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HIPS
KNEES
ANKLES
ELBOWS
SHOULDERS
PROMs

12th Annual Report 2015

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

Surgical data to 31 December 2014

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Additional data and information can also be found as outlined on page 15.

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Chairman's introduction

Laurel Powers-Freeling

As Chairman of the National Joint Registry Steering Committee (NJRSC) for the past three years, it is always a pleasure to introduce our Annual Report. This 12th edition, outlining the substantial progress and work of the NJR during the year 2014/15, showcases the registry's development, which continues apace. None more so than in the continued roll-out of new digital annual reporting arrangements and the launch of new interactive clinical activity reports at the dedicated 'NJR Reports' website (www.njrreports.org.uk).

Moving further into our second decade of data collection, we are entering a new chapter of development and work, firstly through the management and analysis of nearly 2 million records and secondly, through the increased utility that our maturing dataset holds. The registry in particular supports transparency by using and sharing relevant hospital, surgeon and implant-pricing data, as well as enabling the linkage of NJR data with other expanding healthcare information, where it is strategic to do so, and it helps tackle issues and problems in joint replacement surgery.

Similarly to the last reporting period, there have been a number of changes to the membership of the NJRSC with the expiry of a number of long-standing members' terms of office. I would therefore like to take the opportunity to acknowledge the significant contributions made by those outgoing members for their work in having made the NJR a successful and world-leading register.

In particular I would like to thank Keith Tucker, whose term of office recently expired, for his long and dedicated service to the NJR. Keith was a long-standing orthopaedic surgeon member of NJRSC, as well as Chairman of the NJR Implant Performance and Scrutiny Sub-committees. His outstanding commitment and his valuable input to all aspects of our work, has helped to shape the NJR and make it what it is today.

I would also like to record my special thanks to Mary Cowern, patient member representative, whose term of office is due to expire in 2015/16. With the NJR since 2006, Mary has spearheaded the drive for greater patient engagement in the registry and brought the patient voice to the heart of NJRSC decision making. She has shared her experience and expertise across the programme and I would like to acknowledge the valuable and significant contribution she has made.

In turn, a number of new NJRSC appointments have been made and I am delighted to welcome Professor Amar Rangan as a surgeon member and Ms Gillian Coward as a patient member and also the additional co-opted membership of Mr Hussain Kazi, surgeon representative and Mr Matthew Porteous as Chair of the NJR Regional Clinical Coordinators Sub-committee.

We are also delighted to have benefited from closer collaboration between the registry and the profession. This is both through the co-opted role of the British Orthopaedic Association (BOA) President to the NJRSC and the establishment of the Medical Advisory Committee through which specialist orthopaedic societies are formally represented. Current BOA President Professor Colin Howie took on the role from September 2014, with immediate past-President Professor Tim Briggs then taking up a co-opted position as national lead for the Getting It Right First Time (GIRFT) initiative. This year, Colin leaves the NJRSC when his term of office as BOA President expires in September. I would like to thank Colin for his considerable contribution to the NJRSC over the last year, which has been appreciated, and I look forward to welcoming his successor for 2015/16.

Following on from the extensive strategic work done over the past couple of years, we are delighted to report the completion and publication of the NJR's Supporting Data Quality Strategy. This strategy, found at www.njrcentre.org.uk, outlines the registry's current and future intentions for ensuring data quality. Crucially, this includes a programme of work in partnership with hospitals to encourage greater compliance; while data capture for the NJR is mandatory, many hospitals struggle to achieve it.

One of the ways we will be seeking to support hospitals in 2015/16 is through a national programme of local audits to assess data completeness and quality. In the first instance, we intend to work with organisations to review records from one 12-month period. Following on, we will help them each subsequent year to carry on identifying where data might be missing to improve the general quality of their data in the registry.

Those actively taking part in the audit in the coming year, and already achieving best practice and demonstrating quality in their processes, will now gain the new NJR Quality Data Provider certification. Renewable annually, this award is designed to recognise quality data provision and the commitment to patient safety through compliance. Conversely, the certification will also highlight those hospitals who do not comply with mandatory NJR requirements, communicating this status through the NJR data publication and NHS Choices websites, thus allowing patients to be aware of hospitals that choose not to meet NJR quality standards.

The NJR's new economic model arrangements – established in 2014 to reduce the cost burden to the NHS and healthcare sector – continued with the full establishment of the complimentary implant price-benchmarking service (INFORM) to all NHS organisations. More than 60 NHS organisations have now provided their data to the NJR reporting system that in return, shares benchmarks against averages and best implant prices as well as wider organisation-level reports.

With Lord Carter's Efficiency and Procurement Programme developing quickly, we will be pleased to see provider use of this service increase. For those NHS procurement and clinical teams wanting to examine local cost protocols and access reports by procedure type and patient case-mix, we hope to see organisations take the opportunity to register for the 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. The need to have such dialogue is supported by the GIRFT review. Moreover, NJR services will also be an important source of evidence for the sustained momentum in the Department of Health's Quality, Innovation, Productivity and Prevention programme (DH QIPP).

Following the second publication of individual consultant outcomes in November 2014, work has continued with the BOA to develop the range of quality indicators available for publication in 2015. It has now been agreed that later this year the NJR will extend published information on individual surgeons to patient case-mix information and potentially, subject to further development, individual compliance (data submission rates) for primary and revision procedures.

In March 2015 however, the registry led on the development and publication of unit-based measures to complement the information already available for surgeons. Published in the format of 'dashboards' at www.njrsurgeonhospitalprofile.org.uk, the hospital indicators extended further to cover revision and mortality, patient reported outcomes and improvements (PROMs) as well as patient case-mix and information relating to the quality of data they submit to the NJR.

These developments were significant, not only in terms of quality in presentation to patients and the public, but in the planning and delivery that was achieved in a period of just six months. The hospital profiles and the associated dashboards will be an important area for refinement, as part of the surgeon data release in November 2015.

As the largest arthroplasty registry in the world, our international collaboration continues with NJR's Medical Director, Martyn Porter, holding a term of office as President of the International Society of Arthroplasty Registers. This has become increasingly important as the registry readies itself for the introduction of Unique Device Identifiers, and the need to prepare the database to ensure it has the ability to harmonise with global orthopaedic device initiatives. This agenda has led to the start of a whole component database upgrade which is due to complete in December 2015. Representing a significant work programme, these improvements will enable the NJR to report at a granular level and track implant performance in an enhanced and more detailed way.

Additional plans for the 2015/16 operating year include:

- Expansion to the Isle of Man from July 2015
- Continued development of NJR Clinician Feedback, Supplier Feedback and the Annual Clinical Report and Implant price-benchmarking services available through Management Feedback
- Completion of the five-year NJR-funded PROMs programme for hip and knee as well as completion of the three-year follow-up for shoulder replacements. First analysis of knee PROMs is already included in the 12th Annual Report and further work continues as this new area is explored
- Refresh and refinement of NJR Surgeon and Hospital Profile service
- National roll-out and implementation of the NJR's data quality audit programme

While I gave my thanks to colleagues who had stepped down from the NJRSC at the beginning of this introduction, I would like to end by mentioning all remaining members of the NJRSC, and NJR Sub-committees, for their valuable contribution, in particular the chairs of those committees. I would encourage you to read and review the reports from the committee chairmen at www.njrreports.org.uk which provide a strategic view and professional insight into key work areas.

We are also grateful to the orthopaedic surgeons who comprise the NJR Regional Clinical Coordinators Sub-committee and who participate as regional leaders to underpin and champion the work and success of the NJR as well as helping shape service delivery and direction.

Finally, my thanks to the NJR contractors, Northgate Public Services (UK) Ltd, and the University of Bristol, and to all the management and communications team at the Healthcare Quality Improvement Partnership (HQIP), in particular Elaine Young, NJR Director of Operations whose tireless efforts support the NJR's evolution from strength to strength.

Yours sincerely,

Laurel Powers-Freeling

Chairman, National Joint Registry Steering Committee

Foreword from the Chairman of the Editorial Board

The NJR is now in its 12th year of reporting and has achieved compliance in excess of 90%. It already covers England, Wales and Northern Ireland and has (from 1 July 2015) extended to the Isle of Man and the number of hospitals and surgeons reporting data continues to represent a significant logistical exercise. The high compliance rate has been supported further through the introduction of the Best Practice Tariff for hip replacements which provides incentives for hospitals to report data to the NJR. The number of cases reported to the registry every year is now in excess of 200,000 and I would like to acknowledge the support and expertise of Northgate Public Services in providing the IT support for the programme.

The University of Bristol has once again provided excellent support in terms of analysing the outcomes following primary surgery and many peer review publications have been produced from the registry data.

The NJR continues to work with many stakeholders including patients, regulators, hospitals, industry, individual surgeons and procurement. Over the last year we have continued to develop various public-facing websites including hospital 'dashboard' information published in March 2015. We have also developed the level and type of reports available to surgeons. Moreover, the NJR is working increasingly with other agencies to support improvements in joint replacement outcomes notably NHS England, the DH's QIPP team and the GIRFT initiative.

The format of the Annual Report continues to evolve and we are attempting to produce more information online and I would like to draw your attention to the material previously referred to as Part Two which is the descriptive NJR data. There is now an excellent interactive platform at www.njrreports.org.uk which allows the user to filter data so they can access the information they require.

What are the main headlines for 2014?

The trends reported last year continue. The revision rates following primary total hip replacement remain low (less than 3% in many cases at 11 years). The debate regarding fixation as an isolated observation seems to become less of an issue in that it is the combination of the fixation, articulation and patient characteristics which influence the revision outcome. In particular, the controversy created by the poor results of the metal-on-metal articulation need to be considered and if necessary, filtered from the other aspects of the arthroplasty. This is particularly relevant when looking at the data for uncemented fixation where the metal-on-metal articulation was used more frequently. Once this is removed we are now seeing fairly similar revision estimates at 11 years.

It is interesting again to see the effects of patient factors which influence the outcome. Undoubtedly revision remains a problem in young patients under 55 years and is very low for patients over 75 years.

This year, results of revision hip replacement analyses are presented for the first time and it is sobering to see that re-revision rates are almost the order of magnitude higher than the primary procedure. We know that revision operations are also very expensive compared to primary procedures and it will become imperative to examine the fate and provision of revision surgery over the coming years.

The knee replacement data again continues similar trends with the unicompartmental knee having almost a three-fold revision risk compared to total knee replacement. Though, we do note a lower morbidity and mortality rate and we need to further explore the functional differences before we can come to any dogmatic conclusions regarding partial and total knee replacement. In other words, I would like to re-emphasise that revision is not the only consideration.

There is an excellent section on Patient Reported Outcome Measures (PROMs) in relation to knee replacement in this year's report. These data must be one of the largest cohorts ever reported and are fascinating in terms of the questions which arise from the preliminary data. We intend to report on PROMs in hip replacement next year.

We also report on ankle, shoulder and elbow replacements. As these are carried out less frequently and we have a shorter follow-up period and data are still at a relatively early stage. I am pleased that the British Elbow and Shoulder Society (BESS) and the British Orthopaedic Foot and Ankle Society (BOFAS) are working very closely with the NJR to take the analysis of the data forward.

Finally, I would like to thank all members of the NJR Steering Committee and Sub-committees and indeed all the orthopaedic surgeons in hospitals that contribute data. We are carrying out a major data quality evaluation exercise in 2015/16 and this will provide valuable insight into the accuracy of our data and should in itself drive up data quality.

Mr Martyn Porter
Chairman, Editorial Board and NJR Medical Director

Executive summary

Part 1: Annual progress

The 12th Annual Report of the National Joint Registry (NJR) is the formal public report for the period 1 April 2014 to 31 March 2015 and comprises distinct parts, outlined in the summary table on the right (page 15).

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 new, dedicated online annual report website 'NJR Reports' to showcase annual report data and information.

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

A short summary of the NJR's progress over 2014/15 is included below, with further detail available at www.njrreports.org.uk and in the Chairman's introduction and Editorial Board Chairman's foreword.

The total number of procedures recorded in the NJR now exceeds 1.8 million at 31 March 2015, with 2014/15 having the highest ever annual number of submissions at 226,871. 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:

- Overall compliance (case ascertainment) was recorded as 96%
- Patient consent (to record their details in the NJR) was recorded as 93.8%
- Linkability (the ability to link a patient's primary procedure to a revision procedure) was recorded as 92.8%.

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 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. In recognition of the great increase in scope and responsibilities of the NJR, the registry also continued the establishment of a revised governance, structure and operating model – seeing the new Medical Advisory and Executive Sub-committees take shape.

Another key achievement has been to continue the work in implementing a revised economic model. Launched from April 2014, the changes not only represented a significant cost saving to the NHS but meant a new, fair and proportionate cost contribution from orthopaedic device manufacturers for services provided through NJR Management Feedback to support post-market implant surveillance.

It should also be highlighted that the reports from the respective Chairman of the Implant Performance Sub-committee and the Surgeon Outlier Sub-committee are available online and outline how outlier analysis is undertaken. They also include the high-level outcomes of the monitoring process for 2014/15 with statistics provided in a new section on activity and outcomes, alongside hospital performance and outlier analyses.

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 the main NJR website at www.njrcentre.org.uk.

Summary of content for the NJR Annual Report

Section	Summary	Content	Full information can be found
Part One	Executive summaries, annual progress and highlights 2014/15	News and information in executive summaries, committee reports and highlights about the progress of the NJR to 31 March 2015	www.njrreports.org.uk
Part Two	Clinical activity 2014	Statistics on joint replacement activity for hip, knee, ankle, elbow and shoulder activity for the period 1 January to 31 December 2014	www.njrreports.org.uk through interactive reporting
Part Three	Outcomes after joint replacement surgery 2003/2014	Detailed statistical analyses on hip and knee replacement surgery using data from 1 April 2003 to 31 December 2014. Analyses on provisional data for ankles and shoulders is also included representing data collected from 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, new for this year, 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 2014 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 2014

Now to be found online at www.njrreports.org.uk, Part Two of the NJR 12th Annual Report presents data on clinical activity. 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 year 1 January 2014 to 31 December 2014. To be included in the report all procedures must have been entered into the NJR by 28 February 2015.

The information 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 numbers 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
- ASA grades for primary replacement patients
- 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 and
- Patient characteristics and indications for surgery for revision procedures

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
- Use of ODEP-rated implants

For knees specifically

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

The interactive reports are new and users are encouraged to leave feedback using the links provided on the appropriate report page.

Part 3: Outcomes after joint replacement 2003 to 2014

Part Three of the 12th 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 2014.

There were 1,837,781 procedures recorded in this period, though 11% of these were excluded because there were insufficient patient details to enable linkage. This relates predominantly to the early years of the registry and less so as data quality has improved.

There were 708,311 primary total hip replacements, 772,818 knee replacements, 2,554 ankle replacements, 11,399 shoulder replacements and 1,079 elbow replacements.

Hip replacement procedures

The potential follow up for hip procedures was 11.75 years. Osteoarthritis was the predominant diagnosis in 93% of cases. A total of 60% of procedures were carried out on women and the median age at primary was 69 years. In terms of fixation there has been a trend away from cemented hip replacements which was 60.4% in 2003 and in 2014 represented just 31.8%. The most common form of fixation is uncemented but this has slightly declined from 2009 to 41.2% in 2014 with a slight rise of hybrid fixation which is now 23.1%. Hip resurfacing now represents less than 1%. When hips were cemented the most common articulation was metal-on-polyethylene and in uncemented procedures ceramic-on-ceramic was also favoured. With hybrid fixation there has been an increase in the use of ceramic-on-polyethylene.

The Kaplan-Meier cumulative revision risk estimates at eleven years were lowest in the cemented fixation group at 3.63% (95% Confidence Interval 3.43-3.83) and higher in the uncemented group at 8.25% (7.90-8.62). However, the uncemented group contained the majority of metal-on-metal articulations and when uncemented fixation was used with ceramic-on-polyethylene bearing, the eleven-year revision estimate was 3.62% (3.24-4.05). Low revision risk was generally seen with the ceramic-on-polyethylene bearing, the revision probability being 2.98% with the cemented fixation and 2.15% with the hybrid fixation. It would appear that the articulation rather than the fixation has a major influence on survivorship.

The effect of gender and age are presented by fixation and bearing and once again there is a significant increase in revision risk in younger patients. For example, in male patients less than 55, the ten-year revision risk estimate was 7.26% (5.79-9.09) with the cemented hip replacement. In comparison this was just 2.83% (2.46-3.26) in patients over 75 years.

The common stem brand combinations are reported in terms of revision risk. Their numbers are large enough to be further sub-divided into bearing type. Several brands had low revision risk at ten years and were essentially comparable, for example the cemented Exeter V40 with a Contemporary cup with ceramic-on-polyethylene bearing had a ten-year revision estimate of 2.70% (1.72-4.21). The uncemented Corail Pinnacle with ceramic-on-polyethylene bearing had a ten-year revision risk of 2.19% (1.40-3.41). The ASR resurfacing had a revision estimate of 28.28% at ten years (26.21-30.48). It is important to note that the figures at ten years in this paragraph are approximate as at this time point fewer than 250 cases remain at risk.

Revisions for different causes after primary hip replacement identified different trends with different methods of fixation and bearing. With a cemented metal-on-polythene hip replacement, for example, the incidence of aseptic loosening increased with time whereas dislocation and infection decreased. Revisions for adverse reaction to particulate debris were more common in metal-on-metal and the incidence increased with time.

This year the risk of dissociation of liner from the acetabular component was investigated as a reason

for revision in uncemented cups with liners. This was generally a rare event with no particular trends between brands and articulation combinations.

The cumulative mortality was examined up to eleven years following primary surgery and as expected increased with age so for example this was low in men under 55 years of age, 5.48% (4.95-6.05) but rose to 86.20% (83.10-88.92) in men over 85 years.

Primary hip replacement for fractured neck of femur has been investigated in more detail with a cohort of 15,786 primary hip replacements identified. The revision risk was slightly higher than the non-fracture group and the mortality up to eleven years significantly higher approaching 50%, compared to just under 30% for the comparator group.

The revision total hip replacement has been studied. There were a total of 79,859 revisions of which 17,916 were revisions of primary operations identified in the registry and the remaining 52,780 related to unrecorded primaries, (either pre-dating 2003 or the primary had not been captured in the NJR). A total of 87.2% were single-stage revisions, 5.8% were stage one of two-stage procedures and 6.9% were stage two of two-stage procedures. The ten-year re-revision risk was 15.30% (14.72-15.89) which is nearly an order of magnitude greater than in the primary group. It was interesting that the ten-year re-revision risk estimate was 22.67% when the primary was recorded in the NJR compared to 13.9% when the primary was not recorded in the NJR. This probably relates to the fact that the revisions recorded in the NJR relate to infection, dislocation and adverse metal reaction compared to the other group.

Knee replacement procedures

Of the 772,818 primary knee replacements, osteoarthritis was the sole stated indication for surgery in 96% of cases. A total of 43% of primary knee replacement surgeries were performed on men and the median age for a male patient undergoing primary surgery was 70 years. Of all primary knee replacements, 84.3% were cemented total knee replacements, the majority of which were unconstrained fixed bearing knees, 4.7% were uncemented and 1.1% were hybrid. Unicondylar knee replacements were used in 8.7% of procedures and patellofemoral replacement made up 1.3% of all procedures.

In comparison to hip replacement there has been little temporal change between 2003 and 2014 in terms of implant selection. All cemented total knee replacement has risen from 85.1% of all recorded surgeries in 2003 to 87.5% in 2014 and there has been a decline in uncemented total knee replacements from 6.7% to 2.5% over the same time period. Unicondylar replacements have formed between 8% and 9% of all primaries each year over the eleven-year period and patellofemoral replacements have continued to form 1% to 1.5% of surgeries year on year.

The Kaplan-Meier cumulative revision risk estimates at eleven years were 3.62% (3.51-3.75) for cemented total knee replacement, 4.91% (4.38-5.50) for uncemented total knee replacement and 3.57% (3.06-4.16) for hybrid total knee replacement.

As reported in previous years the corresponding eleven-year revision estimate for unicondylar replacements were higher than total knee replacements at 14.29% (13.44-15.18) and for patellofemoral replacement the revision risk was 20.22% (18.05-22.61). Revision estimates have been broken down according to level of constraint, for example the eleven-year estimate for cemented total knee replacement with an unconstrained, fixed bearing was 3.35% (3.20-3.50) and the posterior-stabilised fixed bearing was 4.02% (3.77-4.27). 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 women over 75 years of age, the risk of revision at eleven years after the primary was just 1.53% (1.36-1.71). In comparison, in women aged under 55, the revision risk estimate was 6.94% (6.09-7.90).

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). The chance of first revision at ten years after the primary surgery is similar across the majority of implant brands used in total knee replacements. For example, at ten years

the revision estimate was 3.56% (3.33-3.81) for the Nexgen knee and the AGC had a comparable revision risk estimate of 3.55% (3.29-3.82).

Within the unicondylar brand group, the Zimmer unicompartmental implant shows a low revision estimate at seven years of 5.89% (4.93-7.07) compared to the Preservation at 14.38% (12.68-16.32).

The cumulative mortality at eleven years after the primary knee replacement was similar to that observed in hip replacement and for men under 55 years of age this was 6.38% (5.40-7.54) but rose to 85.01% (81.51-88.17) in men over 85.

Outcomes of revision knee replacement surgery are also reported. There were 47,829 revision operations recorded of which 17,649 were linked to a primary record.

In 2014, 78% of revisions were single-stage; 11.2% were stage one of two-stage and 10.8% stage two of two-stage. The ten-year cumulative percentage probability of re-revision for the whole group was 14.32% (13.60-15.07) and, similar to hip replacement, the re-revision risks were higher when the primary was recorded in the NJR 17.06% (15.32-18.97), compared to 12.43% (11.64-13.27) when the primary was not recorded in the NJR.

A detailed analysis of pre- and post-operative Patient Reported Outcome Measures has been undertaken of a sample of patients who had an elective primary knee replacement in 2010 and had returned pre-operative and 6-month National PROMs. These patients were sent further PROMs at one and three years after their primary. Of the 32,147 invited participants, 20,721 and 17,485 respectively responded at one and three years.

The median pre-operative Oxford Knee Score (OKS) was 19, rising to 37 at six months, 38 at one year and 39 at three years after the primary. The corresponding median EQ-5D Index values at the same points in time were 0.587, 0.760, 0.760 and 0.796.

In relation to OKS, the pre-operative distribution was symmetrical but distributions were highly left skewed in post-operative periods. The EQ-5D Index distribution was bimodal in shape prior to the primary operation while all three post-operative EQ-5D Index distributions featured distinct clusters of Index values. Breakdowns of the OKS distribution are given by age, gender, area deprivation, ethnicity, BMI, ASA grade, living arrangements and co-existing diseases prior to surgery and prosthesis fixation.

Ankle replacement procedures

A total of 2,554 primary ankle replacements have been recorded on the NJR between 1 April 2010 and 31 December 2014. These were carried out by a total of 201 consultants in 217 hospitals. A total of 61% of consultants entered ten or more procedures and the maximum number carried out by any one hospital was 186.

The median age at primary surgery was 68 years and 58% of procedures were carried out in men. A total of 98% of the procedures were uncemented.

The Mobility was the most commonly used brand of replacement until 2013. This has now been overtaken by the use of the Zenith. The Mobility was withdrawn from the market in 2014.

There have been 49 revisions submitted to the NJR which may represent under-reporting. The four-year cumulative revision risk was 3.28% (2.37-4.55).

Shoulder replacement procedures

A total of 11,399 primary shoulder replacements were recorded on the NJR from 1 April 2012 until 31 December 2014. These were carried out by a total of 553 surgeons in 335 hospitals. The median age of primary surgery was 73 years and 71.6% of procedures were carried out in women.

Over the last two years there has been a slight decrease in the use of resurfacing arthroplasty and an increase of the reverse polarity total shoulder replacement which in 2014 represented nearly 40% of cases.

In terms of brand the market leader is the Delta Xtend. There were 165 shoulder revisions overall and the cumulative revision estimate at 2.5 years was 2.8% (2.35-3.42). The relatively small numbers and short follow-up did not allow for detailed breakdown of causes of revision or differences between the brands. The 90-day mortality following surgery, as expected, differed by indication for acute trauma and elective, 90-day mortality following trauma was 2.2% (1.4-3.4) and for elective surgery was 0.3% (0.2-0.4).

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 and Northern Ireland for the 2014 calendar year. Outcomes analysis after hip and knee replacement surgery is also provided for the period 2003 to 2014. This year we have also included data for implant outliers.

Implant performance

The implant scrutiny group 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 seventeen hip stem/cup combinations reported. Four knee brands have been notified.

Details of these implants, when they were notified and their last usage date can be found in the Part Four online document at www.njrreports.org.uk – 'Implant and unit-level activity and outcomes'.

Clinical activity

Overall in 2014, 151 NHS Trusts and Local Health Boards (comprising 245 separate hospitals) and 178 independent hospitals reported patient procedures to the NJR. The proportion of joint replacements entered into 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.

- 46% of NHS providers reported 95% or more of the joint replacements they undertook
- 37% of NHS providers reported between 80% and 95% and
- 17% of NHS providers reported less than 80%

Note: these figures exclude units in Northern Ireland as compliance is not available.

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

- 51% of NHS hospitals achieved a consent rate of greater than 95%
- 35% achieved a consent rate of 80% to 95% and
- 14% recorded a consent rate of less than 80%

Independent hospitals

- 74% of independent hospitals achieved a consent rate greater than 95%
- 21% achieved a consent rate of 80% to 95% and
- 5% 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

- 87% achieved a proportion of patients with a linkable NHS number greater than 95%
- 12% achieved a proportion of 80% to 95% and
- 2% recorded a proportion of linkable records of less than 80%

Independent hospitals

- 61% achieved a proportion of patients with a linkable NHS number greater than 95%
- 33% achieved a proportion of 80% to 95% and
- 6% recorded a proportion of linkable records of less than 80%

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.

Outlier units for 90-day mortality and revision rates for the period 2003 to 2014

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.

Hospitals with a much higher than expected revision rate for hip and knee replacement have been identified (and can be found listed over the page). 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 22 hospitals reported higher than expected rates of revision for knee replacement and 39 hospitals had higher than expected rates of revision for hip surgery.

However, revisions taken only from the last five years of the registry show a drop to eight hospitals reporting higher than expected rates for knees, and six 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 and failed hemi-arthroplasties have been excluded from hip mortality analysis together with hips implanted for metastatic cancer since November 2014 (when recording of this latter reason began).

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 have 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 2010 to 20 February 2015 inclusive, the latter date being when the dataset was 'cut').

Where an outlier hospital has deviated more markedly than the remainder of the outlier group, this is marked with an asterisk*. This reflects where the revision rate is the upper of the 99.99% control limits.

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 since 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
The Tunbridge Wells Hospital
Medway Maritime Hospital *
Northampton General Hospital (Acute)
University Hospital Of Hartlepool *
University Hospital Of North Tees *
North Tyneside General Hospital *
St Michael's Hospital *
Salisbury District Hospital
Musgrove Park Hospital *
Rotherham District General Hospital *
Pilgrim Hospital *
Hospital Of St Cross
St Albans City Hospital *
Watford General Hospital *

[1] 1 April 2003 to 20 February 2015 inclusive.

Outliers for Hip revision rates since 2003[1]
York Hospital *
BMI Gisburne Park Hospital (Lancashire) *
BMI The Somerfield Hospital (Kent) *
Shepton Mallet Treatment Centre (Somerset) *
Nuffield Health Brighton Hospital (East Sussex) *
Nuffield Health Tees Hospital (Cleveland) *
Nuffield Health Wessex Hospital (Hampshire)
Nuffield Health York Hospital (North Yorkshire) *
Ashtead Hospital (Surrey) *
New Hall Hospital (Wiltshire) *
The Berkshire Independent Hospital (Berkshire)
Clifton Park Hospital (North Yorkshire) *
Dunedin Hospital (Berkshire)
Spire Alexandra Hospital (Kent)
Spire Cardiff Hospital (Glamorgan) *
Spire Gatwick Park Hospital (Surrey) *
Spire Tunbridge Wells Hospital (Kent)

Outliers for Knee revision rates since 2003[1]
Basildon University Hospital
Bradford Royal Infirmary *
Llandough Hospital
Conquest Hospital *
Good Hope Hospital *
Withybush General Hospital *
Charing Cross Hospital
James Paget University Hospital *
Southmead Hospital *
Southampton General Hospital
South Tyneside District Hospital
County Hospital Louth
St Richard's Hospital *
St Albans City Hospital *

Outliers for Knee revision rates since 2003[1]
BMI Goring Hall Hospital (West Sussex)
Shepton Mallet Treatment Centre (Somerset)
Southampton NHS Treatment Centre (Hampshire)
King Edward VII Hospital Sister Agnes (Greater London) *
New Hall Hospital (Wiltshire) *
Spire Alexandra Hospital (Kent) *
Spire Clare Park Hospital (Surrey)
Spire Southampton Hospital (Hampshire) *

Outliers for Hip revision rates since 2010[2]
Wrexham Maelor Hospital
Sussex Orthopaedic NHS Treatment Centre *
Homerton University Hospital
The Tunbridge Wells Hospital
Watford General Hospital
BMI Clementine Churchill Hospital (Middlesex)

Outliers for Knee revision rates since 2010[2]
Charing Cross Hospital
South Tyneside District Hospital
County Hospital Louth
St Richard's Hospital *
BMI The Meriden Hospital (West Midlands)
Southampton NHS Treatment Centre (Hampshire) *
King Edward VII Hospital Sister Agnes (Greater London) *
Spire Southampton Hospital (Hampshire) *

[1] 1 April 2003 to 20 February 2015 inclusive.

[2] 21 February 2010 to 20 February 2015 inclusive.

Part 3

Outcomes after joint replacement 2003 to 2014

3.1 Summary of data sources and linkage

The main outcome analyses in this section relate to primary joint replacements. We included all patients with at least one primary joint replacement carried out between 1 April 2003 and 31 December 2014 inclusive, whose records had been submitted to the NJR by 28 February 2015.

Linkage at the patient level:

Documentation of implant survivorship and mortality requires a person-level identifier to be able to relate primary and revision operations on the same individual. Starting with a total of 1,837,781 NJR source records, around 11% were lost because no suitable person-level identifier was found (see Figure 3.1). In around half of these 201,548 procedures (47.3%), the patient had declined to give consent for details to be held, the remainder being attributable to tracing and linkage difficulties. Cases from Northern Ireland were excluded at this step because there was no tracing service for them. Although a person-level identifier was available for 96% of operations since the beginning of 2008, in earlier years the proportion had been much lower; in 2003/4, for example it was only 58%, rising to 79% in 2006 and 90% in 2007. As indicated previously, the subset of patients with longer follow-up, therefore, 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, 4.4% only had revision operations recorded within the time frame, i.e. there was no primary operation for that patient recorded in the NJR. 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 as part of a general overview of outcome after revision, see sections 3.3 and 3.6.

Linkage between primaries and any associated revisions:

A total of 1,219,424 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 (e.g. removal of duplicated primary information on the same side or revision dates that appeared to precede the primary procedure), and the resulting numbers are shown in Tables 3.1 and 3.2 (page 26).

In Table 3.2, of the 618,938 patients with primary hip operations, 14.4% had documented primaries for both hips; likewise 20.1% of the 643,487 patients with knee operations had primaries on both sides. These overall proportions have increased slightly from last year's reporting (13.5% and 19.0% respectively).

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 3.2, 3.4, 3.7 and 3.8 for hips, knees, ankles and preliminary results presented for shoulders; the numbers of elbows remains too small for further breakdown to be informative.

In sections 3.3 and 3.6 we have added an overview of the outcomes after first hip or knee revision procedures, although the numbers requiring further revision procedures were small (see Table 3.2). As we have indicated above, in this section we have also included some revisions to a joint replacement where the associated primary was not documented. The current number of affected joints (rather than total revision procedures) are 52,457 hips, 23,089 knees, 174 ankles, 1,030 shoulders and 322 elbows.

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 it would be difficult to validate this, particularly given that some patients did not have prior replacements recorded in the NJR. 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.

Figure 3.1

Initial numbers of procedures for analysis.

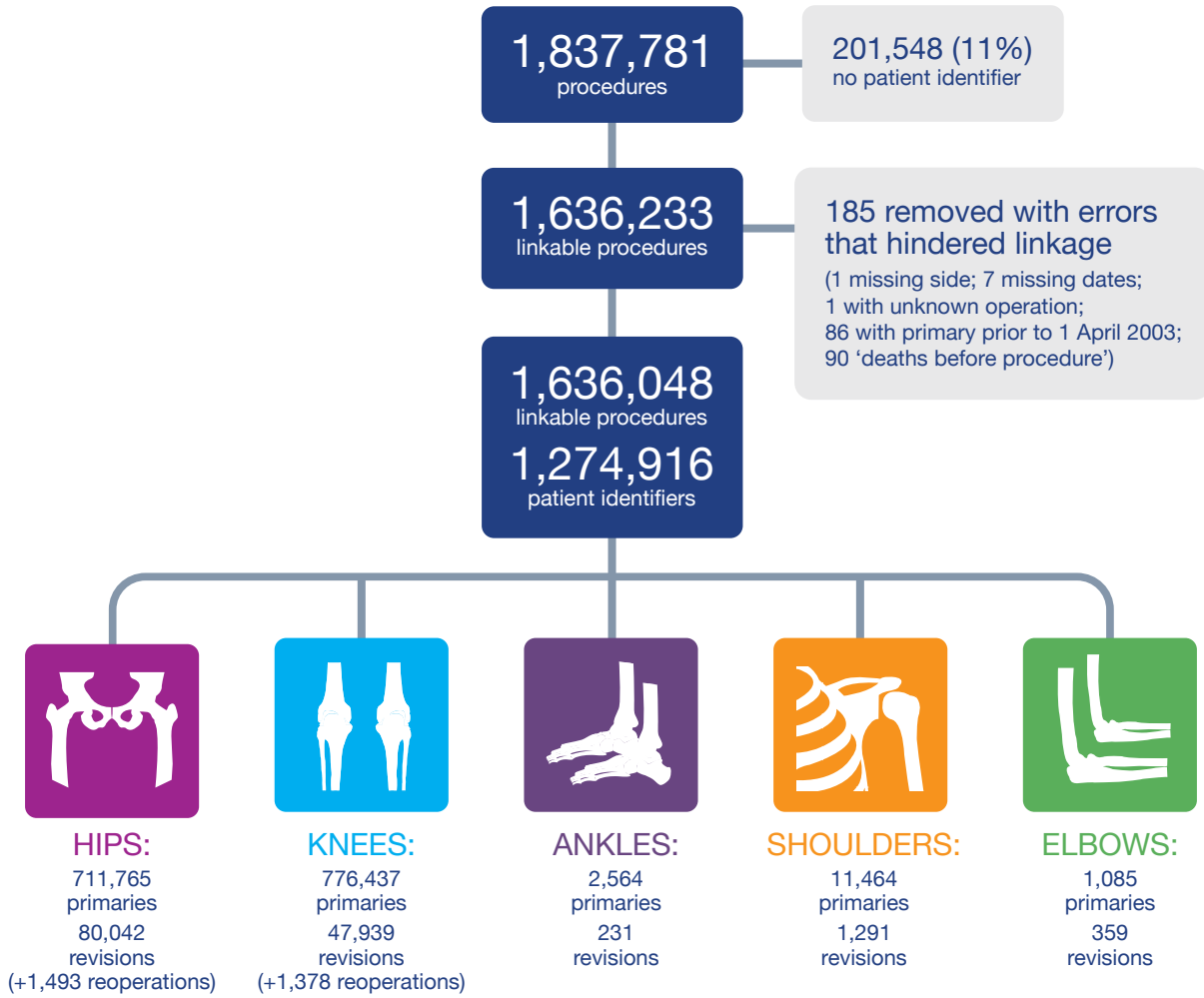


Table 3.1 Summary description of datasets used for main survivorship analysis.

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 2014 (hips and knees) 1 April 2010* – 31 December 2014 (ankles) 1 April 2012* – 31 December 2014 (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	708,311 hips	772,818 knees	2554 ankles	11,399** shoulders	1,079 ** elbows
Number of primaries that were subsequently revised	NJR identified primary-linked first revisions				
	17,916 hips	17,649 knees	49*** ankles	165 shoulders	11 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 shoulders and elbows are provisional.

***Includes 12 conversions to arthrodesis (no amputations recorded).

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

	Joint				
	Hips	Knees	Ankles	Shoulders*	Elbows*
	Number	Number	Number	Number	Number
Number of patients	**618,938**	**643,497**	**2,467**	**11,028**	**1,054**
Number (%) of patients with only one primary joint operation	529,565 (85.6%)	514,176 (79.9%)	2,380 (96.5%)	10,657 (96.6%)	1,029 (97.6%)
Number (%) of patients with both a left and right side primary operation but on different dates	85,687 (13.8%)	120,260 (18.7%)	83 (3.4%)	359 (3.3%)	24 (2.3%)
Number (%) of patients with both a left and a right side operation on the same date (bilateral operations)	3,686 (0.6%)	9,061 (1.4%)	4 (0.2%)	12 (0.1%)	1 (0.1%)
Total number of primary joints	**708,311**	**772,818**	**2,554**	**11,399**	**1,079**
Number with at least one revision operation linked to the primary	17,916	17,649	49**	165	11
Number with more than one revision procedure	2,546***	2,956***	2****	16 (11)*****	1 (0)*****

*Figures for shoulders and elbows are provisional.

**Includes 12 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.

****Both of these were conversions to arthrodesis.

*****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 only the respective stage two.

Part 3

3.2 Outcomes after primary hip replacement

This section looks at revision and mortality for all primary hip operations performed between 1 April 2003 and 31 December 2014. Patients operated on at the beginning of the registry therefore had a potential 11.75 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 708,311 hips were included.

Osteoarthritis was given as a documented reason in 656,571 (93% of the cohort) and was the sole reason given in 633,840 (89%).

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 2014) 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 2014 (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. (In some earlier reports, prior to the 10th Annual Report, Nelson-Aalen estimates of 'cumulative hazard' were given instead). Where possible, the numbers at risk at each anniversary have been added to 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 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.

3.2.1 Overview of primary hip surgery

Table 3.3 (on the right) 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 (87.8% of all cemented primaries, 31.7% of all primaries).

Table 3.3 Numbers and percentage 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	708,311 (100%)		708,311 (100%)
All cemented	255,926 (36.1%)	MoP	224,779 (87.8%)
		MoM	1,148 (0.5%)
		CoP	24,360 (9.5%)
		Others/unsure	5,639 (2.2%)
All uncemented	276,432 (39.0%)	MoP	104,028 (37.6%)
		MoM	28,658 (10.4%)
		CoP	43,056 (15.6%)
		CoC	93,873 (34.0%)
		CoM	2,162 (0.8%)
		Others/unsure	4,655 (1.7%)
All hybrid	121,068 (17.1%)	MoP	77,396 (63.9%)
		MoM	2,218 (1.8%)
		CoP	19,707 (16.3%)
		CoC	19,633 (16.2%)
		Others/unsure	2,114 (1.8%)
All reverse hybrid	17,267 (2.4%)	MoP	11,670 (67.6%)
		CoP	5,504 (31.9%)
		Others/unsure	93 (0.5%)
All resurfacing	37,579 (5.3%)	(MoM)	37,579 (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 (over the page) 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 uncemented implants have decreased in popularity since 2010, but remain the most popular choice. Hybrid implants continue to steadily increase in popularity and now account for a quarter of cases.

With regard to bearing surface, ceramic-on-polyethylene continues to gain in popularity and usage of ceramic-on-ceramic is declining. The use of metal-on-metal stemmed implants has virtually ceased and the proportion of metal-on-metal resurfacing implants has decreased from a peak in 2006 to account for only 1% of implants in 2014.

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= 14,424	2004 n= 28,013	2005 n= 40,181	2006 n= 47,550	2007 n= 60,522	2008 n= 66,850	2009 n= 67,804	2010 n= 70,213	2011 n= 73,220	2012 n= 77,321	2013 n= 79,088	2014 n= 83,125
All cemented	60.4	54.1	48.6	42.8	39.7	34.3	31.9	31.4	32.3	32.9	33.1	31.8
Cemented by bearing surface:												
MoP	91.8	90.9	90.6	90.0	90.1	88.7	88.7	86.8	85.3	86.4	85.6	84.4
MoM	0.2	0.7	0.7	1.0	1.0	1.0	0.4	0.1	0.1	0.1	0.1	0.1
CoP	4.6	6.0	6.2	6.7	6.3	7.8	8.9	10.2	10.8	12.1	13.3	14.7
Others/unsure	3.4	2.4	2.5	2.3	2.7	2.5	2.0	2.9	3.8	1.4	1.1	0.9
All uncemented	16.8	21.4	25.7	30.1	33.3	39.3	43.2	45.8	45.0	44.9	42.6	41.2
Uncemented by bearing surface:												
MoP	36.7	42.4	38.2	34.1	32.2	33.2	34.9	36.9	38.2	39.7	41.3	41.6
MoM	7.6	10.3	21.3	27.9	31.1	27.8	18.4	7.0	1.0	0.2	0.0(3)	0.1
CoP	29.8	23.7	19.8	14.4	11.9	9.8	10.8	12.3	13.5	16.3	19.5	23.5
CoC	20.9	19.8	17.2	20.5	22.0	25.7	31.6	39.6	44.7	42.9	38.5	34.3
CoM	0.0	0.0(2)	0.0(1)	0.1	0.3	1.1	2.2	2.3	1.0	0.1	0.1	0.0(4)
Others/unsure	5.0	3.9	3.5	3.1	2.6	2.4	2.1	1.9	1.6	0.6	0.6	0.5
All hybrid	12.3	13.3	14.1	15.2	14.9	15.0	15.7	16.2	17.2	17.8	20.3	23.1
Hybrid by bearing surface:												
MoP	67.0	68.6	65.4	63.6	65.5	65.1	66.0	66.7	67.1	65.4	60.3	58.3
MoM	5.6	3.6	3.2	4.4	5.3	5.3	2.3	1.2	0.3	0.1	0.1	0.1
CoP	12.0	10.6	8.4	8.1	6.8	8.8	11.2	12.0	13.1	17.6	25.2	30.5
CoC	10.0	14.5	19.5	20.7	19.6	18.1	18.5	18.4	18.2	16.2	13.5	10.4
Others/unsure	5.5	2.7	3.5	3.2	2.8	2.7	2.0	1.8	1.4	0.8	0.9	0.7
All reverse hybrid	0.6	0.9	1.1	1.2	1.7	2.5	2.7	2.8	3.1	3.1	3.0	3.0
Reverse hybrid by bearing surface:												
MoP	56.2	69.6	68.1	73.0	64.1	70.2	69.7	68.4	70.2	65.4	67.0	64.4
CoP	42.7	28.0	30.7	25.7	34.9	28.9	29.5	30.7	29.5	34.5	32.8	35.5
Others/unsure	1.1	2.5	1.2	1.3	1.0	0.9	0.8	0.9	0.4	0.1	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	1.0
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

Figure 3.2

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

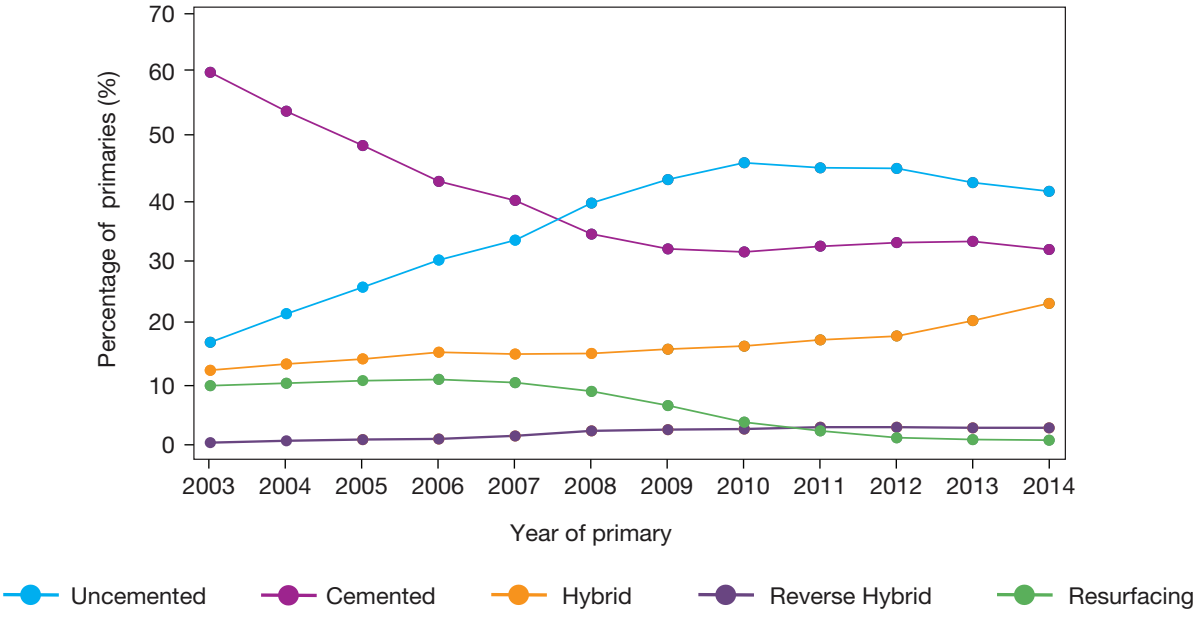


Figure 3.3 (a)

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

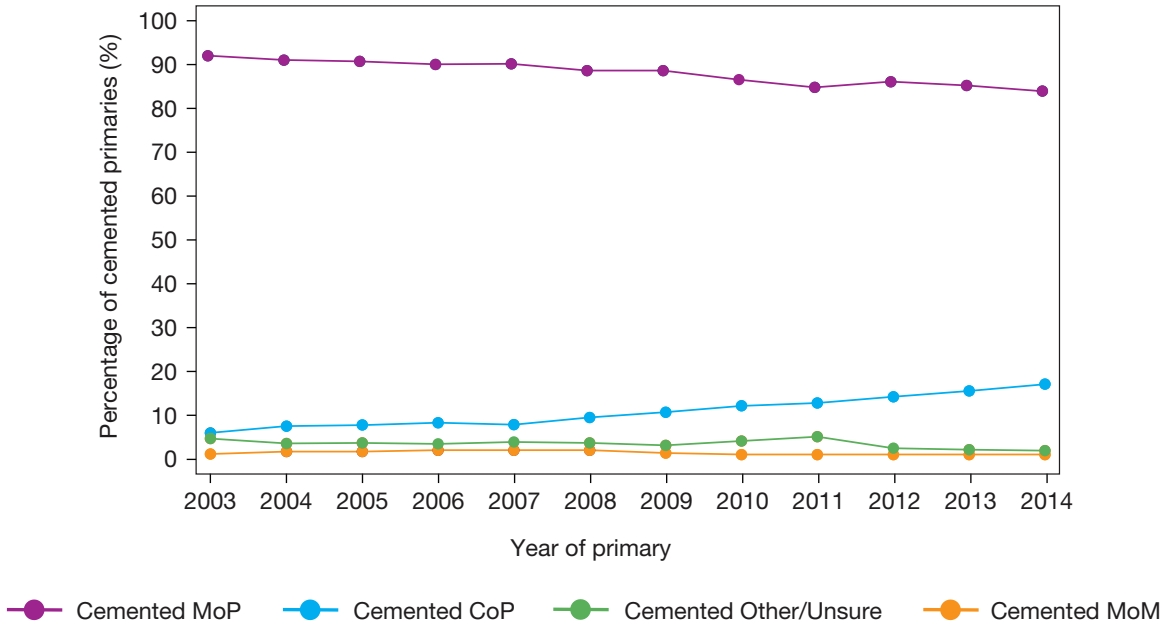


Figure 3.3 (b)

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

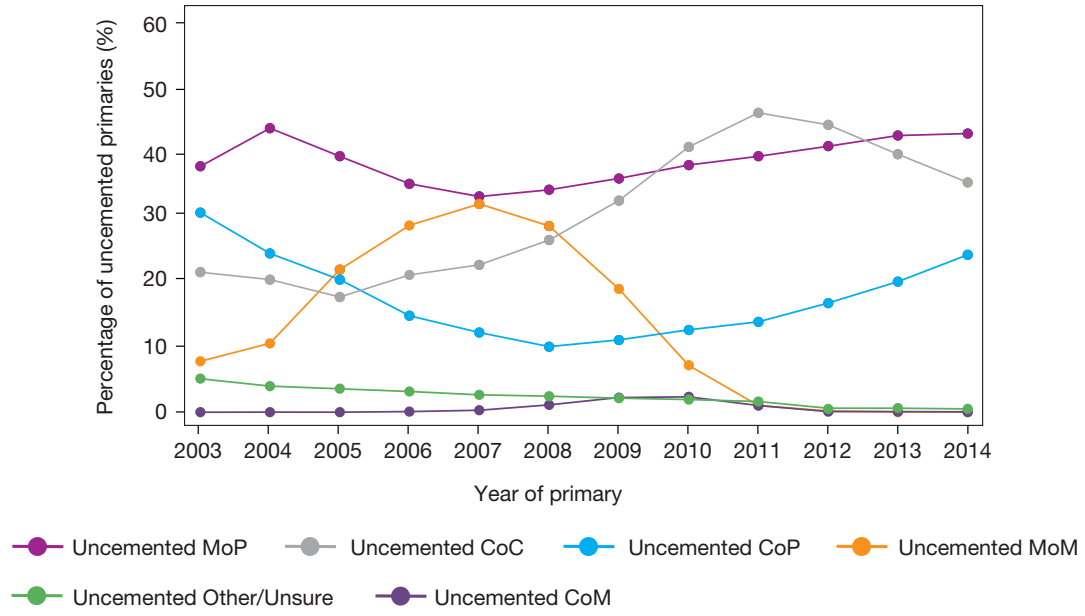


Figure 3.3 (c)

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

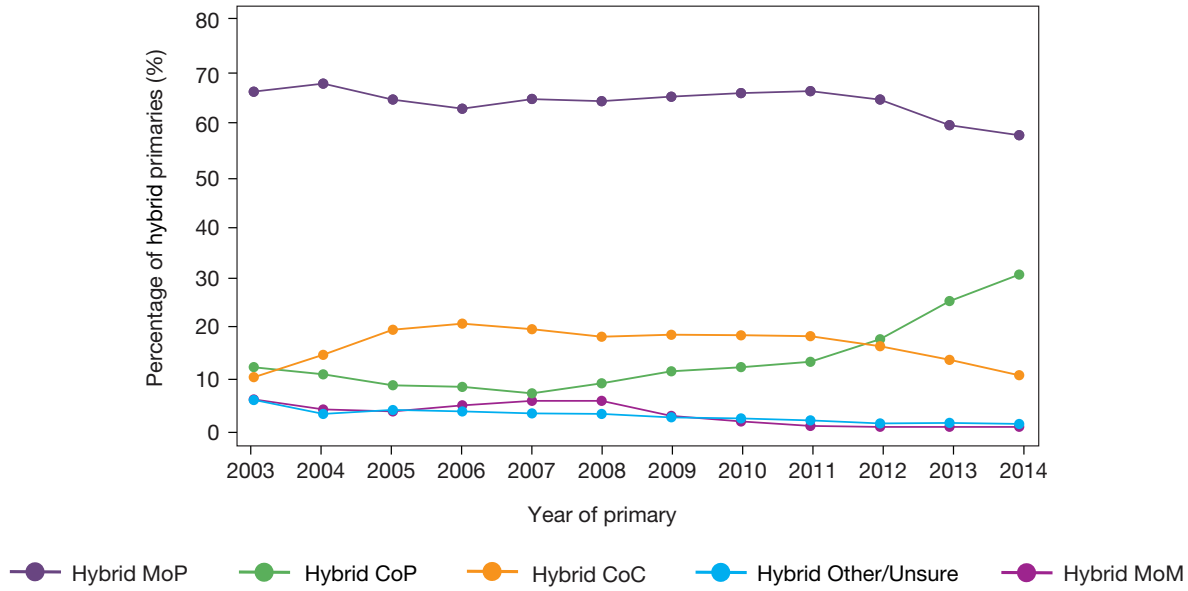
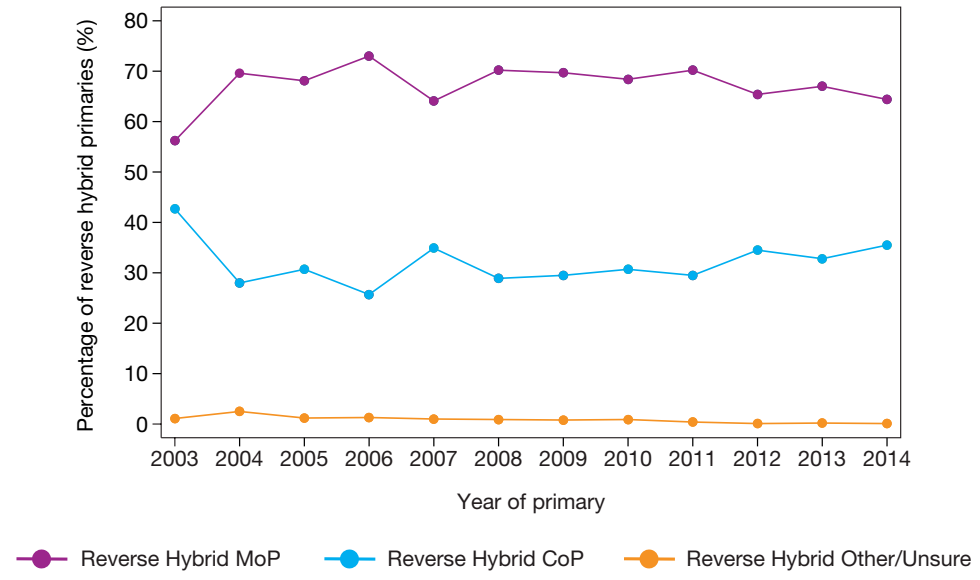


Figure 3.3 (d)

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



In total, the 708,311 primary hip replacement procedures were carried out by 3,056 consultant surgeons working across 463 units.

The median number of primary procedures per consultant surgeon was 65, interquartile range (IQR 8-292) and the median number of procedures per unit was 1,212 (IQR 511-2,155).

Table 3.5 (below) shows the distributions of consultant surgeon and unit caseloads for each type of fixation; note that each of the consultants and units with fewer than ten cases in the database were excluded (793 of 3,056 consultant surgeons; 11 of 463 units).

The table shows, for each fixation type, the percentage of surgeons or units that carried out any procedures of that type, together with the median and IQR of the number of procedures they had carried out.

Table 3.5 Distribution of consultant surgeon and unit primary hip caseload for each fixation type.

	Number of procedures carried out by each consultant surgeon (n=2,263*):			Number of procedures carried out by each unit (n=452**):		
Fixation	% performing this fixation type	Median	(IQR)	% performing this fixation type	Median	(IQR)
Cemented	95.2	46	(13-142)	99.1	308	(100-812)
Uncemented	85.2	43	(9-176)	97.8	410	(155-867)
Hybrids	73.8	14	(3-63)	95.4	105	(27-299)
Reverse hybrids	38.9	3	(1-10)	77.0	8	(3-33)
Resurfacing	34.8	11	(2-47)	87.6	48	(15-109)

* Excludes 793 surgeons who had performed fewer than ten primaries in total.

** Excludes 11 units performing fewer than ten primaries in total.

The majority of the hip primary procedures were carried out in women (males 40.3%: females 59.7%). The median age at primary operation was 69 (IQR 61-76) years[3], overall range 7-105 years.

Table 3.6 (below) gives the breakdown of ages and gender by fixation 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.

Table 3.6 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		**708,311**	**69 (61-76)**	**7**	**105**	**40.3**
All cemented		**255,926**	**74 (68-79)**	**7**	**103**	**33.9**
Cemented and						
	MoP	224,779	74 (69-80)	15	103	33.2
	MoM	1,148	65 (58-73)	25	98	48.6
	CoP	24,360	65 (59-71)	14	101	39.1
	Others/unsure	5,639	72 (64-78)	7	102	36.3
All uncemented		**276,432**	**65 (58-72)**	**11**	**105**	**43.9**
Uncemented and						
	MoP	104,028	71 (65-77)	12	101	40.4
	MoM	28,658	64 (57-70)	13	105	50.6
	CoP	43,056	65 (58-71)	13	100	43.4
	CoC	93,873	60 (53-67)	11	100	46.0
	CoM	2,162	63 (56-69)	20	92	42.4
	Others/unsure	4,655	65 (58-73)	17	96	42.4
All hybrid		**121,068**	**70 (62-76)**	**12**	**100**	**36.9**
Hybrid and						
	MoP	77,396	73 (67-78)	12	100	35.1
	MoM	2,218	64 (56-72)	18	94	47.8
	CoP	19,707	66 (59-72)	15	97	38.6
	CoC	19,633	60 (53-66)	13	93	41.1
	Others/unsure	2,114	69 (61-76)	19	94	35.8
All reverse hybrid		**17,267**	**71 (64-77)**	**13**	**100**	**35.8**
Reverse hybrid and						
	MoP	11,670	73 (68-78)	13	100	34.3
	CoP	5,504	64 (58-70)	16	94	39.0
	Others/unsure	93	69 (62-77)	30	88	34.4
All resurfacing (MoM)		**37,579**	**55 (49-60)**	**12**	**95**	**70.3**
Unsure		**39**	**69 (56-75)**	**18**	**83**	**38.5**

*Excludes 346 cases with unverifiable ages. **Excludes six with uncertain gender. *** IQR=interquartile range.

[3] Omitting 346 cases where the NHS number was not traceable, therefore the age was not verifiable.

3.2.2 Revisions after primary hip surgery

Over the page, Figures 3.4 (a) and (b) illustrate temporal changes in the overall revision rates; procedures have been grouped by the year of the primary operation. Figure 3.4 (b) shows just the first three years after surgery. Revision rates increase steadily for operations from 2003 to 2008 and then the trend is reversed. 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 was maximal in 2008 and then fell (see Table 3.4 on page 30). This will need further exploration.

Table 3.7 (page 38) shows 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 years are added but in general the group sizes are too small for meaningful sub-division, hence many of these estimates are shown in *blue italics*. *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 3.2 still include the ASR system unless explicitly stated otherwise.

Figures 3.5 to 3.8 (pages 39 to 42) 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 which, in uncemented hips (Figure 3.6), fared worse than resurfacings. Ceramic-on-polyethylene bearings have a particularly low failure rate and thus it is encouraging that these are becoming more popular.

In Table 3.7 and Figures 3.5 to 3.8 all age groups and genders were combined. From page 43, in Figures 3.9 (a) to 3.9 (c) 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 (Figure 3.9 (a)). Looking separately at males and females (Figure 3.9 (b)) it can be seen 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 (c) implants with metal-on-metal (or uncertain) bearing surfaces and resurfacings are 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 age spectrum.

Where group sizes permitted (overall group size>10,000), Table 3.8 (from page 46) further expands Table 3.7 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 years are not shown here as the number at risk at this time point remains 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.

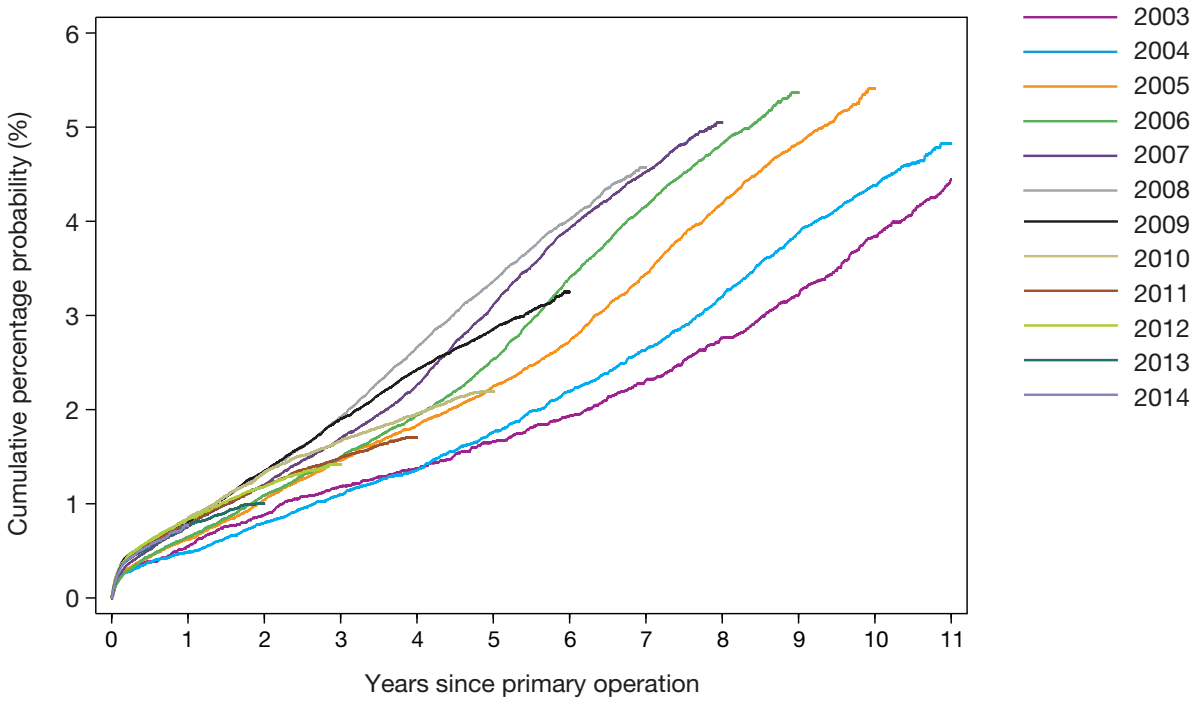


Figure 3.4 (b)

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

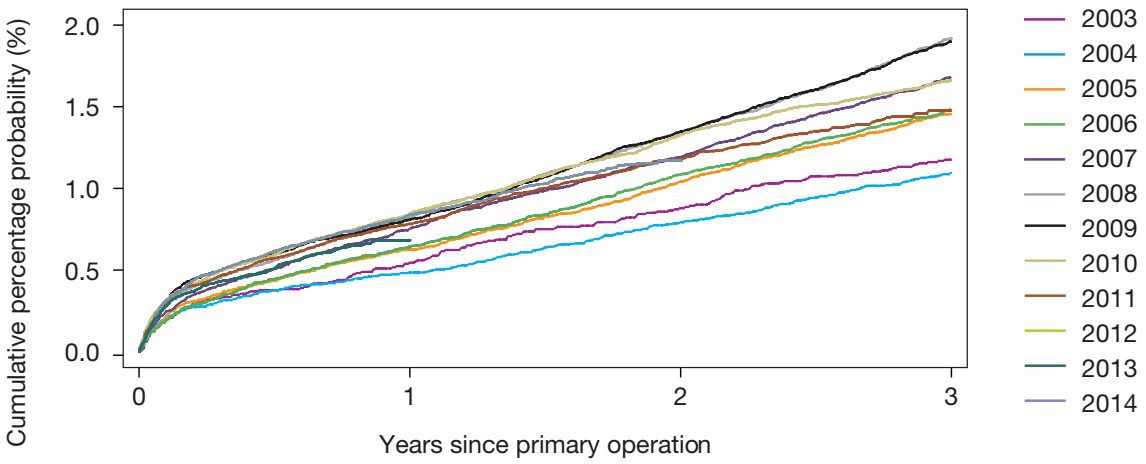


Table 3.7 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI) after primary hip replacement, by year from the primary operation, for all cases and by fixation and bearing surface. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

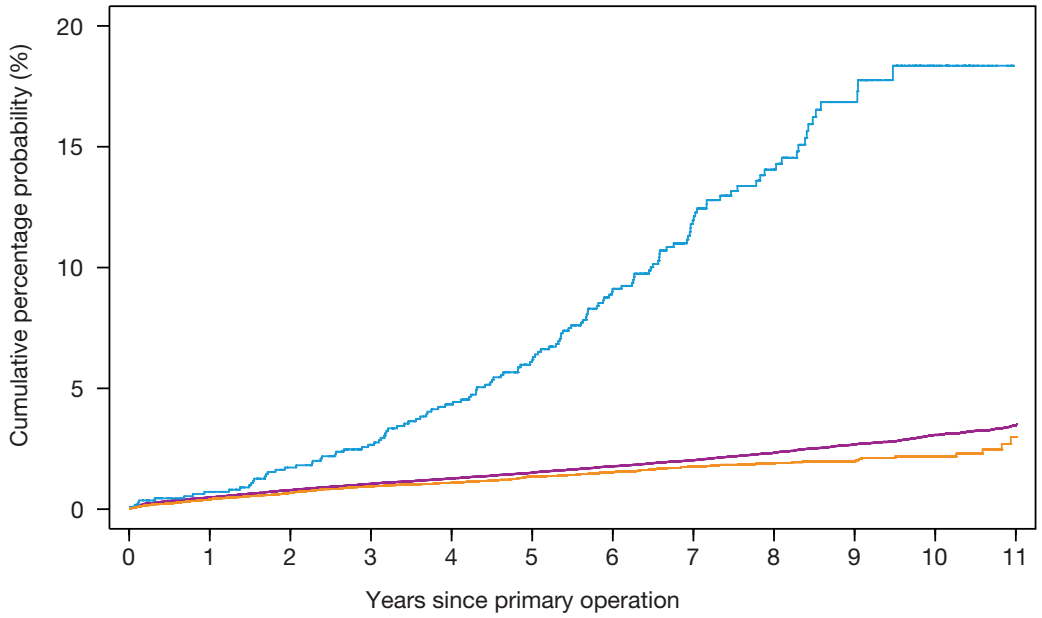
	Cumulative percentage probability of revision (95%CI) at:						
Fixation/bearing types	n	1 year	3 years	5 years	7 years	10 years	11 years
All cases*	708,311*	0.76 (0.74-0.78)	1.61 (1.58-1.64)	2.61 (2.57-2.66)	3.86 (3.80-3.93)	5.64 (5.52-5.75)	6.20 (6.04-6.36)
All cemented	255,926	0.47 (0.45-0.50)	1.04 (1.00-1.09)	1.53 (1.47-1.58)	2.09 (2.01-2.16)	3.13 (3.00-3.26)	3.63 (3.43-3.83)
Cemented by bearing surface							
MoP	224,779	0.48 (0.45-0.51)	1.04 (1.00-1.09)	1.51 (1.45-1.57)	2.02 (1.95-2.10)	3.06 (2.92-3.20)	3.51 (3.31-3.72)
MoM	1,148	0.71 (0.35-1.41)	2.65 (1.85-3.80)	6.28 (4.96-7.95)	12.10 (10.12-14.45)	*18.33 (15.27-21.93)*	*18.33 (15.27-21.93)*
CoP	24,360	0.40 (0.32-0.49)	0.93 (0.80-1.08)	1.35 (1.18-1.55)	1.75 (1.53-2.01)	2.17 (1.85-2.55)	2.98 (2.20-4.02)
Others/unsure	5,639	0.55 (0.38-0.78)	1.09 (0.84-1.41)	1.65 (1.31-2.07)	2.42 (1.95-2.99)	3.47 (2.70-4.45)	*4.98 (3.50-7.06)*
All uncemented	276,432	1.00 (0.96-1.04)	2.05 (2.00-2.11)	3.39 (3.31-3.48)	5.19 (5.06-5.32)	7.60 (7.35-7.85)	8.25 (7.90-8.62)
Uncemented by bearing surface							
MoP	104,028	1.08 (1.02-1.15)	1.88 (1.79-1.97)	2.42 (2.31-2.54)	3.05 (2.91-3.21)	4.40 (4.09-4.72)	5.32 (4.74-5.97)
MoM	28,658	1.03 (0.92-1.16)	3.40 (3.19-3.62)	7.56 (7.26-7.88)	12.74 (12.31-13.19)	20.18 (19.17-21.23)	*23.08 (20.99-25.35)*
CoP	43,056	0.85 (0.77-0.94)	1.56 (1.43-1.70)	2.12 (1.95-2.30)	2.59 (2.38-2.82)	3.56 (3.19-3.97)	3.62 (3.24-4.05)
CoC	93,873	0.95 (0.89-1.01)	1.82 (1.73-1.92)	2.46 (2.34-2.58)	3.09 (2.92-3.27)	4.22 (3.85-4.62)	4.31 (3.91-4.75)
CoM	2,162	0.70 (0.42-1.15)	2.86 (2.23-3.67)	4.74 (3.84-5.83)	*5.09 (4.09-6.32)*	-	-
Others/unsure	4,655	1.35 (1.05-1.73)	2.30 (1.90-2.79)	3.28 (2.77-3.88)	4.38 (3.73-5.14)	5.77 (4.85-6.86)	*6.94 (5.24-9.16)*
All hybrids	121,068	0.67 (0.63-0.72)	1.23 (1.16-1.30)	1.87 (1.78-1.97)	2.59 (2.46-2.73)	3.71 (3.47-3.97)	4.18 (3.82-4.56)
Hybrids by bearing surface							
MoP	77,396	0.70 (0.65-0.77)	1.25 (1.16-1.34)	1.80 (1.69-1.92)	2.32 (2.17-2.47)	3.42 (3.12-3.75)	4.11 (3.63-4.65)
MoM	2,218	0.68 (0.41-1.13)	2.90 (2.27-3.70)	6.48 (5.49-7.64)	11.76 (10.33-13.37)	*17.13 (14.59-20.07)*	*17.64 (14.95-20.75)*
CoP	19,707	0.58 (0.48-0.71)	1.07 (0.91-1.26)	1.50 (1.27-1.77)	1.77 (1.49-2.12)	2.15 (1.76-2.64)	*2.15 (1.76-2.64)*
CoC	19,633	0.57 (0.48-0.69)	1.00 (0.86-1.16)	1.54 (1.35-1.76)	2.00 (1.75-2.28)	2.63 (2.23-3.10)	*2.63 (2.23-3.10)*
Others/unsure	2,114	1.16 (0.78-1.72)	1.55 (1.09-2.19)	1.96 (1.42-2.71)	2.79 (2.05-3.78)	*3.77 (2.73-5.20)*	*3.77 (2.73-5.20)*
All reverse hybrids	17,267	0.83 (0.70-0.98)	1.52 (1.33-1.74)	2.11 (1.85-2.39)	2.80 (2.42-3.22)	4.18 (3.23-5.40)	*4.18 (3.23-5.40)*
Reverse hybrids by bearing surface							
MoP	11,670	0.85 (0.69-1.04)	1.46 (1.24-1.72)	2.09 (1.79-2.45)	2.78 (2.33-3.32)	*4.31 (3.19-5.80)*	*4.31 (3.19-5.80)*
CoP	5,504	0.76 (0.56-1.04)	1.58 (1.24-2.01)	2.07 (1.64-2.60)	2.73 (2.12-3.51)	*3.88 (2.35-6.37)*	*3.88 (2.35-6.37)*
Others/unsure	93**	*2.17 (0.55-8.42)*	*5.83 (2.46-13.47)*	*5.83 (2.46-13.47)*	*7.75 (3.48-16.80)*	-	-
All resurfacing (MoM)	37,579	1.25 (1.15-1.37)	3.12 (2.94-3.30)	5.67 (5.43-5.92)	8.68 (8.37-9.01)	12.63 (12.14-13.12)	13.42 (12.85-14.01)

* Includes 39 with unsure fixation/bearing surface.

** Wide CI because based on very small group size (n=90).

Figure 3.5

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

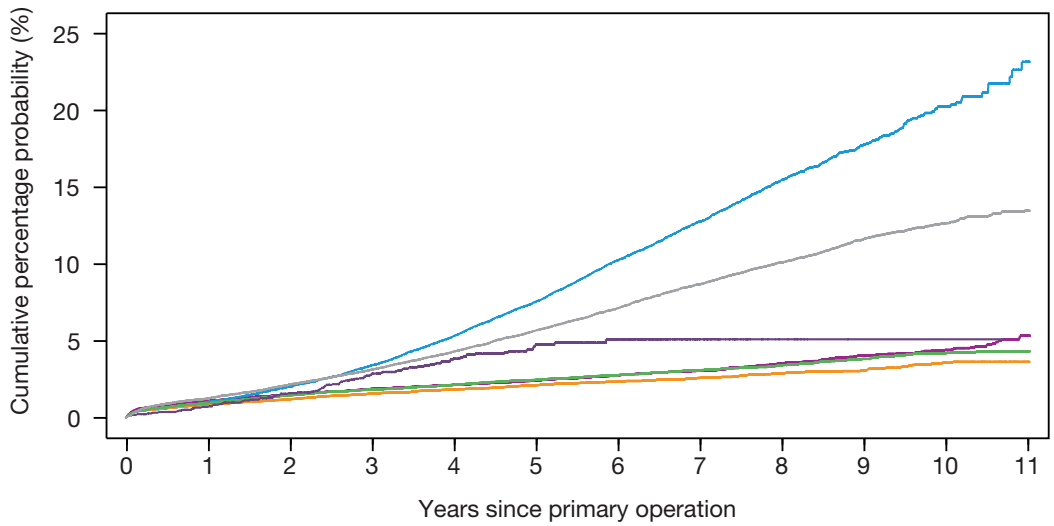


Numbers at risk

Cemented MoP	224,779	197,097	170,766	145,420	122,433	101,223	81,053	61,412	42,348	27,311	14,266	4,940
Cemented MoM	1,148	1,107	1,059	1,011	950	880	761	540	355	184	81	15
Cemented CoP	24,360	20,222	16,568	13,328	10,696	8,378	6,477	4,750	3,339	2,100	1,059	296

Figure 3.6

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

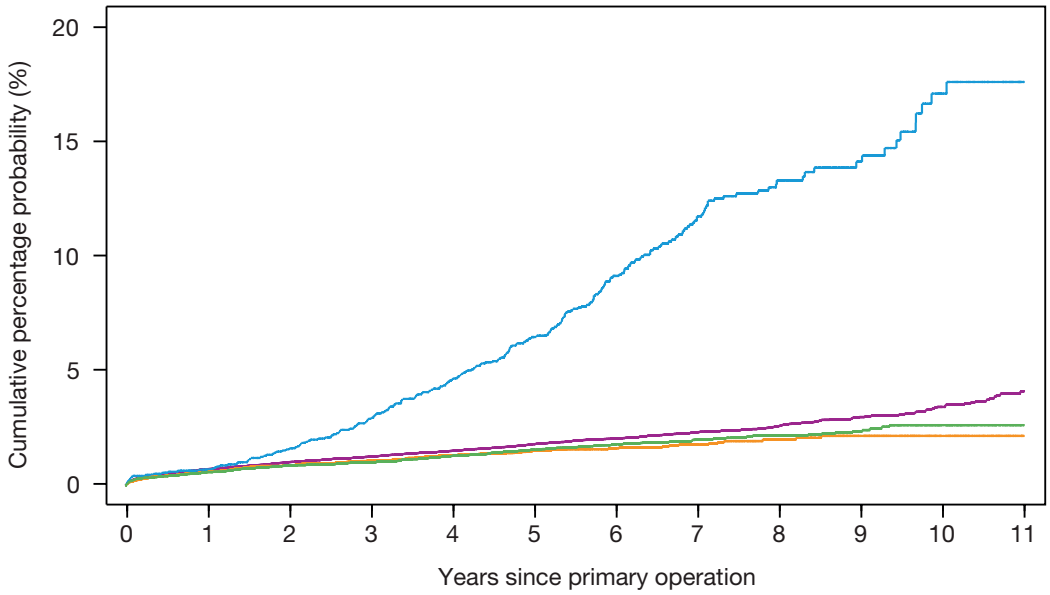


Numbers at risk

Uncemented MoP	104,028	87,461	72,394	57,723	44,706	32,996	23,173	15,219	9,571	5,528	2,469	618
Uncemented MoM	28,658	28,053	27,490	26,663	25,412	22,422	16,934	10,499	5,320	2,229	593	123
Uncemented CoP	43,056	34,406	27,550	21,696	17,092	13,080	9,969	7,507	5,246	3,400	1,711	568
Uncemented CoC	93,873	80,907	67,319	52,189	37,578	25,141	16,244	9,858	5,736	3,049	1,456	424
Uncemented CoM	2,162	2,120	2,048	1,953	1,590	880	301	51	9	1	1	0
Resurfacing	37,579	36,240	34,961	33,451	31,132	28,006	23,432	17,681	11,936	7,369	3,707	1,226

Figure 3.7

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

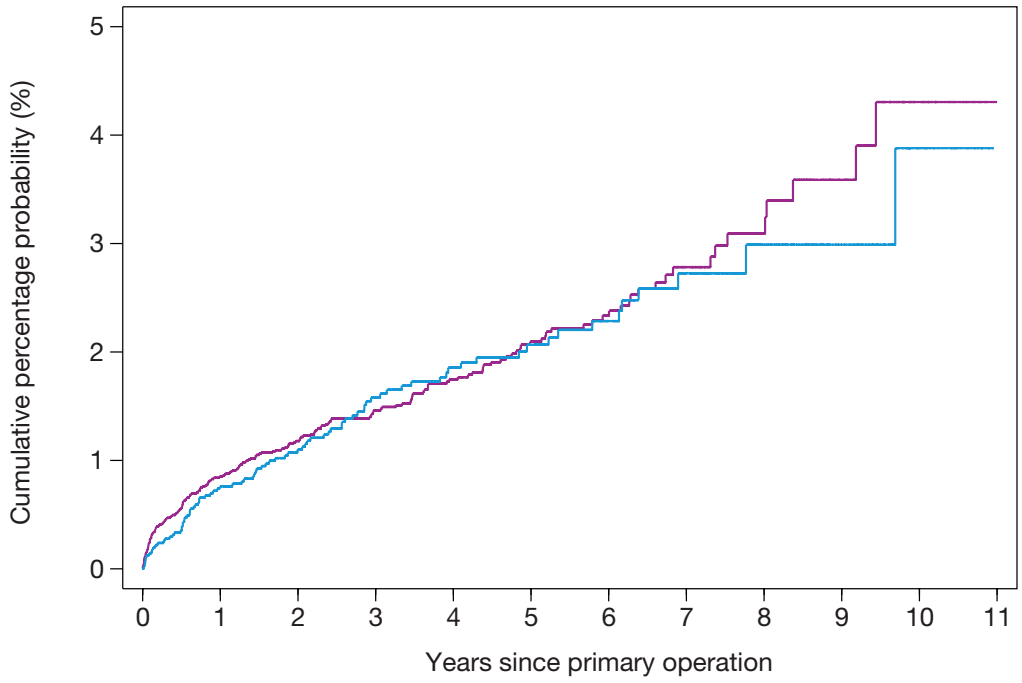


Numbers at risk

Hybrid MoP	77,396	64,431	53,772	43,983	35,024	27,327	20,420	14,530	9,334	5,545	2,722	835
Hybrid MoM	2,218	2,159	2,090	2,015	1,902	1,725	1,444	955	560	319	171	70
Hybrid CoP	19,707	13,634	9,525	7,071	5,409	4,068	2,894	2,020	1,428	907	496	168
Hybrid CoC	19,633	17,442	15,157	12,867	10,508	8,408	6,466	4,717	3,039	1,659	659	152

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

Reverse Hybrid MoP	11,670	9,775	8,035	6,376	4,732	3,413	2,237	1,206	640	345	141	32
Reverse Hybrid CoP	5,504	4,553	3,738	2,884	2,199	1,607	1,079	634	306	184	79	31

Figure 3.9 (a)

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

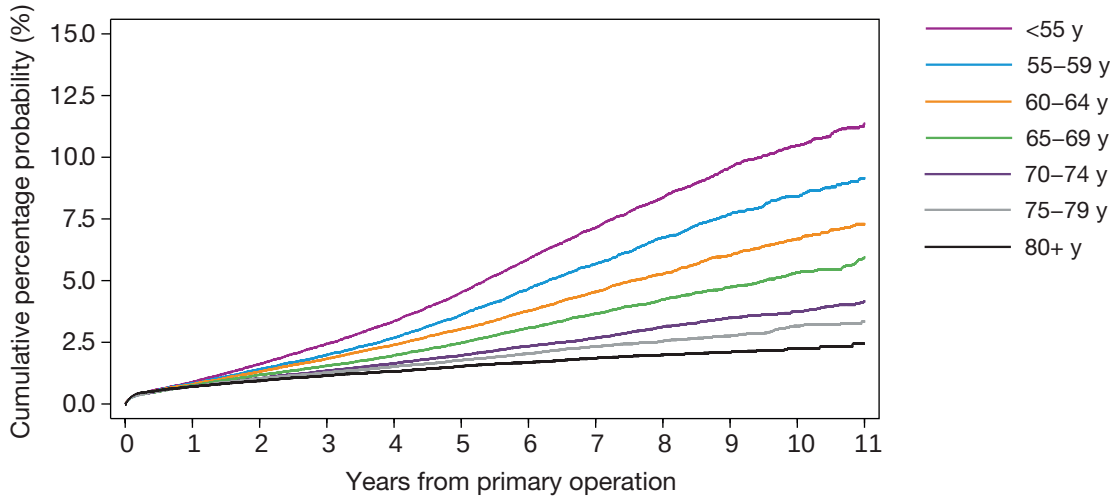


Figure 3.9 (b)

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

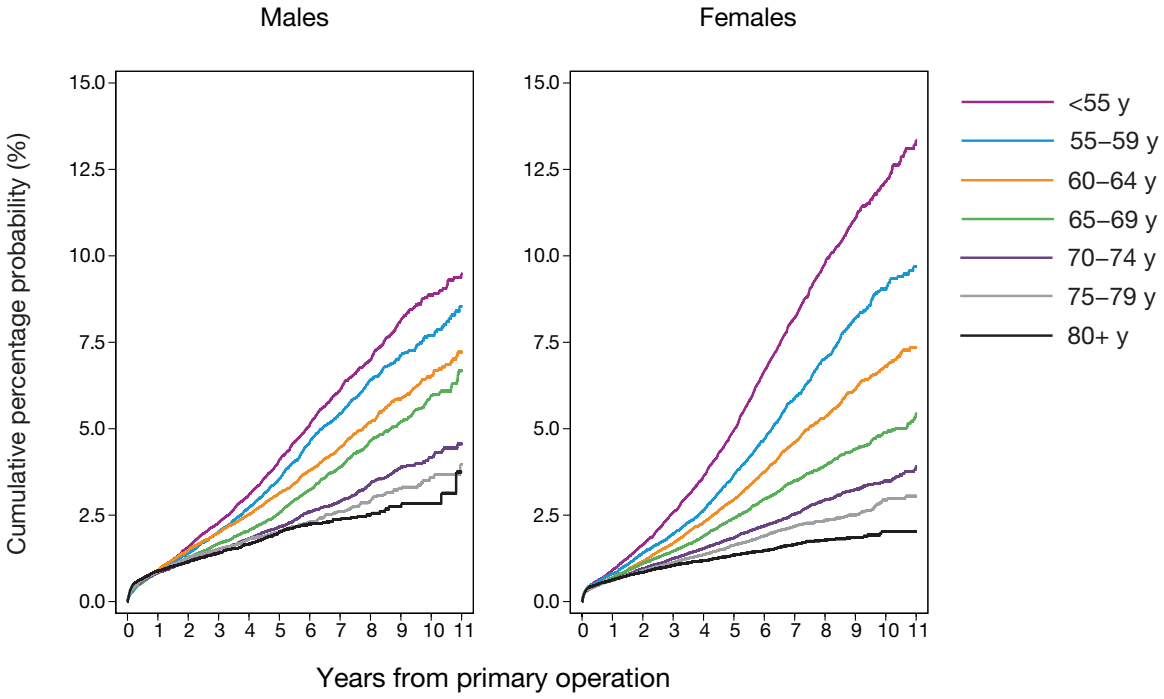


Figure 3.9 (c)

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.

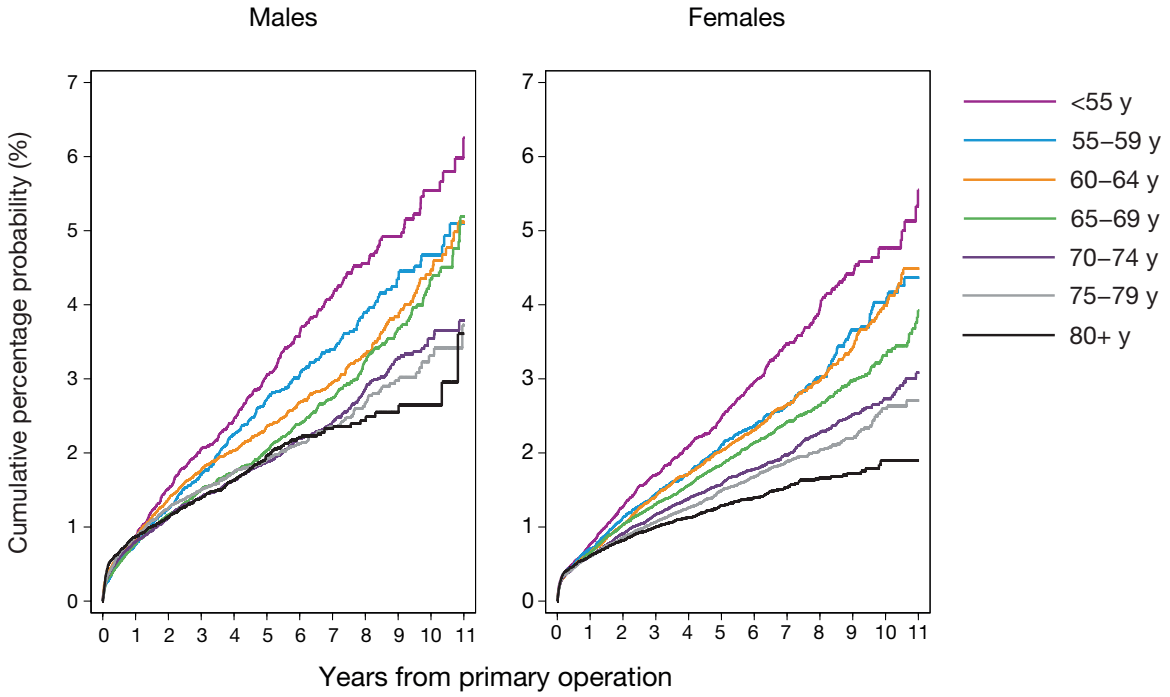


Table 3.8 Kaplan-Meier estimates of the cumulative percentage probability of revision (95% CI), by gender and age, at 1, 3, 5, 7 and 10 years from the primary operation, for each fixation group and main bearing surface. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

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	43,118	0.87 (0.79-0.97)	2.30 (2.15-2.46)	4.11 (3.89-4.35)	6.14 (5.83-6.47)	8.87 (8.36-9.40)	42,800	0.92 (0.83-1.02)	2.59 (2.43-2.76)	4.97 (4.71-5.23)	8.23 (7.86-8.62)	12.15 (11.54-12.80)
	55-64	72,099	0.89 (0.83-0.97)	2.02 (1.91-2.13)	3.31 (3.16-3.47)	4.87 (4.66-5.09)	7.03 (6.68-7.40)	87,190	0.74 (0.69-0.80)	1.80 (1.70-1.89)	3.25 (3.11-3.39)	5.13 (4.93-5.34)	7.73 (7.38-8.09)
	65-74	98,529	0.84 (0.78-0.90)	1.60 (1.51-1.68)	2.38 (2.27-2.49)	3.41 (3.25-3.57)	5.08 (4.80-5.38)	149,890	0.66 (0.62-0.71)	1.35 (1.29-1.41)	2.12 (2.03-2.21)	2.99 (2.88-3.12)	4.17 (3.97-4.37)
	75+	71,322	0.88 (0.81-0.95)	1.48 (1.38-1.58)	2.02 (1.90-2.15)	2.52 (2.36-2.70)	3.34 (3.03-3.68)	143,011	0.63 (0.59-0.67)	1.09 (1.03-1.15)	1.50 (1.42-1.57)	1.93 (1.84-2.04)	2.55 (2.36-2.75)
All Cemented													
	<55	3,467	0.67 (0.44-1.02)	1.91 (1.46-2.51)	3.08 (2.43-3.90)	4.89 (3.93-6.06)	7.26 (5.79-9.09)	5,169	0.73 (0.53-1.02)	1.77 (1.41-2.23)	2.71 (2.21-3.32)	4.56 (3.79-5.49)	6.04 (5.03-7.25)
	55-64	12,535	0.59 (0.47-0.75)	1.42 (1.21-1.67)	2.12 (1.85-2.44)	2.90 (2.54-3.30)	4.61 (4.01-5.29)	20,242	0.47 (0.38-0.57)	1.17 (1.02-1.35)	1.89 (1.68-2.12)	2.71 (2.43-3.02)	4.40 (3.93-4.93)
	65-74	34,871	0.55 (0.48-0.64)	1.14 (1.02-1.26)	1.66 (1.52-1.83)	2.35 (2.15-2.57)	3.70 (3.35-4.09)	62,702	0.40 (0.35-0.45)	1.01 (0.92-1.09)	1.49 (1.38-1.60)	1.98 (1.84-2.12)	2.83 (2.61-3.06)
	75+	35,804	0.67 (0.59-0.77)	1.17 (1.05-1.29)	1.64 (1.49-1.80)	2.06 (1.87-2.28)	2.83 (2.46-3.26)	81,010	0.37 (0.33-0.41)	0.79 (0.73-0.86)	1.12 (1.03-1.21)	1.46 (1.35-1.57)	2.04 (1.83-2.26)
Cemented by bearing surface													
MoP	<55	1,583	1.00 (0.60-1.65)	2.26 (1.58-3.23)	3.36 (2.44-4.62)	4.22 (3.12-5.69)	*7.54 (5.58-10.15)*	2,735	0.97 (0.65-1.43)	2.23 (1.69-2.93)	2.82 (2.18-3.64)	4.32 (3.41-5.47)	5.59 (4.42-7.05)
	55-64	8,458	0.64 (0.49-0.83)	1.66 (1.39-1.99)	2.45 (2.10-2.86)	3.15 (2.72-3.64)	5.00 (4.30-5.80)	14,575	0.49 (0.39-0.62)	1.22 (1.04-1.43)	1.83 (1.59-2.09)	2.57 (2.26-2.91)	4.20 (3.68-4.78)
	65-74	30,583	0.58 (0.50-0.67)	1.17 (1.04-1.30)	1.69 (1.53-1.86)	2.38 (2.17-2.61)	3.76 (3.38-4.17)	55,954	0.39 (0.34-0.45)	0.99 (0.91-1.09)	1.49 (1.38-1.61)	1.97 (1.83-2.12)	2.86 (2.63-3.11)
	75+	33,934	0.68 (0.60-0.78)	1.18 (1.06-1.31)	1.64 (1.49-1.81)	2.09 (1.89-2.32)	2.87 (2.49-3.31)	76,856	0.37 (0.33-0.41)	0.79 (0.72-0.86)	1.11 (1.03-1.20)	1.45 (1.34-1.57)	2.02 (1.82-2.25)
CoP	<55	1,559	0.42 (0.19-0.94)	1.34 (0.80-2.23)	2.14 (1.35-3.37)	3.57 (2.29-5.54)	*3.57 (2.29-5.54)*	2,120	0.44 (0.23-0.85)	1.13 (0.72-1.79)	2.07 (1.36-3.14)	3.29 (2.21-4.88)	*4.36 (2.90-6.53)*
	55-64	3,469	0.50 (0.31-0.82)	0.78 (0.52-1.18)	0.98 (0.66-1.47)	1.43 (0.95-2.15)	*1.98 (1.19-3.30)*	4,943	0.32 (0.20-0.54)	0.85 (0.60-1.20)	1.47 (1.08-1.99)	1.92 (1.42-2.59)	*2.36 (1.66-3.37)*
	65-74	3,377	0.34 (0.19-0.62)	0.89 (0.59-1.33)	1.30 (0.89-1.88)	1.41 (0.97-2.06)	*1.72 (1.15-2.56)*	5,315	0.43 (0.28-0.66)	1.11 (0.83-1.48)	1.23 (0.92-1.63)	1.51 (1.12-2.03)	*1.83 (1.28-2.60)*
	75+	1,110	0.58 (0.26-1.28)	1.08 (0.58-2.02)	1.52 (0.84-2.77)	*1.52 (0.84-2.77)*	*2.44 (1.07-5.50)*	2,446	0.26 (0.12-0.57)	0.48 (0.26-0.90)	0.94 (0.55-1.61)	0.94 (0.55-1.61)	*0.94 (0.55-1.61)*

*Includes cases with unknown fixation/bearing but excludes the 346 cases where the ages were unverifiable plus a further six with uncertain gender.

Table 3.8 (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	21,914	0.90 (0.78-1.04)	2.54 (2.31-2.79)	4.52 (4.17-4.90)	6.76 (6.25-7.31)	10.05 (9.11-11.09)	24,425	0.96 (0.84-1.09)	2.45 (2.24-2.68)	4.56 (4.23-4.92)	7.46 (6.94-8.01)	10.67 (9.78-11.63)
	55-64	37,172	0.92 (0.83-1.03)	2.19 (2.03-2.36)	3.73 (3.50-3.98)	5.76 (5.41-6.13)	8.34 (7.71-9.03)	44,458	0.87 (0.79-0.97)	2.00 (1.86-2.15)	3.59 (3.38-3.81)	5.87 (5.55-6.21)	8.73 (8.14-9.37)
	65-74	41,571	1.02 (0.92-1.12)	1.95 (1.81-2.11)	2.98 (2.79-3.19)	4.38 (4.10-4.69)	6.48 (5.90-7.12)	54,181	0.94 (0.86-1.03)	1.80 (1.69-1.93)	3.02 (2.85-3.21)	4.62 (4.36-4.91)	6.68 (6.17-7.22)
	75+	20,522	1.26 (1.12-1.43)	2.02 (1.82-2.25)	2.78 (2.51-3.08)	3.47 (3.09-3.90)	*4.63 (3.92-5.46)*	32,040	1.27 (1.15-1.40)	1.89 (1.73-2.05)	2.48 (2.28-2.69)	3.28 (3.00-3.59)	4.46 (3.83-5.19)
Uncemented by bearing surface													
MoP	<55	2,390	0.81 (0.51-1.28)	2.19 (1.60-3.00)	3.69 (2.79-4.88)	5.41 (4.14-7.04)	*6.35 (4.86-8.28)*	3,031	1.38 (1.01-1.88)	2.23 (1.73-2.89)	3.00 (2.34-3.85)	4.04 (3.12-5.22)	*5.33 (3.97-7.13)*
	55-64	8,564	0.98 (0.78-1.21)	2.32 (1.99-2.71)	3.11 (2.69-3.60)	4.04 (3.49-4.68)	6.22 (5.14-7.52)	11,553	0.86 (0.70-1.05)	1.93 (1.67-2.22)	2.49 (2.17-2.85)	3.16 (2.76-3.62)	4.91 (4.11-5.87)
	65-74	17,773	1.00 (0.86-1.16)	1.83 (1.62-2.05)	2.30 (2.04-2.58)	3.03 (2.68-3.42)	4.79 (4.01-5.72)	25,627	1.00 (0.89-1.14)	1.66 (1.50-1.84)	2.09 (1.89-2.31)	2.61 (2.35-2.90)	3.40 (2.96-3.90)
	75+	13,244	1.32 (1.13-1.53)	2.07 (1.82-2.36)	2.63 (2.31-3.00)	3.16 (2.72-3.66)	*3.94 (3.23-4.81)*	21,785	1.26 (1.12-1.42)	1.76 (1.58-1.96)	2.25 (2.03-2.50)	2.58 (2.30-2.90)	3.53 (2.85-4.38)
MoM	<55	3,224	0.68 (0.45-1.04)	3.48 (2.90-4.18)	7.39 (6.53-8.37)	11.42 (10.26-12.69)	*19.48 (16.84-22.49)*	2,344	1.80 (1.33-2.42)	5.76 (4.89-6.79)	12.82 (11.52-14.26)	20.59 (18.90-22.41)	*28.37 (25.56-31.41)*
	55-64	5,069	0.83 (0.62-1.12)	2.99 (2.56-3.50)	6.56 (5.90-7.29)	11.33 (10.37-12.36)	*17.72 (15.79-19.87)*	4,774	0.86 (0.63-1.17)	3.59 (3.10-4.16)	8.89 (8.11-9.75)	16.04 (14.93-17.22)	*24.04 (21.78-26.49)*
	65-74	4,514	1.07 (0.81-1.41)	2.99 (2.52-3.53)	6.00 (5.33-6.76)	9.73 (8.79-10.78)	*16.04 (13.43-19.11)*	4,637	1.10 (0.84-1.45)	3.47 (2.98-4.04)	8.66 (7.86-9.52)	14.27 (13.17-15.45)	*23.37 (20.59-26.46)*
	75+	1,691	1.08 (0.68-1.72)	1.98 (1.40-2.79)	3.81 (2.95-4.92)	5.75 (4.49-7.37)	*9.83 (6.67-14.36)*	2,398	1.30 (0.92-1.85)	2.97 (2.35-3.75)	4.80 (3.99-5.77)	7.64 (6.46-9.03)	*12.31 (7.09-20.92)*
CoP	<55	2,850	1.20 (0.84-1.71)	2.30 (1.71-3.08)	3.51 (2.63-4.67)	3.92 (2.92-5.25)	*4.50 (3.29-6.14)*	3,523	0.79 (0.54-1.15)	1.44 (1.05-1.97)	2.28 (1.69-3.06)	3.26 (2.41-4.41)	*3.87 (2.75-5.44)*
	55-64	6,309	0.86 (0.65-1.13)	1.63 (1.31-2.04)	2.30 (1.86-2.84)	2.68 (2.16-3.32)	3.22 (2.52-4.11)	8,124	0.73 (0.56-0.95)	1.55 (1.27-1.88)	2.28 (1.90-2.73)	2.83 (2.36-3.40)	4.45 (3.53-5.61)
	65-74	7,085	0.68 (0.51-0.91)	1.23 (0.97-1.55)	1.42 (1.13-1.79)	1.74 (1.36-2.22)	2.44 (1.73-3.44)	9,121	0.86 (0.69-1.08)	1.55 (1.29-1.86)	2.08 (1.75-2.48)	2.64 (2.21-3.15)	3.68 (2.90-4.66)
	75+	2,421	1.23 (0.85-1.77)	1.73 (1.24-2.41)	2.20 (1.57-3.07)	2.20 (1.57-3.07)	*2.78 (1.71-4.50)*	3,590	0.98 (0.70-1.37)	1.64 (1.23-2.16)	1.83 (1.38-2.41)	2.22 (1.64-3.00)	*3.40 (2.25-5.13)*

*Includes cases with unknown fixation/bearing but excludes the 346 cases where the ages were unverifiable plus a further six with uncertain gender.

Continued >

Table 3.8 (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	12,897	0.91 (0.76-1.10)	2.23 (1.95-2.54)	3.15 (2.78-3.58)	4.18 (3.62-4.83)	*5.44 (4.45-6.66)*	14,811	0.75 (0.62-0.91)	1.82 (1.59-2.07)	2.52 (2.22-2.86)	3.38 (2.93-3.88)	*5.37 (4.35-6.62)*
	55-64	16,326	0.94 (0.80-1.11)	1.88 (1.67-2.13)	2.69 (2.39-3.02)	3.38 (2.97-3.84)	4.63 (3.71-5.76)	18,774	0.93 (0.80-1.08)	1.66 (1.48-1.87)	2.31 (2.07-2.59)	2.79 (2.47-3.16)	3.80 (3.12-4.62)
	65-74	11,205	1.22 (1.03-1.44)	1.93 (1.67-2.23)	2.54 (2.20-2.93)	3.07 (2.63-3.59)	*3.92 (3.06-5.03)*	13,521	0.81 (0.67-0.98)	1.46 (1.25-1.69)	1.78 (1.53-2.06)	2.22 (1.87-2.64)	*2.50 (1.99-3.15)*
	75+	2,727	1.19 (0.84-1.68)	2.11 (1.59-2.79)	2.25 (1.68-3.02)	*2.25 (1.68-3.02)*	*2.25 (1.68-3.02)*	3,566	1.49 (1.14-1.95)	1.89 (1.48-2.41)	2.02 (1.58-2.59)	*2.43 (1.78-3.31)*	*2.43 (1.78-3.31)*
All hybrid													
	<55	4,911	0.80 (0.58-1.11)	1.54 (1.20-1.98)	2.58 (2.06-3.23)	4.73 (3.85-5.80)	6.21 (5.00-7.69)	6,798	0.57 (0.41-0.79)	1.11 (0.86-1.42)	1.99 (1.60-2.46)	3.25 (2.67-3.94)	4.32 (3.40-5.47)
	55-64	10,036	0.75 (0.60-0.95)	1.53 (1.29-1.82)	2.37 (2.04-2.77)	3.05 (2.62-3.54)	4.59 (3.81-5.52)	15,829	0.46 (0.37-0.59)	1.09 (0.92-1.28)	1.84 (1.60-2.12)	2.60 (2.28-2.97)	3.89 (3.33-4.54)
	65-74	16,776	0.78 (0.66-0.93)	1.39 (1.21-1.60)	2.01 (1.76-2.29)	2.69 (2.36-3.06)	4.54 (3.81-5.41)	27,865	0.69 (0.60-0.80)	1.19 (1.06-1.34)	1.79 (1.61-1.99)	2.37 (2.12-2.64)	3.17 (2.75-3.65)
	75+	12,889	0.79 (0.65-0.97)	1.43 (1.21-1.69)	1.88 (1.60-2.21)	2.36 (1.99-2.80)	*3.01 (2.33-3.89)*	25,914	0.61 (0.52-0.72)	1.00 (0.88-1.15)	1.46 (1.29-1.66)	1.91 (1.66-2.19)	2.13 (1.73-2.62)
Hybrid by bearing surface													
MoP	<55	945	1.12 (0.61-2.08)	2.00 (1.22-3.27)	3.78 (2.45-5.80)	*5.67 (3.76-8.50)*	*6.88 (4.55-10.35)*	1,455	0.88 (0.50-1.55)	1.63 (1.05-2.53)	2.60 (1.76-3.83)	3.72 (2.59-5.33)	*6.10 (3.90-9.49)*
	55-64	3,897	1.02 (0.74-1.40)	1.81 (1.41-2.32)	2.47 (1.96-3.10)	2.91 (2.32-3.66)	4.71 (3.63-6.10)	6,738	0.54 (0.39-0.76)	1.05 (0.81-1.35)	1.80 (1.46-2.22)	2.55 (2.09-3.10)	3.64 (2.90-4.56)
	65-74	11,360	0.77 (0.62-0.96)	1.40 (1.19-1.66)	1.93 (1.65-2.26)	2.49 (2.13-2.92)	4.40 (3.56-5.43)	19,834	0.66 (0.56-0.79)	1.18 (1.03-1.36)	1.73 (1.52-1.96)	2.18 (1.92-2.48)	2.98 (2.52-3.52)
	75+	10,919	0.75 (0.60-0.94)	1.43 (1.19-1.71)	1.91 (1.60-2.27)	2.27 (1.90-2.72)	*3.03 (2.28-4.03)*	22,216	0.65 (0.55-0.77)	1.04 (0.90-1.20)	1.43 (1.25-1.64)	1.80 (1.56-2.09)	2.05 (1.62-2.60)
CoP	<55	1,264	0.96 (0.53-1.73)	1.54 (0.88-2.71)	1.86 (1.05-3.28)	*3.18 (1.63-6.14)*	*4.08 (2.08-7.93)*	1,717	0.40 (0.18-0.89)	0.81 (0.43-1.54)	1.36 (0.75-2.47)	*1.65 (0.90-3.00)*	*1.65 (0.90-3.00)*
	55-64	2,333	0.51 (0.28-0.92)	0.89 (0.54-1.48)	1.43 (0.88-2.33)	1.67 (1.01-2.74)	*1.67 (1.01-2.74)*	3,629	0.39 (0.23-0.68)	1.17 (0.81-1.71)	1.60 (1.12-2.30)	1.78 (1.22-2.61)	*2.74 (1.71-4.37)*
	65-74	2,802	0.75 (0.48-1.17)	1.33 (0.89-1.97)	1.74 (1.16-2.61)	2.25 (1.43-3.52)	*3.07 (1.87-5.03)*	4,503	0.68 (0.46-0.99)	1.10 (0.79-1.53)	1.55 (1.12-2.15)	1.67 (1.19-2.33)	*1.67 (1.19-2.33)*
	75+	1,209	0.81 (0.42-1.55)	1.20 (0.63-2.27)	*1.20 (0.63-2.27)*	*1.20 (0.63-2.27)*	*1.20 (0.63-2.27)*	2,241	0.39 (0.18-0.81)	0.55 (0.28-1.08)	0.98 (0.48-2.01)	*0.98 (0.48-2.01)*	*0.98 (0.48-2.01)*

*Includes cases with unknown fixation/bearing but excludes the 346 cases where the ages were unverifiable plus a further six with uncertain gender.

Table 3.8 (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	2,341	0.63 (0.37-1.07)	1.30 (0.89-1.92)	1.74 (1.21-2.50)	2.71 (1.90-3.85)	*3.47 (2.39-5.01)*	3,264	0.42 (0.24-0.72)	0.77 (0.51-1.17)	1.26 (0.87-1.83)	2.06 (1.46-2.89)	*2.64 (1.83-3.80)*
	55-64	3,295	0.56 (0.35-0.89)	1.07 (0.75-1.51)	1.90 (1.41-2.54)	2.06 (1.54-2.76)	*2.37 (1.65-3.40)*	4,809	0.38 (0.24-0.60)	0.81 (0.58-1.13)	1.24 (0.93-1.65)	1.64 (1.23-2.17)	*2.20 (1.58-3.06)*
	65-74	2,048	0.76 (0.46-1.26)	1.20 (0.79-1.82)	1.94 (1.34-2.80)	1.94 (1.34-2.80)	*3.55 (1.81-6.89)*	2,770	0.82 (0.54-1.25)	1.06 (0.73-1.55)	1.50 (1.06-2.11)	2.06 (1.45-2.92)	*2.96 (1.56-5.59)*
	75+	384	1.63 (0.74-3.60)	*1.97 (0.94-4.10)*	*2.54 (1.24-5.19)*	*2.54 (1.24-5.19)*	-	717	0.44 (0.14-1.36)	0.83 (0.34-2.01)	*1.24 (0.52-2.98)*	*1.24 (0.52-2.98)*	-
All reverse hybrid													
	<55	475	0.45 (0.11-1.78)	*1.07 (0.40-2.89)*	*1.07 (0.40-2.89)*	*1.07 (0.40-2.89)*	*5.03 (1.07-21.86)*	651	1.15 (0.55-2.40)	1.82 (0.97-3.40)	*3.77 (2.18-6.47)*	*4.89 (2.89-8.20)*	*6.47 (3.48-11.86)*
	55-64	1,310	1.07 (0.62-1.84)	2.42 (1.63-3.59)	3.17 (2.16-4.62)	*4.19 (2.81-6.21)*	*6.54 (3.75-11.28)*	2,135	0.84 (0.52-1.35)	1.86 (1.32-2.62)	2.75 (2.01-3.75)	3.29 (2.39-4.54)	*4.64 (2.84-7.51)*
	65-74	2,463	1.05 (0.70-1.56)	1.83 (1.32-2.52)	2.43 (1.77-3.32)	4.06 (2.87-5.74)	*4.67 (3.15-6.91)*	4,324	0.56 (0.37-0.84)	1.11 (0.81-1.52)	1.48 (1.10-2.00)	1.99 (1.41-2.80)	*3.60 (1.87-6.87)*
	75+	1,924	1.11 (0.72-1.72)	1.97 (1.38-2.81)	2.23 (1.56-3.17)	*2.66 (1.72-4.09)*	-	3,975	0.76 (0.53-1.09)	1.11 (0.81-1.53)	1.65 (1.21-2.25)	2.04 (1.41-2.96)	*2.04 (1.41-2.96)*
Reverse hybrid by bearing surface													
MoP	<55	106	*0.00*	*2.60 (0.65-10.06)*	*2.60 (0.65-10.06)*	*2.60 (0.65-10.06)*	*2.60 (0.65-10.06)*	160	*0.00*	*0.00*	*2.72 (0.68-10.58)*	*6.15 (2.32-15.74)*	*9.50 (3.77-22.81)*
	55-64	509	1.04 (0.43-2.47)	1.89 (0.94-3.78)	*2.67 (1.41-5.03)*	*3.49 (1.79-6.73)*	*7.71 (3.43-16.81)*	920	0.91 (0.45-1.81)	1.75 (1.04-2.96)	3.28 (2.11-5.08)	*4.18 (2.64-6.57)*	*6.69 (3.62-12.19)*
	65-74	1,683	1.27 (0.82-1.97)	2.20 (1.54-3.13)	2.94 (2.08-4.15)	*4.08 (2.80-5.92)*	*4.08 (2.80-5.92)*	3,136	0.57 (0.35-0.91)	1.01 (0.69-1.48)	1.46 (1.01-2.09)	2.16 (1.43-3.26)	*4.63 (2.09-10.11)*
	75+	1,697	1.20 (0.76-1.87)	2.07 (1.43-2.99)	2.25 (1.55-3.25)	*2.72 (1.72-4.29)*	-	3,451	0.75 (0.51-1.11)	1.11 (0.79-1.56)	1.66 (1.19-2.32)	1.94 (1.30-2.89)	*1.94 (1.30-2.89)*
Resurfacing													
MoM	<55	12,347	0.92 (0.76-1.10)	2.32 (2.06-2.61)	4.30 (3.93-4.70)	6.22 (5.75-6.73)	8.86 (8.14-9.64)	5,753	1.31 (1.04-1.64)	4.92 (4.38-5.51)	9.42 (8.68-10.22)	14.73 (13.78-15.73)	21.63 (20.21-23.14)
	55-64	11,042	1.23 (1.04-1.46)	2.45 (2.17-2.76)	3.98 (3.62-4.38)	5.86 (5.39-6.37)	8.21 (7.50-8.99)	4,522	1.60 (1.27-2.01)	4.43 (3.86-5.07)	8.65 (7.86-9.53)	13.36 (12.34-14.45)	19.54 (18.03-21.17)
	65-74	2,844	1.92 (1.47-2.50)	3.08 (2.50-3.80)	4.51 (3.77-5.38)	6.79 (5.81-7.92)	9.09 (7.76-10.65)	809	1.86 (1.13-3.07)	3.78 (2.66-5.36)	6.93 (5.34-8.98)	11.36 (9.18-14.01)	*16.32 (13.23-20.05)*
	75+	180	*1.69 (0.55-5.16)*	*1.69 (0.55-5.16)*	*3.25 (1.35-7.72)*	*5.24 (2.47-10.93)*	*5.24 (2.47-10.93)*	*65*	*1.56 (0.22-10.58)*	*3.35 (0.85-12.79)*	*7.30 (2.79-18.38)*	*9.74 (4.12-22.08)*	-

*Includes cases with unknown fixation/bearing but excludes the 346 cases where the ages were unverifiable plus a further six with uncertain gender.

3.2.3 Revisions after primary hip surgery: effect of head size for polyethylene monobloc cups and polyethylene liners

This section updates results from an earlier report (NJR 10th Annual Report 2013) on the effect of head size.

Four groups were defined:

(a) Metal-on-polyethylene – cemented monobloc cups n=234,148

(b) Metal-on-polyethylene – uncemented metal shell with polyethylene liners n=179,667

(c) Ceramic-on-polyethylene – cemented monobloc cups n=29,548

(d) Ceramic-on-polyethylene – uncemented metal shell with polyethylene liners n=61,986

Figures 3.10 (a) to 3.10 (d) show respective percentage cumulative probabilities of revision (Kaplan-Meier) for various head sizes, for each of the above groups and up to 11 years from the primary operation.

In Figure 3.10 (a), metal-on-polyethylene cemented monobloc cups, there was a significant effect of head size (overall difference $P<0.001$ by logrank test). Implants with a head size of 36mm, as per the report in 2013, still have the worst failure rates but numbers are small after five years follow-up.

In Figure 3.10 (b), metal-on-polyethylene uncemented metal shell with polyethylene liners, there was a similar effect of head size (overall $P<0.001$), with head size 44mm showing worse failure rates but again numbers were small after five years.

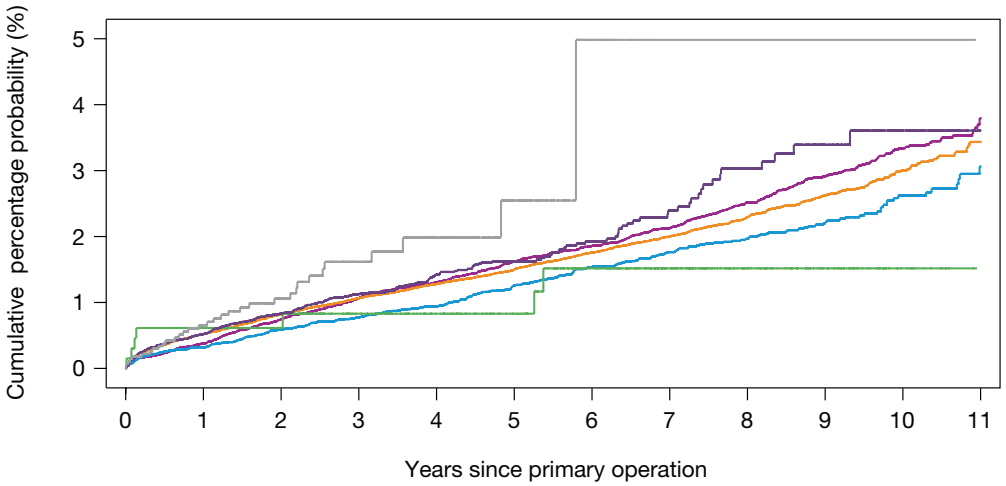
Results were similar in Figure 3.10 (c), ceramic-on-polyethylene – cemented monobloc cups, with a difference between the head sizes overall ($P=0.038$) and the largest head size 36mm showing worse failure rates.

In Figure 3.10 (d), whilst there were significant differences 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 worse outcomes.

Figure 3.10 (a)

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

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

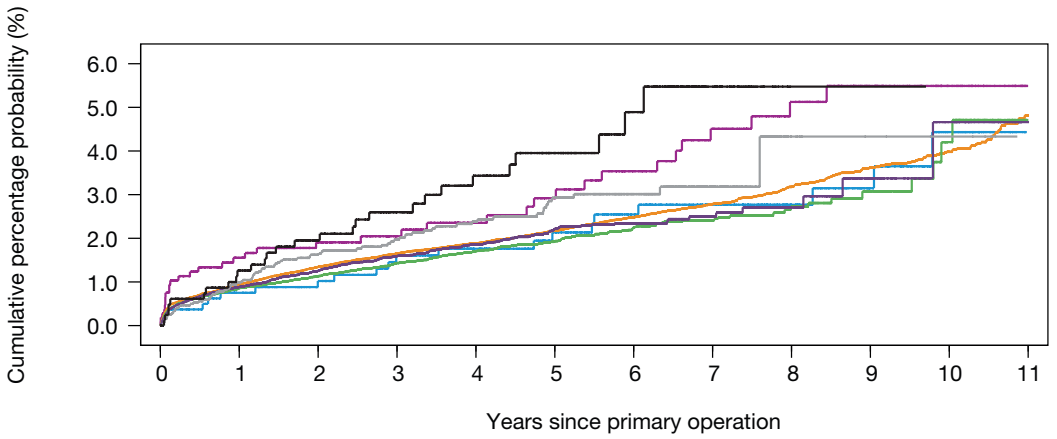


Numbers at risk

Head size = 22.25mm	31,910	30,295	28,398	26,162	23,627	20,887	18,128	15,267	11,910	8,661	5,233	2,037
Head size = 26mm	17,915	16,989	15,974	14,737	13,276	11,909	10,135	8,224	6,247	4,402	2,463	863
Head size = 28mm	151,089	133,076	115,379	98,007	81,587	66,093	51,378	36,845	23,538	13,862	6,378	1,986
Head size = 30mm	655	562	460	400	354	306	233	161	99	60	19	5
Head size = 32mm	29,746	22,231	15,965	10,803	7,258	4,718	2,915	1,794	999	545	256	70
Head size = 36mm	2,769	1,966	1,299	705	342	138	23	1	1	1	1	0

Figure 3.10 (b)

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

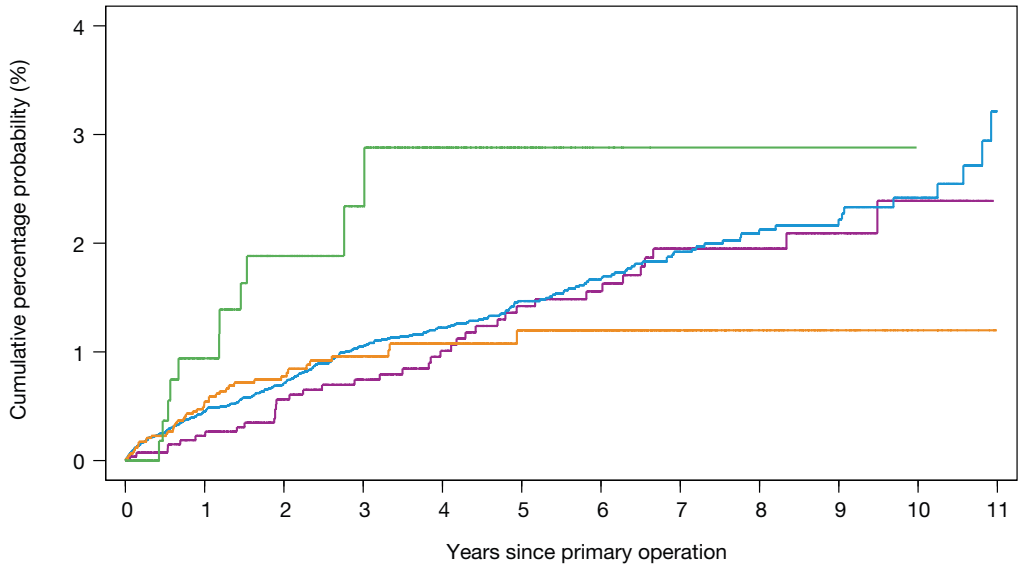


Numbers at risk

Head size = 22.25mm	1,077	892	754	658	560	484	435	367	289	210	128	42
Head size = 26mm	810	765	713	657	588	514	443	366	286	195	97	22
Head size = 28mm	81,398	73,701	66,499	58,613	50,326	41,822	33,228	24,449	16,345	9,857	4,638	1,339
Head size = 32mm	57,906	43,614	31,941	22,438	15,098	9,494	5,368	2,783	1,359	534	195	17
Head size = 36mm	34,244	27,645	21,564	15,451	10,132	5,844	2,746	1,193	428	150	62	13
Head size = 40mm	3,252	3,013	2,772	2,334	1,826	1,281	765	260	17	8	6	1
Head size = 44mm	819	746	648	528	417	295	176	50	1	1	0	0

Figure 3.10 (c)

(c) **Ceramic-on-polyethylene – cemented monobloc cups**

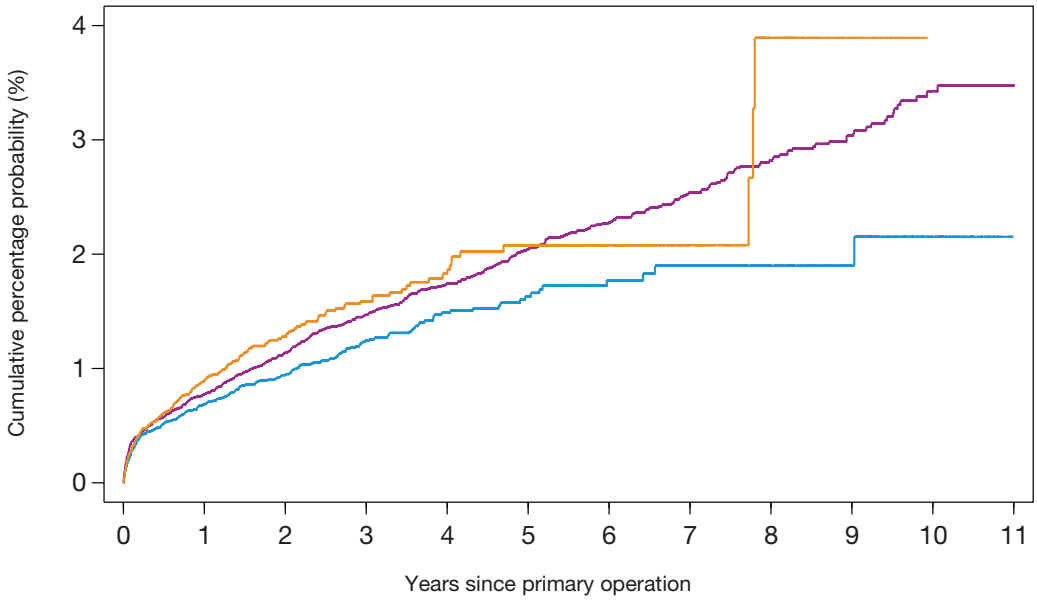


Numbers at risk

Head size = 22.25mm	2,739	2,526	2,282	2,041	1,789	1,573	1,343	1,073	779	465	185	0
Head size = 28mm	20,194	17,256	14,531	11,914	9,681	7,558	5,759	4,102	2,740	1,754	928	317
Head size = 32mm	5,971	4,298	3,008	1,993	1,277	776	412	186	108	55	23	8
Head size = 36mm	639	462	319	184	97	37	7	1	1	1	0	0

Figure 3.10 (d)

(d) **Ceramic-on-polyethylene – uncemented metal shells used with polyethylene liners**



Numbers at risk

Head size = 28mm	23,072	20,410	18,305	16,203	14,132	12,090	10,019	7,976	5,781	3,843	2,036	699
Head size = 32mm	22,435	15,941	11,249	7,941	5,447	3,379	2,012	1,130	695	389	145	33
Head size = 36mm	16,004	10,761	6,791	4,099	2,563	1,462	678	297	112	20	0	0

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

Table 3.9 (below) 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* are at time points where fewer than 250 cases remained at risk; no results are shown at all where the number had fallen below ten.

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 3.9 (below) have been further divided by bearing surface. Table 3.10 (over the page) 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 3.9 were Cemented MoP. Similarly, the majority of the cemented CPT/ZCA and Exeter V40/Exeter Duration combinations shown in Table 3.9 were MoP.

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 operation, for the most commonly used cup-stem brand combinations (group sizes >2,500, 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
Cemented								
Charnley Cemented Stem / Charnley Ogee	9,594	73 (67-78)	38%	0.38 (0.28-0.53)	1.20 (1.00-1.45)	1.88 (1.61-2.19)	2.52 (2.19-2.91)	4.09 (3.55-4.71)
Charnley Cemented Stem / Charnley Cemented Cup	10,746	73 (67-79)	33%	0.34 (0.25-0.47)	0.87 (0.71-1.08)	1.38 (1.16-1.64)	1.89 (1.62-2.20)	2.99 (2.58-3.46)
C-Stem Cemented Stem / Elite Plus Ogee	4,404	72 (66-77)	40%	0.40 (0.25-0.64)	0.89 (0.64-1.24)	1.18 (0.87-1.59)	1.56 (1.17-2.07)	2.02 (1.51-2.69)
C-Stem Cemented Stem / Marathon	3,846	67 (59-74)	41%	0.29 (0.15-0.54)	1.06 (0.72-1.56)	1.32 (0.90-1.94)	-	-
MS-30 / Low Profile Muller	2,669	73 (67-80)	32%	0.23 (0.10-0.52)	0.48 (0.26-0.86)	0.72 (0.42-1.25)	0.72 (0.42-1.25)	*1.03 (0.51-2.07)*
Stanmore Modular Stem / Stanmore-Arcom Cup	4,769	75 (70-80)	29%	0.37 (0.23-0.59)	0.98 (0.72-1.33)	1.36 (1.03-1.79)	1.62 (1.23-2.12)	1.93 (1.43-2.59)
CPT / Elite Plus Ogee	2,805	73 (67-79)	36%	0.62 (0.39-1.00)	1.46 (1.05-2.02)	1.91 (1.41-2.59)	2.41 (1.79-3.26)	*3.04 (2.03-4.56)*
CPT / ZCA	10,259	76 (71-81)	29%	0.72 (0.57-0.91)	1.26 (1.05-1.52)	1.91 (1.62-2.25)	2.57 (2.19-3.02)	3.60 (2.91-4.46)
Exeter V40 / Contemporary	75,093	74 (69-79)	34%	0.48 (0.43-0.54)	1.00 (0.93-1.09)	1.46 (1.36-1.57)	1.94 (1.80-2.08)	2.92 (2.61-3.26)
Exeter V40 / Elite Plus Ogee	21,010	74 (68-80)	35%	0.35 (0.28-0.44)	0.80 (0.64-0.94)	1.11 (0.96-1.29)	1.59 (1.38-1.82)	2.42 (2.03-2.89)
Exeter V40 / Exeter Duration	15,613	73 (67-79)	32%	0.58 (0.47-0.71)	1.22 (1.05-1.42)	1.68 (1.47-1.91)	2.44 (2.16-2.76)	3.73 (3.24-4.29)
Exeter V40 / Opera	2,801	74 (68-80)	32%	0.36 (0.20-0.67)	0.79 (0.51-1.22)	1.15 (0.78-1.69)	1.60 (1.10-2.32)	*1.78 (1.20-2.64)*
Exeter V40/ Cenator Cemented Cup	2,501	75 (69-80)	33%	0.49 (0.28-0.85)	1.35 (0.95-1.92)	2.07 (1.54-2.77)	2.32 (1.74-3.10)	2.71 (2.01-3.64)
Exeter V40 / Elite Plus Cemented Cup	7,513	73 (67-78)	34%	0.44 (0.31-0.63)	0.88 (0.68-1.14)	1.09 (0.85-1.40)	1.31 (1.02-1.69)	1.66 (1.19-2.30)

Continued >

Table 3.9 (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
Exeter V40 / Marathon	2,551	70 (63-77)	36%	0.30 (0.14-0.63)	0.66 (0.36-1.19)	*0.79 (0.44-1.42)*	-	-
Exeter V40 / Exeter Rimfit	12,115	69 (62-76)	37%	0.54 (0.41-0.70)	1.15 (0.88-1.48)	-	-	-
C-Stem AMT Cemented Stem / Elite Plus Cemented Cup	3,327	75 (71-79)	32%	0.52 (0.32-0.84)	1.04 (0.73-1.49)	1.22 (0.86-1.74)	1.50 (1.02-2.20)	-
C-Stem AMT Cemented Stem / Marathon	2,863	74 (68-79)	36%	0.18 (0.07-0.49)	0.66 (0.33-1.33)	*1.53 (0.63-3.70)*	-	-
Uncemented								
Accolade / Trident	21,637	66 (59-73)	43%	0.94 (0.81-1.07)	2.00 (1.81-2.21)	2.84 (2.58-3.13)	3.41 (3.06-3.79)	*4.35 (3.42-5.53)*
Corail / Duraloc Cementless Cup	4,036	70 (64-75)	39%	0.75 (0.52-1.07)	1.69 (1.33-2.14)	2.49 (2.04-3.03)	3.40 (2.84-4.07)	5.57 (4.65-6.68)
Corail / Pinnacle	95,702	66 (59-73)	44%	0.81 (0.76-0.87)	1.74 (1.65-1.83)	2.89 (2.75-3.03)	4.75 (4.51-5.00)	7.94 (7.10-8.88)
Corail / Trilogy	2,721	68 (62-74)	39%	0.64 (0.40-1.02)	1.21 (0.85-1.71)	1.70 (1.25-2.33)	2.38 (1.75-3.23)	*3.27 (2.23-4.78)*
Corail / ASR Resurfacing Cup	2,606	61 (54-67)	54%	1.08 (0.74-1.56)	7.55 (6.60-8.64)	23.41 (21.81-25.11)	35.76 (33.84-37.75)	-
Furlong HAC Stem / CSF	16,226	69 (62-75)	40%	1.00 (0.85-1.16)	1.70 (1.51-1.92)	2.10 (1.88-2.34)	2.64 (2.38-2.93)	3.68 (3.28-4.12)
Furlong HAC Stem / CSF Plus	16,833	66 (59-74)	44%	1.14 (0.99-1.32)	1.87 (1.66-2.11)	2.15 (1.90-2.42)	*2.64 (2.22-3.14)*	-
Polarstem Cementless / R3 Cementless	3,073	67 (60-73)	45%	0.53 (0.32-0.87)	0.75 (0.46-1.22)	*0.75 (0.46-1.22)*	-	-
SL-Plus Cementless Stem / EP-Fit Plus	4,750	65 (59-73)	43%	1.25 (0.97-1.61)	2.71 (2.27-3.23)	3.97 (3.42-4.62)	4.70 (4.05-5.46)	*6.56 (5.25-8.18)*
Taperloc Cementless Stem / Exceed ABT	15,829	65 (58-72)	43%	1.10 (0.94-1.28)	1.56 (1.36-1.79)	1.92 (1.66-2.22)	2.22 (1.84-2.69)	-
M/L Taper / Cementless Continuum	2,535	60 (53-68)	45%	1.14 (0.79-1.67)	1.77 (1.24-2.50)	-	-	-
Hybrid								
CPT / Trilogy	13,344	71 (65-78)	34%	0.84 (0.69-1.01)	1.33 (1.14-1.57)	2.24 (1.93-2.60)	2.71 (2.34-3.14)	3.61 (2.92-4.46)
Exeter V40 / Pinnacle	4,545	72 (65-78)	35%	0.64 (0.44-0.94)	1.06 (0.77-1.47)	1.54 (1.11-2.12)	1.97 (1.30-2.98)	-
Exeter V40 / Trident	42,263	68 (60-75)	39%	0.57 (0.50-0.65)	1.05 (0.95-1.16)	1.46 (1.32-1.61)	1.98 (1.78-2.20)	2.30 (2.04-2.60)
Exeter V40 / Trilogy	11,740	70 (63-76)	40%	0.57 (0.45-0.72)	0.95 (0.79-1.15)	1.35 (1.14-1.60)	1.77 (1.50-2.09)	2.38 (1.98-2.87)
C-Stem AMT Cemented Stem / Pinnacle	4,396	70 (64-76)	37%	0.77 (0.54-1.09)	1.20 (0.89-1.64)	2.04 (1.47-2.83)	2.25 (1.59-3.17)	-
Reverse hybrid								
Corail / Elite Plus Cemented Cup	3,114	72 (67-77)	34%	0.54 (0.33-0.87)	1.14 (0.80-1.62)	1.68 (1.22-2.31)	2.27 (1.63-3.15)	-
Corail / Marathon	5,802	70 (64-76)	38%	0.51 (0.35-0.75)	0.93 (0.68-1.27)	1.14 (0.82-1.59)	-	-
Resurfacing								
Adept Resurfacing Cup	3,469	54 (48-60)	71%	1.16 (0.85-1.58)	2.54 (2.06-3.13)	4.60 (3.92-5.40)	6.94 (5.99-8.04)	-
ASR Resurfacing Cup	3,031	55 (49-60)	68%	1.62 (1.22-2.13)	5.99 (5.20-6.90)	13.69 (12.51-14.97)	21.57 (19.80-22.82)	*28.28 (26.21-30.48)*
BHR Resurfacing Cup	19,629	55 (49-60)	72%	1.07 (0.93-1.22)	2.40 (2.19-2.63)	3.84 (3.57-4.13)	5.57 (5.23-5.94)	8.85 (8.31-9.42)
Cormet 2000 Resurfacing Cup	3,651	55 (48-60)	65%	1.43 (1.09-1.87)	3.55 (2.99-4.20)	7.57 (6.75-8.49)	12.67 (11.57-13.88)	19.02 (17.32-20.85)
Durom Resurfacing Cup	1,692	55 (49-60)	70%	1.36 (0.91-2.04)	3.71 (2.90-4.73)	5.77 (4.74-7.02)	8.28 (6.98-9.81)	*8.99 (7.57-10.68)*
Recap Magnum	1,767	54 (49-60)	73%	1.82 (1.29-2.56)	3.48 (2.71-4.46)	5.58 (4.56-6.83)	8.12 (6.79-9.71)	-
Conserve Plus Resurfacing Cup	1,340	56 (50-61)	63%	2.02 (1.39-2.93)	5.19 (4.13-6.53)	8.33 (6.95-9.97)	11.58 (9.84-13.59)	*15.93 (12.83-19.69)*

Table 3.10 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	MoP	70,069	75 (69-80)	34%	0.48 (0.43-0.53)	1.00 (0.93-1.09)	1.46 (1.36-1.58)	1.96 (1.81-2.11)	2.93 (2.60-3.29)
	CoP	4,507	65 (60-70)	38%	0.49 (0.32-0.75)	0.98 (0.71-1.36)	1.38 (1.01-1.87)	1.63 (1.19-2.23)	*2.70 (1.72-4.21)*
Exeter V40 / Elite Plus Ogee	MoP	19,396	75 (69-80)	35%	0.36 (0.28-0.45)	0.80 (0.68-0.95)	1.10 (0.94-1.28)	1.57 (1.36-1.82)	2.44 (2.02-2.93)
	CoP	1,409	65 (59-70)	45%	0.31 (0.12-0.84)	0.86 (0.46-1.59)	1.40 (0.82-2.39)	1.61 (0.94-2.73)	*2.09 (1.14-3.81)*
Exeter V40 / Exeter Rimfit	MoP	8,560	72 (65-78)	35%	0.55 (0.40-0.75)	1.16 (0.86-1.56)	-	-	-
	CoP	3,508	61 (55-67)	42%	0.49 (0.29-0.83)	1.10 (0.65-1.84)	-	-	-
Uncemented									
Accolade / Trident	MoP	10,378	71 (65-76)	41%	0.97 (0.80-1.18)	2.08 (1.80-2.40)	2.91 (2.54-3.33)	3.44 (2.93-4.04)	*3.98 (3.12-5.07)*
	CoP	3,958	63 (57-68)	44%	0.75 (0.52-1.09)	1.79 (1.36-2.37)	2.30 (1.72-3.07)	*2.30 (1.72-3.07)*	*3.56 (2.11-5.98)*
	CoC	7,112	62 (55-68)	45%	0.99 (0.79-1.25)	2.03 (1.72-2.40)	2.90 (2.49-3.37)	3.60 (3.07-4.23)	*4.61 (3.29-6.45)*
Corail / Pinnacle	MoP	36,776	71 (65-77)	40%	0.86 (0.76-0.96)	1.46 (1.33-1.61)	1.81 (1.65-1.99)	2.36 (2.11-2.64)	*3.59 (2.59-4.96)*
	MoM	11,898	67 (60-74)	47%	0.86 (0.71-1.05)	2.42 (2.15-2.71)	5.15 (4.75-5.57)	9.04 (8.45-9.66)	*15.69 (13.70-17.95)*
	CoP	12,187	64 (58-69)	44%	0.62 (0.49-0.79)	1.11 (0.91-1.36)	1.67 (1.35-2.06)	1.73 (1.39-2.14)	*2.19 (1.40-3.41)*
	CoC	32,309	60 (53-66)	47%	0.83 (0.74-0.94)	1.79 (1.63-1.95)	2.43 (2.23-2.65)	3.13 (2.83-3.47)	*3.95 (3.32-4.71)*
	CoM	1,780	63 (57-70)	41%	0.45 (0.23-0.90)	2.65 (1.99-3.52)	4.38 (3.44-5.56)	*4.77 (3.72-6.12)*	-
Furlong HAC Stem / CSF	MoP	7,491	73 (67-78)	39%	1.17 (0.95-1.45)	1.97 (1.67-2.33)	2.33 (2.00-2.72)	2.94 (2.53-3.40)	4.47 (3.74-5.35)
	CoP	6,814	67 (61-73)	41%	0.73 (0.55-0.96)	1.31 (1.06-1.62)	1.71 (1.41-2.06)	2.14 (1.80-2.56)	2.88 (2.38-3.49)
	CoC	1,631	59 (53-66)	44%	1.29 (0.84-1.97)	2.11 (1.51-2.94)	2.63 (1.95-3.55)	3.30 (2.52-4.33)	*4.33 (3.31-5.65)*
Furlong HAC Stem / CSF Plus	MoP	3,966	74 (70-79)	39%	1.59 (1.24-2.05)	2.17 (1.73-2.72)	2.49 (1.99-3.13)	*2.94 (2.27-3.81)*	-
	CoP	1,886	67 (62-72)	45%	1.17 (0.76-1.78)	2.10 (1.49-2.96)	2.10 (1.49-2.96)	*4.07 (2.00-8.20)*	-
	CoC	10,897	63 (56-70)	45%	0.95 (0.79-1.16)	1.71 (1.47-2.00)	2.02 (1.72-2.37)	*2.28 (1.90-2.74)*	-
Taperloc Cementless Stem / Exceed ABT	MoP	4,881	72 (66-77)	40%	1.18 (0.91-1.54)	1.79 (1.41-2.27)	2.30 (1.75-3.03)	*2.51 (1.86-3.38)*	-
	CoP	2,675	65 (59-71)	44%	0.93 (0.62-1.38)	1.20 (0.80-1.79)	*1.52 (0.90-2.54)*	*2.04 (1.08-3.81)*	-
	CoC	8,086	61 (54-67)	45%	1.09 (0.88-1.35)	1.52 (1.26-1.84)	1.83 (1.51-2.22)	2.14 (1.66-2.76)	-

Continued >

Table 3.10 (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
Hybrid									
CPT / Trilogy	MoP	10,245	73 (66-78)	34%	0.81 (0.65-1.01)	1.31 (1.10-1.57)	2.25 (1.91-2.63)	2.76 (2.36-3.24)	3.77 (3.01-4.72)
	CoP	2,422	68 (61-75)	34%	0.97 (0.63-1.51)	*1.48 (0.92-2.38)*	*1.48 (0.92-2.38)*	*1.48 (0.92-2.38)*	*1.48 (0.92-2.38)*
Exeter V40 / Trident	MoP	23,103	73 (67-79)	37%	0.58 (0.48-0.69)	1.10 (0.96-1.26)	1.44 (1.26-1.65)	1.96 (1.68-2.28)	*2.20 (1.84-2.62)*
	CoP	7,264	65 (58-71)	40%	0.53 (0.38-0.75)	1.04 (0.78-1.38)	1.40 (1.04-1.90)	1.80 (1.22-2.66)	*2.26 (1.36-3.72)*
	CoC	11,209	60 (53-65)	43%	0.56 (0.44-0.72)	1.00 (0.82-1.21)	1.52 (1.28-1.79)	2.00 (1.70-2.36)	2.25 (1.89-2.68)
Exeter V40 / Trilogy	MoP	9,363	71 (65-77)	40%	0.55 (0.42-0.73)	0.92 (0.74-1.14)	1.35 (1.11-1.64)	1.80 (1.49-2.17)	2.46 (1.98-3.05)
	CoP	2,077	63 (58-69)	40%	0.53 (0.30-0.96)	0.96 (0.62-1.51)	1.28 (0.86-1.91)	1.66 (1.13-2.43)	*1.94 (1.33-2.85)*

3.2.5 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, 17,916 of the 708,311 procedures had an associated first revision. The most commonly cited indications were aseptic loosening (cited in 4,376 procedures), pain (3,870), dislocation/subluxation (3,027), adverse soft tissue reaction to particulate debris (3,019, a figure that is likely to be an underestimate - see right) and infection (2,443). Pain was not usually cited alone; in 2,783 out of the 3,870 instances, it was cited together with one or more other indications. Associated PTIRs for these, and the other indications are shown in Table 3.11 (from page 60). 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 study, 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 the 11th Annual Report, 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 1,246 of the 3,019 instances of adverse reactions to particulate debris would thus be included, i.e. we are thereby missing 1,773 of the earlier ones. This year, therefore, 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 3.11 (page 60) includes further breakdowns by hip fixation and bearing. Metal-on-metal bearings (irrespective of fixation) and resurfacings seem to have the highest PTIRs for both aseptic loosening and pain. Metal-on-metal has the highest incidence of adverse reaction to particulate debris.

In Table 3.12 (page 62) 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 11.75 years.). The same overall time trends are seen as before, namely aseptic loosening and pain both increased with time from surgery whereas subluxation/dislocation, infection and peri-prosthetic fracture were all higher in the first year, then fell. Adverse reaction to particulate debris increased with time, as did lysis, although the PTIRs for the latter were low.

Finally, Figure 3.11 (from page 63) shows 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 3.11. 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 the high initial rate for dislocation/subluxation, and that later fell, was seen in all groups (Figure 3.11 (c)). Infection rates were higher initially and fell in all groups apart from uncemented metal-on-metal (Figure 3.11 (d)). 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 3.11 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*	3,146.0	1.39 (1.35-1.43)	1.23 (1.19-1.27)	0.96 (0.93-1.00)	0.78 (0.75-0.81)	0.65 (0.62-0.68)	0.44 (0.42-0.46)	0.30 (0.28-0.32)	0.27 (0.26-0.29)	0.17 (0.15-0.18)	0.05 (0.04-0.06)	0.62 (0.59-0.65)	0.96 (0.93-0.99)	1,644.8	0.76 (0.72-0.80)
All cemented	1,215.8	0.98 (0.92-1.03)	0.47 (0.43-0.51)	0.86 (0.81-0.92)	0.74 (0.69-0.79)	0.36 (0.33-0.40)	0.24 (0.21-0.27)	0.19 (0.16-0.21)	0.13 (0.11-0.15)	0.08 (0.06-0.09)	0.02 (0.01-0.03)	0.18 (0.16-0.20)	0.08 (0.06-0.10)	530.7	0.07 (0.05-0.09)
Cemented by bearing surface															
MoP	1,079.3	0.98 (0.92-1.04)	0.44 (0.41-0.49)	0.90 (0.84-0.95)	0.72 (0.67-0.77)	0.37 (0.34-0.41)	0.25 (0.22-0.28)	0.18 (0.16-0.21)	0.13 (0.11-0.15)	0.07 (0.05-0.08)	0.02 (0.01-0.03)	0.16 (0.14-0.19)	0.02 (0.01-0.03)	461.8	0.03 (0.01-0.05)
MoM	7.5	3.73 (2.57-5.40)	3.86 (2.68-5.56)	1.07 (0.53-2.13)	0.93 (0.44-1.95)	1.20 (0.62-2.30)	0.27 (0.07-1.06)	1.86 (1.10-3.15)	0.27 (0.07-1.06)	0.93 (0.44-1.95)	0.13 (0.02-0.95)	3.06 (2.03-4.61)	7.86 (6.09-10.00)	2.1	8.40 (5.30-1.30)
CoP	99.3	0.73 (0.58-0.91)	0.41 (0.30-0.56)	0.60 (0.47-0.78)	0.85 (0.68-1.05)	0.19 (0.12-0.30)	0.18 (0.11-0.29)	0.13 (0.08-0.23)	0.13 (0.08-0.23)	0.07 (0.03-0.15)	0.01 (0.001-0.07)	0.16 (0.10-0.26)	0.04 (0.02-0.11)	54.5	0.06 (0.02-0.17)
Others/ unsure	29.8	0.97 (0.68-1.40)	0.54 (0.33-0.88)	0.54 (0.33-0.88)	0.94 (0.65-1.36)	0.44 (0.25-0.75)	0.23 (0.11-0.49)	0.17 (0.07-0.40)	0.10 (0.03-0.31)	0.20 (0.09-0.45)	0.00	0.20 (0.09-0.45)	0.30 (0.16-0.58)	12.3	0.16 (0.04-0.65)
All uncemented	1,128.7	1.83 (1.75-1.91)	1.58 (1.51-1.66)	1.13 (1.06-1.19)	0.87 (0.82-0.93)	0.78 (0.73-0.83)	0.62 (0.58-0.67)	0.33 (0.30-0.36)	0.45 (0.41-0.49)	0.25 (0.23-0.28)	0.08 (0.06-0.10)	0.88 (0.82-0.93)	1.62 (1.55-1.70)	713.1	1.15 (1.08-1.24)
Uncemented by bearing surface															
MoP	403.0	1.38 (1.27-1.50)	0.89 (0.80-0.99)	1.42 (1.31-1.54)	0.80 (0.72-0.90)	1.00 (0.91-1.11)	0.59 (0.52-0.67)	0.22 (0.18-0.27)	0.45 (0.39-0.52)	0.10 (0.08-0.14)	0.07 (0.05-0.10)	0.36 (0.31-0.43)	0.13 (0.10-0.17)	258.2	0.16 (0.12-0.22)
MoM	180.2	3.83 (3.55-4.13)	4.95 (4.64-5.29)	1.02 (0.88-1.17)	1.54 (1.37-1.74)	0.62 (0.52-0.75)	0.97 (0.84-1.13)	1.09 (0.95-1.25)	0.74 (0.63-0.88)	0.18 (0.13-0.25)	0.09 (0.06-0.15)	2.91 (2.67-3.17)	9.26 (8.83-9.72)	82.1	8.60 (8.00-9.20)
CoP	163.2	1.32 (1.16-1.51)	0.74 (0.61-0.88)	1.15 (1.00-1.33)	0.61 (0.50-0.74)	0.57 (0.46-0.70)	0.50 (0.40-0.62)	0.15 (0.10-0.23)	0.34 (0.26-0.45)	0.11 (0.07-0.18)	0.07 (0.04-0.13)	0.43 (0.34-0.54)	0.09 (0.06-0.15)	92.0	0.12 (0.07-0.22)
CoC	346.4	1.52 (1.39-1.65)	1.03 (0.93-1.15)	0.83 (0.74-0.93)	0.73 (0.64-0.82)	0.70 (0.62-0.80)	0.52 (0.45-0.60)	0.13 (0.10-0.18)	0.33 (0.28-0.40)	0.52 (0.45-0.60)	0.08 (0.05-0.11)	0.64 (0.56-0.73)	0.17 (0.13-0.22)	258.8	0.18 (0.13-0.24)
CoM	10.1	2.58 (1.76-3.79)	2.28 (1.52-3.43)	0.89 (0.46-1.72)	1.39 (0.82-2.34)	0.50 (0.21-1.19)	1.09 (0.60-1.97)	0.50 (0.21-1.19)	0.89 (0.46-1.72)	0.20 (0.05-0.79)	0.30 (0.10-0.92)	1.19 (0.68-2.10)	1.09 (0.60-1.97)	9.7	1.10 (0.63-2.10)
Others/ unsure	25.7	2.02 (1.54-2.65)	1.28 (0.91-1.80)	1.24 (0.88-1.76)	0.62 (0.38-1.02)	0.89 (0.59-1.35)	0.66 (0.41-1.06)	0.39 (0.21-0.72)	0.39 (0.21-0.72)	0.43 (0.24-0.77)	0.12 (0.04-0.36)	0.54 (0.32-0.92)	0.97 (0.66-1.44)	12.3	0.65 (0.33-1.30)

Table 3.11 (continued)

Fixation/ bearing types	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 hybrid	490.0	0.73 (0.66-0.81)	0.63 (0.56-0.70)	1.10 (1.01-1.19)	0.74 (0.66-0.81)	0.73 (0.66-0.81)	0.31 (0.26-0.36)	0.22 (0.18-0.26)	0.22 (0.18-0.26)	0.13 (0.10-0.17)	0.02 (0.01-0.04)	0.32 (0.27-0.37)	0.28 (0.24-0.33)	272.2	0.20 (0.15-0.26)
Hybrid by bearing surface															
MoP	315.9	0.68 (0.60-0.78)	0.47 (0.40-0.55)	1.24 (1.12-1.37)	0.73 (0.64-0.83)	0.82 (0.73-0.93)	0.30 (0.25-0.37)	0.19 (0.15-0.24)	0.24 (0.19-0.30)	0.09 (0.06-0.13)	0.02 (0.01-0.05)	0.24 (0.19-0.30)	0.06 (0.04-0.09)	175.8	0.07 (0.04-0.12)
MoM	14.5	3.30 (2.49-4.38)	4.40 (3.44-5.62)	1.58 (1.05-2.38)	1.24 (0.78-1.96)	1.58 (1.05-2.38)	0.76 (0.42-1.37)	1.79 (1.22-2.63)	0.34 (0.14-0.83)	0.28 (0.10-0.73)	0.14 (0.03-0.55)	2.68 (1.96-3.67)	7.08 (5.84-8.59)	5.2	6.50 (4.70-9.20)
CoP	57.0	0.51 (0.35-0.73)	0.47 (0.32-0.69)	1.10 (0.86-1.41)	0.74 (0.54-1.00)	0.53 (0.37-0.75)	0.23 (0.13-0.39)	0.12 (0.06-0.26)	0.14 (0.07-0.28)	0.07 (0.03-0.19)	0.04 (0.01-0.14)	0.28 (0.17-0.46)	0.07 (0.03-0.19)	37.9	0.05 (0.01-0.21)
CoC	90.8	0.61 (0.46-0.79)	0.61 (0.46-0.79)	0.54 (0.41-0.71)	0.63 (0.48-0.81)	0.45 (0.33-0.61)	0.34 (0.24-0.49)	0.10 (0.05-0.19)	0.15 (0.09-0.26)	0.29 (0.19-0.42)	0.01 (0.002-0.08)	0.24 (0.16-0.37)	0.10 (0.05-0.19)	48.7	0.12 (0.06-0.27)
Others/ unsure	11.7	0.86 (0.46-1.59)	1.12 (0.65-1.92)	0.94 (0.52-1.70)	1.12 (0.65-1.92)	0.43 (0.18-1.03)	0.17 (0.04-0.69)	0.34 (0.13-0.91)	0.34 (0.13-0.91)	0.09 (0.01-0.61)	0.00	0.26 (0.08-0.80)	0.17 (0.04-0.69)	4.6	0.00
All reverse hybrid	63.2	1.33 (1.07-1.65)	0.71 (0.53-0.95)	1.17 (0.93-1.47)	0.90 (0.70-1.17)	0.63 (0.46-0.86)	0.40 (0.27-0.59)	0.14 (0.07-0.27)	0.21 (0.12-0.35)	0.08 (0.03-0.19)	0.06 (0.02-0.17)	0.36 (0.24-0.55)	0.05 (0.02-0.15)	45.7	0.04 (0.01-0.18)
Reverse hybrid by bearing surface															
MoP	42.7	1.22 (0.93-1.60)	0.52 (0.34-0.78)	1.31 (1.01-1.71)	0.87 (0.63-1.20)	0.77 (0.55-1.09)	0.40 (0.25-0.64)	0.12 (0.05-0.28)	0.14 (0.06-0.31)	0.05 (0.01-0.19)	0.05 (0.01-0.19)	0.35 (0.21-0.58)	0.05 (0.01-0.19)	31.1	0.03 (0.005-0.23)
CoP	20.1	1.50 (1.05-2.14)	1.15 (0.76-1.73)	0.90 (0.57-1.42)	0.95 (0.60-1.49)	0.35 (0.17-0.73)	0.35 (0.17-0.73)	0.20 (0.07-0.53)	0.35 (0.17-0.73)	0.15 (0.05-0.46)	0.10 (0.02-0.40)	0.35 (0.17-0.73)	0.00	14.3	0.00
Others/ unsure**	*0.5*	*4.21 (1.05-16.82)*	*0.00*	*0.00*	*2.10 (0.30-14.93)*	*0.00*	*2.10 (0.30-15.00)*	*0.00*	*0.00*	*0.00*	*0.00*	*2.10 (0.30-15.00)*	*2.10 (0.30-15.0)*	*0.3*	*3.80 (0.54-27.0)*
All resurfacing (MoM)	247.9	2.75 (2.55-2.96)	4.71 (4.45-4.99)	0.38 (0.31-0.46)	0.60 (0.51-0.71)	1.34 (1.21-1.50)	0.86 (0.75-0.98)	0.94 (0.83-1.07)	0.32 (0.26-0.40)	0.31 (0.25-0.39)	0.09 (0.06-0.14)	2.28 (2.10-2.48)	3.84 (3.60-4.09)	83.1	4.00 (3.59-4.45)

*Including 39 with unknown fixation/bearing.

**Based on a small group size (n=93), 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 3.12 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:												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	3,146.0	1.39 (1.35-1.43)	1.23 (1.19-1.27)	0.96 (0.93-1.00)	0.78 (0.75-0.81)	0.65 (0.62-0.68)	0.44 (0.42-0.46)	0.30 (0.28-0.32)	0.27 (0.26-0.29)	0.17 (0.15-0.18)	0.05 (0.04-0.06)	0.62 (0.59-0.65)	0.96 (0.93-0.99)	1,644.8	0.76 (0.72-0.80)
Years															
<1 year	658.9	1.22 (1.14-1.30)	0.79 (0.72-0.86)	2.36 (2.25-2.48)	1.39 (1.30-1.48)	1.60 (1.50-1.70)	0.83 (0.76-0.90)	0.09 (0.07-0.12)	0.30 (0.26-0.34)	0.24 (0.21-0.28)	0.11 (0.09-0.14)	0.77 (0.71-0.84)	0.09 (0.07-0.11)	470.8	0.12 (0.09-0.16)
1-3 years	1,048.6	1.27 (1.20-1.34)	1.10 (1.04-1.16)	0.65 (0.61-0.70)	0.81 (0.76-0.87)	0.31 (0.27-0.34)	0.37 (0.33-0.41)	0.19 (0.16-0.22)	0.16 (0.14-0.18)	0.15 (0.12-0.17)	0.04 (0.03-0.06)	0.49 (0.45-0.53)	0.34 (0.31-0.38)	683.5	0.48 (0.43-0.54)
3-5 years	721.5	1.34 (1.26-1.42)	1.43 (1.34-1.52)	0.50 (0.45-0.56)	0.53 (0.48-0.59)	0.41 (0.36-0.46)	0.31 (0.27-0.35)	0.33 (0.29-0.37)	0.27 (0.23-0.31)	0.13 (0.11-0.16)	0.02 (0.01-0.04)	0.63 (0.58-0.69)	1.33 (1.25-1.42)	375.0	1.50 (1.38-1.63)
5-7 years	439.0	1.64 (1.52-1.76)	1.71 (1.59-1.84)	0.54 (0.48-0.62)	0.44 (0.38-0.50)	0.53 (0.47-0.61)	0.34 (0.29-0.40)	0.56 (0.50-0.64)	0.37 (0.32-0.43)	0.18 (0.14-0.22)	0.03 (0.02-0.05)	0.69 (0.61-0.77)	2.47 (2.33-2.62)	115.5	2.56 (2.29-2.87)
>7 years*	278.0	2.02 (1.86-2.20)	1.51 (1.37-1.66)	0.67 (0.58-0.78)	0.38 (0.32-0.47)	0.54 (0.46-0.64)	0.28 (0.22-0.35)	0.73 (0.64-0.84)	0.51 (0.43-0.60)	0.14 (0.10-0.19)	0.02 (0.01-0.05)	0.61 (0.52-0.71)	2.02 (1.86-2.19)	-	-

*Current maximum observed follow up is 11.75 years.

**Rates likely to be underestimated: this reason not solicited in the early phase of the registry (ie 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.

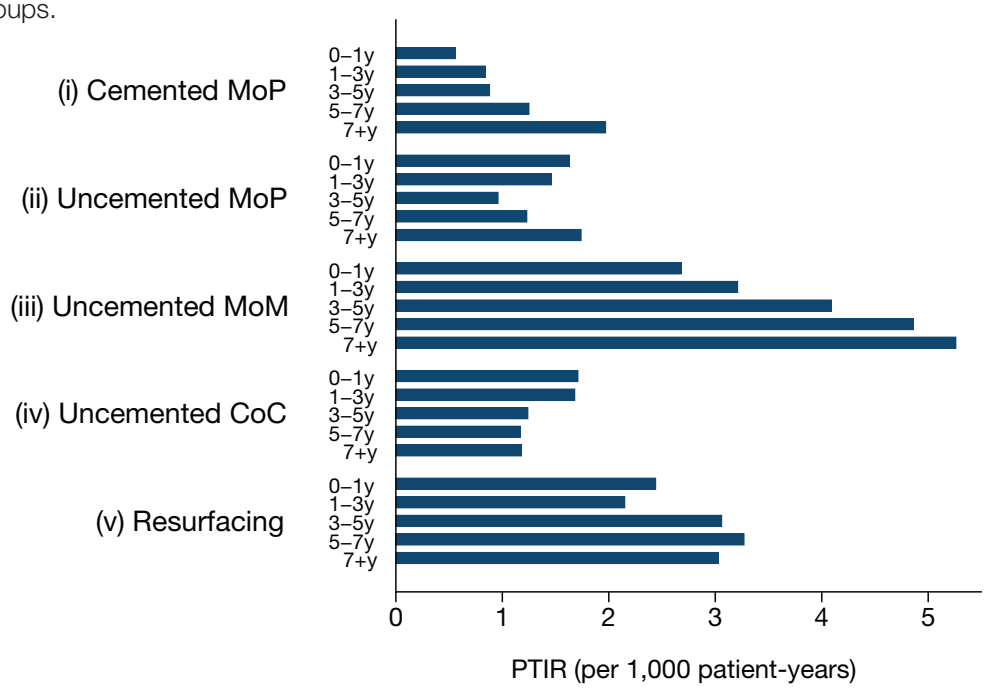


Figure 3.11 (b)

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

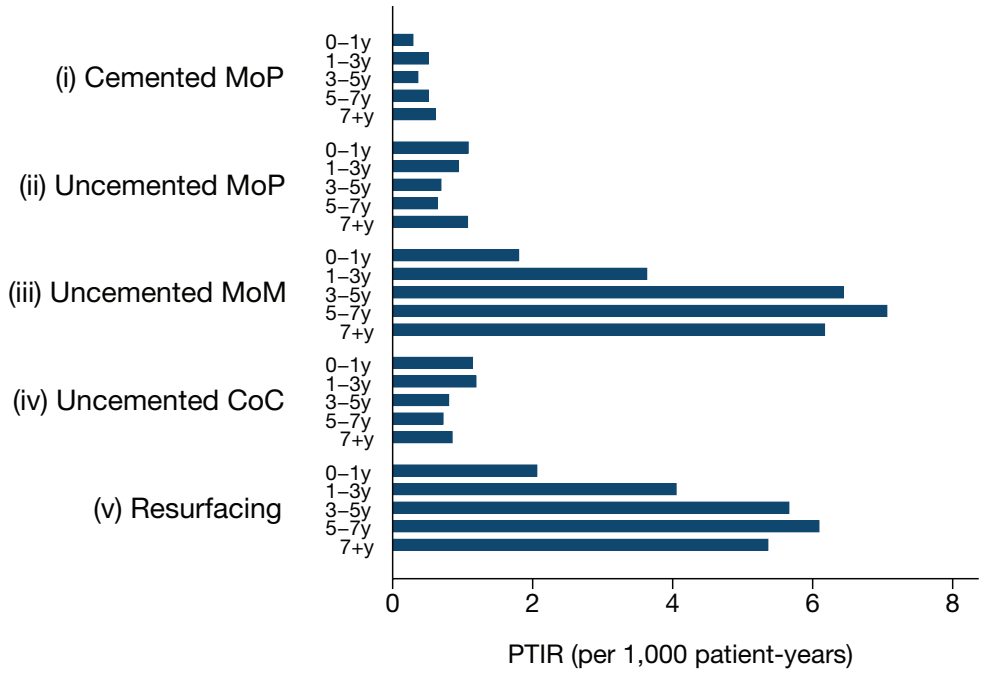


Figure 3.11 (c)

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

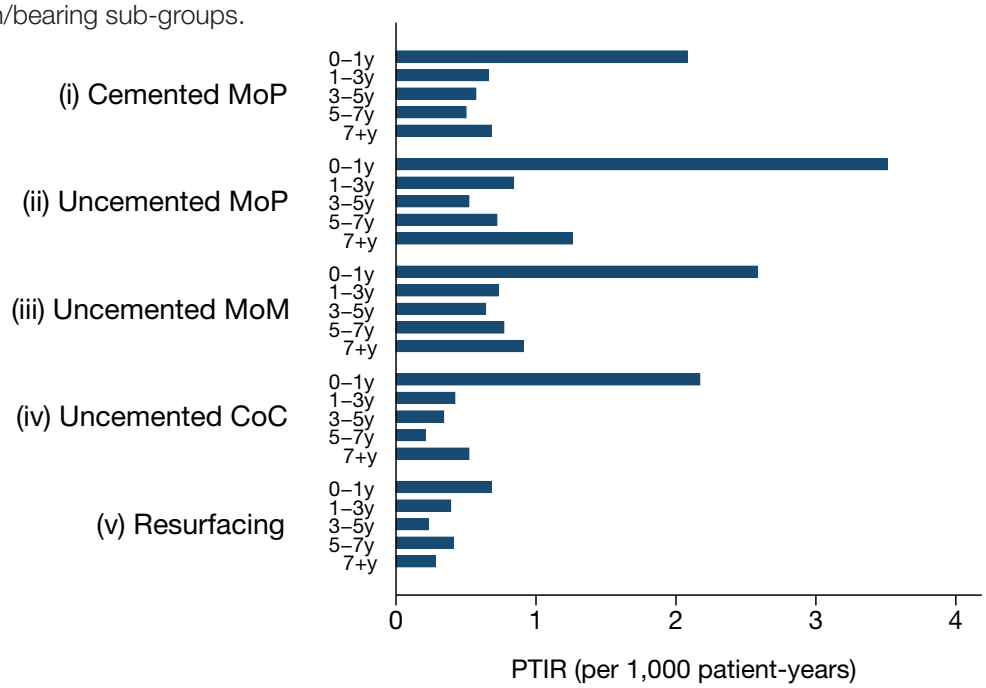


Figure 3.11 (d)

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

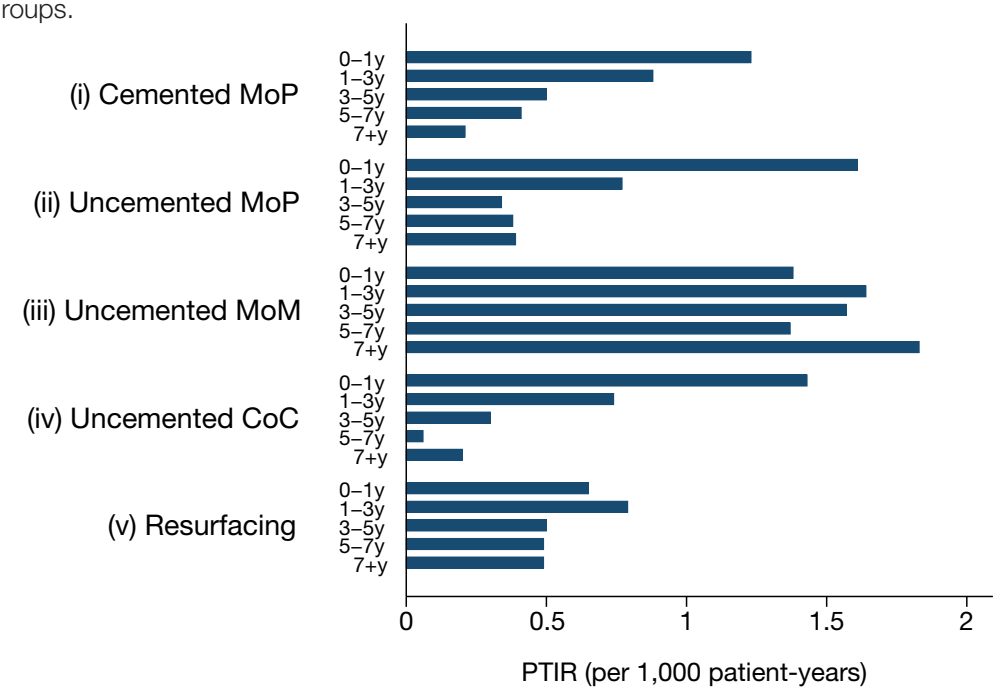


Figure 3.11 (e)

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

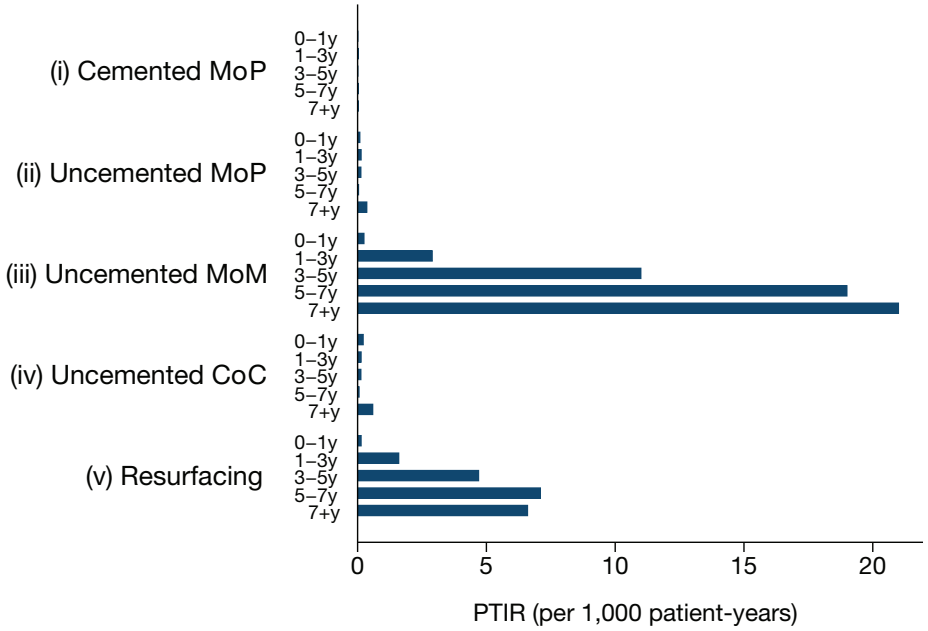
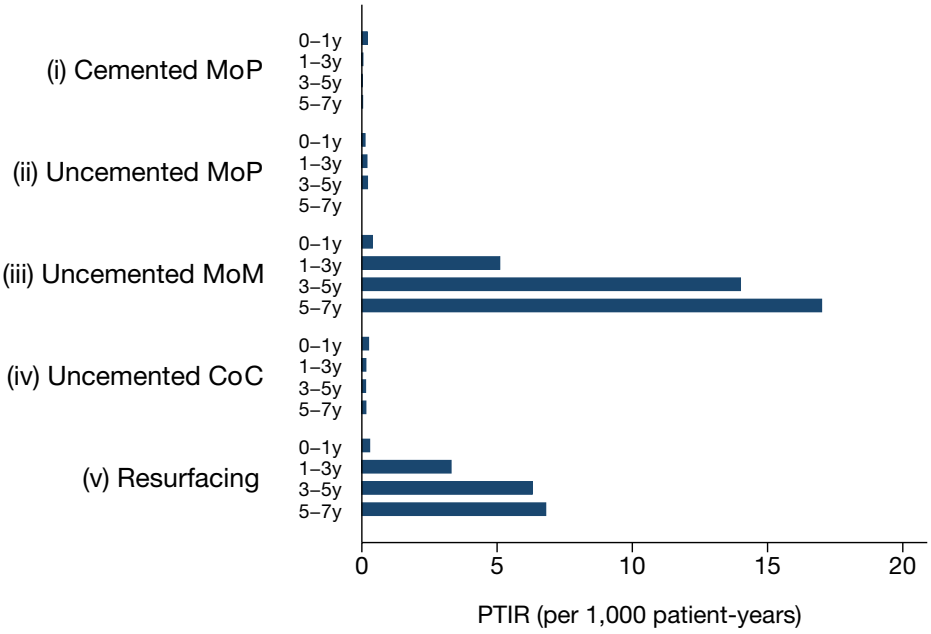


Figure 3.11 (f)

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.



It has been suggested that liner dissociation may occur more frequently in some brands of implants with polyethylene liners, as opposed to ceramic or metal liners. We have looked at revisions for this reason across each of the three groups of liners. In the breakdowns, liner dissociation has been grouped together with wear of the polyethylene component and wear of the acetabular component and called implant wear. Wear of the polyethylene component as a reason for revision was asked for in the early phase of the registry whereas the other two reasons were solicited in the later phase (MDSv2 and later). We therefore looked at primary implants with uncemented shells and liners that were implanted from 2005 onwards, as all revision from this time point used at least MDSv2. Table 3.13 (below) compares polyethylene, ceramic and metal liners in these cases. Ambiguous cases, where multiple liners were entered, have been excluded from these analyses. There seems to be no evidence to suggest that dissociation of liner was more likely to occur in polyethylene, as opposed to other types of liners. The table shows some further sub-division by cup brand where the sub-group sizes exceeded 10,000, namely CSF, CSF Plus, Pinnacle, Trident and Trilogy).

Table 3.13 Dissociation of liner and wear of the acetabular component as reasons for revision in uncemented cups with liners: comparison between polyethylene, ceramic and metal liners (analysis restricted to primary hip replacements from 2005 onwards where information was available – see text above). Further sub-division by cup brand is shown provided the resulting sub-group sizes exceeded 10,000.

Uncemented cups with metal shells with:	Cup brand	n	Revisions where 'dissociation of liner' is stated		Revision where 'wear of acetabular component' is stated		Revision for any reason	
			Number (% of revisions for any reason)	PTIR per 1,000 patient-years	Number (% of revisions for any reason)	PTIR per 1,000 patient-years	Number	PTIR per 1,000 patient-years
Polyethylene liner	All brands	233,695	86 (2.2%)	0.10 (0.08-0.13)	195 (4.9%)	0.23 (0.20-0.26)	3,963	4.68 (4.53-4.82)
	CSF	13,903	4 (1.2%)	0.05 (0.02-0.14)	28 (8.2%)	0.36 (0.25-0.52)	341	4.37 (3.93-4.86)
	Pinnacle	61,710	31 (3.7%)	0.16 (0.12-0.23)	29 (3.5%)	0.15 (0.11-0.22)	837	4.43 (4.14-4.74)
	Trident	49,067	12 (1.6%)	0.07 (0.04-0.13)	25 (3.4%)	0.15 (0.10-0.23)	734	4.51 (4.19-4.85)
	Trilogy	31,794	8 (1.4%)	0.06 (0.03-0.11)	18 (3.2%)	0.12 (0.08-0.20)	554	3.83 (3.53-4.16)
Ceramic liner	All brands	109,268	54 (2.6%)	0.13 (0.10-0.17)	69 (3.4%)	0.17 (0.13-0.21)	2,041	5.00 (4.79-5.22)
	CSF Plus	13,276	8 (3.7%)	0.20 (0.10-0.40)	9 (4.1%)	0.23 (0.12-0.43)	217	5.43 (4.75-6.20)
	Pinnacle	37,085	19 (2.7%)	0.14 (0.09-0.23)	18 (2.6%)	0.14 (0.09-0.22)	705	5.34 (4.96-5.75)
	Trident	19,883	14 (3.4%)	0.14 (0.09-0.24)	14 (3.4%)	0.14 (0.09-0.24)	407	4.18 (3.80-4.61)
Metal liner	All brands	17,580	18 (1.3%)	0.17 (0.11-0.27)	44 (3.3%)	0.42 (0.31-0.57)	1,353	12.97 (12.30-13.68)
	Pinnacle	15,358	15 (1.2%)	0.16 (0.10-0.27)	42 (3.4%)	0.46 (0.34-0.62)	1,220	13.35 (12.62-14.12)

3.2.6 Mortality after primary hip surgery

This section describes the mortality of the cohort up to eleven years from primary operation, according to gender and age group. Deaths were updated on 20 February 2015 using data from the NHS Personal Demographic Service. A total of 346 cases were excluded because the NHS number was not traceable and, therefore, no death date could be ascertained. A further six were excluded because of uncertainty in gender, leaving 707,959. Amongst these were 3,685 bilateral operations, with the left and right side operated on the same day; here the second of the two has been excluded, leaving 704,274 procedures, of whom 70,441 had died before the end of 2014.

Table 3.14 (below) 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 3.14 Kaplan-Meier estimates of the cumulative percentage mortality (95% CI), at different time points after primary operation, 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	704,274*	0.23 (0.22-0.24)	0.49 (0.47-0.50)	1.48 (1.46-1.51)	4.83 (4.78-4.89)	9.39 (9.31-9.47)	14.76 (14.64-14.88)	24.14 (23.93-24.36)	27.12 (26.82-27.41)
Males									
<55 years	42,503	0.08 (0.06-0.11)	0.16 (0.12-0.20)	0.49 (0.43-0.57)	1.31 (1.20-1.44)	2.09 (1.94-2.26)	3.20 (2.97-3.44)	4.95 (4.56-5.38)	5.48 (4.95-6.05)
55-59 years	29,109	0.06 (0.04-0.09)	0.20 (0.16-0.26)	0.62 (0.53-0.72)	1.82 (1.66-2.00)	3.28 (3.04-3.53)	4.91 (4.58-5.25)	7.99 (7.39-8.63)	9.81 (8.87-10.85)
60-64 years	42,351	0.13 (0.10-0.17)	0.25 (0.21-0.31)	0.86 (0.77-0.95)	2.67 (2.50-2.84)	4.82 (4.58-5.07)	7.17 (6.84-7.52)	12.42 (11.75-13.12)	13.76 (12.91-14.66)
65-69 years	49,048	0.17 (0.14-0.21)	0.37 (0.32-0.43)	1.13 (1.04-1.24)	3.60 (3.42-3.79)	6.96 (6.68-7.25)	10.93 (10.54-11.34)	18.23 (17.52-18.97)	20.96 (19.96-21.99)
70-74 years	49,056	0.22 (0.18-0.27)	0.48 (0.42-0.54)	1.62 (1.51-1.74)	5.57 (5.35-5.80)	10.65 (10.32-10.99)	16.75 (16.29-17.22)	28.77 (27.88-29.68)	32.93 (31.69-34.19)
75-79 years	40,195	0.43 (0.37-0.50)	0.80 (0.72-0.89)	2.54 (2.38-2.70)	8.65 (8.35-8.97)	16.96 (16.50-17.43)	27.59 (26.93-28.26)	45.76 (44.55-46.99)	52.59 (50.86-54.33)
80-84 years	21,893	0.81 (0.70-0.94)	1.56 (1.40-1.73)	4.39 (4.11-4.67)	13.71 (13.20-14.24)	27.34 (26.57-28.12)	42.43 (41.40-43.48)	65.51 (63.84-67.17)	*70.30 (68.15-72.42)*
85+ years	9,109	1.73 (1.48-2.02)	3.11 (2.77-3.49)	7.76 (7.22-8.35)	23.41 (22.44-24.42)	43.03 (41.71-44.38)	62.01 (60.43-63.60)	*82.65 (80.39-84.80)*	*86.20 (83.10-88.92)*
Females									
<55 years	42,333	0.06 (0.04-0.08)	0.20 (0.16-0.25)	0.65 (0.58-0.73)	1.56 (1.44-1.70)	2.32 (2.16-2.50)	3.20 (2.99-3.44)	4.86 (4.46-5.28)	4.97 (4.55-5.43)
55-59 years	33,684	0.07 (0.05-0.11)	0.18 (0.14-0.24)	0.58 (0.50-0.67)	1.67 (1.52-1.82)	2.95 (2.74-3.17)	4.27 (3.99-4.57)	6.64 (6.14-7.19)	7.60 (6.89-8.37)
60-64 years	52,907	0.07 (0.05-0.10)	0.16 (0.13-0.20)	0.59 (0.52-0.66)	2.00 (1.87-2.13)	3.84 (3.65-4.05)	5.86 (5.59-6.15)	9.45 (8.93-9.99)	10.91 (10.19-11.68)
65-69 years	71,150	0.08 (0.06-0.11)	0.23 (0.19-0.27)	0.76 (0.70-0.83)	2.48 (2.36-2.62)	4.84 (4.64-5.04)	7.75 (7.47-8.04)	13.56 (13.01-14.12)	15.46 (14.73-16.23)
70-74 years	78,160	0.13 (0.11-0.16)	0.30 (0.27-0.34)	1.00 (0.93-1.08)	3.55 (3.41-3.70)	7.25 (7.03-7.48)	11.87 (11.54-12.20)	21.57 (20.92-22.24)	24.82 (23.92-25.75)
75-79 years	71,103	0.25 (0.22-0.29)	0.48 (0.43-0.54)	1.55 (1.46-1.64)	5.59 (5.41-5.79)	11.58 (11.29-11.88)	18.85 (18.44-19.28)	33.56 (32.75-34.39)	38.47 (37.34-39.63)
80-84 years	47,471	0.40 (0.34-0.46)	0.88 (0.80-0.97)	2.66 (2.51-2.81)	9.01 (8.72-9.30)	18.61 (18.17-19.06)	31.02 (30.40-31.65)	51.74 (50.66-52.84)	58.13 (56.65-59.63)
85+ years	24,202	0.81 (0.71-0.93)	1.84 (1.68-2.02)	4.99 (4.72-5.28)	16.02 (15.51-16.55)	31.34 (30.60-32.09)	48.87 (47.89-49.85)	71.32 (69.80-72.83)	*77.34 (75.29-79.33)*

* Excludes 346 cases where the NHS number was not traceable plus a further six cases with uncertain gender; amongst the remainder, the second of 3,685 pairs of simultaneous bilateral operations were also excluded.

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

A total of 15,786 (2.2%) of the primary total hip replacements were performed for fractured neck of femur (#NOF)[4].

Table 3.15 (below) shows that the proportion has slowly increased with time up to 3.9% in more recent years (2013/14).

Table 3.15 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	14,422	142 (1.0%)
2004	28,013	292 (1.0%
2005	40,179	388 (1.0%)
2006	47,535	524(1.1%)
2007	60,512	771 (1.3%)
2008	66,846	859 (1.3%)
2009	67,801	1,070 (1.6%)
2010	70,212	1,351 (1.9%)
2011	73,219	1,691 (2.3%)
2012	77,321	2,419 (3.1%)
2013	79,088	3,048 (3.9%)
2014	83,125	3,231 (3.9%)
All years	708,273*	15,786 (2.2%)

* Excludes 38 with no data

Table 3.16 (right) 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 (72.8% 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 (right) 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 appears 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: fourteen sub-groups of age <55, 55-59, 60-64, 65-69, 70-74, 75-79, 80+ for each gender).

Finally Figure 3.13 (over the page) shows a marked worse overall survival in the #NOF cases (logrank test<0.001). As in the overall mortality section, 346 cases with NHS untraced have been excluded, together with the unlinked 3,685 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.

[4] These comprised 2,216 with reasons for primary including fractured neck of femur in the early phase of the registry (i.e. 199,323 implants entered using MDSv1 and v2) and 13,570 reasons including acute trauma neck of femur in the later phase (i.e. 508,950 entered using MDSv3 and v6). 38 cases were omitted as no reasons were given.

Table 3.16 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=15,786)	Other reasons (n=692,487)	Comparison
% Females*	72.8%	59.4%	P<0.001 (Chi-squared test)
Median age (IQR)**			
Both genders	72 (65-79)	69 (61-76)	P<0.001 (Mann-Whitney U-test)
Males only	71 (64-79)	67 (59-74)	P<0.001 (Mann-Whitney U-test)
Females only	72 (66-79)	70 (62-77)	P<0.001 (Mann-Whitney U-test)
% Hip type***			
Cemented	43.8%	36.0%	
Uncemented	26.4%	39.3%	
Hybrid	26.7%	16.9%	Overall P<0.001 (Chi-squared test)
Reverse hybrid	2.9%	2.4%	
Resurfacing	0.2%	5.4%	

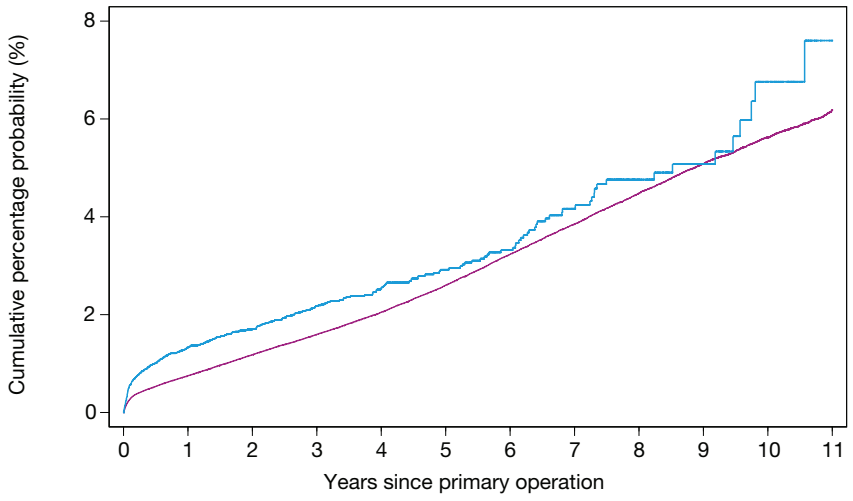
*Excludes six with uncertain gender.

**Excludes 346 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.

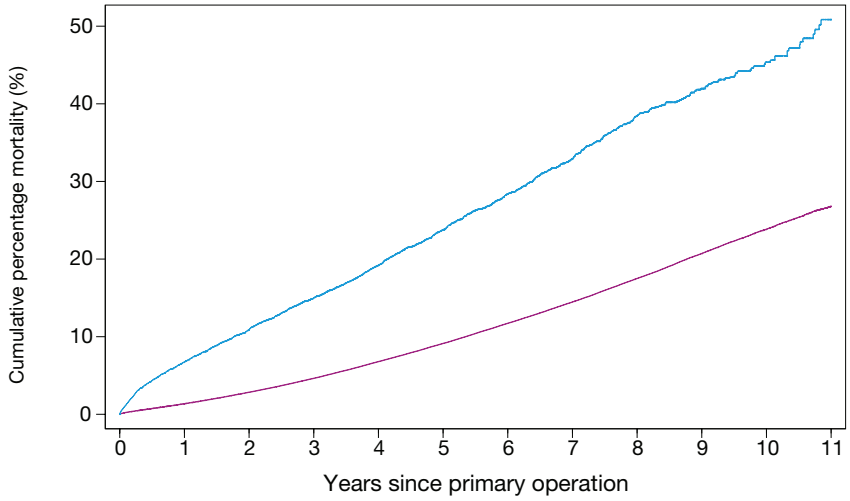


Number at risk

Other	692,487	599,632	514,949	432,705	355,314	283,186	216,189	154,196	101,089	61,405	30,287	9,772
Fract. neck of femur	15,786	11,521	8,247	5,779	4,172	2,917	1,976	1,301	735	415	200	57

Figure 3.13

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



Number at risk

Other	688,506	600,510	517,798	436,886	360,427	288,972	221,966	158,903	104,444	63,560	31,323	10,101
Fract. neck of femur	15,736	11,643	8,363	5,892	4,262	2,999	2,037	1,353	769	434	213	63

3.2.8 Conclusions

As in the previous two annual reports (2013, 2014) 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 gives little indication of satisfaction, relief of pain, improvement in function and greater participation in society. Interestingly the breakdowns by age and gender show that cemented fixation gives 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. The additional data this year 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 analyses whether the outcomes of these two bearing combinations diverge after ten years. It is encouraging that since we reported the low failure rates with ceramic-on-polyethylene bearings the popularity of these has increased steadily.

Metal-on-metal stemmed and resurfacing implants continue to fail at higher than expected rates and the use of these implants 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 26 and 32mm, with heads outside this range associated with higher failure rates and the highest failure rates associated with very large heads.

For the first time, we have analysed total hip replacement for fractured neck of femur. This is becoming an increasingly popular treatment option. It is associated with similar revision rates, but unsurprisingly, with higher mortality than total hip replacement for other causes.

Part 3

3.3 Revisions of a total hip replacement

3.3.1 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 2014, for all patients with valid patient identifiers (whose data therefore could be linked).

In total there were 79,859 revisions on 70,696 individual patient-sides[5] (67,028 actual patients). In addition to revisions on the 17,916 revised primaries described in Part 3.2 of this report, there were revisions associated with 52,780 unrecorded primaries.

Revisions are classified as single-stage and stage one and stage two of two-stage revisions. Information about 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 3.17 (below) gives an overview of all revision procedures carried out each year since April 2003[6]. There were up to a maximum of eight 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 3.17 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*	1,395 (98.0%)	0 (0.0%)	28 (2.0%)	1,423 (100%)
2004	2,415 (89.5%)	117 (4.3%)	166 (6.2%)	2,698 (100%)
2005	3,387 (87.1%)	204 (5.2%)	300 (7.7%)	3,891 (100%)
2006	4,119 (86.6%)	263 (5.5%)	372 (7.8%)	4,754 (100%)
2007	5,502 (87.3%)	345 (5.5%)	458 (7.3%)	6,305 (100%)
2008	6,008 (86.0%)	425 (6.1%)	551 (7.9%)	6,984 (100%)
2009	6,302 (84.3%)	523 (7.0%)	653 (8.7%)	7,478 (100%)
2010	7,077 (86.7%)	500 (6.1%)	590 (7.2%)	8,167 (100%)
2011	7,995 (87.6%)	529 (5.8%)	605 (6.6%)	9,129 (100%)
2012	9,215 (88.1%)	602 (5.8%)	649 (6.2%)	10,466 (100%)
2013	8,469 (87.9%)	558 (5.8%)	612 (6.4%)	9,639 (100%)
2014	7,771 (87.1%)	598 (6.7%)	556 (6.2%)	8,925 (100%)
All years	69,655 (87.2%)	4,664 (5.8%)	5,540 (6.9%)	79,859 (100%)

*Incomplete year.

Table 3.18 (right) shows the stated reasons for the revision surgery. Note that, as several reasons can be stated, the reasons are not mutually exclusive; the column percentages do not add up to 100%.

[5] See footnote 6 below.
[6] For 190 patient-sides, multiple procedures had been entered on the same operation date; 189 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, 183 of the 381 revision procedures have been dropped and 21 have been reclassified.

Table 3.18 Numbers of all hip revision procedures, by type of procedure, carried out each year.

Reason	Type of revision procedure		
	Single stage (n=69,655)	Stage one of two-stage (n=4,664)	Stage two of two-stage (n=5,540)
Aseptic loosening	52.0%	14.3%	13.6%
Pain	23.6%	16.1%	10.7%
Lysis	15.8%	10.1%	6.5%
Dislocation/subluxation	15.0%	4.1%	3.5%
Infection	3.1%	79.7%	71.2%
Periprosthetic fracture	9.2%	3.5%	3.8%
Implant fracture	3.5%	1.2%	1.4%
Implant wear	14.0%	4.1%	2.9%
Malalignment	5.7%	1.6%	1.0%
Head-socket size mismatch	0.8%	0.4%	0.2%
Other indication	8.0%	3.8%	8.7%
Adverse reaction to particulate debris*	10.4% n=51,815	3.0% n=3,654	2.1% n=4,146

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

3.3.2 Rates of hip re-revision

For a given patient-side, we have looked at survival following the first documented revision procedure in the NJR (n=70,696). In most instances (91.0%), the first revision procedure was a single-stage revision, however in the remaining 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 seven).

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) over the page and tabulated in Table 3.19 (a) on page 78. There were 5,702 re-revisions and in 10,354, the patient died without having been revised; the censoring date for the remainder was the end of 2014. We also looked at the survival from the end, rather than the start, of the first revision episode. This would make a difference only for those whose first revision was part of a two-stage revision, by shortening the follow-up time. The effect on the overall rates was negligible (see Figure 3.14 (b)).

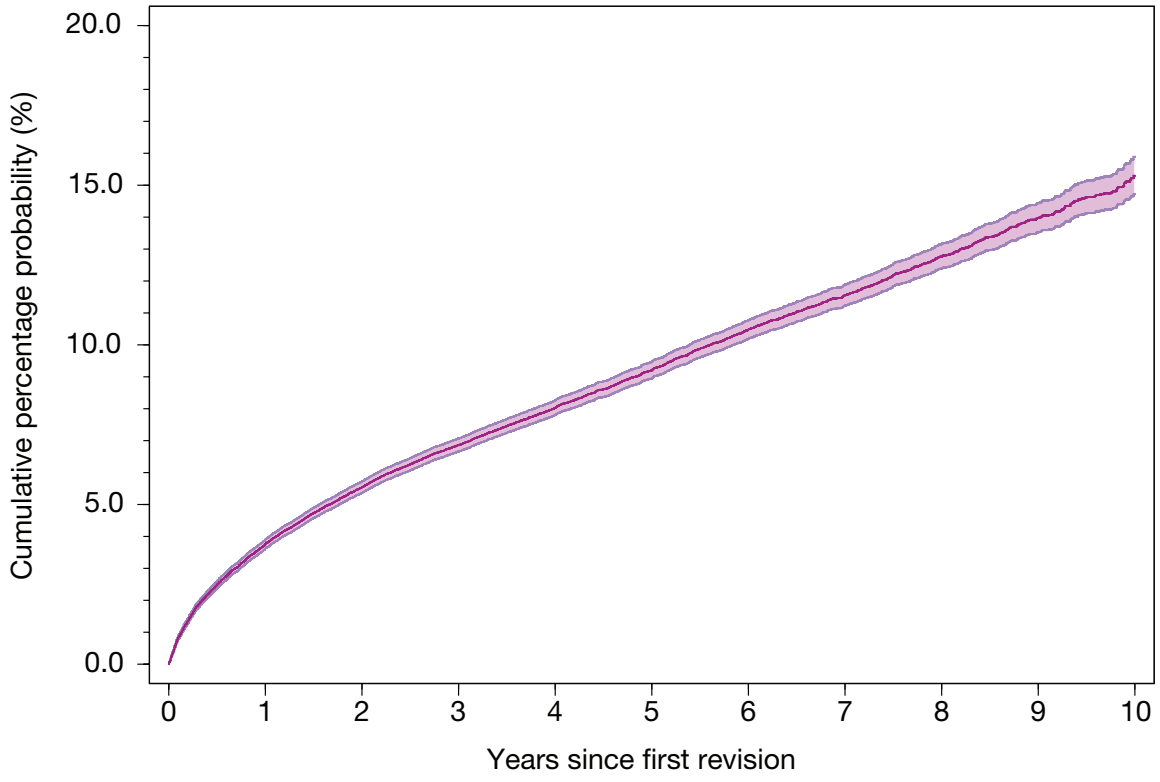
In Figure 3.14 (c) on page 76 we sub-divided the first revisions into those for whom a primary had been recorded in the NJR (n=17,916) and the remainder. The survival of the former appeared much worse. This is interesting as primaries not in the NJR are likely to have been performed prior to 2003 and 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. This needs to be explored further. Figure 3.14 (d) and Table 3.19 (b) further exemplify this on pages 77 and 78; 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.

The relationship between the indication for first revision and the subsequent interval to re-revision needs further study. There is a relationship between the indication for first revision and time to first revision;

earlier in this report (section 3.2.5) 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.

Figure 3.14 (a)

Kaplan-Meier estimate of the cumulative probability of a hip re-revision (shaded area indicate point-wise 95% CI).

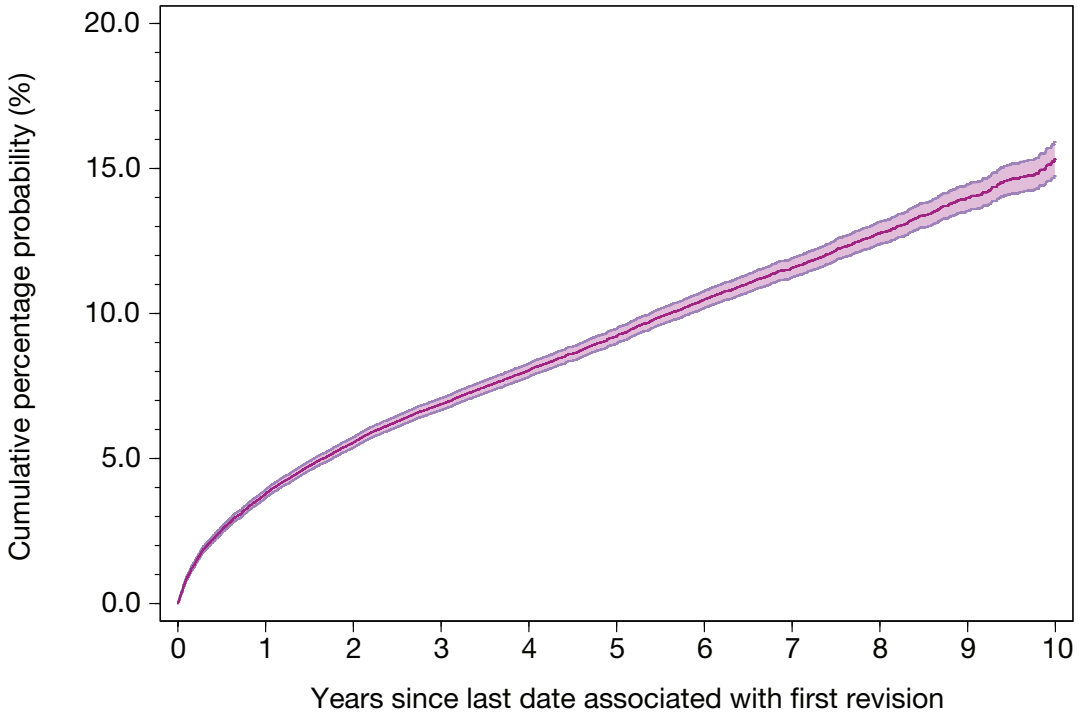


Number at risk

70,696	58,772	48,819	38,919	30,537	23,504	17,502	12,281	7,779	4,585	2,248

Figure 3.14 (b)

Kaplan-Meier estimate of the cumulative probability of a hip re-revision, taking time from last date of the first revision episode (see text; shaded area indicate point-wise 95%CI).

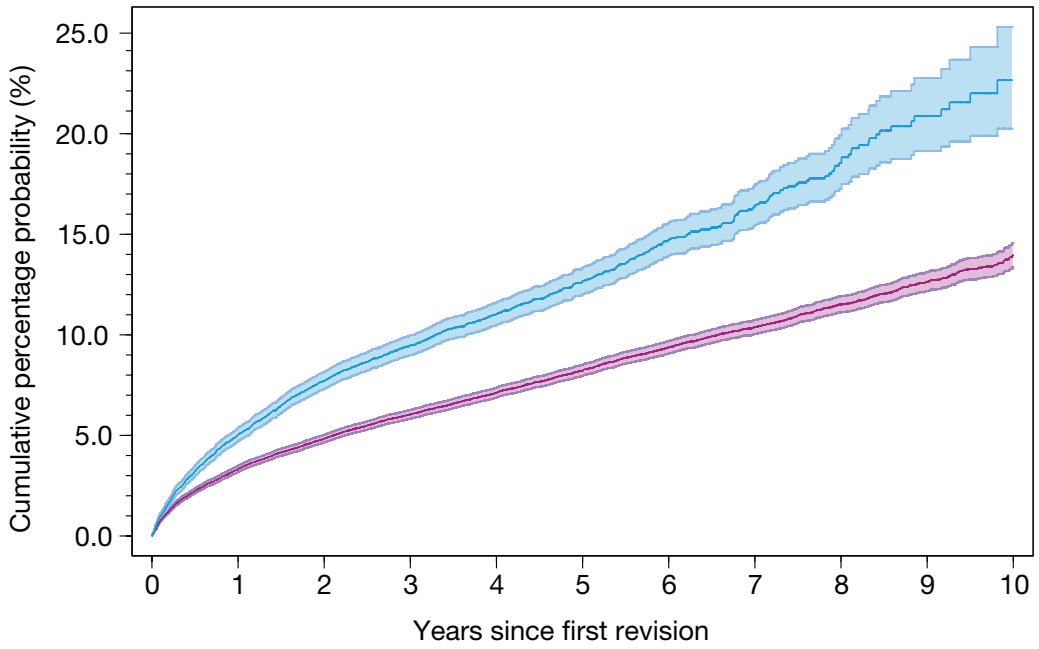


Number at risk

70,696	58,627	48,703	38,804	30,443	23,421	17,435	12,242	7,746	4,551	2,235

Figure 3.14 (c)

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 (shaded area indicate point-wise 95% CI).

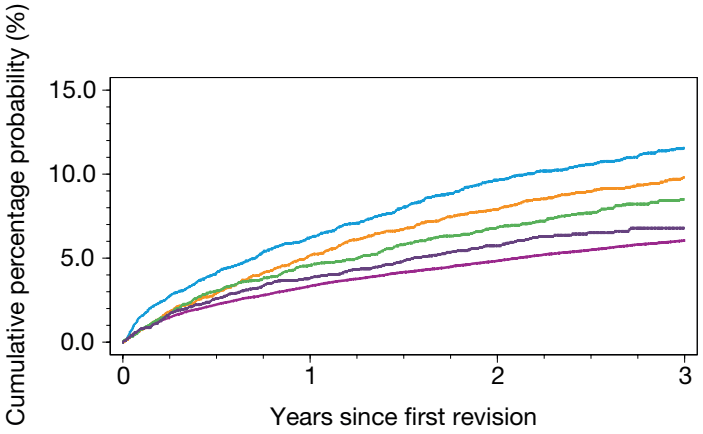


Number at risk

Primary not in NJR	52,780	44,712	38,045	31,416	25,501	20,191	15,448	11,086	7,198	4,311	2,150
Primary in NJR	17,916	14,060	10,774	7,503	5,036	3,313	2,054	1,195	581	274	98

Figure 3.14 (d)

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 subdivided into those that had their first revision within <1, 1-3, 3-5 and >5 years from the initial primary.



Number at risk

Primary not in NJR	52,780	44,712	38,045	31,416
First revision <1 year	5,189	4,154	3,407	2,709
First revision 1–3 years	4,482	3,780	3,187	2,517
First revision 3–5 years	3,651	3,076	2,397	1,527
First revision 5+ years	4,594	3,050	1,783	750

Table 3.19 (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	70,696	3.76 (3.62-3.91)	6.86 (6.66-7.07)	9.20 (8.95-9.46)	11.56 (11.23-11.89)	15.30 (14.72-15.89)
End of first revision 'episode' (see text)	All	70,696	3.79 (3.65-3.94)	6.87 (6.67-7.08)	9.21 (8.96-9.47)	11.58 (11.25-11.91)	15.31 (14.74-15.91)
First revision:	Primary not recorded in the NJR	52,780	3.34 (3.18-3.50)	6.04 (5.83-6.27)	8.22 (7.95-8.50)	10.39 (10.04-10.74)	13.95 (13.36-14.56)
	Primary recorded in the NJR	17,916	5.04 (4.72-5.39)	9.47 (9.00-9.98)	12.66 (12.01-13.34)	16.44 (15.46-17.48	22.67 (20.25-25.32)

Table 3.19 (b) Kaplan-Meier estimates of cumulative percentage probability of a hip re-revision following the first revision.

	n	Cumulative re-revision rate (95% CI) at:	
		1 year	3 years
Primary not in the NJR	52,780	3.34 (3.18-3.50)	6.04 (5.83-6.27)
Primary in the NJR where the first revision took place:			
<1 year after primary	5,189	6.24 (5.59-6.95)	11.55 (10.62-12.54)
1-3 years from primary	4,482	5.17 (4.54-5.88)	9.81 (8.90-10.79)
3-5 years from primary	3,651	4.59 (3.94-5.34)	8.50 (7.55-9.57)
5+ years from primary*	4,594	3.83 (3.28-4.47)	6.79 (5.91-7.79)

*Note: maximum interval was 11.3 years.

3.3.3 Reasons for the hip re-revision

Table 3.20 (right) shows 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 3.20 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	**70,696**	**64,994**	**5,702**	**5,702**
Number revised for:				
Aseptic loosening	35,324	32,653	2,671	1,873
Pain	16,358	15,157	1,201	1,033
Lysis	11,228	10,440	788	421
Implant wear	9,645	8,968	677	369
Dislocation/subluxation	9,154	8,325	829	1,371
Infection	6,370	5,655	715	1,139
Peri-prosthetic fracture	6,082	5,571	511	544
Malalignment	3,767	3,482	285	303
Implant fracture	2,341	2,160	181	191
Head-socket (size) mismatch	542	462	50	44
Adverse reaction to particulate debris	5,201 n=51,741	4,889 n=48,184	312 n=3,557	337 n=4,938
Other indication	5,548	5,070	478	407

Finally Tables 3.21 (a) to 3.21 (e) starting over the page, provide additional evidence that the 52,780 revised joints with no associated primary in the NJR tended to be later revisions than the 17,916 joints who did have an associated primary.

Tables 3.21 (a) and (b) show that the numbers of revisions with an associated primary in the NJR increased with time. In Tables 3.21 (c) and (d) there were trends of increasing prevalence of revisions for aseptic loosening and pain with time in the group with primaries in the NJR, consistent with increasing follow-up periods. Conversely there was a decreasing prevalence of revision for dislocation/subluxation.

3.3.4 90-day mortality after hip revision

The overall cumulative percentage mortality at 90 days was lower in the cases with their primaries documented in the NJR compared with the remainder (Kaplan-Meier estimates 0.89 (95% CI 0.76-1.04) versus 1.57 (1.46-1.68)), in part reflecting the fact that this group were younger at the time of their first revision (median 67 (IQR 59-74) years versus 73 (IQR 65-80) years). The percentage of males was similar in both groups (43.3% versus 42.0% respectively).

Table 3.21 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	1,397	43 (3.1%)
2004	2,613	142 (5.4%)
2005	3,686	299 (8.1%)
2006	4,414	447 (10.1%)
2007	5,825	798 (13.7%)
2008	6,312	1,125 (17.8%)
2009	6,584	1,481 (22.5%)
2010	7,131	1,914 (26.8%)
2011	7,989	2,608 (32.6%)
2012	9,037	3,294 (36.5%)
2013	8,186	2,970 (36.3%)
2014	7,522	2,795 (37.2%)
Total	70,696	17,916 (25.3%)

*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	1,331	38	23	5
2004	2,258	113	213	29
2005	3,056	242	331	57
2006	3,590	360	377	87
2007	4,574	664	453	134
2008	4,704	923	483	202
2009	4,615	1,216	488	265
2010	4,800	1,684	417	230
2011	4,985	2,340	396	268
2012	5,358	2,963	385	331
2013	4,903	2,667	313	303
2014	4,407	2,521	320	274
All years	48,581	15,731	4,199	2,185

*First documented revision in the NJR.

(c) Proportions of first hip revisions where **aseptic loosening** was indicated.

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	65.4%	10.5%	52.2%	0 of 5
2004	70.7%	13.3%	41.8%	20.7%
2005	71.6%	21.5%	26.0%	22.8%
2006	69.4%	33.1%	19.6%	14.9%
2007	66.5%	32.5%	20.5%	9.7%
2008	67.2%	31.4%	27.3%	10.4%
2009	64.1%	29.0%	18.2%	14.0%
2010	60.1%	28.6%	18.0%	10.0%
2011	57.0%	25.6%	12.6%	7.8%
2012	56.4%	24.2%	13.3%	8.5%
2013	53.6%	24.8%	11.5%	8.9%
2014	55.2%	25.7%	12.5%	7.7%
All years	62.0%	26.4%	19.7%	10.2%

*First documented revision in the NJR.

(d) Proportions of first hip revisions where **pain** was indicated.

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	13.7%	0.0%	13.0%	0 of 5
2004	17.0%	3.5%	12.2%	13.8%
2005	18.8%	8.7%	13.6%	15.8%
2006	21.7%	14.4%	17.0%	13.8%
2007	22.3%	15.7%	14.4%	11.2%
2008	28.9%	22.3%	18.8%	15.4%
2009	33.1%	25.0%	18.0%	14.0%
2010	28.0%	26.6%	18.0%	15.2%
2011	25.2%	25.9%	12.1%	12.3%
2012	24.6%	26.8%	14.6%	9.7%
2013	23.6%	22.8%	11.5%	15.5%
2014	21.6%	17.2%	12.2%	11.7%
All years	24.4%	22.8%	15.2%	13.1%

*First documented revision in the NJR.

(e) Proportions of first hip revisions where **dislocation/subluxation** was indicated.

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	11.1%	47.4%	8.7%	2 of 5
2004	10.7%	47.8%	4.7%	6.9%
2005	10.6%	29.8%	3.0%	7.0%
2006	11.3%	27.2%	2.4%	1.2%
2007	12.4%	24.7%	4.0%	6.7%
2008	13.2%	27.5%	6.6%	7.4%
2009	13.9%	26.1%	5.1%	5.3%
2010	13.2%	20.3%	4.1%	2.6%
2011	12.8%	15.1%	3.5%	4.9%
2012	11.4%	14.1%	3.9%	2.1%
2013	12.2%	14.9%	3.5%	3.6%
2014	11.9%	17.9%	4.1%	1.8%
All years	**12.3%**	**18.7%**	**4.2%**	**4.1%**

*First documented revision in the NJR.

(f) Proportions of first hip revisions where **infection** was indicated.

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	9.5%	5.3%	4.4%	0 of 5
2004	3.2%	7.1%	61.0%	65.5%
2005	1.3%	4.6%	71.0%	63.2%
2006	1.3%	4.2%	74.5%	80.5%
2007	1.2%	3.6%	68.7%	72.4%
2008	1.7%	5.2%	64.8%	87.1%
2009	1.9%	5.1%	68.4%	78.1%
2010	2.1%	5.1%	69.8%	80.9%
2011	2.3%	4.0%	74.0%	77.6%
2012	2.0%	4.2%	70.9%	79.2%
2013	1.8%	4.3%	71.6%	79.9%
2014	2.1%	5.8%	71.9%	74.8%
All years	**2.1%**	**4.7%**	**69.5%**	**78.2%**

*First documented revision in the NJR.

Part 3

3.4 Outcomes after primary knee replacement

This section reviews the outcome of primary knee replacement surgery in terms of two key events that could happen post-operatively to a patient or knee joint; first revision of the 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 methodological 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 over the page. 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 on or after 1 April 2003 and up to 31 December 2014 (inclusive). The maximum follow-up time a patient could have for either outcome is 11.75 years, corresponding to a patient operated on at the start of the registry.

Tables 3.1 and 3.2 (page 26) provide an overview of the primary knee replacement patient cohort. Over the period of 2003 to 2014, a total of 772,818 knee joints were replaced for the first time (primary joint replacement). There were a total of 643,497 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 20% 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 (120,260 patients), but 9,061 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 742,653 (96%) of primary knee surgeries and one of the reasons recorded in a further 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 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 a constrained condylar (CCK) or hinged knee 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.

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 CR or PS constraint.

The NJR now distinguishes between medial and lateral unicondylar knee replacements during the data collection process, however, this was not so in earlier versions of the MDS. In addition, there are other possible knee designs, such as combinations of unicondylar and patellofemoral replacements, 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, termed 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 2014, 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 2014), the time until they die after surgery without being revised (and before the end of 2014) or the period of time they are not revised after primary surgery up until the last date of observation in 2014.

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 provide 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 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 (CI). 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.

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.

3.4.1 Overview of primary knee surgery

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

Table 3.22 (right) shows the proportion of all main kinds of primary knee operations carried out between 2003 and 2014, 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 were of the total knee joint (TKRs) with an all cemented implant being the most common technique of fixation used (84.3% of all primary knee operations). A further 5.8 % were either all uncemented or a hybrid type (where at least one component utilises cemented fixation and at least one component utilises uncemented fixation). Most partial knee replacements were unicondylar (9% of the total) with the remainder being patellofemoral unicompartmental knee replacements (1%).

More than half of all operations (55.2%) were total knee replacements which were all cemented, unconstrained and fixed, followed by 21% 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 1.3% of the total cohort).

Table 3.23 (page 90) shows the annual change in the use of primary knee replacement. 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 7%. 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. Each implant of this type now used has decreased proportionally to about a third of those figures reported for 2003.

Table 3.22 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		**651,680**		**84.3**
Cemented and				
	unconstrained, fixed	426,844	65.5	55.2
	unconstrained, mobile	30,641	4.7	4.0
	posterior-stabilised, fixed	161,508	24.8	20.9
	posterior-stabilised, mobile	10,258	1.6	1.3
	constrained condylar	3,976	0.6	0.5
	monobloc polyethylene tibia	9,785	1.5	1.3
	bearing type unknown	8,668	1.3	1.1
All uncemented		**36,135**		**4.7**
All hybrid		**8,098**		**1.1**
Uncemented/hybrid and				
	unconstrained, fixed	20,190	45.6	2.6
	unconstrained, mobile	20,177	45.6	2.6
	posterior-stabilised, fixed	2,976	6.7	0.4
	other constraint	327	0.7	0.04
	bearing type unknown	563	1.3	0.07
Unicompartmental knee replacement				
All unicondylar		**66,915**		**8.7**
Unicondylar and				
	fixed	19,926	29.8	2.6
	mobile	46,048	68.8	6.0
	bearing type unknown	941	1.4	0.1
All patellofemoral		**9,945**	**n/a**	**1.3**
Fixation unknown	**Bearing type unknown**	**45**	**n/a**	**0.01**
All types		**772,818**	**n/a**	**100.0**

Table 3.23 Percentage of 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 by fixation method[1] and percentage breakdown by constraint/bearing type within each fixation type[2]											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total knee replacement												
All cemented	**81.5**	**80.8**	**81.7**	**81.4**	**81.9**	**81.9**	**82.7**	**84.0**	**85.5**	**86.7**	**87.8**	**87.5**
Cemented and												
unconstrained, fixed	65.3	65.4	64.9	62.1	61.4	62.5	63.9	64.5	65.9	68.1	68.1	69.4
unconstrained, mobile	5.0	5.2	6.4	7.9	7.8	7.0	5.8	4.8	3.5	2.8	2.5	2.2
posterior-stabilised, fixed	25.4	25.5	24.1	24.6	24.9	25.6	25.8	25.9	25.3	24.1	24.0	23.4
posterior-stabilised, mobile	1.2	1.3	2.0	2.3	2.0	1.7	1.7	1.7	1.4	1.3	1.4	1.1
constrained condylar	0.5	0.6	0.4	0.4	0.4	0.4	0.3	0.4	0.5	0.7	1.0	1.2
monobloc polyethylene tibia	0.4	0.3	0.4	0.7	1.1	1.0	0.9	1.2	1.9	2.3	2.5	2.2
bearing type unknown	2.3	1.7	1.8	2.0	2.4	1.8	1.4	1.4	1.5	0.7	0.6	0.5
All uncemented	**6.7**	**6.6**	**6.2**	**6.5**	**6.5**	**6.2**	**5.7**	**4.7**	**4.1**	**3.3**	**2.6**	**2.5**
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**
Uncemented/hybrid and												
unconstrained, fixed	51.4	50.1	50.3	48.0	51.8	51.7	52.3	46.0	38.5	34.4	31.9	26.9
unconstrained, mobile	36.5	38.9	38.6	39.3	39.7	40.7	40.2	47.9	55.6	58.7	59.2	61.3
posterior-stabilised, fixed	9.1	7.4	6.8	8.1	6.6	5.9	6.1	5.4	4.7	5.9	8.1	10.6
other constraint	0.2	0.3	2.0	2.5	1.0	0.4	0.2	0.1	0.1	0.8	0.4	0.6
bearing type unknown	2.9	3.3	2.2	2.0	0.9	1.4	1.1	0.6	1.0	0.2	0.4	0.7
Unicompartmental knee replacement												
All unicondylar	**8.0**	**8.7**	**8.7**	**9.2**	**8.9**	**9.1**	**9.0**	**9.0**	**8.5**	**8.2**	**8.1**	**8.1**
Unicondylar and												
fixed	17.0	20.6	23.8	24.8	22.7	23.0	24.9	29.4	31.0	35.9	39.8	40.5
mobile	80.9	77.7	74.7	73.5	75.8	75.0	73.3	69.4	67.6	63.2	58.9	58.7
bearing type unknown	2.1	1.8	1.5	1.7	1.6	2.1	1.8	1.2	1.4	0.9	1.3	0.8
All patellofemoral	**1.0**	**1.0**	**1.1**	**1.1**	**1.4**	**1.5**	**1.5**	**1.4**	**1.5**	**1.4**	**1.2**	**1.1**
Knee type unknown		**0.2**	**0.01**									
All types	**13,523**	**27,724**	**41,884**	**49,513**	**66,660**	**74,033**	**75,893**	**78,529**	**82,143**	**85,833**	**85,128**	**91,955**

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.

3.4.1.2 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 preassessment process. Of all reasons for primary surgery, the dominant diagnosis recorded in the registry is knee osteoarthritis; the number of joints with a sole diagnosis of knee osteoarthritis as the indication for knee replacement is 742,653 (96%) of all 772,674 knee replacements with a reason for primary surgery recorded in the NJR. Other possible diagnoses include avascular necrosis, trauma and infection (see Table 3.24, footnotes 1 to 4).

Table 3.24 (below) 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 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 3.24 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=772,674)		All joints with this reason[1] (% of all joints)	p-value[2]
	Male	Female		
Osteoarthritis	326,478 (98.1)	424,714 (96.6)	751,192 (97.2)	<0.001
Avascular necrosis	1,078 (0.3)	1,761 (0.4)	2,839 (0.4)	<0.001
Previous infection	318 (0.1)	215 (0.05)	533 (0.7)	<0.001
Previous trauma	2,340 (0.7)	1,857 (0.4)	4,197 (0.5)	<0.001
Inflammatory arthritis[3]	4,266 (1.3)	12,961 (3.0)	17,227 (2.2)	<0.001
Trauma	16 (0.2)	24 (0.2)	40 (0.2)	0.657
Other indication[4]	2,500 (0.8)	3,316 (0.8)	5,816 (0.8)	0.881

Note: 1 More than one diagnosis could be indicated by the clinician and results represent all reasons given by the surgeon. 2 Chi-squared test of association between gender and specified primary diagnosis. 3 Inflammatory arthritis for knees combines diagnoses of Rheumatoid arthritis, Seronegative and Seropositive rheumatoid arthritis and other inflammatory arthropathy. 4 Other indication includes failed internal fixation, previous arthrodesis, and other indicated reasons for primary knee replacement.

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

Between 2003 and 2014, a total of 2,926 consultant surgeons carried out at least one type of the 772,818 primary knee joint arthroplasties registered in the NJR. The median number of primary operations performed by a consultant surgeon was 126 (IQR 21-384) over the whole period. The total number of surgical units in which at least one primary knee operation was carried out in the time period was 454. The median number of operations performed in a unit was 1,308 (IQR 576-2,491).

Table 3.25 (below) summarises the distribution of primary operations carried out by consultant surgeons and units for each method of fixation for TKR and by type of UKR. The table shows the proportion of all consultants or units performing operations of each fixation type, alongside the median number and IQR of procedures a consultant or unit has carried out based on all NJR records analysed.

Please note that these distribution summaries exclude consultant surgeons and units with less than a total of ten operations on record over the analysis period, i.e. 518 consultant surgeons and 15 units.

The table shows that consultant surgeons performing cemented TKR (and with a minimum caseload overall of ten operations) carried out a median of 170 operations of this type over the whole period they were observed with an IQR of 53 to 384 procedures. This means that 25% of surgeons had a caseload of fewer than 53 cemented total knee replacements over the time and 25% of surgeons carried out more than 384 procedures. The 10% of surgeons with the highest caseload completed between 655 and 2,998 of all cemented primary TKRs (not shown in table 3.25). The majority of consultant surgeons and units carried out very few, if any, uncemented and hybrid TKRs.

Table 3.25 Distribution of consultant surgeon[1,2] and unit primary knee replacement caseload[1,3] broken down by method of fixation used for total replacements and by partial replacement type (unicondylar or patellofemoral).

	Distribution of number of primary knee operations stratified by fixation method used within a total replacement and by type of partial replacement when carried out by					
	Consultant surgeons (n=2,408)			Surgical units (n=439)		
	Percentage (%) of consultants performing this operation type	Median	IQR	Percentage (%) of consultants performing this operation type	Median	IQR
All knee replacement		**200**	**(63-458)**		**1,308**	**(576-2,491)**
Total knee replacement						
All cemented	99.7	170	(53-384)	100.0	1,130	(497-2,174)
All uncemented	26.3	5.0	(1-41)	63.8	16.5	(2-93)
All hybrid	28.6	2.0	(1-6)	70.2	5.0	(2-16.5)
Unicompartmental knee replacement						
All unicondylar	57.5	14.0	(3-48)	97.5	86.5	(35.5-191.5)
All patellofemoral	31.7	5.0	(2-15)	84.7	14.0	(5-32.5)

Note: 1 Only surgeons or units with at least ten primary operations recorded in the NJR are presented in the tables. 2 The total count of consultant surgeons who had performed any knee replacement between 2003 and 2014 is 2,926. Of these, 518 have performed fewer than ten operations over this period. Excluding these from reported results leaves 2,408 consultants. 3 The total count of units who had performed any knee operation between 2003 and 2014 is 454. Of these, 15 have performed fewer than ten operations over this period. Excluding these from reported results leaves 439 units.

3.4.1.4 Age and gender characterisation of the primary knee patient cohort

Table 3.26 (page 94) 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 64-77 years). However, for unicompartmental primary knee surgery, patients were typically seven (unicondylar) and eleven years younger (patellofemoral). The 99th percentile of patient age for all types of surgery ranged between 85 and 88 years, indicating that surgery was rarely undertaken in a person aged 90 or older, although the maximum age of a patient who underwent primary surgery over the eleven 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 total primary 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 58.

Table 3.26 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[4]	Maximum age
Total knee replacement					
All cemented		**42**	**70 (64-77)**	**13**	**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)	14	99
	monobloc polyethylene tibia	40	74 (70-79)	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	45	69 (62-75)	25	101
	posterior-stabilised, fixed	51	66 (59-74)	20	93
	other type	55	65 (57-73)	33	89
	bearing type unknown	50	69 (61-76)	23	91
Unicompartmental knee replacement					
All unicondylar		**53**	**63 (57-70)**	**18**	**97**
Unicondylar and					
	fixed	54	62 (56-70)	18	97
	mobile	52	64 (57-71)	23	95
	bearing type unknown	51	63 (56-70)	31	91
All patellofemoral		**22**	**59 (51-68)**	**21**	**93**
Fixation unknown	**Bearing type unknown**	**47**	**69 (59-77)**	**43**	**85**
All types		**43**	**70 (63-76)**	**14**	**102**

Note: 1 The percentage male figures are based on a total number of 772,809 primary knee replacements after omitting nine cases where gender was not specified. 2 Age distributions based on age at primary operation excluding those 18 cases where age recorded was either zero or an invalid number of years (i.e. negative) and 332 records where age could not be verified via a traceable NHS Number. Figures are thus based on a total of 772,485 replaced primary knee joints. 3 The interquartile range (IQR) shows the age range of the middle 50% of patients arranged in order of their age at time of primary knee operation. 4 The lowest age excluding 333 cases where an invalid age was recorded.

3.4.2 First revision after primary knee surgery

A total of 17,649 first revisions of a knee prosthesis have been linked to NJR primary knee replacement surgery records of operations undertaken between 2003 and 2014.

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 3.4.2.1):** Formal submission of records of 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 3.15 (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 3.4.2.2):** Figures 3.16 (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 3.4.2.3):** Implant survivorship up to eleven years after the primary operation date are presented in Tables 3.27 (a) and 3.27 (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 3.17 (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 3.4.2.4):** Revision rates for different reasons, broken down by fixation method and by fixation/constraint and bearing, are shown in Tables 3.28 and 3.29. Table 3.30 considers whether revision rates for different reasons change over various periods of time after the date of primary surgery.
- **Type of brand (section 3.4.2.5):** The cumulative percentage chance of revision for different implant brands at different points in time after primary surgery is looked at in Tables 3.31 to 3.33. 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.

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

Figures 3.15 (a) and (b) depict changes in cumulative percentage revision probabilities at different times after primary surgery when operations are grouped by the year in which the primary operation took place.

The cumulative percentage probability of a joint being revised increased slightly for each operative year group between 2003 and 2007, with some indication that the later primary surgery cohorts' survivorship curves are less divergent year on year from 2007 onwards i.e. a slowing in the increasing trend is visible, peaking with the 2008 cohort. Overall, the 2007 and later year cohorts have higher risk of revision compared to the first four operative year cohorts.

For example, five years after primary surgery, the 2008 implant cohort have the highest cumulative chance of revision, of those still at risk, at almost 3%, compared to the 2003 primary cohort where the chance of the implant being revised five years after the initial surgery is circa 1.7%. One possible reason for this is that the registry was not capturing the full range and number of operations taking place in units in England and Wales until circa 2007/8, and so there could be bias in terms of the general overall health and other key characteristics of the patients on record in the NJR in the early years. Further analysis of potential differences in the primary operation year cohorts is necessary to understand this more fully.

Figure 3.15 (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. *Rates are shown up to eleven years post-surgery.*

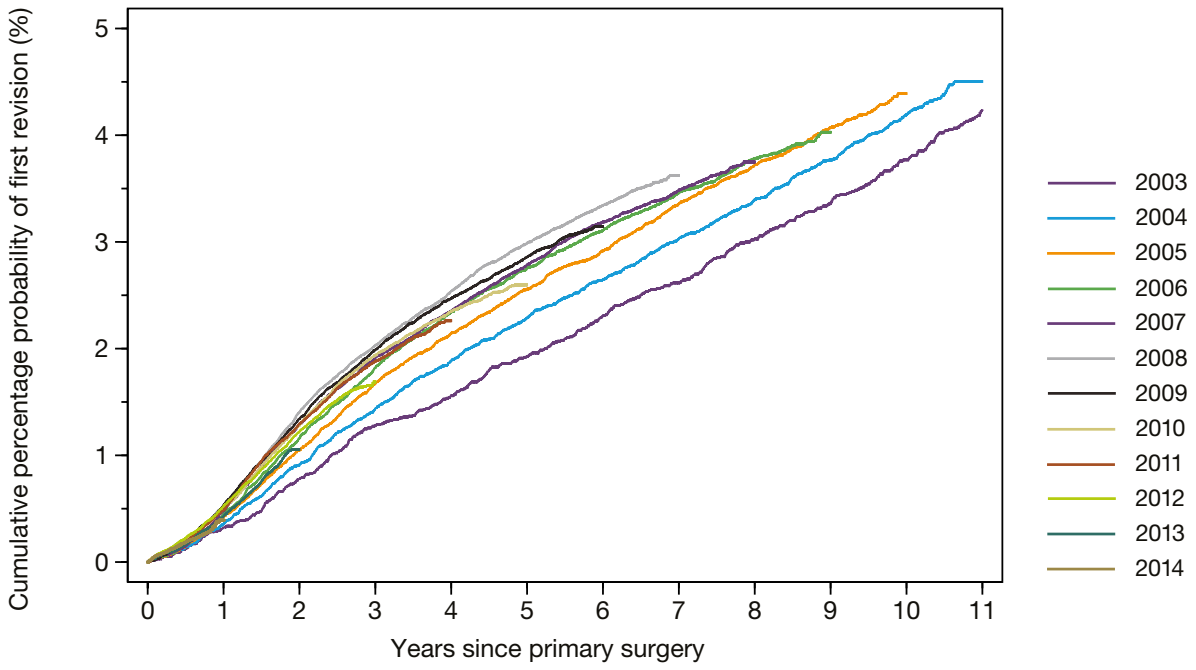
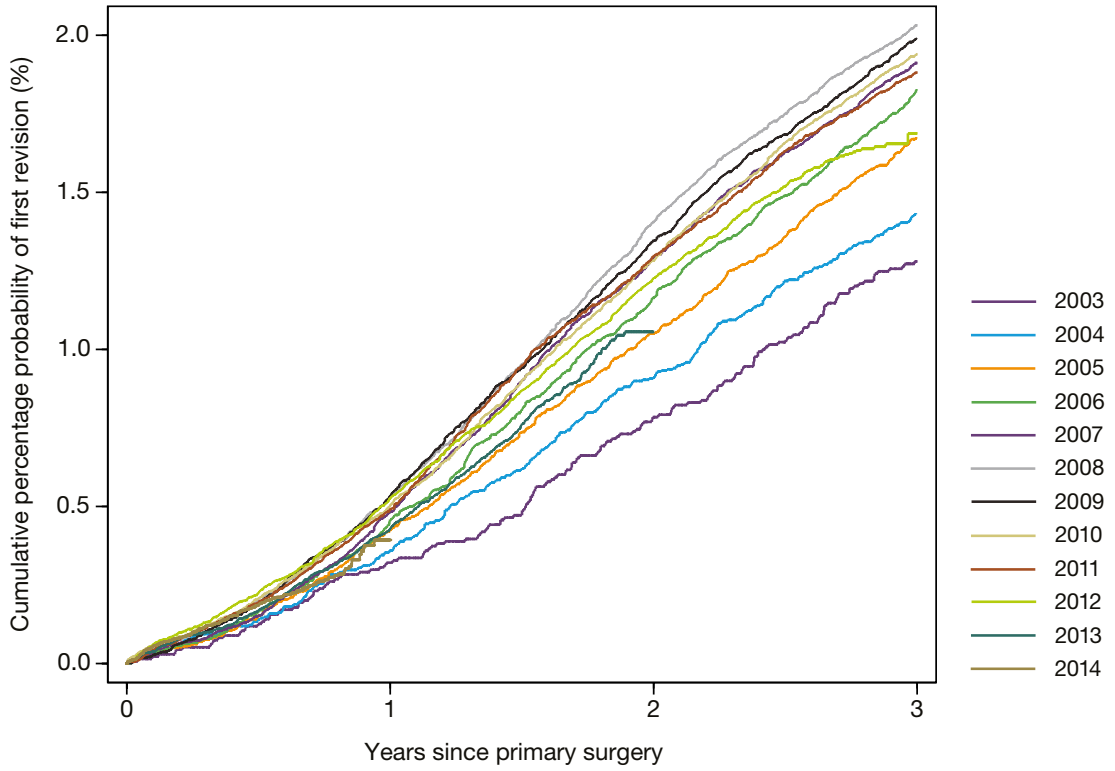


Figure 3.15 (b)

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. *Rates are shown for the first three years post-surgery.*



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

Figures 3.16 (a) below and 3.16 (b) on the right show the chance of knee joint replacement revision after primary surgery being far higher in patients belonging to the younger age groups 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 3.16 (a)

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

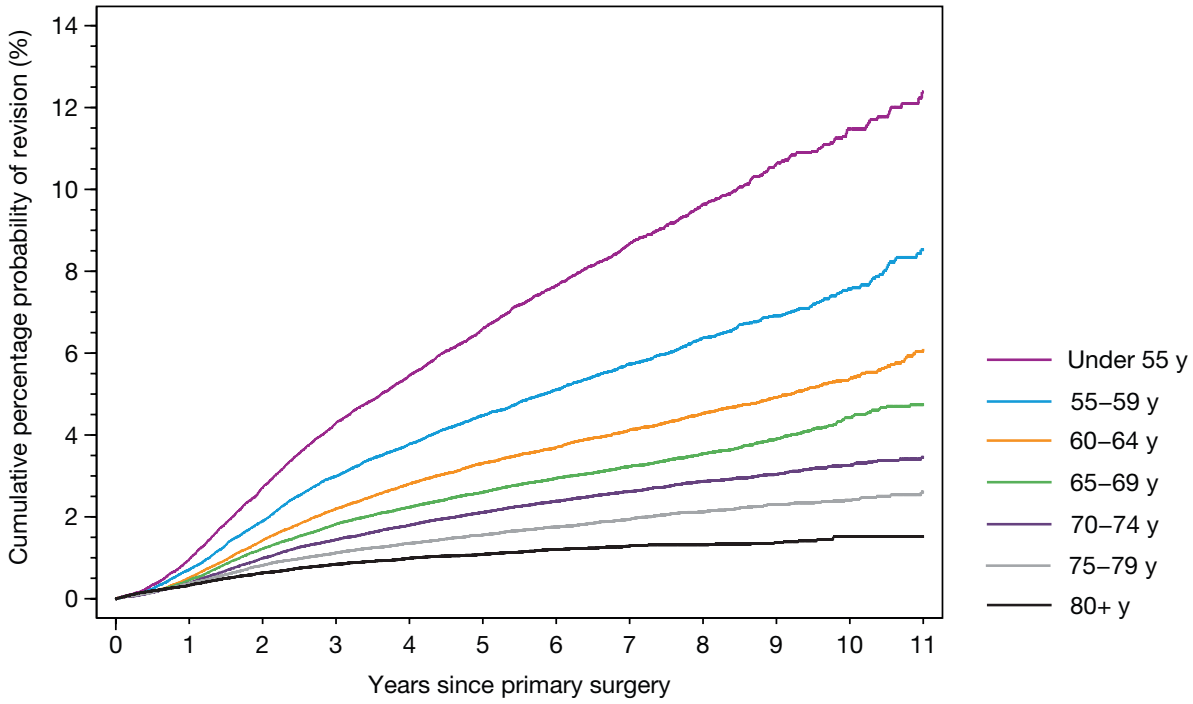
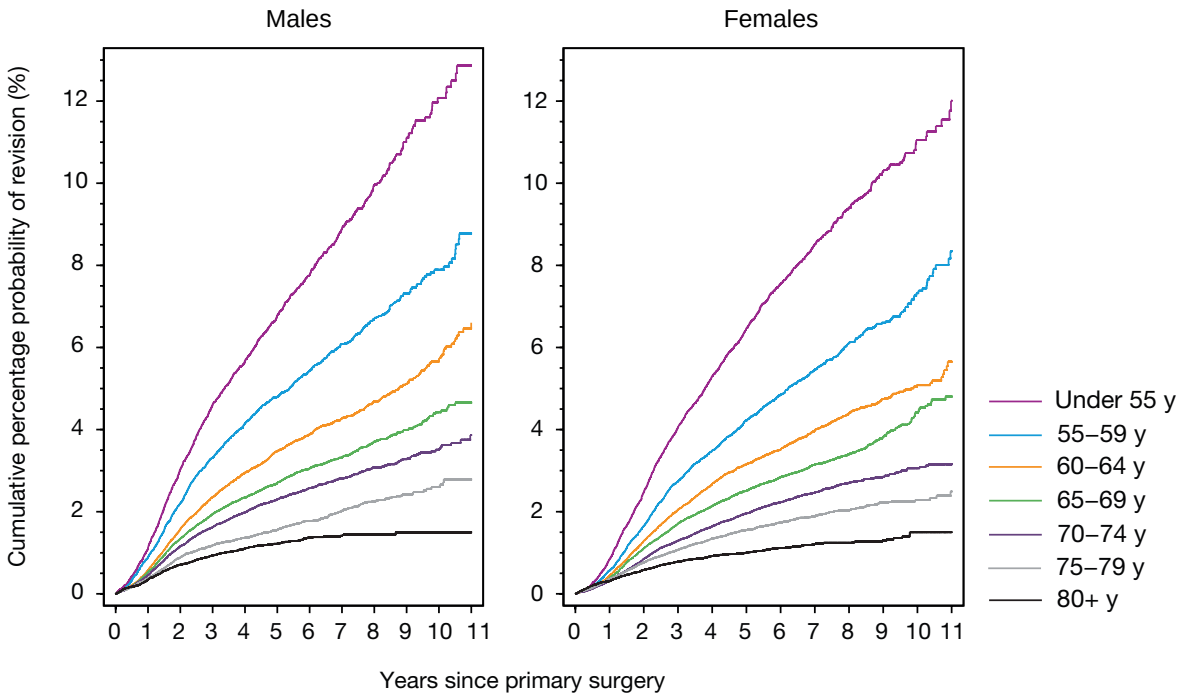


Figure 3.16 (b)

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



3.4.2.3 Revisions after primary knee surgery by fixation method, bearing and constraint type

Table 3.27 (a) on page 104 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 3.27 (b) on page 106 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 and 10 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 of 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 replacements seem to fare worse compared to total knee replacements with the chance of revision at each estimation time point being about double that of a TKR, in general. 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. 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. This may be a function of milder disease in these patients, or the desire to delay a total knee replacement for as long as possible. Younger patients may also be more active which puts more strain on their implants.

Figures 3.17 (a) on the right and (b) on page 102 explore the chance of knee joint revision for different bearings and constraints within a particular knee fixation type; that of cemented, uncemented/hybrid. Figure 3.17 (c) on page 103 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.

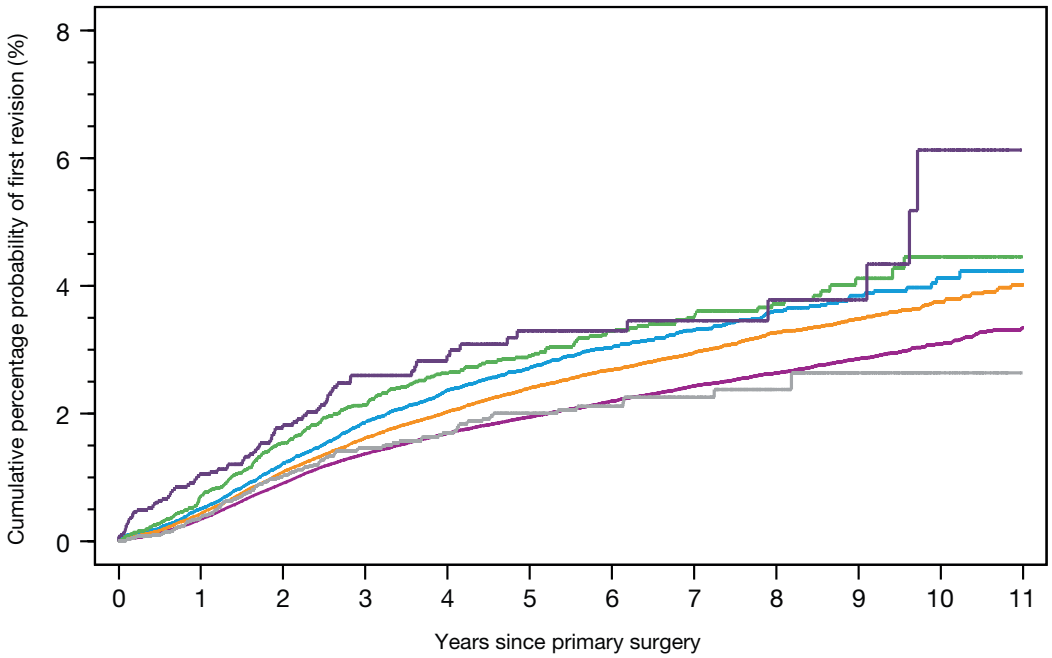
Overall, little difference is seen in implant survivorship by constraint within a fixation type apart from:

- 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 (Figure 3.17 (a)).
- The uncemented/hybrid joints which have a posterior-stabilised constraint and fixed bearings (Figure 3.17(b)); fare worse than the unconstrained bearing type implants,
- Patellofemoral joints are at higher risk of revision compared to a unicondylar fixation combined with any bearing (mobile or fixed) (Figure 3.17(c)).

Figure 3.17 (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**



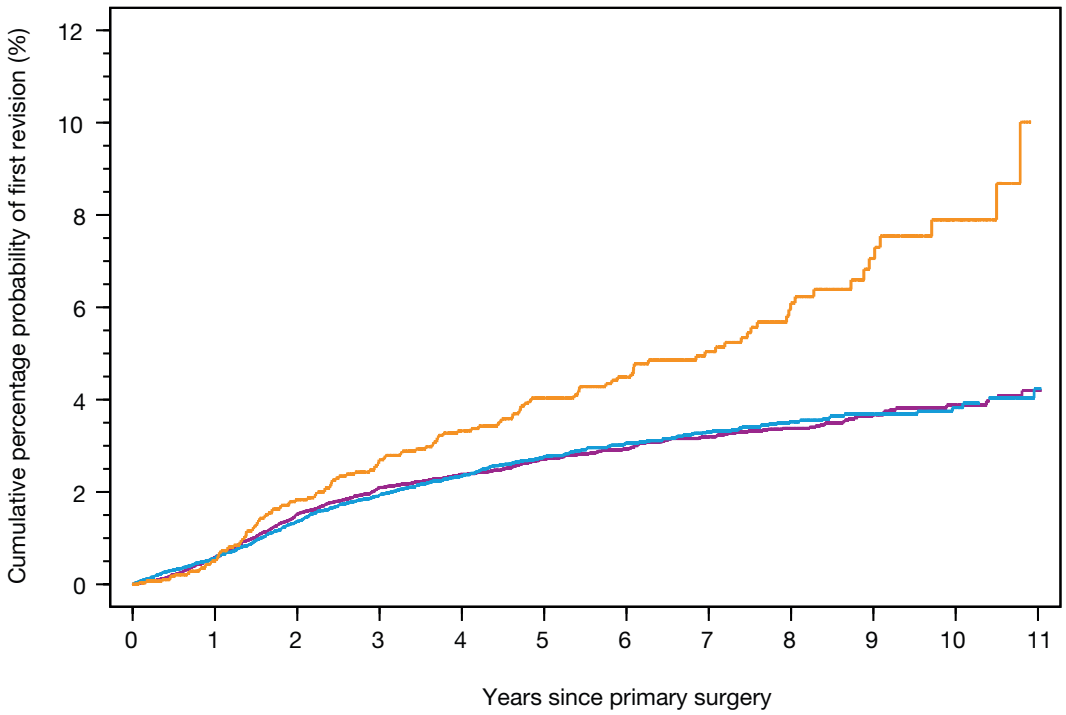
Number at risk

Unconstrained, fixed	426,844	365,548	308,967	253,702	204,212	160,035	119,657	83,828	53,627	32,352	15,055	4,631
Unconstrained, mobile	30,641	28,463	26,084	23,488	20,628	17,183	13,457	9,386	5596	2,906	1,150	335
Posterior-stabilised, fixed	161,508	140,298	119,927	99,982	80,866	63,089	46,881	32,323	20,292	12,089	5,804	1,778
Posterior-stabilised, mobile	10,258	9,213	8,044	6,985	5,904	4,727	3,671	2,675	1,678	879	320	97
Constrained, condylar	3,976	2,855	2,054	1,501	1,142	850	637	464	279	178	82	21
Monobloc polyethylene tibia	9,785	7,872	5,925	4,153	2,814	2,028	1,473	910	433	195	78	30

Figure 3.17 (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**



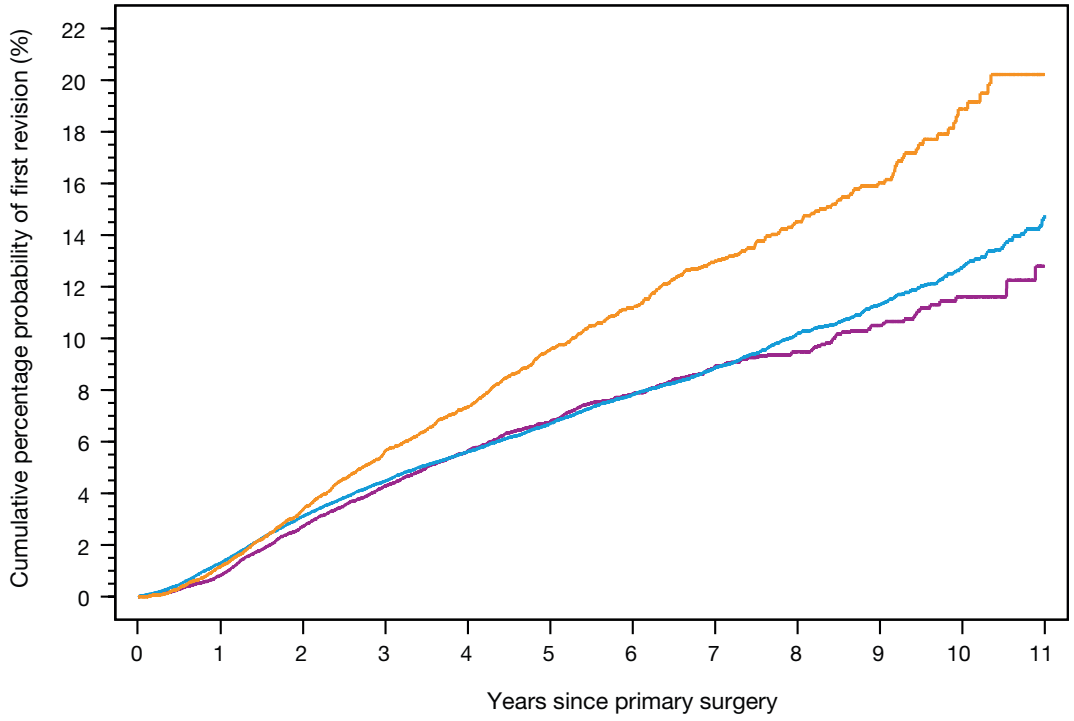
Number at risk

Unconstrained, fixed	20,190	19,101	17,920	16,484	14,748	12,518	9,761	7,014	4,570	2,886	1,402	436
Unconstrained, mobile	20,177	18,224	16,376	14,228	12,003	9,774	7,617	5,438	3,565	2,184	1,090	337
Posterior-stabilised, fixed	2,976	2,648	2,379	2,139	1,918	1,649	1,325	1,005	671	387	192	63

Figure 3.17 (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**



Number at risk

Unicondylar, fixed	19,926	16,555	13,486	10,746	8,480	6,376	4,730	3,307	2,136	1,169	494	129
Unicondylar, mobile	46,048	40,742	35,819	30,784	25,733	20,669	15,698	10,982	6,980	4,136	1,979	602
Patellofemoral	9,945	8,825	7,596	6,284	5,050	3,895	2,858	1,887	1,107	657	297	90

Table 3.27 (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]. *Blue italics signify that fewer than 250 cases remained at risk at these time points.*

	Cumulative percentage probability of a first revision (95% CI) at time shown if time elapsed since primary operation is:											
Fixation/bearing type	n	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years
Total knee replacement												
All cemented	**651,680**	**0.39 (0.37-0.41)**	**1.00 (0.97-1.02)**	**1.49 (1.46-1.53)**	**1.86 (1.82-1.89)**	**2.15 (2.11-2.19)**	**2.41 (2.36-2.46)**	**2.66 (2.61-2.72)**	**2.90 (2.84-2.96)**	**3.12 (3.05-3.20)**	**3.37 (3.29-3.46)**	**3.62 (3.51-3.75)**
Cemented and												
unconstrained, fixed	426,844	0.34 (0.33-0.36)	0.91 (0.88-0.94)	1.37 (1.33-1.41)	1.69 (1.65-1.74)	1.95 (1.90-2.00)	2.19 (2.14-2.25)	2.43 (2.37-2.50)	2.64 (2.57-2.71)	2.86 (2.77-2.94)	3.09 (2.99-3.20)	3.35 (3.20-3.50)
unconstrained, mobile	30,641	0.51 (0.43-0.59)	1.22 (1.10-1.36)	1.86 (1.70-2.03)	2.37 (2.19-2.56)	2.71 (2.52-2.92)	3.03 (2.82-3.26)	3.31 (3.08-3.56)	3.61 (3.35-3.88)	3.85 (3.55-4.17)	4.13 (3.74-4.54)	4.24 (3.81-4.72)
posterior-stabilised, fixed	161,508	0.44 (0.40-0.47)	1.08 (1.03-1.14)	1.62 (1.55-1.69)	2.03 (1.95-2.11)	2.40 (2.31-2.50)	2.68 (2.58-2.79)	2.96 (2.85-3.07)	3.27 (3.14-3.41)	3.49 (3.34-3.64)	3.74 (3.56-3.93)	4.02 (3.77-4.27)
posterior-stabilised, mobile	10,258	0.71 (0.56-0.90)	1.53 (1.30-1.81)	2.14 (1.86-2.47)	2.63 (2.31-3.00)	2.90 (2.55-3.29)	3.29 (2.90-3.73)	3.50 (3.09-3.97)	3.72 (3.27-4.23)	4.12 (3.56-4.76)	4.46 (3.76-5.28)	*4.46 (3.76-5.28)*
constrained, condylar	3,976	1.05 (0.76-1.45)	1.82 (1.39-2.38)	2.60 (2.03-3.31)	2.91 (2.29-3.70)	3.30 (2.59-4.20)	3.30 (2.59-4.20)	3.46 (2.70-4.42)	3.78 (2.85-5.00)	*3.78 (2.85-5.00)*	*6.13 (3.82-9.76)*	*6.13 (3.82-9.76)*
monobloc polyethylene tibia	9,785	0.38 (0.27-0.53)	1.02 (0.82-1.28)	1.46 (1.20-1.78)	1.70 (1.40-2.06)	2.00 (1.65-2.44)	2.11 (1.73-2.58)	2.25 (1.83-2.77)	2.38 (1.91-2.96)	*2.64 (2.00-3.48)*	*2.64 (2.00-3.48)*	*2.64 (2.00-3.48)*
bearing type unknown	8,668	0.77 (0.61-0.99)	1.62 (1.37-1.92)	2.34 (2.03-2.70)	2.89 (2.53-3.30)	3.32 (2.93-3.77)	3.60 (3.18-4.08)	3.94 (3.48-4.45)	4.17 (3.68-4.74)	4.42 (3.86-5.06)	4.59 (3.95-5.32)	*4.95 (4.06-6.05)*
All uncemented	**36,135**	**0.60 (0.52-0.68)**	**1.50 (1.38-1.64)**	**2.12 (1.97-2.29)**	**2.52 (2.35-2.70)**	**2.94 (2.75-3.14)**	**3.20 (3.00-3.41)**	**3.48 (3.26-3.71)**	**3.77 (3.52-4.03)**	**4.10 (3.81-4.40)**	**4.34 (4.01-4.69)**	**4.91 (4.38-5.50)**
All hybrid	**8,098**	**0.54 (0.40-0.73)**	**1.32 (1.09-1.61)**	**1.86 (1.57-2.19)**	**2.14 (1.83-2.50)**	**2.44 (2.10-2.83)**	**2.73 (2.36-3.15)**	**3.03 (2.63-3.48)**	**3.19 (2.77-3.67)**	**3.39 (2.93-3.91)**	**3.57 (3.06-4.16)**	**3.57 (3.06-4.16)**
Uncemented/hybrid and												
unconstrained, fixed	20,190	0.60 (0.50-0.71)	1.52 (1.36-1.70)	2.10 (1.90-2.31)	2.38 (2.17-2.61)	2.72 (2.49-2.97)	2.93 (2.68-3.19)	3.20 (2.93-3.49)	3.38 (3.09-3.68)	3.68 (3.35-4.03)	3.88 (3.51-4.29)	4.11 (3.63-4.64)
unconstrained mobile	20,177	0.59 (0.49-0.70)	1.36 (1.21-1.54)	1.93 (1.74-2.15)	2.35 (2.13-2.60)	2.77 (2.52-3.04)	3.06 (2.79-3.36)	3.30 (3.01-3.62)	3.52 (3.20-3.87)	3.68 (3.34-4.06)	3.83 (3.44-4.27)	4.15 (3.56-4.84)
posterior-stabilised, fixed	2,976	0.50 (0.30-0.85)	1.83 (1.38-2.43)	2.70 (2.13-3.41)	3.32 (2.68-4.12)	4.03 (3.30-4.93)	4.49 (3.69-5.45)	5.04 (4.17-6.10)	6.09 (5.02-7.38)	7.06 (5.75-8.65)	*7.90 (6.34-9.81)*	*9.87 (7.09-13.65)*
other constraint	327	0.32 (0.05-2.27)	1.64 (0.69-3.90)	2.33 (1.12-4.83)	3.07 (1.61-5.83)	*3.07 (1.61-5.83)*	*3.91 (2.18-6.98)*	*4.35 (2.48-7.56)*	*4.35 (2.48-7.56)*	*4.35 (2.48-7.56)*		
bearing type unknown	563	0.73 (0.27-1.92)	1.29 (0.62-2.69)	2.66 (1.59-4.46)	3.48 (2.21-5.48)	3.70 (2.38-5.75)	4.21 (2.76-6.40)	4.54 (2.99-6.85)	*4.54 (2.99-6.85)*	*5.07 (3.32-7.71)*	*5.07 (3.32-7.71)*	*6.27 (3.78-10.32)*

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.

Continued >

Table 3.27 (a) (continued)

Fixation/bearing type	n	Cumulative percentage probability of a first revision (95% CI) at time shown if time elapsed since primary operation is: 1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years	11 years
Unicompartmental knee replacement												
All unicondylar	66,915	1.17 (1.09-1.26)	2.98 (2.85-3.12)	4.40 (4.23-4.58)	5.60 (5.40-5.80)	6.68 (6.46-6.91)	7.80 (7.54-8.06)	8.84 (8.55-9.14)	10.00 (9.66-10.35)	11.08 (10.68-11.50)	12.46 (11.93-13.01)	14.29 (13.44-15.18)
Unicondylar and												
fixed	19,926	0.83 (0.71-0.98)	2.73 (2.49-2.99)	4.28 (3.96-4.62)	5.65 (5.27-6.06)	6.80 (6.36-7.27)	7.86 (7.36-8.40)	8.93 (8.35-9.54)	9.49 (8.85-10.16)	10.50 (9.74-11.32)	11.61 (10.61-12.71)	*12.79 (11.17-14.63)*
mobile	46,048	1.32 (1.21-1.43)	3.12 (2.95-3.29)	4.48 (4.28-4.69)	5.62 (5.39-5.86)	6.70 (6.44-6.98)	7.83 (7.53-8.13)	8.86 (8.53-9.21)	10.20 (9.80-10.61)	11.31 (10.84-11.80)	12.76 (12.14-13.41)	14.77 (13.79-15.82)
bearing type unknown	941	1.00 (0.52-1.90)	1.82 (1.12-2.95)	3.55 (2.48-5.07)	4.46 (3.21-6.17)	4.80 (3.49-6.59)	6.30 (4.68-8.46)	7.14 (5.33-9.53)	*8.40 (6.23-11.28)*	*9.00 (6.62-12.17)*	*10.34 (7.17-14.79)*	*10.34 (7.17-14.79)*
All patellofemoral	9,945	1.16 (0.96-1.40)	3.39 (3.03-3.79)	5.65 (5.17-6.18)	7.35 (6.78-7.97)	9.57 (8.89-10.31)	11.18 (10.40-12.01)	12.99 (12.08-13.95)	14.52 (13.47-15.65)	16.02 (14.77-17.37)	18.88 (17.07-20.86)	*20.22 (18.05-22.61)*
Others/unknown	45	0	0	0	0	0	0	*2.60 (0.37-17.25)*	*2.60 (0.37-17.25)*	*2.60 (0.37-17.25)*	*2.60 (0.37-17.25)*	
All types	772,818	0.48 (0.46-0.50)	1.23 (1.20-1.26)	1.84 (1.81-1.88)	2.30 (2.26-2.34)	2.70 (2.66-2.75)	3.06 (3.01-3.11)	3.41 (3.36-3.47)	3.75 (3.69-3.82)	4.08 (4.01-4.16)	4.47 (4.38-4.56)	4.90 (4.77-5.04)

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 3.27 (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		1 year	3 years	5 years	7 years	10 years
All types													
	<55	23,300	1.12 (0.99-1.27)	4.62 (4.32-4.93)	6.79 (6.41-7.21)	8.91 (8.40-9.44)	12.08 (11.20-13.02)	32,828	0.85 (0.76-0.96)	4.06 (3.82-4.31)	6.47 (6.15-6.82)	8.52 (8.10-8.97)	11.05 (10.35-11.79)
	55-64	84,114	0.70 (0.64-0.76)	2.70 (2.58-2.82)	3.94 (3.79-4.10)	4.92 (4.73-5.12)	6.48 (6.17-6.82)	101,617	0.50 (0.46-0.55)	2.32 (2.22-2.43)	3.57 (3.43-3.71)	4.57 (4.39-4.74)	5.97 (5.69-6.27)
	65-74	131,434	0.50 (0.46-0.54)	1.79 (1.71-1.87)	2.51 (2.41-2.61)	3.07 (2.95-3.20)	3.97 (3.77-4.18)	162,198	0.35 (0.33-0.39)	1.50 (1.43-1.57)	2.22 (2.14-2.31)	2.79 (2.69-2.90)	3.71 (3.53-3.90)
	75+	93,953	0.37 (0.33-0.42)	1.08 (1.01-1.16)	1.43 (1.34-1.52)	1.79 (1.67-1.91)	2.22 (2.03-2.43)	143,033	0.34 (0.31-0.38)	0.95 (0.89-1.00)	1.31 (1.24-1.38)	1.59 (1.51-1.68)	1.94 (1.81-2.09)
Total knee replacement													
All cemented													
	<55	15,278	0.85 (0.71-1.02)	3.71 (3.38-4.07)	5.33 (4.90-5.79)	7.03 (6.47-7.64)	9.03 (8.16-9.99)	21,676	0.59 (0.49-0.71)	2.94 (2.70-3.22)	4.63 (4.28-5.0)	5.82 (5.38-6.29)	7.66 (6.92-8.47)
	55-64	64,770	0.59 (0.53-0.65)	2.29 (2.16-2.42)	3.31 (3.15-3.48)	4.08 (3.88-4.29)	5.15 (4.84-5.48)	82,216	0.40 (0.36-0.45)	1.91 (1.80-2.01)	2.85 (2.72-3.0)	3.53 (3.36-3.71)	4.48 (4.21-4.77)
	65-74	110,950	0.43 (0.39-0.47)	1.57 (1.49-1.65)	2.21 (2.10-2.31)	2.67 (2.55-2.80)	3.31 (3.12-3.52)	142,717	0.31 (0.28-0.34)	1.27 (1.21-1.34)	1.88 (1.79-1.96)	2.33 (2.23-2.44)	2.98 (2.81-3.16)
	75+	83,412	0.33 (0.29-0.37)	0.98 (0.91-1.06)	1.27 (1.19-1.37)	1.59 (1.48-1.72)	1.92 (1.74-2.12)	130,363	0.29 (0.27-0.33)	0.83 (0.77-0.88)	1.12 (1.05-1.19)	1.35 (1.27-1.44)	1.64 (1.50-1.78)
Cemented by bearing and constraint type													
Unconstrained, fixed	<55	9,406	0.76 (0.59-0.96)	3.22 (2.83-3.66)	4.71 (4.19-5.28)	6.46 (5.75-7.25)	8.52 (7.43-9.77)	13,627	0.51 (0.40-0.65)	2.58 (2.28-2.91)	4.14 (3.73-4.60)	5.27 (4.74-5.86)	6.94 (6.09-7.90)
	55-64	42,446	0.48 (0.41-0.55)	2.06 (1.93-2.24)	3.00 (2.81-3.20)	3.74 (3.50-3.99)	4.74 (4.37-5.15)	53,899	0.37 (0.32-0.42)	1.79 (1.67-1.93)	2.59 (2.43-2.76)	3.23 (3.03-3.44)	4.20 (3.86-4.56)
	65-74	74,375	0.40 (0.36-0.45)	1.45 (1.35-1.55)	2.05 (1.93-2.18)	2.46 (2.31-2.62)	3.02 (2.80-3.25)	93,647	0.24 (0.21-0.28)	1.15 (1.08-1.24)	1.69 (1.59-1.79)	2.15 (2.02-2.28)	2.71 (2.51-2.92)
	75+	55,256	0.33 (0.29-0.39)	0.96 (0.87-1.06)	1.20 (1.09-1.32)	1.53 (1.39-1.68)	1.82 (1.60-2.06)	83,992	0.26 (0.22-0.29)	0.78 (0.71-0.85)	1.02 (0.94-1.10)	1.22 (1.13-1.33)	1.53 (1.36-1.71)
Unconstrained, mobile	<55	1,101	1.04 (0.58-1.87)	4.48 (3.33-5.99)	6.25 (4.82-8.07)	7.89 (6.12-10.15)	*9.91 (7.22-13.52)*	1,323	0.79 (0.43-1.46)	3.62 (2.69-4.88)	5.98 (4.67-7.64)	7.66 (6.03-9.71)	*10.16 (6.84-14.97)*
	55-64	3,764	0.71 (0.48-1.04)	2.44 (1.97-3.01)	3.50 (2.92-4.20)	4.39 (3.68-5.22)	*5.17 (4.23-6.32)*	4,346	0.48 (0.31-0.74)	2.16 (1.75-2.67)	3.20 (2.68-3.83)	3.78 (3.18-4.51)	*4.71 (3.74-5.93)*
	65-74	5,087	0.57 (0.39-0.82)	1.93 (1.57-2.37)	2.72 (2.27-3.25)	3.28 (2.76-3.90)	*4.27 (3.29-5.52)*	6,331	0.40 (0.27-0.60)	1.55 (1.25-1.90)	2.24 (1.87-2.68)	2.84 (2.39-3.37)	3.63 (2.97-4.44)
	75+	3,275	0.32 (0.17-0.60)	1.00 (0.70-1.44)	1.66 (1.23-2.24)	1.86 (1.39-2.50)	*2.28 (1.60-3.25)*	5,401	0.38 (0.25-0.59)	1.02 (0.77-1.35)	1.36 (1.05-1.74)	1.56 (1.22-2.0)	*1.64 (1.27-2.12)*

Note: 1 Excludes 341 cases where either gender was not specified and/or ages were invalid. Total sample on which results are based is 772,477 primary knee replacements.

Table 3.27 (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		1 year	3 years	5 years	7 years	10 years
Posterior-stabilised, fixed	<55	3,653	0.74 (0.50-1.10)	4.15 (3.46-4.97)	6.13 (5.21-7.21)	7.70 (6.53-9.07)	*10.34 (8.35-12.77)*	5,309	0.50 (0.33-0.74)	3.24 (2.73-3.84)	4.94 (4.24-5.74)	6.16 (5.28-7.19)	*7.74 (6.36-9.39)*
	55-64	15,299	0.75 (0.62-0.91)	2.63 (2.36-2.93)	3.98 (3.62-4.38)	4.94 (4.50-5.43)	6.01 (5.38-6.72)	20,076	0.46 (0.37-0.56)	2.11 (1.90-2.35)	3.35 (3.06-3.67)	4.13 (3.77-4.52)	4.94 (4.41-5.53)
	65-74	26,499	0.47 (0.39-0.56)	1.70 (1.53-1.88)	2.37 (2.16-2.60)	2.95 (2.69-3.24)	3.79 (3.38-4.25)	36,146	0.40 (0.34-0.48)	1.42 (1.29-1.57)	2.17 (2.0-2.36)	2.58 (2.37-2.81)	3.44 (3.09-3.84)
	75+	20,553	0.32 (0.25-0.41)	1.00 (0.86-1.17)	1.33 (1.15-1.53)	1.62 (1.39-1.89)	2.07 (1.70-2.51)	33,894	0.31 (0.26-0.38)	0.85 (0.75-0.97)	1.24 (1.10-1.39)	1.54 (1.37-1.73)	1.82 (1.56-2.12)
Posterior-stabilised, mobile	<55	599	1.55 (0.81-2.96)	4.76 (3.24-6.99)	5.74 (4.01-8.19)	*7.14 (4.96-10.21)*	*7.14 (4.96-10.21)*	663	1.42 (0.74-2.71)	3.92 (2.62-5.86)	5.41 (3.80-7.67)	*6.06 (4.28-8.55)*	*10.19 (6.09-16.80)*
	55-64	1,586	0.78 (0.45-1.38)	2.38 (1.71-3.32)	2.85 (2.08-3.89)	3.14 (2.30-4.28)	*5.50 (3.35-8.97)*	1,752	0.42 (0.20-0.87)	1.53 (1.02-2.30)	2.94 (2.15-4.02)	4.06 (3.02-5.45)	*4.79 (3.52-6.49)*
	65-74	1,575	0.62 (0.32-1.18)	2.36 (1.65-3.36)	2.99 (2.16-4.14)	3.53 (2.54-4.89)	*3.53 (2.54-4.89)*	1,864	0.62 (0.34-1.12)	1.87 (1.31-2.66)	2.40 (1.73-3.34)	2.89 (2.10-3.97)	*3.15 (2.26-4.38)*
	75+	874	0.61 (0.25-1.46)	1.46 (0.81-2.63)	1.75 (0.97-3.15)	*2.20 (1.19-4.04)*	*2.20 (1.19-4.04)*	1,343	0.54 (0.26-1.14)	1.04 (0.59-1.83)	1.49 (0.88-2.52)	1.69 (1.01-2.82)	*1.98 (1.17-3.35)*
Constrained, condylar	<55	144	*2.98 (1.13-7.75)*	*6.74 (3.18-14.0)*	*8.69 (4.22-17.44)*	*8.69 (4.22-17.44)*		193	*1.20 (0.30-4.73)*	*2.84 (1.06-7.50)*	*2.84 (1.06-7.50)*	*2.84 (1.06-7.50)*	
	55-64	370	1.57 (0.65-3.76)	*2.82 (1.28-6.14)*	*4.15 (1.83-9.29)*	*4.15 (1.83-9.29)*		464	0.52 (0.13-2.08)	*2.68 (1.25-5.69)*	*2.68 (1.25-5.69)*	*2.68 (1.25-5.69)*	*10.53 (3.43-29.90)*
	65-74	499	0.73 (0.23-2.26)	*3.27 (1.74-6.09)*	*5.17 (2.92-9.07)*	*5.17 (2.92-9.07)*	*8.13 (3.67-17.51)*	820	1.08 (0.54-2.17)	2.99 (1.80-4.94)	*3.82 (2.33-6.26)*	*3.82 (2.33-6.26)*	*3.82 (2.33-6.26)*
	75+	438	0.81 (0.26-2.52)	*2.21 (0.97-5.03)*	*2.21 (0.97-5.03)*	*2.21 (0.97-5.03)*		1,043	1.05 (0.57-1.95)	1.43 (0.80-2.57)	*1.76 (0.97-3.20)*	*2.46 (1.22-4.91)*	*2.46 (1.22-4.91)*
Monobloc polyethylene tibia	<55	94	*1.16 (0.16-7.97)*	*7.62 (3.49-16.23)*	*7.62 (3.49-16.23)*	*9.87 (4.70-20.10)*		140	*0.72 (0.10-5.03)*	*4.62 (1.93-10.84)*	*6.07 (2.71-13.28)*	*6.07 (2.71-13.28)*	
	55-64	428	1.09 (0.41-2.90)	*2.87 (1.49-5.50)*	*3.40 (1.81-6.34)*	*4.34 (2.27-8.22)*	*4.34 (2.27-8.22)*	581	0.17 (0.02-1.22)	1.35 (0.55-3.27)	*2.15 (1.0-4.56)*	*2.15 (1.0-4.56)*	*3.47 (1.44-8.24)*
	65-74	1,455	0.15 (0.04-0.62)	1.49 (0.88-2.52)	2.26 (1.34-3.79)	*2.78 (1.59-4.84)*	*2.78 (1.59-4.84)*	2,247	0.41 (0.21-0.83)	1.77 (1.20-2.59)	2.35 (1.61-3.43)	*2.35 (1.61-3.43)*	*2.89 (1.79-4.63)*
	75+	1,974	0.28 (0.12-0.68)	1.18 (0.71-1.95)	1.59 (0.95-2.67)	*1.94 (1.12-3.34)*		2,864	0.43 (0.24-0.77)	0.84 (0.53-1.32)	1.22 (0.76-1.97)	*1.22 (0.76-1.97)*	
Bearing type unknown	<55	281	1.86 (0.78-4.40)	*5.39 (3.15-9.13)*	*8.01 (4.98-12.76)*	*11.07 (7.21-16.81)*	*11.07 (7.21-16.81)*	421	1.97 (0.99-3.90)	5.78 (3.84-8.66)	*8.65 (6.03-12.34)*	*10.70 (7.47-15.20)*	*10.70 (7.47-15.20)*
	55-64	877	1.52 (0.89-2.61)	4.48 (3.25-6.16)	5.69 (4.25-7.58)	5.69 (4.25-7.58)	*8.33 (5.35-12.86)*	1,098	0.75 (0.38-1.50)	2.80 (1.94-4.04)	4.13 (3.01-5.66)	5.14 (3.79-6.96)	*5.52 (4.03-7.54)*
	65-74	1,460	0.70 (0.38-1.30)	2.46 (1.75-3.45)	3.25 (2.40-4.40)	3.51 (2.60-4.74)	*3.81 (2.78-5.20)*	1,662	0.49 (0.25-0.98)	1.45 (0.95-2.19)	2.29 (1.62-3.24)	2.95 (2.11-4.11)	*3.58 (2.47-5.17)*
	75+	1,042	0.10 (0.01-0.70)	0.67 (0.30-1.48)	1.19 (0.61-2.32)	*1.75 (0.93-3.31)*	*2.20 (1.15-4.17)*	1,826	0.67 (0.38-1.17)	1.39 (0.92-2.09)	1.90 (1.32-2.75)	2.17 (1.51-3.13)	*2.52 (1.66-3.81)*

Note: 1 Excludes 341 cases where either gender was not specified and/or ages were invalid. Total sample on which results are based is 772,477 primary knee replacements.

Continued >

Table 3.27 (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		1 year	3 years	5 years	7 years	10 years
All uncemented													
	<55	1,356	0.54 (0.26-1.13)	3.99 (2.99-5.31)	5.56 (4.31-7.16)	6.95 (5.44-8.85)	*9.87 (7.48-12.98)*	1,489	0.98 (0.58-1.65)	4.73 (3.71-6.03)	6.96 (5.64-8.58)	7.58 (6.16-9.32)	*8.44 (6.78-10.48)*
	55-64	4,763	0.61 (0.42-0.88)	2.37 (1.95-2.88)	3.33 (2.81-3.95)	3.97 (3.36-4.68)	5.71 (4.62-7.04)	4,744	0.66 (0.46-0.94)	2.31 (1.90-2.80)	3.64 (3.10-4.28)	4.69 (4.02-5.47)	5.90 (4.95-7.03)
	65-74	6,776	0.57 (0.41-0.79)	1.83 (1.52-2.21)	2.44 (2.06-2.88)	2.92 (2.47-3.45)	3.78 (3.02-4.71)	6,868	0.56 (0.40-0.77)	2.31 (1.96-2.71)	3.00 (2.59-3.48)	3.31 (2.86-3.82)	3.84 (3.26-4.52)
	75+	4,360	0.51 (0.33-0.78)	1.35 (1.03-1.77)	1.70 (1.31-2.19)	2.00 (1.55-2.58)	*2.11 (1.62-2.75)*	5,772	0.59 (0.42-0.83)	1.34 (1.06-1.69)	1.72 (1.39-2.13)	2.01 (1.62-2.49)	2.07 (1.67-2.57)
All hybrid													
	<55	317	0.64 (0.16-2.52)	3.37 (1.83-6.17)	*6.25 (3.92-9.90)*	*7.86 (5.10-12.01)*	*10.42 (5.84-18.20)*	367	0.57 (0.14-2.28)	3.14 (1.70-5.77)	*5.23 (3.23-8.41)*	*7.64 (4.99-11.59)*	*8.32 (5.47-12.56)*
	55-64	931	0.56 (0.23-1.33)	2.09 (1.32-3.29)	2.78 (1.85-4.16)	3.72 (2.56-5.40)	*4.26 (2.83-6.40)*	1,057	0.59 (0.27-1.31)	2.19 (1.43-3.35)	3.09 (2.14-4.46)	3.65 (2.56-5.19)	*3.87 (2.72-5.49)*
	65-74	1,422	0.51 (0.24-1.07)	2.11 (1.45-3.06)	2.29 (1.59-3.28)	2.53 (1.78-3.60)	*3.28 (2.26-4.76)*	1,618	0.38 (0.17-0.84)	1.52 (1.01-2.28)	1.68 (1.13-2.47)	2.09 (1.45-3.02)	*2.60 (1.79-3.77)*
	75+	956	0.44 (0.16-1.16)	1.03 (0.54-1.97)	1.55 (0.87-2.75)	1.79 (1.02-3.13)	*2.22 (1.23-3.97)*	1,430	0.73 (0.39-1.35)	1.45 (0.93-2.27)	1.75 (1.15-2.65)	2.22 (1.47-3.33)	*2.22 (1.47-3.33)*
Uncemented/hybrid by bearing and constraint type													
Uncemented/ hybrid and unconstrained, fixed	<55	763	0.67 (0.28-1.61)	4.43 (3.12-6.28)	6.50 (4.81-8.75)	7.80 (5.85-10.36)	*9.52 (6.96-12.94)*	793	1.17 (0.61-2.24)	3.85 (2.67-5.53)	5.34 (3.89-7.31)	6.47 (4.79-8.71)	*6.47 (4.79-8.71)*
	55-64	2,551	0.40 (0.22-0.75)	2.22 (1.69-2.90)	3.12 (2.47-3.94)	3.71 (2.96-4.64)	*4.93 (3.73-6.50)*	2,588	0.79 (0.51-1.22)	2.51 (1.96-3.22)	3.36 (2.70-4.18)	4.32 (3.52-5.30)	*5.27 (4.19-6.61)*
	65-74	3,893	0.53 (0.34-0.82)	2.10 (1.68-2.62)	2.53 (2.05-3.11)	2.95 (2.39-3.63)	4.09 (3.16-5.30)	3,744	0.49 (0.31-0.78)	2.19 (1.75-2.73)	2.56 (2.08-3.15)	2.83 (2.31-3.46)	3.25 (2.61-4.06)
	75+	2,530	0.49 (0.28-0.87)	1.08 (0.73-1.60)	1.53 (1.08-2.17)	1.63 (1.15-2.31)	*1.83 (1.25-2.66)*	3,327	0.71 (0.47-1.07)	1.38 (1.02-1.85)	1.71 (1.30-2.25)	1.90 (1.45-2.50)	*1.90 (1.45-2.50)*
Unconstrained, mobile	<55	659	0.48 (0.15-1.48)	3.39 (2.15-5.34)	4.95 (3.32-7.35)	*6.84 (4.71-9.89)*	*11.28 (6.60-18.93)*	819	0.77 (0.35-1.71)	4.35 (3.05-6.17)	6.92 (5.15-9.27)	*7.25 (5.40-9.71)*	*8.87 (6.46-12.10)*
	55-64	2,473	0.68 (0.42-1.10)	2.33 (1.78-3.06)	3.33 (2.62-4.23)	3.97 (3.14-5.00)	*4.38 (3.41-5.60)*	2,679	0.51 (0.30-0.88)	1.89 (1.41-2.53)	3.44 (2.73-4.34)	4.19 (3.34-5.26)	*4.67 (3.69-5.90)*
	65-74	3,634	0.55 (0.35-0.87)	1.59 (1.21-2.08)	2.06 (1.60-2.66)	2.56 (1.99-3.29)	*3.07 (2.23-4.20)*	4,150	0.60 (0.40-0.89)	2.08 (1.67-2.60)	2.85 (2.34-3.48)	3.26 (2.68-3.97)	3.56 (2.90-4.36)
	75+	2,396	0.57 (0.33-0.99)	1.37 (0.95-1.99)	1.75 (1.24-2.48)	1.97 (1.40-2.77)	2.20 (1.52-3.19)	3,362	0.59 (0.38-0.92)	1.35 (0.99-1.84)	1.65 (1.23-2.20)	2.08 (1.55-2.79)	*2.08 (1.55-2.79)*

Note: 1 Excludes 341 cases where either gender was not specified and/or ages were invalid. Total sample on which results are based is 772,477 primary knee replacements.

Table 3.27 (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		1 year	3 years	5 years	7 years	10 years
Posterior-stabilised, fixed	<55	194	0.00	*1.16 (0.29-4.54)*	*2.91 (1.08-7.73)*	*4.19 (1.69-10.18)*		192	*0.56 (0.08-3.94)*	*7.19 (4.14-12.33)*	*11.10 (7.0-17.37)*	*12.32 (7.82-19.12)*	
	55-64	524	1.00 (0.42-2.38)	2.12 (1.15-3.92)	2.68 (1.52-4.69)	*3.66 (2.10-6.34)*	*11.00 (6.29-18.86)*	415	0.76 (0.25-2.35)	3.74 (2.23-6.24)	6.08 (3.99-9.20)	*8.41 (5.72-12.26)*	*12.62 (8.02-19.56)*
	65-74	518	0.85 (0.32-2.26)	2.03 (1.06-3.88)	2.95 (1.67-5.17)	*2.95 (1.67-5.17)*	*3.54 (2.0-6.25)*	460	0.22 (0.03-1.54)	2.32 (1.21-4.41)	3.50 (2.04-5.97)	*3.86 (2.29-6.46)*	*5.81 (3.22-10.35)*
	75+	285	*0.00*	*3.20 (1.54-6.61)*	*3.20 (1.54-6.61)*	*4.61 (2.39-8.79)*	*4.61 (2.39-8.79)*	388	0.00	1.61 (0.67-3.84)	*2.91 (1.45-5.78)*	*4.07 (2.17-7.59)*	*4.89 (2.64-8.98)*
Other constraint	<55	35	*0.00*	*9.09 (3.03-25.59)*	*12.59 (4.90-30.24)*	*12.59 (4.90-30.24)*		*25*	*0.00*	*0.00*	*4.35 (0.62-27.07)*	*13.91 (4.70-37.27)*	
	55-64	53	*2.00 (0.28-13.36)*	*6.13 (2.02-17.84)*	*6.13 (2.02-17.84)*	*8.60 (3.30-21.43)*		*49*	*0.00*	*2.22 (0.32-14.75)*	*2.22 (0.32-14.75)*	*2.22 (0.32-14.75)*	
	65-74	54	*0.00*	*0.00*	*0.00*	*0.00*		*42*	*0.00*	*0.00*	*0.00*	*0.00*	
	75+	37	*0.00*	*0.00*	*0.00*	*0.00*		*31*	*0.00*	*0.00*	*0.00*	*0.00*	
Bearing type unknown	<55	22	*4.55 (0.65-28.13)*	*9.32 (2.41-32.42)*	*9.32 (2.41-32.42)*	*9.32 (2.41-32.42)*		27	*0.00*	*8.33 (2.15-29.39)*	*8.33 (2.15-29.39)*	*8.33 (2.15-29.39)*	
	55-64	93	*1.12 (0.16-7.71)*	*3.49 (1.14-10.45)*	*4.85 (1.84-12.46)*	*6.41 (2.70-14.84)*	*6.41 (2.70-14.84)*	70	*0.00*	*0.00*	*1.52 (0.21-10.27)*	*1.52 (0.21-10.27)*	*1.52 (0.21-10.27)*
	65-74	99	*1.01 (0.14-6.95)*	*3.21 (1.05-9.64)*	*6.61 (3.02-14.15)*	*7.88 (3.83-15.85)*	*7.88 (3.83-15.85)*	90	*0.00*	*3.62 (1.18-10.81)*	*3.62 (1.18-10.81)*	*3.62 (1.18-10.81)*	*6.83 (2.31-19.30)*
	75+	68	*0.00*	*0.00*	*0.00*	*3.03 (0.43-19.63)*	*3.03 (0.43-19.63)*	94	*1.11 (0.16-7.63)*	*1.11 (0.16-7.63)*	*1.11 (0.16-7.63)*	*1.11 (0.16-7.63)*	*1.11 (0.16-7.63)*
Unicompartmental knee replacement													
All unicondylar													
	<55	5,653	1.78 (1.45-2.17)	6.61 (5.92-7.38)	10.10 (9.17-11.11)	13.42 (12.18-14.77)	*19.97 (17.43-22.83)*	6,434	1.62 (1.33-1.98)	6.79 (6.13-7.52)	10.73 (9.84-11.71)	14.78 (13.58-16.08)	*18.72 (16.85-20.78)*
	55-64	12,931	1.21 (1.03-1.43)	4.72 (4.33-5.14)	6.99 (6.49-7.53)	8.90 (8.28-9.57)	12.52 (11.40-13.75)	11,174	1.07 (0.89-1.29)	4.53 (4.12-4.97)	7.10 (6.56-7.69)	9.53 (8.83-10.29)	13.34 (12.11-14.69)
	65-74	11,795	1.03 (0.86-1.24)	3.55 (3.19-3.94)	5.05 (4.59-5.54)	6.58 (5.99-7.22)	9.46 (8.38-10.67)	9,389	0.87 (0.70-1.09)	3.60 (3.20-4.04)	5.65 (5.11-6.24)	7.76 (7.05-8.54)	11.62 (10.27-13.13)
	75+	4,895	0.91 (0.67-1.23)	2.39 (1.96-2.92)	3.41 (2.84-4.08)	4.49 (3.72-5.41)	*6.42 (4.93-8.34)*	4,614	1.20 (0.92-1.58)	3.20 (2.69-3.80)	4.86 (4.18-5.64)	6.06 (5.24-7.02)	*8.49 (7.10-10.13)*

Note: 1 Excludes 341 cases where either gender was not specified and/or ages were invalid. Total sample on which results are based is 772,477 primary knee replacements.

Continued >

Table 3.27 (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		1 year	3 years	5 years	7 years	10 years
Unicondylar and													
Fixed	<55	2,125	1.36 (0.93-1.99)	6.15 (5.05-7.49)	10.17 (8.55-12.08)	13.22 (11.01-15.83)	*17.91 (13.06-24.31)*	2,207	1.18 (0.79-1.77)	7.06 (5.89-8.45)	10.86 (9.26-12.71)	14.79 (12.63-17.28)	*16.66 (14.03-19.72)*
	55-64	3,927	0.67 (0.45-1.0)	3.88 (3.23-4.64)	6.64 (5.71-7.72)	8.56 (7.36-9.94)	*12.49 (10.24-15.19)*	3,279	0.87 (0.59-1.28)	4.93 (4.14-5.87)	7.30 (6.26-8.51)	9.77 (8.40-11.36)	*11.56 (9.55-13.96)*
	65-74	3,267	0.71 (0.46-1.09)	3.65 (2.97-4.49)	5.66 (4.71-6.79)	7.13 (5.92-8.58)	*8.14 (6.55-10.10)*	2,546	0.52 (0.30-0.91)	3.25 (2.52-4.18)	5.08 (4.07-6.33)	7.14 (5.74-8.85)	*11.91 (8.71-16.17)*
	75+	1,339	0.67 (0.33-1.33)	1.70 (1.07-2.70)	3.05 (2.01-4.63)	*3.95 (2.52-6.17)*	*5.25 (3.25-8.42)*	1,229	0.89 (0.48-1.66)	2.32 (1.55-3.49)	3.92 (2.77-5.53)	4.70 (3.33-6.62)	*5.51 (3.86-7.84)*
Mobile	<55	3,433	2.05 (1.61-2.60)	6.92 (6.05-7.91)	10.17 (9.04-11.43)	13.53 (12.05-15.18)	*20.51 (17.61-23.81)*	4,125	1.86 (1.48-2.34)	6.69 (5.90-7.59)	10.69 (9.61-11.88)	14.91 (13.46-16.50)	*19.59 (17.23-22.22)*
	55-64	8,820	1.43 (1.19-1.70)	5.08 (4.61-5.60)	7.21 (6.62-7.86)	9.09 (8.36-9.87)	12.62 (11.33-14.04)	7,732	1.18 (0.95-1.45)	4.41 (3.94-4.94)	7.10 (6.47-7.80)	9.58 (8.76-10.47)	14.04 (12.57-15.67)
	65-74	8,384	1.15 (0.94-1.42)	3.57 (3.16-4.03)	4.94 (4.43-5.52)	6.46 (5.80-7.20)	9.91 (8.61-11.40)	6,710	1.00 (0.78-1.28)	3.75 (3.28-4.28)	5.89 (5.26-6.59)	7.99 (7.17-8.89)	11.65 (10.18-13.33)
	75+	3,496	1.01 (0.72-1.42)	2.63 (2.11-3.28)	3.57 (2.92-4.37)	4.73 (3.85-5.81)	*6.85 (5.07-9.21)*	3,325	1.31 (0.96-1.77)	3.49 (2.87-4.23)	5.15 (4.35-6.10)	6.44 (5.47-7.58)	*9.28 (7.58-11.35)*
Bearing type unknown	<55	95	*1.05 (0.15-7.24)*	*5.91 (2.49-13.67)*	*9.30 (4.47-18.81)*	*14.90 (7.54-28.24)*		102	*1.03 (0.15-7.09)*	*6.65 (3.04-14.22)*	*10.82 (5.73-19.90)*	*10.82 (5.73-19.90)*	
	55-64	184	*2.26 (0.85-5.91)*	*4.12 (1.99-8.47)*	*4.92 (2.48-9.64)*	*8.32 (4.53-15.02)*	*10.35 (5.59-18.75)*	163	*0.00*	*3.11 (1.18-8.07)*	*3.11 (1.18-8.07)*	*3.11 (1.18-8.07)*	*3.11 (1.18-8.07)*
	65-74	144	*0.71 (0.10-4.96)*	*0.71 (0.10-4.96)*	*0.71 (0.10-4.96)*	*3.60 (1.12-11.25)*		133	*0.77 (0.11-5.33)*	*2.73 (0.88-8.27)*	*3.84 (1.45-10.01)*	*7.13 (3.15-15.73)*	
	75+	60	*0.00*	*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*	*2.04 (0.29-13.62)*		60	*1.72 (0.24-11.62)*	*3.77 (0.95-14.33)*	*6.18 (2.01-18.15)*	*9.30 (3.49-23.53)*	
All patellofemoral													
	<55	693	2.91 (1.87-4.53)	9.77 (7.58-12.54)	*14.09 (11.23-17.62)*	*17.94 (14.29-22.41)*	*23.05 (17.27-30.38)*	2,860	1.08 (0.75-1.55)	5.84 (4.93-6.89)	10.10 (8.80-11.60)	14.63 (12.83-16.65)	*21.98 (17.80-26.96)*
	55-64	714	1.82 (1.04-3.18)	5.99 (4.33-8.27)	*10.84 (8.30-14.09)*	*14.88 (11.40-19.30)*	*22.39 (16.37-30.20)*	2,421	0.79 (0.50-1.24)	5.64 (4.71-6.75)	9.90 (8.55-11.43)	13.75 (11.95-15.79)	*18.51 (15.61-21.87)*
	65-74	484	2.43 (1.35-4.34)	7.39 (5.21-10.43)	*11.12 (8.13-15.12)*	*12.46 (9.09-16.95)*	*24.64 (14.10-40.94)*	1,599	0.80 (0.45-1.40)	4.82 (3.80-6.10)	8.17 (6.73-9.90)	10.64 (8.82-12.79)	*16.95 (13.02-21.91)*
	75+	324	0.72 (0.18-2.86)	*3.26 (1.64-6.44)*	*4.73 (2.50-8.84)*	*5.85 (3.10-10.88)*		844	0.63 (0.26-1.51)	2.93 (1.90-4.52)	5.82 (4.09-8.25)	*7.25 (5.16-10.13)*	*7.25 (5.16-10.13)*
Other/ unknown		21						24					-

Note: 1 Excludes 341 cases where either gender was not specified and/or ages were invalid. Total sample on which results are based is 772,477 primary knee replacements.

3.4.2.4 Revisions for different clinical causes after primary knee replacement surgery

The Kaplan-Meier estimates of the cumulative probability of first revision of an implant 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 of the prosthesis on the data collection form.

Consultants can indicate more than one reason for revision surgery on the minimum dataset (MDS) forms. This means that the reasons for revision are not mutually exclusive of each other. In addition, over the last eleven years, there have been a number of versions of the minimum dataset 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. 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 the recommendation of revision surgery. 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 form 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. Checking the year of 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 3.28 (over the page) shows the revision incidence rates, for each reason recorded on the minimum dataset forms for joint revision surgery, for all cases and then sub-divided by fixation type and whether the primary procedure was a TKR or a UKR.

Table 3.29 (from page 114) shows these first knee revision PTIRs for each reason broken down further by fixation, constraint and bearing type.

For TKRs, the highest PTIRs, in descending order, were for revision due to aseptic loosening, pain and

Table 3.28 Revision rates (95% CI), expressed as number of revisions per 1,000 patient-years, 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]
		Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Peri-prosthetic fracture	Implant fracture	Implant wear[1]	Instability	Mal-alignment	Other indication[2]		
All cases	3,402.0	1.07 (1.04-1.11)	0.22 (0.20-0.23)	1.03 (0.99-1.06)	1.35 (1.31-1.39)	0.25 (0.24-0.27)	0.14 (0.12-0.15)	0.02 (0.02-0.03)	0.27 (0.26-0.29)	0.73 (0.70-0.76)	0.43 (0.41-0.45)	1.02 (0.99-1.06)	3,209.5	0.36 (0.34-0.39)
TKR by fixation method														
Cemented	2,818.7	0.72 (0.69-0.76)	0.13 (0.12-0.14)	1.09 (1.06-1.13)	1.04 (1.00-1.08)	0.23 (0.21-0.24)	0.12 (0.11-0.13)	0.02 (0.01-0.02)	0.16 (0.15-0.18)	0.68 (0.65-0.71)	0.37 (0.35-0.39)	0.55 (0.52-0.57)	2,513.7	0.38 (0.35-0.40)
Uncemented	190.9	1.24 (1.09-1.41)	0.24 (0.18-0.32)	0.79 (0.67-0.93)	1.85 (1.67-2.05)	0.30 (0.23-0.39)	0.15 (0.11-0.22)	0.07 (0.04-0.12)	0.26 (0.19-0.34)	0.89 (0.76-1.03)	0.50 (0.41-0.61)	0.73 (0.62-0.86)	165.6	0.45 (0.36-0.57)
Hybrid	48.9	0.84 (0.62-1.14)	0.18 (0.10-0.35)	1.08 (0.83-1.42)	1.17 (0.90-1.51)	0.22 (0.12-0.41)	0.10 (0.04-0.25)	0.04 (0.01-0.16)	0.31 (0.18-0.51)	0.76 (0.55-1.04)	0.39 (0.25-0.61)	0.39 (0.25-0.61)	38.2	0.31 (0.18-0.55)
UKR type														
Patellofemoral	43.6	6.13 (5.44-6.91)	1.03 (0.77-1.38)	0.37 (0.23-0.60)	2.39 (1.97-2.89)	0.18 (0.09-0.37)	0.18 (0.09-0.37)	0.18 (0.09-0.37)	1.77 (1.41-2.21)	1.15 (0.87-1.51)	1.81 (1.45-2.26)	9.14 (8.28-10.08)	39.6	0.58 (0.39-0.87)
Unicondylar	299.5	3.58 (3.37-3.80)	0.89 (0.79-1.01)	0.65 (0.57-0.75)	3.86 (3.65-4.09)	0.48 (0.41-0.57)	0.29 (0.23-0.35)	0.04 (0.03-0.07)	1.11 (0.99-1.23)	1.09 (0.98-1.22)	0.78 (0.69-0.89)	4.62 (4.38-4.86)	267.1	0.25 (0.19-0.31)

Note: 1 The reason 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 indications now include arthritis and incorrect sizing. Both these reasons were only given 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 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.

infection. Revision incidences for pain and aseptic loosening were slightly higher for implants which were uncemented, compared to prostheses 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.

There is also interest 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, PTIRs 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 and 7 to 11 years after the primary surgery took place.

Table 3.30 (page 116) 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 other reasons. Conversely, revision one to 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 3.29 Revision rates (95% CI), expressed as number of revisions per 1,000 patient-years, 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:					
		Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Periprosthetic fracture
Total knee replacement							
Cemented							
unconstrained, fixed	1,813.4	0.70 (0.66-0.74)	0.11 (0.10-0.13)	0.98 (0.94-1.03)	0.90 (0.85-0.94)	0.20 (0.18-0.22)	0.09 (0.08-0.10)
unconstrained, mobile	164.1	1.02 (0.87-1.18)	0.23 (0.17-0.32)	1.13 (0.98-1.31)	1.37 (1.20-1.56)	0.37 (0.28-0.47)	0.12 (0.08-0.19)
posterior-stabilised, fixed	703.5	0.67 (0.61-0.73)	0.13 (0.11-0.16)	1.32 (1.24-1.41)	1.30 (1.22-1.39)	0.26 (0.23-0.30)	0.18 (0.15-0.22)
posterior-stabilised, mobile	49.3	1.18 (0.91-1.52)	0.22 (0.12-0.40)	1.01 (0.77-1.34)	1.07 (0.82-1.41)	0.26 (0.15-0.45)	0.26 (0.15-0.45)
constrained, condylar	12.0	0.50 (0.23-1.12)	0.67 (0.33-1.34)	3.68 (2.74-4.94)	1.17 (0.69-1.98)	0.33 (0.13-0.89)	0.25 (0.08-0.78)
bearing type unknown	45.6	1.21 (0.93-1.57)	0.15 (0.07-0.32)	1.21 (0.93-1.57)	1.56 (1.23-1.96)	0.24 (0.13-0.44)	0.18 (0.09-0.35)
monobloc polyethylene tibia	30.8	0.68 (0.45-1.05)	0.2 (0.09-0.43)	1.07 (0.76-1.51)	0.78 (0.52-1.16)	0.16 (0.07-0.39)	0.10 (0.03-0.30)
Uncemented/hybrid							
unconstrained, fixed	117.0	0.91 (0.76-1.11)	0.15 (0.10-0.24)	0.85 (0.70-1.04)	1.73 (1.50-1.98)	0.24 (0.17-0.35)	0.11 (0.06-0.19)
unconstrained, mobile	101.0	1.27 (1.07-1.51)	0.29 (0.20-0.41)	0.81 (0.65-1.01)	1.60 (1.38-1.87)	0.27 (0.18-0.39)	0.14 (0.08-0.23)
posterior-stabilised, fixed	15.9	2.14 (1.53-3.00)	0.50 (0.25-1.01)	1.13 (0.71-1.80)	2.08 (1.48-2.92)	0.63 (0.34-1.17)	0.38 (0.17-0.84)
other constraint	2.2	2.75 (1.24-6.12)	0.00	0.92 (0.23-3.67)	0.00	0.00	0.00
bearing type unknown	3.7	0.81 (0.26-2.50)	0.00	0.54 (0.13-2.15)	3.49 (2.03-6.01)	0.81 (0.26-2.50)	0.27 (0.04-1.91)
Unicompartmental knee replacement							
Unicondylar							
fixed	77.5	4.04 (3.62-4.51)	0.15 (0.09-0.27)	0.81 (0.64-1.04)	4.03 (3.60-4.50)	0.44 (0.31-0.61)	0.31 (0.21-0.46)
mobile	217.1	3.40 (3.17-3.66)	1.16 (1.03-1.31)	0.60 (0.50-0.71)	3.83 (3.58-4.10)	0.51 (0.42-0.62)	0.29 (0.22-0.37)
bearing type unknown	4.9	3.91 (2.49-6.12)	0.62 (0.20-1.91)	0.41 (0.10-1.64)	2.88 (1.70-4.86)	0.00	0.00
Patellofemoral							
	43.6	6.13 (5.44-6.91)	1.03 (0.77-1.38)	0.37 (0.23-0.60)	2.39 (1.97-2.89)	0.18 (0.09-0.37)	0.18 (0.09-0.37)
Other/unknown							
	0.4	0.00	0.00	0.00	2.45 (0.35-17.43)	0.00	0.00

Note: 1 The reason 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 indications now include arthritis and incorrect sizing. Both these reasons were only given 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 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.

Continued >

Table 3.29 (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]		
Cemented								
unconstrained, fixed	1,813.4	0.01 (0.01-0.02)	0.14 (0.12-0.16)	0.64 (0.60-0.67)	0.36 (0.34-0.39)	0.53 (0.49-0.56)	1,613.2	0.37 (0.34-0.40)
unconstrained, mobile	164.1	0.03 (0.01-0.07)	0.25 (0.18-0.34)	0.99 (0.85-1.16)	0.48 (0.39-0.60)	0.46 (0.37-0.58)	148.7	0.57 (0.46-0.70)
posterior-stabilised, fixed	703.5	0.02 (0.01-0.03)	0.19 (0.16-0.22)	0.66 (0.60-0.72)	0.35 (0.31-0.40)	0.55 (0.50-0.61)	626.1	0.33 (0.29-0.38)
posterior-stabilised, mobile	49.3	0.06 (0.02-0.19)	0.28 (0.17-0.48)	1.09 (0.84-1.43)	0.24 (0.14-0.43)	0.97 (0.73-1.29)	45.4	0.79 (0.57-1.10)
constrained, condylar	12.0	0.00	0.33 (0.13-0.89)	0.92 (0.51-1.66)	0.17 (0.04-0.67)	0.33 (0.13-0.89)	10.6	0.28 (0.09-0.88)
bearing type unknown	45.6	0.11 (0.05-0.26)	0.28 (0.17-0.49)	0.81 (0.59-1.12)	0.48 (0.32-0.73)	1.03 (0.77-1.37)	40.0	0.3 (0.17-0.53)
monobloc polyethylene tibia	30.8	0.00	0.13 (0.05-0.35)	0.78 (0.52-1.16)	0.46 (0.27-0.77)	0.59 (0.37-0.93)	29.8	0.27 (0.13-0.54)
Uncemented/hybrid								
unconstrained, fixed	117.0	0.04 (0.02-0.10)	0.24 (0.17-0.35)	0.84 (0.69-1.02)	0.44 (0.33-0.57)	0.62 (0.50-0.78)	98.8	0.39 (0.29-0.54)
unconstrained, mobile	101.0	0.07 (0.03-0.15)	0.26 (0.18-0.38)	0.75 (0.60-0.94)	0.48 (0.36-0.63)	0.6 (0.47-0.78)	87.1	0.40 (0.29-0.56)
posterior-stabilised, fixed	15.9	0.13 (0.03-0.50)	0.44 (0.21-0.92)	1.38 (0.91-2.10)	0.88 (0.52-1.49)	1.2 (0.76-1.88)	13.2	0.68 (0.35-1.31)
other constraint	2.2	0.00	0.46 (0.06-3.25)	1.37 (0.44-4.26)	0.00	0.46 (0.06-3.25)	2.1	1.44 (0.47-4.47)
bearing type unknown	3.7	0.27 (0.04-1.91)	0.54 (0.13-2.15)	1.88 (0.90-3.94)	0.54 (0.13-2.15)	1.07 (0.40-2.86)	2.6	0.38 (0.05-2.68)
Unicompartmental knee replacement								
Unicondylar								
fixed	77.5	0.06 (0.03-0.16)	0.97 (0.77-1.21)	0.84 (0.66-1.07)	0.70 (0.53-0.91)	4.32 (3.88-4.81)	71.2	0.32 (0.21-0.49)
mobile	217.1	0.03 (0.02-0.07)	1.17 (1.03-1.32)	1.17 (1.04-1.33)	0.82 (0.71-0.95)	4.75 (4.47-5.05)	191.7	0.22 (0.17-0.30)
bearing type unknown	4.9	0.21 (0.03-1.46)	0.62 (0.20-1.91)	1.44 (0.69-3.02)	0.41 (0.10-1.64)	3.08 (1.86-5.11)	4.2	0.00
Patellofemoral								
	43.6	0.18 (0.09-0.37)	1.77 (1.41-2.21)	1.15 (0.87-1.51)	1.81 (1.45-2.26)	9.14 (8.28-10.08)	39.6	0.58 (0.39-0.87)
Other/unknown								
	0.4	0.00	2.45 (0.35-17.43)	0.00	0.00	0.00	0.00	-

Note: 1 The reason 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 indications now include arthritis and incorrect sizing. Both these reasons were only given 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 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 3.30 Revision rates (95% CI) broken down by time period in which primary was revised, expressed as number of revisions per 1,000 patient-years, 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]
		Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Peri-prosthetic fracture	Implant fracture	Implant wear[1]	Instability	Mal-alignment	Other indication[2]		
All cases	3,402.1	1.07 (1.04-1.11)	0.22 (0.20-0.23)	1.03 (0.99-1.06)	1.35 (1.31-1.39)	0.25 (0.24-0.27)	0.14 (0.12-0.15)	0.02 (0.02-0.03)	0.27 (0.26-0.29)	0.73 (0.70-0.76)	0.43 (0.41-0.45)	1.02 (0.99-1.06)	3,209.5	0.36 (0.34-0.39)
<1	722.0	0.65 (0.60-0.71)	0.43 (0.38-0.48)	1.59 (1.50-1.68)	0.68 (0.63-0.75)	0.12 (0.10-0.15)	0.24 (0.20-0.27)	0.01 (0.00-0.02)	0.21 (0.18-0.24)	0.58 (0.53-0.64)	0.36 (0.32-0.41)	0.68 (0.62-0.74)	701.7	0.33 (0.29-0.38)
1-3	1,148.9	1.71 (1.63-1.78)	0.23 (0.20-0.26)	1.30 (1.23-1.36)	1.74 (1.66-1.82)	0.28 (0.25-0.31)	0.12 (0.10-0.14)	0.03 (0.02-0.04)	0.25 (0.22-0.28)	0.99 (0.94-1.05)	0.61 (0.57-0.66)	1.29 (1.23-1.36)	1,109.7	0.56 (0.51-0.60)
3-5	783.9	1.01 (0.94-1.08)	0.11 (0.09-0.13)	0.66 (0.61-0.72)	1.40 (1.32-1.49)	0.27 (0.23-0.31)	0.11 (0.09-0.13)	0.02 (0.01-0.03)	0.25 (0.22-0.29)	0.65 (0.60-0.71)	0.37 (0.33-0.41)	0.95 (0.89-1.03)	746.9	0.28 (0.24-0.32)
5-7	468.3	0.65 (0.58-0.73)	0.09 (0.06-0.12)	0.51 (0.45-0.58)	1.31 (1.21-1.42)	0.30 (0.25-0.35)	0.09 (0.06-0.12)	0.03 (0.02-0.05)	0.35 (0.30-0.41)	0.52 (0.46-0.59)	0.31 (0.26-0.36)	0.95 (0.87-1.05)	434.0	0.18 (0.14-0.22)
7-11	279.0	0.47 (0.40-0.56)	0.12 (0.09-0.17)	0.37 (0.31-0.45)	1.41 (1.28-1.56)	0.34 (0.28-0.42)	0.14 (0.10-0.19)	0.04 (0.02-0.07)	0.48 (0.40-0.57)	0.62 (0.53-0.72)	0.26 (0.20-0.33)	1.10 (0.98-1.23)	217.2	0.15 (0.11-0.21)

Note: 1 The reason 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 indications now include arthritis and incorrect sizing. Both these reasons were only given 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 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.

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

Tables 3.31 (below) and 3.32 (over the page) show the Kaplan-Meier estimates of the cumulative percentage probability of first revision, for any reason, of a primary TKR (Table 3.31) and primary UKR (Table 3.32) 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 3.33 (page 119) 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 3.31 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
ACS	1,078	68 (61-74)	49	0.71 (0.34-1.48)	3.61 (2.50-5.22)	3.98 (2.78-5.68)	*4.35 (3.02-6.26)*	
Advance MP	6,633	70 (63-76)	46	0.40 (0.27-0.59)	1.94 (1.61-2.34)	2.51 (2.11-2.99)	3.40 (2.86-4.04)	*3.86 (3.12-4.77)*
AGC	60,916	71 (64-77)	43	0.29 (0.25-0.34)	1.46 (1.36-1.56)	2.04 (1.92-2.17)	2.59 (2.44-2.75)	3.55 (3.29-3.82)
AMP Stature	1,250	68 (62-75)	20	0.26 (0.09-0.82)	2.37 (1.54-3.62)	*5.02 (3.41-7.37)*	*5.02 (3.41-7.37)*	
Columbus	7,485	70 (64-76)	43	0.47 (0.33-0.67)	1.88 (1.54-2.30)	2.57 (2.12-3.13)	3.19 (2.54-3.99)	*3.7 (2.65-5.16)*
E-Motion Bicondylar	2,653	67 (61-74)	45	0.71 (0.45-1.13)	2.25 (1.7-2.98)	3.00 (2.30-3.91)	4.00 (3.07-5.20)	
Endoplus Bicondylar	14,495	70 (64-76)	45	0.67 (0.55-0.82)	1.81 (1.6-2.04)	2.43 (2.18-2.70)	2.81 (2.53-3.12)	3.37 (2.92-3.90)
Genesis 2	43,715	71 (65-77)	42	0.40 (0.35-0.47)	1.43 (1.31-1.57)	2.00 (1.83-2.18)	2.47 (2.25-2.70)	2.67 (2.40-2.97)
Genesis 2 Oxinium	6,447	58 (54-63)	42	0.55 (0.39-0.77)	2.29 (1.91-2.75)	3.43 (2.92-4.04)	4.3 (3.64-5.07)	*5.39 (4.40-6.58)*
Insall-Burstein 2	2,587	71 (65-77)	45	0.27 (0.13-0.57)	1.60 (1.18-2.18)	2.83 (2.24-3.57)	3.74 (3.04-4.59)	5.33 (4.36-6.50)
Kinemax	10,865	71 (64-77)	43	0.24 (0.16-0.35)	1.77 (1.53-2.04)	2.68 (2.38-3.01)	3.47 (3.12-3.85)	4.79 (4.33-5.31)
LCS	2,040	70 (63-76)	41	0.64 (0.37-1.10)	1.80 (1.3-2.49)	2.38 (1.79-3.15)	2.66 (2.03-3.48)	3.12 (2.42-4.02)
LCS Complete	22,007	70 (63-76)	45	0.47 (0.38-0.57)	1.70 (1.52-1.89)	2.61 (2.38-2.87)	3.18 (2.89-3.50)	*3.48 (3.14-3.85)*
Maxim	2,175	70 (63-77)	42	0.37 (0.19-0.74)	1.80 (1.31-2.48)	2.61 (1.98-3.42)	3.12 (2.4-4.05)	*4.72 (3.47-6.41)*
MRK	7,838	70 (64-77)	41	0.26 (0.17-0.41)	1.23 (0.98-1.55)	1.61 (1.31-1.99)	2.25 (1.83-2.78)	*4.15 (2.66-6.45)*
Natural Knee II	2,813	70 (64-76)	42	0.33 (0.17-0.63)	1.37 (0.99-1.91)	2.24 (1.71-2.94)	3.61 (2.84-4.58)	*3.90 (3.00-5.08)*
Nexgen	102,134	70 (63-76)	42	0.37 (0.33-0.41)	1.41 (1.33-1.50)	2.19 (2.08-2.31)	2.83 (2.69-2.98)	3.56 (3.33-3.81)
NRG	11,580	70 (63-76)	43	0.38 (0.28-0.51)	1.59 (1.36-1.86)	2.41 (2.10-2.78)	3.20 (2.66-3.84)	

Table 3.31 (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
Optetrak	2,409	70 (63-76)	43	0.72 (0.45-1.15)	2.84 (2.23-3.62)	4.44 (3.60-5.46)	5.02 (4.08-6.16)	*6.92 (4.71-10.12)*
PFC Sigma-Bicondylar	241,679	70 (64-77)	42	0.37 (0.35-0.40)	1.35 (1.30-1.40)	1.89 (1.82-1.95)	2.21 (2.14-2.29)	2.66 (2.55-2.77)
Profix	3,978	73 (67-78)	44	0.38 (0.23-0.63)	1.32 (1.00-1.73)	1.88 (1.49-2.37)	2.38 (1.92-2.95)	2.73 (2.17-3.44)
Rotaglide	1,276	71 (63-77)	39	0.42 (0.18-1.01)	2.06 (1.36-3.13)	3.20 (2.22-4.59)	3.96 (2.75-5.69)	*3.96 (2.75-5.69)*
Rotaglide +	2,110	70 (63-76)	44	0.62 (0.36-1.07)	3.02 (2.36-3.85)	3.96 (3.19-4.91)	4.80 (3.93-5.86)	6.34 (5.16-7.79)
Scorpio	25,083	71 (64-77)	42	0.43 (0.35-0.52)	1.80 (1.64-1.98)	2.56 (2.37-2.78)	3.18 (2.96-3.43)	4.02 (3.68-4.40)
Triathlon	51,423	70 (63-76)	42	0.48 (0.42-0.55)	1.60 (1.47-1.74)	2.15 (1.98-2.34)	2.63 (2.34-2.96)	
Vanguard	33,492	69 (63-76)	42	0.34 (0.28-0.41)	1.46 (1.30-1.65)	2.23 (1.97-2.52)	2.65 (2.28-3.08)	

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 6,889 primary operations where the knee brand was not recorded.

Table 3.32 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
Patellofemoral								
Avon	4,457	59 (51-68)	24	0.81 (0.58-1.13)	4.34 (3.74-5.04)	7.66 (6.81-8.62)	10.4 0(9.32-11.59)	*14.50 (12.72-16.51)*
FPV	1,433	59 (52-68)	21	0.88 (0.50-1.54)	6.45 (5.19-7.99)	9.84 (8.11-11.91)	*11.69 (9.54-14.30)*	
Journey PFJ Oxinium	1,317	58 (50-67)	23	2.03 (1.37-2.99)	7.34 (5.94-9.06)	12.39 (10.36-14.79)	*17.06 (14.66-21.06)*	
Sigma HP	868	59 (52-67)	22	2.75 (1.82-4.15)	6.84 (5.11-9.13)	*13.29 (9.55-18.33)*		
Zimmer PFJ	1,133	58 (51-67)	23	0.82 (0.41-1.64)	4.08 (2.85-5.83)	*5.29 (3.59-7.77)*		
Unicondylar								
AMC/Uniglide	2,582	64 (57-71)	50	2.36 (1.83-3.04)	6.12 (5.22-7.17)	7.93 (6.86-9.16)	10.03 (8.68-11.57)	*12.16 (9.82-15.01)*
MG Unicondylar	2,368	63 (56-70)	54	0.89 (0.58-1.36)	3.92 (3.21-4.79)	5.09 (5.01-6.94)	7.62 (6.57-8.83)	9.99 (8.5-11.72)
Oxford Partial Knee	44,936	64 (57-71)	52	1.18 (1.08-1.29)	4.21 (4.01-4.42)	6.38 (6.12-6.66)	8.51 (8.17-8.86)	12.38 (11.75-13.04)
Preservation	1,512	62 (56-69)	55	2.32 (1.67-3.22)	7.68 (6.44-9.15)	11.32 (9.81-13.04)	14.38 (12.65-16.32)	*18.00 (15.74-20.54)*
Sigma HP	4,912	62 (55-69)	58	0.90 (0.66-1.24)	3.84 (3.21-4.60)	*5.25 (4.25-6.48)*		
Zimmer Unicompartment	6,442	62 (55-69)	54	0.40 (0.26-0.61)	2.95 (2.46-3.54)	4.76 (4.03-5.62)	*5.89 (4.93-7.03)*	

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.

Table 3.33 Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) of a total 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
AGC								
Cement, unconstrained fixed	57,512	71 (64-77)	42	0.26 (0.22-0.31)	1.39 (1.29-1.50)	1.97 (1.85-2.11)	2.50 (2.35-2.66)	3.42 (3.16-3.70)
Uncem hybrid, unconstrained fixed	2,092	70 (63-76)	50	1.11 (0.74-1.67)	3.05 (2.38-3.89)	3.75 (2.99-4.69)	4.28 (3.44-5.34)	*6.54 (4.50-9.44)*
Columbus								
Cement, unconstrained fixed	6,804	70 (64-76)	43	0.39 (0.26-0.59)	1.74 (1.40-2.17)	2.45 (1.98-3.02)	3.12 (2.44-3.98)	*3.76 (2.54-5.56)*
Endoplus Bicondylar Knee								
Cement, unconstrained fixed	7,799	71 (64-76)	46	0.75 (0.58-0.96)	1.90 (1.62-2.24)	2.55 (2.21-2.93)	2.96 (2.58-3.40)	*3.48 (2.80-4.32)*
Cement, unconstrained mobile	4,577	70 (64-76)	45	0.51 (0.34-0.77)	1.51 (1.18-1.92)	2.10 (1.71-2.59)	2.47 (2.03-3.00)	*3.07 (2.39-3.93)*
Uncem hybrid, PS fixed	1,703	71 (65-77)	39	0.55 (0.28-1.05)	1.74 (1.19-2.55)	2.44 (1.74-3.41)	2.71 (1.94-3.77)	*3.09 (2.12-4.51)*
Genesis 2								
Cement, unconstrained fixed	31,826	71 (65-77)	43	0.32 (0.26-0.39)	1.26 (1.12-1.41)	1.80 (1.62-2.00)	2.25 (2.01-2.52)	2.49 (2.18-2.84)
Cement, PS fixed	10,226	71 (65-77)	40	0.67 (0.53-0.86)	1.91 (1.62-2.25)	2.59 (2.21-3.04)	3.10 (2.59-3.71)	*3.25 (2.68-3.95)*
Insall-Burstein 2								
Cement, PS fixed	2,393	71 (65-77)	46	0.30 (0.14-0.62)	1.43 (1.02-2.01)	2.67 (2.08-3.42)	3.39 (2.70-4.24)	4.74 (3.82-5.87)
Kinemax								
Cement, unconstrained fixed	10,658	71 (64-77)	43	0.25 (0.17-0.36)	1.79 (1.55-2.06)	2.70 (2.40-3.03)	3.49 (3.14-3.87)	4.81 (4.34-5.32)
LCS								
Uncem 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)	2.71 (1.95-3.76)
Maxim								
Cement, unconstrained fixed	1,322	69 (63-76)	43	0.15 (0.04-0.61)	1.42 (0.90-2.25)	2.16 (1.47-3.16)	2.83 (1.98-4.04)	*4.01 (2.78-5.77)*
MRK								
Cement, unconstrained fixed	7,704	70 (64-77)	41	0.27 (0.17-0.42)	1.25 (0.99-1.58)	1.64 (1.33-2.02)	2.29 (1.86-2.82)	*4.19 (2.69-6.48)*
Nexgen								
Cement, unconstrained fixed	43,655	70 (63-76)	42	0.27 (0.23-0.33)	1.07 (0.96-1.19)	1.60 (1.45-1.76)	2.20 (1.99-2.43)	*2.72 (2.34-3.17)*
Cement, PS fixed	49,216	70 (64-77)	41	0.43 (0.37-0.49)	1.54 (1.42-1.67)	2.51 (2.35-2.69)	3.22 (3.01-3.44)	4.10 (3.76-4.46)
Uncem hyb, unconstrained fixed	4,901	65 (59-72)	54	0.55 (0.37-0.80)	2.31 (1.91-2.79)	2.98 (2.51-3.53)	3.28 (2.78-3.88)	*3.55 (2.95-4.27)*
Uncem hybrid, PS fixed	1,882	65 (58-73)	54	0.35 (0.16-0.77)	1.81 (1.25-2.61)	2.53 (1.82-3.51)	3.17 (2.28-4.39)	*4.02 (2.82-5.70)*

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 4,856 joint replacements with no record of a main brand.

Table 3.33 (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
Opetrak								
Cement, PS fixed	1,531	70 (63-76)	43	0.59 (0.31-1.14)	2.64 (1.94-3.60)	4.64 (3.62-5.96)	5.27 (4.13-6.70)	*8.34 (4.42-15.47)*
PFC Sigma Bicondylar								
Cement, unconstrained fixed	151,402	70 (64-76)	43	0.35 (0.32-0.38)	1.22 (1.16-1.29)	1.71 (1.63-1.79)	2.01 (1.92-2.10)	2.35 (2.23-2.49)
Cement, unconstrained mobile	7,225	64 (58-71)	48	0.59 (0.43-0.80)	1.84 (1.54-2.20)	2.58 (2.21-3.02)	3.06 (2.63-3.57)	*3.53 (2.97-4.20)*
Cement, PS fixed	63,980	71 (64-77)	41	0.37 (0.33-0.42)	1.47 (1.37-1.58)	2.05 (1.93-2.19)	2.41 (2.26-2.57)	3.00 (2.77-3.25)
Cement, PS mobile	6,455	64 (58-72)	46	0.71 (0.53-0.96)	2.14 (1.79-2.56)	2.99 (2.55-3.51)	3.57 (3.04-4.19)	*4.45 (3.44-5.75)*
Cement, constraint unknown	1,991	71 (64-77)	47	0.36 (0.17-0.75)	1.58 (1.10-2.27)	2.28 (1.67-3.12)	2.50 (1.83-3.41)	*2.65 (1.94-3.61)*
Monobloc polyethylene tibia	7,301	75 (70-79)	41	0.36 (0.24-0.55)	1.43 (1.12-1.82)	1.87 (1.43-2.43)	*2.08 (1.52-2.85)*	*4.47 (1.56-12.46)*
Uncem hyb, unconstrained fixed	1,671	70 (64-76)	47	0.30 (0.13-0.72)	1.19 (0.76-1.87)	1.82 (1.26-2.63)	1.91 (1.33-2.73)	*2.32 (1.58-3.42)*
Profix								
Uncem hyb, unconstrained fixed	2,309	73 (66-78)	45	0.26 (0.12-0.59)	1.21 (0.83-1.76)	1.47 (1.04-2.07)	1.72 (1.23-2.41)	*1.94 (1.34-2.80)*
Rotaglide								
Cement, unconstrained fixed	1,222	71 (63-77)	38	0.26 (0.08-0.81)	1.88 (1.20-2.94)	3.06 (2.09-4.48)	*3.56 (2.43-5.20)*	*3.56 (2.43-5.20)*
Rotaglide +								
Cement, unconstrained mobile	1,707	70 (64-77)	43	0.47 (0.24-0.94)	2.83 (2.13-3.75)	3.68 (2.87-4.71)	4.32 (3.42-5.46)	5.72 (4.48-7.30)
Scorpio								
Cement, unconstrained fixed	10,659	71 (64-77)	41	0.44 (0.33-0.59)	1.87 (1.63-2.15)	2.59 (2.30-2.93)	3.13 (2.79-3.50)	3.85 (3.35-4.42)
Cement, unconstrained mobile	1,149	69 (63-75)	43	0.35 (0.13-0.93)	2.59 (1.81-3.71)	3.61 (2.66-4.89)	4.42 (3.32-5.86)	*4.71 (3.51-6.29)*
Cement, PS fixed	6,065	71 (65-77)	41	0.23 (0.14-0.39)	1.57 (1.28-1.92)	2.37 (2.00-2.79)	3.09 (2.66-3.59)	4.06 (3.38-4.88)
Cement, PS mobile	1,367	68 (61-76)	45	0.37 (0.15-0.88)	1.42 (0.91-2.22)	2.15 (1.49-3.10)	2.44 (1.72-3.46)	*3.58 (2.34-5.45)*
Uncem hyb, unconstrained fixed	4,798	71 (64-77)	45	0.59 (0.41-0.85)	1.78 (1.44-2.20)	2.42 (2.01-2.93)	3.10 (2.58-3.72)	*4.14 (3.33-5.15)*
Vanguard								
Cement, unconstrained fixed	26,891	69 (63-76)	42	0.33 (0.26-0.41)	1.41 (1.24-1.61)	2.15 (1.87-2.47)	2.44 (2.07-2.86)	
Cement, PS fixed	4,481	70 (63-76)	41	0.43 (0.26-0.70)	1.83 (1.35-2.48)	3.02 (2.19-4.17)	*4.08 (2.61-6.37)*	
E-Motion Bicondylar Knee								
Uncem hybrid, unconstrained mobile	1,753	67 (61-74)	49	0.89 (0.54-1.48)	2.01 (1.42-2.86)	2.83 (2.06-3.88)	3.84 (2.83-5.21)	

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 4,856 joint replacements with no record of a main brand.

Table 3.33 (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
Triathlon								
Cement, unconstrained fixed	39,693	70 (63-76)	43	0.42 (0.35-0.49)	1.51 (1.37-1.67)	1.97 (1.78-2.18)	2.52 (2.19-2.91)	
Cement, PS fixed	10,361	70 (63-76)	40	0.63 (0.49-0.81)	1.68 (1.42-2.0)	2.52 (2.12-2.99)	*2.59 (2.17-3.09)*	
AMP Stature								
Cement, unconstrained fixed	1,080	68 (61-74)	16	0.10 (0.01-0.74)	1.84 (1.07-3.16)	*3.47 (2.10-5.72)*		
NRG								
Cement, unconstrained fixed	6,814	70 (64-77)	43	0.33 (0.21-0.50)	1.46 (1.17-1.81)	2.37 (1.96-2.87)	3.14 (2.44-4.04)	
Cement, PS fixed	4,535	70 (63-76)	43	0.43 (0.27-0.67)	1.74 (1.38-2.20)	2.38 (1.92-2.96)	*2.94 (2.35-3.67)*	
LCS Complete								
Cement, unconstrained mobile	9,533	70 (64-76)	43	0.42 (0.31-0.58)	1.64 (1.38-1.94)	2.71 (2.36-3.12)	3.50 (3.04-4.02)	*3.94 (3.38-4.60)*
Uncem hybrid, unconstrained mobile	12,349	69 (62-76)	46	0.50 (0.39-0.65)	1.76 (1.52-2.03)	2.54 (2.23-2.88)	2.91 (2.55-3.31)	*3.11 (2.71-3.58)*
Natural Knee II								
Cement, unconstrained fixed	2,668	70 (64-76)	41	0.34 (0.18-0.66)	1.45 (1.04-2.02)	2.21 (1.67-2.93)	3.38 (2.63-4.35)	*3.72 (2.78-4.97)*
Advance MP								
Cement, unconstrained fixed	6,562	70 (63-76)	46	0.41 (0.27-0.60)	1.94 (1.61-2.35)	2.53 (2.12-3.01)	3.42 (2.88-4.07)	*3.90 (3.14-4.82)*
Genesis 2 Oxinium								
Cement, unconstrained fixed	4,146	59 (54-63)	43	0.47 (0.29-0.74)	1.87 (1.46-2.38)	2.98 (2.40-3.69)	3.65 (2.95-4.52)	*4.94 (3.84-6.33)*
Cement, PS fixed	2,043	58 (53-63)	42	0.79 (0.48-1.31)	3.33 (2.53-4.37)	4.66 (3.60-6.03)	*6.36 (4.76-8.48)*	

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 4,856 joint replacements with no record of a main brand.

Continued >

3.4.3 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 eleven 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 methodological note III on page 87).

Of the 772,818 records of a primary knee replacement operation over the period 1 April 2003 to 31 December 2014, 332 did not have an NHS number and therefore their death details could not be traced. A further nine had missing information on their age (one) or gender (eight). These were all excluded from analyses on mortality. Among those remaining, 9,056 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 763,421 distinct patients who had had a primary operation to replace one or both knees within the NJR and 72,214 of these patients died in the post-operative time period up to 31 December 2014.

Table 3.34 (right) 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, overall, have had a primary knee replacement and, proportionally, more women than men undergo surgery above the age of 75.

Men, 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 women in the equivalent age group.

Table 3.34 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	11 years
Males									
<55	22,810	0.04 (0.02-0.07)	0.07 (0.04-0.11)	0.27 (0.21-0.35)	1.06 (0.92-1.22)	1.84 (1.63-2.07)	2.87 (2.56-3.22)	5.38 (4.67-6.18)	*6.38 (5.40-7.54)*
55-59	29,054	0.07 (0.05-0.11)	0.13 (0.09-0.18)	0.40 (0.33-0.48)	1.45 (1.30-1.61)	2.87 (2.64-3.12)	4.83 (4.48-5.21)	8.28 (7.58-9.05)	9.90 (8.83-11.08)
60-64	53,336	0.07 (0.05-0.09)	0.12 (0.09-0.15)	0.49 (0.43-0.55)	2.01 (1.89-2.15)	3.97 (3.77-4.18)	6.42 (6.13-6.73)	11.24 (10.63-11.88)	13.22 (12.29-14.22)
65-69	64,771	0.10 (0.08-0.13)	0.19 (0.16-0.23)	0.71 (0.65-0.78)	2.90 (2.75-3.05)	6.06 (5.83-6.29)	9.93 (9.59-10.28)	17.73 (17.04-18.45)	20.39 (19.44-21.38)
70-74	64,820	0.16 (0.13-0.20)	0.31 (0.27-0.36)	1.15 (1.07-1.24)	4.71 (4.53-4.90)	9.86 (9.57-10.15)	16.24 (15.83-16.66)	28.56 (27.75-29.38)	32.74 (31.62-33.88)
75-79	53,534	0.32 (0.28-0.37)	0.57 (0.50-0.63)	1.99 (1.87-2.11)	7.47 (7.23-7.73)	15.52 (15.14-15.91)	25.31 (24.77-25.85)	43.66 (42.67-44.67)	49.08 (47.71-50.46)
80-84	29,021	0.72 (0.63-0.82)	1.21 (1.09-1.34)	3.49 (3.28-3.72)	12.54 (12.12-12.97)	24.91 (24.29-25.54)	40.14 (39.30-41.00)	62.68 (61.28-64.08)	*67.58 (65.71-69.43)*
85+	10,659	1.32 (1.12-1.56)	2.27 (2.01-2.58)	5.94 (5.50-6.42)	20.43 (19.57-21.31)	39.67 (38.46-40.91)	59.53 (58.00-61.08)	*79.7 (77.41-81.89)*	*85.01 (81.51-88.17)*
Females									
<55	32,225	0.02 (0.01-0.05)	0.04 (0.03-0.07)	0.15 (0.11-0.20)	0.69 (0.60-0.81)	1.35 (1.20-1.53)	2.13 (1.90-2.38)	3.63 (3.19-4.12)	3.94 (3.40-4.57)
55-59	38,485	0.03 (0.02-0.05)	0.05 (0.03-0.08)	0.22 (0.18-0.28)	0.89 (0.79-1.00)	1.88 (1.72-2.06)	3.34 (3.08-3.61)	6.07 (5.55-6.65)	7.23 (6.42-8.12)
60-64	61,712	0.05 (0.04-0.07)	0.09 (0.07-0.12)	0.33 (0.28-0.38)	1.35 (1.25-1.45)	2.69 (2.53-2.85)	4.48 (4.25-4.73)	8.34 (7.81-8.90)	9.78 (8.98-10.64)
65-69	77,496	0.07 (0.06-0.10)	0.13 (0.11-0.16)	0.45 (0.40-0.50)	1.94 (1.83-2.06)	3.97 (3.80-4.15)	6.43 (6.18-6.70)	12.61 (12.05-13.20)	14.27 (13.53-15.05)
70-74	83,231	0.10 (0.08-0.12)	0.19 (0.16-0.22)	0.70 (0.64-0.76)	2.87 (2.74-3.00)	6.26 (6.06-6.47)	10.72 (10.41-11.03)	20.45 (19.8-21.10)	23.65 (22.77-24.55)
75-79	76,784	0.18 (0.15-0.21)	0.35 (0.31-0.39)	1.23 (1.15-1.31)	4.85 (4.68-5.02)	10.50 (10.23-10.77)	18.09 (17.69-18.49)	33.73 (32.95-34.53)	38.9 (37.80-40.01)
80-84	46,788	0.33 (0.28-0.38)	0.64 (0.57-0.72)	2.02 (1.89-2.15)	7.88 (7.61-8.15)	16.99 (16.57-17.42)	28.58 (27.98-29.19)	50.73 49.61-51.86)	57.27 (55.74-58.81)
85+	18,695	0.67 (0.57-0.80)	1.34 (1.18-1.54)	3.81 (3.54-4.11)	14.14 (13.59-14.71)	28.86 (28.04-29.69)	47.09 (45.99-48.20)	*72.54 (70.71-74.35)*	*77.20 (74.80-79.53)*
All cases	**763,421**	**0.18 (0.17-0.19)**	**0.33 (0.32-0.34)**	**1.08 (1.05-1.10)**	**4.18 (4.13-4.23)**	**8.69 (8.61-8.77)**	**14.39 (14.27-14.50)**	**25.20 (24.97-25.44)**	**28.55 (28.23-28.87)**

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

Part 3

3.5 Longitudinal knee PROMs

This section investigates changes in the distribution of knee Patient Reported Outcome Measures (PROMs) up to three years after primary knee replacement surgery and the associations between patient demographics, the implant used, method of fixation and the time course of knee PROMs outcomes over this period.

3.5.1 Description of the cohort

3.5.1.1 Background to the NJR longitudinal follow-up dataset

The data described are taken from a NJR-sponsored research study tracking the longitudinal PROMs of a sample of elective knee and hip patients who had joint surgery (a primary or revision) in 2010.

Currently, all patients treated by or on behalf of NHS England for an elective knee and/or hip joint replacement are invited to complete a PROMs questionnaire prior to surgery (Q1) and again at six months after surgery (Q2). The dataset of those Q1 and/or Q2 returned responses which are recorded and held by the Health and Social Care Information Centre (HSCIC) are referred to here as 'National PROMs'.

For the NJR longitudinal sample cohort, a subset of patients who had had elective primary or revision hip/knee surgery carried out in 2010 were invited to complete further follow-up PROMs questionnaires at 12 and 36 months after their initial joint surgery (named Q3 and Q4 respectively). There is interest in how patient reported outcomes of primary (or revision) joint surgery change in the longer term and whether the outcomes of surgery are best evaluated at six months after surgery or at a later point.

The eligibility criteria for inclusion in the sample was a person who had:

(i) had a knee/hip primary or revision surgery date in 2010 (either or both sides)

(ii) returned both the pre-operative PROMs questionnaire, Q1, and the follow-up questionnaire, Q2 (usually completed at about six months post-operation), although this could be partially completed only

(iii) not died up to the point of return of the Q2 PROMs

A third PROMs questionnaire, Q3, was posted to a sample of eligible patients in time for them to respond around 12 months after the initial surgery on that joint and side. The 12-month PROMs contained the same items as Q2. Finally, those who returned a Q3 (and who had not died by circa 35 months after original surgery on the site) were posted a fourth PROMs, Q4 (again containing the identical items in Q2 plus one additional question), to be completed and returned at circa 36 months after the initial surgery on the joint.

Throughout this section we restrict analysis to the NJR longitudinal sample of patients who had had primary knee replacement surgery only. Analysis of hips will be reported next year.

A total of 33,833 knee primary and revision patients were sent a Q3 questionnaire in 2010 (invited sample), of which 32,147 were knee primaries. A total of 20,721 of these primaries resulted in a Q3 questionnaire return with at least one item completed (i.e. 64% were partially or fully completed) and 11,426 knee primary NJR patient procedures resulted in a non-response (36%). A total of 17,485 of the Q3 responders returned a Q4 which was at least partially complete.

The main focus of this section is to highlight differences seen in Oxford Knee Scores (OKS) between sub-groups of patients across the three post-operative time points, although we report briefly on the overall distributions of the EQ-5D Index and EQ-5D Health Scale (VAS) over time.

As part of the work for our 10th Annual Report in 2013 we had access to a National PROMs file of Q1 and/or Q2 returned responses for both primary and revision hip and knee operations carried out between 2009 and 2012 on behalf of NHS England in a hospital or treatment centre. After exclusion of records with empty fields and duplicates on all Q1 and Q2 items, there were 237,696 knee and 207,436 hip PROMs records remaining for this period. The process of linking these National PROMs to the NJR primary joint replacement records was undertaken via NHS Hospital Episode Statistics (HES) inpatient records to report on PROMs outcomes in 2013 (for further details and the steps taken to link please see our 10th Annual Report 2013). The resulting dataset is referred to as the NJR/PROMs

linked dataset and its relevance to the longitudinal dataset is discussed in the following section.

3.5.1.2 Linkage to NJR/HES data

PROMs datasets contain only a limited number of patient factors, they do not contain details of the surgery undertaken or the implant that has been inserted/revised and, furthermore, some operation dates are missing. To obtain additional factors relating to the surgery and the patient, we linked our longitudinal dataset to the NJR/PROMs linked dataset of knee primaries used to report on PROMs outcomes in the 2013 Annual Report. Some patient details: age at primary, gender, BMI, ASA grade, the method of fixation and date of primary surgery were extracted from the NJR; other patient related characteristics – ethnicity and index of multiple deprivation – were obtained via the patients' HES records.

We were able to fully match 24,616 out of the 32,147 longitudinal PROMs knee primaries to the NJR/HES linked file. These knee primaries had already been included in the Q1/Q2 PROMs analysis presented in the 10th Annual Report. In addition, as the longitudinal study sample of NJR primaries had already been directly linked to their relevant PROMs from 2010; we were able to recover a further 7,531 NJR primary operations, which in 2013 we had not been able to match to their PROMs. This meant we could enhance our previous PROMs analyses as well as extending the follow-up period. We were still unable to match these additional NJR/PROMs matched cases to the HES dataset. This explains why the factors originating from the HES data source (ethnicity and the multiple deprivation index) have fewer available cases.

3.5.1.3 Representativeness of the sample of knee primaries in the NJR longitudinal cohort

Before examining the longitudinal profiles we investigated how representative the patients in the longitudinal sample are, generally speaking, of the cohort of NJR primaries with a linked PROMs (best match achieved in 2013) and with a primary operation date which took place in 2010, i.e. those NJR patients who had an elective primary knee surgery in an NHS hospital or a treatment centre in England in 2010 and who had a linked National PROMs (Q1 and Q2 or Q1 only).

Starting with the dataset where the NJR longitudinal sample was matched to the NJR/HES/PROMs best matched dataset of 2013, we restricted to primary operations performed in 2010 only and dropped cases with an incomplete/missing baseline PROMs measure, Q1. This left a total of 43,487 NJR primary knee surgeries which took place in 2010 with a link to at least a baseline PROMs.

We then defined three groups for comparison:

Group A: the 2010 subset of 2013 NJR to PROMs matched knee primaries which had not been invited to take part in the NJR longitudinal study (n=11,354)

Group B: those NJR primary knee surgeries invited to take part in the longitudinal study but who did not respond, i.e. were sent a Q3 questionnaire but did not return it (n=11,418)

Group C: the invited 2010 cohort of knee primaries who did respond to Q3, i.e. the longitudinal sample (n=20,715)

3.5.2 Data sources and statistical methods

Description of patient and surgical factors

Patient age (in years) at time of primary surgery, as recorded in the NJR, was grouped as follows: <55, 55-59, 60-64, 65-69, 70-74, 75-79 and 80+.

We derived an area deprivation indicator based on the patient's area of residence at time of primary surgery as neither HES, the NJR or PROMs data sources gather information on the socioeconomic status of an individual. HES is the sole data source which records the patient's postcode on hospital admission. For each postcode in England, there is a distinct small geographical area (a lower layer super output area, SOAL) and English Indices of Multiple Deprivation (IMD) are published every few years for each SOAL. The most appropriate index for this work was the 2010 IMD. The index is a weighted score reflecting the extent to which people in a SOAL area have

unmet needs due to a lack of resources across seven domains: Income, Employment, Health and disability, Education skills and training, Barriers to housing and Other services, Crime and Living environment. We ranked the IMD over every SOAL in England and, using the quintiles of the score distribution, created a five point categorical indicator of the 20% most deprived (quintile 1) to the 20% least deprived (quintile 5) areas in England.

A patient's ethnicity is captured in HES on admission as an inpatient to a NHS hospital. HES has used the Office for National Statistics 2001 classifications of ethnicity since April 2001. There are 18 ethnic substrata including Asian and Black mixed race groups such as White/Black African, White/Asian, White/Black Caribbean. Prior to 2001, HES used fewer groups; a major difference was that all mixed heritage patients where classed as Other.

We linked all HES records of an NJR patient admission to a NHS England hospital over time for any reason (dating from 1995 up to the end of 2012). For each patient, the distribution of ethnic class responses over all HES records was then found. The final ethnic group classification given to a patient in our analyses is the ethnic group category most frequently stated by the patient. To unify the differing coding schemes used by HES over time, four main ethnic categories were then created: White, Black, Asian and Other. Those patients of mixed heritage or Chinese origin were assigned to the Other ethnic group due to the differences in the HES coding of mixed ethnic heritage over time and as patients of Chinese origin in the NJR are very small in number. The missing category included patients choosing not to disclose their ethnicity and those not well enough to state it.

Patient Body Mass Index was categorised into four groups based on World Health Organisation classes[7]: underweight (10 ≤BMI<18.5), normal (18.5 ≤BMI<25), overweight (25 ≤BMI<30), obese (30 ≤BMI≤60). We excluded values below ten and above 60 kg/m^2 as they were unlikely to be correct.

Patient's general surgical fitness is based on the six point ASA scale where a score of 1 indicates the patient is fit and healthy and 6, that the patient has been declared brain-dead. Patient's original grades have been regrouped into fit and healthy (grade 1), has mild systemic disease (grade 2) and has severe systemic disease or worse (grades 3-5). None of the patients had an ASA grade of 6 on record.

At each issue of the PROMs questionnaire, patients were asked to indicate which statement best described their current living arrangements: live with family or spouse, alone, in a nursing home, hospital or other long-term care home or other arrangement. We created a categorical variable for living arrangements on each occasion preserving these categories.

A variable summarising the total number of coexisting diseases (out of eleven) the patient is living with, as indicated by the patient on the pre-operative PROMs form, was created. A twelfth condition, osteoarthritis, was also included on the Q1 PROMs forms for patients but we have not included this as over 90% of patients had this condition and it is highly likely that it is the primary reason for having primary replacement surgery. A categorical variable was created with the following categories: no diseases, one, two and three or more. The last category took account of small numbers of patients with three or more coexisting conditions. The eleven conditions included are: heart disease, high blood pressure, problems due to stroke, leg pain due to poor circulation, lung disease, diabetes, kidney disease, diseases of the nervous system, liver disease, cancer or depression.

PROMs measures

The Oxford Knee Score (OKS) is a measurement tool to assess the symptoms and function in patients undergoing knee replacement surgery. Within the PROMs questionnaire, there are twelve items relating to the patient's experience of pain, the degree of movement they have in the joint and their ability to carry out normal domestic activities. The total score across the twelve items is calculated and ranges from 0 to 48, where low scores indicate more severe experiences of pain and greater difficulties in coping with/carrying out daily activities.

The EQ-5D index is found by applying social preference weights to the profile of responses given by the patient to five questions within PROMs. These measure five dimensions of a patient's daily quality of life with respect to health: mobility, self-care, usual

[7] Ref: WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series 854. Geneva: World Health Organization, 1995

activities (such as work, leisure, housework), pain and anxiety/depression. The patient can choose from three responses to each of these items; either they have no problems, some problems or severe problems with this aspect of their daily life. The resulting weighted score, the EQ-5D Index, can range in value from -0.594 to 1. A score of 1 means that they are in the best of health and lower scores indicate they are experiencing difficulties in coping with one or more aspects of their daily life. The social preference weights applied to the score are derived from national population-based responses to how a person rates different profiles of health across the five health dimensions. These studies demonstrate that there are differences in the value a person attaches to being in a certain state of health according to their age, gender and nationality.

The EQ-5D Health Scale is a visual scale ranging from 0 to 100 drawn on the PROMs form. Respondents are asked to rate their health state 'on the day' by marking the scale at a relevant point with zero being the worst state and 100 the best.

Statistical methods

Chi-squared tests were used to assess whether there is an association between the distribution of each patient factor and membership of the longitudinal sample or not (either non-responders or those not invited to participate in the study).

Histograms were plotted of the PROMs outcome measures for all available cases at each time measurement point and normality of the distributions were checked by eye and using qnorm plots (quantiles of the PROM against the quantiles of the normal distribution). The EQ-5D Index and EQ-5D health scale distributions were non-normal for all time points (for available cases and complete cases). In addition, the post-operative OKS were non-normally distributed. For the non-normal outcomes, the Kruskal-Wallis non-parametric test was used to test whether the mean ranks of each of the Q2 OKS, Q1 and Q2 EQ-5D Index and Q1 and Q2 Health Scale individual distributions were equal across the 2010 cohort membership Groups A to C (if they were equal this would imply the distributions were identical). If the distributions were found to differ across Groups A to C, the non-parametric unplanned comparison of mean ranks test, Dunn's test, was performed to determine which pairs of Groups differed in mean rank (this is a multiple comparison procedure that adjusts the overall alpha significance level to account for the number of pairwise comparisons made).

The pre-operative OKS distributions were reasonably symmetrical and so a one-way Analysis of Variance (ANOVA) test was used to compare the mean score of each of the Groups A to C. Post-hoc tests using Tukey's Honestly Significant Difference (HSD) method were carried out to determine which pairs of groups differed in mean score.

Boxplots are used to show how the OKS distribution varies over the sub-categories of the patient and other factor variables considered and for each measurement point in time. We show all responses available when restricting to cases where a Q3 response is at least not missing. The boxplots here show the full range of values of the OKS (scores drawn on a vertical scale) seen for each factor strata/ sub-category and also indicate five summary points of the OKS distributions (the box and whisker parts of the diagram) when the scores are ordered from highest to lowest within each strata. The five summary points displayed are the score values below which 10% (lower whisker mark), 25% (lowest horizontal line for the drawn box), 50% or median score (the line dividing the box into two parts), 75% (top horizontal line of the drawn box) and 90% (upper whisker mark) of the scores for the sub-category occur. The difference between the scores denoted by the lowest and upper most vertical parts of the box is the interquartile range (IQR). The scatter of points below the 10th percentile and above the 90th percentile score whisker values show the range of the lowest 10% and highest 10% of scores.

3.5.3 Results

3.5.3.1 Group comparisons of patient mix and longitudinal sample representativeness

We reported previously (10th Annual Report 2013) that the OKS, EQ-5D Index and EQ-5D Health Scale baseline PROMs for those who completed both Q1 and Q2 forms generally showed higher scores for

each measure at Q1 than those with only baseline Q1 measures and no Q2 data. This suggests that patients with both responses were in a better state of health pre-operatively compared to those with no Q2 return. We would expect, therefore, that the longitudinal sample would contain a higher representation of the fitter patients having NHS-funded elective knee primary surgery in a NHS hospital or treatment centre in England compared to the remainder of planned primary knee surgeries carried out in the same providers in 2010 which have the primary recorded in the NJR.

We can gain insight into whether the longitudinal sample of knee primaries in the study is broadly representative of those patients who tend to return a PROMs questionnaire. To this end, we have compared the patient factor and PROMs outcome distributions for the three mutually exclusive sub-divisions of the NJR/PROMs linked cohort of all known primary knee surgeries which took place in 2010 in NHS hospitals or a treatment centre in England.

Tables 3.35 (page 130) and 3.36 (page 132) compare the patient factor and PROMs outcome distributions for the three sub-divisions of the NJR/PROMs linked cohort of known primary knee surgeries which took place in 2010.

With respect to patient case-mix differences across the 2010 cohort Groups A to C; although the statistical tests of whether there is a difference in patient factor distribution across the three groups indicate they are different (i.e. all statistically significant), this is due to the large numbers in each Group. The actual percentage distribution profiles for each group are largely similar across the patient factor sub-categories indicating that, in general, there is a similar representation of patient case-mix in each Group. So, the NJR longitudinal sample, in terms of case-mix, is broadly a reasonable representation of the 2010 cohort of NHS-funded elective knee primary surgery in a NHS hospital or treatment centre in England who returned a PROMs and had a NJR record.

A more detailed comparison of the patient factor distributions shown in Table 3.35 follows. There is some indication of a small difference in the ratio of males to females in Group B compared to the other two groups ($p=0.031$). A higher proportion of younger patient cases constitute the Q3 non-response group compared to Groups A and C. The longitudinal sample has a higher proportion of Whites compared to the other 2010 sub-groups and a significantly lower proportion ($p<0.001$) of patients who live in the most deprived 20% of areas in England (13.4%) compared to non-responses to the longitudinal sample invitation (18.0%) and 15.6% for the remainder of primary operations in 2010. Compared to Groups A and B, the longitudinal sample has a slightly lower proportion of participants who were judged as having severe systematic disease or worse (ASA grade 3-5) when they were assessed prior to primary surgery.

Some differences in the BMI of patients existed across the sample groups but the Q3 longitudinal sample non-response group had a higher proportion of obese cases compared to the other two groups. Again, the percentage of patients with two or more coexisting diseases, as self-reported in Q1, is lower in the longitudinal sample (25.6%) compared to the other two subsets of 2010 primaries, but the highest percentages living with two or more coexisting diseases are the non-respondees to Q3 (Group B at 28%). The proportion of patients living alone or in a nursing home or hospital is slightly higher amongst the longitudinal non-response group of primaries compared to the other groups.

Table 3.36 shows that the longitudinal sample of PROMs outcome distributions are all significantly higher overall than the Q1 and Q2 outcome distributions for Groups A and B. In particular, the Q3 non-response group have worse outcome distributions in comparison to the other two groups.

Table 3.35 Distribution of patient related factors for each primary knee joint replacement surgery in the NJR with a match to National PROMs for Groups A to C and where the primary operation took place in 2010. For each patient factor, the percentage of all non-missing responses represented by each sub-category is shown for each Group. Missing numbers for factors with incomplete information are shown for each Group. The percentage of all cases within a Group with a missing response for the patient factor is shown in brackets.

	2010 cohort of NJR/PROMs matched primary operations			
	Group A: 2010 subset of 2013 NJR to PROMs match, not in longitudinal sample (%) N=11,354	Group B: Invited longitudinal sample but did not participate (%) N=11,418	Group C: Longitudinal sample of respondees to Q3 (%) N=20,715	P-value*
Gender				
Female	6,405 (56.4)	6,601 (57.8)	11,678 (56.4)	0.031
Male	4,949 (43.6)	4,817 (42.2)	9,037 (43.6)	
Age grouping at primary (years)				
<55	737 (6.5)	1,055 (9.2)	1,210 (5.8)	<0.001
55-59	852 (7.5)	1,087 (9.5)	1,768 (8.5)	
60-64	1,797 (15.8)	1,783 (15.6)	3,396 (16.4)	
65-69	2,153 (19.0)	1,991 (17.4)	3,972 (19.2)	
70-74	2,318 (20.4)	2,199 (19.3)	4,183 (20.2)	
75-79	1,949 (17.2)	1,819 (15.9)	3,490 (16.9)	
80+	1,548 (13.6)	1,484 (13.0)	2,696 (13.0)	
Ethnicity**				
White	9,720 (94.7)	7,425 (94.3)	13,957 (96.8)	<0.001
Black	111 (1.1)	109 (1.4)	129 (0.9)	
Asian	346 (3.4)	269 (3.4)	243 (1.7)	
Other	84 (0.8)	71 (0.9)	83 (0.6)	
Missing (% of Group N)	1,093 (9.6)	3,544 (31.0)	6,303 (30.4)	
IMD 2010**				
1 (most deprived)	1,751 (15.6)	1,544 (18.0)	2,111 (13.4)	<0.001
2	2,059 (18.3)	1,649 (19.2)	2,824 (17.9)	
3	2,497 (22.2)	1,908 (22.2)	3,659 (23.2)	
4	2,554 (22.7)	1,850 (21.5)	3,680 (23.3)	
5 (least deprived)	2,370 (21.1)	1,653 (19.2)	3,497 (22.2)	
Missing (% of Group N)	123 (1.1)	2,814 (24.6)	4,944 (23.9)	
BMI				
10-18.5 (underweight)	11 (0.2)	35 (0.5)	29 (0.2)	<0.001
18.5-25 (normal)	703 (9.9)	711 (9.8)	1,220 (9.3)	
25-30 (overweight)	2,449 (34.6)	2,368 (32.7)	4,590 (35.1)	
30-60 (obese)	3,926 (55.4)	4,122 (57.0)	7,222 (55.3)	
Missing (% of Group N)	4,265 (37.6)	4,182 (36.6)	7,654 (36.9)	
ASA grade				
1 (Fit and healthy)	1,096 (9.7)	1,249 (10.9)	2,264 (10.9)	<0.001
2 (Mild disease)	8,422 (74.2)	8,291 (72.6)	15,379 (74.2)	
3-5 (Incapacitating or more severe)	1,836 (16.2)	1,878 (16.5)	3,072 (14.8)	

	2010 cohort of NJR/PROMs matched primary operations			
	Group A: 2010 subset of 2013 NJR to PROMs match, not in longitudinal sample (%) N=11,354	Group B: Invited longitudinal sample but did not participate (%) N=11,418	Group C: Longitudinal sample of respondees to Q3 (%) N=20,715	P-value*
Coexisting diseases				
No disease	3,948 (34.8)	3,988 (34.9)	7,470 (36.1)	<0.001
One disease	4,365 (38.4)	4,237 (37.1)	7,942 (38.3)	
Two diseases	2,108 (18.6)	2,170 (19.0)	3,672 (17.7)	
Three or more diseases	933 (8.2)	1,023 (9.0)	1,631 (7.9)	
Q1 Living arrangements				
Family or spouse	8,083 (74.0)	8,065 (73.2)	15,086 (75.5)	<0.001
Alone	2,773 (25.4)	2,886 (26.1)	4,811 (24.1)	
Nursing home/hospital	14 (0.1)	26 (0.2)	19 (0.1)	
Other	54 (0.5)	45 (0.4)	76 (0.4)	
Missing (% of Group N)	430 (3.8)	396 (3.5)	723 (3.5)	

* Chi-squared test of whether there is a difference in patient factor distribution across 2010 cohort sub-groups (Groups A-C) for non-missing data.

** For Groups B and C, a greater number of knee joint operations have missing data for ethnicity and IMD compared to Group A due, in part, to the extra 7,531 joints from the NJR longitudinal sample which could be matched to the NJR/HES/PROMs 2013 dataset this time. This is due to being able to make a direct link of the longitudinal PROMs sample to the NJR. However, the linking of these cases to the HES dataset has not been possible and these variables originate in the HES dataset.

Table 3.36 Distribution of available PROMs outcomes for each primary knee joint replacement surgery in the NJR/ National PROMs matched data for the 2010 cohort of Groups A to C. Median values for each distribution are shown along with the interquartile range (IQR) in brackets. Available responses for each measure shown in italics.

PROMs outcome	2010 cohort of NJR/PROMs matched primary operations			P-value
	Group A: 2010 subset of 2013 NJR to PROMs match, not in longitudinal sample Median (IQR) (N=11,354)	Group B: Invited longitudinal sample but did not participate Median (IQR) (N=11,418)	Group C: Longitudinal Sample of respondees to Q3 Median (IQR) (N=20,715)	
Q1 OKS	18 (13-24) *11,277*	17 (12-23) *11,338*	19 (14-25) *20,593*	P<0.001**
Q2 OKS	36 (27-42) *9,222*	35 (26-42) *8,454*	37 (28-43) *18,850*	P<0.001*†
Q3 OKS		-	38 (28-44) *19,974*	
Q4 OKS		-	39 (29-44) *16,991*	
Q1 EQ-5D Index	0.585 (0.088-0.691) *10,713*	0.516 (0.055-0.691) *10,783*	0.587 (0.101-0.691) *19,644*	P<0.001*†
Q2 EQ-5D Index	0.727 (0.620-0.883) *8,883*	0.691 (0.587-0.850) *8,049*	0.760 (0.620-1.000) *18,060*	P<0.001*†
Q3 EQ-5D Index			0.760 (0.620-1.000) *19,416*	
Q4 EQ-5D Index			0.796 (0.620-1.000) *16,776*	
Q1 Health Scale (VAS)	70 (50-80) *10,238*	70 (50-80) *10,135*	70 (59-81) *18,715*	P<0.001*†
Q2 Health Scale (VAS)	75 (60-85) *8,942*	70 (55-85) *8,170*	75 (60-89) *18,108*	P<0.001*†
Q3 Health Scale (VAS)			75 (60-86) *19,302*	
Q4 Health Scale (VAS)			75 (60-87) *16,685*	

Note:
† Kruskal-Wallis test of whether the mean ranks of Groups A, B and C are equal and thus whether the distributions are identical to each other.
* Dunn's non-parametric test that the mean rank of the pairwise comparison of Groups A to C are equal, i.e. pairs of Groups A to C have identical distributions.
** ANOVA test that the mean score of each of the 2010 cohort of primary operations sub-groups are equal.

3.5.3.2 Longitudinal sample distribution of Knee PROMs responses for all available cases

Histograms of the distributions of each of the three PROMs outcomes – OKS, EQ-5D Index and EQ-5D Health Scale – are shown for all available cases in the longitudinal sample at each of the measurement points in time for Q1, Q2, Q3 and Q4 (Figures 3.18 (a), 3.18 (b) and 3.18 (c)).

Figure 3.18 (a) on the right shows the distribution of the OKS before surgery is approximately symmetric (n=20,593) with a mean score of 19.3 and median score of 19 (IQR 14-25). All post-surgery score distributions exhibit high left-skew. At Q2, the median is 37 (IQR 28-43), at Q3 the median is 38 (IQR 28-44) and at Q4 the median score is 39 (IQR 29-44). Before surgery, 10% of OKS for a joint are 30 points or more. At circa six months after the primary, 10% of scores are 46 or more and at 12 and 36 months after the primary knee surgery the top 10% of scores are 46.9 and 47.0. There is very little difference in the score distribution at Q3 and Q4 overall with the maximum score of 48 being also the modal score three years after surgery.

Figure 3.18 (b) on page 134 shows the distribution of the EQ-5D Index over time. The distribution is strongly bimodal at Q1 and the post-operative distributions have three clear clusters of index scores, predominantly between 0.5 and 1.

Figure 3.18 (c) on page 135 shows the distribution of the EQ-5D Health Scale over time. The scale distribution is highly left skewed at each measurement point. Patient's self-reported evaluation of their overall general health, as indicated on a percentage scale of zero to 100%, showed the percentage health scale distribution generally improved over the first six months and then little change in the overall distribution of the health scale is seen, thereafter, at, Q3 and Q4. The median is constant at 75% and the IQR also remains essentially the same at all post-operative measurement points.

The complete case distributions for each outcome are not shown (n=13,243). Although the general features of the complete case distributions were very similar to the available case ones, the available case distributions include more of the spectrum of primary surgeries represented by the longitudinal sample at each measurement point and so give a better indication of the total variation seen across the outcome distributions.

Figure 3.18 (a)

Available cases for the Oxford Knee Score (OKS) distribution at each point of measurement in time. At Q1, n=20,593, at Q2, n=18,850, at Q3, n=19,974 and at Q4, n=16,991.

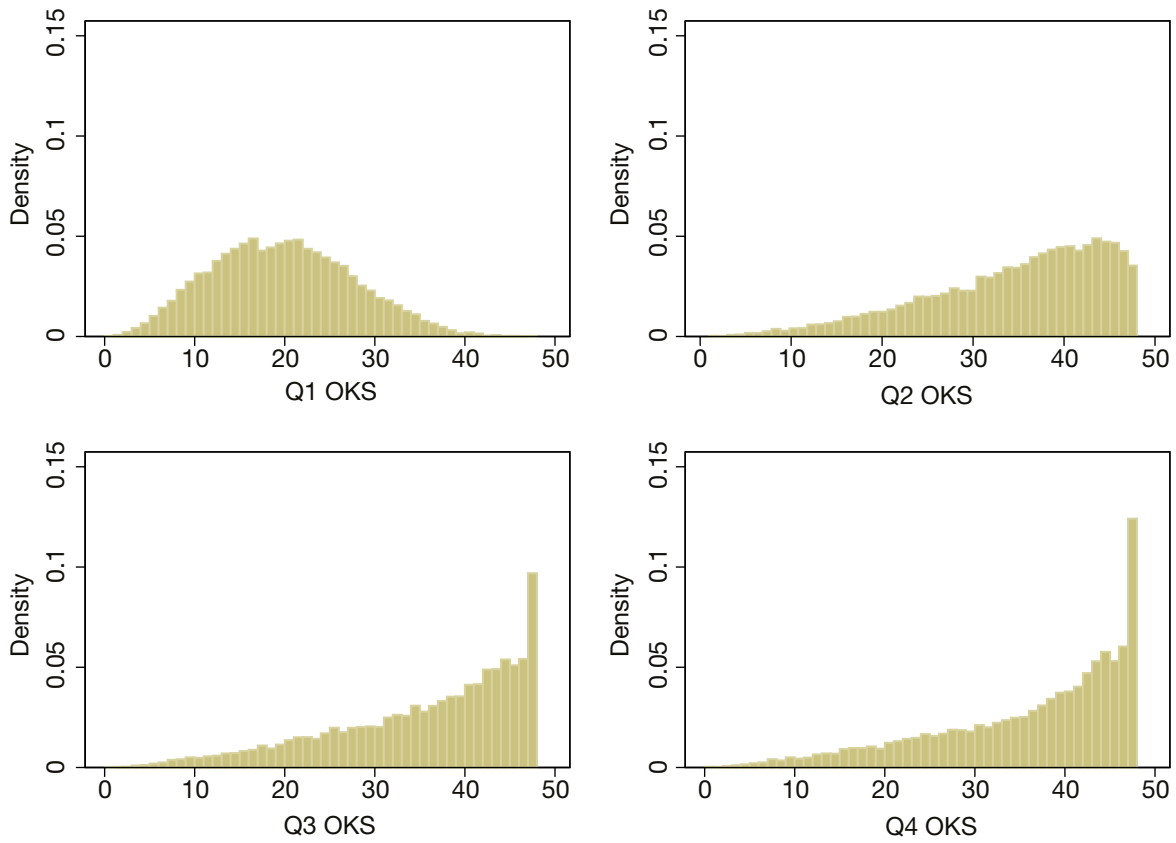


Figure 3.18 (b)

EQ-5D Index distributions at each measurement point in time for all available cases.
At Q1, n=19,664, at Q2, n=18,060, at Q3, n=19,416 and at Q4, n=16,776.

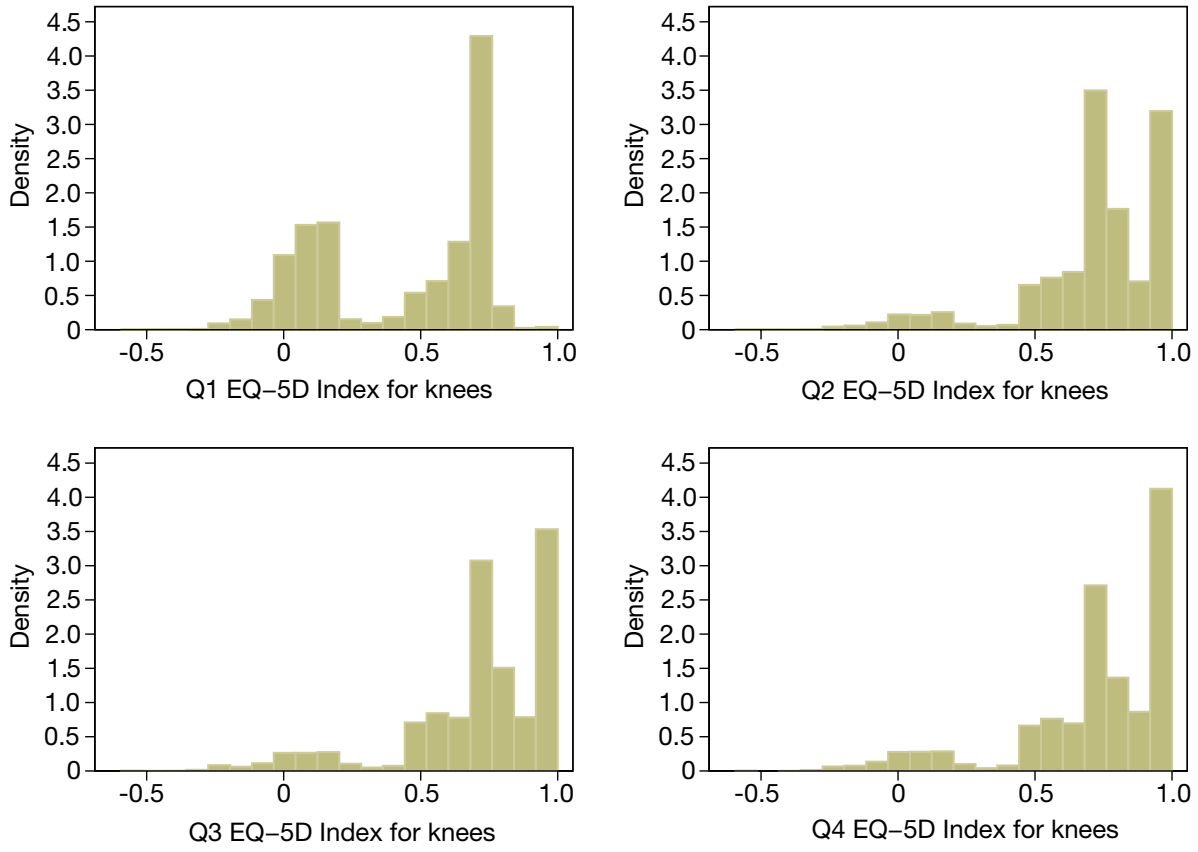
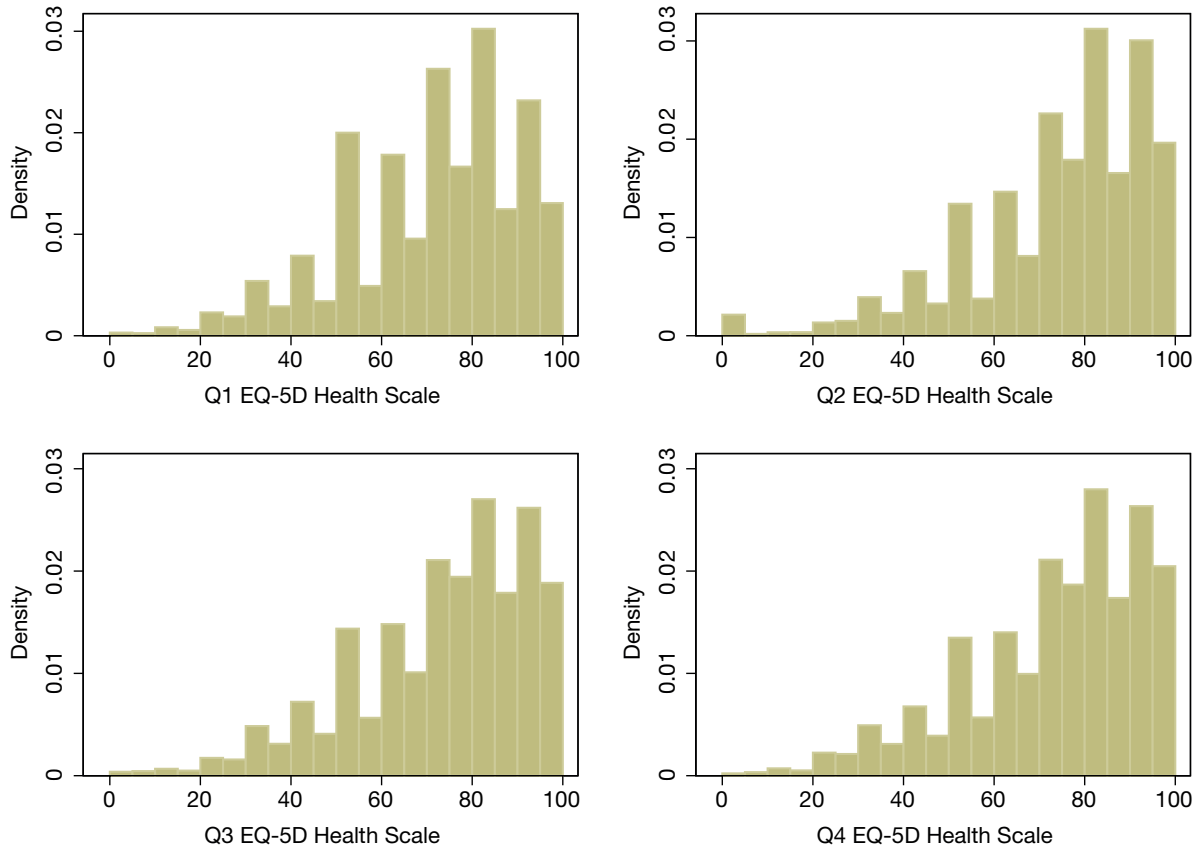


Figure 3.18 (c)

EQ-5D Health Scale (VAS) distributions at each measurement point in time for all available cases. At Q1, n=18,715, at Q2, n=18,108, at Q3, n=19,302 and at Q4, n=16,685.



3.5.3.3 The distributions of OKS over time by patient and surgical factors

Box plots comparing the distribution of OKS at Q1, Q2, Q3 and Q4 when broken down by patient or surgical choice of implant/fixation method factors are presented for all available cases at each time point for the longitudinal sample of knee joint surgeries. Factors explored are ordered as follows in this sub-section; OKS by (i) grouped age of patient at primary operation, (ii) gender, (iii) gender and grouped age at primary operation, (iv) area deprivation index for the area the patient resided in at time of primary operation, IMD 2010, (v) ethnic group, (vi) BMI at Q1, (vii) ASA grade of anaesthetic risk at primary operation, (viii) living arrangements of patient at Q1, (ix) number of coexisting diseases as reported at Q1 and (x) prosthesis fixation method used at primary operation.

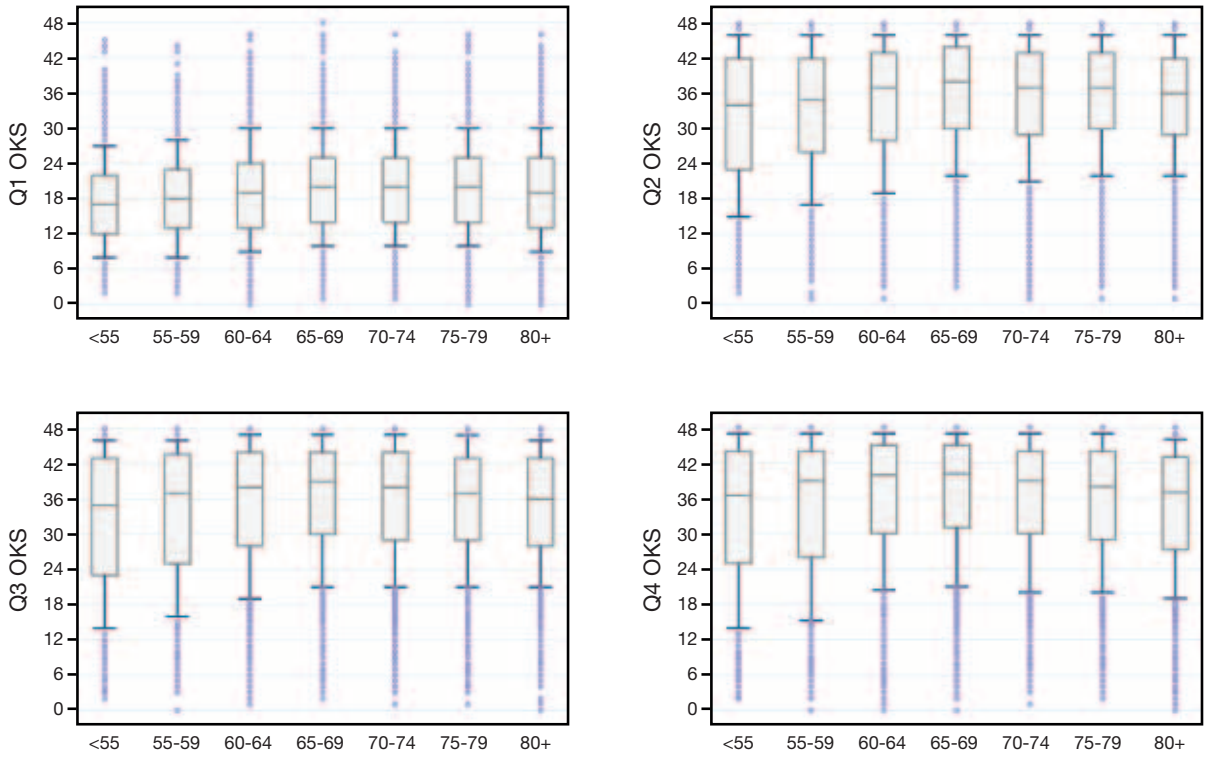
(i) OKS by grouped age of patient at primary operation

Figure 3.19 (over the page) shows the distribution of OKS at each measurement point by grouped age of patient at primary operation. A total of 80% of patients aged under 60 have slightly lower OKS before surgery compared to other age groups (both groups have narrower IQRs and a narrower range between

the 90th and 10th percentile OKS values for these age groups). By three years, OKS are best for the 60-64 and 65-69 age at primary age-groups (highest medians, narrowest IQRs and highest OKS value at which 90% of OKS are more than the 10th percentile threshold value, i.e. a score more than 20). The under 60 age groups have wider IQRs compared to those over 60 years.

Figure 3.19

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **grouped patient age** (in years) at primary surgery.



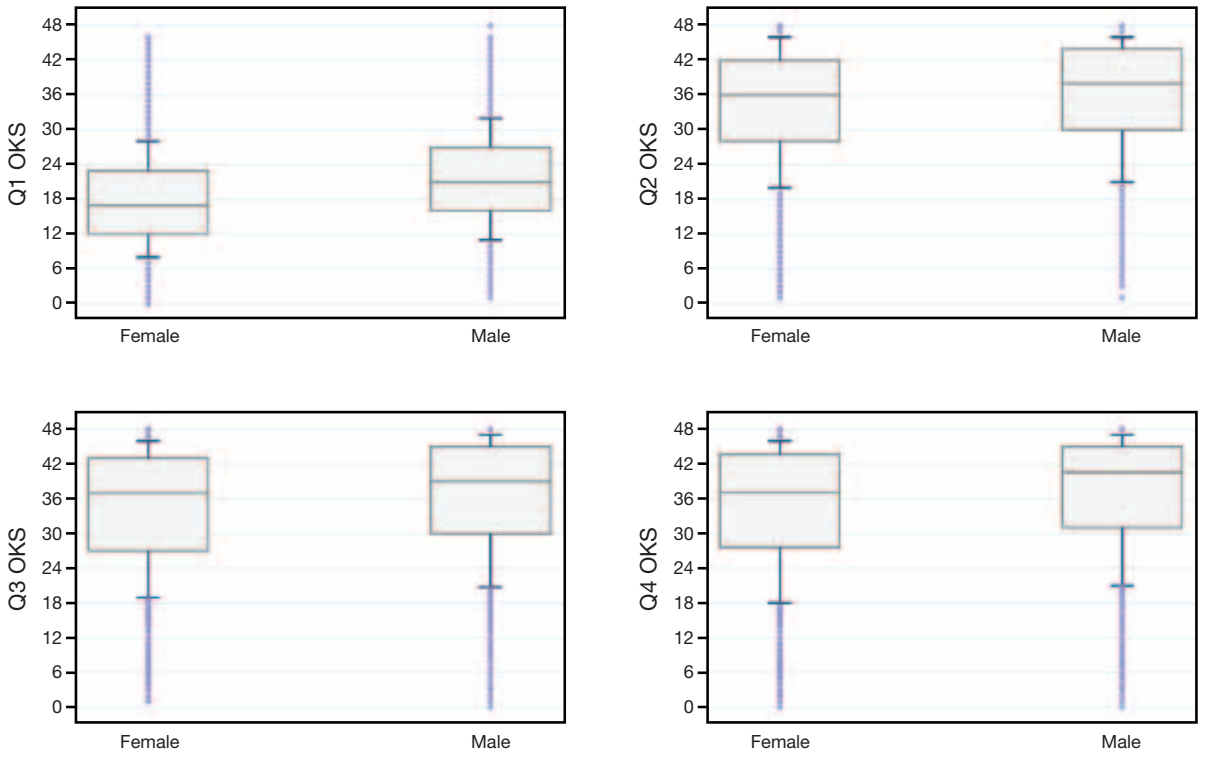
(ii) OKS by patient gender

Figure 3.20 (below) shows the distribution of OKS at Q1, Q2, Q3 and Q4 by patient gender.

Women, before surgery, have lower median scores than men (17 compared to 21). After surgery, female patient median scores remain lower than male patients. At Q4, three quarters of men have scores of 31 or more whereas for women the equivalent threshold is a score of 28 or more.

Figure 3.20

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **patient gender**.



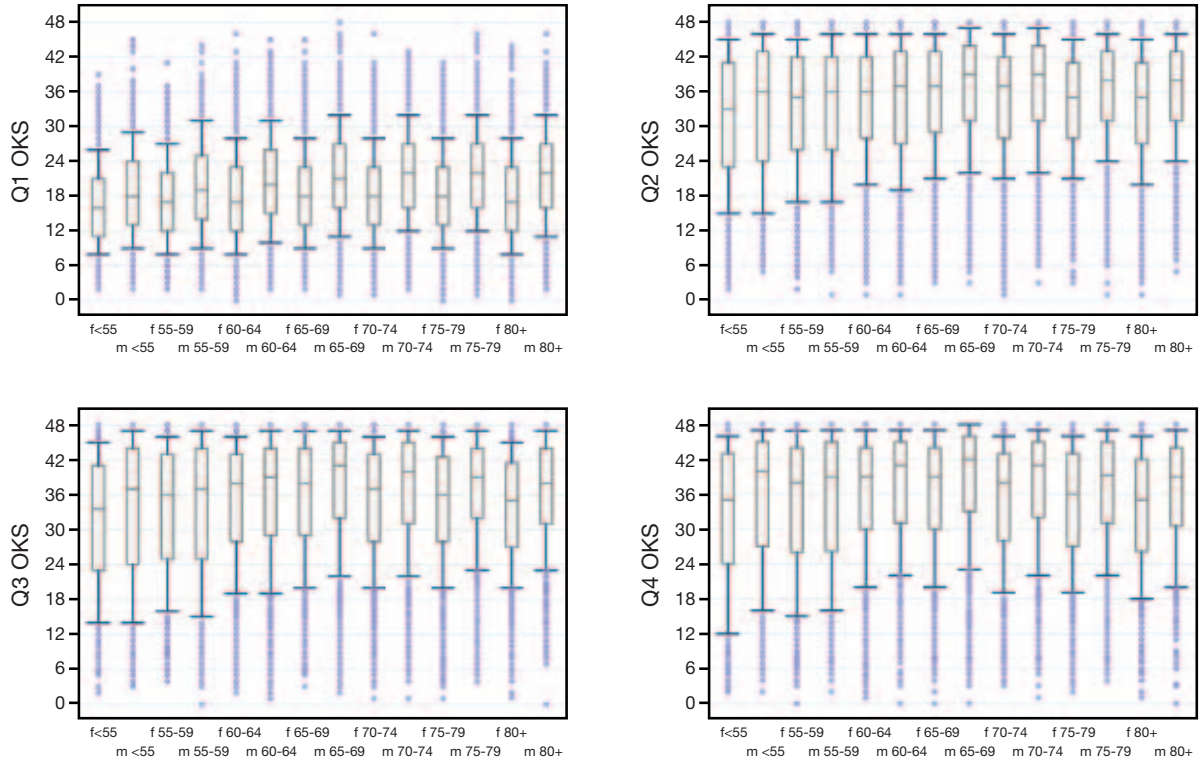
(iii) OKS by patient gender and grouped age at primary operation

Figure 3.21 (below) displays the OKS distribution stratified by gender and grouped age at primary for each of the four measurement occasions.

At Q1, OKS are similarly distributed across the age groups but women tend to have lower median scores (between 2 to 5 points lower than men). A total of 90% of scores for women at Q1 in each age group above 60 years are 28 or lower whereas in the male equivalent age groups from 65 and above, 90% of pre-operative OKS are 32 or lower. Younger age groups have slightly lower threshold scores for the 90th centile of scores and women's thresholds are lower than those for men in equivalent age groups. At 36 months, the difference persists between male and female median scores across the age groups. The younger age groups (under 60) have wider IQRs of scores compared to older groups.

Figure 3.21

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **gender and grouped age** at primary surgery (f and m denote female and male respectively).



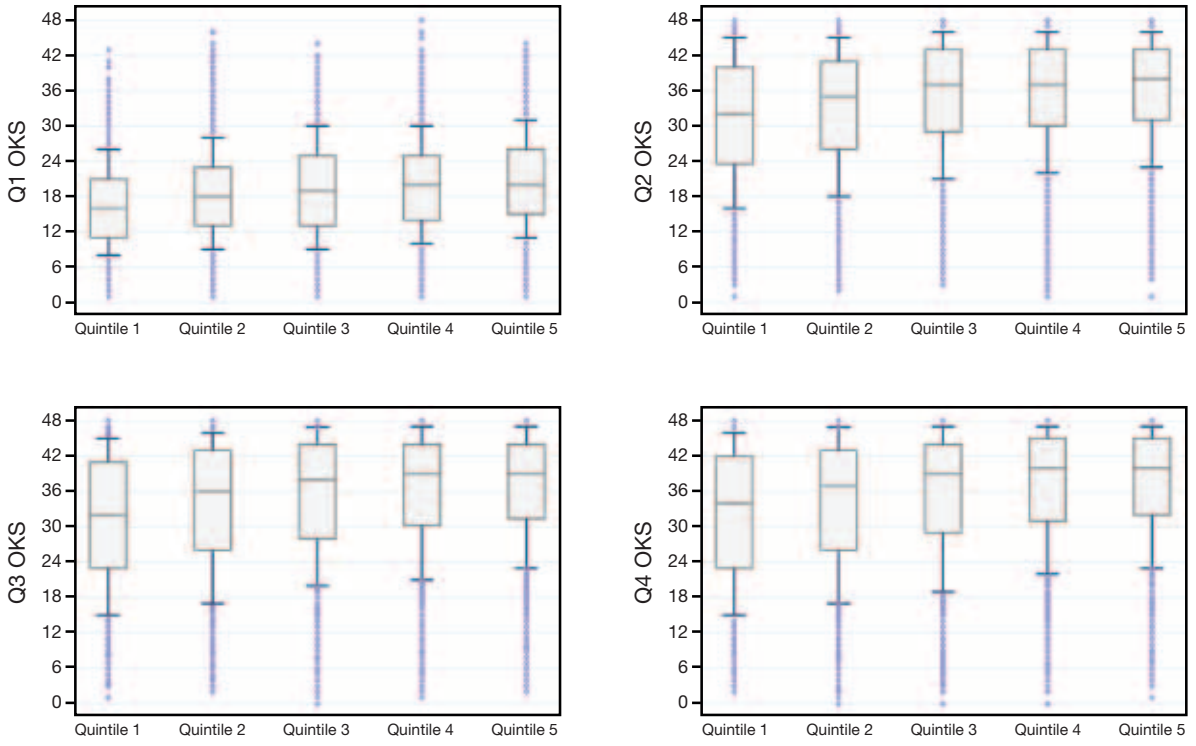
(iv) OKS by area deprivation index (IMD 2010) based on the patient's area of residence at time of primary operation

Figure 3.22 (below) presents the distribution of OKS by area deprivation quintiles based on the patient's area of residence on admission for primary surgery. Quintile 1 denotes the 20% most deprived and quintile 5 the 20% least deprived areas of England.

Prior to the initial knee surgery, patients living in the most deprived 20% of areas in England have a median OKS 5 points lower than patients in the top 40% of least deprived areas in England. Three years after primary surgery, the gap in median scores between patients living in the 20% most deprived areas and those in the top 40% of least deprived areas remains – median OKS of 34 for the most deprived area quintile compared to a median of 40 for quintiles 4 and 5. In addition, those patients living in the most deprived area quintile have a wider IQR of 19 points (23-42) compared to an IQR of 13 (32-45) for quintile 5 and 14 (31-45) for quintile 4 i.e. those living in the top 40% of least deprived areas. The lowest 10% of OKS seen amongst patients living in areas included in quintile 5 are scores of 23 and below whereas the lowest 10% of scores for those living in areas of most deprivation are 15 and below. Thus, a more variable range of OKS is typical amongst those patients living in areas of most deprivation by three years after the primary surgery.

Figure 3.22

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 **by area deprivation** IMD quintile (2010) when admitted for the primary surgery.



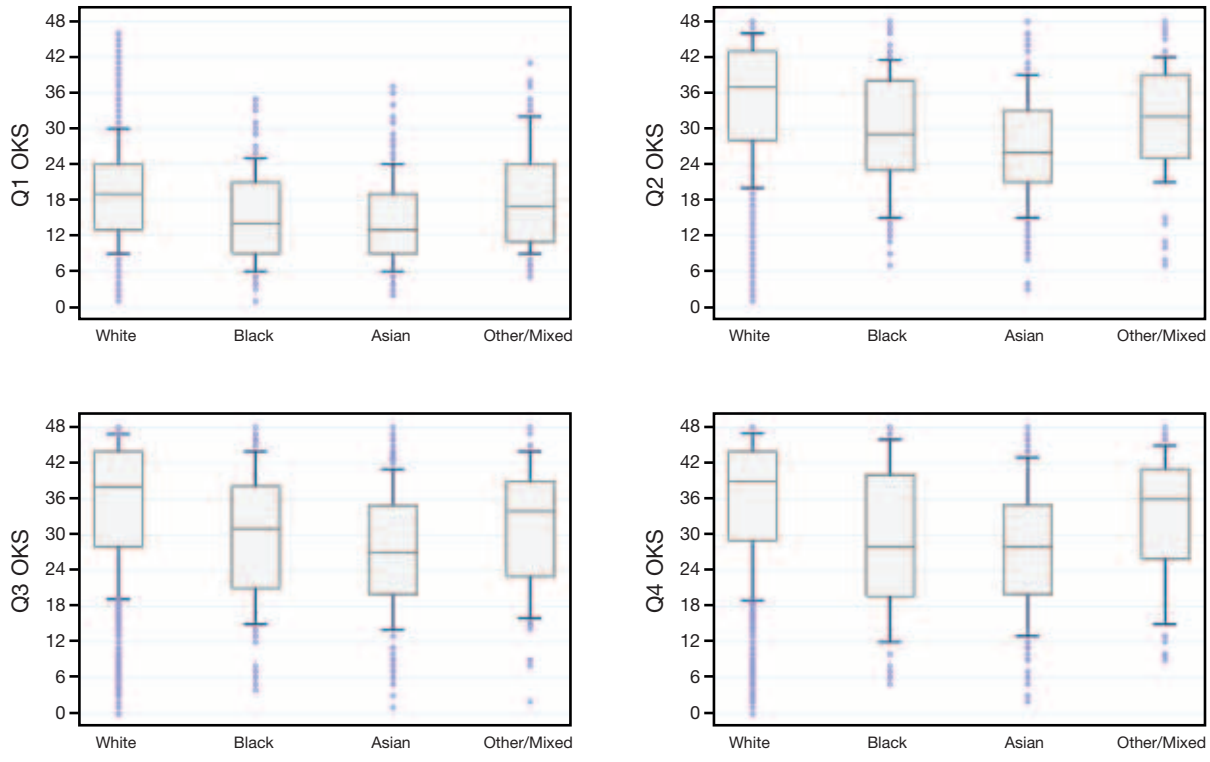
(v) OKS by patient ethnic group

Figure 3.23 (below) shows the resulting distribution of OKS when sub-divided by patient ethnic group over time.

Prior to surgery, Black and Asian patients generally attain lower OKS compared to White and Other ethnic groups with Whites attaining a median score of 19 compared to 13 for both Blacks and Asians respectively. Post-operatively, Asian and Black median scores after three years are 11 points lower than White patients (median of 39 (IQR 29-44)) and 8 points lower than patients of Other ethnic origin. Also after three years, 75% of White patients have OKS ranging from 29 points or more compared to three quarters of Black and Asian patient scores ranging only from 20 points or more.

Figure 3.23

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **ethnic group**.



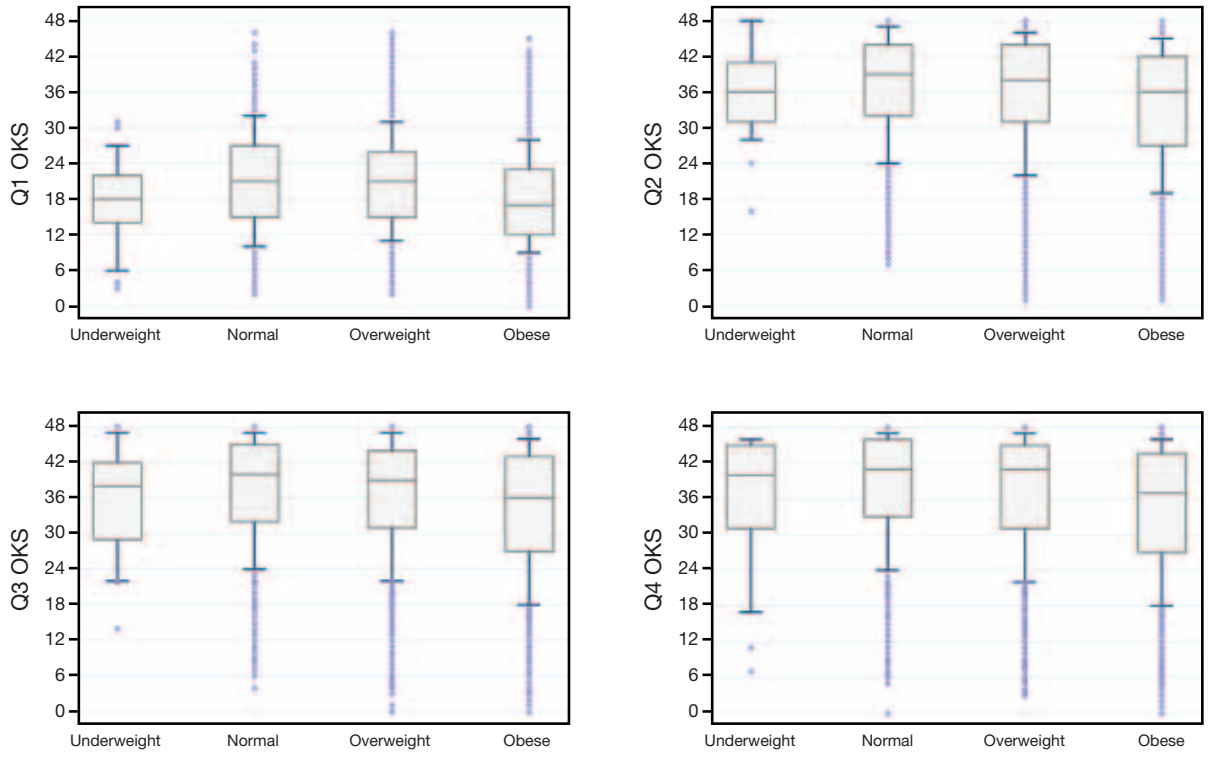
(vi) OKS by patient BMI measured at primary surgery

Figure 3.24 (below) shows how the OKS is distributed before and after surgery according to the patient's BMI category at the time of primary operation.

Prior to operation patients had worse median OKS values if they were obese or underweight (medians of 17 and 18 respectively compared to 21 for the other categories) and underweight patients had a narrower IQR compared to the other patient BMI categories (IQR 14-22). Post-operatively, OKS distributions for patients who are overweight or normal remain consistent in their IQR and median values over time. Obese patients' OKS overall are more variable than OKS for the other groups at all times after surgery. Obese patients' median score is 3 to 4 points lower than the medians for the other BMI groups after 36 months; the median is 37 for obese patients, whereas the other BMI groups score medians of 41 or 40, and the IQR is generally wider for obese patients post-surgery. Underweight patient OKS improve slightly over time.

Figure 3.24

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **BMI category**, as recorded before the primary surgery.



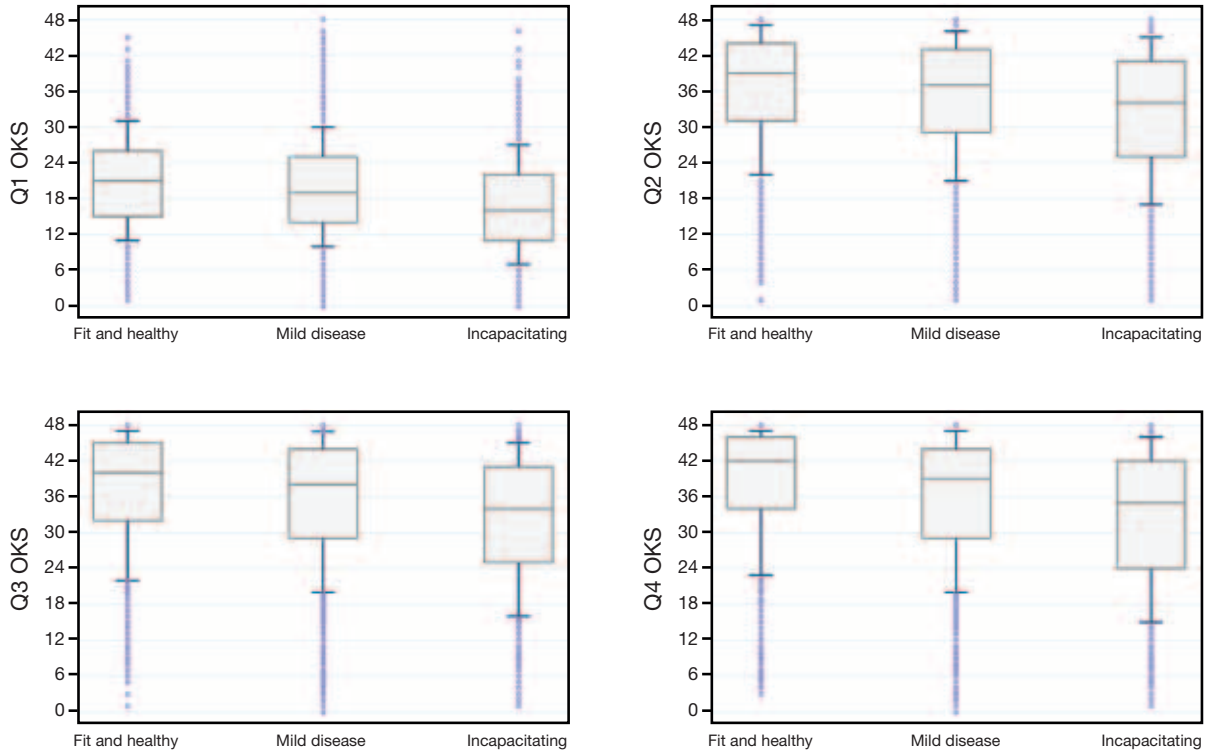
(vii) OKS by ASA grade of anaesthetic risk as clinically assessed shortly before primary surgery

Figure 3.25 (below) shows the distribution of OKS over time for primary surgeries carried out on patients with differing states of anaesthetic risk, as recorded prior to their primary surgery.

Prior to surgery, patients who are least fit for surgery have the lowest median OKS compared to the fitter two categories of patients but the IQR for the three groups are similar at 11 points for the fitter categories and 12 for the least fit. In the longer term, OKS indicate that these patients have a more variable score distribution three years after the surgery than the fitter groups. The IQR of scores at 36 months is wider (24-42) compared to the fittest patient group (34-46) and 25% of ASA grade 3 or worse patients have OKS below 25 points compared to the lowest 25% of scores for the fittest patient group ranging from 34 points or lower.

Figure 3.25

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **ASA grade** of surgical fitness at primary surgery.



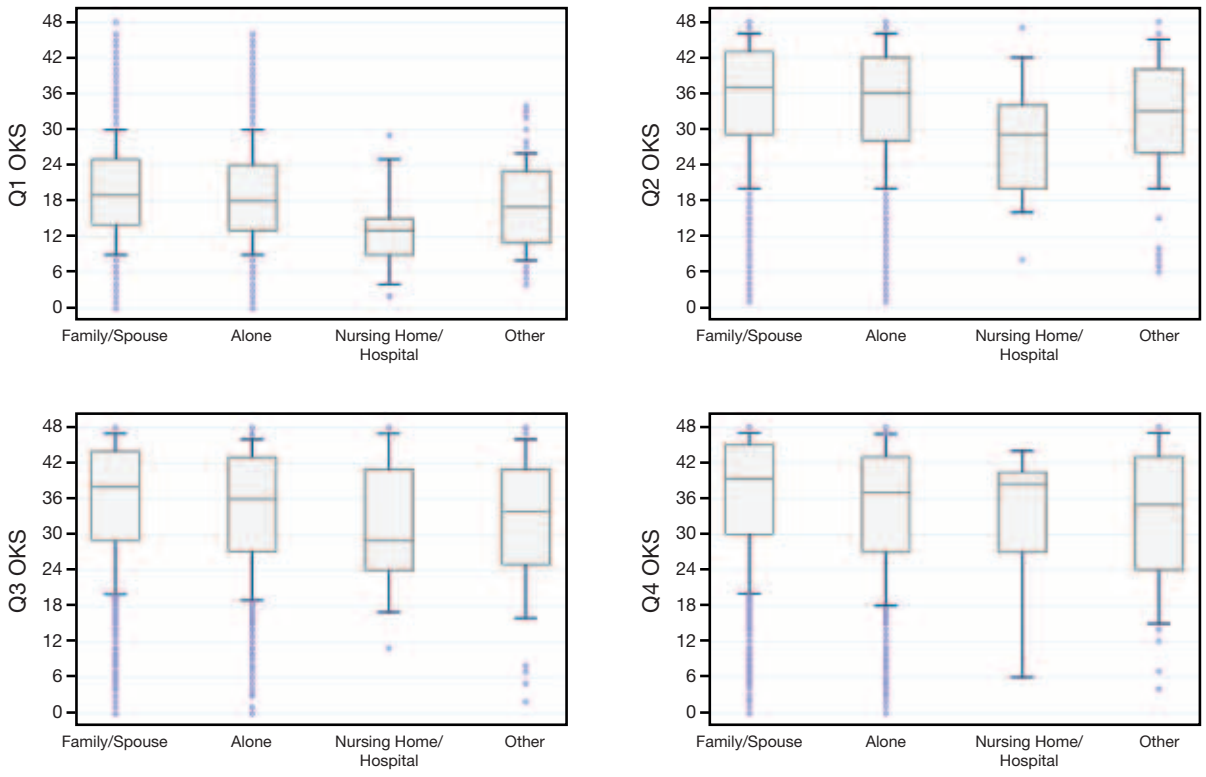
(viii) OKS by patient's living arrangements at Q1

In Figure 3.26 (below), the OKS is broken down over time by the patient's living arrangements at time of primary knee surgery.

Before surgery, patients living in a nursing home, hospital or other long term care home had a lower median score (13) compared to the other living situations of patients with those living with their families attaining the highest pre-operative median score of 19. By three years, those having other living arrangements (as at Q1) have a wide IQR of OKS (24-43) compared to the remaining categories of living arrangements and lowest median score of 35. The median OKS for those living with their family or spouse improves over time and the IQR remains consistent over the three post-operative measurement points.

Figure 3.26

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **patient's living arrangements** at the primary surgery.



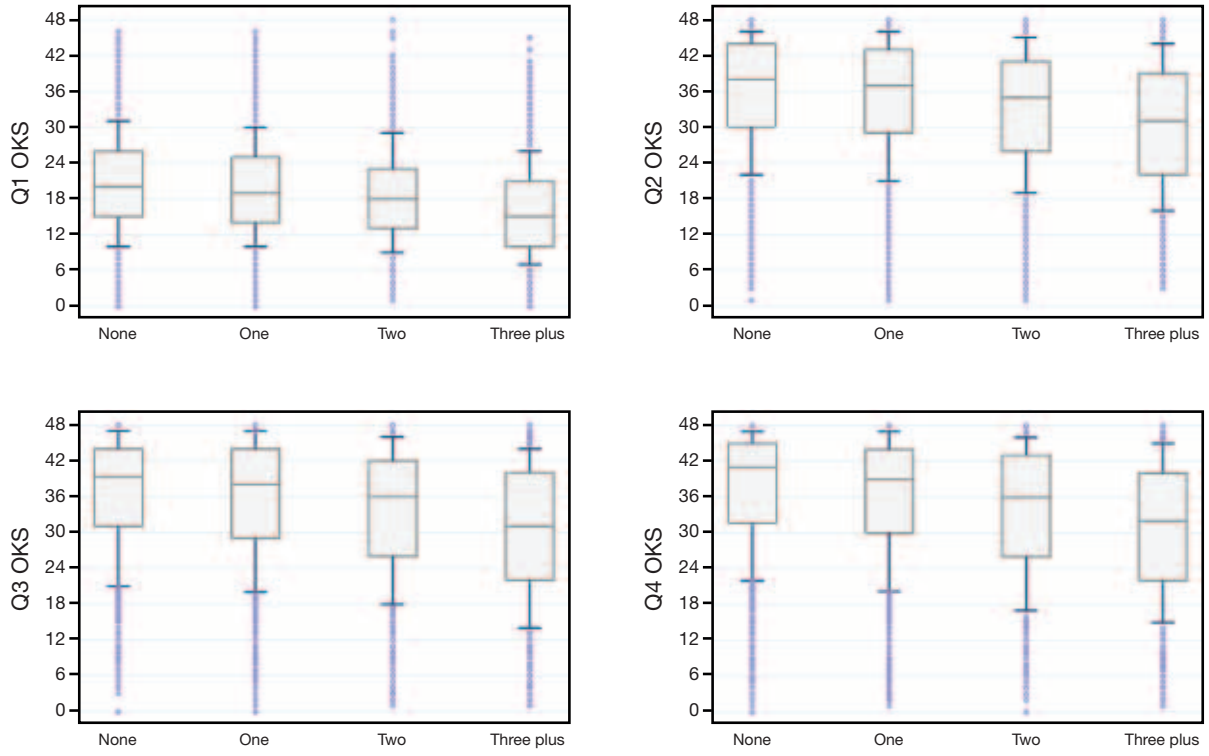
(ix) OKS by number of coexisting diseases affecting patients as reported at Q1

Figure 3.27 (below) displays the distribution of OKS at Q1, Q2, Q3 and Q4 broken down by the number of coexisting diseases the patient lives with, as self-reported at Q1.

Before surgery, patients with three or more coexisting diseases tend to have lower OKS (median of 15 and IQR 10-21) than those with no or one coexisting disease (medians of 20 and 19 and IQR of 15-26 and 14-25 respectively). Patients with three or more self-reported coexisting diseases fare worse overall after replacement surgery compared to those with fewer diseases. By 36 months, the median score of those patients reporting three or more diseases is 32 (IQR 22-40) compared to a median of 41 for those reporting no diseases at Q1 (IQR 32-45) and a median of 39 (IQR 30-44) for those with one coexisting disease.

Figure 3.27

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 stratified by **the number of coexisting diseases** affecting the patient just prior to the primary knee surgery date.



(x) OKS by total replacement fixation method and by partial knee replacement type at primary operation

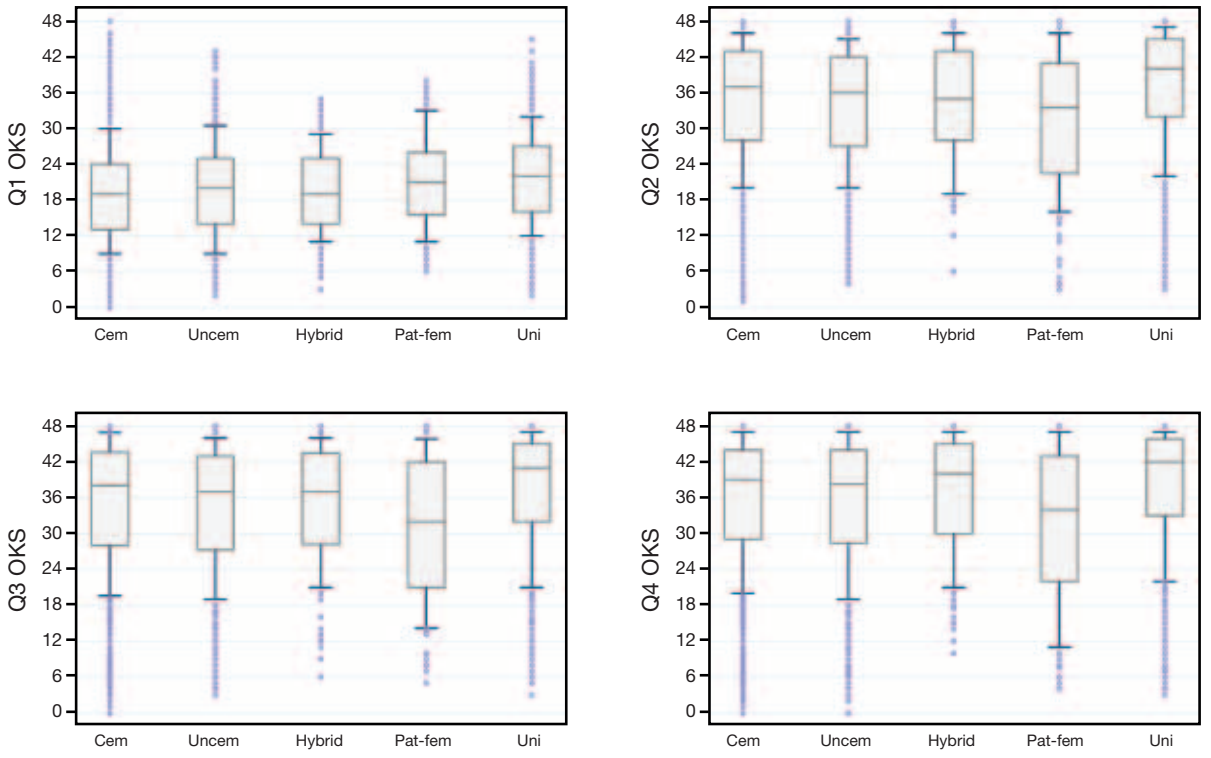
Figure 3.28 (below) shows a breakdown of OKS at Q1, Q2, Q3 and Q4 by total replacement fixation method and by partial knee replacement type.

Before surgery, the distribution of OKS are similar for the middle 50% of patients among those who go on to have different methods of fixation for a TKR (cemented median 19 (IQR 13-24), hybrid median 19 (IQR 14-25), uncemented median 20 (IQR 14-25)) or for those having unicompartmental knee replacement (unicondylar median of 22 (IQR 16-27) and patellofemoral median 21 (IQR 16-26)). The overall spread of scores for cemented/uncemented and unicondylar replacements are also broadly alike, though those who have hybrid TKR or patellofemoral joint replacement have a narrower range of scores overall. The general distributional shape of scores is reasonably symmetric before surgery.

At six months post-surgery, the score distribution is non-normal for all methods of fixation in TKR and UKR and the median OKS for each method of surgery has increased by over 12 points compared to Q1. Cemented, uncemented and hybrid replacements have similar distributions, unicondylar knees have slightly better scores over all knee types and OKS for patellofemoral knee surgery is more variable. This patterning persists at 12 and 36 months with all TKR fixation methods and unicondylar knees attaining a median OKS of at least 38 or more. Patellofemoral replacements are the exception with poorer OKS by comparison; after three years the median OKS for this group is 34 with a larger IQR of scores (22-43).

Figure 3.28

Oxford Knee Score (OKS) distribution at Q1, Q2, Q3 and Q4 by **total replacement fixation method and by partial replacement type**.



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 31 December 2014, for all patients with valid patient identifiers.

In total there were 47,829 joint revision operations recorded for 39,231 individual patients on 40,911 individual patient-sides[8]. As well as the 17,649 first revisions of primary patient-sides reported on earlier in section 3.4 there are 23,262 additional revisions for a patient-side for which we have no associated primary operation record.

Revisions are classified as single-stage and stage one and stage two of two-stage revisions. Information about 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 procedures have been entered without stage two, and vice versa, making identification of individual revision 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/two-stage), 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 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[8] is given in Table 3.37 (below). 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 number of joint operations over time reflects the increasing number of at-risk implants prevailing in the database.

Table 3.37 Number 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*	520 (82.5)	2 (0.3)	108 (17.1)	630
2004	928 (76.0)	80 (6.6)	213 (17.4)	1,221
2005	1,469 (73.6)	212 (10.6)	314 (15.7)	1,995
2006	1,932 (75.1)	283 (11.0)	359 (14.0)	2,574
2007	2,589 (74.7)	388 (11.2)	489 (14.1)	3,466
2008	3,265 (75.4)	474 (10.9)	592 (13.7)	4,331
2009	3,628 (75.9)	527 (11.0)	625 (13.1)	4,780
2010	4,097 (76.8)	574 (10.8)	665 (12.5)	5,336
2011	4,249 (77.1)	615 (11.2)	647 (11.7)	5,511
2012	4,910 (78.3)	624 (10.0)	739 (11.8)	6,273
2013	4,555 (78.0)	624 (10.7)	660 (11.3)	5,839
2014	4,580 (78.0)	658 (11.2)	635 (10.8)	5,873
All years	36,722	5,061	6,046	47,829

*Incomplete year.

[8] A second procedure had been entered on the same operation date for 110 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 statistical analysis team. This led to a decision to drop 110 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 dataset were reclassified as a knee revision after checking records of the type of components used during the surgery.

Table 3.38 (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 3.38 Percentage of all revision knee procedures of each stage type with the indicated reason for revision.

Reason	Percentage of all revision joint operations of each stage type with the stated reason for revision		
	Single stage (n=36,722)[1]	Stage one of two-stage (n=5,061)	Stage two of two-stage (n=6,046)[2]
Aseptic loosening	41.2	12.6	12.2
Pain	19.4	5.8	5.0
Dislocation/subluxation	4.5	1.5	1.3
Infection	5.0	83.2	76.7
Periprosthetic fracture	3.6	1.3	1.3
Lysis	10.5	11.1	6.6
Implant fracture	1.3	0.4	0.3
Implant wear	15.2	3.9	2.6
Instability	17.8	4.5	4.4
Malalignment	8.4	1.5	1.6
Other indication	17.7	4.0	5.9
Stiffness[3]	6.0 n=35,974	2.7 n=5,059	1.9 n=5,884

Note: 1 Four single-stage procedures had a missing entry for the reason for revision and have not been included in the percentage calculations. 2 Five stage two of a two-stage procedures had a missing entry for the reason for revision and have not been included in the percentage calculations. 3 This reason was not recorded in the earliest phase of the registry; only in MDSv2, v3 and 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 re-revision

For a given patient-side, we have looked at the survival following the first NJR documented revision procedure (n=40,911). The majority of first revision procedures (83.5%) were carried out as a single stage revision, however, in the remaining 16.5% 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 these 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 six.

Kaplan-Meier estimates of the cumulative percentage probability of having a subsequent revision (re-revision) were found. There were 3,235 re-revisions and, for 4,505 cases, the patient died without having been revised. The censoring date for the remainder was the end of 2014. 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 3.29 (a) and (b) on pages 150 and 151. The rates at 1, 3, 5, 7 and 10 years after first revision along with their associated 95% Confidence Intervals are given in Table 3.39 (a). The effect on the overall failure rates was negligible as is illustrated in Figures 3.29 (a) and (b) and shown in Table 3.39 (a).

The first revisions in Figure 3.29 (c) on page 152 have been divided into those with a primary recorded in the NJR (n=17,649) and the remainder. 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 3.39 (b). The survival of the first revisions without a linked NJR primary were 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 revision surgery and the original primary. 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 3.29 (d) and Table 3.39 (c) on pages 153 and 154 respectively 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 17,649 with a 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 the primary in the NJR and the group of first revisions without a primary 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 above.

In an earlier section of this report, a link between time to first revision and the cited reason for revision was found (see section 3.4.2.4). It was shown there that if a knee joint was revised within the first year after primary surgery, infection was the most likely reason for this, followed by pain, aseptic loosening and then other reasons. 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 and instability respectively. Tables 3.41 (c) to (f) present proportions of knee joints revised over each year of the registry for the four most common overall reasons for first revision surgery: infection, aseptic loosening, pain, other reasons. The percentage of operations is given for first revision of the joint by stage of operation and, within each type of stage, whether the primary was recorded in the NJR or not. The consistently high proportion of stage one and two of a two-stage first revisions for infection (Table 3.41 (e), page 157) year on year

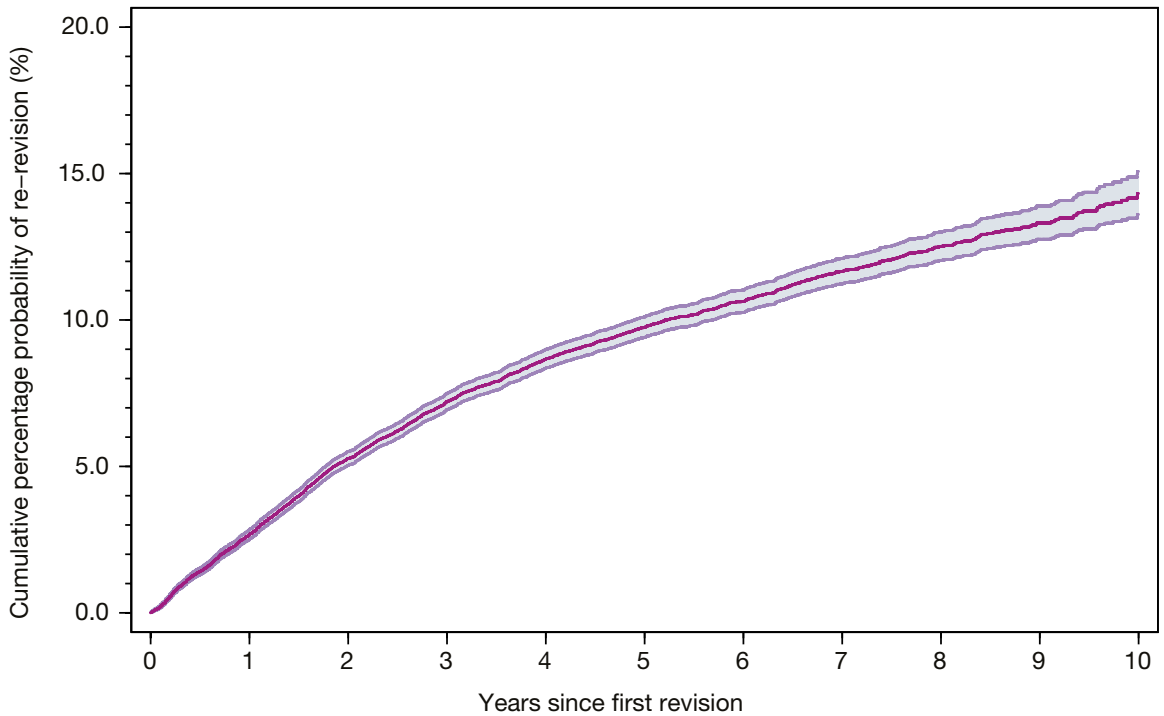
among the first revisions with a linked primary in the NJR reflect the high prevalence of infection within three years of primary surgery. Aseptic loosening, pain and other reasons increase in prevalence over time within the first revision group with a primary in the NJR. This confirms that more first revisions are being attributed to these reasons as the follow-up time from the primary lengthens overall in the NJR.

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 has increased each year since the start of the registry. By the end of 2014, 60% of all first time records of revision surgery for a joint could be linked to an NJR primary operation (see Tables 3.41 (a) and (b) on pages 155 and 156). 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.

Figure 3.29 (a)

Kaplan-Meier estimates of the cumulative percentage probability of a knee re-revision. The shaded area indicates point-wise 95% CI.

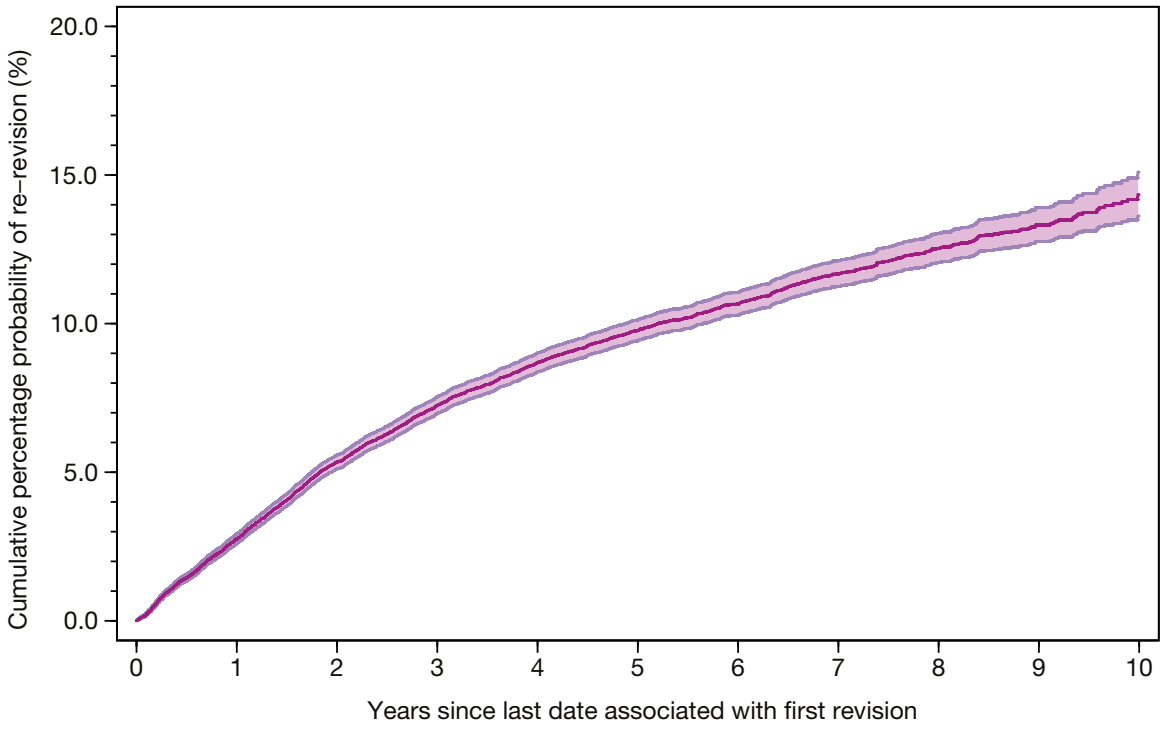


Number at risk

40,911	34,538	28,598	22,743	17,905	13,418	9,658	6,433	3,989	2,283	1,054

Figure 3.29 (b)

Kaplan-Meier estimates 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 indicates point-wise 95% CI.

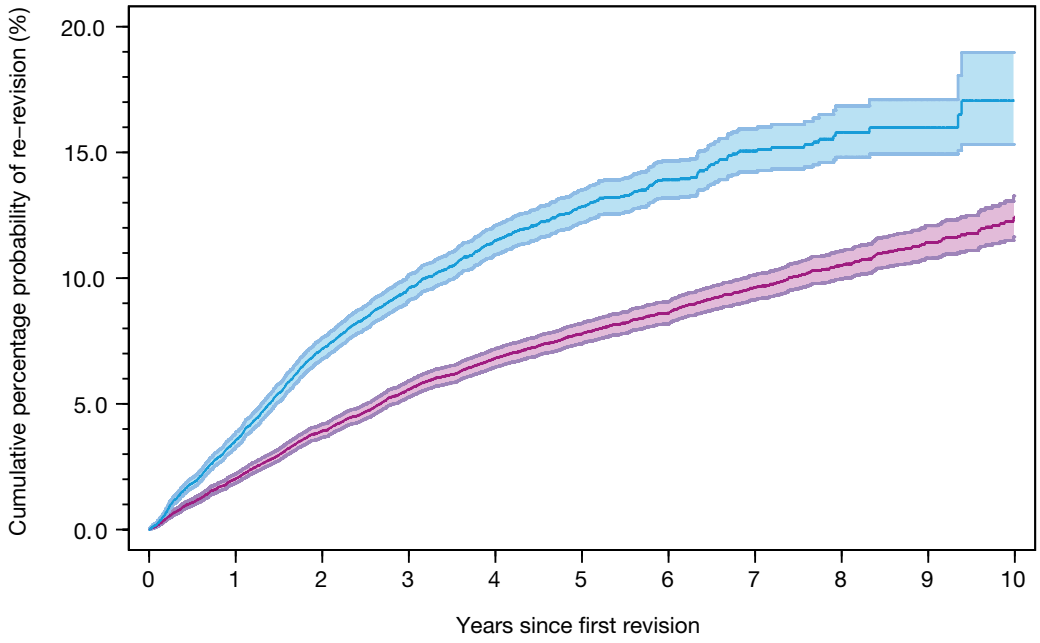


Number at risk

40,911	34,361	28,419	22,593	17,791	13,300	9,566	6,365	3,948	2,266	1,040

Figure 3.29 (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.

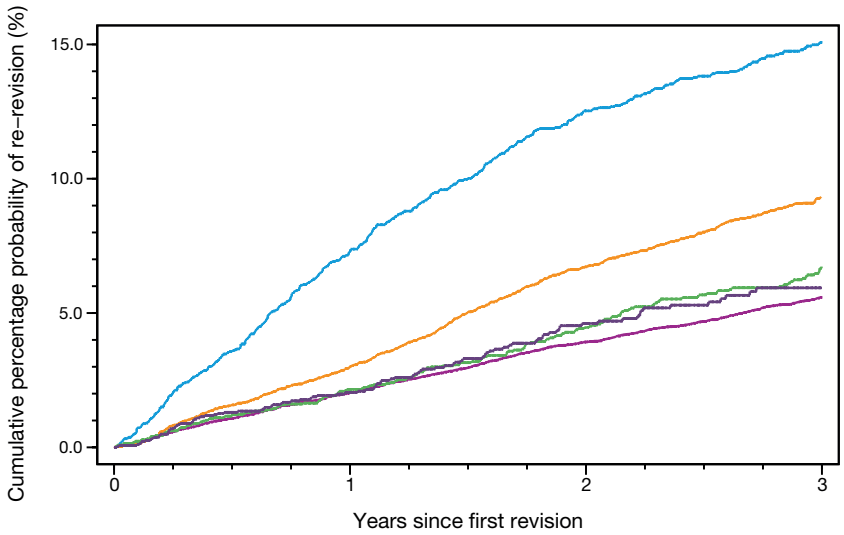


Number at risk

Primary not in NJR	23,262	20,441	17,697	14,771	12,154	9,640	7,365	5,199	3,406	2,048	993
Primary in NJR	17,649	14,097	10,901	7,972	5,751	3,778	2,293	1,234	583	235	61

Figure 3.29 (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.



Number at risk

Primary not in the NJR	23,262	20,441	17,697	14,771
First revision <1 year	3,442	2,793	2,247	1,786
First revision 1–3 years	7,996	6,687	5,398	4,134
First revision 3–5 years	3,479	2,821	2,173	1,485
First revision 5+ years	2,732	1,796	1,083	567

Table 3.39 (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
(i) At start of first revision episode	40,911	2.68 (2.53-2.85)	7.21 (6.94-7.50)	9.75 (9.40-10.10)	11.66 (11.23-12.10)	14.32 (13.60-15.07)
(ii) End of first revision episode	40,911	2.77 (2.61-2.94)	7.26 (6.98-7.54)	9.77 (9.42-10.12)	11.68 (11.25-12.12)	14.34 (13.62-15.10)

Table 3.39 (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
Primary not recorded in the NJR	23,262	2.04 (1.86-2.23)	5.58 (5.27-5.91)	7.78 (7.39-8.20)	9.62 (9.14-10.13)	12.43 (11.64-13.27)
Primary recorded in the NJR	17,649	3.57 (3.44-4.02)	9.62 (9.00-9.98)	12.85 (12.21-13.51)	15.06 (14.22-15.94)	*17.06 (15.32-18.97)*

*Estimates in *blue italics* are based on the number at risk falling below 250 patient-sides (see methodological notes in earlier sections).

Table 3.39 (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	23,262	2.04 (1.86-2.23)	5.58 (5.27-5.91)
Primary in the NJR where the first revision took place:			
<1 year after primary	3,442	7.28 (6.44-8.24)	15.08 (13.82-16.44)
1-3 years after primary	7,996	3.02 (2.65-3.43)	9.31 (8.61-10.06)
3-5 years after primary	3,479	2.16 (1.71-2.73)	6.73 (5.80-7.81)
5+ years after primary*	2,732	2.04 (1.54-2.70)	5.94 (4.82-7.30)

* Note: The maximum of this interval was 11.5 years.

3.6.3 Reason for knee re-revision

Table 3.40 (right) shows breakdowns 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 3.40 The number of knee joints revised for each given revision reason broken down by whether the operation is a first knee revision or a re-revision.

Reason for revision	(i) Number of cases for each given reason for first (recorded) revision N=40,903[1]	Number of cases for each reason given for the first recorded revision for those who were: (ii) Not subsequently re-revised N=37,670[2]	(iii) Subsequently re-revised N=3,233[3]	(iv) Number of cases for each given reason for re-revision N=3,235
Aseptic loosening	15,163	14,150	1,013	879
Pain	7,109	6,487	622	411
Dislocation/subluxation	1,595	1,438	157	146
Infection	6,802	5,992	810	1,122
Peri-prosthetic fracture	1,315	1,228	87	96
Lysis	4,335	4,079	256	210
Implant fracture	458	434	24	38
Implant wear	5,682	5,354	328	178
Instability	6,305	5,811	494	544
Malalignment	3,041	2,823	218	178
Other indication	6,558	6,213	345	282
Stiffness[4]	2,116 n=40,016	1,940 n=36,906	176 n= 3,110	183 n=3,110

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 MSDv1. The total number of joints which were re-revised when stiffness was available as an option for (first recorded) reason for revision on the clinical forms is shown in the superscript.

Table 3.41 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	622	11 (1.8)
2004	1,168	83 (7.1)
2005	1,840	275 (14.9)
2006	2,329	498 (21.4)
2007	3,101	847 (27.3)
2008	3,775	1,340 (35.5)
2009	4,125	1,749 (42.4)
2010	4,549	2,140 (47.0)
2011	4,623	2,274 (49.2)
2012	5,220	2,861 (54.8)
2013	4,786	2,723 (56.9)
2014	4,773	2,848 (59.7)
Total	40,911	17,649 (43.1)

*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	508	5	103	6
2004	858	59	227	24
2005	1,237	196	328	79
2006	1,486	377	345	121
2007	1,853	634	401	213
2008	2,042	1,041	393	299
2009	1,988	1,427	388	322
2010	2,057	1,742	352	398
2011	2,054	1,847	295	427
2012	2,091	2,410	268	451
2013	1,818	2,295	245	428
2014	1,729	2,387	196	461
All years	19,721	14,420	3,541	3,229

(c) Percentage of first knee revisions by whether the primary is in the NJR or not and within each type of stage of operation where **aseptic loosening** was indicated.

Year of (first) revision	Single stage		First documented stage of two-stage	
	Primary not in the NJR as percentage (%) of all first revisions of this type	Primary in the NJR as percentage (%) of all first revisions of this type	Primary not in the NJR as percentage (%) of all first revisions of this type	Primary in the NJR as percentage (%) of all first revisions of this type
2003	41.9	20.0	29.1	0.0
2004	50.7	20.3	21.6	12.5
2005	54.4	27.0	17.1	10.1
2006	51.9	28.1	13.6	10.7
2007	52.7	29.7	13.2	9.4
2008	51.4	30.9	15.5	13.4
2009	50.0	30.4	18.6	12.1
2010	49.4	30.9	12.2	9.5
2011	52.4	31.6	15.9	11.2
2012	49.4	28.5	18.7	9.8
2013	49.2	29.2	18.4	8.9
2014	49.5	27.8	13.8	10.8
All years	50.6	29.5	16.4	10.6

(d) Percentage of first knee revisions by whether the primary is in the NJR or not and within each type of stage of operation where **pain** was indicated.

	Single stage		First documented stage of two-stage	
Year of (first) revision	Primary not in the NJR	Primary in the NJR	Primary not in the NJR	Primary in the NJR
2003	22.0	0.0	27.2	0.0
2004	19.8	16.9	8.8	4.2
2005	16.3	28.6	6.1	3.8
2006	19.1	26.5	7.5	9.1
2007	19.3	28.9	6.5	7.5
2008	18.1	28.4	7.9	9.7
2009	18.7	26.9	7.0	8.1
2010	16.2	26.6	5.1	5.3
2011	15.0	24.9	5.4	4.7
2012	13.2	23.3	5.6	5.3
2013	12.3	21.5	4.5	5.6
2014	11.8	19.1	1.5	3.7
All years	**16.3**	**24.0**	**6.8**	**5.9**

(e) Percentage of first knee revisions by whether the primary is in the NJR or not and within each type of stage of operation where **infection** was indicated.

	Single stage		First documented stage of two-stage	
Year of (first) revision	Primary not in the NJR	Primary in the NJR	Primary not in the NJR	Primary in the NJR
2003	18.5	40.0	18.4	50.0
2004	5.0	15.3	61.2	79.2
2005	1.7	5.1	76.5	86.1
2006	2.5	4.8	80.3	86.0
2007	2.3	4.4	78.6	83.1
2008	3.5	4.2	76.1	77.9
2009	3.1	5.0	73.7	80.7
2010	3.7	5.4	77.3	82.4
2011	3.4	5.4	79.3	83.6
2012	2.8	5.7	73.5	83.6
2013	3.7	5.9	74.7	86.2
2014	2.3	7.0	74.5	84.6
All years	**3.5**	**5.6**	**73.9**	**83.2**

(f) Percentage of first knee revisions by whether the primary is in the NJR or not and within each type of stage of operation where **other reason** was indicated.

	Single stage		First documented stage of two-stage	
Year of (first) revision	Primary not in the NJR	Primary in the NJR	Primary not in the NJR	Primary in the NJR
2003	9.1	0.0	13.6	16.7
2004	8.0	10.2	4.4	12.5
2005	7.4	18.4	0.9	1.3
2006	8.2	8.0	2.6	2.5
2007	9.5	12.1	3.0	4.2
2008	11.6	15.3	5.3	5.0
2009	13.7	18.9	5.4	5.6
2010	15.2	22.0	7.1	5.5
2011	18.6	25.3	6.1	3.5
2012	19.9	26.2	7.1	6.4
2013	20.8	25.1	8.6	3.5
2014	22.6	29.0	7.1	4.3
All years	**14.7**	**23.1**	**5.3**	**4.7**

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 years while 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 their choices.

Cementation of the primary prosthesis in total knee replacements continues to be the most commonly used method of fixation, forming 87.5% of all primary knee replacements in 2014. 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 2.5% of all surgeries last year reporting this type of surgical procedure. UKR (medial and lateral unicondylar and patellofemoral knee replacement) still represents around one in 10 of all primary knee surgeries (9.2% in 2014) and this proportion overall has remained relatively consistent over the 2003 to 2014 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 3.17 (a) and (b) and Table 3.27 (a)). The best eleven-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, at the longest term follow-up times numbers at risk are small in some sub-divisions of surgery type and revision risk estimates are less reliable when cases at risk fall below 250. 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 at different times after surgery is higher in the uncemented and hybrid fixation groups compared to the cemented group at the same lengths of time after surgery.

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 (at all lengths of time after the primary) 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 more likely to be more active than those receiving a TKR and they will tend to be those who have not yet reached retirement age.

Unlike hip surgery findings in the last section, gender differences in the cumulative chance of needing revision surgery 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 the older age groups.

The most common clinical reasons for revision cited for TKR were aseptic loosening, pain and infection, each of which account for more than one revision per 1,000 patient-years 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 6.1 and 9.1 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 0.33%, with the cumulative percentage chance of death rising to 1.08% at 1 year, 8.69% at 5 years and 25.2% at 10 years.

The PROMs data shows interesting new insights into the patient related outcome of knee replacement, particularly with reference to the longitudinal nature of the data. The analysis shows that the NJR PROMs sample is representative of the wider population of patient undergoing elective total and partial knee replacement in 2010, which allows some confidence in interpretation.

The data demonstrates that the overall improvement in OKS score within the longitudinal sample seen at six months after knee replacement is maintained to 36 months. Comparable findings are found for the EQ-5D Index and Health Scale. It is of note that not all patients do well following surgery and in a similar fashion this effect persists at 36 months after surgery.

Patient and surgical factors do have an effect on longitudinal PROMs outcomes. Small differences in OKS are seen between men and women, with women obtaining slightly lower scores at all four time points. Across all age groups significant clinical improvement in OKS is seen from Q1 to Q4. Younger patients tend to have the lowest scores pre-operatively and at 36 months. In general the trend is for differences to be seen at the pre-operative stage that are then carried forward and maintained across scores up to 36 months after surgery. This is true for comorbidity and ASA grade (lower scores with increased morbidity), weight (the lowest median scores seen in the obese group), ethnicity (lower scores seen in Black and Asian patients) and deprivation index (lowest median scores seen in more deprived groups).

Fixation methods do not seem to have a major effect on OKS over time. However, some differences are seen when considering the type of reconstruction performed. In comparison to total knee replacement, unicondylar and patellofemoral replacement tend to have slightly higher pre-operative scores. Post-operation this difference slightly increases for unicondylar replacement, whereas for post-patellofemoral replacement the differences are reversed.

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 2014. There were 2,554 primary ankle operations submitted to the NJR in total (see Tables 3.1 and 3.2 on page 26), 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 62-74 years), with an overall range of 17 to 91 years. More procedures were performed in men than women (men 58.37%). Of the 2,554 primary procedures, 2,500 (98%) used uncemented, 53 (2%) cemented and 1 (0.04%) a hybrid fixation method for the implant.

A total of 201 consultants carried out these primary procedures; 123 (61%) of them entered ten or more procedures. The maximum number of procedures for any consultant was 169. Similarly the total number of units involved was 217; 154 (71%) of which carried out ten or more. The maximum number of procedures carried out by any unit was 186.

Table 3.42 (below) shows an overall breakdown of brands used and further breakdowns by year of primary operation.[9] 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. The next most common brand was Zenith, used in just over one quarter of procedures in 2014.

Table 3.42 Numbers of primary ankle replacements by ankle brand.

		Number (%) of each brand, for each year of operation				
Brand	Number (%)	≤2010*	2011	2012	2013	2014
Mobility	1,111 (43.5)	255 (61.9)	294 (56.8)	283 (49.1)	197 (36.5)	82 (16.1)
Zenith	584 (22.9)	78 (18.9)	107 (20.7)	126 (21.9)	132 (24.5)	141 (27.7)
Box	224 (8.8)	23 (5.6)	29 (5.6)	44 (7.6)	49 (9.1)	79 (15.5)
Salto	185 (7.2)	23 (5.6)	29 (5.6)	38 (6.6)	44 (8.2)	51 (10.0)
Hintegra	174 (6.8)	15 (3.6)	18 (3.5)	34 (5.9)	63 (11.7)	44 (8.6)
Star	166 (6.5)	15 (3.6)	29 (5.6)	31 (5.4)	34 (6.3)	57 (11.2)
Rebalance	36 (1.4)	0 (0.0)	4 (0.8)	13 (2.3)	13 (2.4)	6 (1.2)
Inbone	27 (1.1)	0 (0.0)	0 (0.0)	2 (0.3)	4 (0.7)	21 (4.1)
Infinity	26 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	26 (5.1)
Taric	1 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)
Not known	20 (0.8)	3 (0.7)	8 (1.5)	4 (0.7)	3 (0.6)	2 (0.4)
Total	2,554 (100)	412	518 (100)	576 (100)	539 (100)	509 (100)

*Includes 13 with operation dates prior to 2010.

3.7.2 Revisions after primary ankle surgery

Only 49 of the 2,554 procedures had been revised before the end of 2014. Revision here includes 12 conversions to arthrodesis (no amputations were recorded for these 2,554 primaries).

The estimated cumulative percentage probabilities of first revision overall (using Kaplan-Meier estimation) were at 90 days 0.08 (95% CI 0.02-0.32), at 1 year 0.45 (95% CI 0.24-0.83), at 2 years 1.85 (95% CI 1.32-2.58), at 3 years 2.52 (95% CI 1.85-3.43) and at 4 years 3.28 (95% CI 2.37-4.55). Five-year rates are unreliable as only 13 patients remained at risk at this time.

[9] 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.

BOFAS believes that the small number of revisions may indicate under-reporting of 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 applies to cases where the implants are removed and includes cases where the ankle and hindfoot are fused (conversion to fusion) or amputated (conversion to amputation).

Table 3.43 (below) lists the indications for the 49 first revisions.

Table 3.43 Indications for the 49 first revisions following primary ankle replacement. Note that these are not mutually exclusive.

Indication		Number
Infection	High suspicion (e.g. pus or confirmed micro)	1
	Low suspicion (awaiting micro/histology)	12
Aseptic loosening	Tibial component	10
	Talar component	11
Lysis	Tibia	3*
	Talus	2*
Malalignment		7
Implant fracture	Tibial component	0
	Talar component	2
	Meniscal component	0
Wear of polyethylene component		1
Meniscal insert dislocation		1
Component migration/dissociation		3
Pain (undiagnosed)		16
Stiffness		9
Soft tissue impingement		7
Other indications for revision		12

*One patient had lysis of both tibial and talar component.

3.7.3 Risk of first revision after primary ankle replacement using Mobility replacements

The numbers of cases by brand are generally too small for individual results to be tabulated. However we can report results for the largest brand, Mobility, which was withdrawn from the market in 2014. The last date of a primary replacement using this brand recorded in the NJR was 25 July 2014.

A total of 1,107 ankle primaries were carried out and 37 ankles had been revised by 31 December 2014. The revision outcome for this brand is shown in Table 3.44 (right). As numbers are small, Person-Time Incidence Rates (PTIRs) are also shown. The overall PTIR (95% CI) for first revision for any reason was 1.18 (0.86-1.63) revisions per 100 patient-years.

Table 3.44 PTIR and Kaplan-Meier estimates of the cumulative percentage probability (95% CI) of a first revision at 1 and 3 years after primary ankle replacements using Mobility implants.

Brand	No. of primaries	Median age at primary (IQR)	% Males	No. of first revisions	Patient-years at risk (x 100)	PTIR (per 100 patient-years)	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is:	
							1 year	3 years
Mobility	1,111	68 (61-75)	56	37	31.40	1.18 (0.85-1.63)	0.55 (0.25-1.22)	3.46 (2.44-4.91)

3.7.4 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 any death details were not ascertainable). Among the remaining 2,550, 61 died before the end of 2014.

The estimated cumulative percentage survival (based on Kaplan-Meier estimates) were at 90 days 0.08 (95% CI 0.02-0.32), at 1 year 0.67 (95% CI 0.40-1.10), at 2 years 1.72 (95% CI 1.22-2.42), at 3 years 2.82 (95% CI 2.11-3.77) and at 4 years 4.35 (95% CI 3.28-5.74). Estimates at five years were unreliable as too few patients remained at risk.

Table 3.45 (below) shows the cumulative percentage probability estimate of death at different times after surgery by gender and age at primary groups <65 and 65+ years.

Table 3.45 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. *Figures in blue italics signify time points where fewer than 250 patients remain at risk*

Gender	Grouped age at primary (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
Male	<65	477	0.00	0.00	0.88 (0.29-2.72)	*1.26 (0.47-3.34)*
	65+	1,011	0.21 (0.05-0.82)	0.89 (0.44-1.77)	2.25 (1.39-3.62)	3.75 (2.49-5.64)
Female	<65	405	0.00	0.28 (0.04-1.98)	0.99 (0.32-3.05)	*1.50 (0.55-4.06)*
	65+	656	0.00	1.05 (0.47-2.33)	2.02 (1.08-3.76)	*3.47 (2.08-5.77)*

3.7.5 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 39% of consultant surgeons and 29% of centres have submitted less than ten procedures in the time the NJR has been capturing data, which equates to less than three procedures per year. The market leading brand, the Mobility, was withdrawn from the market in 2014 and the use of other brands has increased accordingly. In addition, fixed bearing implants 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 2014 and documents the revision and mortality for these primaries.

No PROMs outcomes were available at the time of writing this report.

A total of 11,399 linked primary replacements were available for analysis for a total of 11,028 patients. Of these patients, 371 had documented replacements on both left and right sides, 12 of which were bilateral operations (left and right on the same day). Please see Table 3.2 on page 26.

The number of primary shoulder replacements has increased year on year, see Table 3.46 (below). This table also gives a breakdown by stated type of replacement[10]. There has been a slight decrease with time in the percentages of resurfacings (total and hemi-arthroplasties) together with a small increase in the number of reverse polarity total replacements.

Table 3.46 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
2012*	2,446 (100%)	155 (6.3%)	661 (27.0%)	388 (15.9%)	482 (19.7%)	760 (31.1%)
2013	4,197 (100%)	231 (5.5%)	1,211 (28.9%)	700 (16.7%)	587 (14.0%)	1,468 (35.0%)
2014	4,756 (100%)	206 (4.3%)	1,478 (31.1%)	665 (14.0%)	508 (10.7%)	1,899 (39.9%)
Total	**11,399 (100%)**	**592 (5.2%)**	**3,350 (29.4%)**	**1,753 (15.4%)**	**1,577 (13.8%)**	**4,127 (36.2%)**

*Includes 13 in the registry with primary operation dates before 2012.

There were fewer men than women undergoing primary procedures overall (men 28.4%; women 71.6%). The median age at the primary operation was 73 years (IQR 66-79 years), overall range 19-99 years[11].

A total of 553 consultant surgeons had carried out the primary replacements and the median number carried out by each was 11 (IQR 2-31). Similarly the number of units involved was 335, with a median of 18 (IQR 7-42) procedures each.

Table 3.47 (over the page) lists the reasons for the primary operation and shows the number and percentage of primaries indicating each reason. Please note that the reasons are not mutually exclusive – more than one may have been indicated. The majority (93.9%), however, listed only one reason and the numbers of these are shown in the right hand column. Most (658) of the remaining 696 with combinations of reasons had exactly two, the largest of these being osteoarthritis and cuff tear arthropathy (240), trauma sequelae and avascular necrosis (71) and osteoarthritis and other inflammatory arthropathy (61).

[10] Provisional breakdown, awaiting further validation from examination of the actual components used.
[11] Excludes 13 cases where the NHS number was untraceable and therefore the age could not be validated.

Table 3.47 Reasons for primary shoulder replacement.

Reason for primary replacement	Number (%) where the reason was indicated	Number (%) where this was the only reason indicated *
Osteoarthritis	6,669 (58.5%)	6,183 (54.2%)
Cuff tear arthropathy	2,697 (23.7%)	2,343 (20.6%)
Acute trauma	992 (8.1%)	877 (7.7%)
Trauma sequelae	668 (5.9%)	492 (4.3%)
Other inflammatory arthropathy	537 (4.7%)	408 (3.6%)
Avascular necrosis	364 (3.2%)	201 (1.8%)
Other cause(s)**	278 (2.4%)	199 (1.8%)
Total	**11,399**	**11,399**

*696 (6.1%) listed more than one reason, see text.

**Includes one metastatic cancer/malignancy which was only documented separately since November 2014 (after MDSv6 was introduced).

Table 3.48 (below) shows the distributions by gender, age and reason for primary for each of the five types of primary procedure. Reverse polarity total prosthetic replacement is now being used by some surgeons across all indications and reasons for replacement, including primary osteoarthritis.

Table 3.48 Gender, age at primary and reason for primary for five types of primary shoulder replacements.

	Type of primary procedure					All cases (n=11,399)
	Resurfacing total arthroplasty (n=592)	Total prosthetic replacement (n=3,350)	Hemi-arthroplasty (n=1,753)	Resurfacing hemi-arthroplasty (n=1,577)	Reverse polarity total prosthetic replacement (n=4,127)	
Males number (%)	**191 (32.3%)**	**944 (28.2%)**	**511 (29.2%)**	**451 (28.6%)**	**1,142 (27.7%)**	**3,239 (28.4%)**
Median age (IQR) at primary, in years, for all patients combined	62 (69-76)	65 (71-76)	63 (71-78)	64 (72-78)	70 (76-81)	73 (66-79)
Reason for surgery*						
Osteoarthritis	499 (84.3%)	2,916 (87.0%)	733 (41.8%)	1,250 (79.3%)	785 (19.0%)	6,183 (54.2%)
Cuff tear arthropathy	19 (3.2%)	35 (1.0%)	72 (4.1%)	91 (5.8%)	2,126 (51.5%)	2,343 (20.6%)
Acute trauma	2 (0.3%)	9 (0.3%)	520 (29.7%)	2 (0.1%)	344 (8.3%)	877 (7.7%)
Trauma sequelae	9 (1.5%)	52 (1.6%)	116 (6.6%)	26 (1.7%)	289 (7.0%)	492 (4.3%)
Other inflammatory arthropathy	30 (5.1%)	127 (3.8%)	77 (4.4%)	66 (4.2%)	108 (2.6%)	408 (3.6%)
Avascular necrosis	7 (1.2%)	45 (1.3%)	77 (4.4%)	49 (3.1%)	23 (0.6%)	201 (1.8%)
Other cause(s)*	11 (1.9%)	65 (1.9%)	23 (1.3%)	19 (1.2%)	81 (2.0%)	199 (1.8%)
Combinations of two or more reasons	15 (2.5%)	101 (3.0%)	135 (7.7%)	74 (4.7%)	371 (9.0%)	696 (6.1%)

*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 3.49 (below) lists the main stem brands used in the non-resurfacing procedures. Separate listing are given for acute trauma cases, i.e. if this was given as one of the reasons for the primary, and the remaining elective cases.

Note: Not all cases had the stem information recorded and one had multiple stems entered (shown in the bottom row of the table).

Table 3.49 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	Hemi-arthroplasty	Reverse polarity total prosthetic replacement	Total prosthetic replacement	Hemi-arthroplasty	Reverse polarity total prosthetic replacement
Oxford Modular	0	2	0	1	39	0
Ascend	0	0	0	23	6	4
Aequalis stem	0	77	37	203	140	413
Affinity stem	0	0	0	12	1	0
TESS	0	1	1	8	11	29
Comprehensive	1	55	60	171	54	347
Delta Xtend	1	0	64	44	29	1,305
Global Unite	1	38	3	18	14	0
Global FX	2	93	0	1	22	0
Global AP humeral stem	0	3	0	553	124	0
Global Advantage stem	0	26	0	278	161	2
RSP	0	0	1	1	0	29
Vaios stem	0	11	2	66	15	135
Lima SMR stem	1	40	46	153	31	239
Affinis stem	0	0	0	28	22	0
CTA humeral stem	0	0	0	1	2	4
Arrow	1	0	10	50	18	59
Equnoxe	3	37	47	255	54	405
Mosaic	0	1	0	0	0	0
Anatomical shoulder	1	19	29	108	32	257
B/F	0	10	0	47	26	3
TM reverse	0	0	12	52	5	73
EPOCA	0	32	0	289	37	0
SIMPLICITI	0	0	0	142	53	1
VERSO	0	0	7	0	1	10
Univers 2	0	0	0	0	0	5
Biomodular should	0	5	0	4	3	0
METS Shoulder	0	0	0	2	0	3
POLARUS	0	2	0	0	0	0
Nottingham	0	22	0	3	21	0
Ascend Flex	0	0	1	89	21	96
SMR	0	2	0	0	1	3
NEER 3	0	7	0	1	14	0
Affinis Fracture	0	49	11	1	12	5
Affini Inverse	0	0	4	2	3	132
Affinis Short Stem	0	1	0	355	108	0
Aglion Stem	0	0	0	0	1	1
Multiple stem brands entered	0	0	0	1	0	0
Total	11	533	355	2,962	1,081	3,560

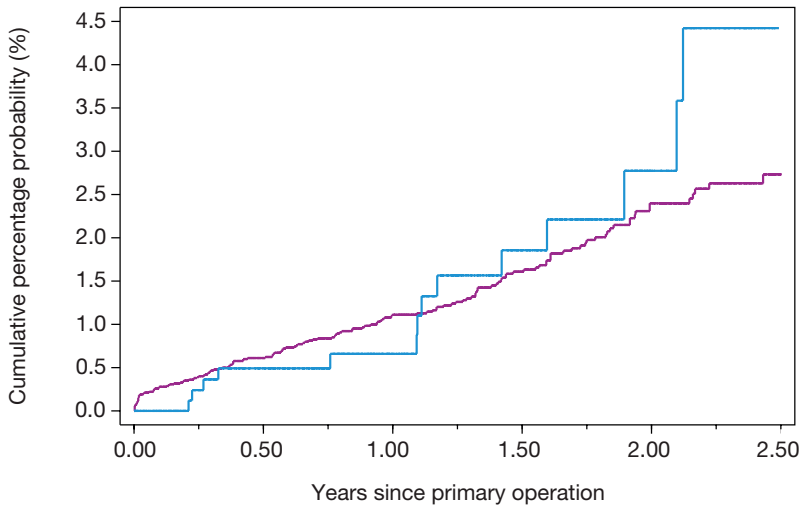
3.8.2 Revisions after primary shoulder replacement surgery

A total of 165 of the shoulder primaries were subsequently revised; the overall cumulative percentage probability of revision (Kaplan-Meier estimates) at 1, 2 and 2.5 years were, respectively, 1.08% (95% CI 0.88%-1.31%), 2.42% (2.03%-2.89%) and 2.84% (2.35%-3.42%). Too few cases remained at risk at three years.

Figure 3.30 (below) shows separate Kaplan-Meier estimates of the cumulative percentage probability of revision for cases where acute fracture was stated as a reason for surgery compared with the remaining (elective) cases. Point-wise, 95% CI bands are not shown because they are wide in the former group, reflecting fewer cases at risk in this group, particularly after 18 months.

Figure 3.30

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



Numbers at risk

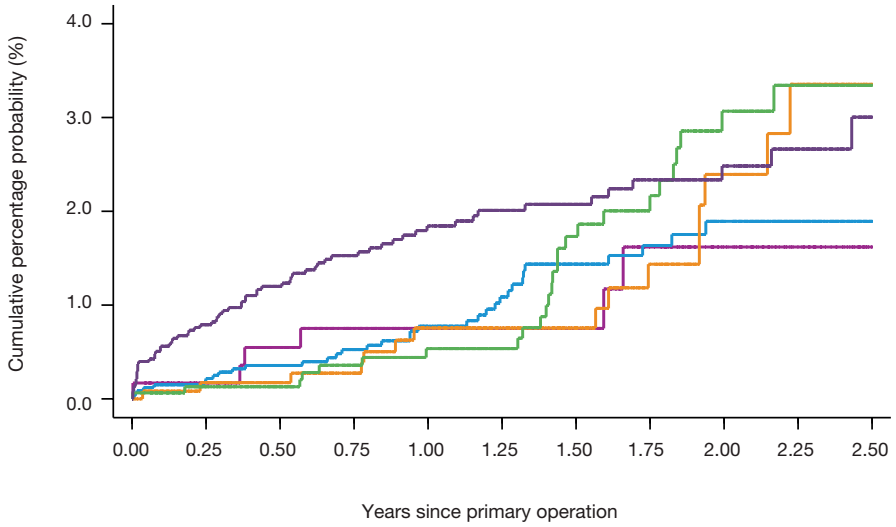
Acute trauma cases	922	727	483	309	137	37
Other (elective) cases	10,477	8,359	5,978	3,987	2,168	695

In Figure 3.31 (below) the elective cases have been sub-divided by stated type of procedure. The cumulative revision rate was much worse for the reverse polarity replacement up to about 18 months after the primary replacement after which time the hemi-arthroplasties appeared to fare worse.

In the case of shoulder replacements, however, it is difficult to evaluate outcome on the basis of revision alone. For example, whilst total prosthetic replacements look as though they have performed relatively well in terms of revision, the options for re-replacement in these cases are limited. We will look at these groups again when the post-operative PROMs data are available. These will help identify poorly performing implants that have not been revised.

Figure 3.31

Kaplan-Meier estimates of cumulative percentage probability of revision up to 2.5 years from primary shoulder replacement surgery, by stated type of procedure, for elective cases only.



Numbers at risk

Resurfacing total arthroplasty	590	547	507	450	380	320	256	203	150	110	57
Total prosthetic replacement	3,339	2,972	2,603	2,229	1,833	1,490	1,174	904	635	414	196
Hemi–arthroplasty	1,210	1,097	1,002	892	744	639	520	388	268	173	83
Resurfacing hemi–arthroplasty	1,572	1,480	1,364	1,220	1,053	929	756	600	456	294	146
Reverse polarity total prosthetic replacement	3,766	3,323	2,883	2,420	1,968	1,615	1,281	962	659	444	213

Table 3.50 (over the page) gives a breakdown of the number of (first) revisions associated with each type of primary procedure, together with the indications for the revision procedure. Please note that the indications for revision were not mutually exclusive and, for 17 revisions, more than one reason has been stated. The revision procedures (as stated) have been added to the table.

Table 3.50 Numbers of first revisions for each type of primary shoulder replacement and indications for revisions.

	Type of primary shoulder procedure (as stated)					All cases (n=11,399)
	Resurfacing total arthroplasty (n=592)	Total prosthetic replacement (n=3,350)	Hemi-arthroplasty (n=1,753)	Resurfacing hemi-arthroplasty (n=1,577)	Reverse polarity total prosthetic replacement (n=4,127)	
Number of revisions	6	34	28	27	70	165
Reason for revision						
Instability	2	12	1	4	26	45
Infection	1	1	4	1	15	22
Cuff insufficiency	0	11	6	12	2	31
Aseptic loosening	0	7	2	1	3	13
Periprosthetic fracture	0	1	1	0	7	9
Conversion from hemi- to total-	0	0	11	11	0	22
Conversion from total- to hemi-	0	0	0	0	1	1
Other indications	1	6	6	8	18	39
Uncertain	2	1	0	0	1	4
Revision procedure (as stated)						
Total prosthetic replacement	1	19	6	6	5	37
Hemi-arthroplasty	1	0	4	3	4	12
Resurfacing total arthroplasty	1	0	0	2	0	3
Resurfacing hemi-arthroplasty	0	0	1	0	1	2
Reverse polarity total prosthetic replacement	3	15	14	16	51	99
Not stated	0	0	3	0	9	12

3.8.3 Mortality after primary shoulder replacement surgery

For this analysis we first deleted thirteen records where the NHS number was not traced (hence the age could not be validated) and, amongst the remainder, deleted the second of the 12 pairs of bilateral operations performed on the same day. Out of the remaining 11,364, a total of 245 had died by 31 December 2014.

A breakdown of cumulative mortality up to 2 years from the primary procedure is shown in Table 3.51 (right).

Acute trauma cases are shown separately from the remaining elective cases. Given that this is all-cause mortality we would expect higher rates in older age groups, and in men, therefore the larger elective group has been further divided by age and gender.

Table 3.51 Kaplan-Meier estimates of the cumulative percentage probability of deaths (95% CI) at 90 days, 1 and 2 years from the primary shoulder replacement. Acute trauma and other (elective) cases are shown separately with further sub-division of the latter group by age and gender. *Figures in blue italics denote time points where fewer than 250 cases remained at risk, hence the 95% CI are not reliable*

Sub-group	n	Time from primary operation: 90 days	1 year	2 years
Acute trauma				
All cases	915	2.2 (1.4-3.4)	4.7 (3.4-6.4)	*6.7 (4.8-9.4)*
Other (elective)				
All cases	10,459	0.3 (0.2-0.4)	1.3 (1.1-1.6)	3.1 (2.7-3.6)
Males				
<65	919	0.2 (0.1-0.9)	0.8 (0.4-1.8)	*1.2 (0.5-2.7)*
65-74	1,173	0.2 (0.04-0.7)	1.1 (0.6-2.0)	*2.6 (1.6-4.4)*
75+	945	0.8 (0.4-1.6)	2.9 (1.9-4.4)	*5.8 (4.0-8.3)*
Females				
<65	1,113	0 .0	0.5 (0.2-1.2)	1.4 (0.7-2.8)
65-74	2,764	0.1 (0.04-0.4)	0.7 (0.4-1.1)	1.8 (1.1-2.7)
75+	3,545	0.4 (0.3-0.7)	1.9 (1.5-2.5)	4.7 (3.8-5.9)

3.8.4 Conclusions

We have presented for the first time some preliminary data on 11,399 primary shoulder replacements. Work remains to be done on this dataset and the analyses will be enhanced when the post-operative PROMs become available.

Shoulder replacements for trauma and shoulder replacements for elective indications such as arthritis are very different. As such they will analysed separately each year to provide far more informative and useful performance results.

While there are many brands of shoulder replacement available there are fundamentally different implant design types that have been designed for different shoulder indications. The data currently suggests that some of these implant types are now being used across all shoulder indications and it will be important to monitor the performance of these implants in each of these indication sub-types.

New shoulder replacement designs are also rapidly entering the market place including 'platform systems'. These systems allow one replacement type to be revised more easily to another replacement type. This introduction may result in an increase in revision rates in some groups while the options for revising more traditional replacements remains more limited. This highlights the critical importance in shoulders of recording PROMs data linked to implants and patients to provide a true context to any variation in revision rates. As well as to ensure low revision rate implants are still performing well from the patient's perspective rather than performing poorly with no technical option to revise.

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 (m^2).
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 and Northern Ireland 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 2014 and 31 March 2015 – the 2014/15 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 2014 inclusive – the 2014 calendar year. The NJR Annual Report Part Three reports on hip, knee and ankle joint replacement revision rates for procedures that took place between 1 April 2003 and 31 December 2014.
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 2014) 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 and Northern Ireland. 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 and Northern Ireland.
NJR Centre	National coordinating centre for the NJR.
NJR StatsOnline	Web facility for viewing and downloading NJR statistics on www.njrcentre.org.uk
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 replacement against benchmarks. The letter represents the strength of evidence and the number the length of time in years during which the implant has been studied. The full benchmark is 10A and the entry is at 3 years with progression through 5 and 7 years. Pre-entry submissions are also recorded. “A” represents strong supporting evidence for the use of the prosthesis, “B” less strong but acceptable evidence. All implants that are used without a 10-year benchmark should be followed up closely.
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 (eg 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 hemiarthroplasty	Replacement of the humeral head with a humeral stem and head or shoulder resurfacing component which articulates with the natural glenoid.
Single-stage revision	A 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.

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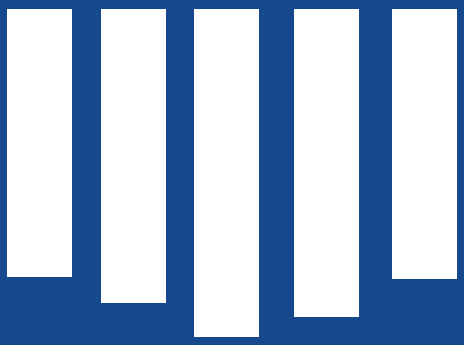

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