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Surgical data to 31st December 2011

National Joint Registry for England and Wales

9th Annual Report 2012

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Chairman's introduction

Laurel Powers-Freeling

The past 12 months have been a whirlwind of activity for everyone involved with the National Joint Registry. The further maturing of our dataset has brought increased interest from many quarters and has allowed important insights to be harvested from the now 1.2 million procedures on the registry. While not a fully comprehensive list of our activities, some milestones from this year include the following:

NJR mandation

In April 2011, the Department of Health made participation in the NJR mandatory for all NHS hospitals in England and the Welsh Government agreed mandation for Wales. We can now further focus on the completeness of the records, which can be variable, and which will continue to be monitored by our Regional Coordinators with the support of the Regional Clinical Coordinators.

The sub-committees of the NJR

The work of the NJR substantially depends on the time and talents of the members of our five sub-committees. We appreciate the dedication and thoughtfulness of the members of each committee, and are particularly grateful to the respective chairmen of the sub-committees for their leadership and commitment. All five sub-committees have made important contributions this year.

- **The Implant Performance Sub-committee:** This has played an important role in working with manufacturers and the Medicines and Healthcare products Regulatory Agency (MHRA) to identify areas of concern with device performance and alert stakeholders as to the performance profiles of implants.
- **Surgeon Outlier Sub-committee:** In 2012, this supported the development and implementation of the NJR Annual Clinical Reports, a new system of annual reporting of surgical outliers and other performance information. This innovative reporting method will enable us to directly share information on clinical outcomes with Chief Executives and management teams within English NHS Trusts, Welsh Health Boards and the private and independent sector for the first time. The reporting process will also be supplemented by the launch of a new electronic Hospital Management Feedback system, which will enable managers to go online to view their relevant NJR data.
- **Research Sub-committee:** The use of NJR data for research has increased dramatically over the year and has also supported the publication of papers in leading medical journals, as well as supporting presentations at national and international conferences. A major achievement was the publication of a paper published in The Lancet on the revision risk of stemmed metal-on-metal joint replacements, demonstrating the value of the NJR data set in identifying and assessing risks and issues in joint replacement procedures. We are grateful to Professor Ashley Blom and the NJR statistical support unit at the University of Bristol for this work.
- **Editorial Board:** The members of the board are responsible for the production of the NJR Annual Report, which continues to evolve to meet the interests of those who use it. The Editorial Board is now developing plans to substantially transfer our Annual Report content to the NJR website in 2013, where it can be regularly supplemented with research and insights as they evolve during the year, thus becoming a more dynamic tool and resource for our stakeholders.
- **Regional Clinical Coordinators' Network:** The RCC Network provides valuable advice to the NJR Steering Committee on how our activities work 'in the field', and is critical in conveying NJR messages and needs at local level including support to the NJR Regional Coordinators. We are pleased this year that the RCC network has a full complement of surgeons to champion the NJR.

Transparency

In line with the Government's transparency agenda, the NJR is reporting on Trust-, Health Board- and unit-level activity and outcomes in Part Four of this report. This is the first year that these statistics have been published, and we hope to build on this level of reporting detail in the future.

Elbows and shoulders

We are delighted to bring on board the collection of elbow and shoulder data, which was initiated in April 2012. We look forward to working with our colleagues from the British Elbow and Shoulder Society as this new area of data develops.

Northern Ireland

We have been working closely with colleagues in Northern Ireland throughout 2012 in order to bring them into the NJR. We are delighted to extend the benefits of the registry to Northern Ireland and hope to welcome them on board later this year.

Post-market surveillance

Our Supplier Feedback programme was launched last year, and now provides manufacturers with data on the performance of individual implants. The system is supported by the NJR component database; with over 60,000 records, this is the largest system of its kind in the world, and allows implant manufacturers a unique opportunity to undertake surveillance of their products. It is our intention to develop the Supplier Feedback tool further to support the regulator and industry to ensure even more depth and breadth of device monitoring in the future.

Patient and public involvement

Last year, the NJR published its first-ever patient guide to our Annual Report which was intended to make our work more accessible and understandable to patients and their families and supporters. This was extremely well received, and the NJR is very proud of this achievement. This year we will again provide the patient guide, which will take on board the feedback we have had to improve its relevance and quality even further.

We also held our first-ever patient focus event earlier this year to share information on the NJR and—more importantly—listen to the views of patients. The event was invaluable to us and was well received by patients and others who attended.

Later this year we will be setting up an NJR Patient Network to help us gather information to better inform our work from a patient perspective and provide a platform for testing ideas and communications.

NJR Patient Reported Outcome Measures (PROMs)

Earlier this year, we undertook our own NJR PROMs to provide ongoing insight into how patients' experience of joint implant procedures evolves. The response rate for questionnaires provided to patients was extremely high, making this one of the largest cohorts in the world for a PROMs programme. Being able to link this data with NJR, HES and national PROMs data will enable us to deliver even richer data for analysis, study and research.

International activities

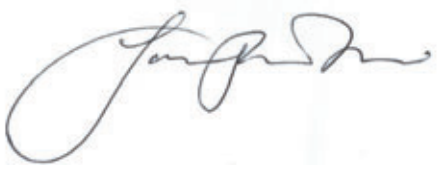
This year, NJR became members of the International Society of Arthroplasty Registers (ISAR), an organisation formed in 2005 to improve international collaboration between joint registries around the world. To mark the 10th Anniversary of the NJR in 2013, we will be acting as host for the ISAR annual meeting in Stratford-upon-Avon, and look forward to sharing this important milestone in our development with our colleagues from around the world.

Governance and structure review

The NJR has grown substantially over the past ten years. Its activities and the demands placed upon it have grown as well, and so the NJR Steering Committee is in the process of reviewing whether our current structure, governance and approach to funding are still appropriate to support a much larger and more complex set of activities than we had at the outset. We will be sharing our evolving strategy and plans and their implications for how we are structured and managed later in the year, with implementation intended in 2013.

All the work that has been done this year has relied on the support and dedication of many people, including our Steering Committee members and the sub-committees, but has also depended on the professionalism of our dedicated team at the Healthcare Quality Improvement Partnership under the leadership of Elaine Young and that of our contracted teams at Northgate Information Solutions and the University of Bristol.

We look forward to another challenging and exciting year at the NJR, and to continuing to support all our stakeholders with data and insights that can make a real difference in achieving good patient outcomes.



Laurel Powers-Freeling
Chairman, National Joint Registry Steering Committee

Foreword from the Chairman of the Editorial Board

This year the 9th Annual Report includes a new section, Part Four, which provides information in relation to hospital units carrying out joint replacement surgery. This is an exciting development, which hopefully will lead to further improvement in data quality and public-facing information.

By 31 March 2012 in excess of 1.2 million records were recorded on the National Joint Registry. Compliance is between 93% and 100% and our ability to link data continues to improve. The various sub-committees have all worked hard to underpin the activity of the register.

The fixation trends in total hip replacement appear now to have stabilised with a predominance of cementless over cemented fixation. The use of metal-on-metal bearings has fallen sharply as a result of adverse events and high revision rates. Surgical technique and thromboprophylaxis regimes have not changed significantly and the market share of a variety of brands remains similar to last year.

Knee replacement again continues to be dominated by the cemented condylar knee replacement and despite high revision rates associated with unicondylar knees, these continue to be used in about 8% of cases.

The development of a new component database for recording joint replacements has significantly enhanced our ability to report the survivorship of implant combinations. This year the University of Bristol has analysed fixation type, bearing and different combinations of implant brands used. This presents a much more realistic picture of what is happening in practice and is more relevant to patients. These trends can also be analysed by gender and age.

The cemented metal- or ceramic-on-polyethylene hip replacement had the lowest revision rate at eight years. Moving towards the eight-year mark, although the cemented hip was still the best, the hybrid fixation is fairly similar which indicates that a revision rate early on in the registry may reveal different revision rates as time goes on. Similarly, the effect of bearing choice may take longer to show differences in performance.

What is clear is the poor results of the metal-on-metal articulation and this year we have included considerable detail of the NJR paper published in The Lancet which recommended that stemmed metal-on-metal total hip replacement should no longer be used.

We were hoping to include Patient Reported Outcome Measures but, unfortunately, data linkage issues prevented us from doing this for 2012. This remains a priority for the 10th Annual Report so we can look at other important end points rather than revision to assess the outcomes of joint replacement. This year the NJR Research Fellows have published NJR data linked to PROMS data in a number of studies.

Once again, I would recommend caution in interpreting registry data. It is important not just to look at the revision rate but also to look at the confidence intervals so the reader can judge whether the differences in revision rates are statistically significant or not.

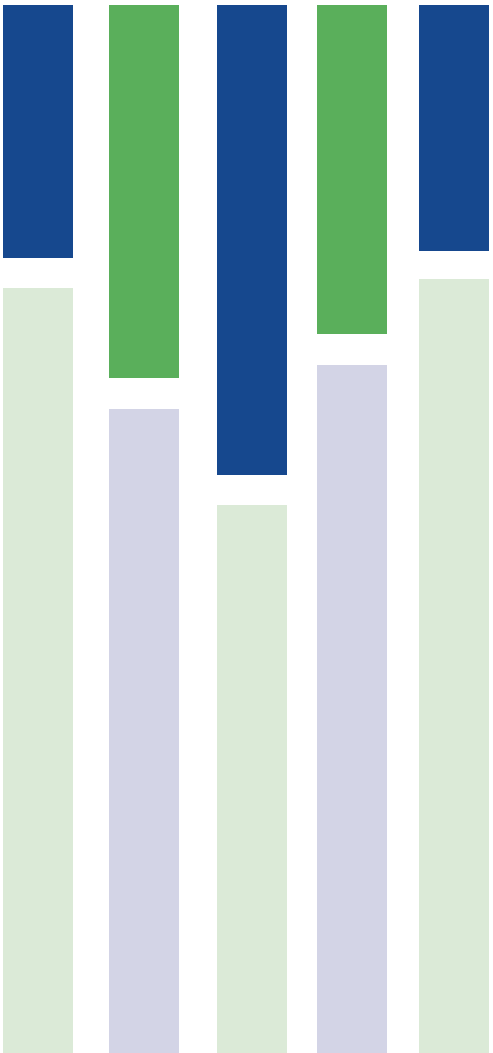
It is also important to point out that registry data, whilst very important, needs to be supplemented by other prospective studies and randomised controlled trials to provide a broader picture.

This year the registry has been more involved in international collaboration and we are excited that registry collaboration will lead to more powerful developments as we move forward.

I would like to thank everybody involved in the production of this report and particularly thank patients for allowing their submissions to be analysed and to surgeons for complying with the register.

Martyn Porter
Chairman, Editorial Board

Executive summary



Part 1: Annual progress

The 9th Annual Report of the National Joint Registry for England and Wales is the formal public report for the period 1 April 2011 to 31 March 2012 (Part One). Also included are statistics on joint replacement activity for the period 1 January to 31 December 2011 (Part Two) and survivorship and more detailed statistical analysis on hip and knee joint replacement surgery using data from 1 April 2003 to 31 December 2011 (Part Three). Part Four shows indicators for hip and knee joint replacement procedures by Trust, Health Board and unit based on the 2011 calendar year.

The NJR Mission Statement has been updated this year and reads: 'The purpose of the National Joint Registry for England and Wales is to collect high quality and relevant data about joint replacement surgery in order to provide an early warning of issues relating to patient safety. In a continuous drive to improve the quality of outcomes and ensure the quality and cost-effectiveness of joint replacement surgery, the NJR will monitor and report on outcomes, and support and enable research'.

This mission statement is supported by six strategic goals outlined in the main body of the report.

The NJR began collecting data on hip and knee replacement operations on 1 April 2003. Data collection on ankle replacements began on 1 April 2010. Data collection on elbow and shoulder replacement started April 2012.

The 2011/12 work of the NJR is funded through a levy raised on the sale of component parts of hip, knee and ankle replacement implants and from April this year elbow and shoulder component parts will be included.

Part One reports on the performance of the NJR during the financial year 2011/12, provides a summary of progress during the year and outlines key forthcoming developments.

The total number of procedures recorded in the NJR exceeded 1.2 million records between 1 April 2003 and 31 March 2012. In 2011/12, 4,564 hip replacements were carried out in Wales and 84,420 in England, the Welsh contribution therefore representing 5.4% of the total.

The "key quality indicators" of the NJR are compliance, consent and linkability.

Compliance, or case ascertainment, reflects the proportion of operations recorded by the NJR that are actually taking place. The NJR assesses compliance in two ways, one by comparing NJR submissions with the number of implants sold and the second method by comparing NJR submissions against records from the Hospital Episodes Statistics (HES) and Patient Episode Data for Wales (PEDW), which record NHS activity in England and Wales respectively. Details of this are discussed in the report. We have also assessed compliance over a three-year period to smooth out data start and end points. Our recent analysis from the period of 2009/10 through to 2011/12 would indicate 100% compliance, but using the HES estimation this would indicate 93% compliance. It is likely, therefore, that the real compliance lies between 93% and 100%. Further work will be carried on data quality issues.

Patient consent has increased year on year and in 2011/12 was 90.4% compared to 88.9% in 2010/11. Finally, linkability, which is important in linking primary activity and revision activity was 95.5% in 2011/12, compared to 91.7% in 2007/08.

All these data quality indicators show improving data quality compliance, consent and linkability throughout the life of the National Joint Registry.

In terms of analysing and reporting on NJR data, the work of the five sub-committees is essential.

The Implant Performance Sub-committee is split into two parts, one instituting policy and the second a scrutiny group which analyses the data. This work is heavily supported by the NJR team at the University

of Bristol. Implant performance is assessed by using the Patient Time Incidence Rate, PTIR. The processes of assessing implant performance are discussed in the report.

Between 2008 and 2011 the Surgeon Outlier Sub-committee identified 63 orthopaedic surgeons as having potentially outlying performance based on PTIR and the mechanisms and outcomes of this process are described in Part One.

The Research Sub-committee has robust data request protocols and data and research governance responsibilities. Their work has supported applications from many different sources and stakeholders in the last year and also monitored and governed the research outputs of the NJR both internally and externally.

The Editorial Board interacts with the other sub-committees to support the production of this Annual Report and its complementary Public and Patient Guide. The publication process is managed by HQIP.

The Regional Clinical Coordinators Network supports surgeons, providing leadership at a regional level.

The highlights of 2011/12 include the extension of the NJR to encompass elbows and shoulders. The NJR recognises the complexity of involving different parts of the anatomy and different challenges in terms of recording data sets and outcomes assessment. The NJR is also in discussion about extending its benefits to Northern Ireland, the Republic of Ireland, the Isle of Man and the Channel Islands.

The NJR has supported two Research Fellows who have worked diligently with many presentations and peer review publications over the last two years.

The NJR operates several feedback and management systems to support various stakeholders, and much progress has been made in 2011/12. Hospital Management Feedback and Annual Clinical Reports are progressing this year. There has been an audit of the HES and PEDW revisions compared to NJR data, which will lead to further research in terms of data quality. NJR Supplier Feedback provides suppliers with detailed information on a monthly basis regarding their own implants. The component management project has enabled the NJR to identify the procedures at a component level, which allows us to analyse the data in much more detail.

In December 2011 the NJR published the Public and Patient Guide to the 8th Annual Report and followed this with a conference in 2012, which was well supported and will lead to future developments.

The NJR recognises the importance of international collaborations mainly with the International Society of Arthroplasty Registers (ISAR) and also the International Collaboration of Orthopaedic Registers (ICOR). The NJR has fully supported both of these initiatives.

Finally, the NJR is now linked to the Department of Health Patient Reported Outcome Measures Initiative which allows the NJR to have a rich source of information in relation to other measures apart from revision.

Part 2: Clinical activity 2011

Part Two of the NJR 9th Annual Report summarises the data and findings for hip, knee and ankle procedures carried out in England and Wales between 1 January 2011 and 31 December 2011. To be included in the report all procedures must have been entered into the NJR by 28 February 2012.

During 2011 there were 411 orthopaedic units that were open, 237 NHS hospitals, 161 independent hospitals and 13 independent sector treatment centres (ISTCs). 95% of units submitted at least one hip, knee or ankle procedure to the NJR within the calendar year 2011.

On average 204 hip replacements and 219 knee replacements were submitted per orthopaedic unit over the year.

Hip replacement procedures

In 2011 there were 80,314 hip replacement procedures recorded on the NJR representing an increase of 5% over 2010. Of these 71,672 were primary and 8,641 were revision procedures. The revision burden was similar to that in 2010 (11%).

Of 71,672 primary hip procedures undertaken in 2011, 36% were cemented total hip replacements (THRs), 44% were cementless THRs and 18% were hybrid or reverse hybrid THRs and just 2% were resurfacing.

Compared to previous years the relative proportion of cemented and cementless fixation now seems to have plateaued. There has been a slight increase in the hybrids and reduction in resurfacing and large head replacements with resurfacing socket.

Patient demographics in terms of age and gender distribution have not changed substantially since 2003. In 2011 the average age of patients undergoing hip replacement was 67.2 years and approximately 60% of patients were females. Despite the suggestion that hip replacement patients are getting younger, NJR data describe a very consistent age range of patients undergoing surgery over the last eight years. For example the proportion of patients undergoing hip replacement below the age of 50 is 6% which has not changed at all and the proportion of patients over the age of 80 remains at about 14%.

The ASA distribution is very similar to last year with 15% being regarded as fit and healthy prior to surgery (16% in 2010).

The average body mass index (BMI) again is similar to last year (28.5).

Although the overall ASA distribution has changed little, there remains a relative discrepancy between patients who are P1 (fit and healthy) prior to surgery (12% in NHS hospitals, 23% in independent hospitals) and patients with incapacitating systemic disease P3 (20% of patients in NHS hospitals, 7% in independent hospitals), which suggests significant case mix distortion between patients operated on in the NHS and independent hospitals.

Patient age and gender significantly influence the type of fixation and the type of hip replacement carried out. For example, in male patients less than 30 years of age at time of surgery, just 9% received cemented hip replacements compared to 62% which were cementless. For male patients between 80 and 89, 52% received cemented replacements and 28% cementless replacements. The indications for surgery were again similar to last year with 93% of patients recorded as having osteoarthritis, 2% with avascular necrosis, 2% fractured neck of femur, 2% congenital dislocation and 1% inflammatory arthropathy.

However, these diagnostic categories varied according to age group. For example in patients less than 30 years of age 22% were recorded as having a diagnosis of congenital dislocation/dysplasia of the hip compared to less than 1% in patients over 60 years of

age. Similarly, 20% of patients less than 30 years of age had a diagnosis of avascular necrosis compared to about 2% in patients over the age of 60 years.

The details of surgical technique have not changed substantially from last year. The lateral position was used in 92% of cases and the posterior approach in 59%. Minimally-invasive surgery was described as being used in 5% and image-guided surgery in less than 1% of cases.

Low molecular weight heparin (LMWH) was used in 71% of cases in terms of thromboprophylaxis and TED stockings were used in 66% of cases. There was a complex array of combinations of chemical and mechanical thromboprophylaxis methods.

In 2011, 142 brands of femoral stem, 119 brands of acetabular cups and 10 brands of resurfacing cups were used. The Orthopaedic Data Evaluation Panel (ODEP) ratings for prosthesis were reviewed. The full 10A benchmark rating was achieved in 85% of cemented stems, 72% of cementless stems, 40% of cemented cups, 3% of cementless cups and, finally, 57% of resurfacing cups.

With cemented fixation the Exeter V40 stem was used in 64% of cases and the Contemporary cup was used in just under 35% of cases.

With cementless fixation the Corail stem was used in 47% and the Pinnacle socket in about 33% of cases.

Hip resurfacing has continued to decline to just 1,801 cases in 2011 compared to 4,350 in 2009. The Birmingham hip resurfacing remains the market leader.

In relation to femoral head size the use of large diameter femoral heads (36 millimetres or greater) remains at just under 30% but this has decreased slightly compared to 2010, mainly as a result of the reduced usage of large head metal-on-metal stemmed total hip replacement.

This year the use of a new component architecture allowed a greater analysis of the hip articulation. Metal-on-polyethylene remains the most commonly used articulation. There has been a significant reduction of metal-on-metal articulation but a significant increase in the use of the ceramic-on-ceramic bearing. The use of ceramic-on-ceramic bearings has risen from less than 2,000 in 2003 to nearly 17,000 in 2011.

A total of 8,639 hip revisions were reported in 2011. Of these 87% were single-stage revision, 6% were Stage 1 of a two-stage process and another 6% were Stage 2 of a two-stage revision. Excision arthroplasty (removal of the prosthesis) was carried out in less than 1% of cases. The indication for revision was recorded as infection in 12% of cases but adverse soft tissue reaction was recorded in 11% of cases confirming the rise in revisions carried out in relation to the failure of metal-on-metal replacements. NHS hospitals performed 84% of all hip revision procedures.

In a single-stage revision both cup and stem were removed in 45% of cases, the acetabular component in 30% and the femoral stem in 15% of cases. In relation to re-implantation a cemented component was used in 28% and cementless component in 30%; on the acetabular side, 18% were cemented components and 59% cementless.

Knee replacement procedures

The number of knee replacement procedures recorded on the NJR in 2011 was 84,653, a 3.3% increase compared to 2010. There were 5,137 revision procedures. The revision burden for knee replacement procedures is 6.1% in 2011. In comparison to hip replacement the proportional use of different modalities of fixation has remained relatively constant over the lifespan of the register. In 2011 86% of total knee replacements were used with cement, 4% without cement, less than 1% hybrid, 1% patello-femoral replacement and 8% were unicondylar knees.

In terms of constraint, in bicondylar primary knee replacement procedures in 2011 an unconstrained fixed bearing knee replacement was used in 68% of cases, a posterior-stabilised fixed bearing knee in 25% of cases, an unconstrained mobile bearing knee in 6%, a posterior-stabilised mobile bearing knee replacement in 1%. A hinge or linked replacement was used in less than 1% and a constrained condylar in less than 1%. Again these proportions have not changed significantly since 2005.

In relation to unicondylar replacement in 2011, 70%

were mobile and 30% were fixed bearing. The average age of patients undergoing knee replacement was just over 68 years and 56% were female. 11% of patients were graded as fit and healthy prior to surgery (ASA P1). The relative proportions of ASA grades and BMI grades have not changed significantly from 2010 although it was noted in the 2011 report that there have been quite significant changes since 2004 indicating that patients are now less fit (higher ASA grade) and more obese (higher BMI).

Age influenced the choice of implants used. As noticed last year male patients and younger patients (under the age of 60) had a higher proportion of unicondylar and patello-femoral replacements compared to elderly patients who had a higher proportion of bicondylar knees and total knee replacement using cement.

In relation to surgical technique the medial parapatellar incision was used in 93% of procedures. An interesting observation was that when cemented knee replacement was used 37% had the patella resurfaced at the time of primary procedure whereas only 8% of patellas were resurfaced during cementless total knee arthroplasty.

In relation to minimally-invasive surgery, 2% of primary total knee replacements using cement were inserted with minimally-invasive surgery and 3% with image-guided surgery. However, with unicondylar replacement 48% were inserted using a minimally-invasive technique but only 1% with image-guided surgery.

Low molecular weight Heparin was used in 70% of cases for thromboprophylaxis and TED stockings in 69% of cases. As noted with total hip replacement there was a number of combinations using chemical and physical thromboprophylactic measures.

The PFC Sigma was the most commonly used total condylar knee replacement, covering about 37% of cases. In unicondylar replacement the Oxford partial knee replacement remains the market leader, covering just under 70% of cases. The Avon patello-femoral replacement is the market leader in patello-femoral knee replacement brands, although its proportional use has reduced significantly since 2003.

5,135 revision knee procedures were recorded, an increase of 1% on 2010. 77% were single-stage revisions, 11% were Stage 1 of a two-stage revision and 12% were Stage 2 of a two-stage revision.

Ankle replacement procedures

Ankle replacement procedures have only been recorded since April 2010 so this is the first year reporting on a complete year. The compliance rate reviewed by comparing NJR entries to levy submissions would suggest that the compliance is only 64%.

Of the 492 ankle replacements recorded between 1 January 2011 and 31 December 2011 there were 21 revision procedures. Of the 471 primary procedures 75% were performed in the NHS sector, and almost all the primary procedures were reported as being uncemented. The diagnosis was recorded as osteoarthritis in 88% of cases and of these 19% had a previous history of fracture and hence post-traumatic osteoarthritis.

56% of patients were male and the average age was approximately 68 years. An anterior incision was used in 97% of cases and associated procedures at the time of surgery included subtalar joint fusion in 5%, talonavicular fusion in 2% and achilles tendon lengthening in 9% of procedures. Bone graft was used in 8% of cases. In terms of thromboprophylaxis, LMWH was used in 74% of cases and TED stockings in 59% of cases.

In 5% of cases an untoward intra-operative event was recorded, of which the most frequent was a fracture of the medial malleolus which occurred in 2% of cases.

The DePuy Mobility ankle prosthesis was used in 57% of primary procedures recorded in 2011.

There were 21 revision procedures recorded in 2011. The indications for revision were multi-factorial but included aseptic tibial loosening, infection, osteolysis of the tibia, malalignment in 24% of cases, polyethylene wear in 29% and undiagnosed pain in 29%.

Part 3: Outcomes after joint replacement 2003 to 2011

Part Three of the 9th Annual Report describes the survivorship of hip and knee replacements in England and Wales up to nearly nine years after primary surgery. Although ankle replacements are now included in the registry the data at this stage are too short-term to include in the survivorship analysis. This section includes analysis of revision rates and mortality after primary joint replacement. Differences according to implant characteristics such as implant brand and prosthesis and fixation and bearing types are explored and results for different patient groups are contrasted.

An important development for the 9th Annual Report is the new component database for recording joint replacements. This means that the survivorship analysis this year has moved away from considering univariables such as fixation and bearings towards looking at the combination of fixation and bearings together. This has allowed a much more in-depth analysis of the data representing the true variability that takes place in clinical practice. For example, instead of comparing cemented versus uncemented versus hybrid fixation, this year we are able to comment on cemented components with different bearing combinations.

The data available for analysis are described in more detail. For the survivorship analysis revisions must be matched to primary operations and so the data has to be restructured from operation-level to person-level. The hip dataset identified 362,110 records with one joint replacement and because of the effects of bilateral joint replacements the total number of person-level records for analysis was 458,568 of which there were 8,429 revisions with a linked primary and 1,063 with more than one revision for a linked primary.

The comparable figures for knees were 355,815 records with one joint replacement. Taking into account bilateral procedures, there were 499,695 person-level records for analysis and 8,765 with at least one revision for a linked primary and 1,326 with more than one revision for a linked primary.

Hip replacement procedures

Looking at the data for primary hip replacement over the observation period of the registry (2003 to 2011), a cemented metal-on-polyethylene replacement was the commonest procedure (carried out in just under 34% of cases) followed by an uncemented metal-on-polyethylene replacement (in just over 13% of cases). However, looking at the trends in fixation and bearing surface, over the period of 2003 to 2011 the all cemented group decreased from just over 60% in 2003 to just 32.6% in 2011, whereas the all uncemented group increased from 16.8% in 2003 to 44.7% in 2011 and the all hybrid group increased from 12.3% in 2003 to 17.4% in 2011. Resurfacings moved from 9.7% in 2003 to just 2.5% in 2011. Furthermore the proportion of cemented metal-on-polyethylene hip replacements almost halved from 55% in 2003 to 28% in 2011 whilst the use of newer bearing surfaces such as uncemented ceramic-on-ceramic increased five-fold from 4.0% in 2003 to 20% in 2011.

The types of hip replacement used seemed to be related to the age of the patient and the plots of the median and inter-quartile ranges show differences between fixation and bearing types between the 15 permutations analysed in this report.

The risks of revision were studied up to eight years following surgery and the lowest rates were associated with cemented fixation of metal- or ceramic-on-polyethylene. Rates for hybrid metal- or ceramic-on-polyethylene were similar and by eight years the difference between hybrid and cemented metal-on-polyethylene was not statistically significant. There were no statistically significant differences between the fixation methods for ceramic-on-polyethylene. Rates for uncemented fixation were slightly higher than cemented fixation. Revision rates were considerably

higher for metal-on-metal bearings whether stemmed prosthesis or resurfacings. It is clear that the revision rate for one brand of metal-on-metal bearing, the ASR, was markedly higher than other types of resurfacing and, therefore, the analysis has been performed both including and excluding the ASR brand to allow more meaningful comparisons.

In the all cemented group the eight-year revision rate was 2.29% (CI 2.14 to 2.44) compared to all uncemented 5.10% (CI 4.82 to 5.39), all hybrids 2.95% (CI 2.65 to 3.28), all reverse hybrids 3.30% (CI 2.48 to 4.40), resurfacing 9.14% (CI 8.52 to 9.81) and excluding the resurfacing ASR brand 7.39% (CI 6.80 to 8.03). However, this data is not risk adjusted according to age, gender or co-morbidity.

The reasons for first revision are described according to the main attributes of pain, dislocation, subluxation, infection, aseptic loosening, lysis, peri-prosthetic fracture, implant fracture, implant failure, head socket mismatch, malalignment and other reasons.

Revision rates for main implant brands are described but instead of considering the stem and socket or cup in isolation, stem and cup combinations are described in tandem. The number of combinations are considerable but, for example, a Charnley cemented stem with a Charnley cemented cup had a revision rate of 1.9% (CI 1.58 to 2.29) at seven years compared to a Corail Pinnacle of 4.12% (CI 3.51 to 4.85) at seven years, a Corail with a resurfacing cup of 21.93% (CI 19.61 to 24.53) at five years and an ASR resurfacing of 24.22% (CI 21.31 to 27.52) at seven years. In comparison the Birmingham resurfacing had a revision rate of 5.09% (CI 4.64 to 5.57) at seven years.

Revision rates are also described for the most commonly used brands for hip replacement by fixation and bearing surface and in the Corail Pinnacle range, for example, the revision rate at five years for an uncemented ceramic-on-ceramic was 2.49% (CI 2.10 to 2.95) and for an uncemented ceramic-on-polyethylene 1.37% (CI 0.88 to 2.14), uncemented metal-on-polyethylene 1.66% (CI 1.41 to 1.96) and uncemented metal-on-metal of 4.28% (CI 3.77 to 4.85) indicating the significant influence of bearing surface on the same stem/cup combination.

4.7% of primary hip replacement components were implanted using minimally-invasive techniques and surgeons utilised image guidance in only 0.34% of primary hip replacements. Multi-variable analysis that controlled for age, gender, ASA grade and type of hip replacement found that neither minimally-invasive surgery nor image-guided surgery had a significantly different rate of revision compared to when these techniques were not used.

Risk of death was studied following total hip replacement. Overall the mortality rates in the first 30 days after surgery were low at around 0.2% although this did vary by both age and gender. By eight years there were very significant differences according to age and gender. For example, in male patients under 55 years of age at time of surgery, the eight-year mortality rate was 3.76% (CI 3.26 to 4.33) compared to males over the age of 80 at 81.85% (CI 77.01 to 87.00).

Two in-depth studies (special topics) have been published in peer review journals. The first paper on stemmed metal-on-metal hip replacements published in The Lancet in March 2012 identified higher revision rates with stemmed metal-on-metal hip replacements and recommended they should no longer be used; the second paper, published in the British Medical Journal in April 2012, did not find evidence of an increased risk of cancer in patients with metal-on-metal hip replacements compared with other bearings at short-term follow up (seven years).

Knee replacement procedures

The restructuring of the component database once again allowed us to consider not just fixation but degree of constraint within the replacement rather than considering each variable separately. Over the lifespan of the registry between 2003 and 2011, 82.8% of knee replacements were cemented and this has changed very little over the lifespan of the registry being 81.5% in 2003 and 85.8% in 2011. Again there were only slight differences between the use of constrained fixation over the lifespan of the registry. For example, 53.6% of knee replacements were cemented unconstrained (posterior cruciate retaining) in 2003 and 58.5% in 2011. All uncemented decreased from 6.7% in 2003 to 3.8% in 2011 and all unicondylars changed very little from 8.0% in 2003 to 8.4% in 2011 despite the

increased revision rate identified in the registry. When considering unicondylar knees the majority were the unicondylar mobile knee replacement.

Analysis of the data seemed to indicate that patients undergoing unicondylar and patello-femoral replacements tended to be slightly younger than those with cemented total knees although these differences were not large.

The estimated short-term revision rates between fixation and constraint did vary. For example, in the cemented unconstrained fixed bearing knee the eight-year revision rate was 2.62% (CI 2.48 to 2.77) although there were not major differences between the other forms of bicondylar knees. However, for the unicondylar group the eight-year revision rate was 10.14% (CI 8.84 to 11.63) for fixed bearing and 11.08% (CI 10.24 to 11.99) for mobile bearing. The revision rate of patello-femoral joints was 14.70% (CI 12.01 to 18.00).

Looking at the survivorship graphs the divergence appeared to occur early on, i.e. within one to two years of implantation.

There were no major differences in implant survivorship at seven years between most of the bicondylar brands. The market leader, the PFC Sigma, had a seven-year revision rate of 2.04% (CI 1.93 to 2.16). The confidence intervals overlap with the majority of major implant brands. Mixing and matching does not apply with knee replacement systems which are implanted as a brand of femoral and tibial component in comparison to hip replacements which are often implanted as a femoral and acetabular component with different manufacturers leading to increased complexity of analysis of hips compared to knees.

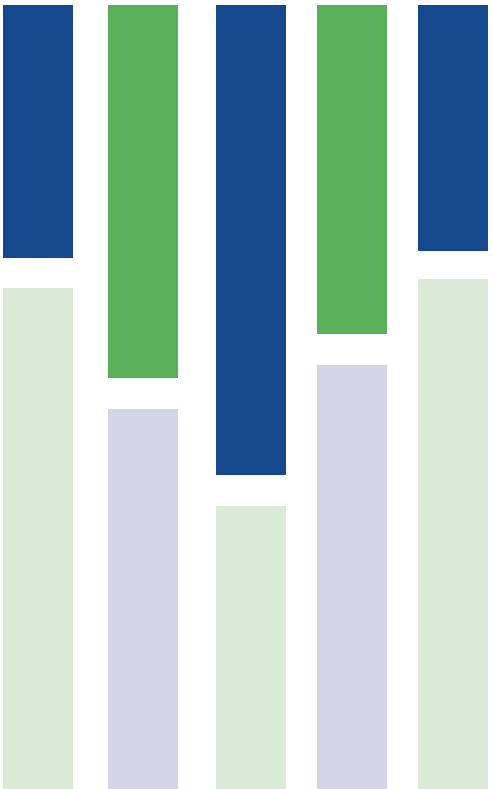
The revision rates for unicondylar knees revealed a seven-year revision rate of the Oxford partial knee replacement of 9.61% (CI 8.96 to 10.30) compared to the MGU knee of 6.64% (CI 5.44 to 8.11).

In relation to surgical technique overall only 6.9% of primary knee replacements were undertaken using minimally-invasive surgery compared to 45.6% with unicondylar knees. Multivariable analysis that controls for age, gender, ASA grade and type of knee replacement found that minimally-invasive surgery was not associated with lower risk of revision.

Risk of death was also analysed and once again the NJR found that the mortality rates in the first 30 days of surgery were low, at around 0.2% and that, in common with hip replacement, the risks of death varied considerably in relation to age at primary surgery. For example, in female patients under 55, the eight-year mortality rate was 3.14% (CI 2.44 to 4.06) compared to patients 80 years or over where the mortality risk was 51.76% (CI 49.46 to 54.16).

Part 1: Annual Progress

1.1 Introduction



1.1.1 The National Joint Registry

The National Joint Registry (NJR) for England and Wales has collected data on hip and knee joint replacement surgery since 2003 and ankle joint replacement surgery since 2010. From April 2012, the registry started to collect data about elbow and shoulder joint replacements. With over 1.2 million records, the NJR is the largest register of its type in the world.

As the NJR has developed, so has its involvement with its many stakeholders: clinicians, patients, healthcare managers, industry, research organisations and the regulatory authorities. Recognising its increased role and ability to support improvements in patient safety and clinical outcomes, the NJR reviewed its original mission statement and strategic goals as part of the development of the registry's Strategic Plan for 2012 to 2014. The revised mission statement and strategic goals, approved by the NJR Steering Committee, are:

Mission statement:

'The purpose of the National Joint Registry for England and Wales is to collect high quality and relevant data about joint replacement surgery in order to provide an early warning of issues relating to patient safety.

In a continuous drive to improve the quality of outcomes and ensure the quality and cost-effectiveness of joint replacement surgery, the NJR will monitor and report on outcomes, and support and enable related research.'

Strategic goals:

1. Monitor in real time the outcomes achieved by brand of prosthesis, hospital, and surgeon, and highlight where these fall below an expected performance in order to allow prompt investigation and to support follow-up action.
2. Inform patients, clinicians, providers and commissioners of healthcare, regulators, and implant suppliers of the outcomes achieved in joint replacement surgery.
3. Evidence variations in outcome achieved across surgical practice in order to inform best practice.
4. Enhance patient awareness of joint replacement outcomes to better inform patient choice and patients' quality of experience through engagement with patients and patient organisations.
5. Support evidence-based purchasing of joint replacement implants for healthcare providers to support quality and cost effectiveness.
6. Support suppliers in the routine post-market surveillance of implants and provide information to clinicians, patients, hospital management and the regulatory authorities.

These goals will be delivered through a series of planned activities and projects, which will ensure that the NJR continues to develop its capabilities and provide a continuous cycle of service improvement for its stakeholders.

1.1.2 Management and funding

The NJR is managed by the Healthcare Quality Improvement Partnership (HQIP) under a contract with the Department of Health (DH) as part of the delivery of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). HQIP supports the work of the NJR Steering Committee and all its sub-committees. The NJR Steering Committee, which met three times in 2011/12, is responsible for overseeing the strategic direction and running of the NJR and is a DH Committee of Experts. A list of members and their declarations are listed in Appendix 1.

There are five sub-committees which support the work of the NJR Steering Committee:

- **Implant Performance Sub-committee**
  Chair, Mr Keith Tucker
- **Surgeon Outliers Sub-committee**
  Chair, Professor Paul Gregg
- **Research Sub-committee**
  Chair, Professor Alex Macgregor
- **Editorial Board**
  Chair, Mr Martyn Porter
- **Regional Clinical Coordinators' Network**
  Chair, Mr Peter Howard

Core NJR services are delivered under three separate contracts:

- The NJR Centre, managed and staffed by Northgate Information Solutions (UK) Ltd. Northgate is responsible for the management and development of the NJR's IT infrastructure, software applications, data management and reporting services. This work is complemented by the NJR Service Desk, a team which provides day-to-day information and support to stakeholders, and the NJR Regional Coordinators (RCs), an eight-strong team providing on-site support to hospital units.

  Northgate also provide additional consultancy and project management support, and are responsible for the provision of all data in response to information requests from stakeholders.
- NJR Statistical support, analysis and research team, based at the University of Bristol. The team is responsible for the delivery of statistical analyses of NJR data and data from other sources, and for developing the statistical methodologies for the identification of potential outlier performance.

  Their role also includes ad hoc data analyses, in addition to those included in the NJR Annual Report, that are central to the work of the Implant Performance Sub-committee, the Surgeon Outliers Sub-committee and others.
- NJR Communications, managed by HQIP. This is a programme of stakeholder and multi-media communication to support the delivery of the strategic plan including the publication of this Annual Report and the complementary Public and Patient Guide. The HQIP communications team also support the Editorial Board and Regional Clinical Coordinators' Network.

The NJR 2011/12 is funded through a levy raised on the sale of hip, knee and ankle implants. HQIP manages the levy payment collection and holds the NJR budget on behalf of the Steering Committee. In 2012/13 this will include the levy on elbow and shoulder implants.

1.1.3 Revised content of the 9th Annual Report

The format of this report differs to that of previous years, with a different emphasis on the content of Part One, and the inclusion of a new section, Part Four.

- **Part One** is an overview of NJR activity for the financial year 1 April 2011 to 31 March 2012. New for the 9th Annual Report, are reports from the Chairs of the NJR's sub-committees, outlining key achievements and progress made throughout the year. A limited set of summary statistics are included but most of those statistics included in previous reports will now be available on the NJR website (www.njrcentre.org.uk).
- **Part Two** provides a description of joint replacement activity as reported to the NJR in the calendar year 1 January to 31 December 2011.
- **Part Three** provides an analysis of survivorship of hip and knee replacement surgery using data submitted to the NJR from 1 April 2003 to 31 December 2011. Data from the Hospital Episodes Statistics (HES) service, Patient Episode Database for Wales (PEDW) are included in the analysis.
- **Part Four,** new for this year, provides a report about clinical activity and outcomes at Trust-, Health Board- and unit-level based on a number of indicators for hip and knee replacements.

Part 1

1.2 Data completeness and quality

1.2.1 Key indicators

Whilst National Health Service (NHS) hospitals in England and Wales have always been 'expected' to submit data to the NJR, the data collection has always been mandatory for independent sector units in England and Wales since the registry started. However, the Standard NHS Contract for Acute Services was amended in April 2011 (Section 12.1.2) and now states that all providers shall participate in audits relevant to the service they provide within NCAPOP, of which the NJR is part. The submission of complete data to the NJR is, therefore, now mandatory for all NHS Trusts and Foundation Trusts within England. The Welsh Government has also agreed that the NJR is mandatory for all NHS Wales hospitals.

In the financial year 2011/12, of elective units, only Guy's Nuffield failed to submit any records to the NJR. However, case ascertainment varies widely between units and not all units are achieving the 95% target for compliance. The hospital named in last year's report for non-compliance, the Orthopaedics and Spine Specialist Hospital in Peterborough, is now submitting data to the NJR.

Three key indicators are used to measure the completeness and quality of the data submitted to the NJR Centre:

- **Compliance:** This is the proportion of procedure records submitted to the NJR compared with the levy returns for the number of implants sold. It is impossible to establish a one-to-one link between a single levy and the use of the implant and this comparison is subject to a number of factors, such as variation in the procurement cycle throughout the year. It is often the case that more procedures are reported than levies are collected, leading to a positive (>100%) compliance rate, followed by periods where there are more levies raised than procedures reported. For individual NHS Trusts and Health Boards, compliance can also be measured against data held in the Hospital Episodes Statistics (HES) service and the Patient Episode Database Wales (PEDW) service, though there are likely to be minor variations between the two because of coding variations. This comparison does not include privately funded procedures that take place in the independent sector in England and Wales as these data are not submitted to either HES or PEDW.
- **Consent:** The number of records submitted where the patient has agreed to their personal data being stored on the NJR database compared with the number of procedures recorded on the NJR[1].
- **Linkability:** The number of records submitted with the patient's NHS number compared with the number of procedures recorded on the NJR. The NHS number is required to link all primary and revision procedures relating to a single patient[2].

Performance against these indicators has continued to improve year on year, although the provision of continuous support to orthopaedic units is required to maintain and improve performance levels. These figures are available throughout the year from NJR StatsOnline on the NJR website.

1.2.2 Performance against key indicators

Progress against the three measures of compliance, consent and linkability for the financial year 2011/12 was as follows:

Compliance

NJR compliance is measured by comparing the number of procedures submitted to the NJR against the number of levies raised through implant sales[3]. The compliance rate across all units for the past eight years, compared to the number of levies, is illustrated in Figure 1.1. Compliance rates have been averaged over three-year time bands in order to compensate for annual fluctuations in implant sales, and thus better illustrate the overall trend. The compliance rate has shown a steady upwards trend since 2003. The compliance rate for the three years 2009/10 to 2011/12 was 102% because more procedures were submitted to the NJR than implant levies raised over the period (the compliance rate for 2011/12 was 90.3%).

[1] Personal information includes NHS number, surname, date of birth and postcode.
[2] NJR data is submitted for NHS number tracing and the 'linkability' figure includes NHS numbers that were traced subsequent to the operation details being submitted to the NJR.
[3] For compliance analysis only, the number of procedures excludes the following procedures: re-operations other than revision; stage 1 of a two-stage revision; excision arthroplasty; amputation; and conversion to arthrodesis. These are excluded because they do not include the implantation of a component attracting the levy.

Compliance (continued)

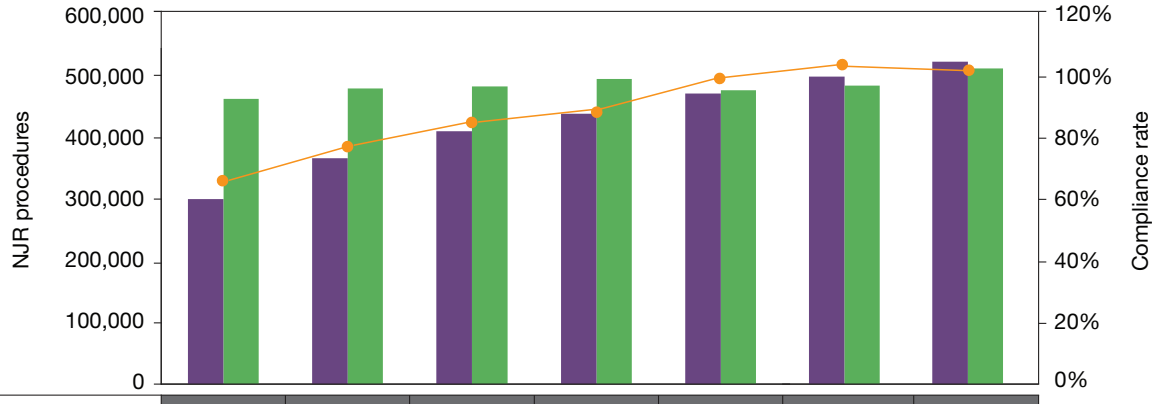
(By comparison, the compliance for English NHS Trusts and Welsh Health Boards, when compared to HES and PEDW, for the year 1 January to 31 December 2011 was 93%).

The overall compliance rate from 1 April 2003 to 31 March 2012 was 85.7% (by levy estimate).

Figure 1.1

NJR Compliance: 2003/04 to 2011/12, based on levies from implant sales.

Source: Procedures entered into the NJR 1 April 2003 to 31 March 2012 and levy submissions to NJR by implant suppliers and manufacturers



Year	2003/04 - 2005/06	2004/05 - 2006/07	2005/06 - 2007/08	2006/07 - 2008/09	2007/08 - 2009/10	2008/09 - 2010/11	2009/10 - 2011/12
NJR procedures	297,602	364,120	407,708	435,275	467,908	495,665	519,510
Levy	459,797	478,207	480,531	492,504	473,052	481,279	509,297
Compliance rate (%)	64.7%	76.1%	84.8%	88.4%	98.9%	103.0%	102.0%

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Consent

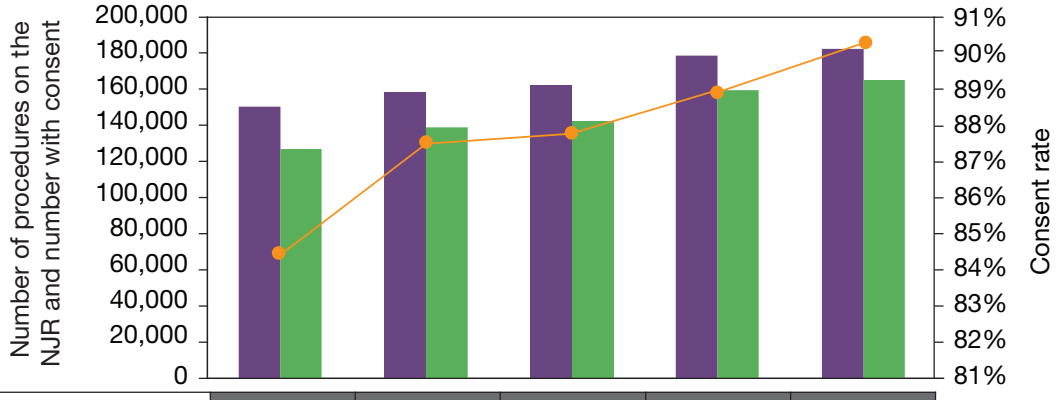
It is a requirement in England and Wales for the NJR that patients 'opt in' to have their personal data held by the NJR. Patient details are essential for linking patient procedures in order to monitor joint replacement procedure outcomes and it follows that without high rates of patient consent, the NJR will not achieve its goals. Patients rarely decline consent, and a number of units have regularly achieved 100% consent rates. Failures to record positive consent are usually due to the lack of robust processes in hospitals which ensure that the completed consent form is available to the person entering the procedure details.

Figure 1.2 shows the rise in the consent rate over the past five years. After a levelling off in 2009/10, the consent rate has since continued to rise and reached 90.4% in 2011/12.

Figure 1.2

NJR Consent: Annual analysis of total records received and those with patient consent, 2007/08 to 2011/12.

Source: Procedures entered into the NJR 1 April 2007 to 31 March 2012



Year	2007/08	2008/09	2009/10	2010/11	2011/12
Number of procedures	150,710	158,710	162,766	178,204	182,631
Number of procedures with consent	127,214	139,012	142,965	158,483	165,166
Consent rate (%)	84.4%	87.6%	87.8%	88.9%	90.4%

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Linkability

The ability to link all operations relating to a single patient is vital in determining clinical outcomes. Operations are linked using the patient's NHS number. The linkability rate refers to the proportion of operations submitted with both patient consent and the NHS number recorded. Low rates of linkability adversely affect the ability of the NJR to monitor clinical and implant performance.

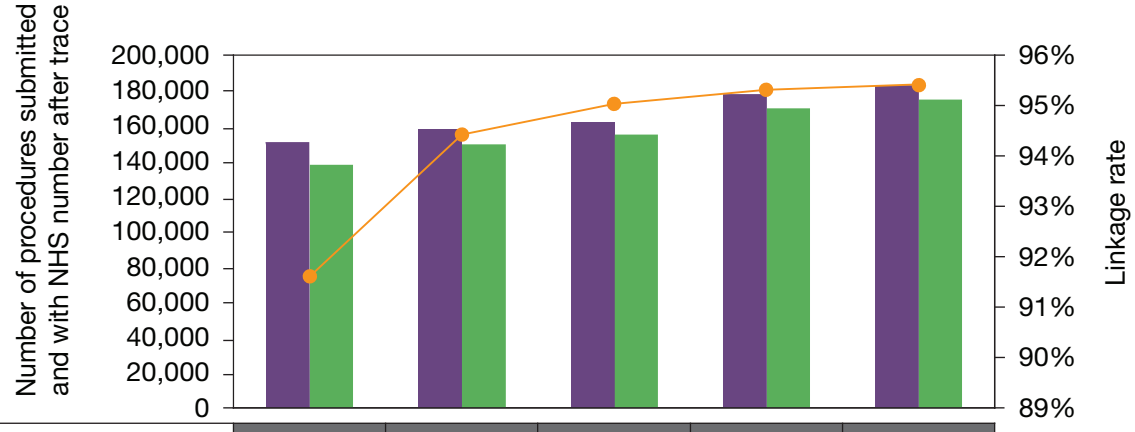
Where the NHS number is missing, tracing is attempted using the NHS Demographics Batch Service (DBS). This relies on the patient's name, date of birth and postcode being correctly entered.

The percentage of linkable records submitted to the NJR from 2007/08 to 2011/12 is shown in Figure 1.3. The linkability rate for 2011/12 was, at 95.5%, the highest for any year.

Figure 1.3

NJR Linkability: Analysis of total records received and those for which NHS numbers have been traced, 2007/08 to 2011/12.

Source: Procedures entered into the NJR 1 April 2007 to 31 March 2012



Year	2007/08	2008/09	2009/10	2010/11	2011/12
Number of procedures	150,710	158,710	162,766	178,204	182,631
Number with NHS number traced	138,175	149,963	154,747	169,995	174,437
Linkage rate (%)	91.7%	94.5%	95.1%	95.4%	95.5%

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1.2.3 Operation totals

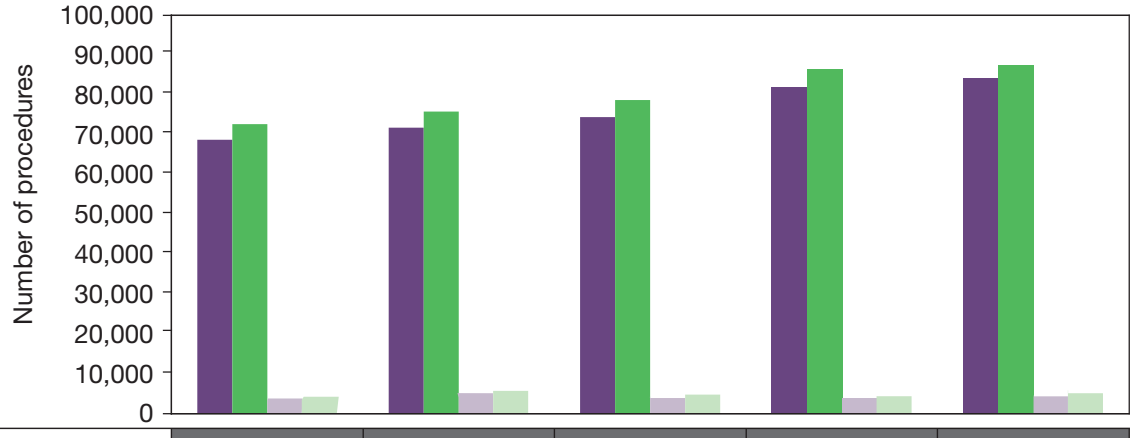
By 31 March 2012, 1,228,516 hip, knee and ankle replacement procedures had been reported to the NJR. There were 182,631 procedures submitted in 2011/12 which represents the largest total of procedures submitted in any year.

Figure 1.4 shows the total number of hip and knee procedures recorded on the NJR in England and Wales each year from 2007/08 to 2011/12. As for the previous four years, the number of knee replacement procedures (93,080) exceeded the number of hip replacement procedures (88,984) in 2011/12 (51.1% and 48.9% as a proportion).

Figure 1.4

Total hip and knee joint replacement procedures entered into the NJR, 2007/08 to 2011/12, recorded by country in which the procedure took place.

Source: Procedures entered into the NJR 1 April 2007 to 31 March 2012



Procedures by year and country	2007/08	2008/09	2009/10	2010/11	2011/12
England hip	69,293	72,037	74,886	82,379	84,420
England knee	72,952	76,116	79,346	86,863	87,975
Wales hip	4,172	4,906	3,921	4,005	4,564
Wales knee	4,293	5,651	4,613	4,507	5,105

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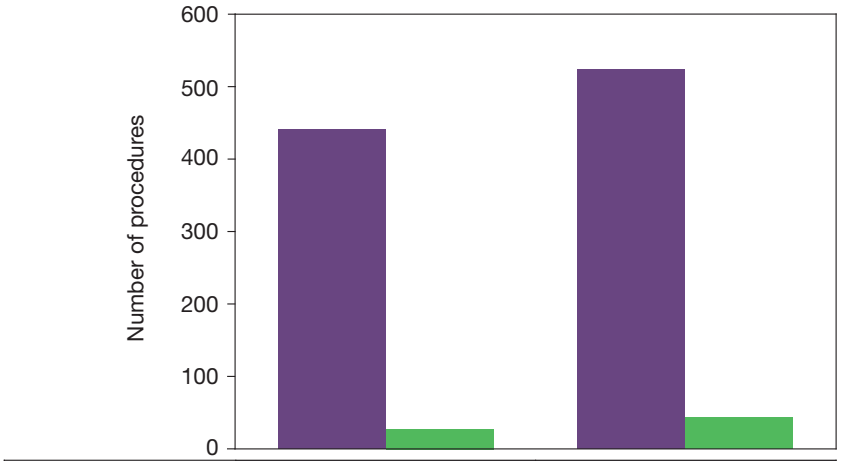
Figure 1.5

Total ankle joint replacement procedures entered into the NJR, 2010/11 to 2011/12, recorded by country in which the procedure took place.

Source: Procedures entered into the NJR 1 April 2010 to 31 March 2012



Procedures by year and country	2010/11	2011/12
England ankle	424	527
Wales ankle	25	40

Figure 1.5 shows the total number of ankle procedures recorded on the NJR in England and Wales in 2010/11. This was the second year of data collection for ankle joint replacement surgery. As the numbers of ankle procedures remain small in comparison to hip and knee procedures, they are displayed separately.

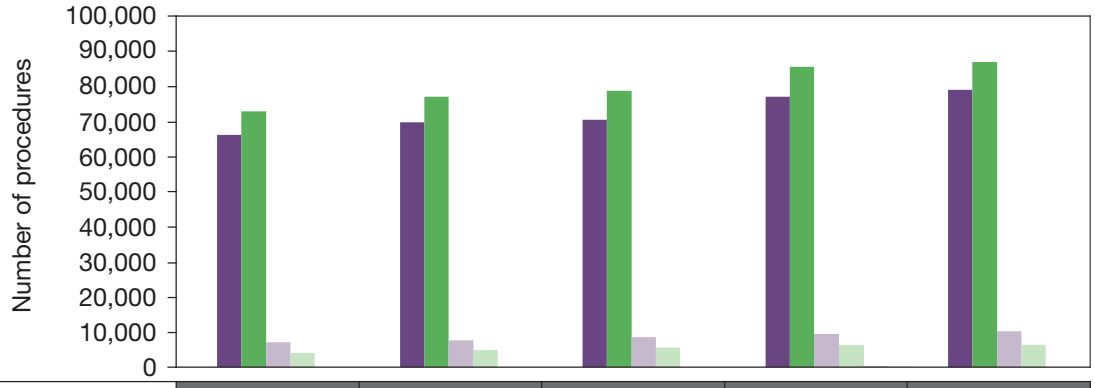
Operation types

Figure 1.6 below shows the number of hip and knee procedures reported by type from 1 April 2007 to 31 March 2012. Primary operations make up 91.3% of all procedures reported, whilst the proportion of revisions has increased slightly to 8.7%, from 8.4% in 2010/2011.

Figure 1.6

Hip and knee joint replacement procedures entered into the NJR, 2007/08 to 2011/12, recorded by procedure type.

Source: Procedures entered into the NJR 1 April 2007 to 31 March 2012



Procedures by year and joint/type	2007/08	2008/09	2009/10	2010/11	2011/12
Hip primary	66,461	69,525	70,468	77,205	78,999
Knee primary	73,108	77,164	78,734	85,550	87,210
Hip revision	6,724	7,342	8,257	9,142	9,984
Knee revision	3,698	4,515	5,149	5,771	5,870

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A separate figure has been used to show ankle procedures due to the small number of procedures reported from 2010/11 to 2011/12. Figure 1.7 shows the proportion of ankle joint replacement procedures by procedure type.

Figure 1.7

Ankle joint replacement procedures entered into the NJR, 2010/11 to 2011/12, recorded by procedure type.
Source: Procedures entered into the NJR 1 April 2010 to 31 March 2012

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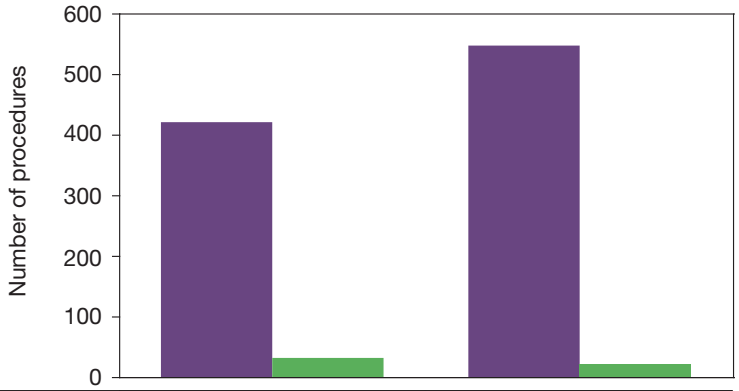


Procedures by year and joint/type	2010/11	2011/12
Ankle primary	419	546
Ankle revision	30	21

Procedures by provider type and funding

There are three types of organisations in England and Wales carrying out hip, knee and ankle joint replacement surgery:

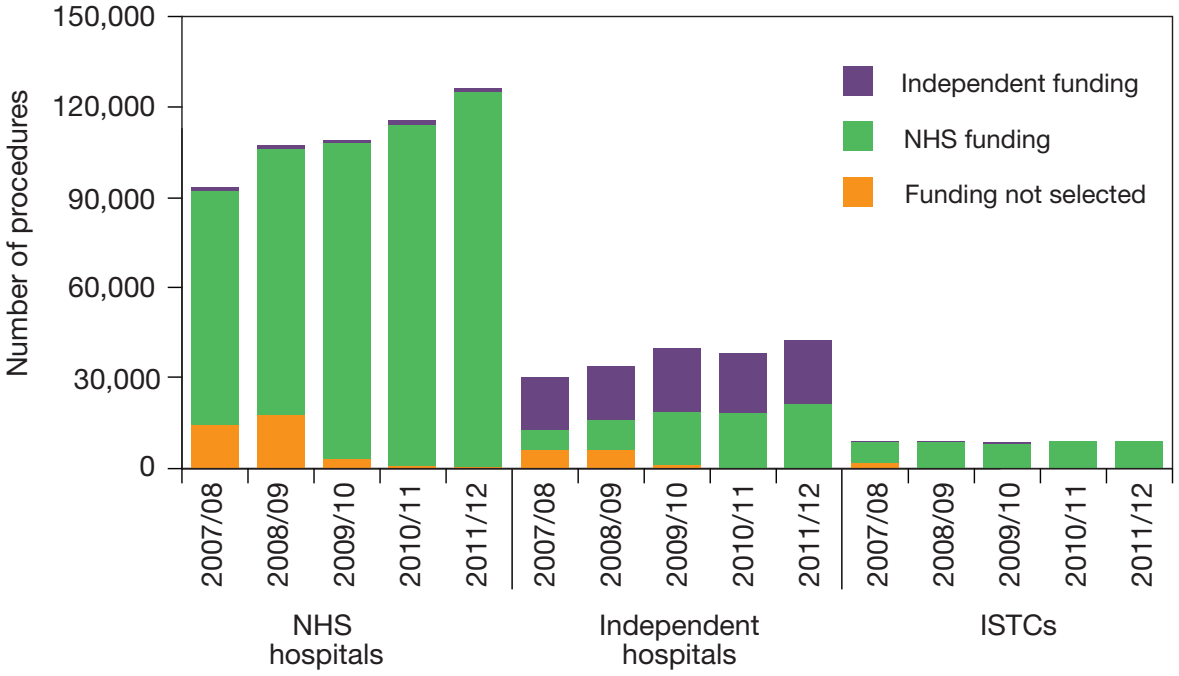
- NHS hospitals
- Independent sector hospitals
- Independent sector treatment centres (ISTCs – there are no ISTCs in Wales)

Figure 1.8 shows the proportion of procedures by type of provider and funding. The main observation is that the number of procedures being undertaken in the NHS continues on an upwards trend whilst the number of NHS-funded procedures undertaken in the independent sector has shown a slight decrease.

Figure 1.8

Proportion of reported procedures by type of provider and funding, 2007/08 to 2011/12.

Source: Procedures entered into the NJR 1 April 2007 to 31 March 2012



	NHS funding		Independent funding		Funding not selected		All NJR
NHS hospitals							
2007/08	78,002	83.0%	1,645	1.8%	14,288	15.2%	93,935
2008/09	88,943	82.5%	1,319	1.2%	17,607	16.3%	107,869
2009/10	105,394	96.2%	1,220	1.1%	2,994	2.7%	109,608
2010/11	114,110	98.4%	1,344	1.2%	547	0.5%	116,001
2011/12	125,461	98.8%	1,297	1.0%	212	0.2%	126,970
Independent hospitals							
2007/08	6,491	21.5%	17,716	58.7%	5,999	19.9%	30,206
2008/09	10,111	29.7%	18,064	53.1%	5,855	17.2%	34,030
2009/10	17,805	44.5%	21,396	53.4%	853	2.1%	40,054
2010/11	18,378	48.0%	19,918	52.0%	14	0.0%	38,310
2011/12	21,353	50.3%	21,035	49.6%	48	0.1%	42,436
ISTCs							
2007/08	6,970	79.1%	121	1.4%	1,720	19.5%	8,811
2008/09	8,505	94.0%	533	5.9%	10	0.1%	9,048
2009/10	8,052	95.2%	399	4.7%	4	0.0%	8,455
2010/11	8,783	99.8%	14	0.2%	1	0.0%	8,798
2011/12	8,912	99.7%	29	0.3%	0	0.0%	8,941

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Further graphs and tables are available on the NJR website under 'NJR 9th Annual Report'.

Part 1

1.3 Work of the Sub-committees

1.3.1 Introduction

2011/12 has been an extremely busy year for the NJR. In addition to service improvements, there has been a significant increase in the number of research and data requests being made, an increasing international recognition of the value of the NJR, and, with two major device alerts, increased co-operation with the MHRA in the provision of additional data analysis. This work has been expanded to include other organisations, including the British Orthopaedic Association (BOA), the Notified Bodies, and industry, to examine how the NJR could support the introduction of new products into the UK market and assist with improved post-market surveillance.

In recognition of the considerable body of work now being undertaken by the NJR's sub-committees, the main part of this section includes reports from the chairmen of those committees.

1.3.2 Implant Performance Sub-committee - Mr Keith Tucker, Chairman

Although the NJR was originally set up with the purpose of detecting poorly performing joint replacements, it was only in 2010 that the then Implant Outlier Committee became a sub-committee in its own right: up until then a single group had dealt with potential surgeon and implant outliers. At the first meeting, members agreed upon "Implant Performance Sub-committee" to emphasise its role in detecting poor performance and promoting good performance. The effectiveness of the sub-committee is closely linked with the maturity of the registry.

The sub-committee is split into two parts: there is the overarching group of members which develops and implements policy and, secondly, the scrutiny group which examines raw NJR data prior to its further analysis.

The membership of the sub-committee reflects the key stakeholders for this area and a full membership list can be found in Appendix 2.

The sub-committee meets twice yearly, with the scrutiny group meeting on the same day and, as necessary, by teleconference throughout the year. The data discussed at the scrutiny group meeting is confidential and, in order to avoid any potential conflict of interest, the industry representatives do not attend those meetings.

The performance of all implants are compared using Patient Time Incidence Rate (PTIR), the number of revisions per 100 patient years. A potential outlier is defined as having a PTIR of more than twice the group average and this will generate a Level One alert directly to the MHRA. Where a PTIR of 1.5 times the average is calculated, a Level Two alert is generated. This will result in a letter directly to the manufacturer with a notification to the MHRA. It is essential that concerns over performance are detected early in order to either remove the implant before it reaches outlier status or, if necessary, ensure that the implant is being used correctly by putting additional education and training in place.

Low volume use does, however, make statistical analysis less reliable. For components where less than 100 implantations have been recorded, crude revision rates are analysed and, where they are found to be higher than expected, the manufacturer is notified and the MHRA informed.

Following the redevelopment and re-classification of the component management system in 2011 (described in detail in 1.4.7), a much more detailed analysis can now be undertaken than that which was possible previously. It is now possible to rapidly quantify concerns raised in publications, at meetings, and from alerts issued by other international registers.

Although the use of PTIRs can be seen in Part Three of the report, the PTIRs, expressed as revisions per 100 patients years, for various classes of implant are shown below:

Cemented stems	-	0.32
Cemented cups	-	0.31
Cementless stems	-	0.66
Cementless cups	-	0.51
Resurfacing cups	-	0.91
Resurfacing heads	-	0.94
Stemmed resurfacing	-	1.09
Total knee replacements	-	0.41
Unicondylar knee replacements	-	1.44
Patello-femoral replacements	-	1.58

Whilst the use of the PTIR is generally robust, there are always some situations which will not fit neatly with established protocols. There are instances where the group average can be skewed: one prosthesis has a disproportionate percentage of the market; where a prosthesis is designed for a niche market; where the surgery is especially challenging. There have also been situations where combinations of implants from different companies have also reached potential outlier status. To date, this has only involved hip replacement procedures.

It is acknowledged that potential outlier status for an implant can be arived at in a number of ways:

- A poor implant in all surgeons' hands
- A perfectly good implant used by a poor surgeon
- Where the implant and the surgeon are good but education has been inadequate

After each meeting of the scrutiny group, letters are sent to the Chief Executives or Managing Directors of the companies whose products have been considered to inform them of the outcomes of the discussion and to provide them with the details of the data used in arriving at the conclusions. Since the adoption of the new protocols and processes, the MHRA have been notified of 16 Level One alerts and 15 Level Two alerts.

Once the MHRA have been notified of a Level One alert, they will initiate their own investigation and take the matter forward with the manufacturer. The outcomes of these meetings are fed back to the scrutiny group and, hence, to the NJR Steering Committee.

It is one of the great strengths of the NJR that it has the ability to monitor device performance in this manner, to facilitate post-market surveillance and outlier device investigation by both the regulator and manufacturers. An excellent example of this was the identification in 2010 of the poor performance of the Depuy ASR hip prosthesis, leading to the voluntary worldwide recall of the device by the manufacturer. There has been some suggestion that the NJR was late in identifying the ASR as an outlier. It was always going to take some time before the NJR was mature enough and there were sufficient data available for it to be possible to provide robust information about individual implant performance. Also, prior to April 2011 the NJR was not mandatory and where compliance is low, it will always be difficult, if not impossible, to detect outlier performance. For instance it is estimated that 2,000 primary procedures involving the use of the ASR were not reported to the NJR and neither were a number of revisions. It is probable that the ASR would have been detected as an outlier earlier had all revisions been reported to the NJR.

It should, however be stressed, that it was when we correctly identified the ASR in April 2010 as being an outlier that the rest of the world were made aware of the issues and ASR was withdrawn. It is almost certain that without the power of NJR data the necessary action would not have been taken at that time and there would have been further delay in recognising the seriousness of the problem.

It is therefore essential that the NJR only gives out information relating to the performance profile of an implant where the data are reliable. For this reason the registry relies on compliance and honesty in order to ensure the quality of its data and achieve its goals of improving patient safety and outcome. Now compliance is mandatory the value of the NJR in the detection of poorly performing implants is significant.

1.3.3 Surgeon Outliers Sub-committee - Professor Paul Gregg, Chairman

Between 2008 and 2011, out of a total of 2,810 consultant orthopaedic surgeons who performed hip or knee replacements, 63 were identified as potential outliers (PTIR was above the 99.8% confidence limit when plotted on a funnel plot). Individual surgeons were written to and provided with their data and asked to comment and correct the data if they thought it to be incomplete or inaccurate.

The surgeons' responses were then peer reviewed by the Chairman and Mr Peter Howard, resulting in the following outcomes:

No case to answer	8
Case to answer, Chief Executive notified and internal audit performed	5
Surgeon retired	8
Surgeon moved abroad	3
Surgeon moved to another unit	1
Surgeon on long-term sick leave	1
Surgeon already altered practice	2
Surgeon no longer outlier on subsequent analysis	7
Infection (problem already identified)	1
Surgeon revising other surgeons' primary cases (not attributable to surgeon's original surgery)	1
Surgeon had already noted increased revision rate and informed his own Medical Director	1
Failure to register all cases originally	3
Use of patello-femoral and/or unicondylar knee replacement	11
Use of DePuy ASR/resurfacing hip prostheses	4
Outlying result due to use of unicondylar knee replacement and resurfacing hip prosthesis	1
Outlying results related to metal-on-metal prosthesis	1
Outlying status due to use of cementless hip replacement	3
Outstanding cases	2

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Following a proposal from the Surgeon Outlier Sub-committee, the NJR Steering Committee, with the support of the Medical Director of the NHS and the BOA, has agreed that outcome data relating to the performance of individual units and their surgeons will now be reported to Trusts, Health Boards and the independent and private sector on an annual basis. The information sent includes statistical analyses of the relative performance of surgeons (revision rates) and units (revision rates and 90-day mortality after primary hip and knee replacement). Results that are significantly different to those expected are flagged as being potentially outlying. Surgeon data is anonymised but, where the data indicate that a surgeon's revision rate is significantly higher than expected, the Chief Executive will be notified separately from the Annual Clinical Report.

In these cases, the surgeon will be informed six weeks prior to this notification in order to provide them with an opportunity to check the data. It is important to emphasise that this notification does not indicate definite sub-standard performance. Factors such as incomplete registration of primary and revision operations, type of prosthesis used, and case complexity could account for the observed results. The NJR relies on the diligence of each hospital when collecting its data in order to ensure that any inaccuracies do not result in the detection of potential incorrect outliers.

Notification of potential outlier status should, however, trigger an internal audit of the surgeon's practice to establish reasons for the higher revision rate. Likewise, it is expected that the notification of outlier status at unit level would involve a comprehensive review of current practice in the unit. The Regional Clinical Coordinator for the relevant Strategic Health Authority and the NJR Steering Committee surgeon members are available to help in the management of a potential outlier. Professional bodies such as the BOA are also available to provide assistance.

The NJR has recommended that Chief Executives establish who within their organisation this Annual Clinical Report data will be routinely shared with, for example the Medical Director and Orthopaedic Clinical Lead. The NJR will be able to provide advice and extra data as required or requested.

The supporting information and data to be included in the Annual Clinical Reports is outlined below:

Compliance, consent and linkability

Compliance, consent and linkability should be greater than 95% to allow confidence in the data that are produced. Generally, missing data of less than 5% of the total is unlikely to distort the overall results.

Revision rate for primary total hip and knee replacements (total practice)

Analysis of revision rates is shown on a funnel plot of results for all surgeons and units. The funnel plots display 95% and 99.8% confidence limits which allow for random variation in the data. Results above the 99.8% confidence limits are regarded as potential outliers.

This analysis is based on the standardised revision ratio (SRR) which is the number of actual revisions divided by the number of expected revisions. An SRR above 1 indicates that the revision rate is higher than expected. For example, an SRR of 2 indicates that the revision rate is twice as high as expected. The number of expected revisions for each surgeon and unit are calculated based on the total amount of time patients are at risk of revision multiplied by the overall NJR revision rate. From October 2011, this analysis has also been adjusted for case-mix factors that could influence revision rates (e.g. age, gender and diagnosis of patients).

90-day mortality (total practice)

Analysis of mortality rates within 90 days of primary joint replacement is shown on a funnel plot for all units. As with the other plots, results above the 99.8% confidence limit should be regarded as potential outliers. Analysis is based on the standardised mortality ratio (SMR) which is the number of actual deaths divided by the number of expected deaths. An SMR above 1 indicates that the mortality rate is higher than expected. For example, an SMR of 2 indicates that the mortality rate is twice as high as expected. The number of expected deaths for each unit is calculated based on the total amount of time patients are at risk of death multiplied by the overall NJR 90-day mortality rate. From October 2011, this analysis has been adjusted for case-mix factors that could influence mortality rates (in this case, the age, gender, ASA grade and diagnosis of patients).

The analysis has been developed by the NJR's statistical team at the University of Bristol and the development of this methodology is ongoing. Of course, there will always be limitations to such analysis both in terms of the available data and the methods used. It is recognised and understood that when analysis identifies outliers, these should be treated as potential outliers requiring further, detailed investigation.

Patient safety is at the heart of the NJR's function and genuinely poor performance should not be overlooked. This must be balanced with the recognition that even potential outlier status can bring serious consequences to surgeons and units, and confidence in the results, therefore, is essential.

I wish to extend my thanks and appreciation for the hard work of the committee members and, in particular, to Mr Peter Howard for his major contribution to the working and development of this process.

1.3.4 Research Sub-committee - Professor Alex MacGregor, Chairman

2011/2012 saw an unprecedented increase in the use of NJR data for research. In all, 12 papers relating to analysis of NJR data were published in peer-reviewed journals (with a further five in press) alongside numerous abstracts presented at national and international meetings. Significant publications include:

- A paper in The Lancet documenting the revision risk of stemmed metal-on-metal joint replacement
- A BMJ paper outlining the absence of short-term risk of cancer following metal-on-metal hip replacement
- A study eliciting the risk of venous thromboembolism associated with the use of aspirin compared with low molecular weight heparin after hip replacement
- Two papers outlining the first use of national PROMS data to assess outcome after knee revision

We particularly acknowledge the major contribution of Professor Ashley Blom and Alison Smith from the University of Bristol team; Jan van der Meulen and Susan Charman at the London School of Hygiene and Tropical Medicine; and the two NJR-appointed orthopaedics Fellows, Paul Baker and Simon Jameson and their supervisory teams at the University of Durham and the University of Newcastle upon Tyne.

The NJR research strategy encourages the analysis of data by the broader research community and industry. A number of analytical initiatives are currently underway from several UK research groups. An additional 12 requests for data were approved in 2011/2012, including studies of the revision risk associated with cement type, and studies of the mortality risk associated with arthroplasty, and studies

of the cost effectiveness of primary hip and knee joint replacement.

A list of publications and active research projects is included in Appendix 3 below and a full list can be accessed on the NJR website. Details of the research request application process for accessing NJR data is also available on the website.

In addition to managing data access and publication, the sub-committee monitors relevant NJR strategic plan projects, including:

- Data collection for a study of 12-month PROMs following total hip and total knee joint surgery
- A pilot biobanking study within the register of genetics of hip dysplasia led by Mark Wilkinson which began data collection in 2012
- Methodological studies investigating the completeness of the identification of revision
- Procedures and the volume/outcome relationship

The NJR continues to participate in the strategic development of arthroplasty research. This included co-sponsoring a workshop into arthroplasty research with Arthritis Research UK in 2011 and, going forward, the NJR will be working closely with Arthritis Research UK and the BOA in developing a National Orthopaedic Research Strategy.

1.3.5 Editorial Board - Mr Martyn Porter, Chairman

The primary role of the Editorial Board is to oversee and coordinate the production of the Annual Report which includes regular reviews and final agreement of the content. The publication process is managed by HQIP. They are supported by the NJR Centre (Northgate Information Solutions) who project manage activity and write Parts One and Two and the NJR statistical support team (University of Bristol) who produce Part Three. Part Four is a joint project between both teams. The various sections are regularly reviewed by the Board which includes representatives from the NJR Steering Committee, the RCC Network and HQIP. The list of members is in Appendix 2.

The Editorial Board meets five times a year, with the first meeting taking place in January. The purpose of that meeting is to agree the overall direction of the report and to review and agree the final list of in-depth studies to be included. Further meetings are held to review progress and agree drafts with the final meeting being held in October. The aim of the final meeting is to review the project and to start the planning for the next report. There is a significant amount of communication and coordination between meetings.

The secondary roles of the Editorial Board include:

- **Identification of special topics and in-depth studies:** The Annual Report presents the main findings of the NJR but it is recognised that many other important studies can take longer to prepare and these are undertaken separately from the Annual Report. Recent topics have included an in-depth analysis of metal-on-metal total hip replacement and resurfacing.
- **NJR Fellows:** The Editorial Board, in conjunction with the Research Committee, also oversees the work of the two NJR Fellows. The Fellows, appointed in November 2010, are both sitting for a higher degree and have contributed enormously to many of the NJR's recent outputs. Some of the work that they have undertaken is included in the list of publications in Appendix 3.
- **Annual Report development and strategy:** It is essential that the board considers the long term strategy for the report and how it should be developed in response to changing issues and priorities. The inclusion of the new Part Four was a direct result of the NJR responding to changing priorities in the type of information it was required to produce. The outputs from other registers are also reviewed in order to ensure consistency and to support development planning.
- **Public and Patient Guide:** In conjunction with HQIP's communications team, the board oversees the production of the Public and Patient Guide to the Annual Report, the first of which was launched last year. Further details are provided in 1.4.8.

- **British Orthopaedic Association Annual Congress:** The board also plans the NJR session each year at the BOA's Annual Congress and agrees the key findings to be passed to the profession by the NJR. Feedback and suggestions from the profession following these sessions are always welcome.

1.3.6 Regional Clinical Coordinators' Network - Mr Peter Howard, Chairman

The NJR Regional Clinical Coordinators (RCC) Network consists of 27 consultant orthopaedic surgeons. This year I am pleased to announce that, following a period of vacant posts, the network is now fully established with all vacancies filled.

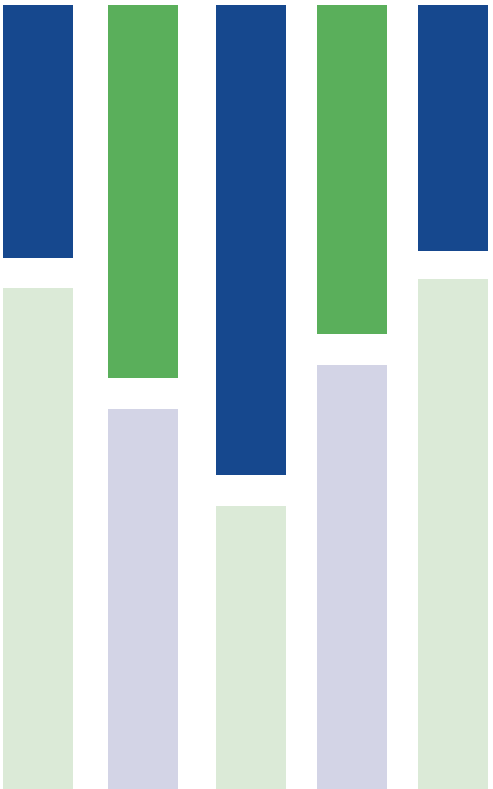
The RCC Network meetings take place three times a year and provide an opportunity for RCCs to hear from their corresponding Regional Coordinator (RC, see p25 for more details) regarding local unit performance in relation to the NJR's key indicators of compliance, consent and linkability. These meetings are also a vehicle for RCs to refer any queries or concerns regarding individual units to the relevant RCC and to present their plans for improving unit performance with regard to key indicators.

Originally formed as a network in order to 'champion' the NJR in their respective regions and to support the work of the RCs, in recent years the RCC Network has been developing more integrated links with the business of the NJR. Examples of this include support to the Research Sub-committee in the peer review of research applications requiring NJR data, and support to the Editorial Board through the review of the Annual Report in its various stages of production. RCC Network members are also asked for their suggestions for the types of analyses to be included in Part Three of the report and the specialist topics which are published separately.

Last year the RCC Network provided the clinical review of the first Public and Patient Guide to the Annual Report and this year RCC representatives will also contribute to the guide's design and content. Other activities undertaken by the RCC network include an annual review of the Minimum Dataset (MDS) and piloting data quality audits through a comparison of NJR data, HES/PEDW data, and theatre records.

Part 1

1.4 Highlights



This section provides a brief summary of NJR activity in 2011/12.

1.4.1 Extension of the NJR: Elbows and shoulders

Last year it was reported that the collection of data for elbows and shoulder joint replacement had been put on hold, following a fundamental review of all data collections in the NHS by the Review of Central Returns. By the time permission was given, the component management project (see 1.4.7) was in such an advanced state, that it was decided to delay the start of the new data collection, as it would have been necessary to re-work some of the software development following the launch into service of the new component structure. As a result, the collection of elbow and shoulder joint replacement data started on 1 April 2012, later than had been originally planned. The NJR Steering Committee also agreed to a pilot project to collect post-operative Oxford Shoulder scores. Oxford Shoulder scores will be collected on both the Shoulder Primary (S1) and Shoulder Revision (S2) forms, and patients will be followed up at six months. Based on the outcomes of the pilot, the NJR Steering Committee will make a decision on whether or not to routinely collect patient post-operative scores for shoulder replacement at six months, three years, and five years. In making the decision, the NJR Steering Committee worked closely with the British Elbow and Shoulder Society (BESS) and recognised that, in the specific case of shoulder replacement surgery, using revision as the only endpoint was inadequate for the detection of outlier performance.

The post-operative scores will be collected from patients directly by the NJR Centre and it is anticipated that the results will be made available directly to surgeons.

1.4.2 Extension of the NJR: Geographical extension

It is planned that, during 2012/13, further progress will be made towards Northern Ireland, the Isle of Man and the Channel Islands submitting data to the NJR. Although the type of data they submit will be identical to that already being collected, some software development will be required. For example, Northern Ireland, Jersey, and Guernsey do not use the same national patient identifier (NHS number in England and Wales) as collected currently. The solution to be developed will be sufficiently generic that other territories could easily join the NJR in the future.

The principal benefits of joining the NJR are improvements to patient safety via access to a comprehensive alerts process, avoidance of initial set up costs, and immediate access to comparative performance data and information.

1.4.3 NJR Fellows

In November 2010, the NJR appointed two Fellows, Paul Baker and Simon Jameson, who took up their one-year appointments in April 2011. Mr Jameson subsequently extended his fellowship to August 2012. The Fellows' research work was directed by Professor Paul Gregg and Mr Martyn Porter with additional support being provided by their respective universities. The Fellows were given access to the linked NJR/HES/PEDW dataset created for the analysis undertaken in the 8th Annual Report and obtained national PROMs data from the NHS Information Centre for Health and Social Care. Both Fellows produced a significant body of work, including papers and posters for professional meetings. The NJR Steering Committee, recognising the value of the work undertaken by Messrs Baker and Jameson, have decided to appoint two more Fellows in 2012 to start work in 2013.

1.4.4 NJR Hospital Management Feedback and Annual Clinical Reports

Development of the Hospital Management Feedback service started in 2011 with the requirements based on the need to support the production of an Annual Clinical Report as described in section 1.3.3. Development completed in early 2012 with the distribution of the first reports planned for autumn 2012 along with the implementation of the online feedback service.

1.4.5 Audit of HES/PEDW revisions

Last year's report outlined the need for a project to identify whether approximately 3,500 revision procedures recorded in HES and PEDW, but not in the

NJR, were actually, by NJR definition, revisions. The purpose of the audit was to determine the extent of disparity, either through non-compliance with the NJR or by miscoding of related procedures in HES/PEDW as revisions. Support under Section 251 of the NHS Act 2006 was sought and granted by the National Information Governance Board for Health and Social Care (NIGB).

After some exclusions, 3,141 records were sent to individual surgeons in 163 different NHS units, asking them to complete a proforma for each procedure. Where necessary, surgeons were sent up to two reminders and many also received a telephone call. Useable responses totalled 2,089, a response rate of 66.5%. Of the 2,089 responses, 78.5% could be confirmed as revisions. It was observed that there was no apparent clustering of non-compliance with the NJR by individual surgeons or hospitals and that the rate of non-compliance had not increased between 2003 and 2009. It was disappointing however, that surgeons, collectively, within a few hospitals with higher numbers of un-linked HES revisions had high levels of non-response rates (>80%). These include Rotherham District Hospital (98%), Cardiff and Vale University Local Health Board (90%), and the United Lincolnshire Hospitals NHS Trust (84%). It would have been preferable to send the list of revisions to a single point of contact within each hospital but advice received from the NIGB meant that records had to be sent to individual surgeons. However, it is understood that, in some hospitals, the audits were carried out centrally.

Whilst the results of the audit have yet to be fully analysed, it is clear that a large number of revisions went unreported to the NJR between 2003 and 2009. The consequences of failing to submit details of revision procedures to the NJR has already been highlighted (see 1.3.2).

For those procedures that were confirmed as revisions, it is expected that surgeons will be contacted again in 2012/13 asking them to submit the procedures to the NJR.

1.4.6 NJR Supplier Feedback

The 8th Annual Report announced the launch, in February 2011, of NJR Supplier Feedback. This online service allows manufacturers to download NJR datasets specific to the indivdual implants that they supply and, where they have been used in combination with other manufacturers' products, details of that use. The NJR is currently the only national joint registry in the world that allows manufacturers direct access to raw data for the purposes of enhancing post-market surveillance.

The Supplier Feedback dataset for primary arthroplasty includes patient demographics, surgeon and provider codes, diagnosis, surgery date, implant product codes and lot numbers, observed years, patient status (unrevised, revised, dead); where a revision has occurred, similar details are also included. The dataset is updated monthly and is limited to NJR-NJR linked data. The dataset does not contain patient identifiers, surgeon identifiers, or unit names.

The dataset allows manufacturers to review both the performance of individual implants and particular implant constructs. Because of the way the NJR's component database is structured and defined, examination of the performance of implant constructs can be conducted at a much more granular level than is generally reported in registry annual reports or publications or is possible in clinical studies. For example, relatively infrequently used implant sizes or combinations can be reviewed.

Manufacturers' statisticians may calculate revision rate data and survivorship for comparison with other arthroplasty registries, published literature and the manufacturer's post-market clinical studies for internal and regulatory purposes. HQIP approval is needed for any external dissemination of such analysis under its Data Use Policy.

Internal linkage to the manufacturer's distribution traceability records and complaints databases can provide insight into unit compliance levels and performance differences, while linkage to company surgeon training records may identify additional needs, particularly for new implant systems.

NJR Supplier Feedback (continued)

Uptake of the system by manufacturers has been high and it is used regularly. Issues relating to the identification of the use of prostheses which are unapproved by the manufacturer or concern about particular combinations have already been identified.

Looking ahead, the NJR plans to develop the Supplier Feedback dataset further to encompass revision surgery.

1.4.7 Component management project

The component database is the most complex element within the NJR IT system and currently holds the details of approximately 60,000 components, making it the largest device database of its kind in the world. It changes continually as new products and new types of product come on to the market. The NJR's component database uses unique codes for each type of implant and each catalogue number includes details such as brand, type, size, material, batch number and lot number, which not only makes it unique, but enables analysis to be undertaken to a level of granularity unachievable by most other device registers. The recording of batch and lot numbers also ensures that, in the event of a device alert affecting specific batches or lots of devices, the NJR Centre notifies units only of those patients directly affected. Originally designed in 2003, it eventually began to struggle with changes in practice (e.g. use of large head sizes in total hip replacement) and taxonomy of device types could not easily be changed so an upgrade process began.

Upgrading the component database was a significant piece of work which took almost 18 months to complete. Not only has the database been extended, it has been redeveloped so that new types of device and additional fields can be added easily. New business rules have also been built into the system to improve data quality. To give an example of the added functionality, in the old structure head sizes greater than 28mm were stored in a single field: in the new structure, all individual head sizes can be analysed separately. The development and the transfer of the data from the old to the new structure enabled the recent analysis on the outcomes of the use of large head stemmed metal-on-metal hip replacements, the results of which were published in The Lancet.

1.4.8 Patient-focused initiatives

Subsequent to the release of the 8th Annual Report in September 2011, the NJR published its first patient guide to the report. The 'Public and Patient Guide to the 8th Annual Report' was developed in conjunction with patients, and its aim was to break down the data and information included in the Annual Report into a more accessible format. The document has received a lot of positive feedback and was awarded the Information Standard logo, a quality mark for evidence-based information, supported by the Department of Health.

A similar guide to the 9th Annual Report will be published in 2012/13, incorporating improvements to the format and content as suggested by patients. The NJR's first patient event, the Patient Focus Confererence held in London in March 2012 provided a key opportunity to gather further patients' views and suggestions about the guide. Patients and patient representatives were invited to review the guide and data during dedicated workshops.

In addition to the workshops, the NJR shared details of its current and future projects and, through networking and question and answer sessions, had the opportunity to listen and respond to patients' thoughts and questions.

The development of an NJR Patient Network will be a key project for 2012/13, in addition to the review of NJR publications and materials designed to support dialogue with patients on key issues such as consent. 'Joint Approach', the refreshed NJR newsletter, is an example of this and can be found at www.njrcentre.org.uk.

The Steering Committee's patient representatives, Mary Cowern and Sue Musson, will work with HQIP to improve the information available to patients and explore how the NJR can better respond to patient needs.

1.4.9 International developments

The NJR is now a full member of the International Society of Arthroplasty Registers (ISAR) and Mr Keith Tucker attended a meeting in San Francisco in February this year where he updated members on the work and status of the NJR. ISAR held its first International Congress in Bergen, Norway, in May 2012, and the NJR was again strongly represented by Mr Keith Tucker, Mr Martyn Porter and Mick Borroff.

Further international collaboration is planned through the International Consortium of Orthopaedic Registries (ICOR). With limited ways of undertaking effective post-market surveillance in the United States, particularly on products not subject to post-approval clinical studies, the US Food and Drugs Administration (FDA) established ICOR in October 2010. ICOR aims to develop a scientific structure in the form of a distributed consortium of US and international registries which will support research into device safety and effectiveness. The NJR has committed itself to this initiative and Mr Keith Tucker attended ICOR's first meeting in May 2011.

1.4.10 Patient Reported Outcomes Measures (PROMs)

The collection of patient responses for the NJR-funded PROMs study announced in the 8th Annual Report has been completed. In 2011, for a six-month period, questionnaires were sent out to patients who were coming up to one year following total hip or total knee replacement surgery. In order to be eligible for the study, patients must have indicated 'yes' on the NJR consent form and have completed a pre-operative questionnaire for the Department of Health-funded PROMs programme in England. A total of 50,000 questionnaires were sent out and approximately 83% of them were completed and returned. This is an exceptionally high return rate and makes this one of the largest cohorts in the world for a PROMs programme. The NJR will follow up this cohort of patients again at three and five years following surgery.

Currently, the data are being assessed for completeness and, once that assessment is complete, it will be linked to NJR data as well as to data from HES and the six month post-operative data collected by the English PROMs programme. Professor Alex MacGregor, Chair of the NJR Research Sub-committee, will draw up a plan for the analysis of the data to be undertaken and reported on in 2012/13.

Part 1

1.5 Finance

1.5.1 Income and expenditure 2011/12

The NJR is self-financing, funded by a levy raised on the sale of hip, knee and ankle implants to NHS and independent healthcare providers in England and Wales. The rate of the levy is recommended by the NJR Steering Committee for approval by the Department of Health (DH), and is subject to a Memorandum of Understanding between the DH, Welsh Government, Independent Healthcare Advisory Services and the Association of British Healthcare Industries' Orthopaedics Special Interest Section.

The levy was set at £20 per joint from 1 April 2011 to 31 March 2012 (of which £15.20 goes to the NJR, £1.50 goes to the manufacturer as an administrative charge, and the remainder is VAT at 20%).

Levy income in 2011/12 was £3,131,630 (2010/2011: £2,616,597). Expenditure for the same period was £2,834,790 (2010/2011: £2,750,605).

Spending on the implementation of the NJR's three-year Strategic Plan was £705,899 (2010/2011: £795,572).

Members of the NJR Steering Committee and RCC Network are volunteers and do not receive payment for their work. However, they are reimbursed for travel and subsistence expenses incurred while attending meetings. The total expenditure for members' expenses during 2011/12 was £26,069 (2010/2011: £28,105).

The NJR's financial results are included in the audited accounts of HQIP (Healthcare Quality Improvement Partnership) which manages the registry. The full audited accounts will be available on HQIP's website (www.hqip.org.uk) from September 2012, and also from the Charity Commission and Companies House.

Part 1

1.6 Appendices

Appendix 1
NJR Steering Committee 2011/12

A1.1 NJR Steering Committee – composition

The composition of the NJRSC by category is:

• Chairman	1
• Orthopaedic surgeons	3
• Patient representatives	2
• Implant manufacturer/supplier industry	2
• Public health/epidemiology	1
• NHS organisation management	1
• Independent healthcare provider	1
• Practitioner with special interest in orthopaedic care who is a GP, nurse or allied health professional (physiotherapist or occupational therapist)	1

A1.2 Membership from 1 October 2011

Members are appointed as posts become vacant.

Laurel Powers-Freeling	Chairman (from April 2011)
Professor Paul Gregg	Vice Chairman Acting Chairman (October 2009 to March 2011) Orthopaedic Surgeon (from October 2003)
Mick Borroff	Orthopaedic device industry (from October 2002)
Mary Cowern	Patient Representative. Patient group – Arthritis Care (from October 2006)
Professor Alex MacGregor	Public health and epidemiology (from October 2002)
Carolyn Naisby	Practitioner with special interest in orthopaedics (from July 2006)
Mr Martyn Porter	Orthopaedic Surgeon (from January 2003)
Dean Sleigh	Orthopaedic device industry (from April 2008)
Mr Keith Tucker	Orthopaedic Surgeon (from May 2007)
Andrew Woodhead	NHS trust management (from January 2007)
Dr Jean-Jacques de Gorter	Independent healthcare sector (from October 2011)
Sue Musson	Patient representative (from October 2011)

A1.3 Observers

The following have regularly attended NJR Steering Committee meetings as observers:

Mr Peter Howard	Chairman of the NJR Regional Clinical Coordinators' Network
Dr Crina Cacou	MHRA
Andy Smallwood	NHS Supply Chain (formerly the NHS Purchasing and Supply Agency)
Elaine Young	National Development Lead, HQIP
Robin Burgess	Chief Executive, HQIP
Robin Rice	Welsh Government

A1.4 Members' declarations of interest

Laurel Powers-Freeling	No interests to declare
Professor Paul Gregg	Consultant Orthopaedic Surgeon, South Tees Hospitals NHS Trust (orthopaedic unit receives research/audit funding from DePuy International Ltd, Stryker UK and Smith & Nephew plc) Orthopaedic Advisor for Ramsay Healthcare
Mick Borroff	Chair, ABHI Orthopaedics Special Interest Section Employed by DePuy International Ltd, manufacturer of orthopaedic prostheses
Mary Cowern	Wales Director for the UK charity, Arthritis Care
Professor Alex MacGregor	Professor of Genetic Epidemiology, University of East Anglia Consultant Rheumatologist, Norfolk and Norwich University Hospital NHS Trust
Carolyn Naisby	Consultant Physiotherapist, City Hospitals Sunderland NHS Foundation Trust
Mr Martyn Porter	Consultant Orthopaedic Surgeon, Wrightington, Wigan and Leigh NHS Trust (orthopaedic unit has received financial support from DePuy International for clinical and RSA studies for Elite Plus femoral stem and C-Stem). Has acted as a consultant to DePuy International in relation to the development of a hip femoral stem (C-Stem AMT) and received royalties on this hip stem
Dean Sleigh	ABHI Council member, ABHI Orthopaedics Special Interest Section
Mr Keith Tucker	Consultant Orthopaedic Surgeon, Norfolk and Norwich University Hospital NHS Trust (various sources of financial support for research undertaken by orthopaedic department). Royalties received from Johnson & Johnson Orthopaedics more than five years ago for contribution to design of hip prostheses (royalties paid to orthopaedic charity)
Andrew Woodhead	Head of Mergers and Acquisitions, NHS London
Sue Musson	Managing Director, Firecracker Projects Limited (supplying management consultancy to NHS organisations). Non-Executive Director, Bridgewater Community NHS Trust
Dr Jean-Jacques de Gorter	Director of Clinical Services, Spire Healthcare

Appendix 2
Composition of Sub-committees

Implant Performance Sub-committee

Mr Keith Tucker	Chairman, Surgeon Representative, NJR Steering Committee
Mick Borroff*	Industry Representative, NJR Steering Committee
Mary Cowern	Patient Representative, NJR Steering Committee
Mr Peter Howard	Orthopaedic Surgeon, Chairman RCC Network
Carolyn Naisby	Practitioner with Special Interest, NJR Steering Commitee
Dean Sleigh*	Industry Representative, NJR Steering Committee
Dr Claire Newell	Data Quality Manager, Northgate Information Solutions
Dr Martin Pickford	Orthopaedic Advisor, Northgate Information Solutions
Alison Smith	Statistician, University of Bristol
Dr Crina Cacou	MHRA
Melissa Wright	NJR Development Officer, HQIP
Elaine Young	National Development Lead, HQIP

* The two industry representatives do not attend meetings of the scrutiny group

Surgeon Outliers Sub-committee

Professor Paul Gregg	Chairman, Surgeon Representative and Vice Chairman, NJR Steering Committee
Mary Cowern	Patient Representative, NJR Steering Committee
Mr Peter Howard	Orthopaedic Surgeon, Chairman RCC Network
Mr Martyn Porter	Surgeon Representative, NJR Steering Committee
Mr Keith Tucker	Surgeon Representative, NJR Steering Committee
Andrew Woodhead	NHS Trust management representative, NJR Steering Committee
Dr Claire Newell	Data Quality Manager, Northgate Information Solutions
Alison Smith	Statistician, University of Bristol
Dr Crina Cacou	MHRA
Melissa Wright	NJR Development Officer, HQIP
Elaine Young	National Development Lead, HQIP

Research Sub-committee

Professor Alex MacGregor	Chairman, Public Health and Epidemiology member, NJR Steering Committee
Mick Borroff	Industry Representative, NJR Steering Committee
Professor Paul Gregg	Surgeon Representative and Vice Chairman, NJR Steering Committee
Mr Peter Howard	Orthopaedic Surgeon, Chairman RCC Network
Mr Martyn Porter	Surgeon Representative, NJR Steering Committee
Mr Keith Tucker	Surgeon Representative, NJR Steering Committee
Dr Claire Newell	Data Quality Manager, Northgate Information Solutions
Dr Martin Pickford	Orthopaedic Advisor, Northgate Information Solutions
Professor Ashley Blom	University of Bristol
Professor Paul Dieppe	The Peninsula University
Mr Simon Jameson	NJR Fellow
Mike Robinson	NJR Research Development Officer, HQIP
Elaine Young	National Development Lead, HQIP

Editorial Board

Mr Martyn Porter	Chairman, Surgeon Representative, NJR Steering Committee
Mick Borroff	Industry Representative, NJR Steering Committee
Professor Paul Gregg	Surgeon Representative and Vice Chairman, NJR Steering Committee
Professor Alex MacGregor	Public Health and Epidemiology member, NJR Steering Committee
Mr Keith Tucker	Surgeon Representative, NJR Steering Committee
Mr Peter Howard	Orthopaedic Surgeon, Chairman RCC Network
Mr Colin Esler	Orthopaedic Surgeon, Vice Chairman RCC Network
Mr Matthew Porteous	Orthopaedic Surgeon, RCC Network
Olivia Forsyth	Project Manager, Northgate Information Solutions
Dr Claire Newell	Data Quality Manager, Northgate Information Solutions
Dr Martin Pickford	Orthopaedic Advisor, Northgate Information Solutions
Mike Swanson	Principal Consultant, Northgate Information Solutions
Professor Ashley Blom	University of Bristol
Alison Smith	Statistician, University of Bristol
Mr Paul Baker	NJR Fellow
Mr Simon Jameson	NJR Fellow
Rebecca Beaumont	NJR Communications Officer, HQIP
Melissa Wright	NJR Development Officer, HQIP
Elaine Young	National Development Lead, HQIP

Regional Clinical Coordinators' Network

Mr Peter Howard	Chairman, East Midlands SHA
Mr Colin Esler	Vice Chairman, East Midlands SHA
Mr Matthew Porteous	East of England SHA
Mr James Wimhurst	East of England SHA
Mr Marcus Bankes	London SHA
Mr Gareth Scott	London SHA
Mr Nigel Brewster	North East SHA
Mr Jim Holland	North East SHA
Mr David Bamford	North West SHA (shared position)
Mr Anil Gambhir	North West SHA (shared position)
Mr Michael O'Connor	North West SHA (shared position)
Mr Glyn Thomas	North West SHA (shared position)
Mr Derek Pegg	North West SHA
Mr John Britton	South Central SHA
Mr Jonathan Rees	South Central SHA
Mr Hagen Jähnich	South East Coast SHA
Mr Richard Slack	South East Coast SHA
Mr Evert Smith	South West SHA
Mr Matthew Wilson	South West SHA
Mr Ian Dos Remédios	West Midlands SHA
Mr David Dunlop	West Midlands SHA
Mr Malcolm Binns	Yorkshire and Humber SHA
Mr Jonathan Conroy	Yorkshire and Humber SHA (shared position)
Mr Ian Stockley	Yorkshire and Humber SHA (shared position)
Mr Muthu Ganapathi	North Wales
Mr David Woodnutt	Mid and West Wales
Mr Alun John	South and East Wales

Appendix 3
List of papers, publications and research requests using NJR data

This appendix provides details of some of the research and analysis that has been undertaken using NJR data. NJR data is available for research purposes following approval by the NJR Research Sub-committee. For further details please visit the NJR website at www.njrcentre.org.uk.

Published papers

Failure rates of stemmed metal-on-metal hip replacements: Analysis of data from the National Joint Registry of England and Wales

Smith AJ, Dieppe P, Vernon K, Porter M, Blom AW; National Joint Registry of England and Wales.
Lancet. 2012 Mar 31;379(9822):1199-204. Epub 2012 Mar 13.

Risk of cancer in first seven years after metal-on-metal hip replacement compared with other bearings and general population: Linkage study between the National Joint Registry of England and Wales and hospital episode statistics

Smith AJ, Dieppe P, Porter M, Blom AW; National Joint Registry of England and Wales.
BMJ. 2012 Apr 3;344:e2383. doi: 10.1136/bmj.e2383.

The effect of aspirin and low molecular weight heparin on venous thromboembolism after knee replacement: A non-randomised comparison using National Joint Registry data

Jameson SS, Baker PN, Charman SC, Deehan DJ, Reed MR, Gregg PJ, van der Meulen JH.
J Bone Joint Surg Br. 2012 Jul;94(7):914-8.

Independent predictors of revision following metal-on-metal hip resurfacing: A retrospective cohort study using National Joint Registry data

Jameson SS, Baker PN, Mason J, Porter ML, Deehan DJ, Reed MR.
J Bone Joint Surg Br. 2012 Jun;94(6):746-54.

The effect of aspirin and low molecular weight heparin on venous thromboembolism after hip replacement: A non-randomised comparison from information in the National Joint Registry

Jameson SS, Charman SC, Gregg PJ, Reed MR, van der Meulen JH.
J Bone Joint Surg Br. 2011 Nov;93(11):1465-70.

Comparison of patient-reported outcome measures following total and unicondylar knee replacement

Baker PN, Petheram T, Jameson SS, Avery PJ, Reed MR, Gregg PJ, Deehan DJ.
J Bone Joint Surg Br. 2012 Jul;94(7):919-27.

The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry of England and Wales

Baker PN, van der Meulen JH, Lewsey J, Gregg PJ; National Joint Registry of England and Wales.
J Bone Joint Surg Br. 2007;89(7):893-900.

Revision following patello-femoral arthoplasty

Baker PN, Refaie R, Gregg P, Deehan D.
Knee Surg Sports Traumatol Arthrosc. 2012 Jan 7. [Epub ahead of print].

Patient Reported Outcome Measures after revision of the infected Total Knee Replacement: Do patients prefer single or two-stage revision?

Baker P, Petheram TG, Kurtz S, Konttinen YT, Gregg P, Deehan D.
Knee Surg Sports Traumatol Arthrosc. 2012 Jun 13.

Reason for Revision Influences Early Patient Outcomes After Aseptic Knee Revision

Baker P, Cowling P, Kurtz S, Jameson S, Gregg P, Deehan D.
Clin Orthop Relat Res. 2012 Feb 22. [Epub ahead of print].

Indications for early hip revision surgery in the UK - a re-analysis of NJR data

Bolland BJ, Whitehouse SL, Timperley AJ.
Hip Int. 2012 Mar-Apr;22(2):145-52. doi: 10.5301/HIP.2012.9184.

Can choices between alternative hip prostheses be evidence based? A review of the economic evaluation literature

Davies C, Lorgelly P, Shemilt I, Mugford M, Tucker K, Macgregor A.
Cost Eff Resour Alloc. 2010 Oct 29;8:20.

Which prostheses are cost-effective?

Lorgelly P, Davies C, Shemilt I, Mugford M, MacGregor A.
Knee. 2009 Dec;16(6):419.

Approved requests for NJR Data for research

Comparison of the cost-effectiveness of the most commonly used types and brands of prosthesis in total hip and knee replacement

Professor R Grieve and M Pennington

Using evidence to reduce risk of healthcare acquired infection following primary total hip replacement

Professor N Graves

Relative revision rates by cement type in cemented and hybrid total hip replacement in England and Wales

Mr J Webb

True Mortality Rates after Total Hip Arthroplasty by method of fixation after adjustment for confounding factors: Results from the NJR in England & Wales (7th Edition)

Professor J Timperley

A retrospective cohort study comparing the relative risks of revision or mortality at one and five years in patients undergoing total hip replacement

Mr R Field

Current trends in primary hip arthroplasty: Influence of these trends and associated factors on survival and revision rates

Professor J Timperley

Orthopaedic Intervention in Rheumatoid Arthritis: A retrospective analysis of cumulative incidence, prognostic markers, outcomes and cost effectiveness over a 20 year period

Dr A Young and Dr E Nikiphorou

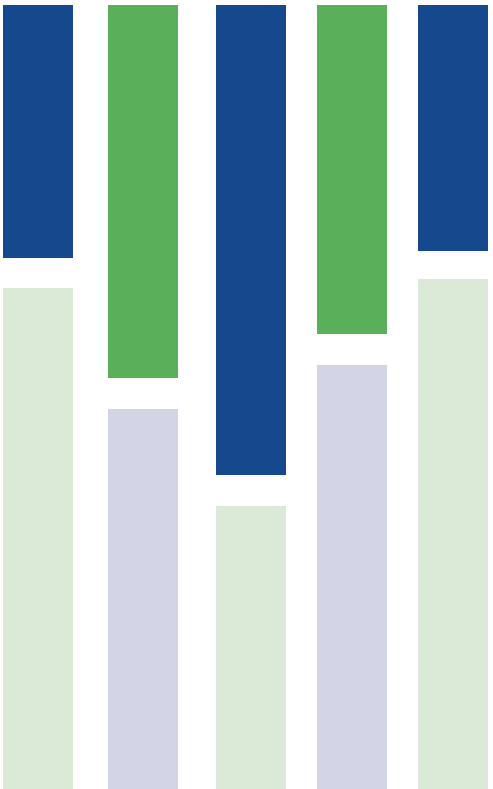
Appendix 4
Additional information on the NJR website
www.njrcentre.org.uk

The following information will also be available on the NJR website:

1.	NJR 9th Annual Report	-	Parts One, Two, Three and Four (annual progress 2011/12, clinical activity 2011, implant survivorship 2003 to 2011, and Trust-, Health Board- and unit-level activity and outcomes 2011)
2.	NJR 9th Annual Report	-	Part One: Annual Progress 2011/12 – Welsh Language
3.	NJR 9th Annual Report	-	NJR Steering Committee Terms of Reference
4.	NJR 9th Annual Report	-	NJR Regional Clinical Coordinators' Terms of Reference
5.	NJR 9th Annual Report	-	Prostheses Data
6.	NJR 9th Annual Report	-	Tables and Figures
7.	NJR 9th Annual Report	-	Public and Patient Guide

Part 2: Clinical activity 2011

2.1 Introduction



This section summarises the number of hip, knee and ankle replacement procedures undertaken in England and Wales between 1 January and 31 December 2011 and entered into the NJR by 28 February 2012. The information is summarised according to the type of hospital or treatment centre, procedure type and patient characteristics.

2.1.1 Hospitals and treatment centres participating in the NJR

During the life of the NJR there has been a trend showing a greater proportion of all hip replacements being performed in larger centres. This trend continued during 2011 (Figure 2.1). A total of 411 orthopaedic units were open and of these 392 (95%) submitted at least one hip, knee or ankle procedure to the NJR (Table 2.1). All of the non-contributing units were trauma-only units.

On average, 204 hip replacements and 219 knee replacements were recorded per orthopaedic unit over the year, although the numbers varied from one to 1,434 procedures. Compared with previous years, there has been an increase in the number of units performing more than 300 hip procedures and an increase in the number of units performing more than 400 knee procedures (Table 2.2). There is a decrease in the number of units performing less than 100 knee procedures. Most units performing ankle procedures perform less than five in a year.

Table 2.1 Total number of hospitals and treatment centres in England and Wales able to participate in the NJR and the proportion actually participating in 2011.

	Total number of units	Number of units submitting	Proportion participating
Total	**411**	**392**	**95%**
NHS hospitals	**237**	**218**	**92%**
England	220	201	91%
Wales	17	17	100%
Independent hospitals	**161**	**161**	**100%**
England	155	155	100%
Wales	6	6	100%
ISTCs	**13**	**13**	**100%**
England	13	13	100%
Wales	0	0	-

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Table 2.2 Number of participating hospitals, according to number of procedures performed during 2011.

	Total number of hospitals	Number of procedures					
		<50	50 - 99	100 - 199	200 - 299	300 - 399	400+
Hip procedures							
Hospitals entering replacements	392	49	75	120	60	50	38
Hospitals entering primary replacements	392	57	79	120	69	41	26
Knee procedures							
Hospitals entering replacements	385	42	61	119	66	41	56
Hospitals entering primary replacements	384	47	58	127	63	43	46
	Total number of hospitals	**Number of procedures**					
		<5	**5 - 9**	**10-14**	**15 - 19**	**20 - 24**	**25+**
Ankle procedures							
Hospitals entering replacements	123	89	25	5	1	1	2
Hospitals entering primary replacements	123	90	27	3	0	1	2

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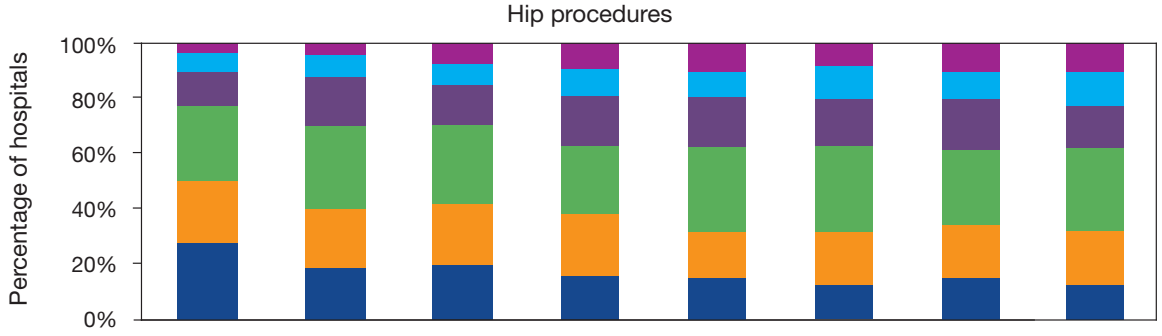
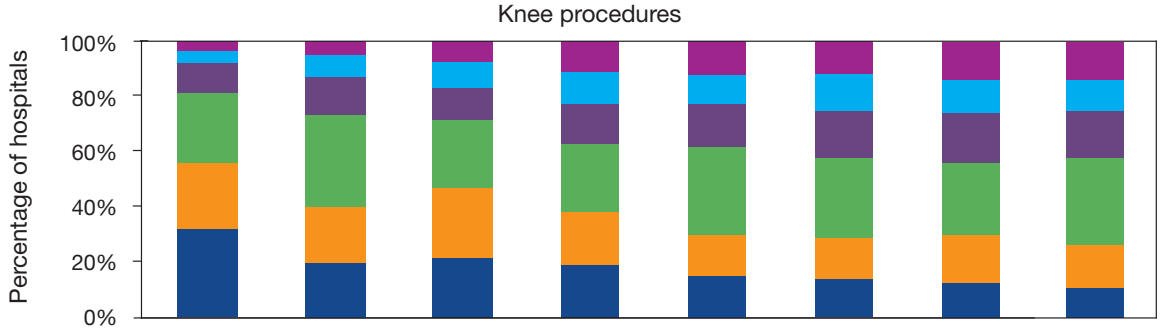
Figure 2.1

Percentage of participating hospitals by number of procedures per annum, 2004 to 2011.



Year	2004	2005	2006	2007	2008	2009	2010	2011
400+	3%	4%	7%	9%	10%	8%	10%	10%
300 - 399	7%	8%	8%	10%	9%	12%	10%	13%
200 - 299	13%	18%	14%	18%	18%	17%	19%	15%
100 - 199	27%	30%	29%	25%	31%	31%	27%	31%
50 - 99	23%	22%	22%	23%	17%	19%	20%	19%
<50	28%	19%	20%	16%	15%	13%	15%	13%
Number of hospitals	392	393	398	391	394	395	399	392
Total hip procedures	53,273	63,855	66,525	74,378	77,841	78,599	80,977	80,314



Year	2004	2005	2006	2007	2008	2009	2010	2011
400+	4%	5%	8%	12%	13%	12%	14%	15%
300 - 399	4%	8%	9%	11%	10%	14%	12%	11%
200 - 299	11%	14%	12%	14%	15%	17%	18%	17%
100 - 199	25%	33%	24%	25%	31%	29%	26%	31%
50 - 99	24%	20%	25%	19%	15%	15%	17%	16%
<50	32%	19%	22%	19%	15%	14%	13%	11%
Number of hospitals	392	391	398	389	390	393	391	385
Total knee procedures	48,900	63,969	66,100	77,827	82,335	83,879	86,522	84,653

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Part 2

2.2 Hip replacement procedures 2011

The total number of hip procedures entered into the NJR during 2011 was 80,314, an increase of 5% over 2010 as reported in the 8th Annual Report. Of these, 71,672 were primary and 8,641 were revision (and re-operation) procedures. The revision 'burden' remained the same compared to 2010 at 11%.

Table 2.3 shows that 93% of patients at independent hospitals and ISTCs were graded as fit and healthy or with mild disease according to the ASA system, compared with 80% at NHS units.

Nearly all procedures (95%) undertaken at ISTCs were primary procedures. The percentage of primary hip resurfacings undertaken in independent hospitals (4%) is double that of NHS hospitals (2%), as shown in Figure 2.2. As a proportion of their primary procedures, independent units and ISTCs perform more cementless hip primary procedures than NHS hospitals.

At NHS hospitals, revision procedures account for a higher percentage of total procedures (13%) than at any other type of provider (11% overall). NHS hospitals perform 82% of all hip revision procedures.

Table 2.3 Procedure details, according to type of provider for hip procedures in 2011.

	NHS hospitals		Independent hospitals		ISTCs		Total	
	No.	%	No.	%	No.	%	No.	%
Total hip procedures	**55,635**	**69%**	**20,850**	**26%**	**3,829**	**5%**	**80,314**	
Patient physical status								
P1 - fit and healthy	6,707	12%	4,746	23%	515	13%	11,968	15%
P2 - mild disease not incapacitating	37,599	68%	14,649	70%	3,042	79%	55,290	69%
P3 - incapacitating systemic disease	10,876	20%	1,437	7%	271	7%	12,584	16%
P4 - life threatening disease	450	<1%	17	<1%	1	<1%	468	<1%
P5 - expected to die within 24hrs with or without an operation	3	<1%	1	<1%	0	0%	4	<1%
Procedure type								
Primary procedures	**48,529**	**68%**	**19,516**	**27%**	**3,627**	**5%**	**71,672**	**89%**
Primary total prosthetic replacement using cement	18,530	38%	5,827	30%	1,432	39%	25,789	36%
Primary total prosthetic replacement not using cement	19,843	41%	9,616	49%	1,848	51%	31,307	44%
Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)	9,185	19%	3,288	17%	321	9%	12,794	18%
Primary resurfacing arthroplasty of joint	971	2%	785	4%	26	<1%	1,782	2%
Revision procedures	**7,105**	**82%**	**1,334**	**15%**	**202**	**2%**	**8,641**	**11%**
Hip single-stage revision	6,116	86%	1,232	92%	189	94%	7,537	87%
Hip stage one of two-stage revision	446	6%	46	3%	3	1%	495	6%
Hip stage two of two-stage revision	496	7%	55	4%	10	5%	561	6%
Hip excision arthroplasty	45	1%	1	<1%	0	0%	46	<1%
Hip re-operation other than revision[4]	2	<1%	0	0%	0	0%	2	<1%
Bilateral or unilateral[5]								
Bilateral	246	<1%	180	<1%	40	1%	466	<1%
Unilateral	55,389	100%	20,670	99%	3,789	99%	79,848	99%
Funding								
Independent	722	1%	10,755	52%	9	<1%	11,486	14%
NHS	54,912	99%	10,095	48%	3,820	100%	68,827	86%
Not selected	1	<1%	0	0%	0	0%	1	<1%

[4] Hip re-operations other than revision are recorded because some units continue to use MDSv2 where these procedures were included. MDSv3 no longer records re-operations. Therefore, the re-operation procedure totals will not reflect the actual number performed.

[5] Bilaterals will only be counted as a bilateral if they are entered under the same operation during data entry. If the two procedures are recorded under two different operations they will be counted as two unilateral procedures. Therefore, the count of bilaterals is likely to be an underestimate.

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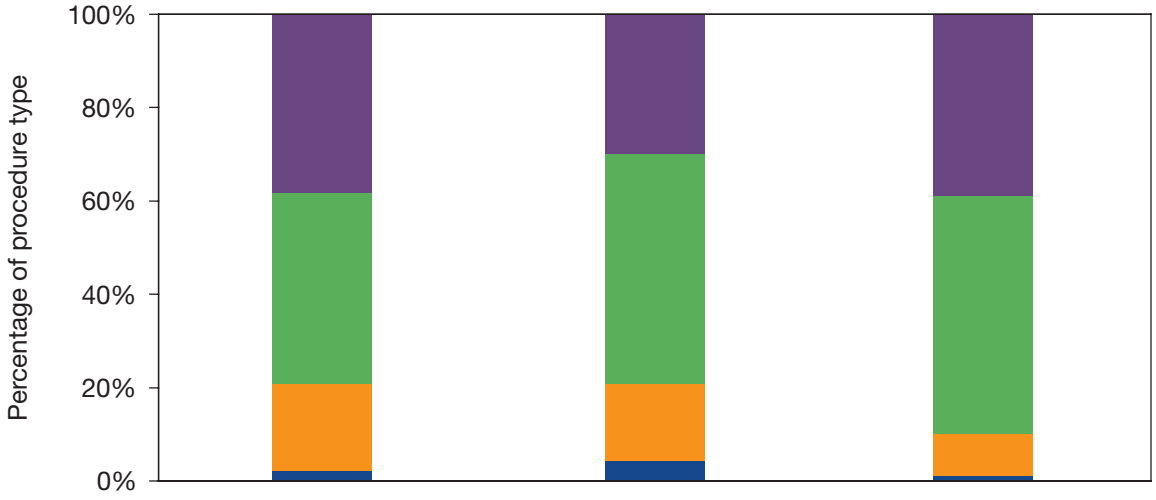
Figure 2.2

Primary hip procedures by type of provider 2011.



Type of provider	NHS hospitals	Independent hospitals	ISTCs
Cemented	38%	30%	39%
Cementless	41%	49%	51%
Hybrid	19%	17%	9%
Resurfacing	2%	4%	1%
Number of procedures	48,529	19,516	3,627

2.2.1 Primary hip replacement procedures 2011

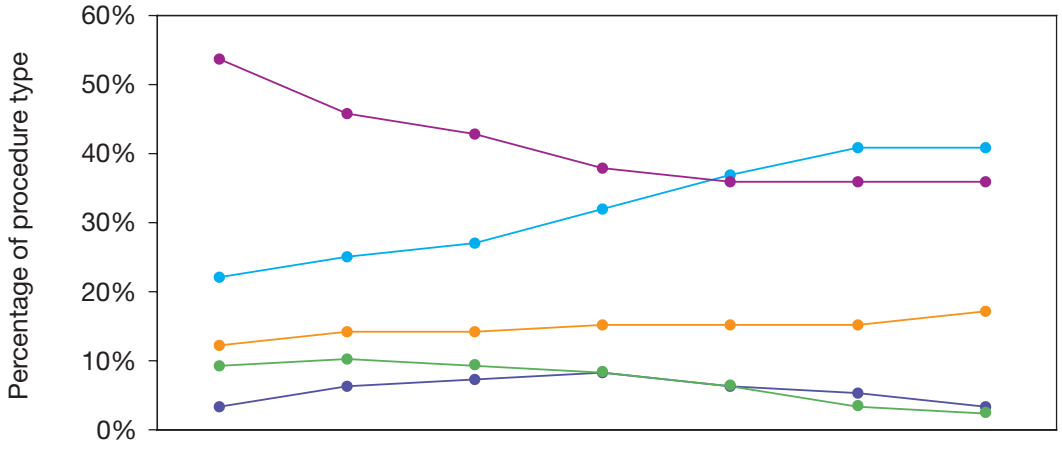
Of the 71,672 primary hip replacement procedures undertaken in 2011, 36% were cemented THRs, 41% were cementless, 2% were hip resurfacing procedures and 3% were where a large metal head (≥36mm) is used with a resurfacing or modular cup - LHMoM THRs (Figure 2.3). Figure 2.3 shows an apparent decrease in the volume of hip procedures between 2010 and 2011. However, not all procedures performed in 2011 were entered into the database before the 28 February 2012 deadline and will be entered after this date.

The ratio between cemented and cementless procedures has not changed significantly in 2011. There has however been an increase in the percentage of hybrid procedures performed. There has also been a significant decrease in the percentage of resurfacing procedures and in procedures where a large metal head is used with a resurfacing cup. This decline is thought to have resulted from the well publicised withdrawal from the market of one brand of resurfacing device and LHMoM (ASR – DePuy) following the reporting to the regulatory authorities by the NJR of high revision rates for this product, and ongoing concerns regarding the safety of LHMoM procedures as reflected in MHRA guidance and follow-up.

In 2011, 15% of hybrid procedures were reverse hybrid (cementless stem, cemented socket) and 85% were standard hybrid (cemented stem, cementless socket).

Figure 2.3

Type of primary hip replacement procedures undertaken between 2005 and 2011.



Year	2005	2006	2007	2008	2009	2010	2011
Cemented	54%	46%	43%	38%	36%	36%	36%
Cementless	22%	25%	27%	32%	37%	41%	41%
Hybrid	12%	14%	14%	15%	15%	15%	17%
Resurfacing	9%	10%	9%	8%	6%	3%	2%
Large head metal-on-metal (≥36mm)	3%	6%	7%	8%	6%	5%	3%
Number of procedures	56,369	59,807	66,906	70,248	70,628	72,452	71,672

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2.2.1.1 Patient characteristics

Age and gender were included for those patients who gave consent for their personal identifiers to be entered into the NJR and where consent was 'Not recorded' (a total of 95). The average age was 67.2 years, the same as last year. Approximately 60% of the patients were female (Table 2.5) which is 1% higher than 2010. On average, female patients were older than male patients at the time of their primary hip replacement (68.6 years and 66.6 years respectively, Table 2.5). Patients undergoing a resurfacing procedure were the youngest, at an average age of 54.2 years (Table 2.5). Five and a half times as many males have a resurfacing procedure compared with females.

According to the ASA system, 15% of patients undergoing a primary hip replacement in 2011 were graded as fit and healthy prior to surgery, compared with 37% in 2003. Figure 2.6 shows the changes in ASA grade over eight years. Patient BMI[6] has increased over the past eight years from 27.4 to 28.6, as shown in Figure 2.7. Females undergoing THR have a consistently lower mean BMI than males; the converse is the case for TKR (Figure 2.22). Figure 2.7 shows that there has been an increase in the number of patients with a BMI of between 30 and 39 and a decrease in the number of patients with BMI between 20 and 24. The single largest indication recorded for surgery was osteoarthritis, recorded in 93% of procedures (Table 2.4). Figure 2.5 shows that the percentage of patients within the age group bands has not changed significantly since 2003, suggesting that the increase in BMI and reduction in fitness of patients is not due to an ageing patient cohort.

[6] BMI: 20-24 normal, 25-29 overweight, 30-39 obese, 40+ morbidly obese

Table 2.4 Patient characteristics for primary hip replacement procedures in 2011, according to procedure type.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Primary resurfacing arthroplasty of joint		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total hip primaries	**25,789**	**36%**	**31,307**	**44%**	**12,794**	**18%**	**1,782**	**2%**	**71,672**	
Patient physical status										
P1 - fit and healthy	2,702	10%	5,823	19%	1,736	14%	804	45%	11,065	15%
P2 - mild disease not incapacitating	18,075	70%	21,883	70%	8,964	70%	929	52%	49,851	70%
P3 - incapacitating systemic disease	4,855	19%	3,489	11%	2,023	16%	49	3%	10,416	15%
P4 - life threatening disease	156	<1%	110	<1%	71	<1%	0	0%	337	<1%
P5 - expected to die within 24hrs with or without an operation	1	<1%	2	<1%	0	0%	0	0%	3	<1%
BMI										
Number with BMI data	14,112	55%	17,580	56%	6,875	54%	1,052	59%	39,619	55%
Average	28.31		28.84		28.60		28.31		28.59	
SD	5.12		5.19		5.33		4.61		5.18	
Indications for surgery										
Osteoarthritis	23,907	93%	29,324	94%	11,529	90%	1,676	94%	66,436	93%
Avascular necrosis	469	2%	777	2%	399	3%	40	2%	1,685	2%
Fractured neck of femur	732	3%	428	1%	480	4%	2	<1%	1,642	2%
Congenital dislocation	173	<1%	676	2%	257	2%	47	3%	1,153	2%
Inflammatory arthropathy	321	1%	402	1%	234	2%	18	1%	975	1%
Failed hemiarthroplasty	83	<1%	42	<1%	60	<1%	1	<1%	186	<1%
Trauma - chronic	286	1%	290	<1%	222	2%	13	<1%	811	1%
Previous surgery - non trauma related	45	<1%	130	<1%	66	<1%	1	<1%	242	<1%
Previous arthrodesis	14	<1%	17	<1%	16	<1%	1	<1%	48	<1%
Previous infection	26	<1%	29	<1%	29	<1%	2	<1%	86	<1%
Other	413	2%	435	1%	202	2%	42	2%	1,092	2%
Side										
Bilateral	67	<1%	288	<1%	65	<1%	37	2%	457	<1%
Left, unilateral	11,395	44%	14,063	45%	5,724	45%	876	49%	32,058	45%
Right, unilateral	14,327	56%	16,956	54%	7,005	55%	869	49%	39,157	55%

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Table 2.5 Age and gender for primary hip replacement patients in 2011.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Primary resurfacing arthroplasty of joint		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total hip primaries	**25,789**	**36%**	**31,307**	**44%**	**12,794**	**18%**	**1,782**	**2%**	**71,672**	
Total hip primaries with patient data	**24,739**	**96%**	**29,751**	**95%**	**12,241**	**96%**	**1,600**	**90%**	**68,331**	**95%**
Average age	72.8		65.4		69.6		54.2		67.2	
SD	9.7		11.3		10.9		9.5		13.4	
Interquartile range	67.2 - 79.5		58.8 - 73.3		63.5 - 77.3		48.6 - 60.7		62.0 - 76.7	
Average age by gender										
Female	**16,112**	**65%**	**16,731**	**56%**	**7,743**	**63%**	**241**	**15%**	**40,827**	**60%**
Average	73.3		65.8		70.1		53.9		68.6	
SD	9.6		11.4		10.9		10.9		12.6	
Interquartile range	67.8 - 80.1		59.2 - 73.7		63.9 - 77.7		47.7 - 61.3		63.1 - 77.5	
Male	**8,627**	**35%**	**13,020**	**44%**	**4,498**	**37%**	**1,359**	**85%**	**27,504**	**40%**
Average	71.8		64.8		68.8		54.3		66.6	
SD	9.8		11.1		10.9		9.3		12.4	
Interquartile range	66.1 - 78.6		58.4 - 72.7		62.8 - 76.4		48.7 - 60.5		60.4 - 75.4	
Age group by gender										
Female										
<30 years	24	<1%	108	<1%	26	<1%	11	5%	169	<1%
30 - 39 years	66	<1%	276	2%	77	<1%	16	7%	435	1%
40 - 49 years	245	2%	1,010	6%	260	3%	51	21%	1,566	4%
50 - 59 years	993	6%	3,137	19%	860	11%	90	37%	5,080	12%
60 - 69 years	3,910	24%	6,033	36%	2,293	29%	66	27%	12,302	30%
70 - 79 years	6,797	42%	4,594	27%	2,879	37%	6	2%	14,276	35%
80 - 89 years	3,829	24%	1,483	9%	1,270	16%	1	<1%	6,583	16%
90+	248	2%	90	<1%	78	<1%	0	0%	416	1%
Male										
<30 years	13	<1%	89	<1%	19	<1%	22	2%	143	<1%
30 - 39 years	46	<1%	238	2%	56	1%	54	4%	394	1%
40 - 49 years	186	2%	919	7%	181	4%	322	24%	1,608	6%
50 - 59 years	704	8%	2,595	20%	585	13%	593	44%	4,477	16%
60 - 69 years	2,340	27%	4,852	37%	1,427	32%	324	24%	8,943	33%
70 - 79 years	3,692	43%	3,476	27%	1,603	36%	40	3%	8,811	32%
80 - 89 years	1,553	18%	811	6%	596	13%	4	<1%	2,964	11%
90+	93	1%	40	<1%	31	<1%	0	0%	164	<1%

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Table 2.6 Indications for hip primary procedures based on age groups.

Total hip primaries	<30 years		30-39 years		40-49 years		50-59 years		60-69 years		70-79 years		80-89 years		90+	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Indication	**312**		**829**		**3,174**		**9,557**		**21,245**		**23,087**		**9,547**		**580**	
Osteoarthritis	137	44%	546	66%	2,650	83%	8,814	92%	20,119	95%	21,898	95%	8,842	93%	504	87%
Avascular necrosis	62	20%	105	13%	200	6%	293	3%	385	2%	334	1%	190	2%	27	5%
Fractured neck of femur	3	<1%	3	<1%	31	<1%	128	1%	413	2%	536	2%	316	3%	24	4%
Congenital dislocation dysplasia of hip	69	22%	187	23%	296	9%	270	3%	176	<1%	80	<1%	16	<1%	1	<1%
Inflammatory arthropathy	41	13%	45	5%	81	3%	175	2%	271	1%	241	1%	73	<1%	3	<1%
Failed hemi-arthroplasty	1	<1%	0	0%	2	<1%	9	<1%	20	<1%	64	<1%	67	<1%	10	2%
Trauma - chronic	9	3%	25	3%	70	2%	136	1%	151	<1%	179	<1%	160	2%	23	4%
Previous surgery, non trauma related	17	5%	41	5%	63	2%	51	<1%	26	<1%	19	<1%	16	<1%	0	0%
Previous arthrodesis	1	<1%	3	<1%	4	<1%	4	<1%	13	<1%	12	<1%	6	<1%	3	<1%
Previous infection	5	2%	8	<1%	8	<1%	19	<1%	22	<1%	16	<1%	4	<1%	1	<1%
Indication other	48	15%	60	7%	119	4%	165	2%	226	1%	244	1%	131	1%	17	3%

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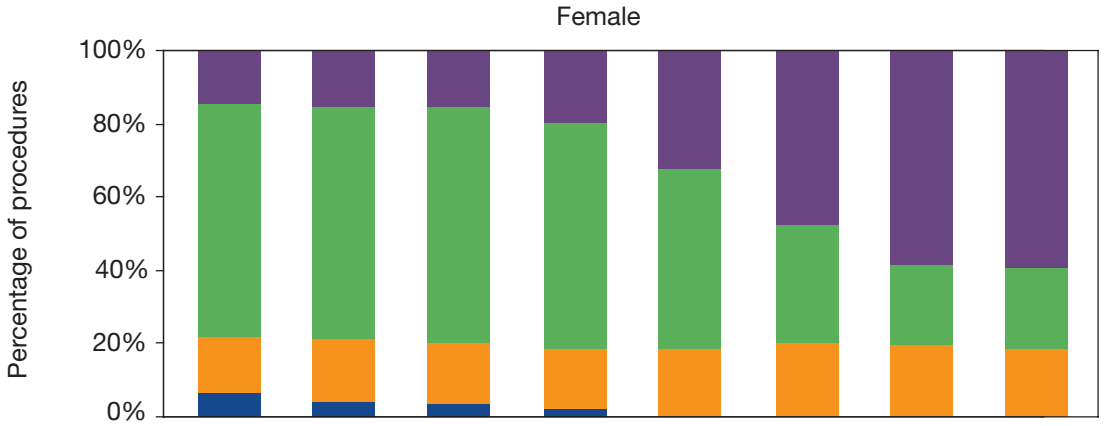
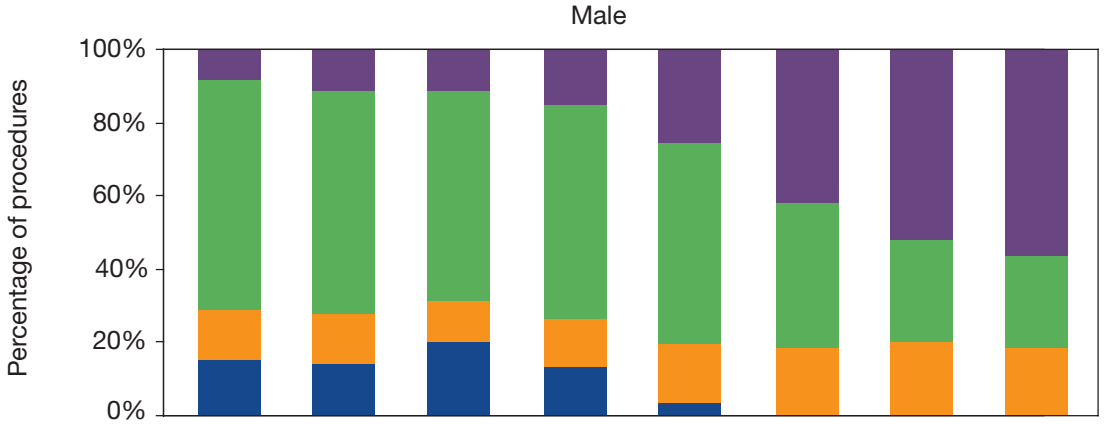
Figure 2.4

Age and gender for primary hip replacement patients in 2011.



Age group	<30	30-39	40-49	50-59	60-69	70-79	80-89	90+
Cemented	14%	15%	16%	20%	32%	48%	58%	60%
Cementless	64%	63%	64%	62%	49%	32%	23%	22%
Hybrid	15%	18%	17%	17%	19%	20%	19%	19%
Resurfacing	7%	4%	3%	2%	<1%	<1%	<1%	0%
Number of patients	169	435	1,566	5,080	12,302	14,276	6,583	416



Age group	<30	30-39	40-49	50-59	60-69	70-79	80-89	90+
Cemented	9%	12%	12%	16%	26%	42%	52%	57%
Cementless	62%	60%	57%	58%	54%	39%	27%	24%
Hybrid	13%	14%	11%	13%	16%	18%	20%	19%
Resurfacing	15%	14%	20%	13%	4%	<1%	<1%	0%
Number of patients	143	394	1,608	4,477	8,943	8,811	2,964	164

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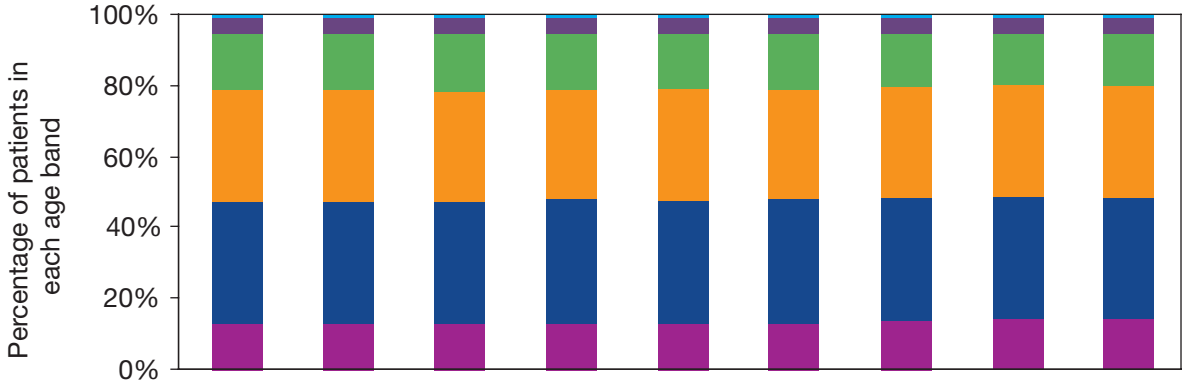
Figure 2.5

Age for primary hip replacement patients between 2003 and 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
<30	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
30-39	1%	1%	1%	1%	1%	1%	1%	1%	1%
40-49	5%	5%	5%	5%	5%	5%	5%	5%	5%
50-59	16%	15%	16%	15%	15%	15%	14%	14%	14%
60-69	31%	31%	31%	30%	31%	30%	30%	30%	31%
70-79	34%	33%	34%	34%	34%	34%	34%	34%	34%
80-89	13%	13%	13%	13%	13%	13%	14%	14%	14%
90+	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of patients	14,443	27,966	40,022	47,305	59,940	66,331	67,231	69,006	68,331

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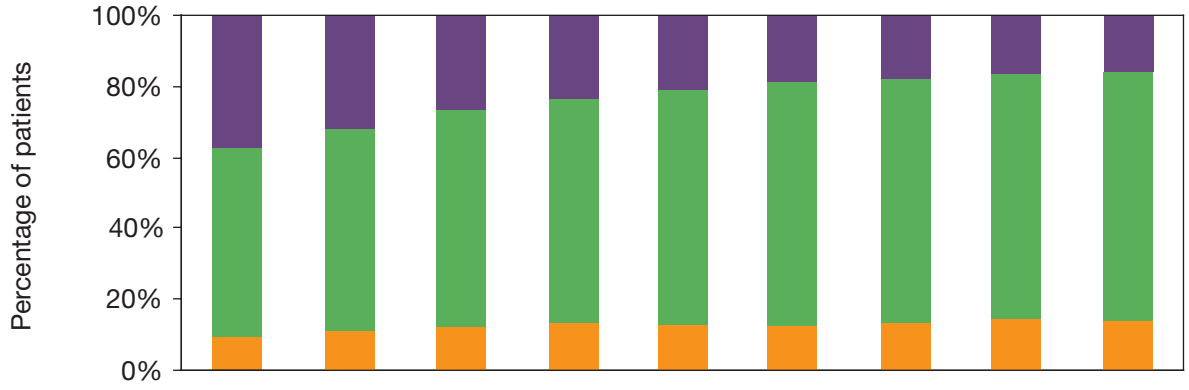
Figure 2.6

ASA grades for primary hip replacement patients between 2003 and 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
P1	37%	31%	26%	23%	20%	18%	17%	16%	15%
P2	53%	57%	60%	63%	66%	69%	69%	69%	70%
P3	9%	11%	13%	13%	13%	13%	14%	15%	15%
P4 and P5	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of patients	26,432	48,029	57,509	59,807	66,907	70,248	70,628	72,452	71,672

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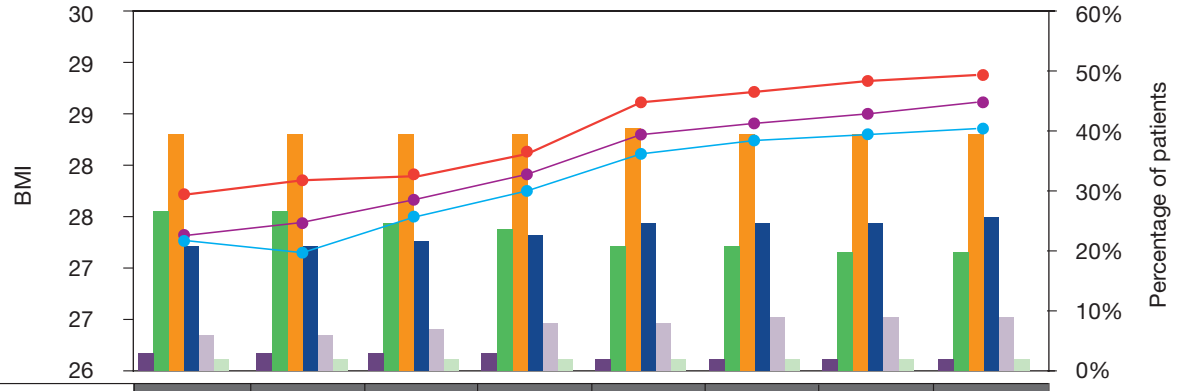
Figure 2.7

BMI for primary hip replacement patients between 2004 and 2011.



Year	2004	2005	2006	2007	2008	2009	2010	2011
Average BMI -all patients	27.35	27.46	27.67	27.90	28.31	28.42	28.51	28.59
Average BMI -female	27.28	27.15	27.53	27.76	28.12	28.22	28.31	28.39
Average BMI -male	27.71	27.86	27.94	28.17	28.61	28.72	28.83	28.90
BMI 15-19	3%	3%	3%	3%	2%	2%	2%	2%
BMI 20-24	27%	27%	25%	24%	21%	21%	20%	20%
BMI 25-29	40%	40%	40%	40%	41%	40%	40%	40%
BMI 30-34	21%	21%	22%	23%	25%	25%	25%	26%
BMI 35-39	6%	6%	7%	8%	8%	9%	9%	9%
BMI 40-44	2%	2%	2%	2%	2%	2%	2%	2%
BMI 45+	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of procedures	5,906	8,985	10,448	14,190	33,769	39,359	43,413	39,619

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2.2.1.2 Surgical techniques

The surgical techniques used in procedures in 2011 are summarised in Table 2.7. Patients were mainly positioned laterally. The lateral position was used more frequently in hybrid and resurfacing procedures than in cemented and cementless procedures. As would be expected, the most frequently used incision approach was posterior for all procedure types, though for cemented procedure types there are nearly as many procedures performed where a lateral (including Hardinge) approach was used.

The reduction in the use of cemented stems (from 77% in 2004 to 51% in 2011) and also in the use of cemented cups (from 56% to 35%) is consistent with the reduction seen in the overall number of cemented procedures (Figure 2.3) since 2004. However, there is no change between 2009 and 2010. The relative use of different types of bone cement is shown in Figure 2.8 and shows that the use of antibiotic cement has increased from 73% in 2003 to 87% in 2011. Use of minimally-invasive surgery was greatest in cementless procedures, although it was used in less than 5% of all procedures (Table 2.7) which is the same as 2010.

Table 2.7 Surgical technique for primary hip replacement procedures in 2011.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Primary resurfacing arthroplasty of joint		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total hip primaries	**25,789**	**36%**	**31,307**	**44%**	**12,794**	**18%**	**1,782**	**2%**	**71,672**	
Patient position										
Lateral	23,235	90%	28,915	92%	12,181	95%	1,764	98%	66,095	92%
Supine	2,554	10%	2,392	8%	613	5%	18	2%	5,577	8%
Incision										
Antero/antero-lateral	6	<1%	7	<1%	3	<1%	1	<1%	17	<1%
Lateral (inc. Hardinge)	10,967	43%	10,294	33%	3,710	29%	253	14%	25,224	35%
Posterior	13,508	52%	19,098	61%	8,498	66%	1,462	82%	42,566	59%
Trochanteric osteotomy	295	1%	48	<1%	8	<1%	15	<1%	366	<1%
Other	1,013	4%	1,860	6%	575	4%	51	3%	3,499	5%
Minimally-invasive surgery										
Yes	592	2%	2,411	8%	225	2%	32	2%	3,260	5%
No	25,196	98%	28,894	92%	12,568	98%	1,750	98%	68,408	95%
Not selected	1	<1%	2	<1%	1	<1%	0	<1%	4	<1%
Image-guided surgery										
Yes	19	<1%	149	<1%	20	<1%	60	3%	248	<1%
No	25,769	100%	31,156	100%	12,773	100%	1,722	97%	71,420	100%
Not selected	1	<1%	2	<1%	1	<1%	0	0%	4	<1%
Bone graft used - femur										
Yes	176	<1%	355	1%	48	<1%	21	1%	600	<1%
No	25,613	99%	30,952	99%	12,746	100%	1,761	99%	71,072	99%
Bone graft used - acetabular										
Yes	992	4%	1,348	4%	772	6%	95	5%	3,207	4%
No	24,797	96%	29,959	96%	12,022	94%	1,687	95%	68,465	96%

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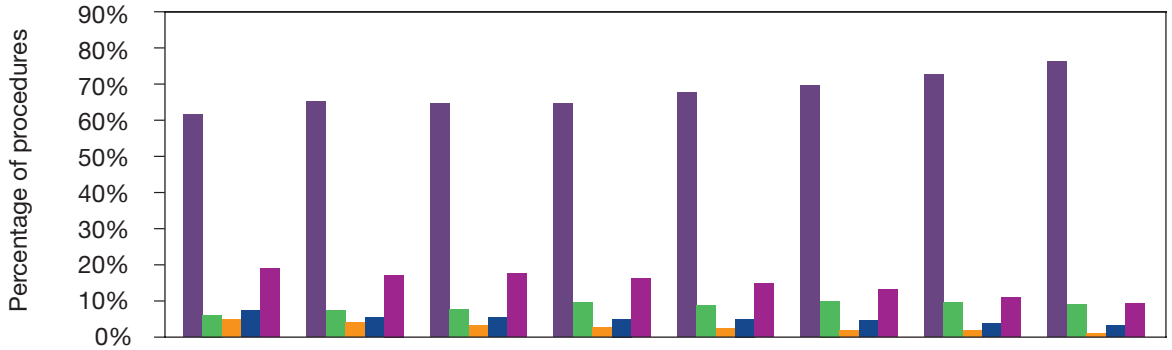
Figure 2.8

Bone cement types for primary hip replacement procedures undertaken between 2004 and 2011.



Year	2004	2005	2006	2007	2008	2009	2010	2011
Antibiotic-loaded high viscosity	62%	65%	65%	65%	68%	70%	73%	77%
Antibiotic-loaded medium viscosity	6%	7%	8%	9%	9%	10%	10%	9%
Antibiotic-loaded low viscosity	5%	4%	3%	3%	3%	2%	2%	1%
High viscosity	7%	6%	6%	5%	5%	5%	4%	3%
Medium viscosity	19%	17%	18%	17%	15%	13%	11%	9%
Low viscosity	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of procedures using cement	34,479	40,434	40,492	44,141	43,216	41,375	40,727	41,277

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2.2.1.3 Thromboprophylaxis

The most frequently prescribed chemical method of thromboprophylaxis for hip replacement patients was LMWH, at 71%, and the most used mechanical method was TED stockings (66%), (Table 2.8). There has been a marked decrease over the past years in the use of aspirin, (20% in 2009 to 9% in 2011) though the use of LMWH has increased again to 2009 levels (71%). Direct thrombin inhibitor is now used in 11% of hip primary procedures and the use of 'Other chemical' has risen from 7% in 2009 to 13% in 2011. This change is also seen in knee primary procedures. The number of procedures for which both chemical and mechanical methods were prescribed rose from 63% in 2007 to 90% in 2011.

Table 2.8 Thromboprophylaxis regime for primary hip replacement patients, prescribed at time of operation.

	Total	
	No.	%
Total hip primaries	**71,672**	
Aspirin	6,149	9%
Low molecular weight heparin (LMWH)	50,767	71%
Pentasaccharide	1,128	2%
Warfarin	559	<1%
Direct thrombin inhibitor	7,810	11%
Other chemical	9,315	13%
No chemical	2,999	4%
Foot pump	18,830	26%
Intermittent calf compression	28,980	40%
TED stockings	47,106	66%
Other mechanical	1,785	2%
No mechanical	4,048	6%
Both mechanical and chemical	64,704	90%
Neither mechanical nor chemical	67	<1%

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2.2.1.4 Untoward intra-operative events

Untoward intra-operative events were reported in 1.5% of procedures (Table 2.9). Of the 1,008 untoward events reported, an increase of 171 events compared with 2010, 28% were attributed to calcar crack. As would be expected, this occurred more often in cementless than in cemented hips. Furthermore, 14% were trochanteric fractures, also more common in cementless procedures. 42% of events were of 'other' description.

Table 2.9 Reported untoward intra-operative events for primary hip replacement patients in 2011, according to procedure type.

	Primary total prosthetic replacement using cement	Primary total prosthetic replacement not using cement	Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)	Primary resurfacing arthroplasty of joint	Total
	No.	No.	No.	No.	No.
Total hip primaries	**25,789**	**31,307**	**12,794**	**1,782**	**71,672**
Total events specified	**304**	**554**	**146**	**4**	**1,008**
Calcar crack	36	206	42	1	285
Pelvic penetration	50	27	19	1	97
Shaft fracture	11	21	4	0	36
Shaft penetration	9	10	5	0	24
Trochanteric fracture	61	61	23	0	145
Other	137	229	53	2	421

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2.2.1.5 Hip primary components

This section outlines in more detail the trends in brand use for hips. For a full listing of brands used in 2011, please visit the NJR website at www.njrcentre.org.uk. This section also includes an analysis of use according to National Institute for Health and Clinical Excellence (NICE) guidelines, as interpreted by the Orthopaedic Data Evaluation Panel (ODEP).

2.2.1.5.1 Compliance with ODEP and NICE guidelines

In 2011, 119 brands of acetabular cups, 10 brands of resurfacing cups and 142 brands of femoral stems were used in primary and revision procedures and recorded on the NJR. This is a small decrease in the use of acetabular cups and stems compared with 2010.

The 2nd NJR Annual Report in 2004[7] gave a full description of the NICE guidance on the selection of prostheses for primary THRs and metal-on-metal hip resurfacing arthroplasty. It also described the establishment of ODEP. Its remit is to provide an independent assessment of clinical evidence, submitted by suppliers, on the compliance of their implants for THR and hip resurfacing against NICE benchmarks for safety and effectiveness. ODEP produced detailed criteria for this assessment and in 2011 there was an ongoing review of this guidance by all stakeholders.

The ODEP committee reviewed suppliers' clinical data submissions and ODEP ratings have been given to 59 brands of femoral stems (44% of those available) and 49 brands of acetabular cups (43%) used in primary procedures. However, there are 47 brands of acetabular cup (41%) and 52 brands of femoral stem (35%) currently being used in England and Wales for which no data has yet been submitted to ODEP. It should be noted however that some of this use relates to stems designed for revision surgery being used in primary procedures for unspecified reasons. Revision brands are not covered by the ODEP process. The latest listings for brands currently being used in England and Wales can be seen on the ODEP website:

https://www.supplychain.nhs.uk/product-areas/orthopaedics/odep/

Analysis of primary procedures shows that the use of products meeting the full 10 year (10A) benchmark, as recommended by NICE, is as follows:

- Cemented stems 85% (using 13 brands out of 57 recorded on the NJR)
- Cementless stems 72% (16 brands out of 85)
- Cemented cups 40% (10 brands out of 48)
- Cementless cups 3% (7 brands out of 71)
- Resurfacing cups 57% (1 brand out of 10)

These percentages are based on the latest ODEP ratings from clinical outcomes data already submitted to the ODEP committee and published in February 2012. Manufacturers are expected to submit additional data to progress through the ratings and this will result in these percentages changing in the future.

Comparison with the 2010 figures shows that use of cemented stems fully compliant with NICE guidelines has not changed significantly (84% in 2010 to 85% in 2011). Use of fully compliant cementless stems is 72% (a decrease of 2% on last year). However, the percentage for fully compliant cementless cups was 3%, suggesting a growing use of products for which there is shorter term clinical outcomes data.

2.2.1.5.2 Hip brand use in primary procedures

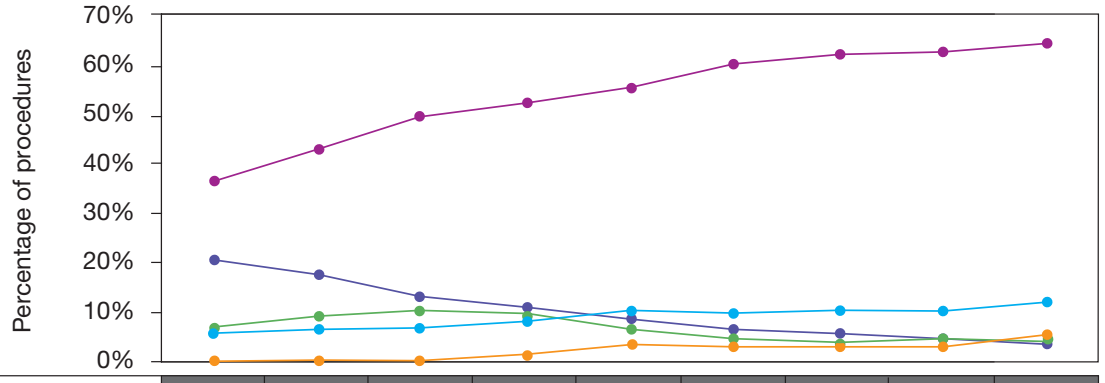
Figures 2.9 to 2.13 show historical trends in the use of the most popular brands of cemented stems, cemented cups, cementless stems, cementless cups and hip resurfacing cups.

Figure 2.9 shows that the market is dominated by polished collarless tapered stems, with the Exeter V40 having a market share of more than 64% and the CPT stem consolidating its position in second place. There has been a corresponding decrease in the use of Charnley-type low friction arthroplasty implants; this segment in total now represents only approximately 4% of the overall market for cemented primary stems.

[7] See pages 86 to 92 of the 2nd NJR Annual Report, available on the NJR website www.njrcentre.org.uk

Figure 2.9

Top five cemented hip stem brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	18,942	31,825	35,569	34,078	35,747	33,924	32,901	33,707	34,674

Exeter V40 | CPT | C-Stem AMT Cemented Stem | C-Stem Cemented Stem | Charnley Cemented Stem

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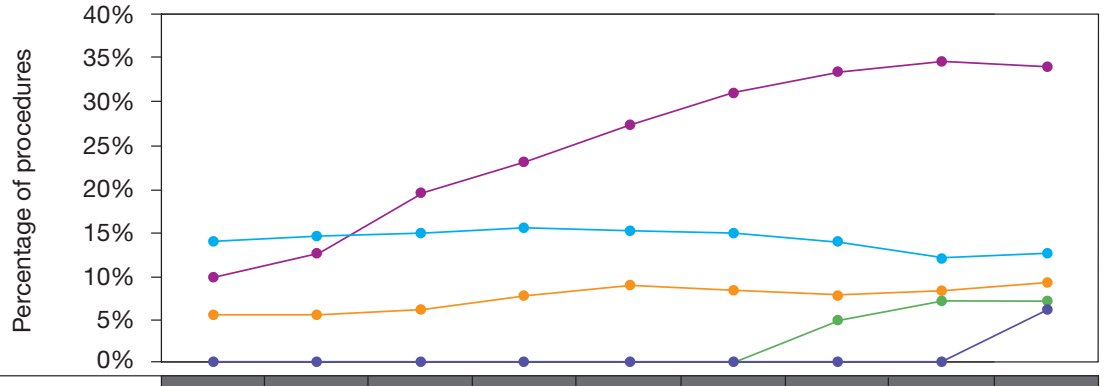
The trend for cemented cups (Figure 2.10) continues to show that sales of different brands are in line with the popularity of the stem manufacturer. The only significant change being a proportion of Exeter stem users switching from the Contemporary to the Exeter Rimfit cup, both manufactured by Stryker.

Figure 2.10

Top five cemented hip cup brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	15,148	25,299	27,690	25,491	26,884	25,151	23,811	23,783	24,349

Contemporary | Elite Plus Ogee | Elite Plus Cemented Cup | Marathon | Exeter Rimfit

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The relative sales of cementless stem brands (Figure 2.11) are very similar to the previous year, with pressfit HA coated stems continuing to dominate the market.

The Corail prosthesis has further consolidated its position as market leader.

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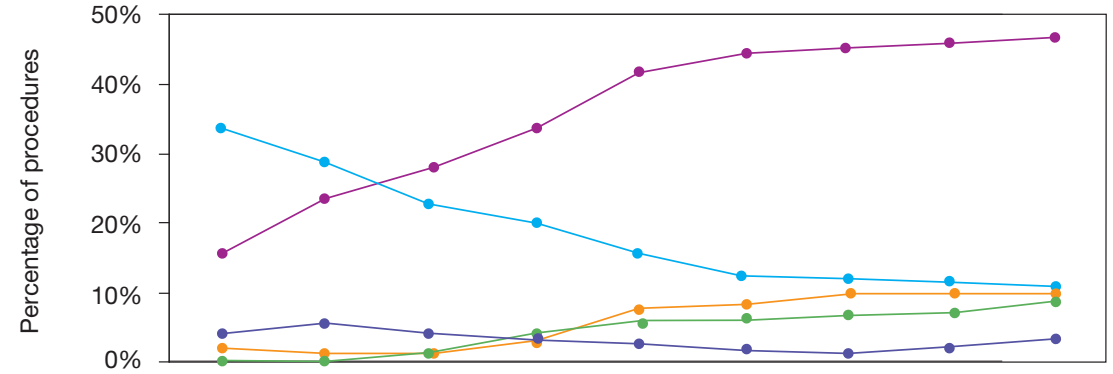
Figure 2.11

Top five cementless hip stems brands, trends 2003 to 2011.



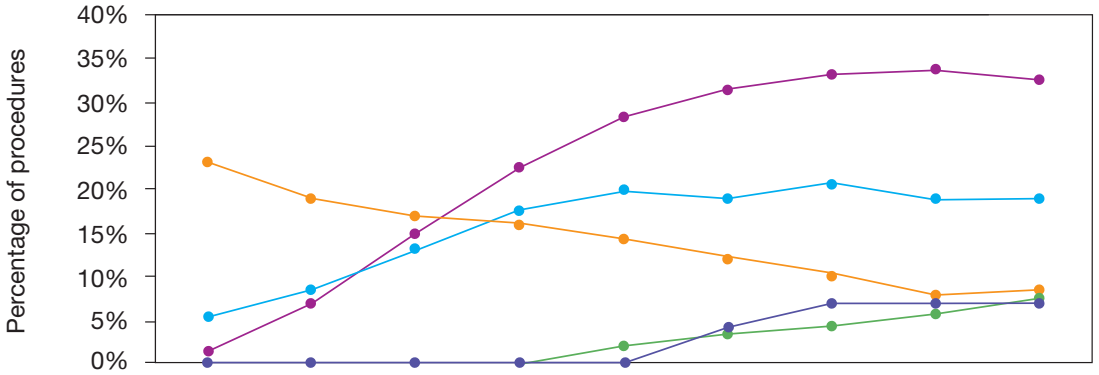
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	4,461	10,766	15,134	18,457	23,439	29,200	32,129	34,550	33,724

Corail
Furlong HAC Stem
Accolade
Taperloc Cementless Stem
Versys Cementless Stem

The cementless stem market share has again reflected the sales of the corresponding cementless cups from the same manufacturers, which means that the Pinnacle cup from DePuy has retained its position as the market leader (Figure 2.12) despite appearing to lose some share to other brands, notably the Exceed ABT from Biomet.

Figure 2.12

Top five cementless hip cup brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	7,905	16,412	21,145	24,068	28,577	34,155	39,227	44,097	44,223

Pinnacle Trident Trilogy Exceed ABT CSF Plus

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Figure 2.13 shows the sales evolution of brands of hip resurfacing prostheses in the English and Welsh markets. It is evident that the previous trend towards a decline in the use of the original brands has continued to reverse. The market share of the BHR brand increased significantly during the course of 2011, at the expense of all other brands reflecting its clinical performance when measured against most of its competitors. However, it should be noted that this is against a background of further reduction in the overall volume of resurfacing hip replacement.

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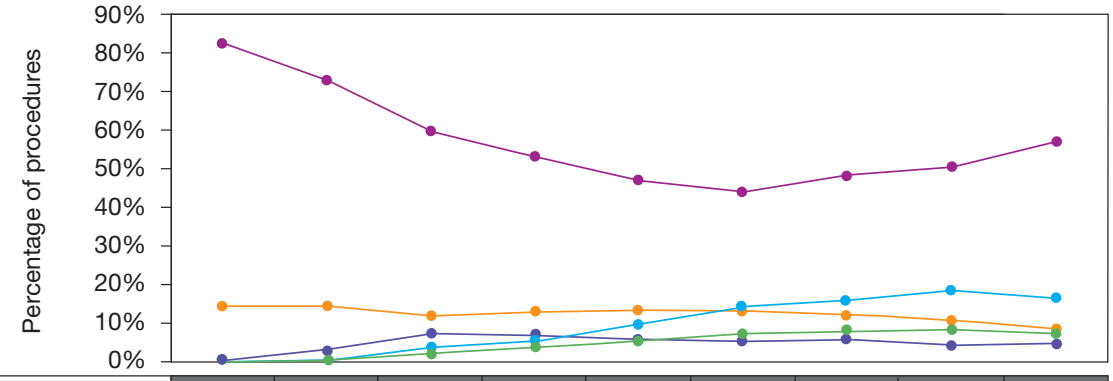
Figure 2.13

Top five resurfacing head brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	2,640	5,023	6,214	6,483	6,678	5,780	4,350	2,680	1,801

BHR Resurfacing Head
Adept Resurfacing Head
Cormet 2000 Resurfacing Head
Recap Resurfacing Head
Durom Resurfacing Head

2.2.1.5.3 Trends in head size use

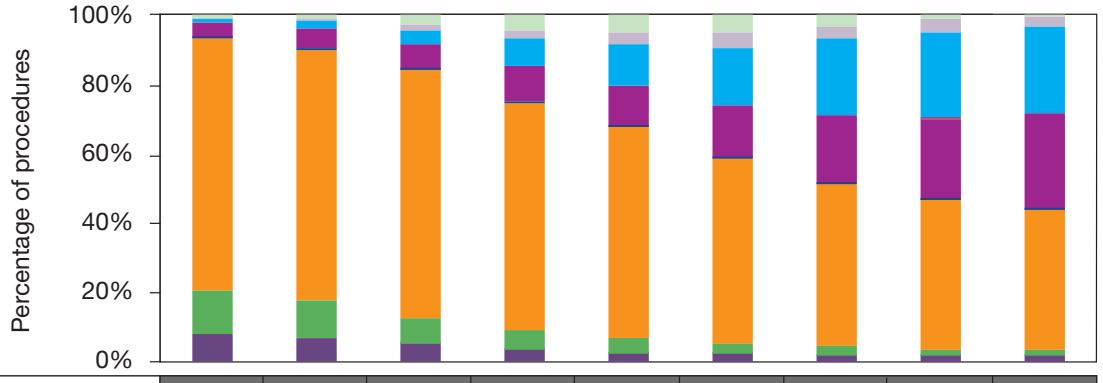
Figure 2.14 shows the relative use of different femoral head sizes (for all femoral heads used in conjunction with a femoral stem) each year since the inception of the NJR. New component architecture allows greater analysis of head size investigation for the first time. It is immediately clear that there has been a gradual increase in the use of larger head sizes (36mm diameter and above). However, between 2010 and 2011 this had been reversed slightly. This trend accurately reflects the trends in use of LHMoM prostheses during the lifetime of the NJR.

2.2.1.5.4 Trends in hip articulation

Figure 2.15 shows the change in hip articulation types since the inception of the NJR. Only those procedures where complete articulation surfaces can be derived are included. New component architecture allows greater analysis of hip articulation for the first time. The most interesting observation being the huge rise in the use of ceramic-on-ceramic bearings, from small numbers in 2003 to nearly 17,000 in 2011. This growth would appear to have been mainly at the expense of metal-on-metal bearings.

Figure 2.14

Femoral head size, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used with head size detail	18,887	36,120	45,032	48,362	56,093	61,384	63,610	67,322	67,625

22.25mm 26mm 28mm 30mm 32mm 34mm

36mm 38-44mm 46+mm

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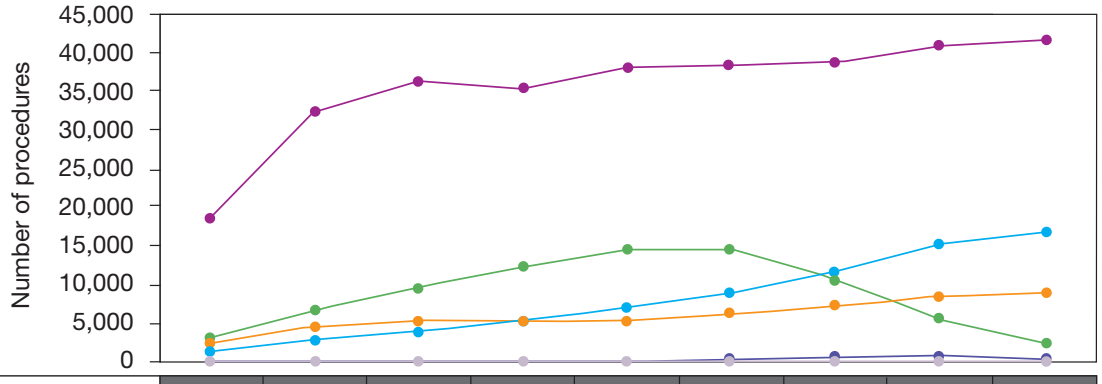
Figure 2.15

Hip articulation, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of procedures with hip articulation details	25,341	46,534	55,659	58,130	65,174	68,557	69,168	70,865	70,111

Metal-on -Poly Ceramic-on -Ceramic Ceramic-on -Poly Metal-on -Metal Ceramic-on -Metal Metal-on -Ceramic*

* This combination is contra-indicated

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2.2.2 Hip revision procedures 2011

A total of 8,639 hip revision procedures were reported in 2011, an increase of 787 compared with 2010. Table 2.10 shows that of these, 7,537 (87%) were single-stage revision procedures, 495 (6%) were stage one of a two-stage process, 561 (6%) procedures were stage two of a two-stage revision and 46 (<1%) were excision arthroplasty procedures. Previous years have shown a relative increase in stage two of two-stage revisions compared with single-stage revisions but in 2011 this changed with a higher percentage of single-stage revisions up from 83% in 2009 to 87% in 2011. Infection as an indication for revision has increased to 12% of the total. Adverse soft tissue reaction was recorded in 11% of all revisions which shows an increase of 6% on 2010. However, this option was added in July 2009 and it is not possible to tell if this increase is actual or due to a delay in the use of the new MDS H2 data forms.

2.2.2.1 Patient characteristics

Table 2.10 summarises patient characteristics for the 8,639 hip revision procedures undertaken in 2011. Compared with 2010, the patient demographics have largely remained unchanged. However, the percentage of patients who were graded as being fit and healthy prior to surgery has decreased from 26% in 2003 to 10% in 2011.

Aseptic loosening and pain have decreased as reasons for revision compared with 2010 for all revision procedure types. Adverse soft tissue reaction was noted for 11% of all revision procedures (Table 2.10).

Table 2.10 Patient characteristics for hip revision procedures in 2011, according to procedure type.

	Hip single-stage revision		Hip stage one of two-stage revision		Hip stage two of two-stage revision		Hip excision arthroplasty		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total hip revisions	**7,537**	**87%**	**495**	**6%**	**561**	**6%**	**46**	**<1%**	**8,639**	
Number with patient data	**7,153**	**95%**	**470**	**95%**	**535**	**95%**	**41**	**89%**	**8,199**	**95%**
Average age	69.9		68.7		67.4		73.2		69.2	
SD	12.3		11.6		11.7		12.7		12.8	
Interquartile range	62.4 - 78.8		62.9 - 77.0		60.6 - 75.9		63.3 - 83.8		62.4 - 78.5	
Gender										
Female	4,291	60%	222	47%	253	47%	30	73%	4,796	58%
Male	2,862	40%	248	53%	282	53%	11	27%	3,403	42%
Patient physical status										
P1 - fit and healthy	804	11%	46	9%	52	9%	1	2%	903	10%
P2 - mild disease not incapacitating	4,821	64%	271	55%	330	59%	14	30%	5,436	63%
P3 - incapacitating systemic disease	1,807	24%	160	32%	174	31%	27	59%	2,168	25%
P4 - life threatening disease	105	1%	18	4%	5	<1%	3	7%	131	2%
P5 - expected to die within 24hrs with or without an operation	0	0%	0	0%	0	0%	1	2%	1	<1%
Indications for surgery										
Aseptic loosening	3,502	46%	52	11%	64	11%	9	20%	3,627	42%
Lysis	1,041	14%	39	8%	29	5%	7	15%	1,116	13%
Pain	1,958	26%	71	14%	55	10%	7	15%	2,091	24%
Dislocation/subluxation	1,112	15%	20	4%	15	3%	9	20%	1,156	13%
Periprosthetic fracture	694	9%	15	3%	15	3%	3	7%	727	8%
Infection	235	3%	411	83%	402	72%	28	61%	1,076	12%
Malalignment	378	5%	5	1%	8	1%	0	0%	391	5%
Fractured acetabulum	97	1%	2	<1%	4	<1%	0	0%	103	1%
Fractured stem	134	2%	3	<1%	3	<1%	0	0%	140	2%
Fractured femoral head	26	<1%	1	<1%	0	0%	0	0%	27	<1%
Incorrect sizing head/socket	63	<1%	1	<1%	1	<1%	0	0%	65	<1%
Wear of acetabular component	1,010	13%	7	1%	15	3%	1	2%	1,033	12%
Dissociation of liner	150	2%	20	4%	13	2%	1	2%	184	2%
Adverse soft tissue reaction	917	12%	13	3%	14	2%	3	7%	947	11%
Other	645	9%	25	5%	59	11%	2	4%	731	8%
Side										
Bilateral	9	<1%	0	0%	0	0%	0	0%	9	<1%
Left, unilateral	3,576	47%	240	48%	282	50%	18	39%	4,116	48%
Right, unilateral	3,952	52%	255	52%	279	50%	28	61%	4,514	52%

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Table 2.11 Indication for surgery for hip revision procedures, 2007 to 2011.

	2007		2008		2009		2010		2011		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Indications for single-stage revision												
Number of procedures	**6,133**	**18%**	**6,394**	**19%**	**6,573**	**19%**	**7,299**	**22%**	**7,537**	**22%**	**33,936**	
Aseptic loosening	3,711	61%	3,790	59%	3,639	55%	3,661	50%	3,502	46%	18,303	54%
Lysis	1,110	18%	1,103	17%	995	15%	1,099	15%	1,041	14%	5,348	16%
Pain	1,242	20%	1,742	27%	2,028	31%	1,989	27%	1,958	26%	8,959	26%
Adverse soft tissue reaction	-	-	1	<1%	84	1%	402	6%	917	12%	1,404	4%
Infection	103	2%	172	3%	189	3%	235	3%	235	3%	934	3%
Indications for stage one of a two-stage revision												
Number of procedures	**400**	**16%**	**455**	**19%**	**554**	**23%**	**524**	**22%**	**495**	**20%**	**2,428**	
Aseptic loosening	73	18%	88	19%	84	15%	72	14%	52	11%	369	15%
Lysis	46	12%	58	13%	50	9%	51	10%	39	8%	244	10%
Pain	57	14%	87	19%	103	19%	110	21%	71	14%	428	18%
Infection	304	76%	365	80%	440	79%	418	80%	411	83%	1,938	80%

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2.2.2.2 Components removed and components used

Both the acetabular and femoral components were removed in approximately half of all revision procedures (Table 2.12). However, comparison of the different types of revision procedures indicates that both components were more likely to be removed during a two stage revision process than during a single-stage revision. This is expected since the majority of two-stage revisions are carried out for reasons of infection, where all components are routinely removed. The components used during revision procedures are shown in Table 2.13.

Table 2.12 Components removed during hip revision procedures in 2011.

	Hip single-stage revision		Hip stage one of a two-stage revision		Hip excision arthroplasty		Total	
	No.	%	No.	%	No.	%	No.	%
Total number of procedures	**7,190**		**479**		**45**		**7,714**	
Both cup and stem	3,239	45%	393	82%	31	69%	3,663	47%
Acetabular cup only	2,169	30%	16	3%	1	2%	2,186	28%
Femoral stem only	1,076	15%	40	8%	9	20%	1,125	15%
Neither cup nor stem	706	10%	30	6%	4	9%	740	10%

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Table 2.13 Components used during single-stage hip revision procedures in 2011.

	Hip single-stage revision	
	No.	%
Total number of procedures	**7,537**	
Femoral prosthesis		
Cemented	2,139	28%
Cementless	2,230	30%
Not revised	3,168	42%
Acetabular prosthesis		
Cemented	1,341	18%
Cementless	4,459	59%
Not revised	1,737	23%

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Part 2

2.3 Knee replacement procedures 2011

The total number of knee replacement procedures entered into the NJR during 2011 was 84,653, an increase of 3.3% over 2010 as reported in 8th Annual Report. Of the 84,653 procedures submitted, 79,516 were primary procedures and 5,137 were revision procedures. Table 2.14 summarises the patient characteristics and details of knee replacement procedures according to type of provider.

As a percentage of their activity, independent hospitals performed more unicondylar knee replacement procedures (Figure 2.16) than any other type of provider and ISTCs performed more cemented bicondylar knee procedures than any other provider. The revision procedures undertaken at NHS hospitals comprised 86% of all revision procedures performed.

Table 2.14 Procedure details, according to type of provider for knee procedures in 2011.

	NHS hospitals		Independent hospitals		ISTCs		Total	
	No.	%	No.	%	No.	%	No.	%
Total knee procedures	**58,779**	**69%**	**21,362**	**25%**	**4,512**	**5%**	**84,653**	
Patient physical status								
P1 - fit and healthy	5,093	9%	3,841	18%	390	9%	9,324	11%
P2 - mild disease not incapacitating	42,064	72%	15,861	74%	3,737	83%	61,662	73%
P3 - incapacitating systemic disease	11,353	19%	1,645	8%	384	9%	13,382	16%
P4 - life threatening disease	265	<1%	14	<1%	1	<1%	280	<1%
P5 - expected to die within 24hrs with or without an operation	4	<1%	1	<1%	0	0%	5	<1%
Procedure type								
Primary procedures	**54,377**	**68%**	**20,741**	**26%**	**4,398**	**6%**	**79,516**	**94%**
Total prosthetic replacement using cement	47,797	88%	16,663	80%	3,952	90%	68,412	86%
Total prosthetic replacement not using cement	2,062	4%	1,233	6%	24	1%	3,319	4%
Hybrid total knee	247	<1%	142	1%	6	<1%	395	<1%
Patello-femoral replacement	729	1%	367	2%	37	1%	1,133	1%
Unicondylar knee replacement	3,542	7%	2,336	11%	379	9%	6,257	8%
Revision procedures	**4,402**	**86%**	**621**	**12%**	**114**	**2%**	**5,137**	**6%**
Knee single-stage revision	3,297	75%	536	86%	97	85%	3,930	77%
Knee stage one of two-stage revision	531	12%	38	6%	9	8%	578	11%
Knee stage two of two-stage revision	548	12%	47	8%	8	7%	603	12%
Knee conversion to arthrodesis	13	<1%	0	0%	0	0%	13	<1%
Amputation	11	<1%	0	0%	0	0%	11	<1%
Knee re-operation other than revision[8]	2	<1%	0	0%	0	0%	2	<1%
Bilateral or unilateral[9]								
Bilateral	522	1%	420	2%	54	1%	996	1%
Unilateral	58,257	99%	20,942	98%	4,458	99%	83,657	99%
Funding								
Independent	437	1%	9,511	45%	18	<1%	9,966	12%
NHS	58,342	99%	11,851	55%	4,494	100%	74,687	88%

[8] Knee re-operations other than revision are recorded because some units continue to use MDSv2 where these procedures were included. MDSv3 no longer records re-operations. Therefore, the re-operation procedure totals will not reflect the actual number performed.

[9] Bilaterals will only be counted as a bilateral if they are entered under the same single operation during data entry. If the two procedures are recorded under two different operations they will be counted as two unilateral procedures. Therefore, the count of bilaterals is likely to be an underestimate.

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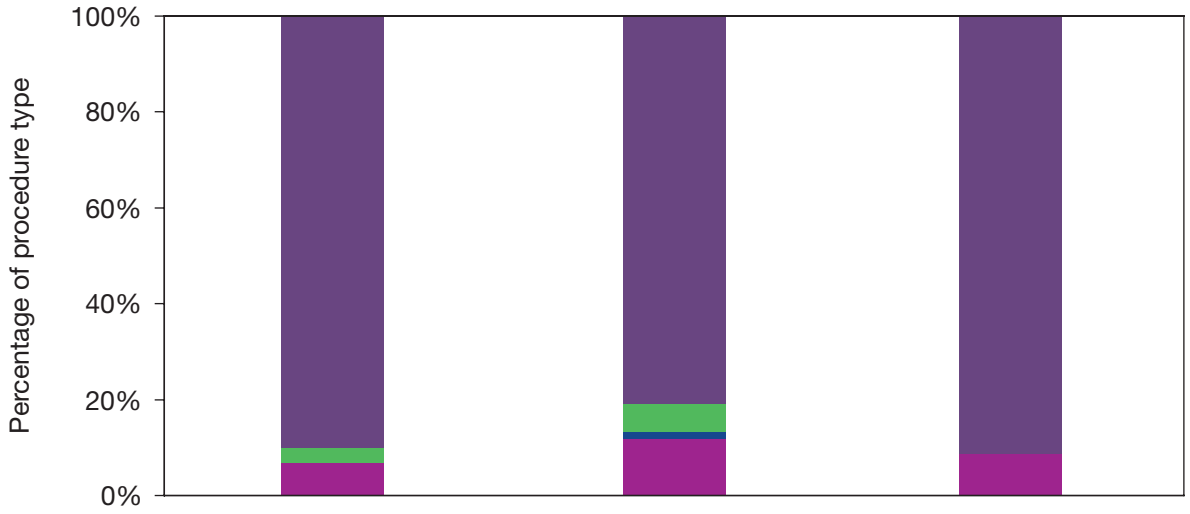
Figure 2.16

Primary knee procedures by type of provider 2011.



Type of provider	NHS hospitals	Independent hospitals	ISTCs
Cemented	88%	80%	90%
Cementless	4%	6%	<1%
Hybrid	<1%	<1%	<1%
Patello -femoral	<1%	2%	<1%
Unicondylar	7%	11%	9%
Number of procedures	54,377	20,741	4,398

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2.3.1 Primary knee replacement procedures 2011

Of the 79,516 primary knee replacements undertaken in 2011, 72,126 (91%) were bicondylar procedures, 6,257 (8%) were unicondylar knee replacements and 1,133 (1%) were patello-femoral replacements (Table 2.15). Compared with previous years, these proportions have largely remained the same (Figure 2.17) though there has been a slight increase in cemented TKR at the expense of cementless TKR over the past 3 years. Figure 2.17 shows an apparent decrease in the volume of knee procedures between 2010 and 2011. However, not all procedures performed in 2011 were entered into the database before the 28 February 2012 deadline and will be entered after this date. Figure 2.18 is based on total condylar knee replacements where the meniscal implant has been specified. The use of unconstrained fixed implants has increased gradually over the past five years at the expense of unconstrained mobile constructs. Figure 2.19 shows that the use of fixed constraint implants has increased since 2007.

The single largest indication recorded for surgery was osteoarthritis, recorded in 98% of all primary procedures (Table 2.15). All other indications are recorded at 1% or less.

Table 2.15 Patient characteristics for primary knee replacement procedures in 2011, according to procedure type.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Patello-femoral replacement		Unicondylar replacement		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total knee primaries	**68,412**	**86%**	**3,319**	**4%**	**395**	**<1%**	**1,133**	**1%**	**6,257**	**8%**	**79,516**	
Total knee primaries with patient data	**65,601**	**96%**	**3,205**	**97%**	**372**	**94%**	**1,075**	**95%**	**5,858**	**94%**	**76,111**	**96%**
Patient physical status												
P1 - fit and healthy	6,443	10%	361	11%	45	12%	270	25%	1,308	22%	8,427	11%
P2 - mild disease not incapacitating	48,372	74%	2,421	76%	273	73%	694	65%	4,066	69%	55,826	73%
P3 - incapacitating systemic disease	10,586	16%	414	13%	52	14%	109	10%	478	8%	11,639	15%
P4 - life threatening disease	198	<1%	9	<1%	2	<1%	2	<1%	4	<1%	215	<1%
P5 - expected to die within 24hrs with or without an operation	2	<1%	0	0%	0	0%	0	0%	2	<1%	4	<1%
BMI												
Number with BMI data	38,925	57%	1,754	53%	231	58%	625	55%	3,945	63%	45,480	57%
Average	30.91		30.82		30.04		29.99		30.11		30.82	
SD of average	5.53		5.17		5.38		5.50		5.07		5.48	
Indications for surgery												
Osteoarthritis	66,628	97%	3,261	98%	382	97%	1,114	98%	6,193	99%	77,578	98%
Avascular necrosis	207	<1%	6	<1%	2	<1%	0	0%	35	<1%	250	<1%
Inflammatory arthropathy	449	<1%	15	<1%	2	<1%	3	<1%	3	<1%	472	<1%
Previous infection	54	<1%	3	<1%	0	0%	2	<1%	0	0%	59	<1%
Rheumatoid arthritis	1,018	1%	25	<1%	2	<1%	1	<1%	5	<1%	1,051	1%
Previous trauma	397	<1%	16	<1%	4	1%	5	<1%	32	<1%	454	<1%
Other	479	<1%	17	<1%	13	3%	23	2%	26	<1%	558	<1%
Side												
Bilateral	589	<1%	33	<1%	15	4%	89	8%	268	4%	994	<1%
Left, unilateral	32,080	47%	1,570	47%	188	48%	498	44%	3,013	48%	37,349	47%
Right, unilateral	35,743	52%	1,716	52%	192	49%	546	48%	2,976	48%	41,173	52%

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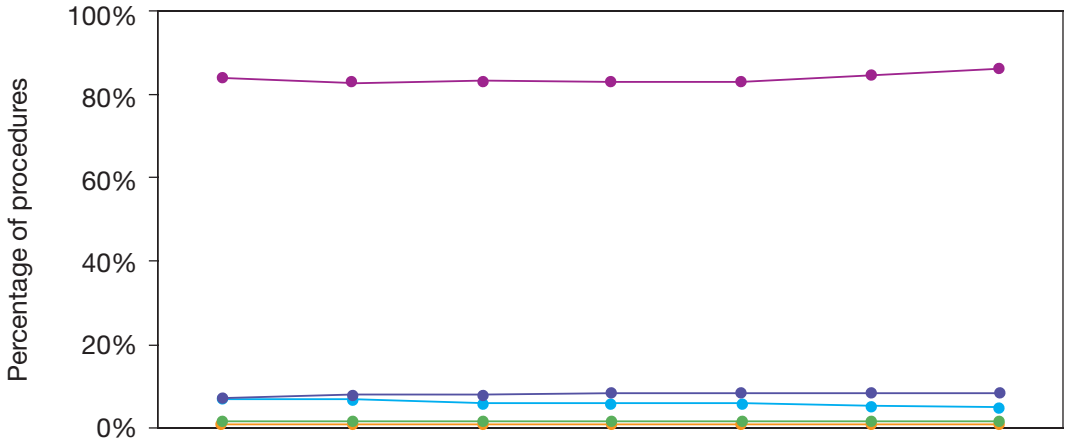
Figure 2.17

Type of primary knee replacement procedures undertaken between 2005 and 2011.



Year	2005	2006	2007	2008	2009	2010	2011
TKR using cement	84%	83%	83%	83%	83%	85%	86%
TKR not using cement	7%	7%	6%	6%	6%	5%	4%
TKR Hybrid	1%	1%	1%	1%	1%	<1%	<1%
Patello-femoral	1%	1%	1%	1%	1%	1%	1%
Unicondylar	7%	8%	8%	8%	8%	8%	8%
Number of procedures	59,385	62,327	73,523	77,624	78,832	81,042	79,516

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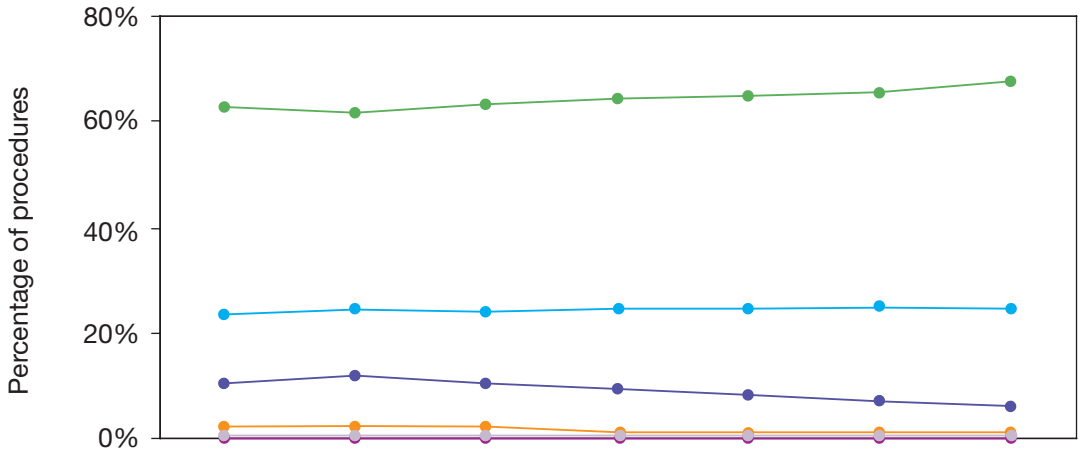
Figure 2.18

Implant constraint for bicondylar primary knee replacement procedures undertaken between 2005 and 2011.



Year	2005	2006	2007	2008	2009	2010	2011
Constrained condylar fixed	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Posterior stabilised fixed	24%	24%	24%	24%	25%	25%	25%
Posterior stabilised mobile	2%	2%	2%	2%	2%	2%	1%
Unconstrained fixed	63%	62%	63%	64%	65%	66%	68%
Unconstrained mobile	11%	11%	11%	10%	8%	7%	6%
Hinged/ linked	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of procedures	53,605	54,775	64,570	68,301	69,583	71,594	70,627

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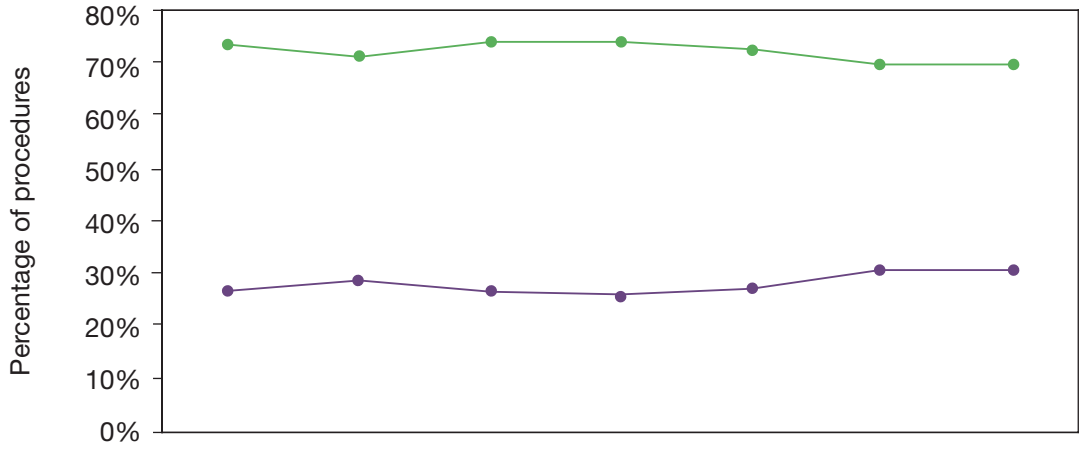
Figure 2.19

Bearing type for unicondylar primary knee replacement procedures undertaken between 2005 and 2011.



Year	2005	2006	2007	2008	2009	2010	2011
Fixed	27%	29%	26%	26%	27%	30%	30%
Mobile	73%	71%	74%	74%	73%	70%	70%
Number of procedures*	5,696	5,989	6,887	7,231	7,203	7,452	6,799

* This is the number of procedures using a unicondylar meniscal implant regardless of patient procedure selected

2.3.1.1 Patient characteristics

According to the ASA grade system, 11% of patients undergoing a primary knee replacement procedure were graded as fit and healthy (Table 2.15).

The average age of patients was 67.4 years and 56% were female. Patients undergoing a patello-femoral replacement were the youngest, at an average age of 60.5 years and 75% of these were female (Table 2.16). On average, female patients were of a similar age to male patients at the time of their primary knee replacement (68.11 years and 68.12 years respectively), see Table 2.16. However, female patients were, on average, older than male patients for cementless, cemented and hybrid procedures but younger for patello-femoral and unicondylar procedures.

Figure 2.21 shows the trend in ASA grade over the past nine years. Since 2003, similar to the data trend for total hip replacement, there has been a reduction in the number of patients assessed as being fit and healthy at the time of operation and an increase in P2 and P3 status of patients. Figure 2.22 shows the increase in BMI[10] over the past eight years for patients having primary knee procedures. This figure has progressively increased from 29.2 to 30.8 over the past eight years. It also shows that there has been a steady increase in the number of patients within the BMI range 30 to 34 and 35 to 39 and a decrease within the ranges 20 to 24 and 25 to 29. The average knee replacement patient in 2011, by BMI measurement, was clinically obese. It is interesting to note that the profile of Figure 2.22 is significantly different to the equivalent chart for hips, Figure 2.7.

[10] BMI: 20-24 normal, 25-29 overweight, 30-39 obese, 40+ morbidly obese

Table 2.16 Age and gender for primary knee replacement patients in 2011.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Patello-femoral replacement		Unicondylar replacement		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total knee primaries	**68,412**	**86%**	**3,319**	**4%**	**395**	**<1%**	**1,133**	**1%**	**6,257**	**8%**	**79,516**	
Total knee primaries with patient data	**65,601**	**96%**	**3,205**	**97%**	**372**	**94%**	**1,075**	**95%**	**5,858**	**94%**	**76,111**	**96%**
Average age	70.01		69.05		68.61		60.53		64.36		67.41	
SD	9.39		9.67		10.18		11.76		9.95		12.18	
Interquartile range	63.8 - 76.8		62.7 - 76.0		62.2 - 76.5		51.8 - 69.0		57.4 - 71.3		63.2 - 76.5	
Average age by gender												
Female	**37,535**	**87%**	**1,666**	**4%**	**221**	**1%**	**807**	**2%**	**2,735**	**6%**	**42,964**	**56%**
Average age	70.26		69.54		69.19		60.04		64.00		68.11	
SD	9.51		9.95		9.68		11.94		10.26		11.82	
Interquartile range	63.9 - 77.3		62.6 - 76.9		62.9 - 76.7		51.5 - 68.3		56.5 - 71.0		63.2 - 76.9	
Male	**28,066**	**85%**	**1,539**	**5%**	**151**	**<1%**	**268**	**1%**	**3,123**	**9%**	**33,147**	**44%**
Average age	69.67		68.51		67.75		61.98		64.68		68.12	
SD	9.2		9.33		10.85		11.08		9.67		11.05	
Interquartile range	63.8 - 76.3		62.7 - 74.8		61.0 - 76.3		53.2 - 70.3		58.8 - 71.4		63.2 - 75.9	
Age group - female												
<30	10	<1%	0	<1%	0	0%	0	0%	0	0%	10	<1%
30 - 39	60	<1%	1	<1%	0	0%	27	3%	12	<1%	100	<1%
40 - 49	778	2%	54	3%	10	5%	141	17%	223	8%	1,206	3%
50 - 59	4,504	12%	253	15%	25	11%	262	32%	764	28%	5,808	14%
60 - 69	12,352	33%	533	32%	87	39%	195	24%	985	36%	14,152	33%
70 - 79	13,936	37%	565	34%	67	30%	138	17%	552	20%	15,258	36%
80 - 89	5,681	15%	249	15%	31	14%	42	5%	189	7%	6,192	14%
90+	214	<1%	11	<1%	1	<1%	2	<1%	10	<1%	238	<1%
Age group - male												
<30	9	<1%	0	0%	0	0%	0	0%	0	0%	9	<1%
30 - 39	53	<1%	6	<1%	1	<1%	6	2%	10	<1%	76	<1%
40 - 49	581	2%	44	3%	9	6%	37	14%	230	7%	901	3%
50 - 59	3,325	12%	211	14%	22	15%	65	24%	712	23%	4,335	13%
60 - 69	10,301	37%	611	40%	54	36%	92	34%	1,272	41%	12,330	37%
70 - 79	10,120	36%	490	32%	40	26%	59	22%	736	24%	11,445	35%
80 - 89	3,563	13%	173	11%	24	16%	9	3%	157	5%	3,926	12%
90+	114	<1%	4	<1%	1	<1%	0	0%	6	<1%	125	<1%

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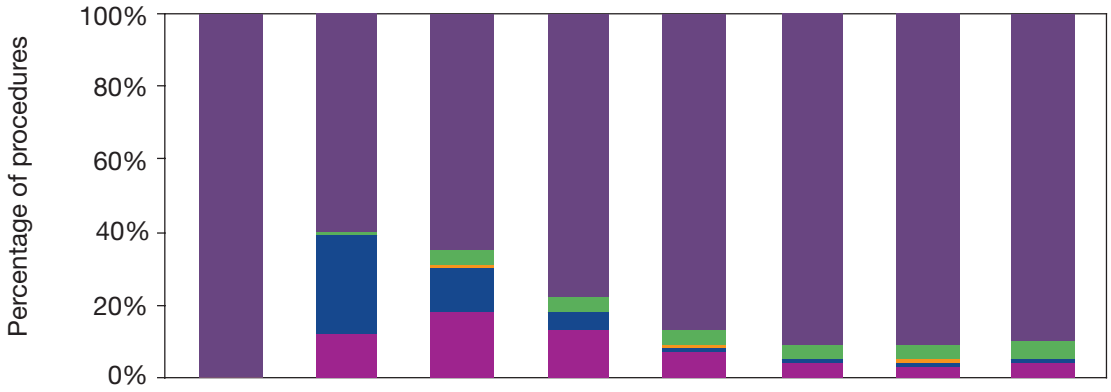
Figure 2.20

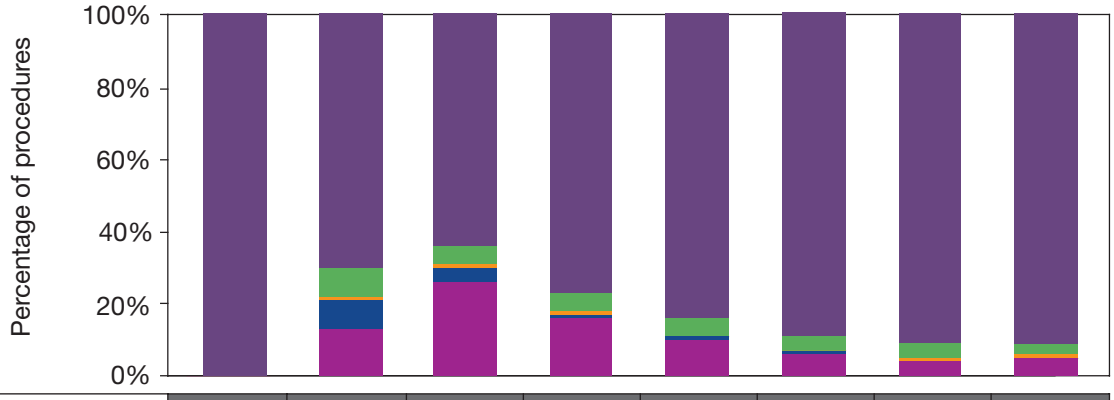
Age and gender for primary knee replacement patients in 2011.

Female



Age group	<30	30-39	40-49	50-59	60-69	70-79	80-89	90+
TKR using cement	100%	60%	65%	78%	87%	91%	92%	90%
TKR not using cement	0%	1%	4%	4%	4%	4%	4%	5%
TKR hybrid	0%	0%	1%	0%	1%	0%	1%	0%
Patello-femoral	0%	27%	12%	5%	1%	1%	1%	1%
Unicondylar	0%	12%	18%	13%	7%	4%	3%	4%
Number of patients	10	100	1,206	5,808	14,152	15,258	6,192	238

Male



Age group	<30	30-39	40-49	50-59	60-69	70-79	80-89	90+
TKR using cement	100%	70%	64%	77%	84%	88%	91%	91%
TKR not using cement	0%	8%	5%	5%	5%	4%	4%	3%
TKR hybrid	0%	1%	1%	1%	0%	0%	1%	1%
Patello-femoral	0%	8%	4%	1%	1%	1%	0%	0%
Unicondylar	0%	13%	26%	16%	10%	6%	4%	5%
Number of patients	9	76	901	4,335	12,330	11,445	3,926	125

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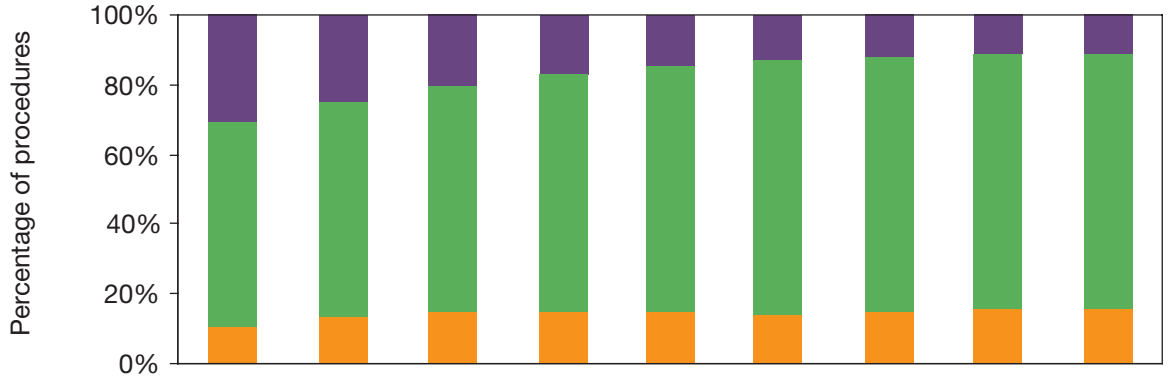
Figure 2.21

ASA grades for primary knee replacement patients between 2003 and 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
P1	31%	25%	20%	17%	15%	13%	13%	12%	11%
P2	58%	62%	65%	68%	71%	73%	72%	73%	73%
P3	10%	13%	14%	14%	14%	13%	15%	15%	15%
P4 and P5	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of procedures	24,662	46,562	60,701	62,327	73,523	77,624	78,832	81,042	79,516

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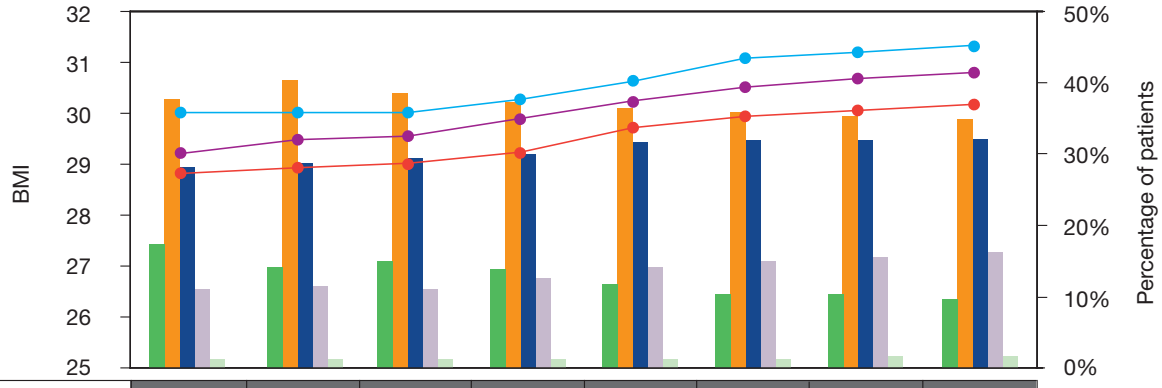
Figure 2.22

BMI for primary knee replacement patients between 2004 and 2011.



Year	2004	2005	2006	2007	2008	2009	2010	2011
Average BMI -all patients	29.25	29.45	29.53	29.85	30.28	30.54	30.66	30.82
Average BMI -female	30.02	29.96	29.97	30.32	30.72	31.04	31.15	31.34
Average BMI -male	28.78	28.92	28.97	29.25	29.7	29.89	30.04	30.16
BMI 15-19	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
BMI 20-24	17%	14%	15%	14%	12%	11%	10%	10%
BMI 25-29	38%	40%	38%	37%	36%	36%	35%	35%
BMI 30-34	28%	29%	29%	30%	31%	32%	32%	32%
BMI 35-39	11%	12%	11%	13%	14%	15%	15%	16%
BMI 40-44	3%	3%	3%	4%	4%	5%	5%	5%
BMI 45+	1%	1%	1%	1%	1%	2%	2%	2%
Number of procedures	5,490	9,098	10,577	16,100	38,178	45,134	49,647	45,480

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2.3.1.2 Surgical techniques

The most common surgical approach was the medial parapatellar, used in 93% of procedures (Table 2.17). Minimally-invasive surgery was used in 48% of unicondylar knee replacement procedures, reflecting the popularity of the Oxford Partial Knee, but was used in only 3% of all other types of knee replacement intervention. For cemented knee procedures, 37% had the patella replaced at the time of the primary procedure whereas only 8% of patellas were replaced during primary cementless knee procedures.

Compared with previous years, the surgical techniques used in primary knee replacements have largely remained unchanged. However, there has been an increase in the use of MIS in unicondylar knee replacements, from 37% in 2004 to 48% in 2011.

The use of bone cement in primary knee procedures is summarised in Figure 2.23.

Table 2.17 Surgical technique for primary knee replacement procedures in 2011.

	Primary total prosthetic replacement using cement		Primary total prosthetic replacement not using cement		Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)		Patello-femoral replacement		Unicondylar replacement		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total knee primaries	**68,412**	**86%**	**3,319**	**4%**	**395**	**<1%**	**1,133**	**1%**	**6,257**	**8%**	**79,516**	
Surgical approach												
Lateral parapatellar	467	<1%	24	<1%	9	2%	18	2%	241	4%	759	<1%
Medial parapatellar	63,670	93%	3,108	94%	327	83%	1,047	92%	5,478	88%	73,630	93%
Mid-vastus	2,047	3%	51	2%	29	7%	29	3%	238	4%	2,394	3%
Sub-vastus	793	1%	38	1%	14	4%	20	2%	103	2%	968	1%
Other	1,435	2%	98	3%	16	4%	19	2%	197	3%	1,765	2%
Patella												
Patella implanted	25,401	37%	270	8%	174	44%	1,043	92%	90	1%	26,980	34%
Patella not implanted	43,011	63%	3,049	92%	221	56%	90	8%	6,167	99%	52,536	66%
Minimally-invasive surgery												
Yes	1,680	2%	122	4%	9	2%	131	12%	2,984	48%	4,926	6%
No	66,732	98%	3,197	96%	386	98%	1,002	88%	3,273	52%	74,590	94%
Image-guided surgery												
Yes	1,731	3%	164	5%	19	5%	2	<1%	91	1%	2,007	3%
No	66,681	97%	3,155	95%	376	95%	1,131	100%	6,166	99%	77,509	97%
Bone graft used - femur												
Yes	581	<1%	27	<1%	4	1%	1	<1%	23	<1%	636	<1%
No	67,831	99%	3,292	99%	391	99%	1,132	100%	6,234	100%	78,880	99%
Bone graft used - tibia												
Yes	259	<1%	19	<1%	5	1%	1	<1%	7	<1%	291	<1%
No	68,153	100%	3,300	99%	390	99%	1,132	100%	6,250	100%	79,225	100%

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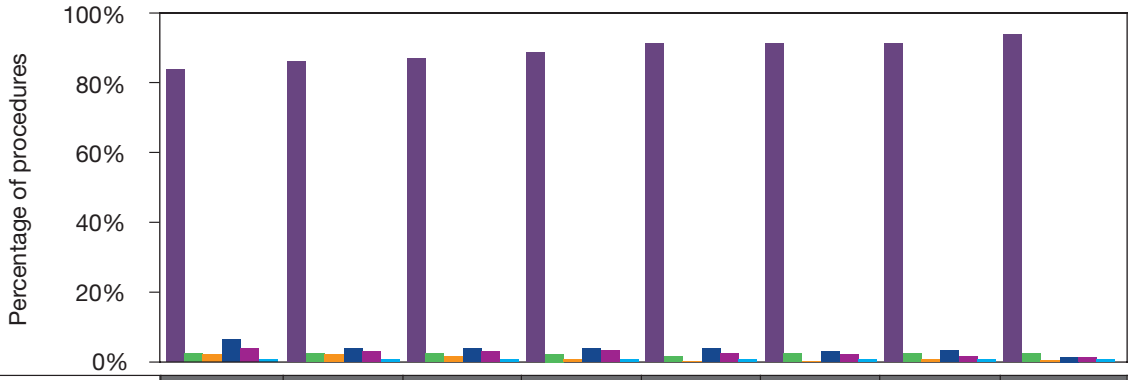
Figure 2.23

Bone cement types for primary knee replacement procedures undertaken between 2004 and 2011.



Year	2004	2005	2006	2007	2008	2009	2010	2011
Antibiotic-loaded high viscosity	84%	86%	87%	89%	91%	91%	91%	93%
Antibiotic-loaded medium viscosity	3%	3%	2%	3%	2%	2%	3%	2%
Antibiotic-loaded low viscosity	3%	3%	2%	1%	<1%	<1%	<1%	<1%
High viscosity	7%	4%	5%	4%	4%	4%	3%	2%
Medium viscosity	4%	3%	4%	3%	2%	3%	2%	2%
Low viscosity	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Number of procedures using cement	36,444	50,000	52,582	64,379	69,589	71,778	75,350	74,626

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2.3.1.3 Thromboprophylaxis

Table 2.18 shows that the most frequently prescribed chemical method of thromboprophylaxis for knee replacement patients was LMWH (70%), while TED stockings were the most used mechanical method (69%). Compared with previous years, there has been an increase in the prescription of a combined chemical and mechanical regime, from 49% in 2004 to 90% in 2011. There has been a marked decrease over the past two years in the use of aspirin (a decrease from 20% in 2009 to 8% in 2011). Direct thrombin inhibitor is now used in 10% of knee primary procedures and the use of 'Other chemical' has gone up from 7% in 2009 to 13% in 2011. This change was also seen in hip primary procedures. Less than 1% of patients had neither mechanical nor chemical prescribed thromboprophylaxis.

Table 2.18 Thromboprophylaxis regime for primary knee replacement patients, prescribed at time of operation.

	Total	
	No.	%
Total knee primaries	**79,516**	
Aspirin	6,364	8%
Low molecular weight heparin (LMWH)	55,853	70%
Pentasaccharide	1,282	2%
Warfarin	499	<1%
Direct thrombin inhibitor	8,000	10%
Other chemical	10,255	13%
No chemical	4,196	5%
Foot pump	21,181	27%
Intermittent calf compression	31,364	39%
TED stockings	55,096	69%
Other mechanical	743	<1%
No mechanical	4,130	5%
Both mechanical and chemical	71,274	90%
Neither mechanical nor chemical	85	<1%

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2.3.1.4 Untoward intra-operative events

Table 2.19 shows that untoward intra-operative events were rare, reported in less than 1% of knee procedures, however there were an additional 106 incidences compared with 2010.

Table 2.19 Reported untoward intra-operative events for primary knee replacement patients in 2011, according to procedure type.

	Primary total prosthetic replacement using cement	Primary total prosthetic replacement not using cement	Primary total prosthetic replacement not classified elsewhere (e.g. hybrid)	Patello-femoral replacement	Unicondylar replacement	Total
	No.	No.	No.	No.	No.	No.
Total knee primaries	**68,412**	**3,319**	**395**	**1,133**	**6,257**	**79,516**
Total events specified	**545**	**31**	**6**	**3**	**24**	**609**
Fracture	104	9	1	0	11	125
Patella tendon avulsion	33	1	0	2	0	36
Ligament injury	47	0	1	0	3	51
Other	361	21	4	1	10	397

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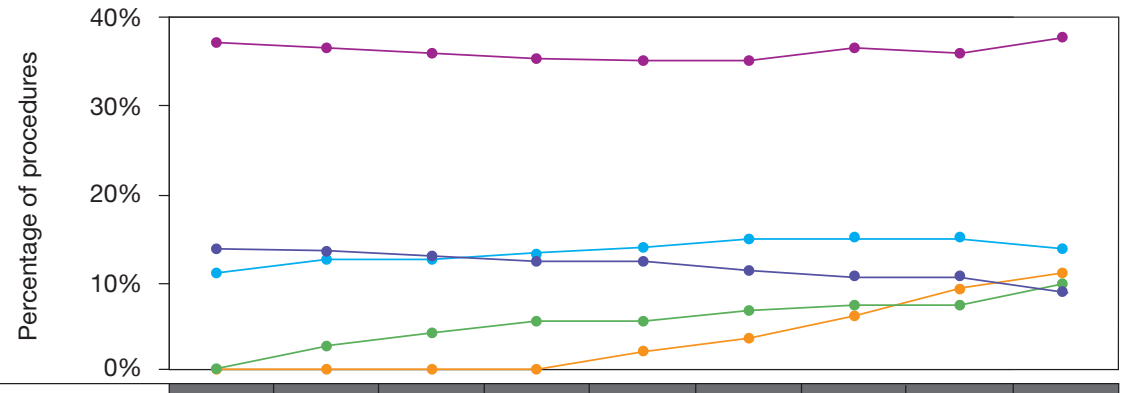
2.3.1.5 Knee primary components

Figure 2.24 shows the leading brands of total condylar knees in England and Wales. The PFC Sigma knee, marketed by DePuy, continues to dominate the market. The Genesis 2 knee, marketed by Smith & Nephew and the AGC, marketed by Biomet, appear to be increasing in popularity.

Figure 2.24

Top five total condylar knee brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	21,624	40,837	53,519	54,755	64,624	68,232	69,255	71,217	70,451

PFC Sigma Nexgen Triathlon Genesis 2 AGC

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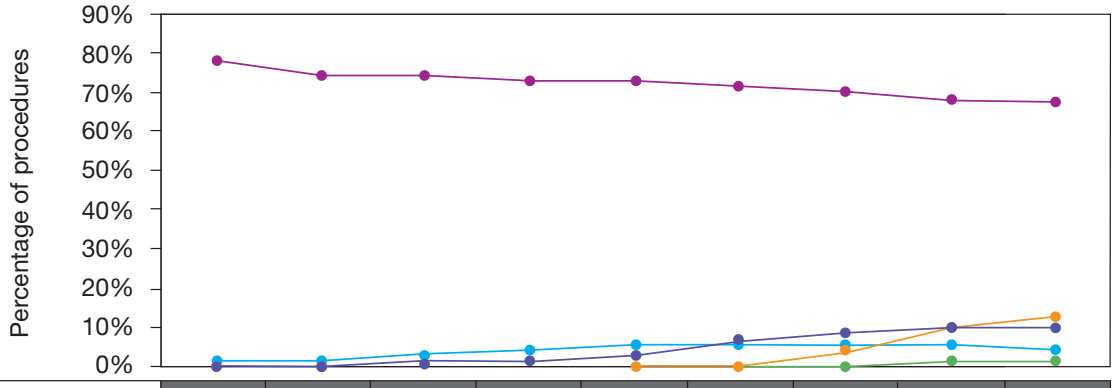
Likewise, the market for unicondylar knees is dominated by one product, the Oxford Partial Knee (Figure 2.25). The market share of the Oxford Partial has decreased gradually since 2003 and the Sigma HP which is relatively new to the market is now the second most used brand of unicondylar knee system.

Figure 2.25

Top five unicondylar knee brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	2,226	4,256	5,428	5,740	6,640	7,069	7,146	7,407	6,811

Oxford Partial Knee — AMC/Uniglide — Sigma HP — Triathlon Uni — Zimmer Uni

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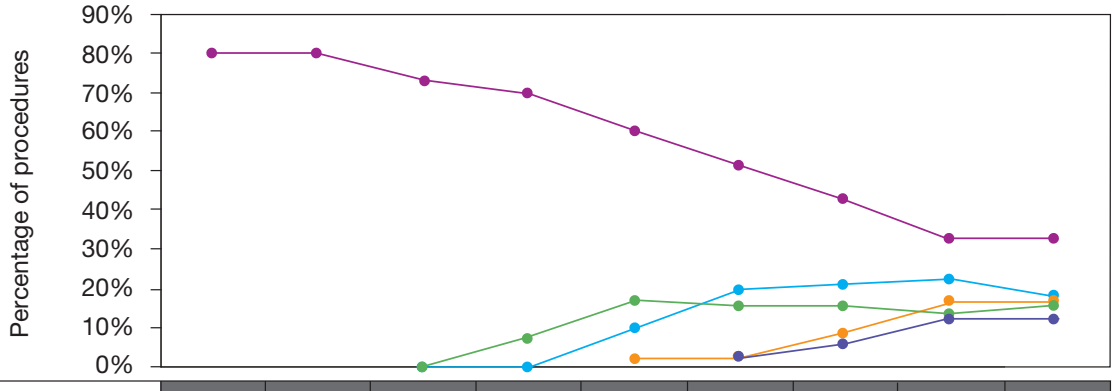
The brand use for patello-femoral prostheses is shown in Figure 2.26 and the equivalent graph for highly constrained and hinged revision knees is shown in Figure 2.27.

Figure 2.26

Top five patello-femoral knee brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	267	503	672	727	1,016	1,152	1,199	1,248	1,212

Avon — FPV — Sigma HP — Journey PFJ — Zimmer PFJ

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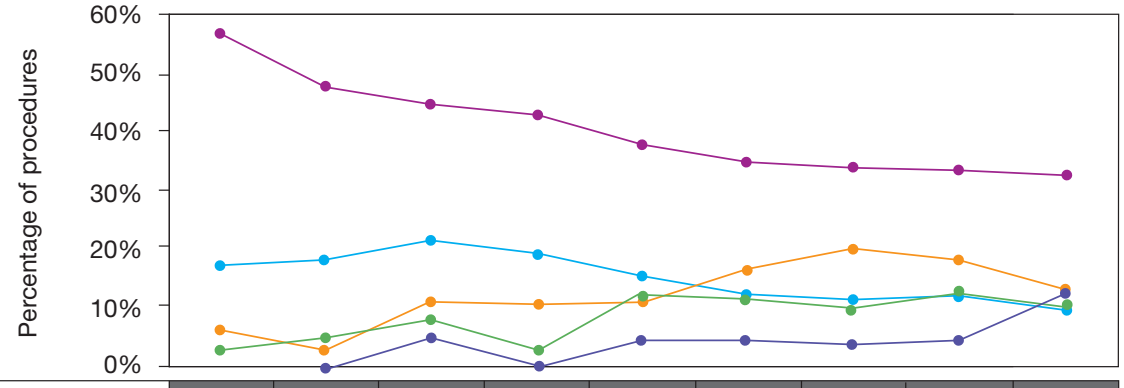
Figure 2.27

Top five fixed hinged knee brands, trends 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of components used	70	129	195	212	259	284	310	304	280

Endo Rotating Hinge — MRH — Nexgen Hinge Type — RT-Plus — Smiles Knee

2.3.2 Knee revision procedures 2011

A total of 5,135 knee revision procedures were reported, an increase of 1% on 2010. Of these, 3,930 (77%) were single-stage revision procedures, 578 (11%) were stage one of a two-stage revision and 603 (12%) were stage two of a two-stage revision (Table 2.20). A further 24 procedures were recorded, comprising 13 conversions of previous knee replacements to arthrodesis and 11 knee amputations. Compared with previous years, there has been no change in the types of revision procedures carried out. MDSv2 re-operations, other than revision, are not included in any of the tables below.

Table 2.20 Patient characteristics for knee revision procedures in 2011, according to procedure type.

	Knee single-stage revision		Knee stage one of two-stage revision		Knee stage two of two-stage revision		Knee conversion to arthrodesis		Knee Amputation		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total knee revisions	**3,930**	**77%**	**578**	**11%**	**603**	**12%**	**13**	**<1%**	**11**	**<1%**	**5,135**	
Total with patient data	**3,767**	**96%**	**546**	**94%**	**565**	**94%**	**13**	**100%**	**9**	**82%**	**4,900**	**95%**
Average age	69.21		71.34		69.96		75.02		78.40		69.45	
SD	10.15		9.35		9.18		9.15		9.54		10.20	
Interquartile range	62.37 - 76.75		65.07 - 78.03		64.01 - 76.85		70.13 - 79.35		77.16 - 82.70		62.90 - 77.08	
Gender												
Female	2,000	53%	236	43%	235	42%	9	69%	5	56%	2,485	51%
Male	1,767	47%	310	57%	330	58%	4	31%	4	44%	2,415	49%
Patient physical status												
P1 - fit and healthy	347	9%	26	4%	29	5%	0	0%	0	0%	402	8%
P2 - mild disease not incapacitating	2,688	68%	342	59%	367	61%	8	62%	4	36%	3,409	66%
P3 - incapacitating systemic disease	866	22%	199	34%	200	33%	5	38%	5	45%	1,275	25%
P4 - life threatening disease	29	<1%	10	2%	7	1%	0	0%	2	18%	48	<1%
P5 - expected to die within 24hrs with or without an operation	0	0%	1	<1%	0	0%	0	0%	0	0%	1	<1%
Indications for surgery												
Aseptic loosening	1,666	42%	78	13%	54	9%	0	0%	0	0%	1,798	35%
Pain	773	20%	29	5%	20	3%	0	0%	1	9%	823	16%
Lysis	413	11%	63	11%	36	6%	0	0%	0	0%	512	10%
Wear of polyethylene component	494	13%	21	4%	9	1%	0	0%	0	0%	524	10%
Instability	665	17%	26	4%	19	3%	0	0%	0	0%	710	14%
Infection	198	5%	483	84%	493	82%	7	54%	10	91%	1,191	23%
Malalignment	335	9%	6	1%	7	1%	0	0%	0	0%	348	7%
Stiffness	227	6%	25	4%	19	3%	0	0%	0	0%	271	5%
Progressive arthritis remaining	386	10%	5	<1%	5	<1%	1	8%	0	0%	397	8%
Dislocation/subluxation	163	4%	7	1%	2	<1%	1	8%	1	9%	174	3%
Periprosthetic fracture	108	3%	8	1%	6	1%	1	8%	0	0%	123	2%
Component dissociation	78	2%	2	<1%	1	<1%	1	8%	0	0%	82	2%
Implant fracture	45	1%	3	<1%	0	0%	0	0%	0	0%	48	<1%
Other	442	11%	21	4%	34	6%	4	31%	3	27%	504	10%
Side												
Bilateral	2	<1%	0	0%	0	0%	0	0%	0	0%	2	<1%
Left, unilateral	1,886	48%	283	49%	291	48%	5	38%	2	18%	2,467	48%
Right, unilateral	2,042	52%	295	51%	312	52%	8	62%	9	82%	2,666	52%

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2.3.2.1 Patient characteristics

The mean age of knee revision patients was 69.5 years (Table 2.20). The average has increased by 0.5 years compared with 2010. There were more female (51%) than male patients (49%), although the gap is closing compared with 2004 when 56% of patients were female and 44% male. Aseptic loosening was the most common indication for single stage revision (42%) and infection was the most common indication for two stage revision, conversion to arthrodesis and amputation.

Compared with previous years, the patient characteristics described above have largely remained the same.

Part 2

2.4 Ankle replacement procedures 2011

The NJR started recording primary and revision total ankle replacements on 1 April 2010. This report is therefore the first Annual Report with a complete year of ankle data. By reviewing submitted procedures against ankle levy submissions, we have calculated compliance of ankle joint NJR submissions to be only 64%.

492 ankle replacements, comprising 471 primary and 21 revision procedures carried out between 1 January 2011 and 31 December 2011, were submitted to the NJR by 28 February 2012. Due to the small number collected so far the procedures tables in this section are displayed at a summary level only. Of all the ankle procedures carried out 83% were funded by the NHS. 86% of patients were classified as P1 – fit and healthy (17%) or P2 – had mild disease not incapacitating (69%).

2.4.1 Primary ankle replacement procedures 2011

Of the 471 primary procedures, 354 (75%) were performed in the NHS sector, 94 (20%) by independent hospitals and 23 (5%) in ISTCs. Almost all of the primary procedures performed were reported as being uncemented but the use of cement was reported in eight cases, one of which pertained to a hybrid procedure.

2.4.1.1 Patient characteristics

The average age of female patients is 67.2 years whereas the average age for a male patient is slightly higher at 68.6 years. 56% of patients were male (Table 2.22). The BMI average was 29.6, which is higher than for hip primary procedures but lower than knee primary procedures. No bilateral procedures were submitted to the NJR and 53% of procedures were performed on the right ankle. 88% of patients had their procedure performed due to osteoarthritis (Table 2.21). Of the patients where osteoarthritis was selected, 78 (19%) of these had a history of a previous fracture and hence had post-traumatic osteoarthritis.

Table 2.21 Patient characteristics for primary ankle procedures in 2011.

	Primary procedures	
	No.	%
Total ankle primaries	**471**	
Patient physical status		
P1 - fit and healthy	78	17%
P2 - mild disease not incapacitating	325	69%
P3 - incapacitating systemic disease	66	14%
P4 - life threatening disease	2	<1%
P5 - expected to die within 24hrs with or without an operation	0	0%
Indications for surgery		
Osteoarthritis	413	88%
Rheumatoid arthritis	42	9%
Other inflammatory arthropathy	10	2%
Other	12	3%
Tibia-hindfoot alignment		
Physiological neutral	178	38%
5-15° Varus	103	22%
16-30° Varus	19	4%
>30° Varus	4	<1%
5-15° Valgus	84	18%
16-30° Valgus	18	4%
>30° Valgus	4	<1%
Not available	61	13%
Pre-operative range of movement ankle dorsiflexion		
5-20°	213	45%
Neutral	172	37%
Fixed equinus	34	7%
Not available	52	11%
Pre-operative range of movement ankle plantarflexion		
5-15°	238	51%
16-45°	173	37%
Not available	60	13%

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Table 2.22 Age and gender for primary ankle replacement patients in 2011.

	Primary procedures	
	No.	%
Total ankle primaries	**471**	
Total ankle primaries with patient data	**444**	**94%**
Female age	**194**	**44%**
Average	67.2	
SD	10.1	
Interquartile range	61.8 - 75.1	
Male age	**250**	**56%**
Average	68.6	
SD	9.3	
Interquartile range	63.4 - 74.8	
Female age groups		
<45 years	6	3%
45 - 54 years	17	9%
55 - 64 years	49	25%
65 - 74 years	72	37%
75 - 84 years	48	25%
>85 years	2	1%
Male age groups		
<45 years	4	2%
45 - 54 years	15	6%
55 - 64 years	63	25%
65 - 74 years	105	42%
75 - 84 years	57	23%
>85 years	6	2%

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2.4.1.2 Surgical techniques

Table 2.23 details the surgical technique used during ankle primary procedures. During a primary ankle replacement other ankle related procedures may be performed and this occurred in 28% of procedures. Achilles tendon lengthening was performed in 9% of procedures. 72% of primary procedures had no associated procedures performed. Bone graft was used in 8% of procedures.

Table 2.23 Surgical technique for primary ankle replacement procedures in 2011.

	Primary procedures	
	No.	%
Total ankle primaries	**471**	
Incision		
Anterior	455	97%
Anterolateral	5	1%
Lateral (transfibular)	0	0%
Other	11	2%
Associated procedures at time of surgery		
Subtalar joint fusion	22	5%
Talonavicular fusion	8	2%
Calcaneal displacement osteotomy	10	2%
Achilles tendon lengthening	43	9%
Fusion distal tibiofibular joint	1	<1%
Fibula osteotomy	1	<1%
Medial malleolar osteotomy	1	<1%
Lateral ligament reconstruction	4	<1%
Medial ligament reconstruction	1	<1%
Other	51	11%
None	340	72%
Image-guided surgery		
Yes	1	<1%
No	470	100%
Bone graft used		
Yes	39	8%
No	432	92%

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2.4.1.3 Thromboprophylaxis

Table 2.24 shows that 76% of primary ankle replacement procedures used both chemical and mechanical thromboprophylaxis regimes and 4% used no regime. LMWH was the most popular chemical thromboprophylaxis regime used in 74% of TAR procedures.

Table 2.24 Thromboprophylaxis regime for primary ankle replacement patients, prescribed at time of operation.

	Total	
	No.	%
Total ankle primaries	**471**	
Aspirin	33	7%
Low molecular weight heparin (LMWH)	350	74%
Pentasaccharide	1	<1%
Warfarin	12	3%
Direct thrombin inhibitor	12	3%
Other chemical	42	9%
No chemical	43	9%
Foot pump	56	12%
Intermittent calf compression	131	28%
TED stockings	276	59%
Other mechanical	7	1%
No mechanical	88	19%
Both mechanical and chemical	357	76%
Neither mechanical nor chemical	17	4%

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2.4.1.4 Untoward intra-operative events

In 5% of procedures an untoward intra-operative event was reported. Of those reported the most common was 'Fracture of the medial malleolus' which occurred in 11 primary procedures (2%).

2.4.1.5 Ankle primary components

The DePuy Mobility ankle prosthesis was used in 57% of all primary procedures recorded in 2011. The next most commonly used is Corin's Zenith ankle at 22%. More information on the other brands used can be found in the document "Prostheses used in hip, knee and ankle replacement procedures 2011" which can be downloaded from the NJR website.

2.4.2 Ankle revision procedures 2011

Of the 21 revision procedures, 14 were performed in the NHS Sector (66%). 66% were single-stage revisions and 25% were Conversion to Arthrodesis.

2.4.2.1 Patient Characteristics

The average age for a patient having a revision procedure was 66.7 years. Only 10% were P1 fit and healthy and 33% had P3 incapacitating systemic disease. 33% of revisions were for aseptic loosening and 24% due to malalignment.

Table 2.25 Patient characteristics for ankle revision procedures in 2011.

	Revision procedures	
	No.	%
Total ankle revisions	**21**	
Patient physical status		
P1 - fit and healthy	2	10%
P2 - mild disease not incapacitating	11	52%
P3 - incapacitating systemic disease	7	33%
P4 - life threatening disease	1	5%
P5 - expected to die within 24hrs with or without an operation	0	0%
Indications for surgery		
Infection high suspicion	2	10%
Infection low suspicion	4	19%
Aseptic loosening - tibial	4	19%
Aseptic loosening - talar	3	14%
Lysis - tibia	4	19%
Lysis - talus	3	14%
Malalignment	5	24%
Implant fracture - tibia	0	0%
Implant fracture - talar	0	0%
Implant fracture - meniscal	3	14%
Wear of polyethylene component	6	29%
Meniscal insert dislocation	2	10%
Component migration/dissociation	1	5%
Pain (undiagnosed)	6	29%
Stiffness	2	10%
Soft tissue impingement	1	5%
Other	4	19%
Side		
Bilateral	0	0%
Left, unilateral	9	43%
Right, unilateral	12	57%

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Part 3: Outcomes after joint replacement 2003 to 2011

3.1 Introduction

Part Three of the 9th Annual Report considers the survivorship of hip and knee replacements in England and Wales in the period of almost nine years after primary surgery (1 April 2003 to 31 December 2011). This includes an analysis of revision rates and mortality after primary joint replacement. The structure of Part Three is:

- Section 3.1 contains an introduction and overall summary of key findings
- Section 3.2 details the data sources used for this analysis
- Section 3.3 describes the outcomes after primary hip replacement
- Section 3.4 explores outcomes after primary knee replacement

3.1.1 Summary of key findings

Hip replacement:

1. The practice of hip arthroplasty has changed significantly since 2003. Despite excellent survivorship, there has been a progressive shift away from cemented total hip replacement. Metal-on-metal stemmed hip replacements were quickly and widely adopted and have been abandoned as quickly. Ceramic-on-ceramic bearing surfaces are increasingly being used.
2. Both cemented and hybrid fixation give very good survivorship up to eight years after implantation. Results for uncemented fixation are only slightly worse in comparison.
3. Metal-on-metal stemmed total hip replacements have very poor implant survivorship in all groups of patients. Survivorship is worse with large diameter articulations and failure is highest in women.
4. Resurfacing arthroplasty has a significantly higher failure rate than stemmed total hip replacement except when compared with large head metal-on-metal total hip replacement.
5. In contrast to metal-on-metal stemmed total hip replacement, ceramic-on-ceramic bearing surfaces have progressively better survivorship as the size of the articulation increases.
6. Metal-on-metal hip replacements are not associated with an increased risk of diagnosis of cancer in the first seven years after hip replacement.

Knee replacement:

1. The practice of knee arthroplasty has changed little since 2003 with the vast majority of procedures being cemented, fixed bearing total knee replacements.
2. Total knee arthroplasty gives good implant survivorship regardless of fixation, constraint or bearing (fixed or mobile).
3. Unicondylar and patello-femoral joint replacement have much worse implant survivorship than total knee replacement and both were typically revised for pain.
4. Mortality after knee replacement is slightly lower than after hip replacement.

Part 3

3.2 Data sources

This section describes the data sources used for the outcome analysis presented in Sections 3.3 and 3.4. The key details are briefly summarised in Table 3.1.

Table 3.1 Summary description of datasets used for survivorship analysis.

	NJR data
Summary of data	All NJR procedure-level data restructured to person-level
Time period	1 April 2003 to 31 December 2011
Data exclusions	- Excludes data where person-level identifier is not present - Excludes patients where no primary operation is recorded in NJR - Excludes any revisions after the first revision
Number of primary operations	458,568 hips 499,695 knees
Number of revisions linked to a primary operation	NJR identified primary-linked first revisions: 8,429 hips 8,765 knees

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3.2.1 Restructuring the data for survivorship analysis

The survivorship analysis requires that a patient is observed from the time of their primary joint replacement until the time of first revision, time of death, or 31 December 2011 (depending on which comes first). Therefore, this analysis is based on those people with at least one primary joint replacement between April 2003 and December 2011 recorded in the NJR. This analysis is conducted for hip and knee replacements. It is not yet possible to look at the survivorship of ankle replacements as only 30 revisions had been recorded in the NJR by 31 December 2011.

For the survivorship analysis, revisions must be matched to primary operations and so the data have to be restructured from operation-level to person-level. This requires a person-level identifier to indicate how different operations are related to an individual person. Overall, 14.8% of NJR data is lost from the analysis because a suitable person-level identifier is not available. Around half of this (47.7%) is due to the patient declining to give consent for personal details to be held and the rest is attributable to tracing and linkage difficulties. A person-level identifier was available for 95.3% of operations from 2008 to 2011. However, for the early years of registry, the ability to link operations for individuals is much lower: for example, only 58.5% of operations in 2004 have a person-level identifier. When interpreting the survivorship analysis in later sections, it is important to remember that the patients on which revision rates at five years or more are based may be less representative than the sample of patients that form the basis of the earlier revision rates.

Some patients will have had primary joint replacements before the NJR started recording data. For example, some individuals (4.9% of patients in the NJR person-level data) only had one or more revision operations observed between April 2003 and December 2011 and so are excluded from the analysis. In addition, some patients (0.7%) had a revision observed but not for the primary operation recorded in the NJR (so a revision of the other side). Overall, just 22.0% of revisions recorded in the NJR with a person-level identifier were a first revision of a primary operation also recorded in the NJR.

Of those with a primary operation linked to a revision in this analysis, 12.6% of hip replacement patients and 15.1% of knee replacement patients had more than one revision of that primary operation recorded in the NJR (Table 3.2). The analysis in this section only considers the time to first revision because of the small numbers involved.

Some patients had at least one primary hip replacement and at least one primary knee replacement during the observation period and so will appear in both the hip and knee analysis datasets (3.4% of patients). In addition, many patients will have

both hips or both knees replaced over their lifetime. In the observation period April 2003 to December 2011, 11.8% of hip replacement patients and 16.8% of knee replacement patients had both sides replaced (Table 3.2). These people appear in the analysis dataset twice so the survivorship of each primary operation can be analysed. There are sometimes statistical concerns about including the same person in any analysis twice, particularly if there is likely to be a correlation between the records in terms of the outcome or explanatory variables. This is unlikely to be a problem here as the survivorship of one joint is largely independent of the other one and patient characteristics like age are recorded at the time of primary surgery on each occasion and so will differ over time (except for the very small number of patients who had bilateral operations on the same day: 0.7% of hip patients and 1.6% of knee patients). In addition, it is not possible to apply a condition of only considering the first primary joint replacement to everyone as many of the patients with only one primary joint replacement observed in this time period will also have had the other side replaced but before we started observing them. To check that the inclusion of these patients was not distorting the analysis, a multivariable statistical model confirmed that patients who were recorded as having both sides replaced in the observation period were no more or less likely to experience revision than were other patients.

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

	Hips	Knees
Number of people with one joint replacement	362,110	355,815
Number with two primary joint replacements (both sides)	48,229	71,940
Number with bilateral joint replacement (same operation date for both)	2,765	6,727
Total number of people	410,339	427,755
Total number of person-level records for analysis	458,568	499,695
Percentage of people with both sides replaced	11.8%	16.8%
Percentage of people with a bilateral operation	0.7%	1.6%
Number with at least one revision for a linked primary	8,429	8,765
Number with more than one revision for a linked primary	1,063	1,326

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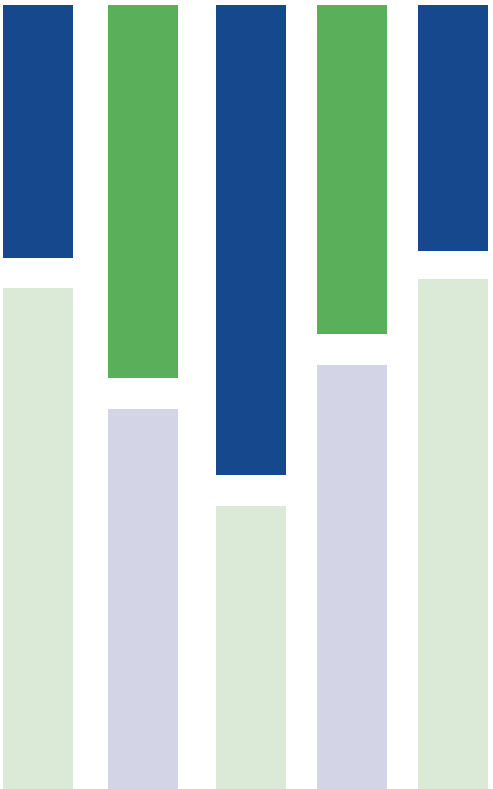
3.2.2 Changes to the component information

Since the 8th Annual Report, the registry has changed the way it records and stores component information for joint replacements. The benefit of this re-classification is that it has allowed a much more detailed analysis to be performed. However, some of the historical component data stored on the NJR has been re-classified as a result of these changes which has led to some relatively minor differences in the results presented in Part Three this year when directly compared with the 8th Annual Report. This has affected the classification of procedures into types based on fixation, bearings, and constraint and may also affect the brand analysis to some degree.

Part 3

3.3 Outcomes after primary hip replacement 2003 to 2011



This section contains statistical analysis of the survivorship of hip replacements in the period up to almost nine years after primary surgery (1 April 2003 to 31 December 2011). This analysis examines the length of time between the primary hip replacement and the first revision of that hip replacement or the patient's death.

Details relating to statistical issues have been summarised separately as methodological notes for readers who require more information.

Methodological note

Throughout this section, survival analysis is used to examine the length of time between a primary joint replacement and the first revision or the time between surgery and the patient's death. Survival analysis involves a shift from analysing people or operations to analysing time. It has the advantage of being able to handle the unequal lengths of time that people have been observed and so does not require those who have not been observed for a certain time period to be dropped from the analysis (as this can introduce bias). Aspects of this analysis (for example, the cumulative hazard) indicate the risk of an event happening over continuous time and so can be used to approximate incidence rates at certain time points.

Terminology note

Bearing surfaces for hip replacements are grouped into six main categories: 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 discussed 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 also have a metal-on-metal bearing surface, resurfacing procedures (where a surface replacement femoral prosthesis is combined with a metal acetabular cup) are treated as a separate category.

3.3.1 Types of hip replacement in England and Wales

A variety of different types of hip replacement have been used in England and Wales because of the various types of bearing surface and methods of fixation available (Table 3.3). The most commonly used type is a cemented metal-on-polyethylene hip replacement (34%) although Table 3.4 indicates that the proportion of cemented metal-on-polyethylene hip replacements has almost halved from 55% in 2003 to 28% in 2011 while the use of newer bearing surfaces like uncemented ceramic-on-ceramic have increased five-fold (from 4% in 2003 to 20% in 2011).

Many surgeons use a mix of different types of hip replacement but some types were used by only a minority of surgeons (Table 3.3). For example, more than half of surgeons had never used resurfacing (61%), cemented ceramic-on-polyethylene (57%), uncemented ceramic-on-metal (93%), uncemented metal-on-metal (57%), hybrid metal-on-metal (85%), hybrid ceramic-on-ceramic (70%), hybrid ceramic-on-polyethylene (68%), or any type of reverse hybrid procedure (66%).

Table 3.3 Types of primary hip replacement by fixation and bearing surface.

Fixation/bearing surface	Number	Percentage of total	Number of primary operations 2003 to 2011					
			Surgeons (n=1,983)			Units (n=438)		
			0	1-9	10+	0	1-9	10+
All cemented	**175,008**	**38.2%**	**4.9%**	**17.4%**	**77.7%**	**0.7%**	**6.6%**	**92.7%**
Cemented CoP	13,871	3.0%	57.3%	30.8%	11.9%	25.6%	32.6%	41.8%
Cemented MoP	155,259	33.9%	5.9%	19.0%	75.1%	1.1%	7.3%	91.6%
All uncemented	**169,177**	**36.9%**	**15.9%**	**23.3%**	**60.8%**	**1.4%**	**4.8%**	**93.8%**
Uncemented CoC	52,514	11.5%	36.8%	27.7%	35.5%	6.4%	13.2%	80.4%
Uncemented CoM	1,935	0.4%	93.4%	4.8%	1.8%	79.0%	13.7%	7.3%
Uncemented CoP	22,246	4.9%	47.9%	34.5%	17.6%	13.0%	31.5%	55.5%
Uncemented MoM	28,410	6.2%	57.3%	22.6%	20.1%	16.2%	26.3%	57.5%
Uncemented MoP	59,983	13.1%	28.3%	32.7%	38.9%	5.5%	15.1%	79.4%
All hybrid	**70,800**	**15.4%**	**29.8%**	**34.0%**	**36.2%**	**5.5%**	**18.2%**	**76.3%**
Hybrid CoC	13,016	2.8%	70.4%	19.6%	10.0%	36.3%	30.1%	33.6%
Hybrid CoP	7,348	1.6%	68.1%	24.4%	7.5%	29.0%	41.8%	29.2%
Hybrid MoM	2,561	0.6%	85.1%	12.1%	2.8%	53.9%	33.3%	12.8%
Hybrid MoP	46,157	10.1%	38.7%	31.4%	29.9%	12.1%	22.4%	65.5%
All reverse hybrid	**9,506**	**2.1%**	**65.9%**	**27.1%**	**7.0%**	**29.2%**	**43.6%**	**27.2%**
Reverse hybrid CoP	2,919	0.6%	83.0%	14.3%	2.7%	53.2%	33.8%	13.0%
Reverse hybrid MoP	6,511	1.4%	71.3%	23.6%	5.1%	36.3%	41.6%	22.1%
Resurfacing	**34,039**	**7.4%**	**61.0%**	**18.8%**	**20.2%**	**11.6%**	**15.5%**	**72.8%**
Other combination	11,761	2.6%	26.5%	57.3%	16.2%	5.7%	32.9%	61.4%
All types	**458,530**	**100.0%**						

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene. Base for surgeon/unit analysis is surgeons or units with at least 10 primary operations recorded in the NJR.

Note: There are a small number of unclassified prosthesis that are not included in the sub-divisions of this table.

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Table 3.4 Trends in use of fixation and bearing surface 2003 to 2011.

Fixation/bearings	2003	2004	2005	2006	2007	2008	2009	2010	2011
All cemented	**60.5%**	**54.2%**	**48.6%**	**42.9%**	**39.9%**	**34.5%**	**32.0%**	**31.4%**	**32.6%**
Cemented CoP	3.0%	3.5%	3.1%	3.0%	2.6%	2.7%	2.9%	3.2%	3.4%
Cemented MoP	55.4%	49.0%	44.0%	38.5%	35.8%	30.5%	28.3%	27.3%	27.9%
All uncemented	**16.8%**	**21.4%**	**25.6%**	**30.0%**	**33.2%**	**39.2%**	**43.1%**	**45.8%**	**44.7%**
Uncemented CoC	3.5%	4.2%	4.4%	6.1%	7.2%	10.1%	13.6%	18.1%	20.0%
Uncemented CoM	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	0.9%	1.0%	0.4%
Uncemented CoP	5.0%	5.1%	5.1%	4.4%	4.0%	3.9%	4.7%	5.6%	6.0%
Uncemented MoM	1.3%	2.2%	5.4%	8.2%	10.2%	10.9%	8.2%	3.5%	0.7%
Uncemented MoP	6.2%	9.0%	9.8%	10.3%	10.8%	13.0%	14.8%	16.6%	16.8%
All hybrid	**12.3%**	**13.3%**	**14.1%**	**15.2%**	**15.0%**	**15.1%**	**15.8%**	**16.3%**	**17.4%**
Hybrid CoC	1.2%	1.9%	2.7%	3.2%	3.0%	2.7%	2.9%	3.0%	3.2%
Hybrid CoP	1.6%	1.5%	1.2%	1.3%	1.1%	1.4%	1.8%	2.0%	2.3%
Hybrid MoM	0.7%	0.5%	0.5%	0.7%	0.8%	1.0%	0.5%	0.3%	0.2%
Hybrid MoP	8.2%	9.1%	9.2%	9.7%	9.7%	9.6%	10.3%	10.8%	11.5%
All reverse hybrid	**0.6%**	**0.9%**	**1.1%**	**1.1%**	**1.8%**	**2.5%**	**2.6%**	**2.7%**	**2.9%**
Reverse hybrid CoP	0.3%	0.2%	0.3%	0.3%	0.6%	0.7%	0.8%	0.8%	0.9%
Reverse hybrid MoP	0.3%	0.6%	0.7%	0.8%	1.1%	1.7%	1.8%	1.8%	2.0%
Resurfacing	**9.7%**	**10.2%**	**10.6%**	**10.8%**	**10.2%**	**8.8%**	**6.5%**	**3.8%**	**2.5%**
Other combination	**3.7%**	**3.0%**	**3.0%**	**2.9%**	**2.8%**	**2.7%**	**2.0%**	**2.2%**	**2.3%**
Base	**14,307**	**27,694**	**39,794**	**47,076**	**59,718**	**66,068**	**66,933**	**68,818**	**68,122**

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.

Note: There are a small number of unclassified prosthesis that are not included in the sub-divisions of this table.

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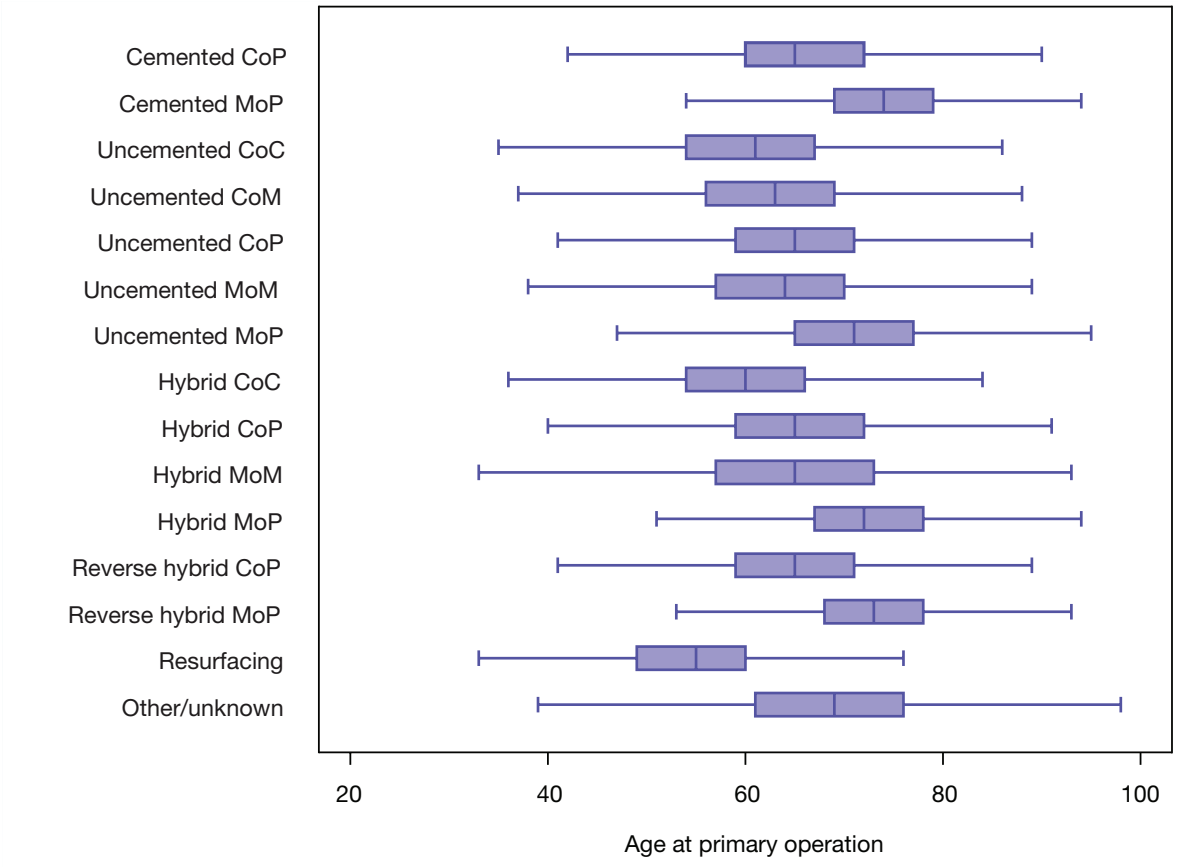
The types of hip replacement used seemed to be related to the age of the patient, at least to some extent (Figure 3.1). Resurfacing patients and those with ceramic-on-ceramic bearings tended to be younger although even these types were used across a variety of age ranges.

Figure 3.1

Age profile of hip replacement patients by fixation and bearing surface.



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Note: On the plot, the box indicates the interquartile range (the 25th-75th percentile) so half of all patients have an age in the box. The line across the box is the median age. The whiskers show the upper and lower adjacent values (these are set at the highest or lowest value in the data within a maximum of 1.5 times the interquartile range). Outliers (unusual values outside these whiskers) are not shown on the plot. The box illustrates the likely ages of patients in each group whereas the lengths of the whiskers relative to the length of the box give an idea of how stretched out the rest of the values are. Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.

3.3.2 Risk of revision

This section considers the first revision after primary hip replacement (due to any cause). Tables 3.5 and 3.6 show the short- and medium-term revision rates for the types of hip replacement discussed so far. The lowest rates were associated with cemented fixation of metal- or ceramic-on-polyethylene. Rates for hybrid metal- or ceramic-on-polyethylene were similar though and by eight years, the difference between hybrid and cemented metal-on-polyethylene was not statistically significant (Figure 3.2). There were no statistically significant differences between the fixation methods for ceramic-on-polyethylene (Figure 3.3). Rates for uncemented fixation were slightly higher but not dramatically so (Figure 3.2). Ceramic-on-ceramic revision rates were comparable to ceramic- or metal-on-polyethylene in many cases, for example, hybrid ceramic-on-ceramic has an eight-year revision rate of 2%.

Revision rates were considerably higher for metal-on-metal bearings whether stemmed prostheses or resurfacings (Figure 3.4). In recent years, attention has particularly focused on the ASR implants (the ASR XL Acetabular Hip System and ASR Hip Resurfacing System) which were voluntarily recalled by the manufacturer, DePuy, in August 2010. ASR implants do have significantly higher revision rates than other resurfacing and metal-on-metal brands (see Section

3.3.4) but they form a relatively small proportion of the total in these groups (8.9% of resurfacing, 10.0% of uncemented metal-on-metal and 4.6% of hybrid metal-on-metal). For completeness, Tables 3.5 and 3.6 show revision rates for these groups with and without the ASR brand included. Although ceramic-on-metal has not been widely used, early results are not favourable with a three-year revision rate of 3%, significantly higher than ceramic-on-ceramic or ceramic-on-polyethylene.

Table 3.5 Estimated short-term revision rates after primary hip replacement by fixation and bearing surface (95% confidence intervals).

Fixation/bearings	30 days	90 days	Year 1	Year 2	Year 3
All cemented	**0.12% (0.10-0.13)**	**0.21% (0.19-0.23)**	**0.42% (0.39-0.46)**	**0.71% (0.67-0.75)**	**0.98% (0.93-1.03)**
Cemented CoP	0.07% (0.04-0.13)	0.13% (0.08-0.21)	0.33% (0.25-0.45)	0.61% (0.48-0.77)	0.85% (0.68-1.04)
Cemented MoP	0.12% (0.10-0.14)	0.21% (0.19-0.24)	0.43% (0.39-0.46)	0.71% (0.67-0.76)	0.97% (0.92-1.03)
All uncemented	**0.36% (0.33-0.39)**	**0.53% (0.50-0.57)**	**0.98% (0.93-1.03)**	**1.56% (1.50-1.63)**	**2.20% (2.12-2.29)**
Uncemented CoC	0.33% (0.29-0.39)	0.53% (0.47-0.59)	0.96% (0.88-1.06)	1.50% (1.39-1.63)	1.90% (1.76-2.05)
Uncemented CoM	0.16% (0.05-0.48)	0.21% (0.08-0.55)	0.60% (0.33-1.09)	1.14% (0.71-1.83)	2.95% (1.87-4.65)
Uncemented CoP	0.31% (0.24-0.39)	0.46% (0.37-0.55)	0.83% (0.71-0.96)	1.16% (1.02-1.33)	1.52% (1.34-1.72)
Uncemented MoM	0.31% (0.25-0.38)	0.47% (0.40-0.56)	1.02% (0.91-1.14)	1.98% (1.82-2.15)	3.29% (3.07-3.53)
Uncemented MoM (excl ASR brand)	0.31% (0.25-0.39)	0.48% (0.40-0.58)	1.00% (0.88-1.13)	1.82% (1.66-2.00)	2.83% (2.62-3.06)
Uncemented MoP	0.40% (0.35-0.45)	0.59% (0.53-0.65)	1.01% (0.93-1.10)	1.48% (1.37-1.59)	1.91% (1.79-2.05)
All hybrid	**0.24% (0.21-0.28)**	**0.37% (0.33-0.42)**	**0.65% (0.59-0.72)**	**0.98% (0.90-1.06)**	**1.24% (1.15-1.34)**
Hybrid CoC	0.23% (0.16-0.33)	0.34% (0.25-0.46)	0.57% (0.46-0.73)	0.88% (0.72-1.07)	1.02% (0.85-1.23)
Hybrid CoP	0.11% (0.05-0.22)	0.17% (0.09-0.29)	0.43% (0.30-0.61)	0.65% (0.48-0.89)	0.92% (0.69-1.22)
Hybrid MoM	0.31% (0.16-0.63)	0.39% (0.21-0.73)	0.59% (0.36-0.99)	1.47% (1.06-2.05)	2.85% (2.22-3.66)
Hybrid MoM (excl ASR brand)	0.33% (0.16-0.66)	0.41% (0.22-0.76)	0.62% (0.38-1.03)	1.50% (1.07-2.10)	2.74% (2.11-3.56)
Hybrid MoP	0.26% (0.22-0.31)	0.40% (0.34-0.46)	0.69% (0.62-0.78)	1.01% (0.91-1.11)	1.23% (1.12-1.35)
All reverse hybrid	**0.15% (0.09-0.25)**	**0.32% (0.23-0.46)**	**0.77% (0.61-0.98)**	**1.17% (0.95-1.43)**	**1.52% (1.25-1.85)**
Reverse hybrid CoP	0.10% (0.03-0.32)	0.24% (0.12-0.51)	0.56% (0.34-0.92)	1.01% (0.67-1.52)	1.40% (0.96-2.05)
Reverse hybrid MoP	0.17% (0.09-0.31)	0.34% (0.23-0.52)	0.86% (0.65-1.13)	1.21% (0.95-1.54)	1.53% (1.21-1.92)
Resurfacing	**0.25% (0.20-0.31)**	**0.66% (0.58-0.75)**	**1.26% (1.15-1.39)**	**2.20% (2.04-2.36)**	**3.16% (2.97-3.37)**
Resurfacing (excl ASR brand)	0.24% (0.19-0.30)	0.65% (0.56-0.74)	1.23% (1.11-1.37)	2.07% (1.91-2.25)	2.85% (2.65-3.05)
Other combination	**0.34% (0.25-0.46)**	**0.47% (0.36-0.61)**	**0.90% (0.74-1.09)**	**1.30% (1.10-1.54)**	**1.79% (1.54-2.08)**
All types	**0.23% (0.22-0.25)**	**0.39% (0.37-0.47)**	**0.73% (0.71-0.76)**	**1.19% (1.15-1.22)**	**1.65% (1.60-1.69)**

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.
Note: Bases are shown in Table 3.3.

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Table 3.6 Estimated medium-term revision rates after primary hip replacement by fixation and bearing surface (95% confidence intervals).

Fixation/bearings	Year 4	Year 5	Year 6	Year 7	Year 8
All cemented	**1.20% (1.14-1.26)**	**1.46% (1.39-1.54)**	**1.73% (1.64-1.81)**	**2.00% (1.89-2.10)**	**2.29% (2.14-2.44)**
Cemented CoP	0.99% (0.81-1.22)	1.27% (1.04-1.55)	1.42% (1.16-1.74)	1.70% (1.36-2.13)	2.00% (1.50-2.68)
Cemented MoP	1.19% (1.13-1.26)	1.44% (1.37-1.52)	1.67% (1.58-1.76)	1.91% (1.81-2.03)	2.21% (2.06-2.37)
All uncemented	**2.83% (2.72-2.93)**	**3.56% (3.42-3.69)**	**4.24% (4.07-4.42)**	**4.76% (4.55-4.99)**	**5.10% (4.82-5.39)**
Uncemented CoC	2.25% (2.08-2.44)	2.65% (2.44-2.89)	3.00% (2.73-3.30)	3.56% (3.15-4.01)	3.89% (3.35-4.52)
Uncemented CoM	-	-	-	-	-
Uncemented CoP	1.80% (1.60-2.03)	2.08% (1.85-2.35)	2.30% (2.03-2.60)	2.46% (2.15-2.80)	2.46% (2.15-2.80)
Uncemented MoM	4.89% (4.60-5.20)	6.96% (6.55-7.41)	9.16% (8.55-9.82)	11.15% (10.17-12.23)	12.48% (11.04-14.10)
Uncemented MoM (excl ASR brand)	3.86% (3.59-4.15)	5.08% (4.72-5.47)	6.46% (5.94-7.03)	8.05% (7.16-9.04)	9.39% (8.03-10.98)
Uncemented MoP	2.17% (2.03-2.32)	2.47% (2.30-2.65)	2.89% (2.67-3.12)	3.18% (2.91-3.48)	3.60% (3.17-4.08)
All hybrid	**1.56% (1.45-1.68)**	**1.92% (1.79-2.07)**	**2.31% (2.13-2.49)**	**2.65% (2.43-2.88)**	**2.95% (2.65-3.28)**
Hybrid CoC	1.30% (1.09-1.57)	1.55% (1.29-1.87)	1.86% (1.53-2.26)	1.95% (1.58-2.41)	1.95% (1.58-2.41)
Hybrid CoP	1.13% (0.86-1.49)	1.45% (1.10-1.92)	1.62% (1.21-2.15)	1.85% (1.36-2.51)	2.26% (1.58-3.22)
Hybrid MoM	4.31% (3.45-5.37)	5.96% (4.80-7.41)	9.08% (7.20-11.43)	12.65% (9.85-16.24)	-
Hybrid MoM (excl ASR brand)	4.02% (3.18-5.08)	5.81% (4.61-7.32)	8.25% (6.45-10.55)	11.61% (8.88-15.18)	-
Hybrid MoP	1.48% (1.35-1.62)	1.81% (1.65-1.98)	2.09% (1.90-2.30)	2.30% (2.08-2.55)	2.52% (2.22-2.87)
All reverse hybrid	**1.78% (1.46-2.16)**	**2.19% (1.76-2.73)**	**2.73% (2.13-3.50)**	**3.30% (2.48-4.40)**	**3.30% (2.48-4.40)**
Reverse hybrid CoP	1.68% (1.16-2.44)	1.68% (1.16-2.44)	1.68% (1.16-2.44)	-	-
Reverse hybrid MoP	1.78% (1.41-2.25)	2.39% (1.82-3.14)	3.04% (2.25-4.11)	3.33% (2.41-4.61)	-
Resurfacing	**4.29% (4.05-4.54)**	**5.52% (5.22-5.83)**	**6.70% (6.34-7.08)**	**8.03% (7.57-8.52)**	**9.14% (8.52-9.81)**
Resurfacing (excl ASR brand)	3.73% (3.50-3.98)	4.56% (4.28-4.85)	5.33% (5.00-5.68)	6.35% (5.93-6.80)	7.39% (6.80-8.03)
Other combination	**2.20% (1.91-2.54)**	**2.69% (2.34-3.10)**	**3.63% (3.14-4.20)**	**4.34% (3.72-5.07)**	**4.62% (3.90-5.46)**
All types	**2.10% (2.05-2.15)**	**2.61% (2.54-2.67)**	**3.10% (3.02-3.18)**	**3.55% (3.45-3.65)**	**3.94% (3.81-4.08)**

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.
Note: Bases are shown in Table 3.3. Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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Figure 3.2

Risk of revision for metal-on-polyethylene bearings (cumulative hazard with 95% confidence intervals) by fixation.

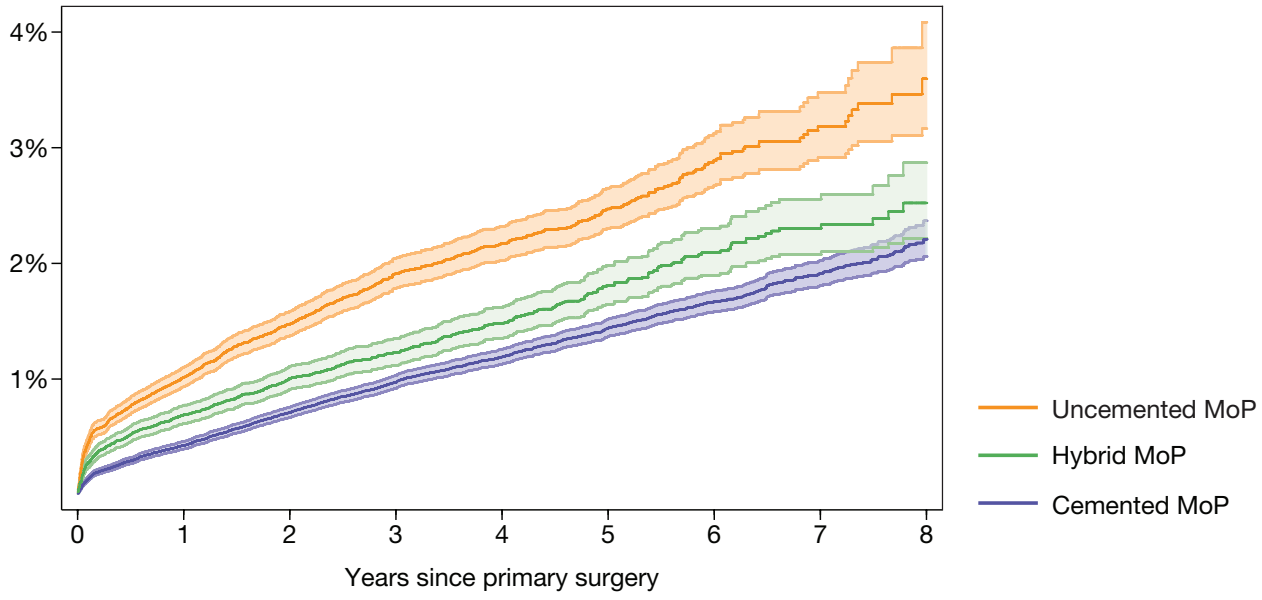

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Figure 3.3

Risk of revision for ceramic-on-polyethylene bearings (cumulative hazard with 95% confidence intervals) by fixation.

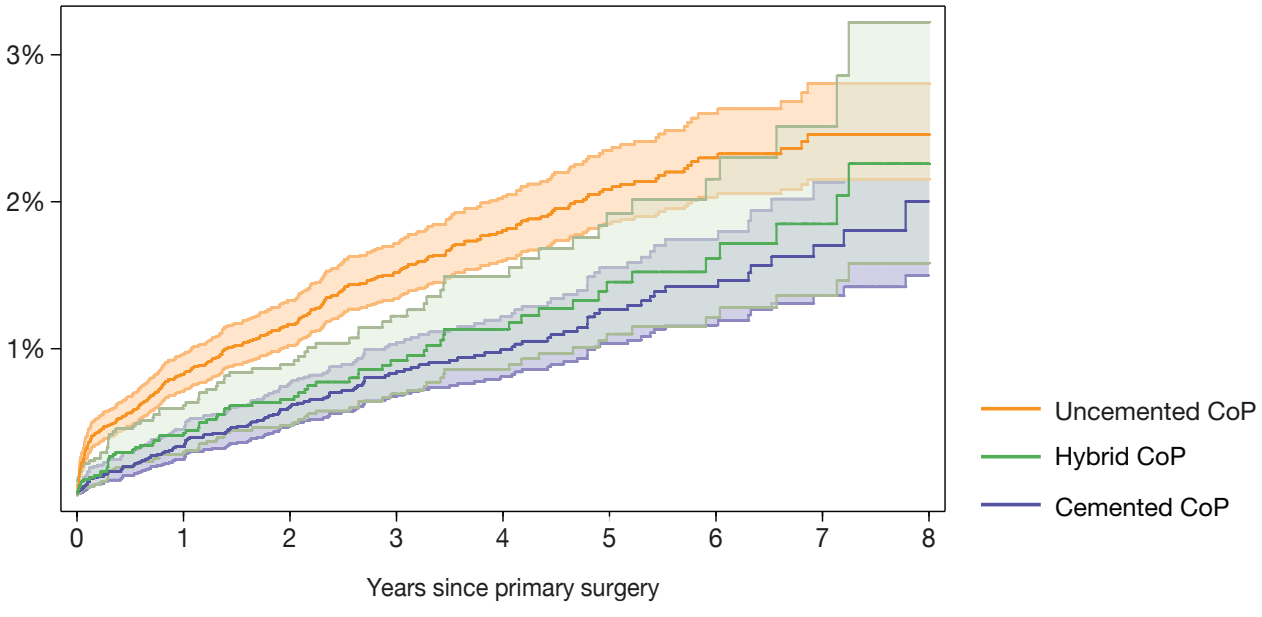

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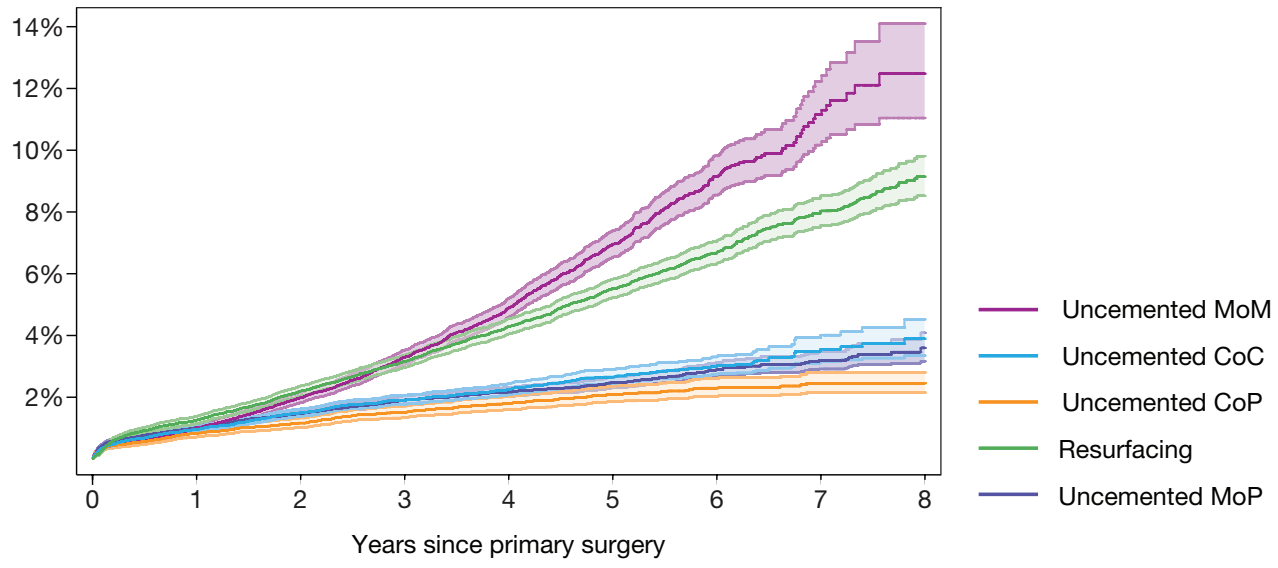
Figure 3.4

Risk of revision for metal and ceramic bearings (cumulative hazard with 95% confidence intervals).



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3.3.3 Reasons for first revision

This section considers the reason for the first revision of a primary hip replacement.

Methodological note

More than one reason for revision can be recorded in the NJR and so this section calculates an incidence rate of revision for each reason. The patient time incidence rate (PTIR) used here divides the number of revisions for that reason by the total length of time the patients have been observed to be at risk of revision (that is the time between the date of primary surgery and the date of revision, date of death, or 31 December 2011). It is shown in the format of the number of revisions per thousand observed years. This is a standardised format that avoids the need to choose time-points at which to estimate incidence rates. However, it does not give any information about how the risk of revision might change over time and it therefore may be an inappropriate indicator of survivorship if the risk of revision is not constant and does vary substantially over time.

The results in this section enable straightforward comparisons to be made across and between the different groups. Comparing the incidence rates for the reasons for revision for a type of hip replacement enables the most common reasons for revision to be identified (those with the highest PTIR). Likewise, comparing the different types of hip replacement for each reason for revision enables us to see if certain hip replacements are more commonly associated with particular reasons for revision than others.

Resurfacing procedures were more likely to be revised for pain, loosening, periprosthetic fracture and other reasons than were non-metal-on-metal bearing surfaces (Table 3.7). Likewise, stemmed metal-on-metal prostheses were more likely to be revised for pain, infection, loosening and other reasons. It is likely that some of the cases recorded as infection or other reason will reflect cases of metallosis. Ceramic-on-metal also has higher rates of revision due to loosening and pain. Resurfacing and stemmed metal-on-metal were around eight times more likely to be revised for pain than was a cemented ceramic- or metal-on-polyethylene hip replacement.

Compared with cemented metal-on-polyethylene, uncemented metal-on-polyethylene was more likely to be revised for pain, dislocation, aseptic loosening and periprosthetic fracture.

Table 3.7 Reasons for revision, patient time incidence rates per 1,000 years (95% confidence intervals).

Fixation/bearings	Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Periprosthetic fracture
All cemented	**0.46 (0.41-0.51)**	**0.87 (0.80-0.94)**	**0.78 (0.71-0.85)**	**0.86 (0.79-0.94)**	**0.17 (0.14-0.20)**	**0.27 (0.23-0.31)**
Cemented CoP	0.49 (0.32-0.73)	0.66 (0.46-0.94)	0.85 (0.62-1.16)	0.70 (0.50-0.99)	0.13 (0.06-0.28)	0.04 (0.01-0.17)
Cemented MoP	0.43 (0.38-0.48)	0.89 (0.82-0.97)	0.76 (0.69-0.83)	0.85 (0.78-0.93)	0.16 (0.13-0.19)	0.27 (0.23-0.32)
All uncemented	**1.57 (1.46-1.68)**	**1.37 (1.27-1.47)**	**0.95 (0.87-1.04)**	**1.85 (1.74-1.97)**	**0.26 (0.22-0.31)**	**0.80 (0.73-0.89)**
Uncemented CoC	1.08 (0.92-1.28)	1.20 (1.03-1.41)	0.80 (0.66-0.97)	1.52 (1.32-1.76)	0.11 (0.07-0.19)	0.92 (0.77-1.10)
Uncemented CoM	1.78 (0.85-3.74)	1.02 (0.38-2.71)	0.76 (0.25-2.37)	2.55 (1.37-4.73)	0.00	0.25 (0.04-1.81)
Uncemented CoP	0.75 (0.58-0.98)	1.12 (0.91-1.40)	0.63 (0.47-0.84)	1.41 (1.16-1.71)	0.16 (0.09-0.29)	0.51 (0.37-0.70)
Uncemented MoM	3.74 (3.39-4.13)	1.13 (0.94-1.35)	1.59 (1.37-1.85)	3.12 (2.80-3.48)	0.63 (0.50-0.80)	0.58 (0.45-0.75)
Uncemented MoP	0.97 (0.83-1.12)	1.73 (1.55-1.94)	0.84 (0.71-0.99)	1.46 (1.29-1.65)	0.17 (0.12-0.24)	0.97 (0.83-1.12)
All hybrid	**0.67 (0.58-0.79)**	**1.23 (1.10-1.39)**	**0.73 (0.63-0.85)**	**0.81 (0.70-0.94)**	**0.20 (0.15-0.27)**	**0.56 (0.47-0.66)**
Hybrid CoC	0.70 (0.49-1.00)	0.70 (0.49-1.00)	0.47 (0.30-0.72)	0.68 (0.47-0.97)	0.09 (0.04-0.25)	0.42 (0.26-0.67)
Hybrid CoP	0.67 (0.40-1.11)	1.07 (0.72-1.60)	0.71 (0.44-1.17)	0.58 (0.34-1.00)	0.18 (0.07-0.48)	0.36 (0.18-0.71)
Hybrid MoM	3.41 (2.44-4.78)	1.71 (1.06-2.75)	1.00 (0.54-1.87)	2.61 (1.78-3.83)	0.90 (0.47-1.74)	1.31 (0.76-2.25)
Hybrid MoP	0.45 (0.36-0.57)	1.39 (1.21-1.59)	0.76 (0.63-0.92)	0.77 (0.65-0.93)	0.18 (0.12-0.27)	0.57 (0.46-0.71)
All reverse hybrid	**0.95 (0.64-1.42)**	**1.10 (0.77-1.61)**	**1.23 (0.86-1.75)**	**1.47 (1.06-2.02)**	**0.16 (0.06-0.42)**	**0.56 (0.33-0.94)**
Reverse hybrid CoP	1.64 (0.96-2.83)	0.89 (0.42-1.86)	0.89 (0.42-1.86)	1.52 (0.86-2.67)	0.25 (0.06-1.01)	0.51 (0.19-1.35)
Reverse hybrid MoP	0.64 (0.36-1.16)	1.23 (0.80-1.89)	1.41 (0.94-2.10)	1.35 (0.90-2.03)	0.12 (0.03-0.47)	0.59 (0.32-1.09)
Resurfacing	**3.82 (3.52-4.15)**	**0.40 (0.31-0.52)**	**0.64 (0.52-0.78)**	**2.62 (2.37-2.90)**	**0.57 (0.46-0.71)**	**1.61 (1.42-1.83)**
Other	1.17 (0.89-1.54)	1.03 (0.77-1.38)	0.89 (0.65-1.22)	1.61 (1.27-2.04)	0.47 (0.30-0.73)	0.77 (0.55-1.09)

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.
Note: Bases are shown in Table 3.3.

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Table 3.8 Reasons for revision, patient time incidence rates per 1,000 years (95% confidence intervals).

Fixation/bearings	Implant fracture	Implant failure	Head socket mismatch	Malalignment	Other reason
All cemented	**0.06 (0.05-0.09)**	**0.01 (0.01-0.03)**	**0.02 (0.01-0.03)**	**0.26 (0.23-0.31)**	**0.28 (0.25-0.33)**
Cemented CoP	0.04 (0.01-0.17)	0.02 (0.00-0.15)	0.02 (0.00-0.15)	0.19 (0.10-0.37)	0.32 (0.19-0.53)
Cemented MoP	0.05 (0.04-0.07)	0.01 (0.01-0.03)	0.02 (0.01-0.03)	0.27 (0.23-0.32)	0.23 (0.20-0.28)
All uncemented	**0.28 (0.23-0.33)**	**0.12 (0.09-0.15)**	**0.09 (0.07-0.12)**	**0.74 (0.66-0.82)**	**1.81 (1.69-1.93)**
Uncemented CoC	0.66 (0.53-0.82)	0.16 (0.10-0.24)	0.12 (0.07-0.20)	0.65 (0.53-0.81)	1.12 (0.95-1.32)
Uncemented CoM	0.25 (0.04-1.80)	0.00	0.25 (0.04-1.80)	1.02 (0.38-2.71)	2.55 (1.37-4.73)
Uncemented CoP	0.15 (0.08-0.27)	0.10 (0.05-0.20)	0.05 (0.02-0.15)	0.48 (0.34-0.67)	0.81 (0.63-1.04)
Uncemented MoM	0.15 (0.09-0.25)	0.13 (0.08-0.22)	0.09 (0.05-0.17)	0.94 (0.77-1.14)	5.04 (4.63-5.49)
Uncemented MoP	0.12 (0.08-0.19)	0.10 (0.06-0.16)	0.08 (0.05-0.14)	0.74 (0.62-0.88)	0.80 (0.68-0.95)
All hybrid	**0.11 (0.08-0.17)**	**0.10 (0.07-0.16)**	**0.02 (0.01-0.05)**	**0.41 (0.34-0.50)**	**0.64 (0.54-0.75)**
Hybrid CoC	0.23 (0.13-0.43)	0.16 (0.08-0.34)	0.00	0.40 (0.25-0.64)	0.42 (0.26-0.67)
Hybrid CoP	0.00	0.09 (0.02-0.36)	0.00	0.13 (0.04-0.42)	0.54 (0.30-0.94)
Hybrid MoM	0.20 (0.06-0.80)	0.00	0.20 (0.05-0.80)	0.60 (0.27-1.34)	5.42 (4.15-7.08)
Hybrid MoP	0.09 (0.05-0.16)	0.09 (0.06-0.16)	0.01 (0.00-0.05)	0.45 (0.36-0.57)	0.38 (0.30-0.50)
All reverse hybrid	**0.08 (0.02-0.32)**	**0.00**	**0.00**	**0.44 (0.24-0.79)**	**0.52 (0.30-0.89)**
Reverse hybrid CoP	0.13 (0.02-0.90)	0.00	0.00	0.38 (0.12-1.18)	0.25 (0.06-1.01)
Reverse hybrid MoP	0.06 (0.01-0.42)	0.00	0.00	0.47 (0.23-0.94)	0.53 (0.27-1.01)
Resurfacing	**0.36 (0.27-0.47)**	**0.05 (0.03-0.11)**	**0.05 (0.02-0.10)**	**0.80 (0.67-0.96)**	**3.71 (3.41-4.03)**
Other	0.33 (0.19-0.55)	0.05 (0.01-0.19)	0.07 (0.02-0.22)	0.54 (0.36-0.81)	1.29 (0.99-1.68)

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.
Note: Bases are shown in Table 3.3.

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3.3.4 Revision rates for main implant brands

Many different brands of stems and cups are used in England and Wales giving a large number of different stem and cup combinations. The most commonly used implant brand combinations have been grouped into five main types according to design and fixation (Table 3.9). Revision rates for resurfacing cups are shown in Table 3.10.

Methodological note

In this section, all-cause revision rates are shown. As any part of a hip replacement could cause the need for revision and components do not act in isolation, analysis here considers stem and cup combinations rather than looking at stems and cups separately. Analysis is only shown for brands with at least 2,500 patients. This cut-off point was chosen because analysis based on fewer patients results in more uncertain estimations (demonstrated by wide confidence intervals) which make any comparisons problematic. Because of a smaller initial group size for resurfacing patients, this cut-off point has been reduced to 1,000 patients for the analysis of resurfacing brands but this does result in some very wide confidence intervals and so comparisons should be made cautiously. Revision rates are estimated for years one, three, five and seven but are only shown where at least 100 patients have been observed for at least that period of time.

In addition, the analysis here is unadjusted in that it does not control for patient characteristics or any other factors that could influence revision rates. It should be noted that there may be variations in revision rates within a particular brand grouping such as with modular uncemented cups, where products may differ in the relative proportions of different bearing types. This is illustrated further for the most-commonly used brands. Overlapping 95% confidence intervals mean that differences are unlikely to be statistically significant and so could simply reflect random variation.

Stem and cup combinations

Comparison of brands within the design and fixation groupings shows little substantive difference between the brands, particularly when the 95% confidence intervals are taken into account (Table 3.9 and Table 3.10). For example, all-cause revision rates for cemented hips were 2.0% at seven years (Table 3.6) whereas the lowest revision rate in this group was the Exeter V40 stem with the Elite Plus Cemented Cup (1.3% at seven years, Table 3.9).

As reported earlier, cemented stems and cups tended to have lower revision rates than hybrid and uncemented combinations.

Table 3.9 Revision rates (all-cause) for main hip stem and cup combinations (95% confidence intervals).

Combination: stem, cup	Number of patients	Year 1	Year 3	Year 5	Year 7
Cemented composite beam stems and cemented cups					
Charnley Cemented Stem, Charnley Cemented Cup	9,902	0.28% (0.19-0.41)	0.79% (0.63-1.00)	1.36% (1.12-1.65)	1.90% (1.58-2.29)
Charnley Cemented Stem, Charnley Ogee	8,646	0.35% (0.24-0.50)	1.08% (0.87-1.34)	1.68% (1.39-2.03)	2.38% (1.98-2.88)
Stanmore Modular, Stanmore-Arcom	3,088	0.40% (0.23-0.71)	1.03% (0.69-1.52)	1.40% (0.95-2.06)	1.52% (1.03-2.26)
Cemented taper slip stems and cemented cups					
C-Stem Cemented Stem, Elite Plus Ogee	3,407	0.43% (0.26-0.73)	0.90% (0.62-1.32)	1.16% (0.81-1.65)	1.37% (0.94-1.99)
CPT, ZCA	7,077	0.68% (0.51-0.91)	1.19% (0.94-1.51)	1.92% (1.54-2.40)	2.52% (1.96-3.23)
Exeter V40, Contemporary	46,784	0.43% (0.37-0.50)	0.91% (0.81-1.01)	1.33% (1.19-1.48)	1.79% (1.55-2.05)
Exeter V40, Elite Plus Cemented Cup	5,203	0.38% (0.24-0.60)	0.82% (0.58-1.16)	0.92% (0.65-1.30)	1.32% (0.86-2.02)
Exeter V40, Elite Plus Ogee	15,378	0.28% (0.20-0.38)	0.74% (0.60-0.91)	1.04% (0.86-1.27)	1.47% (1.19-1.81)
Cemented taper slip stems and uncemented cups					
CPT, Trilogy	7,325	0.79% (0.60-1.03)	1.17% (0.93-1.48)	1.82% (1.45-2.29)	1.96% (1.52-2.52)
Exeter V40, Exeter Duration	12,564	0.56% (0.44-0.71)	1.14% (0.95-1.36)	1.68% (1.42-1.97)	2.28% (1.93-2.71)
Exeter V40, Trident	23,184	0.62% (0.53-0.74)	1.12% (0.97-1.28)	1.58% (1.36-1.83)	2.01% (1.69-2.39)
Exeter V40, Trilogy	9,327	0.58% (0.44-0.76)	1.06% (0.85-1.32)	1.43% (1.15-1.77)	1.97% (1.52-2.54)
Uncemented stems and uncemented cups					
Accolade, Trident	13,712	0.99% (0.83-1.19)	2.15% (1.86-2.48)	3.06% (2.56-3.64)	3.96% (2.70-5.82)
Corail, Duraloc Cementless Cup	3,990	0.74% (0.51-1.06)	1.69% (1.32-2.18)	2.33% (1.85-2.95)	3.14% (2.45-4.03)
Corail, Pinnacle	54,019	0.80% (0.73-0.89)	1.80% (1.67-1.95)	2.84% (2.61-3.10)	4.12% (3.51-4.85)
Furlong HAC, CSF	13,940	0.90% (0.75-1.07)	1.63% (1.43-1.87)	2.03% (1.79-2.31)	2.62% (2.28-3.00)
Furlong HAC, CSF Plus	8,896	1.10% (0.89-1.35)	1.74% (1.43-2.11)	-	-
SL-Plus Cementless Stem, EPF-Plus	3,890	1.24% (0.93-1.65)	2.83% (2.31-3.45)	4.12% (3.36-5.05)	-
Taperloc Cementless Stem, Exceed	6,986	1.00% (0.78-1.28)	1.54% (1.21-1.98)	2.22% (1.36-3.60)	-
Uncemented stems and resurfacing cup					
Corail, ASR Resurfacing Cup	2,685	1.01% (0.69-1.48)	6.93% (5.97-8.05)	21.93% (19.61-24.53)	-

Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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Resurfacing

Revision rates were lowest for the Birmingham Hip Resurfacing (BHR) system with a seven-year all-cause revision rate of 5.1% (Table 3.10), although this is still higher than all the cemented, uncemented and hybrid combinations in Table 3.9. The ASR Resurfacing, now withdrawn, has the highest all-cause revision rate (24.2% at seven years). There remains considerable variation between the highest and lowest rates for resurfacing cups for other brands.

Table 3.10 Revision rates (all-cause) for main hip resurfacing brands (95% confidence intervals).

Resurfacing brand	Number of patients	Year 1	Year 3	Year 5	Year 7
Adept Resurfacing	3,137	1.22% (0.88-1.68)	2.48% (1.95-3.17)	4.41% (3.39-5.73)	-
ASR Resurfacing	2,982	1.53% (1.15-2.05)	5.97% (5.14-6.94)	13.77% (12.29-15.42)	24.22% (21.31-27.52)
BHR Resurfacing	17,519	1.07% (0.93-1.24)	2.41% (2.18-2.67)	3.67% (3.36-4.01)	5.09% (4.64-5.57)
Conserve Plus	1,275	2.00% (1.35-2.97)	5.16% (3.99-6.67)	8.52% (6.76-10.73)	-
Cormet 2000	3,532	1.35% (1.01-1.79)	3.61% (3.02-4.32)	7.13% (6.15-8.25)	10.38% (8.86-12.15)
Durom Resurfacing	1,608	1.46% (0.97-2.20)	3.77% (2.90-4.90)	5.99% (4.74-7.58)	-
Recap Resurfacing	1,618	1.82% (1.26-2.61)	3.63% (2.75-4.79)	5.96% (4.35-8.16)	-

Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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Sub-analysis of large brands

For five stem and cup brand combinations, there are large enough numbers to analyse separately by bearing surface (Table 3.11). There are few significant differences by bearing surface, the exception being the metal-on-metal version of Corail Pinnacle which is doing less well than other bearing surfaces.

Table 3.11 Revision rates (all-cause) for most commonly used brands for hip replacement by fixation and bearing surface (95% confidence intervals).

Stem, cup	Number of patients	Year 1	Year 3	Year 5	Year 7
Accolade, Trident					
Uncemented CoC	5,394	0.97% (0.74-1.29)	2.08% (1.66-2.59)	3.01% (2.34-3.87)	-
Uncemented CoP	1,424	1.09% (0.63-1.89)	2.52% (1.66-3.82)	3.89% (2.40-6.31)	-
Uncemented MoP	6,733	1.00% (0.78-1.29)	2.19% (1.77-2.70)	2.93% (2.17-3.97)	-
Corail, Pinnacle					
Uncemented CoC	17,971	0.87% (0.74-1.03)	1.80% (1.56-2.07)	2.49% (2.10-2.95)	-
Uncemented CoM	1,652	0.38% (0.17-0.85)	2.95% (1.77-4.91)	-	-
Uncemented CoP	4,327	0.61% (0.41-0.90)	0.96% (0.66-1.40)	1.37% (0.88-2.14)	-
Uncemented MoM	11,339	0.83% (0.68-1.02)	2.32% (2.04-2.64)	4.28% (3.77-4.85)	-
Uncemented MoP	18,086	0.81% (0.68-0.95)	1.40% (1.20-1.62)	1.66% (1.41-1.96)	2.05% (1.57-2.68)
Furlong HAC Stem, CSF					
Uncemented CoC	1,579	1.16% (0.73-1.83)	1.96% (1.37-2.81)	2.55% (1.84-3.52)	4.21% (2.89-6.12)
Uncemented CoP	5,883	0.73% (0.54-0.99)	1.26% (1.00-1.60)	1.62% (1.31-2.02)	1.82% (1.45-2.28)
Uncemented MoP	6,193	0.99% (0.76-1.27)	1.90% (1.57-2.31)	2.29% (1.91-2.76)	3.11% (2.56-3.78)
Exeter V40, Contemporary					
Cemented CoP	2,708	0.55% (0.32-0.93)	1.13% (0.74-1.73)	1.52% (0.97-2.36)	1.75% (1.10-2.79)
Cemented MoP	43,660	0.42% (0.36-0.49)	0.90% (0.80-1.01)	1.32% (1.18-1.48)	1.80% (1.55-2.08)
Exeter V40, Trident					
Hybrid CoC	8,318	0.56% (0.42-0.76)	1.06% (0.84-1.33)	1.62% (1.29-2.03)	2.06% (1.60-2.64)
Hybrid CoP	2,425	0.57% (0.32-1.00)	0.92% (0.56-1.50)	2.07% (1.05-4.07)	-
Hybrid MoP	11,891	0.66% (0.52-0.82)	1.19% (0.98-1.44)	1.45% (1.18-1.78)	1.83% (1.41-2.38)

Key: CoC – ceramic-on-ceramic, CoM – ceramic-on-metal, CoP – ceramic-on-polyethylene, MoM – metal-on-metal, MoP – metal-on-polyethylene.
Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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3.3.5 Impact of different surgical techniques

This section considers the impact of using the surgical techniques of minimally-invasive surgery and image-guided surgery.

Methodological note

Information about surgical techniques such as minimally-invasive surgery and image-guided surgery has not always been recorded in the NJR. Most operations recorded in the NJR between 2004 and 2007 did not record this (38.5% of the total). These cases have been excluded from the following analysis. Here, multivariable analysis (a Cox proportional hazards model) has been used to explore whether these surgical techniques were associated with a lower risk of revision after primary hip replacement while controlling for other differences between the patients (age, gender, ASA grade and type of hip replacement) that could also affect revision rates. These models produce hazard ratios. A hazard ratio of 1 means there is no difference between the groups being compared; a hazard ratio of greater than 1 indicates an increased risk of revision; and a hazard ratio below 1 indicates a reduced risk of revision. The 95% confidence interval illustrates a likely range of values where the real result is likely to lie. Where this interval includes the value of 1, we cannot be confident that the groups being compared are different and so the result is termed not statistically significant.

Overall, 4.7% of primary hip replacement operations had used minimally-invasive surgery. This was more commonly used with an uncemented procedure (7.9%) and with ceramic-on-ceramic (8.0%), ceramic-on-metal (8.9%), and metal-on-metal (6.0%) bearings. Only 0.34% of primary hip replacements had used image-guided surgery although these were more commonly used with resurfacing procedures (1.7%).

Multivariable analysis that controlled for age, gender, ASA grade and type of hip replacement found that minimally-invasive surgery was not associated with a lower risk of revision (hazard ratio 1.03, 95% confidence interval 0.90-1.18, p=0.670). The same result was found for image-guided surgery too (hazard ratio 1.07, 95% confidence interval 0.68-1.68, p=0.779).

3.3.6 Risk of death

This section considers the risk of mortality after hip replacement. It is unknown whether surgery itself is associated with an increased risk of death but if it is, we would expect to see this in the first 30 or 90 days after surgery. Longer term mortality rates may be useful when considering the required longevity of the hip prosthesis.

Methodological note

Analysis in this section does not attempt to investigate whether hip replacement surgery is in itself associated with an increased risk of death. It is complex to disentangle the risk of death associated specifically with undergoing surgery from the risk of death more generally. The risk of death will vary for individual patients by factors such as age, gender, and the presence of illness and disease. Therefore, death in the years following hip replacement surgery would not be unexpected for some of the patients considered here. A comparison with all-cause mortality rates for England and Wales (published by the Office for National Statistics) suggests that joint replacement patients have a lower than expected death rate based on their age and gender alone (Part Three of NJR 8th Annual Report). This is likely to reflect what has been observed in other research studies that patients undergoing joint replacement may be generally healthier than others of a comparable age and gender (this is known as the “healthy selection” effect). What this section does illustrate is how the risk of death after joint replacement varies greatly by age and gender.

Mortality rates in the first 30 days after surgery are low at around 0.2% although this varies by both age and gender (Table 3.12). In particular, 30-day mortality rates are higher for men over the age of 60 compared with women of the same age. Mortality rates in the first 30 days are extremely low in patients aged under 60 (less than 0.1%). Mortality rates at 90 days post surgery are also low at around 0.5% although again this varies by age and gender.

Table 3.12 Estimated short-term mortality rates of hip replacement patients by age group and gender (95% confidence intervals).

	Number	Percentage of total	30 days	90 days	Year 1	Year 2
Female						
Under 55	27,337	6.0%	0.06% (0.04-0.10)	0.21% (0.16-0.27)	0.65% (0.56-0.76)	1.02% (0.90-1.16)
55-59	22,634	4.9%	0.10% (0.06-0.15)	0.20% (0.15-0.26)	0.61% (0.51-0.72)	1.15% (1.01-1.31)
60-64	35,678	7.8%	0.07% (0.05-0.11)	0.15% (0.12-0.20)	0.57% (0.49-0.65)	1.21% (1.09-1.34)
65-69	45,025	9.8%	0.09% (0.06-0.12)	0.22% (0.18-0.27)	0.75% (0.67-0.84)	1.57% (1.45-1.71)
70-74	51,107	11.1%	0.14% (0.11-0.18)	0.32% (0.28-0.38)	0.99% (0.91-1.09)	2.16% (2.02-2.30)
75-79	45,631	10.0%	0.29% (0.25-0.35)	0.54% (0.47-0.61)	1.69% (1.57-1.82)	3.61% (3.42-3.81)
80+	45,770	10.0%	0.57% (0.51-0.65)	1.30% (1.20-1.41)	3.62% (3.44-3.80)	7.20% (6.93-7.48)
All females	273,182	59.6%	0.21% (0.19-0.23)	0.46% (0.44-0.49)	1.38% (1.34-1.43)	2.80% (2.73-2.87)
Male						
Under 55	28,157	6.1%	0.07% (0.05-0.11)	0.15% (0.11-0.20)	0.49% (0.41-0.58)	0.82% (0.72-0.95)
55-59	19,634	4.3%	0.04% (0.02-0.07)	0.17% (0.12-0.24)	0.57% (0.47-0.69)	0.99% (0.85-1.16)
60-64	28,813	6.3%	0.11% (0.08-0.16)	0.23% (0.18-0.29)	0.84% (0.74-0.96)	1.64% (1.49-1.81)
65-69	31,426	6.9%	0.19% (0.14-0.24)	0.39% (0.33-0.47)	1.15% (1.03-1.28)	2.23% (2.06-2.42)
70-74	32,915	7.2%	0.21% (0.17-0.27)	0.49% (0.42-0.57)	1.62% (1.48-1.77)	3.48% (3.26-3.70)
75-79	25,523	5.6%	0.48% (0.41-0.58)	0.84% (0.73-0.96)	2.65% (2.45-2.86)	5.47% (5.15-5.80)
80+	18,918	4.1%	1.17% (1.03-1.34)	2.18% (1.98-2.40)	5.59% (5.25-5.96)	11.11% (10.59-11.66)
All males	185,386	40.4%	0.29% (0.26-0.31)	0.57% (0.53-0.60)	1.67% (1.61-1.73)	3.30% (3.21-3.39)
All	**458,568**	**100.0%**	**0.24% (0.23-0.26)**	**0.50% (0.48-0.52)**	**1.50% (1.46-1.53)**	**3.00% (2.95-3.06)**

Longer term mortality rates suggest that the longevity of the implant is less important for older patients (Table 3.13). For those aged 80 or over at time of surgery, 58% of females and 82% of males had died within eight years of surgery. In contrast, for those aged 55 or under at time of surgery, around 96% were still alive eight years later.

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Table 3.13 Estimated medium-term mortality rates of hip replacement patients by age group and gender (95% confidence intervals).

	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Female						
Under 55	1.45% (1.29-1.62)	1.81% (1.63-2.02)	2.14% (1.93-2.38)	2.61% (2.34-2.91)	3.21% (2.85-3.62)	4.06% (3.47-4.76)
55-59	1.59% (1.42-1.79)	2.31% (2.08-2.57)	3.01% (2.72-3.33)	3.83% (3.46-4.23)	4.63% (4.16-5.15)	5.70% (4.97-6.53)
60-64	1.94% (1.78-2.12)	2.76% (2.55-2.99)	3.60% (3.34-3.89)	4.43% (4.10-4.80)	5.51% (5.05-6.00)	6.74% (6.05-7.51)
65-69	2.49% (2.33-2.67)	3.58% (3.37-3.81)	4.80% (4.53-5.09)	6.28% (5.92-6.66)	7.96% (7.47-8.48)	9.95% (9.22-10.73)
70-74	3.54% (3.35-3.73)	5.30% (5.05-5.57)	7.48% (7.15-7.83)	9.97% (9.53-10.44)	12.90% (12.28-13.55)	15.90% (15.01-16.85)
75-79	5.84% (5.59-6.11)	8.68% (8.34-9.04)	12.15% (11.69-12.62)	16.29% (15.67-16.93)	21.05% (20.18-21.96)	26.37% (25.03-27.79)
80+	11.77% (11.40-12.16)	18.04% (17.52-18.57)	25.27% (24.57-25.99)	34.28% (33.31-35.29)	44.69% (43.28-46.14)	57.65% (55.33-60.06)
All females	4.47% (4.38-4.57)	6.61% (6.49-6.73)	9.04% (8.88-9.20)	11.89% (11.67-12.10)	15.08% (14.79-15.38)	18.71% (18.27-19.16)
Male						
Under 55	1.22% (1.08-1.38)	1.61% (1.44-1.80)	1.96% (1.75-2.19)	2.53% (2.26-2.84)	3.18% (2.81-3.59)	3.76% (3.26-4.33)
55-59	1.68% (1.48-1.90)	2.50% (2.24-2.79)	3.04% (2.74-3.39)	3.76% (3.37-4.18)	4.81% (4.28-5.41)	5.96% (5.20-6.82)
60-64	2.69% (2.48-2.93)	3.84% (3.57-4.14)	4.86% (4.52-5.23)	6.60% (6.13-7.11)	7.76% (7.17-8.40)	9.38% (8.51-10.35)
65-69	3.58% (3.34-3.83)	5.09% (4.79-5.42)	6.91% (6.51-7.33)	9.04% (8.52-9.59)	11.57% (10.86-12.32)	14.54% (13.49-15.68)
70-74	5.79% (5.49-6.11)	8.55% (8.15-8.97)	11.17% (10.67-11.70)	14.62% (13.95-15.32)	18.62% (17.70-19.60)	22.53% (21.15-24.00)
75-79	9.06% (8.62-9.52)	13.30% (12.71-13.91)	18.16% (17.38-18.98)	24.39% (23.30-25.53)	31.40% (29.86-33.01)	40.56% (38.10-43.17)
80+	18.04% (17.30-18.81)	27.08% (26.05-28.14)	37.31% (35.92-38.75)	50.42% (48.45-52.48)	65.27% (62.33-68.35)	81.85% (77.01-87.00)
All males	5.32% (5.19-5.44)	7.68% (7.52-7.84)	10.11% (9.90-10.32)	13.17% (12.89-13.44)	16.42% (16.06-16.80)	19.98% (19.45-20.54)
All	**4.81% (4.74-4.89)**	**7.04% (6.94-7.14)**	**9.47% (9.34-9.60)**	**12.40% (12.23-12.57)**	**15.62% (15.39-15.85)**	**19.22% (18.88-19.57)**

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3.3.7 Special topic: Stemmed metal-on-metal hip replacements

Since the last Annual Report, the NJR has been looking in some depth at the subject of stemmed metal-on-metal implants. A research paper was published in The Lancet on 31 March 2012[11] examining the failure rates of stemmed metal-on-metal implants. Another paper was published in the British Medical Journal on 3 April 2012[12] exploring whether there was any link between metal-on-metal bearing surfaces and the incidence of cancer. This section presents the key findings of these papers.

3.3.7.1 An in-depth analysis of survivorship of stemmed metal-on-metal hip replacements

Large diameter metal-on-metal stemmed prostheses became popular in England and Wales as it was thought that favourable tribology[13] would lead to lower wear and subsequent failure as well as lower rates of dislocation. We undertook an in-depth analysis of stemmed metal-on-metal prostheses to see if this was the case.

Methods

Our analysis is based on 402,051 (82%) of 491,505 primary stemmed THR procedures between April 2003 and September 2011, recorded in the NJR, which include patient identifiers that allow revisions to be linked to primary operations. These operations were done in 447 units under the care of 2,578 consultant surgeons.

Our analysis estimates all-cause revision rates. Our unit of analysis is implant (rather than patient) so we include 2,266 bilateral procedures. We estimated revision rates for stemmed metal-on-metal prostheses for different head sizes. Furthermore, we have compared revision rates for three types of bearing

[11] Smith AJ, Dieppe P, Vernon K, Porter M, Blom AW; National Joint Registry of England and Wales. Failure rates of stemmed metal-on-metal hip replacements: analysis of data from the National Joint Registry of England and Wales. Lancet. 2012 Mar 31;379(9822):1199-204. Epub 2012 Mar 13. http://www.thelancet.com/

[12] Smith AJ, Dieppe P, Porter M, Blom AW; National Joint Registry of England and Wales. Risk of cancer in first seven years after metal-on-metal hip replacement compared with other bearings and general population: linkage study between the National Joint Registry of England and Wales and Hospital Episode Statistics. BMJ. 2012 Apr 3;344:e2383. doi: 10.1136/bmj.e2383. http://www.bmj.com/

[13] Tribology is the scientific study of interacting surfaces in relative motion, including the principles of friction, lubrication and wear.

surface: metal-on-metal, ceramic-on-ceramic, and metal-on-polyethylene. We compared various commonly used head sizes for the metal-on-metal and ceramic-on-ceramic groups, whereas the most commonly used head size of 28mm has been chosen for the metal-on-polyethylene group (Table L1). A confounding variable is the fixation of the implant, which we have addressed by reporting the three bearings in uncemented implants. However, since metal-on-polyethylene is so commonly used, we also show results for cemented and hybrid fixation.

There were substantial differences between the bearing groups (Table L1). To reduce the effects of confounding, we selected an analysis sample that represented typical patients. For all bearing groups, this sample was those patients with an ASA grade of 1 or 2 at time of primary surgery and those whose surgery was undertaken for osteoarthritis only. We excluded ASR implants from our metal-on-metal analysis because ASR revision rates are much higher than other brands and the ASR has now been withdrawn by the manufacturers.

Furthermore, we used multivariable analysis to adjust for the age of patients and to measure the effect of head size. Separate models were estimated for men and women because of the very different head size profile of each. We also specified separate models for the different bearing groups: metal-on-metal, ceramic-on-ceramic, and the three metal-on-polyethylene groups (uncemented, cemented, and hybrid fixation).

Table L1 Description of comparison groups, number of cases (percentage of total).

	Bearing surface					
	Metal-on-metal		Metal-on-polyethylene		Ceramic-on-ceramic	
Fixation						
Cemented	531	(1.7%)	123,472	(54.6%)	0	(0.0%)
Uncemented	26,863	(86.2%)	52,999	(23.4%)	45,099	(78.1%)
Hybrid	2,712	(8.7%)	49,528	(21.9%)	12,416	(21.5%)
Unknown	1,065	(3.4%)	166	(0.1%)	233	(0.4%)
Head size						
28mm or less	2,487	(8.0%)	176,449	(78.0%)	12,274	(21.3%)
30-32mm	357	(1.1%)	30,059	(13.3%)	18,680	(32.3%)
36mm	12,805	(41.1%)	13,763	(6.1%)	24,985	(43.3%)
38-42mm	2,342	(7.5%)	2,351	(1.0%)	1,354	(2.3%)
44mm	2,204	(7.1%)	343	(0.2%)	0	(0.0%)
46mm	3,573	(11.5%)	0	(0.0%)	0	(0.0%)
48mm	2,518	(8.1%)	0	(0.0%)	0	(0.0%)
50mm	2,492	(8.0%)	0	(0.0%)	0	(0.0%)
52mm	1,241	(4.0%)	0	(0.0%)	0	(0.0%)
54-60mm	1,150	(3.7%)	0	(0.0%)	0	(0.0%)
Age (mean age in years)	62.8		72.7		59.6	
Aged less than 55 years	6,348	(20.4%)	5,977	(2.6%)	15,694	(27.2%)
Aged 55-64	10,734	(34.4%)	30,516	(13.5%)	23,010	(39.8%)
Aged 65-74	9,547	(30.6%)	91,047	(40.3%)	15,331	(26.5%)
Aged 75 or over	4,542	(14.6%)	98,624	(43.6%)	3,713	(6.4%)
Gender						
Male	15,839	(50.8%)	78,891	(34.9%)	25,290	(43.8%)
Female	15,332	(49.2%)	147,274	(65.1%)	32,458	(56.2%)
ASA Grade						
1 - fit and healthy	7,913	(25.4%)	29,320	(13.0%)	16,048	(27.8%)
2 - mild systemic disease that does not limit activity	19,627	(63.0%)	157,492	(69.6%)	37,196	(64.4%)
3 - systemic disease that limits activity but is not incapacitating	3,485	(11.2%)	37,764	(16.7%)	4,385	(7.6%)
4/5 - incapacitating, life-threatening systemic disease/not expected to survive 24 hours	146	(0.5%)	1589	(0.7%)	119	(0.2%)
Diagnosis						
Osteoarthritis only	27,635	(88.7%)	208,173	(92.0%)	50,626	(87.7%)
Other	3,536	(11.3%)	17,992	(8.0%)	7,122	(12.3%)
ASR prosthesis	3,207	(10.3%)	0	(0.0%)	0	(0.0%)
Total (% of all stemmed THR)	31,171	(7.8%)	226,165	(56.3%)	57,748	(14.4%)
Multivariable model samples						
ASA 1 or 2, OA only, uncemented, all head sizes, ASR excluded	18,679		25,988		36,009	
ASA 1 or 2, OA only, cemented	-		69,569		-	
ASA 1 or 2, OA only, hybrid	-		20,017		-	
Total in model	18,679	(60.0%)	115,574	(51.1%)	36,009	(62.4%)
Number of surgeons	770	(29.8%)	2,144	(83.0%)	1,202	(46.5%)
Number of units	337	(75.4%)	434	(97.1%)	397	(88.8%)
Number of stem brands used	52		124		57	
Number of cup brands used	34		106		43	
Numbers followed up by year						
Less than 1 year	683	(3.7%)	14,871	(12.9%)	9,034	(25.1%)
1 - < 2 years	2,549	(13.6%)	16,967	(14.7%)	8,868	(24.6%)
2 - < 3 years	4,216	(22.6%)	17,257	(14.9%)	6,419	(17.8%)
3 - < 4 years	4,597	(24.6%)	17,852	(15.4%)	4,577	(12.7%)
4 - < 5 years	3,525	(18.9%)	16,906	(14.6%)	2,940	(8.2%)
5 - < 6 years	1,852	(9.9%)	13,218	(11.4%)	1,980	(5.5%)
6 - < 7 years	955	(5.1%)	10,265	(8.9%)	1,182	(3.3%)
7 or more years	302	(1.6%)	8,237	(7.1%)	1,008	(2.8%)

Note: Among the full sample of stemmed total hip replacements (402,051), there are other bearing surfaces which are not shown in this table: 46,290 ceramic-on-polyethylene (11.5% of the total), 2,430 other combinations (0.6%), and 38,247 unknown bearings (9.5%).

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Our multivariable models were flexible parametric survival models that estimate the cumulative incidence of revision in the presence of the competing risk of death. Standard survival analysis treats death simply as censored information, but this overestimates revision rates, particularly in an elderly population (see Part Three of NJR 8th Annual Report). In all models, we selected head size and age as predictors of revision and age as a predictor of death for the competing risk. We allowed the effect of age to differ for the main and competing risks. These models produce hazard ratios (HRs), which are a measure of relative risk (averaged over time). However, to illustrate the absolute effect of these factors, we have used the models to predict revision rates for a typical patient by estimating the covariate-adjusted cumulative incidence function in the presence of competing risks.

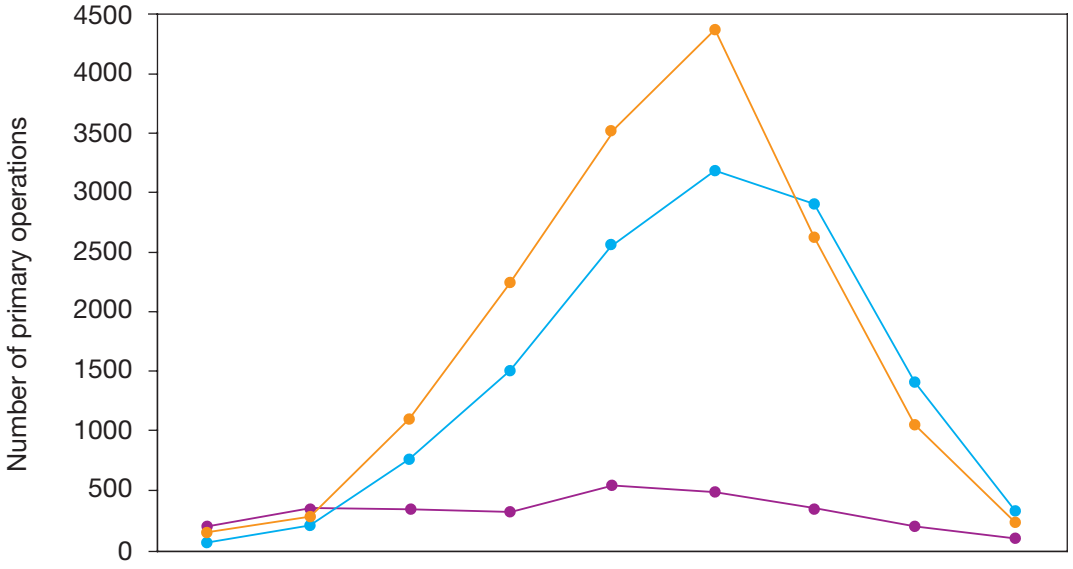
We also assessed reasons for revision across all groups by dividing the number of revisions for each reason by the total patient-time at risk of revision (per 1,000 patient years). This is equivalent to a PTIR and we have estimated 95% confidence intervals (95% CI) by assuming a Poisson distribution.

Results

Overall, about 8% of stemmed THR procedures recorded in the NJR involve a metal-on-metal prosthesis (n=31,171). In England and Wales, the use of stemmed metal-on-metal implants escalated strongly after 2004 to a peak of more than 9,000 operations in 2008, but then declined sharply (Figure L1). The increase in stemmed metal-on-metal from 2004 was almost entirely due to the use of larger heads. Metal-on-metal procedures were evenly split between monobloc (48%) and modular cups (52%). Most modular cups (79%) were 36mm and another 2,469 (15%) were 28mm. From 2007, 617 larger modular cups (>36mm) have also been used (4%).

Figure L1

Trends in stemmed metal-on-metal by head size, 2003 to 2011.



Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
22.25-32mm	200	336	351	341	534	501	352	203	101
36mm	68	204	754	1,487	2,562	3,199	2,896	1,407	327
38-60mm	136	285	1,096	2,277	3,534	4,372	2,637	1,033	245

Note: Figures for 2003 and 2011 are estimated (nine months data extrapolated to 12 months). Because of lower compliance in the early days of the registry, figures for 2003 and 2004 may underestimate the number of operations by around 35%.

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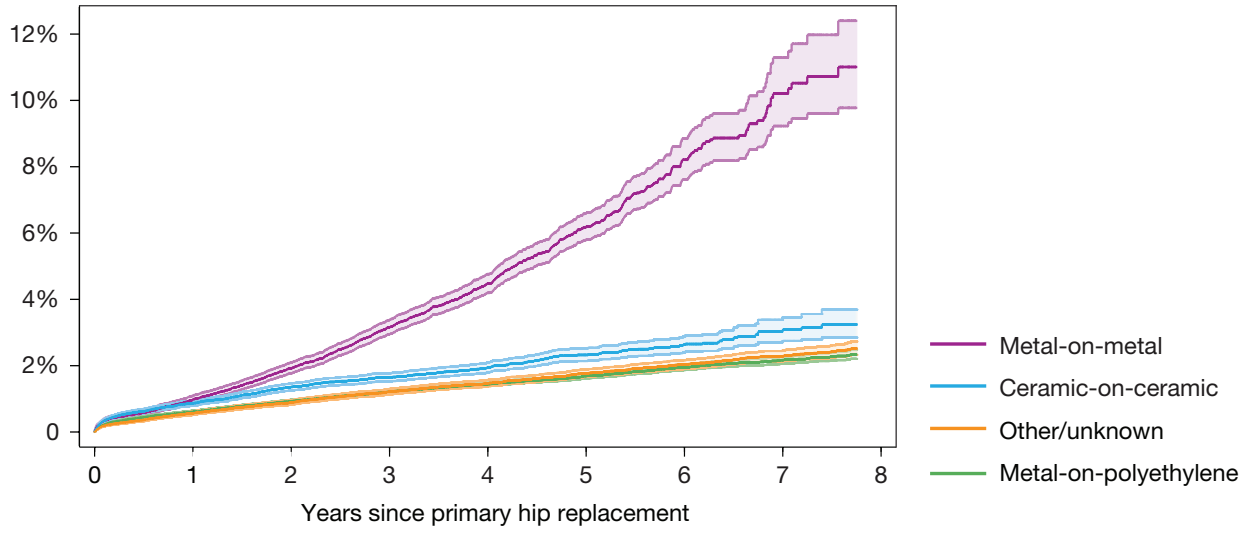
Monobloc cups were larger: 6,526 (79%) of 8,212 men had a cup size between 46mm and 52mm and 5,626 (84%) of 6,708 women had a cup size in the range of 42-48mm. With an overall five-year revision rate of 6.2% (95% CI 5.8–6.6), metal-on-metal articulations failed more quickly than other types of bearing surface (Figure L2).

Figure L2

Risk of revision by bearing surface (cumulative hazard with 95% confidence intervals).



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The multivariable models for metal-on-metal articulations confirmed that head size was an independent predictor of revision for both men (HR 1.020, 95% CI 1.004–1.037; p=0.013) and women (1.019, 1.001–1.038; p<0.0005) suggesting that larger head sizes were more likely to be revised. These HRs can be broadly interpreted as each 1mm increase in head size being associated with a 2% increase in the hazard (the risk at a particular point in time) of revision. Age was a significant predictor of revision for women (HR 0.981, 95% CI 0.970–0.991; p<0.0005) suggesting that younger women were more likely to have their implants revised.

The risk of revision after implantation of stemmed metal-on-metal replacements was lower with smaller head sizes in both men and women (Figure L3). For example, for a man aged 60 years, the five-year revision rate with a 28mm head was 3.2% compared with 5.1% for a 52mm head (Table L2).

Table L2 Predicted revision rates for males with metal-on-metal articulations by age and head size (95% confidence intervals).

Age	Head size	Year 1	Year 3	Year 5	Year 7
Males					
55	28mm	0.73% (0.53-1.01)	1.89% (1.42-2.51)	3.30% (2.50-4.34)	4.59% (3.42-6.16)
55	36mm	0.86% (0.67-1.09)	2.22% (1.83-2.68)	3.86% (3.22-4.63)	5.38% (4.35-6.63)
55	46mm	1.04% (0.84-1.30)	2.70% (2.31-3.16)	4.70% (4.05-5.45)	6.54% (5.42-7.86)
55	48mm	1.09% (0.87-1.36)	2.81% (2.38-3.33)	4.89% (4.17-5.73)	6.79% (5.58-8.25)
55	50mm	1.13% (0.89-1.43)	2.93% (2.44-3.51)	5.09% (4.27-6.06)	7.06% (5.73-8.69)
55	52mm	1.18% (0.92-1.52)	3.05% (2.49-3.72)	5.29% (4.35-6.42)	7.34% (5.86-9.18)
60	28mm	0.71% (0.52-0.96)	1.83% (1.39-2.39)	3.18% (2.45-4.12)	4.43% (3.34-5.86)
60	36mm	0.83% (0.66-1.04)	2.14% (1.80-2.55)	3.73% (3.17-4.38)	5.18% (4.25-6.30)
60	46mm	1.01% (0.82-1.24)	2.61% (2.27-3.01)	4.54% (3.97-5.19)	6.30% (5.28-7.51)
60	48mm	1.05% (0.85-1.31)	2.72% (2.33-3.18)	4.72% (4.07-5.47)	6.55% (5.43-7.89)
60	50mm	1.10% (0.87-1.38)	2.83% (2.38-3.36)	4.91% (4.15-5.80)	6.81% (5.56-8.33)
60	52mm	1.14% (0.89-1.46)	2.95% (2.43-3.57)	5.11% (4.23-6.16)	7.08% (5.67-8.82)
70	28mm	0.66% (0.48-0.90)	1.70% (1.29-2.23)	2.94% (2.25-3.82)	4.07% (3.06-5.40)
70	36mm	0.78% (0.61-0.99)	1.99% (1.65-2.40)	3.44% (2.87-4.12)	4.76% (3.85-5.89)
70	46mm	0.95% (0.75-1.19)	2.43% (2.04-2.90)	4.19% (3.53-4.97)	5.79% (4.71-7.11)
70	48mm	0.99% (0.78-1.26)	2.53% (2.09-3.06)	4.36% (3.62-5.24)	6.03% (4.84-7.48)
70	50mm	1.03% (0.80-1.33)	2.63% (2.14-3.23)	4.54% (3.70-5.55)	6.26% (4.96-7.90)
70	52mm	1.07% (0.81-1.40)	2.74% (2.18-3.43)	4.72% (3.77-5.89)	6.51% (5.06-8.35)

Note: Results are estimated from multivariable competing risks flexible parametric survival model based on 9,445 male uncemented stemmed metal-on-metal cases.

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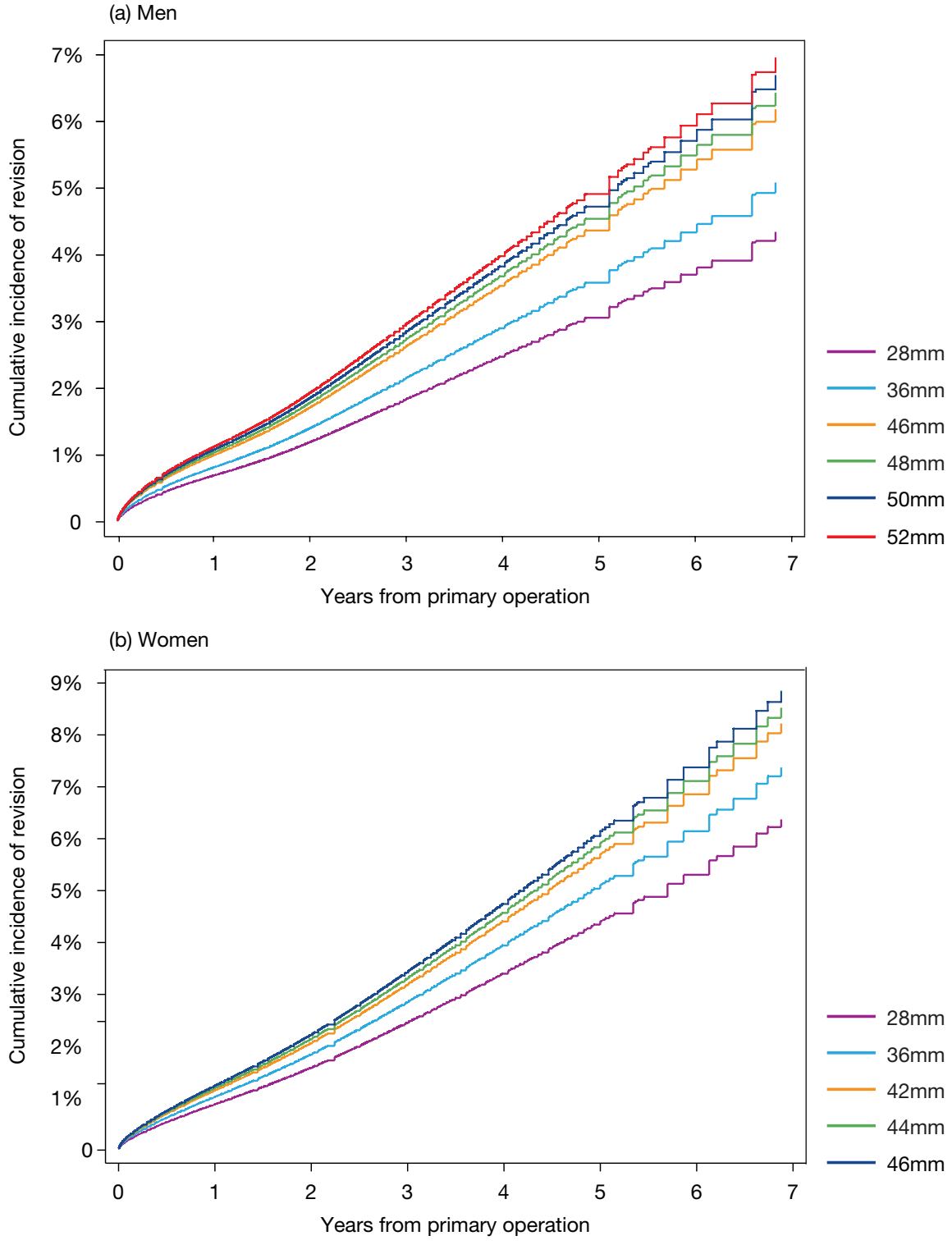
Figure L3

Estimated cumulative incidence of revision by head size, for patients with metal-on-metal articulations aged 60.



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Metal-on-metal revision rates for women were higher than for men, even with the same head size (Table L3). With a head size of 36mm, women aged 60 years had a five-year revision rate of 5.1% compared with 3.7% for men aged 60 years. Age at time of primary operation affected revision rates for women: women aged 55 years with a 28mm head size had a five-year revision rate of 4.8% compared with 3.6% for women aged 70 years. There was little difference by age for men.

Table L3 Predicted revision rates for females with metal-on-metal articulations by age and head size (95% confidence intervals).

Age	Head size	Year 1	Year 3	Year 5	Year 7
Females					
55	28mm	0.98% (0.73-1.32)	2.71% (2.09-3.49)	4.82% (3.77-6.14)	7.25% (5.56-9.41)
55	36mm	1.14% (0.92-1.41)	3.14% (2.68-3.68)	5.58% (4.83-6.44)	8.38% (7.01-9.99)
55	42mm	1.28% (1.04-1.57)	3.51% (3.02-4.08)	6.23% (5.42-7.15)	9.34% (7.84-11.10)
55	44mm	1.33% (1.06-1.65)	3.64% (3.08-4.30)	6.46% (5.54-7.53)	9.68% (8.02-11.65)
55	46mm	1.38% (1.09-1.75)	3.78% (3.13-4.56)	6.70% (5.62-7.98)	10.03% (8.16-12.30)
60	28mm	0.89% (0.67-1.18)	2.45% (1.93-3.12)	4.36% (3.46-5.49)	6.57% (5.10-8.43)
60	36mm	1.03% (0.85-1.26)	2.85% (2.48-3.26)	5.06% (4.47-5.72)	7.60% (6.44-8.94)
60	42mm	1.16% (0.95-1.41)	3.18% (2.78-3.64)	5.65% (5.00-6.37)	8.47% (7.18-9.96)
60	44mm	1.20% (0.98-1.48)	3.30% (2.84-3.85)	5.86% (5.09-6.74)	8.78% (7.34-10.48)
60	46mm	1.25% (0.99-1.57)	3.43% (2.87-4.09)	6.08% (5.15-7.17)	9.10% (7.45-11.08)
70	28mm	0.73% (0.55-0.97)	2.01% (1.57-2.57)	3.56% (2.80-4.51)	5.34% (4.11-6.91)
70	36mm	0.85% (0.69-1.05)	2.33% (1.99-2.72)	4.13% (3.56-4.78)	6.18% (5.14-7.42)
70	42mm	0.95% (0.77-1.18)	2.61% (2.22-3.06)	4.61% (3.96-5.37)	6.90% (5.70-8.32)
70	44mm	0.99% (0.79-1.24)	2.71% (2.26-3.23)	4.79% (4.03-5.67)	7.15% (5.83-8.76)
70	46mm	1.03% (0.80-1.31)	2.81% (2.30-3.43)	4.97% (4.09-6.02)	7.42% (5.93-9.26)

Note: Results are estimated from multivariable competing risks flexible parametric survival model based on 9,234 female uncemented stemmed metal-on-metal cases.

Compared with other bearing surfaces, stemmed metal-on-metal implants with larger head sizes had higher failure rates in men (Table L4). By contrast, a larger head size with a ceramic-on-ceramic bearing surface was associated with lower revision rates (3.3% for a 28mm head at five years compared with 2.0% for a 40mm head for a man aged 60 years). Overall, the lowest revision rates for men aged 60 years were associated with a cemented 28mm metal-on-polyethylene combination (1.8% at five years), although rates for hybrid and uncemented metal-on-polyethylene and larger head ceramic-on-ceramic implants were similar. The highest revision rates were associated with stemmed metal-on-metal implants with the large monobloc cups (5.1% at five years).

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Table L4 Predicted revision rates for 60- and 70-year old males by articulation and fixation (95% confidence intervals).

Articulation/head size	Year 1	Year 3	Year 5	Year 7
60-year old males				
Metal-on-metal				
Uncemented 28mm	0.71% (0.52-0.96)	1.83% (1.39-2.39)	3.18% (2.45-4.12)	4.43% (3.34-5.86)
Uncemented 36mm	0.83% (0.66-1.04)	2.14% (1.80-2.55)	3.73% (3.17-4.38)	5.18% (4.25-6.30)
Uncemented 46mm	1.01% (0.82-1.24)	2.61% (2.27-3.01)	4.54% (3.97-5.19)	6.30% (5.28-7.51)
Uncemented 48mm	1.05% (0.85-1.31)	2.72% (2.33-3.18)	4.72% (4.07-5.47)	6.55% (5.43-7.89)
Uncemented 50mm	1.10% (0.87-1.38)	2.83% (2.38-3.36)	4.91% (4.15-5.80)	6.81%(5.56-8.33)
Uncemented 52mm	1.14% (0.89-1.46)	2.95% (2.43-3.57)	5.11% (4.23-6.16)	7.08% (5.67-8.82)
Ceramic-on-ceramic				
Uncemented 28mm	1.19% (0.90-1.57)	2.35% (1.85-2.99)	3.26% (2.61-4.06)	3.88% (3.10-4.86)
Uncemented 32mm	1.01% (0.85-1.21)	2.00% (1.74-2.30)	2.77% (2.42-3.17)	3.30% (2.82-3.88)
Uncemented 36mm	0.86% (0.72-1.03)	1.70% (1.45-2.00)	2.36% (1.97-2.82)	2.81%(2.28-3.46)
Uncemented 40mm	0.73% (0.55-0.96)	1.45% (1.10-1.91)	2.01% (1.49-2.70)	2.39% (1.73-3.31)
Metal-on-polyethylene				
Cemented 28mm	0.62% (0.48-0.80)	1.20% (0.95-1.52)	1.76% (1.40-2.20)	2.29%(1.82-2.88)
Hybrid 28mm	1.03% (0.75-1.43)	1.79% (1.34-2.37)	2.60% (1.99-3.39)	3.29% (2.51-4.30)
Uncemented 28mm	1.17% (0.92-1.49)	2.12% (1.73-2.60)	2.86% (2.36-3.47)	3.42% (2.78-4.19)
70-year old males				
Metal-on-metal				
Uncemented 28mm	0.66% (0.48-0.90)	1.70% (1.29-2.23)	2.94% (2.25-3.82)	4.07% (3.06-5.40)
Uncemented 36mm	0.78% (0.61-0.99)	1.99% (1.65-2.40)	3.44% (2.87-4.12)	4.76% (3.85-5.89)
Uncemented 46mm	0.95% (0.75-1.19)	2.43% (2.04-2.90)	4.19% (3.53-4.97)	5.79% (4.71-7.11)
Uncemented 48mm	0.99% (0.78-1.26)	2.53% (2.09-3.06)	4.36% (3.62-5.24)	6.03% (4.84-7.48)
Uncemented 50mm	1.03% (0.80-1.33)	2.63% (2.14-3.23)	4.54% (3.70-5.55)	6.26% (4.96-7.90)
Uncemented 52mm	1.07% (0.81-1.40)	2.74% (2.18-3.43)	4.72% (3.77-5.89)	6.51% (5.06-8.35)
Ceramic-on-ceramic				
Uncemented 28mm	1.30% (0.96-1.76)	2.56% (1.95-3.35)	3.53% (2.74-4.53)	4.19% (3.24-5.41)
Uncemented 32mm	1.10% (0.89-1.37)	2.18% (1.81-2.61)	3.00% (2.52-3.58)	3.57% (2.94-4.33)
Uncemented 36mm	0.94% (0.76-1.15)	1.85% (1.53-2.24)	2.55% (2.08-3.13)	3.04% (2.41-3.82)
Uncemented 40mm	0.80% (0.60-1.07)	1.57% (1.18-2.10)	2.17% (1.59-2.96)	2.59% (1.85-3.61)
Metal-on-polyethylene				
Cemented 28mm	0.55% (0.46-0.66)	1.07% (0.93-1.23)	1.55% (1.37-1.76)	2.00% (1.74-2.30)
Hybrid 28mm	0.90% (0.71-1.15)	1.55% (1.28-1.88)	2.24% (1.88-2.67)	2.82% (2.33-3.40)
Uncemented 28mm	0.98% (0.80-1.19)	1.76% (1.50-2.06)	2.37% (2.04-2.75)	2.81% (2.38-3.32)

Note: Results are estimated from multivariable competing risks flexible parametric survival models based on 9,445 uncemented stemmed metal-on-metal cases, 16,136 uncemented ceramic-on-ceramic cases; and for 28mm metal-on-polyethylene: 22,407 cemented, 6,634 hybrid and 9,352 uncemented cases.

Women with stemmed metal-on-metal prostheses had poorer outcomes than with other surgical options (Table L5). Revision rates for stemmed metal-on-metal implants in women were up to four times higher than those of other bearing surfaces. For women aged 60 years, the five-year revision rate for a 46mm metal-on-metal prosthesis was 6.1% compared with 1.6% for a hybrid 28mm metal-on-polyethylene articulation. In Figure L4 we summarise selected results.

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Table L5 Predicted revision rates for 60- and 70-year old females by articulation and fixation (95% confidence intervals).

Articulation/head size	Year 1	Year 3	Year 5	Year 7
60-year old females				
Metal-on-metal				
Uncemented 28mm	0.89% (0.67-1.18)	2.45% (1.93-3.12)	4.36% (3.46-5.49)	6.57% (5.10-8.43)
Uncemented 36mm	1.03% (0.85-1.26)	2.85% (2.48-3.26)	5.06% (4.47-5.72)	7.60% (6.44-8.94)
Uncemented 42mm	1.16% (0.95-1.41)	3.18% (2.78-3.64)	5.65% (5.00-6.37)	8.47% (7.18-9.96)
Uncemented 44mm	1.20% (0.98-1.48)	3.30% (2.84-3.85)	5.86% (5.09-6.74)	8.78% (7.34-10.48)
Uncemented 46mm	1.25% (0.99-1.57)	3.43% (2.87-4.09)	6.08% (5.15-7.17)	9.10% (7.45-11.08)
Ceramic-on-ceramic				
Uncemented 28mm	0.79% (0.63-1.00)	1.71% (1.40-2.07)	2.39% (1.98-2.87)	3.00% (2.45-3.68)
Uncemented 32mm	0.77% (0.66-0.91)	1.66% (1.46-1.88)	2.32% (2.04-2.64)	2.92% (2.46-3.45)
Uncemented 36mm	0.75% (0.61-0.92)	1.61% (1.34-1.95)	2.26% (1.84-2.77)	2.84% (2.23-3.60)
Metal-on-polyethylene				
Cemented 28mm	0.48% (0.39-0.59)	1.09% (0.91-1.31)	1.63% (1.36-1.95)	2.03% (1.69-2.44)
Hybrid 28mm	0.63% (0.47-0.84)	1.10% (0.85-1.42)	1.62% (1.28-2.06)	2.20% (1.72-2.82)
Uncemented 28mm	0.83% (0.67-1.03)	1.50% (1.24-1.82)	1.99% (1.65-2.40)	2.31% (1.89-2.81)
70-year old females				
Metal-on-metal				
Uncemented 28mm	0.73% (0.55-0.97)	2.01% (1.57-2.57)	3.56% (2.80-4.51)	5.34% (4.11-6.91)
Uncemented 36mm	0.85% (0.69-1.05)	2.33% (1.99-2.72)	4.13% (3.56-4.78)	6.18% (5.14-7.42)
Uncemented 42mm	0.95% (0.77-1.18)	2.61% (2.22-3.06)	4.61% (3.96-5.37)	6.90% (5.70-8.32)
Uncemented 44mm	0.99% (0.79-1.24)	2.71% (2.26-3.23)	4.79% (4.03-5.67)	7.15% (5.83-8.76)
Uncemented 46mm	1.03% (0.80-1.31)	2.81% (2.30-3.43)	4.97% (4.09-6.02)	7.42% (5.93-9.26)
Ceramic-on-ceramic				
Uncemented 28mm	0.78% (0.60-1.01)	1.66% (1.31-2.10)	2.32% (1.85-2.90)	2.91% (2.28-3.69)
Uncemented 32mm	0.75% (0.62-0.92)	1.62% (1.36-1.92)	2.26% (1.89-2.68)	2.83% (2.30-3.46)
Uncemented 36mm	0.73% (0.58-0.92)	1.57% (1.27-1.95)	2.19% (1.75-2.75)	2.75% (2.12-3.56)
Metal-on-polyethylene				
Cemented 28mm	0.37% (0.32-0.43)	0.85% (0.76-0.95)	1.26% (1.14-1.40)	1.57% (1.40-1.76)
Hybrid 28mm	0.59% (0.47-0.73)	1.02% (0.86-1.21)	1.49% (1.28-1.74)	2.02% (1.69-2.40)
Uncemented 28mm	0.81% (0.69-0.95)	1.46% (1.28-1.67)	1.93% (1.70-2.19)	2.23% (1.94-2.57)

Note: Results are estimated from multivariable competing risks flexible parametric survival models based on 9,234 uncemented stemmed metal-on-metal cases, 19,873 uncemented ceramic-on-ceramic cases; and for 28mm metal-on-polyethylene: 47,162 cemented, 13,383 hybrid and 16,636 uncemented cases.

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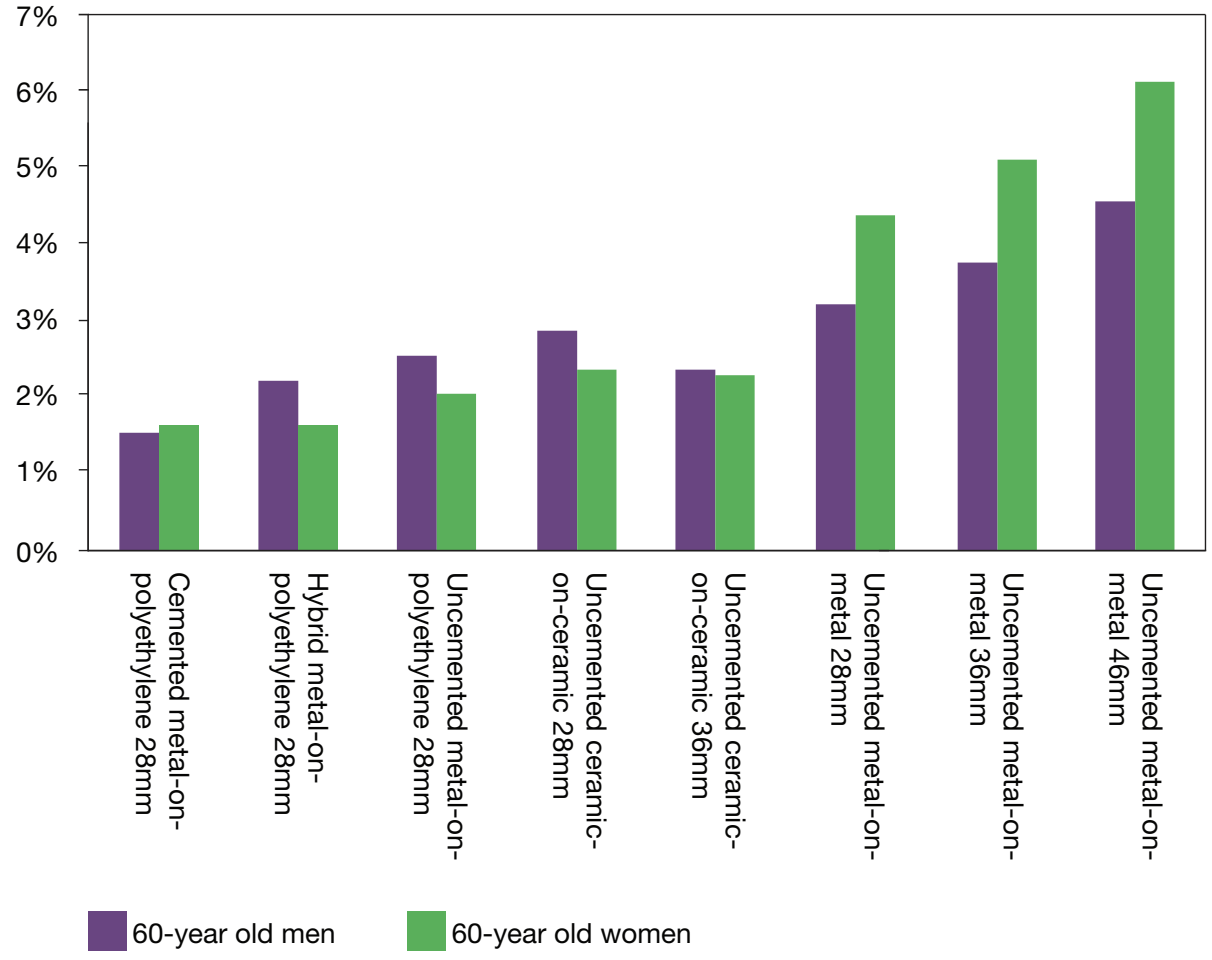
Figure L4

Estimated five-year revision rates by articulation, fixation and gender.



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The most common reasons for revision of stemmed metal-on-metal procedures in both men and women were aseptic loosening and pain and these were significantly higher in patients who received metal-on-metal implants than for other surgical options (Table L6). Revisions for dislocation in men with metal-on-metal replacements were slightly lower, showing some benefit to larger head sizes in this regard. The categories for infection and other complications also show slightly higher incidences of revision for stemmed metal-on-metal implants. It is probable that these relate to some cases of local adverse reaction to metal.

Table L6 Reasons for revision (incidence per 1,000 patient years with 95% confidence intervals) by articulation and fixation.

	Uncemented metal-on-metal	Uncemented ceramic-on-ceramic	Uncemented metal-on-polyethylene 28mm	Hybrid metal-on-polyethylene 28mm	Cemented metal-on-polyethylene 28mm
Males					
Aseptic loosening	2.85 (2.32-3.50)	1.80 (1.42-2.27)	1.88 (1.48-2.41)	0.73 (0.47-1.14)	0.75 (0.58-0.97)
Dislocation/subluxation	0.63 (0.41-0.98)	1.13 (0.84-1.52)	1.56 (1.19-2.04)	1.77 (1.32-2.36)	0.75 (0.58-0.97)
Implant failure	0.13 (0.05-0.34)	0.46 (0.29-0.73)	0.35 (0.20-0.62)	0.12 (0.04-0.37)	0.10 (0.05-0.20)
Implant fracture	0.13 (0.05-0.34)	0.62 (0.41-0.92)	0.03 (0.00-0.21)	0.15 (0.06-0.41)	0.05 (0.02-0.13)
Incorrect sizing	0.03 (0.00-0.22)	0.05 (0.01-0.21)	0.03 (0.00-0.21)	0.00	0.00
Infection	1.64 (1.25-2.16)	1.13 (0.84-1.52)	1.12 (0.81-1.54)	1.15 (0.80-1.65)	1.09 (0.88-1.34)
Lysis	0.47 (0.29-0.79)	0.08 (0.02-0.24)	0.29 (0.16-0.55)	0.19 (0.08-0.46)	0.24 (0.15-0.37)
Malalignment	0.76 (0.51-1.13)	0.59 (0.39-0.89)	0.68 (0.45-1.02)	0.27 (0.13-0.56)	0.21 (0.13-0.34)
Other	1.27 (0.93-1.72)	0.69 (0.48-1.01)	0.18 (0.08-0.39)	0.31 (0.15-0.61)	0.15 (0.09-0.26)
Pain	2.18 (1.72-2.76)	1.13 (0.84-1.52)	1.00 (0.72-1.40)	0.77 (0.50-1.19)	0.46 (0.34-0.64)
Periprosthetic fracture	0.35 (0.19-0.63)	0.64 (0.43-0.95)	0.38 (0.22-0.66)	0.69 (0.44-1.10)	0.51 (0.38-0.70)
Patient time (years)	31,613.2	38,917.4	33,959.7	26,061.9	79,971.8
Number revised	265	255	185	128	267
Number of operations	9,445	16,136	9,352	6,634	22,407
Females					
Aseptic loosening	2.47 (1.98-3.07)	1.25 (0.97-1.61)	1.17 (0.92-1.49)	0.83 (0.61-1.12)	0.75 (0.63-0.90)
Dislocation/subluxation	1.33 (0.98-1.79)	1.09 (0.83-1.42)	1.72 (1.41-2.10)	1.38 (1.09-1.75)	0.81 (0.69-0.96)
Implant failure	0.52 (0.33-0.84)	0.41 (0.26-0.64)	0.21 (0.12-0.38)	0.28 (0.16-0.47)	0.05 (0.03-0.10)
Implant fracture	0.15 (0.06-0.37)	0.66 (0.46-0.93)	0.05 (0.02-0.17)	0.06 (0.02-0.18)	0.03 (0.01-0.07)
Incorrect sizing	0.09 (0.03-0.29)	0.12 (0.06-0.27)	0.05 (0.02-0.17)	0.02 (0.00-0.14)	0.01 (0.00-0.05)
Infection	1.36 (1.01-1.82)	0.41 (0.26-0.64)	0.39 (0.26-0.59)	0.32 (0.19-0.52)	0.56 (0.46-0.69)
Lysis	0.49 (0.30-0.81)	0.12 (0.06-0.27)	0.07 (0.03-0.19)	0.18 (0.09-0.34)	0.14 (0.10-0.21)
Malalignment	1.02 (0.72-1.43)	0.78 (0.57-1.07)	0.82 (0.61-1.09)	0.47 (0.32-0.71)	0.30 (0.23-0.39)
Other	2.03 (1.60-2.59)	0.74 (0.53-1.02)	0.41 (0.27-0.62)	0.18 (0.09-0.34)	0.17 (0.12-0.25)
Pain	2.40 (1.93-3.00)	1.00 (0.76-1.33)	0.68 (0.49-0.93)	0.51 (0.35-0.75)	0.41 (0.33-0.52)
Periprosthetic fracture	0.55 (0.35-0.88)	0.94 (0.71-1.26)	0.55 (0.39-0.78)	0.32 (0.19-0.52)	0.19 (0.14-0.27)
Patient time (years)	32,440.4	48,806.1	56,259.4	50,637.5	167,174.5
Number revised	334	274	248	167	411
Number of operations	9,234	19,873	16,636	13,383	47,162

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Summary

Stemmed metal-on-metal THR has poorer implant survival in the medium term than other bearing surfaces, and larger head sizes are associated with higher, rather than lower, revision rates. Implant survival is particularly poor in women. By contrast, ceramic-on-ceramic articulations have better implant survival with larger head sizes.

3.3.7.2 Risk of cancer in the first seven years after metal-on-metal hip replacement

Some basic science and some epidemiological studies have suggested that metal-on-metal hip replacements may be associated with an increased risk of developing cancer after total hip replacement and specifically with an increase in malignant melanoma and haematological, prostate, and renal tract cancers. We used the data from the NJR linked to NHS Hospital Episodes Statistics (HES) data to test the hypothesis that the use of metal-on-metal bearing surfaces is associated with an increased risk of being diagnosed with cancer in the early years after hip replacement compared with other bearing surfaces.

Detection of any increased risk of cancer requires a suitable population with which to compare patients with metal-on-metal articulations. Comparison with the general population is not straightforward because, on average, patients who undergo hip replacement tend to be healthier than others of the same gender and age group. For instance, the NJR 8th Annual Report found that observed mortality after joint replacement was lower than that among the comparable wider population. Therefore, a more suitable comparison group is patients with other types of hip replacement.

Methods

We utilised NJR data linked to HES data. As HES contains details only on NHS-funded admissions in England, around 14% of National NJR cases (relating to independently-funded operations in England and operations in Wales) cannot be linked to HES. In addition, 17% of NJR records do not contain person-level identifiers that allow linkage to HES, usually because the patient did not give consent for data linkage and for their personal details to be held. When data linkage should be possible, 6% of NJR hip replacements could not be matched to HES. Characteristics of the patients that could not be matched (including the independently-funded patients) were not dissimilar to those shown in Table B1 for linked patients (mean age 66.9, 42% men, mean ASA grade 1.8). We have used the most recent linked data here: patients in England who underwent hip replacement from 1 April 2003 to 31 December 2010 and for whom NJR data could be linked to HES data (n=289,571).

Table B1 Characteristics of hip replacement groups.

	Metal-on-metal		Other bearing surfaces	All hip replacement
	Resurfacing	Stemmed		
Gender				
Male	67.0%	51.6%	36.8%	39.9%
Female	33.0%	48.4%	63.2%	60.1%
Age				
Aged less than 45 years	15.3%	6.7%	2.4%	3.6%
Aged 45-54	35.0%	14.5%	5.6%	8.2%
Aged 55-64	41.1%	34.7%	20.1%	22.6%
Aged 65-74	8.2%	29.8%	38.1%	35.5%
Aged 75-84	0.4%	12.4%	28.5%	25.4%
Aged 85 or over	0.0%	1.8%	5.3%	4.7%
Mean age in years	54.0	63.0	70.0	68.4
ASA grade				
1 - fit and healthy	45.6%	24.8%	16.0%	18.6%
2 - mild systemic disease that does not limit activity	50.8%	62.4%	68.0%	66.5%
3 - systemic disease that limits activity but is not incapacitating	3.5%	12.2%	15.3%	14.3%
4/5 - incapacitating, life-threatening systemic disease/not expected to survive 24 hours	0.1%	0.6%	0.7%	0.6%
Mean ASA score	1.9	1.6	2.0	2.0
Mean number of distinct diagnosis codes at time of hip replacement	2.0	2.8	3.0	2.9
Mean number of previous admissions to hospital	2.3	3.3	3.7	3.5
Base	**19,312**	**21,264**	**248,995**	**289,571**

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HES data for all hospital admissions for these patients between 1997 (the earliest time that such data can be obtained) and 2010 have been used and the relevant ICD-10 (international classification of diseases, 10th revision) diagnosis codes have been used to define these conditions. This method cannot precisely identify the time of diagnosis (as the initial diagnosis might not have been associated with a hospital admission in this period), but when there were multiple hospital episodes for a patient, we chose the earliest date of any hospital admission with the relevant diagnosis code. We focused our main analysis on the risk of receiving a diagnosis of any type of cancer in the years after hip replacement, including all forms of cancer other than non-melanoma skin cancers. The relevant ICD-10 codes are C00-C97 (malignant neoplasms) and D00-D09 (carcinoma in situ), excluding C44 (non-melanoma skin cancers). We also individually considered some specific types of cancer that are suspected of being related to metal ions, giving five sets of analyses: any type of cancer, haematological cancers (such as lymphoma, leukaemia, or myeloma), malignant melanoma, prostate cancer (for men only), and renal cancer (bladder, ureter, or kidney). For each outcome, patients who had a recorded diagnosis of that condition before, or at the time of, their hip replacement were excluded from the analysis. These patients were not excluded for the diagnosis of other cancers.

We compared patients with metal-on-metal hip replacements (both stemmed hip replacements and resurfacing hip arthroplasty) with two groups: the general population and patients with hip replacement with other bearing surfaces. Given the large sample

size, small differences can have P values of less than 0.05 so for all analyses we present 95% confidence intervals to indicate the range of any likely difference between the groups.

Comparison with the general population

We used the Nelson-Aalen cumulative hazard function from survival analysis to estimate unadjusted observed incidence rates for a diagnosis of cancer after hip replacement. The expected incidence is calculated by applying the age and gender-specific national cancer incidence rates (collated from cancer registries and published by the Office for National Statistics) to the hip replacement population considered here. We assumed a binomial distribution to calculate the 95% confidence intervals for the expected rates.

Comparison with alternative bearing surfaces

We separated patients into three groups: those with stemmed metal-on-metal, those with resurfacing arthroplasty, and total hip replacements with other bearing surfaces. As the patients are selected for and not randomised to different surgical options, we used multivariable analysis to adjust for the systematic differences between groups of patients (Table B1). In addition, as we are observing a relatively elderly population, the risk of death in the years after joint replacement is not insignificant and ignoring it could bias the analysis. To adjust for this competing risk, we used a multivariable flexible parametric survival model to estimate the cumulative incidence of cancer diagnosis in the presence of the competing risk of death. This method models the effect of the covariates both on the risk of having a diagnosis of cancer (the main risk) and on the risk of death (the competing risk). The effects of the covariates have been allowed to vary for the main and competing risks. All models control for the age and gender of the patient. In addition, we used three proxy measures of general health at the time of primary surgery. The first is ASA grade, a measure of serious co-morbidities assessed by the anaesthetist at the time of primary surgery and recorded in the NJR. Two other measures were calculated from the HES data: the number of distinct ICD-10 diagnosis codes recorded at time of surgery (a proxy measure of the number of different co-morbidities) and the number of NHS-funded admissions to hospital in the previous five years (a proxy measure of health status over time).

These models produce hazard ratios, which are a measure of relative risk (averaged over time). To illustrate the absolute effect of these factors, we used the models to predict incidence rates for a typical patient by estimating the cumulative incidence function adjusted for covariates in the presence of competing risks. Values of covariates are held constant at factors around the average (for the proxy measures of health) and by choosing a value of age that has large enough numbers in all patient groups to ensure robust estimation. For the multivariable models, we assessed proportionality of hazards by testing, for individual covariates and globally, the null hypothesis of zero slope, which is equivalent to testing that the log hazard ratio function is constant over time. Log-log plots were also assessed. We found no major violations of the proportional hazards assumption. Model fit was assessed by examining the Cox-Snell residuals and deviance residuals, which indicated no outliers or any other cause for concern. We undertook a sensitivity analysis to check whether clustering by implant brand affected the results. The standard errors of a standard Cox proportional hazards model were adjusted for the clustering by brand to allow for intra-group correlation. This did not significantly change the results, probably because many brands of implants were used, particularly in stemmed procedures where different combinations of stems and cups can be used (there were 216 implant types that had been used in at least 100 patients).

Results

Overall, 14% (n=40,576) of patients had some type of metal-on-metal bearing surface: 7% (n=21,264) had a stemmed metal-on-metal prosthesis and 7% (n=19,312) had a resurfacing procedure. The use of metal-on-metal has varied over time. Resurfacing procedures formed 7% of all hip replacements in 2003 rising to 9% in 2005 and 2006 and falling to 3% by 2010. Stemmed metal-on-metal formed just 2% of hip replacements in 2003, rising to a peak of 11% in 2008, and falling to 4% in 2010. This increase in stemmed metal-on-metal was almost entirely because of the use of large head sizes. Table B1 shows the socio-demographic characteristics of the three hip replacement groups. There were substantial differences between the groups, with the resurfacing group in particular being much younger and healthier than the other groups. The mean length of time since

surgery was 3.0 years (median 2.8 years) with 83% of patients having been observed for at least one year and 23% for between five and eight years. Table B2 lists the diagnoses of cancers in this time period, and shows that 1.25% of all patients were diagnosed with some type of cancer within one year of their surgery.

Annual incidence rates tended to be similar with each additional year after surgery, although they increased slightly as the patients became older. By five years, 8% had had a diagnosis of any type of cancer and by seven years it was 11%. Diagnosis of the more specific cancers was rarer (Table B2).

Table B2 Incidence of new cancer diagnosis for all hip replacement patients.

	Number excluded (previous diagnosis)	Number at risk	Total time (years) observed	Number with diagnosis	One-year incidence rate (95% confidence intervals)	Five-year incidence rate (95% confidence intervals)
Stemmed metal-on-metal						
Any cancer	1,078	20,186	58,338.2	653	1.00% (0.87-1.15)	5.65% (5.13-6.23)
Haematological cancer	108	21,156	61,545.0	107	0.13% (0.09-0.19)	0.92% (0.72-1.17)
Malignant melanoma	51	21,213	61,720.7	24	0.04% (0.02-0.08)	0.21% (0.13-0.33)
Prostate cancer	185	10,786	30,435.1	117	0.35% (0.25-0.48)	1.92% (1.52-2.42)
Renal cancer	104	21,160	61,558.0	67	0.12% (0.08-0.18)	0.53% (0.39-0.73)
Resurfacing						
Any cancer	372	18,940	69,358.4	445	0.50% (0.41-0.62)	3.34% (3.01-3.72)
Haematological cancer	46	19,266	71,131.4	55	0.05% (0.03-0.10)	0.41% (0.30-0.54)
Malignant melanoma	28	19,284	71,253.4	20	0.02% (0.01-0.06)	0.12% (0.07-0.21)
Prostate cancer	48	12,882	45,692.4	80	0.14% (0.09-0.22)	0.91% (0.71-1.16)
Renal cancer	50	19,262	71,134.2	46	0.05% (0.03-0.10)	0.36% (0.26-0.49)
Other bearing surfaces						
Any cancer	16,780	232,215	686,499.5	10,845	1.34% (1.29-1.39)	8.17% (8.00-8.36)
Haematological cancer	1,769	247,226	738,237.3	1,835	0.21% (0.19-0.23)	1.31% (1.24-1.38)
Malignant melanoma	722	248,273	741,431.8	415	0.05% (0.04-0.06)	0.28% (0.25-0.31)
Prostate cancer	2,917	88,737	261,664.9	1,558	0.51% (0.47-0.57)	3.09% (2.91-3.27)
Renal cancer	2,058	246,937	737,003.5	1,088	0.11% (0.10-0.14)	0.76% (0.71-0.81)
All hip replacement						
Any cancer	18,230	271,341	814,196.1	11,945	1.25% (1.21-1.30)	7.58% (7.42-7.74)
Haematological cancer	1,923	287,648	870,913.7	1,997	0.19% (0.18-0.21)	1.21% (1.15-1.27)
Malignant melanoma	801	288,770	874,456.0	459	0.05% (0.04-0.06)	0.26% (0.23-0.29)
Prostate cancer	3,153	112,405	337,792.4	1,755	0.45% (0.41-0.45)	2.68% (2.54-2.84)
Renal cancer	2,212	287,359	869,695.8	1,201	0.11% (0.10-0.12)	0.71% (0.66-0.76)

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Comparison with the general population

Based on national cancer incidence rates, the expected one-year incidence of cancer for the hip replacement sample was 1.65% (95% confidence interval 1.60 to 1.70). A comparison of one-year observed diagnosis rates with expected rates showed that men and women with all types of hip replacement were less likely to receive a diagnosis of cancer than an age and gender matched general population (Table B3). Patients with metal-on-metal bearing surfaces had lower observed incidence rates than those with other bearing surfaces, with a particularly low rate in younger patients in the resurfacing metal-on-metal group.

Table B3 Comparison of expected and observed one-year incidence rates for hip replacement patients (with 95% confidence intervals).

	Expected incidence of any cancer in one-year (based on national incidence rates)		Observed incidence of any cancer diagnosis in one-year	
	Male	Female	Male	Female
All hip replacement	1.91% (1.82-2.00)	1.48% (1.42-1.54)	1.46% (1.39-1.54)	1.11% (1.06-1.16)
Stemmed metal-on-metal	1.45% (1.23-1.69)	1.22% (1.02-1.46)	1.15% (0.96-1.38)	0.84% (0.68-1.05)
Resurfacing	0.77% (0.63-0.94)	0.73% (0.54-0.98)	0.48% (0.37-0.62)	0.56% (0.40-0.78)
Other bearing surfaces	2.13% (2.05-2.22)	1.53% (1.47-1.59)	1.66% (1.57-1.76)	1.15% (1.10-1.21)

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Comparison with alternative bearing surfaces

Compared with other types of hip replacement, the multivariable statistical models found no evidence that having a stemmed metal-on-metal hip replacement or a resurfacing procedure was associated with an increased risk of cancer diagnosis in this time period (Table B4). The competing risks models also showed that having a metal-on-metal bearing surface was not associated with an increased risk of death (Table B5). In fact, there was a suggestion of a slight decrease in the risk of any cancer diagnosis associated with metal-on-metal bearing surfaces. The models indicated that patients who underwent resurfacing procedures were less likely than those with other bearing surfaces to get a diagnosis of prostate cancer, haematological cancers, or any cancer (Table B4). They also had a lower risk of death across all models than patients with other bearing surfaces (Table B5). For stemmed metal-on-metal bearing surfaces, the hazard ratio for diagnosis of any type of cancer was 0.92, but the 95% confidence interval was 0.85 to 1.00 suggesting that if there was any reduction in risk it was small. Generally, the other factors in the model were significant predictors of the risk of cancer diagnosis in all models (Table B4). Increasing age was associated with an increased risk of cancer diagnosis for all models. Men were more likely than women to get a diagnosis of renal cancer, melanoma cancer, haematological cancers, and any cancer. Increases in ASA grade, number of diagnosis codes, and number of previous admissions were also predictors of an increased risk of cancer diagnosis for all models except for melanoma. All of these factors were strong and significant predictors of the competing risk of death in all models (Table B5).

Table B4 Results from multivariable flexible parametric competing risks survival models for main risk of cancer diagnosis.

Cancer model	Variable	Hazard ratio	P value	Lower 95% CI	Upper 95% CI
All	Male	1.566	0.000	1.509	1.624
All	Age	1.040	0.000	1.038	1.042
All	Stemmed metal-on-metal	0.918	0.038	0.847	0.995
All	Resurfacing	0.706	0.000	0.638	0.781
All	ASA 1 (compared to ASA 2)	0.881	0.000	0.837	0.928
All	ASA 3 (compared to ASA 2)	1.073	0.006	1.020	1.129
All	ASA 4-5 (compared to ASA 2)	0.881	0.276	0.701	1.107
All	Number of diagnosis codes	1.014	0.005	1.004	1.023
All	Number of previous admissions	1.018	0.000	1.013	1.022
Haematological	Male	1.402	0.000	1.282	1.533
Haematological	Age	1.039	0.000	1.034	1.044
Haematological	Stemmed metal-on-metal	0.929	0.465	0.762	1.132
Haematological	Resurfacing	0.582	0.000	0.439	0.771
Haematological	ASA 1 (compared to ASA 2)	0.874	0.041	0.767	0.994
Haematological	ASA 3 (compared to ASA 2)	1.144	0.026	1.016	1.289
Haematological	ASA 4-5 (compared to ASA 2)	1.281	0.277	0.820	2.000
Haematological	Number of diagnosis codes	1.033	0.003	1.011	1.055
Haematological	Number of previous admissions	1.026	0.000	1.018	1.034
Melanoma	Male	1.307	0.005	1.084	1.576
Melanoma	Age	1.033	0.000	1.023	1.044
Melanoma	Stemmed metal-on-metal	0.885	0.569	0.583	1.346
Melanoma	Resurfacing	0.781	0.312	0.483	1.262
Melanoma	ASA 1 (compared to ASA 2)	0.912	0.472	0.709	1.173
Melanoma	ASA 3 (compared to ASA 2)	0.800	0.129	0.600	1.067
Melanoma	ASA 4-5 (compared to ASA 2)	1.246	0.665	0.461	3.367
Melanoma	Number of diagnosis codes	0.979	0.415	0.930	1.030
Melanoma	Number of previous admissions	1.019	0.043	1.001	1.038
Prostate cancer	Age	1.068	0.000	1.062	1.074
Prostate cancer	Stemmed metal-on-metal	1.040	0.688	0.859	1.259
Prostate cancer	Resurfacing	0.755	0.022	0.594	0.960
Prostate cancer	ASA 1 (compared to ASA 2)	1.045	0.501	0.919	1.187
Prostate cancer	ASA 3 (compared to ASA 2)	1.138	0.050	1.000	1.295
Prostate cancer	ASA 4-5 (compared to ASA 2)	0.943	0.835	0.544	1.635
Prostate cancer	Number of diagnosis codes	0.978	0.080	0.954	1.003
Prostate cancer	Number of previous admissions	1.012	0.011	1.003	1.022
Renal cancer	Male	3.302	0.000	2.929	3.721
Renal cancer	Age	1.052	0.000	1.045	1.059
Renal cancer	Stemmed metal-on-metal	0.938	0.618	0.730	1.206
Renal cancer	Resurfacing	0.774	0.109	0.565	1.059
Renal cancer	ASA 1 (compared to ASA 2)	0.813	0.016	0.686	0.962
Renal cancer	ASA 3 (compared to ASA 2)	1.031	0.704	0.882	1.205
Renal cancer	ASA 4-5 (compared to ASA 2)	1.000	1.000	0.533	1.874
Renal cancer	Number of diagnosis codes	1.032	0.024	1.004	1.061
Renal cancer	Number of previous admissions	1.017	0.004	1.005	1.029

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Table B5 Results from multivariable flexible parametric competing risks survival models for competing risk of death.

Cancer model	Variable	Sub-hazard ratio	P value	Lower 95% CI	Upper 95% CI
All	Male	1.403	0.000	1.350	1.458
All	Age	1.094	0.000	1.092	1.097
All	Stemmed metal-on-metal	1.024	0.618	0.933	1.123
All	Resurfacing	0.723	0.000	0.608	0.859
All	ASA 1 (compared to ASA 2)	0.833	0.000	0.780	0.891
All	ASA 3 (compared to ASA 2)	1.725	0.000	1.652	1.802
All	ASA 4-5 (compared to ASA 2)	2.633	0.000	2.342	2.960
All	Number of diagnosis codes	1.123	0.000	1.116	1.130
All	Number of previous admissions	1.042	0.000	1.039	1.045
Haematological	Male	1.408	0.000	1.365	1.453
Haematological	Age	1.076	0.000	1.074	1.078
Haematological	Stemmed metal-on-metal	0.962	0.316	0.893	1.037
Haematological	Resurfacing	0.586	0.000	0.509	0.673
Haematological	ASA 1 (compared to ASA 2)	0.828	0.000	0.785	0.874
Haematological	ASA 3 (compared to ASA 2)	1.656	0.000	1.598	1.716
Haematological	ASA 4-5 (compared to ASA 2)	2.655	0.000	2.410	2.925
Haematological	Number of diagnosis codes	1.114	0.000	1.108	1.120
Haematological	Number of previous admissions	1.040	0.000	1.038	1.043
Melanoma	Male	1.390	0.000	1.349	1.433
Melanoma	Age	1.073	0.000	1.071	1.075
Melanoma	Stemmed metal-on-metal	0.944	0.115	0.878	1.014
Melanoma	Resurfacing	0.548	0.000	0.479	0.627
Melanoma	ASA 1 (compared to ASA 2)	0.832	0.000	0.791	0.876
Melanoma	ASA 3 (compared to ASA 2)	1.653	0.000	1.598	1.711
Melanoma	ASA 4-5 (compared to ASA 2)	2.744	0.000	2.505	3.006
Melanoma	Number of diagnosis codes	1.112	0.000	1.106	1.117
Melanoma	Number of previous admissions	1.040	0.000	1.038	1.042
Prostate cancer	Age	1.071	0.000	1.068	1.074
Prostate cancer	Stemmed metal-on-metal	0.826	0.000	0.763	0.893
Prostate cancer	Resurfacing	1.619	0.000	1.531	1.711
Prostate cancer	ASA 1 (compared to ASA 2)	0.998	0.968	0.903	1.102
Prostate cancer	ASA 3 (compared to ASA 2)	0.564	0.000	0.481	0.663
Prostate cancer	ASA 4-5 (compared to ASA 2)	2.623	0.000	2.268	3.034
Prostate cancer	Number of diagnosis codes	1.124	0.000	1.115	1.134
Prostate cancer	Number of previous admissions	1.032	0.000	1.029	1.036
Renal cancer	Male	1.379	0.000	1.338	1.422
Renal cancer	Age	1.074	0.000	1.072	1.075
Renal cancer	Stemmed metal-on-metal	0.950	0.169	0.883	1.022
Renal cancer	Resurfacing	0.547	0.000	0.477	0.627
Renal cancer	ASA 1 (compared to ASA 2)	0.829	0.000	0.787	0.873
Renal cancer	ASA 3 (compared to ASA 2)	1.650	0.000	1.593	1.708
Renal cancer	ASA 4-5 (compared to ASA 2)	2.741	0.000	2.498	3.008
Renal cancer	Number of diagnosis codes	1.111	0.000	1.105	1.116
Renal cancer	Number of previous admissions	1.042	0.000	1.040	1.044

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Table B6 shows adjusted incidence rates for any type of cancer for a typical patient aged 60. This analysis shows a relatively small reduction in the risk of cancer diagnosis for patients undergoing resurfacing procedures, smaller than that observed in the unadjusted analysis in Table B3. Generally, the differences between men and women are larger than those between the groups with different types of hip replacement.

Table B6 Predicted cumulative incidence of cancer after hip replacement by bearing surface for a typical patient.

	Year 1	Year 2	Year 3	Year 4	Year 5
60-year old males					
Resurfacing	0.81% (0.73-0.89)	1.75% (1.59-1.92)	2.72% (2.48-2.99)	3.72% (3.39-4.09)	4.78% (4.36-5.25)
Stemmed metal-on-metal	1.05% (0.97-1.15)	2.28% (2.10-2.47)	3.54% (3.27-3.83)	4.83% (4.46-5.22)	6.19% (5.73-6.68)
Other bearing surfaces	1.15% (1.10-1.20)	2.48% (2.38-2.58)	3.85% (3.70-4.00)	5.25% (5.05-5.45)	6.72% (6.47-6.98)
60-year old females					
Resurfacing	0.52% (0.47-0.57)	1.12% (1.01-1.24)	1.75% (1.59-1.93)	2.40% (2.17-2.64)	3.09% (2.80-3.40)
Stemmed metal-on-metal	0.68% (0.62-0.74)	1.46% (1.35-1.59)	2.28% (2.10-2.47)	3.12% (2.88-3.38)	4.01% (3.70-4.34)
Other bearing surfaces	0.74% (0.70-0.77)	1.59% (1.52-1.66)	2.48% (2.38-2.58)	3.39% (3.26-3.53)	4.36% (4.20-4.53)

Note: Results are estimated from multivariable competing risks flexible parametric survival models based on 21,264 stemmed metal-on-metal cases, 19,312 resurfacing procedures, and 248,995 hip replacements with other bearing surfaces. Values of the model covariates are held constant at age of 60 years old, an ASA grade of 2, two previous admissions, and three diagnosis codes at admission.

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Summary

Despite the theoretical risks, we did not find a link between metal-on-metal hip replacements (either stemmed or resurfacing) and increased incidence of cancer diagnosis in the first seven years after hip replacement. The incidence of cancer diagnosis is low after hip replacement and is lower than that predicted for the age and gender matched general population.

However, we cannot extrapolate these findings into the long term as some cancers take a long time to develop. To determine whether metal-on-metal hip replacements are associated with an increased risk of cancer in the long term, we need more longitudinal data as well as more research to help determine the biological consequences of metal exposure and thereby provide a strong theoretical basis to predict which cancers might arise. The analysis reported here will need to be repeated in the future with a longer follow-up of the NJR-HES linked data.

The difficulty of finding a suitable population with which to compare patients with metal-on-metal articulations remains. That the analysis found a reduced incidence of certain cancers in patients with metal-on-metal bearing surfaces is not easy to explain and could reflect a “well patient” effect and the difficulties of adequately measuring and controlling for differences in general health and wellbeing. In particular, the comparison between patients undergoing resurfacing procedures and those with other bearing surfaces is not straightforward. As well as undergoing a different surgical procedure, patients undergoing resurfacing procedures tend to be much younger and more active than other hip replacement patients and are usually selected for the alternative resurfacing procedure for precisely these reasons. Similarly, it is possible that there are differences in the groups of patients who have stemmed metal-on-metal prostheses and those with other bearing surfaces, resulting in confounding by indication. In addition, as all joint replacements produce some metal debris, even if the

bearing surfaces are not metal, it would be prudent to compare them with a control group of patients without joint replacements. The control group would also need to have osteoarthritis as this is associated with lower rates of cancer. This comparison could again be difficult because of a "well patient" effect as patients who have undergone total joint replacement have been shown to have a lower mortality from all-causes and, in this analysis, a lower incidence of cancer than the general population.

3.3.8 Conclusions and recommendations

Last year for the first time we drew some conclusions from the data presented in the Annual Report, rather than simply allow the reader to draw their own conclusions. We did this as the data showed some very strong trends that merited further discussion. We hoped that practitioners and manufacturers would evaluate their practice in light of the data. We accept that the data are open to other interpretations and we welcome this. Furthermore, we must once again stress that implant survivorship alone is an incomplete measure of outcome. Implant survivorship gives little indication of satisfaction, relief of pain, improvement in function and greater participation in society. Readers should also understand that each year more data are available and thus analysis can give a more accurate picture. Each year's analysis thus supercedes the previous analyses and may, in places, appear contradictory with previous reports from a smaller dataset. Furthermore, the data are imperfect and rely on accurate and comprehensive reporting by surgeons. Some fields, such as BMI, are so poorly reported to make any analysis of the variable highly uncertain. We would thus urge surgeons to complete all fields in the NJR forms in order to allow meaningful analysis.

The data continue to support the conclusions drawn last year showing a markedly higher failure rate with metal-on-metal bearing surfaces particularly with stemmed metal-on-metal, but to a lesser degree with resurfacing hip arthroplasty. Likewise, ceramic-on-metal is showing a higher than expected failure rate, although we only have sufficient data to allow an accurate analysis for up to three-year follow up. Other bearing surfaces all appear to have low failure rates regardless of type of fixation suggesting that there are a number of acceptable ways of undertaking hip arthroplasty.

Brand analysis of stem/cup combinations shows higher failure rates with uncemented stem/cup combinations than with hybrid or all cemented combinations. Further sub-analysis of the most commonly used brands suggests that this is due to the use of metal-on-metal bearing surfaces, with uncemented stem/cup combinations doing well when used with other bearings. The in-depth analysis of bearing surfaces with stemmed femoral prostheses reported in The Lancet showed that failure rates for metal-on-metal increased with increased head size, but the opposite was true for ceramic-on-ceramic bearing surfaces, where larger heads appear to give better implant survivorship.

As metal-on-metal stemmed articulations give poor implant survival compared with other options, they should not be implanted. All patients with these bearings should be carefully monitored, particularly young women implanted with large diameter heads. This is in line with the recent recommendations by the British Orthopaedic Association and British Hip Society. Since large diameter ceramic-on-ceramic bearings seem to do well we support their continued use.

Image-guided and minimally-invasive surgery do not appear to affect implant survivorship in the short- to medium-term.

In view of the theoretical risks of cancer posed by exposure to cobalt and chromium we investigated the risks of developing cancer after metal-on-metal hip replacements compared to alternative bearing surfaces. Due to the age of the NJR we could only assess the risk for the first seven years after hip replacement and are happy to report that we could not identify an increased risk of developing cancer. We must, however, point out that many cancers have prolonged latency after initial exposure to carcinogens and thus long-term follow up is needed to provide a definitive answer.

Mortality in the first 30 or 90 days after surgery remains very low suggesting there is little additional risk of dying associated with hip replacement. However, the majority of patients over the age of 80 years die within eight years of surgery, suggesting that long-term implant survivorship is not a critical factor in treating this group.

Part 3

3.4 Outcomes after primary knee replacement 2003 to 2011

This section contains statistical analysis of the survivorship of knee replacements in the period up to almost nine years after primary surgery (1 April 2003 to 31 December 2011). This analysis examines the length of time between the primary knee replacement and the first revision of that knee replacement or the patient's death.

Methodological note

Throughout this section, survival analysis is used to examine the length of time between a primary joint replacement and the first revision or the time between surgery and the patient's death. Survival analysis involves a shift from analysing people or operations to analysing time. It has the advantage of being able to handle the unequal lengths of time that people have been observed and so does not require those who have not been observed for a certain time period to be dropped from the analysis (as this can introduce bias). Aspects of this analysis (for example, the cumulative hazard or the cumulative incidence function) indicate the risk of an event happening over continuous time and so can be used to approximate incidence rates at certain time points.

Terminology note

Both total and partial knee replacement procedures are discussed in this section. At present, the NJR does not differentiate between medial and lateral unicondylar knee replacements. Changes to data collection methods will enable this in the future. There are also other knee designs, such as combinations of unicondylar and patello-femoral joint replacements, but these are not considered here as numbers are too small to comment.

With regard to constraint, total knee replacements are termed unconstrained (often referred to as posterior cruciate-retaining) or posterior-stabilised (also referred to as posterior cruciate-stabilised).

3.4.1 Types of knee replacement

A variety of different types of knee replacement have been used in England and Wales because of the various types of constraint, bearings, and methods of fixation available (Table 3.14). Many surgeons use a mix of different types of knee replacement but some types were less commonly used (Table 3.14). For example, 43% of surgeons had never performed unicondylar knee replacements and 70% had never performed patello-femoral knee replacements. Uncemented and hybrid fixation were not used by a majority of surgeons (73% and 70% respectively). Even with cemented total knee replacements, most surgeons had never used mobile bearings with either unconstrained (64%) or posterior-stabilised (85%) designs. Unlike hip replacements, there were little changes between 2003 and 2011 in the types of knee replacements used (Table 3.15).

Table 3.14 Types of primary knee replacement by fixation, constraint and bearing type.

	Number	Percentage of total	Number of primary operations 2003 to 2011					
			Surgeons (n=2,156)			Units (n=430)		
			0	1-9	10+	0	1-9	10+
All cemented	**413,768**	**82.8%**	**0.3%**	**2.0%**	**97.6%**	**0.0%**	**0.5%**	**99.5%**
Cemented, unconstrained, fixed	269,427	53.9%	8.7%	12.6%	78.7%	1.6%	4.0%	94.4%
Cemented, unconstrained, mobile	23,839	4.8%	63.8%	24.4%	11.8%	24.9%	33.9%	41.2%
Cemented, posterior-stabilised, fixed	104,731	21.0%	20.6%	32.9%	45.5%	5.3%	11.2%	83.5%
Cemented, posterior-stabilised, mobile	7,294	1.5%	85.3%	10.5%	4.3%	59.1%	24.6%	16.3%
All uncemented	**28,057**	**5.6%**	**73.3%**	**15.2%**	**11.5%**	**37.7%**	**27.9%**	**34.4%**
All hybrid	**7,100**	**1.4%**	**70.0%**	**24.7%**	**5.3%**	**30.2%**	**47.7%**	**22.1%**
Uncemented/hybrid, unconstrained, fixed	17,565	3.5%	72.1%	19.9%	8.0%	35.4%	40.5%	24.2%
Uncemented/hybrid, unconstrained mobile	14,495	2.9%	85.7%	8.1%	6.2%	59.3%	21.2%	19.5%
All unicondylar	**44,081**	**8.8%**	**42.9%**	**26.1%**	**31.0%**	**2.3%**	**13.5%**	**84.2%**
Unicondylar, fixed	11,125	2.2%	72.4%	17.8%	9.8%	21.4%	37.9%	40.7%
Unicondylar, mobile	32,270	6.5%	53.3%	22.7%	24.0%	11.4%	15.8%	72.8%
All patello-femoral	**6,645**	**1.3%**	**69.8%**	**21.2%**	**9.0%**	**19.1%**	**40.2%**	**40.7%**
Other/unknown	12,260	2.5%	65.8%	30.5%	3.7%	26.3%	50.5%	23.3%
All types	**499,651**	**100.0%**						

Note: Base for surgeon/unit analysis is surgeons/units with at least 10 primary operations recorded in the NJR.

Note: There are a small number of unclassified prosthesis that are not included in the sub-divisions of this table.

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Table 3.15 Trends in use of fixation and constraint 2003 to 2011.

Fixation/constraint/bearings	2003	2004	2005	2006	2007	2008	2009	2010	2011
All cemented	**81.5%**	**80.9%**	**81.8%**	**81.4%**	**82.0%**	**81.9%**	**82.7%**	**84.1%**	**85.8%**
Cemented, unconstrained, fixed	53.6%	53.2%	53.5%	51.3%	51.4%	52.2%	53.8%	55.5%	58.5%
Cemented, unconstrained, mobile	4.0%	4.2%	5.2%	6.3%	6.3%	5.6%	4.6%	3.9%	2.9%
Cemented, posterior-stabilised, fixed	20.7%	20.6%	19.7%	20.0%	20.5%	21.0%	21.4%	21.8%	21.6%
Cemented, posterior-stabilised, mobile	0.9%	1.1%	1.6%	1.9%	1.7%	1.4%	1.4%	1.4%	1.3%
All uncemented	**6.7%**	**6.6%**	**6.2%**	**6.5%**	**6.5%**	**6.2%**	**5.7%**	**4.6%**	**3.8%**
All hybrid	**2.8%**	**2.8%**	**2.4%**	**1.8%**	**1.4%**	**1.4%**	**1.2%**	**1.0%**	**0.6%**
Uncemented/hybrid, unconstrained, fixed	4.9%	4.8%	4.3%	4.0%	4.1%	3.9%	3.7%	2.7%	1.8%
Uncemented/hybrid, unconstrained, mobile	3.5%	3.7%	3.3%	3.2%	3.1%	3.1%	2.7%	2.6%	2.3%
All unicondylar	**8.0%**	**8.7%**	**8.6%**	**9.2%**	**8.8%**	**9.1%**	**9.0%**	**8.9%**	**8.4%**
Unicondylar, fixed	1.4%	1.8%	2.1%	2.3%	2.0%	2.1%	2.3%	2.6%	2.5%
Unicondylar, mobile	6.4%	6.7%	6.5%	6.8%	6.7%	6.8%	6.6%	6.2%	5.8%
All patello-femoral	**1.0%**	**1.0%**	**1.0%**	**1.1%**	**1.4%**	**1.5%**	**1.5%**	**1.4%**	**1.4%**
Other/unknown	3.6%	2.9%	2.8%	3.1%	2.8%	2.4%	2.0%	1.9%	1.9%
Base	**13,448**	**27,470**	**41,560**	**49,188**	**66,136**	**73,510**	**75,062**	**77,383**	**75,894**

Note: There are a small number of unclassified prosthesis that are not included in the sub-divisions of this table.

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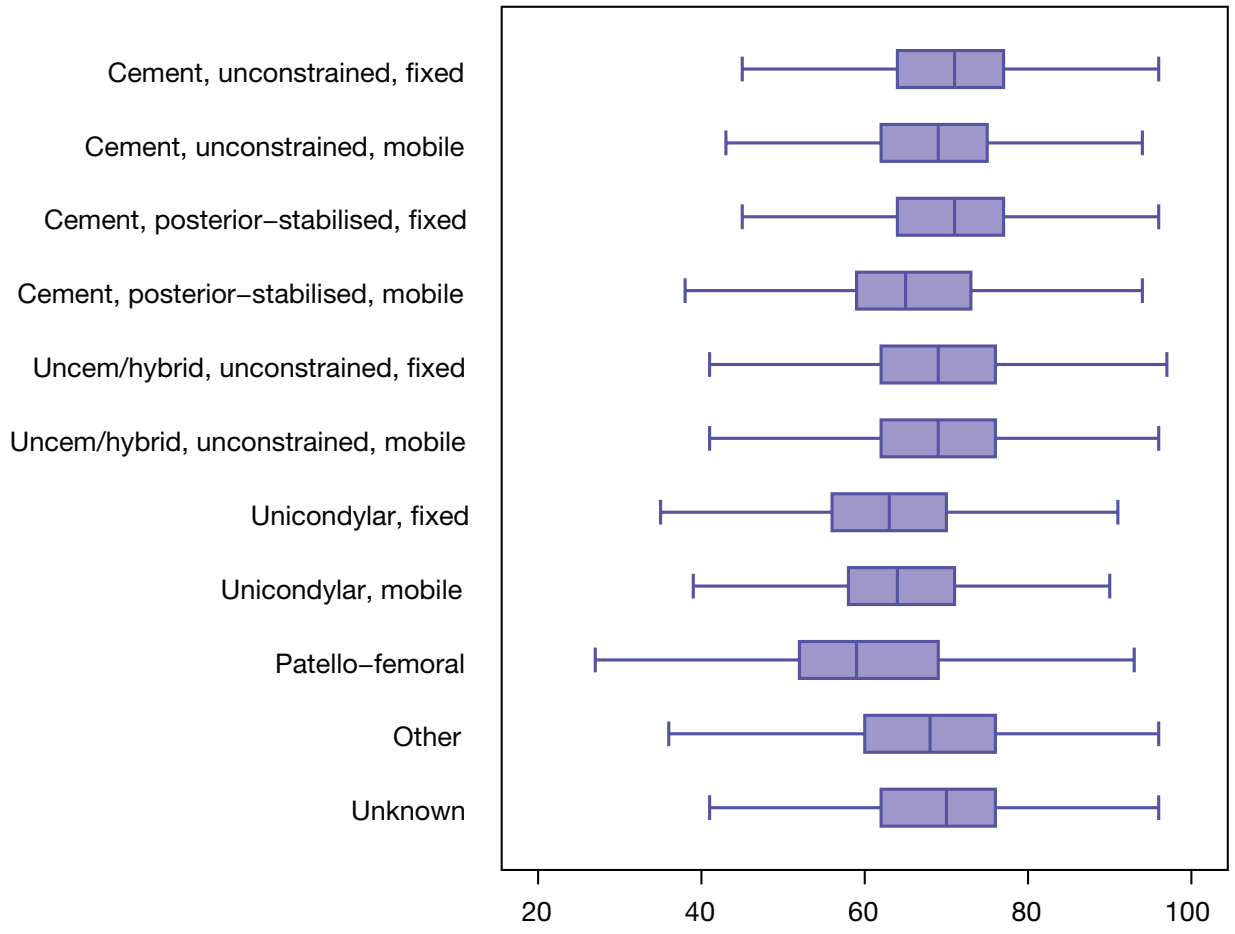
The age profile of knee replacement patients is shown in Figure 3.5. While patients undergoing unicondylar and patello-femoral knee replacements tend to be slightly younger than those with cemented total knees, the differences were not large.

Figure 3.5

Age profile of knee replacement patients by fixation and bearing type.



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Note: The box shows the interquartile range (the 25th-75th percentile) so half of all ages lie in the box. The line across the box is the median age. The whiskers show the upper and lower adjacent values (these are set at the highest or lowest value in the data within a maximum of 1.5 times the interquartile range). Outliers (unusual values outside these whiskers) are not shown on the plot. The box illustrates the likely ages of patients in each group whereas the lengths of the whiskers relative to the length of the box give an idea of how stretched out the rest of the values are.

3.4.2 Risk of revision

This section considers the first revision after primary knee replacement (due to any cause). Tables 3.16 and 3.17 show the short- and medium-term revision rates for the types of knee replacement discussed so far. The lowest rates were associated with cemented unconstrained fixed bearings although the differences between the types of total knee replacement were often small and not always statistically significant (Figures 3.6 and 3.7).

Revision rates were considerably higher for patello-femoral and unicondylar knee replacements (Figure 3.6). For example, the eight-year revision rate was 14.7% for patello-femoral knee replacements and 10.8% for unicondylar knees compared with 2.8% for a cemented total knee replacement (Table 3.17).

Table 3.16 Estimated short-term revision rates after primary knee replacement by fixation, constraint and bearing type (95% confidence intervals).

	30 days	90 days	Year 1	Year 2	Year 3
All cemented	**0.03% (0.03-0.04)**	**0.07% (0.06-0.07)**	**0.36% (0.35-0.38)**	**0.93% (0.90-0.97)**	**1.40% (1.36-1.45)**
Cemented, unconstrained, fixed	0.02% (0.02-0.03)	0.05% (0.04-0.06)	0.31% (0.29-0.34)	0.85% (0.81-0.89)	1.28% (1.23-1.33)
Cemented, unconstrained, mobile	0.09% (0.06-0.14)	0.13% (0.09-0.18)	0.51% (0.43-0.62)	1.22% (1.08-1.38)	1.79% (1.61-1.99)
Cemented, posterior-stabilised, fixed	0.03% (0.02-0.05)	0.08% (0.06-0.09)	0.42% (0.38-0.46)	0.98% (0.91-1.05)	1.49% (1.40-1.58)
Cemented, posterior-stabilised, mobile	0.06% (0.02-0.15)	0.11% (0.06-0.22)	0.66% (0.49-0.89)	1.49% (1.21-1.84)	2.17% (1.81-2.59)
All uncemented	**0.04% (0.02-0.07)**	**0.11% (0.08-0.15)**	**0.62% (0.53-0.73)**	**1.51% (1.36-1.67)**	**2.08% (1.89-2.27)**
All hybrid	**0.03% (0.01-0.11)**	**0.07% (0.03-0.17)**	**0.55% (0.40-0.75)**	**1.32% (1.06-1.63)**	**1.79% (1.48-2.16)**
Uncemented/hybrid, unconstrained, fixed	0.02% (0.01-0.05)	0.07% (0.04-0.12)	0.60% (0.50-0.73)	1.50% (1.32-1.71)	1.96% (1.74-2.20)
Uncemented/hybrid, unconstrained mobile	0.05% (0.02-0.10)	0.14% (0.09-0.22)	0.63% (0.51-0.78)	1.34% (1.15-1.56)	1.94% (1.70-2.22)
All unicondylar	**0.05% (0.03-0.07)**	**0.15% (0.12-0.20)**	**1.22% (1.12-1.34)**	**3.11% (2.93-3.30)**	**4.63% (4.40-4.87)**
Unicondylar, fixed	0.06% (0.03-0.13)	0.12% (0.07-0.20)	0.91% (0.74-1.12)	2.96% (2.62-3.35)	4.72% (4.25-5.24)
Unicondylar, mobile	0.04% (0.03-0.07)	0.17% (0.13-0.22)	1.34% (1.22-1.48)	3.21% (3.00-3.43)	4.65% (4.39-4.94)
All patello-femoral	**0.00%**	**0.06% (0.02-0.16)**	**1.08% (0.84-1.38)**	**3.08% (2.63-3.59)**	**5.42% (4.77-6.15)**
Other/unknown	**0.09% (0.03-0.23)**	**0.20% (0.10-0.38)**	**0.65% (0.45-0.94)**	**2.01% (1.60-2.51)**	**2.96% (2.44-3.59)**
All types	**0.03% (0.03-0.04)**	**0.08% (0.07-0.08)**	**0.47% (0.45-0.49)**	**1.19% (1.16-1.23)**	**1.79% (1.74-1.83)**

Note: Bases are shown in Table 3.14.

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Table 3.17 Estimated medium-term revision rates after primary knee replacement by fixation, constraint and bearing type (95% confidence intervals).

	Year 4	Year 5	Year 6	Year 7	Year 8
All cemented	**1.74% (1.69-1.79)**	**2.04% (1.98-2.10)**	**2.30% (2.24-2.38)**	**2.55% (2.47-2.64)**	**2.82% (2.71-2.94)**
Cemented, unconstrained, fixed	1.58% (1.52-1.64)	1.84% (1.77-1.91)	2.10% (2.02-2.19)	2.34% (2.24-2.44)	2.62% (2.48-2.77)
Cemented, unconstrained, mobile	2.25% (2.03-2.48)	2.56% (2.32-2.83)	2.73% (2.47-3.03)	2.92% (2.61-3.26)	3.13% (2.72-3.62)
Cemented, posterior-stabilised, fixed	1.87% (1.77-1.98)	2.25% (2.13-2.38)	2.52% (2.38-2.67)	2.79% (2.62-2.98)	3.09% (2.86-3.35)
Cemented, posterior-stabilised, mobile	2.60% (2.19-3.09)	2.94% (2.48-3.50)	3.43% (2.86-4.11)	3.63% (2.96-4.46)	3.63% (2.96-4.46)
All uncemented	**2.45% (2.24-2.67)**	**2.78% (2.55-3.04)**	**3.09% (2.82-3.38)**	**3.44% (3.11-3.81)**	**3.69% (3.29-4.14)**
All hybrid	**2.03% (1.69-2.43)**	**2.30% (1.93-2.75)**	**2.49% (2.08-2.98)**	**2.84% (2.36-3.43)**	**2.95% (2.43-3.59)**
Uncemented/hybrid, unconstrained, fixed	2.21% (1.97-2.47)	2.44% (2.18-2.74)	2.60% (2.31-2.92)	3.02% (2.65-3.44)	3.08% (2.69-3.53)
Uncemented/hybrid, unconstrained mobile	2.32% (2.04-2.63)	2.67% (2.35-3.03)	2.96% (2.60-3.37)	3.17% (2.77-3.64)	3.44% (2.91-4.07)
All unicondylar	**5.95% (5.67-6.24)**	**7.24% (6.90-7.59)**	**8.46% (8.05-8.90)**	**9.84% (9.30-10.42)**	**10.82% (10.10-11.59)**
Unicondylar, fixed	6.09% (5.52-6.73)	7.23% (6.55-7.98)	8.39% (7.57-9.31)	9.38% (8.35-10.54)	10.14% (8.84-11.63)
Unicondylar, mobile	5.98% (5.65-6.32)	7.32% (6.93-7.74)	8.55% (8.07-9.06)	10.04% (9.40-10.71)	11.08% (10.24-11.99)
All patello-femoral	**7.40% (6.57-8.34)**	**9.51% (8.45-10.71)**	**10.36% (9.17-11.70)**	**11.81% (10.33-13.51)**	**14.70% (12.01-18.00)**
Other/unknown	**3.70% (3.09-4.44)**	**4.24% (3.55-5.08)**	**4.72% (3.93-5.68)**	**5.42% (4.45-6.59)**	**6.02% (4.81-7.53)**
All types	**2.23% (2.18-2.29)**	**2.64% (2.58-2.70)**	**2.99% (2.92-3.07)**	**3.36% (3.27-3.45)**	**3.71% (3.59-3.84)**

Note: Bases are shown in Table 3.14.

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Figure 3.6

Risk of revision following primary knee replacement (cumulative hazard with 95% confidence intervals), by prosthesis type.

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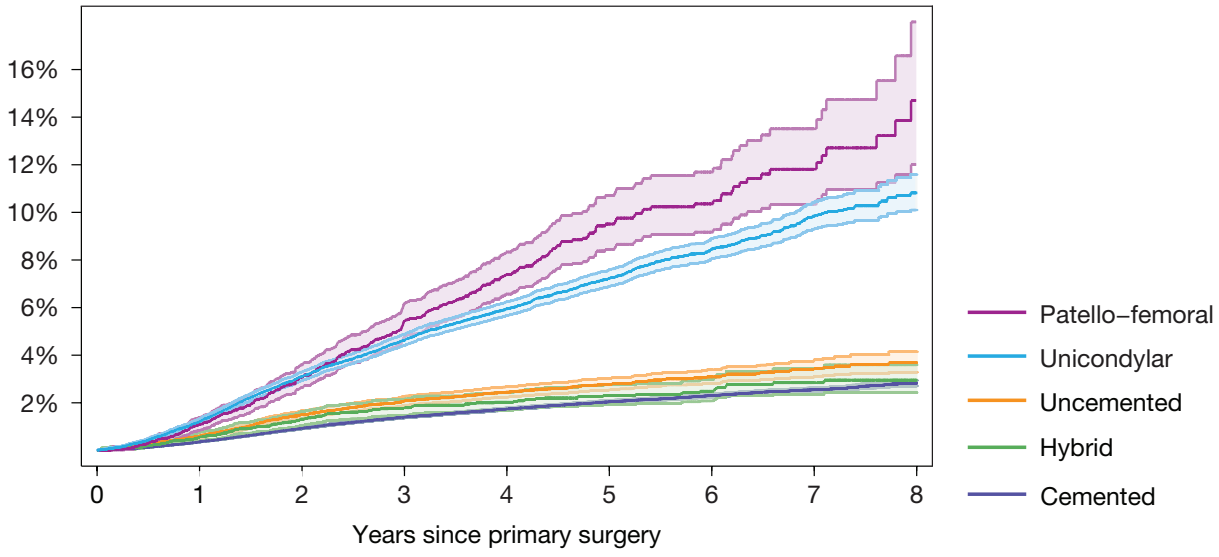

Figure 3.7

Risk of revision following primary knee replacement (cumulative hazard with 95% confidence intervals), by constraint and bearings for cemented fixation.

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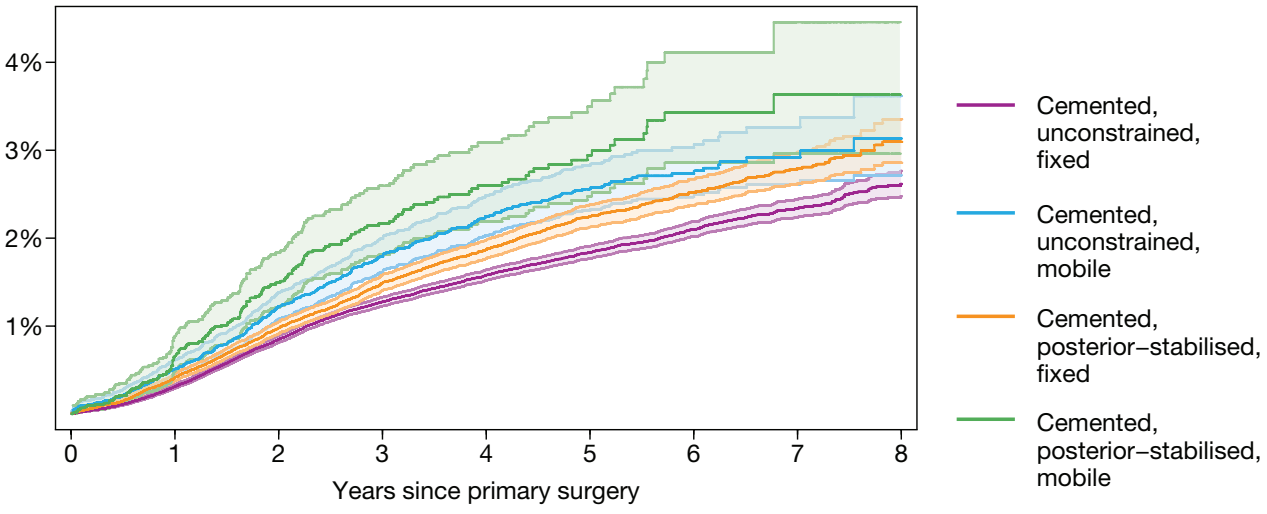

3.4.3 Reasons for first revision

This section considers the reason for the first revision of a primary knee replacement.

Methodological note

More than one reason for revision can be recorded in the NJR and so this section calculates an incidence rate of revision for each reason. The PTIR used here divides the number of revisions for that reason by the total length of time the patients have been observed to be at risk of revision (that is the time between the date of primary surgery and the date of revision, date of death, or 31 December 2011). It is shown in the format of the number of revisions per thousand observed years. This is a standardised format that avoids the need to choose time-points at which to estimate incidence rates. However, it does not give any information about how the risk of revision might change over time and it therefore may be an inappropriate indicator of survivorship if the risk of revision is not constant and does vary substantially over time.

The results in this section enable straightforward comparisons to be made across and between the different groups. Comparing the incidence rates for the reasons for revision for a type of knee replacement enables the most common reasons for revision to be identified (those with the highest PTIR). Likewise, comparing the different types of knee replacement for each reason for revision enables us to see if certain knee replacements are more commonly associated with particular reasons for revision than others.

For cemented total knee replacements, there were few significant differences between the different constraint and bearing types (Tables 3.18 and 3.19).

Unicondylar knee replacements were around five times more likely to be revised for pain than were cemented total knee replacements (Table 3.18). They were also around four times more likely to be revised for loosening. Patello-femoral knee replacements were also primarily revised for pain and revisions for pain were more than six times higher than among cemented knee replacement patients (Table 3.18).

Table 3.18 Reasons for revision after primary knee replacement: patient time incidence rates per 1,000 years (95% confidence intervals).

Fixation/bearings	Pain	Dislocation/ subluxation	Infection	Aseptic loosening	Lysis	Periprosthetic fracture
All cemented	**0.75 (0.70-0.80)**	**0.14 (0.12-0.16)**	**1.13 (1.08-1.19)**	**0.98 (0.93-1.03)**	**0.22 (0.20-0.25)**	**0.11 (0.09-0.13)**
Cemented, unconstrained, fixed	0.73 (0.67-0.78)	0.12 (0.10-0.15)	1.02 (0.96-1.09)	0.84 (0.78-0.90)	0.20 (0.17-0.23)	0.07 (0.06-0.09)
Cemented, unconstrained, mobile	0.94 (0.76-1.17)	0.22 (0.14-0.34)	1.28 (1.06-1.54)	1.24 (1.03-1.50)	0.31 (0.21-0.45)	0.17 (0.10-0.29)
Cemented, posterior-stabilised, fixed	0.66 (0.58-0.76)	0.13 (0.10-0.18)	1.33 (1.22-1.46)	1.20 (1.09-1.32)	0.25 (0.20-0.31)	0.16 (0.12-0.21)
Cemented, posterior-stabilised, mobile	1.36 (0.97-1.91)	0.28 (0.13-0.59)	0.92 (0.61-1.39)	1.00 (0.68-1.48)	0.24 (0.11-0.54)	0.28 (0.13-0.59)
All uncemented	**1.31 (1.10-1.55)**	**0.31 (0.22-0.44)**	**0.90 (0.73-1.10)**	**1.99 (1.74-2.28)**	**0.27 (0.19-0.40)**	**0.14 (0.08-0.23)**
All hybrid	**1.04 (0.73-1.48)**	**0.20 (0.09-0.45)**	**1.27 (0.93-1.75)**	**1.31 (0.96-1.80)**	**0.30 (0.16-0.58)**	**0.10 (0.03-0.31)**
Uncemented/hybrid, unconstrained, fixed	1.04 (0.83-1.32)	0.15 (0.08-0.28)	1.02 (0.80-1.29)	1.69 (1.40-2.03)	0.18 (0.10-0.32)	0.07 (0.03-0.18)
Uncemented/hybrid, unconstrained mobile	1.34 (1.06-1.69)	0.42 (0.28-0.64)	0.94 (0.71-1.24)	1.91 (1.57-2.33)	0.40 (0.26-0.62)	0.19 (0.10-0.36)
All unicondylar	**3.94 (3.63-4.27)**	**0.87 (0.73-1.03)**	**0.76 (0.63-0.91)**	**4.01 (3.70-4.35)**	**0.44 (0.35-0.57)**	**0.33 (0.25-0.43)**
Unicondylar, fixed	4.68 (4.02-5.46)	0.17 (0.08-0.39)	0.78 (0.54-1.14)	4.51 (3.86-5.28)	0.43 (0.26-0.72)	0.32 (0.18-0.57)
Unicondylar, mobile	3.72 (3.37-4.10)	1.10 (0.92-1.31)	0.76 (0.61-0.94)	3.90 (3.55-4.29)	0.46 (0.35-0.60)	0.34 (0.24-0.47)
All patello-femoral	**5.21 (4.31-6.29)**	**1.01 (0.66-1.55)**	**0.34 (0.16-0.71)**	**1.88 (1.37-2.58)**	**0.10 (0.02-0.39)**	**0.24 (0.10-0.58)**
Other/unknown	**2.13 (1.54-2.96)**	**0.65 (0.36-1.18)**	**1.84 (1.30-2.61)**	**1.96 (1.39-2.75)**	**0.18 (0.06-0.55)**	**0.30 (0.12-0.71)**

Note: Bases are shown in Table 3.14.

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Note: bases are shown in Table 3.14

Table 3.19 Reasons for revision after primary knee replacement: patient time incidence rates per 1,000 years (95% confidence intervals).

Fixation/bearings	Implant fracture	Implant failure	Instability	Malalignment	Stiffness	Other
All cemented	**0.02 (0.01-0.03)**	**0.16 (0.14-0.18)**	**0.62 (0.58-0.66)**	**0.34 (0.31-0.38)**	**0.34 (0.31-0.37)**	**0.44 (0.41-0.48)**
Cemented, unconstrained, fixed	0.02 (0.01-0.03)	0.13 (0.11-0.16)	0.57 (0.52-0.62)	0.35 (0.32-0.40)	0.33 (0.30-0.37)	0.44 (0.40-0.48)
Cemented, unconstrained, mobile	0.01 (0.00-0.08)	0.23 (0.15-0.36)	0.96 (0.77-1.18)	0.40 (0.29-0.56)	0.46 (0.34-0.63)	0.41 (0.30-0.57)
Cemented, posterior-stabilised, fixed	0.01 (0.00-0.03)	0.20 (0.16-0.25)	0.60 (0.52-0.69)	0.31 (0.26-0.38)	0.29 (0.24-0.35)	0.38 (0.32-0.45)
Cemented, posterior-stabilised, mobile	0.08 (0.02-0.32)	0.16 (0.10-0.43)	1.04 (0.71-1.53)	0.24 (0.11-0.54)	1.00 (0.68-1.48)	1.20 (0.84-1.72)
All uncemented	**0.07 (0.03-0.14)**	**0.18 (0.11-0.28)**	**0.91 (0.74-1.11)**	**0.59 (0.45-0.75)**	**0.55 (0.42-0.71)**	**0.52 (0.40-0.68)**
All hybrid	**0.07 (0.02-0.27)**	**0.34 (0.18-0.62)**	**0.80 (0.54-1.20)**	**0.44 (0.25-0.75)**	**0.34 (0.18-0.62)**	**0.17 (0.07-0.40)**
Uncemented/hybrid, unconstrained, fixed	0.06 (0.02-0.16)	0.19 (0.11-0.33)	0.84 (0.64-1.09)	0.45 (0.31-0.64)	0.46 (0.33-0.66)	0.40 (0.28-0.59)
Uncemented/hybrid, unconstrained mobile	0.08 (0.03-0.20)	0.27 (0.16-0.45)	0.90 (0.68-1.20)	0.59 (0.42-0.84)	0.42 (0.28-0.64)	0.32 (0.20-0.52)
All unicondylar	**0.05 (0.03-0.11)**	**0.90 (0.76-1.07)**	**1.03 (0.88-1.21)**	**0.78 (0.65-0.94)**	**0.26 (0.19-0.36)**	**3.26 (2.98-3.57)**
Unicondylar, fixed	0.09 (0.03-0.27)	0.61 (0.40-0.93)	0.84 (0.58-1.21)	0.69 (0.47-1.04)	0.35 (0.20-0.61)	3.06 (2.53-3.71)
Unicondylar, mobile	0.04 (0.01-0.10)	1.00 (0.83-1.20)	1.08 (0.90-1.29)	0.81 (0.66-1.00)	0.24 (0.16-0.35)	3.35 (3.03-3.71)
All patello-femoral	**0.10 (0.02-0.39)**	**1.45 (1.01-2.07)**	**0.92 (0.58-1.44)**	**1.59 (1.13-2.24)**	**0.53 (0.29-0.96)**	**6.56 (5.55-7.76)**
Other/unknown	**0**	**0.29 (0.12-0.71)**	**1.07 (0.61-1.69)**	**0.71 (0.40-1.25)**	**0.71 (0.40-1.25)**	**0.83 (0.49-1.40)**

Note: Bases are shown in Table 3.14.

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3.4.4 Revision rates for main implant brands

Revision rates by brand are shown for bicondylar knee replacements in Table 3.20. The lowest revision rates were associated with the MRK and Triathlon brands although the market leader, the PFC Sigma, was not much higher. Once 95% confidence intervals are taken into account, there were not vast differences between any of the brands.

Methodological note

In this section, all-cause revision rates are shown. Analysis is only shown for brands with at least 2,500 patients. This cut-off point was chosen because analysis based on fewer patients results in more uncertain estimations (demonstrated by wide confidence intervals) which make any comparisons problematic. Because of smaller initial group sizes for unicondylar and patello-femoral replacements, this cut-off point has been reduced to 1,000 patients but this does result in some very wide confidence intervals and so comparisons should be made cautiously. Revision rates are estimated for years one, three, five and seven but are only shown where at least 100 patients have been observed for at least that period of time.

In addition, the analysis here is unadjusted in that it does not control for patient characteristics or any other factors that could influence revision rates. It should be noted that there may be variations in revision rates within a particular brand grouping because of different constraints (e.g. unconstrained/ posterior-stabilised) and bearing types used. This is illustrated further for the most-commonly used brands. Overlapping 95% confidence intervals mean that differences are unlikely to be statistically significant and so could simply reflect random variation.

Table 3.20 Revision rates (all-cause) by main implant brands for total knee replacement (95% confidence intervals).

Brand	Number of patients	Year 1	Year 3	Year 5	Year 7
Advance MP	4,308	0.26% (0.14-0.48)	1.65% (1.26-2.16)	2.03% (1.57-2.64)	3.04% (2.20-4.18)
AGC	48,359	0.28% (0.23-0.33)	1.39% (1.27-1.51)	1.93% (1.78-2.10)	2.49% (2.27-2.73)
Columbus	3,310	0.52% (0.31-0.86)	2.10% (1.56-2.82)	2.95% (2.14-4.07)	-
Endoplus Bicondylar Knee	13,342	0.71% (0.58-0.87)	1.74% (1.52-2.00)	2.42% (2.12-2.76)	2.88% (2.43-3.40)
Genesis 2	27,455	0.42% (0.34-0.51)	1.39% (1.23-1.59)	2.17% (1.90-2.47)	2.46% (2.11-2.87)
Kinemax	10,819	0.24% (0.17-0.36)	1.78% (1.54-2.06)	2.71% (2.40-3.07)	3.50% (3.10-3.94)
LCS Complete	15,922	0.47% (0.37-0.59)	1.53% (1.32-1.78)	2.39% (2.07-2.76)	-
MRK	4,712	0.27% (0.15-0.47)	0.97% (0.69-1.35)	1.14% (0.80-1.62)	1.33% (0.88-2.02)
Nexgen	61,344	0.34% (0.30-0.39)	1.32% (1.22-1.43)	2.11% (1.96-2.29)	2.79% (2.54-3.05)
PFC Sigma Bicondylar Knee	158,752	0.36% (0.33-0.39)	1.23% (1.17-1.30)	1.72% (1.64-1.81)	2.04% (1.93-2.16)
Profix	4,833	0.47% (0.31-0.72)	1.58% (1.25-2.00)	2.06% (1.66-2.57)	2.48% (1.96-3.14)
Scorpio	31,743	0.40% (0.34-0.48)	1.74% (1.59-1.91)	2.42% (2.22-2.64)	2.98% (2.67-3.32)
Triathlon	21,170	0.38% (0.30-0.48)	1.36% (1.14-1.62)	1.65% (1.36-2.01)	-
Vanguard	10,608	0.33% (0.22-0.49)	1.52% (1.17-1.98)	2.16% (1.60-2.91)	-

Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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For patello-femoral knee replacements, the market leader, the Avon, had lower than average revision rates (10.4% at seven years compared with the overall patello-femoral revision rate of 11.8%). Among unicondylar brands, revision rates varied and the lowest rates were associated with the MG Uni brand (Table 3.21).

Table 3.21 Revision rates (all-cause) by main implant brands for patello-femoral and unicondylar knees (95% confidence intervals).

Brand	Number of patients	Year 1	Year 3	Year 5	Year 7
Patello-femoral					
Avon	3,382	0.71% (0.46-1.07)	3.89% (3.19-4.73)	7.76% (6.56-9.19)	10.41% (8.66-12.50)
FPV	1,012	0.91% (0.45-1.82)	6.91% (4.97-9.60)	-	-
Unicondylar					
AMC/Uniglide	1,965	2.65% (1.99-3.52)	7.44% (6.14-9.03)	9.75% (8.06-11.80)	-
MG Uni	2,340	0.91% (0.59-1.39)	3.85% (3.11-4.78)	5.58% (4.60-6.77)	6.64% (5.44-8.11)
Oxford Partial Knee	31,309	1.16% (1.04-1.29)	4.29% (4.03-4.57)	6.85% (6.46-7.26)	9.61% (8.96-10.30)
Preservation	1,501	2.30% (1.64-3.22)	7.45% (6.15-9.03)	10.72% (9.03-12.72)	14.25% (11.86-17.12)
Sigma HP	2,054	0.96% (0.59-1.58)	-	-	-
Zimmer Uni	2,570	0.55% (0.31-0.97)	2.92% (2.11-4.03)	-	-

Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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Six brands had large enough numbers for the analysis to compare different constraint and bearing types (Table 3.22). There were some interesting differences observed although these were not large in magnitude. For the PFC Sigma and Scorpio brands, the cemented, unconstrained, fixed bearings version had superior revision rates to the cemented, unconstrained, mobile bearings version. For the Genesis 2 brand, the cemented, unconstrained, fixed bearings version had lower revision rates than the posterior-stabilised version. This trend was also seen with the Nexgen and PFC Sigma brands but not with the Scorpio and Triathlon brands where unconstrained and posterior-stabilised versions had very similar revision rates. Uncemented/hybrid fixation was associated with higher revision rates for the AGC and Nexgen brands but not with the PFC Sigma and Scorpio brands.

Table 3.22 Revision rates (all-cause) of most commonly used implants for total knee replacement by fixation, bearing and constraint (95% confidence intervals).

Brand	Number of patients	Year 1	Year 3	Year 5	Year 7
AGC					
Cemented, unconstrained, fixed	45,242	0.24% (0.20-0.29)	1.30% (1.19-1.43)	1.85% (1.69-2.01)	2.39% (2.16-2.63)
Uncemented/hybrid, unconstrained, fixed	1,978	1.16% (0.76-1.76)	3.15% (2.40-4.14)	3.94% (3.00-5.16)	-
Genesis 2					
Cemented, unconstrained, fixed	20,057	0.32% (0.25-0.42)	1.13% (0.96-1.34)	1.87% (1.58-2.22)	2.23% (1.83-2.73)
Cemented, posterior-stabilised, fixed	6,186	0.75% (0.55-1.02)	2.28% (1.83-2.83)	3.30% (2.60-4.17)	-
Nexgen					
Cemented, unconstrained, fixed	23,076	0.22% (0.16-0.29)	1.00% (0.85-1.17)	1.61% (1.38-1.88)	2.12% (1.73-2.61)
Cemented, posterior-stabilised, fixed	31,181	0.40% (0.33-0.48)	1.38% (1.23-2.55)	2.30% (2.07-2.55)	3.06% (2.72-3.44)
Uncemented/hybrid, unconstrained, fixed	4,321	0.49% (0.31-0.75)	2.01% (1.60-2.53)	2.48% (1.99-3.09)	2.83% (2.23-3.60)
PFC Sigma Bicondylar Knee					
Cemented, unconstrained, fixed	99,824	0.31% (0.28-0.35)	1.07% (1.00-1.15)	1.50% (1.40-1.61)	1.83% (1.70-1.98)
Cemented, unconstrained, mobile	5,946	0.64% (0.46-0.89)	1.93% (1.56-2.38)	2.62% (2.12-3.24)	-
Cemented, posterior-stabilised, fixed	44,202	0.38% (0.32-0.44)	1.37% (1.24-1.50)	1.92% (1.75-2.10)	2.25% (2.03-2.49)
Cemented, posterior-stabilised, mobile	4,594	0.71% (0.49-1.03)	2.30% (1.84-2.88)	3.13% (2.50-3.92)	-
Uncemented/hybrid, unconstrained, fixed	1,576	0.26% (0.10-0.69)	0.85% (0.48-1.50)	1.23% (0.75-2.02)	1.23% (0.75-2.02)
Scorpio					
Cemented, unconstrained, fixed	14,310	0.38% (0.29-0.50)	1.71% (1.48-1.96)	2.40% (2.11-2.73)	2.84% (2.44-3.31)
Cemented, unconstrained, mobile	1,156	0.26% (0.08-0.81)	2.43% (1.65-3.58)	3.50% (2.36-5.21)	-
Cemented, posterior-stabilised, fixed	9,265	0.32% (0.22-0.46)	1.70% (1.43-2.03)	2.39% (2.02-2.83)	2.91% (2.39-3.53)
Cemented, posterior-stabilised, mobile	1,335	0.38% (0.16-0.92)	1.56% (0.99-2.45)	2.07% (1.38-3.10)	-
Uncemented/hybrid, unconstrained, fixed	4,449	0.63% (0.43-0.92)	1.75% (1.37-2.23)	2.16% (1.68-2.78)	-
Triathlon					
Cemented, unconstrained, fixed	15,584	0.31% (0.22-0.42)	1.31% (1.07-1.62)	1.59% (1.27-1.99)	-
Cemented, posterior-stabilised, fixed	4,909	0.48% (0.31-0.75)	1.24% (0.84-1.82)	-	-

Note: Revision rates are only shown where at least 100 patients have been observed for at least that period of time.

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3.4.5 Impact of different surgical techniques

This section considers the impact of using the surgical techniques of minimally-invasive surgery and image-guided surgery.

Methodological note

Information about surgical techniques such as minimally-invasive surgery and image-guided surgery has not always been recorded in the NJR. Most operations recorded in the NJR between 2004 and 2007 did not record this (37.8% of the total). These cases have been excluded from the following analysis. Here, multivariable analysis (a Cox proportional hazards model) has been used to explore whether these surgical techniques were associated with a lower risk of revision after primary knee replacement while controlling for other differences between the patients (age, gender, ASA grade and type of knee replacement) that could also affect revision rates. These models produce hazard ratios. A hazard ratio of one means there is no difference between the groups being compared; a hazard ratio of greater than one indicates an increased risk of revision; and a hazard ratio below one indicates a reduced risk of revision. The 95% confidence interval illustrates a likely range of values where the real result is likely to lie. Where this interval includes the value of one, we cannot be confident that the groups being compared are different and so the result is termed not statistically significant.

Overall, 6.9% of primary knee replacement operations had used minimally-invasive surgery. However, there was a large difference between the use of minimally-invasive surgery in cemented total knee replacements (3.0%) and unicondylar knee replacements (45.6%). Overall, 59.0% of all minimally-invasive surgery was used in unicondylar knee procedures. Only 2.5% of primary knee replacements had used image-guided surgery although this was more commonly used with unconstrained mobile bearings (7.0%).

Multivariable analysis that controlled for age, gender, ASA grade and type of hip replacement found that minimally-invasive surgery was not associated with a lower risk of revision (hazard ratio 0.98, 95% confidence interval 0.87-1.09, p=0.655). Even when looking at only unicondylar knee replacements, there was no statistically significant difference in revision rates between those where minimally-invasive surgery was used (three-year revision rate of 4.0%, 95% confidence interval of 3.5-4.5) and those without (three-year revision rate of 4.7%, 95% confidence interval of 4.3-5.2).

Image-guided surgery was also not associated with a lower risk of revision (hazard ratio 1.15, 95% confidence interval 0.95-1.39, p=0.161).

3.4.6 Risk of death

This section considers the risk of mortality after knee replacement. It is unknown whether surgery itself is associated with an increased risk of death but if it is, we would expect to see this in the first 30 or 90 days after surgery. Longer-term mortality rates may be useful when considering the required longevity of the knee prosthesis.

Methodological note

Analysis in this section does not attempt to investigate whether knee replacement surgery is in itself associated with an increased risk of death. It is complex to disentangle the risk of death associated specifically with undergoing surgery from the risk of death more generally. The risk of death will vary for individual patients by factors such as age, gender and the presence of illness and disease. Therefore, death in the years following knee replacement surgery would not be unexpected for some of

the patients considered here. A comparison with all-cause mortality rates for England and Wales (published by the Office for National Statistics) suggests that joint replacement patients have a lower than expected death rate based on their age and gender alone (Part 3 of NJR 8th Annual Report). This is likely to reflect what has been observed in other research studies that patients undergoing joint replacement may be generally healthier than others of a comparable age and gender. What this section does illustrate is how the risk of death after joint replacement varies greatly by age and gender.

Mortality rates in the first 30 days after surgery are low at around 0.2% although this varies by both age and gender (Table 3.23). In particular, 30-day mortality rates are markedly higher for men over the age of 70 compared with women of the same age. Mortality rates in the first 30 days are extremely low in patients aged under 55 (less than 0.05%). Mortality rates at 90 days post surgery are also low at around 0.4% although again this varies by age and gender.

Table 3.23 Estimated short-term mortality rates after primary knee replacement by age group and gender (95% confidence intervals).

	Number	Percentage of total	30 days	90 days	Year 1	Year 2
Female						
Under 55	19,896	4.0%	0.03% (0.01-0.06)	0.04% (0.02-0.08)	0.14% (0.10-0.21)	0.36% (0.28-0.46)
55-59	24,956	5.0%	0.04% (0.02-0.08)	0.06% (0.04-0.11)	0.27% (0.21-0.34)	0.62% (0.52-0.74)
60-64	40,626	8.1%	0.06% (0.04-0.09)	0.10% (0.07-0.14)	0.36% (0.30-0.42)	0.75% (0.66-0.85)
65-69	48,584	9.7%	0.09% (0.07-0.12)	0.16% (0.12-0.20)	0.48% (0.42-0.55)	1.14% (1.04-1.25)
70-74	55,107	11.0%	0.12% (0.09-0.15)	0.21% (0.17-0.25)	0.75% (0.68-0.83)	1.77% (1.65-1.89)
75-79	51,197	10.3%	0.20% (0.17-0.24)	0.38% (0.33-0.44)	1.35% (1.25-1.46)	3.00% (2.84-3.17)
80+	43,572	8.7%	0.46% (0.40-0.53)	0.90% (0.82-1.00)	2.61% (2.46-2.77)	5.73% (5.48-5.98)
All females	283,938	56.8%	0.16% (0.15-0.18)	0.30% (0.28-0.32)	0.95% (0.92-0.99)	2.14% (2.08-2.20)
Male						
Under 55	14,290	2.9%	0.05% (0.02-0.10)	0.07% (0.04-0.13)	0.29% (0.21-0.40)	0.75% (0.60-0.92)
55-59	19,192	3.8%	0.08% (0.05-0.13)	0.14% (0.10-0.21)	0.44% (0.35-0.55)	0.98% (0.84-1.15)
60-64	36,233	7.3%	0.07% (0.05-0.11)	0.13% (0.10-0.18)	0.53% (0.46-0.62)	1.30% (1.18-1.44)
65-69	41,471	8.3%	0.12% (0.09-0.16)	0.21% (0.17-0.25)	0.77% (0.69-0.87)	1.71% (1.58-1.86)
70-74	43,102	8.6%	0.18% (0.14-0.22)	0.35% (0.29-0.41)	1.21% (1.10-1.32)	2.86% (2.69-3.05)
75-79	35,530	7.1%	0.38% (0.32-0.45)	0.65% (0.57-0.74)	2.14% (1.99-2.31)	4.78% (4.54-5.04)
80+	25,939	5.2%	0.94% (0.83-1.07)	1.60% (1.45-1.77)	4.51% (4.25-4.79)	9.55% (9.13-9.98)
All males	215,757	43.2%	0.26% (0.24-0.28)	0.45% (0.42-0.48)	1.43% (1.37-1.48)	3.16% (3.08-3.25)
All	**499,695**	**100.0%**	**0.20% (0.19-0.21)**	**0.36% (0.35-0.38)**	**1.16% (1.13-1.19)**	**2.58% (2.53-2.63)**

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Longer-term mortality rates suggest that the longevity of the implant is less important for older patients (Table 3.24). For those aged 80 or over at time of surgery, 52% of females and 76% of males had died within eight years of surgery. In contrast, for those aged 55 or under at time of surgery, around 96% were still alive eight years later.

Table 3.24 Estimated medium-term mortality rates after primary knee replacement by age group and gender (95% confidence intervals).

	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Female						
Under 55	0.62% (0.51-0.77)	0.94% (0.78-1.14)	1.33% (1.11-1.60)	1.87% (1.54-2.25)	2.06% (1.69-2.50)	3.14% (2.44-4.06)
55-59	0.96% (0.83-1.11)	1.46% (1.28-1.67)	2.05% (1.81%-2.32)	2.92% (2.58-3.31)	3.74% (3.27-4.27)	4.80% (4.01-5.74)
60-64	1.31% (1.18-1.45)	1.89% (1.73-2.08)	2.59% (2.37-2.83)	3.51% (3.21-3.85)	4.85% (4.39-5.37)	6.10% (5.41-6.88)
65-69	2.03% (1.89-2.19)	3.03% (2.84-3.24)	4.20% (3.94-4.47)	5.52% (5.18-5.88)	6.92% (6.47-7.41)	8.77% (8.05-9.54)
70-74	3.02% (2.85-3.20)	4.46% (4.24-4.69)	6.37% (6.07-6.68)	8.84% (8.43-9.28)	11.49% (10.91-12.09)	14.17% (13.30-15.09)
75-79	5.08% (4.85-5.31)	7.68% (7.37-7.99)	10.85% (10.44-11.27)	15.08% (14.51-15.67)	19.98% (19.17-20.83)	26.69% (25.34-28.10)
80+	10.05% (9.70-10.42)	15.67% (15.18-16.18)	22.21% (21.54-22.90)	30.32% (29.39-31.28)	39.74% (38.38-41.14)	51.76% (49.46-54.16)
All females	3.69% (3.61-3.77)	5.59% (5.48-5.71)	7.87% (7.72-8.03)	10.75% (10.55-10.96)	13.96% (13.67-14.26)	17.93% (17.46-18.41)
Male						
Under 55	1.00% (0.82-1.21)	1.30% (1.08-1.56)	1.75% (1.46-2.10)	2.26% (1.87-2.73)	3.08% (2.51-3.78)	4.15% (3.24-5.33)
55-59	1.60% (1.40-1.82)	2.28% (2.02-2.57)	2.98% (2.66-3.34)	3.83% (3.40-4.30)	5.32% (4.68-6.04)	6.13% (5.30-7.10)
60-64	2.02% (1.85-2.20)	2.94% (2.72-3.18)	4.05% (3.76-4.37)	5.39% (5.00-5.82)	6.58% (6.05-7.15)	8.86% (7.95-9.86)
65-69	3.11% (2.91-3.32)	4.77% (4.50-5.06)	6.30% (5.95-6.66)	8.66% (8.19-9.16)	10.99% (10.35-11.68)	13.42% (12.47-14.43)
70-74	4.95% (4.71-5.21)	7.50% (7.17-7.84)	10.25% (9.82-10.70)	14.26% (13.65-14.89)	18.65% (17.80-19.55)	22.31% (21.11-23.58)
75-79	8.08% (7.73-8.44)	12.16% (11.70-12.65)	17.18% (16.55-17.84)	23.34% (22.48-24.24)	29.72% (28.54-30.96)	38.08% (36.16-40.10)
80+	15.69% (15.11-16.30)	23.50% (22.70-24.33)	32.86% (31.75-34.00)	46.76% (45.10-48.48)	58.73% (56.39-61.17)	75.57% (71.54-79.82)
All males	5.27% (5.16-5.39)	7.85% (7.69-8.00)	10.75% (10.55-10.95)	14.65% (14.37-14.94)	18.47% (18.09-18.86)	22.87% (22.29-23.47)
All	**4.37% (4.30-4.44)**	**6.56% (6.47-6.65)**	**9.10% (8.98-9.22)**	**12.41% (12.24-12.58)**	**15.88% (15.64-16.12)**	**20.03% (19.66-20.40)**

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3.4.7 Conclusions and recommendations

Last year for the first time we drew conclusions and made recommendations derived from the data reported as the NJR Editorial Board felt that the data showed some strong trends that merited further discussion. We hoped that this would provoke debate and encourage surgeons and manufacturers to re-evaluate their practice in light of the evidence provided. We accept that the data are open to other interpretations and we welcome this. Once again, we must stress very strongly that the NJR provides only part of the picture, that of survivorship, and only survivorship of a short- to medium-term duration. We do not know whether these trends will continue in the longer term. Indeed, one of the lessons that we have learnt is that survivorship is not linear. Survivorship also gives little indication of satisfaction, relief of pain, improvement in function and greater participation in society. In many instances these are more important to patients than survivorship. Moreover, the data are imperfect and we are reliant on surgeons completing the data accurately and recording every procedure without exception. Some data fields continue to be poorly completed making meaningful analysis difficult.

Unlike hip arthroplasty, the practice of knee arthroplasty has not changed significantly over the past eight years. This year's analysis shows a continuation of the trends shown previously with total knee replacements surviving markedly better than partial knee replacements.

Overall, the data show that short- to medium-term survivorship is excellent after almost all common types of total knee replacement regardless of fixation, constraint and bearing type. However, multiple studies have now demonstrated that some patients are dissatisfied with their pain and/or function after total knee replacement. We, therefore, advise that surgeons and patients consider patient-based outcome measures in addition to survivorship when choosing prostheses. It is our intention to report both survivorship and, where available, PROMS in next year's Annual Report.

For bicondylar knee replacements, unconstrained implants tended to have slightly lower revision rates than posterior cruciate-stabilised implants while mobile bearing prostheses tended to have a slightly higher failure rate than fixed bearing prostheses. Thus, the lowest revision rates were associated with a cemented, unconstrained, fixed bearing prosthesis. However, these differences are small and the results in all these groups are acceptable. This also holds true for analysis within brands.

Patello-femoral joint replacements have a very high failure rate and were typically revised for pain. However, it should be remembered that patello-femoral joint replacements are undertaken for different reasons than total knee replacements and so a direct comparison of revision rates would be erroneous. Patello-femoral joint replacements may be revised to a total knee replacement because of problems with a different part of the knee and so the reason for revision may be unrelated to the original procedure. In addition, there may be reasons related to the aetiology of patello-femoral arthritis that could explain why replacing the joint, without significantly correcting the underlying biomechanical cause, may not always be a successful strategy. It is interesting to note that the failure rate of patello-femoral replacements is higher than that of stemmed metal-on-metal hip replacements.

Unicondylar knee replacements also have a higher failure rate than total knee replacements (and similar to the failure rate of resurfacing and stemmed metal-on-metal hip replacements). They were commonly revised for pain and loosening. Again, unicondylar knee replacements may be undertaken for different reasons than total knee replacements and they may be revised to a total knee replacement because of disease progression in a non-operated compartment which is unrelated to the original procedure. Therefore, comparing revision rates with total knee replacements is not straightforward. However, given the sizeable difference in failure rates, it would need to be established that unicondylar knee replacements give significantly better function and pain relief to justify using them over a total knee replacement. It is our intention to explore this using PROMS data in the 10th Annual Report.

For the first time we have reported mortality by age following hip and knee arthroplasty. Surprisingly, knee replacement is associated with a slightly lower risk of death compared to hip replacement. We intend to conduct an in-depth analysis of risk of death over the next 12 months.

Part 4: Trust-, Health Board- and unit-level activity and outcomes 2011

4.1 Introduction

For the first time the 9th NJR Annual Report includes a new section. Part Four shows indicators for hip and knee joint replacement procedures at Trust-, Health Board- and unit-level. This data is being published as part of the Government's transparency agenda. This section is based on procedures carried out during the 2011 calendar year and submitted to the NJR by 28 February 2012.

Part Four information is based on the actual operation date (1 January 2011 to 31 December 2011) whereas data in Part One is based on the date the procedure was submitted (1 April 2011 to 31 March 2012). It is therefore possible for a hospital to have zero submissions in Part Four but not be listed as a nil returner in Part One.

Part 4

4.2 Outlier analysis methodology and Trust-, Health Board- and unit-level data

The outlier analysis uses a funnel plot from statistical process control methodology. This aims to distinguish normal variation between units (which is to be expected) from unusual differences (termed 'special-cause' variation) which may indicate the need for further investigation. The funnel plot enables units of different sizes to be compared. Measurements based on smaller numbers of patients will have greater uncertainty from a statistical point of view and this is reflected in the wider confidence limits (the wider part of the funnel in Figures 4.1 and 4.2).

A summary of the methodology for unit revision rates:

- A funnel plot of the standardised revision ratio (SRR) plotted against the number of expected revisions is used. SRR is number of actual revisions divided by number of expected revisions. This is easy to interpret: an SRR of 1 is ideal as the number of actual revisions is equal to the number of expected revisions, an SRR of 2 means that the actual revision rate is twice as high as expected etc.
- The number of expected revisions has been calculated after adjustment for patient characteristics (age group, gender, and diagnosis of patients). In addition, for knee units, adjustment has been made for the percentage of partial knee replacements (patello-femoral and unicondylar procedures) undertaken.
- The confidence limits for the funnel plot are set at four standard deviations. Unit results above the upper confidence limit reflect special-cause variation and are termed 'outliers'. These are indicated in green in Figure 4.1 and Figure 4.2.

Figure 4.1

Funnel plot of revision rates for hip units.

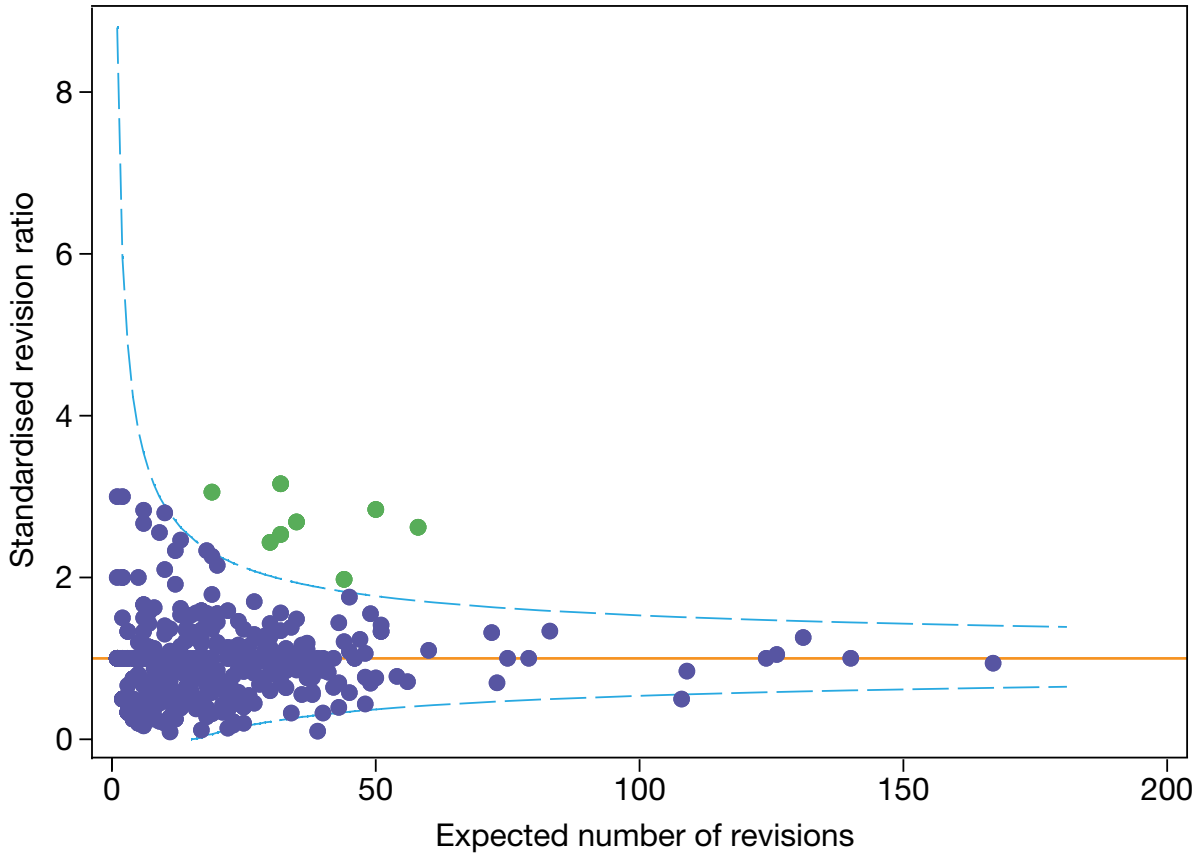

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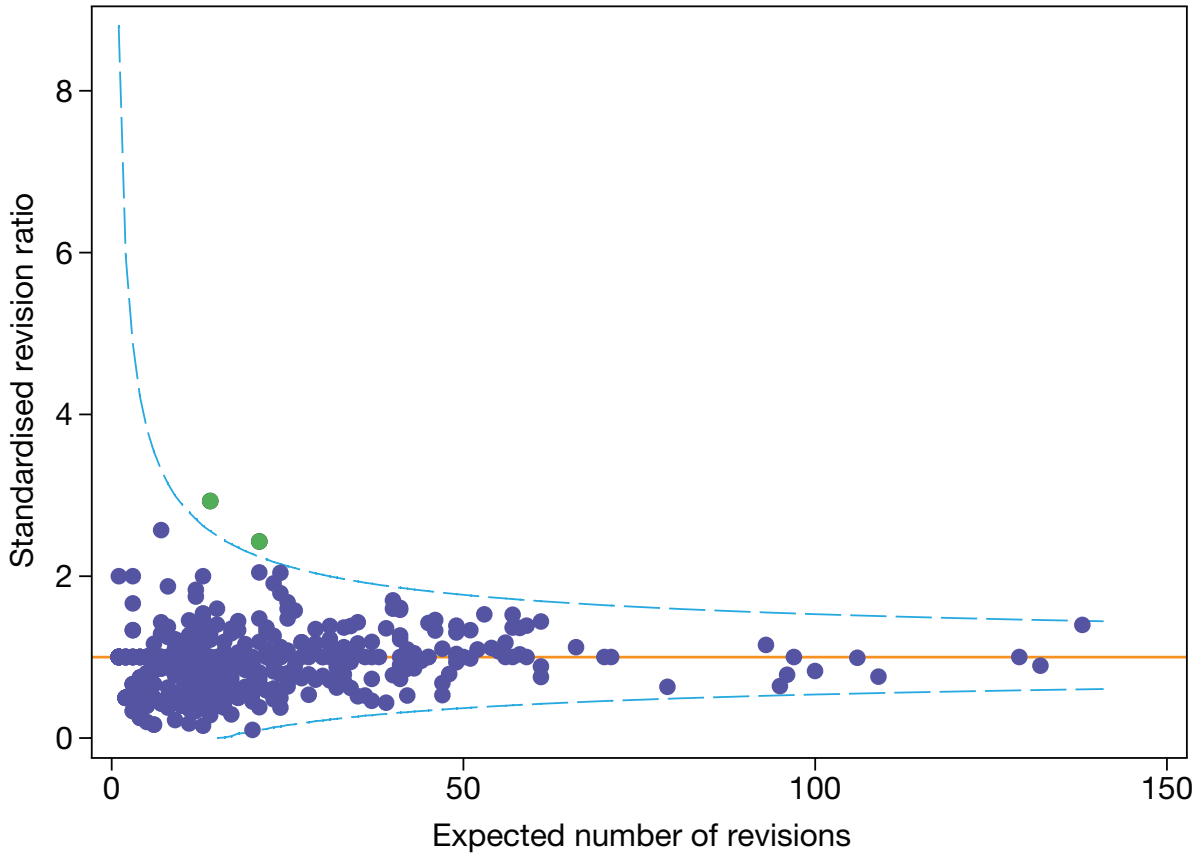
Figure 4.2

Funnel plot of revision rates for knee units.



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Part Three of this Annual Report discusses how metal-on-metal bearing surfaces are associated with higher revision rates than other bearing surfaces. Many of the outlying hip units identified from this analysis have more commonly used stemmed metal-on-metal and resurfacing procedures (Table 4.1) which may explain their higher revision rates.

Table 4.1 Use of metal-on-metal bearing surfaces in outlying hip units 2003 to 2011.

Unit	Stemmed metal-on-metal	Resurfacing	All metal-on-metal
Clifton Park NHS Treatment Centre	18.1%	3.7%	21.8%
Llandough Hospital	35.2%	4.0%	39.3%
Nuffield Health Tees Hospital	23.0%	24.8%	47.8%
Rotherham District General Hospital	37.2%	6.1%	43.3%
Spire Cardiff Hospital	41.6%	10.4%	52.1%
Sussex Orthopaedic NHS Treatment Centre	28.4%	4.4%	32.9%
University Hospital Of Hartlepool	17.4%	9.4%	26.8%
University Hospital Of North Tees	42.2%	24.3%	66.5%
Average across all hip units	7.2%	7.2%	14.4%

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Summary of the methodology for unit 90-day mortality rates:

- A funnel plot of the standardised mortality ratio (SMR) plotted against number of expected deaths is used. The SMR is the number of actual deaths within 90 days of primary joint replacement divided by the number of expected deaths in this period. For example, an SMR of 1 is ideal, an SMR of 2 means that the 90-day mortality rate is twice as high as expected etc.
- The number of expected deaths has been calculated after adjustment for patient characteristics (age, gender, and ASA grade of patients). In addition, for hip units, adjustment is made for whether the operation was undertaken for trauma.
- The confidence limits for the funnel plot are set at four standard deviations.
- As there were no outlying units for 90-day mortality, the funnel plots are not shown here.

Please note for the data in following table:

Compliance, Consent and Linkability are red if lower than 80%, green if 95% or more and amber in between

- Compliance figures may be low due to delayed data entry
- Linkability for some hospitals will be lower than expected if they have private patients from outside England and Wales
- Part 4 data covers procedures carried out between 1 January 2011 and 31 December 2011

The table uses the following footnotes:

14 Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW

15 Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed

16 Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR

17 Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Abertawe Bro Morgannwg University Local Health Board	89%											
Morriston Hospital	850	11	99%	96%	2.0	44%	68.8	30%	26%			
Neath Port Talbot Hospital	619	11	96%	99%	2.1	42%	68.2	0%	41%			
Princess Of Wales Hospital	192	8	94%	98%	2.0	41%	69.4	0%	81%			
Aintree University Hospitals NHS Foundation Trust	83%											
University Hospital Aintree	576	10	63%	95%	2.1	40%	67.2	79%	100%			
Airedale NHS Foundation Trust	95%											
Airedale General Hospital	472	9	100%	100%	2.2	45%	71.4	14%	75%			
Aneurin Bevan Local Health Board	95%											
Nevill Hall Hospital	808	10	99%	100%	2.2	42%	69.9	10%	98%			
Royal Gwent Hospital	358	13	87%	98%	2.3	42%	69.6	1%	36%			
St Woolos Hospital	782	18	99%	98%	2.0	48%	67.5	1%	37%			
Ashford And St Peter's Hospitals NHS Foundation Trust	0%											
Ashford Hospital	0											
St Peter's Hospital	0											
Barking Havering And Redbridge University Hospitals NHS Trust	67%											
King George Hospital	339	11	90%	94%	2.3	39%	70.1	4%	11%			
Barnet And Chase Farm Hospitals NHS Trust	72%											
Barnet Hospital	155	6	99%	99%	2.1	38%	71.8	0%	82%			
Chase Farm Hospital	330	12	62%	82%	2.1	42%	70.2	16%	93%			
Barnsley Hospital NHS Foundation Trust	80%											
Barnsley District General Hospital	469	7	92%	99%	1.9	47%	66.6	6%	96%			
Barts And The London NHS Trust	75%											
The Royal London Hospital	312	12	99%	93%	2.0	43%	67.5	21%	93%			

[14] Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW
[15] Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed
[16] Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR
[17] Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Basildon And Thurrock University Hospitals NHS Foundation Trust	86%											
Basildon University Hospital	651	11	100%	100%	2.2	41%	68.8	43%	79%			
Bedford Hospital NHS Trust	91%											
Bedford Hospital South Wing	409	6	92%	100%	2.1	42%	70.9	68%	31%			
Betsi Cadwaladr University Local Health Board	85%											
Abergele Hospital	411	7	98%	98%	2.0	44%	69.9	44%	85%			
Glan Clwyd General Hospital	37	7	100%	100%	2.7	46%	74.3	59%	76%			
Wrexham Maelor Hospital	367	9	97%	97%	2.1	46%	69.3	0%	39%			
Ysbyty Gwynedd	501	6	96%	95%	2.2	42%	69.9	17%	66%			
Blackpool Teaching Hospitals NHS Foundation Trust	86%											
Blackpool Victoria Hospital	537	9	99%	97%	2.1	44%	70.4	49%	66%			
Bradford Teaching Hospitals NHS Foundation Trust	18%											
Bradford Royal Infirmary	124	7	93%	95%	2.0	46%	67.5	3%	20%			
Brighton And Sussex University Hospitals NHS Trust	80%											
Princess Royal Hospital	325	8	67%	96%	2.7	35%	71.9	35%	50%			
Royal Sussex County Hospital	79	13	66%	95%	2.7	29%	74.7	2%	97%			
Buckinghamshire Healthcare NHS Trust	78%											
Stoke Mandeville Hospital	25	7	92%	80%	2.4	35%	74.1	64%	92%			
Wycombe Hospital	679	10	95%	99%	2.2	36%	70.5	48%	83%			
Calderdale And Huddersfield NHS Foundation Trust	84%											
Calderdale Royal Hospital	920	11	92%	98%	2.1	45%	69.1	60%	56%			
Cambridge University Hospitals NHS Foundation Trust	88%											
Addenbrooke's Hospital	814	11	99%	99%	2.0	40%	69.7	43%	94%			
Cardiff and Vale University Local Health Board	79%											
Llandough Hospital	1,228	14	91%	98%	2.1	39%	68.2	0%	57%			

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Central Manchester University Hospitals NHS Foundation Trust	81%											
Manchester Royal Infirmary	332	10	94%	94%	2.3	45%	66.5	19%	60%			
Chelsea And Westminster Hospital NHS Foundation Trust	61%											
Chelsea & Westminster Hospital	233	8	64%	83%	1.9	41%	70.8	0%	60%			
Chesterfield Royal Hospital NHS Foundation Trust	83%											
Chesterfield Royal Hospital	725	8	92%	94%	2.2	40%	68.6	30%	17%			
City Hospitals Sunderland NHS Foundation Trust	78%											
Sunderland Royal Hospital	831	10	90%	97%	2.2	43%	67.8	1%	85%			
Colchester Hospital University NHS Foundation Trust	97%											
Colchester General Hospital	1,009	8	100%	100%	2.2	41%	70.8	21%	98%			
Countess Of Chester Hospital NHS Foundation Trust	80%											
Countess Of Chester Hospital	328	5	91%	97%	2.2	47%	72.4	1%	99%			
County Durham And Darlington NHS Foundation Trust	91%											
Bishop Auckland Hospital	353	16	97%	99%	1.9	45%	67.2	29%	89%			
Darlington Memorial Hospital	255	9	98%	98%	2.4	44%	68.9	14%	83%			
University Hospital Of North Durham	544	10	92%	97%	2.2	50%	69.2	19%	97%			
Cwm Taf Local Health Board	93%											
Prince Charles Hospital	247	6	99%	100%	2.2	42%	66.5	22%	95%			
The Royal Glamorgan Hospital	407	10	91%	100%	2.1	47%	68.5	2%	59%			
Dartford And Gravesham NHS Trust	78%											
Darent Valley Hospital	411	5	99%	95%	2.0	34%	69.8	56%	97%			
Derby Hospitals NHS Foundation Trust	85%											
Royal Derby Hospital	1,450	14	97%	98%	2.1	39%	69.2	9%	100%			

[14] Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW
[15] Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed
[16] Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR
[17] Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Doncaster And Bassetlaw Hospitals NHS Foundation Trust	54%											
Bassetlaw Hospital	191	8	100%	100%	2.0	45%	70.3	49%	99%			
Doncaster Royal Infirmary	521	11	98%	98%	2.0	46%	66.4	13%	60%			
Dorset County Hospital NHS Foundation Trust	83%											
Dorset County Hospital	590	8	63%	87%	2.1	47%	70.2	6%	93%			
Ealing Hospital NHS Trust	24%											
Ealing Hospital	58	4	93%	97%	2.1	38%	67.7	25%	67%			
East And North Hertfordshire NHS Trust	83%											
Lister Hospital	185	9	71%	99%	2.2	35%	71.4	16%	71%			
Queen Elizabeth II Hospital	391	15	84%	99%	2.1	38%	71.6	15%	89%			
East Cheshire NHS Trust	75%											
Macclesfield District General Hospital	364	3	96%	98%	2.1	44%	71.1	0%	99%			
East Kent Hospitals University NHS Foundation Trust	102%											
Queen Elizabeth The Queen Mother Hospital	810	10	91%	99%	2.1	43%	70.3	12%	91%			
William Harvey Hospital (Ashford)	783	13	72%	99%	2.2	45%	69.7	0%	72%			
East Lancashire Hospitals NHS Trust	83%											
Burnley General Hospital	640	14	97%	95%	2.0	41%	69.7	20%	42%			
Royal Blackburn Infirmary	44	11	55%	95%	2.7	31%	74.6	31%	29%			
East Sussex Hospitals NHS Trust	80%											
Conquest Hospital	599	10	99%	98%	2.1	41%	69.2	0%	68%			
Eastbourne District General Hospital	474	9	56%	91%	2.3	38%	72.3	0%	91%			
Epsom And St Helier University Hospitals NHS Trust	75%											
The Elective Orthopaedic Centre	1,899	25	98%	98%	2.0	38%	70.4	1%	63%			
Frimley Park Hospital NHS Foundation Trust	86%											
Frimley Park Hospital	981	14	98%	97%	2.0	41%	69.6	0%	94%			

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Gateshead Health NHS Foundation Trust	96%											
The North East NHS Surgery Centre	899	10	96%	98%	2.2	41%	68.0	8%	89%			
George Eliot Hospital NHS Trust	93%											
George Eliot Hospital - Acute Services	553	9	90%	97%	2.1	44%	69.2	28%	87%			
Gloucestershire Hospitals NHS Foundation Trust	54%											
Cheltenham General Hospital	781	14	91%	99%	2.1	42%	70.5	40%	99%			
Gloucestershire Royal Hospital	343	11	96%	95%	2.0	47%	69.4	36%	88%			
Great Western Hospitals NHS Foundation Trust	78%											
The Great Western Hospital	846	12	93%	98%	2.1	42%	68.9	0%	99%			
Guy's And St Thomas' NHS Foundation Trust	83%											
Guy's Hospital	581	9	52%	98%	2.0	40%	63.8	22%	71%			
Harrogate And District NHS Foundation Trust	94%											
Harrogate District Hospital	900	11	93%	98%	2.0	43%	70.4	11%	94%			
Heart of England NHS Foundation Trust	77%											
Good Hope Hospital	411	12	86%	98%	2.1	42%	70.6	1%	92%			
Solihull Hospital	981	23	82%	92%	2.1	40%	69.5	77%	82%			
Heatherwood And Wexham Park Hospitals NHS Foundation Trust	94%											
Heatherwood Hospital	663	10	96%	99%	2.0	34%	69.7	10%	100%			
Wexham Park Hospital	155	11	91%	97%	2.4	39%	72.3	12%	96%			
Hinchingbrooke Health Care NHS Trust	78%											
Hinchingbrooke Hospital	492	7	100%	94%	2.2	36%	69.7	0%	100%			
Homerton University Hospital NHS Foundation Trust	89%											
Homerton University Hospital	153	6	78%	86%	2.3	34%	65.7	6%	86%			

[14] Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW
[15] Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed
[16] Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR
[17] Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Hull And East Yorkshire Hospitals NHS Trust	95%											
Castle Hill Hospital	1,099	21	83%	94%	2.0	43%	68.8	11%	99%			
Hywel Dda Local Health Board	90%											
Bronglais General Hospital	243	4	100%	100%	2.4	45%	71.4	47%	89%			
Prince Philip Hospital	657	8	100%	100%	1.8	44%	69.4	3%	99%			
West Wales General Hospital	69	9	99%	99%	2.2	40%	72.9	46%	100%			
Withybush General Hospital	412	5	100%	100%	2.1	39%	69.6	0%	95%			
Ipswich Hospital NHS Trust	91%											
Ipswich Hospital	825	9	94%	99%	2.2	42%	71.5	26%	100%			
Isle of Wight NHS PCT	95%											
St Mary's Hospital	587	5	100%	96%	2.1	39%	71.2	81%	100%			
James Paget University Hospitals NHS Foundation Trust	90%											
James Paget University Hospital	621	8	99%	100%	2.2	41%	70.8	0%	75%			
Kettering General Hospital NHS Foundation Trust	97%											
Kettering General Hospital	783	8	80%	98%	2.0	42%	68.9	30%	60%			
King's College Hospital NHS Foundation Trust	54%											
King's College Hospital (Denmark Hill)	231	8	85%	77%	2.0	31%	67.3	2%	98%			
Kingston Hospital NHS Trust	0%											
Kingston Hospital	0											
Lancashire Teaching Hospitals NHS Foundation Trust	89%											
Chorley and South Ribble Hospital	583	9	91%	99%	2.1	41%	68.4	32%	73%			
Leeds Teaching Hospitals NHS Trust	40%											
Chapel Allerton Hospital	438	10	3%	100%	2.1	43%	68.6	0%	72%			
Lewisham Healthcare NHS Trust	87%											
Riverside Treatment Centre	290	6	61%	87%	2.1	32%	68.5	22%	88%			

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Luton And Dunstable Hospital NHS Foundation Trust	56%											
Luton & Dunstable Hospital	313	9	98%	97%	2.1	39%	69.5	9%	31%			
Maidstone And Tunbridge Wells NHS Trust	88%											
Kent and Sussex Hospital	252	8	98%	98%	2.1	48%	70.2	0%	42%			
Maidstone District General Hospital	221	5	77%	89%	2.2	41%	69.4	20%	100%			
The Tunbridge Wells Hospital	210	11	99%	99%	2.1	42%	70.6	9%	75%			
Medway NHS Foundation Trust	79%											
Medway Maritime Hospital	555	7	89%	98%	2.2	43%	68.3	1%	83%			
Mid Cheshire Hospitals NHS Foundation Trust	54%											
Leighton Hospital	200	7	97%	96%	2.1	46%	70.2	18%	55%			
Mid Essex Hospital Services NHS Trust	49%											
Broomfield Hospital	507	7	92%	100%	2.0	39%	70.1	12%	99%			
Mid Staffordshire NHS Foundation Trust	97%											
Cannock Chase Treatment Centre	694	8	97%	98%	2.1	44%	68.2	13%	72%			
Stafford Hospital	34	6	79%	94%	2.6	38%	75.8	0%	62%			
Mid Yorkshire Hospitals NHS Trust	56%											
Dewsbury and District Hospital	269	7	97%	97%	2.2	46%	69.7	84%	96%			
Pinderfields General Hospital	409	9	84%	85%	2.2	49%	68.4	3%	97%			
Pontefract Elective Unit (Treatment Centre)	90	8	92%	92%	1.9	49%	68.4	3%	93%			
Milton Keynes Hospital NHS Foundation Trust	85%											
Milton Keynes Hospital	446	8	99%	98%	2.0	38%	68.8	0%	52%			
Newham University Hospital NHS Trust	73%											
Gateway Surgical Centre	155	8	100%	97%	2.3	39%	66.7	7%	100%			
Norfolk And Norwich University Hospitals NHS Foundation Trust	92%											
Norfolk & Norwich Hospital	1,212	16	98%	94%	2.2	45%	71.7	7%	87%			

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Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Northampton General Hospital NHS Trust	90%											
Northampton General Hospital (Acute)	670	10	93%	96%	2.2	43%	69.0	2%	76%			
North Bristol NHS Trust	91%											
Frenchay Hospital	66	16	76%	89%	2.5	51%	71.5	48%	95%			
Southmead Hospital	1,635	25	90%	94%	2.2	40%	67.5	21%	77%			
North Cumbria University Hospitals NHS Trust	80%											
Cumberland Infirmary	513	8	94%	93%	2.1	42%	70.0	22%	100%			
West Cumberland Hospital	267	7	76%	96%	2.4	42%	69.5	78%	97%			
Northern Devon Healthcare NHS Trust	97%											
North Devon District Hospital	684	9	95%	99%	2.0	42%	70.9	3%	97%			
Northern Lincolnshire And Goole Hospitals NHS Foundation Trust	82%											
Diana Princess Of Wales Hospital	412	8	98%	99%	2.0	47%	69.0	56%	85%			
Goole Treatment Centre	342	6	94%	97%	1.8	44%	68.4	47%	99%			
Scunthorpe General Hospital	214	8	98%	98%	2.2	48%	69.5	24%	61%			
North Middlesex University Hospital NHS Trust	64%											
North Middlesex Hospital	185	7	99%	97%	2.2	32%	67.9	0%	100%			
North Tees And Hartlepool NHS Foundation Trust	96%											
University Hospital Of Hartlepool	992	8	92%	99%	2.1	44%	67.4	24%	43%			
University Hospital Of North Tees	6	2	67%	50%	2.3	67%	63.8	0%	100%			
Northumbria Healthcare NHS Foundation Trust	88%											
Hexham General Hospital	532	15	96%	100%	1.8	49%	66.9	47%	100%			
North Tyneside General Hospital	608	13	92%	100%	2.1	46%	69.5	14%	100%			
Wansbeck Hospital	688	12	93%	99%	2.1	46%	69.0	50%	100%			
North West London Hospitals NHS Trust	75%											
Central Middlesex Hospital	325	12	79%	95%	2.0	39%	70.4	0%	76%			
Northwick Park Hospital	92	6	57%	96%	2.1	34%	73.2	0%	36%			

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Nottingham University Hospitals NHS Trust	90%											
Nottingham City Hospital	844	11	97%	99%	2.2	42%	69.8	12%	88%			
Queens Medical Centre Nottingham University Hospital	723	14	99%	100%	2.1	44%	67.9	8%	66%			
Nuffield Orthopaedic Centre NHS Trust	133%											
Nuffield Orthopaedic Centre	1,790	16	93%	96%	2.1	42%	67.8	0%	88%			
Oxford University Hospitals NHS Trust	6%											
John Radcliffe Hospital	21	2	57%	57%	1.9	33%	74.3	0%	100%			
Pennine Acute Hospitals NHS Trust	74%											
Fairfield General Hospital	269	6	79%	99%	2.1	38%	68.1	13%	72%			
North Manchester General Hospital	410	6	90%	91%	2.1	36%	67.6	14%	2%			
Rochdale Infirmary	78	3	81%	90%	2.1	50%	68.6	100%	71%			
Royal Oldham Hospital	180	8	98%	89%	2.2	36%	69.7	16%	42%			
Peterborough And Stamford Hospitals NHS Foundation Trust	93%											
Peterborough City Hospital	922	12	92%	96%	2.2	41%	69.2	75%	81%			
Plymouth Hospitals NHS Trust	93%											
Derriford Hospital	1,018	15	95%	98%	2.2	45%	69.1	0%	58%			
Portsmouth Hospitals NHS Trust	36%											
Queen Alexandra Hospital	458	17	99%	100%	2.1	43%	71.8	12%	100%			
Robert Jones And Agnes Hunt Orthopaedic And District Hospital NHS Trust	100%											
Robert Jones & Agnes Hunt Orthopaedic Hospital	2,765	26	80%	95%	2.0	44%	69.1	19%	94%			
Royal Berkshire NHS Foundation Trust	75%											
Royal Berkshire Hospital	857	14	93%	93%	2.0	38%	69.3	5%	99%			

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Royal Bolton Hospital NHS Foundation Trust	92%											
Royal Bolton Hospital	439	11	87%	88%	2.3	44%	69.0	0%	98%			
Royal Cornwall Hospitals NHS Trust	55%											
Royal Cornwall Hospital (Treliske)	425	19	64%	98%	2.2	49%	71.3	29%	61%			
St Michael's Hospital	383	18	61%	99%	1.9	38%	68.2	38%	57%			
Royal Devon And Exeter NHS Foundation Trust	95%											
Royal Devon & Exeter Hospital (Wonford)	1,351	14	89%	95%	2.1	44%	70.3	0%	100%			
Royal Free Hampstead NHS Trust	98%											
Royal Free Hospital	314	6	75%	94%	2.2	31%	69.7	69%	91%			
Royal Liverpool And Broadgreen University Hospitals NHS Trust	86%											
Broadgreen Hospital	654	11	60%	59%	2.1	42%	68.3	12%	80%			
The Royal Liverpool University Hospital	47	5	47%	45%	2.6	52%	71.4	0%	93%			
Royal National Orthopaedic Hospital NHS Trust	74%											
The Royal National Orthopaedic Hospital (Stanmore)	896	12	94%	97%	2.0	38%	63.1	8%	97%			
Royal Surrey County Hospital NHS Foundation Trust	87%											
Royal Surrey County Hospital	601	10	79%	99%	2.0	38%	70.0	1%	38%			
Royal United Hospital Bath NHS Trust	74%											
Royal United Hospital	574	12	76%	96%	2.2	43%	69.3	7%	67%			
Salford Royal NHS Foundation Trust	80%											
Salford Royal	396	10	28%	77%	2.3	44%	67.9	0%	61%			
Salisbury NHS Foundation Trust	77%											
Salisbury District Hospital	462	9	98%	100%	2.1	42%	71.0	1%	49%			
Sandwell And West Birmingham Hospitals NHS Trust	88%											
City Hospital	776	12	97%	97%	2.2	42%	68.3	0%	76%			
Sandwell General Hospital	4	2	100%	100%	2.3	50%	67.1	0%	100%			

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Scarborough And North East Yorkshire Health Care NHS Trust	89%											
Scarborough General Hospital	584	7	82%	99%	2.1	45%	69.3	0%	96%			
Sherwood Forest Hospitals NHS Foundation Trust	95%											
Kings Mill Hospital	611	17	90%	97%	2.2	44%	68.4	8%	99%			
Newark Hospital	138	8	78%	98%	1.9	36%	68.1	0%	100%			
Shrewsbury and Telford Hospital NHS Trust	85%											
Royal Shrewsbury Hospital	21	5	81%	90%	2.2	47%	77.7	18%	94%			
The Princess Royal Hospital	546	7	95%	99%	2.1	41%	69.5	0%	67%			
Southampton University Hospitals NHS Trust	64%											
Southampton General Hospital	683	16	92%	92%	2.1	41%	67.0	15%	72%			
South Devon Healthcare NHS Foundation Trust	87%											
Torbay Hospital	683	15	90%	99%	2.2	45%	70.0	29%	95%			
Southend University Hospital NHS Foundation Trust	85%											
Southend Hospital	854	11	100%	99%	2.0	38%	71.4	6%	33%			
South London Healthcare NHS Trust	77%											
Princess Royal University Hospital	190	11	91%	90%	2.4	39%	74.3	15%	83%			
Queen Elizabeth Hospital Woolwich	124	10	99%	100%	2.4	35%	71.5	0%	21%			
Queen Mary's Hospital Sidcup	798	23	76%	98%	2.0	40%	70.4	2%	93%			
Southport And Ormskirk Hospital NHS Trust	94%											
Ormskirk & District General Hospital	551	9	100%	99%	2.0	41%	69.5	26%	100%			
South Tees Hospitals NHS Foundation Trust	89%											
Friarage Hospital	636	12	94%	100%	2.1	44%	69.2	0%	97%			
The James Cook University Hospital	837	12	99%	99%	2.2	44%	68.1	21%	90%			

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South Tyneside NHS Foundation Trust	99%											
South Tyneside District Hospital	334	6	100%	100%	2.2	42%	69.8	71%	92%			
South Warwickshire NHS Foundation Trust	89%											
Warwick Hospital	778	8	98%	98%	2.1	37%	69.4	0%	100%			
St George's Healthcare NHS Trust	82%											
St George's Hospital (Tooting)	191	8	87%	98%	2.4	43%	68.4	0%	99%			
St Helens And Knowsley Hospitals NHS Trust	95%											
St Helens Hospital	1	1	100%	100%	2.0	100%	74.1	0%	100%			
Whiston Hospital	543	10	88%	98%	2.0	43%	69.3	24%	80%			
Stockport NHS Foundation Trust	93%											
Stepping Hill Hospital	931	13	91%	96%	2.1	41%	69.5	0%	100%			
Surrey And Sussex Healthcare NHS Trust	62%											
East Surrey Hospital	115	8	86%	99%	2.2	39%	69.9	0%	73%			
Redwood Diagnostic Treatment Centre	226	8	87%	94%	2.1	39%	71.3	8%	92%			
Tameside Hospital NHS Foundation Trust	86%											
Tameside General Hospital	357	6	80%	100%	2.2	42%	68.3	10%	55%			
Taunton And Somerset NHS Foundation Trust	91%											
Musgrove Park Hospital	698	11	98%	99%	2.1	43%	70.1	3%	82%			
The Dudley Group Of Hospitals NHS Foundation Trust	96%											
Russells Hall Hospital	955	9	98%	99%	2.0	46%	70.1	9%	95%			
The Hillingdon Hospital NHS Foundation Trust	85%											
Hillingdon Hospital	99	10	52%	92%	2.3	26%	70.6	0%	79%			
Mount Vernon Treatment Centre	416	11	89%	90%	2.0	42%	69.1	0%	81%			
The Newcastle Upon Tyne Hospitals NHS Foundation Trust	76%											
Freeman Hospital	1,098	11	90%	99%	2.2	44%	67.5	22%	88%			

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The Princess Alexandra Hospital NHS Trust	94%											
Princess Alexandra Hospital	798	6	69%	98%	2.0	40%	69.6	32%	98%			
The Queen Elizabeth Hospital King's Lynn NHS Foundation Trust	81%											
The Queen Elizabeth Hospital	479	10	92%	97%	2.3	41%	70.6	60%	99%			
The Rotherham NHS Foundation Trust	93%											
Rotherham District General Hospital	774	11	80%	95%	2.0	43%	68.5	8%	79%			
The Royal Bournemouth And Christchurch Hospitals NHS Foundation Trust	96%											
Royal Bournemouth General Hospital	2,186	14	96%	97%	2.0	41%	71.5	6%	100%			
The Royal Orthopaedic Hospital NHS Foundation Trust	91%											
Royal Orthopaedic Hospital	2,050	23	93%	98%	2.0	41%	66.0	21%	72%			
The Royal Wolverhampton Hospitals NHS Trust	77%											
New Cross Hospital	813	12	98%	98%	2.2	42%	69.1	9%	83%			
The Whittington Hospital NHS Trust	75%											
The Whittington Hospital	194	8	87%	86%	2.0	34%	69.5	0%	30%			
Trafford Healthcare NHS Trust	119%											
Trafford General Hospital	338	11	87%	92%	2.0	44%	68.4	43%	47%			
United Lincolnshire Hospitals NHS Trust	60%											
County Hospital Louth	135	5	84%	99%	2.0	45%	71.0	28%	99%			
Grantham and District Hospital	289	6	99%	100%	2.0	41%	71.0	3%	53%			
Lincoln County Hospital	266	16	79%	97%	2.1	40%	70.3	53%	97%			
Pilgrim Hospital	260	16	70%	99%	2.2	46%	69.8	22%	71%			
University College London Hospitals NHS Foundation Trust	59%											
University College Hospital	304	5	53%	94%	2.1	38%	64.9	4%	49%			

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University Hospital of North Staffordshire NHS Trust	77%											
City General Hospital	612	12	100%	96%	2.3	46%	68.3	3%	87%			
University Hospital Of South Manchester NHS Foundation Trust	75%											
Wythenshawe Hospital	409	6	89%	97%	1.9	39%	69.7	4%	79%			
University Hospitals Bristol NHS Foundation Trust	58%											
Bristol Royal Infirmary	19	6	68%	95%	2.3	22%	72.1	63%	100%			
University Hospitals Coventry And Warwickshire NHS Trust	88%											
Hospital Of St Cross	719	20	97%	97%	1.9	42%	67.5	7%	69%			
University Hospital (Coventry)	474	19	95%	95%	2.4	38%	70.8	12%	83%			
University Hospitals Of Leicester NHS Trust	76%											
Glenfield Hospital	494	19	96%	99%	2.0	42%	68.3	1%	86%			
Leicester General Hospital	994	25	94%	98%	2.2	43%	69.4	24%	86%			
University Hospitals Of Morecambe Bay NHS Foundation Trust	53%											
Furness General Hospital	327	6	99%	95%	2.1	45%	69.4	2%	100%			
Royal Lancaster Infirmary	63	9	92%	97%	2.2	41%	69.6	11%	83%			
Westmorland General Hospital	249	9	100%	97%	1.8	38%	69.4	2%	82%			
Walsall Healthcare NHS Trust	64%											
Manor Hospital	361	10	81%	98%	2.0	45%	69.9	18%	81%			
Warrington and Halton Hospitals NHS Foundation Trust	71%											
Warrington Hospital	458	8	96%	94%	2.2	45%	68.2	9%	56%			
Western Sussex Hospitals NHS Trust	46%											
St Richard's Hospital	731	18	42%	99%	2.2	40%	71.7	25%	40%			
West Hertfordshire Hospitals NHS Trust	93%											
St Albans City Hospital	615	13	95%	98%	2.0	42%	69.8	5%	98%			
Watford General Hospital	157	8	100%	99%	2.7	40%	74.6	4%	98%			

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West Middlesex University Hospital NHS Trust	63%											
West Middlesex University Hospital	140	7	76%	93%	2.0	44%	70.5	70%	93%			
Weston Area Health NHS Trust	84%											
Weston General Hospital	435	9	92%	97%	2.1	44%	69.7	0%	36%			
West Suffolk Hospitals NHS Trust	98%											
West Suffolk Hospital	807	10	100%	100%	2.2	44%	70.7	57%	96%			
Whipps Cross University Hospital NHS Trust	37%											
Whipps Cross University Hospital	186	5	100%	77%	2.2	38%	70.5	32%	63%			
Wirral University Teaching Hospital NHS Foundation Trust	63%											
Arrowe Park Hospital	184	8	83%	91%	2.5	38%	70.6	0%	99%			
Clatterbridge Hospital	420	9	90%	99%	1.9	42%	68.0	0%	100%			
Worcestershire Acute Hospitals NHS Trust	77%											
Alexandra Hospital	499	9	62%	92%	2.2	42%	70.0	42%	69%			
Kidderminster Treatment Centre	122	5	83%	89%	1.8	34%	68.3	62%	100%			
Worcestershire Royal Hospital	349	6	87%	96%	2.1	41%	71.6	25%	98%			
Wrightington Wigan And Leigh NHS Foundation Trust	66%											
Wrightington Hospital	1,353	21	99%	99%	2.1	45%	66.5	1%	11%			
Yeovil District Hospital NHS Foundation Trust	96%											
Yeovil District Hospital	610	7	82%	97%	2.1	40%	69.8	1%	66%			
York Teaching Hospital NHS Foundation Trust	71%											
York Hospital	463	8	89%	92%	2.3	47%	71.0	1%	84%			

[14] Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW
[15] Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed
[16] Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR
[17] Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Aspen Healthcare Limited												
Claremont Hospital	502	17	100%	91%	1.8	40%	68.1	61%	100%			
Holly House Hospital	49	5	94%	86%	1.9	48%	66.7	10%	60%			
Parkside Hospital	233	13	97%	74%	1.9	34%	68.1	1%	84%			
Benenden Healthcare Society												
Benenden Hospital	177	8	92%	91%	2.0	52%	70.0	0%	94%			
BMI Healthcare												
BMI Alexandra Hospital Cheadle	481	28	80%	78%	1.9	48%	67.2	10%	87%			
BMI Bath Clinic	337	9	70%	84%	2.0	44%	68.8	5%	63%			
BMI Beardwood Private Hospital	102	9	73%	87%	2.0	49%	68.7	7%	86%			
BMI Bishops Wood Hospital	160	8	94%	86%	1.9	34%	70.1	0%	81%			
BMI Blackheath Hospital	102	14	77%	89%	1.9	33%	67.0	0%	63%			
BMI Bury St Edmunds	315	8	97%	93%	2.0	41%	69.7	86%	100%			
BMI Chaucer Hospital	150	9	96%	90%	1.9	39%	69.9	0%	87%			
BMI Chelsfield Park Hospital	211	7	100%	91%	1.7	36%	70.7	5%	47%			
BMI Clementine Churchill Hospital	300	15	90%	79%	1.8	33%	69.2	2%	58%			
BMI Esperance	69	5	100%	94%	2.3	43%	72.3	6%	90%			
BMI Fawkham Manor Hospital	149	5	100%	96%	1.9	40%	67.2	21%	78%			
BMI Garden Hospital	23	4	96%	96%	2.0	36%	66.4	0%	77%			
BMI Gisburne Park Hospital	295	12	100%	100%	2.2	47%	68.4	6%	76%			
BMI Goring Hall Hospital	533	9	99%	92%	2.0	36%	71.2	45%	91%			
BMI Hampshire Clinic	250	11	100%	88%	2.0	39%	67.6	2%	77%			
BMI Harrogate	234	6	98%	89%	1.9	45%	67.8	0%	90%			
BMI Highfield Hospital	317	17	97%	85%	2.0	41%	67.7	19%	47%			
BMI Huddersfield	279	7	100%	93%	1.7	44%	67.7	36%	67%			
BMI Kings Oak Hospital	96	6	31%	90%	1.3	41%	71.1	20%	84%			
BMI Lancaster	145	10	88%	92%	1.9	49%	69.0	35%	66%			
BMI Lincoln	207	9	99%	98%	2.1	38%	70.0	46%	95%			
BMI Manor Hospital	87	6	100%	92%	2.0	49%	70.3	14%	49%			
BMI Mount Alvernia Hospital	204	6	100%	91%	1.7	38%	69.9	0%	44%			
BMI Oxford Clinic	312	12	83%	93%	1.9	46%	67.5	0%	88%			

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BMI Princess Margaret	236	13	94%	90%	1.7	37%	69.5	14%	87%			
BMI Priory Hospital	280	18	99%	77%	1.8	54%	62.6	60%	77%			
BMI Ridgeway Hospital	313	9	98%	86%	1.8	47%	65.7	0%	97%			
BMI Runnymede Hospital	187	8	41%	63%	1.8	44%	70.7	3%	50%			
BMI Sandringham Hospital	317	7	92%	80%	2.0	40%	71.5	67%	90%			
BMI Sarum Road Hospital	121	8	97%	89%	2.0	33%	70.4	0%	24%			
BMI Saxon Clinic	195	8	97%	94%	1.9	40%	67.1	0%	71%			
BMI Sefton Hospital	22	2	50%	64%	1.9	29%	62.9	14%	100%			
BMI Shelburne Hospital	62	5	100%	89%	1.9	42%	69.0	29%	85%			
BMI Shirley Oaks Hospital	57	4	47%	86%	1.9	51%	70.1	3%	100%			
BMI The Beaumont Hospital	165	11	78%	92%	1.8	49%	66.6	1%	89%			
BMI The Cavell Hospital	85	8	79%	91%	1.8	31%	68.2	0%	100%			
BMI The Chiltern	236	9	97%	95%	1.8	48%	69.5	39%	76%			
BMI The Droitwich Spa Hospital	234	20	99%	93%	1.8	45%	68.4	30%	70%			
BMI The Edgbaston Hospital	411	24	99%	82%	1.9	51%	64.3	55%	77%			
BMI The Foscote Hospital	99	4	98%	96%	1.8	43%	68.6	0%	98%			
BMI The Harbour Hospital	147	5	76%	76%	1.9	41%	68.2	2%	100%			
BMI The London Independent Hospital	60	7	55%	82%	1.9	51%	66.1	0%	97%			
BMI The Meriden Hospital	246	17	90%	87%	1.8	51%	66.0	0%	54%			
BMI The Park Hospital	384	15	84%	89%	1.9	47%	68.3	23%	76%			
BMI The Sloane Hospital	116	10	91%	90%	1.9	38%	69.5	0%	62%			
BMI The Somerfield Hospital	160	7	98%	94%	2.0	45%	68.1	34%	100%			
BMI The South Cheshire Private Hospital	104	6	100%	93%	1.8	42%	69.6	30%	21%			
BMI Thornbury Hospital	647	14	93%	91%	1.7	47%	65.4	47%	98%			
BMI Three Shires Hospital	284	7	96%	87%	1.9	45%	68.4	1%	70%			
BMI Werndale Hospital	91	6	92%	84%	2.0	33%	73.6	68%	96%			
BMI Winterbourne Hospital	270	8	94%	88%	2.0	42%	71.7	1%	99%			
BMI Woodlands Hospital	274	19	97%	91%	1.8	47%	66.1	32%	70%			

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Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Care UK												
Barlborough NHS Treatment Centre	1,268	8	100%	100%	2.0	45%	70.2	36%	34%			
North East London NHS Treatment Centre	647	8	100%	98%	2.1	40%	70.7	38%	63%			
Southampton NHS Treatment Centre	449	14	95%	98%	2.2	39%	70.2	44%	48%			
Sussex Orthopaedic NHS Treatment Centre	1,105	15	93%	96%	1.9	42%	69.0	22%	54%			
Circle												
Circle Bath Hospital	495	12	94%	97%	1.9	42%	68.3	0%	91%			
Clinicenta Limited												
Lister Surgicentre	39	8	15%	97%	1.8	29%	69.4	19%	76%			
Cromwell Hospital												
Cromwell Hospital	25	9	100%	60%	1.9	67%	62.5	0%	94%			
East Kent Medical Services Ltd												
The Spencer Wing - Margate	73	5	100%	99%	1.9	43%	68.3	0%	75%			
Fairfield Independent Hospital												
Fairfield Independent Hospital	111	6	94%	96%	1.7	38%	69.0	17%	100%			
HCA International Ltd												
London Bridge Hospital	186	11	78%	60%	1.8	51%	62.8	0%	73%			
The Lister Hospital	101	14	57%	60%	1.8	48%	66.2	0%	56%			
The Princess Grace Hospital	373	7	96%	68%	1.8	44%	65.4	15%	37%			
The Wellington Hospital	109	9	90%	67%	1.9	47%	67.1	8%	100%			
Hospital Management Trust												
Sancta Maria Hospital	53	5	100%	74%	2.0	26%	70.5	7%	48%			
St Hugh's Hospital	211	7	95%	100%	2.0	42%	68.2	50%	87%			
Hospital Of St John And St Elizabeth												
Hospital of St John And St Elizabeth	91	9	97%	74%	2.1	28%	69.6	81%	98%			
Interhealth Care Services (UK) Ltd												
Interhealth at BMI Droitwich	34	2	100%	100%	2.0	41%	68.3	30%	100%			
The Cheshire and Merseyside NHS Treatment Centre	472	9	100%	100%	2.0	43%	68.3	22%	81%			

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King Edward VII Hospital Sister Agnes												
King Edward VII Hospital Sister Agnes	500	10	63%	60%	1.8	49%	68.9	19%	62%			
Nuffield Health												
Nuffield Health Bournemouth Hospital	246	8	99%	95%	2.0	36%	73.1	4%	100%			
Nuffield Health Brentwood Hospital	67	13	99%	81%	1.9	50%	68.0	8%	50%			
Nuffield Health Brighton Hospital	121	6	82%	76%	1.9	34%	68.6	3%	50%			
Nuffield Health Bristol Hospital	108	8	93%	81%	1.9	36%	68.0	3%	93%			
Nuffield Health Cambridge Hospital	135	6	91%	89%	1.8	47%	68.7	22%	100%			
Nuffield Health Cheltenham Hospital	131	8	91%	84%	1.9	37%	68.7	21%	100%			
Nuffield Health Chichester Hospital	249	6	73%	86%	1.8	36%	71.4	3%	41%			
Nuffield Health Derby Hospital	493	11	98%	95%	1.8	44%	68.5	10%	100%			
Nuffield Health Exeter Hospital	371	9	88%	93%	2.0	39%	70.2	0%	100%			
Nuffield Health Guildford Hospital	120	6	99%	88%	2.0	46%	72.4	3%	26%			
Nuffield Health Haywards Heath Hospital	70	2	100%	93%	1.8	29%	68.6	67%	88%			
Nuffield Health Hereford Hospital	264	6	99%	94%	1.9	42%	70.3	0%	39%			
Nuffield Health Ipswich Hospital	206	6	100%	91%	1.9	36%	69.8	30%	99%			
Nuffield Health Leeds Hospital	536	14	64%	92%	2.0	46%	67.3	0%	90%			
Nuffield Health Leicester Hospital	192	15	94%	98%	2.0	45%	68.1	8%	85%			
Nuffield Health Newcastle-upon-Tyne Hospital	448	13	99%	90%	1.8	50%	64.4	77%	96%			
Nuffield Health North Staffordshire Hospital	395	7	93%	94%	1.9	47%	68.9	1%	73%			
Nuffield Health Plymouth Hospital	239	7	100%	95%	1.9	46%	67.3	1%	34%			
Nuffield Health Shrewsbury Hospital	173	8	99%	91%	1.9	44%	68.5	1%	94%			
Nuffield Health Taunton Hospital	256	7	96%	93%	2.0	38%	71.0	0%	97%			
Nuffield Health Tees Hospital	515	10	100%	96%	1.9	48%	66.7	12%	36%			
Nuffield Health The Grosvenor Hospital	319	8	100%	96%	2.0	39%	70.5	35%	98%			
Nuffield Health The Manor Hospital	239	11	98%	91%	1.8	46%	67.3	1%	89%			
Nuffield Health Tunbridge Wells Hospital	130	3	92%	89%	1.6	35%	71.8	0%	67%			

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Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Nuffield Health Warwickshire Hospital	270	12	88%	83%	1.9	47%	67.8	0%	85%			
Nuffield Health Wessex Hospital	145	6	94%	91%	1.8	42%	68.1	0%	87%			
Nuffield Health Woking Hospital	51	5	100%	84%	1.6	44%	65.6	5%	6%			
Nuffield Health Wolverhampton Hospital	264	9	98%	94%	1.8	37%	68.4	22%	80%			
Nuffield Health York Hospital	284	7	97%	93%	1.9	47%	68.3	4%	75%			
Orthopaedic Spine and Specialist Hospital												
Orthopaedics and Spine Specialist Hospital	6	1	100%	100%	2.0	33%	62.8	0%	0%			
Ramsay Health Care												
Ashtead Hospital	336	8	91%	90%	1.7	41%	69.4	2%	67%			
Duchy Hospital	762	14	97%	97%	1.8	43%	69.0	27%	43%			
Euxton Hall Hospital	200	13	100%	100%	1.7	46%	64.1	5%	52%			
Fitzwilliam Hospital	352	12	98%	95%	1.9	35%	67.9	79%	93%			
Fulwood Hall Hospital	381	6	97%	98%	1.9	41%	67.4	4%	37%			
Mount Stuart Hospital	316	9	93%	91%	2.0	45%	69.7	9%	92%			
New Hall Hospital	320	8	98%	97%	1.9	41%	68.7	3%	79%			
North Downs Hospital	315	8	100%	98%	1.8	41%	68.4	9%	77%			
Nottingham Woodthorpe Hospital	823	19	97%	97%	1.7	44%	68.1	15%	97%			
Oaklands Hospital	194	6	100%	99%	1.7	46%	64.9	0%	100%			
Oaks Hospital	331	7	89%	93%	1.9	39%	70.6	38%	99%			
Park Hill Hospital	543	8	97%	100%	2.0	41%	69.0	29%	88%			
Pinehill Hospital	207	10	100%	99%	1.9	45%	66.8	5%	60%			
Renacres Hall Hospital	209	6	97%	98%	1.8	46%	67.6	19%	100%			
Rivers Hospital	297	6	86%	86%	1.8	44%	67.9	35%	98%			
Rowley Hall Hospital	96	5	100%	97%	2.0	41%	68.5	2%	63%			
Springfield Hospital	377	8	94%	93%	1.9	44%	68.1	9%	97%			
The Berkshire Independent Hospital	358	6	89%	96%	1.7	43%	67.9	9%	99%			
The Yorkshire Clinic	515	10	92%	93%	1.8	48%	67.9	12%	48%			
West Midlands Hospital	167	9	99%	94%	1.9	47%	68.9	22%	61%			
Winfield Hospital	308	9	89%	91%	1.8	39%	69.1	14%	84%			
Woodland Hospital	321	7	92%	92%	2.0	42%	67.8	17%	75%			

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Clifton Park NHS Treatment Centre	841	9	94%	98%	1.8	42%	67.4	1%	79%			
Horton NHS Treatment Centre	748	9	96%	97%	2.0	45%	68.3	0%	100%			
Kendal NHS Treatment Centre	167	4	89%	93%	2.0	49%	67.4	0%	60%			
Spire Healthcare												
Dunedin Hospital	145	6	96%	94%	1.9	42%	69.9	9%	100%			
Elland Hospital	341	13	100%	97%	2.0	42%	68.2	86%	80%			
Fylde Coast Hospital	301	10	86%	87%	1.7	47%	69.3	10%	63%			
Hull and East Riding Hospital	483	14	100%	96%	2.0	45%	68.4	3%	100%			
Methley Park Hospital	218	10	99%	97%	1.9	49%	67.3	2%	100%			
Regency Hospital	185	4	97%	90%	1.9	43%	70.3	0%	100%			
Spire Alexandra Hospital	221	7	99%	97%	2.0	47%	67.5	3%	58%			
Spire Bristol Hospital	395	16	95%	87%	1.9	44%	65.3	16%	92%			
Spire Bushey Hospital	449	16	99%	88%	1.8	41%	66.8	18%	94%			
Spire Cambridge Lea Hospital	415	12	100%	97%	1.7	48%	66.7	40%	78%			
Spire Cardiff Hospital	234	15	100%	91%	2.0	46%	65.0	0%	81%			
Spire Cheshire Hospital	465	8	100%	91%	2.0	42%	66.9	5%	52%			
Spire Clare Park Hospital	233	7	98%	92%	1.8	41%	67.4	0%	91%			
Spire Gatwick Park Hospital	325	7	95%	97%	1.7	40%	69.3	17%	94%			
Spire Harpenden Hospital	203	18	100%	96%	1.9	48%	66.6	5%	76%			
Spire Hartswood Hospital	184	13	99%	94%	2.0	44%	68.1	26%	58%			
Spire Leeds Hospital	300	12	97%	94%	1.8	43%	68.9	18%	83%			
Spire Leicester Hospital	287	17	99%	92%	2.0	42%	67.6	12%	76%			
Spire Little Aston Hospital	256	17	100%	95%	1.9	37%	69.3	48%	85%			
Spire Liverpool Hospital	150	6	74%	81%	1.9	47%	67.3	2%	92%			
Spire Manchester Hospital	116	13	80%	97%	1.9	50%	65.9	9%	94%			
Spire Murrayfield Hospital	240	7	99%	95%	1.9	41%	67.3	24%	98%			
Spire Norwich Hospital	920	12	93%	93%	1.9	41%	69.0	4%	83%			
Spire Parkway Hospital	345	9	98%	93%	1.6	40%	65.8	55%	69%			

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Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Spire Portsmouth Hospital	470	11	99%	96%	1.7	38%	69.1	32%	100%			
Spire Roding Hospital	149	11	94%	91%	1.8	43%	67.7	0%	67%			
Spire Southampton Hospital	700	12	97%	78%	1.9	42%	68.1	9%	54%			
Spire South Bank Hospital	184	8	96%	89%	1.8	38%	70.6	64%	100%			
Spire St Saviours Hospital	176	9	77%	93%	2.0	33%	70.9	0%	94%			
Spire Sussex Hospital	259	9	99%	95%	2.0	41%	69.3	0%	93%			
Spire Thames Valley	126	9	99%	87%	1.7	37%	69.3	18%	100%			
Spire Tunbridge Wells Hospital	103	4	98%	91%	1.6	41%	72.2	0%	52%			
Spire Washington Hospital	321	15	97%	95%	1.9	44%	66.4	17%	97%			
Spire Wellesley Hospital	321	8	94%	89%	1.9	45%	67.7	3%	85%			
Spire Yale Hospital	172	16	97%	91%	2.0	46%	70.6	22%	68%			
St Anthonys												
St Anthonys	187	7	94%	73%	1.9	44%	66.6	1%	51%			
St Josephs Hospital												
St Josephs Hospital	158	10	89%	84%	2.0	52%	68.8	9%	57%			
The Horder Centre												
The Horder Centre	1,928	13	97%	98%	1.8	40%	70.4	1%	11%			
The London Clinic												
The London Clinic	134	10	84%	49%	1.7	41%	62.6	0%	50%			
The New Victoria Hospital												
The New Victoria Hospital	97	4	99%	88%	1.9	42%	72.2	5%	28%			
UK Specialist Hospitals Ltd												
Emersons Green NHS Treatment Centre	1,079	8	97%	100%	1.9	41%	69.7	10%	100%			
Peninsula NHS Treatment Centre	843	6	100%	99%	2.0	43%	69.4	0%	30%			
Shepton Mallet Treatment Centre	673	11	100%	100%	1.9	41%	70.5	14%	100%			

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Trust/Health Board/Company	Compliance[14]											
Hospital	No. of Procedures 2011	No. of Consultants 2011	Consent Rate (%) 2011[15]	Linkability (%) 2011[16]	Average ASA Grade 2011	Percentage Male Patients 2011	Average Age At Operation 2011	Percentage of 10A Rated Acetabular Implant Hip Primary Procedures 2011	Percentage of 10A Rated Femoral Implant Hip Primary Procedures 2011	Outliers - Mortality[17]	Outliers - Hip revision rate[17]	Outliers - Knee revision rate[17]
Vale Healthcare												
Vale Hospital	195	11	99%	80%	1.8	39%	66.4	0%	25%			

Please note:

Compliance, Consent and Linkability are red if lower than 80%, green if 95% or more and amber in between

- Compliance figures may be low due to delayed data entry
- Linkability for some hospitals will be lower than expected if they have private patients from outside England and Wales
- Part 4 data covers procedures carried out between 1 January 2011 and 31 December 2011

[14] Compliance (NHS Trust and Health Board Only) - the percentage of cases submitted to the NJR compared to HES/PEDW
[15] Consent Rate - percentage of cases submitted to the NJR with patient consent confirmed
[16] Linkability - the proportion of records which include a valid patient's NHS number compared with the number procedures recorded on the NJR
[17] Mortality and Revision rate review period is 2003 to 2011. Units at more than 4 standard deviations from the mean are considered outliers

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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 a natural joint is 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.
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 with or 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 and ceramic-on-ceramic.
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 and the Mobility brand for ankles.
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 and Wales 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 can be the number of levies returned, or for the NHS Sector only, the number of procedures submitted to HES and PEDW.

Competing risks survival analysis	An alternative to standard survival analysis methods (such as Kaplan-Meier estimation or the Cox proportional hazards model) when there are competing risks. A competing risk can prevent the event of interest from occurring (in this case, death is a competing risk to the risk of revision as patients who die will never experience revision). A competing-risks survival analysis adjusts the results accordingly.
Confidence interval (CI)	A confidence interval (CI) gives an estimated range of values which is likely to include the unknown population parameter (e.g. a revision rate) being estimated from the given sample. If independent samples are taken repeatedly from the same population, and a confidence interval calculated for each sample, then a certain percentage (confidence level: e.g. 95%) of the intervals will include the unknown population parameter.
Confounding	Systematic variation due to the presence of factors not on the causal pathway, which affect the outcome, which are unequally distributed amongst interventions being compared which leads to inaccurate inferences about the results.
Cox proportional hazards model	A semi-parametric survival analysis model commonly used to model time-to-event data as it does not require the underlying hazard function to take a particular shape. As it is a multi variable model, it can be used to explore the effects of covariates on the outcome of interest and reduce the impact of confounding.
Cumulative hazard	The cumulative hazard function indicates the probability of failure at a particular time given survival until that time.
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 2011 and 31 March 2012 – the 2011/12 financial year. The NJR Annual Report Parts Two and Four analyse data on hip, knee and ankle procedures undertaken between 1 January and 31 December 2011 inclusive – the 2011 calendar year. The NJR Annual Report Part Three reports on hip and knee joint replacement revision rates for procedures that took place between 1 April 2003 and 31 December 2011.
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.

Flexible parametric proportional hazards model	Developed by Royston and Parmar, this model extends the standard Cox proportional hazards approach by modelling the baseline distribution parametrically using a restricted cubic spline function. This allows more flexibility in modelling the shape of the baseline hazard function than using standard parametric distributions.
Funnel plot	A graphical representation of analyses that plots observed values against expected values. Control limits based on standard deviation are superimposed on the plot.
H	
Head	See Femoral head.
Healthcare provider	NHS or independent sector organisation that provides healthcare; in the case of the NJR, orthopaedic hip, knee or ankle 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.
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).
HQIP	Healthcare Quality Improvement Partnership. Manages the NJR on behalf of the Department of Health. Promotes quality in health and social care services and works to increase the impact that clinical audit has in England and Wales.
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	A statistical method of carrying out a survivorship analysis that can take into account 'censored' data, i.e. patient losses from the sample before the final outcome is observed (for instance, if a patient dies). It is a form of univariable analysis and so does not adjust for any confounding factors.
L	
Levy	Additional payment placed on the sales of specific hip, knee and ankle implants to cover the costs associated with the ongoing operation and development of the NJR.
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.
LHMoM	Large head metal-on-metal. Large metal femoral head (≥36mm) placed on the end of a femoral stem. Normally used with a metal resurfacing cup.
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.
MDS 1 (MDSv1)	Minimum dataset version one, used to collect data from 1 April 2003. MDS 1 closed to new data entry on 1 April 2005.
MDS 2 (MDSv2)	Minimum dataset version two, introduced on 1 April 2004. MDS 2 replaced MDS 1 as the official data set on 1 June 2004.
MDS 3 (MDSv3)	Minimum dataset version three, introduced on 1 November 2007 replacing MDS 2 as the new official data set.
MDS 4 (MDSv4)	Minimum dataset version four, introduced on 1 April 2010 replacing MDS 3 as the new official dataset. This dataset has the same hip and knee MDS 3 dataset, but includes the data collection for total ankle 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.
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	
Nelson Aalen estimator	This estimator is used to derive the cumulative hazard up to a specific time(t), and has a nice interpretation as the expected number of deaths in [0, t] per unit at risk. The hazard at each distinct time of death t(j) is the ratio of the number of deaths to the number exposed, and the estimator of Nelson Aalen is the sum of the hazards at all death times up to t.
NHS	National Health Service.
NICE	National Institute for Health and Clinical Excellence.
NICE benchmark	See ODEP ratings.
NJR	National Joint Registry for England and Wales. The NJR has collected and analysed data on hip and knee replacements since 1 April 2003 and on ankle replacements since 1 April 2010. It covers both the NHS and independent healthcare sectors to ensure complete recording of national activity in England and Wales.
NJR Centre	National co-ordinating centre for the NJR.
NJR StatsOnline	Web facility for viewing and downloading NJR statistics on www.njrcentre.org.uk
O	
ODEP	Orthopaedic Data Evaluation Panel of the NHS Supply Chain. https://www.supplychain.nhs.uk/product-areas/orthopaedics/odep/
ODEP ratings	ODEP ratings are the criteria for product categorisation of prostheses for primary total hip replacement against NICE benchmarks. The categorisation is based on NICE benchmarks: pre-entry benchmark (products commercially available that are involved in post-market clinical follow up studies); entry benchmark (after three, five and seven years; level A – acceptable evidence, level B – weak evidence); full benchmark (10 years; level A – strong evidence, level B reasonable evidence, level C – weak evidence). For each year, there is a level for unacceptable evidence, where products should only be used as part of a clinical trial.

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 the defined control limits.
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.
Patello-femoral knee	Procedure involving replacement of the trochlear and replacement resurfacing of the patella.
Patello-femoral 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 summation of time (in years) for a cohort of primary procedures where the time is measured from the primary date to either date of revision, date of patient's death or analysis date (last observation date).
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 Wales. The Welsh equivalent to Hospital Episode Statistics (HES) in England.
Poisson distribution	This distribution expresses the probability of a number of relatively rare events occurring in a fixed time if these events occur with a known average rate, and are independent of the time since the last event. It is a special case of the binomial distribution in that it models discrete events.
Primary hip/knee/ankle 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 or a total ankle.
PROMs	Patient Reported Outcome Measures.
PTIR	Patient Time Incidence Rate. This is the rate of occurrences of an incidence (i.e. revision) for a given patient time.
R	
Resurfacing (hip)	Resurfacing of the femoral head with a surface replacement femoral prosthesis and insertion of a monobloc acetabular cup, with or without cement.
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 replacement	Operation performed to remove (and usually replace) one or more components of a total joint prosthesis for whatever reason.
S	
Single-stage revision	A revision carried out in a single operation.

Standard Deviation (SD)	The standard deviation is a measure of the spread of the data about the average. The smaller the standard deviation, the less spread out the data.
Subtalar joint (ankle)	The joint between the talus and the calcaneum.
Surgical approach	Method used by a surgeon to gain access to, and expose, the joint.
Survivorship analysis	A statistical method that is used to determine what fraction of a population, such as those who have had a particular hip implant, has survived unrevised past a certain time. See Kaplan-Meier.
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 and ankle 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 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), patello-femoral joint (knee), talar component (ankle).
U	
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.

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