schweizerisches implantat-register
registre suisse des implants

SIRIS

Swiss National Hip & Knee Joint Registry

Report 2020

Annual Report of the SIRIS Registry, Hip & Knee, 2012 – 2019

ANQ

Kantonsspital St.Gallen

swiss orthopaedics

UNIVERSITÄT BERN

Hip and knee replacement results 2012–2019

SIRIS Report 2020
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

Reaching a milestone with transparent publication

The establishment of the SIRIS hip and knee implant registry provides a valuable basis for quality development. All those involved benefit from the almost complete registration of knee and hip implants – whether as an early warning system for manufacturers, for training and further education purposes for clinicians, or now also for deeper insight into the quality of treatment from a regulatory perspective.

The crowning glory of the successful collaboration between the SIRIS Foundation, SwissRDL, and the ANQ is the publication of the data, which is made transparent at the clinic level. As the Board of Health Directors, we support the scientifically based and transparent publication of quality data – for our patients and the continuous development of our health system.

Following the example of SIRIS, we would like to see the registry extended to other service areas, for other implants to achieve such exemplary registry structure. Linking the registry data with patient-reported quality of treatment information should now be the target to extend the registry involving orthopaedic surgeons.

For the Swiss population, high treatment quality and the greatest possible patient safety are important to us. We would like to thank all the experts involved, who over many years have contributed their expertise to the development of the largest implant registry in Switzerland.

Dr. iur., lawyer, LL.M. Lukas Engelberger
Government Councillor of Basel-Stadt and President GDK

Who's afraid of transparency?

As can be seen from this report, the SIRIS Implant Registry contains more than 95% of hip and knee arthroplasties performed in Switzerland. This result is undoubtedly a great success by Swiss standards and reflects the great efforts made by hospitals and clinics and all the participants involved in the registry.

The report contains a wealth of interesting analyses in hip and knee prosthetics and shows great potential for registry data.
One of the key factors of SIRIS is the composition of the board: all relevant partakers are involved from the very beginning and share interest in good and even better long-term results for hip and knee arthroplasties. The SIRIS Foundation will attain its most important milestone with the first transparent publication of 2-year revision rates at the hospital level; this will follow the publication of the annual report. The successful establishment of the registry, the high rate of involvement and the multiple analysis results are steps in the right direction. Discussions on quality can now be conducted based on data and potential for improvement can be identified and addressed in a targeted manner. This is the direction also being pursued with the KVG revision to strengthen quality and efficiency. The SIRIS implant registry is well on its way to achieving this.

Legislators have mapped the way in which collective bargaining partners will transform into quality partners. SIRIS is already living this vision. But SIRIS must not rest on its laurels. The next important step must be to record service provider features, such as treatment numbers and surgeon qualifications. Only in this manner will it be possible to interpret surgical results in a meaningful way. I am convinced that the orthopaedic training offered in Swiss hospitals will prove to be an excellent predictor of good results. Who then can be afraid of transparency?

Dr. med. Markus Trutmann
Head of Policy Division
Member of the Executive Board
H+ The Hospitals of Switzerland

Acknowledgements

SIRIS Scientific Advisory Board

Prof. Martin Beck, MD
Orthopädische Klinik Luzern AG, Lucerne
swiss orthopaedics Hip Expert Group,
Author of the scientific SIRIS-Report

Christian Brand, PhD, MSc
Statistical Analysis and Research
SwissRDL, ISPM, University of Bern

Dr. med. Bernhard Christen, MD, MHA
articon, Salem-Spital Berne,
swiss orthopaedics Knee Expert Group,
Author of the scientific SIRIS-Report

Dr. med. Vilijam Zdravkovic, MSc
Senior Research Officer, Department of Orthopaedic Surgery and Traumatology,
Canton Hospital of St Gall
Author of the scientific SIRIS-Report

SIRIS Expert Group ANQ

Prof. Martin Beck, MD
Orthopädische Klinik Luzern AG, Lucerne
swiss orthopaedics Hip Expert Group

Lilianna Bolliger
User support for SIRIS Hip and Knee, SwissRDL,
ISPM, University of Bern

Christian Brand, PhD, MSc
Statistical Analysis and Research

Dr. med. Bernhard Christen, MD, MHA
articon, Salem-Spital Berne,
swiss orthopaedics Knee Expert Group

Prof. Claudio Dora, MD
Schulthess Clinic, Zurich, Senior Consultant Hip Surgery, SIRIS Board Member

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

Peter Liniger
Johnson & Johnson AG, SIRIS Board Member

Andreas Mischler
conidea GmbH, SIRIS Administration Lead

Adrian Spörri, PhD, MPH
Head of SwissRDL, Statistical Analysis,
Data Linkage and Research

Dr. Peter Wahl, MD
Staff surgeon, Division of Orthopaedics and Traumatology, Cantonal Hospital Winterthur

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

Dr. med. Vilijam Zdravkovic, MSc
Canton Hospital of St Gall
Senior Research Officer

SwissRDL, ISPM, University of Bern

Lilianna Bolliger
User support for SIRIS Hip and Knee

Christian Brand, PhD, MSc
Statistical Analysis and Research
Author of the scientific SIRIS-Report

Adrian Spörri, PhD, MPH
Head of SwissRDL, Statistical Analysis,
Data Linkage and Research

Partner associations of SIRIS

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

Hplus
Association of the Hospitals of Switzerland
geschaeftsstelle@hplus.ch

Swiss Medtech
Association of the Swiss Medtech Industry
office@swiss-medtech.ch

santésuisse
Association of Swiss Medical Insurers
mail@santesuisse.ch

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

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 2020 and all previous reports.

Foundation for quality assurance in implant surgery – SIRIS

c/o conidea GmbH, 3604 Thun
info@siris-implant.ch, www.siris-implant.ch

Content

Preface 2
Acknowledgements 4

1 Introduction 8
1.1 Purpose of the registry 8
1.2 Strong commitment 12

2 Methods 13
2.1 Maintenance and hosting of the registry 13
2.2 Data quality and completeness 14
2.3 Coverage 14

3 Summary of the SIRIS Report 2020 17
3.1 Overall volume of hip and knee surgery in relation to demography 18
3.2 Prosthetic replacement of the hip, including hemiarthroplasty for fractures 19
3.3 Prosthetic replacement of the knee, including partial knee replacement 21
3.4 Implant-specific outcomes 23
3.5 Reporting of prostheses-related revision rates by hospitals 23

4 Hip arthroplasty 27
4.1 Primary total hip arthroplasty 27
4.2 Revision of total hip arthroplasty 36
4.3 First revision of primary total hip arthroplasty 39
4.4 Results of implants in total hip arthroplasty 46
4.5 Estimating performance and detecting outliers 53

5 Fracture of the hip 58
5.1 Treatment of hip fractures 58
5.2 First revision (within two years) after fractures of the hip 66
5.3 Results of implants by THA after hip fractures 69

6 Knee arthroplasty 77
6.1 Primary total knee arthroplasty 77
6.2 Revision of primary total knee arthroplasty 85
6.3 First revision of primary total knee arthroplasty 89

7 Partial knee arthroplasty 96
7.1 Primary partial knee arthroplasty 96
7.2 First revision of primary partial knee arthroplasty 100

Definitions 106
Participating hospitals 108
Involved manufacturers and distributers 110

1. Introduction

1.1 Purpose of the registry

In September 2012, the Swiss National Implant Registry SIRIS was introduced to register hip and knee implants. Participation in SIRIS is compulsory for all hospitals and clinics that have signed the ANQ's national quality agreement and that perform knee and hip arthroplasties.

The mission of the national joint registry needs to be clearly defined if all contributors and participants are striving towards a common goal. This also influences the details of the information contained in the registry, since there will be quite different requirements for each of the partners involved. The fact that a multi-partner association was needed to get SIRIS off the ground meant that more than one point of view had to be taken into consideration for the registry to become successful and acceptable to all. Although each partner naturally tends to focus more on one particular aspect of their interest, in the end there is one basic interest common to all partners: the long-term well-being of the patient after prosthetic joint replacement.

Patient perspective. Patients expect their implants to provide them with long-lasting, pain-free results. 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 who will might better understand and discuss their past or future operation with their surgeon. The SIRIS registry should provide them both interesting topics and information to discuss.

The surgeon's point of view. Surgeons are primarily concerned with avoiding surgical complications and shortcomings for their patients. Indeed, the vision of patients and surgeons is the same: long-lasting, pain-free and full function of the prosthesis. However, by choosing a particular prosthesis, surgeons integrate the performance of the implant into their own performance. The implants must be impeccably manufactured and versatile to avoid problems such as early loosening, particle disease, breakage, dislocation, infection, stiffness or chronic pain. A long, problem-free implant life with the minimum amount of wear on the bearing surfaces is the ultimate goal. In a relatively short time frame the registry should identify "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 a surgeons' daily activities. Although surgeons may appreciate benchmarking their own results to the overall results, the controversial question remains public availability of the information at the individual surgeon's level. This may lead to bias entering into the system and potential changes in patient recruitment practices.

The industrial point of view. The industry's main activity is manufacturing and sales driven by a legitimate profit orientation motive. Designing and providing first-rate, problem-free implant systems are the only worthwhile strategies because the single implant that causes failures in a series of patients may lead to allegations of negligence that could, ultimately, destabilize the company financially. It is clear that economic viability coincides with that of the patients, i.e. the long term well-being 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, designs and concepts in real-life clinical settings. If the industry accepts quality as being the principal market-regulating factor then the registry is a welcome tool and motivates industry participation. The publication of 2-year revision rates for registered implants in the SIRIS report 2019 was met with great interest from involved providers (industry) and users (surgeons) of prosthetics replacements. Obviously, it is not the goal of the registry to regulate the market but to define and provide tools for market regulation through quality assessment.

The hospitals' point of view. Hospitals aim to provide excellent and safe care to a large number of patients at reasonable cost. In hospitals, surgeon/patient interaction takes 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, a hospital's or department's interest includes the aim of assuring that patients do not forget the institution where they were treated so successfully and they return to the same hospital, should it be necessary also for other reasons than prosthetic replacement. Personal recommendations from satisfied patients are the very best publicity. The registry is perceived as an instrument for quality control, not only of the implants used, but of the whole process, ranging from the preoperative consultation to the procedures in the operating room and to the postoperative follow-up. Hospitals, being institutions providing healthcare in today's competitive environment, are also very keen to uphold their reputation and the 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 to place the hospital on contract lists. It appears that participating in the registry might be crucial for the survival of some hospitals and this is a strong motivation in an environment where hospital mergers and closures are frequently discussed. New information soon to accompany the SIRIS Report 2020 is the publication of performance benchmarks of institutions registered in SIRIS.

The insurer's point of view. Insurers and third-party payers want minimal delays and waiting times for insured patients, short hospitalisation times, no expensive re-admissions for complications and the patient's quick return to work. Insurers are very conscious of cost when it comes to implant pricing, medical honoraria 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 informing

Figure 1.1
Organisation of the SIRIS Hip and Knee and SIRIS Spine registry

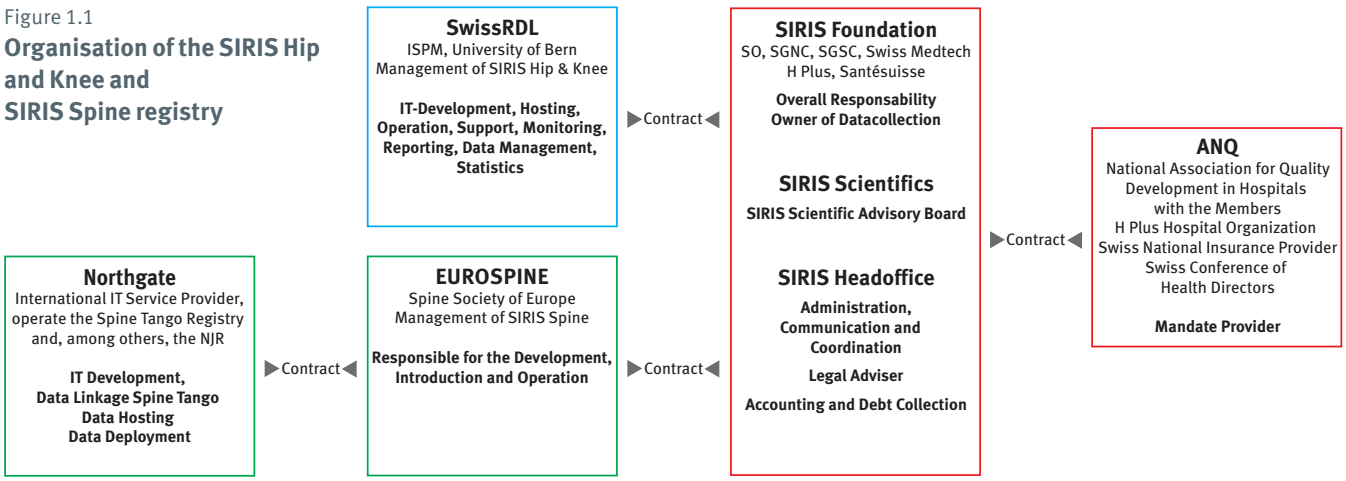


Figure 1.2
Variables collected by the SIRIS registry

Factors	Variables
Patient related	Name
	Surname
	Date of birth
	Gender
	Height
	Weight
Surgery related	Main diagnosis
	Previous surgery
	Date and place of surgery
	Morbidity state
	Charnley class
	Intervention
	Approach
	Positioning
	Component fixation
	Cementing technique
Implant related	Type of implant
	Article number
	LOT number
	Company name
	Brand name

about the quality of surgeons and institutions and as a cost-control tool. Because revisions cause massive additional and unnecessary costs, the interest of insurers remains the same as that of patients: long-lasting pain-free function after prosthetic replacement.

Point of view of the government. The government organises the healthcare system on behalf of all citizens. Therefore, the main challenge it faces is to consider and bring together the needs and preferences of all other actors in the health economy. At the Swiss federal level, government may not have any inherent financial interest in the running of the system but cantonal governments bear a major share of hospital costs directly and are very active participants in all debates on and around treatment in hospitals, outcomes and costs. Governments are also in a better position than patients to assess the bigger picture of quality healthcare provision. While patients understandably tend to place their prime focus on receiving treatment providing optimal long-lasting results, the government certainly shares this aim but must also focus on ensuring that high quality treatment is cost-effective. The government therefore needs data on the overall surgical performance for public health purposes, to assess needs, 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 general 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 use. A specific characteristic of the Swiss healthcare system is that cantons are independent

and are the principal political and financial authorities for their healthcare systems. Furthermore, the healthcare system of the Principality of Lichtenstein (FL) interacts closely with the Swiss healthcare system and participates in SIRIS activities. Therefore, starting in 2020, SIRIS is also presenting some cumulative data for Swiss cantons and FL (Figures 1.3 to 1.6). Although the fragmentation of the dataset may sometimes preclude any meaningful statistical analysis, the information can still be of interest to cantonal/FL governments and the public.

1.2 Strong commitment

The 2020 SIRIS report represents a collaborative data collection effort involving all the institutional partners of SIRIS and includes the surgeons and operating teams of 186 hospital services. Streamlining, improving and optimising data collection is a work in progress involving expert groups and all members, including the industrial partners.

The coverage is one important indicator for the commitment of all parties involved in SIRIS. However, it is difficult to assess it because any other registration system aiming to be a benchmark has some specificities, strengths and drawbacks. For SIRIS, only

Figure 1.3

Relative proportion of total hip arthroplasty procedures using different approaches by Swiss Canton and Principality of Liechtenstein (2015–2019)

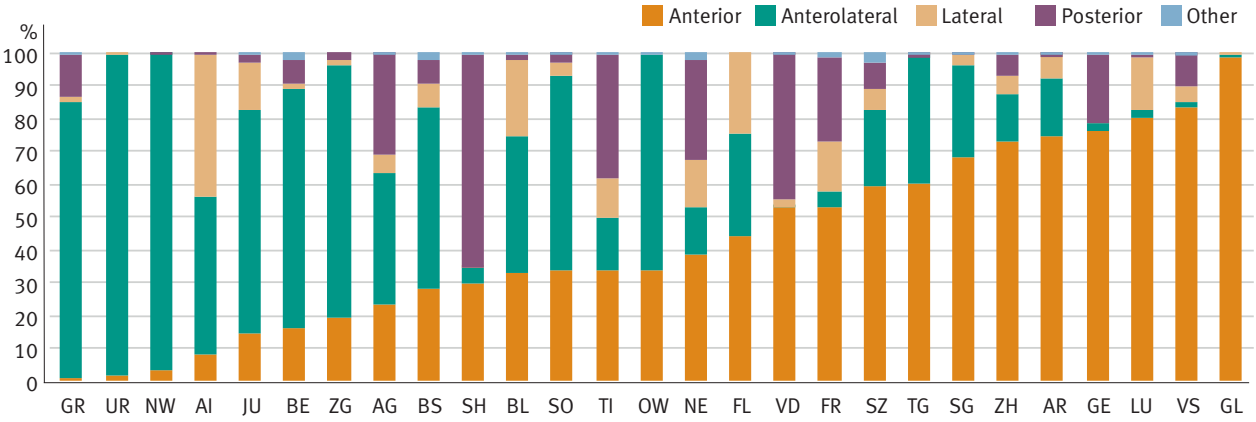
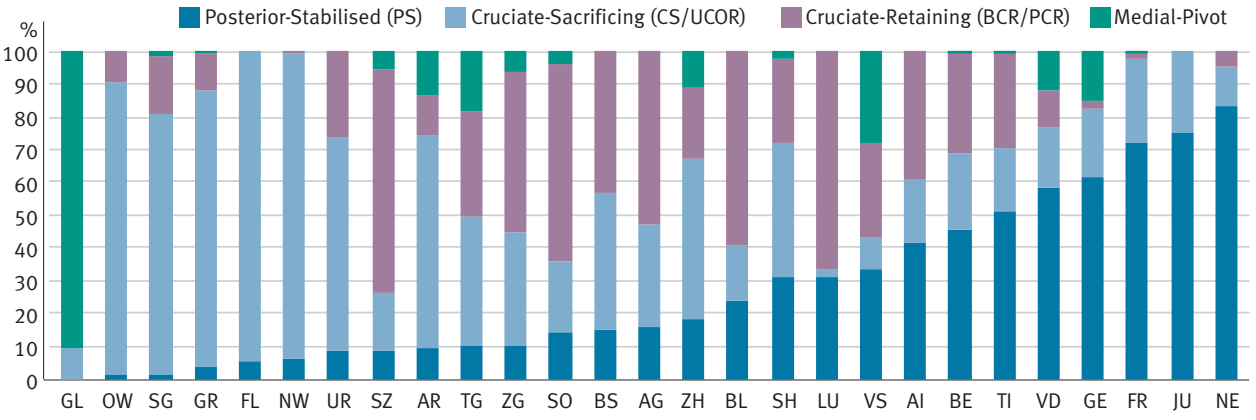


Figure 1.4

Relative proportion of total knee arthroplasty procedures using CR, CS PS, MP by Swiss Canton and Principality of Liechtenstein (2015 – 2019)



performed arthroplasties submitted to the registry as closed cases can be used in the coverage analysis. As a benchmark we use data from the hospital quality report published by the Swiss Federal Health Authorities (BAG) for the period 2015–2018 (data for 2019 are not yet available to be included in SIRIS Report 2020). The data are available to the public and can be put in relation to SIRIS data, although some details in coding and filtering definitions may differ from SIRIS. In 2018, the coverage of SIRIS was 91.7% for hip prosthetics (benchmark: primary total hip prosthesis for all reasons excluding trauma) and 94.1% for knee prosthetics (benchmark: primary total and partial knee prosthesis for all reasons excluding trauma). An alternative data source, explained in detail in chapter 2, indicates that the coverage rate could be increased to more than 95% overall for 2019. Those figures confirm that the commitment of all participating individuals and institutions is strong.

Officially only started in 2012, the registry has already achieved coverage of 100% of the institutions involved. This demonstrates not only strong commitment to the project by the surgeons and their teams, both in public and private hospitals, but also the high quality of the organisation, 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, we hope, the healthcare community, third-party payers, and healthcare regulators will find useful.

Figure 1.5

Primary total knee arthroplasty: Share of TKA procedures with patella resurfacing by Swiss Canton and Principality of Liechtenstein (2015–2019)

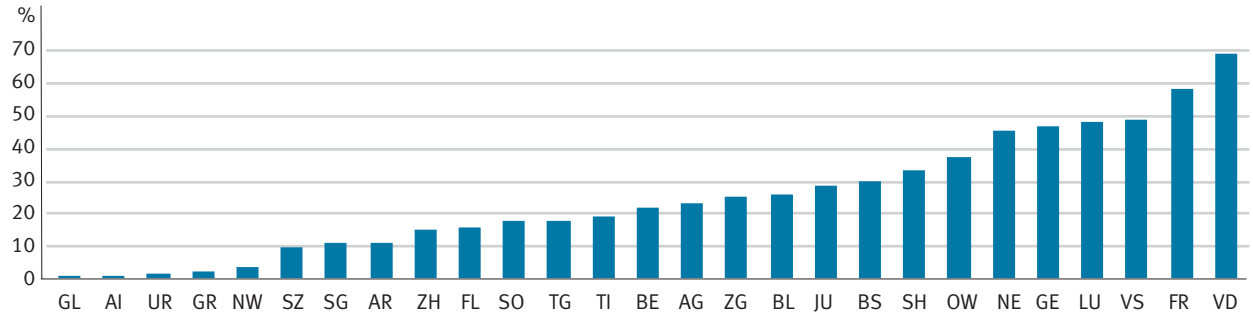
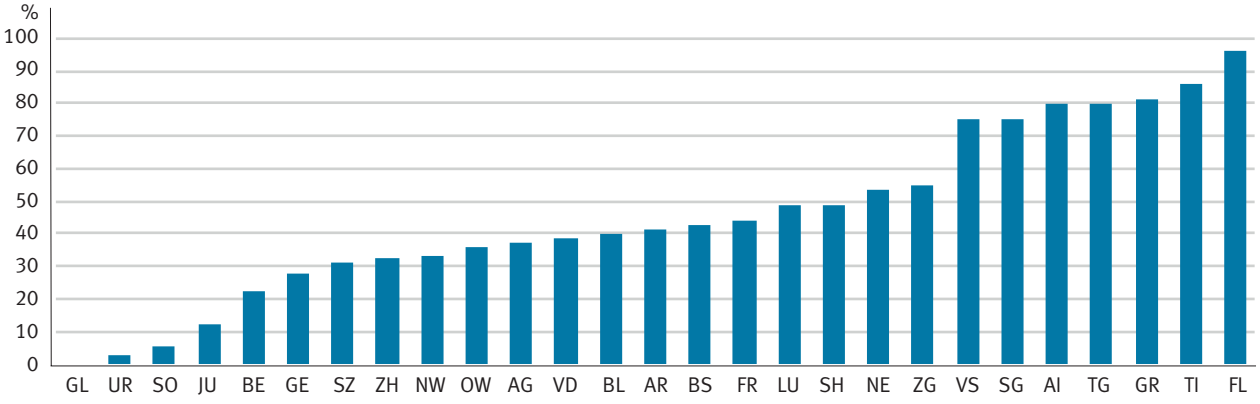


Figure 1.6

Primary total knee arthroplasty: Share of TKA procedures with mobile bearing by Swiss Canton and Principality of Liechtenstein (2015–2019)



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 the project manager, data management specialists and a statistician/methodologist is responsible for the management and maintenance, technical support, reporting and analysis of the registry data. A data monitor supervises the data entries at the hospitals and supports and trains collaborators at the participating locations to ensure the correct and efficient running of the registry.

SIRIS data are collected on an online documentation IT platform (accessible on www.siris-doc.ch). Clinical data on primary arthroplasties, reoperations and component revisions are recorded. All individual implants used (including minor components) are registered alongside all relevant arthroplasties or revisions. The current versions of the SIRIS forms for data entry can be downloaded from www.siris-implant.ch. Most participating surgical units use the online interface for documenting their operations, while a small minority send completed paper forms to SwissRDL for processing. As a third data entry method, some large centres send data exports from their hospital information system via a web service client to SwissRDL.

Specific implant data are mostly entered into SIRIS by scanning the bar codes on the implant tags. Until 2019, it was also possible to enter the information manually via the web interface. However, this data entry mode was associated with considerably lower data quality, which led to time-intensive data revisions or to the exclusion of cases from analyses. Therefore, manual data entry of implants is now restricted to multiple choice drop-down menus containing only known implants. New implants may be registered by SwissRDL on demand by SIRIS users or upon notification by a producer. The clinical data of the SIRIS registry are stored on allocated servers at the University of Bern. SwissRDL is able to have the data protection resources of the university adjusted and the IT infrastructure of the ISPM.
Information identifying the patient (e.g. medical record number, name and date of birth) is stored on a specific module server, physically separate from the clinical data of SIRIS. Identifying information is encrypted into a salted hash code, which allows patients who need revision of the primary implantation at a different health facility to be identified. This is needed to calculate revision rates and for continuous follow-up of 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 someone has died or left Switzerland could only be verified until the end of 2018, as the FSO has not yet published the data for 2019. Therefore, only patients confirmed alive and residing in Switzerland are considered “at risk” of revision. Patients who have died or left the country during the observation period were accounted for proportionally in terms of the number of days until leaving or death. Fewer than 5% had unknown status or were foreigners operated on in Switzerland but not registered in ZAS. These patients were considered lost to follow-up after predetermined time intervals, unless actually revised in Switzerland, and were subsequently excluded from the analysis of (long-term) revision rates.

SwissRDL data protection was audited recently to ensure compliance with current standards. The methodology of separating 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, secured by the surgeons and hospitals participating in the Swiss Joint Registry. They have the right to withdraw, to see what is stored and to have their data completely deleted at any time.

2.2 Data quality and completeness

Data for this report were exported from the database in July 2020. The consistency and completeness of SIRIS data is checked in part through systematic software-generated validation tests of the received data and additionally every quarter by the registry's statistician/methodologist after running it through an automatic analysis script for producing master files for detecting likely data errors. These are then fed back to the data monitoring team who analyse root causes of confirmed problems and provide feedback to hospitals. This latter procedure, established in its current form during the second half of 2019, has already shown great potential for improving data quality.

Two versions of case report forms (CRF) have been used in SIRIS. The first version was used from 2012 to 2014. Since January 2015, an updated version is in use. It includes some changes in the definition of existing variables (particularly for the arthroplasty of the knee) and some new variables have been added: notably the body mass index (BMI) and the morbidity state (ASA). The latter allows the answer "unknown", which was inconsistently used among surgical service providers, including one reporting unknown ASA status in almost all cases. Other common problems are impossible or inconsistent responses, more frequently observed in some parts of the forms than in others: e.g. revisions relating to acetabular components in hemi arthroplasties. This could be due to systematic misunderstanding of the meaning of certain response categories (e.g. confusion between AC revision and conversion to THA after a hemi arthroplasty) or because of random data entry errors likely aggravated by design issues such as long drop-down lists. The hospital are now being closely monitored to reduce missing and implausible values. SIRIS forms are currently undergoing revisions, partly to address recognised problems and a new version is expected to be implemented in early 2021.

2.3 Coverage

Reliable reference data from other sources are needed to estimate the coverage of SIRIS. One option is to compare the annual number of cases reported in the registry with the numbers from quality indicators for Swiss acute care 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 the discharge from hospital of a person residing in Switzerland and includes information about the patient's socio-demographic characteristics, diagnosis and treatment. These figures are published online but only with a considerable time lag (https://www.bag.admin.ch/bag/de/home/zahlen-und-statistiken/zahlen-fakten-zu-spitaelern/qualitaetsindikatoren-der-schweizer-akutspitaeler/qualitaetsindikatoren-dokumentation.html). Detailed definitions may be found here (in German, French and Italian): https://www.bag.admin.ch/bag/de/home/zahlen-und-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 for knee prostheses. As only figures up to 2018 are available in this official report, we used them only to verify the registry's estimated coverage rate as reported in the 2019 annual report. The figures con-

firm that the overall coverage rate for hip procedures had reached nearly 92% in 2018 and was already higher than 94% for knee procedures.

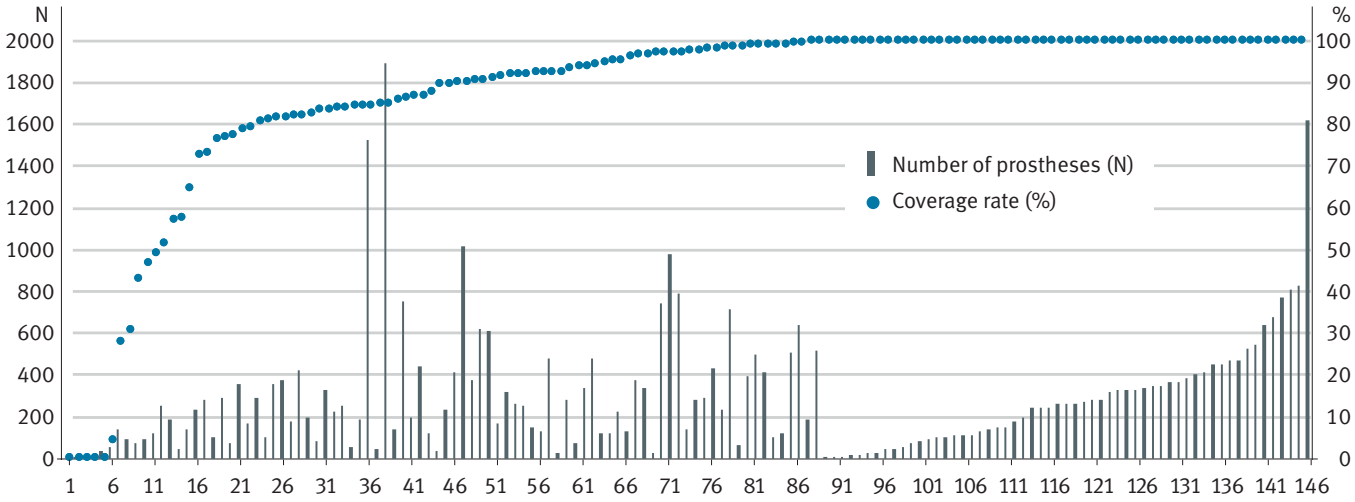
As a second external source, SIRIS has obtained annual implant sales figures for Switzerland: specifically the number of femoral stems and tibia plateaus sold per year between 2017 and 2019 (data provided by the manufacturers). We consider this a very reliable source of information, even though analysis of the figures strongly suggests that sales figures and implant use figures in hospitals do not always reliably agree within the same calendar year. In other words, hospitals can report more procedures per year than implant purchase suggests (i.e. coverage rates above 100%). However, it is reasonable to assume that such discrepancies tend to even out over time and across hospitals. We therefore consider coverage rates between 90% and 110% as the "target zone" for hospitals for this type of analysis.

Based on this information the overall coverage of SIRIS in 2017/2018 was estimated at 90 to 92% across all primary and component revision procedures included and has risen to more than 95% in 2019. We also rely on feedback from individual manufacturers in Swiss industry reporting (implant reports) and know that these high coverage rates are realistic. They tend to be as high as 98% for typical standard implants such as primary hip stems and as low as 60% for hemi-heads. The under-coverage of hemi arthroplasties is a well-known problem, as

Figure 2.1

SIRIS coverage rates and number of hip or knee prostheses per participating hospital 2019

Hospitals sorted by estimated case rate (N= Number of prostheses, %= Coverage 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

It should be noted, however, that this coverage analysis was performed at the procedural level. This report also contains brand-specific results where implants or combinations thereof had to be identified unambiguously in order to include them in the analysis (e.g. a valid femoral stem/acetabular cup combination used in THA). Here, too, we observe clear progress compared to the previous reports, mainly due to improvements in the register's implant library. In 2019, about 96% of primary osteoarthritis THAs had a valid stem/cub combination and more than 95% of unlinked bicondylar TKAs had a valid knee system registered. Gaps emerge for two primary reasons: either an implant is not yet correctly recognised in the implant library (missing match with a catalogue or assigned to the wrong e-class category) or, and this is currently the bigger problem, not all implants are registered. E.g. a stem is registered but not the corresponding cup for a THA. Closing the remaining gap is an ongoing priority.

they are frequently implanted not in orthopaedic departments but in surgical trauma units. Thus, hip coverage is closer to 94% while knee coverage is close to 97% according to 2019 sales figures.

At the hospital level, we have also seen clear progress since 2017. For 2019, we observed that 70% of eligible hospitals were in the target zone of 90-110%. Only 15% of hospitals submitted fewer than 80% of eligible cases. These figures are shown in Figure 2.1., with coverage rates capped at 100%. It shows the individual coverage rates for 144 eligible hospitals as dots (axis on the right in percent) and additionally the sales figure volume per hospital as "spikes" (axis on the left in absolute numbers). From this presentation we can see that almost all hospitals with very low coverage rates are small volume hospitals, thus not affecting overall coverage very much. We also notice two very large volume providers that only achieved approx. 85% coverage in 2019. This relates to recognised IT-interface problems that occurred in the second half of 2019 and were resolved in the first half of 2020.

However, by the time of data export for this report it had not been possible to clear the backlog of cases not yet transferred. We are thus confident that the actual coverage rate for 2019 is indeed even higher; e.g. approx. one percentage point more is expected to be gained from those delayed cases alone. In fact, we have reason to believe that the registry already has a higher, but not officially counted, coverage rate. When cases are created in the SIRIS online system they need to be completed, including at least one implant registered for most types of procedures before they can be submitted to the registry and thus count. We know that a certain proportion of incomplete and unsubmitted cases are left in the system every year. The improvements in "official coverage" since 2017 are, to a certain extent, due to our working with hospitals to help them solve common submission problems. This work will continue. Thus it is likely that hospitals themselves are already capturing close to 99% of knee procedures in the system and approx. 96% of hip procedures, the remaining gap being under-coverage of hemiarthroplasties. However, as explained, for a variety of reasons not every case is then also submitted to the registry.

3. Summary of the SIRIS report 2020

In the past, the purpose of an implant registry was to document short-term and long-term results in the form of revision rates for various types of prostheses and specific implants. With increased demand for transparency, reoperation and revision rates from hospitals are now reported as well. First reports on clinical performance have been published in the Swedish hip registry. The English National Joint registry also reviews hospitals on their over or underperformance. On the other hand, the Australian and New Zealand Joint Registry provide no data concerning the performance of the participating hospitals. Following the Annual Report 2020, SIRIS data specific to hospitals will be published by ANQ on a website devoted to outcomes. This will show for the first time specific revision rates not only for various implants but also for participating institutions.
Demographic data such as gender, age, BMI (body mass index) ASA and Charnley scores, surgical techniques, surgical approach, prostheses types and other parameters such as fixation techniques and bearing surfaces are currently being recorded and evaluated as well.

The most important number when it comes to the credibility of a national implant registry is the coverage rate (rate of registered prostheses relative to a total number of actually implanted prostheses). As explained in Chapter 2, we can use two benchmarks for assessing the coverage rate of SIRIS. The first is the number of primary hip and knee prostheses (without trauma) reported by the federal office of public health (FOPH). In 2018, SIRIS reached coverage of 91.7% for hip prostheses (constant over the last 4 years) and 94.1% for knee prostheses (increasing constantly over the last four years). The second is the number of implants sold in Switzerland and this information is more up-to-date and thus available for 2019. On this basis, we estimate that approx. 94% of hip prostheses and approx. 97% of knee prostheses were actually included in SIRIS in 2019, which would represent a clear improvement over the previous year.

The revision rates were calculated from the number of revisions linked to patients ‘at risk’ (excluding deceased patients and those not residing in Switzerland). In order to be able to determine the number of patients ‘at risk’, SIRIS data were compared with those of the central compensation office ZAS in Geneva. Linked revisions are revisions that can be linked to a primary or revision procedure after the inception of SIRIS. Unlinked revisions are revisions of prostheses implanted prior to 2012, where the identification of the primary implant cannot be traced because the registry did not yet exist.

3.1 Overall volume of hip and knee surgery in relation to demography

Since its inception in 2012, SIRIS has registered more than 235,000 primary hip and knee procedures and over 10,000 linked and over 20,000 unlinked revisions. The absolute number of hip procedures registered in SIRIS has been growing steadily, with the annual growth rates since 2013 averaging more than 2.5%. However, the increase in the total number of procedures is caused, at least partially, by increasing coverage in the registry. In addition, these numbers need to be put in relation to demographic changes of the Swiss population. It seems apparent that the increase in both main procedures (primary hip and knee prostheses, excluding acute trauma) is broadly in line with the increase of the population "most at risk" to need those procedures (50 to 89 years of age).

Comparing the incidence of implantation of prostheses with incidences in other healthcare systems can be difficult, and interpretations must be made cautiously. It is usually 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 analysed. This report presents two calculations with different denominators: overall population and population "most at risk" (those who belong to the age group when this procedure is usually performed) (Figure 3.1 and 3.2). It should be noted, however, that these figures only include procedures registered in SIRIS and, because the registry's coverage is still incomplete, the actual annual incidence rates for Switzerland are approximately 3–8% higher, depending on the year under observation. It should also be noted that the registry's coverage rate improved in 2019. This implies that the apparent above-average increase in that year's incidence figures (Figure 3.1) is bound to be an indicator of this improvement. In other words, in 2019, SIRIS somewhat closed the gap between captured incidence and true incidence.

Figure 3.1
Incidence of primary total hip and total knee arthroplasties registered in SIRIS
Per 100,000 residents (most at-risk*)

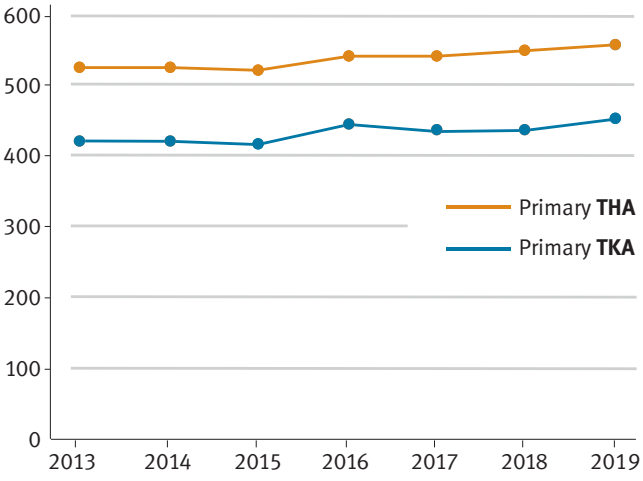
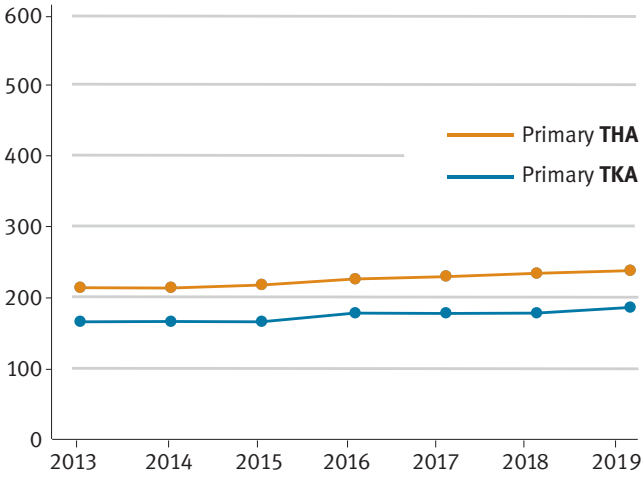


Figure 3.2
Incidence of primary total hip and total knee arthroplasties registered in SIRIS
Per 100,000 residents



* Age group 50–89 years accounts for 93% of all recipients of THA and 97% of all recipients of TKA

3.2 Prosthetic replacement of the hip, including hemiarthroplasty for fractures

Over the past seven years the SIRIS registry has documented the implantation of 134,673 primary total hip arthroplasties (THA). The male/female ratio and age has remained stable over this time. Implants are slightly more frequent in women (52.6%), and their mean age of 70.2 years is higher than in men (66.5 years).

Sixty-six percent of THA are implanted in patients over 65 years of age, of which 6.3% are older than 85 years. Patients younger than 55 constitute 12.3% of the recipients. The distribution among the age groups remained stable during the observation period.

The registry discriminates between THAs performed for primary osteoarthritis (84.6%), the largest group, and implantations done to treat secondary osteoarthrosis, including post-traumatic hip joint degeneration, avascular necrosis and sequels of childhood diseases like dysplasia and Perthes' disease (9.1%). The third group includes THAs for hip fractures (6.4%).

In order to get a more comprehensive view of hip fracture treatment in the elderly, but also in younger patients, the data of this cohort of patients are recorded and analysed for the first time in a separate chapter of the SIRIS report. The registry has covered a total number of 16,529 fractures of the hip since its start in 2012. Thirty-nine percent were treated with THA and 61% with hemiarthroplasty (HA). Women were more often affected at almost 70%. Patients older than 65 incurred 91.7% of the fractures. The age group above 85 accounts for 43.8% (Table 5.1).

Of patients receiving HA 91.3% were older than 75 years. A total of 356 patients younger than 55 years of age sustained a fracture of the hip. Of these 88% (n=316) were treated with THA. In the patients over 85 years of age 16% (n=1142) received THA and 84% (n=6,096) were treated with a HA.

Looking at hospitals treating different numbers of patients with hip fractures, you note an even distribution of the age ranges, with hospitals with smaller numbers (‹50 per year) having slightly more octogenarians. However, the percentage of patients treated by HA in these institutions is significantly higher, 85.7%, than the average of 55.8% (Table 5.3).

Regarding the main outcome parameters the registry

Table 3.1

Total and partial hip arthroplasty (THA & HA), primary and revisions/reoperations

Overall number of documented operations

Year	Primary THA	Primary HA	Primary total THA & HA	linked rev./reop. of THA	linked rev./reop. of HA	unlinked rev./reop. of THA & HA	rev./reop. total	linked rev./reop. [%]
2012*	6,687	643	7,330	113	6	785	905	13.1
2013	16,910	1,935	18,845	396	38	1,853	2,290	19.0
2014	17,193	2,050	19,243	563	62	1,891	2,518	24.8
2015	17,483	1,982	19,465	705	63	1,791	2,560	30.0
2016	18,444	2,013	20,457	812	89	1,680	2,581	34.9
2017	18,762	2,092	20,854	847	80	1,669	2,597	35.7
2018	19,297	2,265	21,562	947	103	1,555	2,605	40.3
2019	19,897	2,323	22,220	1,063	108	1,508	2,681	43.7
All	**134,673**	**15,303**	**149,976**	**5,446**	**549**	**12,732**	**18,737**	**32.0**

* Does not represent a full year of data, as data collection in most hospitals started only in October 2012

distinguishes now between “linked” and “unlinked” revisions/reoperations. “Unlinked” revisions or reoperations are those when the primary procedure was not registered in SIRIS. These are mainly hip or knee arthroplasties from before inception of the register in 2012. Their relative numbers are still substantial as of 2019, but falling steadily. The fact that “unlinked” revisions both tend to be from older primary implants and include a small but unrecognisable proportion of HA revisions is reflected in the different age distribution shown in Figure 3.3b.

Figure 3.3a

Age distribution at surgery of primary total hip arthroplasty and hemiarthroplasty

All documented operations

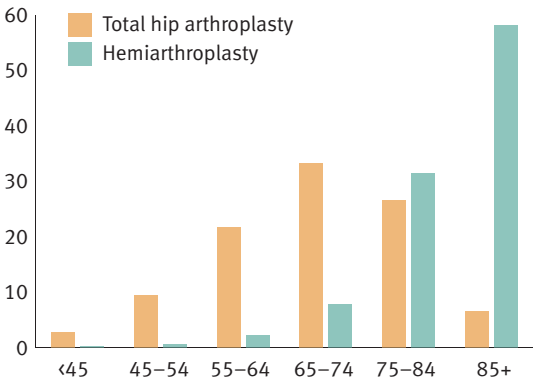


Figure 3.3b

Age distribution at surgery of revision/reoperation of total hip arthroplasty and hemiarthroplasty (linked/unlinked) All documented operations

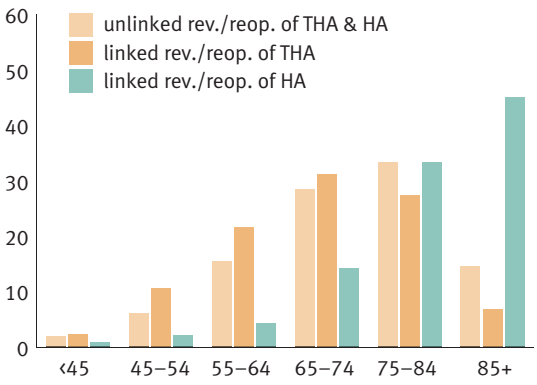


Figure 3.4

Kaplan Meier estimate of cumulative postoperative revision risk after primary hip arthroplasty

in percentages, 2013–2019, all services, all diagnoses

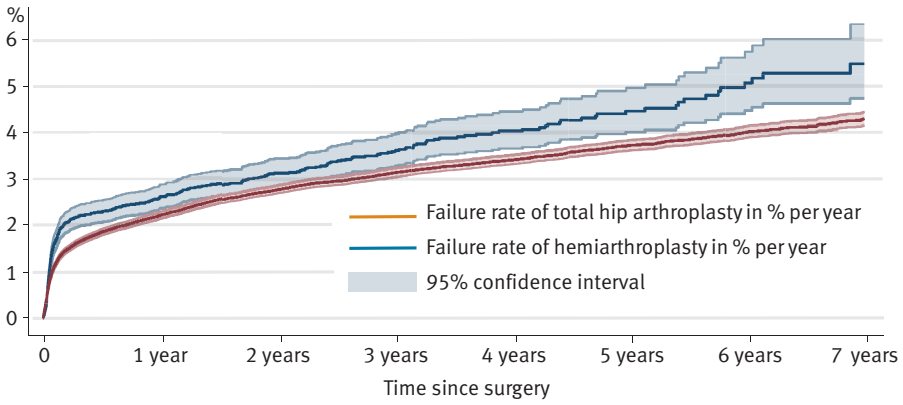


Table 3.2

Kaplan Meier estimate of cumulative postoperative revision risk after primary hip arthroplasty

in percentages, 2013–2019, all services, all diagnoses

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Total hip arthroplasty	2.2 (2.1-2.3)	2.8 (2.7-2.9)	3.1 (3.1-3.2)	3.4 (3.3-3.5)	3.7 (3.6-3.9)	4.0 (3.9-4.2)	4.3 (4.2-4.5)
Hemiarthroplasty	2.6 (2.4-2.9)	3.1 (2.9-3.5)	3.6 (3.3-4.0)	4.0 (3.7-4.5)	4.5 (4.0-5.0)	5.1 (4.5-5.7)	5.5 (4.7-6.3)

3.3 Prosthetic replacement of the knee, including partial knee replacement

In 2019, the total number of registered primary TKAs in the Swiss Joint Registry surpassed 100,000 cases with 72,021 cases during the period since 2015. The rate of women (60.7%) and mean age (69.5 years) remained constant during the entire period of time. The rate of TKAs in younger patients (younger than 45: 0.5% and 45–54 years old: 6.4%) and patients older than 85 years old (4.6%) has remained consistently low over the past years.

Gender, mean age, age groups and BMI did not differ in low or high volume hospitals, whereas hospitals with more than 200 TKAs per year seemed to treat more patients classified as ASA 3.

Most reasons for TKAs were classified as primary arthritis (88.5% in 2019) although more reasons (such as ligament lesions or infection) were introduced in 2015 as possible underlying diagnosis for secondary arthritis and the knowledge about factors causing a knee arthritis have steadily increased over the past decades.

Table 3.3

Total and partial knee arthroplasty (TKA, PKA)

All documented operations

Year	Primary TKA	Primary PKA	Primary total TKA & PKA	linked rev./reop. of TKA	linked rev./reop. of PKA	unlinked rev./reop. of TKA & PKA	rev./reop. total	linked rev./reop. [%]
2012*	4,698	880	5,578	19	2	508	529	4.0
2013	12,787	2,255	15,042	175	45	1,246	1,467	15.0
2014	13,132	2,193	15,325	392	97	1,115	1,607	30.4
2015	13,225	2,312	15,537	571	109	1,061	1,743	39.0
2016	14,459	2,408	16,867	815	182	1,138	2,142	46.5
2017	14,329	2,543	16,872	926	234	1,102	2,268	51.1
2018	14,630	2,612	17,242	1,021	247	1,083	2,358	53.8
2019	15,378	2,908	18,286	1,132	266	1,069	2,481	56.3
All	**102,638**	**18,111**	**120,749**	**5,051**	**1,182**	**8,322**	**14,595**	**42.7**

* Does not represent a full year of data, as data collection in most hospitals started only in October 2012

Figure 3.5

Age distribution at surgery of primary total and partial knee arthroplasty

All documented operations

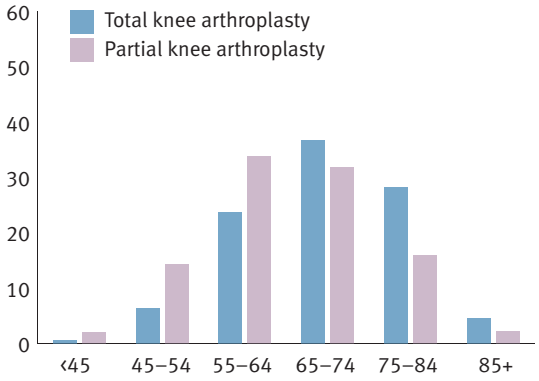
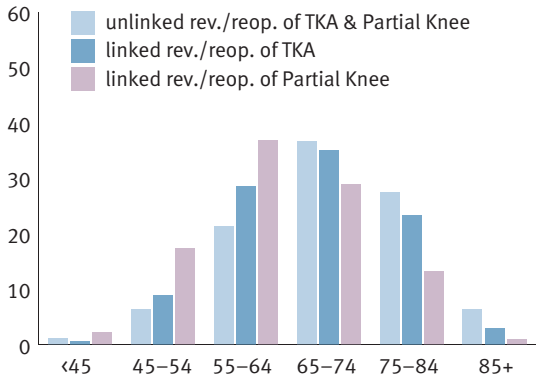


Figure 3.6

Age distribution at surgery of revision/reoperation of total and partial knee arthroplasty

All documented operations



Of all primary knee arthroplasties, 15.9% were partial knee replacements. The proportion has remained constant over the past five years. Women had 49.6% and the mean age at surgery was approximately 65 years. Partial knee arthroplasty was relatively more often implanted in younger patients (peak in the age group 55–64 years) whereas the peak for total knee arthroplasty was in the age group 65–74 years. Partial knee replacements comprised 80.6% performed in hospitals with more than 100 interventions per year.

The revision rate after partial compared to total knee arthroplasty is significantly higher after one year and this higher revision rate increases further up to 7 years after initial surgery (Figure 3.7).

Compared to hip prostheses, the numbers of "unlinked" knee revisions and reoperations are falling faster with more than half of all recorded procedures already belonging to the "linked" category. Here, too, we can see that "unlinked" revisions show an older age structure because they stem from older primary implantations (Figure 3.6).

Figure 3.7

Kaplan Meier estimate of cumulative postoperative revision risk after primary knee arthroplasty

in percentages, 2013–2019, all services, all diagnoses

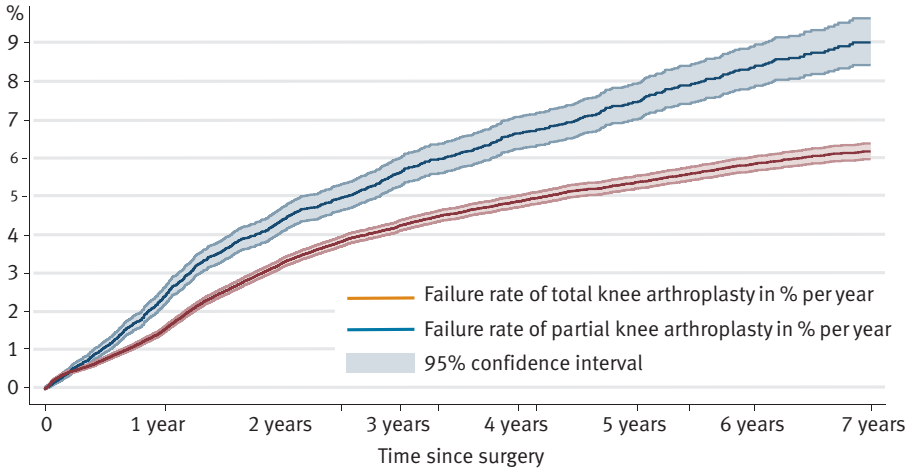


Table 3.4

Kaplan Meier estimate of cumulative postoperative revision risk after primary knee arthroplasty

in percentages, 2013–2019, all services, all diagnoses

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Total knee arthroplasty	1.5 (1.4-1.6)	3.3 (3.2-3.4)	4.3 (4.1-4.4)	4.9 (4.7-5.1)	5.4 (5.2-5.6)	5.9 (5.7-6.1)	6.2 (6.0-6.4)
Partial knee arthroplasty	2.4 (2.2-2.6)	4.4 (4.1-4.7)	5.6 (5.3-6.0)	6.7 (6.3-7.1)	7.5 (7.0-8.0)	8.4 (7.9-8.9)	9.1 (8.5-9.7)

3.4 Implant-specific outcomes

SIRIS regards the rate of implant revision for any reason as the first outcome of interest. In order to minimize random effects, 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 revision rates for implants with fewer than 500 procedures should be interpreted cautiously. Thus, readers are advised to pay close attention to the reported confidence intervals which increase with smaller numbers.

Implant categories with sufficient numbers overall have been analysed for so-called outlier implants. An implant may be considered a "statistical outlier" if its revision rate deviates markedly from the 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 more than twice that reference revision rate.

All potential outliers were evaluated and discussed by the SIRIS Scientific Advisory Board, and for each of these implants a separate outlier analysis was conducted and an outlier report written. When the results of the analyses suggested a justifiable need for action, the SIRIS Scientific Advisory Board changed the outlier's status from "potential outlier" to "confirmed outlier". Any potential random or hospital effects were analysed, as well as the dynamics of use of the implant during the observation period with concise comments from 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 and orthopaedic units that used, still use or intend to use these implants also need to be informed about the SIRIS observations. Therefore, the manufacturers involved and hospital and units received confidential outlier reports before publication of this report.

3.5 Reporting of prostheses-related revision rates by hospitals

More than 150 hospital services in Switzerland provide hip and knee arthroplasty procedures and SIRIS has achieved 100% coverage of these since 2018. Median procedure figures per hospital (Table 3.5) reveal a stable picture over time, with only minimal fluctuation since the registry's first operating year in 2013. Tables 3.6 and 3.7 and Figures 3.8 and 3.9, highlight the distribution of case numbers within service size categories. It is noteworthy that a relatively large number of small units perform a minority of the total procedures, while a small number of large services perform a higher (THA) or nearly as high (TKA) proportion of procedures.

Table 3.5

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

		2013	2014	2015	2016	2017	2018	2019
Primary total hip arthroplasty	N services	150	149	151	157	153	154	152
	M per service	85	84	82	86	87	86	87
Primary hemiarthroplasty	N services	130	131	138	143	136	125	126
	M per service	10.5	11	9	9	9	10	10
Revision arthroplasty of the hip	N services	125	128	133	127	131	127	137
THA and HA	M per service	9	9	10	9	9	9	10
Primary total knee arthroplasty	N services	146	148	150	149	149	151	148
	M per service	78	71	67	75	72	78	79
Primary partial knee arthroplasty	N services	117	123	125	128	127	129	127
	M per service	34	40	42	48	44	41	41
Revision arthroplasty of the knee	N services	122	127	126	131	130	134	133
TKA and partial knee	M per service	7.5	7	7	8	9.5	9	9

Table 3.6

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

Service volume		2013	2014	2015	2016	2017	2018	2019
<100	N procedures/%	3,021/**17.9**	3,110/**18.1**	3,451/**19.9**	3,599/**19.7**	3,190/**17.2**	3,155/**16.3**	2,627/**13.2**
	N services	76	75	83	85	79	77	68
100–199	N procedures/%	6,143/**36.4**	6,158/**35.9**	5,287/**30.5**	5,406/**29.6**	5,695/**30.6**	5,644/**29.2**	6,435/**32.3**
	N services	49	50	41	43	44	43	50
200–299	N procedures/%	3,146/**18.6**	2,836/**16.5**	3,874/**22.3**	3,630/**19.9**	4,499/**24.2**	4,199/**21.8**	4,311/**21.7**
	N services	14	12	17	16	19	19	19
>300	N procedures/%	4,581/**27.1**	5,054/**29.5**	4,744/**27.3**	5,628/**30.8**	5,213/**28.0**	6,299/**32.6**	6,524/**32.8**
	N services	11	12	10	13	11	15	15

Table 3.7

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

Service volume		2013	2014	2015	2016	2017	2018	2019
<100	N procedures/%	3,860/**29.9**	3,735/**28.2**	3,688/**27.7**	3,838/**26.5**	3,086/**21.5**	3,554/**24.3**	3,094/**20.1**
	N services	91	94	97	94	86	91	82
100–199	N procedures/%	4,476/**34.6**	3,863/**29.1**	3,459/**26.0**	3,622/**25.0**	4,810/**33.5**	4,326/**29.6**	4,484/**29.2**
	N services	37	31	29	29	39	33	37
200–299	N procedures/%	2,232/**17.3**	2,958/**22.3**	2,516/**18.9**	2,640/**18.2**	2,940/**20.5**	3,272/**22.4**	3,450/**22.4**
	N services	11	14	12	13	14	14	17
>300	N procedures/%	2,360/**18.3**	2,707/**20.4**	3,650/**27.4**	4,375/**30.2**	3,528/**24.6**	3,478/**23.8**	4,350/**28.3**
	N services	6	7	10	12	9	9	12

Figures 3.10 to 3.13 show funnel plots of risk adjusted revision rates (age and sex, as well as BMI, ASA, Charnley scores, if available) for total hip arthroplasty and hemiarthroplasty as well as total and partial knee arthroplasty procedures. On funnel plots, each dot represents a hospital service and they were centred 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 indicating the surgical units which performed more operations within the reporting period.

Funnel plots include control limits to define the range within which outcomes are expected to be. Following convention, 99.8% control limits were used as the outer limit. It is unlikely for a hospital 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 in Switzerland is relatively homogeneous, but there are exceptions, and there appears to be more variation with knee than with hip procedures.

Figure 3.8

Cases per hospital service 2019: Total hip arthroplasty and hemiarthroplasty

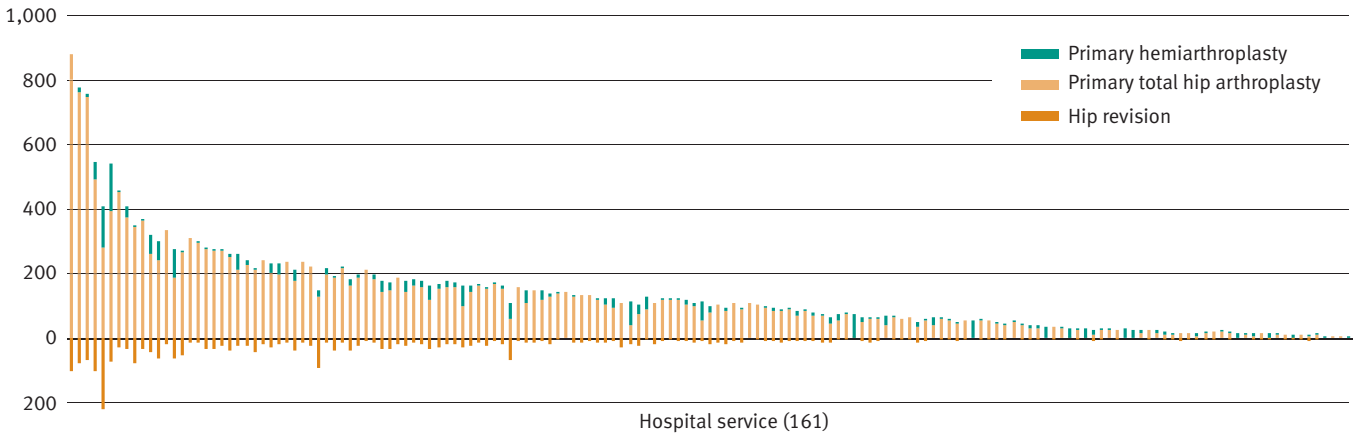


Figure 3.9

Cases per hospital service 2019: Total and partial knee arthroplasty

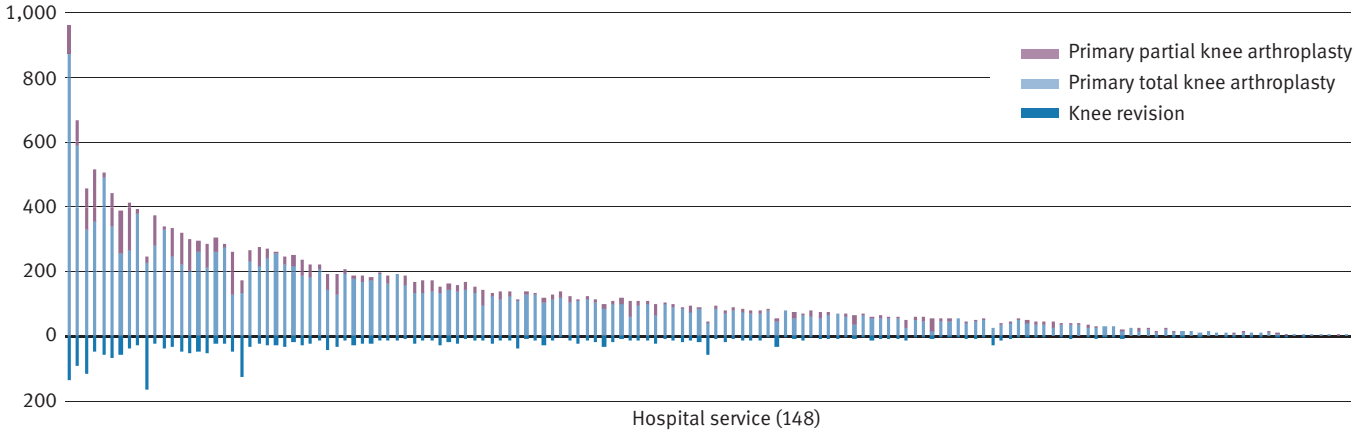
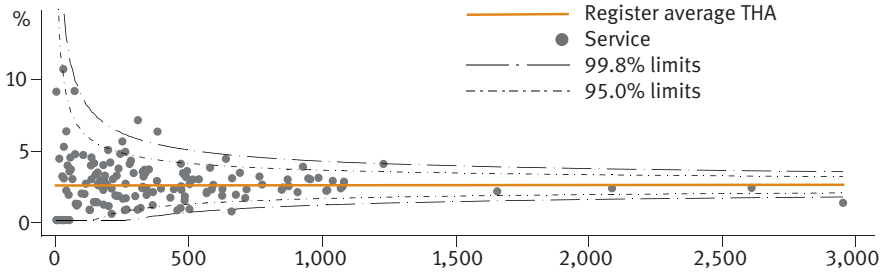


Figure 3.10

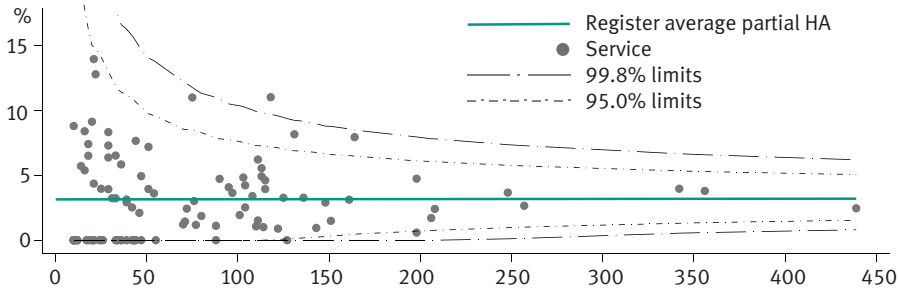
2-year revision rate of primary total hip arthroplasty by service



Number of THA operation in the reporting period 07/2014–06/2018 (4-year moving average, follow-up to 06/2020)

Figure 3.11

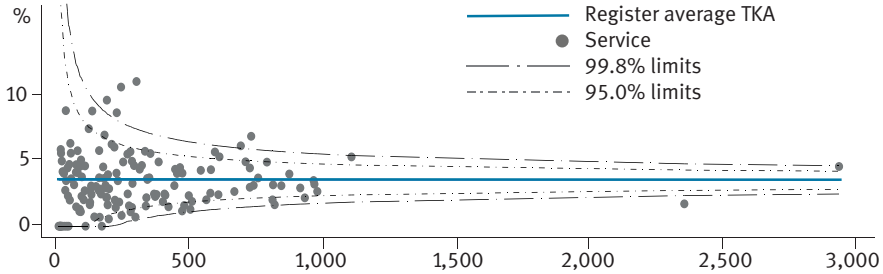
2-year revision rate of primary hemiarthroplasty by service



Number of HA operation in the reporting period 07/2014–06/2018 (4-year moving average, follow-up to 06/2020)

Figure 3.12

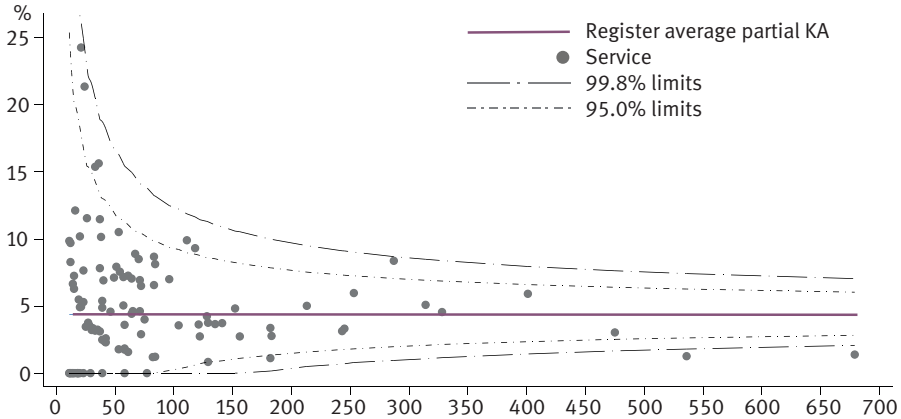
2-year revision rate of primary total knee arthroplasty by service



Number of TKA operation in the reporting period 07/2014–06/2018 (4-year moving average, follow-up to 06/2020)

Figure 3.13

2-year revision rate of partial knee arthroplasty by service



Number of KA operation in the reporting period 07/2014–06/2018 (4-year moving average, follow-up to 06/2020)

4. Hip arthroplasty

4.1 Primary total hip arthroplasty

Over the past seven years the SIRIS registry has documented 134,673 primary total hip arthroplasties (THA) (Table 4.1). The male/female ratio and the age at implantation has remained stable over these years. Hip implants are slightly more frequent in women (52.6%), and their mean age of 70.2 years is higher than in men (66.5 years).

Sixty-six percent of THA are performed in patients older than 65 years of age and 6.3% of implants are 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 of seven years.

The registry distinguishes between THAs performed for primary osteoarthritis (84.6%) – the largest group – and implants done to treat secondary os-

Table 4.1

Primary total hip arthroplasty: Baseline patient characteristics by year

2012–2019. BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**40,790**	**17,483**	**18,444**	**18,762**	**19,297**	**19,897**	**93,883**
Diagnosis [%]	Primary OA	85.5	84.2	83.2	83.9	83.8	83.2	83.6
	Secondary OA	8.7	9.4	10.3	9.5	9.2	9.1	9.5
	Fracture	5.8	6.4	6.5	6.6	7.0	7.8	6.9
Women [%]		52.2	52.6	52.9	53.1	53.4	53.0	53.0
Mean age (SD)	All	68.2 (11.6)	68.6 (11.5)	68.5 (11.5)	68.5 (11.5)	68.9 (11.5)	69.1 (11.5)	68.7 (11.5)
	Women	69.9 (11.3)	70.4 (11.2)	70.3 (11.2)	70.3 (11.2)	70.6 (11.2)	70.8 (11.2)	70.5 (11.2)
	Men	66.3 (11.6)	66.6 (11.6)	66.4 (11.6)	66.5 (11.5)	66.9 (11.5)	67.1 (11.6)	66.7 (11.6)
Age group [%]	<45	3.1	2.6	2.9	2.6	2.3	2.5	2.6
	45–54	9.6	9.6	9.4	9.5	9.3	8.6	9.3
	55–64	21.8	21.3	21.6	21.7	21.6	21.6	21.6
	65–74	33.5	33.7	34.2	33.6	32.7	32.2	33.2
	75–84	26.1	26.2	25.6	26.2	27.1	27.7	26.6
	85+	5.9	6.7	6.3	6.4	7.0	7.3	6.8
N unknown BMI (%)			4,535 (26)	3,842 (21)	3,405 (18)	3,124 (16)	2,985 (15)	17,891 (19)
N known BMI			12,948	14,602	15,357	16,173	16,912	75,992
Mean BMI (SD)			27.1 (5.0)	27.2 (5.4)	27.1 (5.1)	27.2 (5.5)	27.0 (5.1)	27.1 (5.2)
BMI [%]	<18.5		1.8	1.9	1.8	2.1	2.1	1.9
	18.5–24.9		35.1	34.8	35.3	34.9	35.6	35.1
	25–29.9		38.9	39.2	38.9	38.2	39.1	38.8
	30–34.9		17.1	17.5	17.0	17.5	16.6	17.2
	35–39.9		5.4	4.9	5.2	5.4	5.1	5.2
	40+		1.7	1.7	1.7	2.0	1.5	1.7
N unknown ASA (%)			2,420 (14)	2,258 (12)	2,028 (11)	1,804 (9)	1,590 (8)	10,100 (11)
N known ASA			15,063	16,186	16,734	17,493	18,307	83,783
Morbidity	ASA 1		16.4	14.7	13.3	12.0	12.1	13.6
state [%]	ASA 2		58.2	59.5	60.0	59.5	59.0	59.2
	ASA 3		24.8	25.1	26.1	27.6	28.0	26.4
	ASA 4/5		0.6	0.8	0.6	0.9	0.9	0.8

Table 4.2

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

		Primary OA	Secondary OA	Fracture
N (2015–2019)		**78,512**	**8,918**	**6,453**
Women [%]		51.5	57.1	65.8
Mean age (SD)	All	68.8 (10.9)	64.0 (15.1)	74.2 (10.9)
	Women	70.6 (10.5)	66.0 (15.0)	75.2 (10.3)
	Men	66.9 (11.0)	61.4 (14.8)	72.3 (11.6)
Age group [%]	<45	1.8	10.4	0.8
	45–54	8.9	16.6	4.1
	55–64	22.2	21.6	13.4
	65–74	34.7	23.4	28.8
	75–84	26.6	20.5	35.2
	85+	5.8	7.5	17.7
Diagnosis [%]	Osteoarthritis	100.0	0.0	0.0
	Inflammatory arthritis	0.0	5.1	0.0
	Developmental dysplasia	0.0	20.8	0.0
	Osteonecrosis	0.0	52.1	0.0
	Miscellaneous	0.0	22.0	0.0
	Fracture	0.0	0.0	100.0
N unknown BMI (%)		14,795 (19)	1,390 (16)	1,706 (26)
N known BMI		63,717	7,528	4,747
Mean BMI (SD)		27.4 (5.2)	26.7 (5.6)	24.3 (4.5)
BMI [%]	<18.5	1.4	3.0	7.7
	18.5–24.9	33.2	39	54.8
	25–29.9	40.0	35.8	27.7
	30–34.9	18.0	15.8	7.6
	35–39.9	5.5	4.7	1.6
	40+	1.8	1.9	0.5
N unknown ASA		8,728 (11)	752 (8)	620 (10)
N known ASA		69,784	8,166	5,833
Morbidity state	ASA 1	13.9	15.4	7.0
[%]	ASA 2	61.1	52.5	46.9
	ASA 3	24.5	30.7	42.9
	ASA 4/5	0.5	1.4	3.2

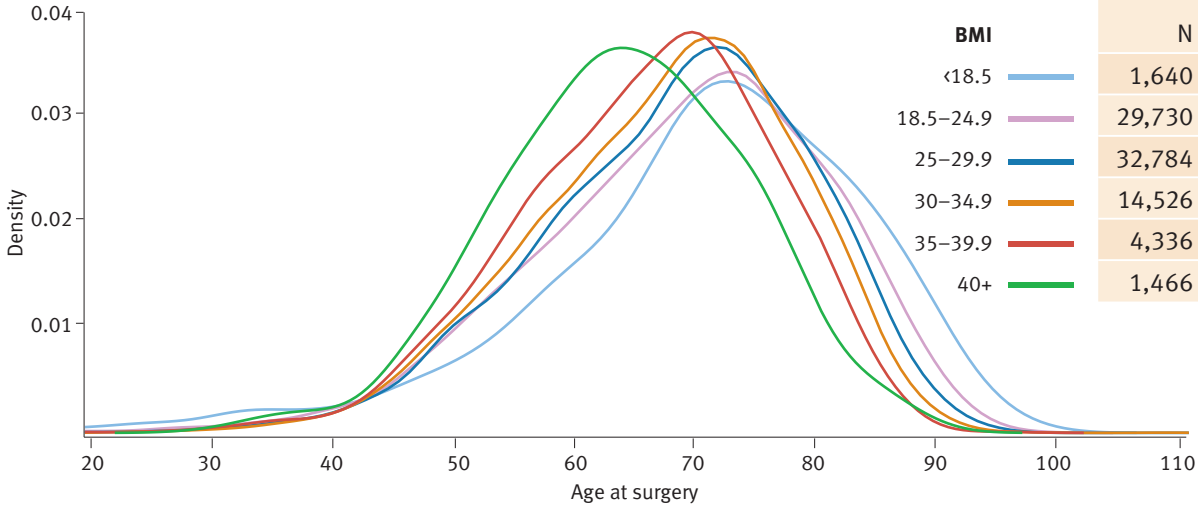
teoarthrosis, including post-traumatic hip joint degeneration, avascular necrosis and sequels of childhood diseases like dysplasia and Perthes' disease (9.1%). The third group includes THAs for fractures of the hip (6.4%).

Data on BMI and the ASA score have been recorded since 2015. Data collection has improved over time. In the first year of recording, 34.8% of the BMI data were missing; this has improved although 15% of BMI data were still missing in 2019 (Table 4.1). The rate of missing BMI is higher in revised hips and was 20% in 2019 (Table 4.11). The documentation of BMI is important and of interest for any service and for the surgeons. BMI is a risk factor for an increased revision rate. In-house calculations have shown that skipping this information may increase the probability of the service or a surgeon reaching an outlier status, when variables that are used for risk-adjustment are omitted. Recording the ASA score is better. Altogether, documentation has improved concerning missing data from 15.9% in 2015 to 11% in 2019. The mean BMI was 27.4 kg/m2 for all patients with primary osteoarthritis (OA); 40% THAs were performed in overweight patients (BMI 25-29.9) and 25.3% in obese patients. Obesity is more frequent in younger patients. Increased patient BMI was associated with younger age at surgery (Figure 4.1). The distribution of BMI remained constant during the observation period. The majority of procedures were performed on healthy individuals; 26.4% of the implants are performed in ASA class ≥3. There was a slight decrease of ASA 1 and slight increase of patients with ASA 3 over time.

Figure 4.1

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

Primary and secondary osteoarthritis patients only. Please note that group sizes vary considerably (see table 4.2)



BMI	N	Mean age at time of THA
<18.5	1,640	71.7
18.5–24.9	29,730	69.6
25–29.9	32,784	68.9
30–34.9	14,526	67.6
35–39.9	4,336	66.0
40+	1,466	64.0

Table 4.3

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

Calculations of hospital service volume based on primary hip surgeries in each included year (2015-2019).

Hospital service volume		<100	100–199	200–299	300+
N (2015–2019)		**15,255**	**28,586**	**21,246**	**28,796**
Women [%]		52.6	52.8	52.8	53.7
Mean age (SD)	All	69.7 (11.1)	69.0 (11.4)	68.9 (11.2)	67.8 (12.0)
	Women	71.6 (10.6)	70.8 (11.0)	70.6 (10.9)	69.6 (11.8)
	Men	67.7 (11.2)	67.0 (11.6)	66.9 (11.2)	65.7 (12.0)
Age group [%]	<45	1.7	2.3	2.2	3.6
	45–54	8.2	9.0	9.0	10.3
	55–64	20.3	21.3	21.5	22.5
	65–74	33.8	33.0	34.2	32.5
	75–84	28.3	27.5	26.5	24.9
	85+	7.7	6.9	6.6	6.2
Diagnosis [%]	Primary OA	83.9	82.9	86.8	81.8
	Secondary OA	8.2	8.5	7.8	12.5
	Fracture	7.9	8.6	5.4	5.7
N unknown BMI (%)		3,631 (24)	5,808 (20)	4,791 (23)	3,661 (13)
N known BMI		11,624	22,778	16,455	2,5135
Mean BMI (SD)		27.2 (5.2)	27.3 (5.2)	27.1 (5.4)	26.9 (5.1)
BMI [%]	<18.5	1.8	1.8	2.0	2.1
	18.5–24.9	34.6	34.1	35.0	36.4
	25–29.9	39.1	39.0	39.2	38.4
	30–34.9	17.6	17.6	17.0	16.6
	35–39.9	5.1	5.6	5.1	4.9
	40+	1.8	1.9	1.7	1.5
N unknown ASA (%)		928 (6)	2,894 (10)	3,147 (15)	3,131 (11)
N known ASA		14,327	25,692	18,099	25,665
Morbidity state [%]	ASA 1	14.6	14.5	13.3	12.3
	ASA 2	59.2	58.5	62.0	58.0
	ASA 3	25.3	26.1	24.1	29.0
	ASA 4/5	0.8	0.9	0.6	0.7

Patients treated for secondary OA were five years younger on average than those treated for primary OA. Secondary OA due to hip dysplasia accounted for one-fifth of these cases, which is 1.9% of all arthritic hips. Of all hips, 4.9% were treated for avascular necrosis. Compared to the other main diagnostic groups there are significantly more young patients treated for secondary OA (10.4% are younger than 45 years of age).

Considerably more women were affected by fractures than men. They accounted for two-thirds of all patients sustaining hip fractures. The average age of women with fractures is 75.2 years compared to men at 72.3 years. More than 80% occur in patients over 65 and more than 50% over 75 years. There is also a much higher proportion of patients in the fracture group belonging to ASA class ≥3. In chapter 5 there is a detailed analysis of patients with hip fractures including and comparing treatment with THA and hemiarthroplasty (HA).

Between 2015 and 2019, 93,883 THAs were implanted in 115 orthopaedic units in Switzerland. Of these 28,796 or 31% were implanted in 15 servicesthat do more than 300 cases per year. Their numbers of secondary OA (33%) in younger patients (36%) is also higher than in other hospitals (Table 4.3).

With minimal variations the percentage of the fixation methods have remained stable over the last five

Table 4.4

Primary total hip arthroplasty: Surgery characteristics by main diagnostic group

Main diagnostic group		Primary OA		Secondary OA		Fracture	
N (2015–2019)		**N**	**%**	**N**	**%**	**N**	**%**
Previous surgery	None			6,934	77.8	5,748	89.1
	Internal fixation femur			466	5.2	498	7.7
	Osteotomy femur			342	3.8	35	0.5
	Internal fixation acetabulum			61	0.7	41	0.6
	Osteotomy pelvis			169	1.9	6	0.1
	Arthrodesis			5	0.1	4	0.1
	Other previous surgery			1,008	11.3	143	2.2
Intervention	Total hip replacement	78,490	100.0	8,913	99.9	6,453	100.0
	Hip resurfacing	22	0.0	5	0.1	0	0.0
Approach	Anterior	36,749	46.8	3,787	42.6	3,016	46.8
	Anterolateral	25,498	32.5	2,928	32.9	1,798	27.9
	Posterior	10,848	13.8	1,351	15.2	934	14.5
	Lateral	4,763	6.1	644	7.2	568	8.8
	Other approach	592	0.8	190	2.1	132	2.0
Fixation	All uncemented	68,081	86.7	7,043	79.0	3,062	47.5
	Hybrid*	8,742	11.1	1,195	13.4	2,566	39.8
	All cemented	1,099	1.4	415	4.7	585	9.1
	Reverse hybrid**	415	0.5	158	1.8	128	2.0
	Reinforcement ring, femur uncemented	88	0.1	36	0.4	38	0.6
	Reinforcement ring, femur cemented	87	0.1	71	0.8	74	1.1

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

Tables 4.5 and Figures 4.2

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

Table 4.5a

Primary osteoarthritis

Relative distribution per year in %

	2012–2014	2015	2016	2017	2018	2019
	0.1	0.2	0.2	0.1	0.1	0.1
	0.1	0.1	0.1	0.1	0.2	0.1
	0.7	0.6	0.5	0.6	0.5	0.4
	11.4	11.6	11.2	10.6	10.9	11.4
	86.4	86.0	86.9	87.0	86.9	86.8
	1.3	1.6	1.2	1.6	1.4	1.2
N	**34,885**	**14,721**	**15,343**	**15,739**	**16,162**	**16,547**

Figure 4.2a

Primary osteoarthritis

Relative distribution per year in %

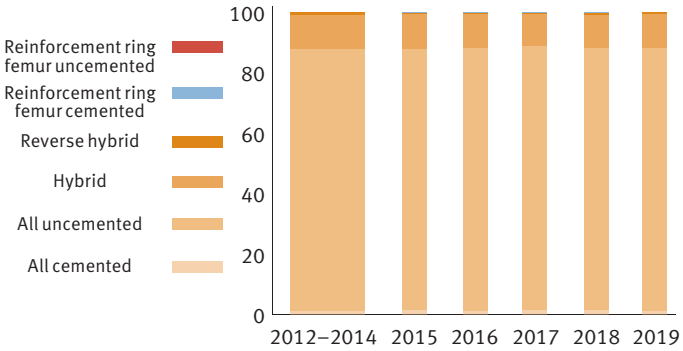


Table 4.5b

Secondary osteoarthritis

Relative distribution per year in %

	2012–2014	2015	2016	2017	2018	2019
	0.8	0.5	0.4	0.3	0.6	0.3
	1.0	0.7	0.7	0.8	0.7	1.1
	1.8	2.0	1.7	1.6	1.9	1.6
	15.1	13.0	14.0	13.4	12.4	14.1
	77.3	79.6	78.1	79.1	79.5	78.7
	4.1	4.2	5.1	4.7	5.0	4.2
N	**3,547**	**1,647**	**1,906**	**1,779**	**1,779**	**1,807**

Figure 4.2b

Secondary osteoarthritis

Relative distribution per year in %

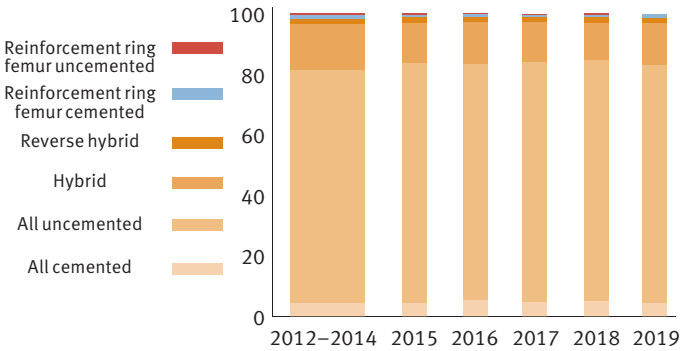


Table 4.5c

Fracture

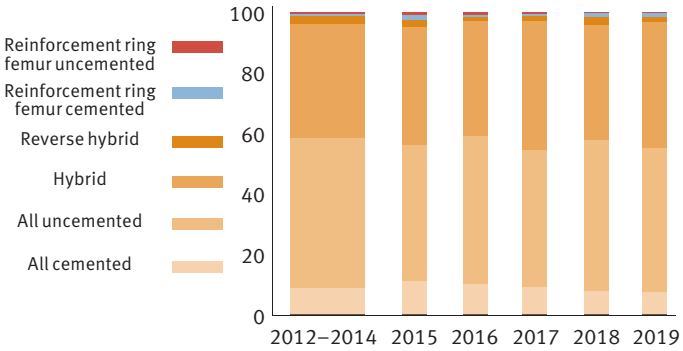
Relative distribution per year in %

	2012–2014	2015	2016	2017	2018	2019
	0.5	0.9	0.8	0.6	0.4	0.4
	0.8	1.6	0.9	0.7	1.3	1.2
	2.5	2.2	1.4	1.8	2.7	1.8
	38.0	39.3	37.7	42.4	37.8	41.4
	49.3	44.9	49.0	45.3	49.9	47.7
	8.9	11.1	10.2	9.2	8.0	7.5
N	**2,358**	**1,115**	**1,195**	**1,244**	**1,356**	**1,543**

Figure 4.2c

Fracture

Relative distribution per year in %



years (Tables 4.5, Figures 4.2) for all three diagnostic groups. In the secondary OA group relatively more acetabular reinforcement rings were used, reflecting more complex surgeries. To treat hip fractures, significantly more stems were cemented and more hybrid fixations used.

The anterior approach is by far the most commonly used approach in Switzerland, followed by the anterolateral approach. In 2019, these two approaches were used in more than 80% of all primary THA implants. Since the start of recording approaches in 2015, using the anterior approach has gradually increased, while the use of lateral and posterior approaches is declining (Table 4.4 and 4.6). The approach chosen depends on the experience and training of the surgeon. The distribution of the approaches per canton are shown in Figure 4.3.

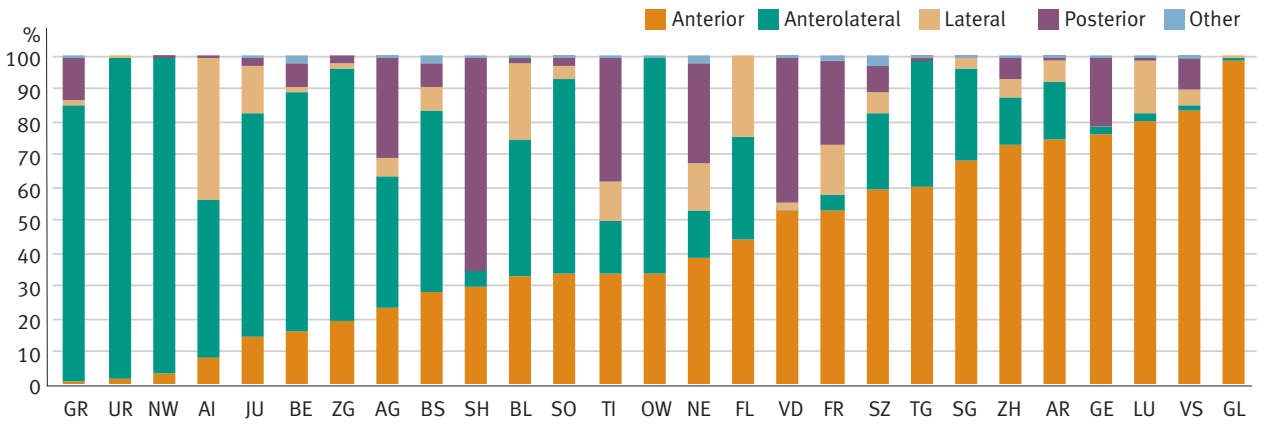
Table 4.6

Primary total hip arthroplasty: Surgical approach by year (in%)

	2015	2016	2017	2018	2019	2015–2019
Anterior	41.9	43.7	47.8	48.5	49.7	46.4
Anterolateral	33.1	32.5	31.5	32.2	31.8	32.2
Lateral	8.3	7.7	6.2	5.1	4.9	6.4
Posterior	15.4	15.2	13.6	13.3	12.7	14.0
Other approach	1.3	0.8	0.9	0.9	1.0	1.0
Total [N]	**17,398**	**18,444**	**18,762**	**19,297**	**19,897**	**93,798**

Figure 4.3

Relative share of total hip arthroplasty procedures using different approaches by Swiss Canton and Principality of Liechtenstein (2015–2019)



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 problems with MoPE were osteolysis and loosening of the implants. Therefore, several improvements were introduced including highly crosslinked PE (XLPE) which has superior wear resistance. The metallic femoral heads were gradually replaced with ceramic femoral heads, metal on metal (MoM) and ceramic on ceramic (CoC) bearings were developed to minimize wear. Currently, the most frequently used bearing in Switzerland is CoXLPE, used in 57.1% of all cases (Table 4.7). The use of CoPE has also increased from 12.2% in 2013 to 14.8% in 2019. The application of MoPE remained low during the observation period. Since the inception of the registry practically no MoM bearings have been used, most likely due to the common severe complications and excessively high revision rates of such bearings, especially those with large diameter femoral heads. The use of CoC bearings has remained stable at approximately 15% (Table 4.7).

Table 4.7
Primary total hip arthroplasty: bearing surface* in primary osteoarthritis by year (in %)

Bearing surface	2012–2014	2015	2016	2017	2018	2019	2015–2019
Metal on polyethylene (PE) (MoPE)	2.4	2.4	2.2	2.1	2.0	1.9	2.1
Ceramic on PE (CoPE)	12.8	13.4	12.7	13.1	14.1	14.8	13.6
Metal on cross-linked PE (MoXLPE)	20.4	15.4	13.3	11.8	11.8	11.0	12.6
Ceramic on cross-linked PE (CoXLPE)	48.1	52.6	55.6	57.6	57.3	57.1	56.1
Metal on metal (MoM)	0.04	0.03	0.04	0.05	0.00	0.00	0.02
Ceramic on ceramic (CoC)	16.2	16.1	16.1	15.4	14.8	15.1	15.5
Other	0.02	0.01	0.01	0.01	0.00	0.00	0.01
N (bearing surface known)	33,512	14,352	15,017	15,311	15,723	15,815	76,218
N (bearing surface unknown)	1,373	369	326	428	439	732	2,294

* Femoral heads and acetabular inserts/monobloc cups

Table 4.8
Primary total hip arthroplasty: bearing surface* in primary osteoarthritis by age (in %)
Figures shown for 2015–2019

	<45	45–54	55–64	65–74	75–84	85+	All
Metal on polyethylene (MoPE)	0.2	0.4	0.4	1.1	4.1	8.9	2.1
Ceramic on polyethylene (CoPE)	9.7	10.1	10.7	12.9	17.0	21.1	13.6
Metal on cross-linked polyethylene (MoXLPE)	11.9	10.4	10.8	12.2	14.3	18.3	12.6
Ceramic on cross-linked polyethylene (CoXLPE)	54.5	57.0	58.4	58.3	53.6	44.3	56.1
Metal on metal (MoM)	0.07	0.04	0.04	0.03	0.00	0.00	0.02
Ceramic on ceramic (CoC)	23.6	22.2	19.7	15.4	11.0	7.3	15.5
Other	0.00	0.00	0.00	0.00	0.02	0.00	0.01
N (bearing surface known)	1,378	6,785	17,018	26,511	20,202	4,313	76,207
N (bearing surface unknown)	52	167	432	756	669	218	2,294

* Femoral heads and acetabular inserts/monobloc cups

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

All uncemented fixations are standard for primary THAs in primary OA in this registry and account for 86.7% of all hips with primary OA. SIRIS shows that more than 90% of patients under the age of 75 receive all uncemented prostheses. As age increases, more and more THAs are cemented. Approximately 40% of stems in patients older than 85 years of age are cemented. Female patients have significantly more cemented stems than male patients (Tables 4.9 and 4.10).

Table 4.9

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

Figures shown for 2015–2019

	<45	45–54	55–64	65–74	75–84	85+	All
All cemented	0.3	0.4	0.4	0.7	2.4	7.0	1.4
All uncemented	95.6	97.0	95.6	90.7	76.6	56.6	86.7
Hybrid*	2.4	2.2	3.4	8.0	20.1	34.6	11.1
Reverse hybrid**	1.5	0.3	0.4	0.4	0.7	1.3	0.5
Reinforcement ring, femur cemented	0.00	0.06	0.08	0.09	0.14	0.35	0.11
Reinforcement ring, femur uncemented	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N	1,430	6,952	17,450	27,267	20,871	4,531	78,501

Table 4.10

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

Figures shown for 2015–2019

	Women	Men	All
All cemented	1.9	0.8	1.4
All uncemented	82.1	91.6	86.7
Hybrid*	14.9	7.1	11.1
Reverse hybrid**	0.7	0.3	0.5
Reinforcement ring, femur cemented	0.16	0.06	0.11
Reinforcement ring, femur uncemented	0.1	0.1	0.1
N	40,442	38,070	78,512

* acetabulum uncemented, femur cemented

** acetabulum cemented, femur uncemented

4.2 Revision of total hip arthroplasty

SIRIS has been recording all hip procedures since 2012, including a number of hip prostheses that were revised, having been implanted prior to 2012. For these implants no comprehensive information is available. Therefore, baseline data of the primary interventions like diagnosis, approach, BMI, ASA etc. cannot be reported here. Table 4.11 shows the demographic data for all revisions performed since 2012.

Revisions since 2012 constitute 12% of all hip procedures. Among the 17,913 THA revisions documented over the entire data collection period, approximately 51% were performed on women (Table 4.11); during the period from 2015 to 2019 with the mean age at

Table 4.11

Revision of total hip arthroplasty: Baseline patient characteristics by year

2012–2019, BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**5,480**	**2,452**	**2,462**	**2,489**	**2,480**	**2,550**	**12,433**
Women [%]		51.5	49.1	52.0	49.7	51.1	51.6	50.7
Mean age (SD)	All	70.4 (12.0)	71.1 (12.1)	70.8 (11.9)	71.4 (11.9)	71.9 (11.8)	72.2 (11.5)	71.5 (11.9)
	Women	71.7 (12.1)	73.3 (12.0)	71.9 (11.9)	72.8 (12.0)	72.9 (12.1)	73.5 (11.3)	72.9 (11.9)
	Men	68.9 (11.8)	69.0 (11.8)	69.6 (11.8)	70.0 (11.7)	70.8 (11.4)	70.8 (11.5)	70.0 (11.7)
Age group [%]	<45	2.5	2.6	2.3	2.2	1.9	1.2	2.0
	45–55	8.2	6.8	8.0	7.8	7.5	6.3	7.3
	55–65	18.9	18.1	17.5	15.5	15.8	17.7	16.9
	65–75	29.0	29.8	31.0	30.4	29.4	28.4	29.8
	75–85	31.1	30.7	30.1	31.4	32.2	32.3	31.3
	85+	10.2	12.1	11.2	12.7	13.3	14.2	12.7
N unknown BMI (%)			767 (31)	531 (22)	526 (21)	508 (20)	518 (20)	2,850 (23)
N known BMI			1,685	1,931	1,963	1,972	20,32	9,583
Mean BMI (SD)			27.3 (5.3)	27.6 (5.7)	27.2 (5.5)	27.3 (5.6)	27.4 (7.1)	27.4 (5.9)
BMI [%]	<18.5		2.6	2.1	2.4	2.6	2.1	2.3
	18.5–24.9		34.7	32.2	36.1	34.2	36.8	34.8
	25–29.9		37.6	38.5	35.9	36.6	35.1	36.7
	30–34.9		16.4	18.0	17.7	17.8	16.6	17.3
	35–39.9		6.9	6.9	5.1	5.8	6.2	6.2
	40+		1.8	2.3	2.8	2.9	3.2	2.7
N unknown ASA (%)			395 (16)	332 (13)	379 (15)	283 (11)	283 (11)	1,672 (13)
N known ASA			2,057	2,130	2,110	2,197	2,267	10,761
Morbidity state	ASA 1		9.1	7.5	6.4	6.1	4.4	6.6
[%]	ASA 2		48.2	50.0	46.8	45.0	43.3	46.6
	ASA 3		40.1	40.4	44.6	46.2	48.6	44.1
	ASA 4/5		2.6	2.2	2.3	2.8	3.7	2.7

revision being 71.5 years. On average, men were almost 3 years younger than women. The age group <45 years accounted for 2% and the age group between 45 and 54 for 7.4% of revisions. The revision rate in patients younger than 54 declined slightly, whereas it increased in the age groups >75 years of age. Of all revisions performed 61% were in the group between 65 and 84 years of age. The proportion of revisions in the age category 85 years and older increased from 9.9% in 2013 to 14.2% in 2019.

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

Table 4.12

Reason for revision of total hip arthroplasty

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

	2015–2019	
	N	**%**
Loosening femoral	2,702	21.7
Infection	2,362	19.0
Loosening acetabular	2,236	18.0
Periprosthetic fracture	1,988	16.0
Dislocation	1,381	11.1
Wear	777	6.2
Metallosis	637	5.1
Acetabular osteolysis	474	3.8
Position/Orientation of cup	467	3.8
Femoral osteolysis	427	3.4
Trochanter pathology	251	2.0
Status after spacer	255	2.1
Implant breakage	250	2.0
Blood ion level	234	1.9
Position/Orientation of stem	229	1.8
Impingement	199	1.6
Acetabular protrusion	151	1.2
Squeaking	69	0.6
Other	1,410	11.3
Total 2015–2019	**16,499**	**132.7**

Table 4.13

Type of revision of total hip arthroplasty

	2015–2019	
	N	**%**
Exchange acetabular and femoral components	2,355	18.9
Exchange acetabular component and head	2,557	20.6
Exchange femoral component	1,769	14.2
Exchange head and inlay	1,192	9.6
Exchange acetabular component	658	5.3
Exchange femoral component and inlay	1,062	8.5
Component reimplantation (after spacer or Girdlestone)	699	5.6
Exchange head	552	4.4
Component removal, spacer implantation	414	3.3
Girdlestone	149	1.2
Exchange femoral component, inlay and osteosynthesis	213	1.7
Exchange inlay	115	0.9
Prosthesis preserving revision	151	1.2
Osteosynthesis	121	1.0
Other intervention	426	3.4
Total 2015–2019	**12,433**	**100**

report, the percentage has remained unchanged. Detailed information about the type of revision and fixation techniques is presented in Tables 4.13 and 4.15 and Figure 4.4. Revision of femoral and acetabular components was performed in 18.9%. Revision of the femoral component alone or in combination with acetabular inlay revision was done in 20.6%. The most frequently used approach was the posterior approach in 34% of the cases (Table 4.14). The choice of the approach remained stable.

Figure 4.4

Revision of total hip arthroplasty: Component fixation by year

Percentage per year

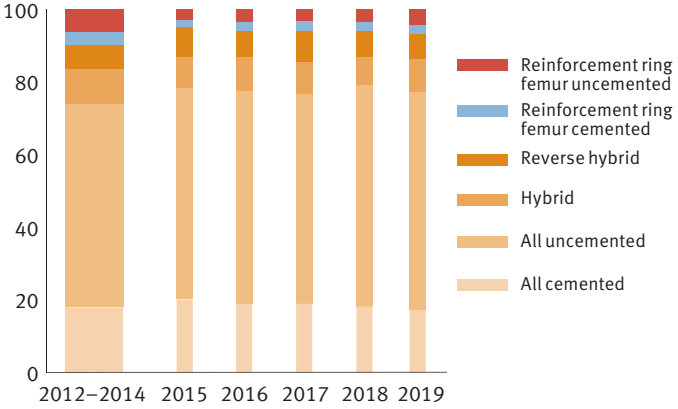


Table 4.14

Approach of revision of total hip arthroplasty

Data only available from 2015 onwards

	2015–2019	
	N	%
Posterior	4,250	34.3
Lateral	2,614	21.1
Anterolateral	2,104	17.0
Anterior	2,138	17.3
Transfemoral	750	6.1
Other approach	534	4.3

Table 4.15

Revision of total hip arthroplasty: Component fixation by year

	2012–2014	2015	2016	2017	2018	2019	2015–2019	
	N	N	N	N	N	N	N	%
Reinforcement ring femur uncemented	271	57	68	65	70	85	345	4.3
Reinforcement ring femur cemented	156	37	52	53	48	52	242	2.6
Reverse hybrid*	288	161	143	166	134	134	738	7.4
Hybrid**	412	164	185	176	145	179	849	8.8
All uncemented	2,396	1,118	1,155	1,128	1,167	1,183	5,751	58.0
All cemented	766	387	372	370	345	339	1,813	18.9
Total	**4,289**	**1,924**	**1,975**	**1,958**	**1,909**	**1,972**	**9,738**	**100.0**

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

4.3 First revision of primary total hip arthroplasty

For benchmarking purposes, the revision rate of a specific implant, hospital or surgeon generally is calculated for primary THA for the treatment of primary osteoarthrosis. This is an international standard and makes sense, because hips with secondary OA often include hips with difficult anatomy, previous osteotomies or unfavourable conditions leading to increased revision rates.

Revision rates are calculated for a moving 4-year window. This has the advantage that the burden of the past will not influence the results of current

Table 4.16

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

BMI and ASA class data only available from 2015 onwards. 4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall **(moving average)**		72,926	2,001	2.8	2.7	2.9
Diagnosis	Primary OA	61,232	1,533	2.5	2.4	2.7
	Secondary OA	6,933	255	3.7	3.3	4.2
	Fracture	4,761	213	4.7	4.1	5.3
Overall Primary OA **(2012–2019)**		61,232	1,533	2.5	2.4	2.7
Gender	Women	31,505	757	2.4	2.3	2.6
	Men	29,727	776	2.6	2.5	2.8
Age group	‹55	6,710	212	3.2	2.8	3.6
	55–64	13,551	322	2.4	2.1	2.7
	65–74	21,438	492	2.3	2.1	2.5
	75–84	16,067	418	2.6	2.4	2.9
	85+	3,440	89	2.6	2.1	3.2
Overall Primary OA **(from 2015)**		54,101	1,360	2.5	2.4	2.7
BMI group	‹18.5	580	7	1.2	0.6	2.6
	18.5–24.9	14,270	272	1.9	1.7	2.2
	25–29.9	17,202	396	2.3	2.1	2.6
	30–34.9	7,813	231	3.0	2.6	3.4
	35–39.9	2,354	93	4.0	3.2	4.8
	40+	781	57	7.3	5.7	9.4
	Unknown	11,101	304	2.8	2.5	3.1
Morbidity state	ASA 1	6,945	139	2.0	1.7	2.4
	ASA 2	29,032	681	2.4	2.2	2.5
	ASA 3	11,285	343	3.1	2.8	3.4
	ASA 4/5	208	8	3.9	2.0	7.7
	Unknown	6,631	189	2.9	2.5	3.3

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

** Rates adjusted for effects of mortality and emigration.

practice of an implant, clinic or surgeon. It also offers the possibility of comparing different periods of time and showing if there is improvement or deterioration over time. The results of the implants for the entire period of the database are calculated and analysed with Kaplan-Meier survival estimates. Therefore, dual information is provided – a short 4-year moving window – showing the performance of the last four years as well as the long-term results of a given implant.

The analysis of first revisions was done on the basis of revisions involving any exchange of prosthetic components. Of the 113,900 documented primary THAs implanted since 2012, 61,232 were at risk; all implants were within the 4-year moving average, between 01.07.2014 and 30.06.2018, with 2-year fol-

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. 4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

	Primary	Revised within 24 months			
		Revised		95% CI	
	N at risk*	N	%**	lower	upper
Overall Primary OA **(moving average)**	61,232	1,533	2.5	2.4	2.7
Stem fixation					
All uncemented	876	25	2.9	2.0	4.3
All cemented	53,095	1,321	2.5	2.4	2.6
Hybrid	7,121	176	2.5	2.2	2.9
Metal on polyethylene (MoPE)	1,329	39	3.0	2.2	4.0
Ceramic on polyethylene (CoPE)	7,873	196	2.5	2.2	2.9
Metal on cross-linked polyethylene (MoXLPE)	8,263	230	2.8	2.5	3.2
Ceramic on cross-linked polyethylene (CoXLPE)	32,779	766	2.4	2.2	2.5
Ceramic on ceramic (CoC)	9,406	246	2.6	2.3	3.0
Overall Primary OA **(from 2015)**	54,101	1,360	2.5	2.4	2.7
Approach					
Anterior	24,535	592	2.4	2.2	2.6
Anterolateral	17,746	441	2.5	2.3	2.7
Lateral	3,636	63	1.8	1.4	2.2
Posterior	7,758	245	3.2	2.8	3.6
Other approach	426	19	4.5	2.9	7.0

Table 4.18

Reason for early first revision of primary total hip arthroplasty

Multiple reasons are possible per patient. 4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

	from 2015	
	N	%
Infection	336	21.9
Loosening femoral	277	18.1
Periprosthetic fracture	268	17.5
Dislocation	221	14.4
Loosening acetabular	131	8.5
Position/Orientation of cup	71	4.6
Position/Orientation of stem	65	4.2
Trochanter pathology	20	1.3
Impingement	19	1.2
Acetabular protrusion	17	1.1
Status after spacer	14	0.9
Implant breakage	13	0.8
Femoral osteolysis	9	0.6
Squeaking	7	0.5
Acetabular osteolysis	5	0.3
Wear	4	0.3
Metallosis	3	0.2
Other	160	10.4

* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

Figure 4.5 a, b and c

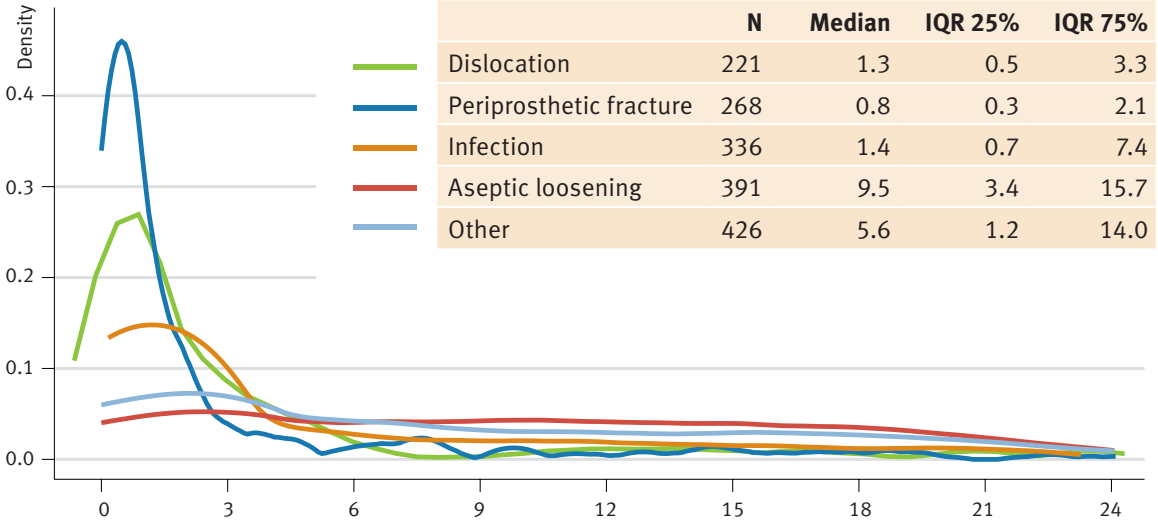
Reason for early first revision by time interval since primary total hip arthroplasty

Moving average

Figure a

All revisions

(N= 1533)

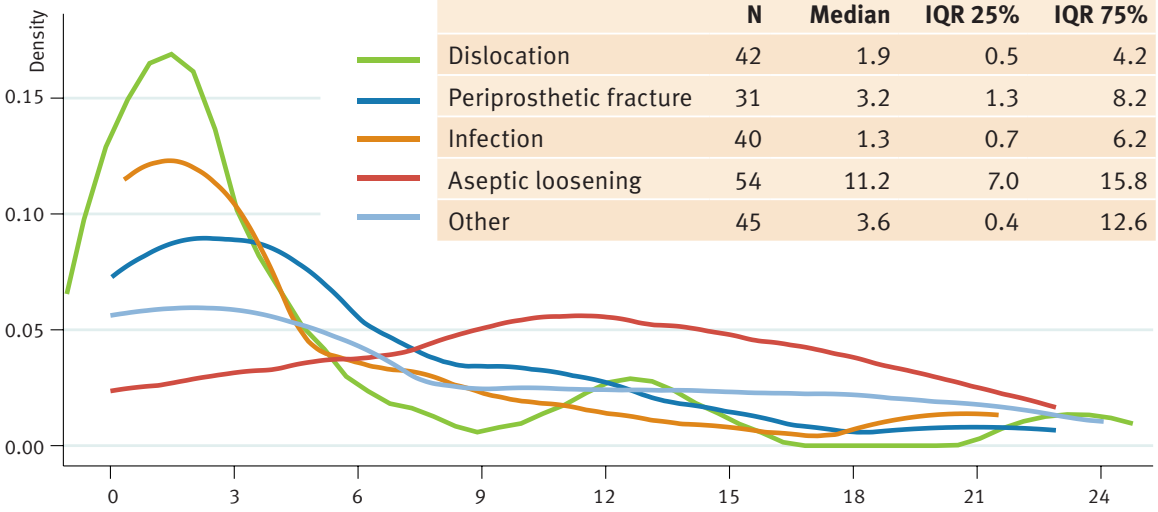


	N	Median	IQR 25%	IQR 75%
Dislocation	221	1.3	0.5	3.3
Periprosthetic fracture	268	0.8	0.3	2.1
Infection	336	1.4	0.7	7.4
Aseptic loosening	391	9.5	3.4	15.7
Other	426	5.6	1.2	14.0

Figure b

Revisions femur cemented only

(N= 189)

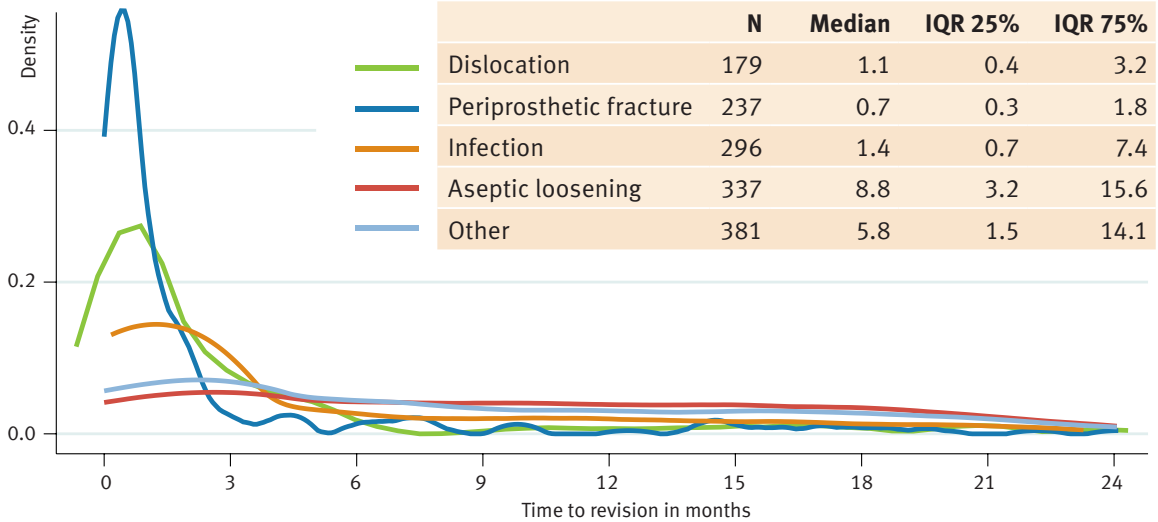


	N	Median	IQR 25%	IQR 75%
Dislocation	42	1.9	0.5	4.2
Periprosthetic fracture	31	3.2	1.3	8.2
Infection	40	1.3	0.7	6.2
Aseptic loosening	54	11.2	7.0	15.8
Other	45	3.6	0.4	12.6

Figure c

Revisions femur uncemented only

(N= 1344)



	N	Median	IQR 25%	IQR 75%
Dislocation	179	1.1	0.4	3.2
Periprosthetic fracture	237	0.7	0.3	1.8
Infection	296	1.4	0.7	7.4
Aseptic loosening	337	8.8	3.2	15.6
Other	381	5.8	1.5	14.1

low-up. Of these, 1,533 hips were revised accounting for a two-year revision rate of 2.5%. The risk of revision was higher in hips with secondary osteoarthritis (3.7%) and even higher in hips treated for fractures (4.7%) (Table 4.17).

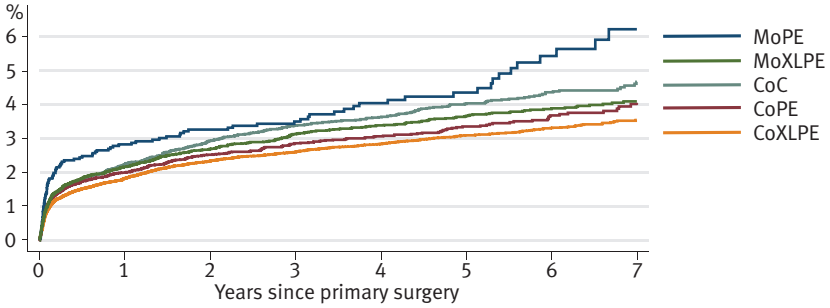
The most common complication of primary THA was infection (21.9%), followed by femoral loosening (18.7%), periprosthetic fracture (17.5%) and dislocation (14.4%). Compared to the previous report femoral loosening had moved up the list from position 4 to 2 (Table 4.18).

Across all stem fixation groups, the majority of revisions occurred during the first three months postoperatively, including high and early peaks of periprosthetic fractures and dislocations. Although infection and aseptic loosing are more frequent complications, their curves are flatter but remain elevated over a longer period of time (Figure 4.5a). Figures 4.5b and 4.5c show the cause and frequency distribution (Kernel density estimation) for cemented and uncemented femoral implants. For uncemented stems, dislocation is an early complication but all the curves are flatter. Periprosthetic fractures occurred early on but only over a short period of time and therefore show the highest peak in hips with uncemented stems fixations.

Figure 4.6

Failure rates of primary total hip arthroplasty for different bearing surfaces

Time since operation, 2012–2019, all services, diagnosis primary OA



Estimated cumulative revision rate

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
MoPE	**2.8** (2.2-3.6)	**3.3** (2.6-4.1)	**3.5** (2.8-4.3)	**4.0** (3.3-5.0)	**4.4** (3.5-5.4)	**5.4** (4.3-6.8)	**6.2** (4.9-7.9)
MoXLPE	**2.2** (2.0-2.4)	**2.7** (2.5-3.0)	**3.1** (2.9-3.4)	**3.4** (3.1-3.7)	**3.7** (3.4-4.0)	**3.9** (3.6-4.2)	**4.1** (3.7-4.5)
CoC	**2.2** (2.0-2.5)	**2.9** (2.7-3.2)	**3.4** (3.1-3.7)	**3.6** (3.3-3.9)	**4.0** (3.7-4.4)	**4.4** (4.0-4.8)	**4.7** (4.3-5.1)
CoPE	**2.0** (1.8-2.2)	**2.5** (2.3-2.8)	**2.9** (2.6-3.2)	**3.1** (2.8-3.4)	**3.4** (3.0-3.7)	**3.7** (3.3-4.1)	**4.0** (3.6-4.5)
CoXLPE	**1.8** (1.7-1.9)	**2.3** (2.2-2.5)	**2.6** (2.5-2.7)	**2.8** (2.7-3.0)	**3.1** (2.9-3.3)	**3.3** (3.1-3.5)	**3.5** (3.3-3.8)

As expected, the revision rate was lowest for the combination of ceramic heads with normal polyethylene (CoPE) and highly crosslinked polyethylene (XLPE). For up to seven years the estimated cumulative revision rate for ceramic on highly crosslinked PE (CoXLPE) had the lowest revision rate of 3.5% (95% CI 3.3–3.8); future years will show if there is a difference. The highest revision rate was found for Metal on PE (MoPE) of 6.2% (95% CI 4.9–7.9). MoPE revisions show a steep increase after 5 years (Figure 4.6).

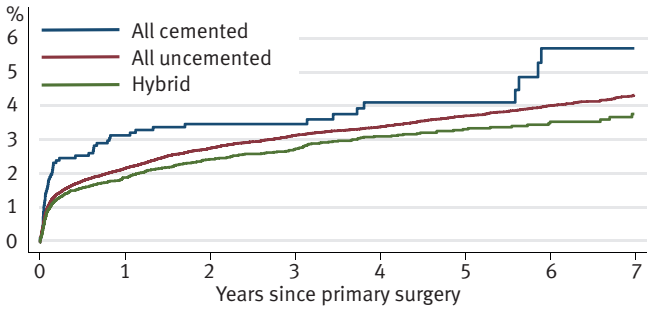
The fixation method has a significant impact on the revision rate (Figure 4.7). Hybrid fixation showed fewer revisions (3.5%, 95% CI 3.1–4.0) than uncemented (4.0, 95% CI 3.8–4.2) or all cemented THA (5.3, 95% CI 3.8–7.3) during up to seven years.

A better understanding of the long-term need for revisions can be gained by looking at the cumulative incidence figures (Figure 4.8). This perspective shows the proportion of implants having experienced at least one revision due to a certain underlying reason (e.g. revision due to loosening of a component). It reveals, as already seen in Figures 4.5a–c that most reasons for revisions tend to show up rather early: a steep initial growth curve followed by very gradual

Figure 4.7

Failure rates of primary total hip arthroplasty for different fixation methods

Time since operation, 2012–2019, all services, diagnosis primary OA



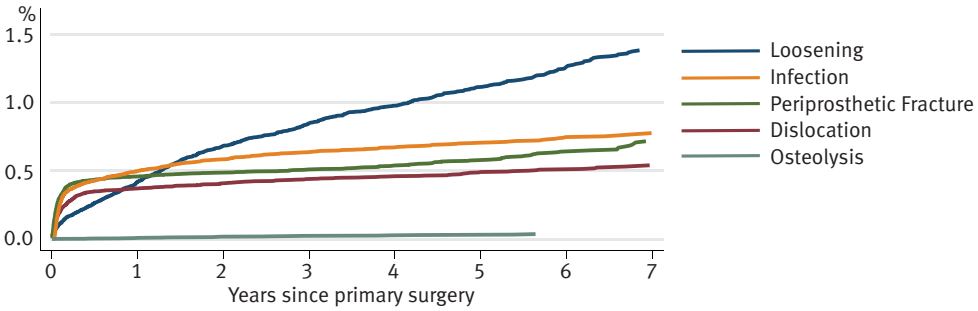
Estimated cumulative revision rate

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
All cemented	**2.9** (2.2–3.9)	**3.2** (2.4–4.2)	**3.2** (2.4–4.2)	**3.8** (2.9–5.0)	**3.8** (2.9–5.0)	**5.3** (3.8–7.3)	**5.3** (3.8–7.3)
All uncemented	**2.0** (1.9–2.1)	**2.5** (2.4–2.6)	**2.9** (2.8–3.0)	**3.1** (3.0–3.2)	**3.4** (3.3–3.6)	**3.7** (3.6–3.8)	**4.0** (3.8–4.2)
Hybrid	**1.8** (1.5–2.0)	**2.3** (2.0–2.5)	**2.5** (2.3–2.8)	**2.9** (2.6–3.2)	**3.1** (2.7–3.4)	**3.2** (2.9–3.6)	**3.5** (3.1–4.0)

Figure 4.8

Cumulative incidence rates for different revision diagnoses

diagnosis primary OA THA



growth in the long run. The exception is the loosening of components which is on a persistent and, in the long run, almost linear growth curve. In this type of graphic, a line starts when the first relevant revision in the SIRIS dataset is observed, and it ends with the last recorded revision.

BMI has a substantial impact for the risk of revision (Table 4.16, Figures 4.9 and 4.10). Revision rates rose with increasing BMI from 1.9% in normal weight patients to 2.9% in the obese class I patients (30–34.9 kg/m²), 4.4% in obese class II patients (35–39.9 kg/m²), and 7.8% in obese class III patients (BMI >40 kg/m²). The majority of complications occurred within the first two to three months.

To analyse subgroups reliably a certain number of "at risk" patients are necessary to get correct and meaningful information. The current number of implants allows this registry to analyse some subgroups. This

Figure 4.9

Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2019, all services, diagnosis primary OA

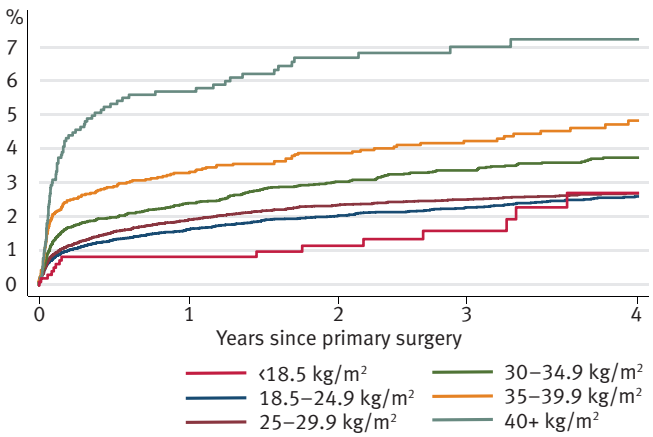
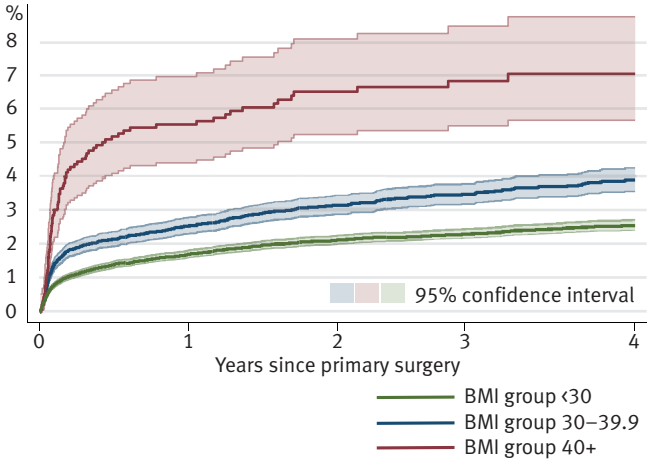


Figure 4.10

Estimated failure rates of primary total hip arthroplasty different BMI categories

Time since operation, 2015–2019, all services, diagnosis primary OA



Estimated cumulative revision rate kg/m²	1 year	2 years	3 years	4 years
<18.5	**0.8** (0.4-1.7)	**1.2** (0.6-2.2)	**1.6** (0.9-2.9)	**2.7** (1.5-4.8)
18.5–24.9	**1.6** (1.5-1.8)	**2.0** (1.9-2.2)	**2.3** (2.1-2.5)	**2.6** (2.4-2.9)
25–29.9	**1.9** (1.8-2.1)	**2.4** (2.2-2.6)	**2.5** (2.3-2.8)	**2.7** (2.5-2.9)
30–34.9	**2.4** (2.2-2.7)	**3.0** (2.7-3.4)	**3.5** (3.1-3.8)	**3.7** (3.4-4.2)
35–39.9	**3.3** (2.8-3.9)	**3.9** (3.3-4.6)	**4.2** (3.6-5.0)	**4.8** (4.1-5.7)
40+	**5.7** (4.5-7.1)	**6.7** (5.4-8.3)	**7.0** (5.6-8.7)	**7.2** (5.8-8.9)
BMI group <30	**1.8** (1.7-1.9)	**2.2** (2.1-2.3)	**2.4** (2.3-2.6)	**2.7** (2.5-2.8)
BMI group 30–39.9	**2.6** (2.4-2.9)	**3.2** (3.0-3.5)	**3.6** (3.3-4.0)	**4.0** (3.7-4.4)
BMI group 40+	**5.7** (4.5-7.1)	**6.7** (5.4-8.3)	**7.0** (5.6-8.7)	**7.2** (5.8-8.9)

report explores the revision rates of implant types that are frequently discussed: double mobility cups (Figures 4.11). However, the numbers are still too small to perform an analysis of the different brands and their modes of failure.

The revision rate for double mobility cups depends amongst other factors on the type of stem fixation. It is interesting that there is no difference between a standard acetabular cup and a double mobility cup, as long as an uncemented stem is used. For both cups the revision rate at 7 years was 4% with similar 95% confidence intervals. However, for hybrid fixation the 7-year revision rate for double mobility cups was much higher (5.2%, 95% CI 3.1–8.8) than for a standard cup (3.4%, 95% CI 3.0–3.9) (Figures 11a and 11b).

Figure 4.11a

Failure rates of primary total hip arthroplasty for different types of cups (primary OA and all uncemented fixation)

Time since operation, 2012–2019, all services, diagnosis primary OA

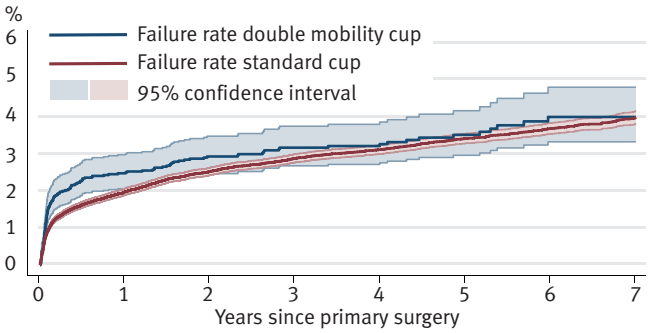
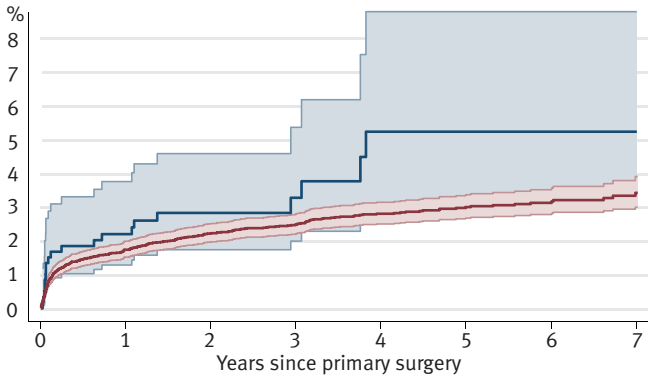


Figure 4.11b

Failure rates of primary total hip arthroplasty for different types of cups (primary OA and hybrid fixation)

Time since operation, 2012–2019, all services, diagnosis primary OA



Cumulative revision rate uncemented fixation							
	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Double mobility cup	**2.5** (2.1-3.0)	**2.9** (2.5-3.5)	**3.2** (2.7-3.7)	**3.3** (2.8-3.9)	**3.5** (3.0-4.2)	**4.0** (3.3-4.8)	**4.0** (3.3-4.8)
Standard cup	**2.0** (1.9-2.1)	**2.5** (2.4-2.6)	**2.9** (2.8-3.0)	**3.1** (3.0-3.2)	**3.4** (3.3-3.6)	**3.7** (3.5-3.8)	**4.0** (3.8-4.2)

Cumulative revision rate hybrid fixation							
Double mobility cup	**2.2** (1.3-3.7)	**2.8** (1.7-4.6)	**3.3** (2.0-5.4)	**5.2** (3.1-8.8)	**5.2** (3.1-8.8)	**5.2** (3.1-8.8)	**5.2** (3.1-8.8)
Standard cup	**1.7** (1.5-2.0)	**2.2** (2.0-2.5)	**2.5** (2.2-2.8)	**2.8** (2.5-3.1)	**3.0** (2.7-3.4)	**3.2** (2.8-3.6)	**3.4** (3.0-3.9)

4.4 Results of implants in total hip arthroplasty

There are several possibilities for presenting the results on implants. The results of the 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. Analysing the interaction of all these components separately is complex and of limited value. Therefore, it makes more sense to focus investigations on currently used combinations and compare those with each other. It may be 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 the diagnosis of primary OA with a follow-up of at least two years. From 2019 onwards SIRIS is reporting early revision rates (within two years) on the basis of a 4-year moving average time frame. In this report this includes all implants from 1.7.2014 to 30.6.2018, with a minimum follow-up until 30.6.2020 (range of data available for this report). 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 97% of all implants by showing combinations with a minimum number of 50 patients. For less than 5% of the THAs, the information for either the cup or the stem is missing and therefore not included in the analysis.

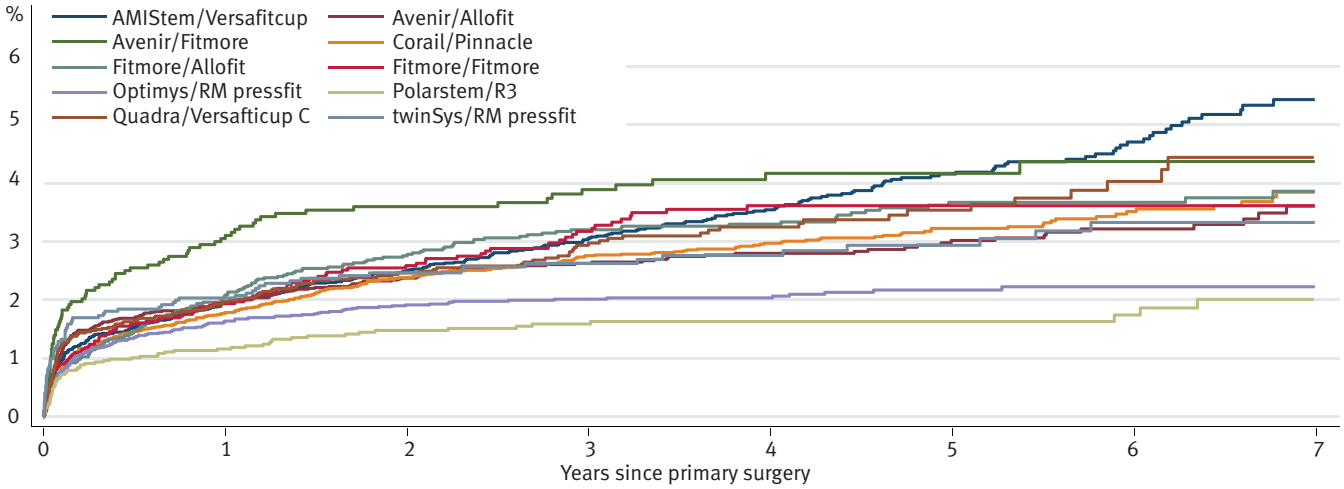
Table 4.19
Top 10 of uncemented implant combinations, primary total hip arthroplasty
2013–2019, diagnosis primary OA

Stem component	Cup component	2013	2014	2015	2016	2017	2018	2019	Total
Corail	Pinnacle	1,341	1,575	1,939	2,066	2,273	2,385	2,485	14,064
Optimys	RM pressfit vitamys	572	987	1,267	1,456	1,667	1,743	1,812	9,504
AMIStem	Versafitcup CC Trio	1,220	1,267	1,378	1,661	1,583	1,425	925	9,459
Avenir	Allofit	945	1,001	1,030	1,083	1,094	1,159	1,132	7,444
Quadra	Versafticup CC Trio	337	609	577	794	939	1,043	917	5,216
Fitmore	Allofit	779	703	698	653	548	505	525	4,411
Polarstem	R3	530	546	503	530	588	630	681	4,008
Fitmore	Fitmore	462	450	461	411	433	586	611	3,414
twinSys	RM pressfit vitamys	395	301	321	352	385	399	388	2,541
Avenir	Fitmore	223	227	330	352	318	297	279	2,026
Other combinations		5,126	4,587	3,854	3,584	3,448	3,403	3,999	28,001
Total		**11,930**	**12,253**	**12,358**	**12,942**	**13,276**	**13,575**	**13,754**	**90,088**

Figure 4.12

Failure rates of primary total hip arthroplasty different uncementetd stem/cup top 10 combinations

Time since operation, 2012–2019, all services, diagnosis primary OA



Cumulative revision rate

Stem	Cup	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Corail	Pinnacle	**1.8** (1.6-2.0)	**2.4** (2.1-2.6)	**2.8** (2.5-3.1)	**3.0** (2.7-3.3)	**3.2** (2.9-3.6)	**3.5** (3.1-3.9)	**3.8** (3.4-4.4)
Optimys	RM pressfit vitamys	**1.6** (1.4-1.9)	**1.9** (1.7-2.2)	**2.0** (1.7-2.3)	**2.0** (1.8-2.4)	**2.2** (1.9-2.5)	**2.2** (1.9-2.6)	**2.2** (1.9-2.6)
AMIStem	Versafitcup CC Trio	**2.0** (1.7-2.2)	**2.5** (2.2-2.8)	**3.0** (2.7-3.4)	**3.5** (3.2-4.0)	**4.2** (3.7-4.6)	**4.7** (4.2-5.3)	**5.4** (4.8-6.2)
Avenir	Allofit	**1.9** (1.7-2.3)	**2.4** (2.1-2.7)	**2.6** (2.3-3.0)	**2.8** (2.4-3.2)	**3.0** (2.6-3.5)	**3.2** (2.8-3.7)	**3.6** (3.0-4.3)
Quadra	Versafitcup CC Trio	**2.0** (1.6-2.4)	**2.5** (2.1-2.9)	**2.9** (2.5-3.5)	**3.2** (2.7-3.8)	**3.5** (3.0-4.2)	**4.0** (3.3-4.9)	**4.4** (3.6-5.5)
Fitmore	Allofit	**2.1** (1.7-2.5)	**2.8** (2.3-3.3)	**3.2** (2.7-3.8)	**3.3** (2.8-3.9)	**3.7** (3.1-4.3)	**3.7** (3.1-4.3)	**3.9** (3.3-4.5)
Polarstem	R3	**1.2** (0.9-1.5)	**1.5** (1.1-1.9)	**1.6** (1.2-2.0)	**1.6** (1.3-2.1)	**1.6** (1.3-2.1)	**1.7** (1.3-2.3)	**2.0** (1.5-2.7)
Fitmore	Fitmore	**1.9** (1.5-2.4)	**2.6** (2.1-3.2)	**3.2** (2.6-3.9)	**3.6** (3.0-4.4)	**3.6** (3.0-4.4)	**3.6** (3.0-4.4)	**3.6** (3.0-4.4)
twinSys	RM pressfit vitamys	**2.0** (1.6-2.6)	**2.5** (1.9-3.1)	**2.6** (2.1-3.3)	**2.8** (2.2-3.5)	**2.9** (2.3-3.7)	**3.3** (2.6-4.2)	**3.3** (2.6-4.2)
Avenir	Fitmore	**3.0** (2.4-3.9)	**3.6** (2.9-4.5)	**3.9** (3.1-4.8)	**4.2** (3.3-5.2)	**4.2** (3.3-5.2)	**4.4** (3.5-5.5)	**4.4** (3.5-5.5)

Table 4.20

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

Covering approx.88% of registered primary OA THAs, uncemented, alphabetic order.
4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
Alloclassic	Alloclassic	171	5	2.9	1.2	6.9
Alloclassic	Allofit	192	4	2.1	0.8	5.6
Alloclassic	Fitmore	348	16	4.6	2.9	7.5
AMIStem	Mpact	265	7	2.7	1.3	5.5
AMIStem	Versafitcup CC/CC light	322	5	1.6	0.7	3.7
AMIStem	Versafitcup CC Trio	6,034	147	2.5	2.1	2.9
AMIStem	Versafitcup DM	67	5	7.5	3.2	17.1
ANA.NOVA solitär	ANA.NOVA hybrid	62	1	1.6	0.2	10.9
ANA.NOVA alpha	ANA.NOVA alpha	78	0	0.0		
Avenir	Alloclassic	349	9	2.6	1.4	4.9
Avenir	Allofit	4,320	102	2.4	2.0	2.9
Avenir	Fitmore	1,276	39	3.1	2.3	4.2
CLS	Allofit	590	21	3.6	2.3	5.4
CLS	Fitmore	795	17	2.1	1.3	3.4
Corail	Allofit	75	2	2.7	0.7	10.5
Corail	Delta motion	116	1	0.9	0.1	6.0
Corail	Fitmore	61	2	3.3	0.8	12.5
Corail	Gyros	519	12	2.3	1.3	4.1
Corail	Pinnacle	8,366	181	2.2	1.9	2.5
Corail	RM pressfit	69	1	1.5	0.2	10.0
Custom hip	April ceramic	238	8	3.4	1.7	6.6
Exception	Avantage	560	19	3.4	2.2	5.3
Exception	Exceed	71	4	5.6	2.2	14.3
Fitmore	Allofit	2,501	75	3.0	2.4	3.8
Fitmore	Fitmore	1,816	45	2.5	1.9	3.3
Fitmore	RM pressfit vitamys	565	12	2.1	1.2	3.7
GTS	G7 bi-spherical	102	15	14.9	9.2	23.5
H-Max	Delta PF	217	7	3.2	1.6	6.7
H-Max	Delta TT	209	3	1.4	0.5	4.4
Harmony	April ceramic	66	1	1.5	0.2	10.3
Harmony	April poly	57	0	0.0		
Harmony	Gyracup	56	3	5.4	1.8	15.7
Minimax	Versafitcup CC Trio	115	3	2.6	0.9	7.9
Nanos	R3	69	3	4.3	1.4	12.9

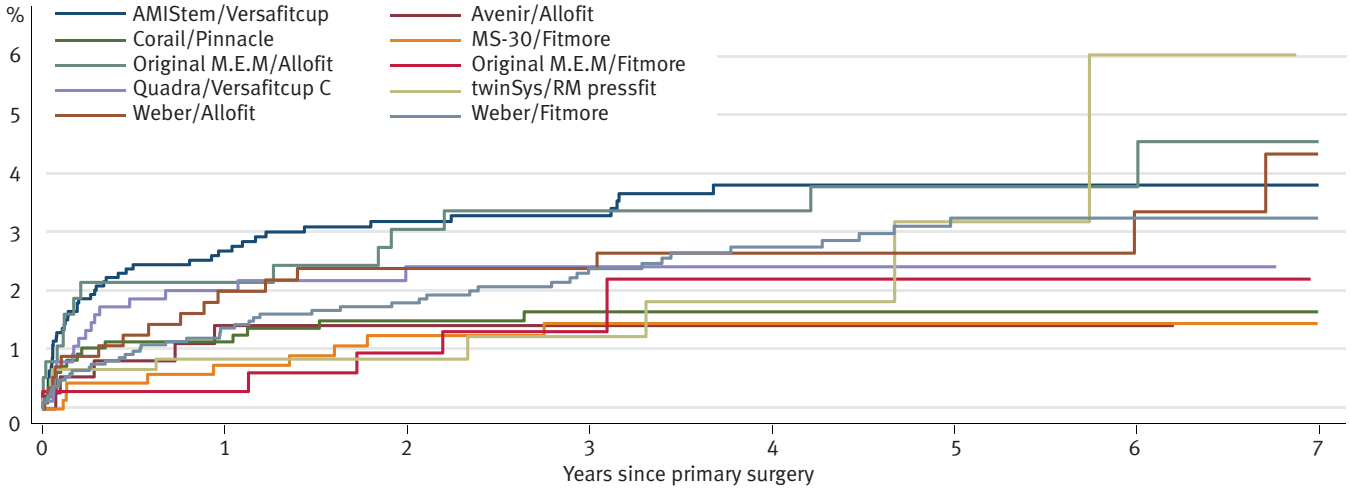
Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
Optimys	Allofit	114	2	1.8	0.4	7.0
Optimys	Anexys cluster	72	0	0.0		
Optimys	Anexys flex	115	2	1.9	0.5	7.3
Optimys	RM pressfit	262	5	1.9	0.8	4.6
Optimys	RM pressfit vitamys	5,782	113	2.0	1.6	2.4
Optimys	Selexys PC	53	0	0.0		
Polarstem	EP-fit	172	9	5.2	2.8	9.8
Polarstem	HI	63	1	1.6	0.2	10.9
Polarstem	Polarcup	821	26	3.2	2.2	4.6
Polarstem	R3	2,213	37	1.7	1.2	2.3
Quadra	Mpact	64	2	3.2	0.8	12.1
Quadra	Versafitcup DM	110	5	4.6	1.9	10.7
Quadra	Versafitcup CC Trio	3,080	74	2.4	1.9	3.0
SBG	HI	123	4	3.3	1.2	8.5
SBG	R3	760	11	1.5	0.8	2.6
SBG	Xentrax-cup	114	2	1.8	0.5	7.1
SL-plus	Bicon-plus Ti	52	2	3.9	1.0	14.8
SL-Plus	EP-fit	617	11	1.8	1.0	3.2
SL-plus	HI	474	14	3.0	1.8	5.0
SL-Plus	R3	901	9	1.0	0.5	1.9
SPS evolution	April ceramic	574	34	5.9	4.3	8.2
SPS evolution	April poly	133	3	2.3	0.7	6.8
SPS HA	April ceramic	86	4	4.7	1.8	11.9
SPS modular	April ceramic	101	6	6.0	2.7	12.8
Stelia stem	ANA.NOVA hybrid	185	11	6.0	3.4	10.6
Trendhip	Plasmafit plus	77	0	0.0		
Tri-lock	Pinnacle	370	4	1.1	0.4	2.9
Twinsys	Anexys flex	56	2	3.6	0.9	13.8
Twinsys	RM pressfit	149	5	3.4	1.4	7.9
Twinsys	RM pressfit vitamys	1,403	41	2.9	2.2	4.0
Twinsys	Selexys PC	54	6	11.1	5.2	23.1
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	1,485	41	2.8	2.1	3.8
Twinsys	Selexys PC	141	6	4.3	1.9	9.2
Group average				**2.5**	**2.4**	**2.6**

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

Figure 4.13

Failure rates of primary total hip arthroplasty different hybrid cemented stem/cup top 10 combinations

Time since operation, 2012–2019, all services, diagnosis primary OA



Cumulative revision rate

Stem	Cup	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Weber	Fitmore	**1.4**(0.9-2.0)	**1.8**(1.3-2.6)	**2.4**(1.8-3.3)	**2.8**(2.1-3.7)	**3.3**(2.4-4.4)	**3.3**(2.4-4.4)	**3.3**(2.4-4.4)
AMIStem	Versafitcup CC Trio	**2.7**(2.0-3.7)	**3.2**(2.4-4.3)	**3.3**(2.5-4.4)	**3.8**(2.9-5.1)	**3.8**(2.9-5.1)	**3.8**(2.9-5.1)	**3.8**(2.9-5.1)
Corail	Pinnacle	**1.1**(0.6-2.1)	**1.5**(0.9-2.5)	**1.7**(1.0-2.7)	**1.7**(1.0-2.7)	**1.7**(1.0-2.7)	**1.7**(1.0-2.7)	**1.7**(1.0-2.7)
Quadra	Versafticup CC Trio	**2.0**(1.2-3.3)	**2.4**(1.5-3.9)	**2.4**(1.5-3.9)	**2.4**(1.5-3.9)	**2.4**(1.5-3.9)	**2.4** 1.5-3.9)	
MS-30	Fitmore	**0.7**(0.3-1.8)	**1.3**(0.6-2.5)	**1.5**(0.8-2.8)	**1.5**(0.8-2.8)	**1.5**(0.8-2.8)	**1.5**(0.8-2.8)	**1.5**(0.8-2.8)
twinSys	RM pressfit vitamys	**0.9**(0.4-2.0)	**0.9**(0.4-2.0)	**1.2**(0.5-2.9)	**1.8**(0.8-4.3)	**3.2**(1.2-8.3)	**6.0**(2.1-16.6)	**6.0**(2.1-16.6)
Weber	Allofit	**2.0**(1.1-3.6)	**2.4**(1.4-4.1)	**2.4**(1.4-4.1)	**2.7**(1.6-4.5)	**2.7**(1.6-4.5)	**3.4**(1.9-6.0)	**4.3**(2.3-8.1)
Avenir	Allofit	**1.4**(0.6-3.4)	**1.4**(0.6-3.4)	**1.4**(0.6-3.4)	**1.4**(0.6-3.4)	**1.4**(0.6-3.4)	**1.4**(0.6-3.4)	
Orig. M.E.M.	Allofit	**2.2**(1.1-4.3)	**3.1**(1.7-5.5)	**3.4**(1.9-5.9)	**3.4**(1.9-5.9)	**3.8**(2.2-6.5)	**3.8**(2.2-6.5)	**4.6**(2.6-7.9)
Orig. M.E.M.	Fitmore	**0.3**(0.0-2.1)	**1.0**(0.3-2.9)	**1.3**(0.5-3.5)	**2.2**(1.0-4.9)	**2.2**(1.0-4.9)	**2.2**(1.0-4.9)	**2.2**(1.0-4.9)

Table 4.21

Top 10 of hybrid fixation implant combinations, primary THA

2013–2019, diagnosis primary OA

Stem component	Cup component	2013	2014	2015	2016	2017	2018	2019	Total
Weber	Fitmore	303	290	304	246	235	184	174	1736
AMIStem	Versafitcup CC Trio	151	151	182	289	199	178	205	1355
Corail	Pinnacle	129	173	105	143	122	117	126	915
Quadra	Versafticup CC Trio	4	44	65	83	182	173	202	753
MS-30	Fitmore	93	86	116	117	90	85	64	651
twinSys	RM pressfit vitamys	33	13	53	75	71	150	196	591
Weber	Allofit	106	76	84	92	74	51	40	523
Avenir	Allofit	1	8	28	62	58	122	90	369
Original M.E.M.	Allofit	92	95	57	29	22	16	20	331
Original M.E.M.	Fitmore	47	79	51	32	43	37	28	317
Other combinations		671	567	611	502	529	582	640	4102
Total		**1,630**	**1,582**	**1,656**	**1,670**	**1,625**	**1,695**	**1,785**	**11,643**

Table 4.22

Revision rates of hybrid fixation primary THA components within 24 months

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.
N<50 is not shown in this table.

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
AMIStem	Versafitcup CC/CC light	110	0	0.0		
AMIStem	Versafitcup CC Trio	843	29	3.5	2.4	4.9
Arcad SO	April ceramic	108	4	3.7	1.4	9.6
Avenir	Allofit	223	3	1.4	0.4	4.2
CCA	RM pressfit vitamys	63	4	6.6	2.5	16.6
Centris	RM pressfit	94	0	0.0		
Centris	RM pressfit vitamys	213	4	1.9	0.7	4.9
Corail	Pinnacle	521	11	2.2	1.2	3.8
Harmony	Liberty	65	0	0.0		
MS-30	Allofit	133	0	0.0		
MS-30	Fitmore	402	4	1.0	0.4	2.7
Original M.E.M.	Allofit	164	6	3.7	1.7	8.1
Original M.E.M.	Fitmore	180	2	1.1	0.3	4.5
PF	Fitmore	61	3	4.9	1.6	14.5
Quadra	Versafitcup CC Trio	444	11	2.5	1.4	4.5
Twinsys	RM pressfit	107	4	3.7	1.4	9.7
Twinsys	RM pressfit vitamys	287	3	1.1	0.3	3.2
Weber	Alloclassic	54	4	7.5	2.9	18.9
Weber	Allofit	321	8	2.5	1.3	5.0
Weber	Fitmore	1,026	16	1.6	1.0	2.6
Group average				**2.4**	**2.1**	**2.8**

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

4.5 Estimating performance and detecting outliers

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 high-performing implant combinations for optimal treatment, on the other hand it can help identify prostheses which have higher than expected revision rates.

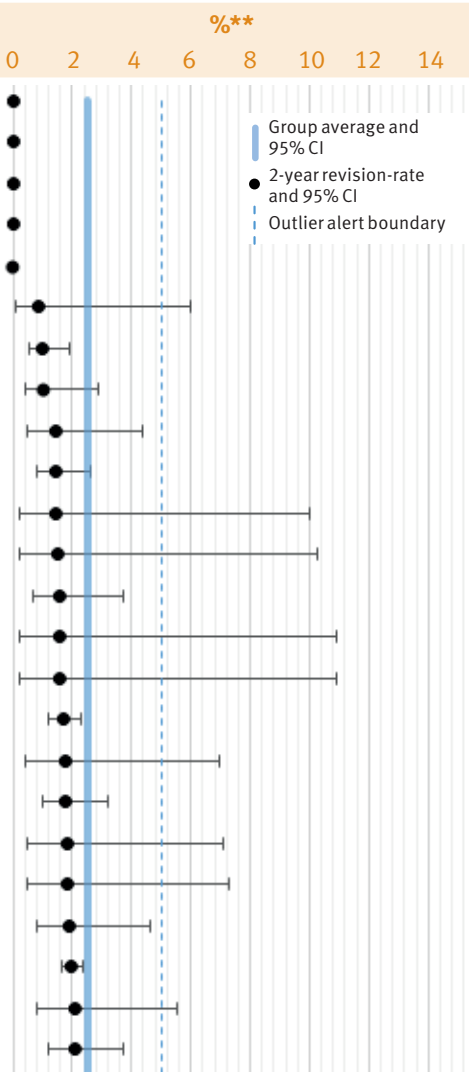
Following recommendation from other registries, the definition for an outlier was adopted as follows: An implant may be considered a "statistical outlier" if its revision rate deviates markedly from the relevant group average. The reference revision rate used in this report is the average revision rate of all corresponding implants (or combinations) in this registry over the observation period (e.g. uncemented stem/cup combinations used in THAs following a diagno-

Figure 4.14 (Part 1)

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
ANA.NOVA alpha	ANA.NOVA alpha	78	0	0.0		
Harmony	April poly	57	0	0.0		
Optimys	Anexys cluster	72	0	0.0		
Optimys	Selexys PC	53	0	0.0		
Trendhip	Plasmafit plus	77	0	0.0		
Corail	Delta motion	116	1	0.9	0.1	6.0
SL-Plus	R3	901	9	1.0	0.5	1.9
Tri-lock	Pinnacle	370	4	1.1	0.4	2.9
H-Max	Delta TT	209	3	1.4	0.5	4.4
SBG	R3	760	11	1.5	0.8	2.6
Corail	RM pressfit	69	1	1.5	0.2	10.0
Harmony	April ceramic	66	1	1.5	0.2	10.3
AMIStem	Versafitcup CC/CC light	322	5	1.6	0.7	3.7
ANA.NOVA solitär	ANA.NOVA hybrid	62	1	1.6	0.2	10.9
Polarstem	HI	63	1	1.6	0.2	10.9
Polarstem	R3	2,213	37	1.7	1.2	2.3
Optimys	Allofit	114	2	1.8	0.4	7.0
SL-Plus	EP-fit	617	11	1.8	1.0	3.2
SBG	Xentrax-cup	114	2	1.8	0.5	7.1
Optimys	Anexys flex	115	2	1.9	0.5	7.3
Optimys	RM pressfit	262	5	1.9	0.8	4.6
Optimys	RM pressfit vitamys	5,782	113	2.0	1.6	2.4
Alloclassic	Allofit	192	4	2.1	0.8	5.6
Fitmore	RM pressfit vitamys	565	12	2.1	1.2	3.7



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

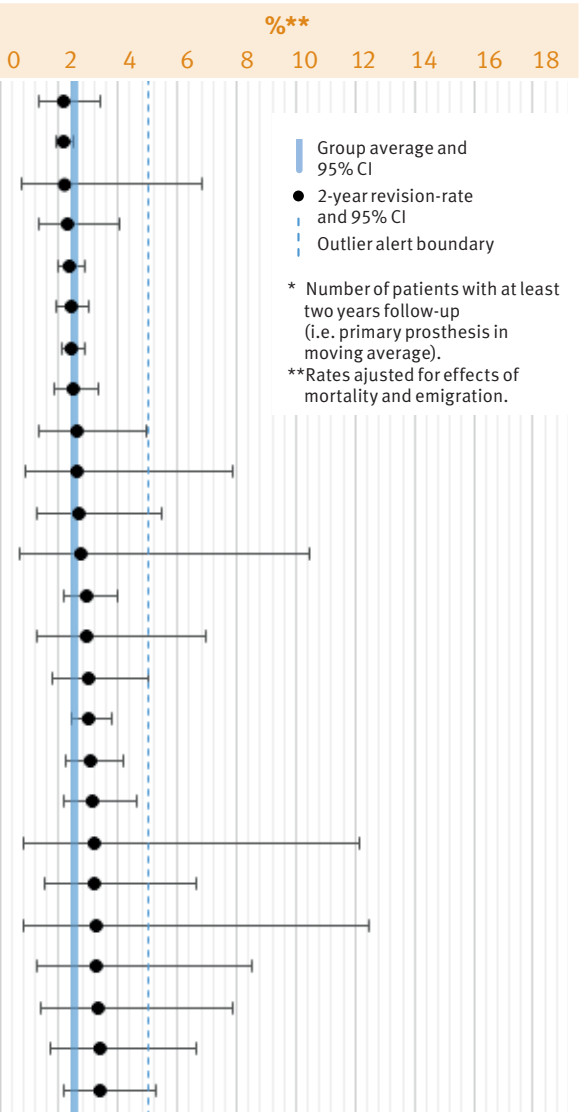
** Rates adjusted for effects of mortality and emigration.

sis 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.

This report shows that individual components performing well in one combination do not necessarily perform as well in another. Therefore, outlier analysis should not only look at a given combination of components but should evaluate the performance

Figure 4.14 (Part 2)

Stem component	Cup component	at risk* N	Revised N	%	95% CI lb	ub
CLS	Fitmore	795	17	2.1	1.3	3.4
Corail	Pinnacle	8,366	181	2.2	1.9	2.5
SPS evolution	April poly	133	3	2.3	0.7	6.8
Corail	Gyros	519	12	2.3	1.3	4.1
Avenir	Allofit	4,320	102	2.4	2.0	2.9
Quadra	Versafitcup CC Trio	3,080	74	2.4	1.9	3.0
AMIStem	Versafitcup CC Trio	6,034	147	2.5	2.1	2.9
Fitmore	Fitmore	1,816	45	2.5	1.9	3.3
Avenir	Alloclassic	349	9	2.6	1.4	4.9
Minimax	Versafitcup CC Trio	115	3	2.6	0.9	7.9
AMIStem	Mpact	265	7	2.7	1.3	5.5
Corail	Allofit	75	2	2.7	0.7	10.5
Twinsys	RM pressfit vitamys	1,403	41	2.9	2.2	4.0
Alloclassic	Alloclassic	171	5	2.9	1.2	6.9
SL-plus	HI	474	14	3.0	1.8	5.0
Fitmore	Allofit	2,501	75	3.0	2.4	3.8
Avenir	Fitmore	1,276	39	3.1	2.3	4.2
Polarstem	Polarcup	821	26	3.2	2.2	4.6
Quadra	Mpact	64	2	3.2	0.8	12.1
H-Max	Delta PF	217	7	3.2	1.6	6.7
Corail	Fitmore	61	2	3.3	0.8	12.5
SBG	HI	123	4	3.3	1.2	8.5
Twinsys	RM pressfit	149	5	3.4	1.4	7.9
Custom hip	April ceramic	238	8	3.4	1.7	6.6
Exception	Avantage	560	19	3.4	2.2	5.3

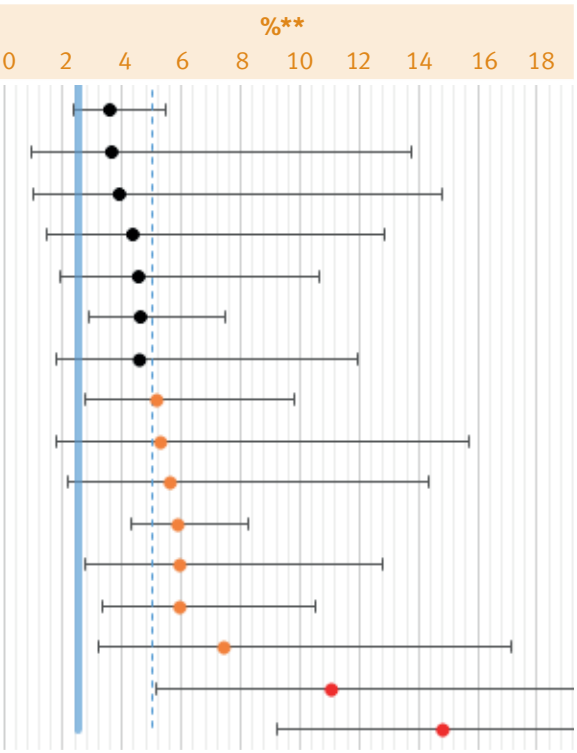


* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

of the isolated component alone and in combination with others. This allows us to distinguish whether a specific implant is problematic in itself or only in combination with certain other components.
The average revision rate is calculated for all primary implants for primary OA per fixation group. The average revision rate for uncemented THAs is 2.5% (CI 2.4 to 2.6) and 2.4% (CI 2.1 to 2.8) for hybrid fixation. Because of infrequent use and small numbers, the analysis for all cemented THAs was omitted. Due to the introduction of the 4-year moving window for the analysis of the 2-year revision rates, the results of some of the implant combinations may be different to those reported in 2019.

Figure 4.14 (Part 3)

Stem component	Cup component	at risk* N	Revised N	Revised %	95% CI lb	95% CI ub
CLS	Allofit	590	21	3.6	2.3	5.4
Twinsys	Anexys flex	56	2	3.6	0.9	13.8
SL-plus	Bicon-plus Ti	52	2	3.9	1.0	14.8
Nanos	R3	69	3	4.3	1.4	12.9
Quadra	Versafitcup DM	110	5	4.6	1.9	10.7
Alloclassic	Fitmore	348	16	4.6	2.9	7.5
SPS HA	April ceramic	86	4	4.7	1.8	11.9
Polarstem	EP-fit	172	9	5.2	2.8	9.8
Harmony	Gyracup	56	3	5.4	1.8	15.7
Exception	Exceed	71	4	5.6	2.2	14.3
SPS evolution	April ceramic	574	34	5.9	4.3	8.2
SPS modular	April ceramic	101	6	6.0	2.7	12.8
Stelia stem	ANA.NOVA hybrid	185	11	6.0	3.4	10.6
AMIStem	Versafitcup DM	67	5	7.5	3.2	17.1
Twinsys	Selexys PC	54	6	11.1	5.2	23.1
GTS	G7 bi-spherical	102	15	14.9	9.2	23.5
Group average				**2.5**	**2.4**	**2.6**



* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted 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.

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

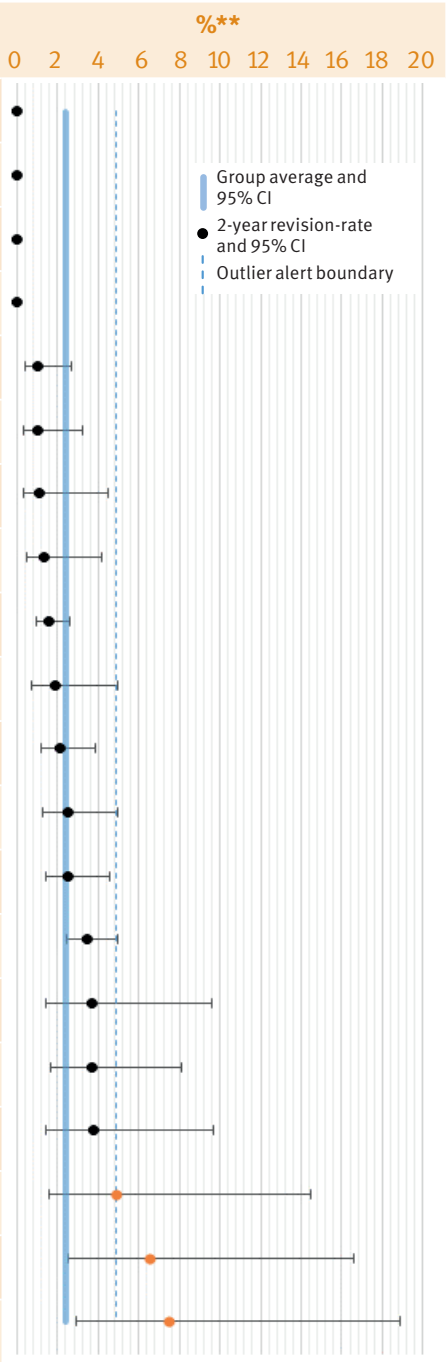
Please be aware that relatively rare implant combinations are frequently used in only a small number or indeed in only one hospital in Switzerland. Manufacturers of detected outlier implants and the hospitals where they were used (and resulting revisions) have been informed by SIRIS.

Figure 4.15

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Stem component	Cup component	at risk*	Revised		95% CI	
		N	N	%	lb	ub
AMIStem	Versafitcup CC/CC light	110	0	0.0		
Centris	RM pressfit	94	0	0.0		
Harmony	Liberty	65	0	0.0		
MS-30	Allofit	133	0	0.0		
MS-30	Fitmore	402	4	1.0	0.4	2.7
Twinsys	RM pressfit vitamys	287	3	1.1	0.3	3.2
Original M.E.M.	Fitmore	180	2	1.1	0.3	4.5
Avenir	Allofit	223	3	1.4	0.4	4.2
Weber	Fitmore	1,026	16	1.6	1.0	2.6
Centris	RM pressfit vitamys	213	4	1.9	0.7	4.9
Corail	Pinnacle	521	11	2.2	1.2	3.8
Weber	Allofit	321	8	2.5	1.3	5.0
Quadra	Versafitcup CC Trio	444	11	2.5	1.4	4.5
AMIStem	Versafitcup CC Trio	843	29	3.5	2.4	4.9
Arcad SO	April ceramic	108	4	3.7	1.4	9.6
Original M.E.M.	Allofit	164	6	3.7	1.7	8.1
Twinsys	RM pressfit	107	4	3.7	1.4	9.7
PF	Fitmore	61	3	4.9	1.6	14.5
CCA	RM pressfit vitamys	63	4	6.6	2.5	16.6
Weber	Alloclassic	54	4	7.5	2.9	18.9



* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted 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. Fracture of the hip

5.1 Treatment of hip fractures

Fractures in the hip area include femoral neck fractures, other fractures of the proximal femur and fractures of the acetabulum. Hip fractures occur more frequently in the elderly patient population but can also be found in younger age groups, most often due to rather severe accidents. The treatment varies from osteosynthesis of the femur or acetabulum to prosthetic replacement with either hemiarthroplasty (HA) or total hip arthroplasty (THA) depending on the pathology, feasibility and experience of the surgeon. Age, activity level and comorbidities also influence the choice of treatment.

In general patients with hip fractures are of advanced age. This injury affects a special group of patients, often with substantial comorbidities and low life expectancy. The mortality rate is high. General-

Table 5.1

Fracture of the hip: Baseline patient characteristics by year

BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**6,813**	**2,993**	**3,096**	**3,220**	**3,469**	**3,751**	**16,529**
Treatment with THA [%]		34.6	37.3	38.6	38.6	39.1	41.1	39.0
Treatment with HA [%]		65.4	62.7	61.4	61.4	60.9	58.9	61.0
Women [%]		71.4	70.4	69.5	69.9	68.2	69.2	69.4
Mean age (SD)	All	80.8 (10.6)	80.9 (10.7)	80.7 (10.7)	81.0 (10.7)	81.1 (10.4)	81.0 (10.6)	80.9 (10.6)
	Women	81.7 (9.9)	81.6 (10.1)	81.4 (10.1)	81.9 (9.9)	82.2 (9.9)	81.7 (10.0)	81.8 (10.0)
	Men	78.7 (11.8)	79.1 (11.8)	79.0 (11.9)	78.7 (11.9)	78.8 (11.2)	79.4 (11.7)	79.0 (11.7)
Age group [%]	<45	0.3	0.3	0.5	0.3	0.2	0.4	0.4
	45–54	1.8	2.0	1.8	1.7	1.7	1.7	1.8
	55–64	6.3	6.1	5.8	6.6	6.2	6.1	6.2
	65–74	15.1	16.0	16.4	15.2	14.4	15.3	15.4
	75–84	33.1	32.0	33.4	31.2	33.6	32.3	32.5
	85+	43.3	43.7	42.1	44.9	43.8	44.2	43.8
N unknown BMI (%)			1,112 (37)	987 (32)	965 (30)	954 (28)	909 (24)	4,927 (30)
N known BMI			1,881	2,109	2,255	2,515	2,842	11,602
Mean BMI (SD)			23.9 (4.7)	23.9 (4.6)	23.8 (4.3)	23.7 (4.4)	23.7 (4.3)	23.8 (4.4)
BMI [%]	<18.5		10.2	9.2	9.4	9.0	9.1	9.4
	18.5–24.9		54.3	55.1	56.4	57.9	57.6	56.4
	25–29.9		27.5	26.7	27.1	25.5	26.1	26.5
	30–34.9		5.8	7.0	5.2	6.3	5.5	5.9
	35–39.9		1.6	1.6	1.5	0.8	1.4	1.4
	40+		0.5	0.3	0.3	0.5	0.3	0.4
N unknown ASA (%)			357 (12)	277 (9)	299 (9)	242 (7)	288 (8)	1,463 (9)
N known ASA			2,636	2,819	2,921	3,227	3,463	15,066
Morbidity state	ASA 1		4.2	3.1	3.3	3.0	3.3	3.4
[%]	ASA 2		33.0	33.1	32.4	31.6	30.8	32.1
	ASA 3		56.6	56.6	57.3	58.8	58.3	57.6
	ASA 4/5		6.1	7.2	6.9	6.5	7.5	6.9

ly, mortality rates from 15% to 35% are reported. Recent work has shown that in Europe, on average, about 22% of patients die within the first year after a fracture of the proximal femur. While in fragile patients HA treatment is preferred, THA is commonly performed in healthier and active patients.

To get a more comprehensive view of the current treatment of fractures of the hip in the elderly and in the younger patients, the data of this cohort of patients is recorded and analyzed in this separate chapter of the SIRIS report for the first time.

Table 5.2
Fracture of the hip: Baseline patient characteristics by type of treatment

Type of treatment		THA	HA
N (2015–2019)		**6,453**	**10,076**
Women [%]		65.8	71.7
Mean age (SD)	All	74.2 (10.9)	85.2 (7.8)
	Women	75.2 (10.3)	85.6 (7.4)
	Men	72.3 (11.6)	84.2 (8.7)
Age group [%]	‹45	0.8	0.1
	45–54	4.1	0.3
	55–64	13.4	1.5
	65–74	28.8	6.9
	75–84	35.2	30.8
	85+	17.7	60.5
N unknown BMI (%)		1,706 (26)	3,221 (32)
N known BMI		4,747	6,855
Mean BMI (SD)		24.3 (4.5)	23.5 (4.4)
BMI [%]	‹18.5	7.7	10.5
	18.5–24.9	54.8	58
	25–29.9	27.7	25.7
	30–34.9	7.6	4.8
	35–39.9	1.6	1.2
	40+	0.5	0.3
N unknown ASA (%)		620 (10)	843 (8)
N known ASA		5,833	9,233
Morbidity state [%]	ASA 1	7.0	1.1
	ASA 2	46.9	22.8
	ASA 3	42.9	66.9
	ASA 4/5	3.2	9.3

Since its start in 2012, the registry has overseen a total number of 16,527 fractures of the hip, with 39% treated with THA and 61% with HA. Women were more frequently affected with almost 70%. Patients older than 65 years of age sustained 91.7% of the fractures. The age group above 85 accounts for 43.8% (Table 5.1).

91.3% of patients receiving HA were older than 75 years. A total of 356 patients younger than 55 years of age sustained hip fractures. Of these 88% (n=316) were treated with THA. Of the patients over 85 years of age only 16% (n=1142) received THA and 84% (n=6096) were treated with HA (Table 5.2)

Table 5.3

Fracture of the hip: Baseline patient characteristics by hospital service volume

Calculations of hospital service volume based on fractures of the hip surgeries in each included year (2015-2019).

Hospital service volume (fracture)		<50	51–99	100–149	150+
N (2015–2019)		**2,467**	**2,085**	**2,699**	**9,278**
Treatment with THA [%]		14.3	41.0	42.5	44.2
Treatment with HA [%]		85.7	59.0	57.5	55.8
Women [%]		71.6	69.6	69.2	68.9
Mean age (SD)	All	83.0 (9.2)	80.8 (10.3)	80.2 (10.8)	80.6 (10.9)
	Women	83.7 (8.7)	81.8 (9.7)	80.9 (10.4)	81.5 (10.2)
	Men	81.3 (10.2)	78.5 (11.2)	78.7 (11.7)	78.7 (12.0)
Age group [%]	<45	0.0	0.2	0.3	0.5
	45–54	0.9	1.4	2.2	2.0
	55–64	3.7	6.6	6.9	6.5
	65–74	11.7	16.1	17.2	15.8
	75–84	33.0	33.3	33.1	32.0
	85+	50.7	42.3	40.3	43.3
N unknown BMI (%)		837 (34)	813 (39)	943 (35)	2,334 (25)
N known BMI		1,630	1,272	1,756	6,944
Mean BMI (SD)		23.7 (4.2)	24.1 (4.9)	24.0 (4.7)	23.7 (4.4)
BMI [%]	<18.5	9.3	9.4	8.2	9.6
	18.5–24.9	56.9	53.0	56.7	56.9
	25–29.9	26.9	27.9	27.4	26.0
	30–34.9	5.5	7.2	5.9	5.8
	35–39.9	1.3	2.0	1.3	1.3
	40+	0.2	0.5	0.6	0.3
N unknown ASA (%)		150 (6)	112 (5)	493 (18)	708 (8)
N known ASA		2,317	1,973	2,206	8,570
Morbidity state [%]	ASA 1	2.6	5.0	3.7	3.1
	ASA 2	29.0	33.7	33.8	32.2
	ASA 3	61.5	55.0	55.8	57.6
	ASA 4/5	6.9	6.2	6.6	7.1

Looking at hospitals treating different numbers of patients with hip fractures, you note an even distribution of the age ranges; hospitals with smaller numbers (‹50 per year) treat slightly more octogenarians. However, the percentage of patients treated by HA in these institutions is significantly higher with 85.7% than the average of 55.8% (Table 5.3). One explanation may be that in these institutions patients are also treated by general trauma surgeons not trained to perform THA.

Of the patients diagnosed with fractures, 5.3% in the THA group and 1.4% in the HA group, have had previous internal fixation for the fracture. However, the time lapse between internal fixation and implantation of THA or HA is unknown. Most HA stems are cemented (86%) as are only 50% of the stems in the THA group (Table 5.4).

Table 5.4

Fracture of the hip: Surgery characteristics by treatment group from 2015 to 2019

Surgical approach recorded from 2015 onwards only.

Main treatment group		THA		HA	
N (2015–2019)		**N**	**%**	**N**	**%**
Previous surgery	None	5,748	89.1	9,736	96.6
	Internal fixation femur	498	4.9	141	1.4
	Osteotomy femur	35	0.3	13	0.1
	Internal fixation acetabulum	41	0.4	0	0.0
	Osteotomy pelvis	6	0.1	1	0.0
	Arthrodesis	4	0.0	1	0.0
	Other previous surgery	143	1.4	184	1.8
Approach	Anterior	3,016	46.8	3,541	35.2
	Anterolateral	1,798	27.9	3,074	30.6
	Posterior	934	14.5	1,536	15.3
	Lateral	568	8.8	1,717	17.1
	Other approach	132	2.0	184	1.8
Fixation	All uncemented	3,062	47.5	1,403	13.9
	Hybrid*	2,566	39.8		
	All cemented	585	9.1	8,663	86.0
	Reverse hybrid**	128	2.0		
	Reinforcement ring, femur uncemented	38	0.6		
	Reinforcement ring, femur cemented	74	1.1		

* acetabulum uncemented, femur cemented

** acetabulum cemented, femur uncemented

Figure 5.1a

Fracture of the hip: Component fixation methods by total hip arthroplasty (THA) by year

Relative distribution per year in %

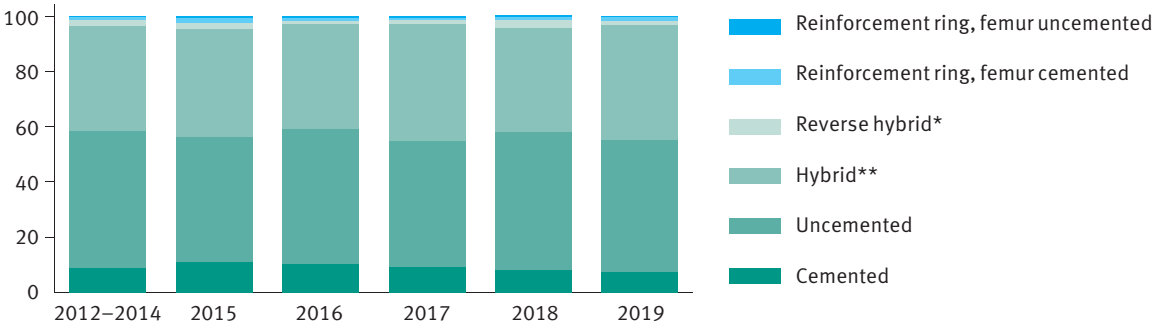


Figure 5.1b

Fracture of the hip: Component fixation methods by hemi hip arthroplasty (HA) by year

Relative distribution per year in %

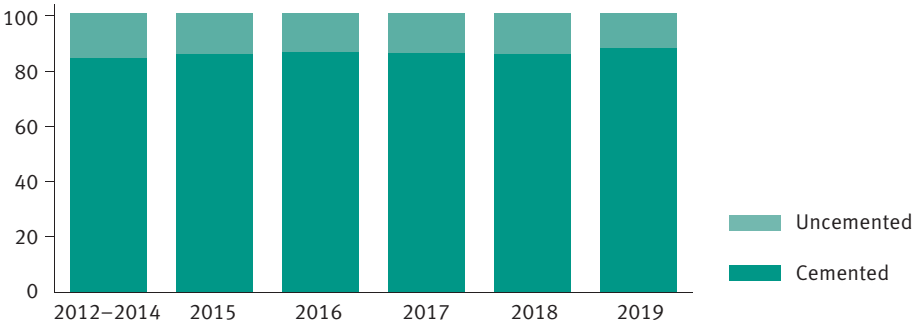


Table 5.5

Fracture of the hip: Component fixation methods by type of treatment by year

Relative distribution per year in %

Total hip arthroplasty (THA)	2012–2014	2015	2016	2017	2018	2019
Reinforcement ring, femur uncemented	0.5	0.9	0.8	0.6	0.4	0.4
Reinforcement ring, femur cemented	0.8	1.6	0.9	0.7	1.3	1.2
Reverse hybrid*	2.5	2.2	1.4	1.8	2.7	1.8
Hybrid**	38.0	39.3	37.7	42.4	37.8	41.4
Uncemented	49.3	44.9	49.0	45.3	49.9	47.7
Cemented	8.9	11.1	10.2	9.2	8.0	7.5
Total [N]	**2,358**	**1,115**	**1,195**	**1,244**	**1,356**	**1,543**

Hemi hip arthroplasty (HA)	2012–2014	2015	2016	2017	2018	2019
Uncemented	15.9	14.7	13.9	14.2	14.7	12.3
Cemented	84.1	85.3	86.1	85.8	85.3	87.7
Total [N]	**4,427**	**1,878**	**1,898**	**1,973**	**2,111**	**2,206**

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

Figure 5.2a

Fracture of the hip: Surgical approach by total hip arthroplasty (THA) by year

Relative distribution per year in %

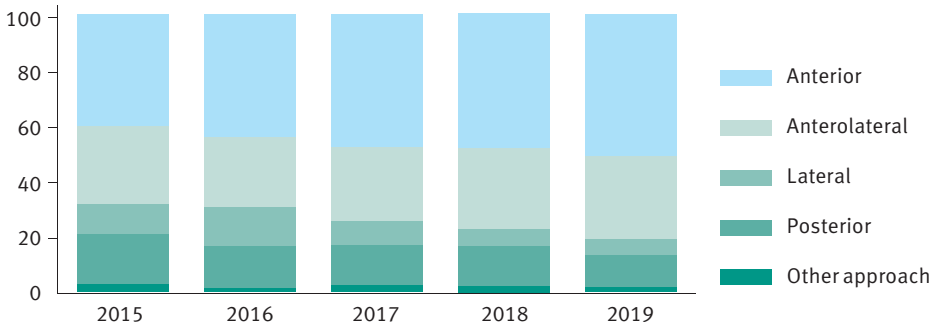


Figure 5.2b

Fracture of the hip: Surgical approach by hemi hip arthroplasty (HA) by year

Relative distribution per year in %

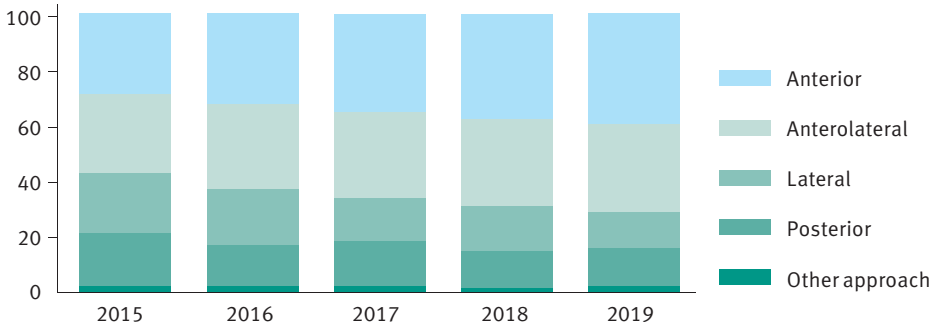


Table 5.6

Fracture of the hip: Surgical approach by year

Relative distribution per year in %

Total hip arthroplasty (THA)	2015	2016	2017	2018	2019
Anterior	40.4	44.4	47.7	48.2	51.3
Anterolateral	28.2	25.0	26.8	29.2	29.6
Lateral	10.5	14.1	8.6	6.2	6.0
Posterior	18.3	15.1	14.5	14.2	11.5
Other approach	2.6	1.4	2.3	2.2	1.7
Total [N]	**1,110**	**1,195**	**1,244**	**1,356**	**1,543**

Hemi hip arthroplasty (HA)	2015	2016	2017	2018	2019
Anterior	29.0	32.6	35.4	38.1	39.8
Anterolateral	28.5	30.5	31.0	31.0	31.7
Lateral	21.5	20.1	15.3	16.5	12.9
Posterior	19.2	14.9	16.2	13.1	13.5
Other approach	1.8	1.9	2.0	1.3	2.1
Total [N]	**1,854**	**1,901**	**1,976**	**2,113**	**2,208**

Table 5.7

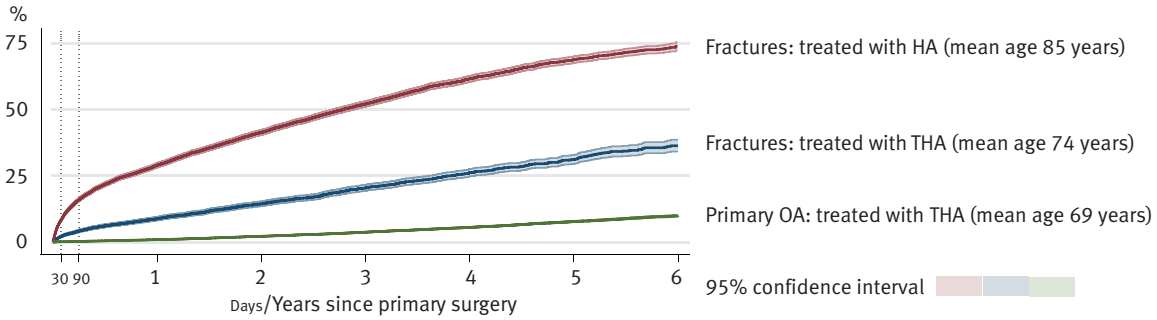
Cement brands used in hemiarthroplasty (HA) for fracture (2012–2019)

Brand	2012–2014	2015	2016	2017	2018	2019	Total
Palacos	1,649	1,112	1,147	1,267	1,348	1,367	7,890
Optipac	286	231	191	146	325	465	1,644
Refobacin	33	60	127	99	22	36	377
SmartSet	37	24	14	49	40	17	181
Hi Fatigue	26	29	56	45	22	0	178
Other	63	71	71	57	23	15	300
Total	**2,094**	**1,527**	**1,606**	**1,663**	**1,780**	**1,900**	**10,570**

Figure 5.3

Mortality rates after treatment for fractures of the hip: total hip arthroplasty (THA) versus hemiarthroplasty (HA) and for comparison versus THA with primary OA

In % of patients died since surgery



Cumulative mortality rates in percent (30 days= postoperative mortality)

	30 days	90 days	1 year	2 years	3 years	4 years	5 years	6 years
THA	**2.2** (1.8-2.5)	**4.1** (3.6-4.6)	**8.8** (8.1-9.5)	**14.4** (13.5-15.4)	**20.5** (19.3-21.7)	**26.3** (24.9-27.7)	**31.2** (29.5-32.9)	**36.4** (34.2-38.7)
HA	**8.6** (8.1-9.1)	**15.9** (15.3-16.6)	**29.0** (28.2-29.9)	**41.5** (40.5-42.4)	**52.2** (51.2-53.3)	**61.7** (60.6-62.8)	**69.0** (67.7-70.2)	**74.1** (72.5-75.7)
THA with primary OA	**0.1** (0.1-0.1)	**0.2** (0.2-0.3)	**0.9** (0.8-1.0)	**2.2** (2.1-2.3)	**3.7** (3.6-3.9)	**5.6** (5.4-5.8)	**7.8** (7.5-8.0)	**9.9** (9.6-10.3)

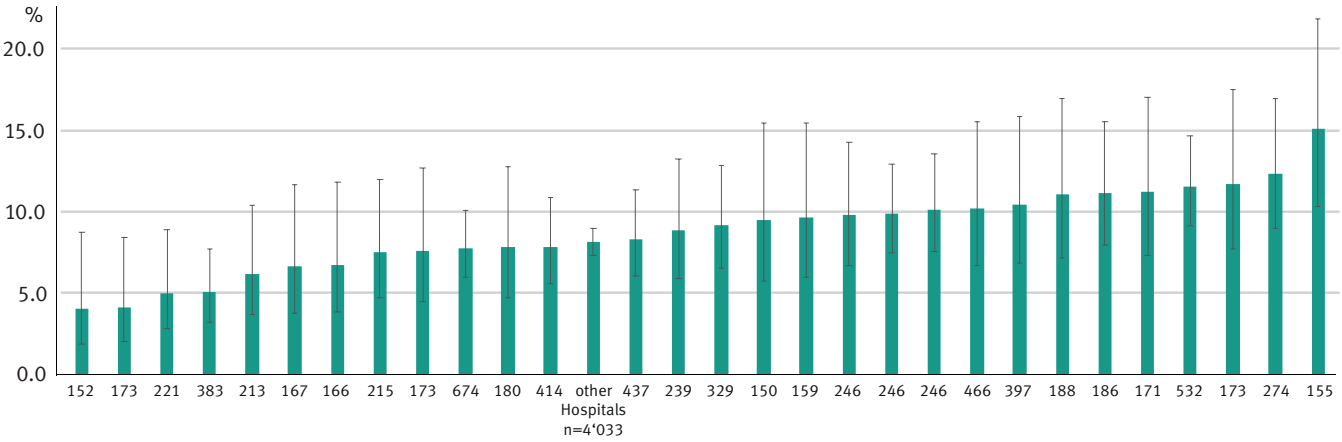
The most common approaches for both procedures are a direct anterior or an anterolateral approach (Table 5.6, Figures 5.2a and 5.2b). In both HA and THA the anterior approach was increasingly used but distinctly more for THAs. The lateral and posterior approaches are used less and less frequently.

For obvious reasons, the estimated mortality rates are different between the HA and THA groups and substantially higher compared to patients treated for primary osteoarthritis of the hip (Figure 5.3). The one year mortality rate for HA patients was 29% and 8.8% in patients with THA fracture treatment. For the same one-year period the mortality rate for a primary THA was 0.9% (Figure 5.3). This is explained by the older age of the patients with HA. We note an interesting pattern of the variability in the 30-day mortality rates after HA. Looking at the main centres where HAs are performed (Figure 5.4), we see that the rates range from under 5% in some centres to over 10% in others. These figures are unadjusted but additional regression analyses have been conducted to test their reliability of these figures. The pattern has been confirmed and actually appears to become more pronounced when examining the age-sex-distribution of cases within centres. It certainly is the case that some centres have mortality rates that are statistically significantly higher than the Swiss national average, let alone the values of the best performing centres. However, the picture becomes less clear when the ASA morbidty score is used as an additional covariate. However, this is also associated with a considerable loss of statistical power due to the reduction in cases available for analysis. These findings warrant further investigation.

Figure 5.4

30-day postoperative mortality rates of HA per hospital

2012–2018, with 95% confidence intervals, Kaplan Meier estimates, only showing hospitals with sufficient numbers (25 HAs annual average – x-axis is showing numbers of operations included in analysis). The average mortality rate in Switzerland is 8.6% (CI 8.1. – 9.1)



5.2 First revision (within two years) after fracture of the hip

A moving 4-year window represents current practices and enables calculating the rate of revisions. This has the advantage that the burden of the past will not influence the results of current practice of an implant, clinic or surgeon. It also allows comparison of different periods of time and shows if there is improvement or deterioration. The results of the implants for the entire period of the database are presented with Kaplan-Meier survival estimates. Therefore, dual information is provided: a short 4-year moving window and the long term behaviour of the implant.

The 2-year revision rate after THA was 4.7% (95%CI 4.1 to 5.3) and higher than in HA patients with 3.2% (95% CI 2.8 to 3.7). Higher BMI and ASA scores are risk factors for revision (Table 5.8). However, the number of patients with BMI ›30 and ASA 4/5% are too small for meaningful analysis. Interestingly, an unknown BMI or ASA score for THA patients bears almost the highest risk for a revision.

Table 5.8

Fracture of the hip: First revisions within 24 months overall and according to baseline characteristics

BMI and ASA class data only available from 2015 onwards, moving average from july 2014 until june 2018

		Total hip arthroplasty					Hemi hip arthroplasty				
		At risk*	Revised		95% CI		At risk*	Revised		95% CI	
		N	N	%**	lower	upper	N	N	%**	lower	upper
Overall (moving average)		4,761	213	4.7	4.1	5.3	7,811	217	3.2	2.8	3.7
Gender	Women	3,141	121	4.0	3.3	4.7	5,660	154	3.1	2.6	3.6
	Men	1,620	92	6.0	5.0	7.4	2151	63	3.6	2.8	4.6
Age group	‹55	244	11	4.6	2.5	8.1	27	4	18.0	7.1	41.5
	55–64	635	38	6.2	4.5	8.4	122	8	7.1	3.6	13.8
	65–74	1,404	69	5.0	4.0	6.3	573	27	5.4	3.7	7.8
	75–84	1,664	67	4.2	3.3	5.3	2,441	83	3.8	3.1	4.7
	85+	810	28	3.7	2.6	5.4	4,644	95	2.3	1.9	2.9
Overall (2015–2019)		4,186	185	4.6	4.0	5.3	6,794	191	3.2	2.8	3.7
BMI group	‹18.5	246	10	4.4	2.4	8.0	468	13	3.4	2.0	5.8
	18.5–24.9	1,593	65	4.3	3.4	5.4	2,560	58	2.6	2.0	3.3
	25–29.9	842	38	4.6	3.3	6.2	1,172	47	4.7	3.5	6.2
	30–34.9	231	9	4.1	2.2	7.8	218	9	4.6	2.4	8.7
	35–39.9	53	4	7.6	2.9	19.1	54	3	5.8	1.9	16.8
	40+	12	4	35.7	14.9	70.2	15	0	0.0		
	Unknown	1,209	55	4.8	3.7	6.2	2,307	61	3.0	2.4	3.9
Morbidity state	ASA 1	272	6	2.2	1.0	4.9	73	3	4.2	1.4	12.4
	ASA 2	1,774	74	4.2	3.4	5.3	1,467	34	2.5	1.8	3.5
	ASA 3	1,577	84	5.6	4.5	6.9	4,110	125	3.5	3.0	4.2
	ASA 4/5	111	1	1.0	0.1	6.8	558	13	3.3	1.9	5.8
	Unknown	452	20	4.8	3.1	7.3	586	16	3.1	1.9	5.1

* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

In both groups uncemented stems have increased risk for revision caused by a periprosthetic fracture. A posterior approach bears a higher risk of revision for THA, whereas for HA the approach seems to play an minor role (Table 5.9). One-third of revisions of HA patients are caused by infection. Malnutrition and poor health status may play a role.

The reasons for first revisions have some imperfections related to the terminology. For example protrusion of an acetabular shell can have a different meaning than protrusion of the HA. While the first implys a loose cup that protrudes into the small pelvis, the latter indicates severe wear of the acetabular cartilage with or without defect of the medial wall. Similar ambiguities are present for the type of revisions. About 12% of HA response categories related to revision of the acetabular implant were chosen. These were interpreted and analysed as conversions.

Periprosthetic fractures, dislocations and infections are the three most common complications in both THA and HA; infections (32.3%) are the most important cause in the HA group (Table 5.10). Interestingly, the dislocation rate in HA is similar to THA, with 22.1% in THA and 18.4% for HA.

Table 5.9

Fracture of the hip: First revisions according to stem fixation and approach

Moving average

	Total hip arthroplasty					Hemi hip arthroplasty				
	At risk*	**Revised**		95% CI		**At risk***	**Revised**		95% CI	
	N	**N**	**%****	lower	upper	**N**	**N**	**%****	lower	upper
Overall (moving average)	4,761	213	4.7	4.1	5.3	7,811	217	3.2	2.8	3.7
All cemented	463	20	4.8	3.1	7.3	6,682	158	2.7	2.3	3.2
All uncemented	2,259	113	5.1	4.3	6.2	1,123	59	6.0	4.7	7.7
Hybrid	1,861	69	3.9	3.1	4.9					
Overall (2015–2019)	4,186	185	4.6	4.0	5.3	6,794	191	3.2	2.8	3.7
Anterior	1,863	72	4.0	3.2	5.0	2,278	63	3.2	2.5	4.1
Anterolateral	1,135	48	4.4	3.4	5.8	2,024	59	3.3	2.6	4.3
Lateral	442	14	3.3	2.0	5.6	1,263	37	3.5	2.5	4.8
Posterior	660	42	6.6	4.9	8.8	1,108	32	3.3	2.3	4.6
Other approach	86	9	11.8	6.3	21.6	121	0	0.0		

* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

Table 5.10

Fracture of the hip: Reasons for early first revisions

2015–2019, multiple responses

	Total hip arthroplasty		Hemi hip arthroplasty	
	N	%	N	%
Periprosthetic fracture	50	23.5	49	22.6
Dislocation	47	22.1	40	18.4
Infection	44	20.7	70	32.3
Loosening femoral	21	9.9	18	8.3
Loosening acetabular	20	9.4		
Position/Orientation of cup	6	2.8		
Acetabular protrusion	6	2.8	4	1.8
Position/Orientation of stem	5	2.3	3	1.4
Acetabular osteolysis	1	0.5	1	0.5
Trochanter pathology	1	0.5	2	0.9
Impingement	1	0.5	0	0.0
Squeaking	1	0.5	0	0.0
Wear	0	0.0	1	0.5
Metallosis	0	0.0	0	0.0
Femoral osteolysis	0	0.0	0	0.0
Status after spacer	0	0.0	0	0.0
Implant breakage	0	0.0	1	0.5
Blood ion level	0	0.0	0	0.0
Other	20	9.4	22	10.1
Total	223	104.7	211	97.2

5.3 Results of implants by THA after hip fractures

In this chapter only the results for HA are presented. The results of THA for fractures are presented in chapter 4, together with the revision rates of implantations for primary osteoarthrosis. The revision rates for HA are between 0 and 5.2% (Table 5.14). Interestingly, the revision rate for bipolar heads is higher in the initial phase but then flattens out, whereas the revision rate for the monopolar heads increases over time (Figure 5.7).

As for the first revisions of primary OA THAs, we provide an additional perspective on the progression of reasons for revision showing the cumulative incidence figures (Figures 5.8a and b). This perspective shows what proportion of implants have experienced at least one revision for certain specific reasons (e.g. revision due to loosening of a component). In this type of graph, a line starts when the first relevant revision in the SIRIS dataset was observed, and ends with the last recorded revision.

As already seen in Figures 5.5 and 5.6, it reveals that infection and dislocation events tend to occur rather early on – a steep initial spike followed by very gradual long run growth. Incidents of loosening and periprosthetic fractures are the drivers of long-term revision rates.

None of the implants reached the status of outlier. An outlier status comes with varying degrees of statistical probability. We consider the outlier status „highly likely“, when both the estimated revision rates and the complete confidence interval exceed the outlier alert boundary (Table. 5.14).

Table 5.11

Fracture of the hip: Type of revisions by primary treatment modality, THA versus HA

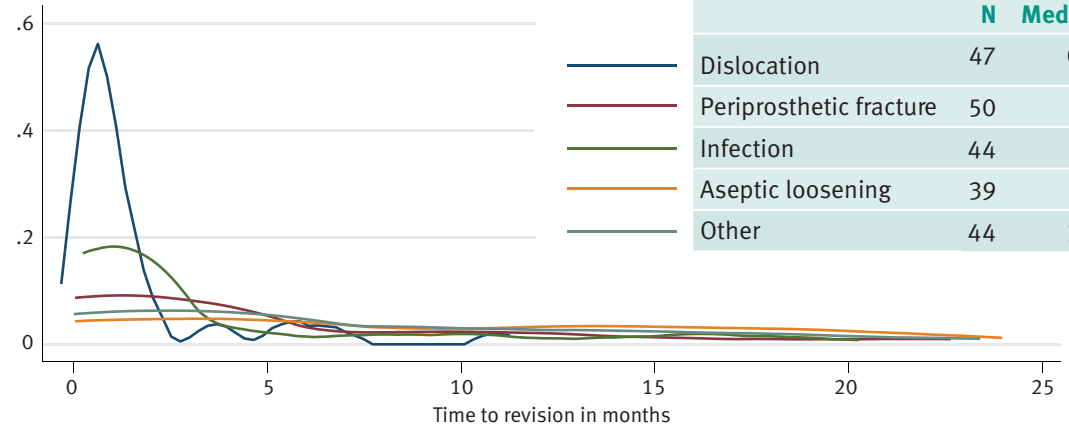
Moving average. HA: in approx. 12% of cases response categories involving acetabular components were chosen. These were recorded as conversions.

	Total hip arthroplasty		Hemi hip arthroplasty	
	N	%	N	%
Exchange acetabular and femoral components	31	14.7		
Exchange acetabular component	9	4.2		
Exchange acetabular component and head	46	21.7		
Exchange femoral component	50	23.6	38	17.5
Exchange femoral component and inlay	9	4.2	7	3.2
Exchange head	16	7.6	53	24.4
Exchange inlay	2	0.9	4	1.8
Exchange head and inlay	28	13.2	18	8.3
Conversion of hemi-prosthesis to THA without stem exchange	0	0.0	39	18.0
Conversion of hemi-prosthesis to THA with stem exchange	0	0.0	31	14.3
Component removal, spacer implantation	4	1.9	3	1.4
Component reimplantation (after spacer or Girdlestone)	3	1.4	3	1.4
Girdlestone	3	1.4	5	2.3
Exchange femoral component, inlay and osteosynthesis	7	3.3	4	1.8
Other intervention	4	1.9	12	5.5
Total	**212**	**100.0**	**217**	**100.0**

Figure 5.5a

Total hip arthroplasty: reasons for early first revisions, hip fractures, all fixation techniques, N=213

Moving average

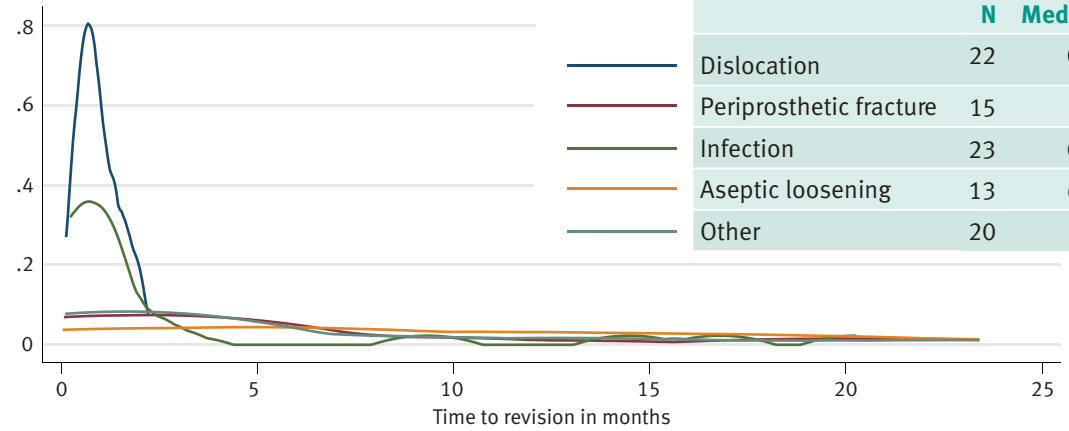


	N	Median	IQR 25%	IQR 75%
Dislocation	47	0.8	0.5	1.6
Periprosthetic fracture	50	1.3	0.5	8.6
Infection	44	1.0	0.5	4.5
Aseptic loosening	39	7.6	1.0	16.3
Other	44	3.9	0.6	12.8

Figure 5.5b

Total hip arthroplasty: reasons for early first revisions, hip fractures, femur cemented, N=93

Moving average

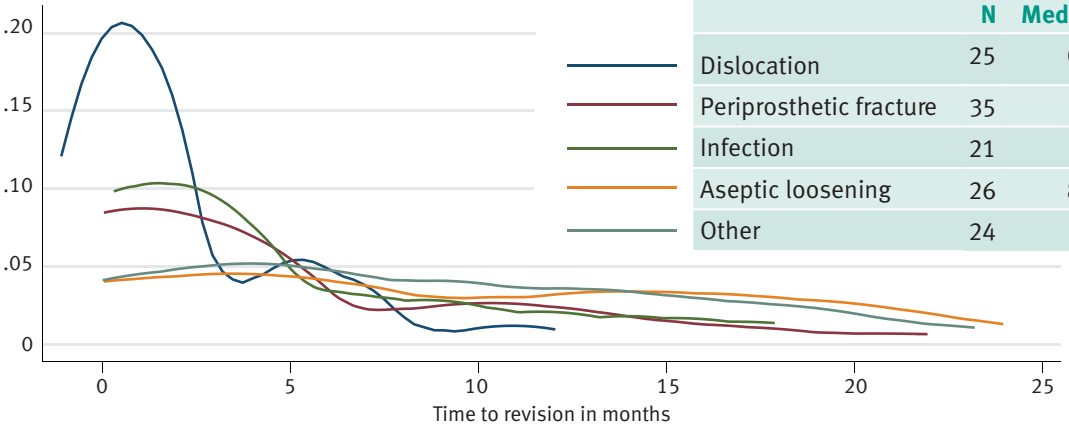


	N	Median	IQR 25%	IQR 75%
Dislocation	22	0.8	0.5	1.3
Periprosthetic fracture	15	1.7	0.5	8.6
Infection	23	0.8	0.5	2.3
Aseptic loosening	13	6.6	0.3	13.0
Other	20	1.5	0.6	8.2

Figure 5.5c

Total hip arthroplasty: reasons for early first revisions, hip fractures, femur uncemented, N=120

Moving average

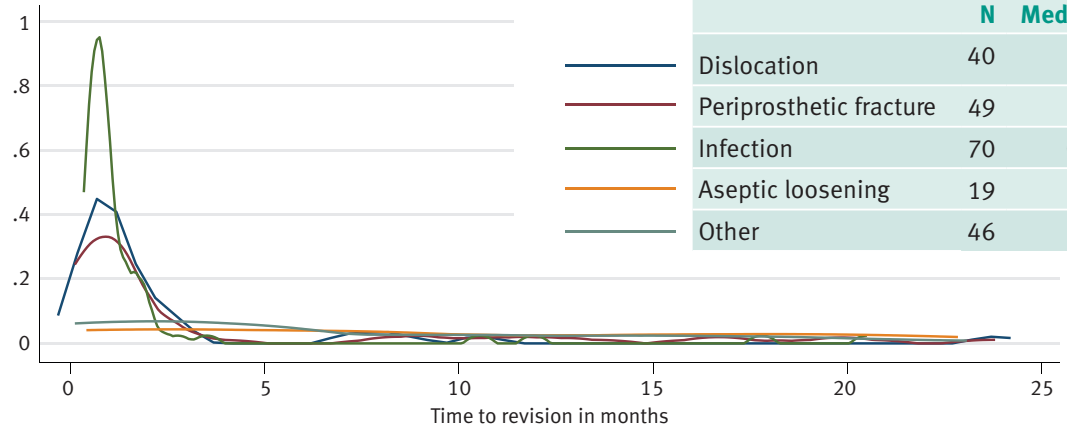


	N	Median	IQR 25%	IQR 75%
Dislocation	25	0.6	0.2	3.5
Periprosthetic fracture	35	1.1	0.4	8.6
Infection	21	1.3	0.7	6.4
Aseptic loosening	26	8.3	1.4	16.3
Other	24	7.2	1.9	13.8

Figure 5.6a

Hemi hip arthroplasty: reason for early first revisions, hip fractures, all fixation techniques, N=217

Moving average

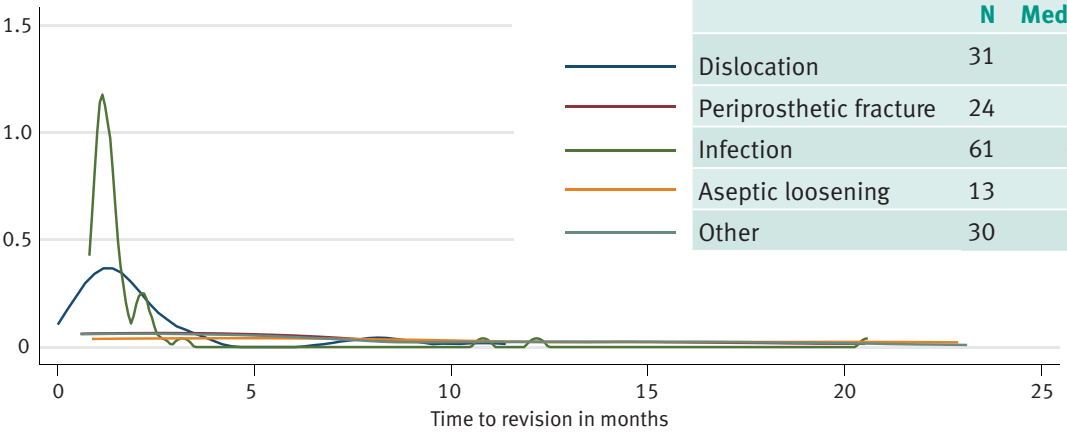


	N	Median	IQR 25%	IQR 75%
Dislocation	40	1.0	0.6	1.9
Periprosthetic fracture	49	1.0	0.5	2.5
Infection	70	0.8	0.6	1.3
Aseptic loosening	19	6.1	1.8	15.9
Other	46	3.2	0.6	12.6

Figure 5.6b

Hemi hip arthroplasty: reason for early first revisions, hip fractures, femur cemented, N=158

Moving average

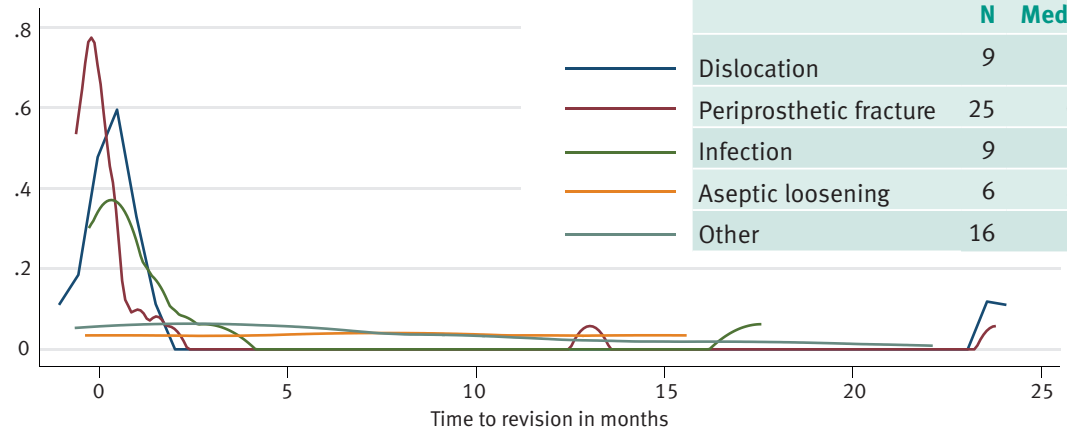


	N	Median	IQR 25%	IQR 75%
Dislocation	31	1.0	0.5	2.3
Periprosthetic fracture	24	2.0	0.8	10.5
Infection	61	0.8	0.6	1.1
Aseptic loosening	13	6.1	1.8	18.6
Other	30	1.4	0.5	13.6

Figure 5.6c

Hemi hip arthroplasty: reason for early first revisions, hip fractures, femur uncemented, N=59

Moving average



	N	Median	IQR 25%	IQR 75%
Dislocation	9	1.1	0.9	1.6
Periprosthetic fracture	25	0.8	0.4	1.1
Infection	9	1.3	0.6	2.0
Aseptic loosening	6	8.3	0.7	15.1
Other	16	5.0	0.9	10.3

Table 5.12

Fracture of the hip: top 10 stem/head combinations used in HA

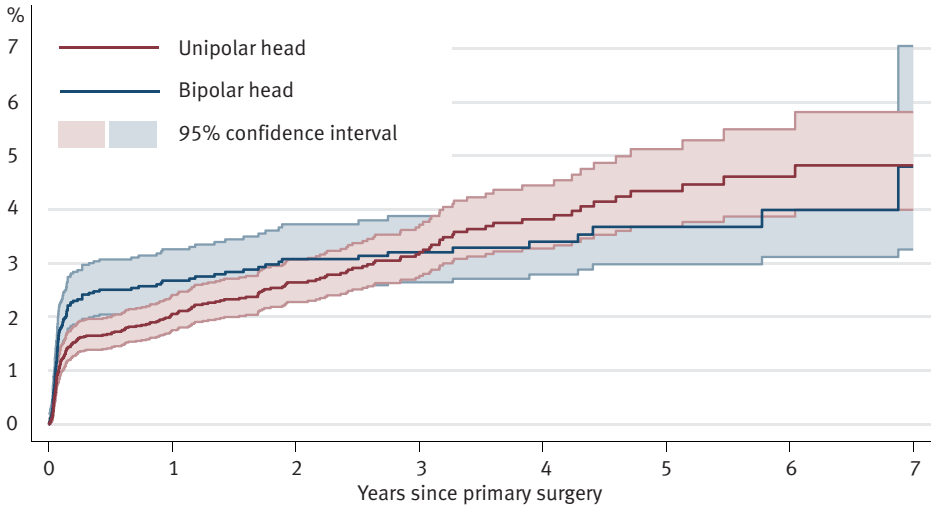
2013–2019

Stem component	Head component	2013	2014	2015	2016	2017	2018	2019	Total
CCA	Mathys Hemi Head Steel	247	301	286	339	334	407	425	2,339
AmiStem	Medacta Endo Head	109	134	151	202	291	279	274	1,440
Weber Stem	Zimmer Biomet Unipolar Head	218	195	170	178	147	250	216	1,374
Original MEM Stem	Zimmer Biomet Unipolar Head	155	149	102	49	51	62	51	619
Harmony cemented	Symbios BIBOP	44	69	66	76	87	84	49	475
Centris	Mathys Hemi Head Steel	14	17	60	86	86	107	97	467
twinSys	Mathys Hemi Head Steel	14	20	34	82	94	67	90	401
AmiStem	Medacta Bipolar Head	12	16	57	57	65	91	88	386
Weber Stem	Zimmer Biomet Bipolar Head	60	66	51	59	43	39	50	368
Corail	Modular Head Carthcart	53	57	41	38	61	39	73	362
Other combinations		619	644	535	440	396	339	487	3,460
Total		**1,545**	**1,668**	**1,553**	**1,606**	**1,655**	**1,764**	**1,900**	**11,691**

Figure 5.7

Fracture of the hip: Failure rates of hemiarthroplasty of the hip: unipolar heads versus bipolar heads

Time since operation, 2012–2019, all services, % of implants revised



Cumulative revision rate	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Unipolar head	**2.1** (1.8-2.4)	**2.6** (2.3-3.1)	**3.2** (2.7-3.7)	**3.8** (3.3-4.4)	**4.3** (3.7-5.1)	**4.6** (3.9-5.5)	**4.8** (4.0-5.8)
Bipolar head	**2.7** (2.2-3.3)	**3.1** (2.5-3.7)	**3.2** (2.6-3.9)	**3.4** (2.8-4.1)	**3.7** (3.0-4.5)	**4.0** (3.1-5.1)	**4.8** (3.3-7.0)

Figure 5.8a

Fracture of the hip: cumulative incidence rates for different revision diagnoses (fracture THA)

Time since operation, 2012–2019, all services, % of implants revised

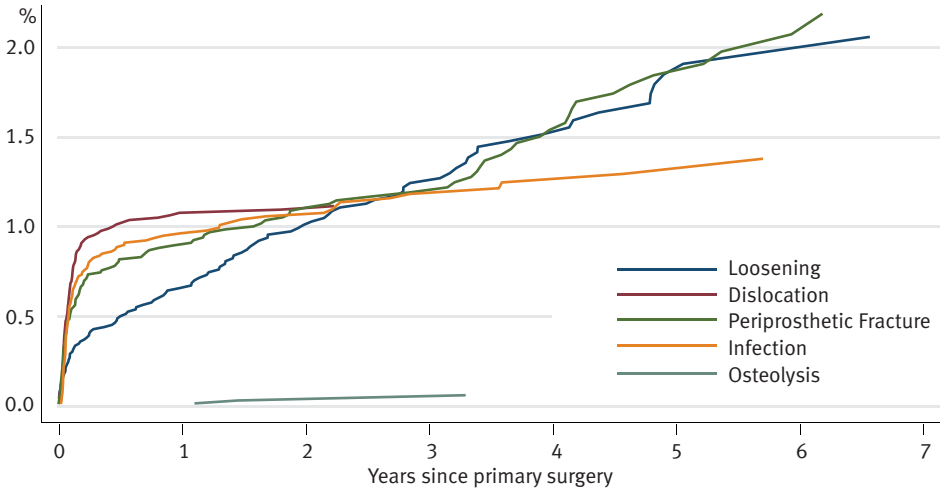


Figure 5.8b

Fracture of the hip: cumulative incidence rates for different revision diagnoses (fracture HA)

Time since operation, 2012–2019, all services, % of implants revised

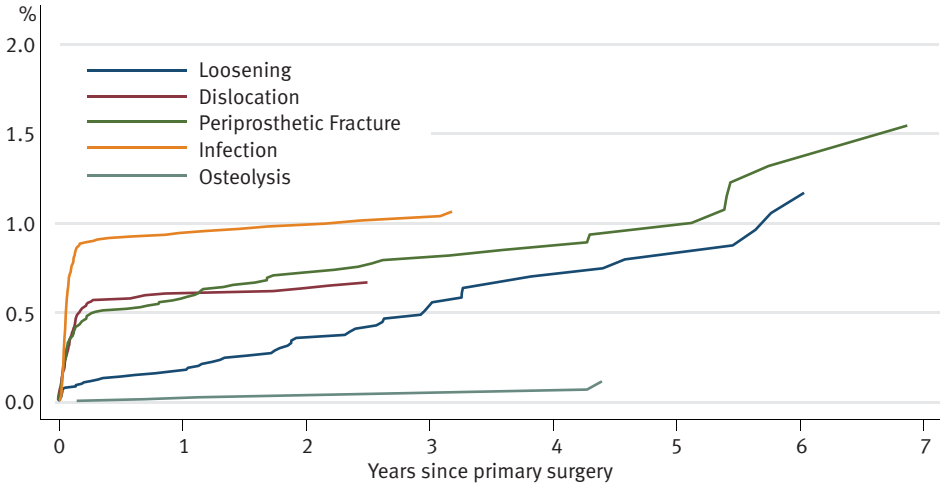


Table 5.13

Fracture of the hip: revision rates of cemented primary HA components within 24 months

Four-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Stem component	Head component	At risk*	Revised		95% CI	
		N	N	%**	lower	upper
CCA	Mathys Hemi Head Steel	1,300	24	2.3	1.5	3.4
AmiStem	Medacta Endo Head	873	24	3.2	2.2	4.8
Weber	Zimmer Biomet Unipolar Head	733	24	3.9	2.6	5.8
Harmony Cemented	Symbios Bibop	321	11	3.8	2.1	6.8
Original MEM Stem	ZB Unipolar Head	314	5	1.9	0.8	4.5
Centris	Mathys Hemi Head Steel	287	6	2.5	1.1	5.6
twinSys	Mathys Hemi Head Steel	258	7	3.0	1.4	6.1
AmiStem	Medacta Bipolar Head	231	6	2.9	1.3	6.4
Original MEM Stem	Zimmer Biomet Bipolar Head	218	3	1.5	0.5	4.6
Weber	Zimmer Biomet Bipolar Head	210	5	2.5	1.0	5.9
Corail	Modular Head Carthcart	190	6	3.4	1.5	7.4
CCA	Mathys Bipolar Head Steel	161	7	5.2	2.5	10.6
Arcad SO	Symbios Bibop	158	5	3.5	1.5	8.4
Avenir	Zimmer Biomet Unipolar Head	110	1	1.0	0.1	7.2
Avenir	Zimmer Biomet Bipolar Head	105	3	3.5	1.1	10.6
Quadra	Medacta Endohead	86	1	1.4	0.2	9.5
MS-30 Stems	Zimmer Biomet Unipolar Head	84	0	0.0		
Quadra	Medacta Bipolar Head	84	1	1.2	0.2	8.2
AmiStem	Mathys Hemi Head Steel	82	1	1.4	0.2	9.6
CS-Plus	S&N Bipolar Ballhead	77	1	1.4	0.2	9.8
MS-30 Stems	Zimmer Biomet Bipolar Head	75	2	2.8	0.7	10.7
CS-Plus	S&N Fracture Head	72	2	3.1	0.8	12.0
Corail	S&N Bipolar Ballhead	58	1	1.8	0.3	12.0
Exception	Zimmer Biomet Bipolar Head	57	1	1.9	0.3	12.4
Exafit	Zimmer Biomet Bipolar Head	52	0	0.0		
Group average				**2.7**	**2.4**	**3.2**

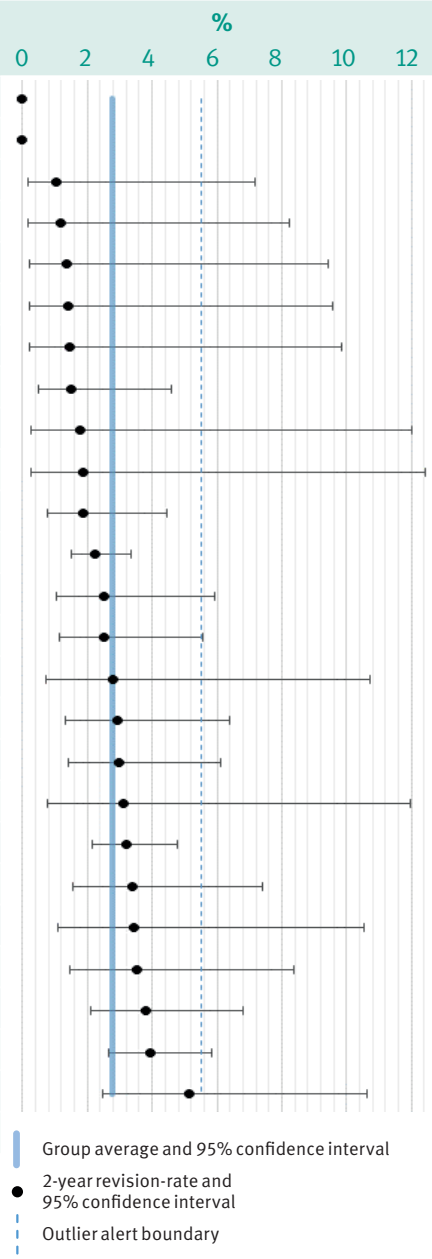
* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

Table 5.14

Fracture of the hip: 2-year revision rates of cemented stem/head combinations used in HA

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Stem component	Head component	At risk N*	Revised N	Revised %**	95% CI lower	95% CI upper
MS-30 Stem	Zimmer Biomet Unipolar Head	84	0	0.0		
Exafit	Zimmer Biomet Bipolar Head	52	0	0.0		
Avenir	Zimmer Biomet Unipolar Head	110	1	1.0	0.1	7.2
Quadra	Medacta Bipolar Head	84	1	1.2	0.2	8.2
Quadra	Medacta Endohead	86	1	1.4	0.2	9.5
AmiStem	Mathys Hemi Head Steel	82	1	1.4	0.2	9.6
CS-PLUS	S&N Bipolar Ballhead	77	1	1.4	0.2	9.8
Orig.MEM Stem	Zimmer Biomet Bipolar Head	218	3	1.5	0.5	4.6
Corail	S&N Bipolar Ballhead	58	1	1.8	0.3	12.0
Exception	Zimmer Biomet Bipolar Head	57	1	1.9	0.3	12.4
Orig.MEM Stem	Zimmer Biomet Unipolar Head	314	5	1.9	0.8	4.5
CCA	Mathys Hemi Head Steel	1,300	24	2.3	1.5	3.4
Weber Stem	Zimmer Biomet Bipolar Head	210	5	2.5	1.0	5.9
Centris	Mathys Hemi Head Steel	287	6	2.5	1.1	5.6
MS-30 Stem	Zimmer Biomet Bipolar Head	75	2	2.8	0.7	10.7
AmiStem	Medacta Bipolar Head	231	6	2.9	1.3	6.4
twinSys	Mathys Hemi Head Steel	258	7	3.0	1.4	6.1
CS-Plus	S&N Fracture Head	72	2	3.1	0.8	12.0
AmiStem	Medacta Endohead	873	24	3.2	2.2	4.8
Corail	Modular Head Carthcart	190	6	3.4	1.5	7.4
Avenir	Zimmer Biomet Bipolar Head	105	3	3.5	1.1	10.6
Arcad SO	Symbios Bibop	158	5	3.5	1.5	8.4
Harmony Cem.	Symbios Bibop	321	11	3.8	2.1	6.8
Weber Stem	Zimmer Biomet Unipolar Heads	733	24	3.9	2.6	5.8
CCA	Mathys Bipolar Head Steel	161	7	5.2	2.5	10.6
Group Average				**2.7**	**2.4**	**3.2**



* 4-year moving average covering implants between 01.07.2014 and 30.06.2018, with 2-year follow-up

** Rates adjusted for effects of departure or mortality

Identification as potential outlier. 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. Knee arthroplasty

6.1 Primary total knee arthroplasty

In the meantime, the total number of registered primary TKAs in the Swiss Joint Registry has surpassed 100,000 cases, 72,021 cases in the period since 2015.

Only since 2015 have the morbidity state (ASA classification) and the Body Mass Index (BMI) been recorded, leading to a separation of the first registration years 2012–2014 (Tables 6.1, 6.5, figures 6.2, 6.3). Therefore baseline characteristics (Table 6.2) and surgical characteristics (Table 6.3) are only presented for the period since 2015. On the other hand whenever possible calculations have included all the registered revisions since 2012.

The rate of surgery performed on women, 60.7%, and their mean age of 69.5 years were constant during the whole period of time (Table 6.1).

The rate of TKAs in younger patients (younger than 45: 0.5% and 45–54 years old: 6.4%) and patients older than 85 years old (4.6%) has remained consistently low over the past years which is an indirect sign that indications for TKA were not extended in a health care system with many hospitals and a high number of orthopaedic surgeons.

The proportion of missing BMIs is still 19% overall but has decreased continuously over the past four years to 15% in 2019. Further improvement is needed as BMI is an important comorbidity factor for TKA. From the data available, we can calculate that the mean BMI was 29.5 kg/m² and seemed to remain constant. Obese patients (BMI ≥ 30 kg/m²) made up 39.8% of the total knee arthroplasty patients in Switzerland.

The age at which total knee arthroplasty was performed, decreased with the increasing BMI category (Figure 6.1). This effect was even more pronounced in patients with BMI 35 to 39.9 and ›40 kg/m². Whereas the mean age at surgery for normal BMI is over 70 years, the mean age is lower with a BMI of more than 35 kg/m² (66.4 years) and decreases to lower than 65 years in case of a BMI more than 40 kg/m². The rate of unrecorded ASA classification was 10% on average.

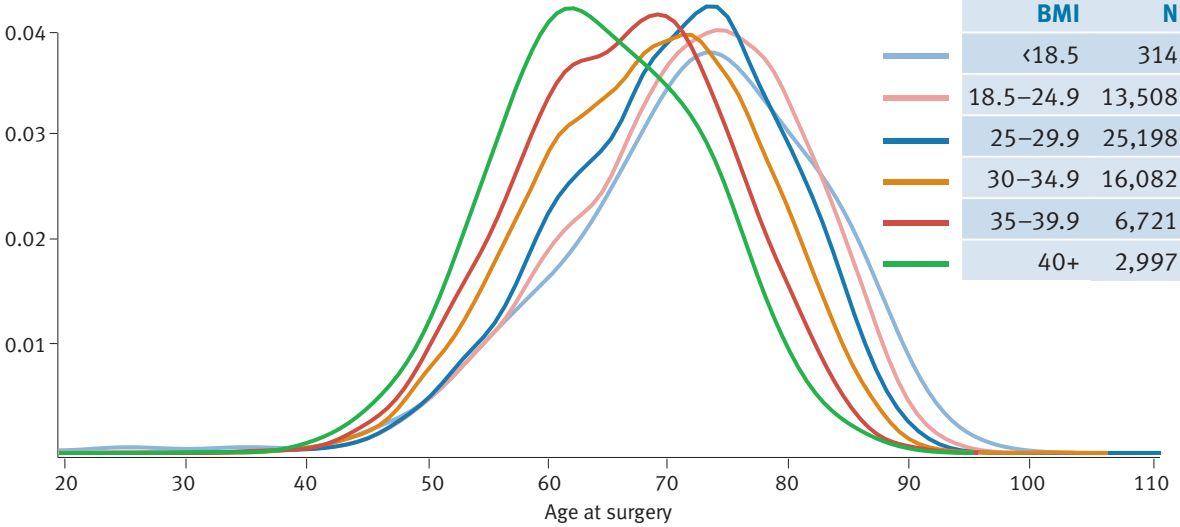
Gender, mean age, age groups and BMI did not differ between low or high-volume hospitals (Table 6.2) whereas hospitals with more than 200 TKAs per year seemed to treat more patients classified as ASA 3.

The most frequent reasons for TKAs were classified as primary arthritis (88.5% in 2019) although more

Figure 6.1

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

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



BMI	N	Mean age at time of TKA
‹18.5	314	72.3
18.5–24.9	13,508	71.7
25–29.9	25,198	70.6
30–34.9	16,082	68.4
35–39.9	6,721	66.4
40+	2,997	64.4

Table 6.1

Primary total knee arthroplasty: Baseline patient characteristics by year

2012–2019. BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**30,617**	**13,225**	**14,459**	**14,329**	**14,630**	**15,378**	**72,021**
Diagnosis [%]	Primary OA	96.4	88.0	88.2	88.0	88.9	88.5	88.3
	Secondary OA	3.6	12.0	11.8	12.0	11.1	11.5	11.7
	Inflammatory origin	0.9	1.2	1.2	0.8	0.9	0.9	1.0
	Fracture	0.5	2.3	2.0	2.2	2.1	2.1	2.1
	Lesion of ligament	0.0	4.8	5.2	5.4	4.8	5.2	5.1
	Infection	0.0	0.2	0.2	0.2	0.2	0.2	0.2
	Osteonecrosis	1.6	2.2	1.7	1.8	1.8	1.5	1.8
	Other	0.5	1.4	1.5	1.6	1.3	1.4	1.5
Women [%]		60.8	61.5	61.3	60.7	60.4	59.6	60.7
Mean age (SD)	All	69.5 (9.7)	69.5 (9.7)	69.3 (9.6)	69.4 (9.4)	69.4 (9.7)	69.8 (9.5)	69.5 (9.6)
	Women	70.2 (9.7)	70.2 (9.7)	70.0 (9.5)	70.0 (9.5)	69.9 (9.7)	70.5 (9.6)	70.1 (9.6)
	Men	68.4 (9.4)	68.4 (9.5)	68.3 (9.6)	68.4 (9.3)	68.6 (9.6)	68.9 (9.3)	68.5 (9.4)
Age group [%]	‹45	0.6	0.6	0.6	0.5	0.5	0.4	0.5
	45–54	6.2	6.6	6.6	6.3	6.4	6.0	6.4
	55–64	23.3	23.4	23.5	23.8	24.4	23.2	23.7
	65–74	36.9	36.8	37.6	37.8	36.4	36.1	36.9
	75–84	28.4	28.0	27.6	27.3	27.7	29.3	28.0
	85+	4.5	4.7	4.2	4.4	4.8	5.1	4.6
N unknown BMI (%)			3,309 (25)	2,934 (20)	2,626 (18)	2,305 (16)	2,310 (15)	13,484 (19)
N known BMI			9,916	11,525	11,703	12,325	13,068	58,537
Mean BMI (SD)			29.4 (6.2)	29.5 (5.6)	29.5 (5.7)	29.5 (5.9)	29.5 (5.8)	29.5 (5.8)
BMI [%]	‹18.5		0.5	0.4	0.5	0.5	0.5	0.5
	18.5–24.9		21.1	21.1	20.8	20.5	20.8	20.9
	25–29.9		39.6	38.9	38.5	38.5	38.8	38.8
	30–34.9		24.2	24.6	24.9	25.4	24.8	24.8
	35–39.9		10.1	10.5	10.6	10.6	10.2	10.4
	40+		4.5	4.6	4.7	4.5	4.8	4.6
N unknown ASA (%)			1,717 (13)	1,552 (11)	1,438 (10)	1,229 (8)	1,194 (8)	7,130 (10)
N known ASA			11,508	12,907	12,891	13,401	14,184	64,891
Morbidity state	ASA 1		11.9	9.8	8.6	8.3	8.2	9.3
[%]	ASA 2		61.4	62.4	63.3	63.0	61.5	62.3
	ASA 3		26.5	27.5	27.7	28.3	29.8	28.0
	ASA 4/5		0.3	0.3	0.4	0.4	0.5	0.4

Table 6.2

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

Calculations of hospital service volume based on primary hip surgeries in each included year (2015-2019).

Hospital service volume		<100	100–199	200–299	300+
N (2015–2019)		**16,582**	**21,302**	**14,616**	**19,521**
Women [%]		61.1	60.1	60.9	60.8
Mean age (SD)	All	69.9 (9.7)	69.6 (9.6)	69.5 (9.5)	69.0 (9.5)
	Women	70.6 (9.6)	70.1 (9.6)	70.1 (9.6)	69.6 (9.6)
	Men	68.9 (9.6)	68.7 (9.5)	68.5 (9.2)	68.0 (9.3)
Age group [%]	<45	0.5	0.5	0.4	0.6
	45–54	6.2	6.3	6.0	6.9
	55–64	22.5	23.8	23.9	24.4
	65–74	36.0	36.3	37.7	37.8
	75–84	29.6	28.6	27.1	26.5
	85+	5.3	4.6	4.9	3.9
Diagnosis [%]	Primary OA	88.8	89.2	87.3	87.7
	Secondary OA	11.2	10.8	12.7	12.3
N unknown BMI (%)		3,660 (22)	3,934 (18)	2,261 (15)	3,629 (19)
N known BMI		12,922	17,368	12,355	15,892
Mean BMI (SD)		29.5 (5.7)	29.7 (6.1)	29.6 (5.9)	29.1 (5.6)
BMI [%]	<18.5	0.5	0.5	0.5	0.5
	18.5–24.9	20.5	20.0	19.9	22.8
	25–29.9	38.6	38.0	38.9	39.9
	30–34.9	25.5	25.4	25.3	23.2
	35–39.9	10.4	11.2	10.6	9.5
	40+	4.6	5.0	4.9	4.1
N unknown ASA (%)		1,328 (8)	1,998 (9)	1,675 (11)	2,129 (11)
N known ASA		15,254	19,304	12,941	17,392
ASA state [%]	ASA 1	10.5	10.2	7.9	8.3
	ASA 2	62.0	64.5	62.5	60.2
	ASA 3	27.1	24.9	29.3	31.2
	ASA 4/5	0.5	0.4	0.4	0.3

Table 6.3

Primary total knee arthroplasty: Surgery characteristics

N (2015–2019)		N	%
Previous surgery	None	47,730	66.3
	Knee arthroscopy	12,100	16.8
	Meniscectomy	11,937	16.6
	ACL reconstruction	2,903	4.0
	Osteotomy tibia close to knee	2,186	3.0
	Osteosynthesis tibia close to knee	946	1.3
	Surgery for patella stabilization	882	1.2
	Synovectomy	572	0.8
	Osteotomy femur close to knee	366	0.5
	Osteosynthesis femur close to knee	346	0.5
	Surgery for treating infection	124	0.2
	Surgery for tumor	27	0.0
	Other	2,203	3.1
Intervention	CS (cruciate sacrificing) / UCOR	23,129	32.1
	unlinked post. stabilised	21,148	29.4
	PCR (posterior cruciate retaining)	18,647	25.9
	BCR (bicruciate retaining)	1,088	1.5
	hinge type	1,144	1.6
	unlinked semi-constrained	921	1.3
	CCK constrained condylar knee	695	1.0
	Other (Medial-Pivot)	4,428	6.2
	Other	743	1.0
Technology	Conventional	51,820	72.0
	Computer assisted	8,540	11.9
	Patient specific instrumentation	9,105	12.6
	Minimally invasive	4,275	5.9
	Other	1,122	1.6

Table 6.4

Primary total knee arthroplasty: Component fixation

Component fixation [%]	2012–2014	2015	2016	2017	2018	2019	2015–2019
N	**30,617**	**13,225**	**14,459**	**14,329**	**14,630**	**15,378**	**72,021**
All uncemented	8.6	5.2	4.4	3.7	3.5	3.9	4.1
Reverse hybrid*	0.5	1.9	0.5	0.4	0.3	0.4	0.7
Hybrid**	24.8	18.1	16.6	15.6	14.1	13.9	15.6
All cemented	66.1	74.8	78.5	80.3	82.1	81.8	79.6

Figure 6.2

Primary total knee arthroplasty: Component fixation by year

Percentage per year

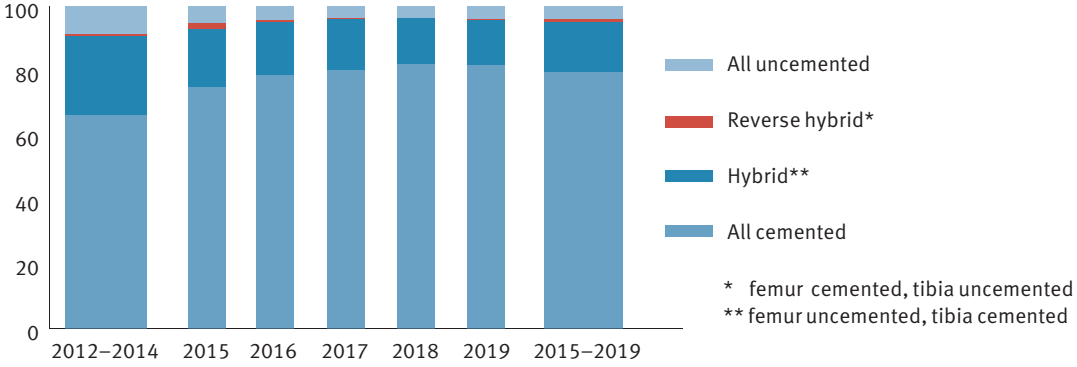


Table 6.5

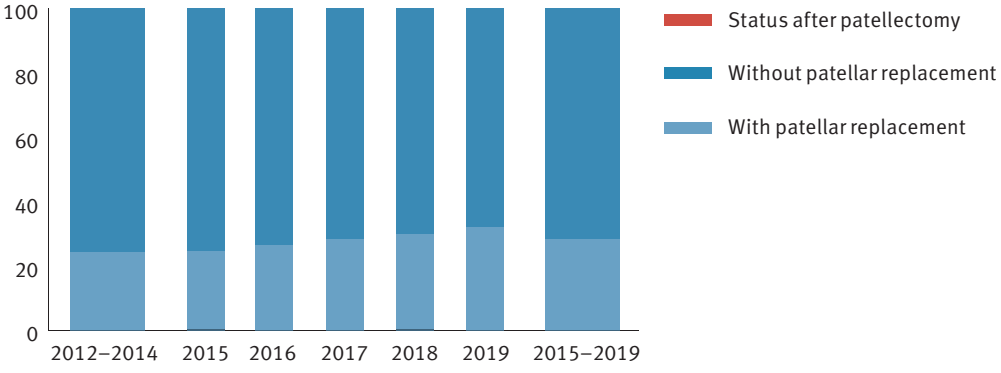
Primary total knee arthroplasty: Patellar component

Patellar component [%]	2012–2014	2015	2016	2017	2018	2019	2015–2019
N	**30,617**	**13,225**	**14,459**	**14,329**	**14,630**	**15,378**	**72,021**
Without patellar replacement	75.9	75.5	73.6	71.6	70.4	68.2	71.8
With patellar replacement	24.1	24.4	26.4	28.3	29.5	31.8	28.2
Status after patellectomy	0.0	0.1	0.0	0.0	0.1	0.0	0.0

Figure 6.3

Primary total knee arthroplasty: Patellar component

Percentage per year



reasons (such as ligament lesions or infections) were introduced in 2015 as possible underlying causes for secondary arthritis, however our knowledge about factors causing knee arthritis has steadily increased over the past decades. A bias towards primary OA is probable, as this reason ranges highest in the selection menu and thus possibly prevents thinking about other diagnoses and alternatives.

There were 66.7% of the knees never operated on before TKA. Previous operations were mostly arthroscopies (16.8%), followed by meniscectomy (16.6%), ACL reconstruction (4%) and osteotomies of the tibia (3.0%). 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.

Table 6.6
Primary total knee arthroplasty: Type of bearing

Type of bearing [%]	2015	2016	2017	2018	2019	2015–2019
N	**12,322**	**13,494**	**13,120**	**13,063**	**13,629**	**65,628**
Mobile bearing	45.6	42.8	41.4	39.3	36.5	41.0
Fixed bearing	54.4	57.2	58.6	60.7	63.5	59.0

Figure 6.4
Primary total knee arthroplasty: Type of bearing
Percentage per year

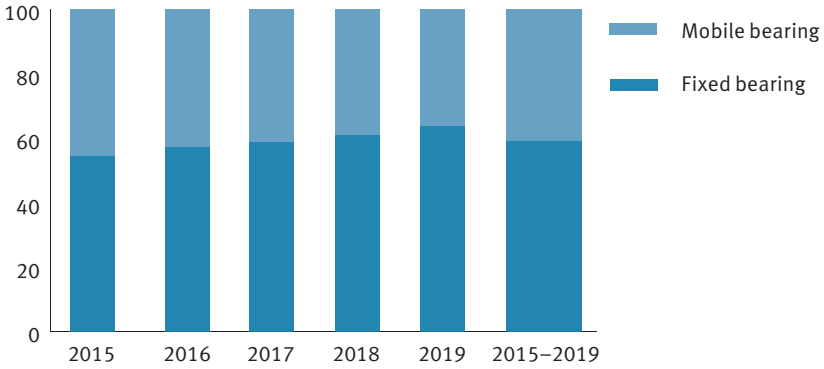
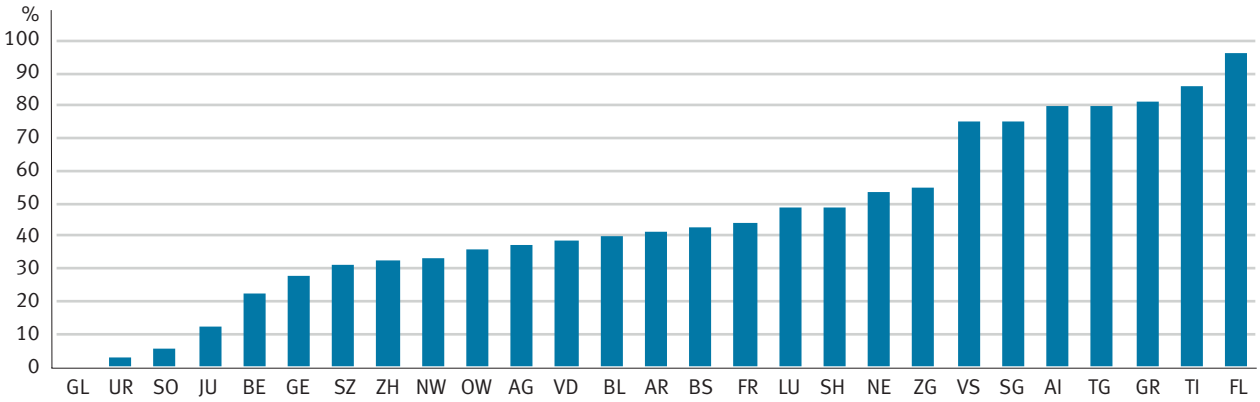


Figure 6.5
Primary total knee arthroplasty: Share of TKA procedures with mobile bearing by Swiss Canton and Principality of Liechtenstein (2015–2019)



The exact type of arthroplasty used is still not clear, partially due to the imprecise classification which was changed in 2015. Thirty-two point one percent (32.1%) were classified as cruciate sacrificing or ultra-congruent inlay (UCOR), 29.4% as posterior stabilized and 25.9% as posterior cruciate-retaining. The group "other" mostly consisted of medial pivoting knees accounting for 6.2% of all TKAs. All other types were rare in primary TKA such as bicruciate-retaining (1.5%), hinge (1.6%) or constrained knees (1.0%). The classification of the type of TKA will be adapted with the next revision of the registration forms, planned for 2021.

In 2019, there were slightly fewer computer-assisted TKAs at a rate of 11.9%. Patient-specific instrumentation (PSI) increased from 8.4% in 2013–2014 to 12.6% in 2015–2019. Robotic assisted TKA (imageless and image-based) were classified as "other". Minimally invasive surgery is on the decrease and was 5.9% in 2015–2019 (Figure 6.6).

In total knee arthroplasty the rate of all cemented fixations remained high (Table 6.4 and Figure 6.2), the use of cement was constantly low in total knee arthroplasties (4.1% in 2019) and hybrid fixation (16.3% in 2019). In 71.8% of the primary cases, the patella was not resurfaced (Table 6.5). The resur-

Table 6.7

Primary total knee arthroplasty: Technologies used

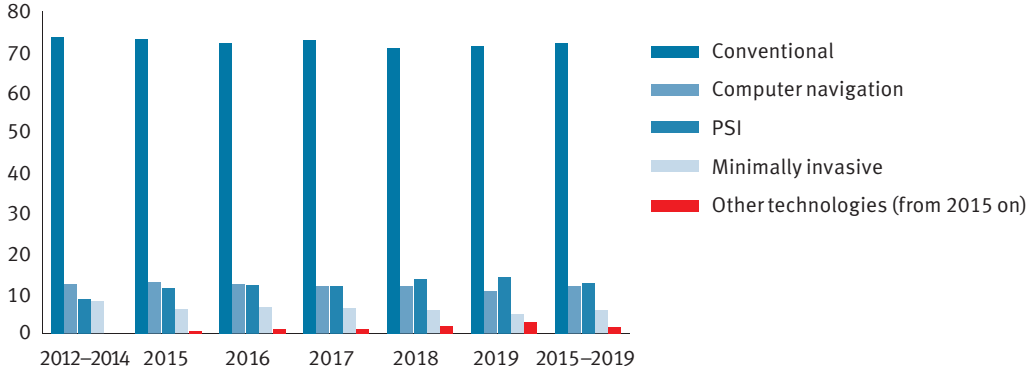
Multiple responses possible

Technology [%]	2012–2014	2015	2016	2017	2018	2019	2015–2019
N	**30,617**	**13,225**	**14,459**	**14,329**	**14,630**	**15,378**	**72,021**
Conventional	73.5	72.9	72.1	72.8	70.8	71.3	72.0
Computer navigation	12.3	12.8	12.3	11.9	11.8	10.7	11.9
PSI	8.6	11.4	12.1	11.8	13.5	14.2	12.6
Minimally invasive	8.2	6.1	6.6	6.4	5.8	4.9	5.9
Other technologies (from 2015)		0.5	1.2	1.1	1.9	2.9	1.6

Figure 6.6

Primary total knee arthroplasty: Technologies used

Percentage per year



facing rate has increased continuously since 2015 from 24.1% to 31.8% in 2019. However, there are considerable differences concerning the numbers of patella resurfacing between the Cantons (Figure 6.7). Parts of these differences can be explained by the use of posterior stabilised knees being more popular in the western part of Switzerland and in centres where a resurfacing of the patella is recommended more than cruciate retaining TKA models. Figure 6.8 shows the high variation of the different types of knee prosthesis (posterior-stabilized PS, cruciate-sacrificing CS/ UCOR, cruciate-retaining BCR/ PCR and medial-pivot MP) in Switzerland. The rate of mobile bearing has continuously decreased over the past five years and was less than 40% in 2019 (Figure 6.4). Nevertheless, the proportion of mobile bearing can vary considerably between cantons from 0% in Glarus to more than 90% in the Principality of Liechtenstein (Figure 6.5).

Figure 6.7

Proportion of total knee arthroplasty procedures with patella resurfacing by Swiss Canton and Principality of Liechtenstein (2015 – 2019)

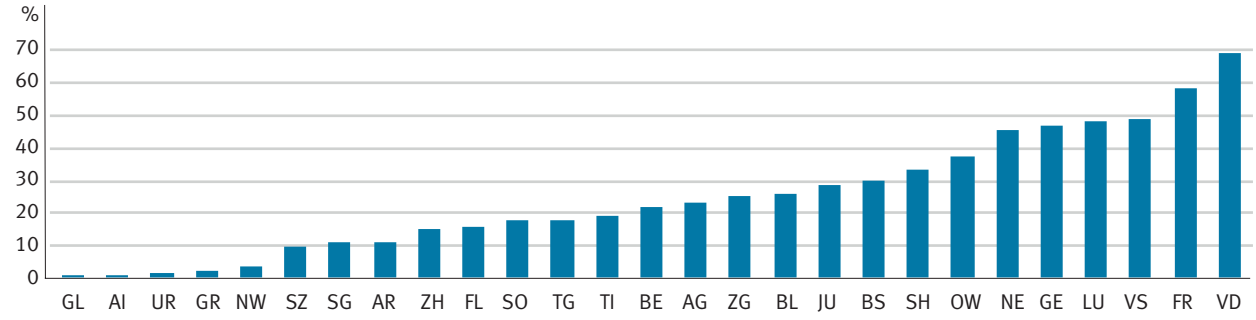
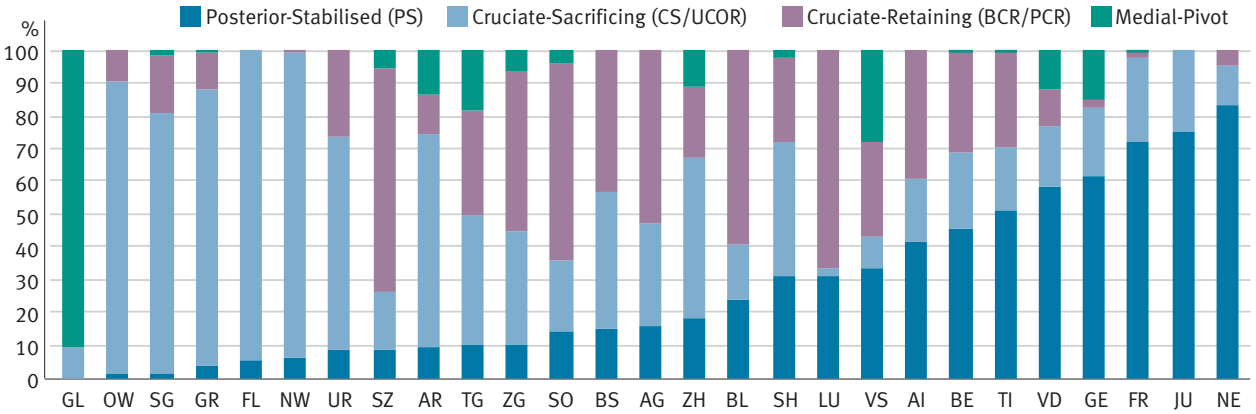


Figure 6.8

Relative proportion of total knee arthroplasty procedures usin CR, CS PS, MP by Swiss Canton and Principality of Liechtenstein (2015 – 2019)



6.2 Revision of primary total knee arthroplasty

Only since 2015 have the morbidity state (ASA classification) and Body Mass Index (BMI) been recorded; this has led to a separation of the first years (2012–2014) of registration from the following years (Table 6.8). In consequence, for reasons of revision (Table 6.9), surgery characteristics (6.10) we present only the period since 2015. On the other hand, calculations include all the registered revisions since 2012, whenever possible.

The mean age at revision was 69.1 years; 59% were women. Fifty-eight point six percent (58.6%) were classified as ASA 1 or 2; the morbidity status was not recorded in 12%. The mean BMI was 29.7 kg/m^2 with BMI not recorded in 25% of cases (Table 6.8).

To understand Table 6.9 regarding the reasons for

Table 6.8

Revision of primary total knee arthroplasty: Baseline patient characteristics by year

2012–2019. BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**3,459**	**1,539**	**1,829**	**1,931**	**1,969**	**2,086**	**9,354**
Women [%]		59.9	59.1	59.7	60.0	59.7	57.8	59.2
Mean age (SD)	All	68.4 (10.3)	68.9 (10.6)	69.0 (10.3)	69.0 (10.0)	69.2 (10.1)	69.6 (10.0)	69.1 (10.2)
	Women	69.0 (10.6)	69.1 (11.0)	69.9 (10.3)	69.6 (10.2)	69.9 (10.2)	70.3 (10.1)	69.8 (10.3)
	Men	67.5 (9.9)	68.5 (10.1)	67.7 (10.1)	68.2 (9.8)	68.2 (10.0)	68.7 (9.7)	68.3 (9.9)
Age group [%]	<45	1.4	1.4	0.9	0.6	1.0	0.3	0.8
	45–54	7.8	8.5	7.4	8.2	6.8	6.9	7.5
	55–64	25.1	23.0	24.4	22.9	24.6	24.2	23.8
	65–74	35.9	35.5	36.5	37.9	35.9	35.5	36.3
	75–84	25.2	26.5	24.9	25.3	26.4	27.6	26.2
	85+	4.6	5.2	5.9	5.0	5.2	5.6	5.4
N unknown BMI (%)			441 (29)	525 (29)	486 (25)	452 (23)	399 (19)	2,303 (25)
N known BMI			1,098	1,304	1,445	1,517	1,687	7,051
Mean BMI (SD)			29.6 (5.8)	30.0 (7.4)	29.8 (5.9)	29.8 (5.8)	29.6 (5.7)	29.7 (6.1)
BMI [%]	<18.5		0.8	0.9	0.5	0.6	0.6	0.7
	18.5–24.9		21.6	18.4	19.1	20.6	20.4	20.0
	25–29.9		36.1	37.0	36.8	35.3	36.7	36.4
	30–34.9		25.3	26.8	26.1	26.4	26.1	26.2
	35–39.9		11.7	11.8	13.1	12.3	12.1	12.2
	40+		4.5	5.1	4.4	4.9	4.1	4.6
N unknown ASA (%)			238 (15)	255 (14)	222 (11)	184 (9)	201 (10)	1,100 (12)
N known ASA			1,301	1,574	1,709	1,785	1,885	8,254
Morbidity state	ASA 1		7.6	7.6	7.1	6.3	5.5	6.7
[%]	ASA 2		52.0	52.1	52.1	51.7	51.5	51.9
	ASA 3		38.9	38.8	39.7	40.7	41.4	40.0
	ASA 4/5		1.5	1.6	1.1	1.3	1.6	1.4

TKA revisions, it is important to note that several reasons can be combined per patient, which result in a sum of 146.1% instead of 100% (if only one reason per revision were accepted).

Patella problems were the main reason for revisions (26.4%), followed by loosening of the tibia in 19.1%. If loosening of the femur (11.7%) and patella (2.3%) were added, loosening would take the lead, being responsible for 33.1% of the revision cases. Infection was the cause for revision in almost 1 of 5 cases (19.1%), instability in 17.4%. Wear was responsible for only 5.9% of the revision of TKAs. Eleven percent of the causes were classified as "other" (Table 6.9).

A deeper understanding of the long-term progression of revisions can be gained by looking at cumulative incidence figures (Figure 6.9). This perspective shows what proportion of implanted patients have experienced at least one revision and for which underlying reasons (e.g. revision due to loosening of a component). In this type of graphic, a line starts when the first relevant revision in the SIRIS dataset is observed, and it ends with the last recorded revision. It shows that while infections occur relatively early, most reasons for revising a TKA tend to manifest themselves relatively late (after one year) and then drive the revision rates upwards, in what might resemble logistic growth curves (slow increase followed by steeper growth and then a flattening out effect). Patella problems, in particular, contribute to the revision rates observed in this fashion, causing a disproportionate number of revisions between one and three years after implantation.

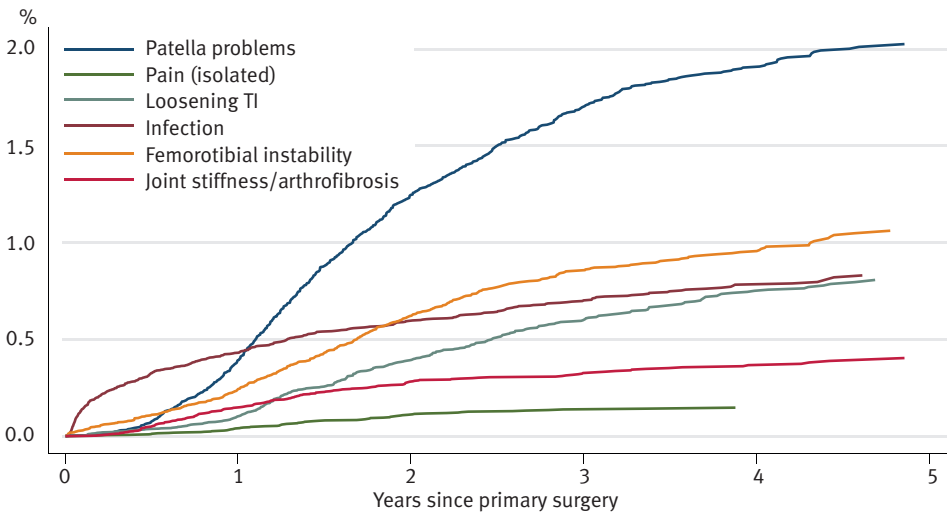
Complete revision was performed in 37.6% of the cases, in 15.9% PE was exchanged. Secondary resurfacing of the patella was performed in 15.6% (Table 6.10). Osteosynthesis was reported in 0.3% which seems to be underreported, as periprosthetic fractures are increasing in all western societies because of the demography and the activity levels. SIRIS mainly records major revisions, i.e. exchange of at least one component. Therefore, open reduction and internal fixation of a periprosthetic facture will usually not be recorded.

Posterior cruciate retaining TKAs were used in 5.0% of the revisions, 22.9% were stabilised posteriorly, 10.1 were classified as cruciate sacrificing or ultra-congruent implants and in 23.5% a hinge type prosthesis was used. Unlinked-semiconstrained or CCK implants were the biggest group (34%), whereas medial pivot was used only in 1.1% (Table 6.10).

Figure 6.9

Cumulative incidence rates for different revision diagnosis of primary total knee arthroplasty

Time since operation, 2012–2019, all services, % of implants revised



In revision surgery, computer navigation, PSI or minimally invasive techniques do not play an important role. The rate of fully cemented implants has steadily increased over the past years reaching 93% in 2019 (Table 6.11, Figure 6.10). Revision-TKA was associated with patella resurfacing in 64.5% of the cases, in 35.2% there was no intervention. This rate is continuously sinking over the past years and reached one-third in 2019 (33.2%).

Table 6.9

Reason for revision of primary total knee arthroplasty

Multiple reasons are possible per patient. 2015 to 2019

	N	%
Patella problems	2,474	26.4
Loosening tibia	1,785	19.1
Infection	1,786	19.1
Femorotibial instability	1,627	17.4
Pain	1,104	11.8
Loosening femur	1,099	11.7
Wear of inlay	551	5.9
Joint stiffness/arthrofibrosis	530	5.7
Component malposition femur	416	4.4
Component malposition tibia	377	4.0
Loosening patella	213	2.3
Patellar instability	211	2.3
Periprosthetic fracture femur	189	2.0
Sizing femoral component	121	1.3
Periprosthetic fracture tibia	71	0.8
Sizing tibial component	52	0.6
Periprosthetic fracture patella	34	0.4
Other	1,027	11.0
Total 2015–2019	13,667	146.1

Table 6.10

Surgery characteristics of revision of primary total knee arthroplasty

2015 to 2019

Intervention type	N	%
complete revision	3,515	37.6
exchange of PE	1,488	15.9
subsequent patella prosthesis	1,462	15.6
tibial revision	540	5.8
reimplantation of prosthesis	561	6.0
subsequent patella prosthesis with exchange of PE	450	4.8
patella revision	369	3.9
component removal with spacer implantation	310	3.3
femoral revision	236	2.5
prosthesis preserving revision	79	0.8
osteosynthesis	28	0.3
arthrodesis	29	0.3
component removal without spacer implantation	27	0.3
reconstruction after injury of extensor mechanism	21	0.2
plastic reconstruction	8	0.1
other	231	2.5
Type of arthroplasty		
Unlinked posterior stabilised	1,111	22.9
Hinge type	1,139	23.5
Unlinked semi-constrained	937	19.3
CS (cruciate sacrificing) / UCOR	491	10.1
CCK constrained condylar knee	714	14.7
PCR (posterior cruciate retaining)	244	5.0
BCR (bicruciate retaining)	29	0.6
Other (Medial-Pivot)	55	1.1
Other	124	2.6
Technology		
Conventional	8,128	94.3
Computer assisted	183	2.1
Patient specific instrumentation	66	0.8
Minimally invasive	227	2.6
Other	74	0.9

Table 6.11

Revision of primary total knee arthroplasty: Component fixation

Component fixation only applicable when new components were implanted

Component fixation	2012–2014	2015	2016	2017	2018	2019	2015–2019
N	**3,186**	**808**	**919**	**1,016**	**1,064**	**1,047**	**4,854**
All uncemented	9.0	3.1	3.7	3.2	2.0	2.0	2.8
Reverse hybrid*	1.5	1.5	1.3	1.3	0.8	1.1	1.2
Hybrid**	10.1	5.9	3.4	4.1	3.4	3.8	4.1
All cemented	79.4	89.5	91.6	91.3	93.9	93.0	92.0

Figure 6.10

Revision of primary total knee arthroplasty: Component fixation by year

Percentage per year

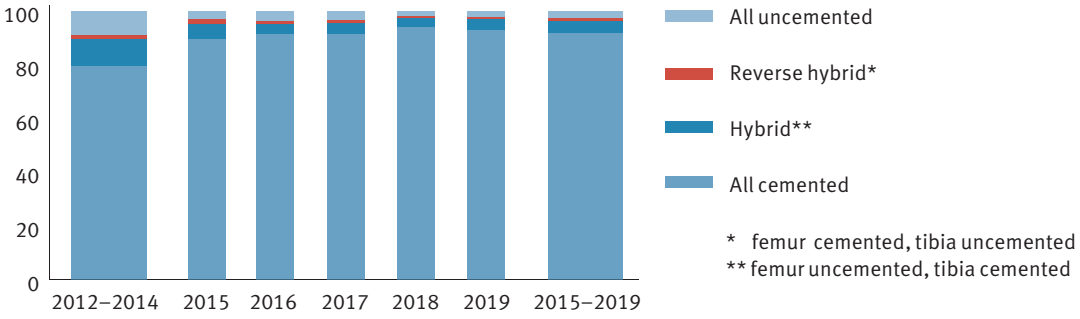


Table 6.12

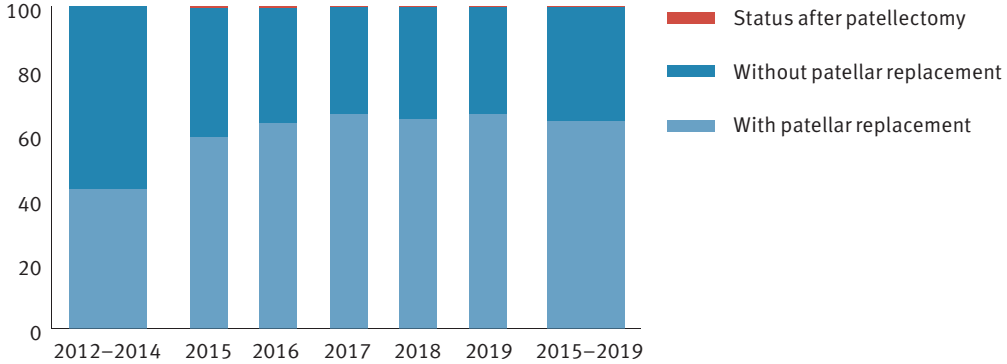
Revision of primary total knee arthroplasty: Patellar component

Patellar component [%]	2012–2014	2015	2016	2017	2018	2019	2015–2019
N	**3,186**	**1,170**	**1,331**	**1,511**	**1,553**	**1,569**	**7,134**
Without patellar replacement	56.7	40.1	36.1	33.2	34.9	33.2	35.2
With patellar replacement	43.3	59.4	63.6	66.6	64.9	66.5	64.5
Status after patellectomy	0.0	0.5	0.4	0.3	0.2	0.3	0.3

Figure 6.11

Revision of primary total knee arthroplasty: Patellar component

Percentage per year



6.3 First revision of a primary total knee arthroplasty

This is the first SIRIS report covering not the whole data set but a defined period from 1.7.2014 to 30.6.2018 in order to calculate the early revision rate of TKA within the first two years after the index surgery. The reason for this moving time window is to stay as accurate as possible with a minimal follow up of 2 years and thus continuously exclude data from the first registry years, which were less detailed. Therefore just one year is remaining before changing the registration form in 2021. In addition, the moving average will cover only the time period of the last 6 years of interest and could show continuously better results with fewer revisions as an effect of the expected learning curve.

Table 6.13

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall (moving average)		**55,645**	**1,886**	**3.4**	**3.3**	**3.6**
Diagnosis	Primary OA	49,600	1,648	3.4	3.2	3.5
	Secondary OA	6,045	238	4.0	3.6	4.6
Overall Primary OA		49,600	1,648	3.4	3.2	3.5
Gender	Women	31,030	1,004	3.3	3.1	3.5
	Men	18,570	644	3.5	3.3	3.8
Age group [%]	<55	2,819	155	5.6	4.8	6.5
	55–64	11,212	498	4.5	4.1	4.9
	65–74	18,942	581	3.1	2.9	3.4
	75–84	14,339	370	2.6	2.4	2.9
	85+	2,250	44	2.0	1.5	2.7
Overall Primary OA **(from 2015)**		43,546	1,478	3.5	3.3	3.6
BMI group	<18.5	136	4	3.1	1.2	8.0
	18.5–24.9	6,931	243	3.6	3.2	4.0
	25–29.9	13,302	426	3.3	3.0	3.6
	30–34.9	8,670	314	3.7	3.3	4.1
	35–39.9	3,800	140	3.7	3.2	4.4
	40+	1,705	63	3.8	2.9	4.8
	BMI unknown	9,002	288	3.2	2.9	3.6
Morbidity state	ASA 1	3,552	132	3.8	3.2	4.5
	ASA 2	24,305	778	3.3	3.0	3.5
	ASA 3	10,807	410	3.9	3.5	4.3
	ASA 4/5	138	5	3.7	1.6	8.7
	ASA unknown	4,744	153	3.3	2.8	3.8

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

** Rates adjusted for effects of mortality and emigration.

Of the 102,638 documented primary TKAs implanted since 2012, there were 55,645 at risk for a revision from 01.07.2014 to 30.6.2018, with a completed 2-year follow-up. Of these, 1,886 knees were revised accounting for the 2-year revision rate of 3.4% (CI 95% 3.3–3.6%). Younger patients were predominantly at risk (6.5% in the age group under 55 years of age). Increasing BMI did slightly raise the early revision rate from 3.1% (‹18.5 kg/m²) to 3.8% in the group ›40 kg/m² (staying within the 95% confidence interval). In contrast, ASA classification did not play an important role (Table 6.13).

All uncemented components seemed to have been revised slightly more often than fully cemented TKA in the first two years after index surgery, although the difference was not significant. Hybrid fixation with cemented tibial and uncemented femoral component performed best which was better compared to fully cemented and completely uncemented fixations (Table 6.14). Taking the whole registry data set in account, the uncemented fixations led to more early revisions from the beginning and seemed to stay parallel on a higher level from 2 years until 7 years after index surgery (Figure 6.10).

Table 6.14

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

All diagnoses

	Primary TKA	Revised within 24 months			
		Revised		95% CI	
	N at risk[1]	N	%[2]	lower	upper
Overall (moving average)	55,645	1,886	3.4	3.3	3.6
Component fixation					
All cemented	43,241	1,491	3.5	3.3	3.7
All uncemented	2,526	108	4.3	3.6	5.2
Hybrid*	9,443	278	3.0	2.7	3.4
Reverse hybrid**	435	9	2.1	1.1	4.0
Patellar replacement					
With patellar replacement	14,757	420	2.9	2.6	3.2
Without patellar replacement	40,864	1,465	3.6	3.5	3.8
Status after patellectomy	24	1	4.2	0.6	26.1

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

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

Table 6.15

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

	2015–2019	
	N	%
Patella problems	663	35.2
Femorotibial instability	327	17.3
Infection	312	16.5
Pain	220	11.7
Loosening tibia	212	11.2
Joint stiffness/arthrofibrosis	152	8.1
Component malposition femur	83	4.4
Component malposition tibia	72	3.8
Loosening femur	55	2.9
Patellar instability	47	2.5
Loosening patella	28	1.5
Wear of inlay	23	1.2
Sizing femoral component	22	1.2
Periprosthetic fracture femur	15	0.8
Periprosthetic fracture tibia	12	0.6
Periprosthetic fracture patella	8	0.4
Sizing tibial component	6	0.3
Other	208	11.0
Total 2015–2019	**2,465**	**130.7**

A non-surfaced patella is more prone to early revision (3.6%) than a TKA with replacement (2.9%), the difference being statistically significant. This can be expected, as secondary patellar resurfacing is an isolated treatment option in painful TKA while a non-resurfaced patella, even though it might not fully resolve the problem of the underlying knee pain, is not addressed (Table 6.14).

The main reasons for early revision were patella problems in 35.2%, followed by instability (17.3%) and infection (16.5%) (Table 6.15). When infection was excluded, surgical technical problems were responsible for the vast majority of early TKA revisions in Switzerland. Exact ratios are not available as multiple reasons are possible per patient. In addition, 11.0% of the reasons were classified as "other". To a large extent this diverse group contains the same reasons as listed above, but with added detail, and includes numerous wound healing problems as well as more special reasons, such as inlay dislocations. Periprosthetic fractures of the femur, tibia and/or patella were rarely responsible for early revisions, and the majority of cases with internal fixation were apparently not registered.

Table 6.16

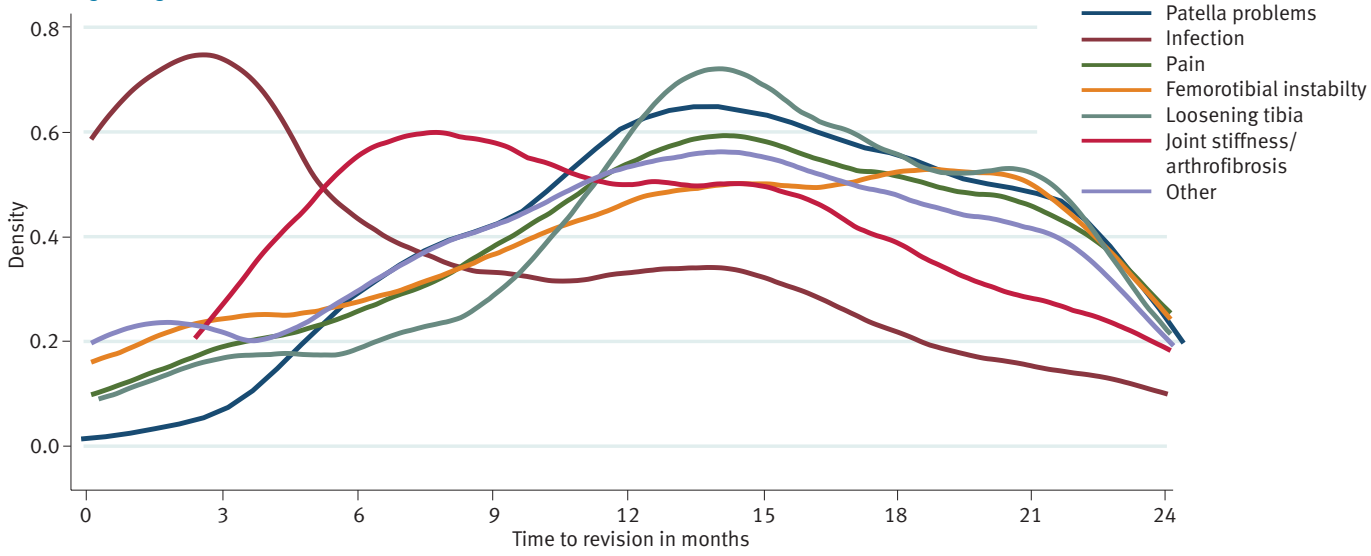
Median time interval between primary total knee arthroplasty and early first revision (in months) according to reason

	N	Median	IQR 25%	IQR 75%
Patella problems	**663**	14.5	10.6	18.9
Infection	**312**	5.9	1.5	13.0
Pain	**220**	14.4	10.0	19.3
Femoral instability	**327**	14.2	8.5	19.1
Loosening tibia	**212**	14.7	11.8	19.4
Joint stiffness/arthrofibrosis	**152**	11.7	7.2	16.4
Other	**1,065**	13.4	8.4	18.0

Figure 6.12

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

Moving average



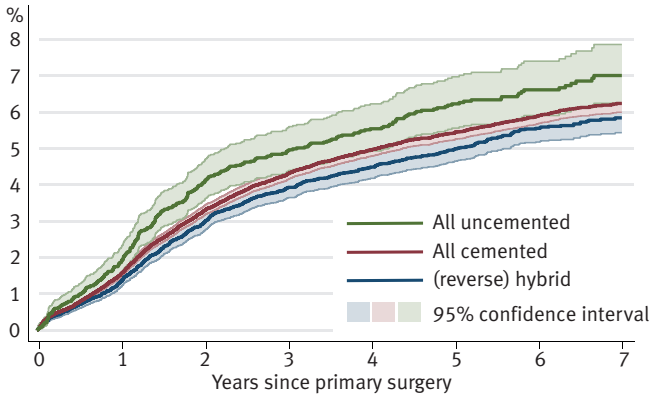
Kernel density shows that only infection leads to early revision of primary TKA (peak at three months), whereas the usual algorithm in patients with unsatisfactory results after TKA seemed to be: "wait and see". After an average of nine months, stiff knees were revised while all the other reasons for revisions took place more than two years after TKA on average (Figure 6.12).

Of the 29 knee systems used in Switzerland for primary TKA, three are possible outliers with the 95% confidence interval still lying within the outlier boundary. One of these critical implants belongs to the top ten group used in Switzerland with results that get worse even 5 to 7 years after surgery (Tables 6.17, 6.18 and 6.19). Most of the systems reach group averages but some are better than average. That small numbers of some systems' additional revisions can considerably change the performance should be noted (Figure 6.14). Following the statistical identification of potential outliers by this report, the SIRIS registry has produced outlier reports in order to further investigate the reasons for the observed deviations from the national average.

Figure 6.13

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

Time since operation, 2012–2019, all services



Cumulative revision rates

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
All cemented	**1.5** (1.5-1.6)	**3.3** (3.2-3.4)	**4.3** (4.1-4.5)	**5.0** (4.8-5.1)	**5.4** (5.2-5.6)	**5.9** (5.7-6.1)	**6.2** (6.0-6.5)
All uncemented	**1.9** (1.5-2.3)	**4.1** (3.6-4.6)	**4.9** (4.4-5.6)	**5.5** (4.9-6.2)	**6.2** (5.6-7.0)	**6.6** (5.9-7.4)	**7.0** (6.2-7.9)
(reverse) hybrid	**1.3** (1.2-1.5)	**3.0** (2.7-3.2)	**3.9** (3.6-4.2)	**4.5** (4.2-4.8)	**5.0** (4.7-5.4)	**5.6** (5.2-6.0)	**5.8** (5.4-6.3)

Table 6.17

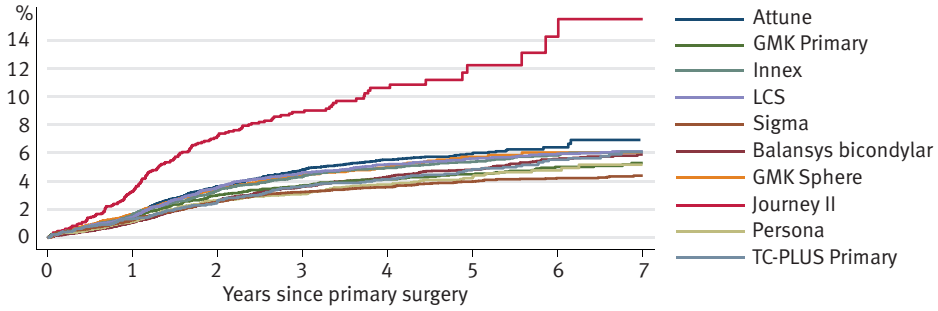
Top 10 implants, primary total knee arthroplasty, all component fixations

System	2013	2014	2015	2016	2017	2018	2019	2013–2019
Attune	152	1,249	2,526	3,107	3,215	3,208	3,120	16,577
Balansys bicondylar	1,626	1,660	1,792	1,859	1,843	1,706	1,813	12,299
Persona	280	833	1,244	1,615	1,991	2,317	2,461	10,741
Sigma	2,277	1,661	1,097	888	676	597	610	7,806
GMK Sphere	151	494	805	1,111	1,342	1,707	1,933	7,543
LCS	1,541	1,357	874	821	864	848	862	7,167
Innex	1,358	1,130	839	681	571	423	331	5,333
GMK Primary	1,027	787	553	545	395	275	193	3,775
TC-PLUS Primary	635	560	456	478	414	334	381	3,258
Journey II	48	71	169	397	466	396	365	1,912
Other	2,767	2,376	2,004	2,089	1,699	1,774	1,993	14,702
Total	**11,862**	**12,178**	**12,359**	**13,591**	**13,476**	**13,585**	**14,062**	**91,113**

Figure 6.14

Failure rates of primary total knee arthroplasty all component fixations, top 10 combinations

Time since operation, 2012–2019, all services



Cumulative revision rates

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Attune	**1.7** (1.5-1.9)	**3.6** (3.3-3.9)	**4.8** (4.5-5.2)	**5.5** (5.1-6.0)	**6.0** (5.5-6.5)	**6.4** (5.8-7.0)	**6.9** (6.0-7.9)
Balansys bicondylar	**1.1** (0.9-1.3)	**2.6** (2.3-2.9)	**3.6** (3.3-4.0)	**4.3** (3.9-4.7)	**4.8** (4.4-5.3)	**5.6** (5.1-6.1)	**5.9** (5.3-6.5)
Persona	**1.1** (1.0-1.4)	**2.7** (2.3-3.0)	**3.1** (2.7-3.5)	**3.8** (3.3-4.2)	**4.3** (3.8-4.9)	**4.8** (4.1-5.5)	**5.2** (4.4-6.1)
Sigma	**1.2** (1.0-1.5)	**2.6** (2.2-2.9)	**3.2** (2.9-3.7)	**3.6** (3.2-4.0)	**4.0** (3.6-4.5)	**4.2** (3.8-4.7)	**4.4** (3.9-4.9)
GMK Sphere	**1.7** (1.4-2.0)	**3.5** (3.0-4.0)	**4.4** (3.9-5.0)	**5.1** (4.5-5.7)	**5.7** (5.0-6.5)	**6.0** (5.2-7.0)	**6.0** (5.2-7.0)
LCS	**1.5** (1.2-1.7)	**3.6** (3.2-4.0)	**4.6** (4.2-5.2)	**5.2** (4.7-5.8)	**5.6** (5.1-6.2)	**5.9** (5.4-6.6)	**6.1** (5.5-6.8)
Innex	**1.7** (1.4-2.0)	**3.4** (2.9-3.9)	**4.3** (3.8-4.9)	**4.9** (4.4-5.6)	**5.4** (4.8-6.0)	**5.8** (5.2-6.5)	**6.1** (5.4-6.8)
GMK Primary	**1.3** (1.0-1.6)	**3.0** (2.5-3.6)	**3.7** (3.1-4.3)	**4.1** (3.6-4.8)	**4.5** (3.9-5.2)	**5.0** (4.3-5.8)	**5.3** (4.5-6.2)
TC-PLUS Primary	**1.3** (1.0-1.8)	**2.6** (2.1-3.2)	**3.6** (3.0-4.4)	**4.1** (3.5-4.9)	**4.8** (4.1-5.8)	**5.5** (4.7-6.6)	**6.1** (5.1-7.3)
Journey II	**3.3** (2.6-4.2)	**7.2** (6.1-8.6)	**8.9** (7.6-10.4)	**10.6** (9.0-12.5)	**12.2** (10.1-14.8)	**14.2** (11.0-18.3)	**15.5** (11.7-20.4)

Table 6.18

Revision rates of primary total knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Knee system	at risk*	Revised		95% CI	
	N	N	%	lb	ub
Advance	439	21	4.9	3.2	7.4
Anatomic	160	4	2.5	1.0	6.6
Attune	11,308	402	3.6	3.3	4.0
Balansys bicondylar	7,105	176	2.5	2.2	2.9
E.motion FP/UC	569	8	1.4	0.7	2.8
E.motion PS	312	19	6.1	4.0	9.5
First	1,064	42	4.0	3.0	5.4
First rev.	147	5	3.5	1.5	8.2
Gemini SL	146	5	3.5	1.5	8.1
GMK primary	1,980	56	2.9	2.2	3.7
GMK sphere	4,335	150	3.5	3.0	4.1
HLS Kneetec deep dish	64	2	3.1	0.8	11.9
HLS Kneetec	177	2	1.1	0.3	4.5
Innex	2,859	110	3.9	3.3	4.7
Journey II	1,266	94	7.5	6.2	9.1
LCS	3,585	118	3.4	2.8	4.0
Legion	646	34	5.4	3.9	7.4
NexGen	614	18	3.0	1.9	4.7
NK Flex	674	24	3.6	2.4	5.3
Persona	6,436	174	2.8	2.4	3.2
Physica KR	59	6	10.6	4.9	22.2
Physica PS	128	13	10.3	6.1	17.1
Score	89	4	4.6	1.7	11.7
Sigma	3,656	101	2.8	2.3	3.4
TC-Plus primary	1,762	50	2.9	2.2	3.8
Triathlon CR	617	29	4.8	3.3	6.8
Triathlon PS	401	14	3.5	2.1	5.9
Unity	102	3	3.0	1.0	9.1
Vanguard	1,088	33	3.1	2.2	4.3
Group average			**3.4**	**3.2**	**3.5**

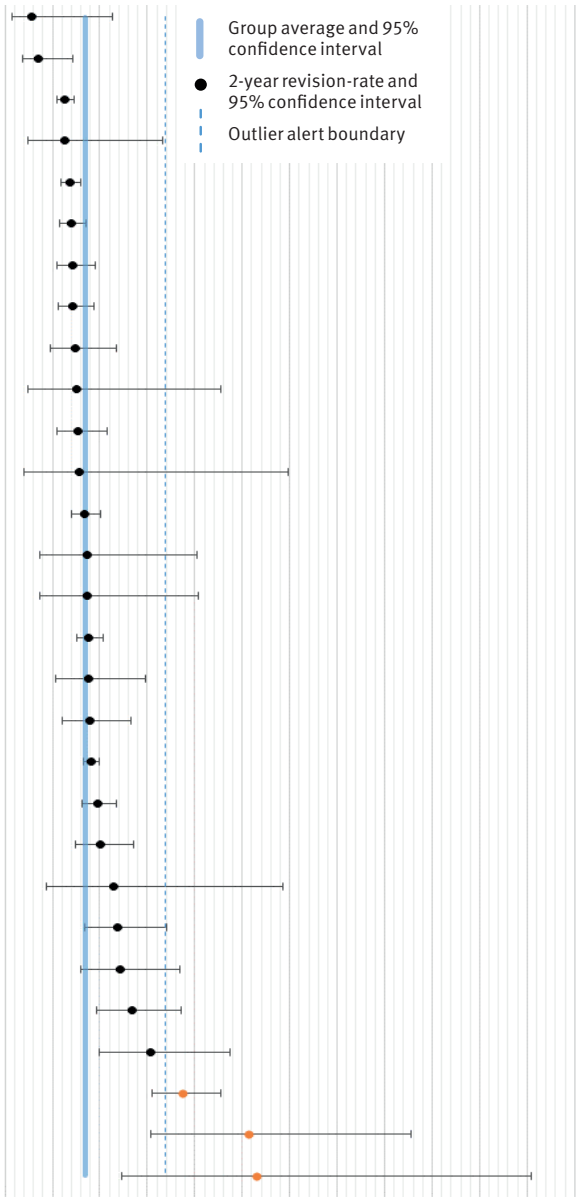
* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).

Table 6.19

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

Knee system	N at risk*	N revised	%	95% CI lower	95% CI upper
HLS Kneetec	177	2	1.1	0.3	4.5
E.motion FP/UC	569	8	1.4	0.7	2.8
Balansys bicondylar	7,105	176	2.5	2.2	2.9
Anatomic	160	4	2.5	1.0	6.6
Persona	6,436	174	2.8	2.4	3.2
Sigma	3,656	101	2.8	2.3	3.4
TC-Plus primary	1,762	50	2.9	2.2	3.8
GMK primary	1,980	56	2.9	2.2	3.7
NexGen	614	18	3.0	1.9	4.7
Unity	102	3	3.0	1.0	9.1
Vanguard	1,088	33	3.1	2.2	4.3
HLS Kneetec deep dish	64	2	3.1	0.8	11.9
LCS	3,585	118	3.4	2.8	4.0
Gemini SL	146	5	3.5	1.5	8.1
First rev.	147	5	3.5	1.5	8.2
GMK sphere	4,335	150	3.5	3.0	4.1
Triathlon PS	401	14	3.5	2.1	5.9
NK Flex	674	24	3.6	2.4	5.3
Attune	11,308	402	3.6	3.3	4.0
Innex	2,859	110	3.9	3.3	4.7
First	1,064	42	4.0	3.0	5.4
Score	89	4	4.6	1.7	11.7
Triathlon CR	617	29	4.8	3.3	6.8
Advance	439	21	4.9	3.2	7.4
Legion	646	34	5.4	3.9	7.4
E.motion PS	312	19	6.1	4.0	9.5
Journey II	1,266	94	7.5	6.2	9.1
Physica PS	128	13	10.3	6.1	17.1
Physica KR	59	6	10.6	4.9	22.2
Group average			**3.4**	**3.2**	**3.5**



* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted 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.

7. Partial knee arthroplasty

7.1 Primary partial knee arthroplasty

Of all primary knee arthroplasties, 15.9% were partial knee replacements (Table 3.4). This proportion remained constant over the past five years and is the highest in the international community, including the United Kingdom. In the past 5 years, 49.6% were performed on women.

The mean age at surgery was almost 65 years (Table 7.1) in the period from 2015 to 2019. In younger age groups, 2.1% of partial knee replacements were performed on patients younger than 45 years and 14.7% on 45–54 year olds. In elderly patients, 16.0% of partial knee replacements were performed on 75–84 year olds, and 2% of the patients were older than 85. Partial knee arthroplasties were more frequently implanted in younger patients (peak in the age group 55–64 years), whereas the peak for total knee arthroplasty was in the age group 65–74 years (Figure 3.4a). The mean BMI was 28.4 kg/m^2 in the partial knee replacement group. BMI was not recorded in 20.0% of the cases.

The ASA classification of 83.7% of patients was 1 or 2. In 9.0% of cases, the morbidity state was not recorded.

Hospitals with more than 100 interventions per year performed 80.6% of the partial knee replacements (Table 7.2): 61.2% of the patients had not had surgery before their partial knee replacement; 22.2% had had previous arthroscopy of the knee; 22.7% a meniscectomy; 1.6% previous ACL reconstruction; 1.7% had undergone an osteotomy close to the knee (Table 7.4). Medial uni-compartmental replacement was performed in 86.2% of the cases, lateral in 6.4% and patello-femoral replacement in 6.9%. In 0.5% “other” was selected, meaning mainly combinations of UKA. Over the past five years the use of cement-less fixations increased continually up to 16.1% in 2018, but dropped to 12.7% in 2019. The mean value reached 13.8% over the past five years. Hybrid fixation was responsible for 1.4% of the cases. The vast majority (84.3%) of partial knee replacements performed from 2015 to 2019 were fully cemented (Table 7.3).

Table 7.1

Primary partial knee arthroplasty: Baseline patient characteristics by year

2012–2019. BMI and ASA class data only available from 2015 onwards

		2012–2014	2015	2016	2017	2018	2019	2015–2019
N		**5,328**	**2,312**	**2,408**	**2,543**	**2,612**	**2,908**	**12,783**
Diagnosis [%]	Primary OA	94.0	89.4	91.2	89.7	90.4	89.6	90.0
	Secondary OA	6.0	10.6	8.8	10.3	9.6	10.4	10.0
	Inflammatory origin	0.2	0.3	0.0	0.2	0.2	0.1	0.2
	Fracture	0.2	0.6	0.6	1.0	1.0	0.6	0.8
	Lesion of ligament	0.0	1.5	1.3	1.7	1.7	2.2	1.7
	Infection	0.0	0.1	0.0	0.0	0.0	0.0	0.0
	Osteonecrosis	5.2	5.8	5.0	4.6	4.9	5.4	5.1
	Other	0.4	2.1	1.9	2.8	2.0	2.1	2.2
Women [%]		51.6	52.1	49.1	50.3	48.3	48.8	49.6
Mean age (SD)	All	64.9 (10.0)	64.8 (10.2)	64.4 (10.0)	64.3 (10.1)	64.9 (10.4)	64.7 (10.4)	64.6 (10.2)
	Women	65.1 (10.3)	64.6 (10.8)	64.0 (10.3)	63.9 (10.5)	64.9 (10.9)	64.6 (10.8)	64.4 (10.7)
	Men	64.7 (9.7)	65.0 (9.7)	64.7 (9.7)	64.6 (9.7)	64.9 (9.9)	64.8 (9.9)	64.8 (9.8)
Age group [%]	<45	1.7	2.2	1.9	2.3	2.2	2.1	2.1
	45–54	13.7	13.9	15.2	15.7	14.1	14.4	14.7
	55–64	33.5	32.9	34.3	34.4	32.5	33.9	33.6
	65–74	33.1	32.0	31.2	30.8	32.1	30.8	31.4
	75–84	15.9	16.5	15.3	15.1	16.6	16.2	16.0
	85+	2.1	2.4	2.0	1.7	2.5	2.5	2.2
N unknown BMI (%)			699 (30)	567 (24)	472 (19)	436 (17)	400 (14)	2,574 (20)
N known BMI			1,613	1,841	2,071	2,176	2,508	10,209
Mean BMI (SD)			28.2 (4.8)	28.4 (4.7)	28.5 (4.8)	28.4 (5.5)	28.5 (5.6)	28.4 (5.1)
BMI [%]	<18.5		0.9	0.4	0.4	0.5	0.5	0.5
	18.5–24.9		26.7	25.1	23.3	23.9	24.8	24.7
	25–29.9		42.4	42.5	42.8	43.4	41.7	42.6
	30–34.9		20.8	23.1	25.0	24.6	23.0	23.4
	35–39.9		7.5	7.0	6.5	5.9	8.1	7.0
	40+		1.7	1.8	2.1	1.7	1.9	1.8
N unknown ASA (%)			305 (13)	267 (11)	212 (8)	174 (7)	147 (5)	1,105 (9)
N known ASA			2,007	2,141	2,331	2,438	2,761	11,678
Morbidity state	ASA 1		22.0	20.5	18.1	16.9	16.8	18.6
[%]	ASA 2		63.9	64.5	65.6	66.1	65.3	65.1
	ASA 3		14.0	14.9	16.0	16.9	17.8	16.0
	ASA 4/5		0.1	0.1	0.3	0.2	0.1	0.2

Table 7.2

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

Calculations by hospital service volume based on primary hip surgeries in each included year (2015–2019).

		<100	100–199	200–299	300+
N (2015–2019)		**2,486**	**3,217**	**2,873**	**4,207**
Women [%]		50.4	47.7	48.6	51.4
Mean age (SD)	All	64.8 (10.3)	64.2 (10.0)	64.4 (10.1)	64.9 (10.4)
	Women	64.5 (10.9)	64.1 (10.4)	64.2 (10.4)	64.8 (10.8)
	Men	65.2 (9.7)	64.4 (9.6)	64.6 (9.8)	65.1 (9.9)
Age group [%]	<45	2.2	2.0	2.1	2.3
	45–54	13.9	15.0	14.9	14.7
	55–64	34.1	35.6	33.8	31.7
	65–74	30.7	30.4	32.9	31.5
	75–84	16.1	15.0	13.8	18.1
	85+	3.0	2.0	2.5	1.9
Diagnosis [%]	Primary OA	91.2	92.0	86.7	90.2
	Secondary OA	8.8	8.0	13.3	9.8
N unknown BMI (%)		708 (28)	759 (24)	409 (14)	698 (17)
N known BMI		1,778	2,458	2,464	3,509
Mean BMI (SD)		28.7 (5.6)	28.6 (4.7)	28.4 (5.0)	28.1 (5.2)
BMI [%]	<18.5	0.6	0.4	0.6	0.5
	18.5–24.9	22.7	22.9	24.6	26.9
	25–29.9	42.3	42.5	42.5	42.8
	30–34.9	24.4	24.7	23.4	22.1
	35–39.9	7.8	7.6	7.1	6.1
	40+	2.2	1.9	1.9	1.5
N unknown ASA (%)		203 (8)	309 (10)	360 (13)	233 (6)
N known ASA		2,283	2,908	2,513	3,974
ASA state [%]	ASA 1	18.7	21.5	17.6	17.2
	ASA 2	67.3	65.1	63.0	65.2
	ASA 3	13.8	13.3	19.1	17.5
	ASA 4/5	0.2	0.1	0.3	0.1

Table 7.3

Primary partial knee arthroplasty: Component fixation

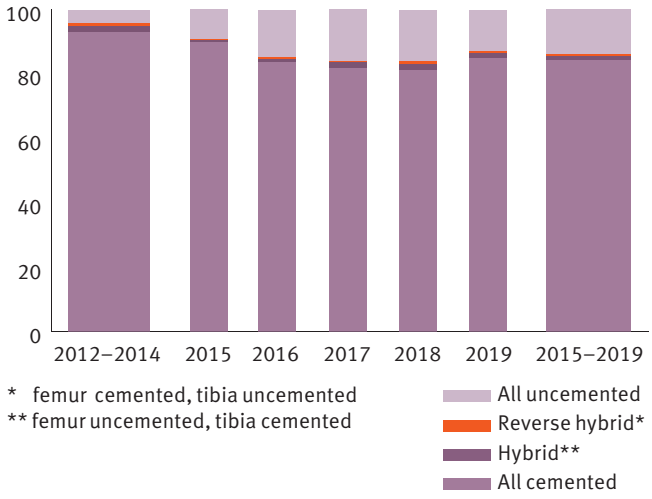
Total numbers by year

Component fixation	2012 to 2014	2015	2016	2017	2018	2019	2015 to 2019
N	**5,328**	**2,146**	**2,228**	**2,351**	**2,425**	**2,746**	**11,896**
All uncemented	4.3	9.1	14.8	15.9	16.1	12.7	13.8
Reverse hybrid*	1.0	0.3	0.5	0.3	0.7	0.6	0.5
Hybrid**	1.6	0.7	0.9	2.0	1.8	1.5	1.4
All cemented	93.1	89.9	83.8	81.8	81.4	85.1	84.3

Figure 7.1

Primary partial knee arthroplasty: Component fixation by year

Percentage by year



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

Table 7.4

Primary partial knee arthroplasty: Surgery characteristics

N (2015–2019)	N	%
Previous surgery		
None	7,821	61.2
Knee arthroscopy	2,832	22.2
Meniscectomy	2,899	22.7
ACL reconstruction	200	1.6
Osteotomy tibia*	186	1.5
Osteosynthesis tibia*	54	0.4
Surgery for patella stabilization	141	1.1
Synovectomy	48	0.4
Osteotomy femur*	21	0.2
Osteosynthesis femur*	26	0.2
Surgery for treating infection	8	0.1
Surgery for tumor	4	0.0
Other	339	2.7
Intervention		
Unicompartment medial	11,015	86.2
Unicompartment lateral	816	6.4
Femoropatellar	887	6.9
Other	62	0.5
Technology		
Conventional	8,761	68.5
Minimally invasive	3,227	25.2
Patient specific instrumentation	590	4.6
Computer assisted	223	1.7
Other	251	2.0

* close to knee

7.2 First revision of a primary partial knee arthroplasty

The analysis of first revisions was done on the basis of revisions involving any exchange of prosthetic components. Of the 18,111 documented PKA implanted since 2012, 9,527 were at risk as they fell within the 4-year moving average time window and had at least two years follow-up by 30 June 2020. Of these, 419 knees were revised, accounting for a two-year revision rate of 4.4%. Younger patients were much more at risk (e.g. 6.1% in the age group under 55 years) than older patients (e.g. 3.4% in the age group 75-84 years) (Table 7.5).

The main reason for early revision was loosening of the tibia (28.9%), followed by pain in 18.4%, pro-

Table 7.5

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

Moving average

		Revised	Revised within 24 months			
					95% CI	
		N at risk[1]	N	%[2]	lower	upper
Overall		**9,597**	**419**	**4.4**	**4.0**	**4.8**
Gender	Women	4,334	192	4.5	3.9	5.1
	Men	4,365	172	4.0	3.4	4.6
Age group	‹55	1,360	82	6.1	4.9	7.5
	55–64	2,977	142	4.8	4.1	5.7
	65–74	2,820	93	3.3	2.7	4.1
	75–84	1,358	46	3.4	2.6	4.5
	85+	182	1	0.6	0.1	3.9

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

Table 7.6

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.

	N	%
Loosening tibia	121	28.9
Pain	77	18.4
Progression of unicomp. OA	55	13.1
Loosening femur	44	10.5
Patella problems	35	8.4
Infection	33	7.9
Femorotibial instability	30	7.2
Periprosthetic fracture tibia	20	4.8
Component malposition tibia	16	3.8
Wear of inlay	15	3.6
Component malposition femur	11	2.6
Joint stiffness/arthrofibrosis	8	1.9
Loosening patella	5	1.2
Sizing femoral component	3	0.7
Patellar instability	2	0.5
Periprosthetic fracture femur	2	0.5
Sizing tibial component	1	0.2
Periprosthetic fracture patella	0	0.0
Other	56	13.4
Total 2015–2019	**534**	**127.4**

gression of osteoarthritis in 13.1%, loosening of the femur in 10.5% as well as infection in 7.9%. Similar to TKA, surgical technical problems were responsible for the majority of early revisions in partial knee arthroplasty (Table 7.6) whereas 13.4% of the reasons were classified as "other". Almost 40% of the revisions within two years after primary surgery were classified as conversion to total knee arthroplasty (Table 7.7), followed by complete revision 27.7% which could also be classified as conversions. Exchange of the polyethylene was performed in 14.1%, then followed by tibial revision in 6%. All the other revision types were rare, only 2.9% were named as "other" (Table 7.7).

Table 7.7

Type of first revision of partial knee arthroplasty

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up.

	N	%
Complete revision	116	27.7
Femoral revision	5	1.2
Tibial revision	25	6.0
Patella revision	6	1.4
Subsequent patella prosthesis	11	2.6
Subsequent patella prosthesis with exchange of PE	2	0.5
Subsequent partial prosthesis, second compartment	3	0.7
Conversion from unicomp. to total prosthesis	166	39.6
Exchange of PE	59	14.1
Component removal with spacer implantation	6	1.4
Reimplantation of prosthesis	8	1.9
Other	12	2.9
Total 2015 – 2019	**419**	**100.0**

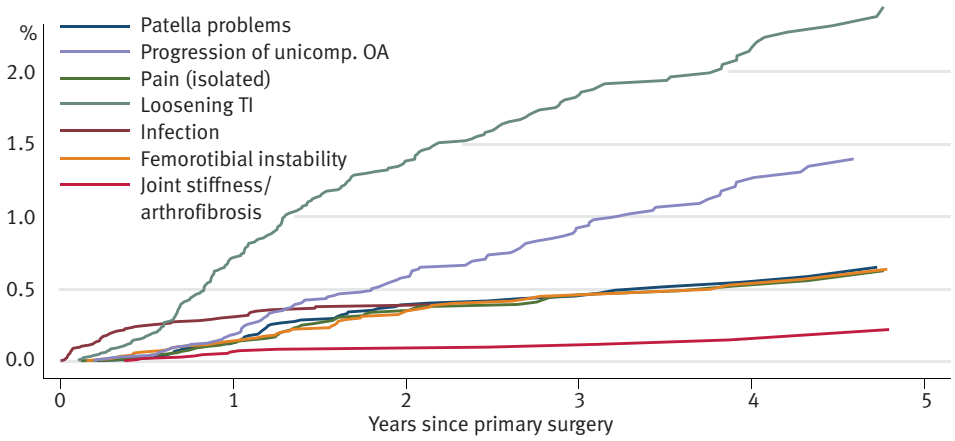
Pain was often named in combination with other reasons as a typical symptom for revision after PKA (18.4%). Only in 6.3% was pain the only reason for revision, which was clearly higher than in TKA (2.7%).

Cumulative incidence figures were also produced for PKA (Figure 7.2). This graph shows what proportion of implants were subjected to at least one revision for a particular underlying cause (e.g. revision due to loosening of a component). In this type of graph, a line starts when the first relevant revision in the SIRIS dataset is recorded and it ends with the last revision registered. The overall picture shares similarities with TKA revisions. Infections occurred relatively early (first year) while all other revision causes were mostly associated with revisions from

Figure 7.2

Cumulative incidence rates for different revision diagnosis of partial knee arthroplasty

Time since operation, 2012–2019, all services, % of implants revised



the second year onwards. Loosening of the tibial component was the clear exception, as these events cause revisions well within the first year and then occur more frequently thereafter. The effect of progression of uni-compartmental OA must also be noted. After a relatively slow start as a reported reason, it contributes to the revision rate in an approximately linear fashion within the observed time frame.

In UKA cemented implants were revised less often than cement-less implants during the first six years after surgery. Hybrid implants were in between the two other groups. This effect can be expected early after surgery as cementless implants have to osteointegrate which might be critical in some cases. Nevertheless, cementless implants do not improve over time, the estimated rate of revision still diverg-

Table 7.8

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up, with and without patellar replacement

Partial knee system	at risk*	Revised		95% CI	
	N	N	%	lb	ub
Allegretto	416	2	0.5	0.1	1.9
Alpina	78	2	2.6	0.7	9.9
Balansys Uni system	1,197	42	3.5	2.6	4.8
GMK Uni	596	19	3.2	2.0	5.0
iBalance Uni	78	3	3.8	1.3	11.5
Journey Uni	434	37	8.6	6.3	11.7
Oxford cemented	1,763	71	4.1	3.2	5.1
Oxford hybrid	71	3	4.3	1.4	12.6
Oxford uncemented	1,044	56	5.4	4.2	7.0
Persona	249	6	2.4	1.1	5.3
Physica ZUK	1,235	53	4.3	3.3	5.6
Sigma	1,524	56	3.7	2.9	4.8
Triathlon PKR	55	2	3.6	0.9	13.8
Group average			**4.1**	**3.7**	**4.6**

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

es four to six years after primary surgery compared to cemented versions (Figure 7.3). The increasing confidence intervals over time reflect the small number of cases in the different groups. Data on computer navigation/robotic assistance in PKA is still very limited and results have therefore been omitted from this report.

PSI seems to lead to slightly more revisions than conventional techniques in the long run, although the difference was not statistically significant.

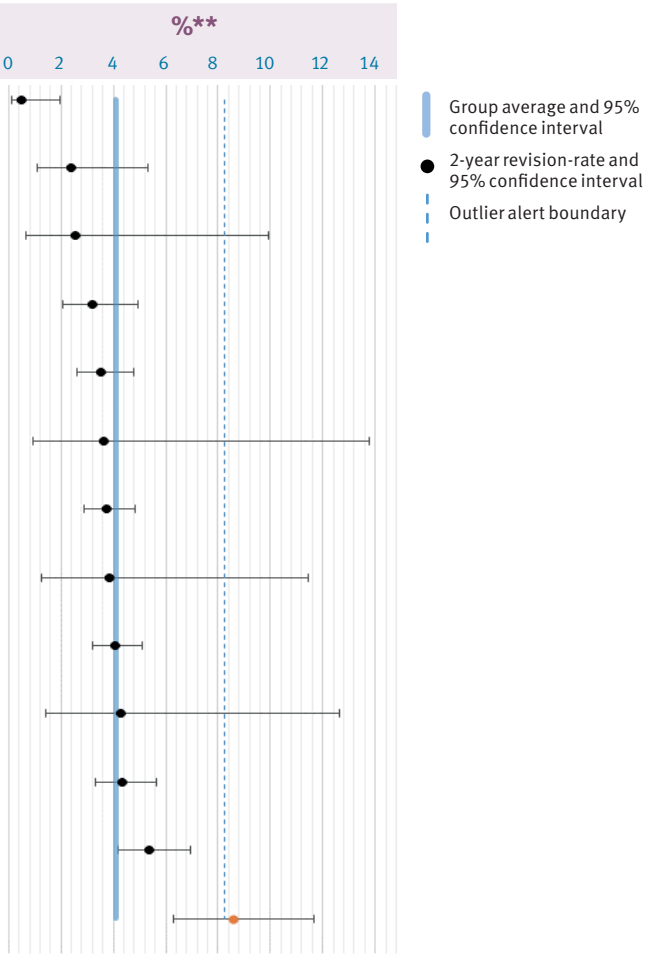
In Switzerland, none of the 13 different partial knee arthroplasty systems was identified as definitive outlier, but one is a possible outlier (Table 7.9).

Table 7.9

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

4-year moving average covering implants between 01.07.2014 and 30.06.2018, with two years follow-up, a small number of hybrid/reverse hybrid Oxford implants have been omitted

Knee system	Revised	at risk*		95% CI	
	N	N	%	lower	upper
Allegretto	416	2	0.5	0.1	1.9
Persona	249	6	2.4	1.1	5.3
Alpina	78	2	2.6	0.7	9.9
GMK Uni	596	19	3.2	2.0	5.0
Balansys Uni system	1,197	42	3.5	2.6	4.8
Triathlon PKR	55	2	3.6	0.9	13.8
Sigma	1,524	56	3.7	2.9	4.8
iBalance Uni	78	3	3.8	1.3	11.5
Oxford cemented	1,763	71	4.1	3.2	5.1
Oxford hybrid	71	3	4.3	1.4	12.6
Physica ZUK	1,235	53	4.3	3.3	5.6
Oxford uncemented	1,044	56	5.4	4.2	7.0
Journey Uni	434	37	8.6	6.3	11.7
Group average			**4.1**	**3.7**	**4.6**



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

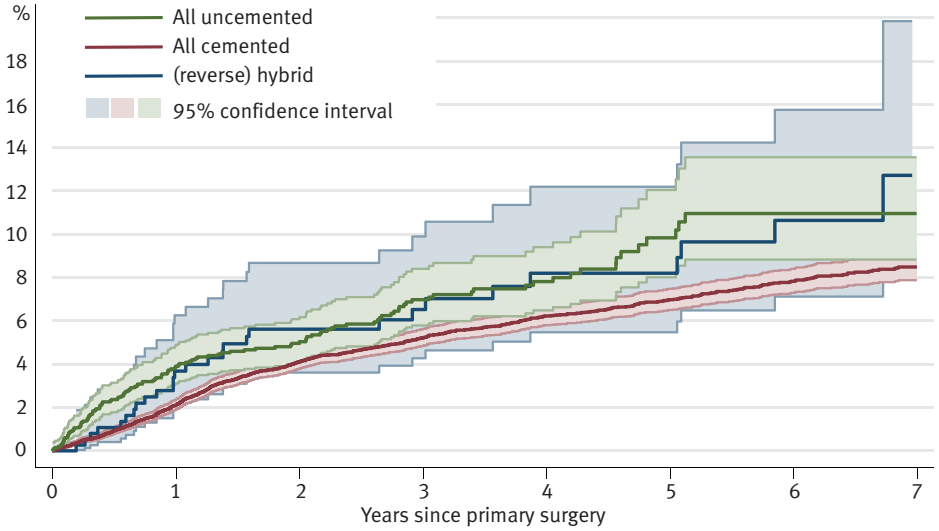
** Rates adjusted for effects of mortality and emigration.

● 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.

Figure 7.3

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

Time since operation, 2012–2019, all services



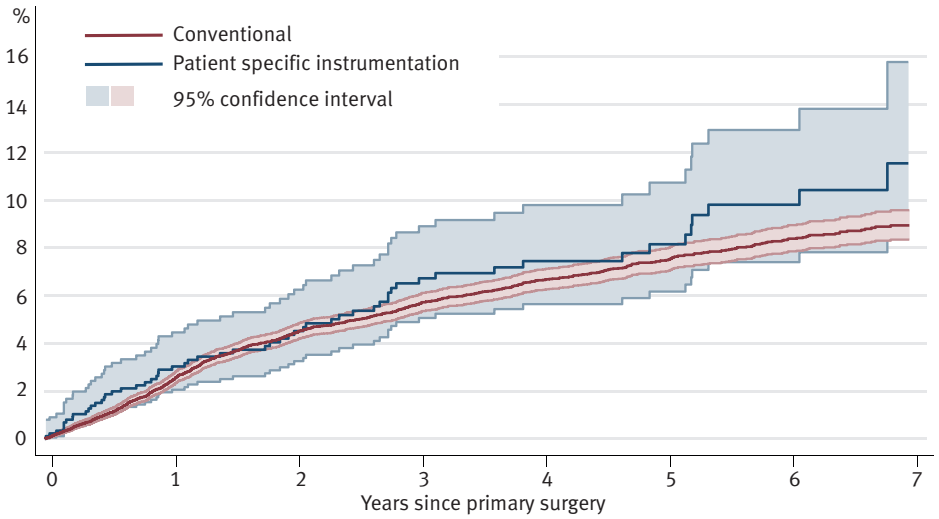
Cumulative revision rates

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
All cemented	**2.1** (1.9-2.4)	**4.1** (3.8-4.5)	**5.2** (4.8-5.6)	**6.2** (5.8-6.7)	**7.0** (6.5-7.5)	**7.8** (7.3-8.4)	**8.5** (7.9-9.1)
All uncemented	**3.9** (3.1-4.9)	**5.0** (4.1-6.2)	**7.0** (5.8-8.4)	**7.8** (6.5-9.4)	**9.8** (8.0-12.0)	**10.9** (8.8-13.5)	**10.9** (8.8-13.5)
(reverse) hybrid	**3.7** (2.2-6.3)	**5.6** (3.6-8.7)	**6.5** (4.3-9.9)	**8.2** (5.5-12.2)	**8.2** (5.5-12.2)	**10.6** (7.1-15.7)	**12.7** (8.0-19.8)

Figure 7.4

Failure rates of primary partial knee arthroplasty: conventional versus patient specific instrumentation

Time since operation, 2012–2019, all services



Cumulative revision rates

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Conventional	**2.3** (2.1-2.6)	**4.4** (4.1-4.7)	**5.6** (5.2-6.0)	**6.6** (6.2-7.1)	**7.5** (7.0-8.0)	**8.3** (7.8-8.9)	**8.9** (8.3-9.6)
Patient spec.instr.	**2.9** (2.0-4.3)	**4.4** (3.1-6.1)	**6.5** (4.9-8.6)	**7.4** (5.6-9.8)	**8.2** (6.2-10.7)	**9.8** (7.4-12.9)	**11.5** (8.4-15.8)

Table 7.10

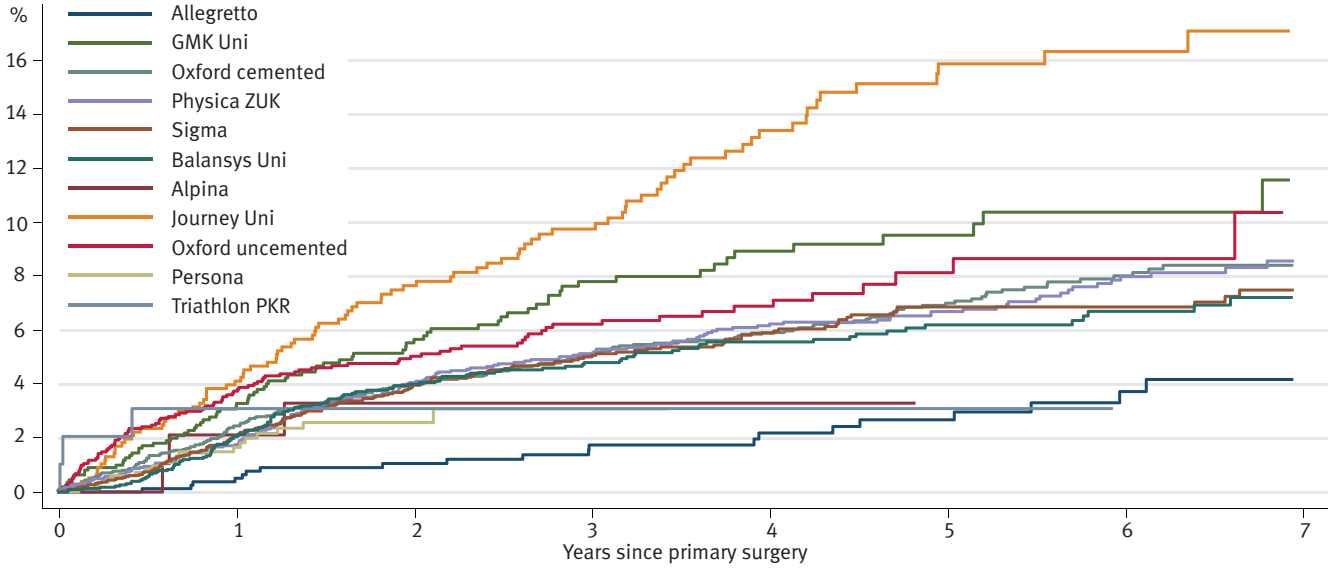
Top 10 implants, partial knee arthroplasty, all component fixations

Knee system	2013	2014	2015	2016	2017	2018	2019	2013–2019
Oxford	557	618	652	796	807	698	602	4,730
Sigma	449	352	316	411	424	413	489	2,854
Physica ZUK	437	456	420	288	217	198	247	2,263
Balansys Uni	327	330	296	283	305	280	350	2,171
GMK Uni	109	85	157	123	185	198	223	1,080
Persona	0	0	0	0	90	340	410	840
Allegretto	156	132	118	104	93	89	101	793
Journey Uni	107	117	101	111	127	89	89	741
Alpina	0	0	10	30	32	12	12	96
Triathlon PKR	0	0	8	16	18	25	28	95
Other	45	48	70	53	59	69	93	437
Total	**2,187**	**2,138**	**2,148**	**2,215**	**2,357**	**2,411**	**2,644**	**16,100**

Figure 7.5

Failure rates for early first revision of partial knee arthroplasty for top 10 systems

Time since operation, 2012–2019, all services



Cumulative revision rates

	1 year	2 years	3 years	4 years	5 years	6 years	7 years
Oxford cem.	**2.4** (1.9-3.0)	**3.9** (3.3-4.7)	**5.0** (4.3-5.9)	**5.9** (5.0-6.8)	**6.9** (5.9-7.9)	**7.9** (6.8-9.2)	**8.3** (7.2-9.7)
Oxford uncem.	**3.7** (2.9-4.8)	**5.0** (4.0-6.2)	**6.2** (5.0-7.6)	**6.8** (5.5-8.4)	**8.1** (6.4-10.2)	**8.6** (6.7-11.0)	**10.3** (7.0-14.9)
Sigma	**2.0** (1.6-2.6)	**3.8** (3.2-4.6)	**5.0** (4.2-5.9)	**5.8** (4.9-6.9)	**6.8** (5.8-8.0)	**6.8** (5.8-8.0)	**7.4** (6.2-8.8)
Physica ZUK	**1.7** (1.3-2.3)	**4.0** (3.3-4.9)	**5.1** (4.2-6.1)	**6.1** (5.2-7.2)	**6.6** (5.6-7.8)	**7.8** (6.6-9.2)	**8.5** (7.1-10.1)
Balansys Uni	**2.0** (1.5-2.7)	**4.0** (3.2-4.9)	**4.8** (3.9-5.8)	**5.5** (4.6-6.7)	**6.1** (5.1-7.4)	**6.6** (5.5-8.0)	**7.1** (5.8-8.7)
GMK Uni	**3.0** (2.2-4.3)	**5.5** (4.2-7.1)	**7.7** (6.1-9.7)	**8.8** (7.0-11.1)	**9.4** (7.5-11.8)	**10.3** (8.1-13.0)	**11.5** (8.5-15.3)
Persona	**1.6** (1.0-2.8)	**2.5** (1.6-4.1)	**3.1** (1.8-5.0)				
Allegretto	**0.4** (0.1-1.2)	**1.0** (0.5-2.1)	**1.4** (0.7-2.5)	**2.2** (1.3-3.7)	**2.7** (1.6-4.4)	**3.3** (2.0-5.3)	**4.1** (2.6-6.6)
Journey Uni	**3.9** (2.8-5.6)	**7.6** (5.9-9.8)	**9.7** (7.7-12.1)	**13.3** (10.8-16.3)	**15.7** (12.8-19.2)	**16.2** (13.2-19.7)	**16.9** (13.7-20.8)
Alpina	**2.1** (0.5-8.1)	**3.3** (1.1-9.8)	**3.3** (1.1-9.8)	**3.3** (1.1-9.8)			
Triathlon PKR	**3.1** (1.0-9.2)	**3.1** (1.0-9.2)	**3.1** (1.0-9.2)	**3.1** (1.0-9.2)	**3.1** (1.0-9.2)		

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

Participating hospitals

	Clinic/Group	Clinic
AG	Spital Zofingen	
AG	Kantonsspital Baden	
AG	Hirslanden Gruppe	Klinik Aarau
AG	Asana Gruppe	Spital Leuggern
AG	Asana Gruppe	Spital Menziken
AG	Swiss Medical Network	Klinik Villa im Park AG
AG	Gesundheitszentrum Fricktal	Spital Rheinfelden
AG	Spital Muri	
AG	Kantonsspital Aarau	
AI	Kantonales Spital und Pflegezentrum Appenzell	
AR	Berit Klinik AG	
AR	Spitalverbund Appenzell (AR)	Spital Herisau
AR	Spitalverbund Appenzell (AR)	Spital Heiden
AR	Hirslanden Gruppe	Klinik Am Rosenberg AG
BE	Lindenhofgruppe	Sonnenhofspital
BE	Swiss Medical Network	Privatklinik Siloah
BE	Spital STS	Spital Thun
BE	Spitalzentrum Biel	
BE	Lindenhofgruppe	Lindenhofspital
BE	Regionalspital Emmental	Standort Burgdorf
BE	Regionalspital Emmental	Standort Langnau
BE	Insel Gruppe	Spital Aarberg
BE	Insel Gruppe	Inselspital, Unispital Bern
BE	Hirslanden Gruppe	Klinik Linde AG
BE	Spitäler fmi	Spital Frutigen
BE	Spitäler fmi	Spital Interlaken
BE	Insel Gruppe	Spital Münsingen
BE	Hirslanden Gruppe	Salem-Spital
BE	Hirslanden Gruppe	Klinik Permanence
BE	Insel Gruppe AG	Spital Riggisberg
BE	Klinik Hohmad	
BE	Spital Region Oberaargau SRO	
BE	Insel Gruppe AG	Spital Tiefenau
BE	Hôpital du Jura bernois	Saint-Imier
BE	Hôpital du Jura bernois	Hôpital de Moutier SA
BL	Hirslanden Gruppe	Klinik Birshof AG
BL	Kantonsspital Baselland	Liestal
BL	Kantonsspital Baselland	Bruderholz
BL	Praxisklinik Rennbahn	
BS	Merian Iselin, Klinik für Orthopädie und Chirurgie	
BS	Universitätsspital Basel	

	Clinic/Group	Clinic
FL	Liechtensteinisches Landesspital	
FR	Swiss Medical Network	Clinique Générale Ste-Anne
FR	Hôpital fribourgeois HFR	HFR Hôpital cantonal
FR	Hôpital fribourgeois HFR	HFR Riaz
FR	Hôpital fribourgeois HFR	HFR Tafers
GE	Hôpital de La Tour	
GE	Hirslanden Gruppe	Clinique La Colline SA
GE	Hôpitaux universitaires de Genève HUG	
GE	Hirslanden Gruppe	Clinique des Grangettes SA
GE	Swiss Medical Network	Clinique Générale-Beaulieu
GL	Kantonsspital Glarus	
GR	Klinik Gut	Standort Fläsch
GR	Spital Oberengadin	
GR	Spital Thusis	
GR	Flury Stiftung Spital Schiers	
GR	Gesundheitszentrum Unterengadin	
GR	Regionalspital Surselva AG	
GR	Kantonsspital Graubünden	
GR	Spital Davos	
GR	Klinik Gut	Standort St. Moritz
JU	Hôpital du Jura	Site de Delémont
LU	Hirslanden Gruppe	Klinik St. Anna AG
LU	Luzerner Kantonsspital LUKS	Luzern
LU	Luzerner Kantonsspital LUKS	Sursee
LU	Luzerner Kantonsspital LUKS	Wolhusen
LU	Hirslanden Gruppe	St. Anna in Meggen
NE	Réseau hospitalier neuchâtelois	La Chaux-de-Fonds
NE	Swiss Medical Network	Hôpital de la Providence
NE	Réseau hospitalier neuchâtelois	Pourtalès
NE	Swiss Medical Network	Clinique Montbrillant
NW	Kantonsspital Nidwalden	
OW	Kantonsspital Obwalden	
SG	Kantonsspital St. Gallen	Spital Flawil
SG	Spitalregion Fürstenland Toggenburg	
SG	Spitalregion Fürstenland Toggenburg	Spital Wattwil

	Clinic/Group	Clinic
SG	Hirslanden Gruppe	Klinik Stephanshorn AG
SG	Spitalregion Rheintal Werdenberg Sarganserland	Spital Altstätten
SG	Spitalregion Rheintal Werdenberg Sarganserland	Spital Grabs
SG	Spitalregion Rheintal Werdenberg Sarganserland	Spital Walenstadt
SG	Spital Linth	
SG	Kantonsspital St. Gallen	Kantonsspital St. Gallen
SG	Kantonsspital St. Gallen	Spital Rorschach
SG	Rosenklinik	
SH	Spitäler Schaffhausen	Kantonsspital
SH	Swiss Medical Network	Privatklinik Belair AG
SO	Solothurner Spitäler	Kantonsspital Olten
SO	Solothurner Spitäler	Bürgerspital Solothurn
SO	Solothurner Spitäler	Spital Dornach
SO	Swiss Medical Network	Privatklinik Obach AG
SZ	Spital Lachen	
SZ	Spital Einsiedeln	
SZ	Spital Schwyz	
TG	Spital Thurgau	Kantonsspital Frauenfeld
TG	Spital Thurgau	Kantonsspital Münsterlingen
TG	Klinik Seeschau	
TI	Ente Ospedaliero Cantonale	Ospedale Regionale di Locarno - La Carità
TI	Ente Ospedaliero Cantonale	Ospedale Regionale di Mendrisio
TI	Ente Ospedaliero Cantonale	Ospedale Regionale di Lugano-Civico
TI	Ente Ospedaliero Cantonale	Ospedale Regionale di Bellinzona e Valli
TI	Ente Ospedaliero Cantonale	Ospedale Regionale di Lugna - Italiano
TI	Clinica Luganese Moncucco	
TI	Swiss Medical Network	Clinica Ars Medica
TI	Clinica Santa Chiara	
UR	Kantonsspital Uri	
VD	Hirslanden Gruppe	Clinique Bois-Cerf
VD	Hôpital intercantonal de la Broye HIB	Payerne
VD	Groupement Hospitalier de l'Ouest Lémanique (GHOL)	Hôpital de Nyon
VD	Ensemble Hospitalier de la Côte EHC	Hôpital de Morges
VD	Clinique La Prairie	

	Clinic/Group	Clinic
VD	Clinique de la Source	
VD	Pôle Santé du Pays-d'Enhaut	Hôpital du Pays-d'Enhaut
VD	Etablissements Hospitaliers du Nord Vaudois eHnv	Hôpital Yverdon-les-Bains
VD	Etablissements Hospitaliers du Nord Vaudois eHnv	Hôpital de Saint-Loup
VD	Clinique CIC Riviera	CIC Groupe Santé SA
VD	Réseau Santé Balcon du Jura RSBJ	Site des Rosiers
VD	Swiss Medical Network	Clinique de Montchoisi
VD	CHUV Centre hospitalier universitaire vaudois	
VD	Swiss Medical Network	Clinique de Genolier
VD	Hôpital Riviera-Chablais HRC	Vaud-Valais
VS	Swiss Medical Network	Clinique de Valère
VS	Hôpital du Valais - Spital Wallis	Spitalzentrum Oberwallis SZO
VS	Clinique CIC Valais	CIC Groupe Santé SA
ZG	Hirslanden Gruppe	AndreasKlinik Cham Zug
ZG	Zuger Kantonsspital	
ZH	Schulthess Klinik	
ZH	Universitätsklinik Balgrist	
ZH	Spital Uster	
ZH	Stadtspital Triemli	
ZH	Stadtspital Waid	
ZH	Spital Zollikerberg	
ZH	Spital Bülach	
ZH	Spital Limmattal	
ZH	Hirslanden Gruppe	Klinik Im Park
ZH	Hirslanden Gruppe	Klinik Hirslanden
ZH	See-Spital	Standort Kilchberg
ZH	See-Spital	Standort Horgen
ZH	GZO	Spital Wetzikon
ZH	Klinik Pyramide am See	
ZH	Spital Affoltern	
ZH	Spital Männedorf	
ZH	Kantonsspital Winterthur	
ZH	Swiss Medical Network	Privatklinik Bethanien
ZH	Swiss Medical Network	Privatklinik Lindberg
ZH	Adus Medica	Adus-Klinik

Manufacturers and Distributors

Table 3.6
List of companies with implants registered in the SIRIS registry
2020

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	Zug

SIRIS
schweizerisches implantat-register
registre suisse des implants

Appendix to the SIRIS Report 2020
Outlier-Watchlist

Implant or Implant combination	Detected as outlier		Risk-adjusted hazard ratios for 2-year revision risk	
		Revised/Total included in evaluation 2020	Adjusted for age and sex **Hazard ratio** 95% CI lb-ub	Adjusted for age, sex, BMI and Charnley Class, from 2015, if available, **Hazard ratio** 95% CI lb-ub
Uncemented stem-cup combinations				
AMIStem + Mpact	2019	**7**/265		
AMIStem + Versafitcup DM	2020	**5**/67	**2.14** 1.02–4.51	**2.30** 1.03–5.15
Corail + Delta motion	2019	**1**/116		
Exception + Exceed	2020	**4**/71	**1.53** 0.69–3.40	**1.30** 0.33–5.22
GTS + Exceed	2019			
GTS + G7 bi-spherical	2019 2020	**15**/102	**5.27** 3.22–8.62	**3.39** 1.52–7.57
Harmony + Gyracup	2020	**3**/56	**3.97** 1.98–7.94	**3.55** 1.76–7.13
Polarstem + EP-fit	2020	**9**/172	**1.93** 1.30–2.86	**2.52** 1.42–4.45
SPS evolution + April ceramic	2020	**34**/574	**2.22** 1.72–2.88	**3.67** 2.47–5.47
SPS modular + April ceramic	2019 2020	**6**/101	**2.95** 1.94–4.49	**1.61** 0.23–11.50
Stelia-stem + Ana.nova hybrid	2019 2020	**11**/185	**2.65** 1.71–4.12	**2.30** 1.26–4.22
Twinsys + Selexys PC	2020	**6**/54	**1.96** 0.98 – 3.93	**4.93** 1.58–15.34

The outlier watchlist provides an overview of all implant combinations or systems identified in SIRIS annual reports. It also contains some of the supplementary information that is given to manufacturers and affected hospitals in the SIRIS outlier reports of the current year (risk-adjusted hazard ratios and summary information). For implants not listed anymore in the current year, reasons and current figures are stated as applicable (revised/total included in evaluation 2020).

Not anymore identified as a potential outlier. The outlier status in 2019 was caused by early implants. Performance since 2017 has been average or better.

It would appear unlikely that AMIStem + Versafitcup DM is a problematic combination. It is in active use in two hospitals, but only in one of them an unusual number of revisions was recorded in recent years against a small volume of operations. Recommended course of action: Investigate causes of revisions and observe future performance.

Not anymore identified as a potential outlier. The outlier status in 2019 was caused by early implants. Performance since 2017 has been average or better.

It is unclear whether Exception + Exceed represents an outlier combination or not. It is in active use in only one hospital where a small number of revisions was recorded against a small volume of operations. Recommended course of action: observe further cases.

Not anymore identified as a potential outlier. This combination is not in active use anymore.

GTS + G7 bi-spherical is very likely a problematic stem-cup combination and it is still in active use. It is practically only used in one hospital, however.

Although based on small numbers, HARMONY + GYRACUP is a potential outlier combination because its revision risk clearly exceeds the alert level of twice the group average. It is only in active use in one hospital, where an unusual number of revisions was recorded in implants used in 2019. Recommended course of action: investigate reasons for revisions and observe further performance.

POLARSTEM and EP-FIT is a potential outlier combination, as its revision risk lies just about within the range of twice the group average. It is still in active use in two hospitals and it is noteworthy that an unusual number of infections was recorded as reasons for revisions. Recommended course of action: investigate reasons for revisions and observe further performance.

SPS Evolution + APRIL Ceramic is probably a problematic outlier combination considering the overall performance over several years of both the combination and the separate components. It is noteworthy that the risk-adjusted hazard ratio clearly exceeds the critical value of two including its confidence interval. Recommended course of action: investigate causes of revisions where those are higher than average and observe future performance.

SPS modular + APRIL ceramic would appear to be a problematic stem-cup combination. Its revision rates are clearly elevated across a range of hospitals and both stem and cup individually register above average revision rates. The use of this combination has, however, practically ceased with only two operations recorded in 2018/2019.

Stelia-stem + Ana.nova hybrid appears to be a problematic stem-cup combination and it is still in active use. It is only used in one hospital, but its use has been declining markedly in recent years.

It would appear that twinSys + seleXys PC is a problematic combination, or has become a problematic combination, in the one hospital where it is still actively used, even though the recorded performance of past implants in other hospitals is not particularly noteworthy. Recommended course of action: Investigate causes of revisions in that hospital and observe future performance.

Implant or Implant combination	Detected as outlier		Risk-adjusted hazard ratios for 2-year revision risk	
		Revised/Total included in evaluation 2020	Adjusted for age and sex **Hazard ratio** 95% CI lb-ub	Adjusted for age, sex, BMI and Charnley Class, from 2015, if available, **Hazard ratio** 95% CI lb-ub
Hybrid fixation stem-cup combinations				
CCA + RM Pressfit vitamys	2020	**4**/63	**1.83** 0.75–4.45	**1.91** 0.60–6.07
PF + Fitmore	2020	**3**/61	**0.84** 0.27–2.61	**1.04** 0.14–7.45
Twinsys + RM pressfit	2019			
Weber + Alloclassic	2019 2020	**4**/54	**2.91** 1.20–7.05	**3.48** 1.10–11.02
Total knee systems				
E.motion PS	2019	**19**/312		
Journey II	2019 2020	**94**/1266	**2.17** 1.81–2.61	**2.10** 1.69–2.61
Physica KR	2019 2020	**6**/59	**3.97** 2.13–7.38	**3.20** 1.20–8.54
Physica PS	2019 2020	**13**/128	**3.32** 1.96–5.61	**3.06** 1.73–5.41
Partial knee systems				
Journey Uni	2020	**37**/434	**1.82** 1.38–2.39	**1.56** 0.96–2.53

It is unlikely that CCA + RM Pressfit vitamys represents a problematic stem-cup combination in current main use. The statistical precision of the outlier status is low. The outlier status is based on a very small number of revisions against a small volume of operations in the reporting timeframe, especially in three hospitals where less than 10 operations were performed overall. The combination is only in active use in one hospital and there its revision performance is unsuspicious. Recommended course of action: observe future performance.

PF Stems + Fitmore Cups is not actually an outlier combination. The potential outlier status (sitting exactly on the alert level boundary in the Annual Report 2020) was an artefact of only 3 revisions against a very small volume of operations in the reporting timeframe. The stem-cup combination is also not actively used anymore.

Not anymore identified as a potential outlier. The active use of this combination has ceased.

It is likely that Weber + Alloclassic (hybrid fixation) represents a problematic stem-cup combination. However, it is practically only used in one hospital, which is also a relatively low volume hospital. Thus, this implant combination accounts for most of the hybrid fixation procedures undertaken there. Its use has practically ended in 2018/2019.

Not anymore identified as a potential outlier. The outlier status in 2019 was caused by early implants. Performance has been improving over time.

It is likely that Journey II represents a problematic system in the sense that it registers above average revision rates. The longer-term performance beyond the report's primary focus of 2-year revision rates would indicate that the system in its current use has problems, at least in some hospitals. The reported hazard ratios (after controls) suggest that the revision risk is indeed doubled compared to all other systems, but it could still be lower or even higher. The revision burden appears to deviate markedly from the group average at about one year after implantation and patella problems/revisions are relatively more common in Journey II than in other systems. The system is used in several hospitals, but about 40% of implants were used in one hospital alone. Recommended course of action: investigate reasons for revisions locally and observe future performance.

Results match those of the Physica PS system, albeit with reduced statistical confidence. It is likely that Physica KR represents a problematic knee system at least in the hospital where the majority of implants have been used. The probability of a local hospital effect must be rated as rather high given the evidence. Recommended course of action: contact hospitals and manufacturer to identify reasons for the unusual revision figures.

It is likely that Physica PS represents a problematic knee system at least in the hospital where the majority of implants have been used. The probability of a local hospital effect must be rated as rather high given the evidence. Recommended course of action: contact affected hospitals and the manufacturer to identify reasons for the unusual revision figures.

It is likely that Journey UNI represents a problematic knee system. While the statistical precision within the report's main timeframe of interest (2-year revision rate) is relatively low, the development of the revision risk beyond two years follow-up strongly suggests an unusual pattern. Recommended course of action: investigate reasons for revisions and observe future performance.

Foundation for quality assurance
in implant surgery – SIRIS

c/o conidea GmbH
Waldheimstrasse 22, 3604 Thun
info@siris-implant.ch
siris-implant.ch