schweizerisches implantat-register
registre suisse des implants

SIRIS

Swiss National Joint Registry

SIRIS Report 2019

Annual Report of the Swiss National Joint Registry, Hip and Knee, 2012 – 2018

ano

Kantonsspital St.Gallen

swiss orthopaedics

UNIVERSITÄT BERN

Hip and knee replacement results 2012–2018

SIRIS Report 2019
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

SwissRDL – Medical Registries and Data Linkage, Institute of Social and Preventive Medicine, University of Bern

Preface

Measurable quality is becoming ever more important

The industry organization Swiss Medtech stands for high quality, safe medical technology and has been an advocate for the development of an independent national implant registry from the very beginning (founding member of the SIRIS foundation, 2007).

By registering all hip and knee prosthetics (ANQ National Quality Agreement), the SIRIS implant registry has developed into an excellent early warning system that makes a valuable contribution to healthcare provision. It would be ideal if all medical organizations could agree on a central registry for the implants they use.

The quality of treatment available today is partly due to the manufacturers' and distribution partners' innovative products and additional services (e.g. surgery training and support, regulatory responsibility and prompt replacement of products, etc.).

Drawing on international practice, Swiss Medtech has supported the comparative evaluation of implants from the very beginning. The analyses from the SIRIS implant registry provide an important additional source of information for the identification of potential outliers. The weaknesses they make visible need to be analyzed and addressed together. Our ultimate goal is to avoid or minimize any potential patient suffering as much as possible.

Dr. iur. Beat Vonlanthen, Councilor of States
President of the Association of the
Swiss Medtech Industry
(Swiss Medtech)

Transparent publication within reach

The Swiss Implant Register (SIRIS) is an active implant registry that is constantly being further developed. Key milestones have been reached since the publication of the last SIRIS report. Links with the Swiss Federal Statistical Office's (BFS) death records and the CCO social security registry allow for more reliable two-year revision rates to be calculated. Revision rates can now also be determined for each implant brand, which further enhances the registry.

With regard to transparent publication, all parties involved agreed on an optimal way of presenting information for the direct comparison of hospitals and clinics. The Swiss National Association for Quality Development in Hospitals and Clinics (ANQ), warmly welcomes their decision, as the selected funnel plot diagrams for rates and other measured values have so far proven to be very successful at ANQ.

In ANQ's view, this preliminary work has satisfied all the key requirements for the publication of the knee and hip implant results in the next annual report, with hospital and clinic names to be included. The transparent publication will be put into effect from 2020. We would like to thank everyone who contributed their invaluable expertise, including the specialists, team of authors, SIRIS foundation, expert associations and SwissRDL, for helping to make SIRIS what is now Switzerland's largest implant registry.

Thomas Straubhaar
President of the National Association for the
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All information in this report was composed with the utmost care. If any changes or modifications are made after publication, these will be published on our website www.siris-implant.ch, where you can also download the SIRIS Report 2019 and all previous reports.

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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 performances at a specific hospital to the mean performances of hospitals throughout Switzerland.

Bilateral Replacing the same joint on both sides of the body (typically both hips or knees) by means of a prosthesis (here meaning the replacement on both sides in one session).

Body Mass Index. Is obtained by dividing body weight in kilograms by height in meters squared. Interpretation: ‹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 Overall incidences over a specific period of an event (such as the revision of a prosthesis or death of a patient).

Cumulative revision percentage Overall revision percentage over a specific period.

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

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

Hybrid fixation Fixation of a prosthesis in which one of the two parts of a prosthesis is cemented and the other one uncemented.

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 of the hip joint.

Hospital service volumes In the tables depicting the total number arthroplasty procedures per year. Four categories of hospital service volume were used (‹100, 100–199, 200–299, 300+ procedures per year). The calculation of the annual volume was performed separately for hip and knee surgeries, using the average of all (primary and revision) procedures recorded in each hospital service in 2013–2018.

Acetabular inlay (insert) Intermediate component (inner layer), made usually of polyethylene (but also other materials), 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.

Kernel density plot A variation of a histogram that uses kernel smoothing to plot values. The underlying kernel is usually Gaussian distribution. One advantage of density plots over histograms is that they are not stepped depending of the number of bins used (histogram bars), but are

always smooth lines. The second advantage is that several lines can be plotted over each other and still be visible, which could be difficult with more than two overlaying histograms.

Knee inlay (insert) Intermediate component of the knee prosthesis. It is made of polyethylene and placed between the femoral and tibial components.

Lateral collateral ligament Lateral (outer) knee ligament.

Malalignment Malpositioning of prosthetic components significantly deviating from physiological norms.

Meniscectomy Meniscus removal.

Metallosis Deposition of metal debris in soft tissues of the body, usually around the prosthesis.

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 the underlying bone are affected

Osteonecrosis Cellular death of bone tissue.

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

Osteotomy Cut of the bone with a saw or chisel 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 replacement of the original joint with a prosthesis .

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.

Reverse hybrid fixation hip prosthesis Fixation of a hip or knee prosthesis in which one component is cemented and the other uncemented.

Revision 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.

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

Revision burden The ratio of revision procedures to all primary and 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 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 Replacement of half the knee (either inner or outer side) by a prosthesis.

Abbreviations

ASA	American Society of Anaesthesiologists
AVN	Avascular Necrosis
BMI	Body Mass Index
CI	Confidence Interval
CRF	Case Report Form
MCL	Medical Collateral (Inner Knee) Ligament
PROMs	Patient Reported Outcome Measures
SD	Standard Deviation
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty
UKA	Unicompartmental Knee Arthroplasty

Contents

1. Introduction

1.1 Purpose of the registry

The Swiss National Implant Registry SIRIS was formally introduced and began registering of hip and knee implants in September 2012. Participation in the activity of SIRIS became compulsory for all hospitals and clinics performing knee and hip arthroplasties and that had signed the ANQ's National Quality agreement, i.e. practically all Swiss hospitals and clinics.

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 signified that more than one point of view had to be taken into consideration if success were to be achieved. Although each of the partners naturally tends to focus more on a particular aspect of their interest, in the end there is one basic interest common to all partners: The long-term wellbeing of the patient after prosthetic joint replacement.

Patient perspective. Patients expect their implant to provide them with a long-lasting, pain-free result. The operation needs to 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 extract the information of interest despite complex methodology behind the tables and graphs. Not all patients will read the registry reports, but those that will might better understand and discuss their past or future operation with their surgeon. The SIRIS registry should provide them both with interesting facts to discuss.

From the surgeon's point of view. Surgeons are primarily concerned with avoiding surgical complications and shortcomings in their individual patients. Indeed, the goal of patients and surgeons is the same: Long-lasting pain-free full function of the prosthesis. The difference is that the patients expect the goal to be achieved while surgeons promise and attempt to achieve the goal. Certainly, all surgeons try to do their best for each and every patient, but by implanting a particular prosthesis they integrate the performance of the implant into their own performance.

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 timeframe the problematic implants and provide valuable early warnings to surgeons. However, entering individual clinical results into the data collection system is not a welcome addition to surgeons' daily activities. Although surgeons may appreciate benchmarking their own results to the overall results, a controversial question remains the public availability of information at the individual surgeon level. This may lead to bias entering into the system and potential changes in patient recruitment practice.

From an industrial point of view. The industry's main activity is manufacturing and sales driven by profit orientation, which is fine in our industrialized world. Designing and providing first-rate, problem-free implant systems is the only worthwhile strategy because a single implant that causes failures in a series of patients may lead to allegations and financially destabilize the company. It is clear that the interest of industry is the same as the interest of patients: The long-term wellbeing of the

patient after prosthetic joint replacement. Progress and technical innovation are extremely important for an industry dedicated to providing safe high-performance implants. The registry is also seen as an essential tool for post-market surveillance and clinical control that validates improvements in materials, design, and concepts in real-life clinical settings. If industry accepts quality as the principal market-regulating factor, then the registry is a welcome tool and the motivation of industry to participate should be high. The goal is not to regulate the market, but to define and provide tools for market regulation through quality assessment.

From the hospitals' point of view. Hospitals aim to provide excellent and safe care, at a reasonable cost, to a large number of patients. Hospitals are a framework where surgeon / patient interaction finds place and both parties have a common interest: After prosthetic replacement patients should be so well that they forget their treated joint in daily living (forgotten joint concept). However, patients should not forget the hospital where they were treated so successfully, and should be confident of coming again to the same hospital, should it be necessary. The registry is perceived as a quality control instrument, not only of the implants used, but of the whole

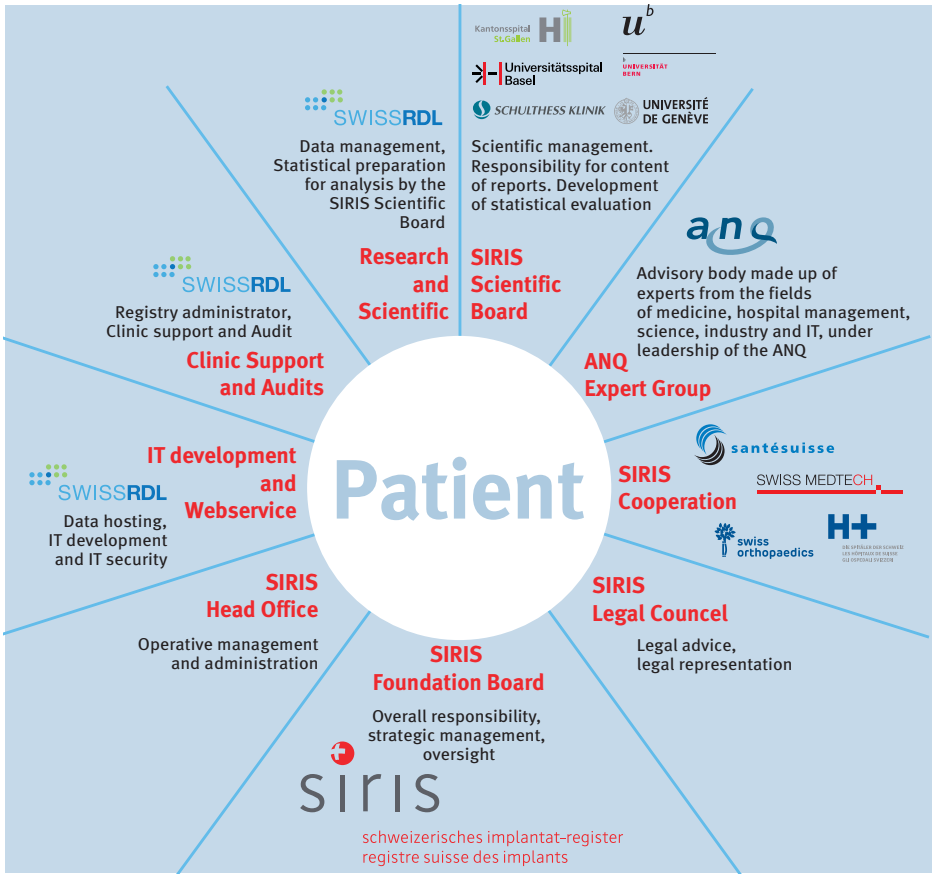


Figure 1.1
Organisation of the SIRIS registry

process, ranging from the preoperative consultation, to the procedures in the operating room and to the post-operative follow-up. Hospitals, being healthcare providing institutions in today's competitive environment, are also very keen to uphold their reputation and a registry is an invaluable tool for this purpose. Some cantons even require SIRIS reports in order to prove that the number of procedures is sufficient for placement of the hospital on contract lists. It appears that participating in the registry might be crucial for survival of some hospitals, and this is a strong motivation in an environment where hospital mergers and closures are frequently discussed.

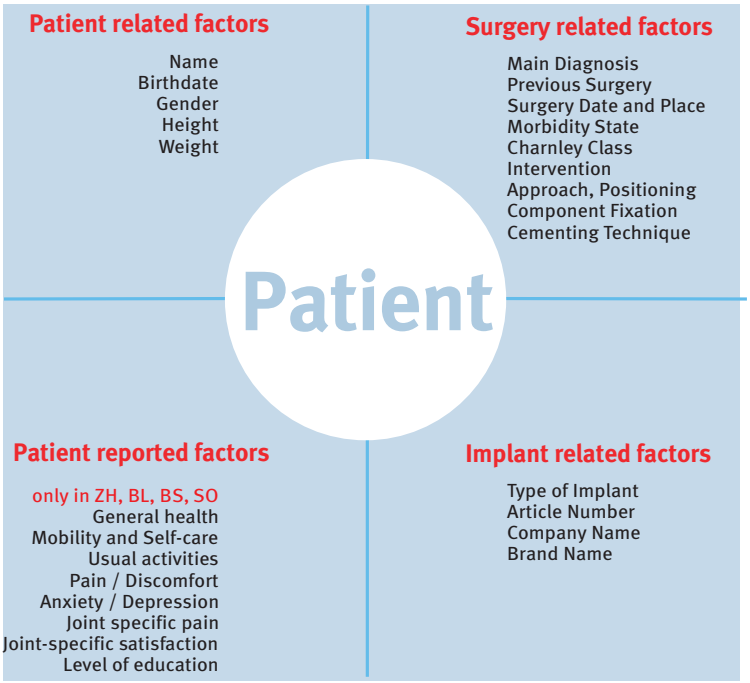
From the insurer's point of view. Insurers and third-party payers want minimal delays and waiting times for insured patients, short hospitalization times, no expensive re-admissions for complications, and a quick return to work. Insurers are very cost conscious when it comes to implant pricing, medical honorarium, and hospital bills. The insurers' wish is to provide equal benefits to 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 as a cost-control tool. Because revisions are causing massive additional and unnecessary costs, the interest of patients is the same as the interest of insurers: Long-lasting pain-free function after prosthetic replacement.

Point of view of the government. The government organizes the healthcare system on behalf of all citizens. Therefore, it has no inherent financial interest, but shares the patients' interest: Cost-efficient treatment providing long-lasting good results. The government therefore needs data on the overall surgical activity for public health purposes, for needs assessments, and for planning the macroeconomic policies related to healthcare. Government agencies are commissioned to ensure that the institutions under their supervision provide high-quality and complication-free healthcare 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 reasonable minimum. Health agencies also play an important role in supervising implant systems as they require guarantees that the industrial standards of nationally manufactured and imported implants are safe and reliable for institutional usage.

1.2 Strong commitment

The 2019 SIRIS report represents a collaborative data collection effort involving all the institutional partners of SIRIS and including the surgeons and operating teams in 186 hospital services. Streamlining, improving and optimizing the data collection is a work in progress involving expert groups and all stakeholders, including the industrial partners.
It is difficult to assess the coverage of the SIRIS register (almost 90% of all performed arthroplasties that were submitted to the registry as closed cases were used in the analysis). As a benchmark we used data from the hospital quality report published by the Swiss Federal Health Authorities (BAG) for 2017. Although the registry officially only started in 2012, it has already enjoyed a coverage of 100% 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. This 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 healthcare community, third-party payers, and healthcare regulators will hopefully find useful.

Figure 1.2
Variables collected by the SIRIS registry



2. Methods

2.1 Maintenance and hosting of the registry

The Swiss National Implant Registry, Hip and Knee (SIRIS) is hosted and maintained by SwissRDL at the Institute for Social and Preventive Medicine ISPM, University of Bern. A dedicated team consisting of a project manager, data management specialists, statistician and an epidemiologist is responsible for the management and maintenance, technical support and reporting and analysis of the registry. A data monitor supervises the data entry at the hospitals and supports and trains the collaborators at the participating hospital services to ensure the smooth and efficient conduct of the registry.

SIRIS data are collected on the online documentation IT platform (accessible on www.siris-doc.ch). Clinical data on primary and revision operations as well as implant data are recorded. The current used version of the SIRIS forms for data entry 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 SwissRDL for processing. As a third data entry method, two large services send data exports from their hospital information system via web service client to SwissRDL.

Implant specification data are entered into SIRIS by scanning the bar codes of the implant tags in the operation room in most participating facilities. It was also possible to enter the information manually via the web interface. However, data quality was reduced and caused substantial time-intensive data-cleaning. Therefore, manual data entry of implants is now restricted to multiple choice dropdown menus containing only registered implants, instead of free manual entry. New implants may be registered by SwissRDL on demand by SIRIS user or upon notification by producer.

The clinical data of the SIRIS registry is stored on dedicated servers at the University of Bern. SwissRDL is able to leverage the IT infrastructure of the ISPM and the data protection resources of the university. The ISPM IT team is managing roughly 30 physical servers and 120 virtual servers.

The clinical data of SIRIS is stored physically separated from the patient identifying information (e.g. medical record number, name and date of birth), which is stored on a specific module server. The identifying information is encrypted into a salted hash code, which allows patients who receive the revision of the primary implantation at a different health facility to be identified. This is needed for the calculation of revision rates and for continuous follow-up of the implants.

In order to estimate the number of patients at risk of revision, all patients from SIRIS are cross-checked with the database of the Swiss Central Compensation Office (ZAS Geneva) and the Federal Statistical Office (FSO Neuchâtel). Whether somebody has died could only be verified until the end of 2017, as the FSO has not published the data for 2018 yet. Only patients confirmed alive and residing in Switzerland were considered “at risk”. Patients who died or emigrated during the observation period were accounted for proportionally in terms of the number of days until emigration or death. Only 4% had unknown status or were foreigners operated on in Switzerland but not registered in ZAS. Those patients were considered lost to follow-up and subsequently excluded from the analysis of revision rates.

SwissRDL data protection was audited recently to ensure compliance with current standards. The methodology of splitting the clinical from the patient identifying information was reviewed and approved by data protection delegates (from the canton of Bern and from the federal authority). Patients must provide written informed consent before data are entered into SIRIS. They have the right to withdraw, to see what is stored and to have their data deleted completely.

2.2 Data quality and completeness

Data for this report were exported from the database on May 1, 2019. 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.

Two case report form (CRF) versions have been used in SIRIS. The first version was used between 2012 and 2014. Since January 2015, an updated version has been used. It includes 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 unknown ASA status in almost all cases. Close monitoring of the hospitals will be set in place to reduce missing values, for example for BMI and ASA.

2.3 Coverage

To estimate the coverage of SIRIS, reliable reference figures from other sources are needed. One option is to compare the annual number of cases reported in the registry with numbers from quality indicators for Swiss acute hospitals as published by the Federal Office of Public Health (FOPH). 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 the patient's socio-demographic characteristics, diagnosis and treatment. This is probably the best suitable reference data set in Switzerland to estimate the coverage of the SIRIS register.

In the master file containing quality indicators for 2016 (https://www.bag.admin.ch/bag/de/home/zahlen-und-statistiken/zahlen-fakten-zu-spitaelern/qualitaetsindikatoren-der-schweizer-akutspitaeler/qualitaetsindikatoren-dokumentation.html) cases of an arthroplasty surgery are identified using CH-IQI quality indicators (Version 4.2). Detailed definitions may be found here (in German, French and Italian): https://www.bag.admin.ch/bag/de/home/zahlenund-statistiken. Codes I.1.8.M, I.1.10.M, and I.1.21.M have been used to identify primary hip prostheses. Codes I.1.15.M, I.1.16.M, and I.1.21.M have been used to identify knee prostheses. This analysis is restricted to primary hip and knee implantations for any reason except fractures.

Because the FSO will release the data for 2017 and 2018 after the closure of the SIRIS 2019 Report, it was only possible to perform the coverage analysis for 2016. Therefore, the coverage of the SIRIS registry relative to FOPH data for 2017 and 2018 can first be reported in the SIRIS Report 2020. As an alternative, and considering the importance of coverage figures, an alternative data source was found: total numbers of femoral stems and tibia plateaus sold in Switzerland in 2017 and 2018 (the data provided by the manufacturers).

Based on this information, the overall coverage of SIRIS in 2017/2018 was estimated at 90 to 92% across all included primary and component revision procedures. We also use this information for estimates of hospital-specific coverage rates, which inform the registry's ongoing data quality monitoring activities. However, this estimation presents with certain methodological difficulties. Because some hospitals are organized in purchasing syndicates, the allocation of implants to specific hospitals may be difficult, leading to over- or underestimation of the coverage for a given hospital. For a variety of reasons, it is also possible that implants are purchased but not implanted in a given time period. Together, these effects may lead to figures over 100% and potentially some artificially low coverage values. For the distribution shown below, we have attempted to make reasonable adjustments for those problems. Overall, we have a high degree of confidence in the coverage figures, especially when compared to the 2016 coverage analysis performed on the basis of more refined FOPH data.

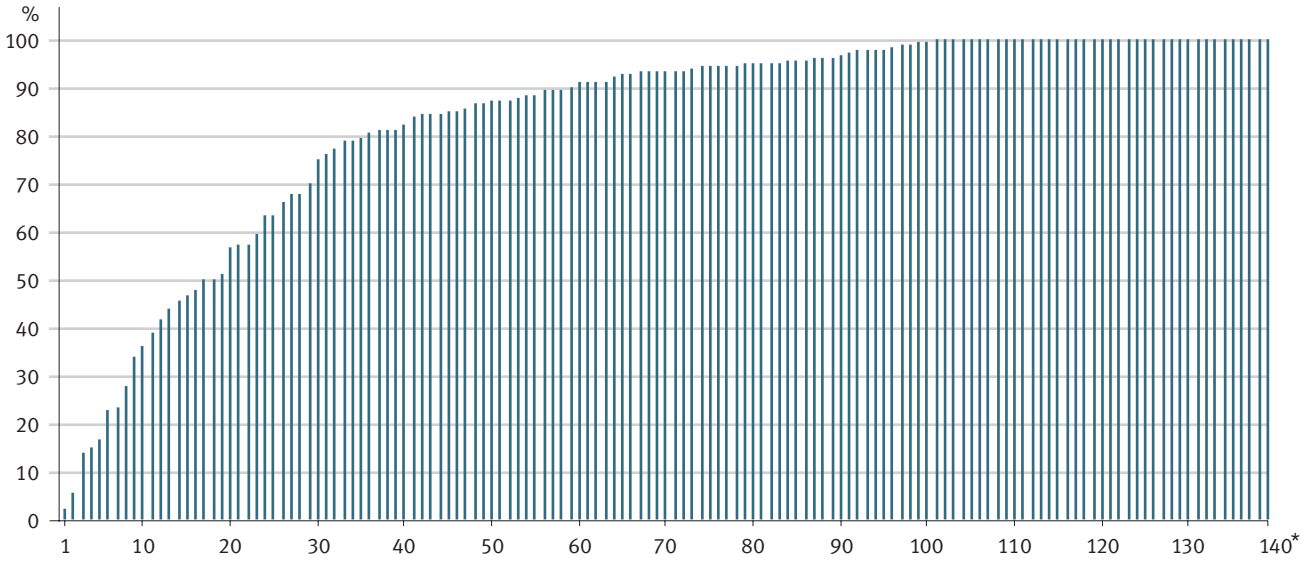
For the reporting period of 2017 to 2018 we estimate that 60% of eligible hospitals achieved coverage rates of at least 90%; 47% even submitted 95% or more of eligible hip and knee procedures. 20%, mostly lower volume services, appear to have submitted fewer than 70% of their eligible procedures. The minority of hospitals that submitted insufficient numbers will be contacted by SwissRDL and asked to investigate the reasons and seek improvements.

It should be noted, however, that this coverage analysis was performed at the procedural level. The implant data used for this report is the result of a variety of data entry modes, some of which can lead to ambiguous data being included in the register's implant library (predominantly through free text entry). In 2017/2018 SIRIS could link unambiguous implant information (e.g. a valid femoral stem/acetabular cup combination) to nearly 94% of registered THAs and to 91% of registered TKAs. To close this gap SwissRDL has been reviewing the data entry modes and the particularly problematic free text entry is about to be eliminated as a result.

Figure 2.1

Estimated SIRIS coverage rates per participating hospital 2017–2018

Hospitals sorted by estimated case ascertainment rate



* Multiple sites had to be combined for a number of multi-site hospitals in order to make valid comparisons of SIRIS and industry data

3. Overview of the SIRIS report 2019

3.1 Demography and hip and knee surgery

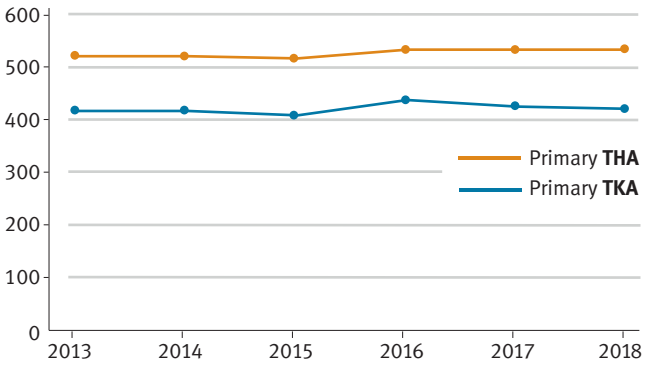
Since its inception in 2012, SIRIS has registered more than 200,000 primary hip and knee procedures and nearly 30,000 revisions. The absolute number of hip procedures in particular has been growing steadily, with annual growth rates since 2013 averaging more than 2%. In this report we take a closer look at the development of relative figures. As the Swiss population is aging fast, it is apparent that the increases in both main procedures are broadly in line with the increase of the population most at risk of needing those procedures; that is 50 to 89 year olds. It should be noted, however, that these figures only include procedures registered in SIRIS and that the registry's coverage is still incomplete. The actual annual incidence rates for Switzerland are slightly higher.

The comparison of the incidence of implantation of prosthesis with incidences in other healthcare systems can be difficult, and interpretations must be made cautiously. It usually is presented as a fraction where the counter shows the number of all prostheses implanted during a given period and the denominator defining the base to which the counter is analyzed. The problem is that the denominator can be very variable between reports and calculations. Therefore, this report presents two calculations with different denominators.

Fig. 3.1 shows the incidence based on the population most at risk, e.g. those who belong to that age group where this procedure is usually performed. This approach takes age partially into account and in an aging population the incidence may rise.

Fig. 3.2 shows the incidence of the entire population of Switzerland, irrespective of age and whether a person is in the age group at risk. In a community with a young population the incidence would be low. Factors that influence the incidence of implantation of a hip or knee prosthesis, besides age, are gender, healthcare system, economic power of a country, availability of the medical service and increasing patient expectation about quality of life.

Figure 3.1
Development of relative primary total hip and total knee arthroplasty figures
Per 100'000 population (most at risk*)



* Age group 50–89 years old accounts for 92% of all recipients of THA and 97% of all recipients of TKA

Figure 3.2
Development of relative primary total hip and total knee arthroplasty figures
Per 100'000 population (Swiss resident population)

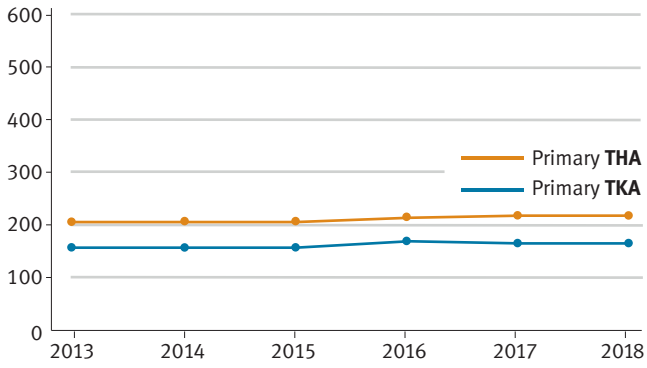


Table 3.3

Total hip arthroplasty

Overall number of documented operations

Year	Primary total	Revision total	Total
2012*	6663	866	7529
2013	16891	2234	19125
2014	17158	2463	19621
2015	17356	2485	19841
2016	18263	2508	20771
2017	18597	2525	21122
2018	18885	2483	21368
All	**113813**	**15564**	**129377**

Figure 3.3

Distribution of age at surgery for total hip arthroplasty and hemiarthroplasty of the hip

All documented operations, kernel density estimation

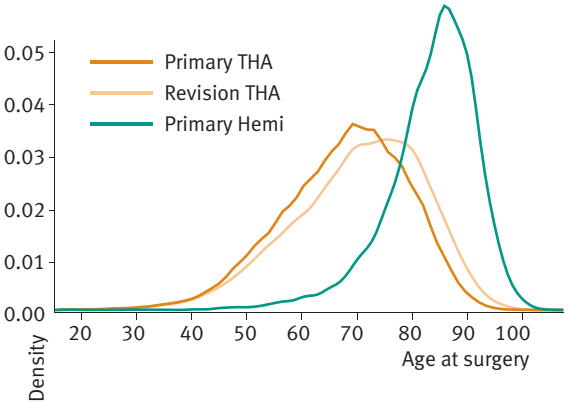


Table 3.4

Hemiarthroplasty of the hip

Overall number of documented operations

Year	Primary hemi-arthroplasty	Conversion to THA	Total
2012*	640	37	677
2013	1927	54	1981
2014	2040	54	2094
2015	1962	60	2022
2016	1977	44	2021
2017	2000	41	2041
2018	2109	42	2151
All	**12655**	**332**	**12987**

* SIRIS registration began in late 2012 and figures do not represent a full year

Table 3.5

Total and partial knee arthroplasty

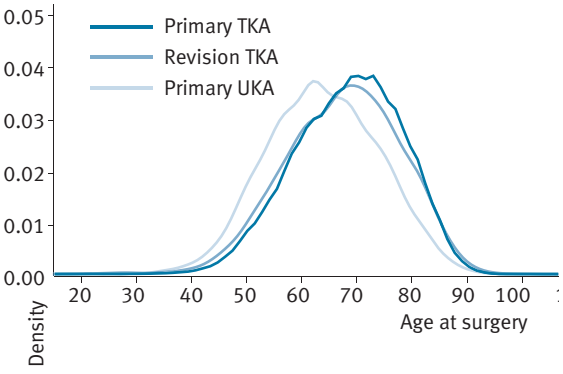
Overall number of documented operations

Year	Primary total	Primary partial	Knee revision	Total
2012*	4739	854	529	6122
2013	12928	2147	1464	16539
2014	13263	2092	1606	16961
2015	13147	2282	1735	17164
2016	14301	2344	2098	18743
2017	14181	2483	2223	18887
2018	14269	2536	2284	19089
All	**86828**	**14738**	**11939**	**113505**

Figure 3.4

Distribution of age at surgery by total and partial knee arthroplasty

All documented operations, kernel density estimation



3.2 Reporting of implant-specific outcomes

Implants are at the core of the SIRIS registry and this report marks the first reporting of implant-specific outcomes. More than 700,000 primary implants (femoral stems, acetabular cups, heads, tibia plateaus, femoral components, inlays) have been registered in SIRIS and the list of manufacturers currently active in Switzerland is provided in Table 3.6.

SIRIS regards the implant revision rate for any reason as its main outcome of interest. In order to minimize random effects, the revision rates were calculated only if more than 50 implants (number at risk) were registered during the observation period. However, revisions are relatively rare events and the rates for implants with less than 500 procedures should be interpreted cautiously. Thus, readers are advised to pay close attention to the reported confidence intervals.

Table 3.6
List of companies with implants registered in the SIRIS registry
2018

Company	Headquarter
Amplitude	Valence (FRA)
B. Braun Medical AG	Sempach
CeramTec	Blochingen (DEU)
Corin GSA GmbH	Solothurn
Dédienne Santé	Nîme (FRA)
Heraeus Medical GmbH	Zürich
Implantec	Mödling (AUT)
Johnson & Johnson Medical	Zuchwil
Lima Implants	Rotkreuz
Link Implants	Bern
Mathys AG	Bettlach
Medacta International SA	Frauenfeld
Smith & Nephew Schweiz AG	Baar
Stemcup Medical Products AG	Zürich
Stryker Osteonics SA	Biberist
Symbios Orthopédie SA	Yverdon-les-Bains
Zimmer Biomet	Winterthur

Implant categories with sufficient numbers overall have been analyzed for so-called outlier implants. An implant may be considered a "statistical outlier" if its revision rate deviates markedly from a relevant group average. The reference revision rate used in this report is the average revision rate of all corresponding implants (or combinations) in the registry over the observation period (e.g. uncemented stem/cup combinations used in THAs following a diagnosis of primary osteoarthritis). The outlier alert boundary was set at twice that reference revision rate.

An implant was regarded as a potential outlier when its 2-year revision rate was higher than the outlier alert boundary, regardless of the extent of the statistical confidence interval. However, the outlier status comes with varying degrees of statistical probability. We consider the potential outlier status "highly likely" when both the estimated revision rate and the complete confidence interval exceed the outlier alert boundary.

All potential outliers were evaluated and discussed by the SIRIS Scientific Board, and for each concerned implant a separate outlier analysis was conducted and an outlier report written. When the results of the analysis suggested a recognizable need for action, the SIRIS Scientific Board changed the outlier's status from "potential outlier" to "confirmed outlier". Any potential random or hospital effects, as well as dynamics of use of the implant during the observation period, have been analyzed, and concise comments of the Board added to the reports.

The outlier reports are a powerful tool for quality management and primarily directed at the manufacturers. However, the hospitals/departments that used, still use or intend to use the concerned implants also need to be informed about these SIRIS observations. Therefore, the involved manufacturers and hospital/departments received confidential outlier reports before publication of this report.

3.3 Hospital services

More than 150 hospital services in Switzerland provide hip and knee arthroplasty procedures and SIRIS achieved 100% coverage of those services in 2018. Looking at median procedure figures per hospital service (Table 3.7) reveals a rather stable picture over time, with only minimal fluctuation since the registry's first full year in 2013. Tables 3.8 and 3.9 as well as Figures 3.5 a, b, c highlight the distribution of case numbers within service size categories. It is noteworthy that a relatively large number of small hospital services still perform a minority of total procedures, while a small number of large services perform a bigger (THA) or nearly as big (TKA) share of procedures.

Table 3.7

Number of participating hospital services (N) and median procedures per service per year

		2013	2014	2015	2016	2017	2018
Primary total hip arthroplasty	N services	150	149	151	157	153	158
	Median procedures per service	85	84	82	86	87	86
Revision of total hip arthroplasty*	N services	130	131	138	143	136	141
	Median procedures per service	10.5	11	9	9	9	9
Primary hemiarthroplasty of the hip	N services	125	128	133	127	131	127
	Median procedures per service	9	9	10	9	9	9
Conversion of hemiarthroplasty of the hip	N services	37	39	41	32	28	29
	Median procedures per service	1	1	1	1	1	1
Primary arthroplasty of the knee	N services	146	148	150	149	149	155
	Median procedures per service	78	71	67	75	72	78
Primary unicompartmental knee arthroplasty	N services	117	123	125	128	127	129
	Median procedures per service	34	40	42	48	44	41
Revision arthroplasty of the knee	N services	122	127	126	131	130	134
	Median procedures per service	7.5	7	7	8	9.5	9

Table 3.8

Number of hospital services and number of primary total hip arthroplasties according to hospital service volume

		2013	2014	2015	2016	2017	2018
Service volume <100	N procedures/%	3021/**17.9**	3110/**18.1**	3451/**19.9**	3599/**19.7**	3190/**17.2**	3408/**18.0**
	N services	76	75	83	85	79	85
Service volume 100–199	N procedures/%	6143/**36.4**	6158/**35.9**	5287/**30.5**	5406/**29.6**	5695/**30.6**	5301/**28.1**
	N services	49	50	41	43	44	40
Service volume 200–299	N procedures/%	3146/**18.6**	2836/**16.5**	3874/**22.3**	3630/**19.9**	4499/**24.2**	3945/**20.9**
	N services	14	12	17	16	19	18
Service volume >300	N procedures/%	4581/**27.1**	5054/**29.5**	4744/**27.3**	5628/**30.8**	5213/**28.0**	6231/**33.0**
	N services	11	12	10	13	11	15

Table 3.9

Number of hospital services and number of primary total knee arthroplasties according to hospital service volume

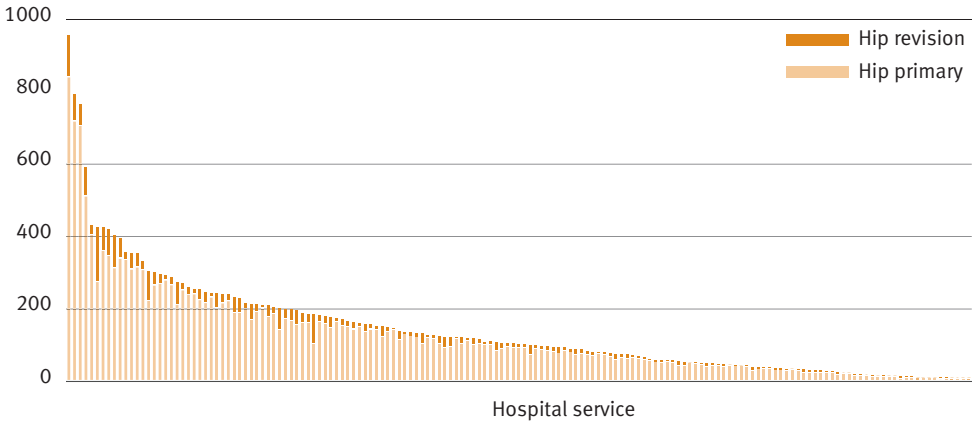
		2013	2014	2015	2016	2017	2018
Service volume <100	N procedures/%	3860/**29.9**	3735/**28.2**	3688/**27.7**	3838/**26.5**	3086/**21.5**	3761/**26.0**
	N services	91	94	97	94	86	99
Service volume 100–199	N procedures/%	4476/**34.6**	3863/**29.1**	3459/**26.0**	3622/**25.0**	4810/**33.5**	4244/**29.4**
	N services	37	31	29	29	39	33
Service volume 200–299	N procedures/%	2232/**17.3**	2958/**22.3**	2516/**18.9**	2640/**18.2**	2940/**20.5**	2945/**20.4**
	N services	11	14	12	13	14	14
Service volume >300	N procedures/%	2360/**18.3**	2707/**20.4**	3650/**27.4**	4375/**30.2**	3528/**24.6**	3504/**24.2**
	N services	6	7	10	12	9	9

* Knee revision without conversion to TKA

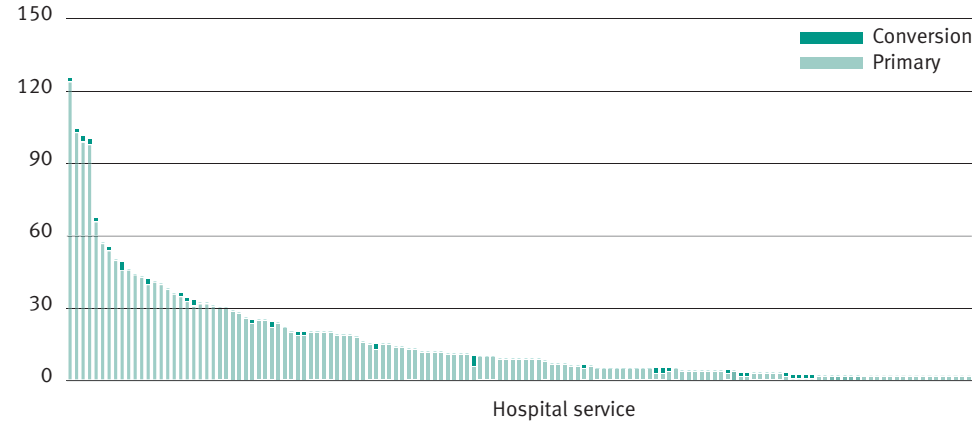
Figures 3.5 a, b and c

Cases per hospital service 2018

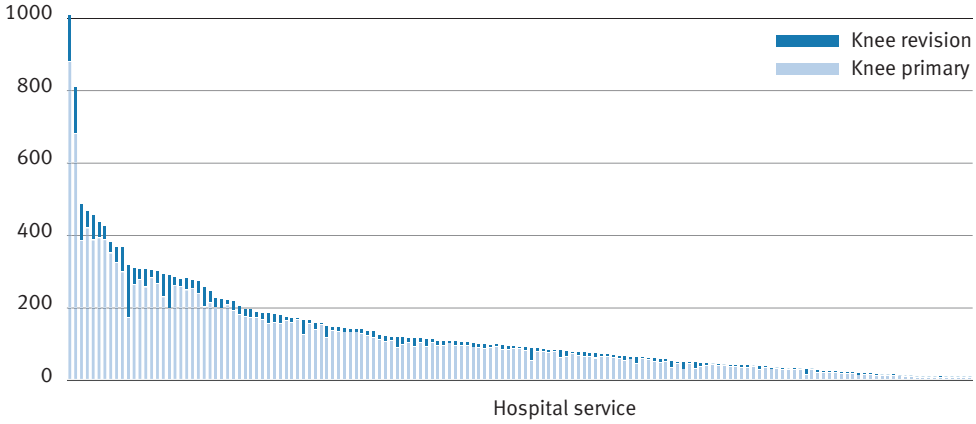
3.5a
Total hip arthroplasty



3.5b
Hemi arthroplasty of the hip



3.5c
Total knee arthroplasty



3.4 Prosthesis-related revision rates by services

Already in its seventh year, SIRIS can now begin to focus on its main purpose: the reporting of revision rates from a variety of perspectives. In this report we focus on two-year rates of first revisions involving prosthesis components. The SIRIS registry does capture certain other reoperations, but these are excluded from the analysis of the revision rates. Figures 3.6 and 3.7 show funnel plots of risk adjusted (age and sex) revision rates for THA and TKA procedures. On a funnel plot, each dot represents a hospital service and they are centered on the national average. The vertical axis indicates the outcome, with dots higher up the axis showing services with higher revision rates.

The horizontal axis shows surgical activity with dots further to the right showing the services which performed more operations in the reporting period.

Funnel plots include control limits to define the range within which we would expect outcomes to lie. Following convention, we use 99.8% control limits as the outer limit. It is unlikely for a hospital service to fall beyond these limits solely because of random variation (a 1 in 500 chance). The main cause of variation within the control limits is likely to be random variation. As the plots show, the spread of outcomes

Figure 3.6
2-year revision rate of primary total hip arthroplasty by service

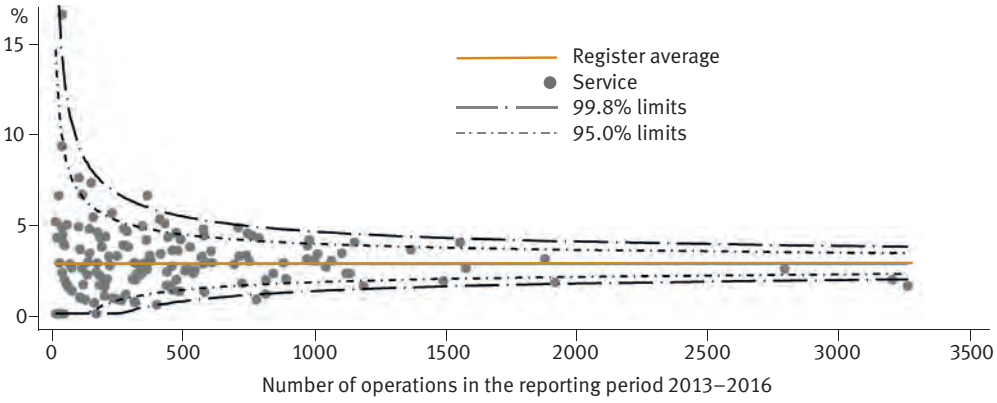
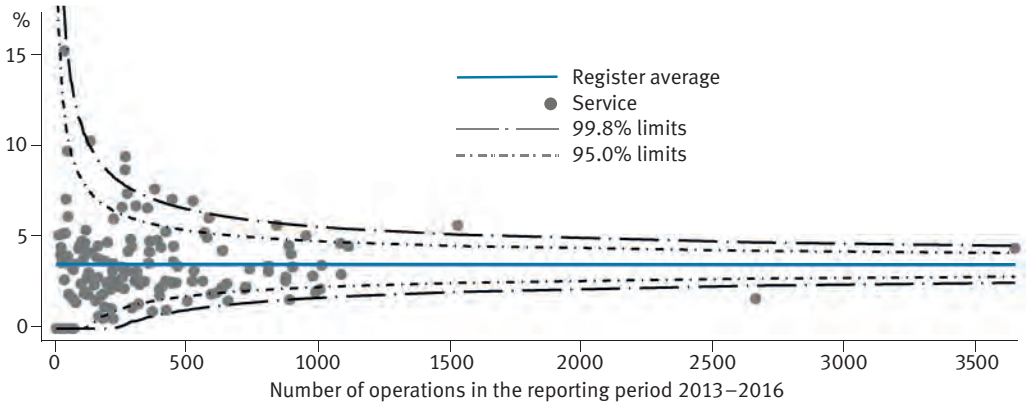


Figure 3.7
2-year revision rate of primary total knee arthroplasty by service



in Switzerland is relatively homogeneous, but there are exceptions, and there appears to be more variation in knee than in hip procedures.

We also take a closer look at failure estimates (cumulative revision rates over time) in Figures 3.8 and 3.9. The oldest cases registered in SIRIS can be followed up for six years and we can see that the cumulative revision rate for this group approaches four percent for THAs and six percent for TKAs. For both types of procedures, there is a steady increase in revisions over time, although it must be noted that as we move to the right of these charts, we face considerably increasing uncertainty regarding the failure estimates (widening confidence intervals providing upper and lower bounds of estimates).

Figure 3.8

Failure estimate of primary total hip arthroplasty

in % in the time since operation, 2013–2018, all services

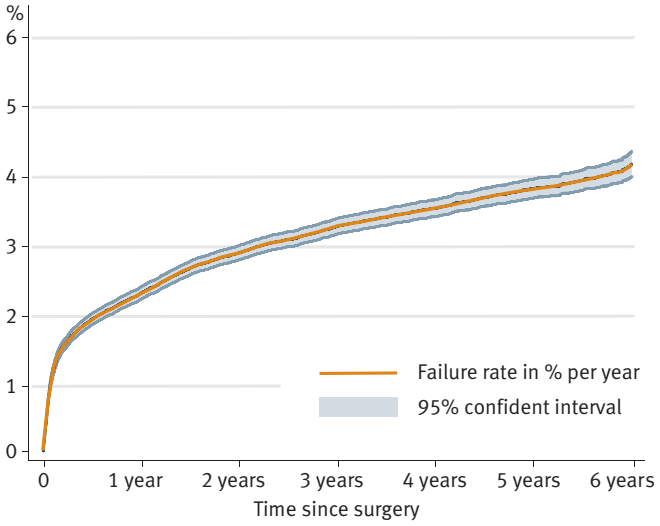
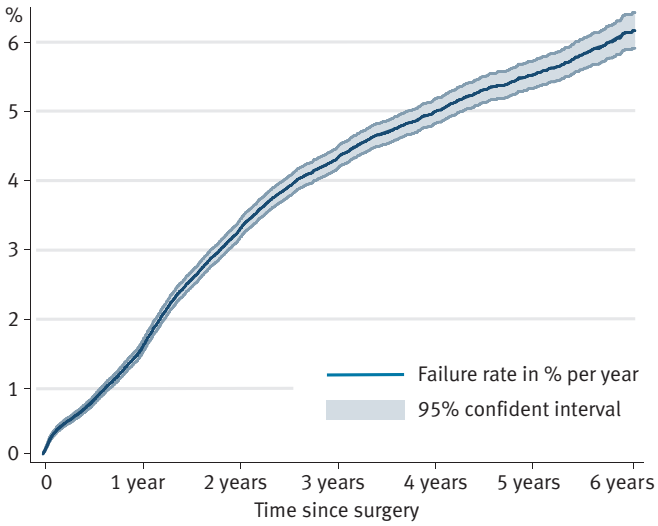


Figure 3.9

Failure estimate of primary total knee arthroplasty

in % in the time since operation, 2013–2018, all services



4. Hip arthroplasty

4.1 Primary total hip arthroplasty

The SIRIS registry has documented the implantation of 107,150 primary total hip arthroplasties (THA) over the past six years (Table 4.1). Implantation is slightly more frequent in women (52.8%), and their mean age of 68.4 years is higher than in men (66.4 years).

The majority are implanted at between 55 and 84 years of age, covering 81.3% of all implants. Only 6.4% are implanted in patients older than 85 years. Patients younger than 55 years constitute 12.3% of the recipients. The distribution among the age groups remained stable during the observation period.

Table 4.1
Primary total hip arthroplasty: Baseline patient characteristics by year
2013–2018. BMI and ASA class data only available from 2015 onwards

		2013	2014	2015	2016	2017	2018	All
N		**16891**	**17158**	**17356**	**18263**	**18597**	**18885**	**107150**
Diagnosis [%]	Primary OA	85.4	85.6	84.3	83.4	84	83.9	84.4
	Secondary OA	9	8.2	9.4	10.1	9.5	9.2	9.2
	Fracture	5.6	6.2	6.3	6.5	6.5	6.9	6.3
Women [%]		52.3	52.5	52.6	52.9	53.1	53.1	52.8
Mean age (SD)	All	67.9 (12.1)	68.3 (12.2)	68.6 (11.6)	68.4 (11.6)	68.5 (11.6)	68.9 (11.5)	68.4 (11.8)
	Women	69.7 (11.8)	70 (11.9)	70.4 (11.3)	70.2 (11.2)	70.3 (11.3)	70.6 (11.2)	70.2 (11.4)
	Men	65.9 (12.1)	66.4 (12.2)	66.6 (11.7)	66.4 (11.6)	66.5 (11.6)	66.9 (11.6)	66.4 (11.8)
Age group [%]	‹45	3.3	3.2	2.6	2.8	2.7	2.3	2.8
	45–54	9.9	9.2	9.8	9.5	9.4	9.3	9.5
	55–64	22	21.3	21.2	21.5	21.9	21.7	21.6
	65–74	33.5	33.4	33.6	34.2	33.5	32.6	33.5
	75–84	25.5	26.6	26.2	25.7	26.1	27.1	26.2
	85+	5.8	6.2	6.6	6.3	6.4	7	6.4
N unknown BMI (%)				4482 (26)	3783 (21)	3336 (18)	3055 (16)	14656 (20)
N known BMI				12874	14480	15261	15830	58445
Mean BMI (SD)				27.1 (5)	27.2 (5.4)	27.1 (5.1)	27.2 (5.5)	27.1 (5.3)
BMI [%]	‹18.5			1.8	1.8	1.8	2.1	1.9
	18.5–24.9			35.1	34.9	35.4	34.8	35
	25–29.9			38.9	39.2	38.9	38.2	38.8
	30–34.9			17.1	17.4	17.1	17.5	17.3
	35–39.9			5.4	4.9	5.2	5.4	5.2
	40+			1.7	1.7	1.7	2	1.8
N unknown ASA (%)				2393 (14)	2226 (12)	2014 (11)	1786 (9)	8419 (12)
N known ASA				14963	16037	16583	17099	64682
Morbidity	ASA 1			16.4	14.7	13.3	11.9	14
state [%]	ASA 2			58.2	59.5	60	59.6	59.4
	ASA 3			24.8	25	26	27.6	25.9
	ASA 4/5			0.6	0.8	0.6	0.9	0.7

Table 4.2

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

BMI and ASA class data only available from 2015 onwards

		Primary OA	Secondary OA	Fracture
N **(2013–2018)**		**90446**	**9902**	**6802**
Women [%]		51.3	56.7	65.8
Mean age (SD)	All	68.6 (11.1)	63.5 (15.3)	73.9 (11.3)
	Women	70.3 (10.7)	65.5 (15.3)	74.9 (10.9)
	Men	66.7 (11.2)	60.8 (15.0)	72.0 (11.7)
Age group [%]	‹45	2	11.4	0.9
	45–54	9.1	17.1	4.3
	55–64	22.2	21.2	13.8
	65–74	34.9	23	29.1
	75–84	26.2	20.1	34.5
	85+	5.5	7.1	17.4
Diagnosis [%]	Osteoarthritis	100		
	Inflammatory arthritis		5.5	
	Developmental dysplasia		21.0	
	Osteonecrosis		54.0	
	Miscellaneous		19.5	
	Fracture			100

		Primary OA	Secondary OA	Fracture
N **(2015–2018)**		**61273**	**6962**	**4781**
N unknown BMI (%)		12171 (20)	1089 (16)	1311 (27)
N known BMI		49102	5873	3470
Mean BMI (SD)		27.4 (5.2)	26.7 (5.6)	24.3 (4.5)
BMI [%]	‹18.5	1.4	2.9	7.9
	18.5–24.9	33.2	39	53.8
	25–29.9	39.9	35.7	28.3
	30–34.9	18.1	15.8	7.8
	35–39.9	5.5	4.7	1.7
	40+	1.9	1.9	0.5
N unknown ASA		7263	596	475
N known ASA		54010	6366	4306
Morbidity state	ASA 1	14.3	15.9	7.1
[%]	ASA 2	61.1	52.5	47.5
	ASA 3	24.1	30.2	42.2
	ASA 4/5	0.5	1.4	3.2

The registry differentiates between THAs performed for primary osteoarthritis (84.4%) being the largest group and implantations done for treatment of secondary osteoarthrosis, including post-traumatic hip joint degeneration, avascular necrosis and sequels of childhood diseases like dysplasia and Perthes' disease (9.2%). The third group includes implantation of THAs in fractures of the hip (6.3%).

In general, the revision rate of a specific implant, hospital or surgeon is calculated based on hips treated for primary osteoarthrosis. For benchmarking, only primary THAs for primary osteoarthrosis are included in the calculations.

BMI and ASA score have been recorded since 2015. The documentation has improved over time. In the first year of recording 34.8% of the BMI data were missing. This has improved although 19.3% of BMI data are still missing. This is important, because the previous report has shown an increase of the revision rate with increasing BMI. The situation is less deficient for the ASA score. The documentation has improved from missing data of 15.9% in 2015 to 10.4% in 2018.

The mean BMI was 27.1 kg/m^2 for the total number of interventions, 38.8% were performed in overweight patients and 24.3% in obese patients. Obesity is more frequent in younger patients. Increasing BMI of the patient was associated with younger age at surgery (Figure 4.1). The distribution of BMI remained constant over the observation period. The majority of procedures are performed on healthy individuals; 26.6% of the implantations are performed in ASA class ≥3. There is a slight increase of patients with ASA class ≥3.

Figure 4.1

Primary total hip arthroplasty: BMI in relation to age (Kernel density estimation)

(Primary and secondary osteoarthritis patients only)

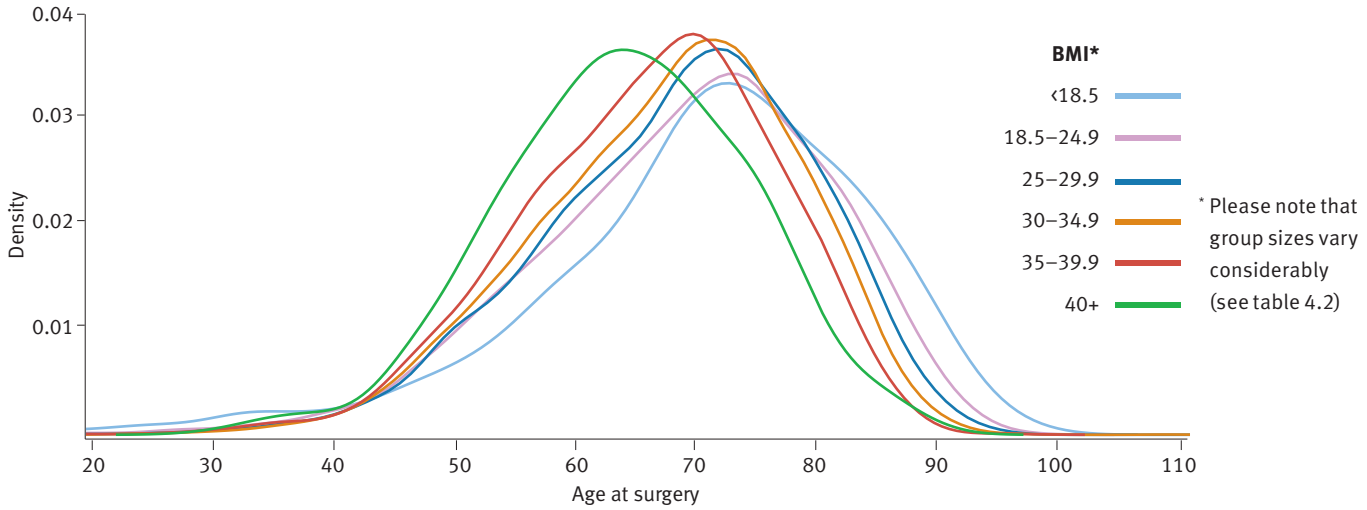


Table 4.3

Baseline characteristics of primary total hip arthroplasty patients by hospital service volume

Calculations of hospital service volume based on all primary and revision hip surgeries in 2018.
BMI and ASA class data only available from 2015 onwards

Hospital service volume		<100	100–199	200–299	300+
N **(2013–2018)**		**13658**	**24721**	**21675**	**47096**
Women [%]		51.8	53.6	52.1	53.3
Mean age (SD)	All	69.2 (11.7)	69.1 (11.4)	68.7 (11.7)	67.7 (11.9)
	Women	71.1 (11.6)	70.8 (10.9)	70.7 (11.3)	69.4 (11.7)
	Men	67.2 (11.6)	67.1 (11.5)	66.6 (11.9)	65.8 (11.9)
Age group [%]	<45	2.3	2.1	2.8	3.4
	45–54	8.5	8.7	9.3	10.3
	55–64	20.6	21.2	21.1	22.3
	65–74	33.6	33.7	33	33.5
	75–84	27.8	27.6	26.8	24.7
	85+	7.2	6.5	7	5.8
Diagnosis [%]	Primary OA	83.6	85.1	83	84.9
	Secondary OA	8.6	8.1	9	10.1
	Fracture	7.8	6.8	8	4.9
N **(2015-2018)**		**9163**	**16738**	**14942**	**32173**
N unknown BMI (%)		2584 (28)	3321 (20)	2568 (17)	6098 (19)
N known BMI		6579	13417	12374	26075
Mean BMI (SD)		27.2 (5)	27.3 (5)	27.4 (6)	26.9 (5)
BMI [%]	<18.5	1.8	2	1.8	1.9
	18.5–24.9	35	33.4	33.4	36.6
	25–29.9	38.7	39.3	38.4	38.7
	30–34.9	17.9	17.7	18.6	16.3
	35–39.9	4.9	5.5	5.9	4.9
	40+	1.8	2.1	1.9	1.6
N unknown ASA (%)		606 (7)	1613 (10)	937 (6)	5178 (16)
N known ASA		8557	15125	14005	26995
Morbidity state [%]	ASA 1	17	14.6	12.7	13.3
	ASA 2	58.2	59.6	60.6	59
	ASA 3	23.9	24.9	25.9	27.1
	ASA 4/5	0.9	0.9	0.7	0.6

Patients treated for secondary osteoarthrosis are on average five years younger than those treated for primary osteoarthritis. It is interesting to note that secondary OA due to hip dysplasia accounts for one fifth of secondary OA, which in turn is 1.9% of all arthritic hips. 5.3% of all arthritic hip were treated for avascular necrosis. In contrast to the other main diagnostic groups there are significantly more young patients treated for secondary OA. 11.4% are younger than 45 years of age.

There are significantly more women affected by fractures than men. They account for almost two thirds of all patients sustaining a fracture around the hip. The average age of women with fractures is 73.9 years of age compared to men with 72 years. More than 80% occur at an age above 65 and more than 50% at an age above 75. There is also a much higher proportion of patients in the fracture group belonging to ASA class ≥3.

Table 4.4

Primary total hip arthroplasty: Surgery characteristics by main diagnostic group

Approach data only available from 2015 onwards

		Primary OA		Secondary OA		Fracture	
		N	%	N	%	N	%
Previous surgery	None			7865	79.4	6009	88.3
	Internal fixation femur			544	5.5	547	8.0
	Osteotomy femur			386	3.9	45	0.7
	Internal fixation acetabulum			55	0.6	48	0.7
	Osteotomy pelvis			173	1.7	7	0.1
	Arthrodesis			3	0.0	5	0.1
	Other previous surgery			1045	10.6	177	2.6
Intervention	Total hip replacement	90401	100.0	9896	99.9	6792	99.9
	Hip resurfacing	45	0.0	6	0.1		
Approach	Anterior	28051	45.8	2950	42.4	2148	44.9
	Anterolateral	20136	32.9	2304	33.1	1323	27.7
	Posterior	8666	14.1	1049	15.1	744	15.6
	Lateral	3977	6.5	522	7.5	469	9.8
	Other approach	451	0.7	138	2.0	98	2.0
Fixation	All uncemented	78416	86.7	7782	78.6	3274	48.1
	Hybrid*	10050	11.1	1363	13.8	2638	38.8
	All cemented	1249	1.4	454	4.6	636	9.4
	Reverse hybrid**	533	0.6	180	1.8	144	2.1
	Reinforcement ring, femur uncemented	103	0.1	48	0.5	40	0.6
	Reinforcement ring, femur cemented	95	0.1	75	0.8	70	1

* acetabulum uncemented, femur cemented ** acetabulum cemented, femur uncemented

Tables 4.5 a, b, c and Figures 4.2 a, b, c

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

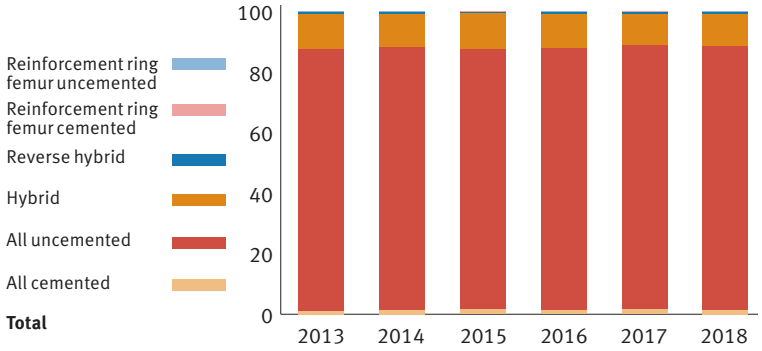
Table/Figure a

Primary osteoarthritis

Total numbers per year

2013	2014	2015	2016	2017	2018
10	19	22	22	14	16
16	16	10	14	14	25
91	104	85	75	94	84
1686	1613	1693	1702	1634	1722
12457	12728	12591	13243	13618	13779
165	206	228	180	250	220
14425	**14686**	**14629**	**15236**	**15624**	**15846**

Percentage per year



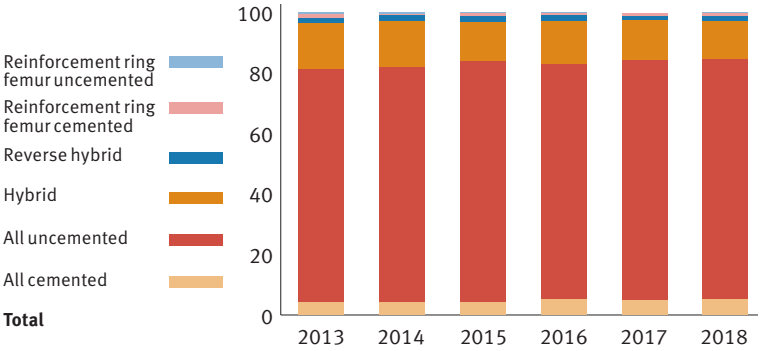
Table/Figure b

Secondary osteoarthritis

Total numbers per year

2013	2014	2015	2016	2017	2018
13	5	8	7	6	9
16	9	12	13	13	12
24	28	33	33	29	33
233	210	213	261	232	214
1174	1091	1297	1438	1402	1380
62	57	69	94	84	88
1522	**1400**	**1632**	**1846**	**1766**	**1736**

Percentage per year



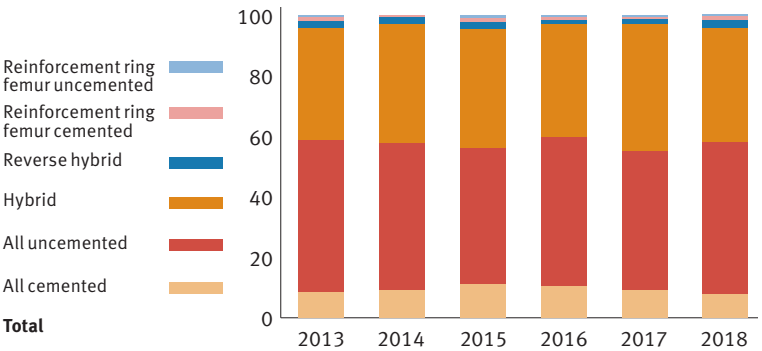
Table/Figure c

Fracture

Total numbers per year

2013	2014	2015	2016	2017	2018
7	2	10	9	7	5
10	7	17	10	9	17
25	22	24	16	22	35
347	422	432	441	504	492
476	520	489	583	555	651
79	99	123	122	110	103
944	**1072**	**1095**	**1181**	**1207**	**1303**

Percentage per year



Within minimal variations the percentage of the fixation methods have remained stable over the last five years (Table 4.5, Figure 4.2) for all three diagnostic groups. In the secondary OA group relatively more acetabular reinforcement rings were used, reflecting more complex surgery. For treatment of hip fractures, significantly more stems are cemented and there are more hybrid fixations.

The anterior approach is by far the most commonly used approach in Switzerland. Followed by the anterolateral approach. These two approaches make up more than 80% of all implantations of primary THAs. Since the start of recording in 2015 the use of the anterior approach gradually increased, while the lateral and posterior approaches are declining.

Bearing is one of the most important factors for wear and implant survival. Traditionally, metal on polyethylene (MoPE) was the standard for a long time. The problem with this bearing was osteolysis and loosening of the implants. Therefore, several developments were introduced, including highly cross-linked PE (XLPE) which has better wear resistance. The metallic femoral head was exchanged for ceramic femoral heads and metal on metal (MoM) and

Table 4.6

Primary total hip arthroplasty: Surgical approach by year

Approach data only available from 2015 onwards

Surgical approach	2015		2016		2017		2018	
	N	%	N	%	N	%	N	%
Anterior	7196	41.7	7986	43.7	8893	47.8	9074	48.0
Anterolateral	5752	33.3	5977	32.7	5860	31.5	6164	32.6
Lateral	1442	8.3	1406	7.7	1142	6.1	978	5.2
Posterior	2666	15.4	2745	15.0	2540	13.7	2508	13.3
Other approach	215	1.2	149	0.8	162	0.9	161	0.9
Total	**17271**	100	**18263**	100	**18597**	100	**18885**	100

Table 4.7

Primary total hip arthroplasty: bearing surface* in primary osteoarthritis by year (in %)

	2013	2014	2015	2016	2017	2018	All
Metal on polyethylene (MoPE)	2.6	2.2	2.5	2.2	2.2	2.1	2.3
Ceramic on polyethylene (CoPE)	12.2	13.4	13.5	12.7	13.2	14.1	13.1
Metal on cross-linked polyethylene (MoXLPE)	21.3	19.2	15.5	13.6	12.2	12.0	15.9
Ceramic on cross-linked polyethylene (CoXLPE)	46.0	49.0	52.0	54.9	56.5	56.5	52.3
Metal on metal (MoM)	0.0	0.0	0.05	0.0	0.1	0	0.04
Ceramic on ceramic (CoC)	18.0	16.0	16.4	16.6	15.9	15.3	16.3
Other	0.1	0.1	0.03	0.0	0.0	0	0.03
N (bearing surface known)	12435	13669	13625	14343	14621	14872	88657
N (bearing surface unknown)**	1919	971	965	892	957	944	7235

* Femoral heads and acetabular inserts/monobloc cups

** Most of those cases relate to missing acetabular inserts in the registry (All=7.6%)

Table 4.8

Primary total hip arthroplasty: bearing surface* in primary osteoarthritis by age (in %)

	<45	45–54	55–64	65–74	75–84	85+	All
Metal on polyethylene (MoPE)	0.4	0.5	0.4	1.2	4.7	9.8	2.3
Ceramic on polyethylene (CoPE)	8.6	9.3	9.7	11.9	17.6	22.0	13.1
Metal on cross-linked polyethylene (MoXLPE)	17.2	13.7	14.9	15.7	17.0	19.9	15.9
Ceramic on cross-linked polyethylene (CoXLPE)	51.1	54.1	55.1	54.6	48.8	40.2	52.3
Metal on metal (MoM)	0.12	0.04	0.05	0.04	0.03	0.02	0.04
Ceramic on ceramic (CoC)	22.5	22.4	19.8	16.6	11.9	8.1	16.3
Other	0.06	0.01	0.02	0.01	0.07	0.06	0.03
N (bearing surface known)	1733	8081	19794	30987	23217	4730	88542
N (bearing surface unknown)**	129	634	1558	2500	1935	472	7235

* Femoral heads and acetabular inserts/monobloc cups

** Most of those cases relate to missing acetabular inserts in the registry (All=7.6%)

Table 4.9

Primary total hip arthroplasty: fixation methods in primary osteoarthritis by age (in %)

	<45	45–54	55–64	65–74	75–84	85+	All
All cemented	0.5	0.4	0.4	0.7	2.3	6.8	1.4
All uncemented	95.0	96.5	95.3	90.4	76.5	57.6	86.7
Hybrid*	2.8	2.6	3.8	8.3	20.1	33.4	11.1
Reverse hybrid**	1.4	0.3	0.3	0.4	0.8	1.7	0.6
Reinforcement ring, femur cemented	0.0	0.1	0.1	0.1	0.2	0.4	0.1
Reinforcement ring, femur uncemented	0.3	0.1	0.1	0.1	0.1	0.1	0.1
N	1862	8715	21352	33487	25152	5202	95770

* acetabulum uncemented, femur cemented

** acetabulum cemented, femur uncemented

ceramic on ceramic (CoC) bearings were developed to minimize wear. Currently, the most frequently used bearing in Switzerland is CoXLPE, being used in 52.3% of all bearings (Table 4.7). Its use showed a steady increase from 46% in 2013 to 56.5% in 2018. CoPE also showed a small increase from 12.2% in 2013 to 14.1% in 2018. The application of MoPE remained low during the observation period. Since the inception of the registry essentially no MoM bearings were used, most likely due to the known severe complications and excessively high revision rates for such bearings, especially those with large diameter femoral heads. Use of CoC bearings has also been declining over time.

The selection of the bearing surface depends, amongst other criteria, on activity and age of the patient (Table 4.8). Bearings with favorable wear characteristics are most often used in younger patients, e.g. CoXLPE and CoC. Standard PE is more often used in older patients, combined with a metal or ceramic head.

All uncemented fixation is standard for primary THAs in primary OA in this registry and accounts for 86.7% of all hips with primary OA. SIRIS shows that more than 90% of patients under the age of 75 receive an all uncemented prosthesis. As age increases, more and more THAs are cemented. Approximately 40% of stems in patients above 85 years of age are cemented. Female patients have significantly more cemented stems than male patients (Table 4.10).

Table 4.10
Primary total hip arthroplasty:
fixation methods in primary osteoarthritis by gender (in %)

	Women	Men	All
All cemented	1.9	0.8	1.4
All uncemented	82.4	91.2	86.7
Hybrid*	14.6	7.5	11.1
Reverse hybrid**	0.8	0.4	0.6
Reinforcement ring, femur cemented	0.2	0.1	0.1
Reinforcement ring, femur uncemented	0.1	0.1	0.1
N	49098	46794	95892

* acetabulum uncemented, femur cemented
** acetabulum cemented, femur uncemented

4.2 Revision of total hip arthroplasty

SIRIS records all hip procedures from 2012 onwards. However, there are a number of hip prostheses that were revised, having been implanted prior to 2012. For these implants no detailed information is available. For this reason, baseline data of the primary intervention like diagnosis, approach, BMI, ASA etc. cannot be reproduced. Table 4.11 shows the demographic data for all revisions performed since 2013.

Revisions in the time period since 2013 constitute 12% of all hip procedures. Among the 14,698 THA revisions documented over the entire data collection period, 51.4% were performed on women (Table 4.11). The mean age at revision was 71.2 years. On average, men were 1.6 years younger than women. The age group ‹45 years accounted for 2.4% and the age group between 45 and 55 for 7.7% of revisions. The revision rate in patients is declining slightly, whereas it is increasing in the age groups ›65 years

Table 4.11

Revision of total hip arthroplasty: Baseline patient characteristics by year

2013–2018, BMI and ASA class data only available from 2015 onwards

		2013	2014	2015	2016	2017	2018	All
N		**2234**	**2463**	**2485**	**2508**	**2525**	**2483**	**14698**
Women [%]		52.2	52.8	49.7	52.3	50.2	51.1	51.4
Mean age (SD)	All	70.1 (12.2)	70.8 (12.7)	71.3 (12.1)	71 (12)	71.6 (12)	72.1 (11.9)	71.2 (12.2)
	Women	71.5 (12.2)	72.5 (12.7)	73.5 (12.1)	72.3 (12)	73.1 (12)	73.3 (12.1)	72.7 (12.2)
	Men	68.6 (12)	69 (12.4)	69.2 (11.8)	69.6 (11.9)	70.1 (11.8)	70.8 (11.5)	69.6 (11.9)
Age group [%]	‹45	2.9	2.5	2.8	2.2	2.3	1.9	2.4
	45–55	7.5	8.3	6.9	7.9	7.9	7.3	7.7
	55–65	19.6	18	17.3	17.4	14.9	15.4	17
	65–75	30.8	26.9	29.2	30.3	30.1	29.6	29.4
	75–85	29.4	32.2	31.3	30.1	31.7	31.8	31.1
	85+	9.9	12.2	12.5	12	13.1	14.1	12.3
N unknown BMI (%)				773 (31)	550 (22)	532 (21)	508 (20)	2363 (24)
N known BMI				1712	1958	1993	1975	7638
Mean BMI (SD)				27.2 (5.3)	27.5 (5.4)	27.1 (5.5)	27.3 (5.6)	27.3 (5.5)
BMI [%]	‹18.5			2.6	2.1	2.5	2.4	2.4
	18.5–24.9			34.9	32.5	36.6	34.3	34.6
	25–29.9			37.7	38.4	35.8	36.6	37.1
	30–34.9			16.2	17.9	17.4	18.1	17.4
	35–39.9			6.8	6.9	5	5.8	6.1
	40+			1.8	2.2	2.8	2.8	2.4
N unknown ASA (%)				393 (16)	334 (13)	386 (15)	286 (12)	1399 (14)
N known ASA				2092	2174	2139	2197	8602
Morbidity state	ASA 1			8.8	7.3	6.2	5.7	7
[%]	ASA 2			47.5	48.9	46	44.2	46.6
	ASA 3			40.8	41.4	45.4	47.2	43.7
	ASA 4/5			2.9	2.4	2.5	2.9	2.7

of age. The age groups 65 to 85 enclosed 60.5% of all revisions. There is an ever-increasing proportion of revisions in the age category 85 years and older from 9.9% in 2013 to 14.1% in 2016.

The mean BMI at time of revision was 27.4 kg/m2 remaining unchanged since 2016 and was similar to primary THA (26.9 kg/m^2).

While information on the type of revision has been available since the start of the registry in 2012, the current listing of the reasons for revisions and the information on approach have only been recorded since 2015. Aseptic loosening of the femoral component was the most common reason for revision, followed by aseptic loosening of the acetabular component, infection, periprosthetic fracture, and dislocation (Table 4.12). Compared to the previous report, infection has increased from 18.0% to 19.1%.

Detailed information about the type of revision is presented in Table 4.13 to 4.15 and Figure 4.3. Revision of femoral and acetabular components was

Table 4.12

Reason for revision of primary total hip arthroplasty

Multiple reasons are possible per patient. The reasons for revisions categories as listed below are only available from 2015 onwards.

	2015–2018	
	N	%
Loosening femoral	2144	21.5
Infection	1903	19.1
Loosening acetabular	1799	18.1
Periprosthetic fracture	1554	15.6
Dislocation	1124	11.3
Wear	603	6.1
Metallosis	505	5.1
Acetabular osteolysis	384	3.9
Position/Orientation of cup	359	3.6
Femoral osteolysis	335	3.4
Trochanter pathology	207	2.1
Status after spacer	206	2.1
Implant breakage	197	2.0
Blood ion level	194	1.9
Position/Orientation of stem	165	1.7
Impingement	164	1.6
Acetabular protrusion	132	1.3
Squeaking	55	0.6
Other	2222	22.3
Total 2015–2018	**14252**	**143.1**

Table 4.13

Type of revision of total hip arthroplasty

2013–2018

	2013–2018	
	N	%
Exchange acetabular and femoral components	3006	20.5
Exchange acetabular component and head	2974	20.2
Exchange femoral component	2351	16.0
Exchange head and inlay	1329	9.0
Exchange acetabular component	983	6.7
Exchange femoral component and inlay	841	5.7
Component reimplantation (after spacer or Girdlestone)	805	5.5
Exchange head	693	4.7
Component removal, spacer implantation	409	2.8
Girdlestone	244	1.7
Exchange femoral component, inlay and osteosynthesis	165	1.1
Exchange inlay	144	1.0
Prosthesis preserving revision	135	0.9
Osteosynthesis	106	0.7
Other intervention	513	3.5
Total 2013–2018	**14698**	**100.0**

performed in 20.5%. Revision of the femoral component alone or in combination with acetabular inlay revision was done in 21.7%. In 26.9% the acetabular component was revised, and in 20.2% this was combined with an exchange of the femoral head implant. The most frequently used approach is the posterior approach with 48%. The utilization of the approaches remains stable.

Figure 4.3
Revision of total hip arthroplasty: Component fixation by year
Percentage per year

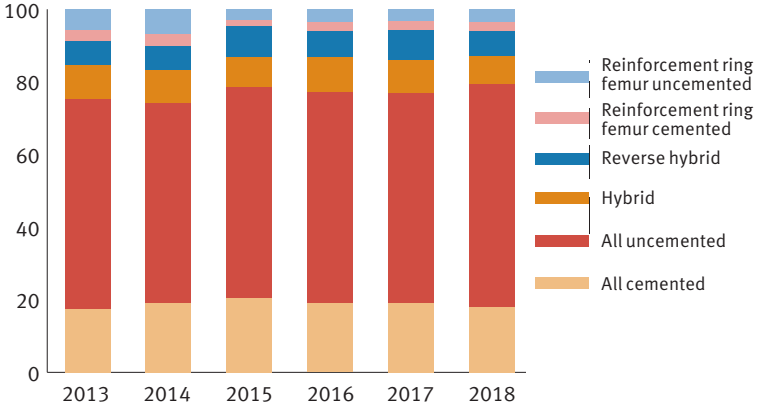


Table 4.14
Approach of revision of total hip arthroplasty
Data only available from 2015 onwards

	2015–2018	
	N	%
Posterior	3378	33.9
Lateral	2203	22.1
Anterolateral	1749	17.6
Anterior	1645	16.5
Transfemoral	572	5.7
Other approach	411	4.1

Table 4.15
Revision of total hip arthroplasty: Component fixation by year

	2013	2014	2015	2016	2017	2018	2013 – 2018	
	N	N	N	N	N	N	N	%
Reinforcement ring femur uncemented	100	132	57	69	65	68	491	4.3
Reinforcement ring femur cemented	53	65	36	51	52	46	303	2.6
Reverse hybrid*	115	129	162	144	165	134	849	7.4
Hybrid**	166	176	163	190	176	141	1012	8.8
All uncemented	1011	1062	1122	1163	1145	1162	6665	58.0
All cemented	305	369	394	380	378	340	2166	18.9
Total	**1750**	**1933**	**1934**	**1997**	**1981**	**1891**	**11486**	**100.0**

* acetabulum cemented, femur uncemented
** acetabulum uncemented, femur cemented

4.3 First revision of primary total hip arthroplasty

The calculation of the revision rate is based on the revisions of hip replacements done for primary OA. This is an international standard and makes sense, because hips with secondary OA often include hips with difficult anatomy, previous osteotomies or unfavorable conditions with increased revision rates. The analysis of first revisions was done on the basis of revisions involving any exchange of prosthetic components. Of the 90,446 documented primary THAs implanted since 2012, 64,462 are at risk; that means they all had a two-year follow-up by the end of 2018. Of these, 1623 hips were revised accounting for a two-year revision rate of 2.5%. The revision

Table 4.16

First revision of primary total hip arthroplasty within 24 months overall and according to baseline characteristics

2012–2018, BMI and ASA class data only available from 2015 onwards

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall **(2012–2018)**		76045	2083	2.8	2.6	2.9
Diagnosis	Primary OA	64462	1623	2.5	2.4	2.7
	Secondary OA	6970	262	3.8	3.4	4.3
	Fracture	4613	198	4.5	3.9	5.1
Overall Primary OA **(2012–2018)**		64462	1623	2.5	2.4	2.7
Gender	Women	32841	778	2.4	2.2	2.6
	Men	31621	845	2.7	2.5	2.9
Age group	‹55	7182	217	3.0	2.7	3.5
	55–64	14369	365	2.6	2.3	2.8
	65–74	22601	534	2.4	2.2	2.6
	75–84	16810	430	2.6	2.3	2.8
	85+	3383	75	2.3	1.8	2.8
Overall Primary OA **(2015–2018)**		29728	771	2.6	2.4	2.8
BMI group	‹18.5	272	2	0.7	0.2	2.9
	18.5–24.9	7612	142	1.9	1.6	2.2
	25–29.9	9238	221	2.4	2.1	2.7
	30–34.9	4141	120	2.9	2.5	3.5
	35–39.9	1235	55	4.4	3.4	5.7
	40+	415	32	7.8	5.6	10.8
	Unknown	6815	199	2.9	2.6	3.4
Morbidity state	ASA 1	4093	95	2.3	1.9	2.9
	ASA 2	15659	369	2.4	2.1	2.6
	ASA 3	5951	192	3.2	2.8	3.7
	ASA 4/5	114	6	5.4	2.5	11.6
	Unknown	3911	109	2.8	2.3	3.3

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).

** Rates ajusted for effects of mortality and emigration.

rate is higher than in the last report. The reason is that in the current report only hips at risk with a complete follow-up of two years, implanted until December 31, 2016, were included. In addition, progress was made with linking of hips revised in a different institution than where the primary implantation was performed. Of first revisions, 21% took place in another hospital service. The risk of revision was higher in hips with secondary osteoarthritis (3.8%) and even higher in hips treated for a fracture (4.5%). Across all groups, the majority of revisions occurred during the first three months (Figure 4.5 a). While Figure 4a shows the overall revisions, Figures 4.5b and 4.5c show the cause and frequency distribution

Table 4.17

First revision of primary total hip arthroplasty according to stem fixation, articulation and approach

The reasons for approach categories as listed below are only available from 2015 onwards.

	Primary	Revised within 24 months			
		Revised		95% CI	
	N at risk*	N	%**	lower	upper
Overall Primary OA **(2012 – 2018)**	64462	1623	2.5	2.4	2.7
Stem fixation					
All uncemented	55776	1424	2.6	2.4	2.7
All cemented	837	27	3.3	2.3	4.7
Hybrid	7700	165	2.2	1.9	2.5
Metal on polyethylene (MoPE)	1434	45	3.2	2.4	4.2
Ceramic on polyethylene (CoPE)	7616	174	2.3	2.0	2.7
Metal on cross-linked polyethylene (MoXLPE)	10546	272	2.6	2.3	2.9
Ceramic on cross-linked polyethylene (CoXLPE)	29700	687	2.3	2.2	2.5
Ceramic on ceramic (CoC)	9815	311	3.2	2.9	3.6
Overall Primary OA **(2015 – 2018)**	29728	771	2.6	2.4	2.8
Approach					
Anterior	12756	321	2.5	2.3	2.8
Anterolateral	9996	252	2.5	2.2	2.9
Lateral	2272	35	1.6	1.1	2.2
Posterior	4486	155	3.5	3.0	4.1
Other approach	247	9	3.7	1.9	6.9

Table 4.18

Reason for early first revision of primary total hip arthroplasty

Multiple reasons are possible per patient. The reasons for revisions categories as listed below are only available from 2015 onwards.

	2015–2018	
	N	%
Infection	468	23.7
Periprosthetic fracture	408	20.7
Dislocation	335	17.0
Loosening femoral	308	15.6
Loosening acetabular	161	8.2
Position/orientation of cup	90	4.6
Position/orientation of stem	77	3.9
Impingement	29	1.5
Acetabular protrusion	26	1.3
Trochanter pathology	24	1.2
Status after spacer	16	0.8
Implant breakage	12	0.6
Squeaking	8	0.4
Femoral osteolysis	7	0.4
Wear	5	0.3
Metallosis	4	0.2
Acetabular osteolysis	4	0.2
Other	393	19.9

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

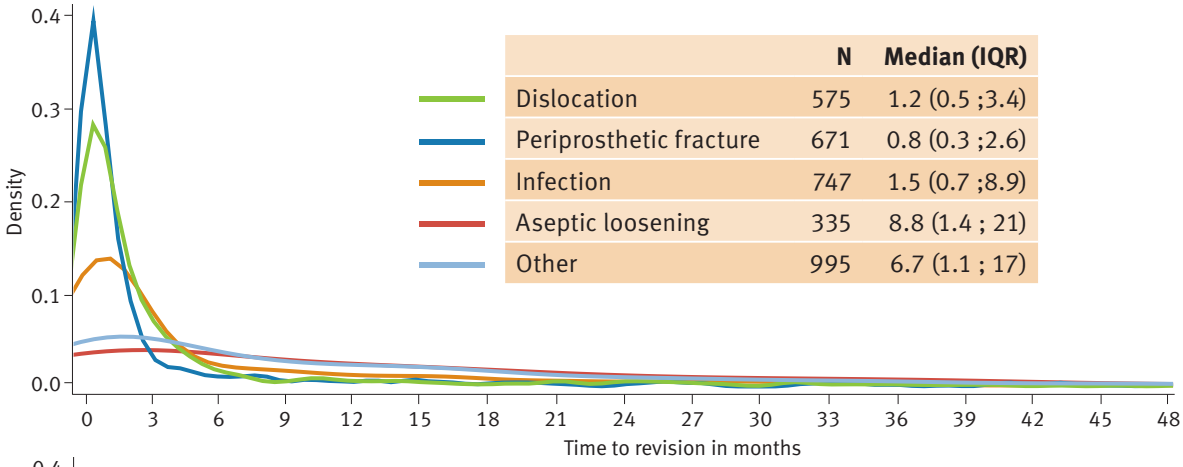
(Kernel density estimation) for cemented and uncemented femoral implants. The graphs show that the main reason of revision for uncemented stems is a periprosthetic fracture. Overall, the most frequent reason for first revision of a primary THA is infection with 23.7%, followed by a periprosthetic fracture in 20.7%. Dislocation and femoral and acetabular loosening are among the top five reasons for revision.

Figure 4.5 a, b and c

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

Figure a

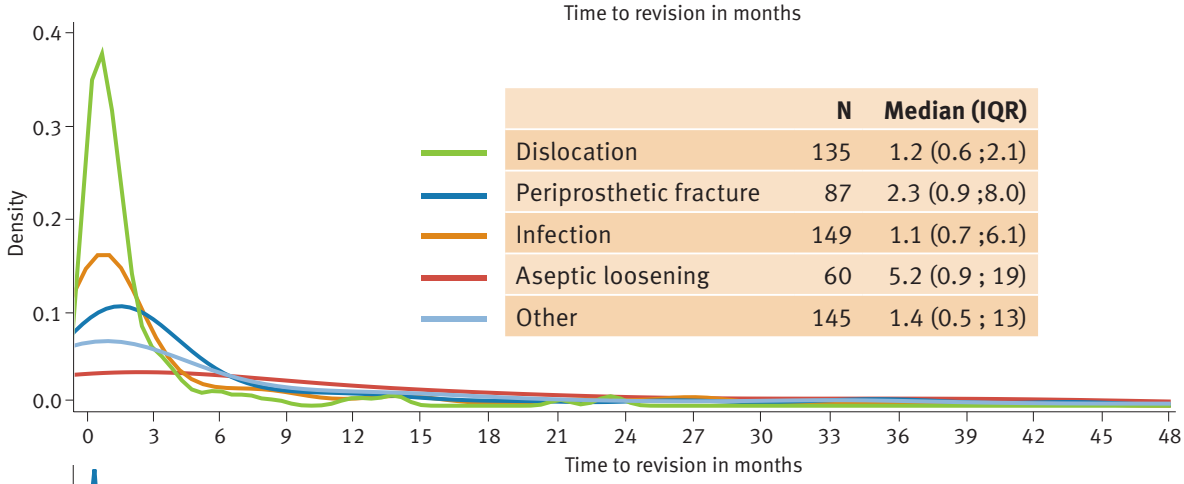
All revisions (N= 3323)



	N	Median (IQR)
Dislocation	575	1.2 (0.5 ;3.4)
Periprosthetic fracture	671	0.8 (0.3 ;2.6)
Infection	747	1.5 (0.7 ;8.9)
Aseptic loosening	335	8.8 (1.4 ; 21)
Other	995	6.7 (1.1 ; 17)

Figure b

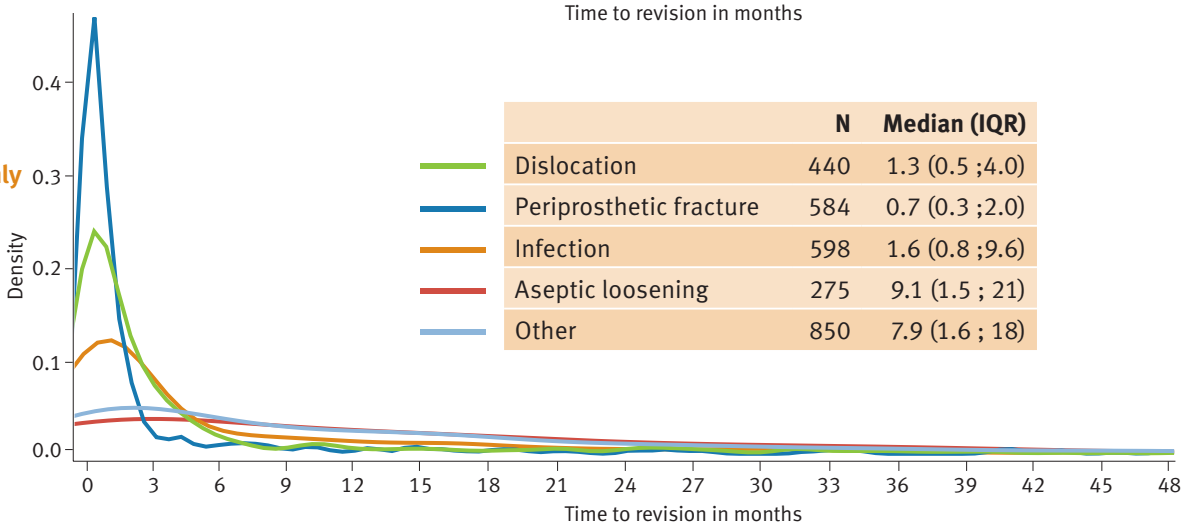
Revisions femur cemented only (N= 576)



	N	Median (IQR)
Dislocation	135	1.2 (0.6 ;2.1)
Periprosthetic fracture	87	2.3 (0.9 ;8.0)
Infection	149	1.1 (0.7 ;6.1)
Aseptic loosening	60	5.2 (0.9 ; 19)
Other	145	1.4 (0.5 ; 13)

Figure c

Revisions femur uncemented only (N= 2747)



	N	Median (IQR)
Dislocation	440	1.3 (0.5 ;4.0)
Periprosthetic fracture	584	0.7 (0.3 ;2.0)
Infection	598	1.6 (0.8 ;9.6)
Aseptic loosening	275	9.1 (1.5 ; 21)
Other	850	7.9 (1.6 ; 18)

While all uncemented THAs have a two year revision rate of 2.6% (CI 2.4, 2.7) and all cemented THAs of 3.3% (CI 2.3, 4.7), it is interesting to note that the combination of a cemented stem with an uncemented cup (hybrid fixation) has the lowest revision rate of these combinations (2.2%, CI 1.9, 2.5).

This year marked the first time an analysis of the bearing surfaces was possible. As expected, the revision rate was lowest for the combination of ceramic heads with normal polyethylene (CoPE) and highly crosslinked polyethylene (XLPE).

The most popular approach in Switzerland is the anterior approach (48%), which has a revision rate of 2.5% at two years. The revision rate for the anterolateral approach is identical. The highest revision rate was reported for the posterior approach (3.7%). The lateral approach had the lowest revision rate with 1.6%, but its number is decreasing steadily and was only used in 978 hips in 2018.

Up to six years ceramic on polyethylene (PE) and highly crosslinked PE (XLPE) have almost an identical revision rate. Future years will show, if there is a

Figure 4.6

Estimated failure rates of primary total hip arthroplasty for different bearing surfaces

Time since operation, 2012–2018, all services, diagnosis primary OA

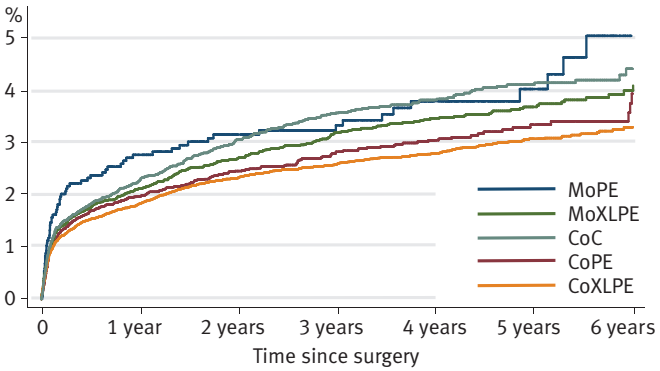


Figure 4.7

Estimated failure rates of primary total hip arthroplasty CoPE/XLPE versus others

Time since operation, 2012–2018, all services, diagnosis primary OA

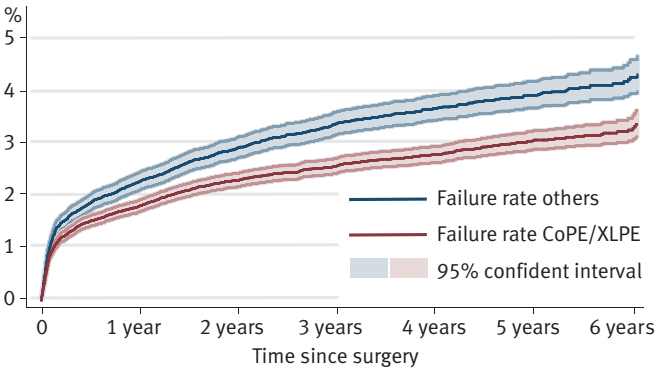
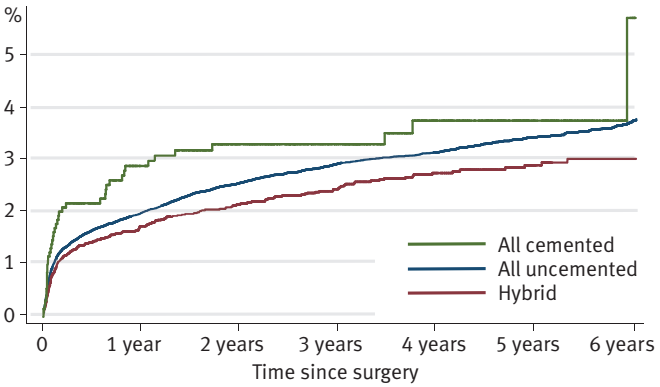


Figure 4.8

Estimated failure rates of primary total hip arthroplasty for different fixation methods

Time since operation, 2012–2018, all services, diagnosis primary OA

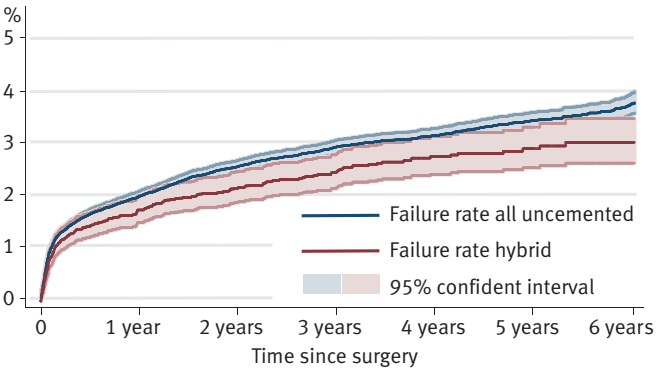


Number at risk	1 year	2 years	3 years	4 years	5 years	6 years
cemented	1010	744	559	339	159	41
uncemented	66714	52629	39290	26984	14967	4111
hybrid	8558	6791	5015	3361	1877	501

Figure 4.9

Estimated failure rates of primary total hip arthroplasty all uncemented versus hybrid

Time since operation, 2012–2018, all services, diagnosis primary OA



difference. Metal on PE or XLPE show the highest revision rate. Ceramic on Ceramic (CoC) are in between (Figure 4.6).

Figure 4.7 plots the revision rate of Ceramic on PE or XLPE against the other bearings. Ceramic seems to have a clear benefit, irrespective of the quality of PE, compared to MoPE/XLPE or CoC.

The fixation method has a significant impact on the revision rate (Figure 4.8 and 4.9). Up to six years hybrid fixation shows better outcome than uncemented or cemented THA.

BMI had a substantial impact on the risk of revision (Table 4.16, Figure 4.10 and 4.11). Revision rates rose with increasing BMI from 1.9% in normal weight patients to 2.9 in obese class I (30–34.9 kg/m^2) patients, 4.4% in obese class II (35–39.9 kg/m^2) patients, and 7.8% in obese class III (BMI ›40 kg/m2) patients. The majority of complications occurred within the first two to three months.

To analyze subgroups a certain number of "at risk" patients are necessary to get correct and meaningful information. The current number of implants allows

Figure 4.10

Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2018, all services, diagnosis primary OA

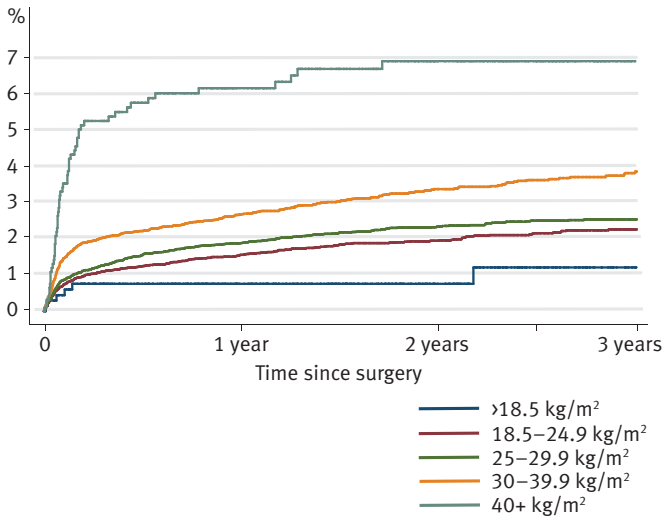
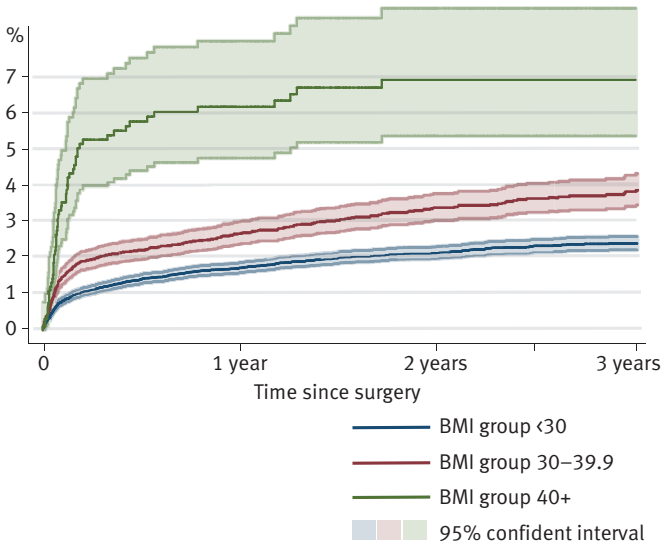


Figure 4.11

Estimated failure rates of primary total hip arthroplasty different BMI categories with CI

Time since operation, 2015–2018, all services, diagnosis primary OA



this registry to analyze some subgroups for the first time. With increasing numbers, it will be possible in the future to analyze the failure modes. This report explored the revision rates of implant types that are frequently discussed: short stems and double mobility cups (Figures 4.12 and 4.13).

Short stems have a lower failure rate compared to standard uncemented stems. As seen by the relatively wide confidence interval, indicating a relatively small total number of implanted short stems, subanalysis of the different brands is not yet possible. Figure 4.13 shows an elevated failure rate for double mobility cups. Again, the wide confidence interval indicates a relatively small number compared to uncemented cups, indicating statistical blurring with limited precision.

Figure 4.12

Estimated failure rates of primary total hip arthroplasty short stem versus uncemented stem

Time since operation, 2012–2018, all services, diagnosis primary OA

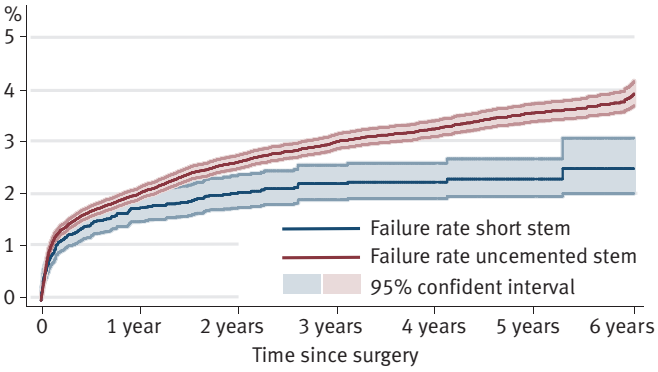
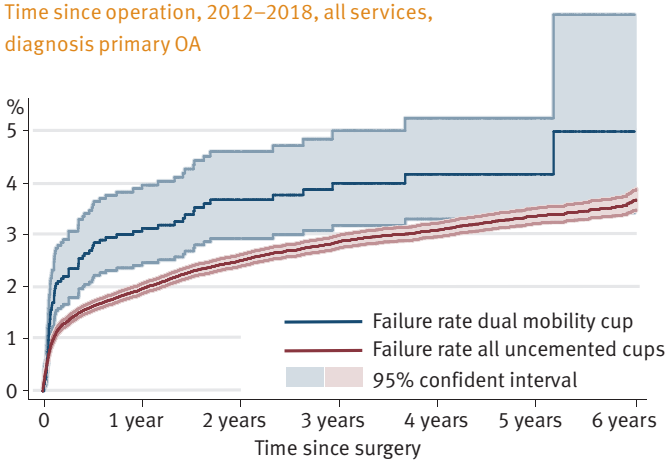


Figure 4.13

Estimated failure rates of primary total hip arthroplasty double mobility cup versus all primary uncemented cups

Time since operation, 2012–2018, all services, diagnosis primary OA



4.4 Results of implants in total hip arthroplasty

There are several possibilities for presenting results of implants. The results of cups can be presented separately from the results of the stems. This gives a rough overview of the performance of a given implant. However, a total hip replacement comprises at least three components, including stem, cup and head. Most often the cup is modular, in a double mobility system the head is modular and there are also modular stems which could result in a THA comprising five components. Analyzing the interaction of all these components separately is complex and of limited value. Therefore, it makes more sense to focus investigations to currently used combinations and compare those to each other. It may show that a cup works well with one stem, but less well with another – and vice versa. For that reason, the following tables present combinations of frequently used implant combinations.

The analysis only includes patients with diagnosis of primary OA with a follow-up of minimal two years (i.e. primary prosthesis in 2012–2016). Only combinations with N >50 are presented. The ten most frequently used uncemented combinations (Table 4.19) cover 69% of all THAs used for primary OA. Table 4.20 covers 88% of all combinations with a minimum size of 50 patients. For approximately 8% of the THAs, the information for either the cup or the stem is missing and therefore not included in the analysis.

Table 4.19

Top 10 of uncemented implant combinations, primary total hip arthroplasty

2013–2018, diagnosis primary OA

Stem component	Cup component	2013	2014	2015	2016	2017	2018	Total
Corail	Pinnacle	1203	1563	1895	1982	2176	2314	11133
AMIStem	Versafitcup CC Trio	1201	1258	1332	1634	1566	1383	8374
Optimys	RM pressfit vitamys	459	977	1262	1442	1642	1683	7465
Avenir	Allofit	821	958	993	1043	1031	1003	5849
Quadra	Versafticup CC Trio	313	596	550	787	929	1035	4210
Fitmore	Allofit	774	702	693	650	548	506	3873
Polarstem	R3	530	545	493	505	579	608	3260
Fitmore	Fitmore	353	422	395	376	433	581	2560
twinSys	RM pressfit vitamys	360	289	312	350	334	317	1962
Avenir	Fitmore	221	171	247	276	264	277	1456
Other combinations		4395	4359	3543	3406	3227	3143	22073
Total		**10630**	**11840**	**11715**	**12451**	**12729**	**12850**	**72215**

Please note the following in Table 4.19 to Figure 4.15:

- **AMIStem:** Comprising of AMIStem-H, H-Proximal Coating, Collared HA coated for uncemented use and AMIStem-C for cemented use, as applicable.
- **Quadra:** Comprising of Quadra-H, -S (only 0.6%) for uncemented use and Quadra-C for cemented use, as applicable
- **Versafitcup System:** comprising of CC Light and DM
- Identification of brands as per the product reference catalogues provided by the manufacturers to SwissRDL upon request

Table 4.20

Revision rates of uncemented primary total hip arthroplasty components within 24 months

2013–2018, covering approx.88% of registered primary OA THAs, uncemented, alphabetic order

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
Accolade	Trident	68	2	2.9	0.7	11.3
Alloclassic	Alloclassic	142	3	2.1	0.7	6.4
Alloclassic	Allofit	250	4	1.6	0.6	4.2
Alloclassic	Fitmore	332	11	3.3	1.9	5.9
AMIStem	Mpact	75	5	6.7	2.9	15.4
AMIStem	Pinnacle	60	1	1.7	0.2	11.2
AMIStem	Versafitcup System	992	21	2.1	1.4	3.2
AMIStem	Versafitcup CC Trio	5796	145	2.5	2.1	3.0
AMIStem	Expansis shell	138	2	1.4	0.4	5.7
Ana.nova	Ana.nova hybrid	184	3	1.7	0.5	5.0
Avenir	Alloclassic	489	7	1.4	0.7	3.0
Avenir	Allofit	4164	105	2.5	2.1	3.1
Avenir	Fitmore	982	31	3.2	2.2	4.5
CLS	Allofit	895	25	2.8	1.9	4.1
CLS	Fitmore	1019	28	2.8	1.9	4.0
Corail	Allofit	107	3	2.8	0.9	8.5
Corail	Delta motion	151	8	5.3	2.7	10.3
Corail	Fitmore	185	7	3.8	1.8	7.8
Corail	Gyros	390	7	1.8	0.9	3.7
Corail	Pinnacle	7124	167	2.4	2.0	2.7
Corail	RM pressfit	88	2	2.3	0.6	8.8
Custom hip	April ceramic	307	15	4.9	3.0	8.0
Exception	Avantage	339	8	2.4	1.2	4.7
Exception	Betacup	50	1	2.0	0.3	13.6
Exception	Exceed	99	3	3.0	1.0	9.1
Fitmore	Allofit	3301	100	3.0	2.5	3.7
Fitmore	Fitmore	1695	54	3.2	2.5	4.2
Fitmore	RM pressfit vitamys	551	11	2.0	1.1	3.6
GTS	Exceed	66	4	6.2	2.4	15.7
GTS	G7	63	9	14.3	7.7	25.7
H-Max	Delta PF	272	12	4.4	2.5	7.7
H-Max	Delta TT	237	4	1.7	0.6	4.5

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
Harmony	April ceramic	50	1	2.0	0.3	13.4
Harmony	April poly	69	1	1.4	0.2	9.8
Minimax	Versafitcup CC Trio	217	8	3.7	1.9	7.3
Optimys	Allofit	134	3	2.3	0.7	6.9
Optimys	RM pressfit	209	3	1.5	0.5	4.5
Optimys	RM pressfit vitamys	4228	76	1.8	1.4	2.3
Optimys	Selexys PC	141	2	1.4	0.4	5.6
Polarstem	Allofit	64	0	0.0	0.0	5.6
Polarstem	EP-fit	346	13	3.8	2.2	6.4
Polarstem	Polarcup	882	19	2.2	1.4	3.4
Polarstem	R3	2236	32	1.4	1.0	2.0
Quadra	Versafitcup System	416	10	2.4	1.3	4.5
Quadra	Versafitcup CC Trio	2278	51	2.3	1.7	3.0
SAM-fit	Delta TT	50	0	-	-	-
SBG	Fitmore	146	0	-	-	-
SBG	HI	221	7	3.2	1.5	6.6
SBG	R3	405	9	2.2	1.2	4.2
SBG	Xentrax-cup	110	2	1.9	0.5	7.2
SL-plus	Ana.nova hybrid	157	3	1.9	0.6	5.9
SL-plus	Bicon-plus Ti	170	3	1.8	0.6	5.4
SL-Plus	EP-fit	581	15	2.6	1.6	4.3
SL-plus	HI	468	10	2.1	1.2	4.0
SL-Plus	R3	1086	8	0.7	0.4	1.5
SPS evolution	April ceramic	708	36	5.1	3.7	7.0
SPS evolution	April poly	196	8	4.1	2.1	8.0
SPS HA	April ceramic	130	5	3.8	1.6	9.0
SPS HA	Hilock	63	1	1.6	0.2	10.7
SPS modular	April ceramic	283	21	7.5	5.0	11.3
Stelia-stem	Ana.nova hybrid	228	18	7.9	5.1	12.3
Trendhip	Plasmafit plus	65	0	0	-	-
Tri-lock	Pinnacle	379	4	1.1	0.4	2.8
Twinsys	RM pressfit	210	9	4.3	2.3	8.1
Twinsys	RM pressfit vitamys	1485	41	2.8	2.1	3.8
Twinsys	Selexys PC	141	6	4.3	1.9	9.2

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016). N<50 is not shown in this table.

Table 4.21

Top 10 of hybrid fixation implant combinations, primary total hip arthroplasty

2013–2018, diagnosis primary OA

Stem component	Cup component	2013	2014	2015	2016	2017	2018	Total
Weber	Fitmore	280	285	282	239	229	179	1494
AMIStem	Versafitcup CC Trio	151	151	180	287	190	159	1118
Corail	Pinnacle	93	168	102	137	118	115	733
MS-30	Fitmore	87	82	112	114	87	81	563
Quadra	Versafticup CC Trio	4	44	61	83	180	171	543
Weber	Allofit	97	69	80	89	74	48	457
Twinsys	RM pressfit vitamys	23	12	51	74	66	147	373
Original M.E.M.	Allofit	90	92	56	25	20	15	298
Avenir	Allofit	1	8	28	62	56	120	275
Original M.E.M.	Fitmore	40	75	50	30	43	37	275
Other combinations		573	506	547	443	462	512	3043
Total		**1439**	**1492**	**1549**	**1583**	**1525**	**1584**	**9172**

Table 4.22

Revision rates of hybrid fixation primary total hip arthroplasty components within 24 months

2012–2018

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
AMIStem	Versafitcup System	216	2	0.9	0.2	3.7
AMIStem	Versafitcup CC Trio	799	22	2.8	1.8	4.2
Arcad SO	April ceramic	123	2	1.6	0.4	6.3
Avenir	Allofit	99	3	3.1	1.0	9.2
CCA	RM pressfit vitamys	91	2	2.4	0.6	9.3
Centris	RM pressfit	90	2	2.2	0.6	8.6
Centris	RM pressfit vitamys	145	1	0.7	0.1	4.8
Corail	Pinnacle	546	7	1.3	0.6	2.7
Exafit	Allofit	103	0	0.0	-	-
Exafit	Fitmore	62	2	3.2	0.8	12.3
MS-30	Allofit	155	3	1.9	0.6	5.9
MS-30	Fitmore	427	6	1.4	0.6	3.1
Original M.E.M.	Allofit	305	9	3.0	1.6	5.7
Original M.E.M.	Fitmore	215	1	0.5	0.1	3.3
PF	Allofit	52	2	3.9	1.0	14.7
PF	Fitmore	155	3	1.9	0.6	5.9
Quadra	Versafitcup CC Trio	192	5	2.7	1.1	6.3
Twinsys	RM pressfit	212	10	4.7	2.6	8.6
Twinsys	RM pressfit vitamys	165	2	1.2	0.3	4.8
Weber	Alloclassic	68	5	7.6	3.2	17.2
Weber	Allofit	367	7	1.9	0.9	4.0
Weber	Fitmore	1189	20	1.7	1.1	2.6
Weber	Pinnacle	67	1	1.5	0.2	10.1

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016). N<50 is not shown in this table.

4.5 Performance estimation and outlier detection

An important function of a registry is to monitor the performance of a given implant/implant system. On the one hand it is helpful to select a high-performing implant combination for optimal treatment, on the other hand it can help identify prosthesis with a higher than expected revision rate.

Following recommendation from other registries, the definition for an outlier was adopted as follows: An implant is considered to be an potential outlier when its revision rate is more than twice the revision rate of the group, allowing for confidence intervals.

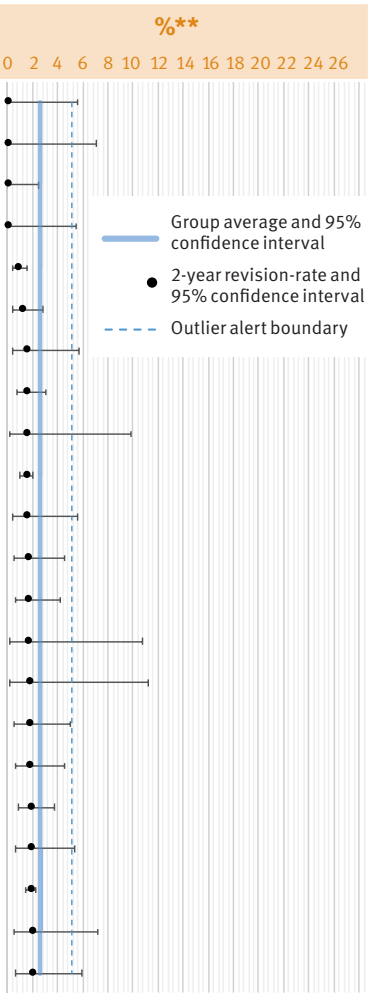
Already this report shows that individual components performing well in one combination do not perform as well in another. Therefore, outlier analysis should not only look at a given combination of

Figure 4.14 (Part 1)

Two year revision rates of uncemented stem-cup combinations used in primary total hip arthroplasty

2012–2018

Combination	N revised	N at risk*
Polarstem + Allofit	0	64
SAM-fit + Delta TT	0	50
SBG + Fitmore	0	146
Trendhip + Plasmafit plus	0	65
SL-Plus + R3	8	1086
Tri-lock + Pinnacle	4	379
AMIStem + Expansis shell	2	138
Avenir + Alloclassic	7	489
Harmony + April Poly	1	69
Polarstem + R3	32	2236
Optimys + Selexys PC	2	141
Optimys + RM pressfit	3	209
Alloclassic + Allofit	4	250
SPS HA + Hilock	1	63
AMIStem + Pinnacle	1	60
Ana.nova + Ana.nova hybrid	3	184
H-Max + Delta TT	4	237
Corail + Gyros	7	390
SL-plus + Bicon-plus Ti	3	170
Optimys + RM pressfit vitamys	76	4228
SBG + Xentrax-cup	2	110
SL-plus + Ana.nova hybrid	3	157



* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

components but should evaluate the performance of the isolated component alone and in combination with other components. This allows distinction between whether a specific implant is problematic or its combination with a certain other component is the problem.

The average revision rate is calculated on all primary implants for primary OA per fixation group. The average revision rate for all uncemented THAs is 2.6% (CI 2.4 to 2.7) and 2.2% (CI 1.9 to 2.5) for hybrid fixation. Because of its infrequent use and small numbers, the analysis for all cemented THAs was omitted.

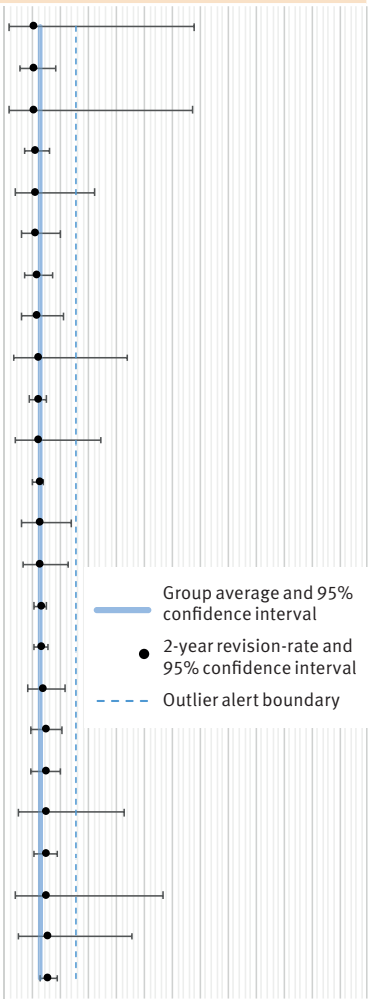
Figures 4.14 and 4.15 show the two-year revision rate of all combinations with N >50. The revision rates are adjusted for effects of mortality and emigration. Combinations of implants lying outside the outlier boundary (revision rate twice the revision rate of the group) are potential outliers. They are further analyzed following the protocol described above.

Figure 4.14 (Part 2)

Two year revision rates of uncemented stem-cup combinations used in primary total hip arthroplasty

2012–2018

Combination	N revised	N at risk*	%**
Exception + Betacup	1	50	
Fitmore + RM pressfit vitamys	11	551	
Harmony + April Ceramic	1	50	
AMIStem+Versafitcup System	21	992	
Alloclassic + Alloclassic	3	142	
SL-plus + HI	10	468	
Polarstem + Polarcup	19	882	
SBG + R3	9	405	
Corail + RM pressfit	2	88	
Quadra + Versafitcup CC Trio	51	2278	
Optimys + Allofit	3	134	
Corail + Pinnacle	167	7124	
Exception + Avantage	8	339	
Quadra + Versafitcup System	10	416	
AMIStem + Versafitcup CC Trio	145	5796	
Avenir + Allofit	105	4164	
SL-Plus + EP-fit	15	581	
CLS + Allofit	25	895	
CLS + Fitmore	28	1019	
Corail + Allofit	3	107	
Twinsys + RM pressfit vitamys	41	1485	
Accolade + Trident	2	68	
Exception + Exceed	3	99	
Fitmore + Allofit	100	3301	



* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

Figure 4.14 (Part 3)

Two year revision rates of uncemented stem-cup combinations used in primary total hip arthroplasty

2012–2018

Combination	N revised	N at risk*
Avenir + Fitmore	31	982
Fitmore + Fitmore	54	1695
SBG + HI	7	221
Alloclassic + Fitmore	11	332
Minimax + Versafitcup CC Trio	8	217
Corail + Fitmore	7	185
Polarstem + EP-fit	13	346
SPS HA + April ceramic	5	130
SPS evolution + April poly	8	196
Twinsys + RM pressfit	9	210
Twinsys + Selexys PC	6	141
H-Max + Delta PF	12	272
Custom hip + April ceramic	15	307
SPS evolution + April ceramic	36	708
Corail + Delta motion	8	151
GTS + Exceed	4	66
AMIStem + Mpact	5	75
SPS modular + April ceramic	21	283
Stelia-stem + Ana.nova hybrid	18	228
GTS + G7	9	63

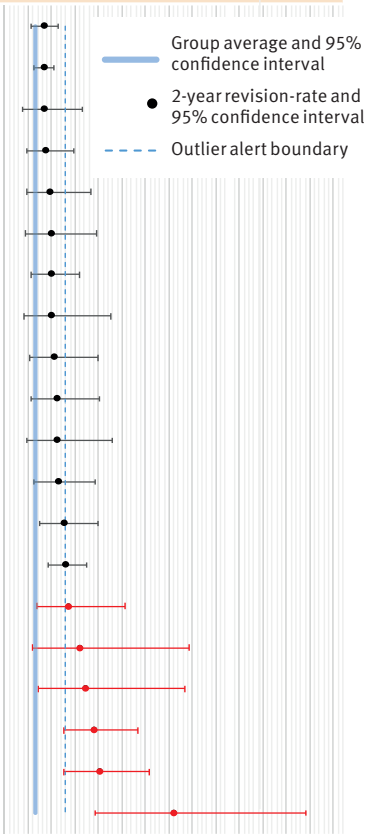
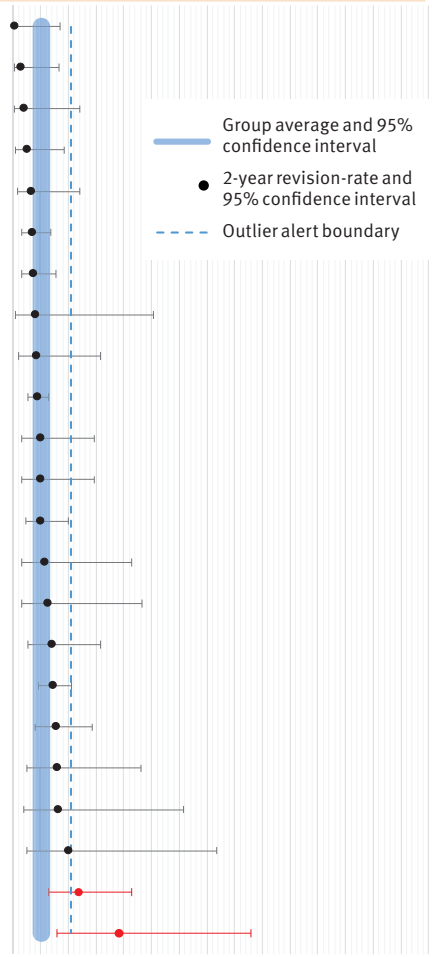


Figure 4.15

Two year revision rates of hybrid fixation stem-cup combinations used in primary total hip arthroplasty

2012–2018

Combination	N revised	N at risk*
Exafit + Allofit	0	103
Original M.E.M. + Fitmore	1	215
Centris + RM pressfit vitamys	1	145
AMIStem + Versafitcup System	2	216
Twinsys + RM pressfit vitamys	2	165
Corail + Pinnacle	7	546
MS-30 + Fitmore	6	427
Weber + Pinnacle	1	67
Arcad SO + April ceramic	2	123
Weber + Fitmore	20	1189
MS-30 + Allofit	3	155
PF + Fitmore	3	155
Weber + Allofit	7	367
Centris + RM pressfit	2	90
CCA + RM pressfit vitamys	2	91
Quadra + Versafitcup CC Trio	5	192
AMIStem + Versafitcup CC Trio	22	799
Original M.E.M. + Allofit	9	305
Avenir + Allofit	3	99
Exafit + Fitmore	2	62
PF + Allofit	2	52
Twinsys + RM pressfit	10	212
Weber + Alloclassic	5	68



* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

- Identified as potential outliers.Please note the statistical confidence intervals. The outlier status comes with varying degrees of statistical probability. We consider the potential outlier status „highly likely“ when both the estimated revision rate and the complete confidence interval exceed the outlier alert boundary).
  Please be aware that relatively rare implant combinations are frequently used in only a small number or indeed only in one hospital in Switzerland. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

5. Hemiarthroplasty of the hip

5.1 Primary hemiarthroplasty of the hip

Patients with femoral neck fractures are usually a special group of patients, within the older age group, often with substantial comorbidities, lower functional needs and low life expectancy. The mortality rate is very high. Approximately 50% of patients die within the first year of sustaining a fracture of the proximal femur. For this reason, the data of this cohort of patients is recorded and analyzed in this separate chapter of the SIRIS report.

More than 57% of the patients belong to the age group 85 years and older (Table 5.1). The second largest group are patients aged 75 to 84 years (32%).

Table 5.1

Primary hemiarthroplasty: Baseline patient characteristics by year

2012–2018. BMI and ASA class data only available from 2015 onwards

		2013	2014	2015	2016	2017	2018	All
N		**1927**	**2040**	**1962**	**1977**	**2000**	**2109**	**12015**
Women [%]		74	73.4	71.7	70.6	71.4	70.6	71.9
Mean age (SD)	All	83.7 (10.3)	84.1 (9.6)	84.3 (9.2)	84.5 (8.6)	84.9 (8.3)	84.8 (8.3)	84.4 (9.1)
	Women	84.3 (9.8)	84.7 (8.6)	84.7 (8.7)	84.9 (8.2)	85.6 (7.6)	85.5 (7.8)	85 (8.5)
	Men	82.1 (11.6)	82.4 (11.6)	83.2 (10.4)	83.5 (9.4)	83.1 (9.4)	83.2 (9.4)	82.9 (10.3)
Age group [%]	<45	0.6	0.4	0.4	0.2	0.1	0.2	0.3
	45–54	0.7	0.6	0.7	0.3	0.5	0.6	0.6
	55–64	2.6	1.9	2.1	2	2	1.7	2
	65–74	8.5	8	8.4	8.5	7.5	7.3	8
	75–84	32.2	33.1	31	33.2	29.6	31.4	31.7
	85+	55.5	56	57.5	55.8	60.4	58.8	57.4
N unknown BMI (%)				770 (39)	641 (32)	599 (30)	594 (28)	2604 (32)
N known BMI				1192	1336	1401	1515	5444
Mean BMI (SD)				23.8 (4.7)	23.8 (4.6)	23.6 (4.5)	23.4 (4.2)	23.6 (4.5)
BMI [%]	<18.5			10.2	9.7	10.7	10.1	10.2
	18.5–24.9			55.4	53.7	57.1	59.3	56.5
	25–29.9			27.3	28.7	25.7	24.4	26.4
	30–34.9			5.3	5.9	4.6	5.2	5.2
	35–39.9			1.4	1.5	1.6	0.9	1.3
	40+			0.5	0.4	0.4	0.2	0.4
N unknown ASA (%)				226 (12)	146 (7)	169 (8)	140 (7)	681 (8)
N known ASA				1736	1831	1831	1969	7367
Morbidity state	ASA 1			2.2	1.4	0.9	1	1.4
[%]	ASA 2			26.5	24.9	23.8	23.3	24.6
	ASA 3			63.4	64.2	65.6	67.3	65.2
	ASA 4/5			7.9	9.5	9.7	8.4	8.9

The BMI is rather low and is on average 23.6 kg/m2. Women are affected more frequently and account for 72% of all patients who have undergone hemiarthroplasty. As expected, the majority of patients are grouped in the ASA 3 class (58%).

Since 2013 there has been a 9% increase in hemiarthroplasties, indicating rapidly aging population demographics. The increase was 5% in 2018 alone. Approximately, one third of patients (34%) are treated in hospitals performing fewer than 100 hip replacement surgeries per year. High-volume hospitals provide treatment for approx. 21% of the cases (Table 5.2).

Table 5.2

Baseline patient characteristics of primary hemiarthroplasty patients

Calculation of hospital services were based on all THA and hemiarthroplasty primary and revision hip surgeries in 2018. BMI data are only available from 2015 onwards

Hospital service volume		<100	100–199	200–299	300+
N **(2013–2018)**		**4039**	**2613**	**2777**	**2586**
Women [%]		72.4	72.7	72.6	69.7
Mean age (SD)	All	84.2 (9)	83.9 (9.5)	84.4 (8.8)	85.2 (9)
	Women	84.8 (8.4)	84.4 (8.7)	84.8 (8.3)	85.8 (8.6)
	Men	82.5 (10.3)	82.5 (11.4)	83.2 (9.6)	83.7 (9.9)
Age group [%]	<45	0.3	0.4	0.2	0.4
	45–54	0.5	0.5	0.6	0.5
	55–64	2	2.1	2.1	1.9
	65–74	8.6	8.7	8	6.3
	75–84	32.6	34	31.9	28
	85+	56	54.2	57.1	62.9
N **(2015–2018)**		**2648**	**1661**	**1986**	**1729**
N unknown BMI (%)		978 (37)	457 (28)	784 (39)	361 (21)
N known BMI		1670	1204	1202	1368
Mean BMI (SD)		23.7 (4.5)	24 (4.7)	23.5 (4.5)	23.3 (4.3)
BMI [%]	<18.5	9.4	9.4	10.6	11.4
	18.5–24.9	56.5	55.3	55.3	58.5
	25–29.9	27.1	26.7	28.2	23.8
	30–34.9	5.1	6.1	4.8	5
	35–39.9	1.5	1.8	0.7	1.2
	40+	0.4	0.7	0.2	0.2
N unknown ASA (%)		148 (6)	158 (10)	233 (12)	118 (7)
N known ASA		2500	1503	1753	1611
Morbidity state [%]	ASA 1	1.6	1.7	0.9	1.2
	ASA 2	25.7	26.5	25.3	20.2
	ASA 3	64.7	61.9	65.5	68.7
	ASA 4/5	8.1	9.8	8.3	9.9

The majority of patients (95.9%) directly underwent implantation of a hemiarthroplasty. Only 1.7% had a previous attempt for fracture fixation (Table 5.3).

As seen for primary OA the most frequent approaches are muscle sparing anterior or anterolateral approaches (63.6%). Cementing the femoral component is the common standard.

Table 5.3

Surgery characteristics of primary hemiarthroplasty

Approach data are only available from 2015 onwards

		N	%
Previous surgery	None	11522	95.9
	Internal fixation femur	209	1.7
	Osteotomy femur	23	0.2
	Osteotomy pelvis	3	0.0
	Arthrodesis	3	0.0
	Internal fixation acetabulum	1	0.0
	Other previous surgery	258	2.1
Intervention	Femoral head prosthesis	8988	74.8
	Bipolar prosthesis	2999	25.0
	Hemi-surface replacement	28	0.2
Approach	Anterior	2649	33.0
	Anterolateral	2458	30.6
	Lateral	1449	18.1
	Posterior	1328	16.5
	Other approach	141	1.8
Stem fixation	Cemented	10044	83.6
	Uncemented	1959	16.3

5.2 First revision of primary hemiarthroplasty of the hip

Hemiarthroplasties are subject to complications and revisions as primary THA. As seen in Table 5.4 hemiarthroplasties are not only used for the treatment of femoral neck fractures but also in a small number of primary and secondary OA. The revision rate for primary hemiarthroplasties for fracture treatment is 3.0% (CI 26 to 3.4) at two years. The revision rate for primary OA is slightly higher at 3.4% (CI 1.8 to 6.2). For secondary OA the revision rate is excessively high at 8.7% (CI 5.1 to 14.6).

Infection (38.1%), periprosthetic fracture (20.8%) and dislocation (19.5%) are the three most frequent complications and responsible for almost 80% of all revisions. Acetabular protrusion is rather infrequent (3.1%).

Table 5.4

First revision of primary hemiarthroplasty within 24 months overall and according to baseline characteristics

2012–2018, BMI and ASA class data only available from 2015 onwards

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall **(2012–2018)**		8663	229	3.1	2.7	3.5
Diagnosis	Primary OA	300	10	3.4	1.8	6.2
	Secondary OA	172	13	8.7	5.1	14.6
	Fracture	8191	206	3.0	2.6	3.4
Overall Primary OA **(2012–2018)**		8191	206	3.0	2.6	3.4
Gender	Women	5976	148	2.8	2.4	3.3
	Men	2215	58	3.4	2.6	4.4
Age group	‹55	35	4	13.6	5.3	32.5
	55–64	144	9	7.0	3.7	13.1
	65–74	642	37	6.5	4.7	8.8
	75–84	2653	69	3.0	2.4	3.8
	85+	4695	87	2.2	1.8	2.7
Overall Primary OA **(2015–2018)**		3715	98	3.1	2.5	3.7
BMI group	‹18.5	237	6	3.0	1.3	6.5
	18.5–24.9	1320	27	2.3	1.6	3.4
	25–29.9	649	25	4.6	3.1	6.7
	30–34.9	126	2	1.8	0.4	7.0
	35–39.9	34	3	9.1	3.0	25.6
	40+	11	0	0.0		
	Unknown	1338	35	3.0	2.1	4.1
Morbidity state	ASA 1	47	1	2.2	0.3	14.4
	ASA 2	837	18	2.4	1.5	3.7
	ASA 3	2201	63	3.3	2.6	4.3
	ASA 4/5	302	7	3.4	1.6	7.2
	Unknown	328	9	3.1	1.6	5.9

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).

** Rates ajusted for effects of mortality and emigration.

Uncemented stems have a revision rate (5.6%) which is more than double that of cemented stems (2.5%). The choice of the approach is wider than in THAs. Anterior and anterolateral approaches are used in almost equal measure and account for 60.1%. The lateral approach is the third most used approach at 20.8% of all hemiarthroplasties for fracture treatment. The anterior approach has the lowest revision rate at 2.6%. The Kaplan-Meyer failure estimation shows a sharp increase of revisions within the first month after surgery. Also of note is the decrease of hips at risk over time, reflecting the high drop-out rate, which can be explained by the high mortality rate after fractures of the hip.

Table 5.5

Reason for early first revision of primary hemiarthroplasty

Multiple reasons are possible per patient. The categories as listed below are only available from 2015 onwards.

	2015–2018	
	N	%
Infection	86	38.1%
Periprosthetic fracture	47	20.8%
Dislocation	44	19.5%
Loosening femoral	21	9.3%
Acetabular protrusion	7	3.1%
Position/orientation of stem	4	1.8%
Other	53	23.5%

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

Table 5.6

First revision of primary hemiarthroplasty according to stem fixation and approach

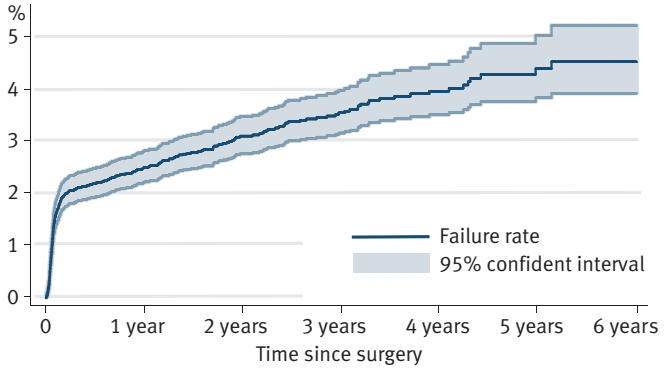
The reasons for approach categories as listed below are only available from 2015 onwards.

	Primary	Revised within 24 months			
		Revised		95% CI	
	N at risk*	N	%**	lower	upper
Stem fixation					
Overall Fracture (2012 – 2018)	8191	206	3.0	2.6	3.4
All cemented	6930	146	2.5	2.1	3.0
All uncemented	1259	60	5.4	4.2	6.9
Approach					
Overall Fracture (2015 – 2018)	3715	98	3.1	2.5	3.7
Anterior	1136	25	2.6	1.7	3.8
Anterolateral	1098	37	3.8	2.8	5.3
Lateral	774	20	3.1	2.0	4.8
Posterior	637	16	2.8	1.7	4.6
Transfemoral	14	0	0		
Other approach	57	0	0		

Figure 5.1

Failure estimate of primary hemiarthroplasty

Time since operation, 2012–2018, diagnosis fracture



5.3 Conversion of hemiarthroplasty to total hip arthroplasty

Complications after hemiarthroplasty are equivalent to those after total hip replacement, including fracture, infection, dislocation, etc. One specific complication is wear of the native acetabulum, causing pain and loss of function. This specific complication is treated with a conversion of the hemiarthroplasty into a total hip replacement by replacing the femoral head component (mono-, or bipolar head) with an acetabular cup. Other conditions which may be treated with conversion are instability, but also infections or periprosthetic fractures may result in conversion to a THA in the course of the treatment. This chapter focuses on the conversion hemiarthro-

Table 5.7
Conversion of hemiarthroplasty: Baseline patient characteristics by year
2013–2018. BMI and ASA class data are only available from 2015 onwards

		2013	2014	2015	2016	2017	2018	All
N		**54**	**54**	**60**	**44**	**41**	**42**	**295**
Women [%]		70.4	74.1	75	70.5	63.4	88.1	73.6
Mean age (SD)	All	78.4 (11.5)	75.6 (12.2)	74.6 (10.9)	75.3 (11.3)	74.8 (14.4)	80.1 (9.6)	76.4 (11.8)
	Women	80.2 (10.9)	78.5 (7.9)	75.5 (10.5)	76.3 (11)	78.8 (12.3)	81.4 (7.4)	78.4 (10.1)
	Men	74.1 (12.1)	67.2 (17.7)	71.7 (11.9)	72.9 (12.3)	67.8 (15.7)	70.6 (18.2)	70.8 (14.1)
Age group [%]	‹45	1.9	3.7		2.3	7.3	2.4	2.7
	45–55	3.7	1.9	6.7	2.3	7.3		3.7
	55–65	5.6	7.4	10	9.1	7.3	4.8	7.5
	65–75	16.7	24.1	21.7	27.3	12.2	14.3	19.7
	75–85	38.9	42.6	40	43.2	41.5	40.5	41
	85+	33.3	20.4	21.7	15.9	24.4	38.1	25.4
N unknown BMI (%)				10 (17)	3 (7)	5 (12)	3 (7)	21 (11)
N known BMI				50	41	36	39	166
Mean BMI (SD)				24.2 (3.9)	25.1 (4.7)	24.7 (4.4)	25 (4.3)	24.7 (4.3)
BMI [%]	‹18.5			4	4.9	11.1	7.7	6.6
	18.5–24.9			56	48.8	44.4	33.3	46.4
	25–29.9			32	31.7	33.3	51.3	36.7
	30–34.9			8	9.8	11.1	5.1	8.4
	35–39.9			4.9	2.6			1.8
N unknown ASA (%)				3 (5)	5 (11)	6 (15)	4 (10)	18 (10)
N known ASA				57	39	35	38	169
Morbidity state	ASA 1			3.5	5.1	2.9	5.3	4.1
[%]	ASA 2			54.4	48.7	40	23.7	43.2
	ASA 3			42.1	43.6	57.1	63.2	50.3
	ASA 4/5			2.6	7.9			2.4

plasty to a THA. During the registry period, 295 hemiarthroplasties were revised to a total hip arthroplasty (Table 5.7).

Based on the total number of 12,015 hemiarthroplasties, the conversion rate is 2.4%. As in the baseline demographics, the proportion of women is 73.6%. Of the total number of revisions, two-thirds are performed in patients over the age of 75 years. Reasons for revision are available from 2015 onwards (Table 5.8). The most frequent reason for conversion was femoral loosening in 21.4% of cases, followed by acetabular protrusion in 15.5% and dislocation in 13.9% of cases.

Table 5.8

Reason for conversion of hemiarthroplasty

Multiple reasons are possible per patient. The reasons for conversion categories as listed below are only available from 2015 onwards.

	2015–2018	
	N	%
Loosening femoral	40	21.4
Acetabular protrusion	29	15.5
Dislocation	26	13.9
Wear	19	10.2
Periprosthetic fracture	18	9.6
Infection	17	9.1
Acetabular osteolysis	10	5.3
Loosening acetabular	7	3.7
Trochanter pathology	4	2.1
Position/orientation of stem	4	2.1
Metallosis	3	1.6
Position/orientation of cup	2	1.1
Impingement	2	1.1
Femoral osteolysis	2	1.1
Implant breakage	1	0.5
Squeaking	1	0.5
Other	60	32.1

Table 5.9

Approach for conversion of hemiarthroplasty

Approach data only available from 2015 onward

	2015–2018	
	N	%
Posterior	70	37.2
Lateral	41	21.8
Anterior	34	18.1
Anterolateral	34	18.1
Transfemoral	6	3.2
Other approach	3	1.6

Table 5.10

Component fixation of conversion of hemiarthroplasty to THA

	2013–2018	
	N	%
Uncemented	171	58.0
Hybrid*	56	19.0
Cemented	54	18.3
Reverse hybrid**	7	2.4
Reinforcement ring, femur cemented	7	2.4

* acetabulum uncemented, femur cemented

** acetabulum cemented, femur uncemented

6. Knee arthroplasty

6.1 Primary total knee arthroplasty

Of the 82,089 primary TKAs documented over the past six years, 60.9% were carried out on women (Table 6.1). The rate of women and mean age of 69.3 years at surgery were constant during the whole period of time.

23.6% of the TKAs were performed in the age group 55–64 years, 36.9% in patients aged between 65 and 74 years old. The number of TKAs in younger patients (younger than 45 and 45–54 years old) and patients older than 85 years old remained consistently low over the past six years.

Morbidity state (ASA classification) and Body Mass Index (BMI) have only been recorded since 2015. The proportion of missing BMI is still 20% overall although the rate has decreased continuously over the past four years. Further improvement is required as BMI is one of the most important comorbidity factors in TKA. Of those with a known value, the mean BMI was 29.5 kg/m^2. Obese patients (BMI ≥ 30 kg/m^2) constituted 35.2% of the total knee arthroplasty patients in Switzerland.

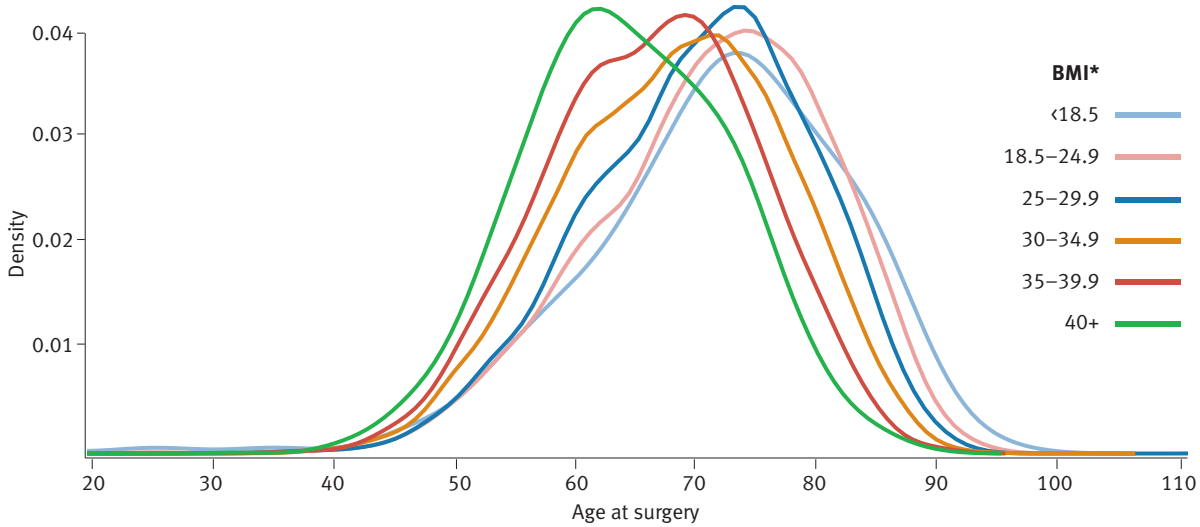
The age, at which total knee arthroplasty was undertaken, decreased with increasing BMI category (Figure 6.1). This effect was even more clear in patients with BMI 35 to 39.9 and >40 kg/m^2.

The rate of unrecorded ASA classification is constantly decreasing and was 9% in 2018.

Most TKAs were performed because of primary arthritis (88.7% in 2018). The rate of secondary arthritis has increased since more reasons (such as ligament lesions or infection) were introduced in 2016 as possible underlying diagnosis.

Figure 6.1

Primary total knee arthroplasty: BMI according to age at surgery



* Please note that sizes of BMI groups vary considerably (see table 6.1).

Table 6.1

Primary total knee arthroplasty: Baseline patient characteristics by year

BMI and ASA class data areonly available from 2015 onwards

		N	2013	2014	2015	2016	2017	2018
N		**82089**	**12928**	**13263**	**13147**	**14301**	**14181**	**14269**
Diagnosis [%]	Primary OA	90.9	96.4	96.7	88	88.3	87.9	88.7
	Secondary OA	9.1	3.6	3.3	12	11.7	12.1	11.3
	Inflammatory origin	1.0	0.9	0.9	1.2	1.2	0.8	0.9
	Fracture	1.6	0.4	0.5	2.3	2	2.2	2.1
	Lesion of ligament	3.4				4.7	5.1	5.4
	Infection	0.1				0.2	0.2	0.2
	Osteonecrosis	1.8	1.7	1.4	2.2	1.8	1.8	1.8
	Other	1.2	0.6	0.5	1.4	1.4	1.7	1.4
Women [%]		60.9	61.2	60.7	61.3	61.2	60.6	60.4
Mean age (SD)	All	69.3 (10)	69.2 (10.7)	69.2 (10.4)	69.4 (10)	69.3 (9.7)	69.4 (9.5)	69.3 (9.8)
	Women	69.9 (10)	70.3 (10.3)	69.8 (10.7)	70.1 (10)	70 (9.7)	70 (9.6)	69.9 (9.7)
	Men	68.3 (9.9)	67.9 (10.6)	68.2 (10)	68.3 (9.9)	68.3 (9.6)	68.4 (9.3)	68.5 (9.8)
Age group [%]	<45	0.7	1.2	0.9	0.7	0.6	0.5	0.6
	45–54	6.5	6.4	6.6	6.6	6.6	6.3	6.4
	55–64	23.6	23	23.2	23.4	23.5	23.7	24.6
	65–74	36.9	36.3	37	36.7	37.5	37.6	36
	75–84	27.8	28.4	28	28	27.7	27.4	27.7
	85+	4.5	4.7	4.4	4.6	4.2	4.4	4.8
N unknown BMI (%)		10991 (20)			3257 (25)	2891 (20)	2590 (18)	2253 (16)
N known BMI		44907			9890	11410	11591	12016
Mean BMI (SD)		29.5 (5.9)			29.4 (6.1)	29.5 (5.6)	29.5 (5.7)	29.5 (5.9)
BMI [%]	<18.5	0.5			0.5	0.4	0.5	0.5
	18.5–24.9	20.9			21.1	21.1	20.9	20.5
	25–29.9	38.9			39.6	38.9	38.5	38.7
	30–34.9	24.8			24.2	24.5	24.9	25.4
	35–39.9	10.4			10.1	10.5	10.6	10.5
	40+	4.6			4.5	4.6	4.7	4.5
N unknown ASA (%)		5902 (11)			1700 (13)	1546 (11)	1431 (10)	1225 (9)
N known ASA		49996			11447	12755	12750	13044
Morbidity state	ASA 1	9.5			11.8	9.7	8.5	8.2
[%]	ASA 2	62.7			61.4	62.5	63.5	63.1
	ASA 3	27.5			26.4	27.4	27.6	28.3
	ASA 4/5	0.4			0.3	0.3	0.4	0.4

Table 6.2

Baseline patient characteristics of primary total knee arthroplasties by hospital service volume

Calculations of hospital service volumes based on all primary and revision knee surgeries in 2018.
BMI and ASA class data are only available from 2015 onwards

Hospital service volume		<100	100–199	200–299	300+
N (2013–2018)		**15637**	**20228**	**10697**	**35527**
Women [%]		60.7	61.2	59.5	61.2
Mean age (SD)	All	69.7 (10.3)	69.6 (9.8)	69.1 (10.1)	69 (9.9)
	Women	70.3 (10.3)	70.2 (9.9)	69.8 (10.2)	69.7 (10)
	Men	68.8 (10.3)	68.6 (9.6)	68 (9.9)	67.9 (9.8)
Age group [%]	<45	0.8	0.6	0.7	0.8
	45–54	6	6.2	7	6.7
	55–64	22.4	23.1	24.5	24.1
	65–74	36.4	36.3	36.3	37.5
	75–84	29.5	28.9	27.1	26.7
	85+	4.8	4.8	4.4	4.2
Diagnosis [%]	Primary OA	91.2	91.8	91.5	90
	Secondary OA	8.8	8.2	8.5	10
N (2015–2018)		**10378**	**13601**	**7408**	**24433**
N unknown BMI (%)		2452 (24)	2391 (18)	1499 (20)	4571 (19)
N known BMI		7926	11210	5909	19862
Mean BMI (SD)		29.4 (5.5)	29.7 (5.7)	29.8 (7.1)	29.3 (5.6)
BMI [%]	<18.5	0.5	0.4	0.4	0.5
	18.5–24.9	21.3	19.9	20.3	21.4
	25–29.9	38.6	38.3	36.8	40
	30–34.9	25.4	25.2	26	23.9
	35–39.9	9.7	11.4	11.6	9.8
	40+	4.6	4.7	4.9	4.4
N unknown ASA (%)		949 (9)	1008 (7)	939 (13)	2928 (12)
N known ASA		9429	12593	6469	21505
ASA state [%]	ASA 1	11.3	10.3	10.8	7.9
	ASA 2	63.1	63.9	65	61
	ASA 3	25.1	25.4	24	30.8
	ASA 4/5	0.4	0.5	0.2	0.3

Table 6.3

Primary total knee arthroplasty: Surgery characteristics

		2013–2014		2015–2018	
		N	%	N	%
Previous surgery	None	17794	67.7	36701	65.7
	Knee arthroscopy	5595	21.3	9631	17.3
	Meniscectomy			9320	16.7
	ACL reconstruction			2211	4.0
	Osteotomy tibia close to knee	705	2.7	1740	3.1
	Osteosynthesis tibia close to knee	399	1.5	705	1.3
	Surgery for patella stabilization	385	1.5	692	1.2
	Synovectomy			459	0.8
	Osteotomy femur close to knee	134	0.5	287	0.5
	Osteosynthesis femur close to knee	133	0.5	277	0.5
	Surgery for treating infection	74	0.3	96	0.2
	Surgery for tumor			22	0.0
	Ligament reconstruction	1019	3.9		
	Other	1585	6.0	1723	3.1
Intervention	CS (cruciate sacrificing) / UCOR			18450	33.1
	unlinked post. stabilised	7026	26.7	16274	29.2
	PCR (posterior cruciate retaining)			14398	25.8
	BCR (bicruciate retaining)			875	1.6
	hinge type	499	1.9	849	1.5
	unlinked semi-constrained	1473	5.6	745	1.3
	CCK constrained condylar knee			512	0.9
	unlinked cruciate retaining	6001	22.8		
	unlinked meniscal	2745	10.4		
	unlinked rotating	7696	29.3		
	Other	829	3.2	3717	6.7
Technology	Conventional	19366	73.7	40242	72.1
	Computer assisted	3173	12.1	6840	12.3
	Patient specific instrumentation	2218	8.4	6761	12.1
	Minimal invasive	2147	8.2	3477	6.2
	Other			685	1.2

65.7% of the knees were never operated on before TKA. Previous operations were mostly arthroscopies (17.3%), followed by meniscectomy (16.7%), then ACL reconstruction (4%) and osteotomies of the tibia (3.1%). Post-traumatic cases after tibial or femoral fractures close to the knee were responsible for 1.8% of the TKA cases. Other surgeries before TKA were rare.

Not really clear is the type of arthroplasty used which is partially due to the unclear classification which was changed in 2015. 33.1% were classified as cruciate sacrificing or ultracongruent inlay (UCOR), 29.2% as posterior stabilized and 25.8% as posterior cruciate retaining. All other types were rare in primary TKA such as bicruciate retaining (1.6%), hinge (1.5%) or constrained knees (2.2%).

Computer-assisted TKA had a constant level of about 12%. Patient-specific instrumentation (PSI) increased from 8.4% in 2013–2014 to 12.1% in 2015–2018. Minimal invasive surgery is on the decrease and was 6.2% in 2015–2018.

In total knee arthroplasty there was a clear trend towards all cemented fixation (82% in 2018) over the past six years (Table 6.4 and Figure 6.2), whereas the use of cementless total knee arthroplasties (3.6% in 2018) and hybrid fixation (28.2% in 2018) decreased. In almost three quarters of the primary cases, the patella was not resurfaced (Table 6.5).

Table 6.4

Primary total knee arthroplasty: Component fixation

Total numbers per year

Component fixation	N	%	2013	2014	2015	2016	2017	2018
All uncemented	4591	5.6	1240	993	693	626	526	513
Reverse hybrid*	596	0.7	82	96	247	73	54	44
Hybrid**	15293	18.6	3338	2971	2377	2378	2219	2010
All cemented	61609	75.1	8268	9203	9830	11224	11382	11702
Total	**82089**	**100**	**12928**	**13263**	**13147**	**14301**	**14181**	**14269**

Figure 6.2

Primary total knee arthroplasty: Component fixation by year

Percentage per year

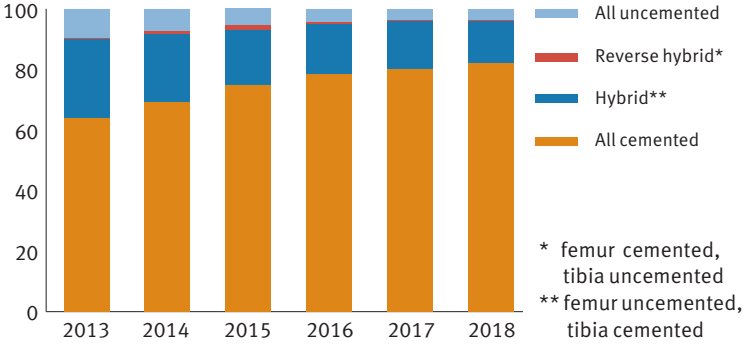


Table 6.5

Primary total knee arthroplasty: Patellar component

	N	%
No	60304	73.5
Yes	21753	26.5
Status after patellectomy	32	0.0

6.2 Primary partial knee arthroplasty

Of all primary knee arthroplasties, 17.0% were partial knee replacements (Table 3.5). The proportion remained constant over the past five years and is the highest in the international community including the United Kingdom. 50.1% were carried out on women. Mean age at surgery was almost 65 years (Table 6.6). In the younger age groups, 2% of partial knee replacements were performed on patients younger than 45 years and 14.2% on 45 to 54 year olds. In elderly patients, 16.1% of partial knee replacements were performed on of 75–84 year olds, and 2% of the patients were older than 85. Mean BMI was 28.4 kg/m^2 in the partial knee replacement group. BMI was not recorded in 27.6% of the cases.

84.3% of patients had an ASA classification of 1 or 2. In 10.6% of cases, the morbidity state was not recorded.

81.5% of the partial knee replacements were performed in hospitals with more than 100 interventions per year (Table 6.7). 61.2% of the patients had not been operated before partial knee replacement surgery, 23.2% had previous arthroscopy of the knee, 22.4% a meniscectomy, 1.4% previous ACL reconstruction, and 1.7% had undergone an osteotomy close to the knee (Table 6.8). Medial unicompartmental replacement was performed in 86.4% of the cases, lateral in 6.3%, and patello-femoral replacement in 7.3%. Over the past five years the use of cementless fixation continually increased up to 19.4% in 2018. Hybrid fixation was responsible for 1.8% of the cases. 87.4% of the partial knee replacements were fully cemented (Table 6.9).

Table 6.6

Primary unicompartmental knee arthroplasty: Baseline patient characteristics by year

BMI and ASA class data are only available from 2015 onwards

		N	2013	2014	2015	2016	2017	2018
N		**13884**	**2147**	**2092**	**2282**	**2344**	**2483**	**2536**
Diagnosis [%]	Primary OA	91.5	93.7	94.4	89.5	91.4	89.7	90.7
	Secondary OA	8.5	6.3	5.6	10.5	8.6	10.3	9.3
	Inflammatory origin	0.2	0.1	0.1	0.4	0	0.2	0.2
	Fracture	0.6	0.2	0.1	0.7	0.6	1	0.9
	Lesion of ligament	3.4			1.4	1.4	1.7	1.1
	Infection	0.1			0.1	0		0
	Osteonecrosis	5.1	5.6	5.2	5.8	4.9	4.6	4.7
	Other	1.5	0.3	0.1	2.1	1.6	2.8	1.8
Women [%]		50.1	50.5	50.5	52	49.1	50.7	48.2
Mean age (SD)	All	64.7 (10.2)	65.1 (10.1)	65.1 (10.2)	64.7 (10.5)	64.3 (10)	64.3 (10.1)	64.9 (10.4)
	Women	64.7 (10.6)	65.8 (10)	65.4 (10.6)	64.5 (11.1)	64 (10.3)	64 (10.5)	64.9 (10.9)
	Men	64.7 (9.8)	64.4 (10.2)	64.8 (9.7)	64.9 (9.9)	64.7 (9.7)	64.7 (9.7)	64.8 (9.9)
Age group [%]	<45	2	1.4	1.7	2.5	2	2.2	2.2
	45–54	14.2	12.7	13.6	14	15.1	15.5	14.1
	55–64	33.4	33.7	32.2	32.5	34.5	34.5	32.9
	65–74	32.2	33.6	34.5	32.5	30.8	30.8	31.7
	75–84	16.1	16.4	16.1	16.3	15.5	15.3	16.8
	85+	2	2.1	2	2.2	2	1.7	2.3
N unknown BMI (%)		2089 (22)			677 (30)	541 (23)	452 (18)	419 (17)
N known BMI		7556			1605	1803	2031	2117
Mean BMI (SD)		28.4 (5)			28.2 (4.8)	28.4 (4.7)	28.5 (4.8)	28.4 (5.5)
BMI [%]	<18.5	0.5			0.9	0.4	0.4	0.5
	18.5–24.9	24.5			26.7	25.1	23.1	23.8
	25–29.9	42.7			42.4	42.3	42.8	43.4
	30–34.9	23.7			20.9	23.3	25.1	24.7
	35–39.9	6.7			7.4	7.1	6.5	6
	40+	1.8			1.7	1.8	2.1	1.7
N unknown ASA (%)		922 (10)			291 (13)	257 (11)	205 (8)	169 (7)
N known ASA		8723			1991	2087	2278	2367
Morbidity state	ASA 1	19			21.8	20.4	18.1	16.4
[%]	ASA 2	65.3			64.1	64.9	65.5	66.6
	ASA 3	15.5			14	14.7	16.1	16.9
	ASA 4/5	0.2			0.2	0.1	0.4	0.2

Table 6.7

Primary unicompartmental knee arthroplasty: Baseline patient characteristics by hospital service volume

Calculations of hospital service volumes based on all primary and revision knee surgeries in all years, BMI and ASA data class are only available from 2015 onwards

		<100	100–199	200–299	300+
N (2013–2018)		**2171**	**3141**	**1244**	**7328**
Women [%]		50.3	51.4	44.7	50.5
Mean age (SD)	All	64.7 (10.6)	64.7 (9.8)	63.8 (10.1)	64.9 (10.3)
	Women	64.2 (11.1)	64.8 (10.3)	63.8 (10.3)	65 (10.6)
	Men	65.1 (10)	64.6 (9.3)	63.8 (10)	64.8 (10)
Age group [%]	<45	2.2	1.6	2.7	2
	45–54	14.3	14.4	15.2	14
	55–64	33.9	34	35.6	32.6
	65–74	31	32.6	31.5	32.5
	75–84	16.4	15.8	12.5	16.7
	85+	2.3	1.5	2.5	2.1
Diagnosis [%]	Primary OA	91.2	93.8	92	90.5
	Secondary OA	8.8	6.2	8	9.5
N (2015–2018)		**1490**	**2167**	**945**	**5041**
N unknown BMI (%)		384 (44)	619 (29)	197 (21)	887 (18)
N known BMI		1106	1548	748	4154
Mean BMI (SD)		28.6 (4.8)	28.6 (4.8)	28.3 (4.7)	28.3 (5.2)
BMI [%]	<18.5	0.1	0.5	0.7	0.6
	18.5–24.9	23	24.2	24.1	25.2
	25–29.9	43.7	41.2	43.6	42.9
	30–34.9	23.9	24.8	23.4	23.2
	35–39.9	7.2	7.4	6.3	6.4
	40+	2.2	1.8	2	1.7
N unknown ASA (%)		123 (8)	220 (10)	94 (10)	483 (10)
N known ASA		1367	1947	851	4558
ASA state [%]	ASA 1	19.5	21.5	22.1	17.2
	ASA 2	68.2	65.7	64	64.5
	ASA 3	11.9	12.7	13.6	18.1
	ASA 4/5	0.4	0.1	0.2	0.2

Table 6.8

Primary unicompartmental knee arthroplasty: Surgery characteristics

	2013–2014		2015–2018	
	N	%	N	%
Previous surgery				
None	2629	62.0	5904	61.2
Meniscectomy			2157	22.4
Knee arthroscopy	1364	32.2	2145	22.2
osteotomy tibia close to knee	58	1.4	140	1.5
ACL reconstruction			134	1.4
Surgery for patella stabilization	11	0.3	111	1.2
Synovectomy			37	0.4
Osteosynthesis tibia close to knee	26	0.6	36	0.4
Osteosynthesis femur close to knee	3	0.1	17	0.2
Osteotomy femur close to knee	8	0.2	15	0.2
Surgery for treating infection	3	0.1	5	0.1
Surgery for tumor			3	0.0
Ligament reconstruction	70	1.7		
Other	192	4.5	248	2.6
Intervention				
Unicompartment medial	3937	92.8	8329	86.4
Femoropatellar			708	7.3
Unicompartment lateral	304	7.2	606	6.3
Technology				
Conventional	2708	63.9	6599	68.4
Minimal invasive	1341	31.6	2553	26.5
Patient specific instrumentation	197	4.6	446	4.6
Computer assisted	25	0.6	66	0.7
Other			75	0.8

Table 6.9

Primary unicompartmental knee arthroplasty: Component fixation

Total numbers by year

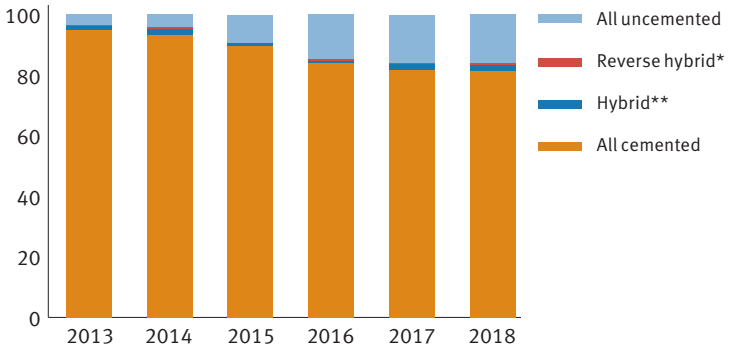
	N	%	2013	2014	2015	2016	2017	2018
All uncemented	1420	10.8	72	90	193	321	364	380
Reverse hybrid*	59	0.4	9	9	7	10	8	16
Hybrid**	182	1.4	28	39	15	17	44	39
All cemented	11515	87.4	2038	1954	1901	1822	1884	1916
Total	**9370**	**100**	**2066**	**1993**	**1916**	**1839**	**1928**	**1955**

* femur cemented, tibia uncemented
** femur uncemented, tibia cemented

Figure 6.3

Primary unicompartmental knee arthroplasty: Component fixation by year

Percentage by year



6.3 Revision of knee arthroplasty

Mean age at revision was 68.2 years, 59% were women. 61.1% were classified as ASA 1 or 2, in 13.5% morbidity status was not recorded. Mean BMI was 29.6 kg/m² with BMI not recorded in 34.1% of cases (Table 6.10).

Patella problems were the main reason for revision with 23.7%, followed by loosening of the tibia in 20.4%. If loosening of the femur of 12.1% were added, loosening would take the lead, responsible for 32.5% of the revision cases. Infection was the reason for revision in 17%, instability for 15.9%. 9.8% of the reasons were classified as "other" (Table 6.11).

Table 6.10

Revision of knee arthroplasty: Baseline patient characteristics by year

BMI and ASA class data only available from 2015 onwards

		N	2013	2014	2015	2016	2017	2018
N per year		**11410**	**1464**	**1606**	**1735**	**2098**	**2223**	**2284**
Women [%]		59	60.9	57.4	58.8	59.1	59.3	58.7
Mean age (SD)	All	68.2 (10.7)	68.2 (10.7)	67.5 (11.4)	68.3 (10.9)	68.5 (10.4)	68.3 (10.4)	68.4 (10.5)
	Women	68.9 (10.9)	68.6 (11.1)	68.1 (12)	68.8 (11)	69.3 (10.5)	68.9 (10.5)	69.2 (10.4)
	Men	67.3 (10.3)	67.5 (10.1)	66.7 (10.5)	67.7 (10.6)	67.3 (10.3)	67.3 (10.1)	67.3 (10.5)
Age group [%]	‹45	1.4	1.6	2.1	1.6	1.2	0.9	1.2
	45–54	8.5	8	9.1	8.5	7.7	9.6	8
	55–64	25.4	25.1	25.9	24.8	25.8	24.1	26.3
	65–74	35.4	35.8	34	35	36	36.5	34.8
	75–84	24.5	25.3	24.2	25.1	23.7	24.2	25
	85+	4.8	4.2	4.7	5	5.5	4.7	4.7
N unknown BMI (%)		2119 (25)			484 (28)	593 (28)	532 (24)	510 (22)
N known BMI		6221			1251	1505	1691	1774
Mean BMI (SD)		29.6 (6.1)			29.4 (5.7)	29.8 (7.2)	29.6 (5.8)	29.5 (5.6)
BMI [%]	‹18.5	0.8			0.9	1.1	0.5	0.7
	18.5–24.9	20.4			22.1	18.5	19.6	21.5
	25–29.9	36.7			36.3	38	36.9	35.6
	30–34.9	26.4			25.7	26.4	26.3	27
	35–39.9	11.5			10.9	11.1	12.7	11.2
	40+	4.2			4.1	4.9	4	4
N unknown ASA (%)		993			260 (12)	284 (15)	245 (14)	204 (9)
N known ASA		7347			1475	1814	1978	2080
ASA state [%]	ASA 1	7.9			9.2	7.8	7.6	7.4
	ASA 2	53.7			52.9	54.3	53.8	53.5
	ASA 3	37.2			36.5	36.3	37.7	37.9
	ASA 4/5	1.2			1.4	1.5	0.9	1.2

Complete revision was performed in 35.4% of the cases, in 14.5% PE was exchanged. Secondary resurfacing of the patella was performed in 13.7% (Table 6.12). Osteosynthesis was reported in 0.3% which seems to be underreported, as periprosthetic fractures are increasing in all western societies because of demography and activity level. SIRIS is mainly recording major revisions, meaning exchange of at least one component. Therefore, open reduction and internal fixation of a periprosthetic facture will usually not be recorded.

Posterior cruciate retaining TKA were used in 7.6% of the revisions, 25.4% were posterior stabilized, 13.8 were classified as cruciate sacrificing or ultracongruent implants, 28.5% as unlinked-semiconstrained or CCK and in 18.1% a hinge type prosthesis was used (Table 6.12).

Table 6.11

Reason for revision of knee arthroplasty

Multiple reasons are possible per patient. The reasons for revision categories as listed below are only available from 2015 onwards

	2015–2018	
	N	%
Patella problems	1974	23.7
Loosening tibia	1700	20.4
Infection	1417	17.0
Femorotibial instability	1325	15.9
Pain	1060	12.7
Loosening femur	1006	12.1
Wear of inlay	487	5.8
Progression of unicomp. OA	415	5.0
Joint stiffness/arthrofibrosis	406	4.9
Component malposition femur	359	4.3
Component malposition tibia	346	4.2
Loosening patella	177	2.1
Patellar instability	168	2.0
Periprosthetic fracture femur	147	1.8
Sizing femoral component	112	1.3
Periprosthetic fracture tibia	80	1.0
Sizing tibial component	50	0.6
Periprosthetic fracture patella	25	0.3
Other	818	9.8

Table 6.12

Surgery characteristics of revision of knee arthroplasty

	2013–2014		2015–2018	
Intervention type	**N**	**%**	**N**	**%**
complete revision	1479	48.0	2950	35.4
exchange of PE	419	13.6	1206	14.5
subsequent patella prosthesis	295	9.6	1141	13.7
conversion from unicompartimental to TKA			684	8.2
tibial revision	229	7.4	476	5.7
reimplantation of prosthesis	165	5.4	454	5.4
subsequent patella prosthesis with exchange of PE			334	4.0
patella revision	159	5.2	280	3.4
component removal with spacer implantation	106	3.4	232	2.8
femoral revision	84	2.7	191	2.3
prosthesis preserving revision			69	0.8
osteosynthesis			26	0.3
arthrodesis	1	0.0	23	0.3
component removal without spacer implantation			21	0.3
reconstruction after injury of extensor mechanism			16	0.2
subsequent partial patella prosthesis in second compartment			11	0.1
plastic reconstruction			5	0.1
other	142	4.6	212	2.5
Type of arthroplasty				
Unlinked posterior stabilised	763	27.0	1210	25.4
Hinge type	424	15.0	863	18.1
Unlinked semi-constrained	432	15.3	749	15.7
CS (cruciate sacrificing) / UCOR			656	13.8
CCK constrained condylar knee			610	12.8
PCR (posterior cruciate retaining)			364	7.6
Unicompartment medial	63	2.2	74	1.6
BCR (bicruciate retaining)			35	0.7
Femoropatellar			18	0.4
Unicompartment lateral	5	0.2	1	0.0
Unlinked rotating	471	16.6		
Unlinked cruciate retaining	329	11.6		
Unlinked meniscal	171	6.0		
Other	172	6.1	186	3.9
Technology				
Conventional	2593	84.2	7095	85.2
Computer assisted	94	3.1	281	3.4
Minimal invasive	131	4.3	277	3.3
Patient specific instrumentation	28	0.9	106	1.3
Other			60	0.7

In total revision knee arthroplasty, the rate of fully cemented implants has steadily increased over the past years reaching 93.1% in 2018 (Table 6.13 and Figure 6.4). Revision TKA was associated with patella resurfacing in 54.1% of cases, 45.7% were not replaced.

Table 6.13

Revision of knee arthroplasty: Component fixation

Component fixation only applicable when new components were implanted. Number by year

	N	%	2013	2014	2015	2016	2017	2018
All uncemented	373	4.9	92	151	30	33	38	29
Reverse hybrid*	96	1.3	22	22	14	14	13	11
Hybrid**	528	7.0	144	142	66	52	71	53
All cemented	6581	86.8	1094	1154	875	1063	1143	1252
Total	**7578**	**100**	**1352**	**1469**	**985**	**1162**	**1265**	**1345**

* femur cemented, tibia uncemented
** femur uncemented, tibia cemented

Table 6.14

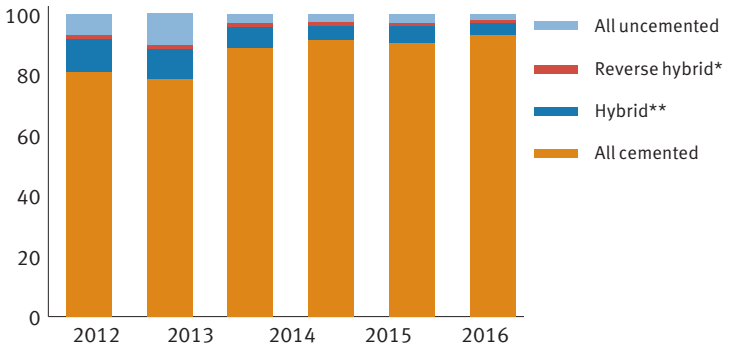
Revision of knee arthroplasty: Patellar component

	N	%
Without patellar replacement	4272	45.7
With patellar replacement	5060	54.1
Status after patellectomy	19	0.2

Figure 6.4

Component fixation in revision knee arthroplasty by year

Component fixation only applicable when new components were implanted. Percentage by year



6.4 First revision of a primary total knee arthroplasty

3.1% of the primary TKA at risk (patients with at least two years of follow-up) had a major revision during the first two years after index surgery, younger patients were predominantly at risk (5.6% in the age group under 55 years of age). BMI or ASA classification did not play a significant role; the rate of 5.7% in ASA 4/5 could be attributed to small numbers (Table 6.15).

All uncemented components seem to be revised slightly more than fully cemented TKA in the first two years after index surgery although the difference is not significant. A non-surfaced patella is more prone to early revision (3.3%) than a TKA with replacement

Table 6.15
First revision of primary total knee arthroplasty within 24 months: Baseline patient characteristics

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall (2012–2018)		**58124**	**1795**	**3.1**	**3.0**	**3.3**
Diagnosis	Primary OA	53792	1642	3.1	3.0	3.2
	Secondary OA	4332	153	3.6	3.1	4.2
Overall Primary OA **(2012–2018)**		53792	1642	3.1	3.0	3.2
Gender	Women	33140	997	3.0	2.9	3.2
	Men	20652	645	3.2	2.9	3.4
Age group [%]	<55	3453	193	5.6	4.9	6.5
	55–64	12297	498	4.1	3.8	4.5
	65–74	20152	555	2.8	2.6	3.0
	75–84	15359	356	2.4	2.1	2.6
	85+	2414	39	1.7	1.2	2.3
Overall Primary OA **(2015–2018)**		24032	786	3.3	3.1	3.6
BMI group	<18.5	75	1	1.4	0.2	9.6
	18.5–24.9	3767	126	3.4	2.9	4.0
	25–29.9	7267	237	3.3	2.9	3.8
	30–34.9	4601	165	3.6	3.1	4.2
	35–39.9	2020	63	3.2	2.5	4.0
	40+	903	30	3.4	2.4	4.8
	BMI unknown	5399	164	3.1	2.7	3.6
Morbidity state	ASA 1	2138	74	3.5	2.8	4.4
	ASA 2	13170	409	3.1	2.9	3.5
	ASA 3	5800	209	3.7	3.2	4.2
	ASA 4/5	73	4	5.7	2.2	14.4
	ASA unknown	2851	90	3.2	2.6	3.9

* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

(2.4%). This can be expected as secondary patellar resurfacing is an option in painful TKA with non-resurfaced patella even though it might not fully resolve the problem if the underlying knee pain reason is not addressed (Table 6.16). Main reason for early revision were patella problems in 35.3%, followed by instability at 17.1% and infection at 15.2% (Table 6.17 and Figure 6.5).

When infection is excluded, surgical technical problems were responsible for the vast majority of early revisions of TKA in Switzerland. Exact ratios are not available as multiple reasons are possible per patient. In addition, 10.4% of the reasons were classified as "other".

Table 6.16

First revision of primary total knee arthroplasty within 24 months overall and according to component fixation

Diagnosis primary OA

	Primary TKA	Revised within 24 months			
		Revised		95% CI	
	N at risk[1]	N	%[2]	lower	upper
Overall	53792	1642	3.1	3.0	3.2
Component fixation					
All cemented	37952	1154	3.1	2.9	3.3
All uncemented	3800	139	3.7	3.1	4.4
Hybrid*	11567	333	2.9	2.6	3.2
Reverse hybrid**	473	16	3.4	2.1	5.5
Patellar replacement					
With patellar replacement	13434	324	2.4	2.2	2.7
Without patellar replacement	40347	1318	3.3	3.1	3.5
Status after patellectomy	11				

* femur uncemented, tibia cemented
** femur cemented, tibia uncemented

[1] Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
[2] Rates ajusted for effects of mortality and emigration.

Table 6.17

Reason for early first revision of primary total knee arthroplasty

Multiple reasons are possible per patient. The reasons for revision categories as listed below only are available from 2015 onwards

	2015–2018	
	N	%
Patella problems	973	35.3
Femorotibial instability	470	17.1
Infection	419	15.2
Loosening tibia	388	14.1
Pain	370	13.4
Joint stiffness/artrofibrosis	204	7.4
Loosening femur	141	5.1
Component malposition tibia	121	4.4
Component malposition femur	117	4.2
Patellar instability	72	2.6
Sizing femoral component	49	1.8
Loosening patella	45	1.6
Wear of inlay	40	1.5
Periprosthetic fracture femur	26	0.9
Progression of unicompartmental OA	24	0.9
Sizing tibial component	18	0.7
Periprosthetic fracture tibia	17	0.6
Periprosthetic fracture patella	15	0.5
Other	286	10.4

Kernel density shows that only infection leads to an early revision of a primary TKA (peak at three months), whereas in all other reasons "wait and see" seems to be the usual algorithm in patients with unsatisfactory results after TKA. After nine months on average, stiff knees are revised while for all the other reasons revision takes place more than two years after TKA on average(Figure 6.5).

Fixation method seems not to play a role as a reason for revision until six years after index surgery (Figure 6.6).

Of 28 knee systems used in Switzerland for primary TKA, two are clearly outliers with regard to two-year revision rates and 95% confidence interval being outside the outlier alert boundary (twice the group average). Two further systems are classified

Figure 6.5

Time interval between primary total knee arthroplasty and first revision by reason

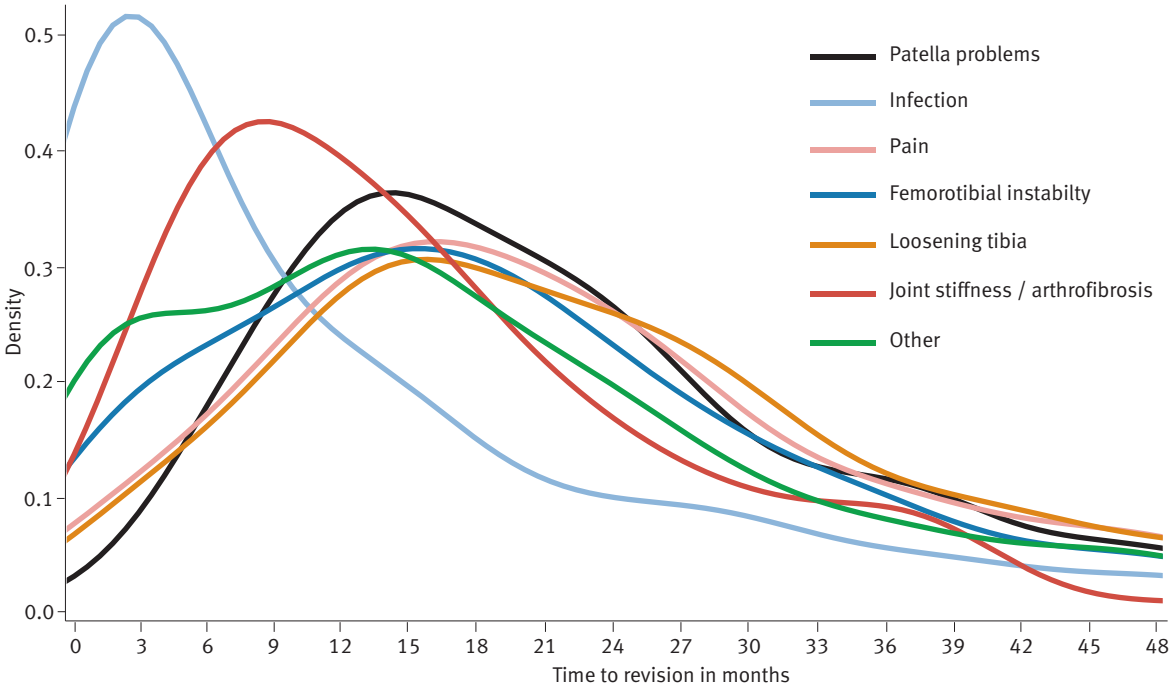


Table 6.18

Median time interval between primary total knee arthroplasty and early first revision (in months) according to reason

	N	Median (IQR)	Mean
Patella problems	973	20 (13; 29)	23 (±13.8)
Infection	531	6.7 (1.5; 18)	12 (±14.2)
Pain	371	20 (13; 30)	23 (±14.3)
Femoral instability	544	18 (10; 27)	20 (±14.2)
Loosening tibia	445	21 (13; 31)	24 (±14.8)
Joint stiffness/arthrofibrosis	262	13 (7.0; 22)	16 (±11.5)
Other	1359	15 (7.7; 26)	19 (±15.2)

Table 6.19

Revision rates of all component fixations primary total knee arthroplasty components within 24 months

2012–2018, with and without patellar replacement

Knee System	at risk*	Revised		95% CI	
	N	N**	%	lb	ub
Anatomic	64	3	4.9	1.6	14.4
Attune	6696	215	3.3	2.9	3.7
Balansys bicondylar	7003	155	2.3	1.9	2.6
E.motion FP/UC	863	20	2.3	1.5	3.6
E.motion PS	238	21	8.9	5.9	13.3
First	1169	30	2.6	1.8	3.7
First rev.	158	6	3.9	1.8	8.4
Gemini SL	192	6	3.2	1.4	6.9
GMK primary	3181	93	3.0	2.4	3.6
GMK sphere	2569	84	3.3	2.7	4.1
HLS Kneetec deep dish	64	1	1.6	0.2	10.6
HLS Kneetec	239	5	2.1	0.9	5.1
Innex	4217	137	3.3	2.8	3.9
Journey II	598	40	6.8	5.0	9.1
LCS	4977	175	3.6	3.1	4.1
Legion	475	25	5.3	3.6	7.8
NexGen	1419	34	2.4	1.7	3.4
NK Flex	1465	39	2.7	2.0	3.7
NK II	149	1	0.7	0.1	4.7
Persona	3899	111	2.9	2.4	3.5
Physica KR	51	7	14.5	7.2	28.1
Physica PS	74	10	13.9	7.7	24.2
Score	147	3	2.0	0.7	6.2
Sigma	6145	142	2.3	2.0	2.8
TC-Plus primary	2290	67	3.0	2.3	3.8
Triathlon CR	766	30	4.0	2.8	5.7
Triathlon PS	468	16	3.5	2.2	5.7
Vanguard	1082	42	3.9	2.9	5.3

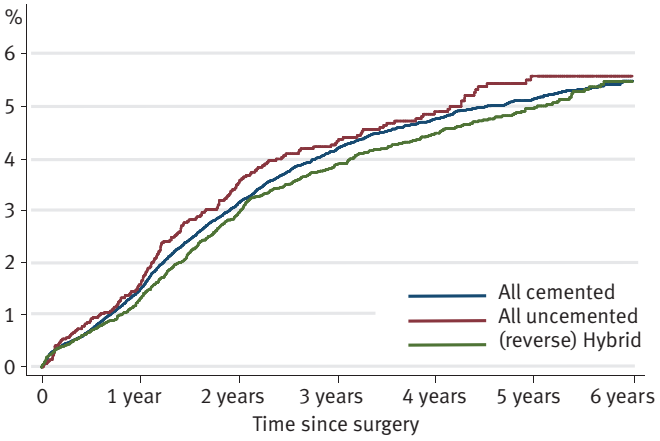
* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).

** N<50 is not shown in this table.

Figure 6.6

Failure estimate of early first revision of primary total knee arthroplasty for different fixation methods

Time since operation, 2012–2018, all services



Number at risk	1 year	2 years	3 years	4 years	5 years	6 years
cemented	44485	33325	23077	14851	7561	1986
uncemented	3778	3215	2637	2017	1235	349
(reverse) hybrid	13390	11053	8694	6285	3644	1048

as possible outliers where 95% confidence interval is still lying within the outlier boundary. Most of the systems reach group average, some are better than average. One should note the small numbers used of some systems additional revisions can considerably change the performance (Figure 6.7). Following the statistical identification of potential outliers for this report, the SIRIS registry has produced outlier reports in order to further investigate the reasons for the observed deviations from the national average.

Table 6.20
Top 10 implants, primary total knee arthroplasty, all component fixations

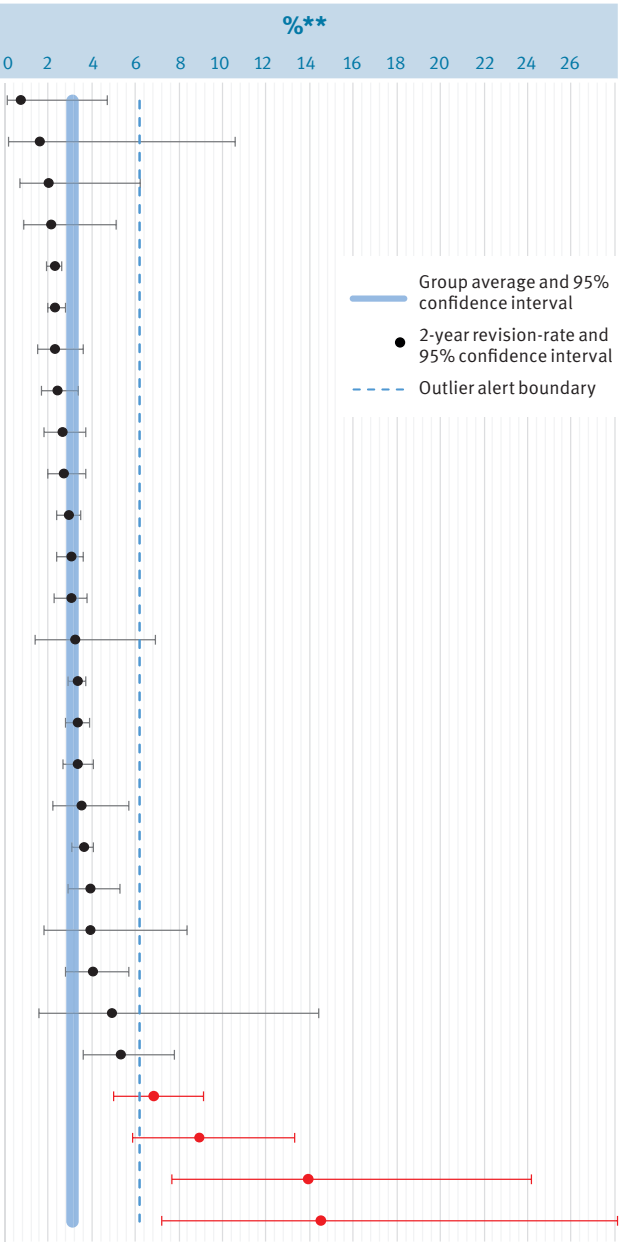
System	2013	2014	2015	2016	2017	2018	Total
Attune	152	1196	2364	2984	3119	3056	12871
Balansys bicondylar	1396	1602	1698	1775	1767	1588	9826
Persona	260	821	1220	1597	1960	2231	8089
Sigma	1956	1587	1025	804	615	552	6539
LCS	1383	1278	870	834	862	842	6069
GMK Sphere	151	493	796	1108	1308	1638	5494
Innex	1124	1098	773	672	565	414	4646
GMK Primary	887	776	546	526	383	260	3378
TC-Plus primary	616	553	434	471	412	328	2814
First	271	258	271	320	226	232	1578
Other	2314	1956	1680	1962	1711	1708	11331
Total	**10510**	**11618**	**11677**	**13053**	**12928**	**12849**	**72635**

Figure 6.7

2-year revision rates of primary total knee arthroplasty systems, all component fixations

2012–2018

Knee system	N revised	N at risk*
NK II	1	149
HLS Knee Tec Deep Dish	1	64
Score	3	147
HLS Kneetec	5	239
Balansys Bicondylar	155	7003
Sigma	142	6145
E.motion FP/UC	20	863
Nexgen	34	1419
First	30	1169
NK Flex	39	1465
Persona	111	3899
GMK Primary	93	3181
TC-Plus primary	67	2290
Gemini SL	6	192
Attune	215	6696
Innex	137	4217
GMK Sphere	84	2569
Triathlon PS	16	468
LCS	175	4977
Vanguard	42	1082
First rev	6	158
Triathlon CR	30	766
Anatomic	3	64
Legion	25	475
Journey II	40	598
E.motion PS	21	238
Physica PS	10	74
Physica KR	7	51



* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

- Identified as potential outliers. Please note the statistical confidence intervals. The outlier status comes with varying degrees of statistical probability. We consider the potential outlier status „highly likely“ when both the estimated revision rate and the complete confidence interval exceed the outlier alert boundary).
  Please be aware that relatively rare implant combinations are frequently used in only a small number or indeed only in one hospital in Switzerland. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

6.5 First revision of a primary partial knee arthroplasty

4% of the partial knee arthroplasties had to be revised within two years of index surgery. Again, younger patients were much more at risk (e.g. 7.1% in the age group under 55 years) (Table 6.21).

Main reason for early revision was early loosening of the tibia, followed by pain in 18.2% and progression of osteoarthritis in 15.2% and loosening of the femur in 13.9%. Infection was only responsible for 6.1% of the early revisions. As in TKA surgical technical problems were responsible for the majority of early revisions in partial knee arthroplasty (Table 6.22). 13.3% of the reasons were classified as "other".

Table 6.21

First revision of primary partial knee arthroplasty: Overall and according to baseline characteristics

		Revised	Revised within 24 months			
					95% CI	
		N at risk[1]	N	%[2]	lower	upper
Overall		**9684**	**388**	**4.0**	**3.6**	**4.4**
Gender	Women	4898	200	4.1	3.6	4.7
	Men	4786	188	4.0	3.4	4.6
Age group	<55	1495	106	7.1	5.9	8.6
	55–64	3242	140	4.3	3.7	5.1
	65–74	3173	93	3.0	2.4	3.6
	75–84	1559	47	3.0	2.2	4.0
	85+	204	2	1.0	0.3	4.0

[1] Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
[2] Rates ajusted for effects of mortality and emigration.

6.22

Reason for first revision of partial knee arthroplasty

Multiple reasons are possible per patient.
The reasons for revision categories as listed below are only available from 2015 onwards.

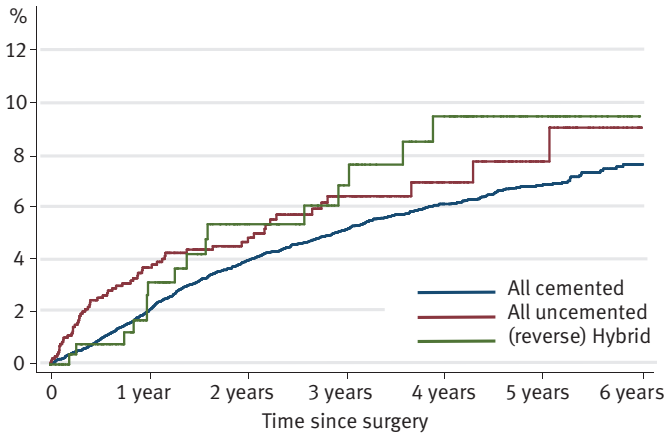
	2015–2018	
	N	%
Loosening tibia	186	30.5
Pain	111	18.2
Progression of unicomp. OA	93	15.2
Loosening femur	85	13.9
Femorotibial instability	47	7.7
Patella problems	45	7.4
Infection	37	6.1
Component malposition tibia	34	5.6
Periprosthetic fracture tibia	23	3.8
Wear of inlay	21	3.4
Component malposition femur	17	2.8
Joint stiffness/Arthrofibrosis	10	1.6
Sizing tibial component	8	1.3
Sizing femoral component	7	1.1
Loosening patella	5	0.8
Patellar instability	3	0.5
Periprostetic fracture femur	2	0.3
Other	81	13.3

In UKA cemented implants are revised less than uncemented or hybrid fixed implants during the first six years after surgery. This effect can be expected early after surgery as uncemented implants have to osteointegrate which might be critical in some cases. Nevertheless, uncemented implants do not improve over time, the estimated rate of revision is still diverging four to six years after index surgery compared to cemented versions (Figure 6.8). In Switzerland none of the partial knee arthroplasty systems were identified as outlier (Figure 6.11).

Figure 6.8

Estimated failure rates for early first revision of partial knee arthroplasty for different fixation methods

Time since operation, 2012–2018, all services



Number at risk	1 year	2 years	3 years	4 years	5 years	6 years
cemented	9919	7919	6069	4231	2371	657
uncemented	902	583	288	136	71	19
hybrid	198	146	117	92	44	8

Figure 6.9

Estimated failure rates of early first revision of partial knee arthroplasty, all cemented versus all uncemented with CI

Time since operation, 2012–2018, all services

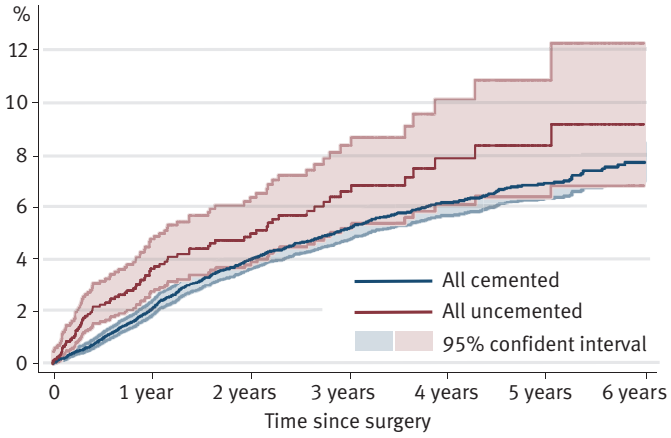


Table 6.23

Revision rates of all component fixations partial knee arthroplasty components within 24 months

2012–2018, with and without patellar replacement

Partial Knee System	at risk*	Revised		95% CI	
	N	N	%	lb	ub
Allegretto	545	5	0.9	0.4	2.2
Balansys Uni system	1347	47	3.5	2.7	4.6
Endomodell sled	53	1	1.9	0.3	12.6
GMK Uni	505	30	6.0	4.2	8.4
Journey Uni	446	30	6.8	4.8	9.5
Oxford cemented	2086	79	3.8	3.1	4.7
Oxford uncemented	593	25	4.2	2.9	6.2
Physica ZUK	1713	61	3.6	2.8	4.6
Sigma	1586	55	3.5	2.7	4.5

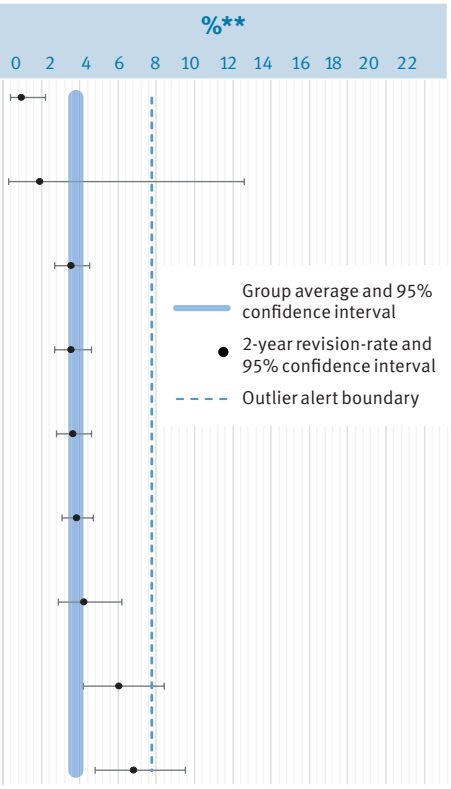
* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).

Figure 6.11

2-year revision rates of partial knee arthroplasty systems, all component fixations

2012 –2018, a small number of hybrid/reverse hybrid Oxford implants have been omitted

Knee system	N revised	N at risk*
Allegretto	5	545
Endo-Modell Sled	1	53
SIGMA	55	1586
balanSys UNI System	47	1347
PHYSICA ZUK	61	1713
Oxford cemented	79	2086
Oxford uncemented	25	593
GMK Uni	30	505
JOURNEY UNI	30	446



* Number of patients with at least two years follow-up (i.e. primary prosthesis in 2012–2016).
** Rates ajusted for effects of mortality and emigration.

Table 6.24

Top 10 implants, partial knee arthroplasty, all component fixations

System	2013	2014	2015	2016	2017	2018	Total
Oxford	550	594	622	767	754	640	3,927
Sigma	407	349	309	382	413	376	2,236
Physica ZUK	379	453	410	287	212	197	1,938
Balansys Uni	302	329	293	282	302	270	1,778
GMK Uni	109	83	153	119	178	184	826
Allegretto	156	130	117	103	93	89	688
Journey Uni	107	115	93	99	112	83	609
Persona	0	0	0	0	82	328	410
Alpina	0	0	10	29	32	12	83
Triathlon PKR	0	0	8	16	17	21	62
Other	26	28	41	34	35	54	218
Total	**2036**	**2081**	**2056**	**2118**	**2230**	**2254**	**12775**

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 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 Clinique des Grangettes SA, Chêne-Bougeries
Hirslanden Klinik Aarau
Hirslanden Klinik am Rosenberg, Heiden
Hirslanden Klinik Belair, Schaffhausen
Hirslanden Klinik im Park, Zürich
Hirslanden Klinik Linde AG, Biel
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-Chablais, Site de Monthey
Hôpital Riviera-Chablais, Site de Montreux
Hôpital Riviera-Chablais, Site de Vevey
Hôpitaux Universitaires de Genève (HUG)
Insel Gruppe AG, Inselspital, Univesitätsspital Bern
Insel Gruppe AG, Spital Aarberg
Insel Gruppe AG, Spital Münsingen
Insel Gruppe AG, Spital Riggisberg
Insel Gruppe 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
La Tour Réseau de Soins SA, Hôpital de la Tour, Meyrin
Lichtensteinisches Landesspital, Vaduz
Lindenhofgruppe, Sonnenhofspital, 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
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
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Solothurner Spitäler AG, Kantonsspital Olten
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St. Claraspital AG, Basel
Stadtspital Triemli, Zürich
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