schweizerisches implantat-register
registre suisse des implants

SIRIS

Swiss National Joint Registry

SIRIS Report 2012–2015

Annual Report of the Swiss National Joint Registry, Hip and Knee

ano

swiss orthopaedics

UNIVERSITÄT BERN

Hip and knee replacement results

SIRIS Report 2012–2015

Annual Report of the Swiss National Joint Registry, Hip and Knee

SIRIS – Foundation for Quality Assurance in Implant Surgery
swiss orthopaedics – Swiss Society of Orthopaedics and Traumatology
ANQ – National Association for the Development of Quality in Swiss Hospitals and Clinics
ISPM – Institute for Social and Preventive Medicine, University of Bern.

Preface

Implant registry – what is it for?

Many databases containing clinical data are individually programmed and are based on a wide variety of validated and non-validated measurement tools, which makes comparing the data difficult or impossible. Compulsory centralized registries are a solution to this problem.

Registries are advantageous from both a technical and a content perspective. Alongside the ability to compare results, they can evaluate a large number of cases that occur over a short period of time and offer the opportunity to compare the performances of implants, clinics and surgeons.

By collecting information about both standard and more innovative medical methods in the registry, it is possible to make an objective assessment of the results. The registry also means that information on complications such as infections, excessive bleeding or thromboembolism can be collected as comprehensively as possible over an extended period of time and used as quality parameters.

A further function of the implant registry is as an early warning system for recognizing implants that are rejected due to production or design faults. As this is a very rare occurrence due to the quality of modern implants, it can usually only be recognized by the long-term analysis of large numbers in order for the implant to be removed from the market.

However, to ensure that the collection of data in the registry is adequate and accurate, and to avoid a so-called „data graveyard", a registry as significant as the SIRIS Swiss National Implant Registry, Hip and Knee will need to conduct an independent audit long term.

Prof. Max Aebi
President of the Foundation for Quality Assurance in Implant Surgery, SIRIS – Swiss National Implant Registry, Hip and Knee

Successful development

The SIRIS implant registry has been established and is on its way to becoming a new source of information for quality data in the Swiss healthcare system. This is a significant achievement which has been made possible through the constructive cooperation of all the organizations involved, namely the SIRIS foundation and the professional association swiss orthopaedics (SO) as well as designated experts.

At the end of 2011, the SIRIS Swiss National Implant Registry, Hip and Knee was integrated into the ANQ timetable. Since September 2012, all hospitals and clinics have recorded the hip and knee prosthetics that have been implanted. The ANQ ensures the obligatory participation of these institutions in the registry, enabling widespread coverage and the gathering of meaningful data. Within just a few years this could offer an important basis for aiding quality development in orthopedics.

We would like to sincerely thank everyone who has played a part in producing this first report, in particular the team of writers, who invested a great deal of effort in developing the optimal format for a sophisticated report that we can build on from now on.

Thomas Straubhaar
President of the National Association for the Development of Quality in Swiss Hospitals and Clinics (ANQ)

Definitions

Acetabular component The part of a hip prosthesis that is implanted into the acetabulum – the socket part of a ball and socket joint

Arthrodesis A procedure in which a natural joint is fused together

Arthrofibrosis Rigidity of the joint as a consequence of connective tissue adhesion

Arthrotomy The opening of a joint during surgery

Articulation The two surfaces that move together (articulate) in a total joint replacement

ASA score The scoring system of the American Society of Anaesthesiologists (ASA) for grading the overall physical condition of the patient, as follows–
I: fit and healthy; II: mild disease, not incapacitating; III: incapacitating systemic disease; IV: life-threatening disease

Benchmark Comparing the performance at a specific hospital to the mean performances of hospitals throughout Switzerland helps hospitals to learn from each other

Bilaterality Replacing the same joint on both sides of the body (typically both hips or knees) by means of a prosthesis within a specific period

Body Mass Index ‹18.5: underweight; 18.5–24.9: normal weight; 25–29.9: overweight; 30–34.9: obese class I; 35–39.9: obese class II; ›40: obese class III

Case mix Term used to describe variation in the population, relating to factors such as diagnosis, patient age, gender and health condition

Cement Material (polymethyl methacrylate) used to fix joint replacements to bone

Charnley score Clinical classification system –
A: one joint affected; B1: both joints affected; B2: contralateral joint with a prosthesis; C: several joints affected or a chronic disease that affects quality of life

Competing risks survival analysis Method to calculate survival taking into account various outcomes, in this case revision and death

Cumulative incidence The combined incidences over a specific period of an event (such as the revision of a prosthesis or death of a patient)

Cumulative revision percentage Combined revision percentage over a specific period

Dual mobility cup Acetabular component that consists of a dual cup and, therefore, has two independent articulation points

Femoral component Part of a hip or knee prosthesis that is implanted into the femur (thigh bone) of the patient

Femoral head component Part of a hip prosthesis that is implanted on top of the femoral component of a hip prosthesis and moves inside the acetabular component or the cup of the hip joint

Girdlestone Hip revision procedure in which the hip joint or hip prosthesis is removed and no new prosthesis is implanted (often because of a bacterial infection)

Hybrid fixation Fixation of a prosthesis in which (most often) one of the two parts of a prosthesis is cemented and the other one uncemented

Inlay (insert) Intermediate component (inner layer), made of polyethylene, which is placed in the acetabular component

Kaplan-Meier survival analysis Method to calculate survival, in which only one end point is possible, in this case revision

Knee insert Intermediate component (inner layer), made of polyethylene that is placed in the tibial component of a knee prosthesis

Lateral collateral ligament Lateral (outer) knee ligament

Malalignment Strain on a part of the body due to an abnormal position of a joint component with respect to other components

Meniscectomy Meniscus removal

Metallosis Deposition of metal debris in soft tissues of the body

Osteoarthritis Disease of the joint in which the cartilage is damaged/destroyed, and the underlying bone altered

Osteochondral bone defect Defect of the joint surface in which both cartilage and underlying bone are affected

Osteonecrosis Cellular death of bone tissue

Osteosynthesis Securing broken bone parts together with plates, pins and/or screws

Osteotomy Incision of the bone in order to correct its position, to shorten or lengthen it

Patellar component Part of a knee prosthesis that is implanted on the inner side of the knee cap

Patellofemoral prosthesis Two-piece knee prosthesis that provides a prosthetic (knee) articulation surface between the patella and trochlea (furrow) of the thigh bone (femur)

Primary prosthesis The first time (primary) a prosthesis is implanted to replace the original joint

PROMs Patient Reported Outcome Measures

Resurfacing hip arthroplasty
Hip prosthesis in which the cup (acetabulum) is replaced and a metal cap is implanted on top of the femoral head

Reversed hybrid fixation hip prosthesis
Fixation of a hip or knee prosthesis in which the proximal component is cemented and the distal component is uncemented

Revision arthroplasty Any exchange (insertion, replacement and/or removal) of one or more components of the prosthesis

Revision burden Ratio of revision procedures to all (primary and revision) arthroplasty procedures

Sarcopenia The degenerative loss of skeletal muscle mass and strength associated with aging.

Synovectomy Removal of inflamed mucosa in a joint

Tibial component Part of a knee or ankle prosthesis that is inserted in the tibia (shin bone) of a patient

Total joint arthroplasty Arthroplasty in which the entire joint of a patient is replaced

Unicompartimental knee arthroplasty Resurfacing of half the knee (either inner or outer side) by a prosthesis

Abbreviations

ASA	American Society of Anaesthesiologists
BMI	Body Mass Index
CI	Confidence Interval
CRF	Content Report Form
PROMs	Patient Reported Outcome Measures
SD	Standard Deviation
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty
UKA	Unicompartmental Knee Arthroplasty

Testimonials

”Long-lasting quality is mandatory in joint replacement surgery. A joint registry will identify badly performing implants early and will help to improve outcome by identifying the causes for early and late revision surgeries.”

Martin Beck (Orthopaedic Surgeon)

”As an orthopaedic surgeon who is focused on joint replacement of the knee and hip I’m absolutely convinced that a Swiss Joint Registry is mandatory for my own quality control and will be a benchmark for the rest of the swiss orthopaedic community and other international joint registries.”

Bernhard Christen (Orthopaedic Surgeon)

”Independent and professional recording, analyzing and reporting are key factors for the quailty of a joint registry in orthopaedic surgery. SIRIS has reached to unite all.”

Bernhard Jost (swiss orthopaedics)

”All implants designed to remain inside a patient for a long period of time need independent and adequate monitoring – SIRIS delivers the data and the objective truth! ”

Armin Schrick (FASMED)

”SIRIS is essential to adequately, and objectively, monitor results in joint replacement in Switzerland, as this domain requires large medical resources, and as many outcomes go far beyond the observational scope of the individuals involved.”

Peter Wahl (Orthopaedic Surgeon)

”SIRIS – the building block for long-lasting, positive outcomes following joint replacement surgery.”

Christian Westerhoff (Hirslanden)

Synopsis

Early days

Since the start of the Swiss National Jojnt Registry (SIRIS) in September 2012, 65716 total hip arthroplasties, including primary and revision operations have been recorded. The numbers oscillate between 19120 procedures for 2013 and 19532 for 2015. Revisions represents 12.2% of all total hip arthroplasty procedures.

For knee arthroplasties the situation is similar, with 56457 entries reported since September 2012. The number of interventions has been stable with 16519 primary and revision operations performed in 2013 and 16938 in 2015. The revision burden over the entire period was 9.4%.

Total Hip Arthroplasty

With regard to primary total hip arthroplasty, the results show that 52% were performed in women, two-third of interventions occurred in patients aged over 65 years (the mean age of the entire cohort being 68 years), and 63% of patients were overweight or obese. In 2015, for primary total hips, the anterior approach was used in 42%, while the antero-lateral approach was used in 34% of cases and the posterior approach in 15%. In patients with a diagnosis of osteoarthritis , 86% of the primary total hip arthroplasties used were uncemented. Interestingly, 17% of primary total hip arthroplasties were performed in hospitals completing fewer than 100 procedures annually, and 32% were performed in institutions treating more than 300 cases annually.

For revisions of hip arthroplasties, the main causes were aseptic loosening of the femoral and/or acetabular component (44%), infection (15%), periprosthetic fracture (14%) and dislocation (11%). In 60% of cases the revisions included the exchange of one or both of the acetabular and/or femoral components.

Hemiarthroplasty of the hip

Hemiarthroplasties of the hip concern fractures of the femoral neck or, more rarely, intertrochanteric fractures. Compared to the more than 65000 total hip arthroplasties implanted between 2012 and 2015, the number of hemiarthroplasties was much lower, accounting for 6534 interventions. It is important to note that the patients receiving these implants were much older (a mean age of 84 years) and frailer, many having underlying conditions such as osteoporosis and sarcopenia. In contrast to the recipients of total hip arthroplasties, the proportion of obese patients was low (7% compared to 24%). Women constituted 73%, and the operation generally followed a low-energy fall or traumatic event. Interestingly, 40% of hemiarthroplasties were performed in hospitals with less than 100 hip procedures annually compared to 17% performed in institutions performing more than 300 hip cases annually.

Knee arthroplasty

With regard to primary arthroplasties of the knee, 61% occurred in women, 69% of the interventions occurred in patients aged over 65 years (compared to the mean age of the entire cohort of 69.2 years) and 78% of patients were overweight or obese. Primary osteoarthritis was the main diagnosis in 88% of cases in 2015, and 36% of patients had had previous surgery, with arthroscopic exploration and meniscectomy accounting for 25% of all previous interventions. Cruciate sacrificing, posterior stabilized, and posterior cruciate retaining implants accounted for 89% of implanted total knee prostheses in 2015. Twenty-four percent of the interventions were reported as being computer assisted or using patient-specific instrumentation. In more than two-thirds of procedures, an all-cemented component fixation was reported. Patellar components were used only in one of four cases. It is of interest to note that 25% of primary knee arthroplasties were performed in

hospitals completing fewer than 100 procedures annually and that 32% of primary knee arthroplasties were performed in institutions dealing with more than 300 cases annually.

Primary unicompartimental prostheses accounted for 7329 cases between 2012 and 2015. Of the total number of operations, 51% were performed in women and the mean age at surgery was 65 years. Seventy-two percent of the patients were overweight or obese. Primary osteoarthritis was the diagnosis in 90% of the cases, while half of the remaining 10% were ascribed to osteonecrosis. The data show that 40% of the patients had had previous surgery, with knee arthroscopy and meniscectomy accounting for 43% of the total. Of these operations, 87% were medial, 6% were lateral and 7% patellofemoral component replacements. In 93% an all-cemented technique was used.

Finally, findings of interest stand out from the report:
– Early revisions among the primary arthroplasty procedures recorded since 2012 occurred on average 1 month after hip arthroplasty as compared to 10 months after knee arthroplasty.
– More than 80% of revision operations occured in the same institution where the primary was performed.
– A majority of operations were performed in overweight or obese patients.

Work in progress

SIRIS is a proactive registry providing essential information that patients and health-care providers at all levels will find useful. The information in the SIRIS report is derived from the data forms filled out and delivered to the system. Clearly, it is not possible to give information on data that were not collected. It must also be pointed out that some elements are not explored in the current report, such as the exact type and manufacturer of a given implant. This information is available from the barcodes, but an additional translation effort is necessary in cooperation with industrial partners in order to provide this information in future editions. It must be emphasized that this "translation work" will be beneficial for all future registries in Switzerland. Streamlining, improving and optimizing the data collection is a work in progress involving expert groups and all stakeholders so that in the future a more complete assessment of the Swiss national hip and knee arthroplasty situation will be made available to all.

Strong commitment

The 2015 SIRIS report represents a collaborative effort involving all the institutional partners of SIRIS, and including the surgeons and operating teams in 149 clinics and hospital services. Overall, the response rate of the hospitals and clinics for sending in data has been remarkable. Although the registry officially only started in 2012, it has already enjoyed a response rate of over 95% of the involved institutions.

This demonstrates not only the strong commitment to the project by the surgeons and their teams both in public and private institutions but also the high quality of the organization, coaching and data collection of the SIRIS team. The report provides factual information on the state of hip and knee replacements in Switzerland and presents a wealth of new information. The report also offers important and verifiable information that the health-care community, third-party payers and health-care regulators will find useful.

Acknowledgments

Analyses and editorial board

Scientific board (analyses and report writing)

Prof. Pierre Hoffmeyer, MD
Author of the scientific SIRIS report
Professor emeritus University of Geneva

Dr. Anne Lübbeke-Wolff, MD, DSc
Epidemiologist, Lead Geneva Arthroplasty Registry, Division of Orthopaedic Surgery and Traumatology, Geneva University Hospitals

Dr. Lukas Staub, MD, PhD
Senior Research Associate, SwissRDL, Institute of Social and Preventive Medicine (ISPM), University of Bern

SIRIS Expert Group

Prof. Martin Beck, MD
Chief physician, Orthopaedic division Canton Hospital of Luzern, swiss orthopaedics, Hip Expert Group

Dr. Bernhard Christen, MD, M.H.A.
Christenortho AG, swiss orthopaedics, Knee Expert Group

Prof. Claudio Dora, MD
Vice-Chair Department of Orthopaedics University Clinic Balgrist, Zurich
Member Board SIRIS

Regula Heller, MNSc, MPH
Chair Akutsomatik ANQ
Lead and moderation SIRIS Expert Group

Peter Liniger
Johnson & Johnson AG, Member Board SIRIS

Andreas Mischler
conidea GmbH, Lead SIRIS Administration

Jasmin Vonlanthen
User Support for SIRIS Hip and Knee, ISPM

Dr. Peter Wahl, MD
Staff surgeon, Clinic for Orthopaedics and Traumtalogy, Canton Hospital of Winterthur

Dr. Christian Westerhoff, MD
Chief Clinical Officer Hirslanden,
Member QA Akutsomatik ANQ

Partner associations of SIRIS

ANQ
National Association for the Development of Quality in Swiss Hospitals and Clinics
info@anq.ch

FASMED
Swiss Federation of Medical Technologies
fasmed@medizinprodukte.ch

santésuisse
Association of Swiss Medical Insurers
mail@santesuisse.ch

swiss orthopaedics
Swiss Society of Orthopaedics and Traumatology
welcome@swissorthopaedics.ch

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Foundation for quality assurance in implant surgery – SIRIS
c/o Conidea GmbH, Waldheimstrasse 22,
3604 Thun, +41 79 356 63 59, info@siris-implant.ch

Contents

1. Introduction

A registry is defined by Gliklich et al. as "an organized system that uses observational study methods to collect uniform data (clinical and other) to evaluate specified outcomes for a population defined by a particular disease, condition, or exposure, and that serves one or more predetermined scientific, clinical, or policy purposes."[1]

Moreover, the Swiss Medical Association (FMH) defines a registry as a "systematic gathering of data pertaining to a population or to patients including medical data relative to health-care quality and/or economics in a predefined sector including their evaluation in order to attain a specific goal but also allowing some variability to use the data for different purposes".[2] Therefore, the major purpose of a medical registry is not only to compile data, but to be a uniquely powerful tool that allows comparative research, quality assessment, economic analysis and clinical evaluation.
In August 2007, swiss orthopaedics joined forces with the Swiss Federation of Medical Technologies (FASMED) and the Association of Swiss Medical Insurers (santésuisse) to set up the Foundation for Quality in Orthopaedics. The Foundation's goal was to organize, produce and fund the future SIRIS implant registry. Management of the arthroplasty registry was entrusted by the Foundation to the ISPM of the University of Bern. This involved finding solutions for technical issues, evaluating the data and establishing reports, as well as assuming responsibility for leading the SIRIS project.

In parallel, Swiss hospitals and clinics were requested to sign a national quality contract under the auspices of the newly founded National Association for the Development of Quality in

[1] Gliklich RE, Dreyer NA. Registries for Evaluating Patient Outcomes, 3rd edition. 2014

[2] Mathis and Wild, 2008, HTA Projektbericht n°11 Vienna

Swiss hospitals and clinics (ANQ). This meant that hospitals and clinics were then contractually required to record their implants into the SIRIS national registry. The formal cooperation between SIRIS and the ANQ was initiated in 2011 and from 2012, inclusion was declared compulsory.

The Swiss National Implant Registry, Hip and Knee (Schweizerisches Implantat Register – Registre Suisse des Implants; SIRIS) was formally introduced in September 2012. Participation in the activity of SIRIS became compulsory for all hospitals and clinics performing knee and hip arthroplasties that had signed the National Quality agreement, i.e. practically all Swiss hospitals and clinics. After the necessary planning period, orthopaedic services began to upload in earnest their case data starting in 2012.

SIRIS is a national registry whose goal is to help oversee the safety and effectiveness of the various implanted arthroplasties and to detect as early as possible potential problems related to poor implant performance. For the industrial partners, SIRIS should serve as a post-marketing surveillance instrument so as to allow industry to track the performance of their implants over the long term. Moreover, each hospital and each surgeon can compare their own data with the complete dataset and evaluate their results against the overall results found in the registry. The ambition was that analysis of the information from the data collected by SIRIS would ultimately be used prospectively so as to improve quality of care in Swiss hospitals and clinics.

The present report covers all recorded hip and knee arthroplasties from September 2012 to December 2015. Less than 3% of the centers sent partial information. The data available currently allow us to describe quantitatively, and realistically, the epidemiology of knee and hip arthroplasties implanted in Switzerland. Since SIRIS is now in its fourth year of data collection it is possible to analyze early revisions, which has provided the first valuable indications of the global quality of Swiss health-care services in this area. More time will be needed, however, to fully and accurately assess data related to implants, manufacturers, surgical techniques and hospitals.

2. Methods

The Swiss National Implant Registry, Hip and Knee (SIRIS) is hosted by the Institute of Social and Preventive Medicine (ISPM) at the University of Bern. A dedicated team consisting of a project manager, data management specialists and an epidemiologist is responsible for the administration and individual training of participating hospital services to ensure the smooth and efficient conduct of the registry.

SIRIS data are collected on the online documentation platform MEMdoc (accessible on www.siris-doc.ch). On this system, both clinical data on primary and revision operations as well as implant data are recorded. The current SIRIS content report forms for clinical data can be downloaded from www.siris-implant.ch. Most participating hospital services use the online interface when documenting their operations, while a small minority sends completed paper forms to the ISPM for processing. As a third data entry method, two large services send data exports from their hospital information system via Webservice Client to the ISPM.

Details of the used implant components are directly scanned off the supplier labels in the operating room by the majority of participating services. It is also possible to manually enter the information directly via the web interface.

The method of data acquisition is continually improved. Since 2015, for example, the different surgical cements have been documented on a separate form, thereby enhancing the precision, thoroughness and quality of the documentation.

To ensure the continuity of implant follow-up even when patients change hospital services (e.g. when a revision is performed in a service other than where the primary implantation took place), the data are collected in an identifiable format but are then stored using codes.

2.1 Data protection and coding

The central server, housed at the ISPM, hosts the main application and the central database, which stores all clinical study data using codes. Only internal numeric identifiers (Patient ID) as well as data on patients' sex and year of birth are stored in the central database.

A satellite server, the SIRIS module that is also hosted by the ISPM, stores all personal data about users, institutions and patients, including the key list. No health-related data is stored on the satellite server.

Newly entered data is split so that only internal numeric identifiers for the user, patient, clinic, and department are stored in the central database. Questionnaires are coded through the internal numeric identifiers.

All health-related data is retrieved from and stored directly on the central server and linked to the SIRIS module via these internal identifiers. Medical data never pass through and are never stored on the satellite server.

This methodology was reviewed and approved by data protection delegates (from the canton of Bern and from the Federal Authority). Patients must provide written consent to have their data recorded centrally into SIRIS, and they have the possibility to refuse inclusion or to have their data removed at any time.

2.2 Definitions

A revision procedure is a secondary surgical procedure of a patient's hip or knee joint whereby the complete primary implant or parts thereof are replaced by new components.

All other secondary procedures, where no components of the primary implantation are removed, are reoperations.

One measure commonly used to estimate the quality of arthroplasty surgery in a health-care system is the revision burden, defined as the ratio of revision procedures to all (primary and revision) arthroplasty procedures. In this report, we calculated the revision burden separately for total hip arthroplasties, hemiarthroplasties of the hip and total knee arthroplasties.

In the tables depicting the case mix of arthroplasty populations, four categories of hospital service volume (‹100, 100–199, 200–299, 300+ procedures per year) were used. The calculation of the annual volume was performed separately for hip and knee surgeries, based on all (primary and revision) procedures recorded in each hospital service in 2015.

2.3 Data quality and completeness

Data for this report were exported from the database on September 16th 2016. The consistency and completeness of SIRIS data is checked through systematic software-generated validation tests of received data and a rollback in case of errors. This means that data entered in the registry is checked both for completeness and plausibility. For example, when a case of developmental hip dysplasia is entered, the system automatically checks that subsequent items on the questionnaire relevant for this pathology are completed and plausible. Error messages are displayed if the system detects missing or implausible information, and only fully completed forms can be saved and submitted to the central database.

It is not possible to distinguish between a revision of a total and a unicompartmental knee arthroplasty when the primary arthroplasty was performed before September 2012 (except when the conversion from unicompartmental to TKA was indicated as reason for revision). The same applies to hemiarthroplasties of the hip.

Two content report form (CRF) versions have been used in SIRIS. The first version was used in the years 2012 to 2014. An updated version, introduced in January 2015, included some changes in the definition of existing variables (particularly for the arthroplasty of the knee), and some new variables were added, most notably the body mass index (BMI) and the morbidity state (ASA). The latter allows the answer "unknown", which was inconsistently used across hospital service-providers, including one service reporting unkown ASA status in 100% of cases. To provide more reliable estimates of the morbidity index in this report, we excluded from this analysis all hospital services that reported an unknown ASA status in more than 80% of cases. This applied to seven services.

2.4 Coverage

To estimate the coverage of SIRIS, we compared the annual numbers of cases reported in the registry with those available in the Swiss hospital discharge master file of the Federal Statistical Office (FSO). This encompasses a complete survey of all annual hospital discharges in Switzerland. Each entry represents a hospital discharge of a person residing in Switzerland and includes information about socio-demographic patient characteristics, diagnosis and treatment.

In the Swiss hospital discharge master file, cases of an arthroplasty surgery were identified using the CHOP treatment classification of the FSO, which is an ICD-9-CM-based treatment classification. A set of CHOP codes (in brackets) was selected for primary THA (81.51); hip revision surgery (81.53, 00.70, 00.71, 00.72, 00.73); primary TKA (81.54.00, 81.54.11, 81.54.12, 81.54.14, 81.54.99); and for knee revision surgery (81.55, 00.80, 00.81, 00.82, 00.83, 00.84).

At the time of writing, data from the year 2015 was not yet available from the Federal Statistical Office. Hence, we are only able to report on the coverage of SIRIS data for the years 2013 and 2014. The overall coverage of SIRIS was 87.9 percent in 2013, and this increased to 90.8 percent in 2014. Note that these results must be taken as estimates, because for legal reasons the SIRIS data could not be linked to those of the FSO at an individual level and because the method used to define cases in SIRIS and the FSO data are not identical.

3. Discussion

3.1 The path to SIRIS

Historically, the conviction to create a joint arthroplasty registry was deeply rooted among of the membership of the Swiss Society for Orthopaedics and Traumatology (SSOT/SGOT), or "swiss orthopaedics" as it is known today. Indeed, for many years surgeons have recognized the need for the creation of a tool at the Swiss national level to exhaustively monitor the quality and outcome of the rapidly growing number of implanted artificial joints. In 1975, Sweden was the first nation to implement a joint implant registry, closely followed by the other Nordic countries. The governments of these countries soon made the inclusion of all implanted artificial joints mandatory, starting with the most frequent: the hip and the knee. Following in the footsteps of the Nordic pioneers, and recognizing the necessity of developing a tool for assessing the fast-growing numbers of joint implants, swiss orthopaedic surgeons became convinced of the necessity of setting up a national arthroplasty registry. Shortcomings related to hip implant failure such as the Capital Hip in the UK or the large-head metal-on-metal hip implants, boosted the need for serious and exhaustive monitoring of all implants. Therefore the time was ripe, and quite naturally the concept of a Swiss national registry entered mainstream thinking. The question then, was not so much whether there was a need for a registry, but how it should be set up and in conjunction with whom. In 2006, during its annual meeting in Luzern, the members of the general assembly of swiss orthopaedics formally approved the concept of the creation of a joint arthroplasty registry. Some things were immediately clear: The data was to be owned by swiss orthopaedics, it needed to be exhaustive, a solid financial basis was to be found and outside government interference was to be minimal or entirely avoided. At that same meeting, the next item on the agenda was the creation of a privately run, owned and funded Foundation which would organize, produce and finance the fledgling SIRIS registry. To achieve this, it was decided that it would be necessary and efficient to bring in external partners, namely the Federation of Swiss medical devices' trade and industry associations (FASMED), the Swiss Association of Healthcare Insurers (santésuisse) and the association of Swiss hospitals (H+). The Foundation's aim would be to ensure quality in orthopaedics by promoting SIRIS, an exhaustive national joint arthroplasty registry that would begin by collecting data focused on hip and knee arthroplasties but would eventually encompass all orthopaedic implants.

When looking through the archives of swiss orthopaedics, it is apparent that the path to success was thorny indeed, even though the idea of a registry was appealing and undoubtedly accepted by all from the outset. The plan of establishing a registry was first mentioned seriously as a project in October 2004. A little later, in 2005, a preliminary meeting between swiss orthopaedics and members of FASMED took place. This led to an in-depth and detailed discussion in 2006 within the swiss orthopaedics leadership. It was foreseen at that time to create a pilot project with the Maurice E. Muller (MEM) Foundation. The future registry was to be financed by the industrial partner, the FASMED and the association of Swiss Association of Healthcare Insurers "santésuisse". Undoubtedly, this was found to be an excellent solution by swiss orthopaedics. Also in that year of 2006, the leadership of swiss orthopaedics determined that the exact nature of the data collected needed to be exactly defined by the society's Hip and Knee Expert Groups (EG) and that the data would belong to both swiss orthopaedics and to the patient. Data protection and anonymization was to be ensured by the MEM Foundation. In those days the main task at hand was felt to be the motivation of the members of swiss orthopaedics to accurately fill out the questionnaires and to enroll all their cases, a fundamental

step if the registry was to be successful. The other aspect of the discussion was all about finances. The essential question was how to sustainably fund the registry. All were in agreement that a solutions must be found involving surgeons, insurers, industry and hospitals. It was also recognized that government support was needed but with minimal state interference in the functioning and ownership of the future national implant registry. For that purpose a first meeting took place in December 2006 together with representatives of all major stakeholders, including R. Guetg (santésuisse), E. Plozik (ministry of health), J. Schnetzer and P. Liniger (FASMED), U. Müller (MEM-Institute), B. Wegmüller (H+), J. Brandenberg and C. Perrin (swiss orthopaedics). The stage was set for all parties to formally agree on the need of a national joint registry, but despite this unanimity the means for attaining the goal and, more specifically the financial situation remained uncertain. Therefore, although the idea of a national registry was universally recognized and also supported by the ministry of health, solutions still had to be found if the dream, of establishing such a necessary quality assessment tool was to become a reality. The main points of discussion revolved around the comprehensiveness and anonymity of the data, as well as how the project would be financed. It was estimated that an annual budget of approximately 1 million CHF per year would be needed to run the registry. It was clear from the outset that it was necessary to create a Foundation which would be expected to house the future registry. An independent, privately owned and administered Foundation entitled "Quality in Orthopaedics" whose mission would be to insure quality in orthopedics was envisioned. Its main practical role would be to support the registry by implementing and supervising the collection, analysis and publication of the acquired data. Finally, after more meetings and discussions, the Foundation for "Quality in Orthopaedics" was created in April 2007. The founding members were swiss orthopaedics, the FASMED, and santésuisse. In July 2008, the Foundation's aims were broadened to become the Foundation for "Quality assurance in implant medicine" so as to be inclusive of all health-related registries, including the future national arthroplasty registry. For the technical aspects of SIRIS, the Foundation benefited from the experience and know-how of the Institute for Evaluative Research in Medicine (IEFM) of the University of Bern led by Prof. Dr. med. Max Aebi, which defined its mission as "a dedicated academic research institute in the field of health technology assessment, at the interface of economy and delivery of care, and for outcome research in medicine". As of January 2016, the Institute for Evaluative Research in Medicine (IEFM) and the Institute of Social and Preventive Medicine (ISPM) have merged and continue to work under the name ISPM which is now managed by Prof. Dr. med. Matthias Egger.

Even though there was unanimous agreement on the need to create a national implant registry, there still remained the matter of resolving the financial issues. To be viable in the long term SIRIS needed a sustainable income base. The health environment scene was changing, and with increasing related costs, the quality and efficiency of the delivery of health-care was emerging as a major political issue in Switzerland. Quality became the first and foremost issue in hospital and clinic administrations across the nation. Registries became of interest and individual hospitals were asked to contribute financially to their upkeep by the H+ association. Finally, after a vote including all affiliated hospitals that took place in the fall of 2008, the members of H+ accepted the principle of contributing a sum per intervention to fund the registry. At the annual Geneva meeting in 2009, the members of the swiss orthopaedics general assembly formally agreed to participate in the creation and functioning of the future SIRIS and even enthusiastically voted to provide an extraordinary contribution of 100 000 CHF out of its own budget

in order to begin collecting data for the registry. However, it still needed more meetings, solicitations and letters to the Ministers of Health of the Cantons before the situation was finally clarified.

Administratively the Foundation was set up and SIRIS created, but things got off to a slow start. Individual surgeons, hospitals and clinics were reluctant, to say the least, to begin collecting the contributive data for SIRIS. The National Association for the Development of Quality in Swiss Hospitals and Clinics (ANQ) was founded in order to implement the Federal Health Insurance Act (HIA Art. 22a; HIO 77). Following the creation of the ANQ in November 2009, all hospitals and clinics were invited to sign an agreement with the ANQ, which included the mandatory contribution of data to SIRIS. This was a boon for SIRIS: all hospitals and clinics were now obliged to provide data concerning their artificial hip and knee joints activities to the registry.

On June 23rd, 2011, in Lausanne, the general assembly of swiss orthopaedics, presided over by C. Gerber, decided the following: From January 1st, 2012 inclusion into SIRIS was mandatory; SIRIS would be financed by a modest increase in intervention pricing – an extra 20 CHF per intervention; the primary owners of data would be the patients, the hospitals and clinics, and the surgeons; and the data was to be anonymized and external researchers may access the data only after obtaining permission from the Foundation's board.

The legal and financial aspects were now on a solid base, with a guaranteed steady stream of income stemming from contributions of the industry and the hospitals supervised by the ANQ.
The data was electronically transferred to the SIRIS data base located in Bern using evaluation forms tailored for the purpose. Because ergonomics and user-friendliness were a primary concern, surgeon interaction was purposefully kept to a minimum. All the hospitals and clinics were regularly coached by the SIRIS staff, thereby ensuring that the input data would be of high quality. Patient participation was decided to be on a voluntary basis and any patient may have his data erased from the database on demand. All the data is anonymized and encrypted. The first data registrations into SIRIS began in September 2012. It is of interest to note that although SIRIS is funded and managed by a private Foundation, the impetus for its function came from the ANQ. In fact, by signing the ANQ agreement, the hospitals agreed to cooperate with SIRIS, thereby providing both the data and the necessary funding.

In 2012 SIRIS published its internal rules, which were signed by the four partners, swiss orthopaedics, FASMED, santésuisse and H+. The robust SIRIS framework and the strong incentives for nation-wide quality control were the keys to the registry's astounding success, as measured by the fact that today more than 95% of all implants sold on the orthopaedic implant market appear in the SIRIS database.

For SIRIS to succeed, it needed the voluntary collaboration of the four independent associations, namely swiss orthopaedics, FASMED, santésuisse and H+, which together have coalesced into a solid multi-partner, privately run and funded Foundation that is focused on quality and supported by both, academia (ISPM) and private enterprises. The ANQ provided the crucial impetus which led to establishing SIRIS as a perennial and unanimously supported endeavor born from a strong and unique joint venture. The creation of SIRIS, a national registry, in our federal system can be viewed as one of swiss orthopaedics' major accomplishments in this century. Even more effort will be needed to maintain and even expand the registry in the future.

3.2 The missions of SIRIS

The **mission** of a national joint registry needs to be clearly defined so that all stakeholders and participants strive towards a common goal. This also influences the granularity of the information contained in the registry as this will be quite a different requirement for each of the involved partners. The fact that a multi-partner association was needed to get SIRIS off the ground and flying signified that more than one point of view had to be taken into consideration if success were to be achieved. Although all the motivations pertaining to the significance of registries apply to all the partners involved, each partner tends to focus more on a particular aspect.

Patients expect their implant to provide them with a long lasting, pain-free result. The operation must be adapted to their level of activity and should be tissue sparing and complication-free, followed by rapid rehabilitation. The registry data should be presented in such a way as to be readily comprehensible, allowing patients to distinguish between fact and fiction in the "jungle" of orthopaedic arthroplasty implants.

Surgeons are primarily concerned with avoiding complications and shortcomings to their individual patients. The implants must be impeccable in their manufacture, versatile and avoid problems such as early loosening, particle disease, breakage, dislocation, infection, stiffness, or chronic pain. A long, problem-free implant life with a minimum amount of wear of the bearing surfaces is the ultimate goal. The registry should identify in a relatively short time frame the problematic implants as well as the reliable ones. Surgeons are essentially motivated by their own individual clinical results to enter proper and complete information into the data collection system with minimal interference in their daily activities. Surgeons will also want to benchmark their own results as compared to the overall results for each implant, technique, and patient or disease category. A moot question is the public availability of information at the individual surgeon level. This may lead to bring bias entering into the system by encouraging some surgeon groups to avoid complex or complication-prone patients, who are then left to seek treatment in publicly funded institutions.

The **industry's** main focus is on manufacturing and sales. Designing and providing a first-rate, problem-free implant system is its primary goal. Progress and technical innovation are also powerful motivators for an industry dedicated to providing high-performance implants. The registry is seen as an essential tool of post-market surveillance and clinical control that justifies improvements in materials, design and concepts. The down-side is that overregulation may hinder efforts at innovation, thereby missing opportunities to create better and safer products.

Hospitals aim to provide excellent and safe care, at a reasonable cost, to a large number of patients. Hospitals want to avoid the expenditures and hazards related to implant systems of uncertain reliability and value. The registry is perceived as a quality control instrument, not only of the implants used, but of the whole chain of its clinical organization ranging from the preoperative consultation, to the procedures in the operating room and to the post-operative follow-up. Hospitals, being health-care-providing institutions in today's competitive environment, are also very keen to upholding their reputation and a registry is an invaluable tool for this purpose.

Insurers and third-party payers want minimal delays and waiting times for employed patients, short hospitalization times, no expensive re-admissions for complications and a quick return to work. In-

surers are very cost-conscious when it comes to implant pricing, medical honorarium and hospital bills. The insurers wish is to provide equal benefits for all their clients within the budget available to them. The registry is therefore perceived as an instrument for quality control of surgeons and institutions and also a cost-control tool.

The **government** is concerned with the welfare of the whole population. It therefore needs data on the overall surgical activity for public health purposes, for needs assessments and for planning the macroeconomic policies related to health-care. Government agencies are keen to ensure that the institutions under their supervision provide high-quality and complication-free health care to the overall population. The agencies will also have an interest in benchmarking hospitals and in keeping insurance and third-party payer costs down to a minimum. Health agencies also play an important role in supervising implant systems as they seek to guarantee that the industrial specifications of nationally manufactured and imported implants are safe and reliable for public usage.

3.3 Commentary on the SIRIS report 2012–2015

SIRIS, together with and thanks to all the partners, has been successful in implementing nationwide data collection on hip and knee arthroplasties – with a coverage of 95% of all operations after only two years of its existence. Moreover, high initial completeness has already been achieved for the case-mix variables of BMI and ASA score introduced in 2015.

Working on the present report has enabled analysts to identify the registry's strengths and weaknesses – a step that is essential for future improvement of registry coverage, data content, structure, accuracy, completeness, analysis and interpretation. SIRIS, in its present form, cannot answer all the queries posed by the different stakeholders. Some questions are related to medium- and long-term follow-up, whereas the registry can today only provide information from 2012 onward. The granularity and accuracy of the information is dependent on the information that the registry receives from the hospitals and clinics.

Patient-reported outcomes including clinical scores are not available yet, and if this information is to be made available it will need large investments in time and resources from the orthopaedic community as a whole. Implant-related information is also not yet available for specific brands of implants.

The information that is processed today can only pertain to generic characteristics such as cemented or uncemented implants. Because the SIRIS philosophy is to generate the least possible demand on the surgical team's time it currently relies on forms to be filled out manually or electronically and on the information contained in implant barcodes. Manufacturer barcode information in Switzerland is very rich but not yet accessible to automated and computerized analysis because of the way it is formatted. It is felt that it is impractical and too time consuming for individual surgeons to fill out complex forms describing in detail the implanted material (alloys used, thickness of hydroxyapatite coatings, ceramic type etc). As a consequence, in this version of the SIRIS report, individual results for specific implants cannot be presented.

Revision is the accepted outcome measure; it was chosen because it is a hard and reproducible endpoint. However, it must be realized that revision occurs at the end of the implant failure process. In some circumstances, such as the relatively rare complication of implant breakage, the time from onset to revision is very short but in many other circumstances, such as slowly progressive loosening,

the onset of implant failure becomes clinically apparent and leading to actual revision may take years to materialize and therefore impart a false sense of security.

3.4 Future developments of SIRIS

The future lies in coaxing or coercing the industrial partners to provide analysis-friendly barcode information and in collaboration with the German and UK Registries (EPRD and NJR), which together have built up an implant library based on the manual analysis of more than 38 000 implants, a job of titanic proportions.

The collection of variables such as BMI, age, sex, ASA score, diagnosis etc. will continue and will allow for case-mix adjustment between hospitals and clinics in the coming years. This will allow adequate and accurate comparisons to be drawn between high- and low-volume institutions.

The process to access nation wide mortality data is underway in order to calculate implant survival rates as mortality is the major risk along with implant failure.

Ongoing modifications and improvements to the structure and content of the data-entry sheets are an important aspect. For example, the knee is made up of three distinct joint compartments: the medial, lateral and patellofemoral compartments. The list of possible diagnoses will need to be refined on the data sheet if queries such as the result of TKA in isolated patello-femoral disease are to be answered. This will be an important task in the coming years which will involve the swiss orthopaedics Expert Groups. Of course, input from all stakeholders is also being encouraged.

Other joint arthroplasty systems such as the shoulder, elbow, wrist, hand, and foot and ankle will be included in future years. Again, this will necessitate serious participation from all stakeholders.

Interactive query systems will be made available in future years, thereby allowing surgeons to choose the best possible implant tailored to the individual patient.

SIRIS cannot successfully answer all these challenges by its own means. As an organization it must benefit and contribute to the international family of registries that exist all around the globe. In fact, there are 24 arthroplasty registries within Europe, and 6 registries outside of Europe according to the latest tally of the European Federation of National Societies of Orthopaedics and Traumatology (EFORT). SIRIS needs to become a full-standing member with a strong voice in the international associations dedicated to advancing science and research in the field of implant registries, such as the Network of Orthopaedic Registries in Europe (NORE) and the International Association of Arthroplasty Registries (ISAR) a global consortium of joint replacement registries throughout the world.

4. Overview of SIRIS

The results documented in this first scientific report include all total and partial hip arthroplasties as well as all total and partial knee arthroplasties – both primary operations and revisions – reported to SIRIS between September 1st, 2012 and December 31st, 2015. Partial hip arthroplasties will be named hemiarthroplasties of the hip, while partial knee arthroplasties will be named partial or unicompartmental knee arthroplasties (UKA) in the following pages. They include medial and lateral unicondylar as well as patellofemoral arthroplasties.

For the hip, 57 718 primary and 7 998 revision THAs were reported over the entire data collection period (Table 1). The number of procedures reported increased between 2013 and 2014, whereas it remained quite stable between 2014 and 2015. About 17 000 primary total hip arthroplasties (THA) were performed annually. The revision burden over the entire data collection period was 12.2%.

Table 1
Total hip arthroplasty
Overall number of documented operations

Year	Primary total	Revision total	Total
2012	6627	862	7489
2013	16886	2234	19120
2014	17117	2458	19575
2015	17088	2444	19532
All	**57718**	**7998**	**65716**

Overall, 6534 hemiarthroplasties and 205 conversions of hemiarthroplasties to THAs were reported between 2012 and 2015 (Table 2). The number of procedures was again highest in 2014. Conversions represented 3% of all procedures (revision burden).

For the knee, 43828 primary Total Knee Arthroplasties (TKA), 7329 primary UKAs, and 5300 revision (total and unicompartmental) knee arthroplasties were reported over the entire data collection period (Table 3). The total number of knee arthroplasty procedures reported increased from 2013 to 2015. However, the increase between 2014 and 2015 was small. About 13000 primary TKAs were performed annually. The revision burden over the entire data collection period was 9,4%.

Table 2
Hemiarthroplasty of the hip
Overall number of documented operations

Year	Primary hemiarthroplasty	Conversion to total hip arthroplasty	Total
2012	636	37	673
2013	1923	54	1977
2014	2036	54	2090
2015	1939	60	1999
All	**6534**	**205**	**6739**

Table 3
Total and partial knee arthroplasty
Overall number of documented operations

Year	Primary total	Primary partial	Revision	Total
2012	4712	852	526	6090
2013	12920	2147	1452	16519
2014	13223	2083	1604	16910
2015	12973	2247	1718	16938
All	**43828**	**7329**	**5300**	**56457**

The number of participating hospital services substantially increased for all procedure categories between 2012 and 2013 and changed only marginally after that (Table 4). In 2015, primary THA and primary TKA procedures were reported to the registry from 149 hospital services.

With regard to primary hip and knee arthroplasty more than half of the participating hospital services performed less than 100 procedures per year (Table 5).

Table 4
Number of participating hospital services (N) and maximum number of procedures per service per year (Max N)

		2012	2013	2014	2015
Primary total hip arthroplasty	N services	129	150	148	149
	Max N procedures per service	384	743	741	719
Revision of total hip arthroplasty	N services	97	130	130	137
	Max N procedures per service	100	234	241	146
Primary hemiarthroplasty of the hip	N services	99	124	126	131
	Max N procedures per service	44	102	103	91
Conversion of hemiarthroplasty of the hip	N services	24	37	39	41
	Max N procedures per service	4	5	4	5
Primary arthroplasty of the knee	N services	126	146	147	149
	Max N procedures per service	437	864	878	944
Revision arthroplasty of the knee	N services	87	122	127	124
	Max N procedures per service	51	112	121	100

Table 5
Number of hospital services and number of procedures according to hospital service volume

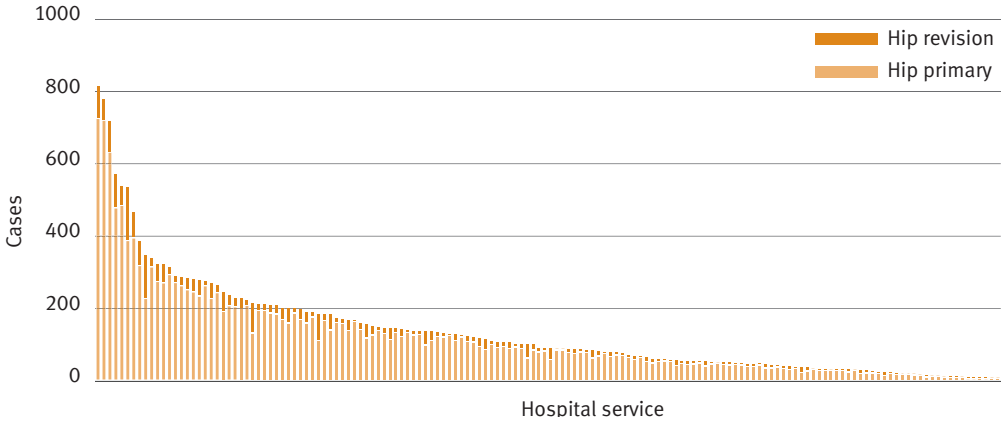
		<100	100–199	200–299	300+
Primary total hip arthroplasty	N services	86	39	24	13
	N procedures	9868	14511	15142	18197
Primary knee arthroplasty	N services	98	35	11	13
	N procedures	12655	13973	8228	16301

For THA, the total number of patients operated increased steadily with increasing hospital volume, whereas for knee arthroplasty 52% of the procedures were performed in services with a volume of fewer than 200 cases per year, compared to 48% in those with volumes ≥ 200 cases. The numbers of cases per hospital service are shown in Figures 1a–c.

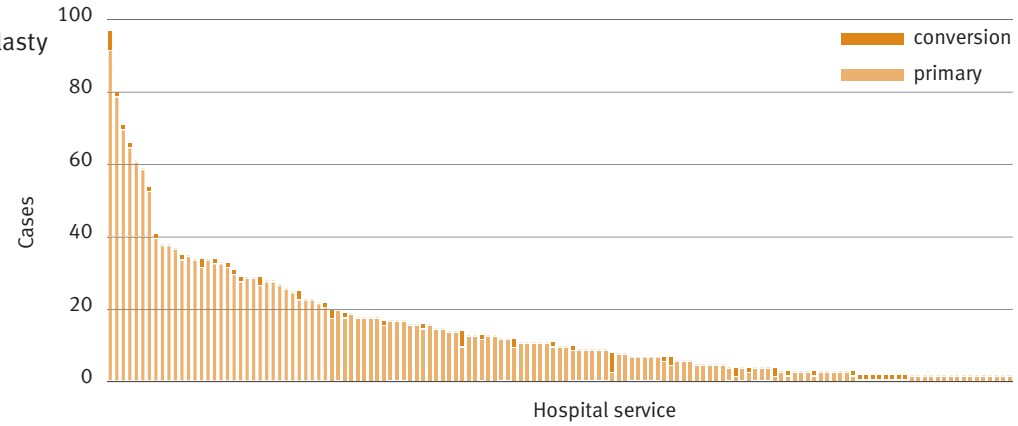
Figures 1 a, b, c

Cases per hospital service

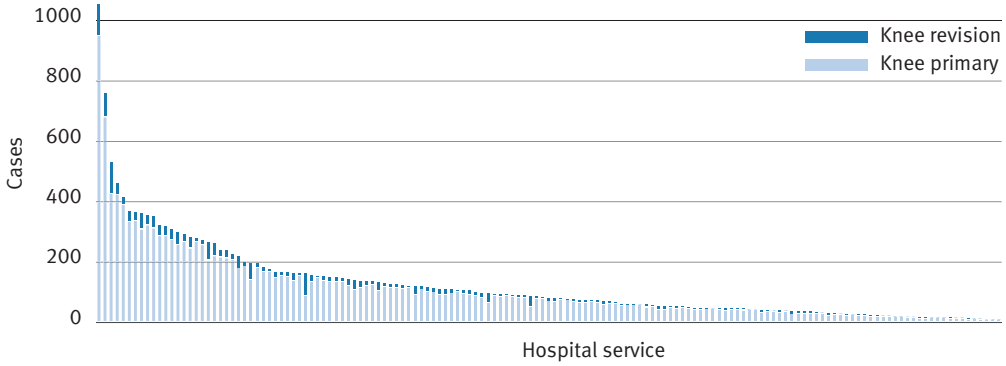
1a Total hip arthroplasty



1b Hemiarthroplasty of the hip



1c Knee arthroplasty



5. Hip arthroplasty

5.1 Primary total hip arthroplasty

Among the 57718 primary THAs documented over the entire data collection period, 52% were performed in women (Table 7). The mean age was 68 years. One-third of the interventions were performed in patients aged between 65 and 74, one-third in patients aged below 65 years and one-third in patients aged 75 years and older. On average, men were younger (66 years old) than women (70 years old) at the time of surgery. In 85% of cases the diagnosis was primary osteoarthritis, in 9% secondary osteoarthritis, and in 6% surgery was performed following a fracture. The proportion of primary osteoarthritis changed from 86% in 2012 to 84.3% in 2015, whereas the proportion of fractures changed from 5% in 2012 to 6.3% in 2014/15.

Table 7 also shows BMI and morbidity state (ASA class) results following the collection of this data for the first time in 2015.

Table 7

Primary total hip arthroplasty: Baseline patient characteristics by year

2012–2015. BMI and ASA class data are only available from 2015 onwards

		2012	2013	2014	2015	All
N		**6627**	**16886**	**17117**	**17088**	**57718**
Women [%]		50.5	52.2	52.5	52.6	52.2
Mean age (SD)	All	67.2 (12.3)	67.9 (12.1)	68.3 (12.2)	68.6 (11.6)	68.1 (12.0)
	Women	68.8 (12.0)	69.7 (11.8)	70 (11.9)	70.4 (11.3)	69.9 (11.7)
	Men	65.6 (12.3)	65.9 (12.1)	66.4 (12.2)	66.6 (11.7)	66.2 (12.1)
Age group [%]	‹45	3.9	3.3	3.3	2.6	3.2
	45–54	10.1	9.9	9.2	9.8	9.7
	55–64	23.3	21.9	21.3	21.3	21.7
	65–74	32.7	33.5	33.4	33.6	33.4
	75–84	25.2	25.5	26.6	26.1	26.0
	85+	4.9	5.8	6.2	6.6	6.1
Mean BMI (SD)					27.1 (5.0)	27.1 (5.0)
BMI [%]	‹18.5				1.8	1.8
	18.5–24.9				35.0	35.0
	25–29.9				39.2	39.2
	30–34.9				16.8	16.8
	35–39.9				5.4	5.4
	40+				1.7	1.7
Morbidity state [%]	ASA 1				14.7	14.7
	ASA 2				51.3	51.3
	ASA 3				22.8	22.8
	ASA 4				0.5	0.5
	unknown				10.6	10.6
Diagnosis [%]	Primary OA	86.0	85.4	85.6	84.3	85.2
	Secondary OA	9.0	9.0	8.2	9.4	8.9
	Fracture	5.0	5.6	6.3	6.3	5.9

The mean BMI was 27.1 kg/m². Of the total number of interventions, 27% were performed in normal- or underweight patients, 39% in overweight and 24% in obese patients. Regarding the morbidity state, the largest group of patients was ASA class 2 (51%). All baseline patient characteristics differed substantially between the three main diagnostic groups primary osteoarthritis, secondary osteoarthritis and fracture (Table 8).

Among patients with secondary osteoarthritis, osteonecrosis was the most common cause (55%) followed by developmental dysplasia (22%).

Table 8

Primary total hip arthroplasty: Baseline patient characteristics by main diagnostic group

BMI and ASA class data are only available from 2015 onwards

		Primary OA	Secondary OA	Fracture
N		**49175**	**5122**	**3421**
Women [%]		50.8	56.5	66.4
Mean age (SD)	All	68.3 (11.4)	62.9 (15.5)	73.7 (11.7)
	Women	70 (11)	65.2 (15.4)	74.6 (11.5)
	Men	66.5 (11.5)	59.9 (15)	71.9 (11.9)
Age group [%]	<45	2.3	12.5	1
	45–54	9.2	17.6	4.6
	55–64	22.3	21	14.2
	65–74	34.9	22.4	29
	75–84	26.1	19.8	33.7
	85+	5.2	6.7	17.5
Mean BMI (SD)		27.4 (5)	26.5 (5.2)	24.2 (4.7)
BMI [%]	<18.5	1	3.5	10.7
	18.5–24.9	33.3	39.9	50.8
	25–29.9	40.4	35.2	28.8
	30–34.9	17.8	14	6.9
	35–39.9	5.5	6.1	2.3
	40+	1.9	1.3	0.4
Morbidity state [%]	ASA 1	14.9	17.7	7.9
	ASA 2	52.6	46.1	40.5
	ASA 3	21.5	25.7	37.2
	ASA 4	0.4	0.8	2.5
	Unknown	10.6	9.7	11.9
Diagnosis [%]	Osteoarthritis	100		
	Osteonecrosis		55.4	
	Developmental dysplasia		22.2	
	Inflammatory arthritis		5.9	
	Miscellaneous		16.5	
	Fracture			100

In the primary osteoarthritis group, 51% of patients were women, whereas in the fracture group they represented 66%. The mean age was lowest (63 years) in patients with secondary osteoarthritis as compared to primary osteoarthritis (68 years) and fracture (74 years). The relation between BMI and age categories for patients with osteoarthritis is shown in Table 9.

The proportion of underweight patients was highest in those over 85 years of age, followed by the youngest category (less than 45 years). The proportion of obese patients (BMI ≥ 30) was highest in the age category 45–54 (29%) followed by the age category 55–64 (27%).

Table 9

Primary total hip arthroplasty: BMI in relation to age

(Primary and secondary osteoarthritis patients only)

	<45	45–54	55–64	65–74	75–84	85+
<18.5	2	0.8	1.2	1.1	1.5	2.7
18.5–24.9	33.4	32.3	31.5	32.6	35.2	49.2
25–29.9	40.4	38.4	40.3	40.5	40.2	35.1
30–34.9	14.2	19	17.4	18.4	17.3	10.9
35–39.9	7.9	6.3	6.6	5.8	4.8	2.1
40+	2	3.3	2.9	1.7	0.9	

Except for the gender distribution, baseline characteristics (case mix) varied according to hospital service volume (Table 10). The mean age at surgery decreased sightly from 69 to 67 years as volumes increased. This decrease in age was seen in both men and women. The highest proportion of secondary osteoarthritis was reported from hospital services with a volume of 300 and more cases followed by those with a volume of fewer than 100 cases. The highest proportion of fractures was reported from hospital services with a volume of fewer than 100 cases, followed by those with a volume of 300 and more cases.

Table 10

Baseline characteristics of primary total hip arthroplasty patients

Calculations of hospital service volume were based on all primary and revision hip surgeries in 2015. BMI data were only recorded from 2015.

		‹100	100–199	200–299	300+
N		**9868**	**14511**	**15142**	**18197**
Women [%]		52.1	51.7	52.1	52.8
Mean age (SD)	All	69.1 (12.2)	68.2 (11.7)	68.5 (11.8)	67.3 (12.3)
	Women	70.9 (12.1)	69.9 (11.4)	70.4 (11.3)	68.9 (12.1)
	Men	67 (11.9)	66.4 (11.8)	66.3 (12)	65.5 (12.3)
Age group [%]	‹45	2.5	2.9	2.6	4.2
	45–54	8.5	9.7	9.1	10.7
	55–64	20.4	21.9	21.3	22.5
	65–74	33.3	33.7	34.4	32.5
	75–84	28.2	26	26.6	24.2
	85+	7	5.8	6	5.8
Mean BMI (SD)		27 (4.8)	27.5 (5.1)	27.1 (5.1)	26.9 (5)
BMI [%]	‹18.5	1.7	1.1	2.4	2
	18.5–24.9	35.5	32.8	34.5	36.7
	25–29.9	40.4	39.7	38.9	38.7
	30–34.9	16.2	17.6	17.3	16
	35–39.9	4.7	6.5	5.4	4.9
	40+	1.5	2.2	1.5	1.6
Diagnosis [%]	Primary OA	83.5	87	86.4	83.7
	Secondary OA	9.5	7.7	8	10.2
	Fracture	7.1	5.2	5.6	6.1

Total hip arthroplasties constituted 99.9% of all procedures (Table 11). In addition, 50 hip resurfacing procedures were documented.

The surgical approach has only been recorded since 2015. In 2015, in all three diagnostic groups the anterior approach was the most frequently performed method followed by the anterolateral and the posterior approaches. The most commonly used component fixation was "all uncemented" in the three diagnostic groups. However, the proportions varied between 86% in the primary osteoarthritis group, 78% in secondary osteoarthritis, and 48%

Table 11

Primary total hip arthroplasty: Surgery characteristics by main diagnostic group

Approach data are only available from 2015 onwards

		Primary OA		Secondary OA		Fracture	
		N	%	N	%	N	%
Previous surgery	None			4202	82.0	2968	86.8
	Internal fixation femur			295	5.8	312	9.1
	Osteotomy femur			203	4.0	29	0.8
	Internal fixation acetabulum			27	0.5	33	1.0
	Osteotomy pelvis			90	1.8	5	0.1
	Arthrodesis			3	0.1	3	0.1
	Other previous surgery			403	7.9	102	3.0
Intervention	Total hip prosthesis	49133	99.9	5117	99.9	3418	99.9
	Hip resurfacing	42	0.1	5	0.1	3	0.1
Approach	Anterior	6009	41.8	672	42.3	426	39.8
	Anterolateral	4861	33.8	508	32.0	307	28.7
	Posterior	2190	15.2	250	15.8	198	18.5
	Lateral	1165	8.1	125	7.9	113	10.6
	Other approach	153	1.1	32	2.0	27	2.5
Fixation	All uncemented	42446	86.3	4000	78.1	1643	48.0
	Hybrid (acetabulum uncemented, femur cemented)	5648	11.5	743	14.5	1315	38.4
	All cemented	657	1.3	208	4.1	323	9.4
	Reverse hybrid (acetabulum cemented, femur uncemented)	312	0.6	93	1.8	81	2.4
	Reinforcement ring, femur uncemented	58	0.1	34	0.7	22	0.6
	Reinforcement ring, femur cemented	54	0.1	44	0.9	37	1.1

in the fracture group. In the latter group, hybrid fixation was used in 38% of the interventions. The component fixation choice did not substantially change between 2012 and 2015 in the primary and secondary OA group (Figures 2a–c). However, after fracture there was in increase in the use of all-cemented fixation from 8.3% in 2012/13 to 11% in 2015.

Figures 2 a, b, c

Primary total hip arthroplasty: Component fixation by diagnostic group by year

Figure 2a Primary osteoarthritis

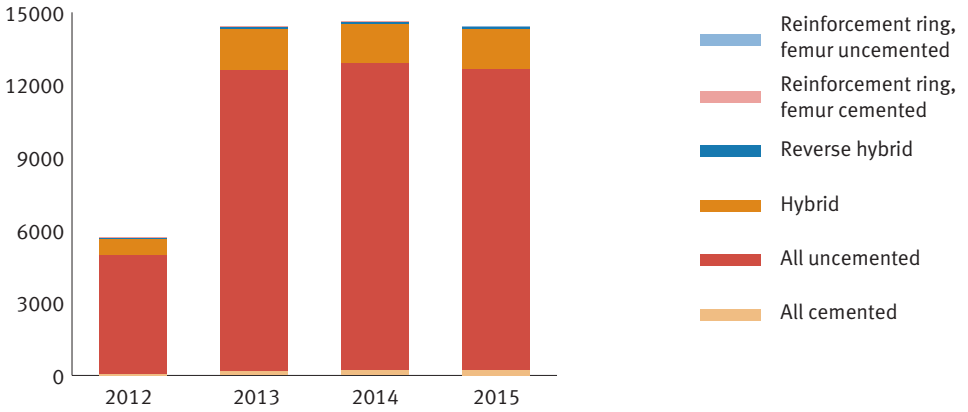


Figure 2b Secondary osteoarthritis

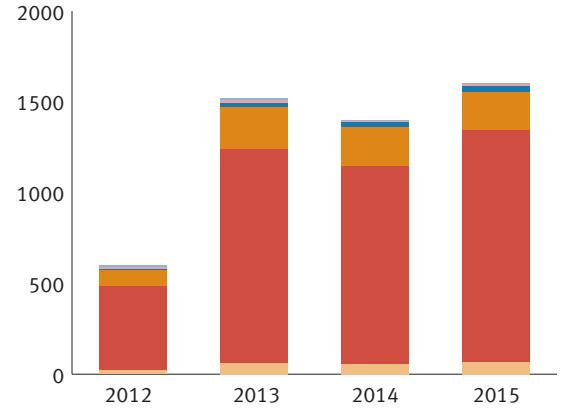
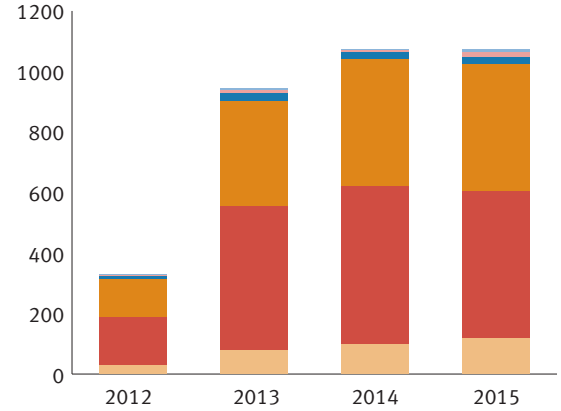


Figure 2c Fracture



5.2 Revision of total hip arthroplasty

Among the 7998 THA revisions documented over the entire data collection period, 51% were performed in women (Table 12). The mean age at revision was 71 years. On average, men were younger (69 years old) than women (72 years old) at the time of surgery. When looking at year-by-year mean ages in men and women, there was an increase in both groups from 2012 to 2015: from 68 to 69 years in men and from 70 to 73 years in women. Revisions performed in the age category 85 years and older accounted for 12.5% of total cases in 2015 as compared to 9% in 2012.

The mean BMI at the time of revision was 27.2 kg/m^2 and was quite similar to primary THAs. Of the total number of interventions, 37% were performed in normal- or underweight patients, 38% in overweight and 25% were performed in obese patients. Regarding the morbidity state, 42% of patients belonged to ASA class 2 and 36% to class 3.

Table 12

Revision of total hip arthroplasty: Baseline patient characteristics by year

2012–2015, BMI and ASA class data are only available from 2015 onwards.

		2012	2013	2014	2015	All
N		**862**	**2234**	**2458**	**2444**	**7998**
Women [%]		47.6	52.1	52.8	49.8	51.1
Mean age (SD)	All	69.3 (13.5)	70.1 (12.2)	70.8 (12.7)	71.3 (12.2)	70.6 (12.
	Women	70.4 (13.6)	71.5 (12.2)	72.5 (12.7)	73.4 (12.1)	72.3 (12.
	Men	68.3 (13.4)	68.6 (12.1)	68.9 (12.4)	69.2 (11.9)	68.8 (12.
Age group [%]	<45	3.6	2.9	2.5	2.8	2.8
	45–55	8.8	7.5	8.3	7	7.7
	55–65	18.4	19.6	18	17.3	18.3
	65–75	30	30.8	26.9	29.1	29
	75–85	30	29.4	32.1	31.2	30.9
	85+	9	9.9	12.2	12.5	11.3
Mean BMI (SD)					27.2 (5.3)	27.2 (5.3)
BMI [%]	<18.5				2.5	2.5
	18.5–24.9				34.7	34.7
	25–29.9				38.1	38.1
	30–34.9				16	16
	35–39.9				6.8	6.8
	40+				1.9	1.9
Morbidity state [%]	ASA 1				8	8
	ASA 2				41.5	41.5
	ASA 3				36.2	36.2
	ASA 4				2.4	2.4
	Unknown				11.8	11.8

Aseptic loosening of the femoral component was reported as the most common reason for revision, followed by aseptic loosening of the acetabular component, infection, periprosthetic fracture and dislocation in 2015 (Table 13). In 51 cases a revision was performed because of implant failure/breakage. In 2015, additional choices were added to the revision THA form, among them metallosis, which accounted for 4.9% of cases, and blood ion levels which accounted for 1.8% of the reasons for revisions in that year. The exchange of both the acetabular and femoral component was the most common type of revision – it was performed in 22.5% of cases (Table 14).

Table 13

Reason for revision of primary total hip arthroplasty

Multiple reasons possible per patient, the reason for revision categories as below only available from 2015 onwards.

	2015	
	N	%
Loosening femoral	528	22.0
Loosening acetabular	437	18.2
Infection	424	17.7
Periprosthetic fracture	367	15.3
Dislocation	289	12.0
Wear	146	6.1
Metallosis	117	4.9
Acetabular osteolysis	96	4.0
Femoral osteolysis	83	3.5
Position/Orientation of cup	65	2.7
Trochanter pathology	54	2.2
Status after spacer	53	2.2
Implant failure/breakage	51	2.1
Blood ion level	44	1.8
Position/Orientation of stem	36	1.5
Impingement	35	1.5
Acetabular protrusion	24	1.0
Squeaking	16	0.7
Other	578	24.1

Table 14

Type of revision of total hip arthroplasty

2012–2015

	2012–2015	
	N	%
Exchange acetabular and femoral components	1800	22.5
Exchange acetabular component and head	1549	19.4
Exchange femoral component	1457	18.2
Exchange acetabular component	709	8.9
Exchange head and inlay	696	8.7
Component reimplantation (after spacer or Girdlestone)	430	5.4
Exchange head	366	4.6
Girdlestone	177	2.2
Component removal, spacer implantation	176	2.2
Exchange femoral component and inlay	170	2.1
Exchange inlay	87	1.1
Exchange femoral component, inlay and osteosynthesis	47	0.6
Other intervention	334	1.2

Regarding the surgical approach taken, which only began to be documented from 2015, the posterior approach was used in 33% of cases followed by the lateral approach, which was used in 25% of the revisions (Table 15). An all-uncemented component fixation was chosen in 57% of the revisions (Table 16). There was an increase in the use of all-cemented component fixation from 17.2% in 2012/13 to 20.1% in 2015 (Figure 3). A reinforcement ring was used in 8% of the revisions.

Table 15

Approach of revision of total hip arthroplasty

only available from 2015 onwards

	2015	
	N	%
Posterior	784	32.6
Lateral	592	24.6
Anterolateral	430	17.9
Anterior	334	13.9
Transfemoral	132	5.5
Other approach	131	5.5

Table 16

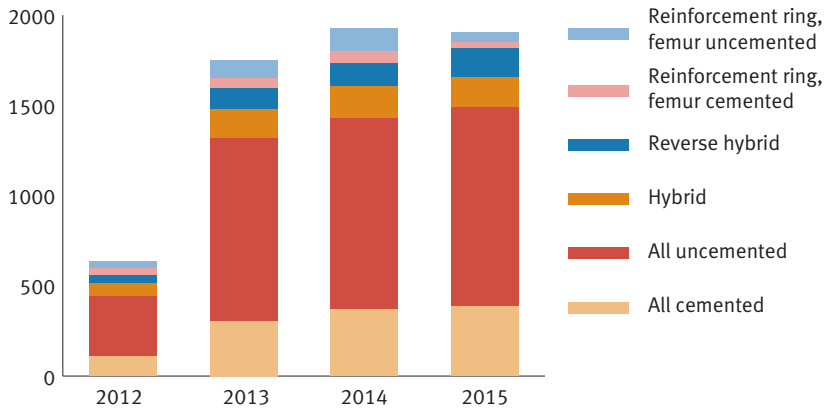
Component fixation of revision of total hip arthroplasty

2012–2015

	2012–2015	
	N	%
All uncemented	3516	56.5
All cemented	1163	18.7
Hybrid (acetabulum uncemented, femur cemented)	576	9.3
Reverse hybrid (acetabulum cemented, femur uncemented)	450	7.2
Reinforcement ring, femur uncemented	326	5.2
Reinforcement ring, femur cemented	192	3.1

Figure 3

Revision of total hip arthroplasty: Component fixation by year



5.3 First revision of primary total hip arthroplasty

Of the primary THAs documented in the registry since September 2012 (N=57718), 1227 operations corresponding to 2.1% of total cases were revised by the end of 2015 (Table 17). Of these 1227 revisions, 1144 were performed by the same provider that performed the primary operation. Among those who received their initial THA for primary OA, no difference in the early revision rate was seen between men and women. The rate was higher in patients over 75 years (2.1%) as compared to those under 75 (1.9%). Early revision rates varied according to the underlying diagnosis of the primary THA. In the primary osteoarthritis group, 1.9% had an early first revision compared to 3.1% in the secondary osteoarthritis and 3.6% in the fracture group.

Table 17
First revision of primary total hip arthroplasty: Baseline characteristics

		Primary THA	Revised		Revised same service	
		N	N	%	N	%
Overall		57718	1227	2.1	1144	93.2
Primary OA		49175	944	1.9	879	93.1
Sex	Women	24974	473	1.9	444	93.9
	Men	24201	471	1.9	435	92.4
Age group	‹55	5674	108	1.9	97	89.8
	55–64	10960	212	1.9	196	92.5
	65–74	17154	309	1.8	290	93.9
	75–84	12826	265	2.1	249	94.0
	85+	2561	50	2.0	47	94.0
Secondary OA		5122	161	3.1	154	95.7
Fracture		3421	122	3.6	111	91.0

As of December 31st, 2015, the overall median observation period since the start of the registry in September 2012 was 21 months (min. 0 days, max. 49 months). With respect to the time interval between the primary THA and the first revision, the median interval was 37 days (min. 0 days, max. 38 months) and the mean interval was 135 days (SD= 204 days). Overall, 558 cases (45.5%) were revised within 30 days, 261 (21.3%) within 31–90 days, 120 (9.8%) within 91–180 days, 120 (9.8%) within 181–365 days, and 168 cases (13.7%) were revised after 365 days (Figure 4).

Among the reasons for the first revision, the most common was periprosthetic fracture, followed by infection and dislocation with a similar occurrence. In 16 cases the early revision was due to implant failure/breakage (Table 18). Most revisions occurred during the first 90 days after surgery and were mostly due to a fracture, dislocation and/or infection. After 90 days, aseptic loosening of the femoral component was the most frequent cause of first revision (Figure 5).

Table 18

Reason for early first revision of primary total hip arthroplasty

Multiple reasons possible per patient, the reason for revision categories as below only available from 2015 onwards.

	2015	
	N	%
Periprosthetic fracture	76	26.8
Infection	65	22.9
Dislocation	63	22.2
Loosening femoral	25	8.8
Loosening acetabular	17	6.0
Position/orientation of stem	13	4.6
Position/orientation of cup	9	3.2
Implant failure/breakage	4	1.4
Status after spacer	2	0.7
Trochanter pathology	2	0.7
Wear	1	0.4
Impingement	1	0.4
Acetabular protrusion	1	0.4
Other	39	13.7

Figure 4

First revision of total hip arthroplasty: Time interval

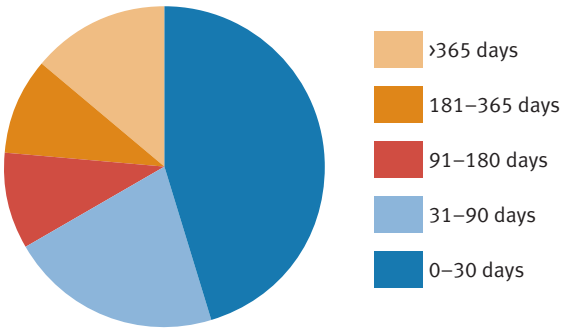
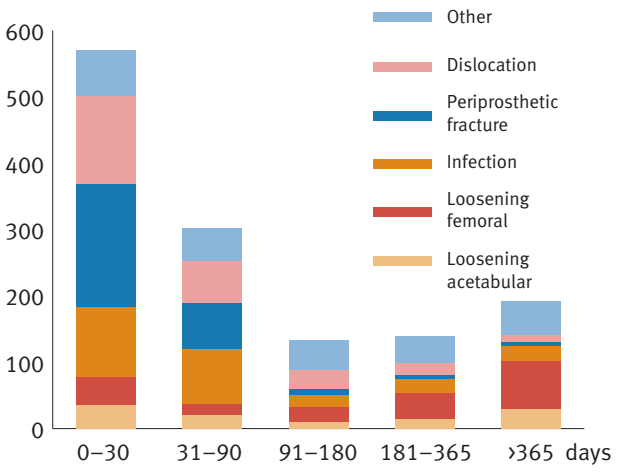


Figure 5

Reason for early first revision by time interval since primary total hip arthroplasty



5.4 Primary hemiarthroplasty

Among the 6534 hemiarthroplasties documented over the entire data collection period, 73% were performed in women (Table 19). The mean age was 84 years. On average, men were younger (83 years old) than women (85 years old) at the time of surgery. Hemiarthroplasties performed in the age category 85 years and older accounted for 58% of cases in 2015 as compared to 54% in 2012. The mean BMI was 23,8 kg/m^2. Of the total number of interventions, 11% were performed in underweight patients, 55% in normal weight, 27% in overweight, and 7% were performed in obese patients. Regarding the morbidity state, the largest group of patients was ASA class 3 (56%).

Table 19

Primary hemiarthroplasty: Baseline patient characteristics by year

2012–2015. BMI and ASA class data are only available from 2015 onwards.

		2012	2013	2014	2015	All
N		**636**	**1923**	**2036**	**1939**	**6534**
Women [%]		71.5	73.9	73.3	71.6	72.8
Mean age (SD)	All	83.2 (11.1)	83.7 (10.3)	84.1 (9.5)	84.3 (9.2)	84 (9.9)
	Women	83.9 (10.2)	84.2 (9.8)	84.7 (8.6)	84.8 (8.7)	84.5 (9.2)
	Men	81.5 (12.8)	82.1 (11.6)	82.4 (11.6)	83.2 (10.4)	82.5 (11.4)
Age group [%]	‹45	0.8	0.6	0.4	0.4	0.5
	45–54	1.4	0.7	0.6	0.7	0.7
	55–64	3	2.6	1.9	2.1	2.3
	65–74	8	8.4	7.9	8.4	8.2
	75–84	32.9	32.3	33.1	30.8	32.2
	85+	53.9	55.4	56.1	57.7	56.2
Mean BMI (SD)					23.8 (4.7)	23.8 (4.7)
BMI [%]	‹18.5				10.5	10.5
	18.5–24.9				55.2	55.2
	25–29.9				27.3	27.3
	30–34.9				5.1	5.1
	35–39.9				1.4	1.4
	40+				0.5	0.5
Morbidity state [%]	ASA 1				2.1	2.1
	ASA 2				23.9	23.9
	ASA 3				55.5	55.5
	ASA 4				6.6	6.6
	ASA 5				0.3	0.3
	Unknown				11.6	11.6

Most baseline characteristics (case mix) varied according to hospital service volume (Table 20). The proportion of women was highest in low-volume services. The mean age at surgery was highest in the high-volume category (86 years old) as compared to the three other categories (about 84 years old). Accordingly, hemiarthroplasties performed in patients aged 85 years and older accounted on average for 64% of cases in high-volume services as compared to 53–56% in the three other categories. There were no substantial differences in mean BMI.

Table 20

Baseline characteristics of primary hemiarthroplasty patients

Calculation of hospital services were based on all THA and hemiarthroplasty primary and revision hip surgeries in 2015. BMI data were only recorded from2015.

		<100	100–199	200–299	300+
N		**2581**	**1476**	**1379**	**1098**
Women [%]		74.3	73.2	72	69.9
Mean age (SD)	All	83.8 (10)	83.4 (9.8)	83.5 (10.5)	85.6 (8.4)
	Women	84.3 (9.5)	84.1 (8.8)	84.1 (9.8)	86.2 (7.6)
	Men	82.4 (11.3)	81.7 (12)	82 (12)	84.2 (9.8)
Age group [%]	<45	0.5	0.4	0.7	0.2
	45–54	0.5	1.2	0.7	0.7
	55–64	2.1	2.6	3.1	1.3
	65–74	8.5	8.9	8.9	5.6
	75–84	33.6	33.5	31	28.2
	85+	54.7	53.4	55.5	64
Mean BMI (SD)		23.8 (5.2)	23.7 (4.5)	23.9 (4.7)	23.6 (4.3)
BMI [%]	<18.5	9.7	12.7	8.4	10.7
	18.5–24.9	58.2	50.6	54.2	57
	25–29.9	24.6	29.1	30.7	26
	30–34.9	4.9	6	4.9	4.5
	35–39.9	1.5	1.6	1.3	1.2
	40+	1	0.4	0.4	

Femoral monopolar head prostheses constituted 73% of all procedures and bipolar prostheses 27% (Table 21). In 2015, the anterior and anterolateral approaches were the most frequently performed approaches (each accounting for 29% of cases) followed by the lateral (21%) and posterior approaches (20%). As many as 83% of the stems were cemented.

Table 21

Surgery characteristics of primary hemiarthroplasty

Approach data only available from 2015 onwards

		N	%
Previous surgeries	None	6305	96.5
	Internal fixation femur	105	1.6
	Osteotomy femur	13	0.2
	Arthrodesis	3	0.0
	Osteotomy pelvis	2	0.0
	Internal fixation acetabulum	1	0.0
	Other previous surgery	107	1.6
Intervention	Femoral head prosthesis	4802	73.5
	Bipolar prosthesis	1732	26.5
Approach	Anterior	552	28.8
	Anterolateral	550	28.7
	Lateral	401	20.9
	Posterior	376	19.6
	Other approach	38	2.0
Component fixation	Cemented	5421	83.0
	Uncemented	1113	17.0

5.5 Conversion of hemiarthroplasty to total hip arthroplasty

Among the 205 conversions of hemiarthroplasty to THA documented over the entire data collection period, 74% were performed in women (Table 22). The mean age at revision was 77 years. On average, men were younger (73 years old) than women (78 years old) at the time of surgery. The mean BMI at the time of conversion was 24.2. Of the total number of interventions, 4% were performed in underweight patients compared to 55% in normal weight, 33% in overweight and 8% in obese patients. The largest group of patients was ASA class 2 (52%).

Table 22

Conversion of hemiarthroplasty: Baseline patient characteristics by year

2012–2015. BMI and ASA class data are only available from 2015 onwards.

		2012	2013	2014	2015	All
N		**37**	**54**	**54**	**60**	**205**
Women [%]		78.4	70.4	74.1	75	74.1
Mean age (SD)	All	79.9 (7.1)	78.4 (11.5)	75.6 (12.2)	74.6 (10.9)	76.8 (11)
	Women	79.2 (7.7)	80.2 (10.9)	78.5 (7.9)	75.5 (10.5)	78.2 (9.6)
	Men	82.5 (3.1)	74.1 (12.1)	67.2 (17.7)	71.7 (11.9)	72.9 (13.6)
Age group [%]	‹45	1.9	3.7			1.5
	45–55	3.7	1.9	6.7		3.4
	55–65	5.4	5.6	7.4	10	7.3
	65–75	18.9	16.7	24.1	21.7	20.5
	75–85	51.4	38.9	42.6	40	42.4
	85+	24.3	33.3	20.4	21.7	24.9
Mean BMI (SD)					24.2 (3.9)	24.2 (3.9)
BMI [%]	‹18.5				4.1	4.1
	18.5–24.9				55.1	55.1
	25–29.9				32.7	32.7
	30–34.9				8.2	8.2
Morbidity state [%]	ASA 2				54.5	54.5
	ASA 3				40.9	40.9
	Unknown				4.5	4.5

Aseptic loosening of the femoral component was reported as the most frequent reason for conversion, followed by acetabular protrusion and dislocation (Table 23). Conversions of bipolar or femoral head prosthesis to THA without stem exchange (118 cases, 57.6%) were more frequent than conversions with stem exchange (87 cases, 42.4%). Conversions were most often performed using the posterior approach (used in 34% of cases) followed by the anterolateral approach, which was used in 28% (Table 24). An all-uncemented component fixation was chosen in 57% of the conversions (Table 25).

Table 23

Reason for conversion of hemiarthroplasty

Multiple reasons possible per patient, the reason for conversion categories as below only available from 2015 onwards

	2015	
	N	%
Loosening femoral	13	21.7
Acetabular protrusion	11	18.3
Dislocation	6	10.0
Wear	4	6.7
Infection	3	5.0
Periprosthetic fracture	3	5.0
Position/Orientation of stem	2	3.3
Trochanter pathology	2	3.3
Other	30	50.0

Table 24

Approach of conversion of hemiarthroplasty

Approach data are only available from 2015 onward

	2015	
	N	%
Posterior	21	34.4
Anterolateral	17	27.9
Lateral	13	21.3
Anterior	8	13.1
Other approach	2	3.3

Table 25

Component fixation of conversion of hemiarthroplasty to THA

	2012–2015	
	N	%
Uncemented	117	57.1
Hybrid Acetabulum uncemented, femur cemented	47	22.9
Cemented	29	14.1
Reverse hybrid Acetabulum cemented, femur uncemented	6	2.9
Reinforcement ring Femur cemented	5	2.4
Reinforcement ring Femur uncemented	1	0.5

6. Knee arthroplasty

6.1 Primary total knee arthroplasty

Among the 43 828 primary TKAs documented over the entire data collection period, 61% were performed in women (Table 26). The mean age was 69 years. Of the total number of interventions, 37% were performed in patients aged between 65 and 74 years, 30% in those below 65 years and 33% in those 75 years and older. On average, men were younger (68 years old) than women (70 years old) at the time of surgery. In 2015, primary osteoarthritis was the diagnosis in 88% of the cases.

Table 26

Primary total knee arthroplasty: Baseline patient characteristics by year

2012–2015. BMI and ASA class data are available from 2015 onwards.

		2012	2013	2014	2015	All
N		**4712**	**12920**	**13223**	**12973**	**43828**
Women [%]		59.4	61.1	60.7	61.3	60.9
Mean age (SD)	All	68.8 (10.4)	69.2 (10.7)	69.2 (10.4)	69.4 (10)	69.2 (10.4)
	Women	69.5 (10.4)	70 (10.6)	69.8 (10.7)	70.1 (10)	69.9 (10.4)
	Men	67.7 (10.3)	67.9 (10.6)	68.2 (10)	68.2 (9.8)	68.1 (10.2)
Age group [%]	<45	1.1	1.2	0.9	0.7	0.9
	45–54	7	6.4	6.6	6.6	6.6
	55–64	24	23	23.2	23.5	23.3
	65–74	36.5	36.3	37.1	36.7	36.7
	75–84	27.3	28.4	27.9	28	28
	85+	4.1	4.7	4.3	4.6	4.5
Mean BMI (SD)					29.4 (6.2)	29.4 (6.2)
BMI [%]	<18.5				0.5	0.5
	18.5–24.9				21.1	21.1
	25–29.9				40.1	40.1
	30–34.9				23.6	23.6
	35–39.9				10.2	10.2
	40+				4.5	4.5
Morbidity state [%]	ASA 1				11.2	11.2
	ASA 2				54.4	54.4
	ASA 3				23.5	23.5
	ASA 4				0.3	0.3
	Unknown				10.6	10.6
Diagnosis [%]	Primary OA	95.9	96.4	96.7	87	
	Secondary OA	4.1	3.6	3.3	13	
	Lesion of ligament				4.7	
	Fracture	0.6	0.4	0.5	2.3	
	Osteonecrosis	1.8	1.7	1.4	2.2	
	Inflammatory origin	1.1	0.9	0.8	1.2	
	Infection				0.2	
	Other	0.6	0.6	0.5	1.4	

Table 26 also shows BMI and morbidity state (ASA class) results following the collection of this data for the first time in 2015.The mean BMI was 29.4 kg/m^2. Of the total number of interventions, 22% were performed in normal- or underweight patients, 40% in overweight, and 38% were performed in obese patients. Of those, 5% had a BMI ≥ 40 (Table 27). Regarding the morbidity state, the largest group of patients belonged to ASA class 2 (54%).

The relation between BMI and age categories for patients with osteoarthritis is shown in Table 27. The proportion of underweight patients was highest in those over 85 years of age followed by the youngest category (less than 45 years old). The proportion of obese class II and III patients (BMI ≥ 35) was highest in the age category 45–54 (26%), followed by the age category 55–64 (22%).

Table 27

Primary total knee arthroplasty: BMI according to age

	<45	45–54	55–64	65–74	75–84	85+
<18.5	1.5	0.2	0.3	0.5	0.5	2
18.5–24.9	25.4	16.2	16.4	19.7	25.4	35.6
25–29.9	31.3	29.6	34.2	41	45.8	42.1
30–34.9	25.4	28.3	27.5	24	20.2	14.7
35–39.9	9	17	13.3	11	6.2	4.5
40+	7.5	8.8	8.2	3.9	1.9	1.1

Baseline characteristics (case mix) varied according to hospital service volume. Patients operated upon in a high-volume service were on average about one year younger than those operated upon in a service of one of the three other volume categories (Table 28). This was observed in both men and women. The mean BMI (recorded from 2015 only) was lowest in the highest-volume category (≥ 300 procedures per year). The proportion of obese patients in the latter category corresponded to 35% as compared to 39–41% in the three other categories.

Table 28

Baseline characteristics of primary total knee arthroplasties

Calculations of hospital service volumes were based on all primary and revision knee surgeries in 2015. BMI data were only recorded from 2015.

		<100	100–199	200–299	300+
N		**11085**	**12391**	**7190**	**13162**
Women [%]		61.2	59.3	62	61.5
Mean age (SD)	All	69.5 (10.8)	69.3 (10.1)	69.6 (10.6)	68.6 (10.2)
	Women	70 (10.9)	70.2 (10.1)	70.3 (10.6)	69.3 (10.2)
	Men	68.6 (10.6)	68.1 (9.8)	68.4 (10.4)	67.4 (10)
Age group [%]	<45	1.1	0.7	1	1
	45–54	6.1	6.6	5.6	7.5
	55–64	21.8	23.8	22.6	24.5
	65–74	36.8	36.3	37	36.8
	75–84	29.3	28.2	28.2	26.6
	85+	4.9	4.4	5.5	3.7
Mean BMI (SD)		29.5 (6.4)	29.7 (6.1)	29.6 (7.4)	29 (5.3)
BMI [%]	<18.5	0.4	0.4	0.5	0.7
	18.5–24.9	21.4	19.6	19.9	22.7
	25–29.9	39	39.5	38.6	41.8
	30–34.9	24.1	24.3	25.6	21.7
	35–39.9	10.4	11.1	10.6	9.2
	40+	4.7	5	4.8	3.9
Diagnosis [%]	Primary OA	93.8	94.1	93.9	92.9
	Secondary OA	6.2	5.9	6.1	7.1

About one-third of the patients undergoing a primary TKA had had prior operations in the affected joint (Table 29). The most frequently reported previous surgeries in 2015 were knee arthroscopies (19%) and meniscectomies (16%). In 2015, the cruciate sacrificing TKA was the most frequently implanted model (36%), followed by the unlinked posterior stabilized (27%) and the posterior cruciate retaining (26%) models. In the majority of the procedures (73%) the use of conventional technology was reported.

Table 29

Primary total knee arthroplasty: Surgery characteristics

		2012–2014		2015	
		N	%	N	%
Previous surgeries	None	20842	67.4	8277	64.2
	Knee arthroscopy	6627	21.4	2389	18.5
	Meniscectomy			2061	16.0
	ACL reconstruction			487	3.8
	Osteotomy tibia close to knee	852	2.8	433	3.4
	Osteosynthesis tibia close to knee	480	1.6	176	1.4
	Surgery for patella stabilization	439	1.4	161	1.2
	Synovectomy			100	0.8
	Osteotomy femur close to knee	163	0.5	72	0.6
	Osteosynthesis femur close to knee	157	0.5	67	0.5
	Surgery for treating infection	92	0.3	19	0.1
	Surgery for tumor			1	0.0
	Ligament reconstruction	1213	3.9		
	Other	1920	6.2	442	3.4
Intervention	CS (cruciate sacrificing) / UCOR			4574	35.5
	Unlinked post. stabilized	8296	26.8	3538	27.4
	PCR (posterior cruciate retaining)			3380	26.2
	BCR (bicruciate retaining)			264	2.0
	Unlinked semi-constrained	1698	5.5	219	1.7
	Hinge type	608	2.0	198	1.5
	CCK constrained condylar knee			89	0.7
	Unlinked cruciate retaining	7089	22.9		
	Unlinked meniscal	3100	10.0		
	Unlinked rotating	9211	29.8		
	Other	931	3.0	633	4.9
Technology	Conventional	22718	73.4	9409	73.0
	Computer assisted	3767	12.2	1663	12.9
	Patient specific instrumentation	2648	8.6	1445	11.2
	Minimal invasive	2559	8.3	802	6.2
	Other			62	0.5

In more than two-thirds of the procedures (69%), an all-cemented component fixation was documented (Table 30). Use of all-cemented fixation increased from 61% in 2012 to 75% in 2015 (Figure 6). In 2015, a cemented tibial component and uncemented femoral component was the second most often used fixation. The patellar component was replaced in 25% of cases (Table 31).

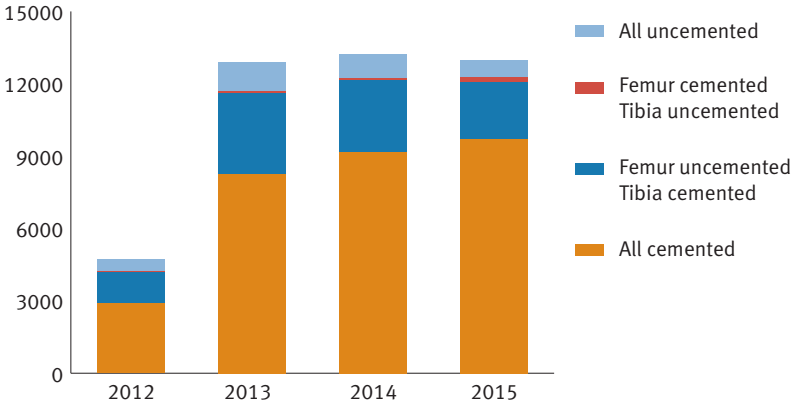
Table 30
Primary total knee arthroplasty: Component fixation

	N	%
Femur cemented Tibia cemented	30033	68.5
Femur uncemented Tibia cemented	9953	22.7
Femur uncemented Tibia uncemented	3389	7.7
Femur cemented Tibia uncemented	453	1.0

Table 31
Primary total knee arthroplasty: Patellar component

	N	%
No	33032	75.4
Yes	10785	24.6
Status after patellectomy	11	0.0

Figure 6
Primary total knee arthroplasty: Component fixation by year



6.2 Primary unicompartmental knee arthroplasty

Among the 7329 UKAs documented over the entire data collection period, 51% were performed in women (Table 32). The mean age at surgery was 65 years old, which was similar in men and women. About half of the interventions were performed in patients below 65 years of age, one-third took place in patients between 65 and 74 years and about one in five were performed in patients aged 75 years and older. In 2015, primary osteoarthritis was

Table 32

Primary unicompartmental knee: Baseline patient characteristics by year

2012–2015. BMI and ASA class data were only available from 2015 onwards.

		2012	2013	2014	2015	All
N		**852**	**2147**	**2083**	**2247**	**7329**
Women [%]		50.9	50.5	50.6	52	51.1
Mean age (SD)	All	64.6 (10.9)	65.1 (10.1)	65.1 (10.2)	64.7 (10.5)	64.9 (10.3)
	Women	64.3 (11.7)	65.8 (10)	65.3 (10.6)	64.5 (11.1)	65.1 (10.7)
	Men	65 (10)	64.4 (10.2)	64.8 (9.7)	64.8 (9.9)	64.7 (9.9)
Age group [%]	<45	2.5	1.4	1.7	2.4	2
	45–54	12.8	12.7	13.6	14.1	13.4
	55–64	35.6	33.7	32.2	32.2	33
	65–74	31.6	33.6	34.4	32.7	33.3
	75–84	15.3	16.4	16.1	16.3	16.2
	85+	2.3	2.1	2	2.2	2.1
Mean BMI (SD)					28.2 (4.8)	28.2 (4.8)
BMI [%]	<18.5				1	1
	18.5–24.9				26.7	26.7
	25–29.9				42.7	42.7
	30–34.9				20.5	20.5
	35–39.9				7.4	7.4
	40+				1.7	1.7
Morbidity state [%]	ASA 1				21.8	21.8
	ASA 2				55.4	55.4
	ASA 3				12.2	12.2
	ASA 4				0.1	0.1
	Unknown				10.5	10.5
Diagnosis [%]	Primary OA	93.1	93.7	94.4	89.5	
	Secondary OA	6.9	6.3	5.6	10.5	
	Osteonecrosis	5.6	5.6	5.2	5.9	
	Lesion of ligament				1.5	
	Fracture	0.5	0.2	0.1	0.7	
	Inflammatory origin	0.2	0.1	0.1	0.3	
	Infection				0.1	
	Other	0.6	0.3	0.1	2.1	

the diagnosis in 90% of cases. Table 32 also shows BMI and morbidity state (ASA class) results following the collection of this data for the first time in 2015. The mean BMI was 28.2 kg/m^2. Of the total number of interventions, 28% were performed in normal- or underweight patients, 43% in overweight and 29% were performed in obese patients. Regarding the morbidity state, the largest group of patients belonged to ASA class 2 (55%). Baseline characteristics (case mix) did not substantially vary by hospital service volume with respect to gender distribution, age and diagnosis (Table

Table 33

Case mix of primary unicompartmental knee arthroplasty patients

Calculations of hospital service volumes were based on all primary and revision knee surgeries.
BMI data were only recorded from 2015.

Hospital service volume		<100	100–199	200–299	300+
N		**1570**	**1582**	**1038**	**3139**
Women [%]		54.5	50	48.8	50.6
Mean age (SD)	All	64.8 (10.8)	65 (9.9)	65.7 (10.5)	64.7 (10.2)
	Women	64.4 (11.3)	65.8 (10.2)	66.4 (10.4)	64.7 (10.7)
	Men	65.2 (10.2)	64.1 (9.6)	65 (10.6)	64.7 (9.7)
Age group [%]	<45	2.1	1.6	1.4	2.2
	45–54	13.6	13.1	13.1	13.6
	55–64	33.4	34.3	29.2	33.5
	65–74	31.7	34.3	35.5	32.9
	75–84	16.8	14.9	18.3	15.8
	85+	2.4	1.9	2.4	2
Mean BMI (SD)		28.8 (4.9)	28.1 (4.6)	28.3 (4.7)	27.9 (4.9)
BMI [%]	<18.5	0.8	1.2	1.1	0.8
	18.5–24.9	20.9	25.1	26.4	29.5
	25–29.9	41	46	43.3	41.6
	30–34.9	25.5	19.4	20.9	19.1
	35–39.9	10.5	6.9	7.2	6.8
	40+	1.3	1.5	1.1	2.2
Diagnosis [%]	Primary OA	92	94	92	92.2
	Secondary OA	8	6	8	7.8

33). The mean BMI (recorded from 2015 only) was highest in the services with the lowest volume (‹100 procedures per year). The proportion of obese patients in the latter category corresponded to 37% of the total, as compared to 28–29% in hospitals with higher volumes.

About 40% of the patients undergoing a primary UKA had been operated upon previously (Table 34). The most frequently reported previous surgeries in 2015 were knee arthroscopies (23%) and meniscectomies (20%). In 2015, the medial compartment was replaced in 87% of the cases. The use of conventional technology was most frequently reported (in 66% of cases).

Table 34
Primary unicompartmental knee: Surgery characteristics

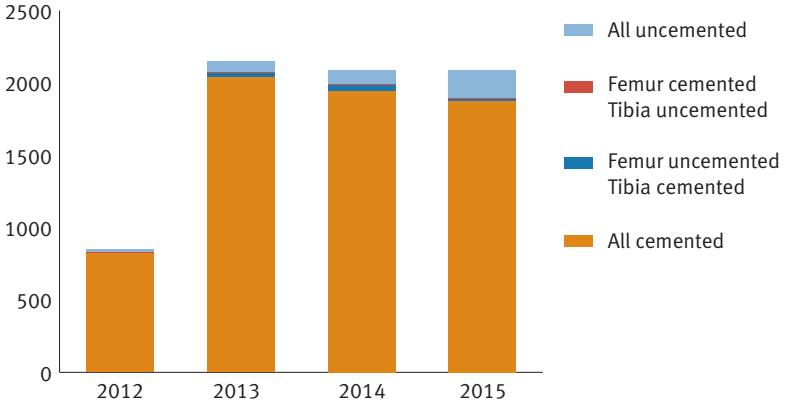
	2012–2014		2015	
	N	%	N	%
Previous surgeries				
None	3177	62.5	1363	60.7
Knee arthroscopy	1614	31.7	517	23.0
Meniscectomy			457	20.4
Surgery for patella stabilization	11	0.2	32	1.4
ACL reconstruction			29	1.3
Osteotomy tibia close to knee	71	1.4	28	1.2
Osteosynthesis tibia close to knee	32	0.6	9	0.4
Osteotomy femur close to knee	9	0.2	7	0.3
Osteosynthesis femur close to knee	4	0.1	7	0.3
Synovectomy			5	0.2
Surgery for treating infection	4	0.1	1	0.0
Ligament reconstruction	83	1.6		
Other	231	4.5	57	2.5
Intervention				
Unicompartment medial	4736	93.2	1943	86.5
Unicompartment lateral	348	6.8	142	6.3
Patellofemoral			160	7.1
Technology				
Conventional	3293	64.8	1472	65.6
Minimal invasive	1566	30.8	653	29.1
Patient specific instrumentation	236	4.6	124	5.5
Computer assisted	30	0.6	6	0.3
Other			4	0.2

In 93% of the procedures an all-cemented component fixation was documented (Table 35). The use of all-cemented fixation remained stable over the data collection period (Figure 7). In 2015, a cemented tibial component and uncemented femoral component was the second most often used fixation. Patellar replacements in medial or lateral UKAs were rare, occurring in less than 1% of cases.

Table 35
Primary unicompartmental knee: Component fixation

	N	%
Femur cemented Tibia cemented	6676	93.1
Femur uncemented Tibia uncemented	378	5.3
Femur uncemented Tibia cemented	88	1.2
Femur cemented Tibia uncemented	27	0.4

Figure 7
Primary unicompartmental knee: Component fixation by year



6.3 Revision knee arthroplasty

Among the 5300 revisions of a total or partial knee arthroplasty documented over the entire data collection period, 59% were performed in women (Table 36). The mean age at revision was 68 years. On average men were younger (67 years old) than women (69 years old) at the time of surgery. Revisions performed in the age categories less than 65 years accounted for 35% of the procedures. The mean BMI at the time of revision was 29.4 kg/m^2 – similar to primary TKA. Of the total number of interventions, 23% were performed in normal- or underweight patients, 37% in overweight, and 40% were perfor-

Table 36

Revision knee arthroplasty: Baseline patient characteristics by year

2012–2015, BMI and ASA class data are only available from 2015 onwards.

		2012	2013	2014	2015	All
N		**526**	**1452**	**1604**	**1718**	**5300**
Women [%]		59.3	61	57.4	58.8	59
Mean age (SD)	All	68.6 (9.9)	68.2 (10.7)	67.5 (11.4)	68.3 (10.9)	68.1 (10.9)
	Women	69.3 (10.1)	68.6 (11.1)	68.1 (12)	68.8 (11.1)	68.6 (11.3)
	Men	67.5 (9.5)	67.5 (10)	66.7 (10.5)	67.7 (10.6)	67.3 (10.3)
Age group [%]	<45	0.8	1.6	2.1	1.6	1.7
	45–54	7	8	9.1	8.6	8.4
	55–64	24.9	25.2	25.9	24.9	25.3
	65–74	39	35.7	34	34.9	35.2
	75–84	25.3	25.3	24.2	25.1	24.9
	85+	3	4.3	4.7	5	4.5
Mean BMI (SD)					29.4 (5.7)	29.4 (5.7)
BMI [%]	<18.5				0.9	0.9
	18.5–24.9				21.9	21.9
	25–29.9				36.7	36.7
	30–34.9				25.2	25.2
	35–39.9				11.1	11.1
	40+				4.2	4.2
Morbidity state [%]	ASA 1				9	9
	ASA 2				45.4	45.4
	ASA 3				30.3	30.3
	ASA 4				1	1
	Unknown				14.4	14.4

med in obese patients. Of those, 5% had a BMI ≥ 40. Regarding the morbidity state, the largest group of patients belonged to ASA class 2 (45%).

Loosening of the tibial component was reported as the most frequent reason for revision, followed by patellar-related problems, infection, loosening of the femoral component and femorotibial instability (Table 37). In 2015, additional choices were added to the revision TKA form, among them pain, which accounted for 11.5% of the revisions in that year.

Table 37

Reason for revision of knee arthroplasty

Multiple reasons possible per patient, the reason for revision categories as below only available from 2015 onwards.

	2015	
	N	%
Loosening tibia	380	22.2
Patella problems	373	21.8
Infection	281	16.5
Loosening femur	239	14.0
Femorotibial instability	229	13.4
Pain	196	11.5
Wear of inlay	118	6.9
Joint stiffness/arthrofibrosis	96	5.6
Component malposition tibia	79	4.6
Progression of unicomp. OA	79	4.6
Component malposition femur	75	4.4
Periprosthetic fracture femur	38	2.2
Loosening patella	34	2.0
Patellar instability	31	1.8
Periprosthetic fracture tibia	20	1.2
Sizing femoral component	20	1.2
Sizing tibial component	15	0.9
Periprosthetic fracture patella	4	0.2
Other	171	10.0

Table 38

Surgery characteristics of revision of knee arthroplasty

	2012–2014		2015	
Intervention type	**N**	**%**	**N**	**%**
Complete revision	1715	47.7	598	35.0
Exchange of inlay	500	13.9	262	15.3
Subsequent patella prosthesis	353	9.8	243	14.2
Conversion unicompartmental to TKA			112	6.6
Tibial revision	262	7.3	111	6.5
Reimplantation of prosthesis	188	5.2	94	5.5
Patella revision	188	5.2	60	3.5
Subsequent patella prosthesis with exchange of inlay			55	3.2
Femoral revision	103	2.9	51	3.0
Component removal with spacer implantation	122	3.4	44	2.6
Component removal without spacer implantation			10	0.6
Arthrodesis	1	0.0	5	0.3
Other	160	4.5	63	3.6
Type of arthroplasty				
Unlinked posterior stabilized	896	27.1	262	27.1
Unlinked semi-constrained	513	15.5	163	16.8
Hinge type	516	15.6	155	16.0
CS (cruciate sacrificing) / UCOR			138	14.3
CCK constrained condylar knee			98	10.1
PCR (posterior cruciate retaining)			89	9.2
Unicompartment medial	74	2.2	13	1.3
BCR (bicruciate retaining)			12	1.2
Patellafemoral			3	0.3
Unicompartment lateral	6	0.2		
Unlinked rotating	542	16.4		
Unlinked cruciate retaining	367	11.1		
Unlinked meniscal	184	5.6		
Other	211	6.4	35	3.6
Technology				
Conventional	3030	84.4	1457	85.3
Computer assisted	113	3.1	63	3.7
Minimal invasive	152	4.2	62	3.6
Patient specific instrumentation	31	0.9	18	1.1
Other			5	0.3

Exchange of all components was the most frequent type of revision – this was performed in 35% of the cases in 2015, followed by exchange of polyethylene (15%) (Table 38).

In 2015, the unlinked posterior stabilized TKA was the most frequently implanted prosthesis (27%), followed by the unlinked semi-constrained (17%) and hinge type (16%) prostheses. In the majority of the procedures (85%) the use of conventional technology was reported.

In 82% of the procedures, an all-cemented component fixation was chosen (Table 39). The use of all-cemented fixation increased over the data collection period (Figure 8). Patellar replacement was performed in 46% of the revisions (Table 40).

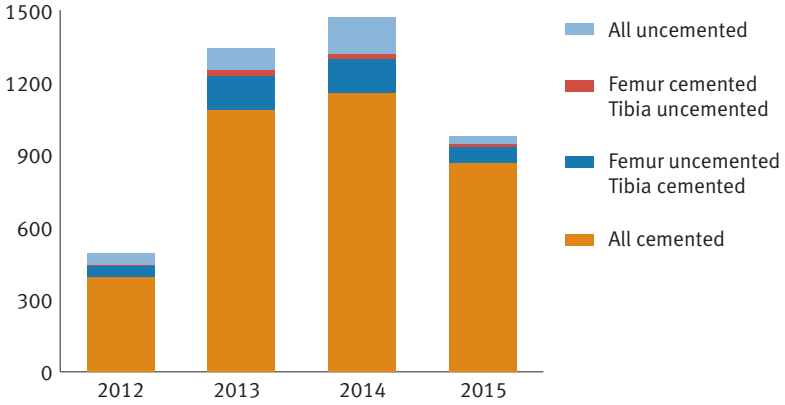
Table 39
Revision of knee arthroplasty: Component fixation

	N	%
Femur and tibia cemented	3494	81.8
Femur uncemented Tibia cemented	397	9.3
Femur and tibia uncemented	319	7.5
Femur cemented Tibia uncemented	64	1.5

Table 40
Revision of knee arthroplasty: Patellar component

	N	%
Without patellar replacement	2498	53.9
With patellar replacement	2131	46.0
Status after patellectomy	6	0.1

Figure 8
Component fixation in revision knee arthroplasty by year
Component fixation only applicable when new components were implanted



6.4 First revision of a primary total knee arthroplasty documented since 2012

Of the primary TKAs documented in the registry since September 2012 (N=43828), 827 (corresponding to 1.9%) were revised (Table 41). Of these 827 revisions, 730 (88.3%) were performed by the same provider that performed the primary TKA. Among those who received their initial TKA for primary OA, the early revision rate was higher in men (2.1%) than in women (1.8%). The rate was highest in patients under 55 years (3.3%) and decreased with increasing age.

Table 41
First revision of primary total knee arthroplasty: Baseline characteristics

		Primary TKA	Revised		Revised in same service	
		N	N	%	N	%
Overall		43828	827	1.9	730	88.3
Primary OA		41165	788	1.9	695	88.2
Sex	Women	25163	451	1.8	400	88.7
	Men	16002	337	2.1	295	87.5
Age group	<55	2869	96	3.3	85	88.5
	55–64	9499	240	2.5	200	83.3
	65–74	15332	262	1.7	238	90.8
	75–84	11623	171	1.5	153	89.5
	85+	1842	19	1.0	19	100.0
Secondary OA		2663	39	1.5	35	89.7

As of December 31st, 2015, the overall median observation period was 21 months (min. 0 days, max. 49 months). With respect to the time interval between the primary TKA and first revision, the median interval was 10 months (min. 0 days, max. 42 months) and the mean time was 331 days (SD= 254 days). Overall, 100 cases (12.1%) were revised within 30 days, 88 (10.6%) within 31–90 days, 91 (11%) within 91–180 days, 197 (23.8%) within 181–365 days, and 351 cases (42.4%) were revised after 365 days (Figure 9). Among the reasons for first revision in 2015, the most common was a patellar-related problem (34%) followed by infection (16%) and pain (13%) (Table 42).

Figure 9

First revision of total knee arthroplasty: Time interval

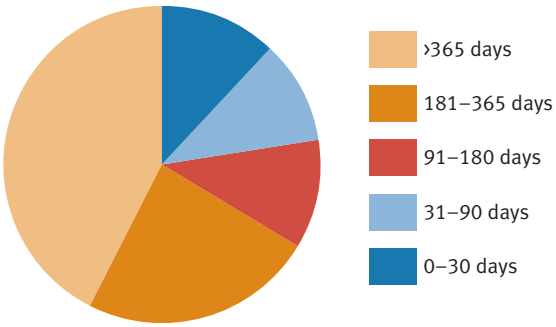


Table 42

Reason for early first revision of primary total knee arthroplasty

Multiple reasons possible per patient, the reason for revision categories as below only available from 2015 onwards.

	2015	
	N	%
Patella problems	121	33.9
Infection	56	15.7
Pain	46	12.9
Femorotibial instability	45	12.6
Loosening tibia	44	12.3
Joint stiffness/arthrofibrosis	26	7.3
Component malposition tibia	12	3.4
Loosening femur	12	3.4
Patellar instability	11	3.1
Component malposition femur	11	3.1
Wear of inlay	8	2.2
Periprosthetic fracture femur	4	1.1
Sizing femoral component	4	1.1
Sizing tibial component	3	0.8
Progression of unicomp. OA	3	0.8
Loosening patella	2	0.6
Periprosthetic fracture tibia	2	0.6
Periprosthetic fracture patella	2	0.6
Other	43	12.0

6.5 First revision of a primary unicompartmental knee arthroplasty documented since 2012

Of the primary UKAs documented in the registry since September 2012 (N=7329), 182 (corresponding to 2.5%) were revised (Table 43). Of the 182 revisions, 160 (87.9%) were performed in the same hospital service in which the primary UKA had been done. The early revision rate was 2.7% in men and 2.2% in women (Risk difference 0.5%, 95% CI -0.2; 1.2) The rate was highest in patients under 55 years of age (3.7%) and tended to decrease with increasing age.

Table 43
First revisions of unicompartmental knee arthroplasty: Baseline characteristics

		Primary unicompartmental arthroplasties	Revised		Revised same service	
		N	N	%	N	%
Overall		7329	182	2.5	160	87.9
Sex	Women	3742	84	2.2	72	85.7
	Men	3587	98	2.7	88	89.8
Age group	‹55	1126	42	3.7	37	88.1
	55–64	2421	75	3.1	64	85.3
	65–74	2441	38	1.6	35	92.1
	75–84	1185	26	2.2	24	92.3
	85+	156	1	0.6	0	0.0

As of December 31st,2015, the overall median observation period was 21 months (min. 1 day, max. 48 months). With respect to the time interval between the primary UKA and first revision the median interval was 10 months (min. 2 days, max. 44 months) and the mean time was 339 days (SD= 242 days). Overall, 8 cases (4.4%) were revised within 30 days, 15 (8.2%) within 31–90 days, 33 (18.1%) within 91–180 days, 55 (30.2%) within 181–365 days, and 71 cases (39%) were revised after 365 days (Figure 10).

Among the reasons for the first revision in 2015, the most common was loosening of the tibial component (29%) followed by pain (18%) and loosening of the femoral component (16%) (Table 44).

Table 44

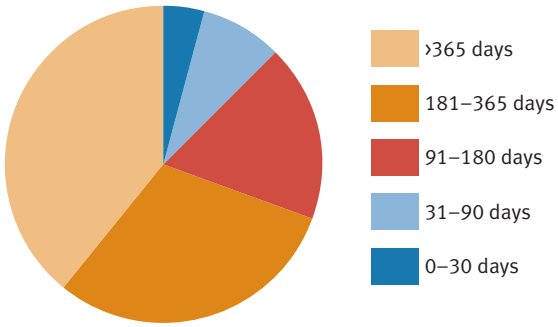
Reason for early first revision of unicompartmental knee arthroplasty

Multiple reasons possible per patient, the reason for revision categories as below only available from 2015 onwards.

	2015	
	N	%
Loosening tibia	18	28.6
Pain	11	17.5
Loosening femur	10	15.9
Progression of unicomp. OA	8	12.7
Infection	6	9.5
Femorotibial instability	5	7.9
Wear of inlay	3	4.8
Component malposition tibia	3	4.8
Periprosthetic fracture tibia	2	3.2
Patella problems	1	1.6
Joint stiffness/Arthrofibrosis	1	1.6
Sizing tibial component	1	1.6
Sizing femoral component	1	1.6
Other	9	14.3

Figure 10

First revision of primary unicompartmental knee arthroplasty: Time interval



7. Participating hospitals

Asana Gruppe AG, Spital Menziken
Asana Gruppe, Spital Leuggern
Berit Klinik, Speicher
Center da Sandà, Engiadina Bassa CSEB, Scuol
Centre Hospitalier Universitaire Vaudois CHUV, Lausanne
CIC Groupe Santé SA, Clinique CIC Riviera Centre, Clarens
CIC Groupe Santé SA, Valais, Saxon
Clinica Luganese SA, Lugano
Clinica Santa Chiara SA, Locarno
Clinique de la Source, Lausanne
Clinique des Grangettes SA, Chêne-Bougeries
Clinique Générale Beaulieu, Genève
EHC, Hôpital de Morges
eHnv, Hôpital St-Loup, Pompaples
eHnv, Hôpital Yverdon-les-Bains
EOC, Ospedale regionale di Bellinzona (San Giovanni)
EOC, Ospedale regionale di Locarno (La Carità)
EOC, Ospedale regionale di Lugano (Civico e Italiano)
EOC, Ospedale regionale di Mendrisio (Beata Vergine)
Flury Stiftung, Spital Schiers
Gesundheitszentrum Fricktal AG, Spital Laufenburg
Gesundheitszentrum Fricktal AG, Spital Rheinfelden
Groupement Hospitalier de l'Ouest Lémanique GHOL, Nyon
GZO AG Spital Wetzikon
Hirslanden AndreasKlinik Cham, Zug
Hirslanden Bern AG, Klinik Beau-Site, Bern
Hirslanden Bern AG, Klinik Permanence, Bern
Hirslanden Bern AG, Klinik Salem, Bern
Hirslanden Clinique La Colline SA, Genève
Hirslanden Klinik Aarau
Hirslanden Klinik am Rosenberg, Heiden
Hirslanden Klinik Belair, Schaffhausen
Hirslanden Klinik im Park, Zürich
Hirslanden Klinik St. Anna AG, Luzern
Hirslanden Klinik St. Anna AG, Meggen
Hirslanden Klinik Stephanshorn, St. Gallen
Hirslanden Lausanne SA, Clinique Bois-Cerf, Lausanne
Hirslanden, Klinik Birshof AG, Münchenstein
Hôpital du Jura bernois SA, Site de Moutier
Hôpital du Jura bernois SA, Site de Saint-Imier
Hôpital du Jura, Site de Delémont
Hôpital du Pays-d'Enhaut, Château-d'Oex
Hôpital du Valais (RSV), Martigny
Hôpital du Valais (RSV), Sion
Hôpital du Valais SZO, Spital Brig
Hôpital du Valais SZO, Spital Visp
Hôpital fribourgeois HFR, Hôpital cantonal, Fribourg
Hôpital fribourgeois HFR, Site de Riaz
Hôpital fribourgeois HFR, Site de Tafers
Hôpital intercantonal de la Broye HIB, Payerne
Hôpital neuchâtelois HNE, Site de la Chaux-de-Fonds
Hôpital neuchâtelois HNE, Site de Pourtalès, Neuchâtel
Hôpital Riviera, Site de Chablais Monthey
Hôpital Riviera, Site de Riviera Montreux
Hôpital Riviera, Site de Riviera Vevey
Hôpitaux Universitaires de Genève (HUG)
Insel Gruppe AG, Inselspital, Bern
Inselgruppe AG, Spital Aarberg
Inselgruppe AG, Spital Münsingen
Inselgruppe AG, Spital Riggisberg
Inselgruppe AG, Spital Tiefenau, Bern
Kantonales Spital und Pflegeheim Appenzell
Kantonsspital Aarau AG
Kantonsspital Baden AG
Kantonsspital Baselland, Standort Bruderholz
Kantonsspital Baselland, Standort Laufen
Kantonsspital Baselland, Standort Liestal
Kantonsspital Glarus AG
Kantonsspital Graubünden, Chur
Kantonsspital Nidwalden, Stans
Kantonsspital Obwalden, Sarnen
Kantonsspital St. Gallen, Spital Flawil
Kantonsspital St. Gallen, Spital Rorschach
Kantonsspital St. Gallen, Standort St. Gallen
Kantonsspital Uri, Altdorf
Kantonsspital Winterthur
Klinik Gut, Fläsch
Klinik Gut, St. Moritz
Klinik Hirslanden Zürich
Klinik Hohmad, Thun
Klinik Pyramide am See AG, Zürich
Klinik Seeschau AG, Kreuzlingen

Klinik Siloah AG, Gümligen
Klinik St.Georg Goldach AG
La Tour Réseau de Soins SA, Hôpital de la Tour, Meyrin
Lindenhofgruppe, Klinik Sonnenhof, Bern
Lindenhofgruppe, Lindenhofspital Bern
Luzerner Kantonsspital LUKS, Luzern
Luzerner Kantonsspital LUKS, Sursee
Luzerner Kantonsspital LUKS, Wolhusen
Merian Iselin Klinik, Basel
Nouvelle Clinique Vert-Pré SA, Conches-Genève
Praxisklinik Rennbahn AG, Muttenz
Privatklinik Linde AG, Biel
Regionalspital Surselva AG, Ilanz
Réseau Santé Balcon du Jura RSBJ, St. Croix
Rosenklinik, Rapperswil
Schulthess Klinik, Zürich
See-Spital, Horgen
See-Spital, Kilchberg
SMN SA, Clinica Ars Medica, Gravesano
SMN SA, Clinique de Genolier
SMN SA, Clinique de Montchoisi, Lausanne
SMN SA, Clinique de Valère, Sion
SMN SA, Clinique Générale Ste-Anne SA, Fribourg
SMN SA, Clinique Montbrillant, La Chaux-de-Fonds
SMN SA, Hôpital de la Providence, Neuchâtel
SMN SA, Klinik Villa im Park AG, Rothrist
SMN SA, Privatklinik Bethanien, Zürich
SMN SA, Privatklinik Lindberg, Winterthur
SMN SA, Privatklinik Obach AG, Solothurn
Solothurner Spitäler AG, Bürgerspital Solothurn
Solothurner Spitäler AG, Kantonsspital Olten
Solothurner Spitäler AG, Spital Dornach
Spital Affoltern, Affoltern a. A.
Spital Altstätten
Spital Bülach
Spital Davos AG
Spital Einsiedeln
Spital Emmental AG, Burgdorf
Spital Emmental AG, Langnau
Spital Grabs
Spital Lachen AG
Spital Limmattal, Schlieren
Spital Linth, Uznach
Spital Männedorf AG
Spital Muri
Spital Oberengadin, Samedan
Spital Schwyz
Spital STS AG, Spital Thun
Spital Thurgau AG, Kantonsspital Frauenfeld
Spital Thurgau AG, Kantonsspital Münsterlingen
Spital Thusis
Spital Uster
Spital Walenstadt
Spital Zofingen
Spital Zollikerberg
Spitäler fmi AG, Spital Frutigen
Spitäler fmi AG, Spital Interlaken
Spitäler Schaffhausen. Kantonsspital
Spitalregion Fürstenland Toggenburg, Spital Wattwil
Spitalregion Fürstenland Toggenburg, Spital Wil
Spitalregion Rheintal Werdenberg Sarganserland,
Spitalregion Rheintal Werdenberg Sarganserland,
Spitalregion Rheintal, Werdenberg, Sarganserland,
Spitalverbund Appenzell Ausserrhoden, Heiden
Spitalverbund Appenzell Ausserrhoden, Herisau
Spitalzentrum Biel AG
SRO AG, Spital Langenthal
St. Claraspital AG, Basel
Stadtspital Triemli, Zürich
Stadtspital Waid, Zürich
Universitätsklinik Balgrist, Zürich
Universitätsspital Basel USB
UniversitätsSpital Zürich
Zuger Kantonsspital AG, Baar

Foundation for quality assurance in implant surgery – SIRIS

c/o conidea GmbH
Waldheimstrasse 22
3604 Thun

+41 79 356 63 59
info@siris-implant.ch
siris-implant.ch