (2.63-3.28)	4.35 (3.79-4.99)	29,205	0.98 (0.87-1.10)	1.63 (1.48-1.79)	2.10 (1.92-2.30)	2.64 (2.40-2.89)	3.52 (3.14-3.96)
	75+	15,158	1.32 (1.15-1.52)	2.05 (1.82-2.31)	2.58 (2.30-2.90)	3.08 (2.70-3.51)	3.62 (3.09-4.23)	24,690	1.25 (1.11-1.40)	1.72 (1.56-1.90)	2.21 (2.00-2.43)	2.56 (2.31-2.84)	3.56 (3.05-4.16)
MoM	<55	3,223	0.68 (0.45-1.04)	3.51 (2.92-4.21)	7.40 (6.54-8.37)	11.35 (10.27-12.55)	18.59 (16.69-20.68)	2,345	1.79 (1.33-2.42)	5.75 (4.88-6.77)	12.75 (11.46-14.18)	20.08 (18.47-21.80)	27.41 (25.17-29.80)
	55-64	5,076	0.83 (0.61-1.12)	2.99 (2.55-3.49)	6.52 (5.87-7.25)	10.94 (10.07-11.88)	16.83 (15.36-18.42)	4,779	0.86 (0.63-1.17)	3.56 (3.07-4.13)	8.87 (8.09-9.72)	15.68 (14.64-16.78)	22.65 (21.08-24.32)
	65-74	4,514	1.07 (0.81-1.41)	3.00 (2.54-3.55)	5.97 (5.30-6.72)	9.32 (8.46-10.27)	14.24 (12.66-15.99)	4,630	1.08 (0.82-1.43)	3.45 (2.96-4.03)	8.55 (7.76-9.40)	13.84 (12.83-14.93)	21.35 (19.57-23.27)
	75+	1,685	1.09 (0.69-1.72)	1.98 (1.41-2.79)	3.77 (2.91-4.86)	5.86 (4.69-7.31)	*10.94 (8.23-14.47)*	2,389	1.31 (0.92-1.85)	2.98 (2.36-3.75)	4.77 (3.97-5.74)	7.28 (6.22-8.52)	*9.25 (7.40-11.53)*
CoP	<55	3,837	1.27 (0.94-1.70)	2.20 (1.71-2.83)	3.19 (2.48-4.11)	3.51 (2.70-4.56)	*3.97 (3.00-5.24)*	4,508	0.80 (0.57-1.12)	1.56 (1.19-2.05)	2.39 (1.86-3.08)	3.14 (2.42-4.07)	*4.09 (3.01-5.54)*
	55-64	7,961	0.90 (0.71-1.15)	1.68 (1.38-2.03)	2.45 (2.04-2.95)	2.93 (2.43-3.53)	3.40 (2.78-4.16)	9,929	0.73 (0.57-0.92)	1.55 (1.30-1.85)	2.27 (1.93-2.67)	2.69 (2.28-3.17)	4.07 (3.33-4.97)
	65-74	8,733	0.77 (0.60-0.98)	1.31 (1.07-1.60)	1.57 (1.29-1.92)	1.94 (1.58-2.39)	2.67 (2.08-3.42)	10,985	0.87 (0.71-1.06)	1.55 (1.32-1.83)	2.03 (1.73-2.38)	2.52 (2.15-2.95)	3.39 (2.81-4.10)
	75+	2,926	1.24 (0.89-1.73)	1.74 (1.29-2.34)	2.38 (1.77-3.20)	2.38 (1.77-3.20)	*2.77 (1.91-4.02)*	4,199	0.96 (0.70-1.31)	1.54 (1.18-2.00)	1.89 (1.46-2.43)	2.18 (1.67-2.85)	*3.15 (2.24-4.40)*

*Includes cases with unknown fixation/bearing but excludes the 226 cases where the ages were unverifiable plus a further five with uncertain gender.

Table 3.7 (continued)

Fixation/ bearing types	Age at primary (years)	Males						Females					
		n	Years from primary operation					n	Years from primary operation				
			1 year	3 years	5 years	7 years	10 years		1 year	3 years	5 years	7 years	10 years
CoC	<55	14,710	0.90 (0.75-1.07)	2.15 (1.91-2.43)	3.05 (2.72-3.41)	3.80 (3.37-4.29)	5.14 (4.32-6.10)	16,514	0.80 (0.67-0.95)	1.81 (1.60-2.04)	2.45 (2.19-2.74)	3.25 (2.89-3.66)	5.13 (4.34-6.06)
	55-64	18,207	0.95 (0.81-1.10)	1.90 (1.70-2.13)	2.58 (2.32-2.86)	3.21 (2.87-3.59)	4.49 (3.81-5.29)	20,609	0.91 (0.79-1.05)	1.61 (1.44-1.81)	2.23 (2.01-2.48)	2.70 (2.43-3.02)	3.70 (3.17-4.32)
	65-74	12,352	1.16 (0.98-1.36)	1.93 (1.69-2.20)	2.47 (2.18-2.81)	2.86 (2.50-3.26)	3.69 (2.95-4.62)	14,812	0.81 (0.68-0.97)	1.47 (1.28-1.69)	1.78 (1.56-2.04)	2.09 (1.81-2.41)	2.43 (2.01-2.93)
	75+	2,951	1.22 (0.88-1.70)	2.03 (1.55-2.65)	2.12 (1.62-2.78)	2.32 (1.72-3.11)	*2.71 (1.85-3.96)*	3,837	1.43 (1.10-1.86)	1.91 (1.51-2.41)	2.14 (1.69-2.70)	2.48 (1.92-3.21)	*4.12 (2.16-7.77)*
All Hybrid													
	<55	5,900	0.95 (0.73-1.24)	1.66 (1.34-2.07)	2.57 (2.11-3.13)	4.35 (3.62-5.23)	6.19 (5.13-7.46)	8,034	0.62 (0.46-0.82)	1.23 (0.99-1.53)	2.00 (1.65-2.42)	3.19 (2.68-3.80)	4.56 (3.78-5.50)
	55-64	11,828	0.78 (0.63-0.96)	1.57 (1.34-1.83)	2.41 (2.09-2.77)	2.96 (2.58-3.39)	4.50 (3.86-5.24)	18,561	0.53 (0.43-0.65)	1.12 (0.97-1.30)	1.82 (1.60-2.07)	2.59 (2.29-2.91)	3.72 (3.27-4.22)
	65-74	19,897	0.83 (0.71-0.97)	1.43 (1.26-1.63)	2.04 (1.82-2.30)	2.65 (2.36-2.98)	4.15 (3.62-4.76)	33,335	0.73 (0.64-0.83)	1.20 (1.08-1.34)	1.76 (1.60-1.94)	2.33 (2.12-2.57)	3.16 (2.82-3.54)
	75+	15,584	0.85 (0.71-1.01)	1.50 (1.30-1.73)	1.93 (1.68-2.23)	2.40 (2.07-2.78)	3.65 (2.89-4.62)	31,218	0.67 (0.59-0.77)	1.07 (0.95-1.21)	1.52 (1.36-1.70)	1.95 (1.73-2.19)	2.27 (1.97-2.62)
Hybrid by bearing surface													
MoP	<55	1,121	1.41 (0.85-2.33)	2.48 (1.66-3.70)	3.91 (2.70-5.64)	5.38 (3.76-7.66)	*7.73 (5.39-11.04)*	1,700	0.87 (0.52-1.47)	1.74 (1.17-2.57)	2.64 (1.86-3.74)	3.73 (2.69-5.16)	*6.07 (4.25-8.63)*
	55-64	4,432	0.99 (0.73-1.33)	1.79 (1.42-2.26)	2.62 (2.13-3.23)	2.98 (2.42-3.66)	4.76 (3.80-5.94)	7,698	0.67 (0.51-0.89)	1.18 (0.94-1.46)	1.87 (1.55-2.25)	2.55 (2.14-3.04)	3.44 (2.85-4.14)
	65-74	13,200	0.82 (0.68-0.99)	1.46 (1.26-1.70)	2.00 (1.74-2.30)	2.54 (2.21-2.93)	4.07 (3.46-4.79)	23,282	0.72 (0.61-0.84)	1.23 (1.08-1.39)	1.75 (1.56-1.97)	2.24 (2.00-2.51)	3.08 (2.69-3.52)
	75+	13,095	0.79 (0.65-0.96)	1.49 (1.27-1.75)	1.93 (1.65-2.25)	2.27 (1.94-2.67)	3.55 (2.72-4.62)	26,525	0.72 (0.63-0.83)	1.12 (0.99-1.27)	1.52 (1.35-1.71)	1.86 (1.64-2.11)	2.18 (1.86-2.56)
CoP	<55	1,820	1.15 (0.73-1.80)	1.62 (1.05-2.49)	1.85 (1.18-2.89)	*2.84 (1.62-4.98)*	*3.49 (1.94-6.21)*	2,368	0.41 (0.21-0.79)	0.97 (0.58-1.62)	1.39 (0.84-2.28)	2.09 (1.26-3.45)	*3.03 (1.74-5.26)*
	55-64	3,332	0.68 (0.44-1.05)	1.16 (0.80-1.68)	1.59 (1.09-2.32)	1.93 (1.30-2.86)	*2.88 (1.65-5.00)*	4,998	0.46 (0.30-0.70)	1.06 (0.76-1.47)	1.40 (1.00-1.94)	1.87 (1.32-2.65)	*2.50 (1.69-3.69)*
	65-74	3,895	0.75 (0.51-1.09)	1.24 (0.88-1.74)	1.56 (1.09-2.23)	1.93 (1.30-2.87)	*3.16 (1.86-5.35)*	6,284	0.72 (0.53-0.98)	1.08 (0.82-1.42)	1.42 (1.07-1.88)	1.51 (1.13-2.01)	*1.51 (1.13-2.01)*
	75+	1,698	1.04 (0.64-1.69)	1.45 (0.90-2.34)	*1.85 (1.15-2.98)*	*1.85 (1.15-2.98)*	*1.85 (1.15-2.98)*	3,129	0.40 (0.22-0.73)	0.70 (0.42-1.16)	1.14 (0.66-1.96)	*1.14 (0.66-1.96)*	*1.14 (0.66-1.96)*

*Includes cases with unknown fixation/bearing but excludes the 226 cases where the ages were unverifiable plus a further five with uncertain gender.

Continued >

Table 3.7 (continued)

Fixation/ bearing types	Age at primary (years)	Males						Females					
		n	Years from primary operation					n	Years from primary operation				
			1 year	3 years	5 years	7 years	10 years		1 year	3 years	5 years	7 years	10 years
CoC	<55	2,590	0.68 (0.42-1.09)	1.30 (0.91-1.86)	1.77 (1.27-2.46)	2.72 (1.99-3.72)	*3.44 (2.49-4.73)*	3,612	0.54 (0.35-0.85)	0.92 (0.64-1.32)	1.37 (0.99-1.89)	2.08 (1.54-2.80)	2.87 (2.11-3.90)
	55-64	3,546	0.57 (0.37-0.89)	1.13 (0.82-1.55)	1.87 (1.42-2.46)	2.00 (1.52-2.62)	2.41 (1.79-3.25)	5,204	0.37 (0.24-0.58)	0.83 (0.61-1.14)	1.28 (0.98-1.67)	1.74 (1.34-2.24)	2.37 (1.79-3.15)
	65-74	2,241	0.83 (0.52-1.31)	1.32 (0.91-1.93)	2.07 (1.49-2.86)	2.07 (1.49-2.86)	*2.86 (1.82-4.50)*	3,017	0.75 (0.49-1.14)	0.96 (0.66-1.39)	1.42 (1.02-1.98)	2.05 (1.48-2.84)	*3.04 (2.03-4.53)*
	75+	435	1.43 (0.64-3.15)	1.72 (0.82-3.59)	*2.18 (1.07-4.43)*	*2.18 (1.07-4.43)*		839	0.37 (0.12-1.16)	0.70 (0.29-1.70)	1.04 (0.44-2.48)	*1.04 (0.44-2.48)*	
All reverse hybrid													
	<55	548	0.38 (0.10-1.51)	1.39 (0.62-3.10)	*1.39 (0.62-3.10)*	*1.39 (0.62-3.10)*	*7.00 (2.29-20.36)*	765	0.83 (0.37-1.85)	1.40 (0.72-2.70)	2.81 (1.62-4.85)	*3.69 (2.17-6.24)*	*5.95 (3.21-10.90)*
	55-64	1,541	0.92 (0.54-1.58)	2.17 (1.47-3.19)	3.00 (2.07-4.33)	*3.78 (2.60-5.49)*	*7.06 (3.83-12.81)*	2,437	0.82 (0.52-1.28)	1.76 (1.27-2.44)	2.42 (1.78-3.27)	2.97 (2.18-4.02)	*5.31 (3.25-8.60)*
	65-74	2,799	0.99 (0.67-1.45)	2.00 (1.50-2.68)	2.49 (1.88-3.30)	3.66 (2.72-4.91)	*5.61 (3.07-10.14)*	4,998	0.53 (0.36-0.78)	1.05 (0.78-1.41)	1.56 (1.19-2.05)	2.03 (1.53-2.70)	*2.98 (1.84-4.81)*
	75+	2,187	1.02 (0.67-1.56)	1.87 (1.33-2.63)	2.23 (1.59-3.13)	*2.23 (1.59-3.13)*	*2.23 (1.59-3.13)*	4,518	0.68 (0.48-0.98)	1.08 (0.80-1.45)	1.56 (1.17-2.09)	2.04 (1.50-2.77)	*2.22 (1.61-3.07)*
Reverse hybrid by bearing surface													
MoP	<55	118	*0.00*	*3.33 (1.08-9.99)*	*3.33 (1.08-9.99)*	*3.33 (1.08-9.99)*	*3.33 (1.08-9.99)*	174	*0.00*	*0.00*	*1.02 (0.14-7.02)*	*3.88 (1.25-11.74)*	*6.41 (2.30-17.18)*
	55-64	594	0.73 (0.27-1.92)	1.45 (0.69-3.05)	*3.06 (1.63-5.71)*	*3.72 (2.00-6.87)*	*9.44 (4.49-19.27)*	1,039	1.10 (0.61-1.97)	1.98 (1.24-3.14)	3.23 (2.16-4.81)	*3.86 (2.58-5.75)*	*7.72 (4.49-13.12)*
	65-74	1,920	1.23 (0.81-1.86)	2.18 (1.57-3.04)	2.78 (2.01-3.83)	3.61 (2.57-5.04)	*5.80 (2.69-12.25)*	3,668	0.52 (0.33-0.82)	0.97 (0.68-1.39)	1.44 (1.03-2.01)	2.09 (1.48-2.93)	*3.39 (1.89-6.02)*
	75+	1,936	1.10 (0.71-1.70)	1.99 (1.40-2.82)	2.30 (1.61-3.28)	*2.30 (1.61-3.28)*	*2.30 (1.61-3.28)*	3,960	0.68 (0.46-0.99)	1.06 (0.76-1.46)	1.56 (1.14-2.14)	1.91 (1.37-2.67)	*2.12 (1.48-3.03)*
Resurfacing													
MoM	<55	12,763	0.90 (0.75-1.08)	2.31 (2.06-2.59)	4.21 (3.86-4.59)	6.06 (5.62-6.53)	8.45 (7.83-9.11)	5,776	1.33 (1.07-1.67)	4.92 (4.39-5.51)	9.30 (8.57-10.09)	14.38 (13.47-15.34)	20.59 (19.38-21.86)
	55-64	11,311	1.23 (1.04-1.45)	2.45 (2.18-2.76)	3.99 (3.63-4.38)	5.66 (5.22-6.13)	7.68 (7.09-8.31)	4,548	1.65 (1.32-2.07)	4.55 (3.98-5.20)	8.69 (7.90-9.56)	13.18 (12.20-14.23)	18.22 (16.96-19.55)
	65-74	2,923	1.90 (1.46-2.47)	3.07 (2.50-3.78)	4.48 (3.76-5.33)	6.40 (5.50-7.44)	8.32 (7.17-9.64)	814	1.85 (1.12-3.04)	3.73 (2.62-5.29)	6.76 (5.21-8.76)	11.06 (9.00-13.57)	*17.36 (14.28-21.02)*
	75+	189	*2.15 (0.81-5.62)*	*2.15 (0.81-5.62)*	*3.54 (1.60-7.78)*	*6.01 (3.13-11.39)*	*6.01 (3.13-11.39)*	66	*1.54 (0.22-10.42)*	*3.30 (0.83-12.59)*	*6.88 (2.63-17.34)*	*9.04 (3.84-20.52)*	

*Includes cases with unknown fixation/bearing but excludes the 226 cases where the ages were unverifiable plus a further five with uncertain gender.

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

This section updates results from an earlier report (NJR 10th Annual Report 2013) on the effect of head size on revisions after primary surgery. We have also added two more groups to last year's report (NJR 12th Annual Report 2015). In total, six groups were defined:

(a) Metal-on-polyethylene cemented monobloc cups n=257,577

(b) Metal-on-polyethylene uncemented metal shells with polyethylene liners n=206,758

(c) Metal-on-metal uncemented metal cups or metal shells with metal liners n=30,777

(d) Ceramic-on-polyethylene cemented monobloc cups n=34,444

(e) Ceramic-on-polyethylene uncemented metal shells with polyethylene liners n=79,377

(f) Ceramic-on-ceramic uncemented metal shells with ceramic liners n=122,723

Figures 3.10 (a) to 3.10 (f) show respective percentage cumulative probabilities of revision (Kaplan-Meier) for various head sizes, for each of the above groups and up to twelve years from the primary operation.

In Figure 3.10 (a), for metal-on-polyethylene cemented monobloc cups, there was a statistically significant effect of head size (overall difference P<0.001 by logrank test) on revision rates. Estimates of cumulative revision are unreliable when the number at risk falls below 250. Up to five years, implants with head size 36mm had the worst failure rates. At ten years, implants with head size 32mm were worse than those with head sizes 22.25mm, 26mm and 28mm.

Figure 3.10 (b) shows revision rates for different head sizes for metal-on-polyethylene uncemented metal shell with polyethylene liners. There was a statistically significant effect of head size (overall P<0.001), with head size 44mm showing worse failure rates, but there were small numbers after five years.

In Figure 3.10 (c) for metal-on-metal uncemented metal cup / metal shell with liners, there was a similar effect of head size (overall P<0.001), with head size 40mm showing the worse failure rate for the whole duration of follow-up, although head size 46mm had the worst failure rate during the first ten years of follow-up. Please note that the risk table could not be included in this figure due to the large range of categories for the head sizes.

Results were similar for ceramic-on-polyethylene cemented monobloc cups shown in Figure 3.10 (d), with a statistically significant difference between the head sizes overall (P=0.002) and the largest head size 36mm showing worse failure rates.

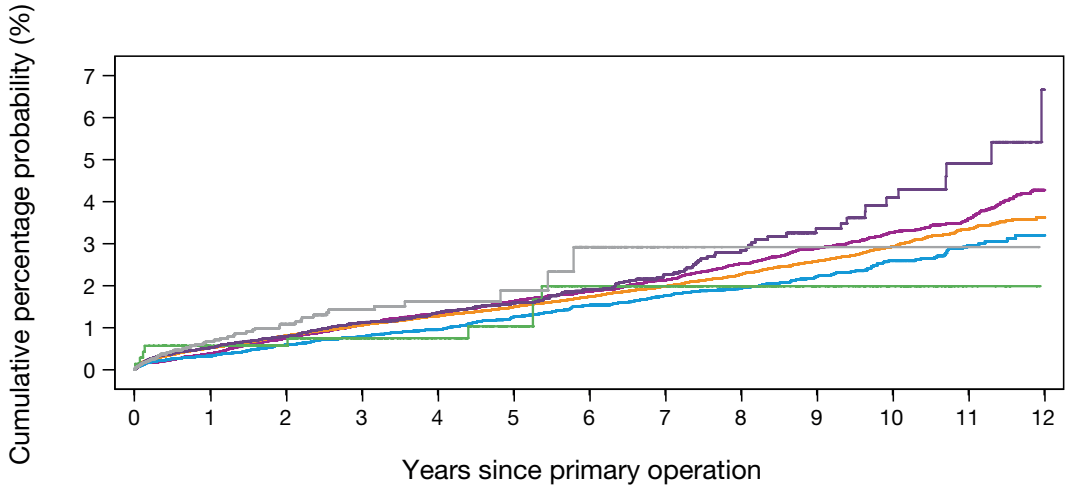
For ceramic-on-polyethylene metal shells used with polyethylene liners (Figure 3.10 (e)), whilst there was a statistically significant difference between the three head sizes shown (P=0.005), the best survival rate was in the intermediate size group (32mm) with 28mm and 36mm both showing similar worse outcomes.

Figure 3.10 (f) showed statistically significant differences between all four head sizes shown (P=0.01) for ceramic-on-ceramic uncemented metal shells used with ceramic liners. Head sizes 28mm, 32mm, and 36mm showed similar worse failure rates. Head size 40mm showed the best survival rate, though there were small numbers available.

Figure 3.10 (a)

Effect of head size on cumulative revision rates after primary hip replacement using cemented polyethylene monobloc cups, uncemented metal shells with polyethylene liners, uncemented metal cups/metal shells with liners, or uncemented metal shells with ceramic liners (only head sizes where n>500 are shown).

(a) **Metal-on-polyethylene cemented monobloc cups**

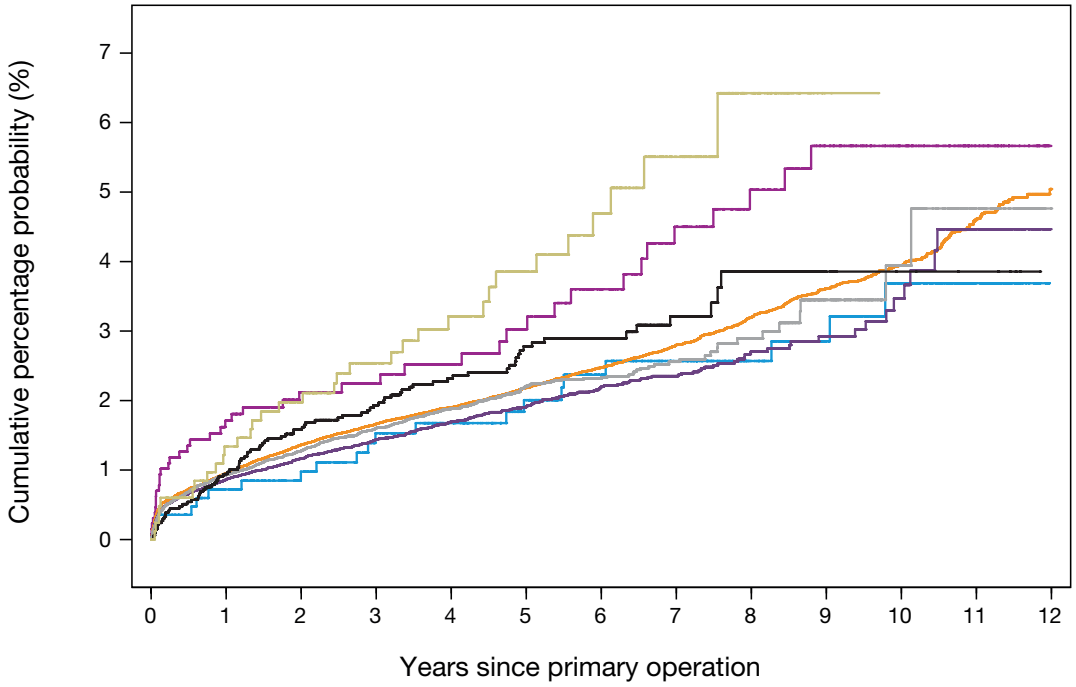


Numbers at risk

Head size = 22.25mm	32,757	31,219	29,602	27,658	25,311	22,759	20,084	17,377	14,466	11,214	8,087	4,862	1,880
Head size = 26mm	18,228	17,512	16,633	15,572	14,261	12,807	11,419	9,652	7,781	5,875	4,123	2,300	772
Head size = 28mm	164,261	147,179	129,170	111,237	93,850	77,620	62,270	48,065	34,296	21,796	12,806	5,816	1,823
Head size = 30mm	704	646	548	439	375	327	284	209	145	88	55	14	5
Head size = 32mm	37,964	29,099	21,554	15,336	10,291	6,826	4,403	2,699	1,650	925	497	239	65
Head size = 36mm	3,593	2,768	1,967	1,263	680	323	125	21	1	1	1	1	0

Figure 3.10 (b)

(b) **Metal-on-polyethylene uncemented metal shells with polyethylene liners**



Numbers at risk

Head size = 22.25mm	1,299	1,052	879	731	624	529	462	404	339	274	200	122	41
Head size = 26mm	842	795	754	697	642	578	498	432	358	272	178	94	22
Head size = 28mm	87,421	79,851	72,367	65,014	57,000	48,849	40,335	31,982	23,346	15,590	9,359	4,366	1,260
Head size = 32mm	72,287	56,980	42,861	31,160	21,738	14,578	9,090	5,142	2,634	1,273	502	170	16
Head size = 36mm	40,538	33,502	27,032	20,966	14,931	9,751	5,601	2,607	1,123	408	141	60	13
Head size = 40mm	3,356	3,155	2,940	2,704	2,250	1,753	1,229	731	243	16	8	6	1
Head size = 44mm	835	796	730	626	516	402	282	168	49	2	0	0	0

Figure 3.10 (c)

(c) **Metal-on-metal uncemented metal cups or metal shells with metal liners**

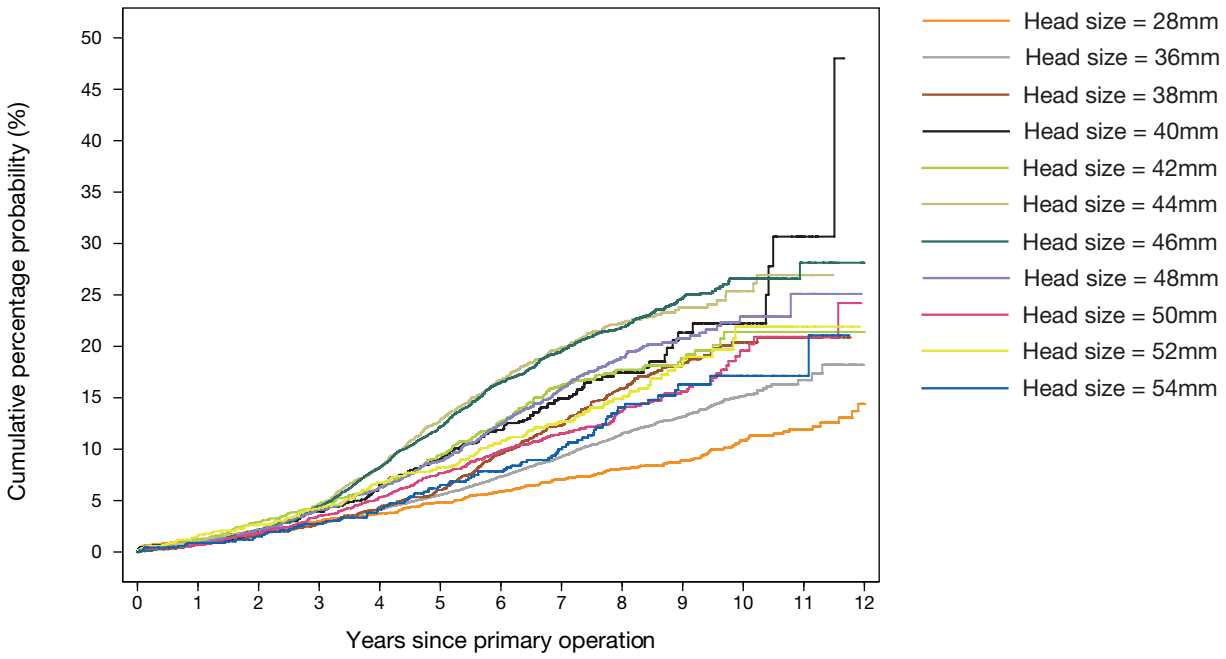
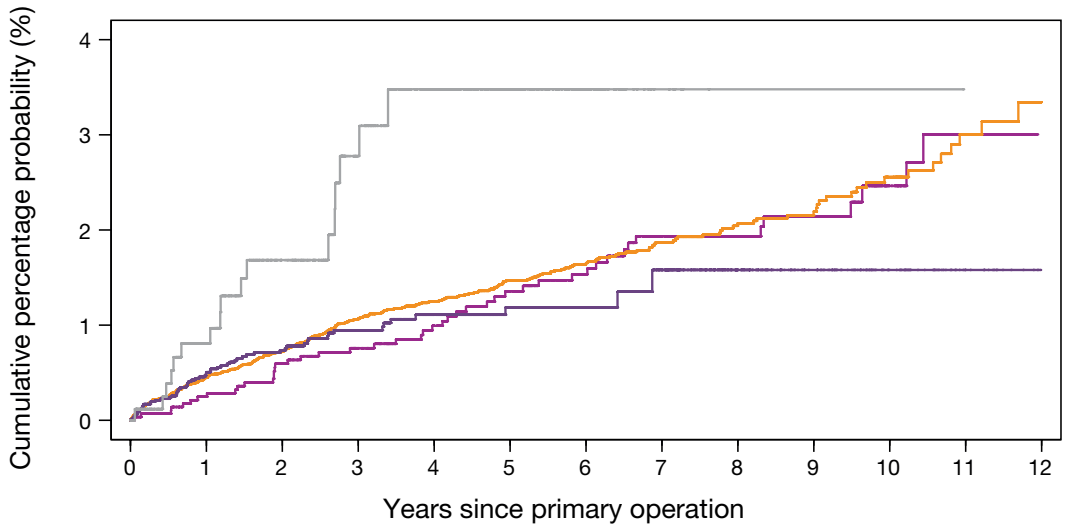


Figure 3.10 (d)

(d) **Ceramic-on-polyethylene cemented monobloc cups**

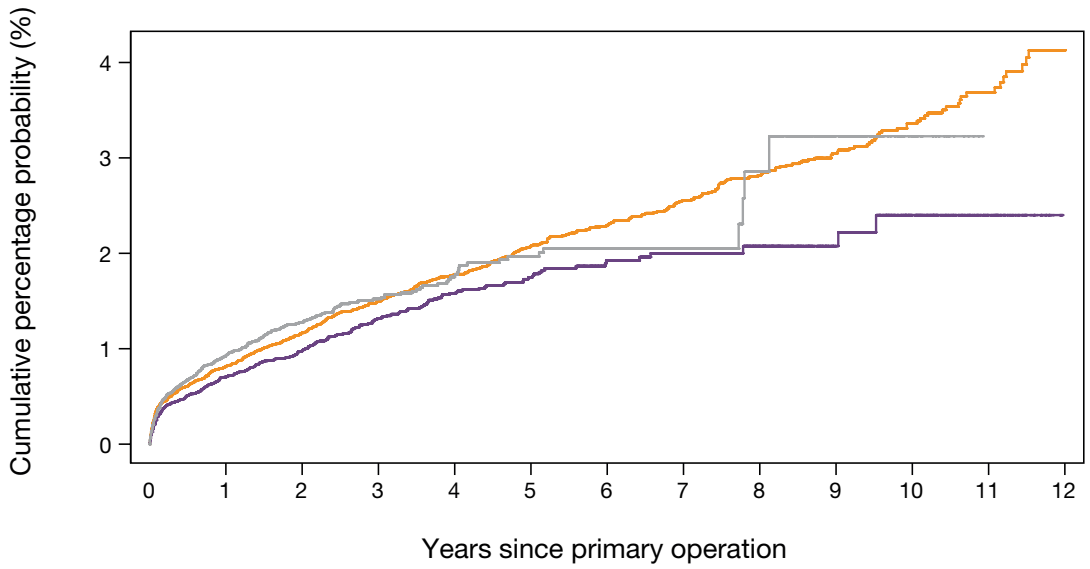


Numbers at risk

Head size = 22.25mm	2,911	2,729	2,504	2,263	2,031	1,770	1,555	1,322	1,062	759	458	182	0
Head size = 28mm	22,881	19,944	16,933	14,137	11,570	9,336	7,247	5,480	3,866	2,543	1,621	850	298
Head size = 32mm	7,792	5,918	4,215	2,954	1,949	1,240	753	393	175	104	54	21	7
Head size = 36mm	855	620	453	307	186	99	37	7	1	1	1	0	0

Figure 3.10 (e)

(e) **Ceramic-on-polyethylene uncemented metal shells with polyethylene liners**

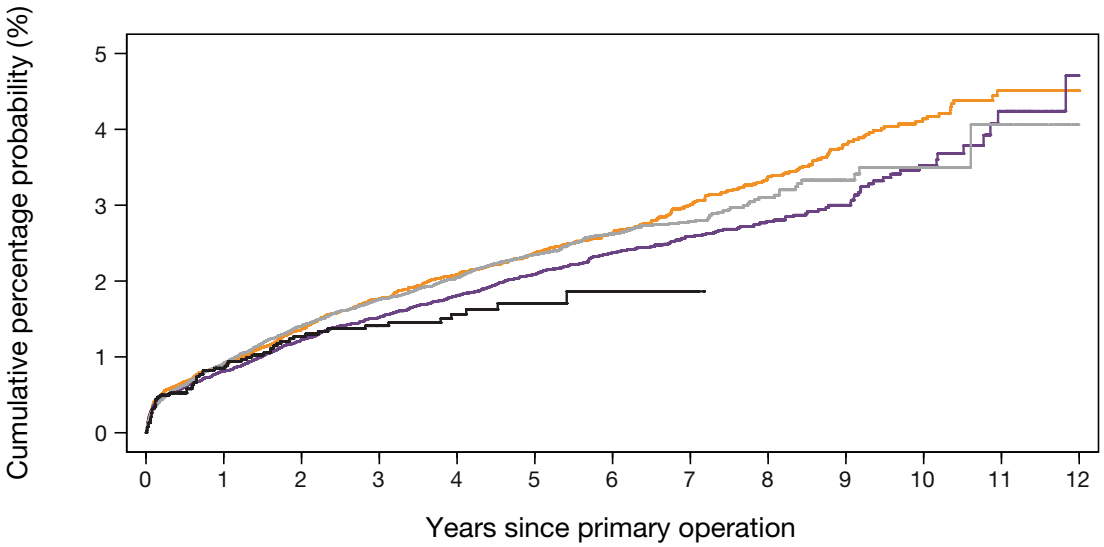


Numbers at risk

Head size = 28mm	25,545	22,808	20,188	18,069	15,907	13,861	11,822	9,793	7,744	5,616	3,719	1,965	671
Head size = 32mm	30,813	22,367	15,818	11,106	7,831	5,349	3,321	1,960	1,111	676	380	144	33
Head size = 36mm	22,529	15,894	10,625	6,691	4,035	2,508	1,433	655	292	113	20	0	0

Figure 3.10 (f)

(f) **Ceramic-on-ceramic uncemented metal shells with ceramic liners**



Numbers at risk

Head size = 28mm	17,060	16,222	15,227	14,126	12,768	11,085	9,412	7,809	6,077	4,300	2,743	1,404	400
Head size = 32mm	38,612	34,788	30,326	25,581	20,446	15,441	11,391	7,987	5,182	2,996	1,454	557	140
Head size = 36mm	63,186	55,648	46,736	37,710	28,123	19,180	11,736	6,513	3,053	1,307	409	104	22
Head size = 40mm	3,843	3,510	3,059	2,439	1,630	878	281	15	0	0	0	0	0

3.3.4 Revisions after primary hip surgery for the main stem-cup brand combinations

Table 3.8 shows Kaplan-Meier estimates of the cumulative percentage probability of revision (for any reason) for the main stem-cup brands.

As in previous reports, we have only included stem-cup brand combinations with more than 2,500 procedures for cemented, uncemented, hybrid and reverse hybrid hips or more than 1,000 in the case of resurfacings.

The figures in *blue italics* show time points where fewer than 250 cases remained at risk; no results are shown at all where the number had fallen below ten cases.

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.

Sub-groups with more than 10,000 procedures in Table 3.8 have been further divided by bearing surface. Table 3.9 shows the estimated cumulative percentage probabilities for the resulting fixation/bearing sub-groups provided there were more than 1,000 procedures.

Note: no further sub-divisions were made for Charnley Cemented Stem/Charnley Cemented Cup, as all the procedures described in Table 3.8 were Cemented MoP. Similarly, the majority of the cemented CPT/ZCA and Exeter V40/Exeter Duration combinations shown in Table 3.8 were MoP.

Table 3.8 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI) at 1, 3, 5, 7, 10, and 12 years after the primary hip replacement operation, for the most commonly used cup-stem brand combinations (group sizes >2500, or >1,000 in the case of resurfacings). *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	Cumulative percentage probability of revision (95% CI) at:					
				1 year	3 years	5 years	7 years	10 years	12 years
Cemented									
Charnley Cemented Stem / Charnley Ogee	9,842	73 (67-78)	38%	0.37 (0.27-0.52)	1.20 (1.00-1.45)	1.89 (1.62-2.19)	2.47 (2.15-2.83)	3.96 (3.47-4.51)	5.02 (4.32-5.84)
Charnley Cemented Stem / Charnley Cemented Cup	4,451	72 (66-78)	38%	0.32 (0.19-0.54)	1.12 (0.85-1.49)	1.69 (1.33-2.13)	2.32 (1.89-2.86)	3.36 (2.78-4.06)	4.46 (3.56-5.58)
Charnley Cemented Stem / Elite Plus LPW	6,467	74 (68-79)	29%	0.34 (0.23-0.52)	0.73 (0.55-0.98)	1.13 (0.89-1.44)	1.53 (1.23-1.90)	2.57 (2.11-3.13)	2.79 (2.28-3.41)
C-Stem Cemented Stem / Elite Plus Ogee	4,711	72 (66-77)	40%	0.37 (0.23-0.60)	0.88 (0.64-1.21)	1.17 (0.87-1.56)	1.56 (1.19-2.04)	2.18 (1.65-2.88)	*2.80 (1.87-4.16)*
C-Stem Cemented Stem / Marathon	4,935	67 (59-75)	41%	0.36 (0.22-0.59)	1.04 (0.74-1.46)	1.45 (1.04-2.02)	*2.18 (1.39-3.39)*		
MS-30 / Low Profile Muller	3,005	74 (67-80)	31%	0.24 (0.12-0.51)	0.50 (0.29-0.86)	0.76 (0.46-1.24)	0.98 (0.60-1.60)	*1.80 (1.00-3.26)*	*1.80 (1.00-3.26)*
Stanmore Modular Stem / Stanmore-Arcom Cup	4,966	75 (70-80)	29%	0.39 (0.25-0.61)	1.00 (0.75-1.34)	1.45 (1.12-1.87)	1.79 (1.40-2.28)	2.28 (1.76-2.95)	*3.78 (2.44-5.85)*
CPT / Elite Plus Ogee	2,908	73 (67-79)	36%	0.67 (0.42-1.04)	1.45 (1.06-1.99)	1.97 (1.48-2.62)	2.38 (1.79-3.14)	*3.32 (2.35-4.68)*	*3.32 (2.35-4.68)*
CPT / ZCA	11,370	76 (71-81)	30%	0.73 (0.58-0.90)	1.26 (1.05-1.50)	1.93 (1.66-2.26)	2.54 (2.19-2.95)	3.43 (2.88-4.07)	*4.61 (3.29-6.43)*
Exeter V40 / Contemporary Flanged	62,115	74 (68-79)	34%	0.38 (0.34-0.44)	0.84 (0.76-0.92)	1.20 (1.10-1.31)	1.54 (1.41-1.68)	2.24 (2.01-2.49)	2.65 (2.28-3.07)
Exeter V40 / Elite Plus Ogee	22,581	74 (69-80)	35%	0.34 (0.27-0.43)	0.79 (0.67-0.92)	1.11 (0.96-1.27)	1.53 (1.34-1.74)	2.22 (1.92-2.57)	2.64 (2.21-3.16)
Exeter V40 / Exeter Duration	16,241	73 (67-79)	32%	0.58 (0.48-0.71)	1.22 (1.05-1.41)	1.67 (1.47-1.90)	2.50 (2.22-2.80)	3.68 (3.27-4.15)	4.30 (3.68-5.02)
Exeter V40 / Opera	2,804	74 (68-80)	32%	0.40 (0.22-0.72)	0.83 (0.55-1.26)	1.19 (0.82-1.71)	1.56 (1.10-2.21)	2.57 (1.74-3.78)	*6.09 (3.42-10.72)*
Exeter V40 / Cenator Cemented Cup	2,538	75 (69-80)	32%	0.56 (0.33-0.94)	1.38 (0.98-1.93)	2.04 (1.53-2.71)	2.25 (1.70-2.98)	2.59 (1.94-3.44)	*4.02 (2.40-6.69)*
Exeter V40 / Elite Plus Cemented Cup	4,735	73 (66-78)	34%	0.30 (0.18-0.51)	0.63 (0.43-0.92)	0.86 (0.61-1.20)	1.07 (0.76-1.49)	1.31 (0.89-1.91)	*1.71 (1.10-2.65)*

Table 3.8 (continued)

Stem/cup brand	n	Median (IQR) age at primary	Percentage (%) males	Cumulative percentage probability of revision (95% CI) at:					
				1 year	3 years	5 years	7 years	10 years	12 years
Exeter V40 / Marathon	3,298	70 (63-77)	36%	0.42 (0.24-0.72)	0.99 (0.65-1.51)	1.32 (0.86-2.02)	*1.32 (0.86-2.02)*		
Exeter V40 / Exeter Rimfit	16,348	69 (62-77)	36%	0.54 (0.43-0.67)	1.05 (0.87-1.28)	*1.21 (0.96-1.54)*			
Exeter V40 / Contemporary Hooded	22,370	75 (69-80)	33%	0.81 (0.70-0.94)	1.53 (1.37-1.72)	2.17 (1.96-2.40)	2.88 (2.61-3.19)	4.07 (3.62-4.57)	*4.63 (4.01-5.34)*
Exeter V40 Charnley and Elite Plus LPW	4,049	73 (67-78)	31%	0.64 (0.43-0.95)	1.32 (0.99-1.75)	1.58 (1.20-2.08)	1.86 (1.41-2.45)	2.08 (1.56-2.76)	*2.43 (1.67-3.53)*
C-Stem AMT Cemented Stem / Elite Plus Ogee	2,758	77 (72-81)	31%	0.23 (0.10-0.52)	0.71 (0.41-1.21)	1.07 (0.66-1.74)	1.76 (1.08-2.86)		
C-Stem AMT Cemented Stem / Marathon	4,414	74 (68-79)	35%	0.45 (0.28-0.73)	0.94 (0.61-1.45)	*1.35 (0.79-2.32)*	*1.35 (0.79-2.32)*		
C-Stem AMT Cemented Stem Charnley and Elite Plus LPW	2,709	75 (71-79)	33%	0.53 (0.31-0.90)	1.12 (0.77-1.63)	1.36 (0.96-1.95)	1.65 (1.13-2.41)		
Uncemented									
Accolade / Trident	23,475	66 (59-73)	43%	0.93 (0.81-1.06)	1.96 (1.78-2.15)	2.75 (2.51-3.00)	3.37 (3.07-3.70)	*4.38 (3.74-5.13)*	*6.60 (3.39-12.66)*
Corail / Duraloc Cementless Cup	4,039	70 (64-75)	39%	0.75 (0.52-1.07)	1.69 (1.33-2.14)	2.51 (2.06-3.05)	3.59 (3.03-4.26)	5.70 (4.87-6.67)	*9.28 (7.41-11.59)*
Corail / Pinnacle	108,331	66 (59-73)	44%	0.81 (0.76-0.87)	1.70 (1.62-1.79)	2.72 (2.60-2.84)	4.36 (4.17-4.55)	7.23 (6.77-7.73)	*8.18 (7.39-9.05)*
Corail / Trilogy	2,849	67 (61-74)	39%	0.65 (0.41-1.03)	1.23 (0.87-1.72)	1.75 (1.30-2.35)	2.22 (1.68-2.94)	3.15 (2.21-4.47)	*3.15 (2.21-4.47)*
Corail / ASR Resurfacing Cup	2,608	61 (54-67)	54%	1.08 (0.74-1.55)	7.55 (6.59-8.63)	23.38 (21.79-25.08)	35.40 (33.55-37.32)	*43.67 (41.08-46.34)*	
Corail Pinnacle Gription	2,602	66 (57-74)	39%	1.19 (0.81-1.73)	2.14 (1.51-3.03)	*2.35 (1.64-3.37)*			
Furlong HAC Stem / CSF	16,556	69 (62-75)	40%	1.01 (0.87-1.17)	1.72 (1.53-1.94)	2.10 (1.88-2.34)	2.64 (2.38-2.91)	3.52 (3.18-3.89)	4.09 (3.64-4.60)
Furlong HAC Stem / CSF Plus	18,902	66 (59-73)	44%	1.13 (0.98-1.29)	1.86 (1.66-2.08)	2.21 (1.98-2.46)	2.64 (2.33-3.00)		
Polarstem Cementless / R3 Cementless	4,403	67 (60-73)	45%	0.58 (0.39-0.87)	0.92 (0.65-1.31)	*1.05 (0.71-1.55)*			
SL-Plus Cementless Stem / EP-Fit Plus	4,966	65 (59-73)	43%	1.17 (0.91-1.52)	2.58 (2.17-3.08)	3.79 (3.26-4.41)	4.48 (3.88-5.17)	5.92 (5.05-6.93)	
Synergy Cementless Stem / R3 Cementless	2,675	65 (56-71)	50%	1.02 (0.69-1.49)	1.69 (1.18-2.42)	2.75 (1.82-4.14)	*4.94 (3.00-8.08)*		
Taperloc Cementless Stem / Exceed ABT	18,526	65 (58-72)	44%	1.09 (0.95-1.25)	1.50 (1.32-1.70)	1.79 (1.58-2.04)	2.10 (1.80-2.44)		
Anthology R3 Cementless	2,785	64 (55-71)	41%	1.08 (0.75-1.57)	1.49 (1.06-2.09)	3.09 (2.05-4.63)	*6.64 (3.58-12.14)*		
Metafix Stem Trinity	2,591	63 (55-69)	45%	0.86 (0.55-1.33)	1.45 (1.00-2.10)	*1.77 (1.11-2.82)*			
M/L Taper Cementless Continuum	4,004	61 (53-68)	49%	1.13 (0.84-1.53)	1.84 (1.42-2.37)	*1.95 (1.50-2.55)*			
Hybrid									
CPT / Trilogy	15,575	71 (65-78)	35%	0.89 (0.75-1.05)	1.42 (1.23-1.64)	2.29 (2.01-2.61)	2.70 (2.37-3.08)	3.91 (3.28-4.65)	*4.50 (3.50-5.79)*
CPT Continuum	3,292	67 (57-75)	36%	1.40 (1.03-1.89)	2.11 (1.61-2.77)	*2.46 (1.85-3.27)*			
CPT Trilogy IT	3,411	68 (61-75)	37%	1.31 (0.97-1.77)	2.65 (1.82-3.86)				
Exeter V40 / Pinnacle	5,393	72 (65-78)	35%	0.70 (0.51-0.98)	1.10 (0.83-1.46)	1.48 (1.12-1.95)	1.73 (1.26-2.38)	*2.06 (1.37-3.10)*	
Exeter V40 / Trident	50,969	68 (60-75)	39%	0.57 (0.51-0.64)	1.06 (0.96-1.16)	1.45 (1.33-1.58)	1.95 (1.78-2.14)	2.64 (2.35-2.96)	*2.84 (2.45-3.29)*
Exeter V40 / Trilogy	12,518	70 (63-76)	40%	0.59 (0.47-0.75)	1.00 (0.83-1.20)	1.39 (1.19-1.63)	1.75 (1.50-2.04)	2.36 (2.00-2.77)	*2.76 (2.26-3.36)*

Continued >

Table 3.8 (continued)

Stem/cup brand	n	Median (IQR) age at primary	Percentage (%) males	Cumulative percentage probability of revision (95% CI) at: 1 year	3 years	5 years	7 years	10 years	12 years
Exeter V40 ABG II Cementless Cup	2,513	65 (59-72)	35%	0.28 (0.13-0.59)	0.81 (0.52-1.26)	1.26 (0.87-1.82)	1.80 (1.31-2.49)	2.38 (1.74-3.25)	*2.83 (2.01-3.98)*
C-Stem AMT Cemented Stem / Pinnacle	5,863	71 (65-77)	37%	0.75 (0.55-1.02)	1.14 (0.86-1.50)	1.89 (1.41-2.53)	2.23 (1.61-3.07)	*4.64 (2.68-7.97)*	
Reverse hybrid									
Corail / Marathon	7,591	70 (63-76)	38%	0.44 (0.31-0.63)	0.92 (0.70-1.22)	1.15 (0.86-1.52)	*1.50 (1.05-2.13)*		
Resurfacing									
Adept Resurfacing Cup	3,537	54 (48-60)	72%	1.20 (0.89-1.62)	2.57 (2.09-3.16)	4.58 (3.92-5.35)	6.64 (5.79-7.61)	*9.19 (7.86-10.74)*	
ASR Resurfacing Cup	3,033	55 (49-60)	68%	1.62 (1.22-2.13)	5.99 (5.20-6.89)	13.67 (12.49-14.95)	20.88 (19.46-22.39)	27.05 (25.30-28.89)	*30.35 (26.94-34.09)*
BHR Resurfacing Cup	20,295	55 (49-60)	73%	1.06 (0.93-1.22)	2.42 (2.21-2.64)	3.82 (3.55-4.10)	5.47 (5.14-5.82)	8.39 (7.93-8.88)	9.91 (9.29-10.57)
Cormet 2000 Resurfacing Cup	3,657	55 (48-60)	65%	1.45 (1.11-1.89)	3.59 (3.04-4.25)	7.61 (6.79-8.53)	12.43 (11.38-13.58)	18.31 (16.87-19.86)	*21.14 (19.27-23.16)*
Durom Resurfacing Cup	1,694	55 (49-60)	70%	1.36 (0.90-2.04)	3.68 (2.88-4.69)	5.66 (4.65-6.89)	7.89 (6.66-9.33)	8.38 (7.09-9.88)	
Recap Magnum	1,745	54 (49-60)	73%	1.83 (1.30-2.58)	3.42 (2.66-4.40)	5.48 (4.48-6.69)	7.79 (6.55-9.25)	*9.69 (8.07-11.61)*	
Conserve Plus Resurfacing Cup	1,344	56 (50-61)	63%	2.01 (1.38-2.92)	5.17 (4.11-6.51)	8.33 (6.96-9.95)	10.97 (9.36-12.84)	*14.09 (11.75-16.84)*	*14.09 (11.75-16.84)*

Please 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.

Table 3.9 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI) at 1, 3, 5, 7 and 10 years after the primary hip replacement for the most commonly used cup-stem brand combinations (group size >10,000) with further sub-division by main bearing surface; results are shown only for the bearing surface sub-groups with >1,000 procedures. *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	Cumulative percentage probability of revision (95% CI) at: 1 year	3 years	5 years	7 years	10 years
Cemented									
Exeter V40 / Contemporary Flanged	MoP	57,557	74 (69-79)	34%	0.37 (0.32-0.42)	0.83 (0.75-0.91)	1.19 (1.08-1.30)	1.54 (1.41-1.69)	2.23 (1.99-2.50)
	CoP	4,171	65 (60-70)	38%	0.52 (0.34-0.80)	0.96 (0.68-1.35)	1.34 (0.98-1.84)	1.41 (1.03-1.93)	*2.13 (1.35-3.36)*
Exeter V40 / Elite Plus Ogee	MoP	20,746	75 (69-80)	35%	0.34 (0.27-0.43)	0.79 (0.67-0.93)	1.09 (0.95-1.27)	1.52 (1.32-1.74)	2.23 (1.91-2.59)
	CoP	1,625	65 (59-70)	45%	0.34 (0.14-0.81)	0.80 (0.44-1.45)	1.25 (0.75-2.10)	1.42 (0.85-2.35)	*2.03 (1.17-3.51)*
Exeter V40 / Exeter Rimfit	MoP	11,525	72 (66-79)	34%	0.58 (0.45-0.75)	1.10 (0.88-1.37)	*1.22 (0.92-1.62)*		
	CoP	4,770	62 (56-67)	41%	0.41 (0.26-0.66)	0.94 (0.63-1.39)	*1.19 (0.78-1.83)*		
Exeter V40 / Contemporary Hooded	MoP	21,194	75 (70-80)	32%	0.81 (0.70-0.95)	1.51 (1.35-1.70)	2.16 (1.95-2.40)	2.90 (2.62-3.21)	4.02 (3.57-4.54)
	CoP	1,030	66 (61-71)	38%	0.72 (0.34-1.51)	2.08 (1.31-3.29)	2.56 (1.67-3.93)	3.03 (1.99-4.60)	*5.29 (3.27-8.50)*
Uncemented									
Accolade / Trident	MoP	11,148	71 (65-76)	41%	1.00 (0.83-1.20)	2.06 (1.80-2.36)	2.85 (2.52-3.23)	3.69 (3.22-4.23)	*4.97 (3.80-6.48)*
	CoP	4,885	62 (56-68)	45%	0.69 (0.49-0.98)	1.67 (1.30-2.14)	2.17 (1.69-2.79)	2.49 (1.79-3.47)	*3.85 (2.45-6.05)*
	CoC	7,255	62 (55-68)	45%	0.97 (0.77-1.23)	1.99 (1.69-2.35)	2.81 (2.43-3.25)	3.31 (2.87-3.82)	*4.09 (3.28-5.11)*

Table 3.9 (continued)

Stem/cup brand	Bearing surface	n	Median (IQR) age at primary	Percentage (%) males	Cumulative percentage probability of revision (95% CI) at:				
					1 year	3 years	5 years	7 years	10 years
Corail / Pinnacle	MoP	42,469	71 (65-77)	41%	0.84 (0.76-0.93)	1.42 (1.30-1.55)	1.77 (1.62-1.93)	2.28 (2.07-2.51)	3.16 (2.72-3.66)
	MoM	11,906	67 (60-73)	47%	0.86 (0.71-1.04)	2.42 (2.16-2.72)	5.17 (4.77-5.59)	8.86 (8.32-9.42)	14.59 (13.51-15.73)
	CoP	16,320	64 (58-70)	45%	0.75 (0.63-0.90)	1.26 (1.07-1.48)	1.90 (1.61-2.24)	2.14 (1.77-2.57)	*2.81 (2.13-3.72)*
	CoC	35,092	60 (53-66)	48%	0.81 (0.72-0.91)	1.78 (1.64-1.94)	2.38 (2.20-2.57)	2.95 (2.72-3.21)	4.00 (3.38-4.74)
	CoM	1,781	63 (57-69)	41%	0.45 (0.23-0.90)	2.68 (2.02-3.55)	4.38 (3.50-5.47)	6.35 (5.07-7.94)	
Furlong HAC / Stem CSF	MoP	7,682	73 (67-78)	39%	1.20 (0.98-1.47)	2.03 (1.73-2.38)	2.36 (2.03-2.74)	2.99 (2.60-3.44)	4.27 (3.68-4.96)
	CoP	6,949	67 (61-73)	41%	0.73 (0.55-0.96)	1.30 (1.05-1.60)	1.69 (1.40-2.03)	2.10 (1.77-2.50)	2.72 (2.28-3.23)
	CoC	1,634	59 (53-66)	44%	1.29 (0.84-1.97)	2.10 (1.50-2.92)	2.62 (1.94-3.52)	3.24 (2.47-4.24)	4.15 (3.20-5.36)
Furlong HAC / Stem CSF Plus	MoP	4,537	74 (70-79)	39%	1.61 (1.28-2.03)	2.33 (1.90-2.85)	2.90 (2.38-3.54)	3.48 (2.77-4.36)	
	CoP	2,187	67 (62-72)	46%	1.15 (0.77-1.71)	1.96 (1.42-2.70)	2.21 (1.59-3.06)	*2.94 (1.99-4.34)*	
	CoC	12,090	63 (56-69)	46%	0.93 (0.77-1.12)	1.65 (1.43-1.92)	1.94 (1.68-2.25)	2.28 (1.93-2.70)	
Taperloc Cementless Stem Exceed ABT	MoP	5,766	72 (66-77)	41%	1.21 (0.95-1.53)	1.72 (1.39-2.12)	2.15 (1.72-2.68)	*2.25 (1.79-2.84)*	
	CoP	3,314	65 (59-71)	45%	0.89 (0.62-1.28)	1.08 (0.75-1.54)	1.33 (0.89-1.99)	*1.99 (1.26-3.15)*	
	CoC	9,257	61 (54-67)	46%	1.08 (0.89-1.32)	1.49 (1.25-1.78)	1.73 (1.45-2.06)	2.03 (1.66-2.49)	
Hybrid									
CPT / Trilogy	MoP	11,332	73 (66-78)	34%	0.84 (0.68-1.03)	1.40 (1.18-1.65)	2.30 (1.99-2.66)	2.76 (2.39-3.18)	4.10 (3.41-4.93)
	CoP	3,552	68 (61-75)	34%	1.06 (0.76-1.48)	1.51 (1.08-2.10)	*1.71 (1.18-2.47)*	*1.71 (1.18-2.47)*	*1.71 (1.18-2.47)*
Exeter V40 / Trident	MoP	28,116	73 (67-79)	37%	0.58 (0.49-0.68)	1.12 (0.99-1.27)	1.45 (1.29-1.64)	1.93 (1.70-2.20)	2.75 (2.25-3.35)
	CoP	10,476	64 (57-71)	41%	0.53 (0.40-0.71)	0.95 (0.75-1.22)	1.29 (1.00-1.67)	1.75 (1.29-2.36)	*2.66 (1.53-4.59)*
	CoC	11,711	59 (53-65)	43%	0.58 (0.46-0.74)	1.02 (0.85-1.23)	1.52 (1.29-1.78)	2.01 (1.73-2.33)	2.48 (2.11-2.92)
Exeter V40 / Trilogy	MoP	9,968	71 (65-77)	40%	0.57 (0.44-0.74)	0.94 (0.76-1.16)	1.37 (1.14-1.65)	1.76 (1.48-2.09)	2.46 (2.03-2.97)
	CoP	2,231	63 (58-68)	40%	0.54 (0.31-0.96)	1.04 (0.69-1.58)	1.32 (0.91-1.93)	1.63 (1.14-2.33)	1.85 (1.30-2.64)

Please 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.

3.3.5 Revisions for different causes after primary hip surgery

Methodological note

The preceding sections looked at first revisions for any reason. Given that several indications may have been given for a particular revision, these will not be mutually exclusive and so cannot be regarded as 'competing risks'.

Here we have calculated incidence rates for each reason using patient-time incidence-rates (PTIRs); the total number of revisions for that reason has been divided by the total of the individual patient-years at risk. The figures shown are numbers of revisions per 1,000 years at risk.

This method is appropriate if the hazard rate (the rate at which revisions occur in the unrevised cases) remains constant. The latter is further explored by sub-dividing the time interval from the primary operation into intervals and calculating PTIRs for each interval.

Overall, 20,926 of the 796,636 procedures had an associated first revision. The most commonly cited indications were aseptic loosening (cited in 5,073 procedures), pain (4,078), adverse soft tissue reaction to particulate debris (3,548, a figure that is likely to be an underestimate - see below), dislocation/subluxation (3,517), and infection (2,889). Pain was not usually cited alone; in 2,900 out of the 4,078 instances, it was cited together with one or more other indications. Associated PTIRs for these, and the other indications are shown in Table 3.10. Here implant wear denotes either wear of the polyethylene component, wear of the acetabular component or dissociation of the liner.

The number of adverse reactions to particulate debris is likely to be under-estimated because this was not solicited (i.e. not an option) on the revision report forms in the early phase of the NJR, i.e. was missing for MDSv1/2. Some of these cases may have been put under 'other' but we simply do not know. Adoption of the later revision report forms (MDSv3) was staggered over time and so revisions associated with a few primaries as late as 2010 had revisions reported on versions 1 and 2 of the data collection form. By restricting our analyses to primaries from 2008 onwards however, as we did in our previous two annual reports, ensures that 99% of revisions had been recorded on later forms (as opposed to 78% of the primaries from earlier years). We noted, however, that only 1,534 of the 3,548 instances of adverse reactions to particulate debris would thus be included, i.e. we are thereby missing 2,014 of the earlier ones. Therefore, as we did last year, we present two sets of PTIRs, one set for all primaries, which are likely to be underestimates, and the other set for all primaries performed since the beginning of 2008, which has better ascertainment but does not include the cases with longer-term follow-up.

Table 3.10 includes further breakdowns by hip fixation and bearing. Metal-on-metal (irrespective of fixation) and resurfacings seem to have the highest PTIRs for both aseptic loosening and pain. Metal-on-metal bearings have the highest incidence of adverse reaction to particulate debris.

In Table 3.11, the PTIRs for each indication are shown separately for different time periods from the primary operation, within the first year from primary operation, and between 1-3, 3-5, 5-7 and 7+ years after surgery. (Note the maximum follow-up for any implant is now 12.75 years). The same overall time trends are seen as before – revision rates due to aseptic loosening and pain both increased with time from surgery, whereas the rates due to subluxation/dislocation, infection, peri-prosthetic fracture, and mal-alignment were all higher in the first year and then fell. Adverse reaction to particulate debris increased with time, as did lysis, although the PTIRs for the latter were low.

Finally, Figures 3.11 (a) to 3.11 (f) show how PTIRs for aseptic loosening, pain, dislocation/subluxation, infection and adverse soft tissue reaction to particulate debris changed with time in an arbitrary selection of the cemented/uncemented bearing sub-groups from Table 3.10. Only sub-groups with a total overall patient-years at risk of more than $>150x10^3$ have been included. With time from operation, PTIRs for aseptic loosening and pain tended to rise in uncemented metal-on-metal replacements and resurfacings. These trends were not seen in the other groups shown (Figures 3.11 (a) and (b)). Conversely, there was a high initial rate for dislocation/subluxation in all fixation/bearing groups which later fell (Figure 3.11 c). Revision rates for infection rates were initially high and then fell in all groups apart from uncemented metal-on-metal (Figure 3.11 (d)). Revision rates due to adverse reaction to particulate debris increased with time up to five years in uncemented metal-on-metal and resurfacings (Figures 3.11 (e) and (f)). Confidence Intervals have not been shown here for simplicity, but could be quite wide; these trends require more in-depth investigation.

Table 3.10 Revision rates after primary hip replacement for each indication, expressed as numbers per 1,000 patient-years (95% CI), for all cases and by fixation and bearing surface.

Fixation/ bearing types	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:												Patient-years at risk (x1,000) for primaries from 1.1.2008****	Revisions per 1,000 patient-years (95% CI) for adverse reaction to particulate debris for primaries from 1.1.2008****
		Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Peri-prosthetic fracture	Mal-alignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris***		
All cases*	3,806.8	1.33 (1.30-1.37)	1.07 (1.04-1.10)	0.92 (0.89-0.95)	0.76 (0.73-0.79)	0.67 (0.64-0.69)	0.41 (0.39-0.43)	0.29 (0.28-0.31)	0.28 (0.26-0.30)	0.16 (0.15-0.18)	0.05 (0.04-0.05)	0.57 (0.54-0.59)	0.93 (0.90-0.96)	2,166.1	0.71 (0.67-0.74)
All cemented	1,433.2	0.99 (0.94-1.04)	0.40 (0.37-0.44)	0.85 (0.80-0.90)	0.70 (0.66-0.74)	0.40 (0.37-0.44)	0.22 (0.20-0.25)	0.19 (0.17-0.21)	0.14 (0.12-0.16)	0.07 (0.06-0.09)	0.02 (0.01-0.03)	0.17 (0.15-0.19)	0.08 (0.07-0.10)	693.3	0.07 (0.05-0.09)
Cemented by bearing surface															
MoP	1267.3	0.99 (0.94-1.05)	0.38 (0.35-0.42)	0.88 (0.83-0.93)	0.68 (0.64-0.73)	0.41 (0.38-0.45)	0.23 (0.21-0.26)	0.19 (0.16-0.21)	0.14 (0.12-0.17)	0.06 (0.05-0.08)	0.02 (0.01-0.03)	0.15 (0.13-0.18)	0.03 (0.02-0.04)	600.9	0.03 (0.02-0.04)
MoM	8.1	3.57 (2.48-5.13)	3.69 (2.58-5.28)	0.98 (0.49-1.97)	0.98 (0.49-1.97)	1.35 (0.75-2.44)	0.25 (0.06-0.98)	1.97 (1.21-3.21)	0.25 (0.06-0.98)	0.86 (0.41-1.80)	0.12 (0.02-0.87)	3.07 (2.08-4.55)	8.49 (6.70-11.00)	2.3	9.60 (6.30-15.00)
CoP	123.6	0.77 (0.63-0.94)	0.36 (0.27-0.49)	0.61 (0.49-0.77)	0.78 (0.64-0.96)	0.27 (0.19-0.38)	0.16 (0.10-0.25)	0.11 (0.08-0.19)	0.12 (0.07-0.20)	0.08 (0.04-0.15)	0.01 (0.00-0.06)	0.15 (0.09-0.23)	0.05 (0.02-0.11)	74.9	0.07 (0.03-0.16)
Others/ unsure	34.2	1.02 (0.74-1.43)	0.47 (0.29-0.76)	0.59 (0.38-0.91)	0.91 (0.64-1.29)	0.41 (0.24-0.69)	0.20 (0.10-0.43)	0.20 (0.10-0.43)	0.12 (0.04-0.31)	0.18 (0.08-0.39)	0	0.23 (0.12-0.47)	0.32 (0.18-0.58)	15.2	0.20 (0.06-0.61)
All uncemented	1398.9	1.71 (1.64-1.78)	1.35 (1.29-1.42)	1.04 (0.99-1.10)	0.84 (0.79-0.89)	0.76 (0.71-0.80)	0.58 (0.54-0.62)	0.31 (0.29-0.35)	0.44 (0.41-0.48)	0.24 (0.22-0.27)	0.07 (0.06-0.09)	0.79 (0.74-0.84)	1.55 (1.49-1.62)	940.2	1.09 (1.03-1.16)
Uncemented by bearing surface															
MoP	504.0	1.29 (1.20-1.40)	0.76 (0.69-0.84)	1.33 (1.23-1.43)	0.76 (0.69-0.84)	0.99 (0.91-1.08)	0.54 (0.48-0.60)	0.22 (0.18-0.26)	0.45 (0.40-0.51)	0.10 (0.08-0.13)	0.07 (0.05-0.09)	0.35 (0.30-0.40)	0.14 (0.11-0.18)	344.6	0.17 (0.13-0.22)
MoM	202.2	3.72 (3.46-3.99)	4.60 (4.32-4.91)	0.94 (0.82-1.09)	1.51 (1.35-1.69)	0.64 (0.54-0.76)	0.94 (0.82-1.08)	1.15 (1.01-1.31)	0.69 (0.59-0.82)	0.18 (0.13-0.25)	0.10 (0.06-0.15)	2.76 (2.54-3.00)	9.68 (9.26-10.12)	94.6	9.20 (8.60-9.80)
CoP	209.3	1.25 (1.11-1.41)	0.62 (0.52-0.74)	1.08 (0.95-1.23)	0.68 (0.58-0.80)	0.61 (0.51-0.73)	0.48 (0.40-0.59)	0.14 (0.10-0.20)	0.41 (0.33-0.50)	0.11 (0.08-0.17)	0.06 (0.03-0.10)	0.40 (0.32-0.49)	0.09 (0.05-0.14)	130.1	0.11 (0.06-0.18)
CoC	441.6	1.43 (1.33-1.55)	0.89 (0.80-0.98)	0.75 (0.67-0.83)	0.70 (0.63-0.78)	0.62 (0.55-0.70)	0.50 (0.44-0.57)	0.12 (0.09-0.15)	0.32 (0.27-0.38)	0.48 (0.42-0.55)	0.07 (0.05-0.10)	0.57 (0.50-0.65)	0.16 (0.13-0.21)	344.4	0.16 (0.13-0.21)
CoM	12.0	2.83 (2.02-3.96)	2.00 (1.34-2.98)	0.83 (0.45-1.55)	1.42 (0.88-2.28)	0.50 (0.22-1.11)	0.92 (0.51-1.65)	0.50 (0.22-1.11)	0.92 (0.51-1.65)	0.17 (0.04-0.67)	0.17 (0.04-0.67)	1.42 (0.88-2.28)	1.50 (0.94-2.38)	11.5	1.60 (0.98-2.50)
Others/ unsure	29.7	1.92 (1.48-2.49)	1.14 (0.82-1.60)	1.01 (0.71-1.44)	0.64 (0.41-1.00)	0.84 (0.57-1.24)	0.64 (0.41-1.00)	0.34 (0.18-0.63)	0.37 (0.20-0.67)	0.44 (0.25-0.75)	0.10 (0.03-0.31)	0.61 (0.38-0.96)	1.10 (0.76-1.50)	14.9	0.80 (0.46-1.40)

*Including 39 with unknown fixation/bearing.

**Based on a small group size (n=94), therefore estimates are unreliable.

***Rates likely to be underestimated: this reason 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 stated this reason for revision.

Continued >

Table 3.10 (continued)

Fixation/ bearing types	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:												Patient-years at risk (x1,000) for primaries from 1.1.2008****	Revisions per 1,000 patient-years (95% CI) for adverse reaction to particulate debris for primaries from 1.1.2008****
		Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Peri-prosthetic fracture	Mal-alignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris***		
All hybrid	614.7	0.68 (0.62-0.75)	0.56 (0.50-0.62)	1.08 (1.00-1.17)	0.78 (0.71-0.85)	0.80 (0.73-0.87)	0.30 (0.26-0.35)	0.20 (0.17-0.24)	0.22 (0.19-0.27)	0.15 (0.12-0.18)	0.03 (0.02-0.05)	0.31 (0.27-0.36)	0.26 (0.22-0.30)	372.4	0.18 (0.14-0.23)
Hybrid by bearing surface															
MoP	394.6	0.66 (0.59-0.75)	0.43 (0.37-0.50)	1.20 (1.10-1.31)	0.79 (0.71-0.89)	0.89 (0.81-0.99)	0.29 (0.24-0.35)	0.18 (0.14-0.23)	0.25 (0.20-0.30)	0.11 (0.08-0.14)	0.02 (0.01-0.04)	0.25 (0.20-0.30)	0.07 (0.05-0.10)	238.3	0.07 (0.04-0.11)
MoM	16.0	3.32 (2.54-4.34)	4.07 (3.19-5.19)	1.57 (1.06-2.32)	1.19 (0.76-1.87)	1.50 (1.01-2.24)	0.75 (0.43-1.32)	1.69 (1.16-2.47)	0.31 (0.13-0.75)	0.31 (0.13-0.75)	0.13 (0.03-0.50)	2.69 (2.00-3.63)	7.26 (6.06-8.71)	5.9	6.70 (4.90-9.10)
CoP	80.3	0.45 (0.32-0.62)	0.36 (0.25-0.52)	1.13 (0.92-1.39)	0.83 (0.66-1.06)	0.68 (0.53-0.89)	0.24 (0.15-0.37)	0.12 (0.07-0.23)	0.16 (0.09-0.28)	0.09 (0.04-0.18)	0.05 (0.02-0.13)	0.24 (0.15-0.37)	0.06 (0.03-0.15)	58.7	0.05 (0.02-0.16)
CoC	110.5	0.55 (0.43-0.71)	0.59 (0.46-0.75)	0.53 (0.41-0.69)	0.59 (0.46-0.75)	0.47 (0.36-0.62)	0.33 (0.24-0.46)	0.10 (0.06-0.18)	0.16 (0.10-0.26)	0.31 (0.22-0.43)	0.03 (0.01-0.08)	0.25 (0.17-0.37)	0.09 (0.05-0.17)	63.8	0.11 (0.05-0.23)
Others/ unsure	13.3	0.75 (0.40-1.39)	1.05 (0.62-1.77)	1.12 (0.68-1.86)	1.20 (0.73-1.96)	0.37 (0.16-0.90)	0.15 (0.04-0.60)	0.30 (0.11-0.80)	0.30 (0.11-0.80)	0.15 (0.04-0.60)	0	0.22 (0.07-0.70)	0.15 (0.04-0.60)	5.6	0
All reverse hybrid	77.8	1.27 (1.05-1.55)	0.57 (0.42-0.76)	1.02 (0.81-1.27)	0.86 (0.68-1.09)	0.67 (0.51-0.88)	0.36 (0.25-0.52)	0.15 (0.09-0.27)	0.22 (0.14-0.35)	0.05 (0.02-0.14)	0.05 (0.02-0.14)	0.35 (0.24-0.51)	0.06 (0.03-0.15)	60.3	0.07 (0.02-0.18)
Reverse hybrid by bearing surface															
MoP	52.7	1.16 (0.90-1.49)	0.40 (0.26-0.61)	1.12 (0.87-1.45)	0.78 (0.57-1.06)	0.82 (0.61-1.10)	0.36 (0.23-0.57)	0.13 (0.06-0.28)	0.17 (0.09-0.33)	0.04 (0.01-0.15)	0.04 (0.01-0.15)	0.34 (0.22-0.54)	0.06 (0.02-0.18)	40.8	0.05 (0.01-0.20)
CoP	24.6	1.46 (1.06-2.03)	0.89 (0.59-1.36)	0.81 (0.52-1.26)	1.02 (0.69-1.50)	0.37 (0.19-0.70)	0.33 (0.16-0.65)	0.20 (0.08-0.49)	0.33 (0.16-0.65)	0.08 (0.02-0.33)	0.08 (0.02-0.33)	0.33 (0.16-0.65)	0.04 (0.01-0.29)	19.2	0.05 (0.01-0.37)
Others/ unsure**	*0.5*	*3.80 (0.95-15.18)*	*1.90 (0.27-13.48)*	*0*	*1.90 (0.27-13.48)*	*0*	*1.90 (0.27-13.00)*	*0*	*0*	*0*	*0*	*1.90 (0.27-13.00)*	*1.90 (0.27-13.48)*	*0.3*	*3.20 (0.45-23.0)*
All resurfacing (MoM)	281.8	2.65 (2.46-2.84)	4.33 (4.09-4.58)	0.35 (0.29-0.43)	0.58 (0.50-0.67)	1.28 (1.16-1.42)	0.80 (0.70-0.91)	0.93 (0.83-1.05)	0.31 (0.25-0.38)	0.30 (0.24-0.37)	0.09 (0.06-0.13)	2.11 (1.95-2.29)	3.89 (3.66-4.12)	100.0	3.91 (3.54-4.32)

*Including 39 with unknown fixation/bearing.

**Based on a small group size (n=94), therefore estimates are unreliable.

***Rates likely to be underestimated: this reason 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 stated this reason for revision.

Table 3.11 Revision rates after primary hip replacement for each indication, expressed as numbers per 1,000 patient-years (95% CI), overall and by time interval from primary operation.

Time from primary operation	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for: Aseptic loosening	Pain	Dislocation/ subluxation	Infection	Peri-prosthetic fracture	Mal-alignment	Lysis	Implant wear	Implant fracture	Head/ socket size mismatch	Other indication	Adverse reaction to particulate debris***	Patient-years at risk (x1,000) for primaries from 1.1.2008***	Revisions per 1,000 patient-years (95% CI) for adverse reaction to particulate debris for primaries from 1.1.2008***
All cases	3,806.8	1.33 (1.30-1.37)	1.07 (1.04-1.10)	0.92 (0.89-0.95)	0.76 (0.73-0.79)	0.67 (0.64-0.69)	0.41 (0.39-0.43)	0.29 (0.28-0.31)	0.28 (0.26-0.30)	0.16 (0.15-0.18)	0.05 (0.04-0.05)	0.57 (0.54-0.59)	0.93 (0.90-0.96)	2,166.1	0.71 (0.67-0.74)
Years															
<1 year	745.5	1.17 (1.09-1.25)	0.71 (0.65-0.78)	2.37 (2.26-2.48)	1.47 (1.39-1.56)	1.65 (1.56-1.74)	0.80 (0.74-0.87)	0.08 (0.06-0.11)	0.32 (0.28-0.36)	0.24 (0.20-0.28)	0.12 (0.09-0.14)	0.74 (0.68-0.81)	0.09 (0.07-0.11)	557.3	0.12 (0.09-0.15)
1-3 years	1,205.0	1.21 (1.15-1.27)	1.00 (0.94-1.06)	0.65 (0.61-0.70)	0.79 (0.74-0.84)	0.32 (0.30-0.36)	0.36 (0.33-0.40)	0.18 (0.15-0.20)	0.16 (0.14-0.19)	0.14 (0.12-0.16)	0.04 (0.03-0.05)	0.46 (0.42-0.50)	0.31 (0.28-0.35)	839.7	0.42 (0.38-0.47)
3-5 years	857.5	1.23 (1.16-1.31)	1.24 (1.16-1.31)	0.49 (0.44-0.54)	0.50 (0.46-0.55)	0.42 (0.38-0.46)	0.29 (0.25-0.33)	0.29 (0.26-0.33)	0.25 (0.22-0.29)	0.13 (0.11-0.16)	0.02 (0.01-0.03)	0.56 (0.52-0.62)	1.16 (1.09-1.23)	510.7	1.16 (1.08-1.26)
5-7 years	555.0	1.50 (1.40-1.61)	1.41 (1.31-1.51)	0.48 (0.43-0.55)	0.43 (0.38-0.49)	0.53 (0.48-0.60)	0.30 (0.26-0.35)	0.50 (0.45-0.57)	0.35 (0.31-0.40)	0.17 (0.14-0.20)	0.03 (0.02-0.05)	0.60 (0.54-0.67)	2.25 (2.13-2.38)	231.3	1.98 (1.81-2.17)
>7 years*	443.8	1.92 (1.80-2.06)	1.13 (1.04-1.24)	0.63 (0.56-0.71)	0.39 (0.34-0.45)	0.60 (0.53-0.67)	0.28 (0.23-0.33)	0.69 (0.62-0.78)	0.50 (0.43-0.57)	0.16 (0.13-0.20)	0.02 (0.01-0.03)	0.53 (0.47-0.61)	1.94 (1.81-2.07)	27.1	2.29 (1.78-2.93)

*Current maximum observed follow up is 12.75 years.

**Rates likely to be underestimated: this reason not solicited in the early phase of the registry (i.e. revision report forms MDSv1/MDSv2).

***For primaries from 2008 onwards the majority of revision report forms were MDSv3/MDSv6 which explicitly stated this reason for revision.

Figure 3.11 (a)

Change in PTIR with time from primary hip replacement, for **aseptic loosening** for selected fixation/bearing sub-groups.

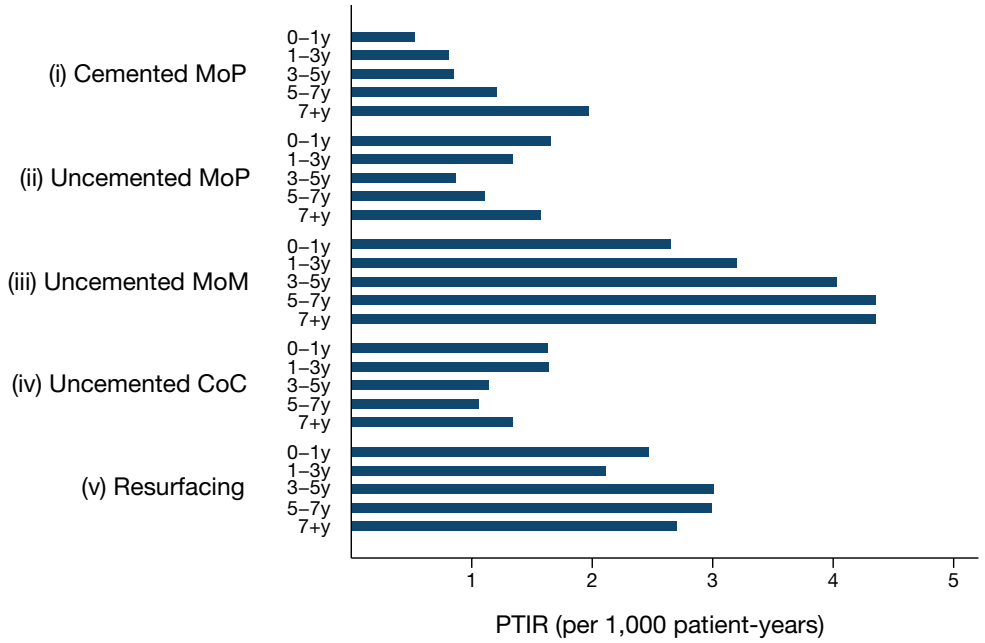


Figure 3.11 (b)

Change in PTIR with time from primary hip replacement, for **pain** for selected fixation/bearing sub-groups.

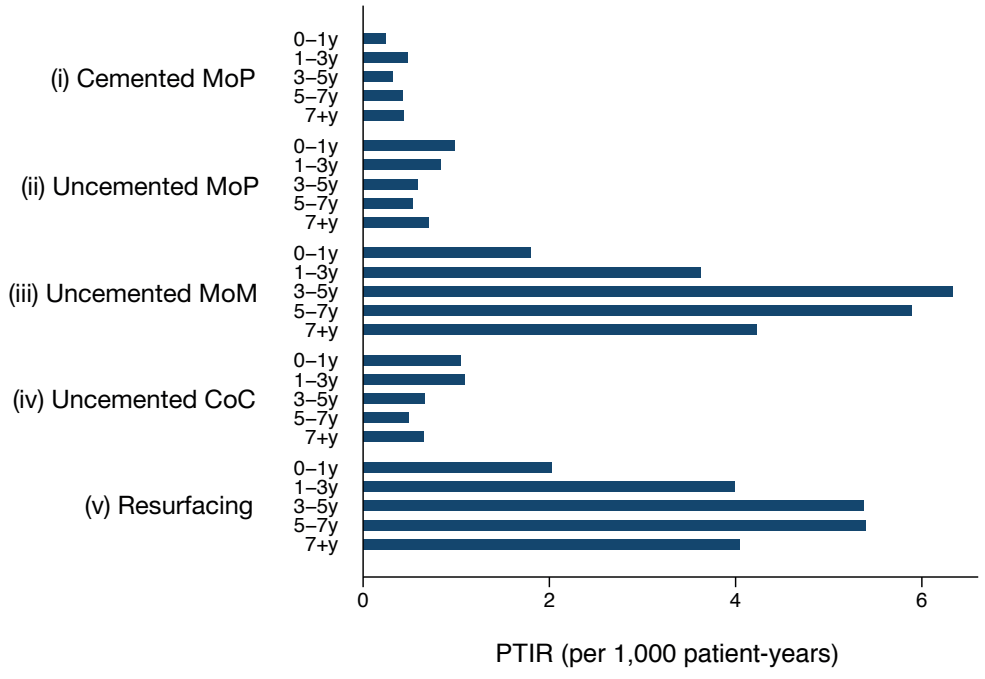


Figure 3.11 (c)

Change in PTIR with time from primary hip replacement, for **dislocation/subluxation** for selected fixation/bearing sub-groups.

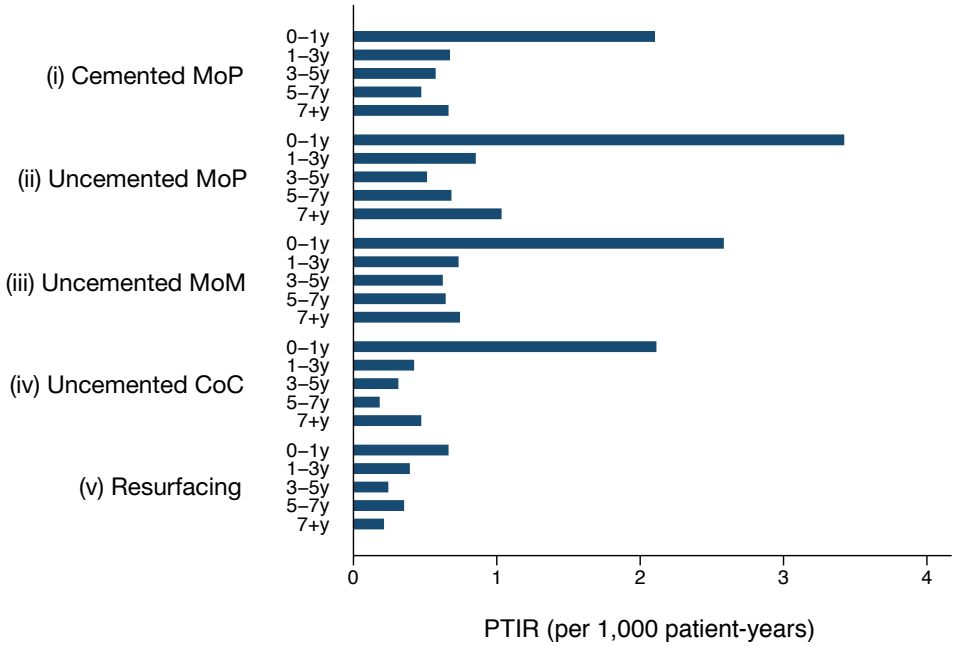


Figure 3.11 (d)

Change in PTIR with time from primary hip replacement, for **infection** for selected fixation/bearing sub-groups.

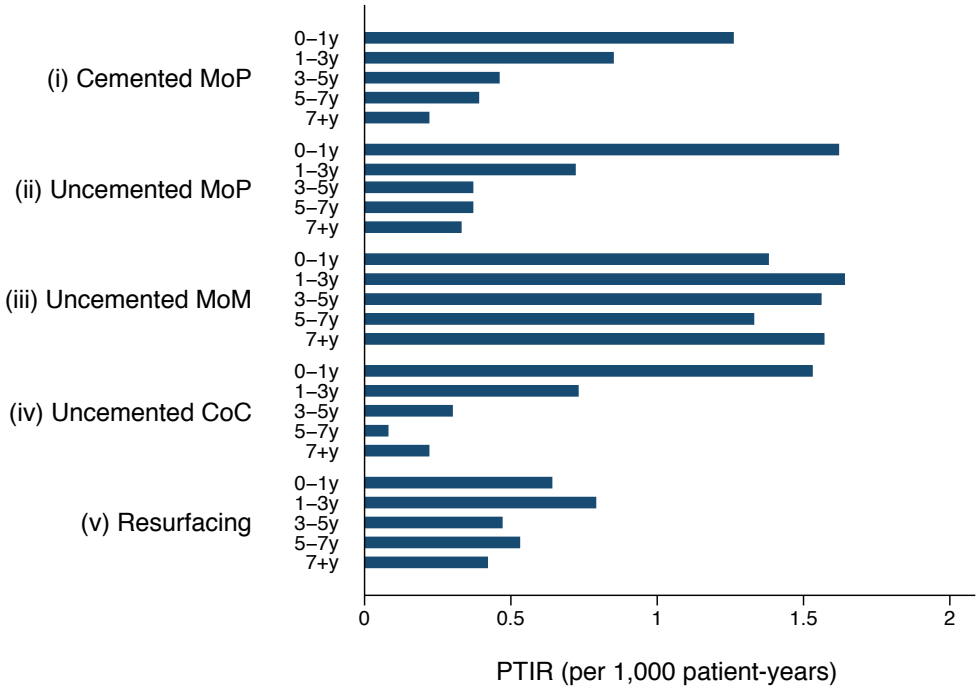


Figure 3.11 (e)

Change in PTIR with time from primary hip replacement, for **adverse soft tissue reaction to particulate debris** for selected fixation/bearing sub-groups.

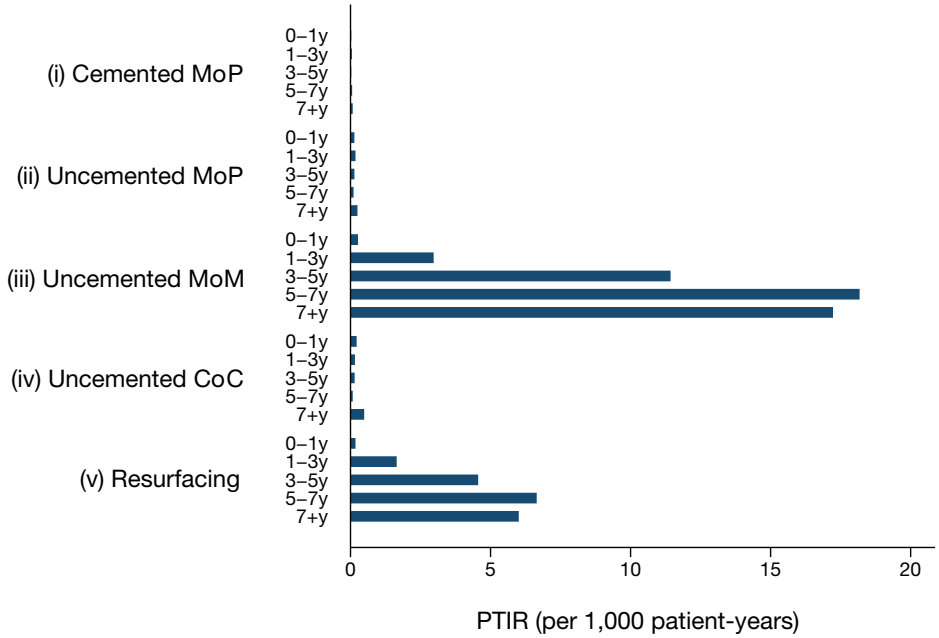
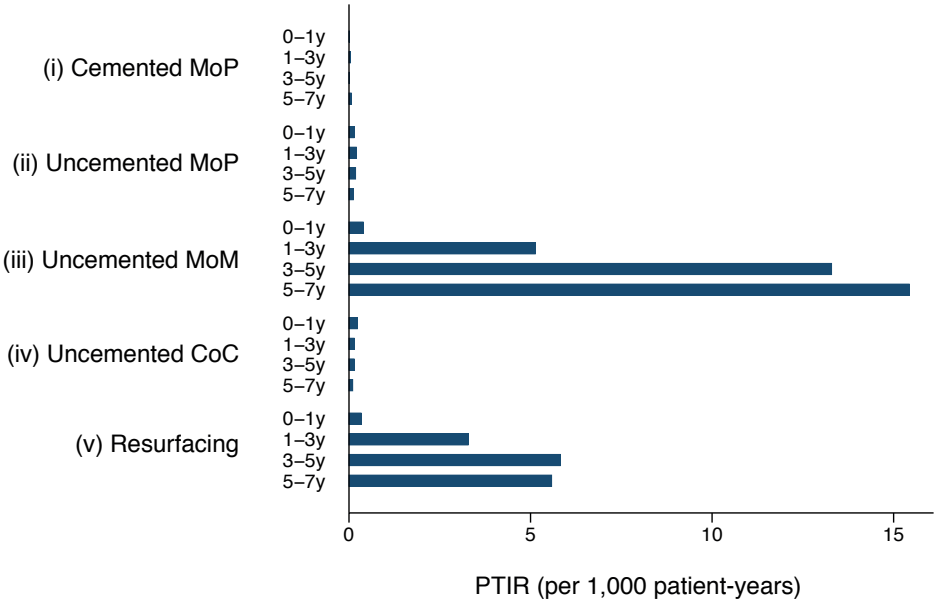


Figure 3.11 (f)

Change in PTIR with time from primary hip replacement, for **adverse soft tissue reaction to particulate debris** for selected fixation/bearing sub-groups including primaries since 2008 only.



3.3.6 Mortality after primary hip surgery

This section describes the mortality of the cohort up to twelve years from primary operation, according to gender and age group. Deaths were updated on 20 February 2016 using data from the NHS Personal Demographic Service. A total of 226 cases were excluded because the NHS number was not traceable and, therefore, the ages could not be verified. A further five were excluded because of uncertainty in gender, leaving 796,405. Amongst these, were 3,991 bilateral operations, with the left and right side operated on the same day; here the second of the two has been excluded, leaving 792,414 procedures, of whom 90,846 had died before the end of 2015.

Table 3.12 shows Kaplan-Meier estimates of cumulative percentage mortality at 30 days, 90 days and at 1, 3, 5, 7, 10, and 11 years from the primary operation, for all cases and by age and gender.

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

Table 3.12 Kaplan-Meier estimates of the cumulative percentage mortality (95% CI), at different time points after primary hip replacement, for all cases and by age/gender.

		Cumulative percentage probability of death (95% CI) at:							
	n	30 days	90 days	1 year	3 years	5 years	7 years	10 years	11 years
All cases	792,414*	0.22 (0.21-0.23)	0.48 (0.47-0.50)	1.49 (1.46-1.52)	4.90 (4.85-4.96)	9.51 (9.43-9.59)	15.05 (14.95-15.16)	24.88 (24.70-25.06)	28.51 (28.28-28.74)
Males									
<55 years	47,620	0.08 (0.06-0.11)	0.16 (0.13-0.20)	0.51 (0.44-0.57)	1.38 (1.27-1.50)	2.20 (2.05-2.36)	3.31 (3.11-3.53)	5.03 (4.70-5.38)	5.56 (5.16-5.99)
55-59 years	32,698	0.06 (0.04-0.09)	0.20 (0.16-0.26)	0.64 (0.56-0.73)	1.86 (1.71-2.03)	3.32 (3.10-3.56)	5.02 (4.72-5.35)	8.21 (7.71-8.74)	9.59 (8.94-10.29)
60-64 years	47,037	0.13 (0.10-0.17)	0.25 (0.21-0.30)	0.85 (0.77-0.94)	2.64 (2.48-2.80)	4.81 (4.59-5.04)	7.25 (6.94-7.56)	12.43 (11.89-12.99)	14.18 (13.51-14.90)
65-69 years	55,370	0.17 (0.14-0.21)	0.38 (0.33-0.43)	1.13 (1.05-1.23)	3.62 (3.45-3.79)	6.94 (6.69-7.21)	11.05 (10.69-11.42)	18.54 (17.94-19.16)	21.69 (20.91-22.48)
70-74 years	54,899	0.21 (0.18-0.25)	0.48 (0.42-0.54)	1.68 (1.57-1.79)	5.67 (5.46-5.89)	10.72 (10.41-11.03)	16.86 (16.44-17.29)	29.57 (28.83-30.31)	34.71 (33.76-35.67)
75-79 years	45,298	0.41 (0.36-0.47)	0.78 (0.71-0.87)	2.53 (2.38-2.68)	8.70 (8.41-8.99)	17.06 (16.64-17.50)	27.78 (27.19-28.38)	46.72 (45.74-47.72)	53.89 (52.64-55.14)
80-84 years	25,038	0.81 (0.71-0.93)	1.54 (1.39-1.70)	4.34 (4.09-4.61)	13.68 (13.21-14.17)	27.42 (26.72-28.13)	42.98 (42.06-43.91)	66.76 (65.43-68.08)	73.14 (71.56-74.69)
85+ years	10,439	1.67 (1.44-1.94)	3.12 (2.80-3.47)	7.81 (7.30-8.36)	23.84 (22.94-24.78)	43.83 (42.63-45.06)	63.12 (61.72-64.51)	*85.30 (83.65-86.86)*	*89.95 (88.12-91.60)*
Females									
<55 years	47,546	0.05 (0.03-0.08)	0.19 (0.15-0.23)	0.66 (0.59-0.74)	1.61 (1.49-1.74)	2.45 (2.30-2.62)	3.38 (3.17-3.60)	4.89 (4.57-5.23)	5.30 (4.92-5.71)
55-59 years	37,803	0.07 (0.05-0.10)	0.18 (0.14-0.22)	0.57 (0.49-0.65)	1.66 (1.52-1.80)	2.95 (2.76-3.16)	4.41 (4.15-4.69)	6.95 (6.52-7.41)	7.99 (7.44-8.58)
60-64 years	58,904	0.07 (0.05-0.09)	0.17 (0.14-0.20)	0.60 (0.54-0.66)	2.00 (1.88-2.13)	3.80 (3.62-3.99)	5.81 (5.57-6.07)	9.53 (9.10-9.98)	11.31 (10.75-11.91)
65-69 years	80,464	0.08 (0.06-0.10)	0.23 (0.20-0.26)	0.76 (0.70-0.82)	2.53 (2.41-2.65)	4.83 (4.65-5.01)	7.72 (7.47-7.98)	13.67 (13.22-14.14)	15.90 (15.33-16.49)
70-74 years	87,993	0.12 (0.10-0.15)	0.29 (0.26-0.33)	0.98 (0.91-1.04)	3.57 (3.44-3.71)	7.25 (7.05-7.46)	11.95 (11.65-12.25)	21.73 (21.20-22.27)	25.92 (25.23-26.63)
75-79 years	80,461	0.24 (0.21-0.28)	0.48 (0.43-0.53)	1.55 (1.46-1.64)	5.66 (5.48-5.84)	11.72 (11.44-11.99)	19.22 (18.44-19.61)	34.69 (34.03-35.37)	41.00 (40.14-41.87)
80-84 years	53,442	0.38 (0.33-0.44)	0.86 (0.79-0.94)	2.63 (2.50-2.77)	9.09 (8.82-9.36)	18.78 (18.38-19.20)	31.54 (30.98-32.11)	53.63 (52.74-54.51)	61.55 (60.47-62.63)
85+ years	27,402	0.82 (0.72-0.93)	1.85 (1.70-2.02)	4.98 (4.72-5.25)	16.27 (15.79-16.77)	31.89 (31.20-32.58)	50.13 (49.26-51.00)	73.89 (72.72-75.05)	*80.18 (78.80-81.52)*

*Excludes 226 cases where the age could not be verified (because NHS number was not traceable) plus a further five cases with uncertain gender; amongst the remainder, the second of 3,991 pairs of simultaneous bilateral operations were also excluded.

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

As total hip replacement is becoming an increasingly popular treatment option for fractured neck of femur; this section updates results from last year's annual report (12th Annual Report 2015) on revision and mortality rates for primary hip replacements performed as a result of fractured neck of femur compared to cases implanted for other reasons. A total of 19,872 (2.5%) of the primary total hip replacements were performed for fracture of the neck of femur (#NOF)[3].

Table 3.13 below shows that the proportion of primary hip replacements due to fractured neck of femur has continued to increase with time to a maximum of 4.5% in 2015.

Table 3.13 Proportions of primary total hip replacements for fractured neck of femur by year of primary operation.

Year of primary	n	Number (%) with fractured neck of femur
2003	14,431	142 (1.0%)
2004	28,029	292 (1.0%)
2005	40,200	388 (1.0%)
2006	47,558	524 (1.1%)
2007	60,560	771 (1.3%)
2008	66,918	860 (1.3%)
2009	67,900	1,072 (1.6%)
2010	70,394	1,356 (1.9%)
2011	73,442	1,700 (2.3%)
2012	77,639	2,438 (3.1%)
2013	79,669	3,103 (3.9%)
2014	85,972	3,493 (4.1%)
2015	83,886	3,733 (4.5%)
All years	796,598*	19,872 (2.5%)

* Excludes 38 with no data

Table 3.14 compares the #NOF group with the remainder with respect to gender and age composition together and type of hip received. A significantly larger percentage of the #NOF cases compared with the remainder were women (73.0% versus 59.4%: P<0.001, Chi-squared test). The #NOF cases were significantly older (median age 72 years versus 69 years at operation: P<0.001 by Mann-Whitney U-test). Cemented and hybrid hips were used more commonly in #NOF than in the other group.

Figure 3.12 shows that the overall failure rate (cumulative revision) was higher in the #NOF group compared with the remainder (P<0.001, logrank test). This effect appeared not to be 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, 55-59, 60-64, 65-69, 70-74, 75-79, 80+ for each gender).

Finally, Figure 3.13 shows a marked worse overall survival in the #NOF cases compared to cases implanted for other reasons (logrank test<0.001). As in the overall mortality section, 226 cases with untraced NHS numbers have been excluded, together with 3,991 cases that were the second of simultaneous bilateral procedures. Gender/age differences did not fully explain the difference seen, as a stratified analysis still showed a difference P<0.001) but the results warrant further exploration.

[3] These comprised 2,216 with reasons for primary including fractured neck of femur in the early phase of the registry (i.e. 199,417 implants entered using MDSv1 and v2) and 17,656 reasons including acute trauma neck of femur in the later phase (i.e. 597,181 entered using MDSv3 and v6). 38 cases were omitted as no reasons were given.

Table 3.14 Comparison between primary hip replacements for fractured neck of femur and the remainder of cases with respect to gender, age and type of primary hip received.

	Reason for primary hip replacement		
	Fractured neck of femur (n=19,872)	Other reasons (n=776,726)	Comparison
% Females*	73.0%	59.4%	P<0.001 (Chi-squared test)
Median age (IQR)**			
Both genders	72 (IQR 66-79)	69 (IQR 61-76)	P<0.001 (Mann-Whitney U-test)
Males only	72 (IQR 64-79)	67 (IQR 59-74)	P<0.001 (Mann-Whitney U-test)
Females only	73 (IQR 66-79)	70 (IQR 62-77)	P<0.001 (Mann-Whitney U-test)
% Hip type***			
Cemented	44.3%	35.2%	
Uncemented	24.8%	39.5%	
Hybrid	28.1%	17.9%	Overall P<0.001 (Chi-squared test)
Reverse hybrid	2.7%	2.5%	
Resurfacing	0.2%	4.9%	

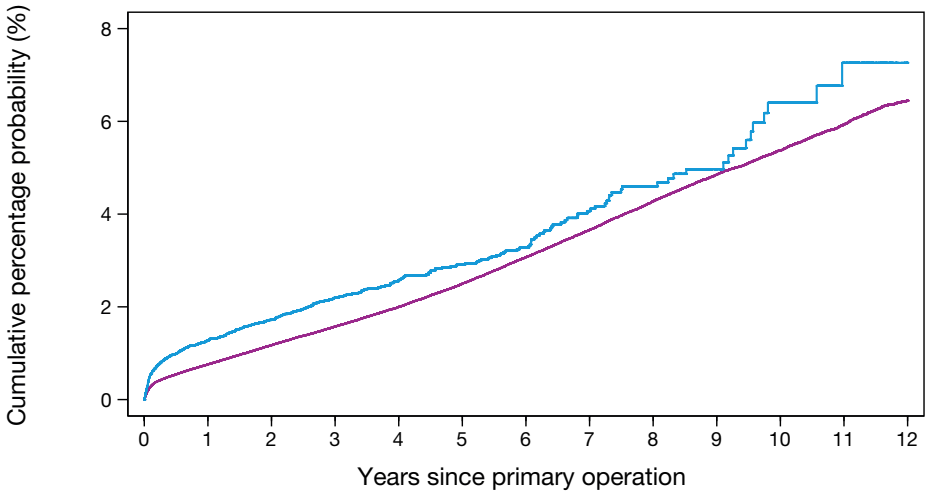
*Excludes five with uncertain gender.

**Excludes 226 whose NHS number was untraced whose ages, therefore, could not be verified.

***Excludes 39 with uncertain hip type.

Figure 3.12

Cumulative percentage revision rates (Kaplan-Meier) for hip primaries implanted for fractured neck of femur compared with all other cases.

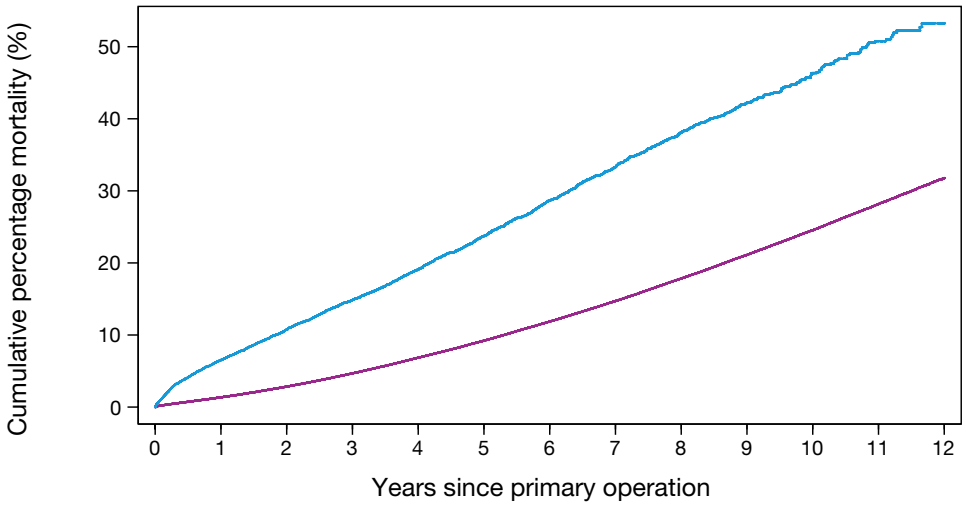


Numbers at risk

Other	776,726	681,906	589,548	504,043	421,527	344,737	273,400	207,946	147,578	96,399	58,351	28,599	9,166
Fract. neck of femur	19,872	14,850	11,018	7,844	5,483	3,919	2,722	1,824	1,188	684	376	183	54

Figure 3.13

Cumulative percentage mortality (Kaplan-Meier) for hip primaries implanted for fractured neck of femur compared with all other cases.



Numbers at risk

Other	772,545	683,205	592,999	508,992	427,524	351,630	280,811	214,974	153,166	100,328	60,793	29,775	9,534
Fract. neck of femur	19,836	15,010	11,190	7,997	5,611	4,020	2,814	1,900	1,246	723	404	197	60

3.3.8 Conclusions

As in previous annual reports, we have analysed implants by revision of the construct, rather than revision of a single component, as the mechanisms of failure (such as wear, ALVAL and dislocation) are interdependent between different parts of the construct. We have also stratified revision by age and gender. The highest failure rates are among young women and the lowest among older women. Once again we must emphasise that implant survivorship is only one measure of success and cannot be used as an indication of satisfaction, relief of pain, improvement in function or greater participation in society. Interestingly the breakdowns by age and gender show that cemented fixation has the lowest implant revision rate at ten years in all age bands and both genders.

With regard to bearing surfaces, we have previously noted that ceramic-on-polyethylene is associated with particularly low revision rates. This new data adds strength to that observation and it appears that at ten years the survivorship of ceramic-on-polyethylene is measurably better than metal-on-polyethylene. It will be interesting to see in future annual reports whether the outcomes of these two bearing combinations diverge after ten years. There has been a steady increase in the use of ceramic-on-polyethylene bearings since we reported low failure rates associated with these bearings.

Metal-on-metal stemmed and resurfacing implants continue to fail at higher than expected rates and their use is now extremely rare. It is striking to note the high rates of revision for adverse soft tissue reaction to particulate debris in these patients.

Our analysis of the relationship between head size and revision rates in hard-on-soft bearings appears to indicate an ideal head size of between 26mm and 32mm, with heads outside this range associated with higher failure rates and the highest failure rates associated with very large heads.

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

Part 3

3.4 Revisions of a total hip replacement

3.4.1 Overview of hip revision procedures

This section looks at all hip revision procedures performed since the start of the registry, 1 April 2003, up to 31 December 2015, for all patients with valid patient identifiers (i.e. whose data could therefore be linked).

In total there were 88,822 revisions on 78,130 individual patient-sides[4] (73,936 actual patients). In addition to revisions on the 20,926 revised primaries described in Part 3.3 of this report, there were revisions associated with 57,204 unrecorded primaries.

Revisions are classified as single stage and stage one and stage two of two-stage revisions. Information on stage one and stage two are entered into the database separately, whereas stage one and stage two revisions in practice will be linked. Stage one revisions have been entered without stage two, and vice versa, making identification of individual revision episodes difficult. An attempt has been made to do this later in this section.

Table 3.15 below gives an overview of all revision procedures carried out each year since April 2003[4]. There were up to a maximum of nine documented revision procedures associated with any individual patient-side (discussed later in this section). The temporal increase reflects the increasing number of at-risk implants prevailing in the database.

Table 3.15 Numbers of all hip revision procedures, by type of procedure, carried out each year.

Year of revision surgery	Type of revision procedure			All procedures
	Single stage	Stage one of two-stage	Stage two of two-stage	
2003*	1,426 (100.0%)	0 (0.0%)	0 (0.0%)	1,426 (100%)
2004	2,430 (90.0%)	117 (4.3%)	154 (5.7%)	2,701 (100%)
2005	3,395 (87.0%)	205 (5.3%)	301 (7.7%)	3,901 (100%)
2006	4,119 (86.6%)	263 (5.5%)	372 (7.8%)	4,754 (100%)
2007	5,507 (87.3%)	345 (5.5%)	459 (7.3%)	6,311 (100%)
2008	6,011 (86.0%)	425 (6.1%)	551 (7.9%)	6,987 (100%)
2009	6,308 (84.3%)	523 (7.0%)	653 (8.7%)	7,484 (100%)
2010	7,095 (86.7%)	501 (6.1%)	590 (7.2%)	8,186 (100%)
2011	8,007 (87.6%)	529 (5.8%)	606 (6.6%)	9,142 (100%)
2012	9,243 (88.1%)	604 (5.8%)	650 (6.2%)	10,497 (100%)
2013	8,516 (87.8%)	565 (5.8%)	615 (6.3%)	9,696 (100%)
2014	8,166 (87.2%)	632 (6.7%)	572 (6.1%)	9,370 (100%)
2015	7,215 (86.2%)	614 (7.3%)	538 (6.4%)	8,367 (100%)
All years	**77,438 (87.2%)**	**5,323 (6.0%)**	**6,061 (6.8%)**	**88,822 (100%)**

*Incomplete year.

Table 3.16 (right) shows the stated reasons for the revision surgery. Please note that, as several reasons can be stated, the reasons are not mutually exclusive and therefore the column percentages do not add up to 100%.

[4] For 210 patient-sides, multiple procedures had been entered on the same operation date; 209 had two on the same date and 1 had three. Details of the components that had been entered for these cases were reviewed. As a result of this, 201 of the 423 revision procedures have been dropped and 22 have been reclassified.

Table 3.16 Reasons for the hip revision procedures: percentages indicating each reason, calculated separately for single and two-stage revisions.

Reason	Type of revision procedure		
	Single stage (n=77,438)	Stage one of two-stage (n=5,323)	Stage two of two-stage (n=6,061)
Aseptic loosening	51.0%	13.7%	12.7%
Pain	22.0%	14.6%	9.8%
Lysis	15.6%	9.9%	6.3%
Dislocation/subluxation	15.1%	4.1%	3.4%
Infection	3.3%	80.0%	72.2%
Periprosthetic fracture	9.6%	3.6%	3.9%
Implant fracture	3.6%	1.2%	1.3%
Implant wear	14.1%	4.3%	3.0%
Malalignment	5.7%	1.6%	0.9%
Head-socket size mismatch	0.8%	0.3%	0.2%
Other indication	7.8%	3.6%	8.5%
Adverse reaction to particulate debris*	10.8% n= 59,545	2.9% n=4,312	2.2%% n=4,706

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

3.4.2 Rates of hip re-revision

For a given patient-side, we have looked at the survival following the first documented revision procedure in the NJR (n=78,130). In most instances (91.1%), the first revision procedure was a single stage revision, however in the remaining 8.9% it was part of a two-stage procedure. We have looked at the time from the first documented revision procedure (of any type) to the time at which a second revision procedure was undertaken. For this purpose, we regarded an initial stage one followed by either a stage one or a stage two as being the same revision episode and these were disregarded, looking instead for the start of a second revision episode. (We counted the maximum number of distinct revision episodes for any patient-side to be eight).

Kaplan-Meier estimates were calculated to estimate the cumulative probability of a subsequent revision (re-revision). These rates are plotted in Figure 3.14 (a) and tabulated in Table 3.17 (a). There were 6,633 re-revisions and in 13,059, the patient died without having been revised; the censoring date for the remainder was the end of 2015.

In Figure 3.14 (b) we sub-divided the first revisions into those for whom a primary had been recorded in the NJR (n=20,926) and the remainder. The survival of the former appeared much worse. This is interesting as primaries not in the NJR are likely to have been performed prior to 2003 and thus represent late failure. In contrast, revisions linked to primaries in the NJR are more likely to represent early failure. It thus appears that revision after late failure is less likely to need re-revision than revision after early failure. Figure 3.14 (c) and Table 3.17 (b) further exemplify this; cumulative re-revision rates up to three years are shown separately for those with primaries in the NJR according to their time intervals to first revision, less than 1 year, 1 to 3, 3 to 5 and more than 5 years.

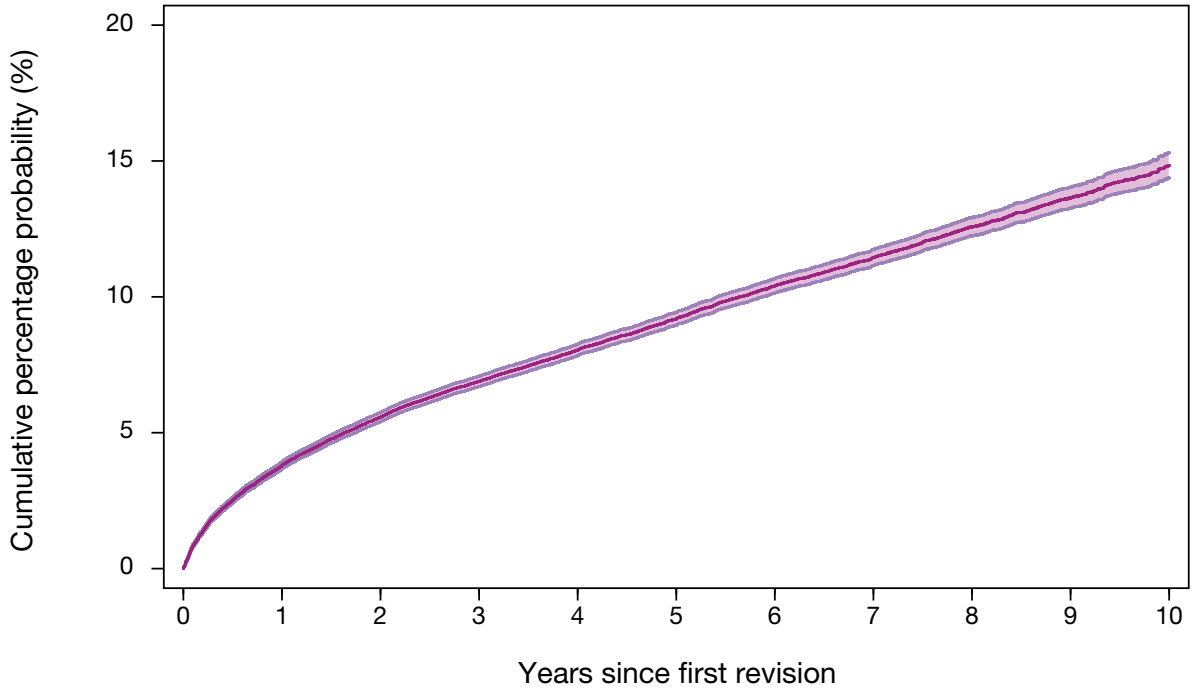
There is a relationship between the indication for first revision and time to first revision; earlier in this report (section 3.3.5) we showed, for example, that revisions for dislocation/subluxation and pain were more prevalent in the early period after the primary and aseptic loosening and pain later 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 require further investigation.

For those with documented primaries within the NJR, Figures 3.15 (a) to (e) show cumulative re-revision rates up to five years from the first revision, 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 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, and resurfacing hip replacements, those who had their first revision within one year of the initial primary hip replacement, experienced the worst re-revision rates. However, for reverse hybrid hip replacements, the worst re-revision rates were experienced by those who had their first revision within 3 to 5 years of the initial primary hip replacement; though the numbers were small and therefore the results should be interpreted with caution.

Table 3.17 (c) shows cumulative re-revision rates at 1, 3, and 5 years following the first revision for those with documented primaries within the NJR, broken down by fixation types and bearing surfaces. Overall, the worst re-revision rates were demonstrated in those where the initial primary had been uncemented, with metal-on-metal bearings faring worse than other bearings within the group. The failure rates for resurfacings were comparatively low.

Figure 3.14 (a)

Kaplan-Meier estimate of the cumulative probability of a hip re-revision.

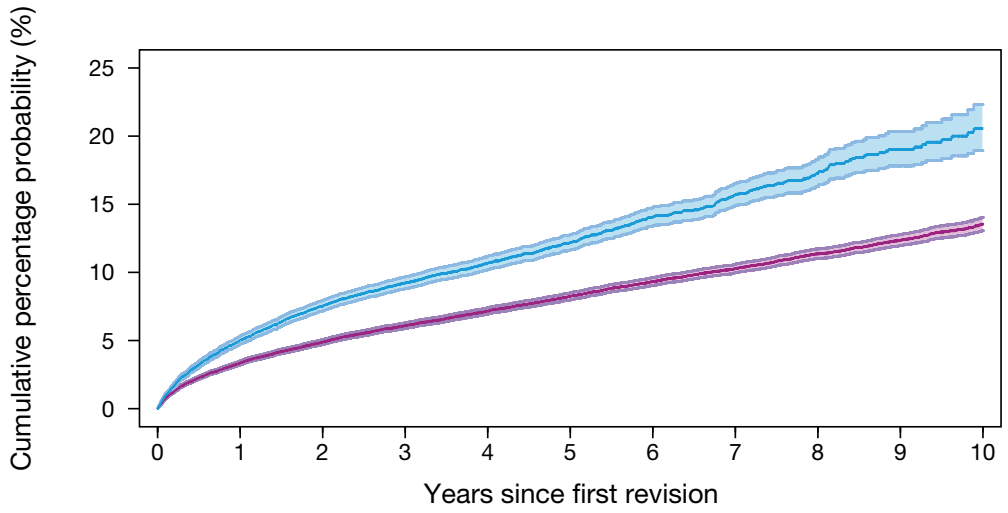


Numbers at risk

78,130	66,138	56,193	46,639	37,014	28,863	22,151	16,432	11,482	7,219	4,244

Figure 3.14 (b)

Kaplan-Meier estimates of the cumulative probability of a hip re-revision, shown separately for those with documented primaries in the NJR and the remainder.

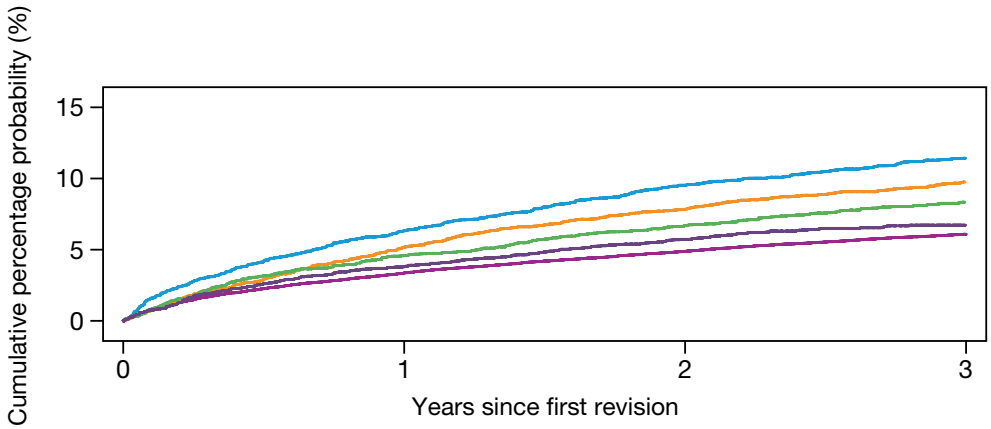


Numbers at risk

Primary not in the NJR	57,204	49,325	42,742	36,281	29,808	24,062	19,009	14,488	10,363	6,673	3,988
Primary in the NJR	20,926	16,813	13,451	10,358	7,206	4,801	3,142	1,944	1,119	546	256

Figure 3.14 (c)

Kaplan-Meier estimates of the cumulative probability of a hip re-revision up to three years from the first revision. Those with documented primaries in the NJR are shown separately from the remainder and have been sub-divided into those that had their first revision within <1, 1-3, 3-5 and >5 years from the initial primary.



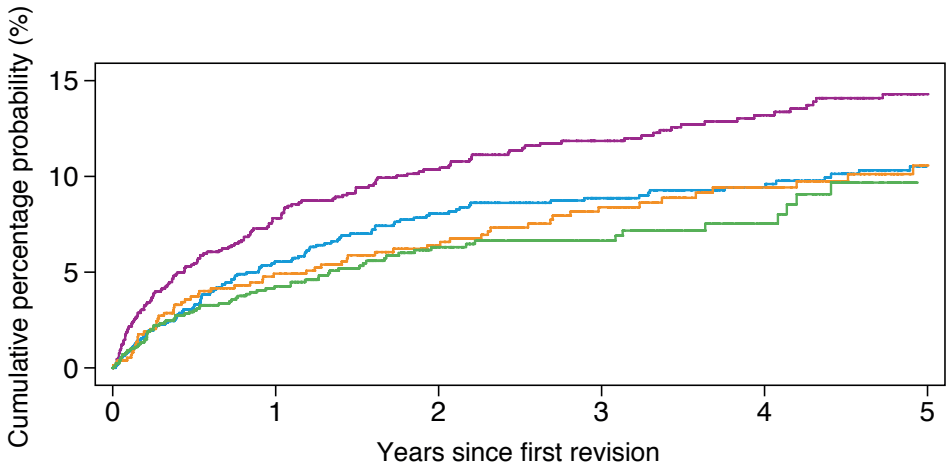
Numbers at risk

Primary not in the NJR	57,204	49,325	42,742	36,281
First rev. <1y	5,924	4,779	3,918	3,245
First rev. 1–3y	4,990	4,204	3,625	3,062
First rev. 3–5y	3,997	3,452	2,965	2,312
First rev. 5+y	6,015	4,378	2,943	1,739

Figure 3.15 (a)

Kaplan-Meier estimates of the cumulative probability of a hip re-revision up to five years from the first revision, shown separately for type of fixation used in the primary, with further sub-division by length of time from the primary to the first revision (<1, 1-3, 3-5 and >5).

(a) **Cemented**

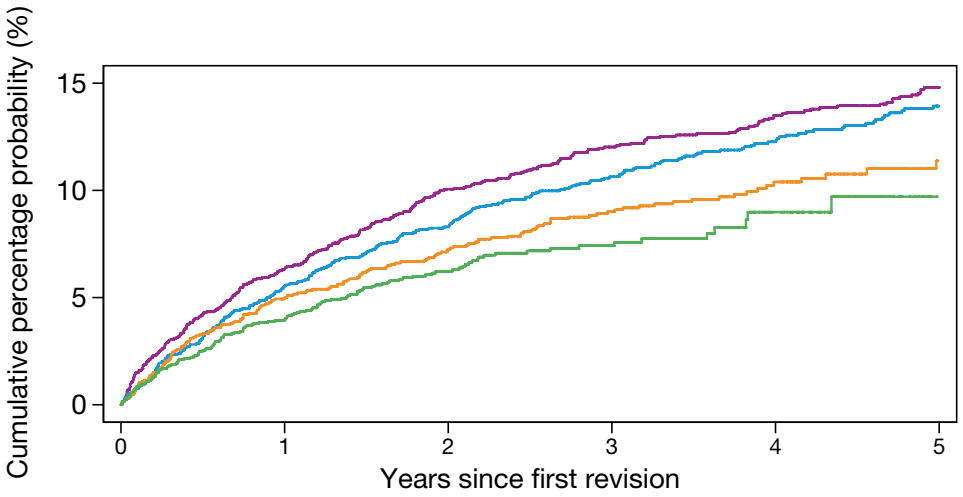


Numbers at risk

First rev. <1y	1,305	1,027	823	665	516	396
First rev. 1–3y	1,255	1,010	836	704	549	419
First rev. 3–5y	752	616	521	406	299	194
First rev. 5+y	1,302	903	596	380	199	88

Figure 3.15 (b)

(b) **Uncemented**

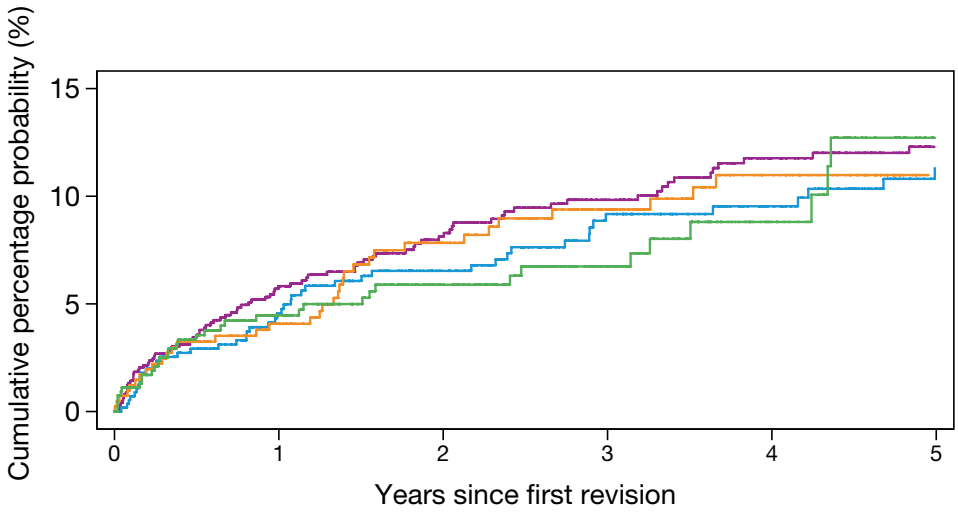


Numbers at risk

First rev. <1y	3,002	2,442	1,999	1,635	1,257	937
First rev. 1–3y	2,387	2,024	1,748	1,449	1,107	763
First rev. 3–5y	1,938	1,663	1,414	1,053	587	238
First rev. 5+y	2,631	1,855	1,179	618	208	58

Figure 3.15 (c)

(c) **Hybrid**

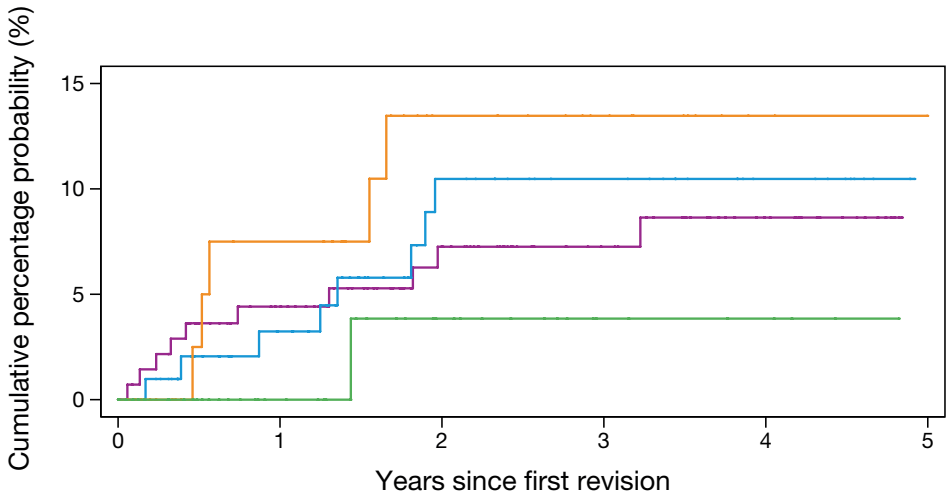


Numbers at risk

First rev. <1y	995	739	572	466	369	291
First rev. 1–3y	564	450	368	289	232	176
First rev. 3–5y	412	338	254	201	145	94
First rev. 5+y	541	373	260	169	79	41

Figure 3.15 (d)

(d) **Reverse hybrid**

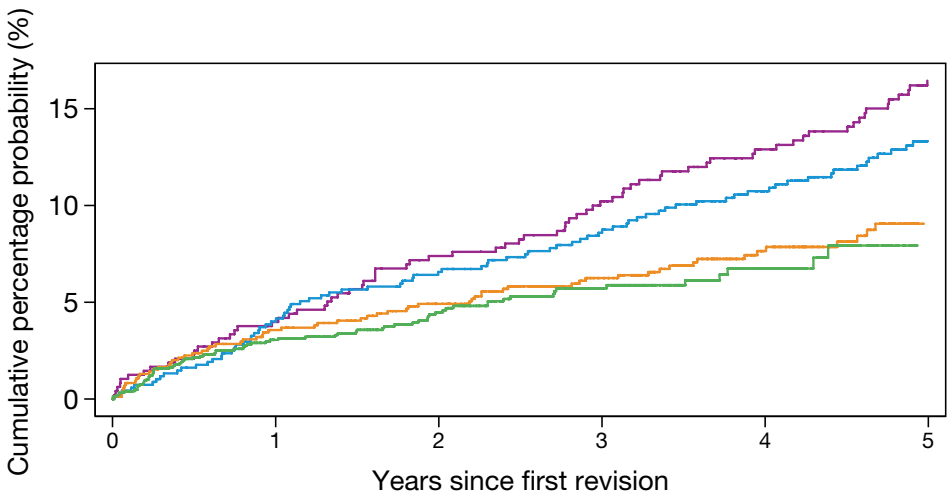


Numbers at risk

First rev. <1y	142	117	93	69	53	37
First rev. 1–3y	102	80	57	49	39	30
First rev. 3–5y	48	36	22	16	8	6
First rev. 5+y	48	31	19	10	8	4

Figure 3.15 (e)

(e) **Resurfacing**



Numbers at risk

First rev. <1y	480	454	431	410	378	343
First rev. 1–3y	682	640	616	571	503	376
First rev. 3–5y	847	799	754	636	437	236
First rev. 5+y	1,493	1,216	889	562	233	74

Table 3.17 (a) Kaplan-Meier estimates of cumulative percentage probability of a hip re-revision following the first revision.

Time point from which time was measured:	Sub-group	n	Cumulative re-revision rate (95% CI) at:				
			1 year	3 years	5 years	7 years	10 years
First revision	All	78,130	3.80 (3.67-3.94)	6.89 (6.70-7.08)	9.19 (8.95-9.43)	11.45 (11.16-11.76)	14.83 (14.38-15.31)
First revision	Primary not recorded in the NJR	57,204	3.36 (3.22-3.52)	6.08 (5.88-6.30)	8.22 (7.97-8.49)	10.29 (9.98-10.61)	13.54 (13.06-14.04)
First revision	Primary recorded in the NJR	20,926	5.02 (4.72-5.34)	9.23 (8.80-9.67)	12.20 (11.64-12.77)	15.71 (14.91-16.55)	20.56 (18.94-22.31)

Table 3.17 (b) Kaplan-Meier estimates of cumulative percentage probability of a hip re-revision following the first revision, sub-divided by time since primary.

	n	Cumulative re-revision rate (95% CI) at:	
		1 year	3 years
Primary not in the NJR	57,204	3.36 (3.22-3.52)	6.08 (5.88-6.30)
Primary in the NJR where the first revision took place:			
<1 year after primary	5,924	6.32 (5.72-7.00)	11.43 (10.57-12.35)
1-3 years from primary	4,990	5.18 (4.59-5.85)	9.76 (8.91-10.68)
3-5 years from primary	3,997	4.60 (3.98-5.31)	8.34 (7.47-9.31)
5+ years from primary*	6,015	3.82 (3.34-4.36)	6.72 (6.01-7.52)

*Note: maximum interval was 12.3 years.

Table 3.17 (c) Kaplan-Meier estimates of the cumulative percentage probability of a hip re-revision (95% CI) at 1, 3, and 5 years following the first revision in those with documented primaries in the NJR, by fixation and bearing surface (group size >1,000 in the case of bearing surfaces).

Fixation	Bearing surface	n	Cumulative percentage probability of re-revision (95% CI) following first revision at:		
			1 year	3 years	5 years
All types	All	20,926	5.02 (4.72-5.34)	9.23 (8.80-9.67)	12.20 (11.64-12.77)
Cemented	All	4,614	5.75 (5.09-6.49)	9.12 (8.24-10.09)	11.32 (10.24-12.51)
	MoP	4,004	5.71 (5.01-6.51)	8.88 (7.95-9.90)	10.90 (9.77-12.16)
Uncemented	All	9,958	5.29 (4.85-5.76)	10.06 (9.42-10.74)	12.96 (12.13-13.84)
	MoP	2,625	5.54 (4.70-6.53)	9.92 (8.71-11.29)	12.25 (10.76-13.93)
	MoM	3,849	5.02 (4.36-5.78)	9.91 (8.92-11.00)	13.80 (12.40-15.35)
	CoC	2,232	4.81 (3.97-5.82)	9.17 (7.92-10.60)	11.77 (10.16-13.61)
Hybrid	All	2,512	4.96 (4.15-5.93)	9.04 (7.84-10.42)	11.64 (10.13-13.37)
	MoP	1,558	5.35 (4.30-6.65)	8.98 (7.50-10.74)	11.38 (9.53-13.57)
Resurfacing	(MoM)	3,502	3.51 (2.94-4.19)	7.22 (6.35-8.19)	11.53 (10.27-12.93)

*Note: maximum interval was 11.3 years.

3.4.3 Reasons for the hip re-revision

Table 3.18 show breakdowns of the stated indications for the first revision and for any subsequent revision (note the indications are not mutually exclusive). Column (i) shows indications for the first revision in the NJR, (ii)/(iii) for the first revision but depending on whether or not the implants were subsequently re-revised, and (iv) for the re-revisions themselves.

Table 3.18 Reasons for the hip first revision and subsequent re-revision.

		Reasons for the first recorded revision for those who were:		
	(i) Reasons for first (recorded) revision	(ii) Not subsequently re-revised	(iii) Subsequently re-revised	(iv) Reasons for the re-revision
Number of cases	**78,130**	**71,497**	**6,633**	**6,633**
Number revised for:				
Aseptic loosening	38,310	35,268	3,042	2,144
Pain	16,875	15,500	1,375	1,091
Lysis	12,242	11,326	916	501
Implant wear	10,741	9,948	793	426
Dislocation/subluxation	10,168	9,234	934	1,576
Infection	7,133	6,290	843	1,350
Peri-prosthetic fracture	7,068	6,466	602	659
Malalignment	4,124	3,790	334	334
Implant fracture	2,597	2,377	220	232
Head-socket (size) mismatch	590	533	57	48
Adverse reaction to particulate debris	6,149 n=59,162	5,731 n=54,804	418 n= 4,358	405 n= 5,868
Other indication	6,015	5,468	547	457

Finally, Tables 3.19 (a) and 3.19 (b) provide additional evidence that the 57,204 revised joints with no associated primary in NJR tended to be later revisions than the 20,926 joints who did have an associated primary. The results also show that the numbers of revisions with an associated primary in the NJR increased with time.

3.4.4 90-day mortality after hip revision

The overall cumulative percentage mortality at 90 days after hip revision was lower in the cases with their primaries documented in the NJR compared with the remainder (Kaplan-Meier estimates 0.96 (95% CI 0.83-1.10) versus 1.61 (1.51-1.72)). This may reflect the fact that this patient group were younger at the time of their first revision, median age of 67 (IQR 59-75) years compared to the group without primaries documented in the NJR who had a median age of 73 (IQR 65-80) years. The percentage of males was similar in both groups (43.5% versus 42.0% respectively).

Table 3.19 Temporal changes in first hip revisions reported in the NJR and associated indications.

(a) Number of first hip revisions by year and proportions with an associated primary in the NJR.

Year of first revision in the NJR*	Number of (first) revisions*	Number (%) with the associated primary in the NJR
2003	1,400	43 (3.1%)
2004	2,616	141 (5.4%)
2005	3,695	300 (8.1%)
2006	4,414	448 (10.1%)
2007	5,829	800 (13.7%)
2008	6,315	1,125 (17.8%)
2009	6,587	1,483 (22.5%)
2010	7,149	1,923 (26.9%)
2011	7,998	2,613 (32.7%)
2012	9,060	3,300 (36.4%)
2013	8,227	2,980 (36.2%)
2014	7,883	2,939 (37.3%)
2015	6,957	2,831 (40.7%)
Total	78,130	20,926 (26.8%)

*First documented revision in the NJR.

(b) Numbers of first recorded hip revisions by stage and whether or not primary was 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	1,357	43	0	0
2004	2,266	120	209	21
2005	3,063	243	332	57
2006	3,589	361	377	87
2007	4,577	666	452	134
2008	4,707	923	483	202
2009	4,616	1,218	488	265
2010	4,808	1,693	418	230
2011	4,991	2,343	394	270
2012	5,375	2,968	385	332
2013	4,930	2,677	317	303
2014	4,605	2,654	339	285
2015	3,840	2,534	286	297
All years	52,724	18,443	4,480	2,483

*First documented revision in the NJR.

Part 3

3.5 Outcomes after primary knee replacement

This section reviews the outcomes of primary knee replacement surgery in terms of two key events that could happen post-operatively to a patient who has undergone a knee replacement or to the knee joint; the first revision of a knee implant and/or patient death or mortality.

Core to the analysis approach for both outcomes is modelling the time until the event is observed to happen and giving due consideration to the time the patient or joint is at risk of the event happening. Further details of the statistical methods are given in statistical methodology notes I to III.

The outcomes of total and partial knee replacement procedures are discussed throughout this section, hereon referred to as total (TKR) and unicompartmental (UKR) replacement. Brief details of the type of orthopaedic surgery involved for each form of replacement can be found in the terminology note. Of special note here is that the NJR data collection process now collects separate information on medial and lateral unicondylar replacements, although this was not the case in the past.

The patient cohort described in this section is any patient whose recorded primary knee replacement surgery date fell between 1 April 2003 and 31 December 2015 (inclusive). The maximum follow-up time a patient could have for either outcome is 12.75 years, corresponding to a patient operated on at the start of the registry.

Tables 3.1 and 3.2 in Section 3.2 provide an overview of the primary knee replacement patient cohort. Over the period of 2003 to 2015, a total of 871,472 knee joints were replaced for the first time (primary joint replacement). There were a total of 719,985 patients with a NJR record of primary knee replacement on one or both sides. Four fifths of the patient cohort had just one record of a primary knee joint replacement since the establishment of the NJR. The remaining fifth of patients were those who had records of both left and right knees being replaced for the first time. The majority of this patient sub-group had primary knee surgery at different times for each side (141,697 patients), but 9,790 patients had surgery for both knees on the same date (1.4% of all patients in the cohort).

The predominant clinical reason recorded for primary surgery was osteoarthritis (OA); it was the sole stated reason in 837,843 (96%) of primary knee surgeries and one of the reasons recorded in a further 1.1% of primaries performed when multiple clinical reasons for surgery were given on the data collection form.

Terminology note:

The knee is made up of three compartments: medial, lateral and patellofemoral compartments. When a total knee replacement (TKR) is implanted, two out of the three compartments are always replaced (medial and lateral) and the patella is resurfaced if the surgeon considers this to be of benefit to the patient. If a single compartment is replaced then the term unicompartmental is applied to the implant (UKR). The medial, lateral or patellofemoral compartments can all be replaced independently, if clinically appropriate.

There is variation in the constraint of the tibial insert 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. The tibial element may be modular with a metallic tibial tray and a polyethylene insert or non-modular consisting of an all-polyethylene tibial component (monobloc polyethylene tibia). In recent years monobloc all-polyethylene tibial components have increased in popularity.

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 either CR or PS constraint.

The NJR now distinguishes between medial and lateral unicondylar knee replacements during the data collection process, however, this was not the case in earlier versions of the dataset form. In addition, there are other possible knee designs, such as combinations of unicondylar and patellofemoral replacement, but these are not reported on here, as the numbers are too small.

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

Methodological note I: Survival analysis, time at risk and censoring

Survival analyses have been employed to provide estimates of the two main outcomes of interest after primary knee replacement surgery; namely the cumulative probability that an implant is revised for the first time at different times after primary operation (revision outcome) and the cumulative probability that a patient dies at different lengths of time after primary knee surgery (mortality outcome).

Key to these methods is correctly specifying the period of time after primary surgery each replaced joint is at risk of the event of being revised or the patient is at risk of dying. In addition, not all replaced joints will be revised (or all patients will die) over the observation period, i.e. the event of interest will not happen to all joints/patients. When this is the case, the time observations are censored. Censored observations occur for a number of reasons; they can be those cases which have not experienced the outcome of interest by the end of the observation period or those which are no longer available to be observed until the end date of the observation period, which are classified as observations lost to follow up. As a consequence of censoring, the total number of patients at risk of the event at different points in time will vary over the whole observation period.

For mortality, the period of time at risk contributed by a patient in the cohort is the length of time until they died post primary surgery or, if they do not die, the time from primary surgery until the last day in December 2015 (the last date of the period of observation for this report).

Turning to the revision outcome, the time a joint is at risk of being revised for the first time is either the time until the joint is revised post-primary surgery (and before the end of 2015), the time until they die after surgery without being revised (and before the end of 2015) or the period of time they are not revised after primary surgery up until the last date of observation in 2015.

Methodological note II: Use of Kaplan-Meier estimation for describing mortality and revision

The main tables and figures shown in the text are based on Kaplan-Meier estimates of the cumulative probability of the joint being revised or the patient dying at different times after the primary surgery. The calculated probabilities have been multiplied by 100 in all results presented here and so represent the cumulative percentage probability of having a first revision or of dying at different times after surgery.

This is a change to previous NJR annual reports (prior to 2014) where a mixture of Kaplan-Meier estimation of the cumulative probability of having a first revision (or of dying) and Nelson-Aalen estimation of cumulative hazard (the expected total number of revisions or deaths up to a point in time) were reported. Clearly, the two methods find different quantities – one is a probability and the other is not – but, under certain conditions, both methods provided similar estimates in terms of actual numerical values (see the glossary for further technical details). This is no longer the case and we now solely use Kaplan-Meier estimation throughout Part Three.

The Confidence Intervals (CI) found for the cumulative percentage probability estimates of revision or death, based on the Kaplan-Meier method, become less reliable when the number at risk of revision or death falls below 250. Several methods have been proposed to calculate Confidence Intervals. These proposed methods produce confidence intervals which are all in agreement with one another when there are high numbers at risk. However, they begin to give very different upper and lower limits once the numbers at risk falls below 250. To date, there has been no clear consensus on which method is to be preferred when numbers at risk are small. For this reason, we highlight the point estimate of the cumulative chance of revision/death and the confidence interval throughout in *blue italics* once the number at risk drops below 250 cases.

Methodological note III: Competing risks considerations

One assumption which underpins the use of the Kaplan-Meier method to estimate the cumulative chance of death or first revision is that the patients/joints whose times are censored have the same chance of having the event of interest happen to them after censoring as those cases still at risk in the study.

This assumption could be compromised if the reason they are censored is as a result of other events happening to the patient or joint after primary knee surgery, but not the main one of interest, which potentially change the likelihood of the main outcome (first revision or death) occurring afterwards. An event like this is known as a competing risk.

For example, if a patient dies before having a first revision, their observation will be treated as censored but the chance of the outcome revision happening after death is impossible. Death, here, is the competing risk. The true effect of the event death on the Kaplan-Meier estimates for revision as the main outcome can only be assessed if it is accounted for in the modelling process. One commonly proposed method is the use of the Cumulative Incidence Function (CIF) adjusting for the competing risk of death (see section 3.3.2.6 of the NJR Annual Report 2014 where the impact of CIF on the probability estimates obtained was considered).

In the main analyses presented here, we have not made adjustments for competing risks in the modelling of first revision and death as outcomes.

So, in the case of the revision outcome, no adjustment for the competing risk of death has been made in the main survival table and figure presentations. However, a simple assessment of the impact of the competing risk of death on the revision outcome estimates using the cumulative incidence function is presented in the text.

For mortality, we have not accounted for the impact that having a first or further revision after primary surgery may have on the likelihood of a patient dying subsequently, compared to the likelihood of death for those who have not had a first or further revision surgery.

3.5.1 Overview of primary knee surgery

3.5.1.1 Main types of primary knee surgery and changes in type of operation over time

Table 3.20 shows the proportion of all main kinds of primary knee operations carried out between 2003 and 2015, broken down by the method of fixation, constraint and bearing used for the implant in surgery. A breakdown within each method of fixation of the percentage of constraint and bearing types used in surgery is shown in a separate column. The vast majority of replacements performed were total knee replacements (TKRs) with an all cemented implant being the most common technique of fixation used (84.7% of all primary knee operations). A further 5.4% were either all uncemented or hybrid total knee replacements (where at least one component utilises cemented fixation and at least one component utilises uncemented fixation). Most partial knee replacements (UKRs) were unicondylar (8.7% of the total) with the remainder being patellofemoral unicompartmental knee replacements (1.3%).

More than half of all operations (55.9%) were total knee replacements which were all cemented, unconstrained and fixed, followed by 20.8% which were all cemented, posterior stabilised and fixed. Within each method of fixation, it can be seen that uncemented/hybrid prostheses are mostly unconstrained (cruciate retaining) but almost equally likely to have a mobile or fixed bearing. About two-thirds of cemented implants are unconstrained (cruciate retaining) and have a fixed bearing. Unicondylar knee surgery typically involves the use of a mobile type of bearing/constraint. A number of primary knee joint operations could not be classified according to their bearing/constraint (approximately 1.2% of the total cohort).

Table 3.21 shows the annual change in the usage of primary knee replacements. Overall, more than 80% of all primaries utilised an all cemented fixation method and since 2003, the share of all implant replacements of this type has increased by almost 6%. The main decline in the type of primary knee surgery carried out has been in the use of all uncemented and hybrid total knee replacements over time (now 2.7% of all knee replacements). Each implant of this type now used has decreased proportionally to less than a third of those figures reported for 2003 (when they were 9.5% of all knee replacements).

Table 3.20 Numbers and percentages of primary knee replacements by fixation method, constraint and bearing type.

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			
Total knee replacement				
All cemented		**737,759**		**84.7**
Cemented and				
	unconstrained, fixed	487,448	66.1	55.9
	unconstrained, mobile	32,490	4.4	3.7
	posterior-stabilised, fixed	181,648	24.6	20.8
	posterior-stabilised, mobile	10,991	1.5	1.3
	constrained condylar	5,063	0.7	0.6
	monobloc polyethylene tibia	11,231	1.5	1.3
	bearing type unknown	8,888	1.2	1.0
All uncemented		**38,428**		**4.4**
All hybrid		**8,453**		**1.0**
Uncemented/hybrid and				
	unconstrained, fixed	20,715	44.2	2.4
	unconstrained, mobile	21,843	46.6	2.5
	posterior-stabilised, fixed	3,178	6.8	0.4
	other constraint	576	1.2	0.1
	bearing type unknown	569	1.2	0.1
Unicompartmental knee replacement				
All unicondylar		**75,719**		**8.7**
Unicondylar and				
	fixed	23,721	31.3	2.7
	mobile	51,140	67.5	5.9
	bearing type unknown	858	1.1	0.1
All patellofemoral		**11,068**	**n/a**	**1.3**
Fixation unknown	**Bearing type unknown**	**45**	**n/a**	**0.01**
All types		**871,472**	**n/a**	**100.0**

Table 3.21 Percentage of all primary knee replacements performed in each year by total and partial knee replacement types and, within total replacements, by fixation method[1]. Further percentage breakdowns are by constraint/bearing type for UKR and within each fixation method for TKR[2].

	Percentage of primary knee replacements performed in each year												
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total knee replacement													
All cemented	**81.5**	**80.8**	**81.7**	**81.4**	**81.9**	**81.8**	**82.6**	**84.0**	**85.4**	**86.7**	**87.8**	**87.4**	**87.4**
Cemented and													
unconstrained fixed	65.3	65.4	64.9	62.0	61.4	62.5	63.9	64.5	65.9	68.1	68.1	69.4	70.5
unconstrained mobile	4.9	5.2	6.4	7.9	7.8	7.0	5.8	4.8	3.5	2.8	2.5	2.3	2.0
posterior-stabilised fixed	25.4	25.5	24.1	24.6	24.9	25.6	25.9	25.9	25.3	24.2	24.0	23.4	23.1
posterior-stabilised mobile	1.1	1.3	2.0	2.3	2.0	1.7	1.7	1.7	1.4	1.2	1.4	1.1	0.9
constrained condylar	0.5	0.6	0.4	0.4	0.4	0.3	0.3	0.4	0.5	0.7	0.9	1.2	1.4
monobloc polyethlene tibia	0.4	0.3	0.4	0.7	1.1	1.0	0.9	1.2	1.9	2.3	2.4	2.2	1.7
bearing/ constraint unknown	2.3	1.7	1.8	2.0	2.4	1.8	1.4	1.4	1.5	0.7	0.6	0.4	0.3
All uncemented	**6.7**	**6.6**	**6.2**	**6.5**	**6.5**	**6.2**	**5.7**	**4.7**	**4.1**	**3.3**	**2.5**	**2.5**	**2.3**
Uncemented and													
unconstrained fixed	38.5	36.1	38.4	41.7	46.7	45.4	45.6	38.6	34.6	31.0	29.0	24.6	28.9
unconstrained mobile	47.5	50.8	51.4	47.7	46.1	47.4	46.2	54.9	59.4	62.0	61.8	64.0	61.1
posterior-stabilised fixed	11.0	8.6	7.6	8.4	6.2	6.0	6.2	5.0	4.0	5.8	8.4	9.9	8.6
other constraint	0.2	0.1	0.1	0.3	0.1	0.2	0.9	1.0	1.1	1.0	0.6	1.1	0.6
constraint unknown	2.9	4.4	2.6	2.0	0.9	0.9	1.1	0.5	0.8	0.1	0.3	0.4	0.8
All hybrid	**2.8**	**2.8**	**2.4**	**1.7**	**1.4**	**1.4**	**1.2**	**0.9**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**
Hybrid and													
unconstrained fixed	82.5	83.1	80.3	72.0	75.3	79.9	81.4	79.3	59.4	50.8	43.4	29.8	22.1
unconstrained mobile	10.1	11.0	6.5	8.2	10.0	11.0	10.8	11.4	26.3	33.3	44.7	49.4	67.4
posterior-stabilised fixed	4.5	4.4	4.9	7.0	8.6	4.9	5.5	7.4	9.9	6.8	6.3	13.8	2.9
other constraint		1.0	6.9	10.8	5.4	2.1	1.0	0.3	2.2	8.5	5.0	5.0	6.4
constraint unknown	2.9	0.5	1.4	2.0	0.6	2.2	1.4	1.6	2.2	0.6	0.5	2.0	1.2

Note: 1 Percentage of all primary operations in a particular year which used one of the five fixation methods: cemented, uncemented, hybrid, patellofemoral or unicondylar. 2 Percentage breakdown of constraint/bearing types used within each type of method of fixation for total replacements or within unicondylar partial replacements.

Continued >

Table 3.21 (continued)

	Percentage of primary knee replacements performed in each year												
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Unicompartmental knee replacement													
All unicondylar	**8.0**	**8.7**	**8.6**	**9.3**	**8.9**	**9.1**	**9.0**	**9.0**	**8.5**	**8.2**	**8.1**	**8.5**	**8.9**
Unicondylar and													
fixed	17.0	20.6	23.8	24.8	22.6	23.0	25.0	29.5	31.0	36.1	40.5	41.2	41.9
mobile	80.9	77.7	74.7	73.5	75.8	75.0	73.2	69.4	67.6	63.3	58.7	58.5	57.9
constraint unknown	2.1	1.7	1.5	1.7	1.6	2.0	1.8	1.2	1.4	0.5	0.8	0.2	0.2
All patellofemoral	**1.0**	**1.0**	**1.0**	**1.1**	**1.4**	**1.5**	**1.5**	**1.4**	**1.5**	**1.4**	**1.2**	**1.1**	**1.1**
Knee type unknown		**0.2**	**0.01**										
All types	**13,529**	**27,737**	**41,923**	**49,544**	**66,713**	**74,115**	**76,062**	**78,752**	**82,349**	**86,158**	**85,753**	**94,814**	**94,023**

Note: 1 Percentage of all primary operations in a particular year which used one of the five fixation methods: cemented, uncemented, hybrid, patellofemoral or unicondylar. 2 Percentage breakdown of constraint/bearing types used within each type of method of fixation for total replacements or within unicondylar partial replacements.

3.5.1.2 Reasons for primary knee replacement surgery

The diagnostic reason(s) for a patient being recommended for primary knee replacement surgery form part of the clinical pre-assessment process and are recorded by the clinician on the MDS data collection form. Of all reasons for primary knee surgery, the dominant diagnosis recorded in the registry is osteoarthritis; the number of joints with a sole diagnosis of knee osteoarthritis as the indication for knee replacement is 837,843 (96%) of all 871,328 knee replacements with a reason for primary surgery recorded in the NJR. Other possible diagnoses include avascular necrosis, trauma and infection (see Table 3.22 footnotes for primary diagnoses details).

Table 3.22 shows the main reasons cited by clinicians for primary surgery, as selected from the listed diagnoses available on the particular version of the data collection form filled out by the clinician. The total number of indications, the percentage this forms of the total number of knee operations and a breakdown of these by gender are shown separately for each reason. Reasons shown are all indications given for a primary surgery and in some cases multiple reasons have been given for a primary operation. Therefore, reasons are not mutually exclusive of each other. In addition, 144 knee procedures had no recorded reason for undergoing primary surgery.

After osteoarthritis, the most frequently given indication for surgery was inflammatory arthritis (forming about 2% of reasons). There is some indication of gender differences in the primary reason given for carrying out knee replacement, although for some diagnoses, the numbers of cases are small.

Table 3.22 Reasons for primary knee replacement surgery; number and percentage of all NJR recorded primary knee replacement surgeries carried out for each clinical reason broken down by gender.

Reason for Knee Primary	Number (%) of knee joints with specified primary diagnosis[1] (n=871,328)		All joints with this reason[1] (% of all joints)
	Male	Female	
Osteoarthritis	368,662 (96.9)	478,818 (95.5)	847,480 (96.1)
Avascular necrosis	1,218 (0.3)	1,940 (0.4)	3,158 (0.4)
Previous infection	367 (0.1)	235 (0.0)	602 (0.1)
Previous trauma	2,711 (0.7)	2,156 (0.4)	4,867 (0.6)
Inflammatory arthritis[2]	4,724 (1.2)	14,200 (2.8)	18,924 (2.1)
Trauma	16 (0.004)	24 (0.005)	40 (0.005)
Other indication[3]	2,841 (0.7)	3,768 (0.8)	6,609 (0.7)

Note: 1 Note that more than one diagnosis could be indicated by the clinician and results represent all reasons given by the surgeon. 2 Inflammatory Arthritis for knees combines diagnoses of Rheumatoid Arthritis, Seronegative and Seropositive Rheumatoid Arthritis and Other Inflammatory Arthropathy. 3 Other indication includes failed internal fixation, previous arthrodesis, and Other indicated reasons for primary knee replacement.

3.5.1.3 Summary of the types of primary knee surgery performed by consultant surgeons and units

Between 2003 and 2015, the 871,472 primary knee joint replacement procedures contributing to our analyses were carried out by a total of 3,021 consultant surgeons working across 456 units. Over the last three years (1 January 2013 to 31 December 2015), 274,590 primary knee procedures were performed by 1,999 consultant surgeons working across 395 units. Looking at caseload over this three-year period, the median number of primary procedures per consultant surgeon was 99 (IQR 23-203) and the median number of procedures per unit was 608 (IQR 313-945). Over this three-year period, there have been 248,182 primary total knee replacements performed by 1,991 surgeons (median=92; IQR 23-187) in 395 separate units (median=556 cases per unit; IQR 273-879). In the same time period, there have been 23,320 primary unicondylar knee procedures performed by 830 consultant surgeons (median=11; IQR 3-31) in 365 units (median=37 cases per unit; IQR 13-75). The number of procedures per consultant over this period may be lower for newly qualified consultants and those who may have retired during this period.

3.5.1.4 Age and gender characterisation of the primary knee patient cohort

Table 3.23 shows the age and gender distribution of patients undergoing a first replacement of their knee joint. The median age of a person receiving a cemented total knee replacement was 70 years (IQR 64-76 years). However, for unicompartmental primary knee surgery, patients were typically six (unicondylar; median age 64 years; IQR 57-70) and eleven years younger (patellofemoral; median age 59 years; IQR 51-67). The 99th percentile of patient age for all types of surgery ranged between 85 and 91 years, indicating that surgery was rarely undertaken in a person aged 90 years or older, although the maximum age of a patient who underwent primary surgery over the twelve year record was aged 102 years.

Over all operation types, a higher percentage of females (57%) than males have had a knee joint replaced. Women are also more likely to have a primary total knee replacement; 58%, 52% and 55% of cemented, uncemented and hybrid type procedures respectively are carried out on female patients. Conversely, unicondylar surgery is performed on a higher proportion of males (53%). Patellofemoral surgery is predominantly carried out on females (78% of patients) who are typically younger than a TKR or unicondylar patient with a median age at operation of 59.

Table 3.23 Age (in years) and percentage male at primary operation[1,2] for different types of knee replacement and by fixation, constraint and bearing type.

Fixation method	Constraint and bearing type	Percentage male[1]	Age of patient (years)[2]		
			Median (IQR)[3]	Minimum age	Maximum age
Total knee replacement					
All cemented		**42**	**70 (64-76)**	**7**	**102**
Cemented and					
	unconstrained, fixed	43	70 (64-76)	13	101
	unconstrained, mobile	43	69 (62-75)	23	98
	posterior-stabilised, fixed	41	70 (64-77)	15	102
	posterior-stabilised, mobile	45	66 (59-73)	22	95
	constrained, condylar	37	71 (63-78)	18	97
	bearing type unknown	42	70 (63-77)	7	99
	monobloc polyethylene tibia	41	74 (69-79)	25	96
All uncemented		**48**	**69 (62-75)**	**20**	**101**
All hybrid		**45**	**69 (62-76)**	**23**	**96**
Uncemented/hybrid and					
	unconstrained, fixed	48	69 (62-76)	24	99
	unconstrained mobile	46	69 (62-75)	25	101
	posterior-stabilised, fixed	51	66 (59-74)	20	93
	other type	64	66 (59-74)	33	93
	bearing type unknown	49	69 (61-76)	23	91
Unicompartmental knee replacement					
All unicondylar		**53**	**64 (57-70)**	**18**	**97**
Unicondylar and					
	fixed	54	63 (56-70)	18	97
	mobile	53	64 (57-71)	23	95
	bearing type unknown	51	63 (56-70)	31	91
All patellofemoral		**22**	**59 (51-67)**	**21**	**93**
Fixation unknown	**Bearing type unknown**	**47**	**69 (59-77)**	**43**	**85**
All types		**43**	**69 (63-76)**	**7**	**102**

Note: 1 The percentage male figures are based on a total number of 871,467 primary knee replacements after omitting five cases where gender was not specified. 2 Age distributions based on age at primary operation excluding 207 with age registered as less than or equal to zero or unverifiable age or gender. Figures are thus based on a total of 871,265 replaced primary knee joints. 3 The inter-quartile range (IQR) shows the age range of the middle 50% of patients arranged in order of their age at time of primary knee operation.

3.5.2 First revision after primary knee surgery

A total of 20,863 first revisions of a knee prosthesis have been linked to NJR primary knee replacement surgery records of operations undertaken between 2003 and 2015.

This section explores how different surgical, clinical and patient factors affect the estimated cumulative probability of a knee prosthesis being revised for the first time at increasing time points after the primary surgery.

In brief, the main factors we consider, with references to the main results associated with these, are:

- **Year of primary operation (section 3.5.2.1)**: Formal submission of records of publicly funded joint replacement surgery taking place in England and Wales to a national database was not a mandatory requirement in the initial years of the NJR. Figures 3.16 (a) and (b) review the chance of knee implant first revision by year of operation given the shift from optional to mandatory record keeping
- **Age and gender (section 3.5.2.2):** Figures 3.17 (a) and (b) show age and age-gender stratified Kaplan-Meier estimates of the cumulative percentage chance of revision after primary surgery
- **Fixation method and constraint (section 3.5.2.3):** Implant survivorship data up to twelve years after the primary operation date are presented in Tables 3.24 (a) and 3.24 (b) broken down by fixation method and then by constraint and bearing within fixation method. The latter table also gives age group and gender sub-divisions of survivorship, when numbers are sufficient for these sub-groups. Figures 3.18 (a), (b) and (c) compare the implant survivorship of different bearing/constraints when the method of fixation used for the knee joint was each of cemented, uncemented/hybrid or a unicompartmental replacement, respectively
- **Clinical reasons for revision (section 3.5.2.4):** Revision rates for different reasons, broken down by fixation method and by fixation/constraint and bearing, are shown in Tables 3.25 and 3.26. Table 3.27 considers whether revision rates for different reasons change over various periods of time after the date of primary surgery
- **Type of brand (section 3.5.2.5):** The cumulative percentage chance of revision for different implant brands at different points in time after primary surgery is looked at in Tables 3.28 to 3.30. These tables have additional columns detailing brand specific summaries of patient age at primary operation (median and IQR) and the proportion of males receiving the particular implant brand at primary surgery

3.5.2.1 Temporal trends in the cumulative probability of a first revision by year of primary knee replacement

Figures 3.16 (a) and (b) illustrate temporal changes in the overall revision rates using Kaplan-Meier; procedures have been grouped by the year of the primary operation. Figures 3.16 (a) plots each Kaplan-Meier survival curve with a common origin, i.e. time zero is equal to the year of operation. Figure 3.16 (b) shows the same curves plotted against calendar time, where the origin of each curve is the year of operation. Figure 3.16 (b) separates each year which allows changes in failure rates to be clearly identified. In addition, the revision rate at one, three and five years has been highlighted. If revision rates and timing of revision rates were static across time we would expect all failure curves to be the same shape and equally spaced, a departure from this would indicate a change in the number, and timing of revision procedures.

The cumulative probability of a joint being revised at three and five years increased for each operative year group between 2003 and 2008, with indication that the probability of being revised at three and five years reducing for operations performed between 2009 and 2015. From the peak in 2008, the yearly survivorship curves are less divergent, i.e. a slowing in the increasing trend.

Possible reasons for a peak in the probability of revision in the 2008 cohort is: i) the registry was not capturing the full range and number of operations taking place in units in England and Wales until 2008, and ii) there could be bias in terms of the general overall health, risk of revision and other key characteristics of the patients on record in the NJR in the early years.

Figure 3.16 (a)

Changes in cumulative percentage chance of knee replacement failure by year of primary operation. Kaplan-Meier estimates of cumulative percentage probability of a first revision grouped by year in which primary surgery took place.

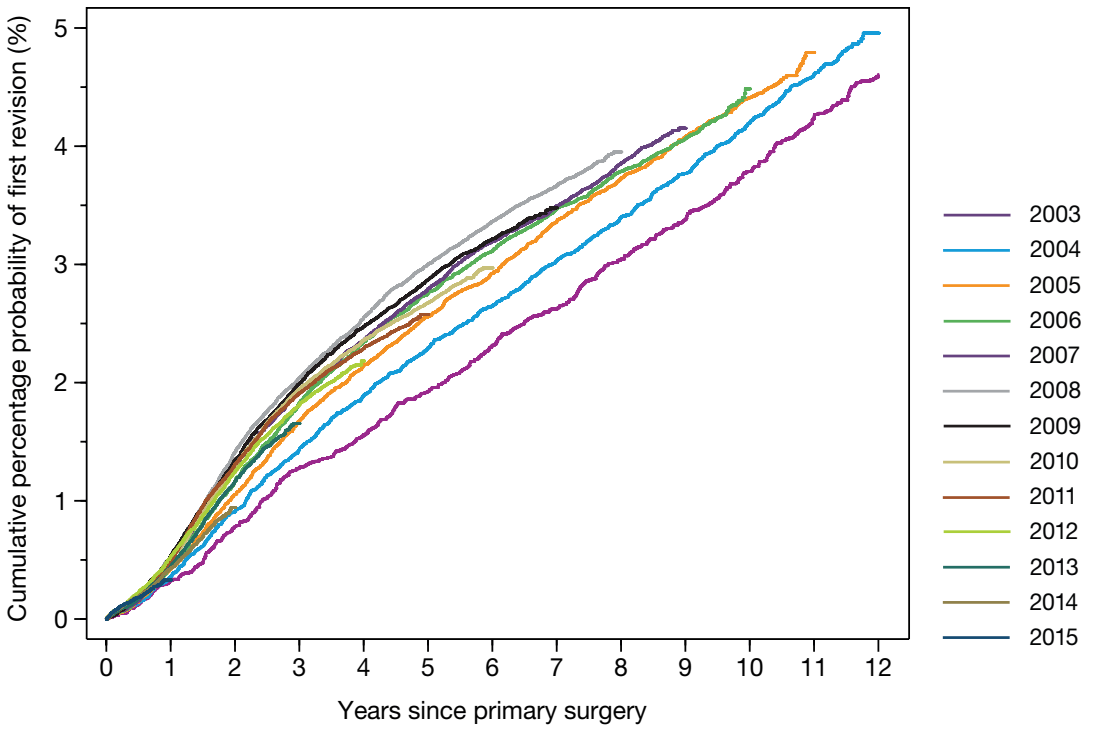
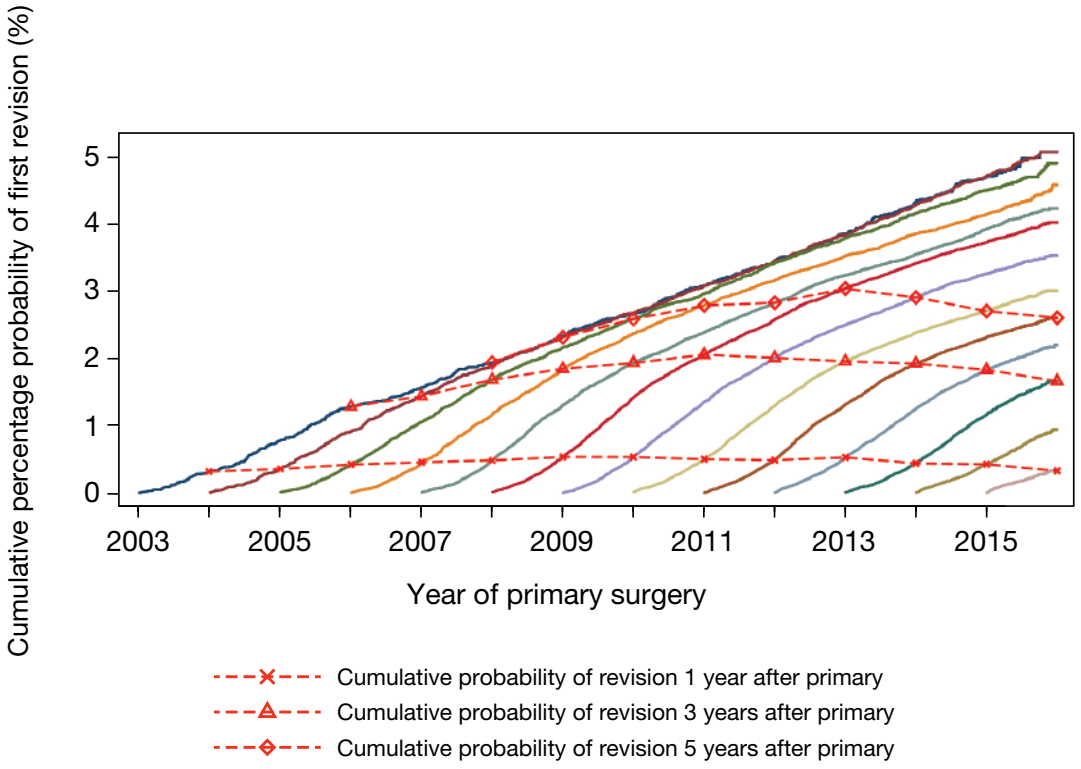


Figure 3.16 (b)

Temporal changes in revision rates after primary knee replacement: Kaplan-Meier estimates of cumulative percentage probability of revision for each year of primary operation with failure rates at 1, 3, and 5 years indicated.



3.5.2.2 Revisions after primary knee surgery by grouped age at primary and gender

Figure 3.17 (a) shows that the chance of revision after primary cemented total knee replacement 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 75 when they underwent primary surgery.

Figure 3.17 (a)

Kaplan-Meier estimates of the cumulative percentage probability of a first revision of primary **cemented** knee replacement broken down by age group (age at primary in years) at increasing years after the primary surgery.

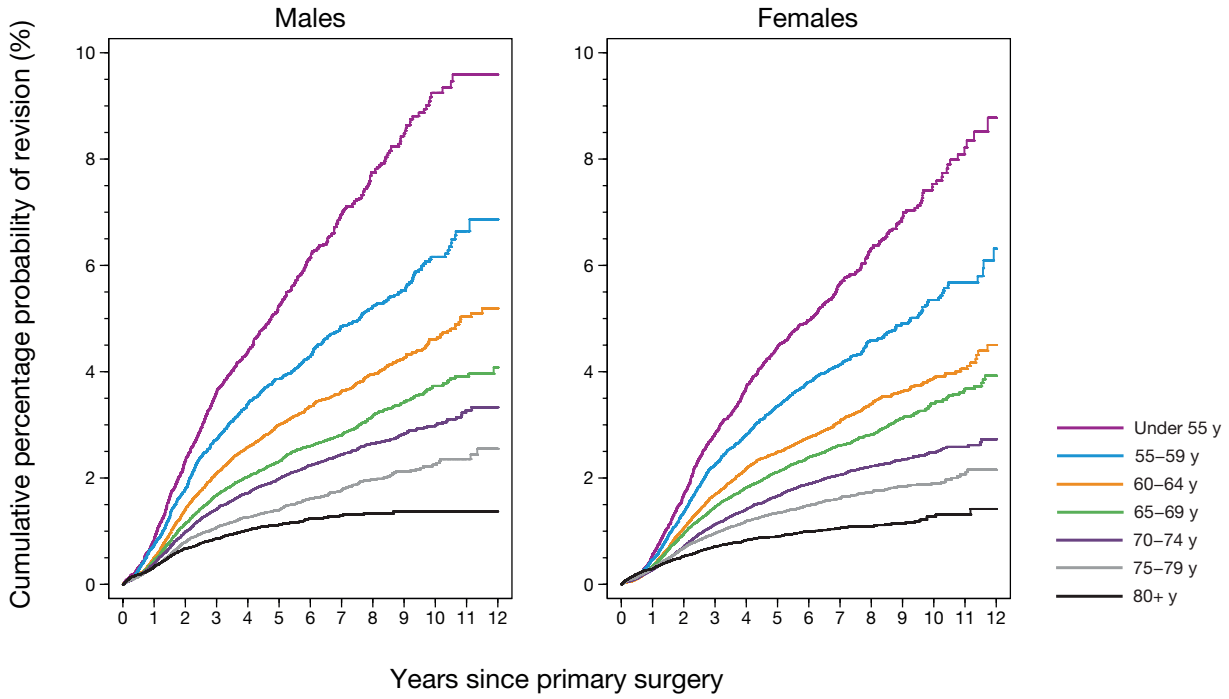
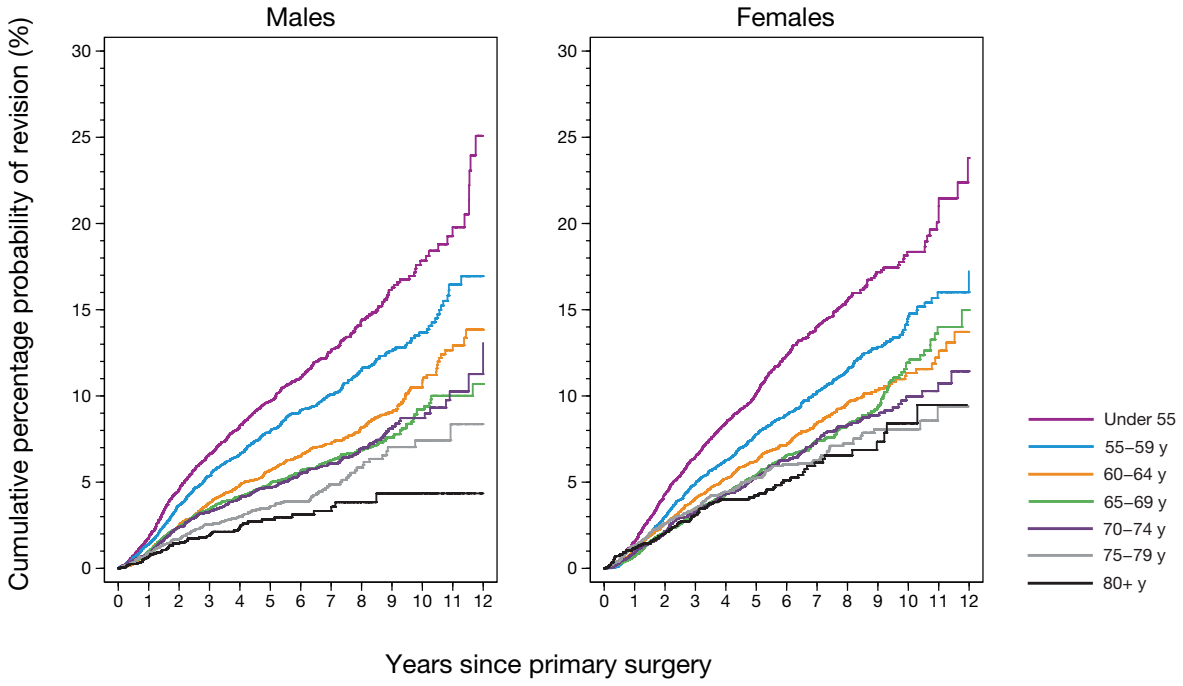


Figure 3.17 (b) shows that the risk of revision of primary unicondylar knee replacement is, again, substantially higher for younger patient cohorts but that there are less marked differences in younger patients in the risk of revision according to gender, the risk of revision appears to be higher in females over the age of 75 than in males.

Figure 3.17 (b)

Kaplan-Meier estimates of the cumulative percentage probability of a first revision of primary **unicondylar** knee replacement broken down by age group (age at primary in years) and gender at increasing years after the primary surgery.



3.5.2.3 Revisions after primary knee surgery by fixation method and constraint

Table 3.24 (a) 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 and sub-divided further within each fixation type by bearing/constraint type and for UKR, by bearing/constraint type. Estimates are shown, together with 95% Confidence Intervals (95% CI), at each year after primary surgery.

Table 3.24 (b) shows gender and age stratified Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any revision cause, firstly for all cases combined, then by knee fixation/ constraint sub-divisions. Estimates are shown, along with 95% CI, at 1, 3, 5, 7, 10 and 12 years after the primary operation.

Estimates in *blue italics* indicate that the cumulative percentage probability of a first revision of a knee joint replacement estimate is less reliable as these are based on fewer than 250 at risk at that point in time. When this is the case further revisions in this group are very unlikely and if any further revision does occur to those remaining at risk, the impact on the Kaplan-Meier estimate is disproportionate and so highly inaccurate. In addition, for a group at risk size of fewer than 250, the upper 95% CI limit tends to be underestimated by the estimation method used here. Other methods have been proposed which take into account the impact that censoring has on estimation of CIs when numbers at risk are small. However, the upper limit values found differ considerably and as yet there is no clear consensus as to which method provides the most accurate upper limit. Estimates (and CIs) are not given when the number at risk falls below ten.

Unicompartmental knee replacements seem to fare worse compared to total knee replacements with the chance of revision at each estimated time point being more than double that of a TKR. The revision rate for unicondylar (medial or lateral UKR) is 2.9 times higher than the observed rate for all types of knee replacement at twelve years and the revision rate for patellofemoral replacement is over four times higher at eleven and twelve years although less than 250 remain at risk at twelve years. First revision of an implant is slightly less likely in women than men overall for the most commonly used fixation method (cemented) but, broadly, a patient from younger age groups 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. Conversely, female patients are more likely to have a unicondylar implant revised compared to their male, age equivalent, counterpart. The reverse pattern is seen in patellofemoral implant survivorship. It is clear that partial knee replacement surgery is used generally in younger patients. Younger patients may also be more active which may put more strain on their implants and increase the risk of revision.

Figures 3.18 (a) and (b) explore the chance of knee joint revision for different bearings and constraints within a particular knee fixation type; that of cemented, uncemented/hybrid. Figure 3.18 (c) looks at the chance of revision for the most commonly used constraints in a unicondylar knee replacement and patellofemoral implants. It should be noted that unknown constraint/ fixation combinations are not shown.

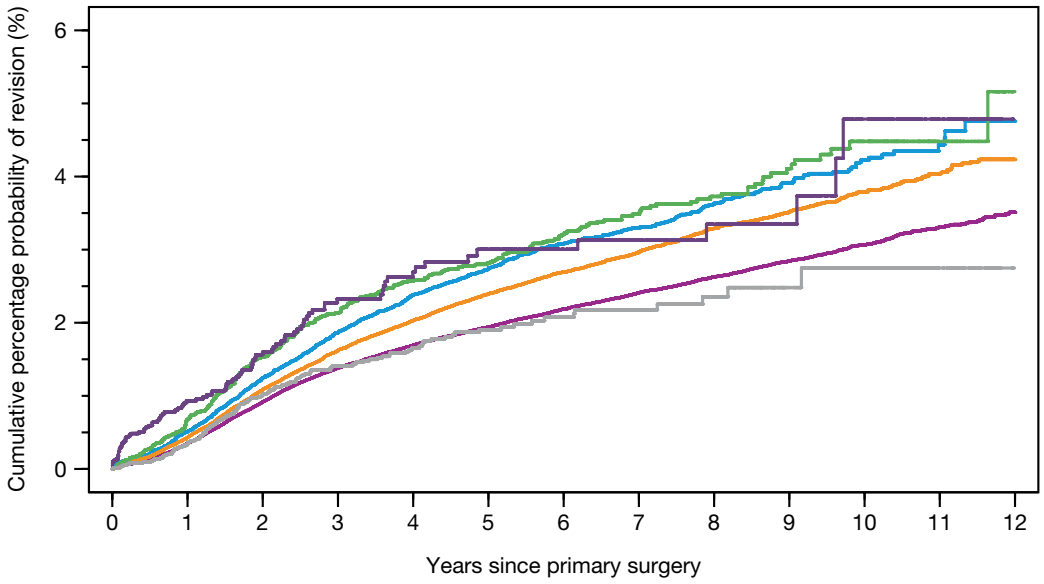
Overall, little difference is seen in implant survivorship by constraint within a fixation type apart from:

- Cemented unconstrained, fixed bearing total knee replacement results in lower chances of revision overall compared to other combinations of constraint and bearing used in a cemented fixation of the joint with modular tibial components (Figure 3.18 (a))
- Uncemented/hybrid total knee replacements (Figure 3.18(b)) with posterior stabilised constraint and fixed bearings fare worse than their unconstrained bearing equivalents
- Patellofemoral knee replacements are at higher risk of revision compared to unicondylar knee replacements combined with either mobile or fixed bearings (Figure 3.18(c))

Figure 3.18 (a)

Comparison of the Kaplan-Meier cumulative percentage probability estimates of a knee prosthesis first revision for different constraint and bearing types at increasing years after the primary surgery when the primary arthroplasty method of fixation is cemented only.

(a) **Cemented**



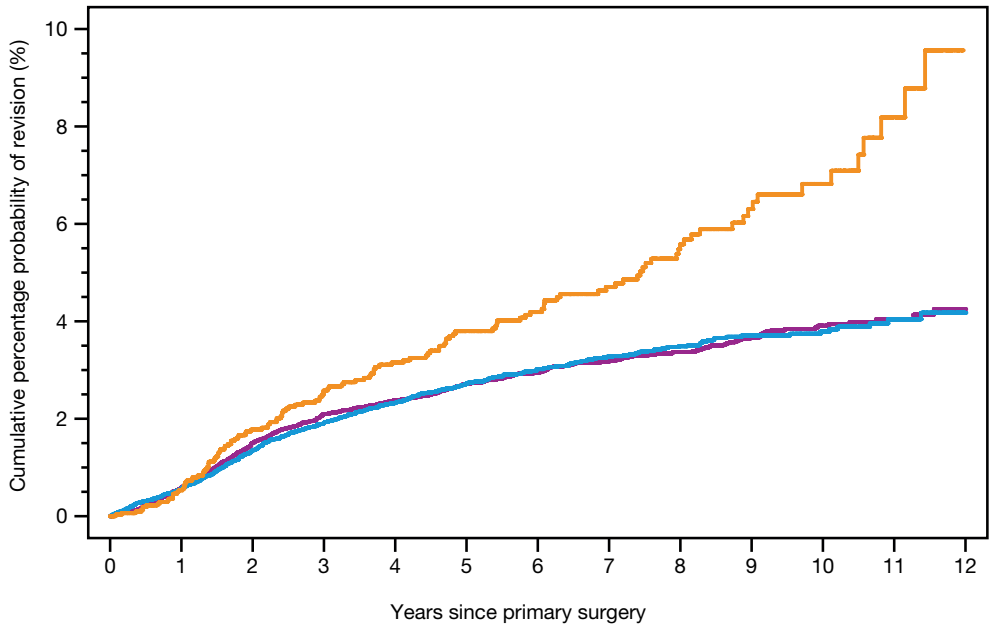
Numbers at risk

Unconstrained, fixed	487,448	423,349	359,208	302,276	247,335	198,351	154,463	115,104	79,925	50,839	30,476	14,124	4,273
Unconstrained, mobile	32,490	30,392	27,967	25,527	22,943	20,113	16,680	13,020	9,047	5,326	2,739	1,082	312
Posterior–stabilised, fixed	181,648	159,937	137,723	117,172	97,251	78,336	60,747	44,927	30,724	19,250	11,370	5,442	1,658
Posterior–stabilised, mobile	10,991	10,099	8,999	7,844	6,815	5,748	4,595	3,567	2,585	1,611	842	310	95
Constrained, condylar	5,063	3,803	2,734	1,949	1,421	1,082	795	597	422	259	158	75	20
Monobloc polyethylene tibia	11,231	9,644	7,692	5,760	4,038	2,719	1,954	1,410	870	414	189	77	30

Figure 3.18 (b)

Comparison of the Kaplan-Meier cumulative percentage probability estimates of a knee prosthesis first revision for different constraint and bearing types at increasing years after the primary surgery when the primary arthroplasty method of fixation is uncemented or hybrid.

(b) **Uncemented/hybrid**



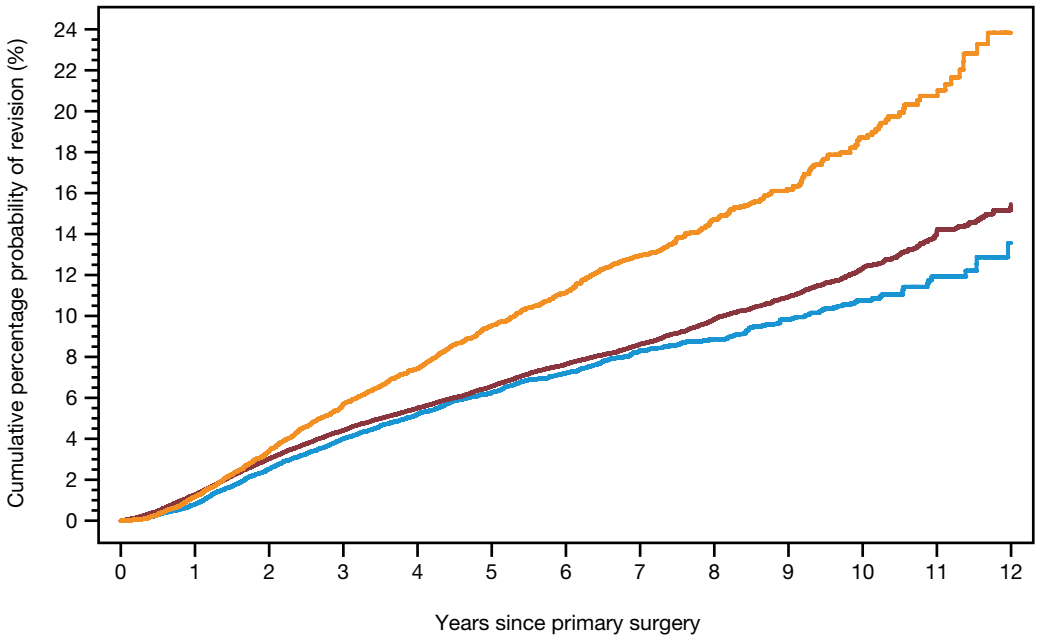
Numbers at risk

Unconstrained, fixed	20,715	19,651	18,557	17,370	15,978	14,274	12,096	9,413	6,759	4,386	2,738	1,325	395
Unconstrained, mobile	21,843	19,989	17,884	16,030	13,926	11,671	9,451	7,374	5,244	3,412	2,084	1,019	311
Posterior–stabilised, fixed	3,178	2,934	2,576	2,316	2,083	1,859	1,601	1,275	947	637	360	179	60

Figure 3.18 (c)

Comparison of the Kaplan-Meier cumulative percentage probability estimates of a knee prosthesis first revision for different constraint and bearing types at increasing years after the primary surgery when the primary is a unicondylar or patellofemoral partial knee replacement.

(c) **Unicondylar and patellofemoral partial knee replacements**



Numbers at risk

Unicondylar, fixed	23,721	19,983	16,279	13,211	10,530	8,274	6,223	4,613	3,228	2,050	1,122	471	119
Unicondylar, mobile	51,140	45,519	39,806	35,061	30,164	25,112	20,115	15,238	10,582	6,719	3,956	1,884	570
Patellofemoral	11,068	9,877	8,586	7,380	6,125	4,868	3,781	2,756	1,818	1,066	623	283	85

Table 3.24 (a) Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) at specified times after primary knee replacement, by fixation, constraint and bearing type[1,2].

Fixation/ constraint/ bearing type	Cumulative percentage probability of a first revision (95% CI) at time shown if time elapsed since primary operation is:												
	n	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years	12 years
Total knee replacement													
All cemented	**737,759**	**0.39 (0.38-0.41)**	**1.00 (0.97-1.02)**	**1.50 (1.47-1.53)**	**1.85 (1.82-1.89)**	**2.14 (2.10-2.18)**	**2.41 (2.36-2.45)**	**2.65 (2.60-2.70)**	**2.90 (2.84-2.95)**	**3.12 (3.06-3.19)**	**3.37 (3.30-3.45)**	**3.61 (3.52-3.70)**	**3.82 (3.71-3.94)**
Cemented and													
unconstrained, fixed	487,448	0.35 (0.33-0.37)	0.92 (0.89-0.95)	1.38 (1.34-1.42)	1.69 (1.65-1.74)	1.94 (1.90-1.99)	2.19 (2.14-2.24)	2.41 (2.35-2.47)	2.63 (2.56-2.69)	2.85 (2.77-2.92)	3.07 (2.98-3.15)	3.31 (3.20-3.42)	3.51 (3.37-3.66)
unconstrained, mobile	32,490	0.51 (0.44-0.60)	1.25 (1.13-1.38)	1.86 (1.71-2.03)	2.38 (2.21-2.57)	2.74 (2.55-2.94)	3.08 (2.88-3.30)	3.30 (3.08-3.53)	3.63 (3.39-3.88)	3.91 (3.64-4.19)	4.22 (3.91-4.56)	4.44 (4.06-4.85)	4.76 (4.25-5.33)
posterior-stabilised, fixed	181,648	0.43 (0.40-0.46)	1.09 (1.04-1.14)	1.62 (1.56-1.69)	2.03 (1.96-2.11)	2.40 (2.31-2.48)	2.69 (2.60-2.79)	2.97 (2.87-3.07)	3.29 (3.18-3.41)	3.52 (3.39-3.65)	3.79 (3.63-3.94)	4.04 (3.86-4.23)	4.23 (4.01-4.47)
posterior-stabilised, mobile	10,991	0.68 (0.54-0.86)	1.53 (1.31-1.79)	2.14 (1.87-2.45)	2.57 (2.27-2.92)	2.81 (2.49-3.18)	3.21 (2.85-3.61)	3.49 (3.10-3.92)	3.73 (3.31-4.20)	4.11 (3.62-4.66)	4.48 (3.91-5.13)	4.48 (3.91-5.13)	*5.16 (3.88-6.85)*
constrained, condylar	5,063	0.93 (0.69-1.25)	1.60 (1.25-2.05)	2.32 (1.85-2.91)	2.69 (2.16-3.37)	3.00 (2.40-3.75)	3.00 (2.40-3.75)	3.13 (2.49-3.93)	3.35 (2.61-4.29)	3.35 (2.61-4.29)	*4.79 (3.26-6.99)*	*4.79 (3.26-6.99)*	*4.79 (3.26-6.99)*
monobloc polyethylene tibia	11,231	0.35 (0.25-0.48)	1.02 (0.83-1.24)	1.40 (1.17-1.68)	1.65 (1.39-1.97)	1.91 (1.60-2.27)	2.07 (1.74-2.48)	2.18 (1.82-2.61)	2.36 (1.93-2.87)	2.48 (2.01-3.07)	*2.75 (2.10-3.60)*	*2.75 (2.10-3.60)*	*2.75 (2.10-3.60)*
bearing type unknown	8,888	0.81 (0.64-1.02)	1.65 (1.40-1.95)	2.46 (2.15-2.82)	2.99 (2.64-3.39)	3.45 (3.06-3.89)	3.82 (3.41-4.29)	4.19 (3.74-4.70)	4.42 (3.94-4.95)	4.56 (4.06-5.13)	5.03 (4.40-5.74)	5.21 (4.51-6.02)	*5.58 (4.63-6.71)*
All uncemented	**38,428**	**0.58 (0.51-0.66)**	**1.48 (1.36-1.61)**	**2.10 (1.95-2.26)**	**2.49 (2.33-2.66)**	**2.89 (2.71-3.08)**	**3.16 (2.97-3.36)**	**3.42 (3.22-3.64)**	**3.69 (3.47-3.93)**	**3.99 (3.74-4.26)**	**4.19 (3.92-4.48)**	**4.59 (4.24-4.97)**	**4.74 (4.34-5.17)**
Uncemented and													
unconstrained, fixed	14,751	0.65 (0.53-0.79)	1.65 (1.45-1.88)	2.31 (2.07-2.57)	2.60 (2.34-2.88)	2.96 (2.68-3.26)	3.18 (2.89-3.51)	3.42 (3.11-3.76)	3.61 (3.29-3.98)	3.90 (3.53-4.31)	4.24 (3.80-4.72)	4.50 (3.98-5.08)	*4.50 (3.98-5.08)*
unconstrained, mobile	20,376	0.55 (0.45-0.66)	1.34 (1.19-1.52)	1.91 (1.72-2.12)	2.33 (2.12-2.57)	2.74 (2.50-3.00)	3.03 (2.77-3.31)	3.28 (3.00-3.59)	3.50 (3.20-3.82)	3.72 (3.40-4.08)	3.76 (3.43-4.13)	4.04 (3.61-4.51)	4.18 (3.68-4.74)
posterior-stabalised, fixed	2,633	0.48 (0.27-0.85)	1.70 (1.25-2.31)	2.44 (1.88-3.17)	3.04 (2.39-3.85)	3.65 (2.91-4.55)	4.05 (3.27-5.02)	4.51 (3.66-5.56)	5.58 (4.55-6.85)	6.33 (5.14-7.79)	6.96 (5.61-8.61)	*8.64 (6.68-11.14)*	*9.58 (7.10-12.88)*
other constraint	221	*0*	*1.10 (0.28-4.34)*	*2.26 (0.85-5.91)*	*2.87 (1.20-6.76)*	*2.87 (1.20-6.76)*	*2.87 (1.20-6.76)*	*2.87 (1.20-6.76)*	*2.87 (1.20-6.76)*	*2.87 (1.20-6.76)*			
bearing type unknown	447	0.69 (0.22-2.13)	0.69 (0.22-2.13)	1.68 (0.81-3.50)	2.69 (1.50-4.82)	3.48 (2.08-5.82)	3.77 (2.28-6.17)	4.11 (2.53-6.64)	*4.11 (2.53-6.64)*	*4.62 (2.86-7.44)*	*4.62 (2.86-7.44)*	*5.46 (3.30-8.97)*	*5.46 (3.30-8.97)*

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 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.

Table 3.24 (a) (continued)

Fixation/ constraint/ bearing type	Cumulative percentage probability of a first revision (95% CI) at time shown if time elapsed since primary operation is:												
	n	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years	12 years
All hybrid	**8,453**	**0.59 (0.44-0.78)**	**1.34 (1.11-1.62)**	**1.89 (1.61-2.22)**	**2.17 (1.87-2.53)**	**2.46 (2.13-2.84)**	**2.75 (2.40-3.16)**	**3.07 (2.68-3.51)**	**3.22 (2.82-3.68)**	**3.51 (3.07-4.02)**	**3.66 (3.19-4.20)**	**3.66 (3.19-4.20)**	*4.17 (3.47-5.00)*
Uncemented/hybrid and													
unconstrained, fixed	5,964	0.48 (0.33-0.69)	1.14 (0.90-1.45)	1.60 (1.30-1.96)	1.87 (1.54-2.26)	2.15 (1.80-2.57)	2.38 (2.01-2.83)	2.64 (2.24-3.11)	2.80 (2.38-3.30)	3.13 (2.65-3.70)	3.24 (2.74-3.83)	3.24 (2.74-3.83)	*3.68 (2.95-4.59)*
unconstrained mobile	1,467	0.96 (0.56-1.65)	1.47 (0.94-2.31)	2.00 (1.34-2.99)	2.27 (1.54-3.35)	2.43 (1.65-3.56)	2.79 (1.91-4.07)	3.03 (2.07-4.43)	3.30 (2.24-4.83)	*3.30 (2.24-4.83)*	*4.02 (2.51-6.41)*	*4.02 (2.51-6.41)*	*4.02 (2.51-6.41)*
posterior-stabilised, fixed	545	0.75 (0.28-1.98)	2.13 (1.18-3.81)	3.23 (1.99-5.23)	3.71 (2.35-5.84)	4.50 (2.95-6.85)	4.82 (3.18-7.27)	*5.59 (3.73-8.33)*	*5.59 (3.73-8.33)*	*6.16 (4.10-9.20)*	*6.16 (4.10-9.20)*	*6.16 (4.10-9.20)*	*9.39 (4.56-18.80)*
other constraint	355	0.30 (0.04-2.13)	1.87 (0.84-4.12)	2.53 (1.27-5.00)	*2.88 (1.51-5.47)*	*2.88 (1.51-5.47)*	*3.75 (2.08-6.71)*	*4.20 (2.39-7.33)*	*4.20 (2.39-7.33)*	*4.20 (2.39-7.33)*	*4.20 (2.39-7.33)*		
bearing type unknown	122	*1.65 (0.41-6.42)*	*4.34 (1.83-10.14)*	*7.18 (3.65-13.88)*	*7.18 (3.65-13.88)*	*7.18 (3.65-13.88)*	*8.55 (4.49-15.95)*	*10.21 (5.50-18.56)*	*10.21 (5.50-18.56)*	*10.21 (5.50-18.56)*	*10.21 (5.50-18.56)*		
Unicompartmental knee replacement													
All unicondylar	**75,719**	**1.13 (1.05-1.21)**	**2.86 (2.73-2.99)**	**4.27 (4.12-4.44)**	**5.39 (5.21-5.58)**	**6.44 (6.24-6.65)**	**7.50 (7.27-7.74)**	**8.49 (8.24-8.76)**	**9.58 (9.28-9.88)**	**10.63 (10.29-10.98)**	**11.94 (11.53-12.38)**	**13.58 (13.01-14.18)**	**14.99 (14.16-15.87)**
Unicondylar and													
fixed	23,721	0.81 (0.70-0.94)	2.53 (2.32-2.76)	4.01 (3.73-4.31)	5.20 (4.87-5.56)	6.26 (5.88-6.67)	7.21 (6.78-7.67)	8.31 (7.81-8.84)	8.87 (8.33-9.45)	9.82 (9.18-10.50)	10.77 (10.00-11.59)	11.92 (10.87-13.07)	*13.56 (11.67-15.74)*
mobile	51,140	1.28 (1.18-1.39)	3.03 (2.87-3.19)	4.41 (4.22-4.61)	5.50 (5.29-5.73)	6.57 (6.32-6.82)	7.65 (7.37-7.93)	8.62 (8.32-8.93)	9.86 (9.51-10.22)	10.94 (10.54-11.36)	12.35 (11.85-12.86)	14.15 (13.48-14.86)	15.47 (14.53-16.45)
bearing type unknown	858	0.71 (0.32-1.56)	1.67 (0.99-2.80)	3.56 (2.48-5.08)	4.38 (3.16-6.05)	4.84 (3.54-6.60)	6.26 (4.71-8.31)	6.89 (5.22-9.07)	*8.01 (6.10-10.50)*	*9.38 (7.07-12.41)*	*11.05 (8.06-15.06)*	*11.05 (8.06-15.06)*	*14.34 (8.63-23.33)*
All patellofemoral	**11,068**	**1.16 (0.97-1.38)**	**3.42 (3.08-3.80)**	**5.69 (5.23-6.19)**	**7.43 (6.89-8.00)**	**9.53 (8.89-10.20)**	**11.14 (10.43-11.89)**	**12.95 (12.14-13.81)**	**14.70 (13.76-15.69)**	**16.18 (15.11-17.32)**	**18.71 (17.31-20.20)**	**20.75 (18.99-22.64)**	*23.83 (21.19-26.73)*
Others/unknown	**45**		*0*	*0*	*0*	*0*	*0*	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*	*2.63 (0.37-17.25)*	
All types	**871,472**	**0.48 (0.46-0.49)**	**1.22 (1.19-1.24)**	**1.83 (1.80-1.86)**	**2.27 (2.24-2.31)**	**2.66 (2.62-2.70)**	**3.02 (2.98-3.07)**	**3.36 (3.31-3.41)**	**3.71 (3.65-3.77)**	**4.04 (3.98-4.10)**	**4.42 (4.34-4.49)**	**4.82 (4.72-4.92)**	**5.19 (5.05-5.33)**

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 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.

Table 3.24 (b) Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) at specified times after primary knee replacement, by age and gender[1], for each fixation, constraint and bearing group. *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	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
All types															
	<55	26,599	1.12 (1.00-1.26)	4.58 (4.31-4.87)	6.68 (6.32-7.05)	8.71 (8.26-9.17)	11.61 (10.92-12.35)	*13.81 (12.56-15.18)*	37,574	0.83 (0.74-0.93)	3.92 (3.71-4.15)	6.22 (5.93-6.53)	8.25 (7.87-8.64)	10.89 (10.33-11.49)	13.04 (11.99-14.17)
	55-64	94,438	0.68 (0.63-0.74)	2.67 (2.56-2.79)	3.87 (3.73-4.02)	4.81 (4.64-4.99)	6.35 (6.09-6.62)	7.58 (7.16-8.02)	114,147	0.49 (0.45-0.53)	2.30 (2.20-2.40)	3.49 (3.37-3.62)	4.45 (4.29-4.60)	5.85 (5.62-6.09)	6.86 (6.45-7.30)
	65-74	149,003	0.49 (0.46-0.53)	1.76 (1.68-1.83)	2.44 (2.35-2.54)	3.00 (2.89-3.11)	3.95 (3.78-4.12)	4.47 (4.19-4.77)	183,526	0.35 (0.33-0.38)	1.49 (1.43-1.56)	2.20 (2.12-2.28)	2.76 (2.67-2.86)	3.62 (3.48-3.77)	4.21 (3.97-4.45)
	75+	105,785	0.37 (0.33-0.41)	1.08 (1.01-1.15)	1.43 (1.35-1.52)	1.78 (1.67-1.89)	2.24 (2.08-2.41)	2.47 (2.22-2.75)	160,193	0.35 (0.32-0.38)	0.96 (0.91-1.02)	1.32 (1.26-1.39)	1.60 (1.53-1.68)	1.92 (1.81-2.04)	2.18 (2.01-2.37)
Others/ unknown		13							19						
Total knee replacement															
All cemented															
	<55	17,549	0.84 (0.71-0.99)	3.63 (3.33-3.96)	5.26 (4.87-5.68)	6.97 (6.46-7.51)	9.24 (8.48-10.08)	*9.59 (8.74-10.52)*	24,920	0.57 (0.48-0.68)	2.83 (2.61-3.08)	4.47 (4.17-4.80)	5.68 (5.29-6.09)	7.53 (6.94-8.17)	*8.78 (7.81-9.86)*
	55-64	73,082	0.59 (0.53-0.65)	2.31 (2.19-2.43)	3.29 (3.14-3.45)	4.05 (3.87-4.24)	5.14 (4.88-5.42)	5.76 (5.39-6.16)	92,854	0.39 (0.35-0.44)	1.90 (1.81-2.00)	2.81 (2.69-2.94)	3.47 (3.32-3.62)	4.43 (4.21-4.66)	5.18 (4.77-5.63)
	65-74	126,300	0.43 (0.39-0.47)	1.55 (1.47-1.63)	2.15 (2.06-2.25)	2.62 (2.51-2.74)	3.35 (3.18-3.52)	3.70 (3.46-3.96)	162,119	0.31 (0.28-0.34)	1.29 (1.23-1.35)	1.88 (1.80-1.96)	2.32 (2.22-2.42)	2.91 (2.78-3.05)	3.29 (3.08-3.52)
	75+	94,239	0.33 (0.30-0.37)	0.99 (0.92-1.06)	1.29 (1.20-1.38)	1.59 (1.48-1.70)	1.94 (1.78-2.11)	2.16 (1.90-2.46)	146,520	0.30 (0.28-0.33)	0.85 (0.80-0.90)	1.15 (1.08-1.21)	1.37 (1.29-1.45)	1.62 (1.52-1.74)	1.84 (1.67-2.03)
Cemented by bearing and constraint type															
Unconstrained, fixed	<55	10,936	0.76 (0.61-0.95)	3.21 (2.85-3.61)	4.70 (4.23-5.22)	6.30 (5.68-6.98)	8.81 (7.82-9.93)	*9.21 (8.09-10.47)*	15,810	0.51 (0.40-0.64)	2.43 (2.17-2.72)	3.99 (3.62-4.40)	5.14 (4.67-5.65)	6.83 (6.12-7.62)	*8.19 (6.92-9.67)*
	55-64	48,460	0.49 (0.43-0.56)	2.11 (1.97-2.26)	2.98 (2.81-3.17)	3.72 (3.50-3.95)	4.69 (4.38-5.03)	5.35 (4.90-5.83)	61,411	0.36 (0.32-0.42)	1.77 (1.66-1.89)	2.51 (2.37-2.66)	3.12 (2.95-3.31)	4.04 (3.77-4.32)	4.83 (4.31-5.41)
	65-74	85,376	0.40 (0.36-0.45)	1.43 (1.34-1.52)	2.00 (1.89-2.11)	2.43 (2.29-2.57)	3.04 (2.85-3.25)	3.39 (3.09-3.72)	107,452	0.24 (0.22-0.28)	1.18 (1.11-1.25)	1.69 (1.60-1.79)	2.11 (2.00-2.23)	2.61 (2.46-2.78)	2.94 (2.70-3.20)
	75+	62,962	0.33 (0.29-0.38)	0.97 (0.88-1.06)	1.22 (1.12-1.32)	1.50 (1.37-1.63)	1.80 (1.62-1.99)	2.14 (1.79-2.56)	94,912	0.27 (0.24-0.31)	0.82 (0.76-0.89)	1.07 (1.00-1.15)	1.27 (1.18-1.37)	1.54 (1.41-1.68)	1.68 (1.49-1.89)
Unconstrained, mobile	<55	1,159	0.98 (0.54-1.76)	4.28 (3.21-5.70)	6.06 (4.73-7.75)	7.73 (6.12-9.74)	*10.00 (7.62-13.07)*	*11.38 (8.14-15.81)*	1,398	0.74 (0.40-1.37)	3.51 (2.62-4.69)	5.70 (4.49-7.21)	7.11 (5.68-8.88)	*9.13 (7.01-11.86)*	*9.13 (7.01-11.86)*
	55-64	3,927	0.73 (0.50-1.05)	2.54 (2.08-3.11)	3.70 (3.12-4.39)	4.43 (3.77-5.21)	5.31 (4.47-6.31)	*5.31 (4.47-6.31)*	4,598	0.50 (0.33-0.75)	2.21 (1.81-2.71)	3.29 (2.77-3.90)	3.81 (3.24-4.48)	4.82 (4.03-5.77)	*6.36 (4.42-9.12)*
	65-74	5,382	0.54 (0.37-0.78)	1.85 (1.51-2.27)	2.62 (2.19-3.12)	3.08 (2.60-3.64)	4.36 (3.58-5.30)	*4.88 (3.71-6.39)*	6,745	0.45 (0.32-0.65)	1.62 (1.33-1.98)	2.29 (1.93-2.71)	2.95 (2.52-3.45)	3.89 (3.25-4.65)	*4.43 (3.50-5.59)*
	75+	3,468	0.36 (0.21-0.64)	1.00 (0.70-1.42)	1.69 (1.26-2.24)	1.86 (1.40-2.46)	*2.22 (1.64-2.99)*	*2.22 (1.64-2.99)*	5,807	0.36 (0.23-0.55)	0.97 (0.73-1.27)	1.38 (1.08-1.76)	1.58 (1.25-2.00)	1.74 (1.37-2.21)	*1.99 (1.45-2.75)*

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
Posterior-stabilised, fixed	<55	4,234	0.72 (0.49-1.03)	4.03 (3.41-4.77)	6.03 (5.20-6.99)	7.98 (6.89-9.22)	*10.39 (8.76-12.29)*	*10.39 (8.76-12.29)*	6,165	0.48 (0.33-0.69)	3.15 (2.69-3.69)	4.81 (4.18-5.52)	6.19 (5.40-7.10)	7.88 (6.73-9.21)	*9.68 (7.69-12.15)*
	55-64	17,170	0.73 (0.61-0.88)	2.66 (2.40-2.94)	3.93 (3.60-4.29)	4.83 (4.44-5.27)	6.03 (5.47-6.64)	*6.81 (6.00-7.73)*	22,574	0.43 (0.35-0.53)	2.13 (1.93-2.35)	3.36 (3.09-3.65)	4.09 (3.77-4.44)	5.09 (4.62-5.59)	*5.72 (5.01-6.53)*
	65-74	29,991	0.46 (0.39-0.55)	1.71 (1.56-1.88)	2.36 (2.16-2.57)	2.95 (2.71-3.21)	3.91 (3.55-4.31)	4.32 (3.84-4.86)	40,582	0.41 (0.35-0.48)	1.42 (1.29-1.55)	2.15 (1.99-2.32)	2.58 (2.39-2.79)	3.34 (3.06-3.65)	3.63 (3.25-4.04)
	75+	23,009	0.33 (0.26-0.41)	1.01 (0.87-1.16)	1.36 (1.19-1.55)	1.72 (1.50-1.97)	2.23 (1.86-2.66)	*2.23 (1.86-2.66)*	37,888	0.32 (0.26-0.38)	0.85 (0.75-0.95)	1.22 (1.10-1.36)	1.50 (1.35-1.67)	1.75 (1.55-1.98)	*2.11 (1.73-2.58)*
Posterior-stabilised, mobile	<55	633	1.45 (0.76-2.77)	4.34 (2.95-6.36)	5.20 (3.63-7.41)	*6.60 (4.65-9.31)*	*7.54 (5.10-11.06)*		709	1.47 (0.79-2.71)	4.53 (3.17-6.47)	5.84 (4.24-8.02)	6.37 (4.65-8.69)	*9.87 (6.79-14.25)*	
	55-64	1,673	0.74 (0.42-1.30)	2.26 (1.63-3.14)	2.67 (1.96-3.63)	3.27 (2.43-4.39)	*5.52 (3.80-7.96)*	*5.52 (3.80-7.96)*	1,870	0.39 (0.19-0.81)	1.70 (1.17-2.45)	2.99 (2.24-4.00)	3.98 (3.04-5.21)	*5.20 (3.92-6.87)*	*5.20 (3.92-6.87)*
	65-74	1,706	0.56 (0.29-1.07)	2.08 (1.45-2.96)	2.63 (1.90-3.64)	3.18 (2.31-4.36)	*3.18 (2.31-4.36)*	*3.18 (2.31-4.36)*	2,009	0.57 (0.32-1.03)	2.00 (1.44-2.78)	2.48 (1.82-3.36)	3.13 (2.33-4.20)	*3.31 (2.46-4.45)*	*6.89 (2.48-18.39)*
	75+	943	0.67 (0.30-1.48)	1.44 (0.82-2.52)	1.66 (0.96-2.89)	*2.04 (1.14-3.61)*	*2.04 (1.14-3.61)*		1,447	0.57 (0.29-1.14)	1.01 (0.59-1.74)	1.40 (0.85-2.31)	1.74 (1.07-2.83)	*1.97 (1.21-3.19)*	
Constrained, condylar	<55	187	*2.81 (1.18-6.63)*	*5.57 (2.76-11.09)*	*7.05 (3.55-13.73)*	*7.05 (3.55-13.73)*			249	*0.90 (0.23-3.55)*	*2.18 (0.81-5.78)*	*2.18 (0.81-5.78)*	*2.18 (0.81-5.78)*	*7.93 (1.90-30.00)*	
	55-64	461	1.21 (0.50-2.89)	*2.65 (1.27-5.49)*	*3.65 (1.72-7.68)*	*3.65 (1.72-7.68)*	*3.65 (1.72-7.68)*		601	0.57 (0.18-1.76)	*2.44 (1.25-4.77)*	*2.44 (1.25-4.77)*	*2.44 (1.25-4.77)*	*6.88 (2.61-17.49)*	
	65-74	653	0.53 (0.17-1.64)	3.02 (1.70-5.34)	*5.01 (2.98-8.35)*	*5.01 (2.98-8.35)*	*7.17 (3.60-14.01)*		1,068	1.00 (0.54-1.86)	2.67 (1.70-4.18)	*3.33 (2.12-5.23)*	*3.33 (2.12-5.23)*	*3.33 (2.12-5.23)*	
	75+	548	0.62 (0.20-1.93)	*1.74 (0.76-4.00)*	*1.74 (0.76-4.00)*	*1.74 (0.76-4.00)*			1,294	0.99 (0.56-1.74)	1.29 (0.75-2.22)	1.80 (1.04-3.10)	*2.34 (1.26-4.33)*	*2.34 (1.26-4.33)*	
Monobloc polyethylene tibia	<55	112	*0.98 (0.14-6.76)*	*6.64 (3.03-14.26)*	*6.64 (3.03-14.26)*	*8.48 (4.04-17.31)*	*8.48 (4.04-17.31)*		159	*0.64 (0.09-4.43)*	*4.69 (2.13-10.19)*	*5.96 (2.83-12.33)*	*5.96 (2.83-12.33)*		
	55-64	498	0.89 (0.34-2.36)	*2.55 (1.37-4.71)*	*3.44 (1.93-6.11)*	*4.18 (2.32-7.46)*	*5.44 (2.88-10.16)*		673	0.32 (0.08-1.26)	1.81 (0.94-3.48)	*2.81 (1.57-5.01)*	*2.81 (1.57-5.01)*	*4.96 (2.48-9.80)*	
	65-74	1,712	0.13 (0.03-0.51)	1.39 (0.86-2.24)	1.92 (1.20-3.05)	*2.32 (1.39-3.88)*	*2.32 (1.39-3.88)*		2,569	0.34 (0.17-0.69)	1.59 (1.11-2.26)	2.15 (1.51-3.04)	2.35 (1.64-3.36)	*2.69 (1.80-4.00)*	
	75+	2,234	0.24 (0.10-0.58)	1.23 (0.80-1.89)	1.62 (1.06-2.48)	*2.12 (1.34-3.35)*			3,271	0.43 (0.25-0.74)	0.79 (0.52-1.21)	1.12 (0.74-1.69)	1.12 (0.74-1.69)	*1.12 (0.74-1.69)*	
Bearing type unknown	<55	288	2.10 (0.95-4.62)	*5.97 (3.70-9.58)*	*9.31 (6.16-13.93)*	*12.65 (8.71-18.19)*	*12.65 (8.71-18.19)*		430	1.90 (0.95-3.76)	6.20 (4.23-9.04)	*8.83 (6.33-12.25)*	*10.82 (7.84-14.83)*	*13.57 (9.09-20.01)*	*13.57 (9.09-20.01)*
	55-64	893	1.60 (0.95-2.68)	4.66 (3.43-6.33)	5.87 (4.46-7.73)	6.07 (4.61-7.96)	*9.22 (6.43-13.13)*	*9.22 (6.43-13.13)*	1,127	0.82 (0.43-1.57)	2.94 (2.08-4.16)	4.31 (3.21-5.78)	5.93 (4.52-7.76)	*6.39 (4.88-8.35)*	*6.39 (4.88-8.35)*
	65-74	1,480	0.76 (0.42-1.36)	2.59 (1.88-3.58)	3.20 (2.38-4.29)	3.53 (2.64-4.69)	*3.71 (2.77-4.94)*	*3.71 (2.77-4.94)*	1,694	0.54 (0.28-1.04)	1.52 (1.02-2.26)	2.63 (1.93-3.59)	3.36 (2.51-4.49)	*4.25 (3.00-6.00)*	*6.37 (3.19-12.52)*
	75+	1,075	0.10 (0.01-0.68)	0.64 (0.29-1.41)	0.95 (0.47-1.92)	1.42 (0.74-2.75)	*1.75 (0.91-3.33)*	*1.75 (0.91-3.33)*	1,901	0.64 (0.36-1.13)	1.38 (0.93-2.06)	1.85 (1.29-2.65)	2.08 (1.46-2.95)	*2.31 (1.59-3.34)*	*3.47 (1.72-6.93)*

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Continued >

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
All uncemented															
	<55	1,464	0.64 (0.33-1.23)	4.30 (3.31-5.58)	5.65 (4.46-7.14)	7.06 (5.64-8.81)	*8.95 (7.08-11.28)*	*10.46 (7.89-13.80)*	1,582	0.92 (0.54-1.54)	4.53 (3.56-5.76)	6.67 (5.44-8.18)	7.26 (5.94-8.85)	*8.40 (6.79-10.38)*	*8.40 (6.79-10.38)*
	55-64	5,058	0.61 (0.43-0.87)	2.38 (1.97-2.86)	3.33 (2.83-3.91)	4.01 (3.44-4.67)	5.24 (4.42-6.21)	*6.38 (5.01-8.11)*	5,041	0.64 (0.45-0.91)	2.29 (1.90-2.77)	3.53 (3.02-4.13)	4.42 (3.81-5.12)	5.57 (4.75-6.52)	*6.39 (5.23-7.79)*
	65-74	7,230	0.56 (0.41-0.77)	1.80 (1.51-2.16)	2.39 (2.04-2.81)	2.89 (2.47-3.38)	3.61 (3.03-4.31)	*3.80 (3.13-4.59)*	7,315	0.53 (0.39-0.73)	2.28 (1.94-2.67)	3.04 (2.64-3.49)	3.33 (2.91-3.82)	3.99 (3.44-4.62)	*4.57 (3.74-5.57)*
	75+	4,635	0.47 (0.31-0.73)	1.26 (0.95-1.65)	1.59 (1.24-2.05)	1.98 (1.55-2.53)	2.14 (1.67-2.74)	*2.14 (1.67-2.74)*	6,094	0.56 (0.40-0.79)	1.29 (1.03-1.63)	1.65 (1.34-2.04)	1.92 (1.56-2.36)	1.97 (1.60-2.41)	*2.26 (1.66-3.07)*
Uncemented by bearing and constraint type															
Unconstrained, fixed	<55	596	0.87 (0.36-2.09)	4.74 (3.22-6.94)	6.20 (4.39-8.73)	*7.44 (5.36-10.29)*	*9.23 (6.54-12.94)*		578	1.25 (0.60-2.59)	3.72 (2.41-5.70)	5.11 (3.50-7.43)	5.71 (3.95-8.21)	*7.22 (4.71-10.98)*	*7.22 (4.71-10.98)*
	55-64	1,960	0.47 (0.25-0.91)	2.55 (1.92-3.39)	3.42 (2.66-4.40)	4.15 (3.28-5.25)	*5.47 (4.19-7.13)*	*6.00 (4.46-8.05)*	1,897	0.76 (0.45-1.28)	2.63 (1.99-3.49)	3.49 (2.71-4.47)	4.46 (3.54-5.60)	*5.72 (4.40-7.43)*	*6.46 (4.68-8.88)*
	65-74	2,859	0.61 (0.38-0.99)	2.20 (1.71-2.84)	2.77 (2.19-3.49)	3.25 (2.59-4.08)	4.05 (3.09-5.29)	*4.05 (3.09-5.29)*	2,649	0.55 (0.32-0.92)	2.74 (2.16-3.47)	3.26 (2.62-4.06)	3.50 (2.82-4.33)	4.18 (3.31-5.27)	*4.18 (3.31-5.27)*
	75+	1,831	0.51 (0.27-0.98)	1.01 (0.63-1.63)	1.40 (0.92-2.13)	1.40 (0.92-2.13)	*1.58 (1.03-2.43)*	*1.58 (1.03-2.43)*	2,380	0.74 (0.46-1.19)	1.49 (1.06-2.09)	1.84 (1.34-2.51)	1.90 (1.40-2.59)	*1.90 (1.40-2.59)*	*1.90 (1.40-2.59)*
Unconstrained, mobile	<55	665	0.62 (0.23-1.65)	4.49 (3.05-6.59)	5.66 (3.98-8.03)	*7.69 (5.53-10.66)*	*9.09 (6.41-12.80)*	*9.09 (6.41-12.80)*	824	0.76 (0.34-1.67)	4.33 (3.06-6.11)	6.84 (5.13-9.08)	7.30 (5.51-9.65)	*8.14 (6.10-10.83)*	
	55-64	2,493	0.62 (0.38-1.03)	2.31 (1.77-3.03)	3.33 (2.64-4.20)	3.95 (3.16-4.93)	4.23 (3.37-5.31)	*5.05 (3.76-6.76)*	2,701	0.54 (0.32-0.91)	1.92 (1.44-2.56)	3.38 (2.70-4.24)	4.09 (3.29-5.08)	4.81 (3.86-5.99)	*5.41 (4.04-7.23)*
	65-74	3,766	0.53 (0.34-0.83)	1.55 (1.18-2.03)	1.98 (1.54-2.54)	2.53 (1.98-3.21)	3.28 (2.51-4.27)	*3.28 (2.51-4.27)*	4,180	0.56 (0.38-0.85)	1.98 (1.58-2.49)	2.91 (2.39-3.53)	3.25 (2.69-3.94)	3.68 (3.02-4.48)	*4.22 (3.12-5.70)*
	75+	2,461	0.51 (0.29-0.90)	1.27 (0.87-1.86)	1.62 (1.14-2.29)	2.10 (1.50-2.95)	*2.28 (1.61-3.22)*	*2.28 (1.61-3.22)*	3,282	0.47 (0.28-0.77)	1.21 (0.87-1.68)	1.48 (1.09-2.01)	1.83 (1.36-2.46)	1.83 (1.36-2.46)	*2.38 (1.43-3.94)*
Posterior-stabilised, fixed	<55	173	*0*	*1.32 (0.33-5.16)*	*2.38 (0.75-7.43)*	*2.38 (0.75-7.43)*	*7.38 (2.73-19.15)*		158	*0.67 (0.09-4.64)*	*8.60 (4.97-14.67)*	*12.22 (7.63-19.27)*	*13.42 (8.48-20.89)*	*15.08 (9.55-23.38)*	
	55-64	495	0.84 (0.32-2.23)	1.55 (0.74-3.23)	2.12 (1.10-4.06)	*3.01 (1.63-5.54)*	*8.52 (4.94-14.49)*		358	0.89 (0.29-2.73)	3.74 (2.14-6.49)	*5.57 (3.49-8.83)*	*7.34 (4.82-11.10)*	*11.16 (7.20-17.07)*	
	65-74	459	0.70 (0.23-2.16)	1.49 (0.67-3.29)	2.51 (1.30-4.81)	*2.51 (1.30-4.81)*	*3.07 (1.61-5.82)*		392	0.26 (0.04-1.80)	2.41 (1.21-4.78)	3.48 (1.93-6.21)	*3.88 (2.21-6.76)*	*5.53 (3.12-9.69)*	*8.39 (3.92-17.49)*
	75+	251	*0*	*3.11 (1.41-6.81)*	*3.11 (1.41-6.81)*	*4.63 (2.31-9.17)*	*4.63 (2.31-9.17)*		344	0	*0.70 (0.17-2.77)*	*2.17 (0.90-5.21)*	*3.39 (1.60-7.09)*	*4.22 (2.07-8.49)*	*4.22 (2.07-8.49)*

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
Other constraint	<55	17	*0*	*7.69 (1.12-43.36)*					3						
	55-64	40	*0*	*3.23 (0.46-20.77)*	*3.23 (0.46-20.77)*				23	*0*	*0*	*0*			
	65-74	68	*0*	*1.72 (0.24-11.62)*	*1.72 (0.24-11.62)*				23	*0*	*0*				
	75+	38	*0*	*3.03 (0.43-19.63)*	*3.03 (0.43-19.63)*				8						
Bearing type unknown	<55	13	*0*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*	*8.33 (1.22-46.10)*			19		*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*	*5.26 (0.76-31.88)*		
	55-64	70	*2.88 (0.73-11.02)*	*4.42 (1.45-13.09)*	*7.58 (3.22-17.28)*	*7.58 (3.22-17.28)*	*7.58 (3.22-17.28)*		62	*0*	*0*	*1.72 (0.24-11.62)*	*1.72 (0.24-11.62)*	*1.72 (0.24-11.62)*	
	65-74	78	*0*	*0*	*5.64 (2.15-14.33)*	*7.11 (3.02-16.25)*	*7.11 (3.02-16.25)*		71	*0*	*1.61 (0.23-10.90)*	*1.61 (0.23-10.90)*	*1.61 (0.23-10.90)*	*5.01 (1.17-20.13)*	
	75+	54	*0*	*0*	*0*	*3.45 (0.49-22.05)*	*3.45 (0.49-22.05)*		80	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	*1.32 (0.19-8.97)*	
All Hybrid															
	<55	326	0.93 (0.30-2.87)	3.51 (1.96-6.26)	*6.13 (3.90-9.57)*	*7.43 (4.89-11.20)*	*8.81 (5.53-13.87)*		386	0.54 (0.13-2.12)	3.23 (1.80-5.76)	5.17 (3.24-8.20)	*7.61 (5.09-11.29)*	*8.13 (5.48-11.98)*	*10.68 (6.14-18.22)*
	55-64	966	0.63 (0.29-1.41)	2.09 (1.34-3.25)	2.73 (1.84-4.05)	3.72 (2.60-5.32)	*4.41 (3.04-6.37)*	*7.14 (3.98-12.64)*	1,120	0.56 (0.25-1.24)	2.28 (1.52-3.41)	3.21 (2.26-4.54)	3.79 (2.73-5.27)	*4.27 (3.06-5.93)*	*4.27 (3.06-5.93)*
	65-74	1,479	0.63 (0.33-1.20)	2.14 (1.49-3.07)	2.41 (1.71-3.39)	2.72 (1.95-3.78)	3.48 (2.49-4.85)	*3.48 (2.49-4.85)*	1,688	0.48 (0.24-0.96)	1.64 (1.12-2.40)	1.78 (1.23-2.57)	2.15 (1.52-3.03)	2.65 (1.89-3.72)	*2.65 (1.89-3.72)*
	75+	998	0.42 (0.16-1.12)	0.99 (0.52-1.89)	1.47 (0.83-2.61)	1.68 (0.96-2.92)	*2.48 (1.38-4.46)*	*2.48 (1.38-4.46)*	1,490	0.70 (0.38-1.29)	1.38 (0.88-2.16)	1.66 (1.09-2.52)	2.17 (1.47-3.21)	*2.40 (1.61-3.59)*	*2.40 (1.61-3.59)*
Hybrid by bearing and constraint type															
Uncemented/ hybrid and unconstrained, fixed	<55	197	*1.02 (0.26-4.02)*	*3.14 (1.42-6.86)*	*6.06 (3.40-10.69)*	*6.70 (3.85-11.51)*	*6.70 (3.85-11.51)*		248	*0.82 (0.21-3.26)*	*3.90 (2.05-7.37)*	*5.75 (3.38-9.70)*	*7.34 (4.55-11.73)*	*7.34 (4.55-11.73)*	*10.65 (5.36-20.57)*
	55-64	647	0.31 (0.08-1.25)	1.28 (0.64-2.55)	2.17 (1.26-3.71)	2.81 (1.72-4.56)	*3.70 (2.25-6.06)*	*5.71 (2.68-11.96)*	756	0.80 (0.36-1.78)	2.48 (1.57-3.90)	3.23 (2.16-4.82)	3.77 (2.57-5.49)	*4.37 (2.98-6.37)*	*4.37 (2.98-6.37)*
	65-74	1,101	0.28 (0.09-0.86)	1.83 (1.17-2.86)	2.05 (1.34-3.13)	2.31 (1.54-3.47)	*3.04 (2.02-4.56)*	*3.04 (2.02-4.56)*	1,212	0.33 (0.12-0.88)	1.09 (0.64-1.88)	1.19 (0.70-1.99)	1.63 (1.03-2.59)	2.26 (1.47-3.48)	*2.26 (1.47-3.48)*
	75+	746	0.42 (0.14-1.30)	1.01 (0.48-2.11)	1.60 (0.86-2.97)	1.85 (1.02-3.36)	*2.87 (1.52-5.36)*	*2.87 (1.52-5.36)*	1,057	0.58 (0.26-1.28)	1.07 (0.60-1.93)	1.42 (0.84-2.40)	1.89 (1.17-3.05)	*2.16 (1.33-3.52)*	*2.16 (1.33-3.52)*

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Continued >

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
Unconstrained, mobile	<55	54	*0*	*2.04 (0.29-13.62)*	*5.10 (1.26-19.43)*	*8.75 (2.81-25.48)*			65	*0*	*0*	*0*	*0*		
	55-64	163	*1.28 (0.32-5.03)*	*2.11 (0.68-6.44)*	*2.11 (0.68-6.44)*	*2.11 (0.68-6.44)*	*2.11 (0.68-6.44)*		222	*0*	*1.24 (0.31-4.86)*	*2.19 (0.69-6.84)*	*2.19 (0.69-6.84)*	*2.19 (0.69-6.84)*	
	65-74	204	*1.12 (0.28-4.40)*	*1.12 (0.28-4.40)*	*2.01 (0.63-6.29)*	*3.12 (1.13-8.47)*	*3.12 (1.13-8.47)*		320	1.29 (0.49-3.41)	*3.87 (2.08-7.15)*	*3.87 (2.08-7.15)*	*3.87 (2.08-7.15)*	*3.87 (2.08-7.15)*	
	75+	136	*0.74 (0.10-5.10)*	*0.74 (0.10-5.10)*	*0.74 (0.10-5.10)*	*0.74 (0.10-5.10)*			303	1.51 (0.57-3.97)	*2.10 (0.86-5.06)*	*2.10 (0.86-5.06)*	*3.46 (1.35-8.68)*	*3.46 (1.35-8.68)*	
Posterior-stabilised, fixed	<55	33		*0*	*3.45 (0.49-22.05)*	*8.81 (2.19-31.86)*			42		*2.44 (0.35-16.08)*	*5.31 (1.35-19.70)*	*9.25 (2.99-26.68)*		
	55-64	72	*1.39 (0.20-9.45)*	*4.43 (1.45-13.13)*	*4.43 (1.45-13.13)*	*4.43 (1.45-13.13)*	*4.43 (1.45-13.13)*		82	*0*	*2.65 (0.67-10.19)*	*5.90 (2.24-15.04)*	*8.51 (3.49-19.94)*	*8.51 (3.49-19.94)*	
	65-74	94	*3.23 (1.05-9.67)*	*5.55 (2.34-12.85)*	*5.55 (2.34-12.85)*	*5.55 (2.34-12.85)*			94	*0*	*1.23 (0.17-8.44)*	*2.53 (0.64-9.76)*	*2.53 (0.64-9.76)*	*2.53 (0.64-9.76)*	
	75+	54	*0*	*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*			74	*0*	*4.99 (1.63-14.80)*	*4.99 (1.63-14.80)*	*4.99 (1.63-14.80)*		
Other constraint	<55	34		*8.82 (2.93-24.91)*	*8.82 (2.93-24.91)*	*8.82 (2.93-24.91)*			23			*4.55 (0.65-28.13)*	*13.64 (4.61-36.56)*		
	55-64	66	*1.56 (0.22-10.58)*	*6.44 (2.46-16.27)*	*6.44 (2.46-16.27)*	*9.04 (3.77-20.84)*			50	*0*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*	*2.44 (0.35-16.08)*	
	65-74	59	*0*	*0*	*0*	*0*			39		*0*	*0*	*0*		
	75+	47	*0*	*0*	*0*	*0*	*0*		37	*0*	*0*	*0*	*0*		
Bearing type unknown	<55	8							8						
	55-64	18		*5.56 (0.80-33.36)*	*5.56 (0.80-33.36)*				10						
	65-74	21	*4.76 (0.68-29.28)*	*17.58 (5.92-45.83)*	*17.58 (5.92-45.83)*				23		*10.00 (2.60-34.40)*	*10.00 (2.60-34.40)*			
	75+	15	*0*	*0*					19	*0*	*0*	*0*			
Unicompartmental knee replacement															
All unicondylar															
	<55	6,473	1.80 (1.49-2.17)	6.62 (5.98-7.33)	9.70 (8.87-10.60)	12.66 (11.60-13.81)	17.84 (16.04-19.81)	*25.08 (20.68-30.24)*	7,379	1.58 (1.31-1.90)	6.48 (5.88-7.14)	10.17 (9.37-11.05)	14.03 (12.98-15.15)	18.35 (16.76-20.08)	*23.80 (19.93-28.28)*
	55-64	14,539	1.10 (0.94-1.29)	4.47 (4.11-4.86)	6.66 (6.20-7.15)	8.44 (7.88-9.03)	11.98 (11.08-12.95)	*15.16 (13.64-16.82)*	12,456	1.06 (0.89-1.26)	4.47 (4.09-4.89)	6.95 (6.45-7.49)	9.29 (8.66-9.97)	12.96 (11.97-14.03)	*15.44 (13.64-17.45)*

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
	65-74	13,457	0.96 (0.81-1.15)	3.39 (3.06-3.74)	4.85 (4.44-5.30)	6.19 (5.68-6.75)	9.04 (8.15-10.01)	*11.59 (9.68-13.86)*	10,670	0.82 (0.66-1.01)	3.40 (3.04-3.81)	5.36 (4.87-5.90)	7.45 (6.81-8.14)	11.03 (9.96-12.20)	*13.30 (11.57-15.26)*
	75+	5,558	0.83 (0.62-1.12)	2.32 (1.92-2.81)	3.34 (2.82-3.96)	4.36 (3.67-5.17)	6.47 (5.29-7.91)	*7.19 (5.51-9.36)*	5,167	1.29 (1.01-1.65)	3.33 (2.84-3.91)	4.84 (4.21-5.57)	6.18 (5.40-7.07)	8.11 (6.99-9.41)	*9.37 (7.65-11.46)*
Unicondylar and															
Fixed	<55	2,554	1.42 (1.01-1.99)	5.87 (4.89-7.03)	9.01 (7.67-10.58)	11.54 (9.76-13.61)	*14.44 (11.64-17.85)*		2,639	1.13 (0.78-1.64)	6.59 (5.56-7.79)	9.78 (8.42-11.35)	13.83 (11.96-15.98)	*17.35 (14.53-20.65)*	*25.73 (16.12-39.57)*
	55-64	4,658	0.61 (0.42-0.90)	3.56 (2.99-4.23)	6.21 (5.38-7.17)	7.95 (6.91-9.13)	*11.16 (9.51-13.07)*	*11.90 (9.82-14.39)*	3,824	0.85 (0.60-1.21)	4.49 (3.80-5.31)	6.79 (5.87-7.85)	9.35 (8.13-10.75)	*11.32 (9.60-13.33)*	*12.86 (10.32-15.97)*
	65-74	3,945	0.70 (0.47-1.03)	3.44 (2.84-4.17)	5.13 (4.31-6.09)	6.59 (5.53-7.83)	*8.01 (6.54-9.79)*	*9.17 (7.16-11.71)*	3,055	0.47 (0.27-0.81)	2.90 (2.28-3.70)	4.60 (3.72-5.67)	6.51 (5.31-7.96)	*9.29 (7.24-11.87)*	*9.29 (7.24-11.87)*
	75+	1,601	0.61 (0.32-1.18)	1.58 (1.02-2.46)	2.93 (1.99-4.29)	3.60 (2.40-5.38)	*5.82 (3.70-9.10)*		1,440	0.92 (0.52-1.62)	2.63 (1.84-3.76)	3.96 (2.90-5.42)	4.59 (3.36-6.26)	*5.86 (4.10-8.35)*	
Mobile	<55	3,834	2.06 (1.65-2.58)	7.08 (6.25-8.02)	10.13 (9.09-11.29)	13.24 (11.94-14.68)	*19.11 (16.92-21.54)*	*25.14 (20.37-30.81)*	4,646	1.84 (1.48-2.28)	6.46 (5.72-7.28)	10.36 (9.37-11.45)	14.25 (12.98-15.64)	18.69 (16.81-20.75)	*23.30 (19.57-27.62)*
	55-64	9,708	1.32 (1.11-1.58)	4.89 (4.45-5.38)	6.94 (6.39-7.54)	8.72 (8.06-9.43)	12.41 (11.34-13.57)	*16.26 (14.43-18.29)*	8,485	1.17 (0.96-1.43)	4.48 (4.03-4.98)	7.08 (6.48-7.73)	9.40 (8.66-10.20)	13.65 (12.46-14.95)	*16.31 (14.23-18.66)*
	65-74	9,383	1.08 (0.89-1.32)	3.41 (3.03-3.84)	4.82 (4.34-5.34)	6.10 (5.52-6.74)	9.39 (8.34-10.56)	*11.88 (9.67-14.56)*	7,492	0.97 (0.76-1.22)	3.63 (3.19-4.12)	5.69 (5.11-6.34)	7.78 (7.04-8.60)	11.53 (10.30-12.90)	*14.36 (12.28-16.75)*
	75+	3,907	0.93 (0.67-1.30)	2.60 (2.10-3.21)	3.53 (2.92-4.27)	4.66 (3.86-5.63)	*6.51 (5.19-8.16)*	*6.51 (5.19-8.16)*	3,670	1.43 (1.08-1.88)	3.58 (2.99-4.29)	5.14 (4.38-6.01)	6.65 (5.72-7.73)	8.73 (7.39-10.29)	*10.34 (8.23-12.96)*
Bearing type unknown	<55	85	*1.18 (0.17-8.06)*	*7.27 (3.33-15.48)*	*10.15 (5.19-19.34)*	*14.20 (7.71-25.34)*	*21.35 (10.02-42.07)*		94	*1.06 (0.15-7.31)*	*6.59 (3.01-14.08)*	*10.33 (5.50-18.96)*	*10.33 (5.50-18.96)*		
	55-64	173	*1.75 (0.57-5.34)*	*3.57 (1.62-7.78)*	*4.28 (2.06-8.78)*	*6.85 (3.70-12.51)*	*8.13 (4.46-14.56)*		147	*0*	*3.77 (1.59-8.82)*	*3.77 (1.59-8.82)*	*3.77 (1.59-8.82)*	*3.77 (1.59-8.82)*	
	65-74	129	*0*	*0.79 (0.11-5.46)*	*1.94 (0.48-7.73)*	*4.48 (1.68-11.68)*	*4.48 (1.68-11.68)*		123	*0*	*1.85 (0.47-7.21)*	*2.86 (0.93-8.63)*	*6.90 (3.12-14.91)*	*11.94 (5.68-24.16)*	
	75+	50		*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*			57	*1.79 (0.25-12.01)*	*3.64 (0.92-13.78)*	*5.93 (1.93-17.43)*	*8.97 (3.36-22.73)*		

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

Continued >

Table 3.24 (b) (continued)

Fixation/ constraint/ bearing type	Age at primary (years)	Males							Females						
		n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is						n	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is					
			1 year	3 years	5 years	7 years	10 years	12 years		1 year	3 years	5 years	7 years	10 years	12 years
All patellofemoral															
	<55	784	2.73 (1.77-4.20)	9.64 (7.60-12.19)	14.84 (12.12-18.12)	*18.41 (15.11-22.34)*	*22.05 (17.49-27.59)*		3,305	1.08 (0.77-1.52)	6.01 (5.16-6.99)	10.06 (8.87-11.40)	14.53 (12.94-16.30)	*21.34 (18.52-24.52)*	*25.53 (20.61-31.37)*
	55-64	788	1.77 (1.03-3.04)	5.90 (4.34-8.00)	10.42 (8.14-13.30)	*14.08 (11.08-17.80)*	*20.90 (15.52-27.82)*		2,671	0.79 (0.51-1.22)	5.44 (4.58-6.47)	9.61 (8.37-11.01)	13.36 (11.76-15.17)	*18.35 (15.93-21.09)*	*21.36 (17.75-25.59)*
	65-74	530	2.59 (1.51-4.42)	7.57 (5.46-10.46)	*11.38 (8.59-15.01)*	*12.83 (9.72-16.85)*	*21.13 (13.87-31.43)*		1,727	0.85 (0.51-1.44)	4.96 (3.98-6.19)	8.12 (6.78-9.72)	11.04 (9.33-13.03)	*18.01 (14.78-21.84)*	*24.39 (18.87-31.19)*
	75+	349	0.63 (0.16-2.51)	*3.75 (2.03-6.88)*	*4.93 (2.79-8.65)*	*5.85 (3.32-10.20)*	*9.77 (4.18-21.95)*		912	0.57 (0.24-1.37)	2.88 (1.90-4.35)	5.60 (4.04-7.75)	*7.06 (5.16-9.63)*	*8.58 (5.96-12.28)*	

Note: 1 Excludes 207 cases where either gender was not specified and/or ages were invalid and NHS trace not complete. Total sample on which results are based is 871,265 primary knee replacements.

3.5.2.4 Revisions for different clinical causes after primary knee replacement surgery

The Kaplan-Meier estimates of the cumulative probability of a first revision of an implant that have been presented so far, have been shown irrespective of the clinical reason given for the revision surgery. This sub-section looks more closely at the various reasons recorded for revision on the MDS data collection form.

Clinicians can indicate more than one diagnosis as the indication for revision surgery on the MDS collection form. This means that the reasons for revision are not mutually exclusive of each other. In addition, over the last twelve years, there have been a number of versions of the MDS collection form and the reasons for revision options available have varied across these versions. As a result of these inconsistencies, we opt to use person-time incidence rates (PTIR) for each reason for revision on record so that the incidence rates for each reason, taking into account the different time periods of availability, can be compared.

Methodological note: Patient-time incidence rate (PTIR)

Incidence rates for each reason have been calculated using patient–time incidence rates (PTIRs). This is found by dividing the total number of times a revision for that specific reason has been given in a period of time by the total number of years all patients have been at risk of revision (for any reason) over the time period.

The PTIRs are given in the tables as the number of revisions for that reason per 1,000 patient-years at risk for the period of time considered.

The PTIR method assumes that the hazard rate remains constant over the whole time period. When this may not be appropriate, PTIR incidence rates for sub-divisions of the whole time period of interest can be calculated to see whether the hazard rate holds constant across smaller time intervals.

In the earliest version of the minimum dataset form for revision, form MDSv1, both arthritis and incorrect sizing were available as clinical reasons for revision surgery to be performed. Subsequent forms, however, omitted these as options available to clinicians. Similarly, stiffness became available as a clinical reason for revision surgery on the later forms MDSv2, MDSv3 and MDSv6 but was not an option on the MDSv1 form.

As the number of cases of incorrect sizing is small and the MDSv1 form on which it was an option ceased to be used after 2004, we have added incorrect sizing to the Other indication category for estimating PTIRs.

In the case of stiffness, an adjustment needs to be made to the total number of patients considered to be at risk as any revisions occurring before the MDSv2 form was issued could not have been at risk of this reason for revision as it could not be selected by the clinician. Checking the year of the primary operation against all knee joints which have been revised over the life of the registry, the MDSv2 form was being used to record reasons for revision in over 95% of all revision surgeries for primary operations which took place from 2005 onwards. Thus, for the PTIR calculation for stiffness, we have restricted the period a primary replaced knee joint is at risk of revision for stiffness to all primary knee joint replacement surgeries which took place from 1 January 2005 onwards. This explains why fewer patient-years at risk are shown for stiffness in the tables discussed in this section.

Table 3.25 shows the revision incidence rates, for each reason recorded on the MDS forms for knee revision surgery, for all cases and then sub-divided by fixation type and whether the primary procedure was a TKR or an UKR.

Table 3.26 shows these first knee revision PTIRs for each reason broken down further by fixation, constraint and bearing type.

For TKRs (see Table 3.25), the highest PTIRs, in descending order, were for revision due to aseptic loosening, pain and infection. Revision incidences for pain and aseptic loosening were slightly higher for implants which were uncemented compared to prosthesis implanted using a hybrid or cemented fixation.

For patellofemoral type unicompartmental replacements, the top three reasons for revision were for Other indication (including progressive arthritis), pain and aseptic loosening. The first two reasons had the highest incidence rates across all reasons by fixation method breakdowns. Similarly for unicondylar knee replacements (medial and lateral unicompartmental knee replacements), the highest three incidence rates for reasons for revising the implant were Other indication, aseptic loosening and pain, respectively.

Interest also lies in whether PTIRs for different reasons remain the same for different time intervals after primary surgery and whether certain reasons for revision are more profound in the short, medium or longer term after primary surgery. To this end, PTIR for each revision reason have been calculated for the following time periods; <1 year, 1 to 3 years, 3 to 5 years, 5 to 7, 7 to 10 and 10 to 12 years after the primary surgery took place.

Table 3.27 shows the PTIR for each specified reason for first revision for different periods of time after primary surgery. It is clear that most of the PTIRs for a particular reason do vary, most especially for infection, aseptic loosening and pain 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 less likely than some other reason. Conversely, revision between one and three years after surgery is more likely for aseptic loosening and pain, with incidence rates dropping off for pain later on. PTIRs for aseptic loosening continue to remain relatively higher than other indicated reasons for revision for implants surviving for longer periods after surgery.

Table 3.25 Revision rates (95% CI), expressed as number of revisions per 1,000 patient-years (PTIRs), for each recorded reason for first knee revision. Rates shown are for all revised cases by total replacement fixation method and by type of partial replacement.

	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:												Patient-years at risk (x1,000)	Revisions per 1,000 patient-years for stiffness[3]
		All causes	Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Peri-prosthetic fracture	Implant fracture	Implant wear[1]	Instability	Mal-alignment	Other indication[2]		
All cases	4,130.5	**4.93 (4.86-5.00)**	0.99 (0.96-1.02)	0.20 (0.19-0.22)	0.99 (0.96-1.02)	1.29 (1.26-1.33)	0.25 (0.23-0.26)	0.15 (0.13-0.16)	0.03 (0.02-0.03)	0.28 (0.26-0.29)	0.71 (0.69-0.74)	0.41 (0.40-0.44)	1.06 (1.03-1.09)	3,726.4	0.36 (0.34-0.38)
TKR by fixation method															
Cemented	3,435.1	3.86 (3.80-3.93)	0.68 (0.65-0.70)	0.12 (0.11-0.14)	1.05 (1.02-1.09)	1.00 (0.97-1.04)	0.22 (0.21-0.24)	0.13 (0.12-0.14)	0.02 (0.02-0.02)	0.17 (0.16-0.19)	0.67 (0.64-0.70)	0.36 (0.34-0.38)	0.58 (0.55-0.60)	3,108.9	0.36 (0.34-0.39)
Uncemented	223.0	4.96 (4.68-5.26)	1.15 (1.02-1.30)	0.22 (0.17-0.29)	0.76 (0.66-0.89)	1.75 (1.59-1.94)	0.28 (0.22-0.36)	0.14 (0.10-0.20)	0.06 (0.03-0.10)	0.26 (0.20-0.34)	0.80 (0.69-0.93)	0.46 (0.38-0.56)	0.73 (0.63-0.85)	195.8	0.41 (0.33-0.51)
Hybrid	55.6	4.14 (3.63-4.71)	0.79 (0.59-1.06)	0.16 (0.08-0.31)	1.06 (0.82-1.37)	1.19 (0.93-1.51)	0.20 (0.11-0.36)	0.13 (0.06-0.26)	0.04 (0.01-0.14)	0.32 (0.20-0.51)	0.72 (0.53-0.98)	0.38 (0.25-0.58)	0.40 (0.26-0.60)	44.2	0.27 (0.15-0.48)
UKR type															
Unicondylar	363.6	13.01 (12.64-13.38)	3.22 (3.04-3.41)	0.83 (0.74-0.93)	0.62 (0.55-0.71)	3.61 (3.42-3.81)	0.46 (0.39-0.53)	0.29 (0.24-0.35)	0.04 (0.02-0.07)	1.08 (0.97-1.19)	1.06 (0.96-1.17)	0.75 (0.67-0.85)	4.67 (4.45-4.89)	328.9	0.23 (0.18-0.29)
Patellofemoral	52.8	19.58 (18.43-20.82)	5.95 (5.32-6.64)	0.93 (0.70-1.23)	0.40 (0.26-0.61)	2.41 (2.02-2.86)	0.23 (0.13-0.40)	0.19 (0.10-0.35)	0.17 (0.09-0.33)	1.76 (1.44-2.16)	1.08 (0.83-1.40)	1.61 (1.30-1.99)	10.04 (9.22-10.93)	48.6	0.58 (0.40-0.83)

Note: 1 Implant failure, as reported on 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. The latter cause for revision is now indicated separately as implant fracture. 2 Other indication now includes arthritis and incorrect sizing. Both these reasons were only asked in MDSv1 and so are associated with primaries which took place in the first few years of the registry with little potential for long term follow-up of the incidence of revision for these specific clinical reasons. 3 This reason was asked in versions MDSv2, v3 and v6 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer patient-years at risk.

Table 3.26 Revision rates (95% CI), expressed as number of revisions per 1,000 patient-years (PTIRs), for each recorded reason for first knee revision. Rates shown are broken down by constraint and bearing sub-group for each total replacement fixation method and for unicondylar partial replacements.

By fixation, constraint and bearing sub-groups	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:						
		All causes	Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Periprosthetic fracture
Total knee replacement								
All cemented	3,435.1	3.86 (3.80-3.93)	0.68 (0.65-0.70)	0.12 (0.11-0.14)	1.05 (1.02-1.09)	1.00 (0.97-1.04)	0.22 (0.21-0.24)	0.13 (0.12-0.14)
All cemented and								
unconstrained, fixed	2,221.6	3.52 (3.44-3.60)	0.66 (0.63-0.69)	0.11 (0.09-0.12)	0.96 (0.92-1.00)	0.85 (0.81-0.89)	0.19 (0.18-0.21)	0.10 (0.09-0.11)
unconstrained, mobile	191.5	4.69 (4.40-5.01)	0.92 (0.79-1.07)	0.24 (0.18-0.32)	1.10 (0.96-1.26)	1.36 (1.21-1.54)	0.36 (0.28-0.46)	0.15 (0.11-0.22)
posterior-stabilised, fixed	854.7	4.33 (4.19-4.47)	0.62 (0.57-0.68)	0.12 (0.10-0.14)	1.26 (1.18-1.33)	1.29 (1.22-1.37)	0.26 (0.23-0.30)	0.19 (0.17-0.22)
posterior-stabilised, mobile	58.7	5.03 (4.49-5.64)	1.02 (0.79-1.32)	0.20 (0.12-0.36)	0.95 (0.73-1.24)	1.14 (0.90-1.45)	0.27 (0.17-0.45)	0.26 (0.15-0.42)
constrained, condylar	15.8	6.09 (4.99-7.44)	0.38 (0.17-0.85)	0.63 (0.34-1.18)	3.11 (2.35-4.11)	1.08 (0.67-1.73)	0.25 (0.10-0.68)	0.38 (0.17-0.85)
bearing type unknown	52.5	5.84 (5.23-6.54)	1.14 (0.89-1.47)	0.19 (0.10-0.35)	1.24 (0.97-1.58)	1.56 (1.26-1.94)	0.27 (0.16-0.45)	0.19 (0.10-0.35)
monobloc polyethylene tibia	40.4	3.57 (3.03-4.20)	0.64 (0.44-0.95)	0.20 (0.10-0.40)	0.97 (0.71-1.32)	0.79 (0.56-1.12)	0.17 (0.08-0.36)	0.17 (0.08-0.36)
All uncemented	223.0	4.96 (4.68-5.26)	1.15 (1.02-1.30)	0.22 (0.17-0.29)	0.76 (0.66-0.89)	1.75 (1.59-1.94)	0.28 (0.22-0.36)	0.14 (0.10-0.20)
All uncemented and								
unconstrained, fixed	90.7	4.98 (4.54-5.46)	0.94 (0.76-1.16)	0.11 (0.06-0.20)	0.73 (0.57-0.93)	1.98 (1.71-2.30)	0.25 (0.17-0.38)	0.13 (0.08-0.23)
unconstrained, mobile	112.8	4.64 (4.26-5.06)	1.17 (0.99-1.39)	0.27 (0.19-0.38)	0.81 (0.66-0.99)	1.52 (1.31-1.77)	0.24 (0.16-0.35)	0.12 (0.07-0.21)
posterior-stabilised, fixed	15.1	7.14 (5.91-8.62)	2.05 (1.44-2.91)	0.53 (0.26-1.06)	0.79 (0.45-1.40)	1.78 (1.22-2.60)	0.66 (0.36-1.23)	0.26 (0.10-0.70)
other constraint	1.0	5.07 (2.11-12.19)	5.07 (2.11-12.19)	1.01 (0.14-7.20)	0.00	1.01 (0.14-7.20)	0.00	0.00
bearing type unknown	3.3	5.12 (3.18-8.24)	0.90 (0.29-2.80)	0.00	0.30 (0.04-2.14)	3.31 (1.83-5.98)	0.90 (0.29-2.80)	0.30 (0.04-2.14)
All hybrid	55.6	4.14 (3.63-4.71)	0.79 (0.59-1.06)	0.16 (0.08-0.31)	1.06 (0.82-1.37)	1.19 (0.93-1.51)	0.20 (0.11-0.36)	0.13 (0.06-0.26)
All hybrid and								
unconstrained, fixed	42.7	3.61 (3.08-4.23)	0.68 (0.47-0.98)	0.19 (0.09-0.37)	0.94 (0.69-1.28)	0.98 (0.73-1.33)	0.16 (0.08-0.34)	0.09 (0.04-0.25)
unconstrained, mobile	6.5	4.76 (3.35-6.76)	0.77 (0.32-1.84)	0.15 (0.02-1.09)	0.92 (0.41-2.05)	1.69 (0.93-3.05)	0.46 (0.15-1.43)	0.15 (0.02-1.09)
posterior-stabilised, fixed	3.3	7.56 (5.11-11.19)	1.21 (0.45-3.22)	0.00	2.72 (1.42-5.23)	2.42 (1.21-4.84)	0.30 (0.04-2.15)	0.60 (0.15-2.42)
other constraint	2.4	4.22 (2.27-7.84)	2.11 (0.88-5.07)	0.00	0.84 (0.21-3.37)	0.42 (0.06-3.00)	0.00	0.00
bearing type unknown	0.7	13.40 (7.21-24.90)	1.34 (0.19-9.51)	0.00	2.68 (0.67-10.71)	5.36 (2.01-14.28)	0.00	0.00
Unicompartmental knee replacement								
All unicondylar	363.6	13.01 (12.64-13.38)	3.22 (3.04-3.41)	0.83 (0.74-0.93)	0.62 (0.55-0.71)	3.61 (3.42-3.81)	0.46 (0.39-0.53)	0.29 (0.24-0.35)
All unicondylar and								
fixed	97.9	12.10 (11.43-12.81)	3.46 (3.11-3.85)	0.12 (0.07-0.22)	0.74 (0.58-0.93)	3.55 (3.20-3.95)	0.40 (0.29-0.55)	0.28 (0.19-0.40)
mobile	260.2	13.40 (12.96-13.85)	3.12 (2.91-3.34)	1.11 (0.99-1.24)	0.59 (0.50-0.69)	3.65 (3.43-3.89)	0.49 (0.41-0.58)	0.30 (0.24-0.37)
bearing type unknown	5.5	10.75 (8.33-13.88)	3.65 (2.35-5.65)	0.36 (0.09-1.46)	0.36 (0.09-1.46)	2.55 (1.51-4.31)	0.00	0.18 (0.03-1.29)
All other/unknown	0.4	2.29 (0.32-16.22)	0.00	0.00	0.00	2.29 (0.32-16.22)	0.00	0.00

Note: 1 Implant failure, as reported on 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. The latter cause for revision is now indicated separately as implant fracture. 2 Other indication now includes arthritis and incorrect sizing. Both these reasons were only asked in MDSv1 and so are associated with primaries which took place in the first few years of the registry with little potential for long term follow-up of the incidence of revision for these specific clinical reasons. 3 This reason was asked in versions MDSv2, v3 and v6 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer patient-years at risk.

Table 3.26 (continued)

By fixation, constraint and bearing sub-groups	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:					Patient-years at risk (x1,000)	Revisions per 1,000 patient-years for stiffness[3]
		Implant fracture[1]	Implant wear[1]	Instability	Malalignment	Other indication[2]		
Total knee replacement								
All cemented	**3,435.1**	**0.02 (0.02-0.02)**	**0.17 (0.16-0.19)**	**0.67 (0.64-0.70)**	**0.36 (0.34-0.38)**	**0.58 (0.55-0.60)**	**3108.9**	**0.36 (0.34-0.39)**
unconstrained, fixed	2,221.6	0.02 (0.01-0.02)	0.15 (0.14-0.17)	0.62 (0.59-0.65)	0.35 (0.33-0.38)	0.56 (0.53-0.60)	2007.5	0.35 (0.33-0.38)
unconstrained, mobile	191.5	0.03 (0.01-0.07)	0.28 (0.22-0.37)	1.02 (0.89-1.18)	0.48 (0.39-0.58)	0.45 (0.37-0.56)	175.0	0.51 (0.42-0.63)
posterior-stabilised, fixed	854.7	0.02 (0.01-0.03)	0.18 (0.15-0.21)	0.67 (0.62-0.73)	0.35 (0.31-0.39)	0.58 (0.53-0.64)	771.9	0.34 (0.30-0.38)
posterior-stabilised, mobile	58.7	0.07 (0.03-0.18)	0.31 (0.19-0.49)	1.04 (0.81-1.34)	0.20 (0.12-0.36)	1.02 (0.79-1.32)	54.4	0.70 (0.51-0.96)
constrained, condylar	15.8	0.00	0.25 (0.10-0.68)	0.82 (0.48-1.42)	0.25 (0.10-0.68)	0.32 (0.13-0.76)	14.3	0.28 (0.11-0.75)
bearing type unknown	52.5	0.10 (0.04-0.23)	0.32 (0.20-0.52)	0.86 (0.64-1.15)	0.48 (0.32-0.70)	1.12 (0.87-1.45)	46.6	0.28 (0.16-0.48)
monobloc polyethylene tibia	40.4	0.02 (0.00-0.18)	0.12 (0.05-0.30)	0.74 (0.52-1.06)	0.55 (0.36-0.83)	0.45 (0.28-0.71)	39.3	0.38 (0.23-0.63)
All uncemented	**223.0**	**0.06 (0.03-0.10)**	**0.26 (0.20-0.34)**	**0.80 (0.69-0.93)**	**0.46 (0.38-0.56)**	**0.73 (0.63-0.85)**	**195.8**	**0.41 (0.33-0.51)**
unconstrained, fixed	90.7	0.04 (0.02-0.12)	0.24 (0.16-0.37)	0.84 (0.67-1.05)	0.44 (0.32-0.60)	0.78 (0.62-0.99)	80.7	0.42 (0.30-0.59)
unconstrained, mobile	112.8	0.06 (0.03-0.13)	0.24 (0.16-0.35)	0.68 (0.55-0.85)	0.42 (0.31-0.55)	0.60 (0.48-0.76)	99.1	0.36 (0.26-0.50)
posterior-stabilised, fixed	15.1	0.13 (0.03-0.53)	0.46 (0.22-0.97)	1.26 (0.80-1.97)	0.93 (0.55-1.56)	1.39 (0.91-2.13)	12.8	0.63 (0.31-1.25)
other constraint	1.0	0.00	0.00	1.01 (0.14-7.20)	0.00	1.01 (0.14-7.20)	1.0	2.09 (0.52-8.36)
bearing type unknown	3.3	0.00	0.60 (0.15-2.41)	1.81 (0.81-4.02)	0.60 (0.15-2.41)	0.60 (0.15-2.41)	2.3	0.43 (0.06-3.07)
All hybrid	**55.6**	**0.04 (0.01-0.14)**	**0.32 (0.20-0.51)**	**0.72 (0.53-0.98)**	**0.38 (0.25-0.58)**	**0.40 (0.26-0.60)**	**44.2**	**0.27 (0.15-0.48)**
unconstrained, fixed	42.7	0.02 (0.00-0.17)	0.33 (0.19-0.55)	0.59 (0.40-0.87)	0.37 (0.23-0.61)	0.33 (0.19-0.55)	33.2	0.21 (0.10-0.44)
unconstrained, mobile	6.5	0.00	0.46 (0.15-1.43)	0.77 (0.32-1.84)	0.77 (0.32-1.84)	0.61 (0.23-1.64)	5.3	0.38 (0.09-1.51)
posterior-stabilised, fixed	3.3	0.00	0.00	1.51 (0.63-3.63)	0.00	0.00	2.8	0.35 (0.05-2.52)
other constraint	2.4	0.00	0.42 (0.06-3.00)	1.69 (0.63-4.50)	0.00	0.42 (0.06-3.00)	2.3	0.87 (0.22-3.49)
bearing type unknown	0.7	1.34 (0.19-9.51)	0.00	1.34 (0.19-9.51)	0.00	4.02 (1.30-12.46)	0.6	0.00
Unicompartmental knee replacement								
All unicondylar	**363.6**	**0.04 (0.02-0.07)**	**1.08 (0.97-1.19)**	**1.06 (0.96-1.17)**	**0.75 (0.67-0.85)**	**4.67 (4.45-4.89)**	**328.9**	**0.23 (0.18-0.29)**
fixed	97.9	0.05 (0.02-0.12)	0.91 (0.74-1.12)	0.83 (0.67-1.03)	0.66 (0.52-0.85)	4.25 (3.86-4.68)	91.1	0.32 (0.22-0.46)
mobile	260.2	0.03 (0.02-0.07)	1.14 (1.02-1.28)	1.14 (1.02-1.28)	0.80 (0.69-0.91)	4.83 (4.57-5.11)	232.9	0.20 (0.15-0.27)
bearing type unknown	5.5	0.18 (0.03-1.29)	0.91 (0.38-2.19)	1.09 (0.49-2.43)	0.36 (0.09-1.46)	4.19 (2.79-6.31)	4.8	0.00
All other/ unknown	**0.4**	**0.00**	**2.29 (0.32-16.22)**	**0.00**	**0.00**	**0.00**	**0.0**	**0.00**

Note: 1 Implant failure, as reported on 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. The latter cause for revision is now indicated separately as implant fracture. 2 Other indication now includes arthritis and incorrect sizing. Both these reasons were only asked in MDSv1 and so are associated with primaries which took place in the first few years of the registry with little potential for long term follow-up of the incidence of revision for these specific clinical reasons. 3 This reason was asked in versions MDSv2, v3 and v6 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer patient-years at risk.

Table 3.27 Revision rates (95% CI) broken down by time period in which primary was revised, expressed as number of revisions per 1,000 patient-years (PTIRs), for each recorded reason for first knee revision.

Time period (years) since primary	Patient-years at risk (x1,000)	Number of revisions per 1,000 patient-years (95% CI) for:												Patient-years at risk (x1,000)	Revisions per 1,000 patient-years for stiffness[3]
		All causes	Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Peri-prosthetic fracture	Implant fracture	Implant wear[1]	Instability	Mal-alignment	Other indication[2]		
All cases	4,130.5	4.93 (4.86-5.00)	0.99 (0.96-1.02)	0.20 (0.19-0.22)	0.99 (0.96-1.02)	1.29 (1.26-1.33)	0.25 (0.23-0.26)	0.15 (0.13-0.16)	0.03 (0.02-0.03)	0.28 (0.26-0.29)	0.71 (0.69-0.74)	0.41 (0.40-0.44)	1.06 (1.03-1.09)	3925.5	0.35 (0.33-0.37)
<1	819.1	4.57 (4.42-4.72)	0.62 (0.57-0.68)	0.40 (0.36-0.44)	1.60 (1.52-1.69)	0.66 (0.60-0.71)	0.11 (0.09-0.14)	0.26 (0.22-0.29)	0.01 (0.00-0.02)	0.19 (0.17-0.23)	0.57 (0.52-0.63)	0.36 (0.32-0.40)	0.69 (0.64-0.75)	798.9	0.33 (0.29-0.37)
1-3	1,320.8	6.71 (6.57-6.85)	1.65 (1.58-1.72)	0.22 (0.20-0.25)	1.28 (1.22-1.35)	1.67 (1.60-1.74)	0.27 (0.25-0.30)	0.12 (0.10-0.14)	0.03 (0.02-0.04)	0.25 (0.22-0.27)	0.99 (0.93-1.04)	0.60 (0.56-0.65)	1.38 (1.31-1.44)	1,281.6	0.56 (0.52-0.61)
3-5	936.9	4.23 (4.10-4.36)	0.93 (0.87-1.00)	0.10 (0.08-0.13)	0.65 (0.60-0.70)	1.32 (1.25-1.40)	0.26 (0.22-0.29)	0.11 (0.09-0.13)	0.02 (0.01-0.03)	0.24 (0.21-0.27)	0.64 (0.59-0.69)	0.37 (0.33-0.41)	0.96 (0.90-1.02)	900.0	0.27 (0.24-0.31)
5-7	599.7	3.57 (3.42-3.73)	0.59 (0.53-0.66)	0.09 (0.07-0.12)	0.52 (0.47-0.58)	1.23 (1.14-1.32)	0.28 (0.24-0.33)	0.10 (0.08-0.13)	0.03 (0.02-0.05)	0.33 (0.28-0.37)	0.51 (0.46-0.57)	0.29 (0.25-0.33)	0.98 (0.90-1.06)	565.4	0.17 (0.14-0.21)
7-11	393.1	3.58 (3.39-3.77)	0.45 (0.38-0.52)	0.13 (0.10-0.18)	0.38 (0.32-0.44)	1.33 (1.22-1.45)	0.34 (0.29-0.41)	0.16 (0.12-0.20)	0.04 (0.02-0.06)	0.49 (0.43-0.57)	0.60 (0.52-0.68)	0.23 (0.19-0.28)	1.12 (1.02-1.23)	347.3	0.14 (0.10-0.18)
10-12	60.9	4.05 (3.58-4.59)	0.25 (0.15-0.41)	0.18 (0.10-0.33)	0.33 (0.21-0.51)	1.69 (1.39-2.05)	0.33 (0.21-0.51)	0.21 (0.12-0.37)	0.05 (0.02-0.15)	0.92 (0.71-1.19)	0.74 (0.55-0.99)	0.23 (0.14-0.39)	1.36 (1.10-1.69)	32.4	0.06 (0.02-0.25)

Note: 1 Implant failure, as reported on 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. The latter cause for revision is now indicated separately as implant fracture. 2 Other indication now includes arthritis and incorrect sizing. Both these reasons were only asked in MDSv1 and so are associated with primaries which took place in the first few years of the registry with little potential for long term follow-up of the incidence of revision for these specific clinical reasons. 3 This reason was asked in versions MDSv2, v3 and v6 of the clinical assessment forms for joint replacement/revision surgery and hence, for these reasons, there are fewer patient-years at risk.

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

Tables 3.28 and 3.29 show the Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any reason, of a primary TKR (Table 3.28) and primary UKR (Table 3.29) by implant brand. We have only included those brands that have been used in a primary knee procedure in 1,000 or more operations. Figures in *blue italics* indicate those time points where fewer than 250 primary knee joint replacements remain at risk. No attempt has been made to adjust for other factors that may influence the chance of revision so the figures are unadjusted probabilities. In addition, simple indicators of the age profile and proportion of male patients who typically receive that implant brand are shown.

Table 3.30 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. Again, patient summaries of age and gender by brand are also given.

Table 3.28 Kaplan-Meier estimated cumulative percentage probability of first revision (95% CI) of a primary total knee replacement by main type of implant brand at the indicated number of years after primary operation[1].

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
All total knee replacements	**784,640**	**70 (63-76)**	**42%**	**0.40 (0.39-0.42)**	**1.53 (1.50-1.56)**	**2.18 (2.15-2.22)**	**2.70 (2.65-2.74)**	**3.42 (3.35-3.49)**
ACS	1,779	68 (62-75)	47%	0.71 (0.40-1.25)	3.31 (2.50-4.37)	3.67 (2.80-4.81)	4.48 (3.44-5.81)	*5.03 (3.66-6.88)*
Advance MP	7,348	70 (63-76)	46%	0.49 (0.35-0.68)	2.07 (1.74-2.45)	2.88 (2.47-3.36)	3.59 (3.10-4.16)	4.27 (3.54-5.14)
Advance MP Stature	1,204	68 (62-75)	15%	0.09 (0.01-0.62)	1.66 (1.00-2.75)	3.37 (2.19-5.17)	*3.37 (2.19-5.17)*	
Advance PS	1,020	72 (66-77)	45%	0.61 (0.28-1.36)	2.65 (1.76-3.96)	3.52 (2.45-5.05)	4.38 (3.09-6.18)	*6.33 (4.09-9.74)*
AGC	63,196	71 (64-77)	43%	0.30 (0.26-0.35)	1.49 (1.39-1.59)	2.07 (1.96-2.20)	2.63 (2.49-2.78)	3.56 (3.34-3.79)
Attune	4,463	68 (61-75)	44%	0.25 (0.13-0.49)	*1.39 (0.64-3.03)*			
Columbus	9,128	70 (64-76)	43%	0.46 (0.34-0.64)	1.84 (1.53-2.20)	2.54 (2.13-3.02)	2.90 (2.42-3.48)	*4.40 (2.43-7.91)*
E-Motion Bicondylar Knee	2,905	67 (61-74)	45%	0.75 (0.49-1.15)	2.45 (1.91-3.14)	3.25 (2.57-4.10)	4.34 (3.45-5.44)	*4.62 (3.62-5.89)*
Endo Rotating Hinge	1,057	76 (68-83)	29%	1.57 (0.95-2.59)	4.09 (2.93-5.70)	5.84 (4.32-7.88)	*6.71 (4.97-9.02)*	*11.06 (6.70-17.95)*
Genesis 2	50,899	71 (65-77)	42%	0.39 (0.34-0.45)	1.39 (1.28-1.51)	1.90 (1.75-2.05)	2.35 (2.17-2.55)	2.78 (2.51-3.07)
Genesis 2 Oxinium	7,229	58 (53-64)	42%	0.54 (0.39-0.75)	2.29 (1.93-2.70)	3.42 (2.95-3.96)	4.23 (3.65-4.89)	5.73 (4.77-6.88)
†Insall-Burstein 2	2,587	71 (65-77)	45%	0.27 (0.13-0.57)	1.64 (1.21-2.22)	2.91 (2.31-3.65)	3.77 (3.08-4.62)	5.23 (4.34-6.31)
†Kinemax	10,923	71 (64-77)	43%	0.25 (0.17-0.36)	1.77 (1.53-2.03)	2.69 (2.40-3.02)	3.51 (3.17-3.89)	4.71 (4.28-5.18)
†LCS	2,043	70 (63-76)	41%	0.64 (0.37-1.10)	1.80 (1.30-2.48)	2.38 (1.79-3.15)	2.66 (2.03-3.48)	3.10 (2.41-3.99)
LCS Complete	23,771	70 (63-76)	45%	0.45 (0.37-0.55)	1.69 (1.53-1.88)	2.60 (2.38-2.84)	3.15 (2.89-3.43)	3.82 (3.45-4.24)
Maxim	2,177	70 (63-77)	42%	0.37 (0.19-0.74)	1.81 (1.32-2.48)	2.67 (2.05-3.48)	3.32 (2.59-4.24)	4.69 (3.66-6.00)

Continued >

Table 3.28 (continued)

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
MRK	9,115	70 (64-77)	42%	0.28 (0.19-0.42)	1.26 (1.03-1.56)	1.68 (1.39-2.03)	2.35 (1.96-2.82)	3.30 (2.54-4.29)
Natural Knee II	2,827	70 (64-76)	42%	0.32 (0.17-0.62)	1.34 (0.97-1.85)	2.26 (1.74-2.93)	3.55 (2.83-4.44)	4.28 (3.38-5.40)
Nexgen	117,347	70 (63-76)	42%	0.37 (0.33-0.41)	1.41 (1.34-1.49)	2.15 (2.05-2.26)	2.81 (2.68-2.95)	3.62 (3.43-3.82)
NRG	12,304	70 (64-76)	43%	0.39 (0.29-0.52)	1.61 (1.39-1.87)	2.43 (2.14-2.76)	2.94 (2.58-3.36)	
Optetrak	2,430	70 (63-76)	43%	0.71 (0.44-1.13)	2.91 (2.30-3.67)	4.45 (3.65-5.41)	5.15 (4.26-6.23)	*7.79 (5.85-10.32)*
PFC Sigma Bicondylar Knee	270,232	70 (64-76)	43%	0.38 (0.35-0.40)	1.36 (1.32-1.41)	1.88 (1.82-1.94)	2.21 (2.14-2.28)	2.65 (2.55-2.75)
Profix	3,979	73 (67-78)	44%	0.38 (0.23-0.63)	1.31 (1.00-1.73)	1.88 (1.49-2.37)	2.35 (1.90-2.91)	2.76 (2.23-3.41)
Rotaglide	1,370	71 (63-77)	38%	0.39 (0.16-0.93)	2.21 (1.51-3.23)	3.34 (2.41-4.63)	4.24 (3.09-5.81)	*4.58 (3.31-6.34)*
† Rotaglide +	2,113	70 (63-76)	44%	0.62 (0.36-1.06)	3.01 (2.36-3.85)	3.93 (3.17-4.87)	4.72 (3.86-5.75)	6.36 (5.26-7.68)
Scorpio	25,181	71 (64-77)	42%	0.43 (0.35-0.52)	1.80 (1.64-1.98)	2.59 (2.39-2.80)	3.20 (2.98-3.43)	4.01 (3.73-4.32)
TC Plus	14,932	70 (64-76)	44%	0.67 (0.55-0.82)	1.78 (1.58-2.02)	2.40 (2.16-2.67)	2.79 (2.52-3.08)	3.40 (3.03-3.82)
Triathlon	63,568	70 (63-76)	42%	0.47 (0.41-0.53)	1.58 (1.47-1.70)	2.18 (2.02-2.34)	2.74 (2.51-3.00)	*3.32 (2.83-3.90)*
Vanguard	43,342	70 (63-76)	42%	0.32 (0.27-0.38)	1.44 (1.31-1.59)	2.11 (1.91-2.33)	2.50 (2.22-2.81)	

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable. 2 Brands shown have been used in at least 1,000 primary total knee replacement operations.
Excludes 7,014 primary operations where the knee brand was not recorded. † denotes a brand that has been discontinued/withdrawn/not implanted in last three years.

Table 3.29 Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) of a primary unicompartmental knee replacement by main type of implant brand at the indicated number of years after primary operation[1].

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
All unicompartmental knee replacements	**86,787**	**63 (56-70)**	**49%**	**1.13 (1.06-1.21)**	**4.46 (4.31-4.62)**	**6.85 (6.65-7.05)**	**9.08 (8.83-9.33)**	**12.79 (12.39-13.21)**
Patellofemoral								
Avon	4,842	59 (51-68)	22%	0.79 (0.57-1.09)	4.25 (3.67-4.91)	7.55 (6.75-8.45)	10.21 (9.22-11.31)	14.86 (13.31-16.57)
FPV	1,537	59 (51-68)	23%	0.95 (0.56-1.59)	6.54 (5.34-8.01)	9.78 (8.21-11.62)	*11.34 (9.54-13.46)*	
Journey PFJ Oxinium	1,454	58 (50-67)	22%	2.21 (1.55-3.15)	7.24 (5.92-8.83)	12.49 (10.62-14.67)	18.43 (15.84-21.39)	
Sigma HP	1,023	59 (51-67)	22%	2.61 (1.77-3.84)	8.03 (6.32-10.17)	*12.65 (10.10-15.79)*	*18.12 (12.00-26.87)*	
Zimmer PFJ	1,448	57 (50-66)	22%	0.64 (0.32-1.28)	3.99 (2.90-5.48)	*5.09 (3.72-6.96)*	*10.26 (5.29-19.41)*	
Unicondylar								
AMC/Uniglide	2,719	64 (57-71)	50%	2.24 (1.74-2.88)	6.00 (5.14-7.00)	7.67 (6.66-8.82)	9.97 (8.72-11.40)	*12.28 (10.51-14.32)*
† MG Unicondylar	2,374	63 (56-70)	54%	0.89 (0.58-1.36)	3.91 (3.20-4.77)	5.92 (5.04-6.96)	7.64 (6.62-8.82)	10.27 (8.91-11.82)
Oxford Partial Knee	50,033	64 (57-71)	52%	1.15 (1.06-1.26)	4.17 (3.98-4.36)	6.28 (6.03-6.53)	8.29 (7.99-8.60)	12.02 (11.51-12.54)
† Preservation	1,512	62 (56-69)	55%	2.32 (1.67-3.22)	7.68 (6.44-9.15)	11.30 (9.79-13.02)	14.32 (12.62-16.23)	17.11 (15.14-19.32)
Sigma HP	6,191	62 (55-69)	57%	0.82 (0.61-1.10)	3.65 (3.11-4.28)	5.20 (4.42-6.12)	*5.85 (4.79-7.14)*	
*Zimmer Unicompartment	8,227	62 (55-69)	55%	0.43 (0.31-0.62)	2.63 (2.23-3.11)	4.19 (3.60-4.88)	5.53 (4.72-6.48)	*6.31 (5.16-7.70)*

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. Blank cells indicate the number at risk is below ten and therefore estimates are omitted as they are unreliable. 2 Brands shown have been used in at least 1,000 primary total knee replacement operations. Excludes 126 primary operations where the knee brand was not recorded. † denotes a brand that has been discontinued/withdrawn/not implanted in last three years. * denotes that this brand is now marketed by Lima.

Table 3.30 Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) of a total knee replacement or unicompartmental knee replacement at the indicated number of years after primary operation, by main implant brands and, within brand, by type of fixation, constraint and bearing sub-group[1, 3].

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
Total knee replacements								
Advance MP								
Cement, unconstrained fixed	7,114	70 (63-76)	46%	0.47 (0.34-0.67)	2.00 (1.68-2.38)	2.72 (2.32-3.19)	3.46 (2.96-4.04)	4.16 (3.42-5.05)
Advance MP Stature								
Cement, unconstrained fixed	1,200	68 (62-75)	15%	0.09 (0.01-0.62)	1.67 (1.00-2.76)	3.39 (2.20-5.20)	*3.39 (2.20-5.20)*	
Advance PS								
Cement, posterior-stabilised fixed	1,020	72 (66-77)	45%	0.61 (0.28-1.36)	2.65 (1.76-3.96)	3.52 (2.45-5.05)	4.38 (3.09-6.18)	*6.33 (4.09-9.74)*
AGC								
Uncemented hybrid, unconstrained fixed	2,097	70 (63-76)	50%	1.11 (0.74-1.66)	3.26 (2.58-4.13)	3.96 (3.20-4.91)	4.52 (3.67-5.55)	*5.99 (4.68-7.65)*
Cement, unconstrained fixed	59,787	71 (64-77)	42%	0.27 (0.23-0.31)	1.42 (1.32-1.52)	2.00 (1.88-2.12)	2.53 (2.39-2.69)	3.44 (3.22-3.68)
Attune								
Cement, posterior-stabilised fixed	1,251	68 (61-76)	41%	0.37 (0.14-0.98)				
Cement, unconstrained fixed	2,230	68 (61-75)	45%	0.20 (0.06-0.65)				
Columbus								
Cement, unconstrained fixed	8,256	70 (64-76)	44%	0.41 (0.29-0.58)	1.75 (1.44-2.12)	2.40 (2.00-2.89)	2.79 (2.30-3.40)	*4.54 (2.32-8.79)*
E-Motion Bicondylar Knee								
Uncemented hybrid, unconstrained mobile	1,887	67 (61-74)	49%	0.87 (0.54-1.42)	2.01 (1.44-2.80)	2.79 (2.07-3.77)	3.97 (3.01-5.24)	*4.29 (3.19-5.76)*
Genesis 2								
Cement, unconstrained fixed	36,818	71 (65-77)	43%	0.32 (0.27-0.39)	1.22 (1.10-1.36)	1.71 (1.55-1.88)	2.16 (1.95-2.39)	2.56 (2.27-2.88)
Cement, posterior-stabilised fixed	12,267	71 (65-77)	39%	0.61 (0.48-0.77)	1.85 (1.59-2.15)	2.42 (2.09-2.79)	2.88 (2.47-3.35)	*3.31 (2.65-4.12)*
Genesis 2 Oxinium								
Cement, posterior-stabilised fixed	2,350	58 (53-63)	42%	0.78 (0.48-1.24)	3.01 (2.32-3.90)	4.40 (3.47-5.59)	5.99 (4.68-7.65)	*6.29 (4.89-8.08)*
Cement, unconstrained fixed	4,583	59 (54-64)	42%	0.44 (0.28-0.69)	1.97 (1.57-2.47)	3.05 (2.51-3.70)	3.61 (2.98-4.36)	5.38 (4.29-6.75)
†Insall-Burstein 2								
Cement, posterior-stabilised fixed	2,393	71 (65-77)	46%	0.30 (0.14-0.62)	1.47 (1.05-2.05)	2.75 (2.15-3.51)	3.44 (2.75-4.29)	4.76 (3.89-5.83)
†Kinemax								
Cement, unconstrained fixed	10,670	71 (64-77)	43%	0.25 (0.17-0.36)	1.79 (1.55-2.06)	2.71 (2.41-3.04)	3.53 (3.19-3.92)	4.72 (4.29-5.20)
†LCS								
Uncemented hybrid, unconstrained mobile	1,357	70 (63-76)	41%	0.74 (0.40-1.37)	1.87 (1.27-2.76)	2.42 (1.72-3.40)	2.50 (1.79-3.50)	2.69 (1.94-3.73)
LCS Complete								
Cement, unconstrained mobile	10,205	70 (64-76)	42%	0.43 (0.32-0.59)	1.62 (1.37-1.90)	2.70 (2.37-3.08)	3.37 (2.97-3.82)	4.64 (3.87-5.55)
Uncemented hybrid, unconstrained mobile	13,438	69 (62-75)	46%	0.47 (0.37-0.61)	1.77 (1.55-2.03)	2.53 (2.24-2.85)	2.95 (2.62-3.32)	3.26 (2.88-3.70)
Maxim								
Cement, unconstrained fixed	1,322	69 (63-76)	43%	0.15 (0.04-0.61)	1.48 (0.94-2.30)	2.17 (1.49-3.15)	2.95 (2.10-4.12)	3.98 (2.88-5.50)

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 Brands shown have been used in at least 1,000 primary knee replacement operations for that type of fixation and bearing type. 3 Excludes 4,916 joint replacements with no record of main brand. † denotes a brand that has been discontinued/withdrawn/not implanted in the last three years. * denotes that this brand is now marketed by Lima

Continued >

Table 3.30 (continued)

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
MRK								
Cement, unconstrained fixed	8,962	70 (64-77)	42%	0.29 (0.19-0.43)	1.27 (1.03-1.56)	1.69 (1.40-2.05)	2.37 (1.97-2.85)	3.33 (2.56-4.32)
Natural Knee II								
Cement, unconstrained fixed	2,683	70 (64-76)	41%	0.34 (0.18-0.65)	1.41 (1.02-1.95)	2.24 (1.71-2.93)	3.36 (2.65-4.26)	4.16 (3.24-5.33)
Nexgen								
Uncemented hybrid, unconstrained fixed	5,010	65 (59-72)	55%	0.55 (0.38-0.80)	2.29 (1.90-2.76)	2.91 (2.46-3.44)	3.25 (2.77-3.82)	3.65 (3.08-4.33)
Cement, posterior-stabilised fixed	56,035	70 (64-77)	41%	0.42 (0.37-0.48)	1.56 (1.45-1.68)	2.50 (2.34-2.66)	3.30 (3.10-3.51)	4.32 (4.03-4.63)
Cement, PS mobile	1,010	67 (59-74)	40%	0.92 (0.48-1.76)	2.90 (1.98-4.24)	3.73 (2.65-5.25)	5.07 (3.72-6.89)	*6.73 (5.01-9.01)*
Cement, unconstrained fixed	51,545	70 (63-76)	42%	0.28 (0.24-0.34)	1.10 (1.00-1.21)	1.59 (1.46-1.74)	2.12 (1.94-2.32)	2.60 (2.33-2.91)
Uncemented hybrid,ps fixed	2,048	65 (58-73)	54%	0.31 (0.14-0.69)	1.68 (1.17-2.41)	2.32 (1.68-3.21)	2.91 (2.13-3.97)	*3.65 (2.66-5.00)*
NRG								
Cement, posterior-stabilised fixed	4,645	70 (63-77)	43%	0.44 (0.28-0.68)	1.71 (1.36-2.14)	2.42 (1.98-2.96)	2.86 (2.35-3.47)	
Cement, unconstrained fixed	7,429	70 (64-77)	43%	0.34 (0.23-0.51)	1.53 (1.26-1.87)	2.40 (2.02-2.85)	2.91 (2.43-3.48)	
Optetrak								
Cement, posterior-stabilised fixed	1,608	70 (63-76)	41%	0.56 (0.29-1.08)	2.69 (1.99-3.62)	4.61 (3.65-5.82)	5.25 (4.18-6.57)	*8.82 (5.81-13.29)*
PFC Sigma Bicondylar Knee								
Cement, bearing/ constraint unknown	2,038	71 (64-77)	47%	0.35 (0.17-0.73)	1.58 (1.11-2.25)	2.33 (1.73-3.15)	2.78 (2.08-3.71)	*2.89 (2.17-3.84)*
Cement, posterior-stabilised fixed	69,776	71 (64-77)	41%	0.39 (0.34-0.44)	1.48 (1.38-1.58)	2.05 (1.93-2.17)	2.40 (2.27-2.55)	2.94 (2.74-3.14)
monobloc polyethylene tibia	8,496	75 (70-79)	41%	0.32 (0.22-0.48)	1.35 (1.09-1.67)	1.74 (1.40-2.17)	1.94 (1.52-2.48)	*2.67 (1.52-4.66)*
Cement, unconstrained fixed	172,131	70 (64-76)	43%	0.35 (0.32-0.38)	1.25 (1.19-1.31)	1.72 (1.65-1.79)	2.01 (1.93-2.10)	2.38 (2.27-2.50)
Cement, PS mobile	6,719	65 (59-72)	46%	0.69 (0.51-0.92)	2.11 (1.78-2.51)	2.83 (2.43-3.30)	3.44 (2.96-3.99)	4.32 (3.55-5.26)
Uncemented hybrid, unconstrained mobile	1,006	68 (62-75)	49%	0.83 (0.42-1.66)	1.57 (0.93-2.64)	2.03 (1.26-3.26)	*2.52 (1.58-4.01)*	*3.67 (2.11-6.36)*
Uncemented hybrid, unconstrained fixed	1,708	70 (63-76)	46%	0.35 (0.16-0.79)	1.22 (0.79-1.89)	1.82 (1.27-2.61)	1.90 (1.33-2.70)	2.32 (1.62-3.31)
Cement, unconstrained mobile	7,571	64 (58-72)	48%	0.59 (0.43-0.79)	1.87 (1.58-2.22)	2.64 (2.28-3.07)	3.03 (2.63-3.50)	3.61 (3.08-4.22)
Profix								
Uncemented hybrid, unconstrained fixed	2,310	73 (66-78)	45%	0.26 (0.12-0.59)	1.20 (0.83-1.75)	1.50 (1.07-2.10)	1.76 (1.27-2.43)	2.17 (1.55-3.05)
Rotaglide								
Cement, unconstrained mobile	1,304	71 (63-77)	38%	0.24 (0.08-0.74)	2.05 (1.37-3.08)	3.24 (2.30-4.54)	3.75 (2.69-5.22)	*4.11 (2.90-5.80)*
†Rotaglide +								
Cement, unconstrained mobile	1,710	70.5 (64-77)	43%	0.47 (0.24-0.94)	2.83 (2.13-3.74)	3.65 (2.85-4.68)	4.25 (3.36-5.37)	5.77 (4.61-7.21)
Scorpio								
Cement, posterior-stabilised fixed	6,087	71 (65-77)	41%	0.23 (0.14-0.39)	1.58 (1.29-1.93)	2.36 (2.00-2.78)	3.08 (2.66-3.57)	3.93 (3.39-4.57)
Cement, unconstrained fixed	10,701	71 (64-77)	41%	0.44 (0.33-0.59)	1.86 (1.62-2.14)	2.61 (2.32-2.94)	3.16 (2.82-3.52)	3.84 (3.43-4.29)
Cement, unconstrained mobile	1,171	69 (63-75)	43%	0.34 (0.13-0.91)	2.54 (1.77-3.64)	3.63 (2.69-4.90)	4.50 (3.43-5.90)	*5.04 (3.84-6.60)*
Uncemented hybrid, unconstrained fixed	4,810	71 (64-77)	45%	0.61 (0.42-0.87)	1.80 (1.46-2.23)	2.50 (2.08-3.00)	3.04 (2.56-3.61)	4.37 (3.58-5.33)

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 Brands shown have been used in at least 1,000 primary knee replacement operations for that type of fixation and bearing type. 3 Excludes 4,916 joint replacements with no record of main brand. † denotes a brand that has been discontinued/withdrawn/not implanted in the last three years. * denotes that this brand is now marketed by Lima

Table 3.30 (continued)

Brand[2]	Number of knee joints	Median (IQR) age at primary	Percentage (%) male	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is				
				1 year	3 years	5 years	7 years	10 years
Cement, PS mobile	1,368	68 (61-76)	44%	0.37 (0.15-0.88)	1.49 (0.96-2.30)	2.20 (1.53-3.15)	2.57 (1.83-3.60)	3.56 (2.55-4.95)
TC Plus								
Cement, unconstrained mobile	4,714	70 (64-76)	44%	0.51 (0.35-0.77)	1.49 (1.17-1.89)	2.06 (1.67-2.52)	2.46 (2.03-2.98)	3.12 (2.54-3.83)
Cement, unconstrained fixed	7,889	71 (64-76)	46%	0.75 (0.58-0.97)	1.90 (1.62-2.23)	2.55 (2.22-2.93)	2.93 (2.57-3.34)	3.50 (2.96-4.12)
Uncemented hybrid, unconstrained mobile	1,930	71 (64-77)	39%	0.55 (0.29-1.01)	1.63 (1.12-2.37)	2.34 (1.68-3.23)	2.68 (1.95-3.69)	*3.38 (2.39-4.75)*
Triathlon								
Uncemented hybrid, unconstrained fixed	1,133	69 (62-76)	47%	0.97 (0.52-1.80)	2.98 (2.02-4.36)	*3.29 (2.27-4.77)*		
Cement, posterior-stabilised fixed	12,491	70 (63-76)	41%	0.58 (0.46-0.74)	1.64 (1.41-1.92)	2.52 (2.18-2.92)	3.01 (2.52-3.58)	
Cement, unconstrained fixed	49,352	70 (63-76)	43%	0.42 (0.37-0.49)	1.52 (1.39-1.66)	2.03 (1.86-2.21)	2.61 (2.34-2.91)	*3.11 (2.60-3.71)*
Vanguard								
Cement, posterior-stabilised fixed	5,740	70 (63-77)	40%	0.37 (0.24-0.58)	1.90 (1.49-2.42)	2.91 (2.28-3.72)	*3.70 (2.69-5.06)*	
Cement, unconstrained fixed	34,809	70 (63-76)	42%	0.32 (0.26-0.39)	1.40 (1.25-1.56)	2.03 (1.82-2.27)	2.36 (2.07-2.68)	
Cement, constrained condylar	1,402	69 (63-76)	39%	0.28 (0.09-0.87)	*1.38 (0.56-3.36)*			
Unicompartmental knee replacements								
AMC/Uniglide								
Unicondylar, fixed	1,306	67 (60-75)	47%	0.32 (0.12-0.85)	3.10 (2.23-4.30)	4.67 (3.52-6.18)	7.05 (5.37-9.24)	*9.45 (6.73-13.19)*
Unicondylar, mobile	1,397	62 (56-68)	53%	4.03 (3.11-5.21)	8.70 (7.31-10.35)	10.47 (8.92-12.28)	12.76 (10.96-14.82)	*14.93 (12.73-17.48)*
Avon								
Patello-femoral	4,843	59 (51-68)	22%	0.79 (0.57-1.09)	4.25 (3.67-4.90)	7.55 (6.74-8.45)	10.21 (9.22-11.30)	14.86 (13.31-16.57)
FPV								
Patello-femoral	1,537	59 (51-68)	23%	0.95 (0.56-1.59)	6.54 (5.34-8.01)	9.78 (8.21-11.62)	*11.34 (9.54-13.46)*	
Journey PFJ Oxinium								
Patello-femoral	1,454	58 (50-67)	22%	2.21 (1.55-3.15)	7.24 (5.92-8.83)	12.49 (10.62-14.67)	18.43 (15.84-21.39)	
†MG Uni								
Unicondylar, fixed	2,334	63 (57-70)	55%	0.86 (0.55-1.33)	3.93 (3.21-4.81)	5.94 (5.04-6.99)	7.64 (6.61-8.83)	10.17 (8.82-11.71)
Oxford Partial Knee								
Unicondylar, mobile	49,093	64 (57-71)	52%	1.16 (1.07-1.27)	4.19 (4.00-4.38)	6.31 (6.07-6.57)	8.33 (8.02-8.64)	12.04 (11.54-12.57)
†Preservation								
Unicondylar, fixed	1,217	63 (57-70)	54%	1.81 (1.20-2.74)	6.82 (5.53-8.40)	10.14 (8.56-12.00)	13.02 (11.22-15.10)	*14.80 (12.72-17.18)*
Sigma HP								
Patello-femoral	1,023	59 (51-67)	22%	2.61 (1.77-3.84)	8.03 (6.32-10.17)	*12.65 (10.10-15.79)*	*18.12 (12.00-26.87)*	
Unicondylar, fixed	6,179	62 (55-69)	57%	0.82 (0.61-1.10)	3.64 (3.10-4.26)	5.19 (4.41-6.11)	*5.85 (4.78-7.14)*	
Zimmer PFJ								
Patello-femoral	1,449	57 (50-66)	22%	0.64 (0.32-1.28)	3.99 (2.90-5.48)	*5.09 (3.72-6.95)*	*10.26 (5.28-19.41)*	
***Zimmer Unicompartmental**								
Unicondylar, fixed	8,093	62 (55-69)	55%	0.44 (0.31-0.63)	2.59 (2.19-3.07)	4.18 (3.58-4.89)	5.55 (4.71-6.53)	*6.17 (5.03-7.57)*

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 Brands shown have been used in at least 1,000 primary knee replacement operations for that type of fixation and bearing type. 3 Excludes 4,916 joint replacements with no record of main brand. † denotes a brand that has been discontinued/withdrawn/not implanted in the last three years. * denotes that this brand is now marketed by Lima

3.5.3 Mortality after primary knee surgery

This section looks at differences in the likelihood of a patient dying at increasing lengths of time after primary operation according to a patient's gender and age at the time of primary. Kaplan-Meier estimates of the cumulative percentage probabilities of a patient undergoing knee surgery dying in the short term (30 or 90 days after the primary operation) and in the longer term, up to twelve years after their primary operation are shown. For simplicity, we do not take into account whether the patient had a first (or further) joint revision after the primary operation when calculating the cumulative probability of death (see statistical methodology note III).

Of the 871,472 records of a primary knee replacement operation over the period 1 April 2003 to 31 December 2015, 201 did not have an NHS number and therefore any record of their death could not be traced. There were also ten individuals with missing information on their age (five) or gender (five). These were all excluded from analyses on mortality. Among those remaining, 9,790 were bilateral operations, where the patient had had both knees replaced on the same day. Patients identified as having a bilateral operation have had the second recorded joint excluded from the sample used for mortality analysis.

This identified a mortality analysis sample of 861,478 distinct patients who had undergone a primary operation to replace one or both knees within the NJR and 93,236 of these patients died in the post-operative time period up to 31 December 2015.

Table 3.31 shows the Kaplan-Meier estimated cumulative percentage probability of a patient dying at the indicated number of years after surgery stratified by age group 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.

Table 3.31 Kaplan-Meier estimated cumulative percentage probability (95% CI) of a patient dying at the indicated number of years after a primary knee joint replacement operation by age group and gender.

Age group (years)	Number of patients	Cumulative percentage probability of patient death (95% CI) if time elapsed since primary operation is							
		30 days	90 days	1 year	3 years	5 years	7 years	10 years	12 years
Males									
<55	26,055	0.03 (0.02-0.07)	0.06 (0.04-0.10)	0.27 (0.21-0.34)	1.04 (0.91-1.18)	1.87 (1.68-2.08)	3.00 (2.72-3.31)	5.31 (4.76-5.92)	*7.92 (6.62-9.47)*
55-59	32,898	0.07 (0.04-0.10)	0.12 (0.08-0.16)	0.39 (0.32-0.46)	1.46 (1.32-1.61)	2.85 (2.64-3.08)	4.81 (4.49-5.14)	8.25 (7.70-8.85)	11.43 (10.35-12.62)
60-64	59,654	0.07 (0.05-0.09)	0.13 (0.10-0.16)	0.47 (0.42-0.53)	1.97 (1.85-2.09)	3.95 (3.76-4.14)	6.53 (6.27-6.81)	11.52 (11.03-12.04)	15.64 (14.70-16.64)
65-69	73,809	0.10 (0.08-0.13)	0.19 (0.16-0.22)	0.70 (0.64-0.76)	2.83 (2.70-2.97)	5.90 (5.70-6.12)	9.89 (9.59-10.20)	17.95 (17.38-18.53)	24.42 (23.37-25.51)
70-74	73,201	0.16 (0.13-0.19)	0.30 (0.26-0.34)	1.13 (1.05-1.21)	4.66 (4.50-4.84)	9.80 (9.54-10.07)	16.35 (15.98-16.72)	28.99 (28.33-29.66)	39.77 (38.55-41.02)
75-79	60,244	0.31 (0.26-0.35)	0.55 (0.49-0.61)	1.92 (1.81-2.03)	7.38 (7.16-7.62)	15.47 (15.12-15.83)	25.57 (25.09-26.07)	44.60 (43.79-45.42)	58.03 (56.61-59.46)
80-84	32,641	0.69 (0.60-0.78)	1.16 (1.05-1.28)	3.37 (3.17-3.58)	12.42 (12.03-12.83)	24.85 (24.28-25.44)	40.53 (39.77-41.29)	64.00 (62.88-65.11)	*77.70 (75.88-79.46)*
85+	12,119	1.27 (1.09-1.49)	2.18 (1.94-2.46)	5.85 (5.43-6.29)	20.21 (19.42-21.03)	39.65 (38.54-40.78)	59.81 (58.46-61.17)	*83.03 (81.26-84.72)*	*91.24 (88.68-93.42)*
Females									
<55	36,903	0.03 (0.01-0.05)	0.04 (0.03-0.07)	0.14 (0.10-0.18)	0.70 (0.61-0.81)	1.37 (1.23-1.53)	2.16 (1.96-2.39)	3.98 (3.57-4.44)	5.46 (4.62-6.44)
55-59	43,455	0.03 (0.01-0.05)	0.05 (0.03-0.07)	0.23 (0.19-0.28)	0.89 (0.80-0.99)	1.89 (1.74-2.05)	3.37 (3.14-3.62)	6.09 (5.66-6.55)	8.27 (7.51-9.12)
60-64	69,155	0.04 (0.03-0.06)	0.09 (0.07-0.12)	0.33 (0.29-0.38)	1.33 (1.24-1.43)	2.75 (2.61-2.90)	4.54 (4.33-4.76)	8.67 (8.24-9.11)	12.00 (11.17-12.89)
65-69	88,190	0.07 (0.06-0.09)	0.13 (0.11-0.16)	0.44 (0.40-0.49)	1.90 (1.80-2.00)	3.90 (3.74-4.06)	6.39 (6.16-6.62)	12.66 (12.21-13.13)	18.02 (17.11-18.98)
70-74	93,772	0.10 (0.08-0.12)	0.18 (0.16-0.21)	0.66 (0.61-0.72)	2.84 (2.72-2.96)	6.19 (6.01-6.38)	10.84 (10.56-11.12)	20.95 (20.42-21.48)	29.40 (28.38-30.44)
75-79	86,237	0.17 (0.14-0.20)	0.34 (0.30-0.38)	1.20 (1.13-1.28)	4.84 (4.69-5.01)	10.51 (10.27-10.77)	18.27 (17.92-18.64)	34.81 (34.17-35.46)	47.86 (46.66-49.07)
80-84	52,210	0.32 (0.28-0.38)	0.64 (0.57-0.71)	1.99 (1.87-2.12)	7.82 (7.57-8.08)	16.94 (16.55-17.33)	28.78 (28.24-29.33)	52.47 (51.58-53.38)	66.97 (65.44-68.49)
85+	20,935	0.67 (0.57-0.80)	1.30 (1.15-1.46)	3.76 (3.51-4.04)	14.16 (13.64-14.70)	28.99 (28.24-29.76)	47.56 (46.58-48.55)	72.49 (71.13-73.84)	*85.79 (83.27-88.10)*
All cases	**861,478**	**0.17 (0.16-0.18)**	**0.32 (0.31-0.33)**	**1.05 (1.03-1.07)**	**4.13 (4.08-4.18)**	**8.64 (8.56-8.71)**	**14.45 (14.35-14.56)**	**25.68 (25.50-25.87)**	**34.11 (33.76-34.46)**

Note: 1 Estimates in *blue italics* indicate that fewer than 250 cases remain at risk at the time shown. 2 Excludes 9,790 bilateral operations performed on the same day and a further 204 with unverifiable age or gender.

Part 3

3.6 Revisions of knee replacements

3.6.1 Overview of knee revisions

This section looks at knee revision procedures performed since the registry began on 1 April 2003 up to the end of December 2015, for all patients with valid patient identifiers.

In total there were 54,153 knee joint revision operations recorded for 44,031 individual patients on 45,983 individual patient-sides. As well as the 20,863 first revisions of primary patient-sides reported on earlier in part 3.5 there are 25,120 additional revisions for a patient-side for which we have no associated primary procedure record.

Revisions are classified as single-stage, Stage one or Stage two of two-stage revisions. Information about Stage one and Stage two of two-stage revisions are entered into the database separately, whereas Stage one and Stage two revisions in practice will be linked when both records have been properly recorded in the NJR. Stage one procedures have been entered without Stage two, and vice versa, making identification of individual revision surgical episodes difficult. An attempt to link these multiple stages and/or other information to identify an overall revision episode is made later in this section.

An outline of the main revision themes explored in this section are as follows: we look at numbers of knee revision operations recorded in the NJR over time by type of revision operation (single stage or part of a two-stage procedure), the reasons given for knee joint revision by stage of operation and the survival of the first documented revision of the joint to re-revision. The sensitivity of model survival estimates for re-revision in relation to the choice of the starting point of the first revision episode and resulting survival times to the next re-revision is explored. Reasons for re-revision are also presented.

An overview of all knee joint revision procedures carried out each year since April 2003[5] is given in Table 3.32. There were up to a maximum of nine documented revision procedures associated with any individual patient-side (discussed later in this section). The increase in the number of operations over time reflects the increasing number of 'at-risk' implants prevailing in the database.

Table 3.32 Numbers of knee joint revision operations carried out each year, by revision operation type. The percentages of each revision operation type for each year is shown in brackets.

Year of revision surgery	Number of revision joint operations of each revision stage type per year (% of all revision joint operations in a year)			Total revision joint operations
	Single stage	Stage one of two-stage	Stage two of two-stage	
2003*	521 (82.6)	2 (0.3)	108 (17.1)	631
2004	928 (76.0)	80 (6.6)	213 (17.4)	1,221
2005	1,470 (73.7)	211 (10.6)	314 (15.7)	1,995
2006	1,934 (75.1)	283 (11.0)	359 (13.9)	2,576
2007	2,593 (74.7)	387 (11.2)	490 (14.1)	3,470
2008	3,272 (75.4)	476 (11.0)	594 (13.7)	4,342
2009	3,638 (75.9)	527 (11.0)	630 (13.1)	4,795
2010	4,118 (76.9)	575 (10.7)	665 (12.4)	5,358
2011	4,261 (77.2)	615 (11.1)	647 (11.7)	5,523
2012	4,921 (78.3)	626 (10.0)	739 (11.8)	6,286
2013	4,597 (78.1)	629 (10.7)	663 (11.3)	5,889
2014	4,836 (77.9)	699 (11.3)	676 (10.9)	6,211
2015	4,626 (79.0)	613 (10.5)	617 (10.5)	5,856
All years	41,715	5,723	6,715	54,153

Note: *Incomplete year

[5] A second procedure had been entered on the same operation date for 126 patient-sides. For these cases, a review of both the components entered for the surgery and information on all remaining revision surgeries linkable to the patient and side was carried out by one of the orthopaedic surgeons in the NJR Bristol team. This led to a decision to drop 126 of the duplicated patient side records with the same operation date and to a reclassification of 15 of the remaining revision operations which had been duplicated originally. In addition, the nine knee joint revision procedures which had been misclassified as a hip revision procedure in the original raw data set were reclassified as a knee revision after checking records of the type of components used during the surgery.

Table 3.33 below shows the stated reasons for the revision surgery. Note that, as several reasons can be stated for the same operation, the reasons are not mutually exclusive and so the column percentages do not add up to 100%. Aseptic loosening accounts for over two fifths of single stage revision operations and pain almost a fifth. Of the two-stage revision operations, infection is the main reason recorded for revision surgery in over 75% of either Stage one or Stage two.

Table 3.33 Percentage of all revision knee procedures of each stage type with the indicated reason for revision.

Reason for revision	Percentage of all revision joint operations of each stage type with the stated reason for revision		
	Single stage (n=41,711)[1]	Stage one of two-stage (n=5,723)	Stage two of two-stage (n=6,710)[2]
Aseptic loosening	40.2	12.3	12.0
Other indication	18.8	4.1	5.9
Pain	18.6	5.5	4.8
Instability	17.9	4.5	4.4
Implant wear	14.9	3.8	2.5
Lysis	10.3	10.6	6.5
Malalignment	8.3	1.5	1.6
Infection	5.3	83.5	77.1
Dislocation/subluxation	4.4	1.6	1.2
Periprosthetic fracture	3.8	1.5	1.4
Implant fracture	1.3	0.5	0.3
Stiffness[3]	5.9 (n=40,966)	2.7 (n=5,721)	1.9 (n=6,553)

Note: 1 There were four single-stage procedures that had a missing entry for the reason for revision. These have not been included in the percentage calculations. 2 There were five stage two of a two-stage procedures that had a missing entry for the reason for revision. These have not been included in the percentage calculations. 3 This reason was not recorded in the earliest phase of the registry; only in MDS v2, v3 & v6. The number of joints on which the percentage is based is stated beside the percentage figure.

3.6.2 Survival of first recorded knee revision to any subsequent re-revision procedure

For a given patient-side, we have looked at the survival following the first NJR documented revision procedure (n=45,983). The majority of first revision procedures (83.9%) were carried out as a single stage revision, however, in the remaining 16.1% of first revisions, the process of first revision involved either stage of a two-stage procedure. We have looked at the time from the first documented revision procedure (of any type) to the time at which a second revision procedure was undertaken. For this purpose, we took an initial Stage one followed, subsequently, by either a Stage one or a Stage two as being the same revision episode and any interim stages were disregarded, looking instead for the start of a second revision episode. On this premise, the maximum number of distinct revision episodes for any patient-side was found to be seven.

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were found. There were 3,868 re-revisions and, for 5,786 cases, the patient died without having been revised. The censoring date for the remainder was the end of 2015. Estimates were found for two approaches to modelling the start-time to next failure: (i) taking the start time as the time of the first revision episode and (ii) taking the start time to be the end of the first revision episode. This would make a difference only for those whose first revision was not a single stage revision, by shortening their follow-up time. A plot comparing the cumulative percentage probabilities for the two methods of re-revision is shown in Figures 3.19 (a) and (b). The rates at 1, 3, 5, 7, 10 and 12 years after first revision along with their associated 95% Confidence Intervals are given in Table 3.34 (a). The effect on the overall failure rates was negligible as is illustrated in Figures 3.19 (a) and (b) and shown in Table 3.34 (a).

The first revisions in Figure 3.19 (c) have been divided into those with a primary recorded in NJR (n=20,863) and the remainder (n=25,120). The Kaplan-Meier estimates of the cumulative percentage chance of having a re-revision after the first revision (and 95% CI) for these two groups are shown in Table 3.34 (b). The survival of the first revisions without a linked NJR primary was much better than those with a linked NJR primary. Those without primaries in the NJR are likely to have been performed before 2003 and so imply a long period between the original primary or previous revision surgery that was not recorded in the NJR and the recorded episode of revision surgery. On the other hand, revisions linked to primaries in the NJR are likely to represent shorter times to the first revision of the joint.

Figure 3.19 (d) and Table 3.34 (c) illustrate this difference in early (within the first three years) risk of re-revision for those with primaries in the NJR and those without a recorded primary in the NJR. The 20,863 with an NJR primary on record have been grouped by time interval to the first failure (less than 1 year, 1 to 3 years, 3 to 5 years and 5 years or more). It is clear that the risk of re-revision is higher for those primaries which have already failed for the first time in the first few years (under 1 year or 1 to 3 years after the primary replacement) compared to those which were revised at later times after the primary and the group without a known primary on record. The risk of re-revision is similar for both the first revision after 3 to 5 and 5+ year groups with a primary procedure recorded in the NJR and the group of first revisions without a primary procedure recorded in the NJR. A more in-depth future investigation of the reasons for first revision and the next re-revision of the joints with linked NJR primaries and those without and the patient case mix for each type may yield further insights into why there are the differences described here.

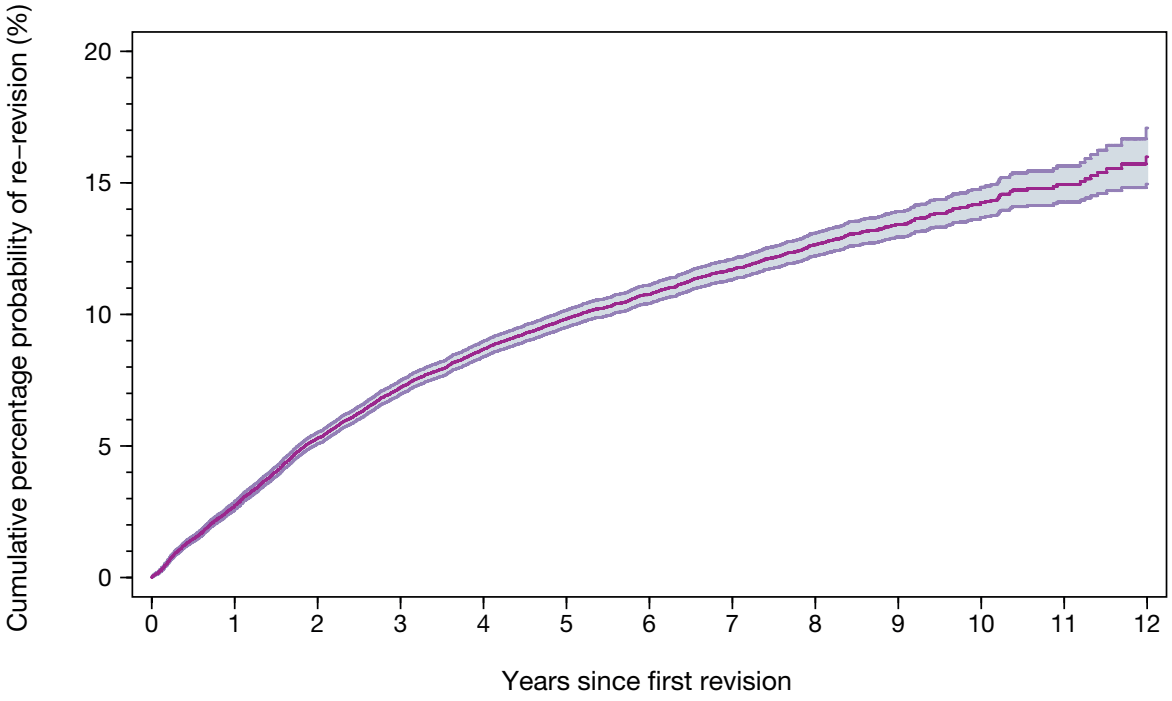
In an earlier section of this report, a link between time to first revision and the cited reason for revision was found (see Section 3.5.2.4). It was shown that if a knee joint was revised within the first year after primary surgery, infection was the most likely reason for this, followed by other reasons for revision, then aseptic loosening and pain. The most common reasons given for first revision (of the primary) between one and three years were found to be aseptic loosening, pain, other reasons, infection and instability respectively.

Future work will explore the relationship between (i) the time to first revision and the subsequent time to re-revision and (ii) the reason for the first revision and the resulting time to re-revision.

The numbers of recorded first revisions in the NJR with an associated NJR primary record has increased each year since the start of the registry. By the end of 2015, 63% of all first time records of revision surgery for a joint could be linked to an NJR primary operation (see Tables 3.36 (a) and (b)). This is a further indication that the first revisions with a linked primary in the NJR are failing sooner than the group of revisions without a linkable primary within the NJR dataset.

Figure 3.19 (a)

Kaplan-Meier estimate of the cumulative percentage probability of a knee re-revision. The shaded area indicate point-wise 95% CIs.

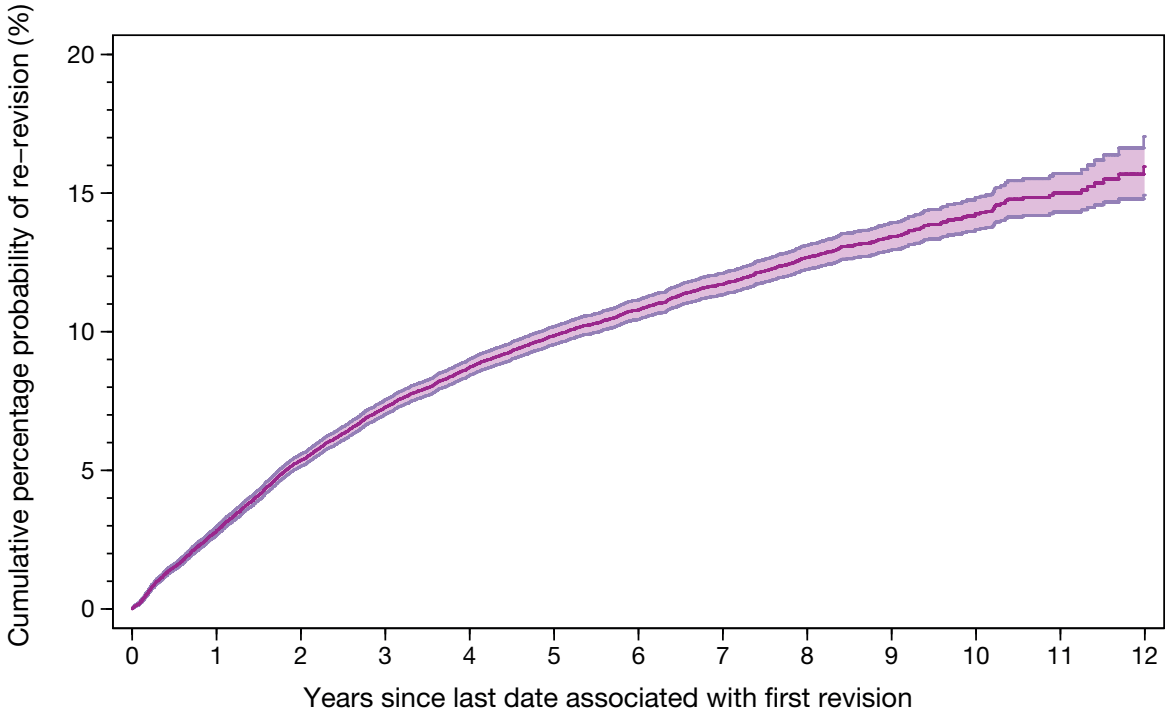


Numbers at risk

45,983	39,410	33,060	27,346	21,790	17,088	12,807	9,132	6,074	3,725	2,109	979	311

Figure 3.19 (b)

Kaplan-Meier estimate of the cumulative percentage probability of a knee re-revision, based on time from the last date of the first revision episode. The shaded area indicate point-wise 95% CIs.

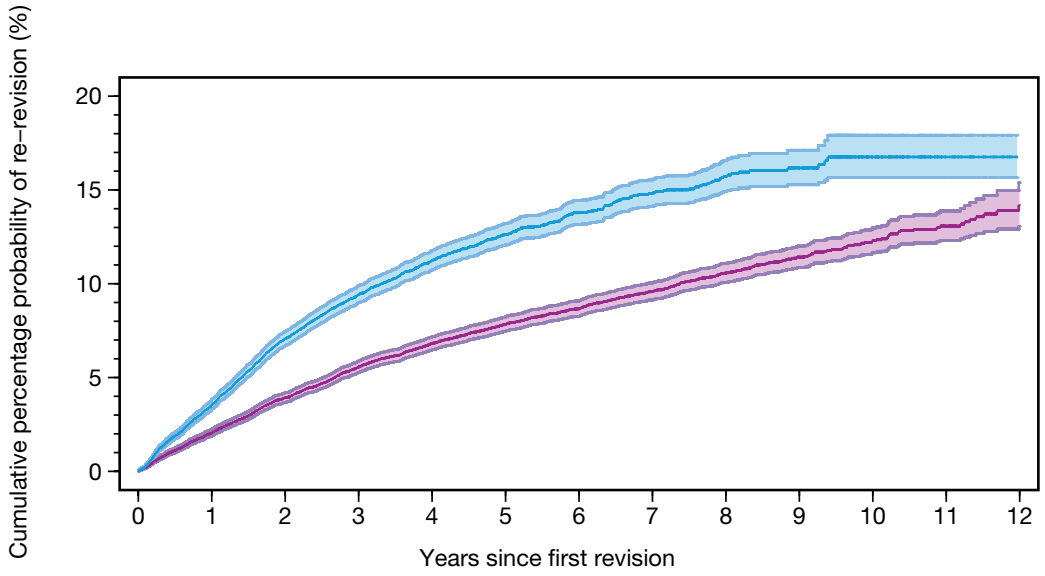


Numbers at risk

45,983	39,214	32,874	27,185	21,651	16,975	12,689	9,040	6,009	3,684	2,092	966	311

Figure 3.19 (c)

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision, shown for those with documented primaries in the NJR and the remainder. Shaded areas are point-wise 95% CI for the rate estimates.

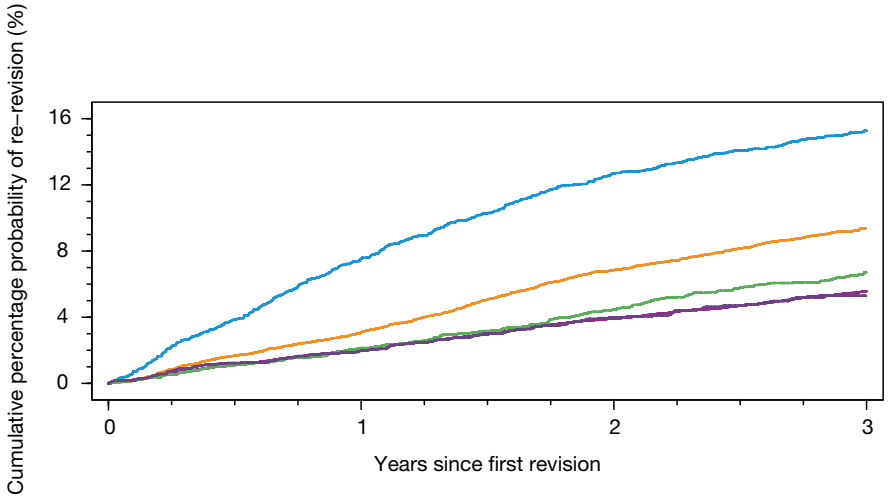


Numbers at risk

Primary not in NJR	25,120	22,395	19,612	16,848	14,122	11,559	9,148	6,936	4,896	3,169	1,882	920	307
Primary in NJR	20,863	17,015	13,448	10,498	7,668	5,529	3,659	2,196	1,178	556	227	59	4

Figure 3.19 (d)

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision up to three years from the first revision. Those with recorded primaries in the NJR are shown separately from the remainder and have been split into those that had their first revision within 1 year, 1 to 3, 3 to 5 years or more than 5 years after the initial primary.



Numbers at risk

Primary not in NJR	25,120	22,395	19,612	16,848
1st revision <1 year	3,876	3,168	2,609	2,143
1st revision 1–3 years	9,126	7,782	6,395	5,197
1st revision 3–5 years	4,030	3,394	2,722	2,100
1st revision 5+ years	3,831	2,671	1,722	1,058

Table 3.34 (a) Kaplan-Meier estimates of cumulative percentage probability (95% CI) of knee re-revision following the first revision using different start points for time at risk of re-revision.

Time point from which time to re-revision was measured:	Number of revised joints at risk of re-revision	Cumulative percentage probability of a re-revision (95% CI) at time shown if time elapsed since first revision is:					
		1 year	3 years	5 years	7 years	10 years	12 years
(i) At start of first revision episode	45,983	2.74 (2.59-2.89)	7.23 (6.98-7.50)	9.83 (9.51-10.16)	11.70 (11.32-12.10)	14.25 (13.69-14.84)	15.99 (14.96-17.09)
(ii) End of first revision episode	45,983	2.83 (2.68-2.99)	7.28 (7.02-7.55)	9.85 (9.53-10.18)	11.72 (11.34-12.11)	14.25 (13.69-14.84)	15.95 (14.93-17.04)

Table 3.34 (b) Kaplan-Meier estimates of cumulative percentage probability (95% CI) of knee re-revision following the first revision broken down by whether a primary is on record in the NJR or not.

Revised patient-sides	Number of first revised joints at risk of re-revision	Cumulative percentage probability of a re-revision (95% CI) at time shown if time elapsed since first revision is:*					
		1 year	3 years	5 years	7 years	10 years	12 years
Primary not recorded in the NJR	25,120	2.07 (1.90-2.26)	5.57 (5.27-5.88)	7.84 (7.47-8.23)	9.58 (9.14-10.05)	12.30 (11.65-12.98)	14.19 (13.07-15.39)
Primary recorded in the NJR	20,863	3.56 (3.31-3.83)	9.45 (9.01-9.91)	12.62 (12.06-13.21)	14.84 (14.14-15.57)	*16.76 (15.66-17.92)*	*16.76 (15.66-17.92)*

*Estimates in *blue italics* are based on the number at risk falling below 250 patient-sides (see methodological notes in earlier sections). The number at risk for the year 12 estimate for those with primary recorded in the NJR is only five.

Table 3.34 (c) Kaplan-Meier estimates of the cumulative percentage probability (95% CI) of knee re-revision following the first revision when the group of patient-sides with a primary record in the NJR are stratified by the time intervals in which the first revision took place after the primary operation.

Revised patient-sides	Number of first revised joints at risk of re-revision	Cumulative percentage probability of a re-revision (95% CI) at time shown if time elapsed since first revision is:	
		1 year	3 years
Primary not in the NJR	25,120	2.07 (1.90-2.26)	5.57 (5.27-5.88)
Primary in the NJR where the first revision took place:			
<1 year after primary	3,876	7.51 (6.70-8.41)	15.27 (14.09-16.55)
1-3 years after primary	9,126	3.10 (2.76-3.49)	9.39 (8.75-10.08)
3-5 years after primary	4,030	2.14 (1.72-2.66)	6.76 (5.92-7.71)
5+ years after primary*	3,831	1.97 (1.55-2.50)	5.29 (4.43-6.31)

* Note: The maximum of this interval was 12.5 years.

3.6.3 Reason for knee re-revision

Table 3.35 shows a breakdown of the stated reasons for the first revision and for any subsequent revision. The reasons are not mutually exclusive. The four columns show the number of joints which indicated each type of reason for revision when the revision was (i) the first recorded revision in the NJR, (ii) the first revision and the implant was not subsequently revised, (iii) the first revision and the implant was subsequently re-revised, and (iv) the re-revision of the first revision.

Table 3.35 Reasons given for first knee revision and re-revision.

Reason for revision	(i) Number of cases for each given reason for first (recorded) revison N=45,975[1]	Number of cases for each reason given for the first recorded revision for those who were: (ii) Not subsequently re-revised N=42,117[2]	(iii) Subsequently re-revised N=3,858[3]	(iv) Number of cases for each given reason for re-revision N=3,860
Aseptic loosening	16,711	15,508	1,203	1,043
Other indication	7,888	7,448	440	355
Pain	7,693	6,969	724	474
Infection	7,591	6,629	962	1,332
Instability	7,089	6,496	593	673
Implant wear	6,312	5,921	391	202
Lysis	4,793	4,486	307	245
Malalignment	3,393	3,137	256	215
Stiffness[4]	2,371 n=45,087	2,159 n=41,358	212 n=3,729	236 n=3,729
Dislocation/subluxation	1,752	1,571	181	170
Periprosthetic fracture	1,547	1,446	101	118
Implant fracture	510	480	30	47

Note: 1 Reasons for revision for eight first revisions were missing. 2 Reasons for first revision for six joints not re-revised were missing. 3 Reasons for first revision for two subsequently re-revised joints were missing. 4 Stiffness as a reason for revision was not recorded in MDSv1 and hence the total numbers for stiffness is in superscript for this reason for revision.

Table 3.36 Temporal changes in first knee revisions reported in the NJR and associated indications.

(a) Number of first knee revisions by year of surgery and proportions with an associated knee primary in the NJR.

Year of first revision in the NJR*	Number of (first) revisions*	Number of first revisions (%) with the associated primary in the NJR
2003	623	11 (1.8)
2004	1,168	83 (7.1)
2005	1,841	275 (14.9)
2006	2,331	498 (21.4)
2007	3,104	850 (27.4)
2008	3,784	1,349 (35.7)
2009	4,139	1,755 (42.4)
2010	4,571	2,147 (47.0)
2011	4,632	2,280 (49.2)
2012	5,232	2,877 (55.0)
2013	4,828	2,754 (57.0)
2014	5,019	3,014 (60.1)
2015	4,711	2,970 (63.0)
Total	45,983	20,863 (45.4)

*First documented revision in the NJR.

(b) Numbers of first recorded knee revisions by stage and whether or not primary was in the NJR.

Year of (first) revision	Single stage		First documented stage of two-stage	
	Primary not in the NJR total per year	Primary in the NJR total per year	Primary not in the NJR total per year	Primary in the NJR total per year
2003	509	5	103	6
2004	858	59	227	24
2005	1,238	196	328	79
2006	1,488	377	345	121
2007	1,854	636	400	214
2008	2,041	1,048	394	301
2009	1,994	1,432	390	323
2010	2,071	1,749	353	398
2011	2,057	1,854	295	426
2012	2,087	2,424	268	453
2013	1,829	2,322	245	432
2014	1,796	2,538	209	476
2015	1,577	2,540	164	430
All years	21,399	17,180	3,721	3,683

3.6.4 Conclusions

Once again, the current year's analysis does not show any marked changes from the previous year's analysis with previous trends continuing into the longer term. In general, total knee replacements have excellent implant survivorship at ten to twelve years whilst unicompartmental knee replacements have higher implant revision rates. However, implant survivorship is not the only metric of success and patients and surgeons need to consider patient demographics, disease pattern and severity, pain relief, function, participation in society and post-operative mortality when making choices about whether to undergo surgical intervention and the type of surgical intervention that is appropriate for them.

Cementation of the primary prosthesis in total knee replacements continues to be the most commonly used method of fixation forming 87.4% of all primary total knee replacement surgery in 2015. Conversely, surgery involving both the tibial and femoral implants being inserted using an all uncemented method of fixation for primary TKR continues to decline in use with only 2.3% of all surgeries last year reporting this type of surgical procedure. UKR (medial and lateral unicondylar and patellofemoral knee replacement) still represents one in ten of all primary knee surgeries (10.0%) and this proportion overall has remained relatively consistent over the 2003 to 2015 period.

In terms of choice of bearing/constraint in TKR surgery and the cumulative chance of revision of the implant, the majority of these perform equally well over time (Figures 3.18 (a) and (b) and Table 3.24 (a)). The best twelve-year survivorship is observed in the cemented unconstrained (cruciate retaining) fixed bearings compared to the unconstrained mobile, posterior-stabilised fixed and mobile and constrained condylar implants; although the numbers are small at the longest term follow-up so estimates are less reliable. Promising survivorship results are seen in the monobloc polyethylene tibia implants but the numbers at risk are small beyond the medium term. The cumulative risk of revision is higher in the uncemented and hybrid fixation groups.

Unicondylar fixed and mobile constraints again perform similarly overall but, compared to any TKR constraint choice, fare worse in terms of the need for revision surgery. The use of a patellofemoral implant incurs

the highest cumulative risk of revision over all surgical choices, although it is recognised that the type of patient receiving this type of surgery is typically younger (by about ten years) and therefore may be more likely to be more active than those receiving a TKR.

Unlike the hip surgery findings in the last section, gender differences in the cumulative chance of needing revision surgery following total knee replacement are only small, with men at slightly higher risk than women for all ages. However, as also seen in hip replacement surgery, younger patients are at far higher risk of requiring first knee revision surgery than patients belonging to older age groups.

The most common clinical reasons for revision cited for TKR were aseptic loosening, pain, infection and other indication (excluding dislocation/subluxation, lysis, periprosthetic fracture, implant fracture, implant wear, instability, malalignment and stiffness), each of which account for approximately one revision per 1,000 patient-years or more across all cases. However, for UKRs, the incidence rates of revision for pain, aseptic loosening and other indication each account for around four revisions per 1,000 patient-years. The indicated reasons for revision of a primary patellofemoral knee resemble those of unicondylar indications for revision surgery, but PTIRs are even higher than those reported for revision of a unicondylar implant with pain and other indication having PTIRs of 6.0 and 10.0 revisions per 1,000 patient-years respectively.

In the first year after primary surgery, revision due to infection has the highest PTIR. Between one and three years post-primary surgery, aseptic loosening and pain become more prevalent as reasons for revision surgery and in the longer term, aseptic loosening is the dominant reason for revision.

The cumulative chance of death remains higher in men than women in the same age group in the short, medium and long term after primary knee surgery, and the cumulative risk of dying increases the older the patient is when they present initially for primary surgery. The cumulative percentage probability of death within 90 days of surgery in primary knee replacement is 0.32%, with the cumulative percentage chance of death rising to 1.05% at 1 year, 8.64% at 5 years, 25.7% at 10 years and 34.1% at 12 years.

Part 3

3.7 Outcomes after primary ankle replacement

3.7.1 Overview of primary ankle surgery

This section looks at revision and mortality for all primary ankle operations performed up to 31 December 2015. There were 3,174 primary ankle operations in total (see Tables 3.1 and 3.2), including four bilateral operations (both sides done at the same time). Although ankles were entered routinely from 2010, 13 primary operations have been entered that had been carried out before this date.

The median age at primary surgery was 68 years (IQR 61-74 years), with an overall range of 17 to 91 years. More procedures were performed in men than women (men 58.6%). Of the 3,174 primary procedures, 2,986 (94%) used uncemented and 164 (5%) used cemented fixation methods for the implant. There were 24 (0.8%) joints where the fixation type was uncertain.

A total of 214 consultants carried out these primary procedures; 94 (44%) of them entered ten or more procedures. The maximum number of procedures for any consultant was 207. Similarly the total number of units involved was 228; 79 (35%) of which carried out ten or more. The maximum number of procedures carried out by any unit was 234.

Table 3.37 below shows an overall breakdown of brands used and further breakdowns by year of primary operation. Please note that 13 procedures had dates of operation before 2010 (four in 2008 and nine in 2009) and these have been combined with those performed in 2010. The most common brand overall was Mobility, which was used in just under half of the procedures overall but whose usage since 2012 declined and in June 2014 was withdrawn from the market. In 2015 the most common brand used was the Zenith (25.6%), followed by the Box (22.3%) and Infinity (15.5%).

Table 3.37 Numbers of primary ankle replacements by ankle brand.

		Number (%) of each brand, for each year of operation					
Brand	Number (%)	≤2010*	2011	2012	2013	2014	2015
Mobility	1,119 (35.3)	258 (62.2)	295 (56.7)	284 (49.1)	198 (36.5)	84 (15.7)	0 (0.0)
Zenith	744 (23.4)	78 (18.8)	108 (20.8)	126 (21.8)	133 (24.5)	150 (28.0)	149 (25.6)
Box	360 (11.3)	23 (5.5)	29 (5.6)	45 (7.8)	50 (9.2)	83 (15.5)	130 (22.3)
Salto	244 (7.7)	23 (5.5)	29 (5.6)	38 (6.6)	44 (8.1)	56 (10.5)	54 (9.3)
Hintegra	226 (7.1)	15 (3.6)	18 (3.5)	35 (6.0)	63 (11.6)	44 (8.2)	51 (8.8)
Star	244 (7.7)	15 (3.6)	29 (5.6)	31 (5.4)	34 (6.3)	60 (11.2)	75 (12.9)
Rebalance	40 (1.3)	0 (0.0)	4 (0.8)	13 (2.3)	13 (2.4)	6 (1.1)	4 (0.7)
Inbone	47 (1.5)	0 (0.0)	0 (0.0)	2 (0.4)	4 (0.7)	22 (4.1)	19 (3.3)
Infinity	117 (3.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	27 (5.0)	90 (15.5)
Akile	4 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.7)
Taric	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)
Not known	28 (0.9)	3 (0.7)	8 (1.5)	4 (0.7)	3 (0.6)	4 (0.8)	6 (1.0)
Total	**3,174 (100)**	**415 (100)**	**520 (100)**	**579 (100)**	**542 (100)**	**536 (100)**	**582 (100)**

*Includes 13 with operation dates prior to 2010.

3.7.2 Revisions after primary ankle surgery

The definition of revision accepted by the British Orthopaedic Foot and Ankle Society (BOFAS) is the removal or exchange of any component of the ankle replacement, except in the case of an incidental exchange of a polythene liner in a mobile bearing implant. In situations where this definition is met, the surgeon should complete an NJR A2 form. Only 105 (3.3%) of the 3,174 procedures had been revised before the end of 2015. The first revisions shown here include 16 conversions to arthrodesis but no amputations.

The estimated cumulative percentage probabilities of first revision overall (using Kaplan-Meier estimation) were: 0.10 (95% CI 0.03-0.30) at 90 days; 0.58 (95% CI 0.35-0.94) at 1 year; 2.50 (95% CI 1.94-3.21) at 2 years; 3.57 (95% CI 2.86-4.46) at 3 years; 4.76 (95% CI 3.85-5.87) at 4 years; and 6.83 (95% CI 5.47-8.52) at 5 years.

BOFAS believes that the small number of revisions above may indicate under-reporting of the revision procedures as these figures are lower than published data in the literature. BOFAS and the NJR encourage surgeons to complete A2 forms where relevant and wishes to remind surgeons that this is a mandated requirement and that all conversion of an ankle replacement to an arthrodesis requires the completion of an NJR A2 form.

Table 3.38 below lists the indications for the 105 first revisions.

Table 3.38 Indications for the 105 first revisions following primary ankle replacement. Note: these are not mutually exclusive.

Indication		Number
Infection	High suspicion (e.g. pus or confirmed micro)	5
	Low suspicion (awaiting micro/histology)	23
Aseptic loosening	Tibial component	30
	Talar component	30
Lysis	Tibia	7*
	Talus	7*
Malalignment		12
Implant fracture	Tibial component	2
	Talar component	4
	Meniscal component	0
Wear of polyethylene component		8
Meniscal insert dislocation		2
Component migration/dissociation		6
Pain (undiagnosed)		36
Stiffness		16
Soft tissue impingement		9
Other indications for revision		115

*Three patients had lysis of both tibial and talar component.

3.7.3 Mortality after primary ankle replacement

Our analysis excluded the second of each of the four bilateral procedures plus one additional procedure where the NHS number was untraceable (and hence the age could not be validated). Among the remaining 3,169, a total of 101 patients died before the end of 2015.

The estimated cumulative percentage survival (based on Kaplan-Meier estimates) were: 0.07 (95% CI 0.02-0.26) at 90 days; 0.68 (95% CI 0.43-1.06) at 1 year; 1.73 (95% CI 1.29-2.34) at 2 years; 2.89 (95% CI 2.26-3.70) at 3 years; 4.77 (95% CI 3.83-5.92) at 4 years; and 6.01 (95% CI 4.82-7.47) at 5 years. Estimates at five years were unreliable as too few patients remained at risk.

Table 3.39 shows the estimated cumulative percentage probability of death at different times after surgery by gender and age at primary groups <65 and 65+ years.

Table 3.39 Kaplan-Meier estimates of the cumulative percentage mortality (95% CI), by gender and age, at 90 days and 1, 2, and 3 years after primary ankle replacement.

Gender	Age at primary (years)	Number of patients	Cumulative percentage probability of patient death (95% CI) if time elapsed since primary operation is:			
			90 days	1 year	2 years	3 years
Male	<65	600	0.00	0.00	0.91 (0.34-2.42)	1.78 (0.85-3.74)
	65+	1,257	0.16 (0.04-0.66)	1.07 (0.61-1.87)	2.38 (1.60-3.55)	4.14 (2.98-5.74)
Female	<65	505	0.00	0.23 (0.03-1.63)	0.78 (0.25-2.42)	1.13 (0.42-3.01)
	65+	807	0.00	0.85 (0.38-1.89)	1.92 (1.09-3.37)	2.95 (1.83-4.73)

3.7.4 Conclusions

The collection of data relating to ankle primary operations only began in 2010 and hence total number of primaries remain small and numbers of first revisions even smaller, although we believe that there is under-reporting of revision procedures, making outcome analysis difficult.

A total of 56% of consultant surgeons and 65% of units have submitted less than ten primary procedures in the time the NJR has been capturing data.

Since the withdrawal of the market leading brand (Mobility) in 2014, the use of other brands such as Zenith and Box has increased accordingly. In addition, fixed bearing implants such as the Infinity are gaining popularity.

The cumulative percentage probability of death following primary ankle surgery is very low.

Part 3

3.8 Outcomes after primary shoulder replacement

3.8.1 Overview of primary shoulder replacement surgery

The registry has recorded shoulder replacements since 1 April 2012. This section gives an overview of the (linked) primary shoulder replacements performed up to 31 December 2015 and documents the first revision and mortality for these primaries.

A total of 17,199 linked primary replacements were available for analysis for a total of 16,417 patients. Of these patients, 782 had documented replacements on both left and right sides, 15 of which were bilateral operations (left and right on the same day), see Table 3.2 in Section 3.2.

The number of primary shoulder replacements has continued to increase year-on-year, see Table 3.40. This table also gives a breakdown by the stated type of replacement[6].

A number of cases (218) had discrepancies between the stated type of procedure and the entered components and these are shown under the column headed Uncertain. This final column comprises cases that were (i) designated as resurfacings but information about a stem component had been entered, (ii) designated as resurfacings or reverse polarity total prosthetic replacements but for which a uni-polar or a bi-polar head had been entered, (iii) designated as total prosthetic replacements, hemiarthroplasty or reverse polarity total prosthetic replacement where a humeral head resurfacing part had been entered, and (iv) designated as hemi-arthroplasty but glenoid part(s) had been entered. Other inconsistencies remain to be explored but it is likely that due to the rapid expansion of new shoulder arthroplasty designs that the classification system does not account for these newer implants. The classification system for shoulder arthroplasty will need updating to allow for the future accurate classification of what is a rapidly changing product area. The proportion of resurfacings (both total and hemi-arthroplasty) has continued to decline with time and the proportion of reverse polarity total replacements has increased.

Table 3.40 Numbers of primary shoulder replacements by year and percentages of each type.

Year of primary	Total number of primaries	Number (%) of each type of shoulder replacement (as stated):					
		Resurfacing total arthroplasty	Total prosthetic replacement	Hemi-arthroplasty	Resurfacing hemi-arthroplasty	Reverse polarity total prosthetic replacement	Uncertain/ unsure
2012*	2,524 (100%)	151 (6.0%)	669 (26.5%)	381 (15.1%)	464 (18.4%)	798 (31.6%)	61 (2.4%)
2013	4,291 (100%)	213 (5.0%)	1,229 (28.6%)	692 (16.1%)	575 (13.4%)	1,512 (35.2%)	70 (1.6%)
2014	5,163 (100%)	204 (4.0%)	1,584 (30.7%)	707 (13.7%)	536 (10.4%)	2,077 (40.2%)	55 (1.1%)
2015	5,221 (100%)	159 (3.1%)	1,687 (32.3%)	614 (11.8%)	363 (7.0%)	2,366 (45.3%)	32 (0.6%)
Total	**17,199 (100%)**	**727 (4.2%)**	**5,169 (30.1%)**	**2,394 (13.9%)**	**1,938 (11.3%)**	**6,753 (39.3%)**	**218 (1.3%)**

*Includes 33 in the registry with primary operation dates before 2012.

The majority of the replacements were performed on women (men 28.6%; women 71.4%).

The median age at the primary operation was 73 years (IQR 67-79 years) overall, with a range of 18-99 years.

The replacements were carried out by a total of 636 consultant surgeons and the median number entered for each was 13 (IQR 2-41). Similarly the number of units involved was 369, with a median of 28 (IQR 11-59) procedures each.

Table 3.41 lists the reasons for the primary operation and shows the number and percentage of primaries indicating each reason. The reasons are not mutually exclusive and more than one may have been indicated. The majority (94.2%), however, listed only one reason and the numbers of these are shown in the right hand column. Most (950) of the remaining 1,003 with combinations of reasons had exactly two, the largest combinations being osteoarthritis and cuff tear arthropathy (376).

Whilst osteoarthritis is the most common indication for surgery, we show acute trauma first. These 1,464 cases are later separated from the remaining 15,735 elective cases.

[6] Provisional breakdown using the primary procedure as stated, without further validation of the actual components used.

Table 3.41 Reasons for primary shoulder replacement. Please note the percentages shown are of the total number of primary shoulder replacement procedures.

Reason for primary replacement	Number (%) where the reason was indicated	Number (%) where this was the only reason indicated *
Acute trauma	1,464 (8.5%)	1,406 (8.2%)
Osteoarthritis	9,895 (57.5%)	9,189 (53.4%)
Cuff tear arthropathy	4,210 (24.5%)	3,671 (21.3%)
Trauma sequelae	1,011 (5.9%)	765 (4.5%)
Other inflammatory arthropathy	770 (4.5%)	595 (3.5%)
Avascular necrosis	535 (3.1%)	307 (1.8%)
Other cause(s)**	374 (2.2%)	263 (1.5%)

*1,003 (5.8%) listed more than one reason, see text.

**Includes ten metastatic cancer/malignancies which has only been documented separately since November 2014 (when MDSv6 was introduced).

Table 3.42 shows the reasons for primary for each of the five types of primary procedure. Reverse polarity total prosthetic replacement continues to be used by some surgeons across all indications.

Table 3.42 Reasons for main types of primary shoulder replacements.

	Type of primary procedure						
	Resurfacing total arthroplasty (n=727)	Total prosthetic replacement (n=5,169)	Hemi-arthroplasty (n=2,394)	Resurfacing hemi-arthroplasty (n=1,938)	Reverse polarity total prosthetic replacement (n=6,753)	Uncertain/ unsure (n=218)	All cases (n=17,199)
Reason for primary*:							
Acute trauma	1 (0.1%)	15 (0.3%)	736 (30.7%)	4 (0.2%)	649 (9.6%)	1 (0.5%)	1,406 (8.2%)
Osteoarthritis	618 (85.0%)	4,531 (87.7%)	985 (41.1%)	1,557 (80.3%)	1,314 (19.5%)	184 (84.4%)	9,189 (53.4%)
Cuff tear arthropathy	22 (3.0%)	52 (1.0%)	90 (3.8%)	104 (5.4%)	3,397 (50.3%)	6 (2.8%)	3,671 (21.3%)
Trauma sequelae	12 (1.7%)	79 (1.5%)	169 (7.1%)	29 (1.5%)	473 (7.0%)	3 (1.4%)	765 (4.5%)
Other inflammatory arthropathy	40 (5.5%)	179 (3.5%)	106 (4.4%)	87 (4.5%)	178 (2.6%)	5 (2.3%)	595 (3.5%)
Avascular necrosis	8 (1.1%)	75 (1.5%)	119 (5.0%)	49 (2.5%)	48 (0.7%)	8 (3.7%)	307 (1.8%)
Other cause(s)*	10 (1.4%)	90 (1.7%)	34 (1.4%)	22 (1.1%)	106 (1.6%)	1 (0.5%)	263 (1.5%)
Combinations of two or more reasons	16 (2.2%)	148 (2.9%)	155 (6.5%)	86 (4.4%)	588 (8.7%)	10 (4.6%)	1,003 (5.8%)

*For those where this is the only reason stated. Those with more than one reason are combined together and shown in the bottom row of the table.

Table 3.43 below summarises the age and gender distributions of the acute trauma and elective cases according to their primary procedure.

Table 3.43 Gender and age at primary for the main types of primary shoulder replacements, these are shown separately for acute trauma and elective cases.

		Type of primary procedure					
		Resurfacing total arthroplasty (n=727)	Total prosthetic replacement (n=5,169)	Hemi-arthroplasty (n=2,394)	Resurfacing hemi-arthroplasty (n=1,938)	Reverse polarity total prosthetic replacement (n=6,753)	Uncertain/ unsure (n=218)
Acute trauma (n=1,464)	Number of cases	1	19	764	7	672	1
	Male Number (%)	1	9 (47.4%)	193 (25.3%)	1	118 (17.6%)	0
	Age at primary in years*:						
	Median		70	70	69	77	
	(IQR**)		(64-77)	(63-78)	(52-79)	(72-81)	
	Range***		40-86	37-94	51-82	51-99	
Other 'elective' cases (n=15,735)	Number of cases	726	5,150	1,630	1,931	6,081	217
	Male Number (%)	237 (32.6%)	1,470 (28.5%)	516 (31.7%)	567 (29.4%)	1,739 (28.6%)	69 (31.8%)
	Age at primary in years:						
	Median	70	71	70	72	76	71
	(IQR**)	(62-77)	(65-76)	(62-77)	(64-78)	(70-80)	(63-78)
	Range***	18-95	22-94	19-94	20-95	22-96	28-92

*Cells are blank when there are too few data for meaningful analysis.

**IQR=Inter-quartile range, i.e. 25th to 75th centile.

***Range is lowest to highest.

Figures 3.20 (a) to (e) show the distributions by gender and age groups of the elective patients, according to the primary patient procedure.

Figure 3.20 (a)

Gender and age distribution of elective primaries, for each type of primary procedure.

(a) Gender and age distribution of elective primaries receiving a **Resurfacing total arthroplasty.**

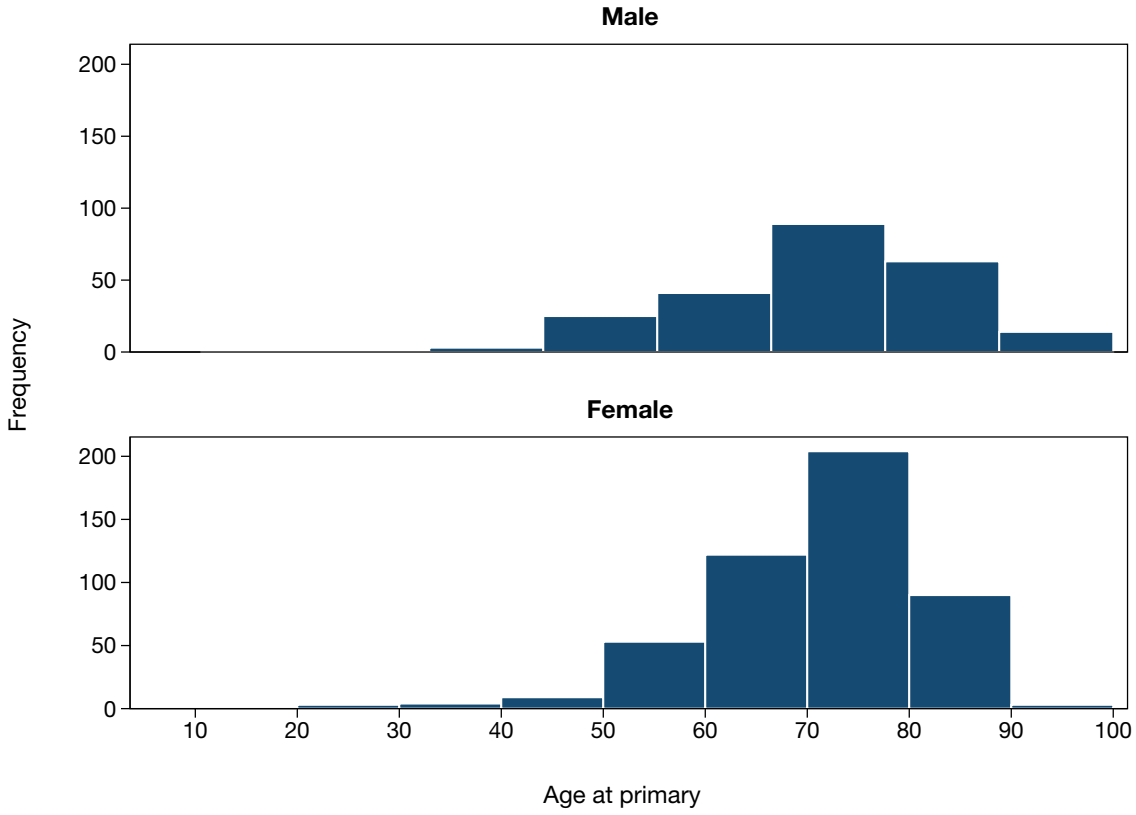


Figure 3.20 (b)

(b) Gender and age distribution of elective primaries receiving a **Total prosthetic replacement.**

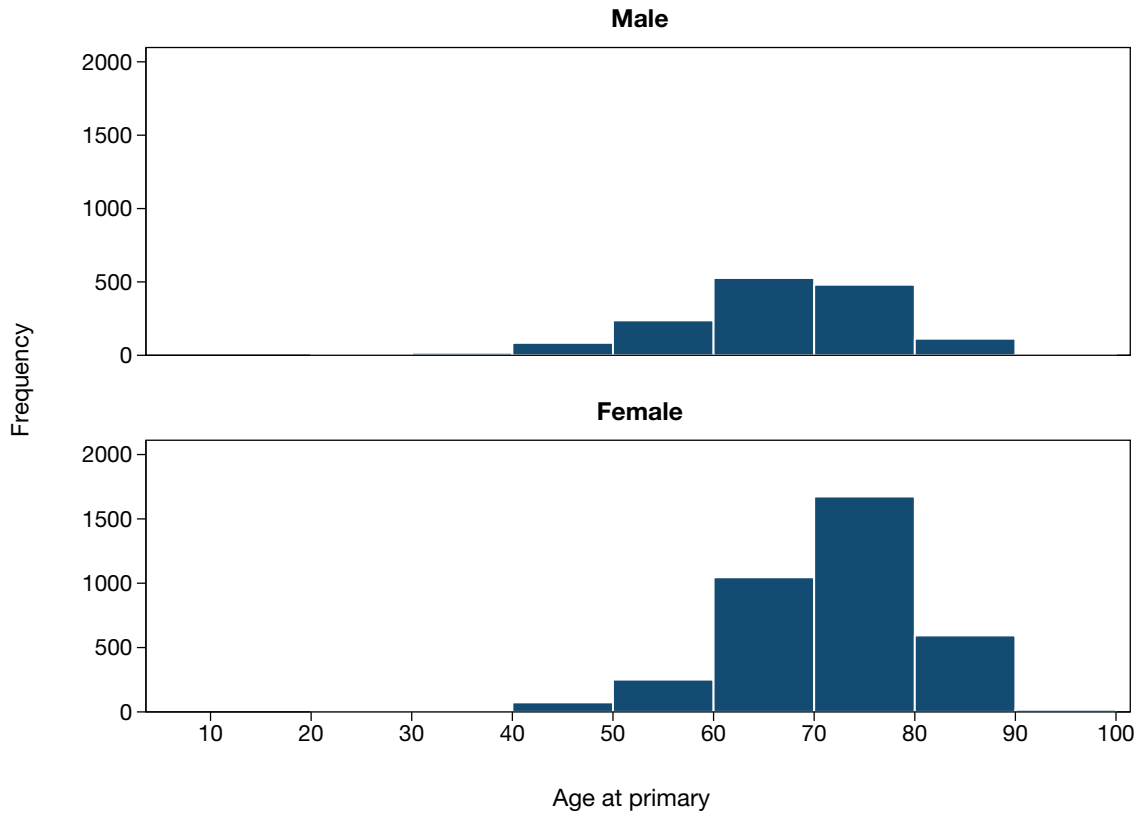


Figure 3.20 (c)

(c) Gender and age distribution of elective primaries receiving a **Hemi-arthroplasty.**

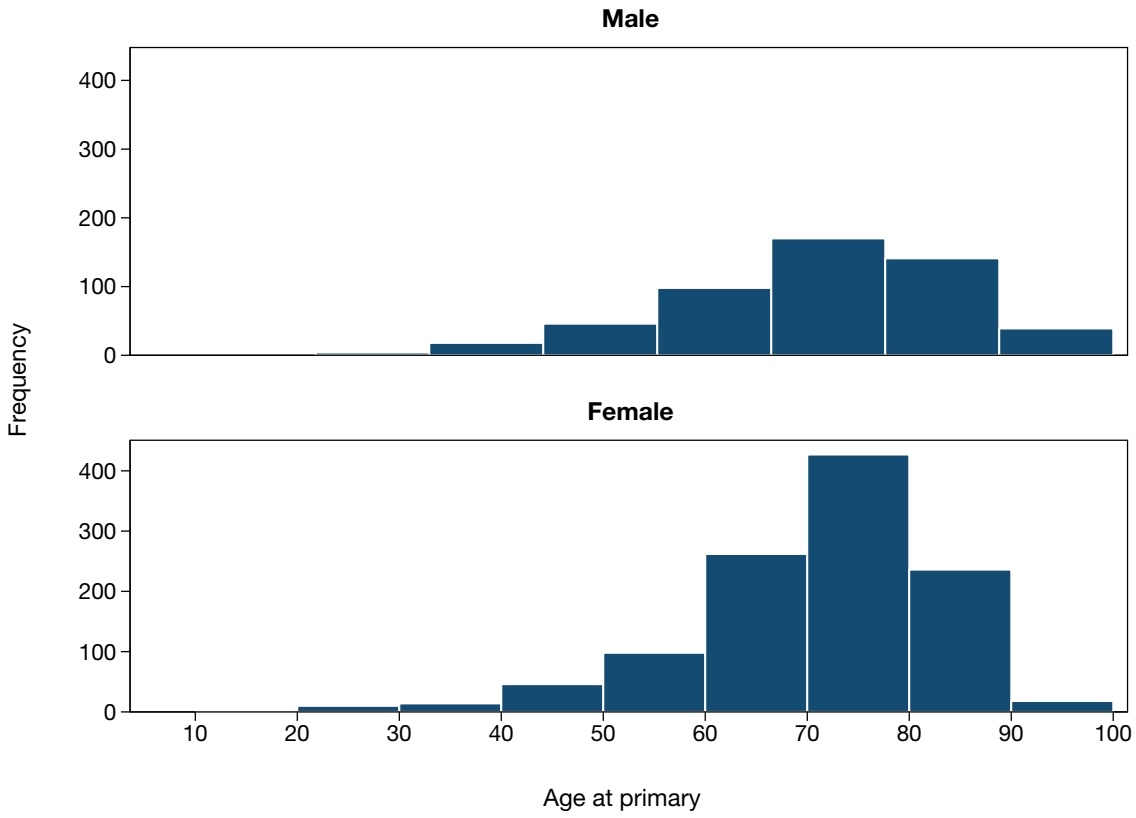


Figure 3.20 (d)

(d) Gender and age distribution of elective primaries receiving a **Resurfacing hemi-arthroplasty.**

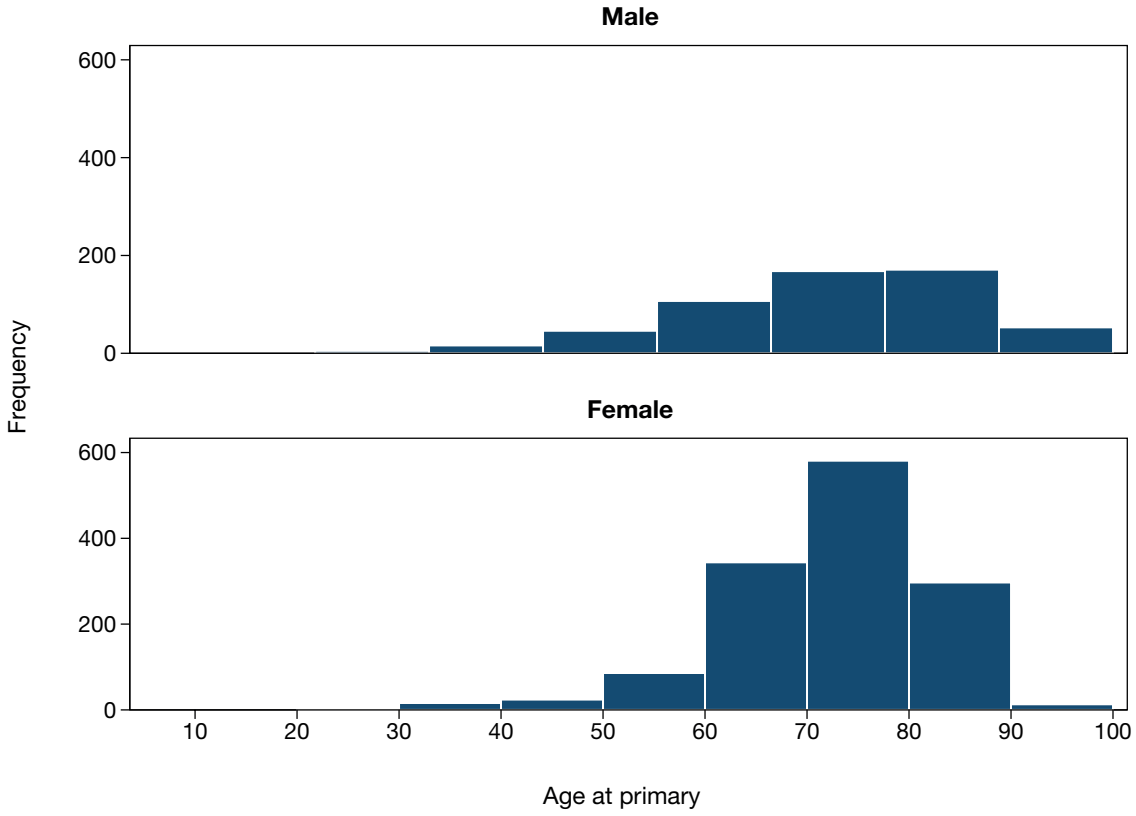


Figure 3.20 (e)

(e) Gender and age distribution of elective primaries receiving a **Reverse polarity total prosthetic replacement.**

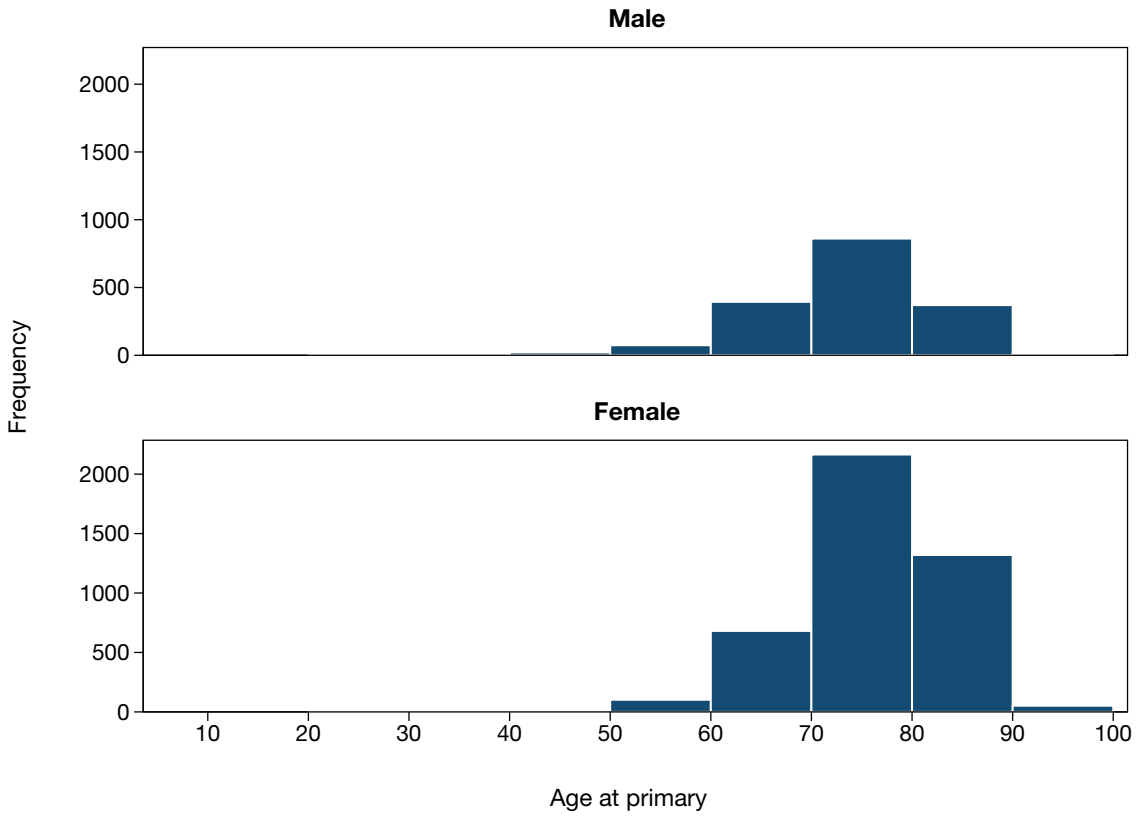


Table 3.44 lists the main stem brands used in the non-resurfacing procedures. Acute trauma and elective cases are shown separately. Note: not all cases had the stem information recorded and a number had multiple stems entered.

Table 3.44 Stem brand used in non-resurfacing shoulder replacements, shown separately for acute trauma versus remaining elective cases.

	Acute trauma			Other (elective)		
Stem brand	Total prosthetic replacement (n=19)	Hemi-arthroplasty (n=764)	Reverse polarity total prosthetic replacement (n=672)	Total prosthetic replacement (n=5,150)	Hemi-arthroplasty (n=1,630)	Reverse polarity total prosthetic replacement (n=6,081)
Oxford Modular	0	3	0	1	62	0
Ascend	0	0	0	26	7	1
Aequalis stem	1	103	88	238	165	591
Affiniti Stem	0	0	0	13	1	0
TESS	0	1	1	13	17	28
Comprehensive	3	75	127	301	75	634
Delta Xtend	1	1	144	56	38	1,939
Global Unite	2	70	6	101	31	0
Global FX	2	118	0	1	30	0
Global AP humeral stem	0	5	0	715	180	0
Global Advantage stem	0	39	0	428	194	2
RSP	0	0	3	1	0	65
Vaios stem	0	18	4	92	24	208
Lima SMR stem	1	62	87	256	45	450
Affinis stem	0	0	0	49	33	0
UNIC	0	0	0	1	2	4
Arrow	1	0	10	83	23	83
Equinoxe	3	55	84	395	73	631
Mosaic	0	1	0	0	0	0
Anatomical shoulder	1	23	45	185	37	398
B/F	0	11	0	56	33	2
TM reverse	0	0	23	72	9	157
EPOCA	2	43	0	405	45	0
Simpliciti	0	0	0	211	72	1
Verso	0	0	8	1	1	16
Bio-Modular shoulder	0	5	0	4	4	0
METS Shoulder	0	0	0	2	1	7
Polarus	0	4	0	0	1	0
Nottingham	0	24	0	3	22	0
Ascend Flex	0	1	3	225	61	247
Eclipse Stem	0	1	0	189	59	0
SMR	0	3	0	0	1	5
NEER 3	0	8	0	1	16	0
Affinis Fracture	1	76	21	1	20	8
Affini Inverse	0	0	7	2	3	240
Affinis Short	0	1	0	578	165	0
Aglion Stem	0	0	0	0	1	1
Humelock II	0	0	0	0	1	2
Univers Reverse	0	0	0	0	0	8
Multiple stem brands entered	0	0	0	21	1	1
No brand entered	1	13	11	424	77	352

Similarly, Table 3.45 lists the main resurfacing (humeral head) brands used in the resurfacing procedures.

Table 3.45 Resurfacing brands used in resurfacing shoulder replacements, shown separately for acute trauma and elective cases.

Stem brand	Acute trauma		Other (elective)	
	Resurfacing total arthroplasty (n=1)	Resurfacing hemi-arthroplasty (n=7)	Resurfacing total arthroplasty (n=726)	Resurfacing hemi-arthroplasty (n=1991)
Aequalis head	0	0	49	188
Copeland	0	3	206	1,103
Global CAP	0	1	77	385
Vaios Head	0	0	7	18
Lima SMR head	0	0	18	76
Arrow Resurfacing Head	0	0	14	20
Sidus	0	0	68	50
EPOCA Resurfacing	0	0	270	75
hemicap	0	0	1	2
Equinoxe humeral head	0	0	1	1
Multiple resurfacing humeral head brands entered	0	0	0	1
No brand entered	1	3	15	72

3.8.2 Revisions after primary shoulder replacement surgery

A total of 364 of the shoulder primaries were subsequently revised. This number includes one excision arthroplasty.

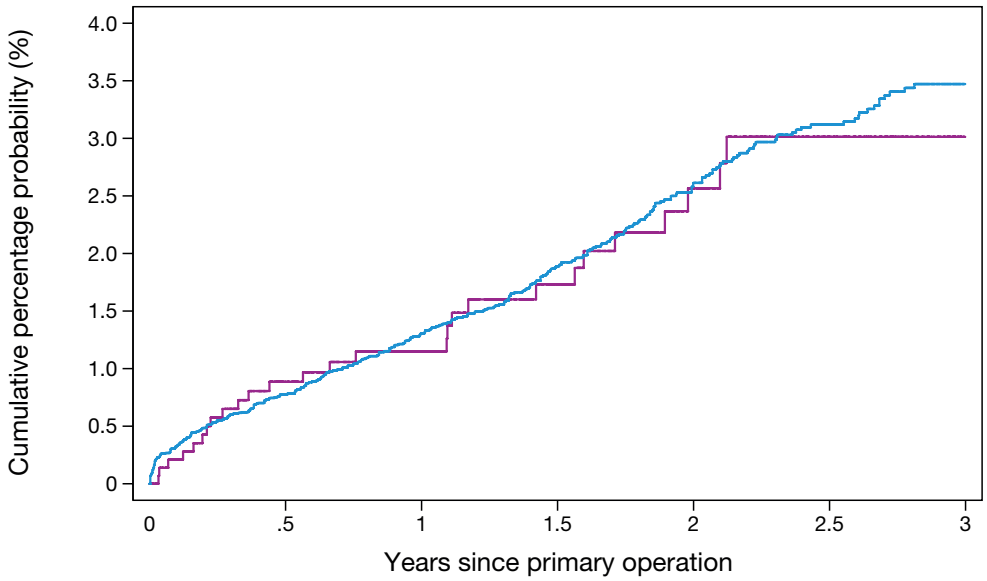
Kaplan-Meier estimates of the cumulative percentage probability of revision at 1, 2 and 3 years after the primary operation, together with 95% Confidence Intervals, for all cases are shown in Table 3.46 to the right, together with a separation into acute trauma and elective cases. Figure 3.21 further compares the acute trauma and elective cases for all time points up to three years, after which time point there were too few cases for meaningful summary.

Table 3.46 Kaplan-Meier estimates of cumulative percentage probability of revision (95% CI) by time from shoulder primary procedure, shown separately for acute trauma and elective cases. *Figures in blue italics signify time points where fewer than 250 patients remain at risk.*

Stem brand	Cumulative percentage probability of revision (95% CI)		
	At 1 year	At 2 years	At 3 years
All cases (n=17,999)	1.29 (1.12-1.49)	2.61 (2.33-2.93)	3.44 (3.07-3.86)
Acute trauma only (n=1,464)	1.15 (0.69-1.90)	2.57 (1.70-3.87)	*3.01 (2.01-4.51)*
Elective cases only (n=15,735)	1.30 (1.13-1.51)	2.61 (2.32-2.94)	3.47 (3.08-3.91)

Figure 3.21

Kaplan-Meier estimate of the cumulative percentage probability of revision after primary shoulder replacement with acute trauma and elective cases shown separately.



Numbers at risk

Acute trauma	1,464	1,204	935	725	477	301	132
Elective	15,735	13,223	10,715	8,382	5,921	3,903	2,151

A further breakdown by gender and age of the cumulative percentage revisions in the elective cases, shown in Table 3.47 below, suggests a worse outcome up to three years after primary surgery for men and a trend to worse outcomes in younger patients of either gender. The acute trauma group remains too small for a similar breakdown.

Table 3.47 Kaplan-Meier estimates of cumulative percentage probability of revision (95% CI) by time from elective shoulder primary, by gender and age at 1, 2 and 3 years from the primary operation.

Males				
Age at primary (years)*	n	Years from primary operation:		
		1 year	2 years	3 years
<65	1,400	2.32 (1.60-3.35)	5.04 (3.77-6.72)	7.15 (5.40-9.43)
65-74	1,747	2.26 (1.62-3.14)	3.35 (2.48-4.52)	4.11 (3.02-5.57)
75+	1,449	2.22 (1.55-3.19)	3.24 (2.31-4.55)	3.49 (2.47-4.91)
Females				
Age at primary (years)*	n	Years from primary operation:		
		1 year	2 years	3 years
<65	1,635	1.32 (0.83-2.09)	2.76 (1.92-3.95)	4.45 (3.18-6.20)
65-74	4,157	0.82 (0.57-1.17)	2.17 (1.67-2.82)	3.18 (2.46-4.09)
75+	5,338	0.85 (0.63-1.17)	1.84 (1.44-2.35)	2.11 (1.65-2.71)

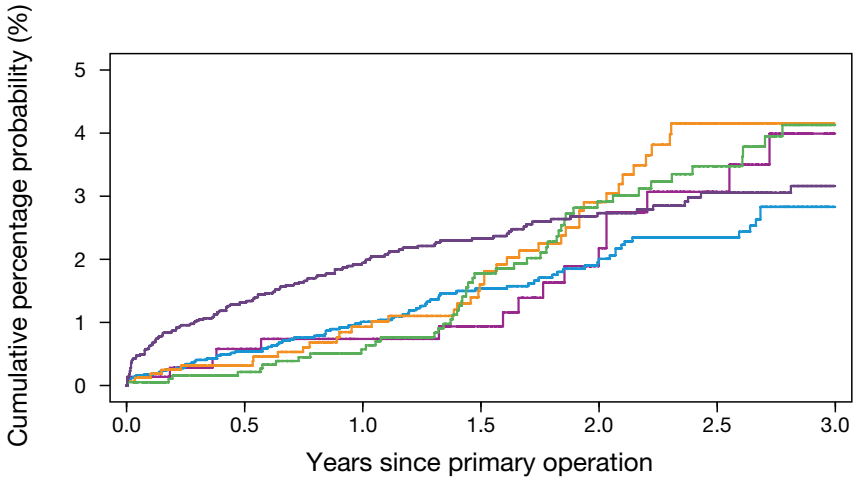
*Excludes nine cases for whom the NHS number was not traced and therefore age was not validated.

In Figure 3.22, the elective cases have been sub-divided by the type of procedure. The cumulative revision rate was much worse for the reverse polarity replacement up to about two years after the primary replacement after which time the hemi-arthroplasties appear to fare worse. Total prosthetic replacements look as though they have performed relatively well in terms of revision. However, as mentioned in last year's report, the options for revision of some of these replacements are limited and challenging and so it is difficult to evaluate the true outcomes of shoulder arthroplasty on the basis of revision rates alone.

Later in this section we present the initial shoulder PROMs results and compare the available pre- and post-operative Oxford Shoulder Scores in these sub-groups.

Figure 3.22

Kaplan-Meier estimates of cumulative percentage probability of revision up to three years from primary shoulder replacement surgery, by type of procedure, for elective cases only.



Numbers at risk

Resurfacing total arthroplasty	726	645	558	472	345	231	143
Total prosthetic replacement	5,150	4,288	3,409	2,596	1,818	1,156	622
Hemi–arthroplasty	1,630	1,411	1,178	954	693	478	256
Resurfacing hemi–arthroplasty	1,931	1,754	1,550	1,307	987	692	418
Reverse polarity total prosthetic replacement	6,081	4,921	3,839	2,897	1,958	1,253	659

Table 3.48 (over the page) gives a breakdown of the number of primaries that were subsequently revised together with the indications for the first revision procedure. Please note the indications for revision were not mutually exclusive and for 49 of the 364 first revisions more than one reason was stated.

Table 3.48 Number of first revisions for each type of primary shoulder replacement and indications for revision. Acute trauma and elective cases are shown separately

(i) Acute trauma cases only

Acute trauma	All cases (n=1,464)	Type of primary procedure:					
		Resurfacing total arthroplasty (n=1)	Total prosthetic replacement (n=19)	Hemi-arthroplasty (n=764)	Resurfacing hemi-arthroplasty (n=7)	Reverse polarity total prosthetic replacement (n=672)	Uncertain/ Unsure (n=1)
Total number revised	28	0	0	21	1	6	0
Reason for revision							
Infection	2			2	0	0	
Instability	7			2	1	4	
Cuff insufficiency	8			8	0	0	
Aseptic loosening	1			0	0	1	
Periprosthetic fracture	1			1	0	0	
Conversion hemi- to total-	0			0	0	N/A	
Conversion total- to hemi-	0			N/A	N/A	0	
Uncertain	7			7	0	0	
Other indications	6			5	0	1	

*Listed as conversions hemi- to total- but six were revised to reverse polarity total prosthetic replacements and one to a further hemi-arthroplasty.

(ii) Elective cases only

Elective	All cases (n=15,735)	Type of primary procedure:					
		Resurfacing total arthroplasty (n=726)	Total prosthetic replacement (n=5,150)	Hemi-arthroplasty (n=1,630)	Resurfacing hemi-arthroplasty (n=1,931)	Reverse polarity total prosthetic replacement (n=6081)	Uncertain/ unsure (n=217)
Total number revised	336	17	83	40	51	135	10
Reason for revision*							
Infection	41	3	4	3	3	27	1
Instability	92	5	31	2	4	48	2
Cuff insufficiency	77	3	36	10	21	4	3
Aseptic loosening	29	0	12	4	1	12	0
Periprosthetic fracture	14	0	1	0	0	13	0
Conversion hemi- to total-	45	N/A	N/A	16	23	N/A	6
Conversion total- to hemi-	1	0	1	N/A	0	N/A	0
Uncertain	14	6	2	1	0	5	0
Other indications	79	2	18	11	13	34	1

*Note the reasons are not mutually exclusive; more than one could be stated.

**Listed as conversions but of a type that would be incompatible with the primary implant.

3.8.3 PROMs Oxford Shoulder Scores (OSS) associated with primary shoulder replacement surgery

While the OSS is not yet part of a national mandated Patient Reported Outcome Measures (PROMs) programme, the NJR, with the support of the British Elbow and Shoulder Society (BESS), has collected OSS since April 2012. This section reports on the available OSS PROMs questionnaires completed just prior to surgery (Q1) and again at six months after surgery (Q2). The former were collected in the surgical unit whilst the latter were later posted to the patient.

The OSS consists of twelve multiple choice questions asking about problems that the patient encountered with their shoulder over the preceding four weeks[7]. The questions cover pain, mobility, personal care and general day-to-day activity. Originally they were coded from 1 to 5 (from best to worst) and then summed. Here, in line with updated OSS recommendations[8], we reverse-coded each item from 0 to 4, with 4 representing the best outcome, before we summed them. The final total score thus ranges from 0 to 48, with 48 representing the best outcome. Where up to two items were missing, the average of the remaining items were substituted for the missing values[8]. If more than two items were missing, the results were disregarded.

With respect to the pre-operative questionnaire, Q1, of 17,199 primaries, we had no data for 9,915 procedures. Of the remainder, 153 missed between two to eleven responses and therefore had to be discounted. Complete data were available for 6,718 primaries, with a further 413 missing only one or two items. The overall OSS scores for these latter two groups (n=7,131) are illustrated in Figure 3.23 (a).

For the post-operative questionnaire, Q2, we had no data for 9,644 procedures and a further 52 had between three and eleven items missing. Of the remainder, 7,123 answered all questions and a further 380 missed only one or two. The overall scores for the latter two groups combined (n=7,503) are shown in Figure 3.23 (b). The stated completion dates for Q2 were at a median of 36 weeks (IQR 27-48 weeks) after the primary operation.

When we had looked at similar data for hips and knees we had found some bias in completion at six months; those completing Q2 had had better scores at Q1. For the shoulders we found no evidence of such bias (data not shown).

In total, 3,411 patients had both pre- and post-operative OSS total scores from fully completed questionnaires. From these we calculated the score increase (post-operative OSS minus pre-operative OSS). Figures 3.24 (a), (b) and (c) show pre- and post-OSS, together with the increase in score, in those with complete data. Figures 3.24 (a) and (b) mirror (a) and (b) of the preceding Figure 3.23, despite only representing a fraction of the cohort. Figure 3.24 (c) shows that there is an overall improvement after surgery. Whilst it is interesting to see the post-operative improvement reflected by the increase in OSS in Figure 3.24 (c), it must be borne in mind there would be a ceiling effect to the amount of change that would be possible, as there is a maximum value to the score.

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

Figure 3.23 (a)

OSS distribution pre- and post-operation.

(a) **Pre-operative (Q1) OSS for 7,131 patients**

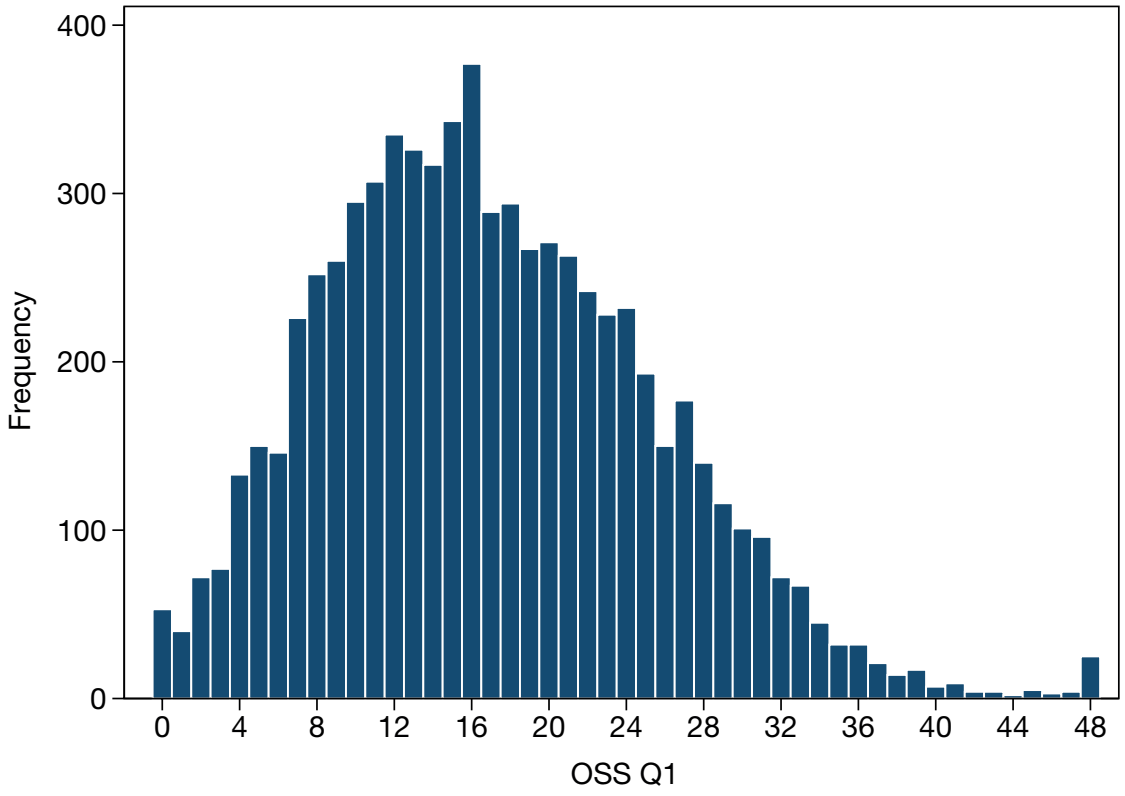


Figure 3.23 (b)

(b) **Post-operative (Q2) OSS for 7,503 patients**

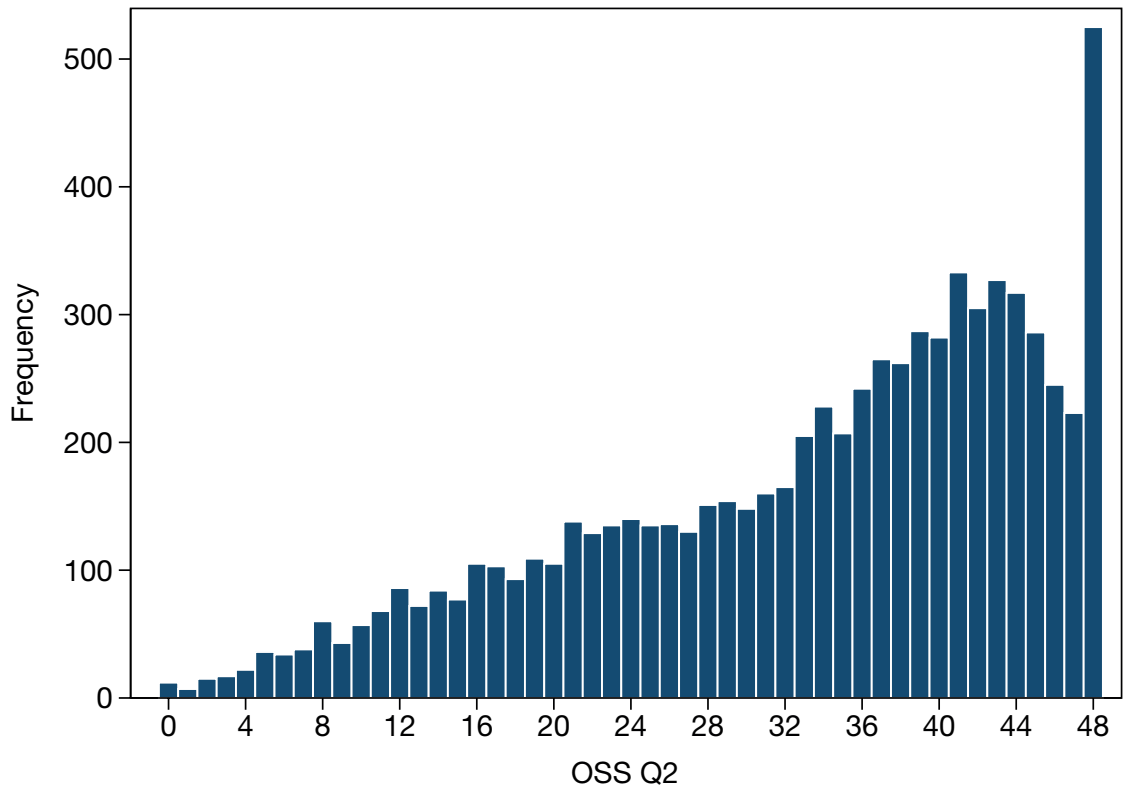


Figure 3.24 (a)

OSS distribution pre- and post-operation and the change score for those with scores at both time points (n=3,411)

(a) **Pre-operative (Q1) OSS**

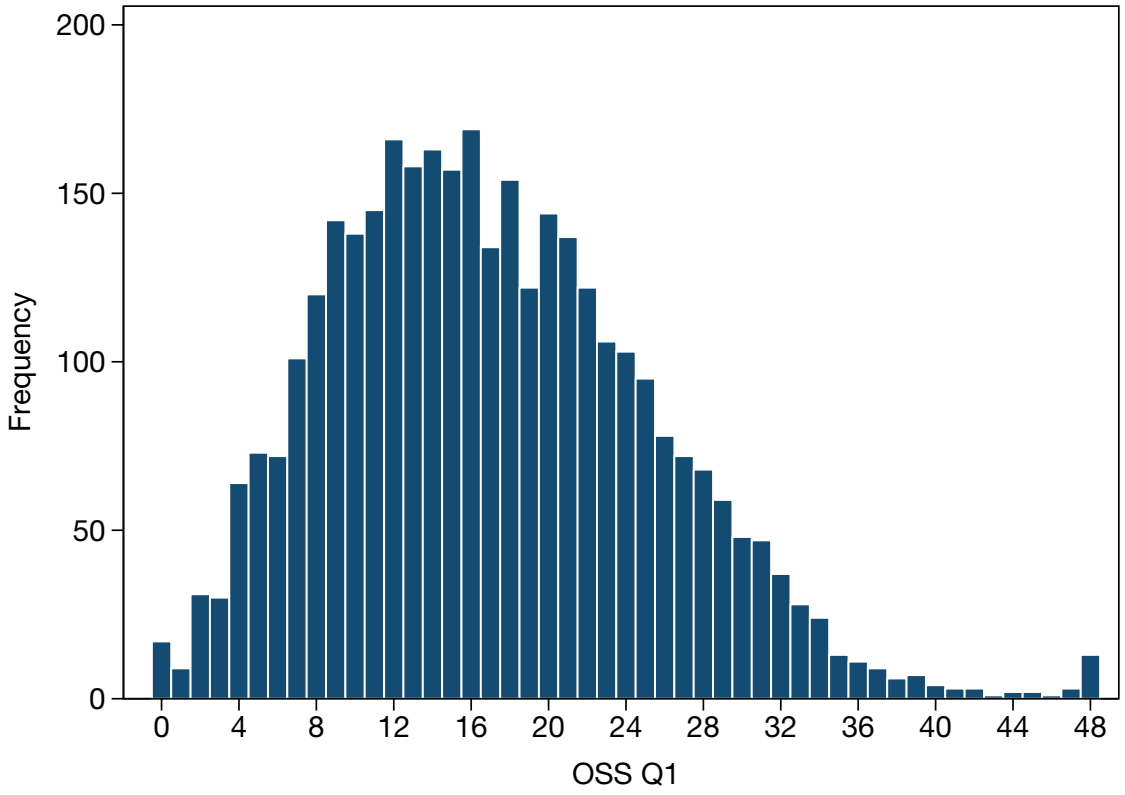


Figure 3.24 (b)

(b) **Post-operative (Q2) OSS**

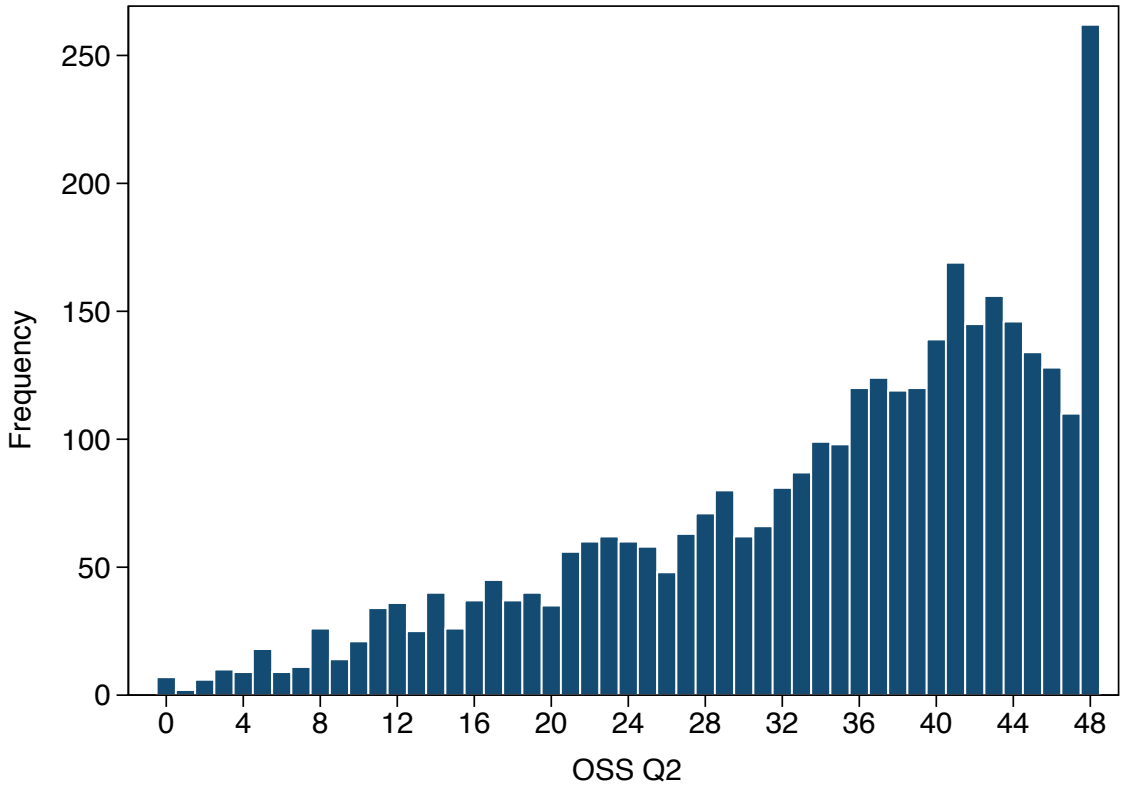
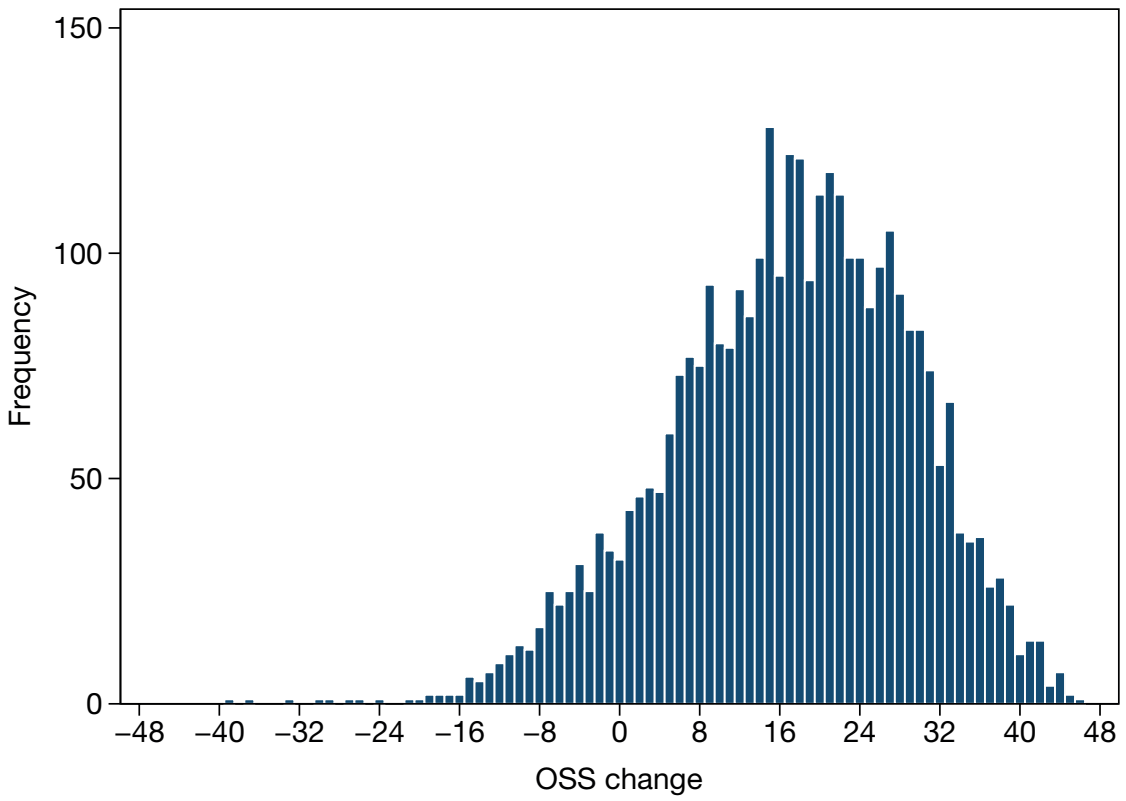


Figure 3.24 (c)

(c) **Change in OSS (post-op Q2 minus pre-op Q1)**



A summary of OSS by year of primary is shown in Table 3.49 below. Whilst there was a suggestion of a slight improvement in the post-operative results for primaries from 2014, the post-operative data for 2015 are not yet complete.

Table 3.49 A summary of available total OSS, pre- and post-operation together with the change, by year of the primary.

Year of primary	Summary of all available OSS, by year of primary		
	Pre-op (Q1): Median (IQR), n	Post-op (Q2): Median (IQR), n	Change (Q2-Q1): Median (IQR), n
2012*	16 (10-22), n=1,109	35 (24-42), n=1,708	17 (7-26), n=825
2013	16 (11-23), n=1,794	35 (24-41), n=2,132	17 (9-24), n=968
2014	16 (11-23), n=2,219	38 (27-44), n=2,723	19 (10-27), n=1,248
2015	16 (11-23), n=2,009	37 (27-43), n=940	19 (11-27), n=370
All cases	16 (11-23), n=7,131	36 (25-43), n=7,503	18 (9-26), n=3,411

*Includes a few with primary operation dates prior to 2012.

A summary of OSS for the acute trauma versus elective cases is shown in Table 3.50 below. Both the pre- and the post-operative overall OSS were lower in the acute trauma group than in the elective group. Although the overall changes looked similar, the changes in the acute trauma were more widely spread than the elective cases. While a larger proportion of patients had lower scores after the operation in the trauma group than they did before (which might be expected), a significant proportion of patients in both groups had a worse score after surgery at Q2 assessment: 24 out of 80 acute trauma cases (30%) compared with 275 of 3,331 elective cases (8%).

Table 3.50 A summary of available total OSS, pre- and post-operation together with the change, by acute fracture versus elective.

Reason for primary	Summary of pre- and post-OSS, for complete pairs, by primary patient procedure				
	All available data		Complete pairs (with both Q1 and Q2)		
	Pre-op (Q1): Median (IQR), n	Post-op (Q2): Median (IQR), n	Pre-op (Q1): Median (IQR), n	Post-op (Q2): Median (IQR), n	Change (Q2-Q1): Median (IQR
Acute fracture	10 (3-26), n=175	31 (21-39), n=570	11 (4-42), n=80	36 (26-42), n=80	20.5 (-5.5-32), n=80
Elective	16 (11-23), n=6,956	36 (26-43), n=6,933	16 (11-22), n=3,331	37 (27-43), n=3,331	18 (9-26), n=3,331
Comparison (two-tailed Mann-Whitney U-test)	P<0.001	P<0.001	P=0.054	P=0.55	P=0.58

The final table in this section, Table 3.51 (over the page), summarises the OSS for the elective patients according to the primary patient procedure.

Table 3.51 A summary of pre- and post-operative OSS for elective cases with both scores, together with their changes, by patient procedure.

Primary procedure (Elective cases only)*	Summary of pre- and post-OSS, for complete pairs, by primary patient procedure			
	Number of complete pairs	Pre-op (Q1): Median (IQR)	Post-op (Q2): Median (IQR)	Change (Q2-Q1): Median (IQR)
Resurfacing total arthroplasty	169	17 (12-24)	37 (28-43)	17 (9-25)
Total prosthetic replacement	1,127	17 (12-23)	41 (33-45)	21 (13-28)
Hemi-arthroplasty	265	15 (11-21)	32 (21-39)	14 (4-22)
Resurfacing hemi-arthroplasty	478	18 (12-23)	34 (23-40)	13 (5-21)
Reverse polarity total prosthetic replacement	1,241	15 (10-21)	35 (25-42)	17 (9-26)
Comparison (two-tailed Mann-Whitney U-test)		P<0.001	P<0.001	P<0.001

*Excludes 31 with uncertain primary procedure.

3.8.4 Mortality after primary shoulder replacement surgery

For this analysis, we first deleted the second of the 15 pairs of bilateral operations performed on the same day (see Table 3.2). Of the remaining 17,184 implants, 581 of the recipients had died by the end of December 2015. Estimates of the cumulative percentage probability of mortality in this cohort was 0.41 (0.33-0.52) at 90 days and 1.52 (1.33-1.73), 3.75 (3.41-4.13) and 6.25 (5.70-6.86) respectively at 1, 2 and 3 years after the primary operation.

Table 3.52 shows the overall cumulative percentage probability of mortality shown separately for acute trauma and the elective cases and shows higher rates in the acute trauma group.

However this is all-cause mortality and in extended follow up beyond the immediate post-operative period, we would expect higher rates in older age groups, and also in men. In the subsequent table, Table 3.53, the larger, elective group has been sub-divided in to gender and age sub-groups; the number remains too small for further breakdown in the acute trauma cases.

Table 3.52 Kaplan-Meier estimates of cumulative percentage probability of mortality (95% CI) by time from shoulder primary, for acute trauma and elective cases at 90 days, 1, 2 and 3 years from the primary shoulder replacement. *Figures in blue italics denote time points where fewer than 250 cases remained at risk, hence the 95% CI are not reliable.*

	Time from shoulder primary operation				
	Number	90 days	1 year	2 years	3 years
Acute trauma	1,460	1.8 (1.2-2.6)	4.2 (3.2-5.4)	7.9 (6.3-9.8)	*11.5 (9.2-14.3)*
Elective	15,724	0.3 (0.2-0.4)	1.3 (1.1-1.5)	3.4 (3.0-3.8)	5.8 (5.2-6.4)

Table 3.53 Kaplan-Meier estimates of cumulative percentage probability of mortality (95% CI) by time from elective shoulder primary, by age and gender at 90 days, 1, 2 and 3 years from the primary shoulder replacement. *Figures in blue italics denote time points where fewer than 250 cases remained at risk, hence the 95% CI are not reliable.*

Age at primary (years)	Males					Females				
	n*	Time from primary operation:				n*	Time from primary operation:			
		90 days	1 year	2 years	3 years		90 days	1 year	2 years	3 years
<65	1,399	0.2 (0.1-0.7)	0.9 (0.5-1.6)	2.1 (1.3-3.3)	*3.0 (1.9-4.9)*	1,634	0.1 (0.01-0.5)	0.4 (0.2-0.9)	1.2 (0.7-2.2)	2.2 (1.3-3.7)
65-74	1,747	0.3 (0.1-0.7)	1.2 (0.8-1.9)	3.3 (2.4-4.6)	*4.8 (3.5-6.6)*	4,153	0.10 (0.04-0.3)	0.6 (0.4-0.9)	1.7 (1.3-2.3)	3.2 (2.5-4.3)
75+	1,448	0.8 (0.4-1.4)	3.2 (2.3-4.3)	7.2 (5.7-9.1)	*12.0 (9.6-15.0)*	5,334	0.4 (0.3-0.6)	1.7 (1.4-2.2)	4.73 (4.04-5.53)	8.5 (7.3-9.8)

*Excludes nine cases whose NHS number was not traced therefore the age could not be validated.

3.8.5 Conclusions

In this report we have been able to build on last year's first report of shoulder replacements by presenting the data on 17,199 primary shoulder replacements in a more useful and granular way. Our intention is to continue to evolve this section of the report to ensure accurate and highly relevant data is presented in an optimum manner to all stakeholders to aid decision-making and to ultimately improve patient outcomes. This year, for the first time, we have also presented an initial analysis of patient reported outcome measures (PROMs) that have been recorded for some of the patients who have undergone shoulder replacements.

Due to their fundamental differences, we continue to present shoulder replacements for trauma and elective indications separately.

Some implant types continue to be used across all shoulder indications and it remains important to monitor the performance of these implants in different sub-groups using PROMs as well as revision rates. Although not complete, the PROMs data in this year's report indicates a substantial benefit is possible for patients undergoing shoulder replacement surgery for elective reasons. For the Q1 and matched Q2 cohort the biggest improvement in OSS were in patients undergoing anatomical total prosthetic replacement, although it must be noted that this PROMs analysis group is a fraction of the overall cohort. We hope to present larger numbers next year provided PROMs collection continues.

The importance of an on-going PROMs programme is highlighted by the fact that some patients in the elective group have worse outcome scores at Q2 than Q1 (8%). This group will need further analysis by implant type and indication to see if there are particular risk factors that can be identified. This mismatch in revision rates and poor PROMs outcomes indicates the importance of PROMs in assessing true patient outcome and implant performance for shoulder replacement surgery.

For the first time, we also present some age demographics data on patients being offered shoulder replacement surgery. It should be noted that overall revision rates are much higher in younger patients, particularly males, and these rates are higher than in similar patients undergoing hip and knee replacements.

Finally there continues to be an expansion and introduction of many different shoulder implant designs that do not fit easily into existing classification systems and many of these have been recorded in this report in the unknown column. An update of the classification system in response to this industry change in implant types is being assessed in collaboration with the British Elbow and Shoulder Society.

Part 4

Implant and unit-level activity and outcomes

Part Four of the annual report gives performance and data entry quality indicators for Trusts, 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 2015 calendar year. Outcomes analysis after hip and knee replacement surgery is also provided for the period 2003 to 2015.

This section now also provides data for implant outliers since 2003 and further information on notification and last usage date.

The full analysis for both units and implants can be found in the Part Four online document at www.njrreports.org.uk – 'Implant and unit-level activity and outcomes'.

4.1 Implant performance

The Implant Scrutiny Committee reports Level 1 outlier implants to the MHRA. Since the committee's formation in 2009 there have been three hip stems, three hip acetabular (cup) components and 17 hip stem/cup combinations reported. Five knee brands have been notified.

4.2 Clinical activity

Overall in 2015, 151 NHS Trusts and Local Health Boards (comprising 247 separate hospitals) and 177 independent hospitals were open and eligible to report patient procedures to the NJR. Of these units, only eleven did not submit any data.

The proportion of all hip and knee joint replacements entered in to the NJR against those carried out (compliance) is only available by NHS Trust and Local Health Board. No data on this is currently available from private providers and figures would also exclude units in Northern Ireland and the Isle of Man as compliance is not available.

At the time of publication, it has not been possible to produce compliance figures for the financial year 1 April 2015 to 31 March 2016 due to the unavailability of data from the Hospital Episodes Statistics (HES) service.

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

NHS hospitals

- 50% of NHS hospitals achieved a consent rate of greater than 95%
- 38% achieved a consent rate of 80% to 95% and
- 12% recorded a consent rate of less than 80%

Independent hospitals

- 68% of independent hospitals achieved a consent rate greater than 95%
- 24% achieved a consent rate of 80% to 95% and
- 8% recorded a consent rate of less than 80%

Similarly, the proportion of entries in which there is significant data to enable the patient to be linked to an NHS number ('linkability') are listed below:

NHS hospitals

- 88% achieved a proportion of patients with a linkable NHS number greater than 95%
- 11% achieved a proportion of 80% to 95% and
- 1% recorded a proportion of linkable records of less than 80%

Independent hospitals

- 66% achieved a proportion of patients with a linkable NHS number greater than 95%
- 28% achieved a proportion of 80% to 95% and
- 6% recorded a proportion of linkable records of less than 80%

Note: Independent hospitals might be expected to have lower linkability rates than NHS hospitals, as a proportion of their patients may come from abroad and not have an NHS number. Linkability figures are not currently available for Northern Ireland or the Isle of Man.

4.3 Outlier units for 90-day mortality and revision rates for the period 2003 to 2015

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 life of the registry, a total of 30 hospitals reported higher than expected rates of revision for knee replacement and 44 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 ten hospitals reporting higher than expected rates for knees, and four for hips.

The 90-day mortality for hip and knee replacement was calculated for all hospitals by plotting standardised mortality ratios for each hospital against the expected number of deaths. One hospital (closed in 2013) had a higher than expected mortality rate for knee replacement while none were identified for hip 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 latter 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 in Part Four have been notified. All units are provided with an Annual Clinical Report and additionally have access to an online NJR Management Feedback system.

Important note about the outlier hospitals listed below

In previous annual reports, the NJR has reported outlying hospitals based on all cases submitted to the NJR since 1 April 2003. To reflect changes in hospital practices and component use, the NJR now also reports outlying hospitals based on the last five years of data (21 February 2011 to 20 February 2016 inclusive, the latter date being when the dataset was cut). This five year cut of data excludes from the analysis the majority of withdrawn outlier implants, and metal on metal total hip replacements, and thus better represents contemporary practice..

Outlier for Hip mortality rates since 2003[1]
None identified

Outlier for Knee mortality rates since 2003[1]
Redwood Diagnostic Treatment Centre [closed in 2013]

Outliers for Hip revision rates, all linked primaries from 2003[1]
Nevill Hall Hospital
The Royal London Hospital
Sussex Orthopaedic NHS Treatment Centre
Llandough Hospital
Prince Charles Hospital
Queen Elizabeth The Queen Mother Hospital
Basingstoke and North Hampshire Hospital
Homerton University Hospital
Maidstone District General Hospital [closed in 2011]
Medway Maritime Hospital
Northampton General Hospital (Acute)
University Hospital Of Hartlepool
University Hospital Of North Tees
North Tyneside General Hospital
Royal Cornwall Hospital (Treliske)
St Michael's Hospital
Salisbury District Hospital
Musgrove Park Hospital

(Continued)

Outliers for Hip revision rates, all linked primaries from 2003[1]
Rotherham District General Hospital
Pilgrim Hospital
Hospital Of St Cross
University Hospital (Coventry)
St Albans City Hospital
Watford General Hospital
York Hospital
BMI Gisburne Park Hospital (Lancashire)
BMI Sarum Road Hospital (Hampshire)
BMI The Somerfield Hospital (Kent)
Shepton Mallet Treatment Centre (Somerset)
Nuffield Health Brighton Hospital (East Sussex)
Nuffield Health Haywards Heath Hospital (West Sussex)
Nuffield Health Tees Hospital (Cleveland)
Nuffield Health Wessex Hospital (Hampshire)
Nuffield Health York Hospital (North Yorkshire)
Ashtead Hospital (Surrey)
New Hall Hospital (Wiltshire)
North Downs Hospital (Surrey)
Clifton Park Hospital (North Yorkshire)
Dunedin Hospital (Berkshire)
Spire Alexandra Hospital (Kent)
Spire Cardiff Hospital (Glamorgan)
Spire Gatwick Park Hospital (Surrey)
Spire Harpenden Hospital (Hertfordshire)
Spire Tunbridge Wells Hospital (Kent)

Outliers for Hip revision rates, all linked primaries from 2011[2]
Wrexham Maelor Hospital
Salisbury District Hospital
St Richard's Hospital
Watford General Hospital

Outliers for Knee revision rates, all linked primaries from 2003[1]
Bradford Royal Infirmary
Llandough Hospital
Conquest Hospital
Good Hope Hospital

(Continued)

Outliers for Knee revision rates, all linked primaries from 2003[1]
Homerton University Hospital
Withybush General Hospital
Charing Cross Hospital
James Paget University Hospital
Southmead Hospital
Southampton General Hospital
South Tyneside District Hospital
Cannock Chase Hospital
County Hospital Louth
Grantham and District Hospital
University College Hospital
Hospital Of St Cross
St Richard's Hospital
St Albans City Hospital
Weston Treatment Centre [closed in 2007]
BMI Goring Hall Hospital (West Sussex)
BMI The Meriden Hospital (West Midlands)
North East London NHS Treatment Centre (Essex)
Shepton Mallet Treatment Centre (Somerset)
Southampton NHS Treatment Centre (Hampshire)
King Edward VII Hospital Sister Agnes (Greater London)
New Hall Hospital (Wiltshire)
Horton NHS Treatment Centre (Oxfordshire)
Spire Alexandra Hospital (Kent)
Spire Clare Park Hospital (Surrey)
Spire Southampton Hospital (Hampshire)

Outliers for Knee revision rates, all linked primaries from 2011[2]
Ashford Hospital
Charing Cross Hospital
County Hospital Louth
University College Hospital
St Richard's Hospital
BMI The London Independent Hospital (Greater London)
North East London NHS Treatment Centre (Essex)
Southampton NHS Treatment Centre (Hampshire)
King Edward VII Hospital Sister Agnes (Greater London)
Spire Southampton Hospital (Hampshire)

Note: 1 1 April 2003 to 20 February 2016 inclusive. 2 21 February 2011 to 20 February 2016 inclusive.

Glossary

A	
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.
Antibiotic-loaded bone cement	See cement.
Arthrodesis	A procedure where the bones of a natural joint are fused together (stiffened).
Arthroplasty	A procedure where a natural joint is reconstructed with an artificial prosthesis.
ABHI	Association of British Healthcare Industries - the UK trade association of medical device suppliers.
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.
ASA	American Society of Anaesthesiologists scoring system for grading the overall physical condition of the patient, as follows: P1 – fit and healthy; P2 – mild disease, not incapacitating; P3 – incapacitating systemic disease; P4 – life threatening disease; P5 – expected to die within 24 hrs without an operation.
B	
Bearing type	The two surfaces that articulate together in a joint replacement. Options include metal-on-polyethylene, metal-on-metal, ceramic-on-polyethylene, ceramic-on-metal and ceramic-on-ceramic.
Beyond Compliance	A system of post market surveillance initiated in 2013. Under this system a scrutiny committee closely monitors the usage and performance of implants which are new to the market in order that any problems may be quickly indentified and that the necessary corrective actions are undertaken in order to protect patient safety.
Bilateral operation	Operation performed on both sides, e.g. left and right knee procedures, carried out during a single operation.
BMI	Body mass index. 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 (m2).
BOA	British Orthopaedic Association - the professional body representing orthopaedic surgeons.
Bone cement	See cement.
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	
CQC	Care Quality Commission. Regulators of care provided by the NHS, local authorities, private companies and voluntary organisations.
Case ascertainment	Proportion of all relevant joint replacement procedures performed in England, Wales, Northern Ireland and the Isle of Man 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	The material used to fix cemented joint replacements to bone - polymethyl methacrylate (PMMA). Antibiotic can be added to bone cement to try and reduce the risk of infection.
Cemented	Prostheses designed to be fixed into the bone using cement.
Cementless	Prostheses designed to be fixed into the bone by bony ingrowth or ongrowth, without using cement.
Compliance	The percentage of all total joint procedures that have been entered into the NJR within any given period compared with the expected number of procedures performed. The expected number of procedures is based on the number of procedures submitted to HES and PEDW.

Compliance Confidence Interval (CI)	A 'Confidence Interval' (CI) is calculated to accompany anything being estimated from just a random sample of cases, for example the cumulative probability of revision; a CI tells us something about the range of values that the 'true' (population) value can take. Whilst calculated Confidence Intervals by their very nature will vary from sample to sample, calculation of a '95% Confidence Interval' (95% CI) means that 95% of all such calculated intervals should actually contain the 'true' value.
Confounding	Can occur when an attempt to quantify how a particular variable of interest affects outcome is hampered by another variable(s) being related to both the variable of interest and the outcome. For example a comparison of the revision rates between two distinct types of implant may be hampered by the fact that one implant has been used on an older group of patients than the other; age here is a 'confounder' for the relationship between implant type and outcome because revision rate also depends on age. Statistical methods may help to 'adjust' for such confounding variables.
Cox 'proportional hazards' model	A type of multivariable regression model used in survival analysis to look at the simultaneous effects of a number of variables ('predictors') on outcome (first revision or death). The effect of each variable is adjusted for the effects of all the other 'predictor' variables in the model so the Cox model can be used to adjust for 'confounders' (see above). 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 predictor variables affect the hazard rates in a 'proportional' way; the latter requiring some careful model checking when this method is used.
Cross-linked polyethylene	See modified polyethylene.
Cumulative incidence function (CIF)	Used instead of Kaplan-Meier to estimate the cumulative probability of 'failure' in the presence of a 'competing risk(s)'. A competing risk event can prevent the event of interest from occurring; 'death' for example is a 'competing risk' for revision because once unrevised patients die they can no longer experience revision. Instead of 'censoring' for death (which technically assumes that such patients might still be at risk of revision but that no further information is available), cumulative incidence functions make appropriate adjustment.
Cup	See Acetabular component.
D	
Data collection periods for annual report analysis	The NJR Annual Report Part One reports on data collected between 1 April 2015 and 31 March report analysis 2016 – the 2015/16 financial year. The NJR Annual Report Parts Two and Four analyse data on hip, knee, ankle, elbow, and shoulder procedures undertaken between 1 January and 31 December 2015 inclusive – the 2015 calendar year. The NJR Annual Report Part Three reports on hip, knee, ankle and shoulder joint replacement revision rates for procedures that took place between 1 April 2003 and 31 December 2015.
DDH	Developmental dysplasia of the hip. A condition where the hip joint is malformed, usually with a shallow socket (acetabulum), which may cause instability.
DH	Department of Health.
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	
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.
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). Has a femoral head mounted on it to form the complete femoral component.

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.
Glenoid head	Domed head portion of the glenoid component of the reverse shoulder replacement attached to the scapula.
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.
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. Data on case mix, procedures, length of stay and other hospital statistics collected routinely by NHS hospitals in England.
HQIP	Healthcare Quality Improvement Partnership. Manages 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)	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)	Part of a total or partial shoulder joint 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 cup	The shallow socket of a reverse shoulder replacement attached to the scapula.
Humeral head	Domed head portion of the humeral component of the artificial shoulder replacement attached to the humeral stem.
Humeral prosthesis	Portion of a total joint 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 component.
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 (cementless stem, cemented socket) and hybrid (cemented stem, cementless socket).
I	
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.
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.
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. '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 the analysis period (end of 2015) without having been revised. The estimates do not adjust for any confounding factors.

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.
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 physically connected.
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.
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. MDS version one closed to new data entry on 1 April 2005.
MDSv2	Minimum dataset version two, introduced on 1 April 2004. MDS version two replaced MDS version one 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.
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.
Mixing and matching	Also known as 'cross breeding'. Hip replacement procedure in which a surgeon chooses to implant a femoral component from one manufacturer with an acetabular component from another.
Modified Polyethylene	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, e.g. a monobloc knee tibial component.
N	
NHS	National Health Service.
NICE	National Institute for Health and Care Excellence.
NICE benchmark	See ODEP ratings.

NJR	National Joint Registry for England, Wales, Northern Ireland and the Isle of Man. The NJR has collected and analysed data on hip and knee replacements since 1 April 2003, on ankle replacements since 1 April 2010 and on elbow replacements and shoulder replacements since April 2012. It covers both the NHS and independent healthcare sectors to ensure complete recording of national activity in England, Wales, Northern Ireland and the Isle of Man.
NJR Centre	National coordinating centre for the NJR.
NJR StatsOnline	Web facility for viewing and downloading NJR statistics on www.njrcentre.org.uk.
O	
ODEP	Orthopaedic Data Evaluation Panel of the NHS Supply Chain. www.odep.org.uk.
ODEP ratings	ODEP ratings are the criteria for product categorisation of prostheses for primary total hip and knee replacement against benchmarks. An ODEP rating consists of a number and a letter and a star. The number represents the number of years for which the product's performance has been evidenced. The letter represents the strength of evidence (data) presented by the manufacturer. The star has been added to the rating system following revised guidelines from NICE in February 2014, in which a benchmark revision rate of less than 5% at 10 years was defined. The star is awarded where products are evidenced to comply with this benchmark. A* represents evidence above A and B. Ratings without a star signify compliance with the prior NICE guidance of a replacement rate of less than 10% at 10 years. The same benchmark has been adopted by ODEP for knees. All implants that are used without a 10-year benchmark should be followed up closely. See www.odep.org.uk.
OPCS-4	Office of Population, Censuses and Surveys: Classification of Surgical Operations and Procedures, 4th Revision – 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'.
P	
Pantalar (ankle)	Affecting the whole talus, i.e. the ankle (tibio talar) joint, the subtalar (talo calcaneal) joint and the talonavicular joint.
Patella resurfacing	Replacement of the surface of the patella (knee cap) with a prosthesis.
Patellofemoral knee	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.
Patient procedure	Type of procedure carried out on a patient, e.g. primary total prosthetic replacement using cement.
Patient-time	The total of the lengths of time a cohort of patients were 'at risk'. In the calculation of PTIRs for revision, for example, each individual patient's 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 last observation date. The individual time intervals are then added together.
PDS	The NHS Personal Demographics Service is the national electronic database of NHS patient demographic details. The NJR uses the PDS Demographic 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 total joint replacement operation is performed on any individual joint in a patient.
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.
PROMs	Patient Reported Outcome Measures.

PTIR	Patient-Time Incidence Rate. The total number of events (e.g. first revisions) divided by the total of the lengths of times the patients were at risk (see 'patient-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.
Resurfacing (hip)	Resurfacing of the femoral head with a surface replacement femoral prosthesis and insertion of a monobloc acetabular cup, with or without cement.
Resurfacing (shoulder)	Resurfacing of the humeral head with a surface replacement humeral prosthesis inserted, with or without cement.
Reverse 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	Operation performed to remove (and usually replace) one or more components of a total joint prosthesis for whatever reason.
S	
Shoulder hemi-arthroplasty	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 revision carried out in a single operation.
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.
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, with or without cement.
TED stockings	Thrombo embolus 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 (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).
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.
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.

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, found on its upper outer aspect.
Trochanteric osteotomy	Temporary incision of the trochanter, used to aid exposure of hip joint during some types of total hip replacement.
Two-stage revision	A revision procedure carried out as two operations, often used in the treatment of deep 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	See cementless.
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 not physically connected.

National Joint Registry
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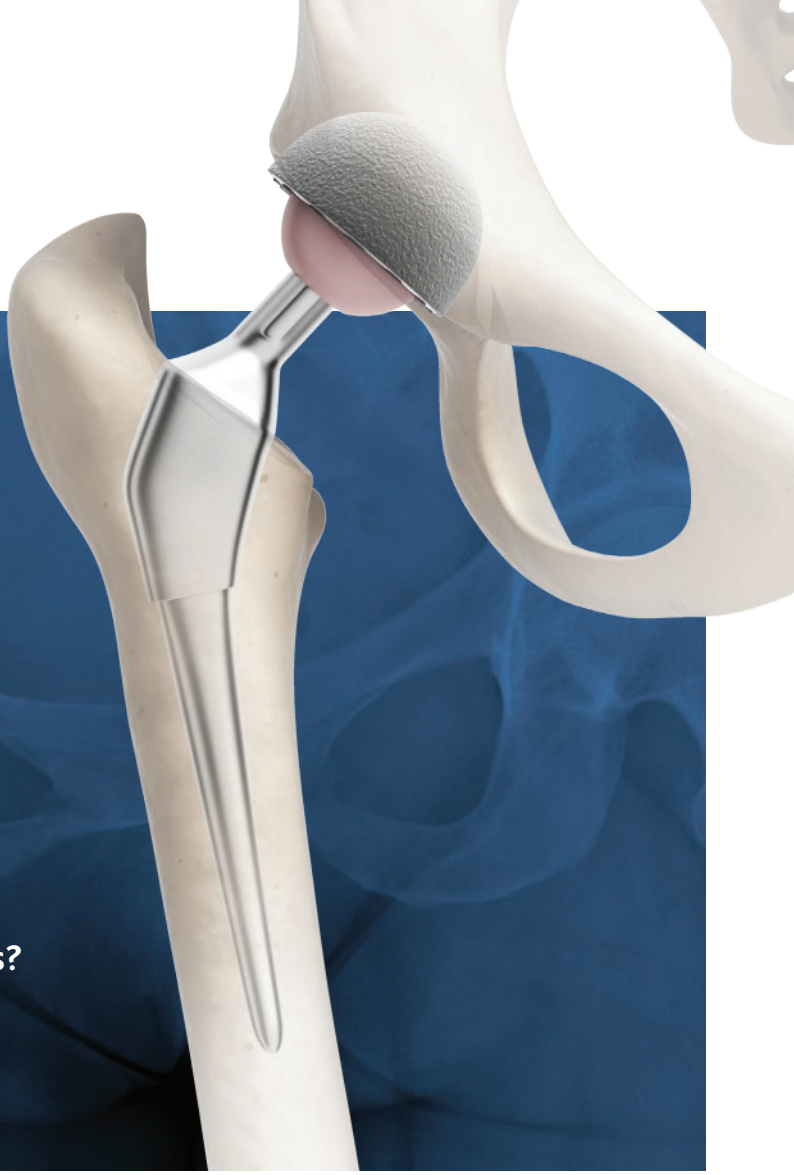
Working for patients, driving forward quality



EMBED - NJR Price Benchmarking Service

Supporting productivity, efficiency and cost saving in orthopaedic implant procurement.

Do you:

- **Achieve best possible value for implants?**
- **Follow clinical protocols based upon national evidence?**

Through the work of Lord Carter set out in his recent report[1] and Professor Tim Briggs, National Director for Clinical Quality and Efficiency with GIRFT[2] the NHS is challenged to achieve best value in procurement, including orthopaedic implants.

EMBED is a service from the NJR providing information to support hospitals achieve best value in the procurement of orthopaedic implants, enabling greater efficiency to be made in this area of significant spend.

Following its launch in 2015, the NJR Price Benchmarking Service now includes detailed implant pricing across the NHS.

Of specific importance, the NJR contains in-depth information regarding implant usage, implant combinations and the long term survivorship of implants.

The combination of national pricing and usage data, profiled against the type and complexity of cases enables the NJR to provide a unique resource for hospitals, offering personalised assessment of cost saving opportunity in the selection, procurement and usage of joint replacement prostheses.

[1] Operational productivity and performance in English NHS acute hospitals: Unwarranted variations. An independent report for the Department of Health by Lord Carter of Coles, Feb 2016.

[2] Getting It Right First Time (GIRFT) - A national review of adult elective orthopaedic services in England, 16th March 2015.

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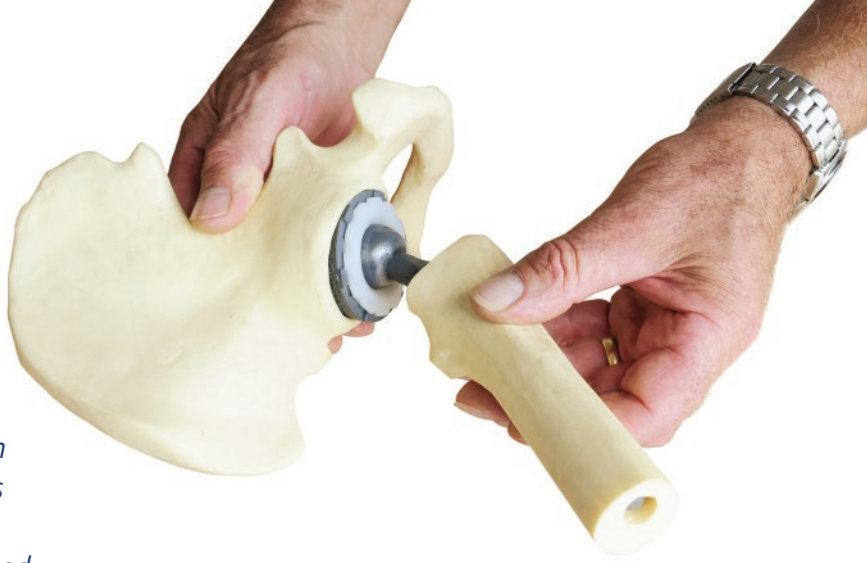

The NJR pilot on pricing demonstrated large variation in price being paid for the same prostheses. The trusts involved in the pilot were quickly able to realise very significant savings by challenging pricing. It is proposed, based on the experience of the NJR pilot and from collaboration with trust procurement teams, that a saving of up to £40 million per annum could be achieved across the 120 elective providers. ***Saving £40 million per year = £200 million over 5 years.***

GIRFT Report

"Average price paid for hip prosthesis varies from £788 to £1590, and trusts buying the most are not paying the lowest price."

Carter Report

WHO IS IT FOR?

✓ **PROCUREMENT LEADS**
looking to assess prices and benchmark costs

✓ **SURGEONS**
looking to understand cost of implants used in their practice, set in a clinical context

✓ **BUSINESS LEADS / TRUST MANAGEMENT**
looking to understand variation in implant costs across the organisation

✓ **FINANCE MANAGERS**
looking to assess cost saving opportunities and ensure best value

WHAT ARE THE BENEFITS?

- Give surgeons access to implant pricing data for all their practice
- Compare your implant pricing to national average, best and best quartile pricing
- Assess your current pricing regime against national benchmarks
- Assess implant usage in your organisation against clinical protocols
- Understand your total implant cost picture in the context of your case mix
- Understand your use of higher cost implants (such as ceramics) against national average use

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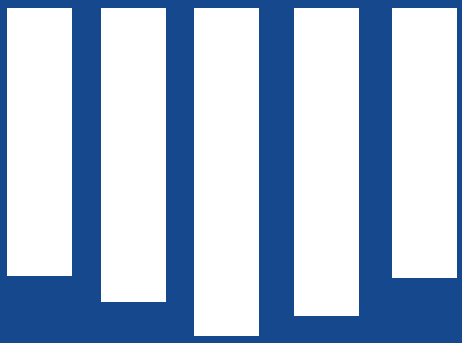

Every effort was made at the time of publication to ensure that the information contained in this report was accurate. If amendments or corrections are required after publication, they will be published on the NJR website at www.njrcentre.org.uk and on the dedicated NJR Reports website at www.njrreports.org.uk.

At www.njrreports.org.uk, this document is available to download in PDF format along with additional data and information on NJR progress and developments, clinical activity and implant and unit-level activity and outcomes.

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