schweizerisches implantat-register
registre suisse des implants

SIRIS

# Swiss National Hip & Knee Joint Registry

# Report 2021

## Annual Report of the SIRIS Registry Hip & Knee, 2012 – 2020

ANQ

Kantonsspital St.Gallen

swiss orthopaedics

UNIVERSITÄT BERN

# Hip and knee replacement results 2012 – 2020

**SIRIS Report 2021**
**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

## Siris – A way to control quality

Total joint arthroplasty (TJA) is a tremendously successful operation and can be an absolute life changer. Total hip arthroplasty has been called the surgery of the century for the huge positive impact in an ever-ageing population. Nevertheless, it can be a life changer going in the wrong direction as well. Most of our patients will have a favorable outcome and will be able to go back to their daily business with a clearly improved quality of live with better mobility and less pain. However, for a couple of our patients a long difficult and thorny road to prolonged suffering, repeated hospitalizations, multiple surgeries, and potentially bad outcome will start as soon as the surgeon cuts into their flesh. Fortunately, these adverse outcomes are rare, but we must do everything possible and impossible to bring these numbers down.

Complications in orthopaedic surgery involving total joint arthroplasties can be due to suboptimal patient choice, bad implant choice, surgical technique and of course the surgeon. The only and certainly best way to improve the outcome after TJA are registries. A joint register like SIRIS allows a fine and precise analysis of the work orthopaedic surgeons are producing every day in our country. It allows the scientific board of SIRIS, which is doing an outstanding job, to analyze factors potentially impacting the outcome after TJA. They are able, with an ever-growing number of implanted joints, to analyze more and more precisely the revision rates of implants or hospitals and today even single surgeons. This information will lead to choosing the implants with the least revision risk, to choosing the hospitals/surgeons with the lowest revision rate but much more important it must help the hospitals/surgeons with high revision rates to make an auto analysis. If the results of the surgery do not correspond to the expected success rate, every surgeon and every hospital must do its own autocritique and review procedures and pathways to get the complication rate down. The Siris register must absolutely not be a policing medium for the different partners involved in the project but must be by all means, a way of improving outcome through auto analysis of the results. The analysis of the results should/must ideally be supported by high-level specialists discussing with the concerned manufacturers, hospitals and surgeons in order to find and cure the origins of an unexpected and unwanted negative outcome.

I am absolutely convinced that the SIRIS register will lead our way in the years to come and that the outcomes of our arthroplasties will become better and better.

**Prof. Olivier Borens**
President swiss orthopaedics

## Quality assurance in the interests of patients and premium-payers

Generally speaking, the assumption that our health system meets high standards is absolutely correct. Patients thus place a great deal of trust in the abilities of the doctors who treat them. The health insurers, for their part, have a strong interest in ensuring that patients are treated appropriately, effectively and cost-effectively – not just because they bear the cost, but also because they have a legal obligation as trustees of those who pay the premiums.

The quality of healthcare can only improve through permanent measurement and advancement. Corrective action must be taken as quickly as possible whenever problems are identified. In this respect, there have been some positive developments in our health system over the past few years. For example, all hospitals in Switzerland now provide transparent reporting on the basis of predefined quality metrics. This means that they compete directly with each other on quality, which leads to steady improvements in treatment.

The SIRIS Implant Registry complements and enriches these quality measurements and is thus a key instrument in the field of implants. It serves as an evidence-based record of products' real-world performance beyond the controlled environment in which they are approved. Where the SIRIS data show that treatment goals have not been achieved or that harmful side-effects have been observed, indications and products can be fine-tuned to prevent unnecessary interventions or reoperations. SIRIS is thus a valuable quality assurance tool that produces benefits in terms of patients' wellbeing as well as cost-effectiveness for premium-payers.

The SIRIS Implant Register is a work in progress that needs to be constantly questioned and refined. Given the good progress achieved in recording hip and knee implants, extending the register to other joints such as the shoulder would appear to be the next logical step.

**Verena Nold**
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All information in this report was composed with the utmost care. If any changes or modifications are made after publication, these will be published on our website www.siris-implant.ch, where you can also download the SIRIS Report 2021 and all previous reports.

# Content

# 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 joined 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 to strive 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.

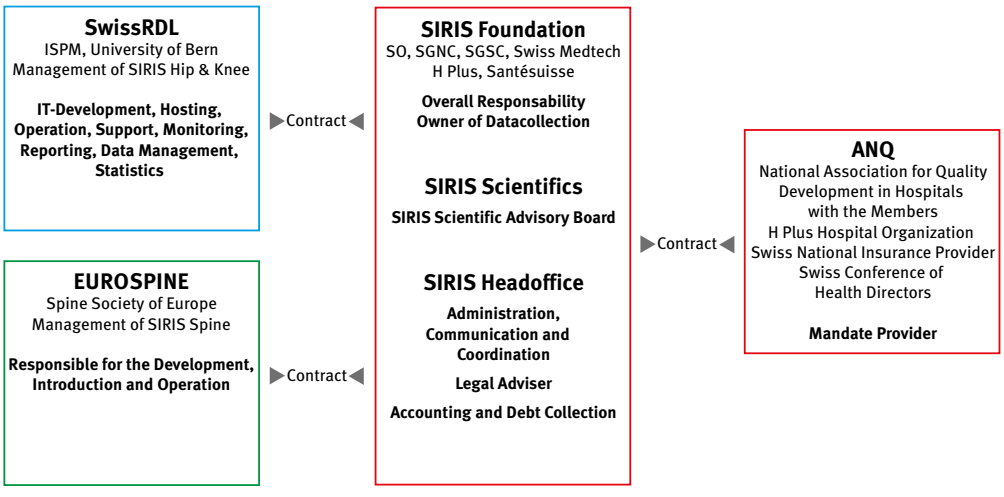
**The surgeons' point of view.** Surgeons are primarily concerned with avoiding surgical complications and shortcomings for their patients. Indeed, the vision of patients and surgeons is the same: long-lasting, pain-free and full function of the prosthesis. However, by choosing a particular prosthesis, 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 could, in some situations, lead to bias in data entry and potential changes in patient recruitment practices. At least partly in order to guard against this, the individual surgeon reports are confidential and individually accessible only for surgeons participating in SIRIS.

**The manufacturers' 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, destabilise the company financially. It is clear that economic viability coincides with interest 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. Because the industry declares quality the principal market-regulating factor, the registry is a welcome tool and motivates industry participation. The first 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 might be that patients remember the institution where they were treated so successfully, and that they return to the same hospital, should it be necessary also for reasons other 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. The revision rates for each hospital are available but not published in this report. However, the data are presented as interactive funnel plots on the ANQ homepage (https://www.anq.ch/de/fachbereiche/akutsomatik/messergebnisse-akutsomatik/step3/measure/20/year/2020/).

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



**The insurers' 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' aim to provide equal benefits to all their clients within the budget available to them. The registry is therefore perceived as a source of information about the performance 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.

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 |

**The governments' point of view.** 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 involved 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. The cantonal governments have interest and tools to assess the overall picture of effective healthcare quality. While patients may understandably place their prime focus on receiving treatment providing best long-lasting results, the government 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 Liechtenstein (FL) interacts closely with the Swiss healthcare system and participates in SIRIS activities. Therefore, starting in 2020, the SIRIS report also contains cumulative data for Swiss cantons and FL

(Figures 1.3 to 1.6). Although the fragmentation of the dataset may sometimes preclude meaningful statistical analysis, the information can still be of interest to cantonal/FL governments and the public.

## 1.2 Strong commitment

The 2021 SIRIS report represents a collaborative data collection effort involving all the institutional partners of SIRIS and includes the surgeons and operating teams of 145 Swiss hospitals. 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 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 2015–2019 (data for 2020 are not yet available to be included in SIRIS Report 2021). The data are available to the public and can be put in relation

Figure 1.3
**Relative proportion of total hip arthroplasty procedures using different approaches by Swiss Canton and Principality of Liechtenstein (2015–2020)**

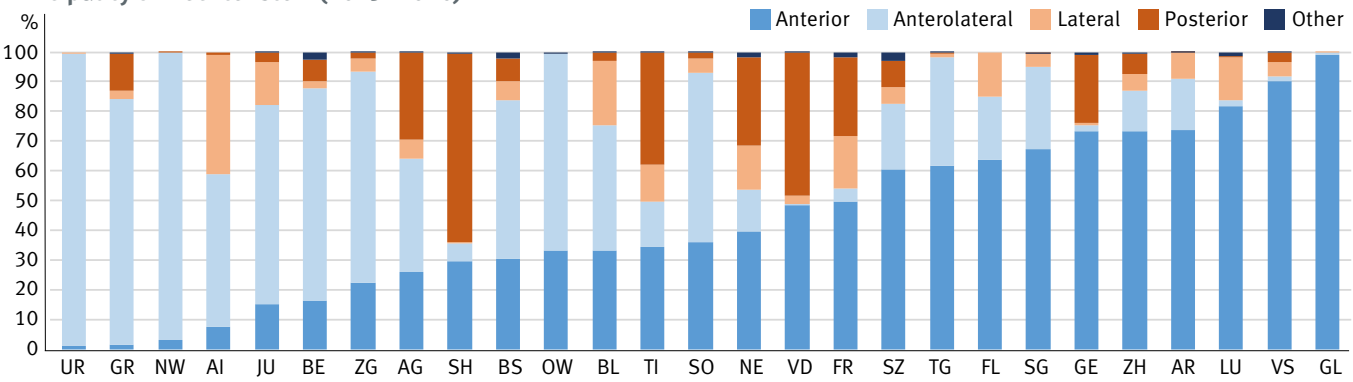
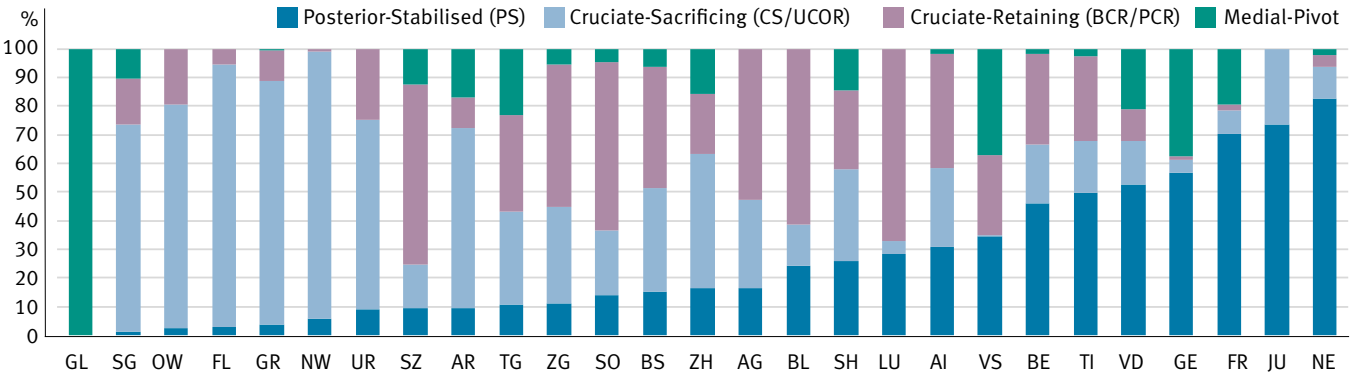



Figure 1.4
**Relative proportion of total knee arthroplasty procedures using CR, CS PS, MP by Swiss Canton and Principality of Liechtenstein (2015 – 2020)**



to SIRIS data, although some details in coding and filtering definitions may differ from SIRIS. In 2019, the coverage of SIRIS was estimated to be 94.9% for hip prosthetics (benchmark: primary total hip prosthesis for all reasons excluding trauma) and 96.3% 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 in 2020 the overall coverage rate could be higher than 96.5%. Those figures confirm that the commitment of all participating individuals and institutions is strong.

Officially only started in 2012, the registry has long achieved de-facto 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 (2015–2020)**

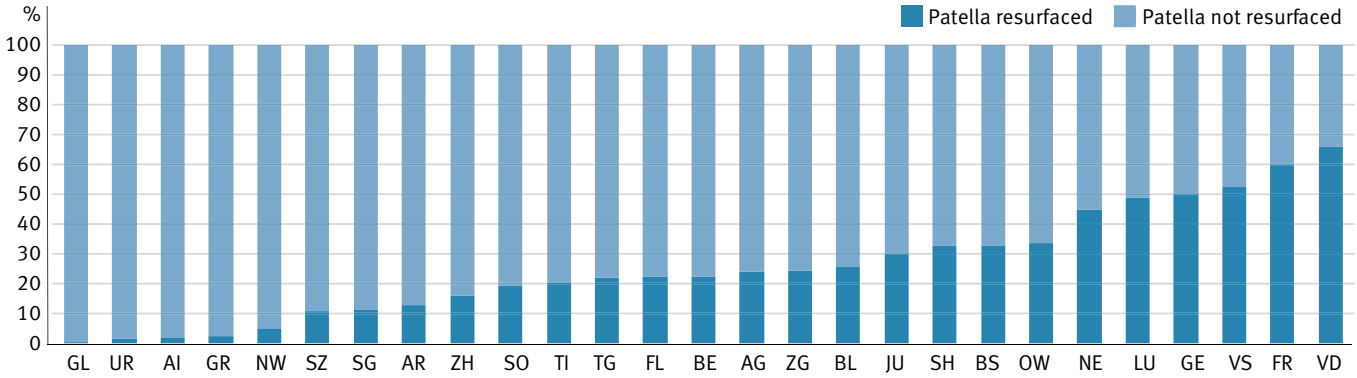
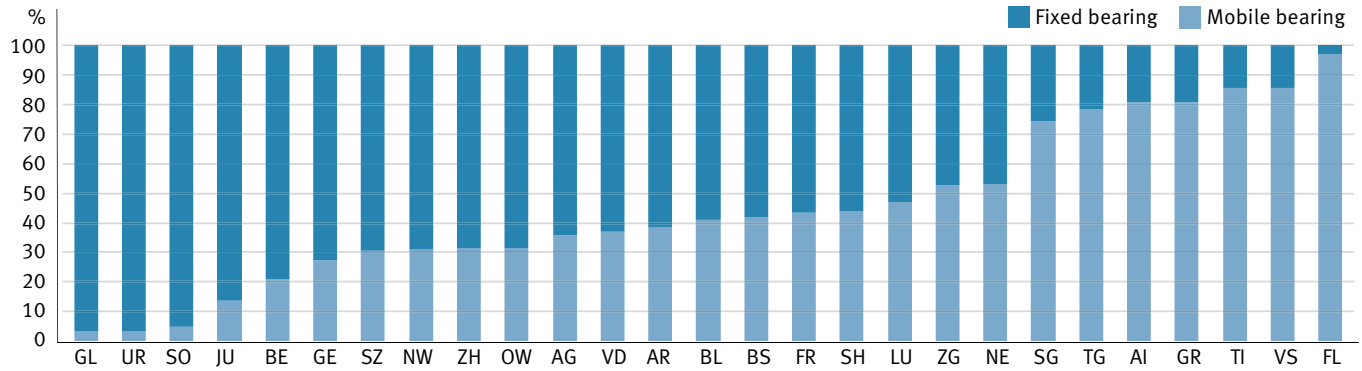



Figure 1.6
**Primary total knee arthroplasty: Share of TKA procedures with mobile bearing by Swiss Canton and Principality of Liechtenstein (2015–2020)**



# 2. Methods

## 2.1 Maintenance and hosting of the registry

The Swiss National Implant Registry, Hip and Knee (SIRIS) is hosted and maintained by SwissRDL at the Institute for Social and Preventive Medicine (ISPM), University of Bern. A dedicated team consisting of a statistician/methodologist, data monitor, data management/IT specialists and support staff is responsible for the management and maintenance, technical support, reporting and analysis of the registry data. The 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. Overall project management at SwissRDL is provided jointly by the data monitor and the statistician/methodologist. Both positions are also represented as members in the SIRIS Scientific Advisory Board that directs and oversees the registry and, among other things, produces this annual report.

SIRIS data are collected on an online documentation IT platform (accessible on https://siris.memdoc.org). Clinical data on primary arthroplasties, reoperations and component revisions are recorded. Clinics may also register, at their own discretion, post-operative follow-up data. All individual implants used (including minor components) are registered alongside all relevant arthroplasties or revisions. The current versions of the SIRIS forms (v2021) for data entry can be downloaded from www.siris-implant.ch. Most participating surgical units use the online interface for documenting their operations but some large centres send data exports from their hospital information system via a web service client to SwissRDL. Alternative registration based on paper forms that were sent to SwissRDL was phased out in 2021.

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.

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 be verified until the end of 2019, as the FSO has not yet published the data for 2020. 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 complies 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 2021. 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. In addition to the ongoing data quality checking routines, a number of specific methodological decisions are taken in order to report figures as accurately as possible. For example, there are registered cases where form information and registered implants are contradictory and it was not yet possible to verify the case locally (e.g. on the form, hemi-arthroplasty is selected but total hip components are registered). In such cases, the implant registration information is given priority and the case is (provisionally) counted as a total hip arthroplasty. Where such decisions had to be made, they are clearly indicated in this report at the relevant table or figure.

Three versions of case report forms (CRF) have been used in SIRIS. The first version was used from 2012 to 2014. From 2015 to 2020, an updated version was in use. In its descriptive content, this report covers this version (2015-2020). It included some changes in the definition of existing variables (particularly for the arthroplasty of the knee) and some new variables were 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. A new case report form was introduced in 2021, mainly in order to address a number of those problems and to update the content to reflect changing practices.

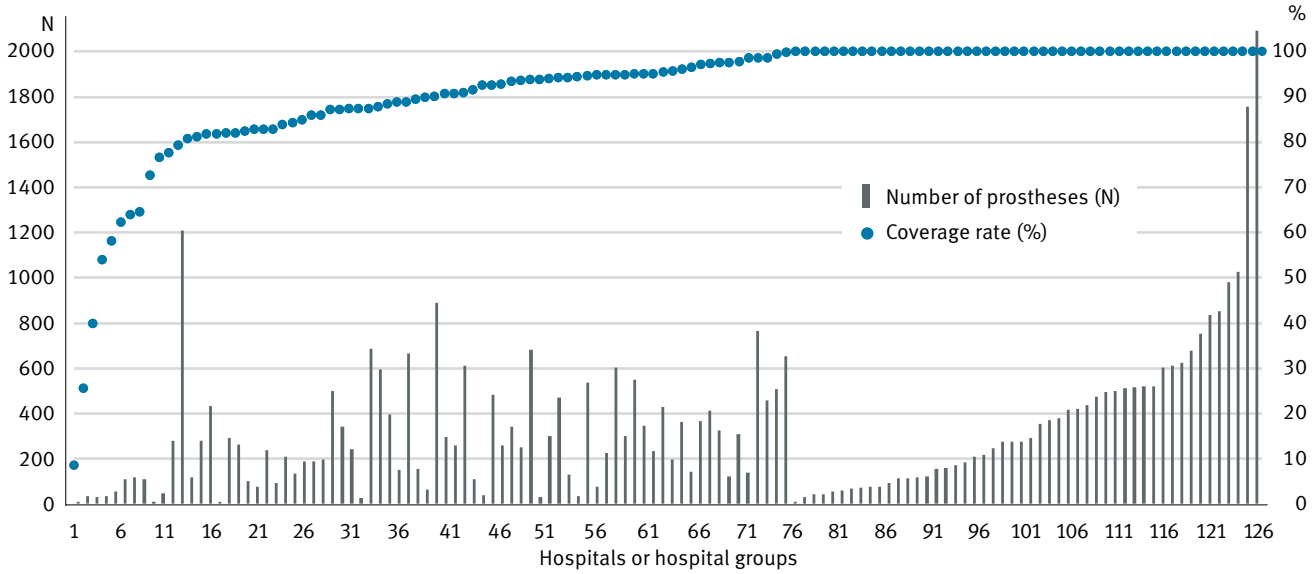
## 2.3 Coverage

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 / BAG). 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. Detailed definitions may be found here (in German, French and Italian): https://www.bag.admin.ch/bag/de/home/zahlen-und-statistiken/zahlen-fakten-zu-spitaelern/qualitaetsindikatoren-der-schweizer-akutspitaeler/qualitaetsindikatoren-dokumentation.html. Codes I.1.8.F, I.1.9.F, I.1.10.F can be used to identify primary hip prostheses of any kind and for any diagnosis, codes

Figure 2.1

**Estimated SIRIS coverage rates and number of hip or knee prostheses per participating hospital 2020**

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



I.1.15.F, I.1.16.F for knee prostheses. At the time of writing the 2021 report, only figures up to 2019 are available and therefore we rely on an alternative source for a detailed analysis of current coverage (2020).

SIRIS accesses annual implant sales figures for Switzerland: specifically the number of femoral stems and tibia plateaus sold per year (data provided by the manufacturers). We consider this a generally 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%). We also became aware of the possibility that implants are imported directly from foreign suppliers and therefore not counted as official sales in Switzerland. However, it is reasonable to assume that such discrepancies tend to even out over time and across hospitals or are relatively small. 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, to more than 95% in 2019, and for 2020 is estimated to lie between 96.5% and 98.3%. We arrive at this estimate by first comparing 41,895 relevant components that were registered in 2020 (primary and revision) to 42,900 components that

Figure 2.2
**Estimated SIRIS coverage rates per participating hospital 2020**

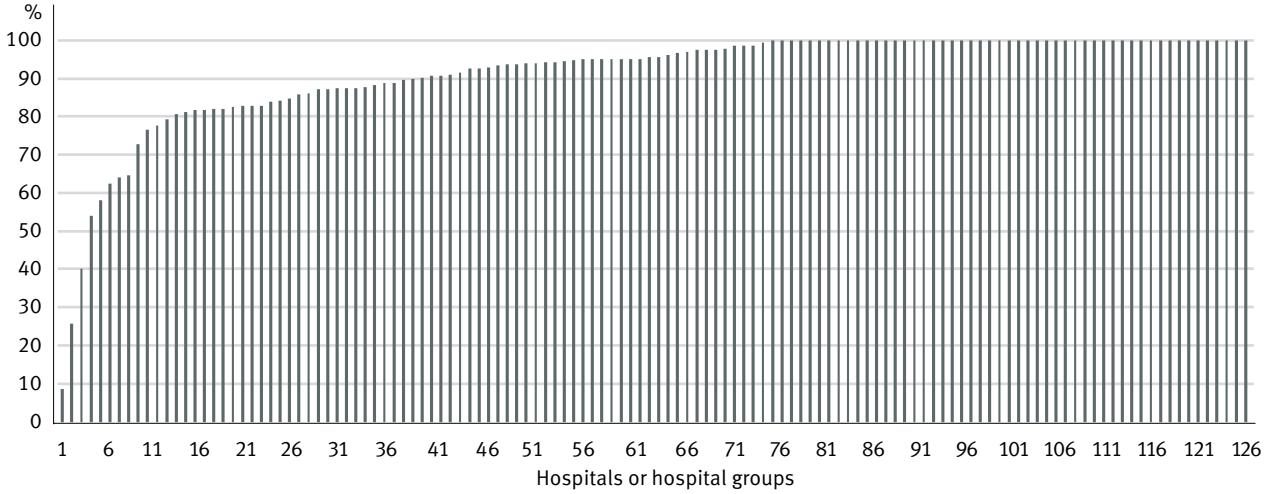



Table 2.1
**Retrospective coverage analysis for 2019 based on National Office of Public Health figures (BAG)**

| | Hip* | Knee** | all prostheses |
|---|---|---|---|
| BAG | 23,619 | 19,181 | 42,800 |
| SIRIS | 22,417 | 18,470 | 40,887 |
| **Coverage %** | **94.9** | **96.3** | **95.5** |

* I.1.8.F/I.1.9.F/I.1.10.F (all first hip prostheses, all diagnoses)
** I.1.15.F/I.1.16.F (all first knee prostheses, all diagnoses)

were reportedly sold in Switzerland (upper end of estimate). However, in some hospitals the number of registered implants exceeds the number of sold implants by far more than the 10% "allowed" by our definition of a target zone. It is therefore likely that the sales figures represent an undercount in some locations. We then add this excess (796 implants) to the number of expected implants in 2020 and by comparing again to the number of observed registrations we arrive at an alternative estimate of 96.5% (lower estimate). All things considered, we deem this figure to be a realistic estimate of current coverage.

We also rely on feedback from individual manufacturers in Swiss industry reporting (implant reports) and know that these high coverage rates are realistic. In specific implant reports, they tended to be as high as 98% for typical standard implants such as primary hip stems and as low as 60% for hemiheads. The under-coverage of hemi arthroplasties is a well-known problem, as they are frequently implanted not in orthopaedic departments but in surgical trauma units, where participation in the registry is less complete. Thus, hip coverage can be assumed to be slightly lower than knee coverage.

At the hospital level, we have also seen clear progress since 2017. In 2020, we observed that 56% of eligible hospitals were in the target zone of 90–110%, which represents actually a big drop compared to the 70% in that zone in 2019. However, 15% of hospitals exceeded the target zone and the 29% below the target zone are predominantly smaller units.

Only 10% of hospitals submitted fewer than 80% of eligible cases. These figures are shown in Figure 2.1. and 2.2., with coverage rates capped at 100%. It shows the individual coverage rates for 126 eligible hospitals or hospital groups 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. Of the larger hospitals (500+ cases) only one had a coverage rate of just below 80%, which is being dealt with by data monitoring as a matter of priority.

Last year we stated that we had reason to believe that the registry already had 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. Indeed, the number of registered cases in 2019 increased after publication of the 2020 report by 219 cases, which represents 0.9 percentage points coverage in that year. These figures illustrate well the effect of the backlog in case registration.

We used the official federal office for public health (FOPH / BAG) figures to re-estimate the 2019 figures. In the annual report 2020 we stated that "hip coverage is closer to 94% while knee coverage is close to 97% according to 2019 sales figures." Based on official figures we now arrive at an estimate of 94.9% for hips and 96.3% for knees and the total coverage rate was 95.5% (Table 2.1).

## 2.4 Statistical precision and outlier detection

Figures in this report are, where appropriate, accompanied by 95% confidence intervals. This interval tells us the plausible range of values within which the "true" value should lie with 95% probability, assuming that the registered cases are subject to some random variation. All confidence intervals are unadjusted for the various forms of clustering that may also affect precision, especially when figures are dependent on small numbers of surgeons or hospitals. The latter aspect is a particular challenge for a medical registry in a small yet diverse country like Switzerland and must be evaluated on a case-by-case basis (e.g. in outlier detection).

We detect statistical outliers – i.e. units or products that perform markedly different than expected – by two principal means. For clinics and surgeons (not part of the scope of this report) we rely on risk-adjusted funnel plots and use the 99.8% limit as the relevant threshold. That is to say that a clinic is deemed an "outlier" if the 2-year revision rate is higher than the range of plausible observations in which 99.8% of observations would fall if the value was the result purely of random variation. In other words, the likelihood of observing a value of at least that extreme is 1 in 500 if it was just pure chance.

For implants we use a much simpler method, but also report the results with much more caveats and additional context. We determine that an implant is a "potential outlier" if the observed 2-year revision rate is more than twice that of the relevant group average. We thus benchmark implants directly against the relatively narrow field of comparable products in their normal variety of uses. In other words, there is no further risk-adjustment, as products of a kind are already meant to be used for a particular range of comparable patient characteristics and diagnoses. However, detailed outlier reports are produced for manufacturers and affected hospitals and there we also provide additional analytical information such as risk-adjusted hazard ratios. We also benchmark implants within a moving time window (four years). This is to make sure that results are not affected by period effects and represent "current" performance, albeit with a necessary two-year time lag in order to allow for complete follow-up of at least two years. As implants come in hugely different group sizes, readers must pay attention to the reported 95% confidence intervals and any other context information – especially relating to small numbers of clinics involved – stated on the outlier watch board in this report.

## 2.5 Evolving statistical methodology

The mainstay of statistical visualisation and reporting in joint registries is the well-established Kaplan-Meier method (KM). Kaplan-Meier charts allow us to track visually the risk of revision of implants or groups of patients over time (failure curves). However, much statistical debate has taken place on the topic of its suitability in the presence of competing risks. In the context of joint registries, the one obvious competing risk is death of a patient. A patient who dies will not have their implant revised at any later point in time. Risk of death is said to "compete" with the risk of revision in patients. Within the constraints of the Kaplan-Meier method we account for death by declaring patients who died during their observation time as "censored" from the day of death. This already provides an important correction to the model, as we do not falsely assume that those implants are still "at risk" of revision. In terms of statistical terminology, we remove them from the risk set. However, the implicit assumption of the method is that the occurrence of death is unrelated to the risk of revision. In other words, if the patient had not died, he or she would or would not have experienced a revision just like any of the surviving patients. This assumption is basically not testable and will frequently be false. The patients that died can never experience a revision and probably had a lower likelihood to begin with, maybe because they were particularly frail and had low mobility. On the other hand, the cause of a potential revision may also be the cause of death. Competing risks regression, which comes in the form of a number of related but actually competing statistical approaches, is an attempt to correct for the implied overestimation of revision risks using KM in the presence of strong competing risks. In the 2021 report we include a first special analysis in the chapter on hip fractures, where mortality rates are a special concern for every analysis even in the short run.

# 3. Summary of the SIRIS Report 2021

# 3. Summary of the SIRIS report 2021

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 increasing 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 registries provide no data concerning the performance of the participating hospitals. Following the Annual Report 2020, SIRIS data specific to hospitals have been published by ANQ on a website devoted to outcomes (https://www.anq.ch/de/fachbereiche/akutsomatik/messergebnisse-akutsomatik/step2/measure/20/). This showed 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), morbidity (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 2019, SIRIS reached coverage of 94.9% for hip prostheses (slight increase compared to 2018) and 96.3% for knee prostheses (increasing constantly over the last four years). The second benchmark is the number of implants sold in Switzerland. This information is more up-to-date and thus available for 2020. On this basis, the estimated coverage rate for all prostheses amounts to at least 96.5% overall, which would represent a slight 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 310,000 primary hip and knee procedures and over 15,000 linked and over 20,000 unlinked revisions (Table 3.1 and Table 3.3). The absolute number of hip and knee procedures registered in SIRIS has been growing steadily, with the annual growth rates since 2013 averaging more than 2.5%. The increase in the total number of procedures is caused, at least partially, by increased coverage in the registry and needs 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 particularly "at risk" of needing 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 numerator shows the number of all prostheses implanted during a given period and the denominator defining the base against which the numerator is evaluated. Exact definitions used in such indicators may differ and readers are advised to always pay attention to any technical appendices or small print provided in publications. This report presents two calculations with different denominators: overall population and population "at risk" (those who belong to the age group when this procedure is usually performed) (Figures 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 could be approximately 1.7–3.5% higher, depending on the year under observation. It should also be noted that the registry's coverage rate slightly improved in 2020.

The COVID-19 pandemic impacted all sectors of public activities in 2020, and especially the Swiss

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

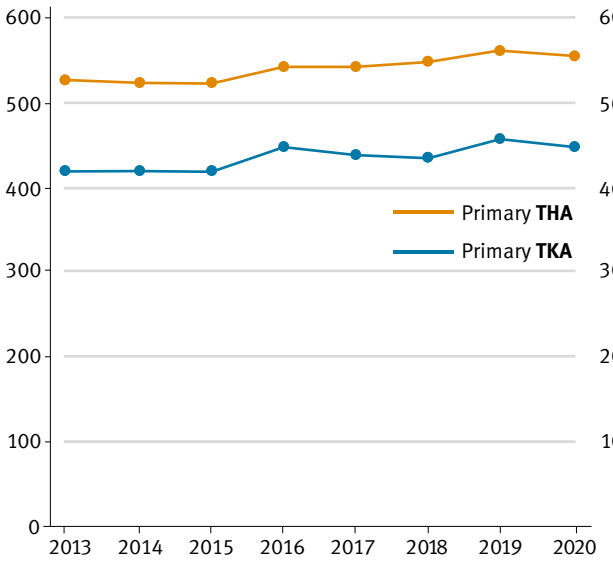
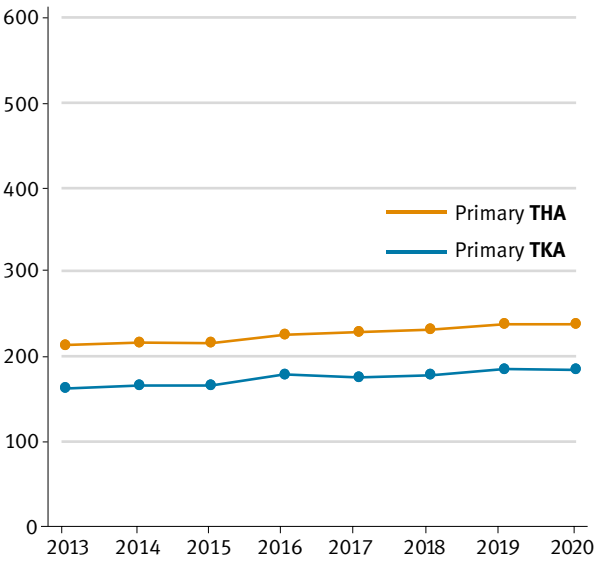



Figure 3.2
**Incidence of primary total hip and total knee arthroplasties registered in SIRIS**
Per 100,000 residents




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

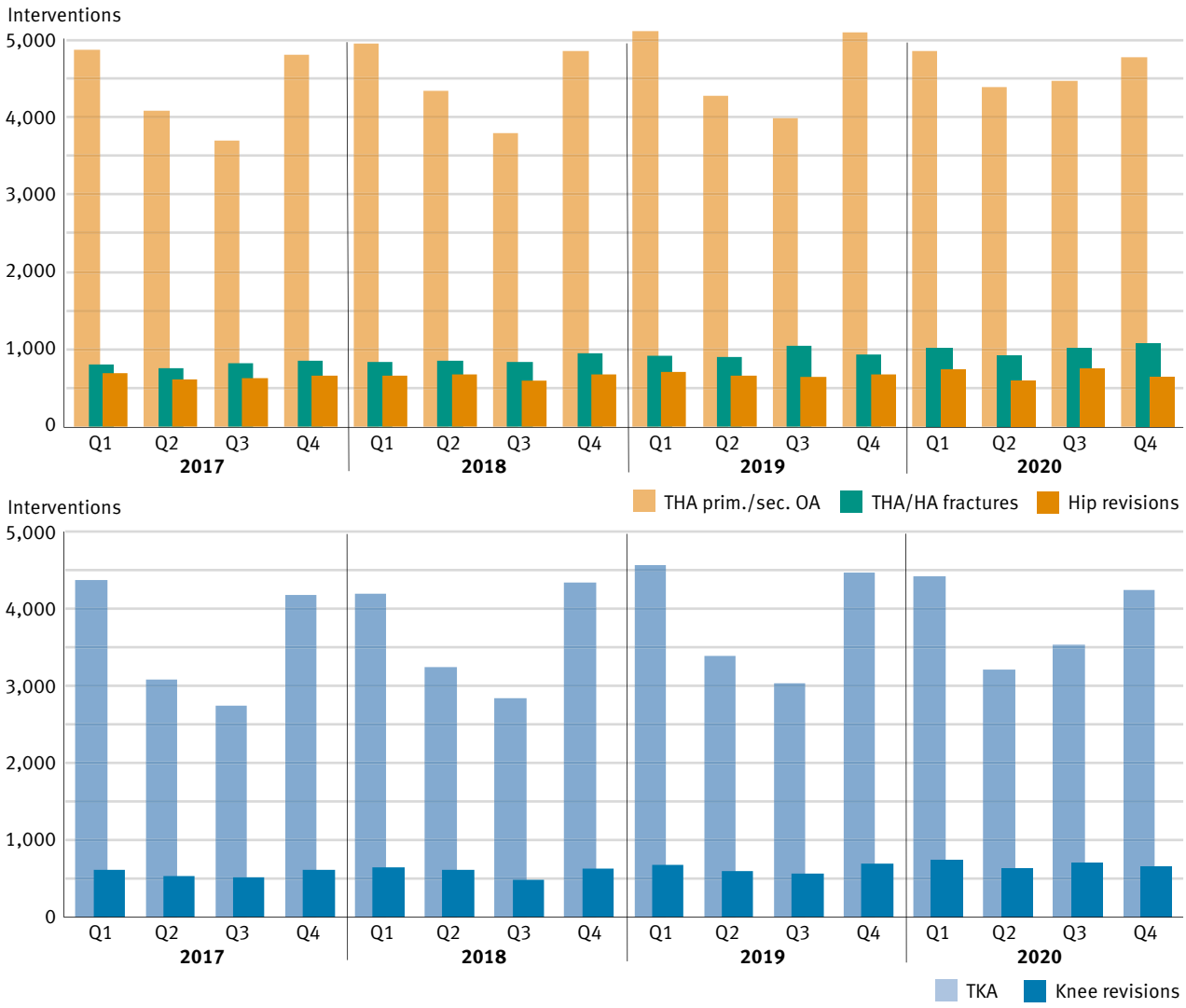
health system. Looking at the hardly changing numbers of THAs and TKAs in 2020 compared to 2019 (Tables 3.1 and 3.3) the impact of the pandemic appears obvious, even though it clearly did not result in major reductions in elective procedures as some might have predicted. However, a closer look at the development of these figures during the year is appropriate. In Figure 3.3 we show a distinctive seasonal pattern in THAs and TKAs that was apparently distorted by the pandemic. Its effect was, however, limited to the following aspects:

1. There was a relatively moderate drop in cases in the first quarter (3–6%)
2. Cases were apparently shifted to the third quarter in particular
3. The previously observable natural growth rate in elective procedures disappeared in 2020
4. The drop in cases in the fourth quarter (relative to previous years) was slightly bigger than in the first quarter

It is therefore possible that cases have been shifted from Q4-2020 into the year 2021 as well and we might observe corresponding catch-up effects in the next report.

Figure 3.3

**Distinctive seasonal pattern in primary procedures was distorted in 2020, most probably due to COVID-19 pandemic.**



## 3.2 Prosthetic replacement of the hip, including hemiarthroplasty for fractures

Over the past eight years the SIRIS registry has documented the implantation of 155,466 primary total hip arthroplasties (THA) (Table 3.1). The male/female ratio and age has remained stable over this time. In 2020, implants were slightly more frequent in women (52.4%), and their mean age of 70.6 years is higher than in men (67.2 years) (Table 4.1).

In the last five years, 66.6% of THA were implanted in patients over 65 years of age, of which 6.8% were older than 85 years. Patients younger than 55 constituted 11.7% of the recipients. The distribution among the age groups remained stable during the observation period.

The registry discriminates between THAs performed for primary osteoarthritis (OA) (83.9%), the largest group, and implantations done to treat secondary OA, including post-traumatic hip joint degeneration, avascular necrosis and sequels of childhood diseases like dysplasia and Perthes' disease (8.8%). The third group includes THAs for hip fractures (7.2%).

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 in a separate chapter of the SIRIS report. The registry has covered a total number of 20,687 fractures of the hip between 2015 and 2020. THA was implanted in 39.7% patients, the major part (60.3%) received hemiarthroplasty (HA).

Table 3.1

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

All documented operations

| Year | Primary THA | Primary HA | Primary others or type uncl. | Primary total | Linked Rev./Reop. of THA** | Linked Rev./Reop. of HA** | Unlinked Rev./Reop. of THA & HA | Rev./Reop. total | % Linked Rev./Reop. |
|---|---|---|---|---|---|---|---|---|---|
| **2012*** | 6,712 | 637 | 7 | 7,356 | 113 | 6 | 787 | 906 | 13.1 |
| **2013** | 16,920 | 1,932 | 12 | 18,864 | 398 | 39 | 1,855 | 2,292 | 19.1 |
| **2014** | 17,226 | 2,027 | 4 | 19,257 | 569 | 60 | 1,890 | 2,519 | 25.0 |
| **2015** | 17,565 | 1,948 | 9 | 19,522 | 715 | 63 | 1,793 | 2,571 | 30.3 |
| **2016** | 18,525 | 1,970 | 9 | 20,504 | 818 | 85 | 1,690 | 2,593 | 34.8 |
| **2017** | 18,839 | 2,055 | 6 | 20,900 | 854 | 76 | 1,672 | 2,602 | 35.7 |
| **2018** | 19,387 | 2,218 | 10 | 21,615 | 954 | 100 | 1,557 | 2,611 | 40.4 |
| **2019** | 20,077 | 2,331 | 9 | 22,417 | 1,088 | 105 | 1,510 | 2,703 | 44.1 |
| **2020** | 20,215 | 2,372 | 8 | 22,595 | 1,208 | 102 | 1,447 | 2,757 | 47.5 |
| **All** | **155,466** | **17,490** | **74** | **173,030** | **6,717** | **636** | **14,201** | **21,554** | **34.1** |

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

** i.e. primaries already in SIRIS

Women were more often affected (69%). Patients older than 65 incurred 91.7% of the fractures. The age group above 85 accounted for 44% (Table 5.1). Of patients receiving HA, 91.7% were older than 75 years. Among all patients that sustained a fracture of the hip only 4.7% were younger than 55 years of age. Of these, 93% were treated with THA. In patients aged 85 years and older, 16% (n=1,470) received THA and 84% (n=7,634) were treated with a HA (derived from Table 5.2).

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 was significantly higher, 83.8%, than the overall average of 60.3% (Table 5.3). The reason for this difference is not clear. A possible explanation could be that in smaller hospitals orthopaedic coverage is less institutionalised and therefore the expertise to implant a THA is missing.

Regarding the main outcome parameters, the registry distinguishes between linked and unlinked revisions/reoperations. Unlinked revisions or reoperations are those when the primary procedure was

Figure 3.4a

**Age distribution at surgery of primary total hip arthroplasty and hemiarthroplasty**

All documented operations

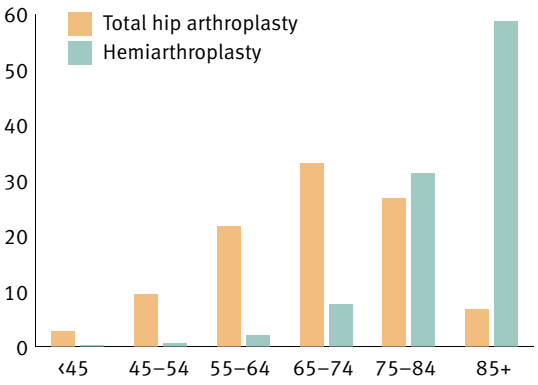
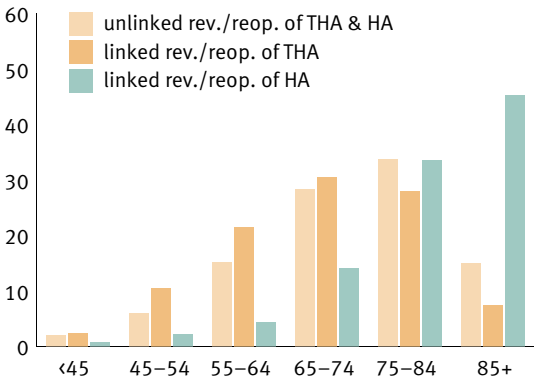



Figure 3.4b

**Age distribution at surgery of revision/reoperation of total hip arthroplasty and hemiarthroplasty**

All documented operations

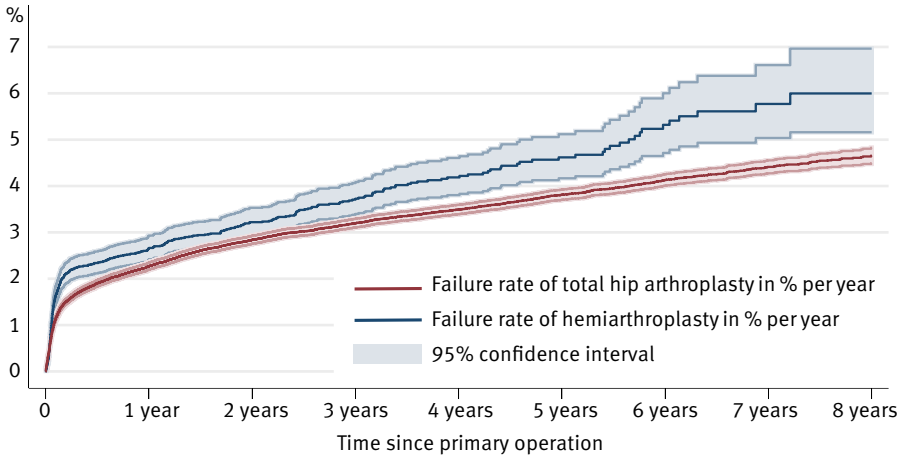


not registered in SIRIS. These are mainly hip or knee arthroplasties from before inception of the registry in 2012. Their relative numbers are still substantial as of 2020, but falling steadily. The fact that unlinked revisions both tend to be from older primary implants and include a small but unrecognisable proportion of HA revisions is reflected in the different age distribution shown in Figures 3.4a and 3.4b. Figure 3.5 gives an overview of the revision rates of THA and HA. At two years the overall revision rate for THA is 2.8% and 3.3% (95% CI 2.9 to 3.7). Comparison with international registries is a difficult topic because of sometimes different definitions and coverage rates, and because there may be numerous contextual factors at play in individual countries that are associated with higher or lower revision rates overall. Mainly due to this complexity we have so far not attempted to place the Swiss figures in an international context.

Figure 3.5

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

in percentages of implants revised, 2012–2020, all services, all diagnoses




As a result of a number of improvements in SIRIS data quality, we observe higher revision rates in comparison with estimates published in the Annual Report 2020. The main driver is likely the improved coverage rate that increases the likelihood of a revision being registered and therefore being counted.

Table 3.2

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

in percentages, 2012–2020, all services, all diagnoses

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Total hip arthroplasty | **2.3**(2.2-2.3) | **2.8**(2.8-2.9) | **3.2**(3.1-3.3) | **3.5**(3.4-3.6) | **3.8**(3.7-3.9) | **4.1**(4.0-4.3) | **4.4**(4.3-4.6) | **4.7**(4.5-4.8) |
| Hemiarthroplasty | **2.7**(2.4-2.9) | **3.2**(2.9-3.5) | **3.7**(3.4-4.1) | **4.2**(3.8-4.6) | **4.6**(4.2-5.1) | **5.3**(4.7-6.0) | **5.8**(5.0-6.6) | **6.0**(5.2-7.0) |

## 3.3 Prosthetic replacement of the knee, including partial knee replacement

In 2020, the total number of registered primary TKAs in the Swiss Joint Registry reached 118,000 cases (Table 3.3). The share of women (60.3%) and mean age (69.5 years) remained approximately constant during the entire period of time. The share of younger patients (younger than 45: 0.5% and 45–54 years old: 6.2%) and patients older than 85 years old (4.6%) did not change significantly over the past years (Table 6.1).

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 (Table 6.2).

Most reasons for TKAs were classified as primary OA (88.5% in 2020) although more reasons (such as ligament lesions or infection) were introduced in 2015 as possible underlying diagnosis for secondary OA and the knowledge about factors causing a knee OA have steadily increased over the past decades.

Between 2015 and 2020 the implantation of 16,178 partial knee replacements (PKA) was performed, which accounts for 15.6% of all knee arthroplasties. This proportion remained constant over the past five years and is among the highest in the western community. In 2020, the total number of partial knee replacements was 3,102. There were 49% of women, and the overall mean age at surgery was approximately 64.6 years, significantly young-

Table 3.3
**Total and partial knee arthroplasty (TKA, PKA)**
All documented operations

| Year | Primary TKA | Primary PKA | Primary others or type uncl. | Primary total | «Linked» Rev./Reop. of TKA** | «Linked» Rev./Reop. of PKA | «Unlinked» Rev./Reop. of TKA & PKA | Rev./Reop. Total | % «Linked» Rev./Reop. |
|---|---|---|---|---|---|---|---|---|---|
| **2012*** | 4,673 | 918 | 17 | 5,608 | 19 | 2 | 508 | 529 | 4.0 |
| **2013** | 12,683 | 2,369 | 32 | 15,084 | 172 | 49 | 1,247 | 1,468 | 15.1 |
| **2014** | 13,049 | 2,286 | 39 | 15,374 | 390 | 101 | 1,116 | 1,607 | 30.6 |
| **2015** | 13,304 | 2,377 | 15 | 15,696 | 581 | 117 | 1,065 | 1,763 | 39.6 |
| **2016** | 14,500 | 2,441 | 15 | 16,956 | 828 | 187 | 1,138 | 2,153 | 47.1 |
| **2017** | 14,359 | 2,582 | 29 | 16,970 | 927 | 255 | 1,097 | 2,279 | 51.9 |
| **2018** | 14,622 | 2,674 | 26 | 17,322 | 1,019 | 269 | 1,073 | 2,361 | 54.6 |
| **2019** | 15,453 | 3,002 | 15 | 18,470 | 1,169 | 286 | 1,060 | 2,515 | 57.9 |
| **2020** | 15,358 | 3,102 | 11 | 18,471 | 1,280 | 377 | 1,065 | 2,722 | 60.9 |
| **All** | **118,001** | **21,751** | **199** | **139,951** | **6,385** | **1,643** | **9,369** | **17,397** | **46.1** |

* Does not represent a full year of data, as data collection in most hospitals started only in October 2012
** i.e. primaries already in SIRIS

er than in the group with total knee arthroplasty (Table 7.1). 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 (Figure 3.5). Slightly over 81% of partial knee replacements were implanted in hospitals with more than 100 interventions per year (Table 7.2).

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 originate from earlier primary implantations (Figure 3.6).

The revision rate after partial compared to total knee arthroplasty was significantly higher after one year and this higher revision rate increased further up to 7 years after initial surgery (Figure 3.7 and Table 3.4).

To resurface the patella or not at the time of implantation of a TKA is an ongoing debate and has led in some countries to the undesired increase of (unnecessary) primary resurfacing in order to avoid an increased revision rate of a hospital or surgeon. Therefore the 2021 SIRIS report provides an extensive analysis on primary and secondary patellar resurfacing in Switzerland. Switzerland reflects the worldwide discussions about patella resurfacing in primary TKA like in a biotope: small country, small numbers but using almost all the existing TKA sys-

Figure 3.6a

**Age distribution at surgery of primary total and partial knee arthroplasty**

All documented operations

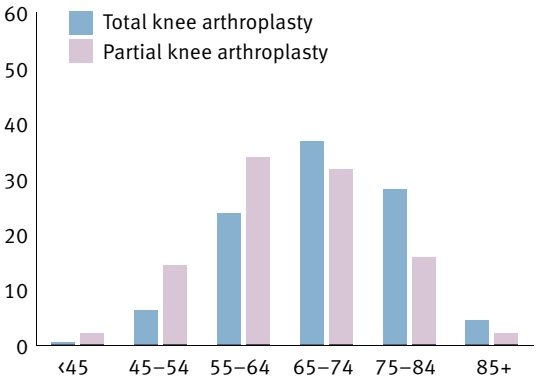
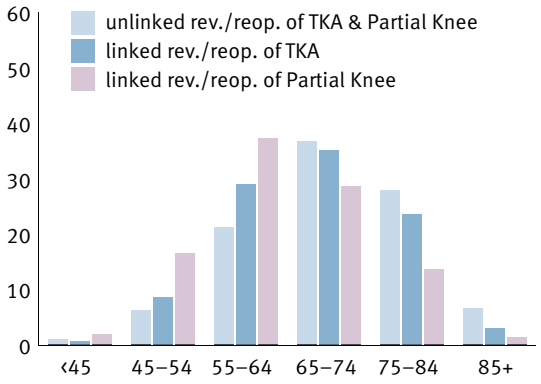



Figure 3.6b

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

All documented operations



tems and brands in hospitals and regions which have a great variety in knee philosophies, preferred systems and brands. Looking closer the TKA type or brand clearly play a smaller role than surgeons' preference. There are more or less patella friendly TKA systems and brands expressed in low rates of primary and secondary patella resurfacing. Astonishingly, not all the modern knee systems were patella friendly and not all the older implants systematically unfriendly. Both rare and frequent patella resurfacing surgeons realised comparable results using the same systems. Resurfacing in defined indications led to comparable results whereas a missing strategy which might be reflected in a resurfacing rate of 20–49% leads to elevated revision rates.

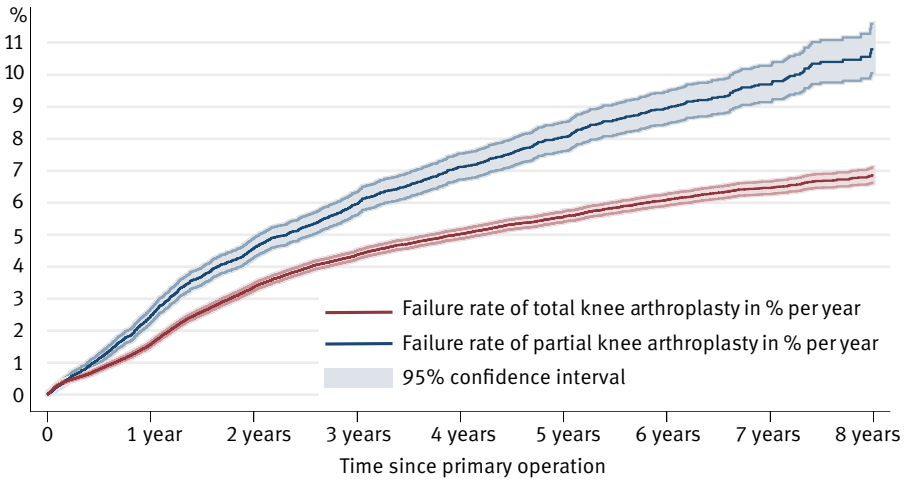
The data of the Swiss Joint registry do not justify increasing or decreasing the rate of patella resurfacing. The increasing rate of resurfacing from 2015 of 24.4% to 31.9% in 2020 in general is an observation, but one would not find any arguments for or against in terms of rates of complication, revision or re-revision.

The patella topic in TKA remains complex as the anterior knee pain is one of the most common complaints after primary TKA irrespective of patella resurfacing. When not resurfaced, secondary resurfacing is an option which does not exist when the patella was replaced during the primary procedure. Nevertheless, only about 50% of the patients profit from secondary resurfacing. Resurfacing itself may lead to a variety of new complications due to malpositioning, fracture, necrosis, loosening, maltracking and therefore contribute to the significant re-revision burden detected in this registry.

Figure 3.7

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

in percentages, 2012–2020, all services, all diagnoses




As a result of a number of improvements in SIRIS data quality, we observe higher revision rates in comparison with estimates published in the Annual Report 2020. The main driver is likely the improved coverage rate that increases the likelihood of a revision being registered and therefore being counted.

Table 3.4

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

in percentages, 2012–2020, all services, all diagnoses

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Total knee arthroplasty | **1.6** (1.5-1.6) | **3.4** (3.3-3.5) | **4.4** (4.2-4.5) | **5.0** (4.9-5.2) | **5.6** (5.4-5.7) | **6.1** (5.9-6.3) | **6.5** (6.3-6.7) | **6.9** (6.6-7.1) |
| Partial knee arthroplasty | **2.4** (2.2-2.7) | **4.6** (4.3-4.9) | **6.0** (5.6-6.3) | **7.1** (6.7-7.5) | **8.1** (7.6-8.5) | **9.0** (8.5-9.5) | **9.7** (9.1-10.3) | **10.8** (10.1-11.1) |

## 3.4 Implant-specific outcomes

SIRIS regards the rate of implant revision for any reason as the first outcome of interest. In order to minimise 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 therefore be interpreted cautiously. Thus, readers are advised to pay close attention to the reported confidence intervals which increase with smaller numbers.

Implant categories with sufficiently large numbers 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.

Table 3.5
**Number of participating hospital services (N) and median procedures (M) per unit per year**

| | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|
| **Primary total hip arthroplasty** | N services | 150 | 149 | 151 | 157 | 153 | 154 | 152 | 153 |
| | M per service | 85 | 84 | 82 | 86 | 87 | 86 | 87 | 94 |
| **Primary hemiarthroplasty of the hip** | N services | 130 | 131 | 138 | 143 | 136 | 125 | 126 | 125 |
| | M per service | 10.5 | 11 | 9 | 9 | 9 | 10 | 10 | 10 |
| **Revision arthroplasty of the hip THA and HA** | N services | 125 | 128 | 133 | 127 | 131 | 127 | 137 | 134 |
| | M per service | 9 | 9 | 10 | 9 | 9 | 9 | 10 | 12 |
| **Primary total knee arthroplasty** | N services | 146 | 148 | 150 | 149 | 149 | 151 | 148 | 146 |
| | M per service | 78 | 71 | 67 | 75 | 72 | 78 | 79 | 77 |
| **Primary partial knee arthroplasty*** | N services | 117 | 123 | 125 | 128 | 127 | 129 | 127 | 128 |
| | M per service | 10 | 9 | 9 | 10 | 10 | 11 | 12 | 12 |
| **Revision arthroplasty of the knee TKA and PKA** | N services | 122 | 127 | 126 | 131 | 130 | 134 | 133 | 130 |
| | M per services | 7.5 | 7 | 7 | 8 | 9.5 | 9 | 9 | 13 |

* Please note that incorrect values were reported in the annual reports 2019 and 2020

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.

Table 3.6
**Number of hospital services and number of primary total hip arthroplasties according to hospital volume**

| Service volume | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| ‹100 | N procedures/% | 3,451/**19.9** | 3,599/**19.7** | 3,190/**17.2** | 3,040/**15.7** | 2,236/**12.1** | 2,829/**14.0** |
| | N services | 83 | 85 | 79 | 74 | 64 | 73 |
| 100–199 | N procedures/% | 5,287/**30.5** | 5,406/**29.6** | 5,695/**30.6** | 5,742/**29.7** | 6,669/**33.3** | 5,551/**27.5** |
| | N services | 41 | 43 | 44 | 44 | 51 | 43 |
| 200–299 | N procedures/% | 3,874/**22.3** | 3,630/**19.9** | 4,499/**24.2** | 4,242/**21.9** | 4,424/**22.1** | 4,995/**24.8** |
| | N services | 17 | 16 | 19 | 19 | 20 | 22 |
| ›300 | N procedures/% | 4,744/**27.3** | 5,628/**30.8** | 5,213/**28.0** | 6,303/**32.6** | 6,522/**32.5** | 6,800/**33.7** |
| | N services | 10 | 13 | 11 | 15 | 15 | 15 |

Table 3.7
**Number of hospital services and number of primary total knee arthroplasties according to hospital volume**

| Service volume | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| ‹100 | N procedures/**%** | 3,688/**27.7** | 3,838/**26.5** | 3,086/**21.5** | 3,554/**24.5** | 3,184/**20.5** | 2,721/**17.7** |
| | N services | 97 | 94 | 86 | 90 | 81 | 78 |
| 100–199 | N procedures/**%** | 3,459/**26.0** | 3,622/**25.0** | 4,810/**33.5** | 4,327/**29.6** | 4,523/**29.1** | 4,698/**30.5** |
| | N services | 29 | 29 | 39 | 35 | 37 | 39 |
| 200–299 | N procedures/**%** | 2,516/**18.9** | 2,640/**18.2** | 2,940/**20.5** | 3,273/**22.3** | 3,461/**22.3** | 3,240/**21.0** |
| | N services | 12 | 13 | 14 | 16 | 17 | 16 |
| ›300 | N procedures/**%** | 3,650/**27.4** | 4,375/**30.2** | 3,528/**24.6** | 3,480/23.7 | 4,352/**28.0** | 4,754/**30.8** |
| | N services | 10 | 12 | 9 | 9 | 12 | 13 |

## 3.5 Reporting of prostheses-related revision rates by hospitals

More than 150 hospital services in Switzerland (orthopaedic or trauma departements) provide hip and knee arthroplasty procedures and SIRIS has achieved 100% participation of institutions 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 full operating year in 2013. Tables 3.6 and 3.7 and Figures 3.8 and 3.9, highlight the distribution of case numbers for hip and knee surgeries 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.

Figures 3.10 and 3.11 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 total knee arthroplasty procedures. On funnel plots, each dot represents a hospital service and they were all centred on the national average. The vertical axis indicates the outcome, with dots higher up the axis showing services with

Figure 3.8
**Cases per hospital service 2020: Total hip arthroplasty and hemiarthroplasty**

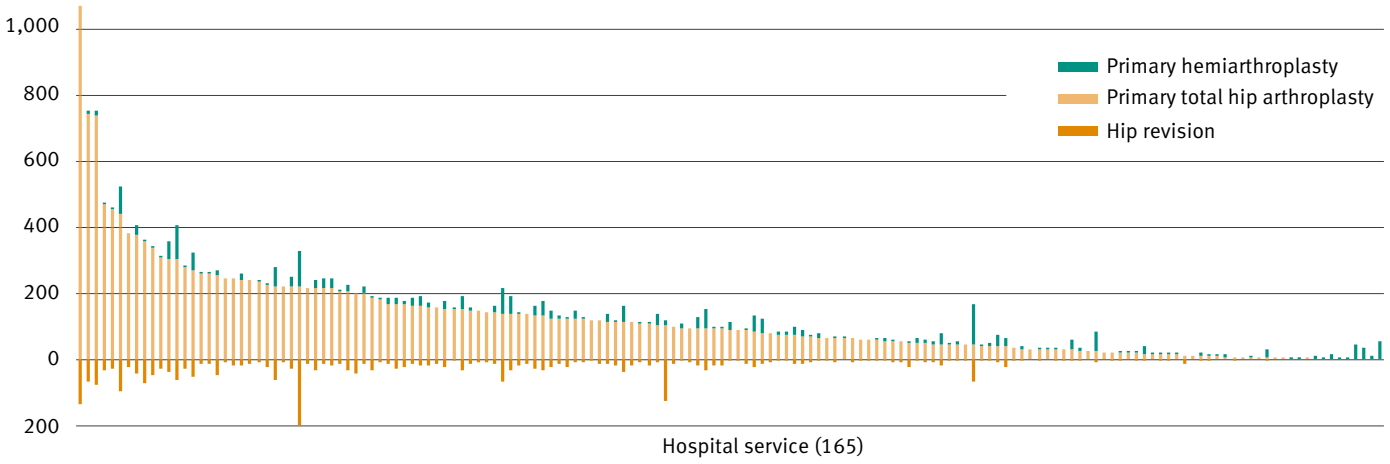
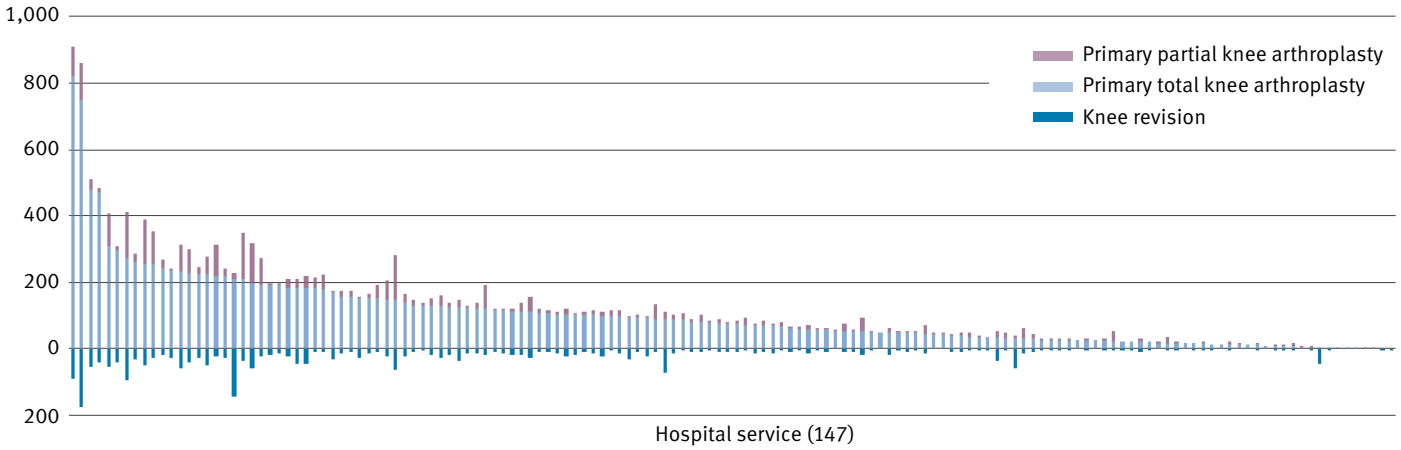



Figure 3.9
**Cases per hospital service 2020: Total and partial knee arthroplasty**



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 reported 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 was relatively homogeneous, but there were exceptions, and there appears to be more variation with knee than with hip procedures.

Figure 3.10

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

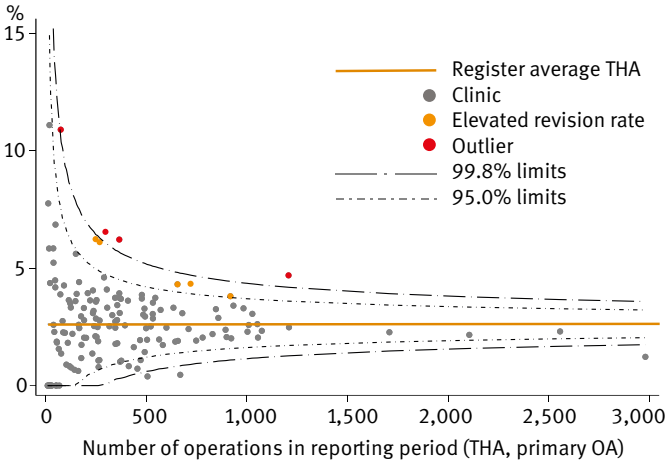
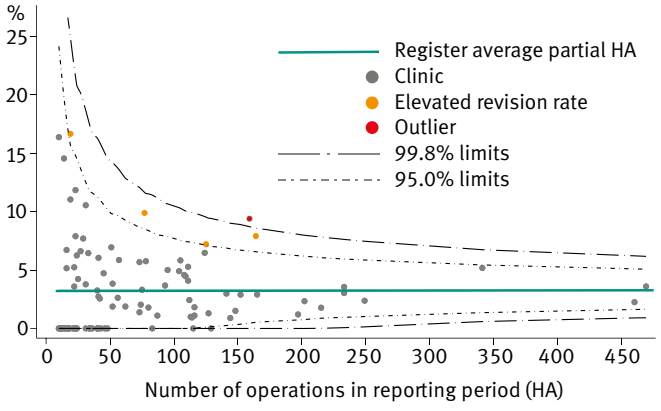



Figure 3.11

**2-year revision rate of primary hemiarthroplasty by service***




* Number of operations in the reporting period 01/2015–12/2018 (4-year moving average, follow-up to 12/2020).
THA and TKA results restricted to patients with primary osteoarthritis (prim OA). Results are risk-adjusted for age, sex and BMI, ASA, Charnley Score if available.

Figure 3.12

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

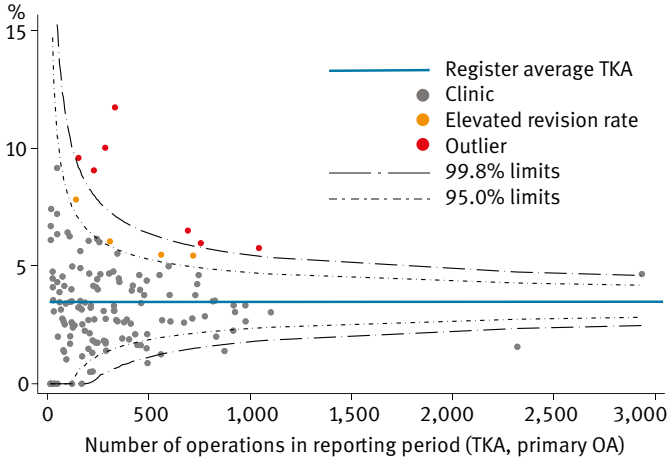



Figure 3.13

## 2-year revision rate of partial knee arthroplasty by service*

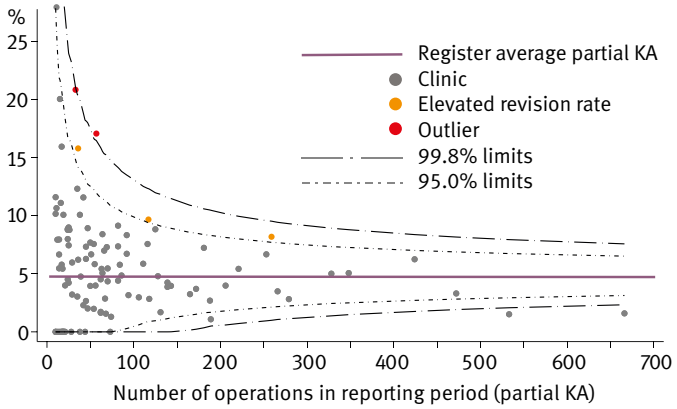
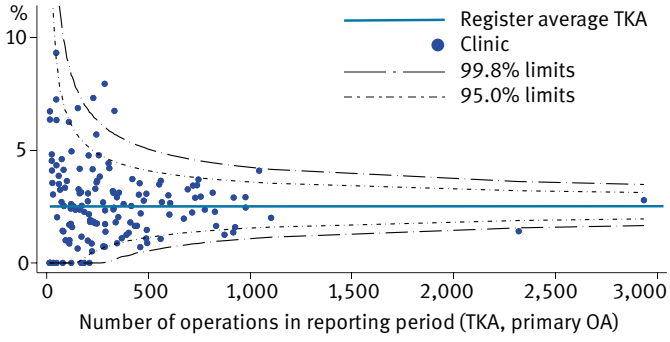



Figure 3.14

## 2-year revision rate of primary total knee arthroplasty by service w/o isolated secondary Patella resurfacing




**Important information on interpretation of funnel plots**

- The coloured line denotes the Swiss average 2-year revision rate
- Clinics that lie between the 95% limits (grey) have revision rates that are within the statistically expected range of observations given their operation volume
- Clincs below the 95/99.8% limits are performing better than the average
- Clinics above the 95% limit and below the 99.8% limit (orange) have elevated 2-year revision rates.This could be due to random variation, but we recommend that possible reasons are investigated, in particular if the position should be stable over time or worsen.
- Clinics above the 99.8% limit (red) have 2-year revision rates that deviate markedly from the national average (unlikely to be due to random variation alone).

# 4. Hip arthoplasty

# 4. Hip arthroplasty

## Introduction

Implantations of hip prosthesis have been recorded and documented since 2012. The first year with full documentation of the majority of services performing total hip replacements was 2013. Morbidity state (ASA classification) and the Body Mass Index (BMI) have been recorded since 2015. One problem of continuing data collections is that the outdated data have the same weight as new data and past or current problems may be over- or underestimated. In order to overcome the problem of overaged (antiquated) data it was decided that some analyses are carried out within a four-year moving window, including the last four years with full two-year follow-up. For this report the data of implantations from 1.1.2015 to 31.12.2018 are analysed with completed two-year follow-up until 31.12.2020 (the scope of this report).

However, for Kaplan-Meier survival estimates and the calculation of cumulative revision rates the entire period from 2012 onwards is used in order to extend the follow-up period to its maximum.

Comparing previous Annual Reports, the observant reader may find that the numbers of implantations per year may have increased. This is because even after longer periods of time, implantations that occurred in previous years are eventually uploaded for documentation. Therefore, the coverage rate also improves over time. The participating services are advised to follow the proposed deadlines for data entry, but there are always some that lag behind.

## 4.1 Primary total hip arthroplasty

Since 2015 the SIRIS registry has documented 114,608 primary total hip arthroplasties (THA) (Table 4.1). The registry discriminates between THAs performed for primary osteoarthritis (OA) (83.9%) – the largest group – and implantations for treating secondary osteoarthrosis, including post-traumatic hip joint degeneration, inflammatory diseases, avascular necrosis and sequels of childhood diseases like dysplasia and Perthes' disease (8.8%). The third group includes THAs for fractures of the hip (7.2%).

For primary OA the male/female ratio and the age at implantation remained stable over these years. Hip implants were slightly more frequent in women (52.9%), and their mean age of 70.5 years was higher than that of men (66.8 years).

Table 4.1
**Primary total hip arthroplasty: Baseline patient characteristics by year**

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| N | | **17,565** | **18,525** | **18,839** | **19,387** | **20,077** | **20,215** | **114,608** |
| Diagnosis [%]* | Primary OA | 85.0 | 84.3 | 84.6 | 84.3 | 83.5 | 82.1 | 83.9 |
| | Secondary OA | 8.6 | 9.1 | 8.7 | 8.6 | 8.7 | 9.3 | 8.8 |
| | Fracture | 6.4 | 6.5 | 6.7 | 7.0 | 7.8 | 8.6 | 7.2 |
| Women [%] | | 52.5 | 52.9 | 53.1 | 53.4 | 53.0 | 52.4 | 52.9 |
| Mean age (SD) | All | 68.6 (11.5) | 68.5 (11.5) | 68.5 (11.5) | 68.9 (11.5) | 69.1 (11.5) | 69.0 (11.6) | 68.8 (11.5) |
| | Women | 70.4 (11.2) | 70.3 (11.2) | 70.3 (11.2) | 70.6 (11.2) | 70.8 (11.1) | 70.6 (11.4) | 70.5 (11.2) |
| | Men | 66.6 (11.6) | 66.4 (11.6) | 66.5 (11.5) | 66.9 (11.5) | 67.1 (11.6) | 67.2 (11.6) | 66.8 (11.6) |
| Age group [%] | <45 | 2.6 | 2.8 | 2.6 | 2.3 | 2.5 | 2.5 | 2.5 |
| | 45–54 | 9.6 | 9.4 | 9.5 | 9.3 | 8.6 | 8.9 | 9.2 |
| | 55–64 | 21.3 | 21.6 | 21.7 | 21.6 | 21.6 | 21.9 | 21.6 |
| | 65–74 | 33.6 | 34.2 | 33.6 | 32.8 | 32.3 | 31.5 | 32.9 |
| | 75–84 | 26.3 | 25.7 | 26.2 | 27.1 | 27.7 | 27.9 | 26.9 |
| | 85+ | 6.7 | 6.3 | 6.4 | 7.0 | 7.3 | 7.3 | 6.8 |
| N unknown BMI (%) | | 4,375 (25) | 3,703 (20) | 3,300 (18) | 3,025 (16) | 2,912 (15) | 2,485 (12) | 19,800 (17) |
| N known BMI | | 13,190 | 14,822 | 15,539 | 16,362 | 17,165 | 17,730 | 94,808 |
| Mean BMI (SD) | | 27.1 (5.2) | 27.2 (5.4) | 27.1 (5.1) | 27.2 (5.5) | 27.0 (5.1) | 26.9 (5.3) | 27.1 (5.2) |
| BMI [%] | <18.5 | 1.8 | 1.8 | 1.8 | 2.1 | 2.1 | 2.3 | 2.0 |
| | 18.5–24.9 | 35.1 | 35.0 | 35.4 | 35.0 | 35.6 | 36.4 | 35.4 |
| | 25–29.9 | 38.9 | 39.2 | 38.9 | 38.1 | 39.1 | 38.1 | 38.7 |
| | 30–34.9 | 17.1 | 17.4 | 17.0 | 17.4 | 16.6 | 16.6 | 17.0 |
| | 35–39.9 | 5.3 | 4.9 | 5.2 | 5.4 | 5.2 | 4.8 | 5.1 |
| | 40+ | 1.8 | 1.7 | 1.7 | 2.0 | 1.5 | 1.7 | 1.7 |
| N unknown ASA (%) | | 2,252 (13) | 2,130 (11) | 1,923 (10) | 1,699 (9) | 1,500 (7) | 1,236 (6) | 10,740 (9) |
| N known ASA | | 15,313 | 16,395 | 16,916 | 17,688 | 18,577 | 18,979 | 103,868 |
| Morbidity | ASA 1 | 16.3 | 14.6 | 13.3 | 12.0 | 12.1 | 11.6 | 13.2 |
| state [%] | ASA 2 | 58.2 | 59.5 | 60.0 | 59.5 | 59.0 | 59.0 | 59.2 |
| | ASA 3 | 24.9 | 25.1 | 26.1 | 27.6 | 28.0 | 28.3 | 26.8 |
| | ASA 4/5 | 0.6 | 0.8 | 0.6 | 0.9 | 0.9 | 1.0 | 0.8 |

*A diagnostic category could not be determined in 819 cases (0.71%). Percentages shown are of n=113,789 THAs with valid diagnostic group.

Table 4.2

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

| | | Primary OA | Secondary OA | Fracture |
|---|---|---|---|---|
| N (2015–2020)* | | **95,508** | **10,068** | **8,213** |
| Women [%] | | 51.4 | 57.1 | 65.0 |
| Mean age (SD) | All | 68.8 (10.9) | 63.6 (15.3) | 74.3 (10.8) |
| | Women | 70.6 (10.5) | 65.5 (15.2) | 75.3 (10.3) |
| | Men | 67.0 (11.0) | 61.0 (15.0) | 72.4 (11.5) |
| Age group [%] | ‹45 | 1.8 | 11.0 | 0.7 |
| | 45–54 | 8.8 | 17.3 | 4.0 |
| | 55–64 | 22.3 | 21.9 | 13.6 |
| | 65–74 | 34.4 | 22.2 | 28.6 |
| | 75–84 | 26.9 | 20.1 | 35.3 |
| | 85+ | 5.8 | 7.5 | 17.9 |
| Diagnosis [%] | Osteoarthritis | 100.0 | 0.0 | 0.0 |
| | Inflammatory arthritis | 0.0 | 5.3 | 0.0 |
| | Developmental dysplasia | 0.0 | 23.5 | 0.0 |
| | Osteonecrosis | 0.0 | 56.3 | 0.0 |
| | Miscellaneous | 0.0 | 14.9 | 0.2 |
| | Fracture | 0.0 | 0.0 | 99.8 |
| N unknown BMI (%) | | 16,293 (17) | 1,430 (14) | 1,939 (24) |
| N known BMI | | 79,215 | 8,638 | 6,274 |
| Mean BMI (SD) | | 27.3 (5.2) | 26.7 (5.5) | 24.2 (4.5) |
| BMI [%] | ‹18.5 | 1.4 | 3.0 | 7.8 |
| | 18.5–24.9 | 33.5 | 39 | 54.9 |
| | 25–29.9 | 39.9 | 35.7 | 27.8 |
| | 30–34.9 | 17.9 | 15.8 | 7.4 |
| | 35–39.9 | 5.5 | 4.7 | 1.6 |
| | 40+ | 1.8 | 2.0 | 0.5 |
| N unknown ASA | | 9,228 (10) | 745 (7) | 665 (8) |
| N known ASA | | 86,280 | 9,323 | 7,548 |
| Morbidity state | ASA 1 | 13.5 | 14.9 | 7.2 |
| [%] | ASA 2 | 61.2 | 52.4 | 46.0 |
| | ASA 3 | 24.8 | 31.3 | 43.6 |
| | ASA 4/5 | 0.5 | 1.4 | 3.2 |

*Number of cases with clear diagnostic information (in 0.7% of cases we cannot determine the diagnosis)

66.6 percent of THA were performed in patients older than 65 years of age and 6.8% of implants were in patients older than 85 years. Patients younger than 55 years constituted 11.7% of the recipients. The distribution among the age groups remained stable during the last six years.

Data on BMI and the ASA score have been recorded since 2015. Data collection has improved over time. The mean BMI was 27.3 kg/m² for all patients with primary osteoarthritis (OA); 39.9% of THAs were performed in overweight patients (BMI 25–29.9) and 25.2% in obese patients (BMI >= 30 kg/m²) (Table 4.2). Higher BMI was associated with younger age. This is true for male and female patients (Figure 4.1). The distribution of BMI remained constant during the observation period.

Most procedures were performed on healthy individuals; 27.6% of the implants were performed in ASA class ≥3. The decrease in ASA 1 assessments continued. Concurrently, the number of patients with ASA 3 increased.

Patients treated for secondary OA were on average five years younger than those treated for primary OA. Hip dysplasia showed an increase from 20.5% in 2015 to 23.5% in 2020 among all secondary OA patients. 56.3% of the hips with secondary OA were treated for avascular necrosis. Compared to the other main diagnostic groups there were increasingly more young patients treated for secondary OA (11% were younger than 45 years of age) (Table 4.2). Considerably more women were affected by fractures than men. They accounted for two-thirds (65%) of all patients sustaining hip fractures. The average age of women with fractures was 75.3 years compared to men at 72.4 years. More than 80% occur in patients over 65 and more than 50% in patients over 75. There was also a much higher proportion of patients in the fracture group belonging to ASA class ≥3. In chapter 5 we provide a detailed analysis of patients with hip fractures, comparing treatment with THA to treatment with hemiarthroplasty (HA).

Figure 4.1

**Primary total hip arthroplasty: Mean age at primary arthroplasty depending on BMI class**

Primary and secondary osteoarthritis patients only. Please note that group sizes vary considerably.

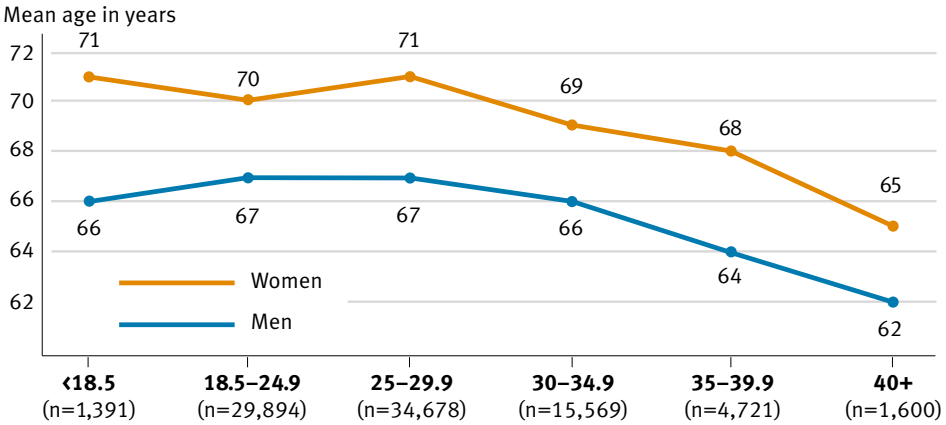


Table 4.3

## 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 (2015-2020).

| Hospital service volume | | <100 | 100–199 | 200–299 | 300+ |
|---|---|---|---|---|---|
| N (2015–2020) | | **17,570** | **34,506** | **26,885** | **35,647** |
| Women [%] | | 52.2 | 53.0 | 52.6 | 53.4 |
| Mean age (SD) | All | 69.7 (11.1) | 69.2 (11.4) | 68.9 (11.3) | 67.8 (12.0) |
| | Women | 71.5 (10.7) | 71.0 (10.9) | 70.6 (11.0) | 69.5 (11.8) |
| | Men | 67.7 (11.2) | 67.2 (11.6) | 67.0 (11.2) | 65.8 (12.0) |
| Age group [%] | <45 | 1.7 | 2.2 | 2.2 | 3.6 |
| | 45–54 | 8.3 | 8.7 | 9.0 | 10.2 |
| | 55–64 | 20.3 | 21.2 | 21.6 | 22.6 |
| | 65–74 | 33.6 | 32.8 | 33.5 | 32.3 |
| | 75–84 | 28.3 | 27.8 | 26.9 | 25.2 |
| | 85+ | 7.7 | 7.2 | 6.7 | 6.2 |
| Diagnosis [%] | Primary OA | 83.6 | 83.0 | 86.6 | 83.0 |
| | Secondary OA | 8.1 | 8.1 | 7.4 | 11.1 |
| | Fracture | 8.3 | 9.0 | 6.0 | 5.9 |
| N unknown BMI (%) | | 4,068 (23) | 6,471 (19) | 5,133 (19) | 4,128 (12) |
| N known BMI | | 13,502 | 28,035 | 21,752 | 31,519 |
| Mean BMI (SD) | | 27.2 (5.3) | 27.2 (5.2) | 27.1 (5.5) | 26.9 (5.1) |
| BMI [%] | <18.5 | 1.9 | 1.9 | 2.0 | 2.1 |
| | 18.5–24.9 | 34.8 | 34.3 | 35.6 | 36.6 |
| | 25–29.9 | 38.9 | 38.8 | 38.8 | 38.4 |
| | 30–34.9 | 17.5 | 17.5 | 16.8 | 16.5 |
| | 35–39.9 | 5.0 | 5.6 | 5.1 | 4.8 |
| | 40+ | 1.9 | 1.9 | 1.8 | 1.6 |
| N unknown ASA (%) | | 1,021 (6) | 3,256 (9) | 3,098 (12) | 3,365 (9) |
| N known ASA | | 16,549 | 31,250 | 23,787 | 32,282 |
| Morbidity state [%] | ASA 1 | 14.6 | 13.7 | 12.9 | 12.2 |
| | ASA 2 | 59.3 | 59.1 | 60.8 | 58.1 |
| | ASA 3 | 25.2 | 26.3 | 25.5 | 28.9 |
| | ASA 4/5 | 0.9 | 0.8 | 0.8 | 0.7 |

Between 2015 and 2020, 114,608 THAs were implanted in 167 orthopaedic units in Switzerland. 17,570 hips (12%) were implanted in units doing on average (2015–2020) less than 100 cases per year. 31% of the primary THA (35,647) were implanted in services that do more than 300 cases per year. In those large units do on average (2015–2020) more complex cases (secondary OA) were done in patients that were slightly younger on average (Table 4.3).

Resurfacing of the hip has been largely abandoned in Switzerland. Only 33 cases were treated this way in the past five years (Table 4.4).

With minimal variations registered, the fixation methods remained stable over the last five years (Tables 4.5, Figures 4.2) for all three diagnostic groups. Relatively more acetabular reinforcement rings were used in the secondary OA group, reflecting more complex surgeries. For treatment of hip fractures, significantly more stems were cemented and more hybrid fixations were used.

Table 4.4

**Primary total hip arthroplasty: Surgery characteristics by main diagnostic group**

| Main diagnostic group | | Primary OA | | Secondary OA | | Fracture | |
|---|---|---|---|---|---|---|---|
| N (2015–2020) | | N | % | N | % | N | % |
| Previous surgery | None | 91,988 | 96.3 | 8,441 | 83.8 | 7,344 | 89.4 |
| | Internal fixation femur | | | 591 | 5.9 | 609 | 7.4 |
| | Osteotomy femur | | | 409 | 4.1 | 43 | 0.5 |
| | Internal fixation acetabulum | | | 69 | 0.7 | 53 | 0.6 |
| | Osteotomy pelvis | | | 216 | 2.1 | 7 | 0.1 |
| | Arthrodesis | | | 4 | 0.0 | 5 | 0.1 |
| | Other previous surgery | 3,520 | 3.7 | 430 | 4.3 | 178 | 2.2 |
| Intervention | Total hip replacement (from entry) | 95,168 | 99.6 | 10,003 | 99.4 | 8,130 | 99.0 |
| | Full hip resurfacing | 27 | 0.0 | 6 | 0.1 | 0 | 0.0 |
| | Other (free text entry or recognised as THA)*** | 313 | 0.3 | 59 | 0.6 | 83 | 1.0 |
| Approach | Anterior | 45,636 | 47.8 | 4,131 | 41.1 | 3,983 | 48.5 |
| | Anterolateral | 30,689 | 32.2 | 3,532 | 35.1 | 2,254 | 27.5 |
| | Posterior | 13,033 | 13.7 | 1,460 | 14.5 | 1,140 | 13.9 |
| | Lateral | 5,412 | 5.7 | 735 | 7.3 | 665 | 8.1 |
| | Other approach | 674 | 0.7 | 199 | 2.0 | 166 | 2.0 |
| Fixation | All uncemented | 83,018 | 86.9 | 7,930 | 78.8 | 3,988 | 48.6 |
| | Hybrid* | 10,496 | 11.0 | 1,364 | 13.5 | 3,261 | 39.7 |
| | All cemented | 1,287 | 1.3 | 454 | 4.5 | 666 | 8.1 |
| | Reverse hybrid** | 484 | 0.5 | 178 | 1.8 | 161 | 2.0 |
| | Reinforcement ring, femur uncemented | 103 | 0.1 | 46 | 0.5 | 45 | 0.5 |
| | Reinforcement ring, femur cemented | 120 | 0.1 | 96 | 1.0 | 92 | 1.1 |

* acetabulum uncemented, femur cemented ** acetabulum cemented, femur uncemented *** in case of inconsistencies between form entry and implant registration, we use the implant in determining the relevant category (e.g. entered „bipolar prosthesis“ but registered stem and double mobility cup)

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 %

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 |
| 0.6 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 |
| 11.6 | 11.2 | 10.6 | 10.9 | 11.3 | 10.5 |
| 86.0 | 86.8 | 87.0 | 86.8 | 86.8 | 88.0 |
| 1.6 | 1.3 | 1.7 | 1.5 | 1.2 | 0.8 |
| **14,797** | **15,414** | **15,813** | **16,249** | **16,699** | **16,536** |

Figure 4.2a

### Primary osteoarthritis

Relative distribution per year in %

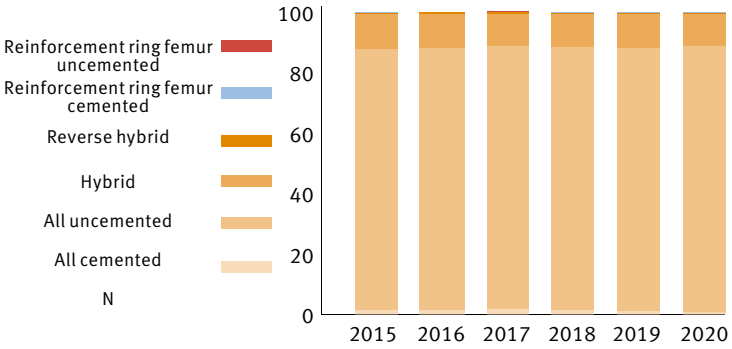



Table 4.5b

### Secondary osteoarthritis

Relative distribution per year in %

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 0.5 | 0.4 | 0.4 | 0.6 | 0.3 | 0.5 |
| 0.8 | 0.8 | 0.9 | 0.7 | 1.1 | 1.4 |
| 1.9 | 1.7 | 1.6 | 2.0 | 1.7 | 1.7 |
| 13.6 | 14.8 | 13.7 | 12.7 | 14.1 | 12.5 |
| 79.1 | 76.6 | 78.5 | 78.9 | 78.6 | 80.8 |
| 4.0 | 5.7 | 5.0 | 5.2 | 4.3 | 3.1 |
| **1,491** | **1,672** | **1,624** | **1,665** | **1,740** | **1,876** |

Figure 4.2b

### Secondary osteoarthritis

Relative distribution per year in %

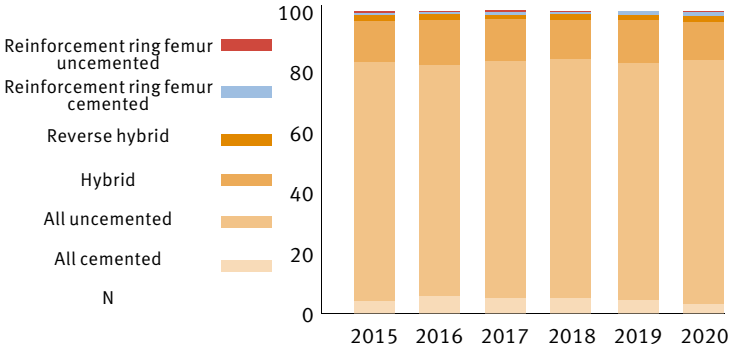



Table 4.5c

### Fracture

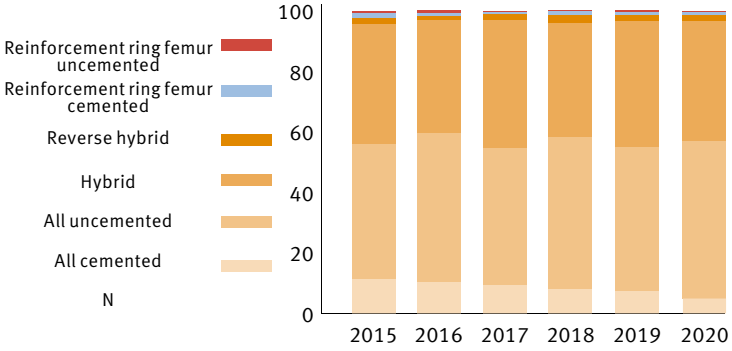
Relative distribution per year in %

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| 0.9 | 0.8 | 0.6 | 0.4 | 0.4 | 0.3 |
| 1.6 | 0.9 | 0.7 | 1.2 | 1.2 | 1.1 |
| 2.1 | 1.4 | 1.8 | 2.7 | 1.9 | 1.9 |
| 39.4 | 37.5 | 42.3 | 37.6 | 41.4 | 39.7 |
| 44.8 | 49.3 | 45.4 | 50.2 | 47.9 | 52.0 |
| 11.2 | 10.1 | 9.2 | 8.0 | 7.2 | 4.9 |
| **1,118** | **1,196** | **1,245** | **1,358** | **1,563** | **1,733** |

Figure 4.2c

### Fracture

Relative distribution per year in %



For all diagnostic groups the anterior approach was by far the most commonly used approach, followed by the anterolateral approach. Since the start of recording approaches in 2015, using the anterior approach has gradually increased and reached 52.7% in 2020, while the use of lateral and posterior approaches were declining (Table 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.

Bearing is one of the most important factors for wear and implant survival. The improvement of bearing materials has led to a decrease in instances of osteolysis. Currently, the most frequently used bearing in Switzerland is CoXLPE. In 2020, in 58% of all primary hip implants for primary OA this bearing was chosen (Table 4.7). Also, the combination of ceramic head and standard PE (CoPE) increased over the years and was used in 16% of implantations. The combinations of MoPE and MoXLPE steadily decreased between 2015 and 2020,

Table 4.6
**Primary total hip arthroplasty: Surgical approach by year**

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % |
| Anterior | 41.8 | 44.0 | 48.0 | 49.1 | 50.3 | 52.7 | 47.8 |
| Anterolateral | 33.7 | 33.1 | 32.0 | 32.1 | 31.5 | 30.8 | 32.2 |
| Lateral | 8.2 | 7.2 | 5.8 | 4.9 | 4.6 | 3.7 | 5.7 |
| Posterior | 15.2 | 15.1 | 13.5 | 13.2 | 12.8 | 12.4 | 13.7 |
| Other approach | 1.1 | 0.7 | 0.6 | 0.7 | 0.7 | 0.5 | 0.7 |
| Total [N] | 14,733 | 15,414 | 15,813 | 16,249 | 16,699 | 16,536 | 95,444 |

Please note that surgical approach is missing in 64 cases registered in 2015 (using SIRIS 2012 form version which did not contain approach)

Figure 4.3
**Relative share of total hip arthroplasty procedures using different approaches by Swiss Canton and Principality of Liechtenstein (2015–2020)**

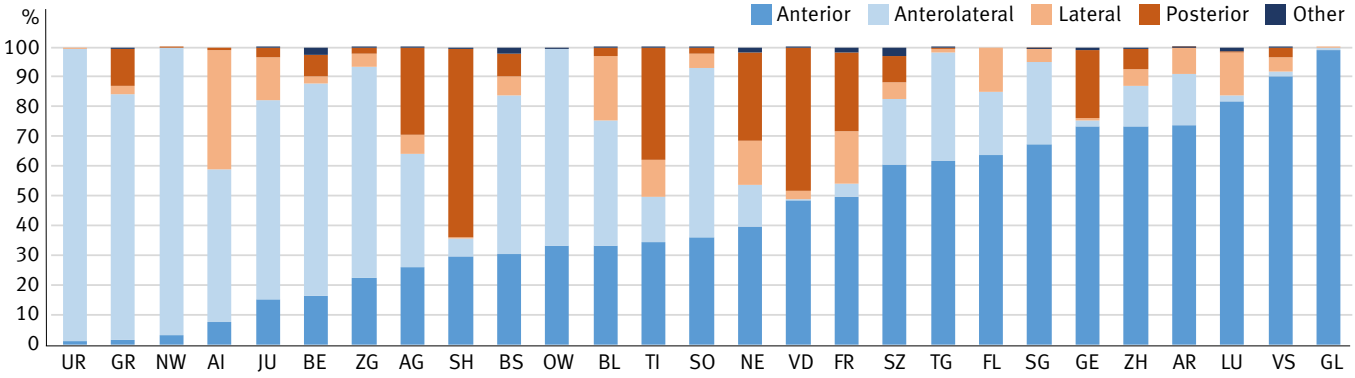


Table 4.7

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

| Bearing surface | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| Metal on polyethylene (PE) (MoPE) | 2.4 | 2.2 | 2.1 | 2.0 | 2.1 | 1.3 | 2.0 |
| Ceramic on PE (CoPE) | 13.5 | 12.8 | 13.3 | 14.2 | 14.8 | 16.0 | 14.1 |
| Metal on cross-linked PE (MoXLPE) | 15.4 | 13.3 | 11.8 | 11.7 | 10.9 | 9.5 | 12.0 |
| Ceramic on cross-linked PE (CoXLPE) | 52.4 | 55.4 | 57.4 | 57.2 | 57.0 | 58.0 | 56.3 |
| Metal on metal (MoM) | 0.03 | 0.05 | 0.05 | 0.01 | 0.00 | 0.00 | 0.02 |
| Ceramic on ceramic (CoC) | 16.1 | 16.1 | 15.2 | 14.8 | 15.1 | 15.1 | 15.4 |
| Other | 0.09 | 0.15 | 0.14 | 0.11 | 0.09 | 0.02 | 0.10 |
| | | | | | | | |
| N (bearing surface known) | 14,454 | 15,113 | 15,459 | 15,917 | 16,152 | 15,913 | 93,008 |
| N (bearing surface unknown) | 343 | 301 | 354 | 332 | 547 | 623 | 2,500 |

* Femoral heads and acetabular inserts/monobloc cups

Table 4.8

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

| | <45 | 45–54 | 55–64 | 65–74 | 75–84 | 85+ | All |
|---|---|---|---|---|---|---|---|
| Metal on polyethylene (MoPE) | 0.2 | 0.4 | 0.4 | 1.1 | 3.9 | 8.3 | 2.0 |
| Ceramic on polyethylene (CoPE) | 10.3 | 10.7 | 11.5 | 13.5 | 17.1 | 21.3 | 14.1 |
| Metal on cross-linked polyethylene (MoXLPE) | 10.8 | 9.7 | 10.2 | 11.7 | 13.7 | 17.8 | 12.0 |
| Ceramic on cross-linked polyethylene (CoXLPE) | 55.0 | 57.1 | 58.5 | 58.4 | 54.0 | 44.9 | 56.3 |
| Metal on metal (MoM) | 0.06 | 0.04 | 0.03 | 0.02 | 0.00 | 0.02 | 0.02 |
| Ceramic on ceramic (CoC) | 23.6 | 22.0 | 19.4 | 15.3 | 11.1 | 7.5 | 15.4 |
| Other | 0.06 | 0.04 | 0.04 | 0.10 | 0.15 | 0.21 | 0.10 |
| | | | | | | | |
| N (bearing surface known) | 1665 | 8224 | 20841 | 32078 | 24891 | 5300 | 92999 |
| N (bearing surface unknown)** | 59 | 164 | 447 | 814 | 771 | 245 | 2500 |

* Femoral heads and acetabular inserts/monobloc cups, ** please note that age is missing in 9 cases

whilst the use of CoC bearings remained relatively stable (Table 4.7). In 2.6% the bearing combination remained unknown due to gaps in the implant database that yet have to be filled.

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

Uncemented fixation is standard for primary THAs in primary OA in this registry and account for 86.9% of all hips with primary OA. SIRIS shows that more than 90% of patients under the age of 75 received uncemented prostheses. As age increases, more and more THAs were cemented. Approximately 40% of stems in patients older than 85 years of age were cemented. Female patients received 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 %)**

| | <45 | 45–54 | 55–64 | 65–74 | 75–84 | 85+ | All |
|---|---|---|---|---|---|---|---|
| All cemented | 0.3 | 0.3 | 0.3 | 0.7 | 2.3 | 6.6 | 1.3 |
| All uncemented | 95.9 | 97.1 | 95.8 | 90.8 | 77.0 | 57.2 | 86.9 |
| Hybrid** | 2.3 | 2.1 | 3.3 | 7.9 | 19.8 | 34.4 | 11.0 |
| Reverse hybrid*** | 1.4 | 0.3 | 0.4 | 0.4 | 0.6 | 1.3 | 0.5 |
| Reinforcement ring, femur cemented | 0.00 | 0.06 | 0.10 | 0.09 | 0.16 | 0.41 | 0.13 |
| Reinforcement ring, femur uncemented | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 |
| N | 1,724 | 8,388 | 21,288 | 32,892 | 25,662 | 5,545 | 95,499 |

* please note that age is missing in 9 cases

Table 4.10

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

| | Women | Men | All |
|---|---|---|---|
| All cemented | 1.9 | 0.8 | 1.3 |
| All uncemented | 82.2 | 91.9 | 86.9 |
| Hybrid** | 14.9 | 6.8 | 11.0 |
| Reverse hybrid*** | 0.7 | 0.3 | 0.5 |
| Reinforcement ring, femur cemented | 0.18 | 0.07 | 0.13 |
| Reinforcement ring, femur uncemented | 0.1 | 0.1 | 0.1 |
| N | 49,079 | 46,429 | 95,508 |

** acetabulum uncemented, femur cemented

*** acetabulum cemented, femur uncemented

## 4.2 Revision of total hip arthroplasty

SIRIS has been recording all primary and revision hip procedures since 2012. Some of the revisions were carried out on hip prostheses implanted before 2012. These are so-called "unlinked revisions" because we cannot link the revision procedure to a registered primary procedure. Revisions of primary implantations registered in SIRIS are termed "linked revisions". These form the basis for calculations of survival and first revision rates (see chapter 4.3). As explained above, a four-year moving window is used, allowing for the analysis of relatively current data with implants starting on 1.1.2015.

Table 4.11 shows the demographic data for all revisions performed since 2012, whether linked or unlinked. Revisions since 2015 constituted 11.6% of all hip procedures (the overall revision burden). Of the 15,123 THA revisions documented since 2015, 50.3% were performed on women (Table 4.11) with

Table 4.11
**Revision* of total hip arthroplasty: Baseline patient characteristics by year**

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| N | | **2,463** | **2,478** | **2,497** | **2,488** | **2,574** | **2,623** | **15,123** |
| Women [%] | | 49.0 | 52.1 | 49.7 | 51.0 | 51.5 | 48.6 | 50.3 |
| Mean age (SD) | All | 71.1 (12.1) | 70.8 (11.9) | 71.4 (11.9) | 71.9 (11.8) | 72.2 (11.5) | 72.0 (12.1) | 71.6 (11.9) |
| | Women | 73.2 (12.1) | 71.9 (11.9) | 72.8 (12.0) | 73.0 (12.1) | 73.6 (11.3) | 73.8 (11.9) | 73.1 (11.9) |
| | Men | 69.0 (11.8) | 69.6 (11.8) | 70.0 (11.7) | 70.7 (11.5) | 70.8 (11.6) | 70.2 (12.1) | 70.1 (11.8) |
| Age group [%] | ‹45 | 2.6 | 2.3 | 2.2 | 1.9 | 1.2 | 2.1 | 2.1 |
| | 45–55 | 6.8 | 8.0 | 7.8 | 7.6 | 6.2 | 7.0 | 7.2 |
| | 55–65 | 18.0 | 17.6 | 15.5 | 15.7 | 17.7 | 16.2 | 16.8 |
| | 65–75 | 29.8 | 30.9 | 30.4 | 29.4 | 28.3 | 26.8 | 29.2 |
| | 75–85 | 30.7 | 30.0 | 31.3 | 32.1 | 32.3 | 33.9 | 31.7 |
| | 85+ | 12.1 | 11.3 | 12.7 | 13.3 | 14.3 | 14.0 | 13.0 |
| N unknown BMI (%) | | 735 (30) | 498 (20) | 491 (20) | 480 (19) | 485 (19) | 434 (17) | 3,123 (21) |
| N known BMI | | 1,728 | 1,980 | 2,006 | 2,008 | 2,089 | 2,189 | 12,000 |
| Mean BMI (SD) | | 27.3 (5.4) | 27.6 (5.7) | 27.2 (5.5) | 27.3 (5.6) | 27.4 (7.1) | 27.5 (6.8) | 27.4 (6.1) |
| BMI [%] | ‹18.5 | 2.5 | 2.2 | 2.4 | 2.6 | 2.2 | 2.3 | 2.4 |
| | 18.5–24.9 | 34.9 | 32.7 | 36.2 | 34.3 | 37.0 | 33.9 | 34.8 |
| | 25–29.9 | 37.0 | 38.1 | 35.9 | 36.6 | 34.9 | 37.4 | 36.6 |
| | 30–34.9 | 16.8 | 17.9 | 17.6 | 17.9 | 16.6 | 16.7 | 17.3 |
| | 35–39.9 | 6.8 | 6.8 | 5.1 | 5.8 | 6.1 | 7.1 | 6.3 |
| | 40+ | 1.9 | 2.3 | 2.7 | 2.9 | 3.3 | 2.6 | 2.6 |
| N unknown ASA (%) | | 366 (15) | 292 (12) | 339 (14) | 255 (10) | 246 (10) | 225 (9) | 1,723 (11) |
| N known ASA | | 2097 | 2186 | 2158 | 2233 | 2328 | 2398 | 13400 |
| Morbidity state | ASA 1 | 8.9 | 7.3 | 6.5 | 6.1 | 4.3 | 4.2 | 6.2 |
| [%] | ASA 2 | 48.5 | 49.8 | 46.6 | 44.9 | 43.6 | 44.0 | 46.1 |
| | ASA 3 | 40.1 | 40.7 | 44.6 | 46.3 | 48.3 | 48.1 | 44.8 |
| | ASA 4/5 | 2.5 | 2.2 | 2.3 | 2.8 | 3.8 | 3.7 | 2.9 |

* includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report

the mean age at revision being 71.6 years. On average, men were three years younger than women when revised. The age group <45 years accounted for 2.1% and the age group between 45 and 54 for 7.2% of revisions. The relative share of revisions in patients younger than 54 declined slightly until 2019 and increased thereafter again. Of all revisions performed, approximatively 60% were in the group between 65 and 84 years of age.

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). Detailed information about the type of revision and fixation techniques is presented in Tables 4.13 and 4.15 and Figure 4.4.

The most frequently used approach was the posterior approach in 34% of cases (Table 4.14). The choice of the approach shifted slightly from the posterior approach to the anterior and anterolateral approach.

Table 4.12

**Reason for revision* of total hip arthroplasty**

Multiple responses possible (percentages do not sum to 100)
The reasons for revisions categories as listed below are only available from 2015 onwards

| | 2015–2020 | |
|---|---|---|
| | **N** | **%** |
| Loosening femoral | 3,222 | 21.3 |
| Infection | 2,992 | 19.8 |
| Loosening acetabular | 2,606 | 17.2 |
| Periprosthetic fracture | 2,519 | 16.7 |
| Dislocation | 1,699 | 11.2 |
| Wear | 933 | 6.2 |
| Metallosis | 738 | 4.9 |
| Acetabular osteolysis | 575 | 3.8 |
| Position/Orientation of cup | 573 | 3.8 |
| Femoral osteolysis | 520 | 3.4 |
| Trochanter pathology | 292 | 1.9 |
| Status after spacer | 318 | 2.1 |
| Implant breakage | 292 | 1.9 |
| Blood ion level | 261 | 1.7 |
| Position/Orientation of stem | 319 | 2.1 |
| Impingement | 242 | 1.6 |
| Acetabular protrusion | 188 | 1.2 |
| Squeaking | 85 | 0.6 |
| Other | 1,665 | 11.0 |
| **Total** | **20,039** | |

Table 4.13

**Type of revision* of total hip arthroplasty**

| | 2015–2020 | |
|---|---|---|
| | **N** | **%** |
| Exchange acetabular and femoral components | 2,860 | 18.9 |
| Exchange acetabular component and head | 3,064 | 20.3 |
| Exchange femoral component | 2,154 | 14.2 |
| Exchange head and inlay | 1,466 | 9.7 |
| Exchange acetabular component | 752 | 5.0 |
| Exchange femoral component and inlay | 1,296 | 8.6 |
| Component reimplantation (after spacer or Girdlestone) | 860 | 5.7 |
| Exchange head | 686 | 4.5 |
| Component removal, spacer implantation | 525 | 3.5 |
| Girdlestone | 195 | 1.3 |
| Exchange femoral component, inlay and osteosynthesis | 256 | 1.7 |
| Exchange inlay | 138 | 0.9 |
| Prosthesis preserving revision | 179 | 1.2 |
| Osteosynthesis | 166 | 1.1 |
| Other intervention | 526 | 3.5 |
| Total | **15,123** | **100.0** |

* includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report.

Figure 4.4

## Revision of total hip arthroplasty: Component fixation by year

Percentage per year

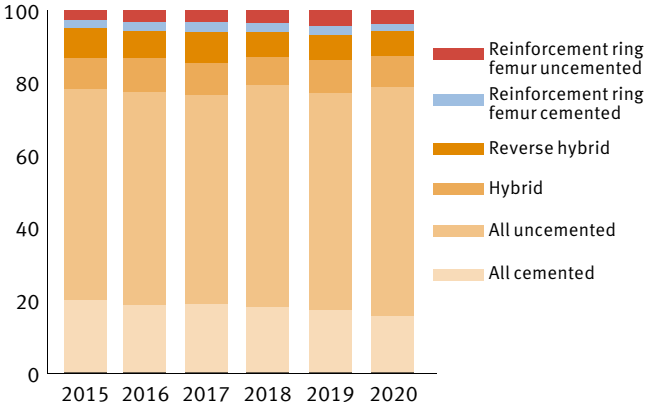



Table 4.14

## Approach of revision of total hip arthroplasty

| | 2015–2020 | |
|---|---|---|
| | N | % |
| Posterior | 5,108 | 33.9 |
| Lateral | 3,117 | 20.7 |
| Anterolateral | 2,530 | 16.8 |
| Anterior | 2,727 | 18.1 |
| Transfemoral | 935 | 6.2 |
| Other approach | 663 | 4.4 |

Table 4.15

## Revision of total hip arthroplasty: Component fixation by year

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 | |
|---|---|---|---|---|---|---|---|---|
| | N | N | N | N | N | N | N | % |
| Reinforcement ring femur uncemented | 57 | 68 | 65 | 70 | 85 | 77 | 365 | 3.7 |
| Reinforcement ring femur cemented | 39 | 52 | 53 | 48 | 54 | 41 | 248 | 2.5 |
| Reverse hybrid* | 162 | 143 | 166 | 134 | 135 | 137 | 715 | 7.3 |
| Hybrid** | 166 | 187 | 177 | 145 | 181 | 164 | 854 | 8.7 |
| All uncemented | 1,122 | 1,164 | 1,130 | 1,174 | 1,193 | 1,246 | 5,907 | 60.1 |
| All cemented | 389 | 374 | 371 | 347 | 343 | 308 | 1743 | 17.7 |
| Total | **1,935** | **1,988** | **1,962** | 1,918 | 1,991 | 1,973 | 9,832 | 100 |

* acetabulum cemented, femur uncemented = Reverse hybrid
** acetabulum uncemented, femur cemented = Hybrid

## 4.3 First revision of primary total hip arthroplasty

First revisions cover all revisions where the revision can be linked to a primary implantation registered in SIRIS and that occur for the first time (as opposed to a re-revision). We differentiate between early revisions within the first two years after implantation and revisions in the longer term, currently up to 8 years after implantation. For long term outcome, Kaplan-Meier (KM) survival estimations and cumulative revision rates were calculated.

For benchmarking, the two-year revision rate of an implant, hospital or surgeon was calculated for primary THA for the treatment of primary osteoarthritis (OA). 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.

Early revision rates were calculated for a moving four-year window. This includes the last four years with full two-year follow-up. For this report the data of implantations between 1.1.2015 and 31.12.2018

Table 4.16

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| | | Primary | Revised within 24 months | | | |
|---|---|---|---|---|---|---|
| | | | Revised | | 95% CI | |
| | | N at risk* | N | %** | lower | upper |
| Overall (moving average) | | 74,317 | 2,088 | 2.8 | 2.7 | 3.0 |
| Diagnosis | Primary OA | 62,272 | 1,613 | 2.6 | 2.5 | 2.7 |
| | Secondary OA | 7,138 | 252 | 3.6 | 3.2 | 4.1 |
| | Fracture | 4,907 | 223 | 4.8 | 4.2 | 5.4 |
| Overall Primary OA | | 62,272 | 1,613 | 2.6 | 2.5 | 2.7 |
| Gender | Women | 32,120 | 801 | 2.5 | 2.3 | 2.7 |
| | Men | 30,152 | 812 | 2.7 | 2.5 | 2.9 |
| Age group | ‹55 | 6,739 | 220 | 3.3 | 2.9 | 3.8 |
| | 55–64 | 13,794 | 347 | 2.5 | 2.3 | 2.8 |
| | 65–74 | 21,783 | 518 | 2.4 | 2.2 | 2.6 |
| | 75–84 | 16,427 | 436 | 2.7 | 2.4 | 2.9 |
| | 85+ | 3,521 | 92 | 2.7 | 2.2 | 3.2 |
| BMI group | ‹18.5 | 689 | 8 | 1.2 | 0.6 | 2.4 |
| | 18.5–24.9 | 16,738 | 334 | 2.0 | 1.8 | 2.2 |
| | 25–29.9 | 20,043 | 473 | 2.4 | 2.2 | 2.6 |
| | 30–34.9 | 9,089 | 287 | 3.2 | 2.8 | 3.6 |
| | 35–39.9 | 2,772 | 114 | 4.1 | 3.5 | 5.0 |
| | 40+ | 943 | 67 | 7.2 | 5.7 | 9.0 |
| | Unknown | 11,934 | 328 | 2.8 | 2.5 | 3.1 |
| Morbidity state | ASA 1 | 7,912 | 159 | 2.0 | 1.7 | 2.4 |
| | ASA 2 | 33,786 | 821 | 2.5 | 2.3 | 2.6 |
| | ASA 3 | 13,352 | 423 | 3.2 | 2.9 | 3.5 |
| | ASA 4/5 | 259 | 10 | 4.0 | 2.2 | 7.3 |
| | Unknown | 6,899 | 198 | 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.

were analysed with completed two-year follow-up until 31.12.2020. This practice 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 offers the possibility of comparing different periods of time and shows if there is improvement or deterioration over time. Kaplan-Meier survival estimates cover the entire run of the registry since 2012. Therefore, dual information is provided – the two-year revision rate in a four-year moving window – showing the performance of the last four years as well as the long-term results for some implants and numerous selections of data.

A revision is defined as any removal, addition or exchange of any prosthetic component. Of the 95,508 documented primary THAs for OA implanted since 2015, 62,272 were at risk within the four-year moving average, between 01.01.2015 and 31.12.2018, with two-year follow-up. Of these, 1,613 hips were revised accounting for a two-year revision rate of 2.6%. The risk of revision was higher in hips with secondary osteoarthritis (3.6%) and even higher in hips treated for fractures (4.8%) (Table 4.16).

The most common complication of primary THA was infection (24.7%), followed by periprosthetic fracture (18.4%), femoral loosening (18.2%), and dislocation (14.9%). Compared to the previous report periprosthetic fractures moved up on the list by one position (Table 4.17).

Across all stem fixation groups, the majority of revisions occurred during the first three months postoperatively, including high and early peaks of peri-

Table 4.17

**Reason for early first revision of primary total hip arthroplasty**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Early first revisions are those occurring within 2 years of the primary arthroplasty. Multiple responses possible (percentages do not sum to 100)

| | N | % |
|---|---|---|
| Infection | 398 | 24.7 |
| Periprosthetic fracture | 296 | 18.4 |
| Loosening femoral | 293 | 18.2 |
| Dislocation | 241 | 14.9 |
| Other | 170 | 10.5 |
| Loosening acetabular | 140 | 8.7 |
| Position/orientation of cup | 88 | 5.5 |
| Position/orientation of stem | 78 | 4.8 |
| Trochanter pathology | 22 | 1.4 |
| Impingement | 20 | 1.2 |
| Acetabular protrusion | 18 | 1.1 |
| Spacer | 15 | 0.9 |
| Implant failure | 12 | 0.7 |
| Osteolysis FE | 8 | 0.5 |
| Squeaking | 6 | 0.4 |
| Wear | 5 | 0.3 |
| Osteolysis AC | 5 | 0.3 |
| Metalosis | 3 | 0.2 |

Figure 4.5 a, b and c

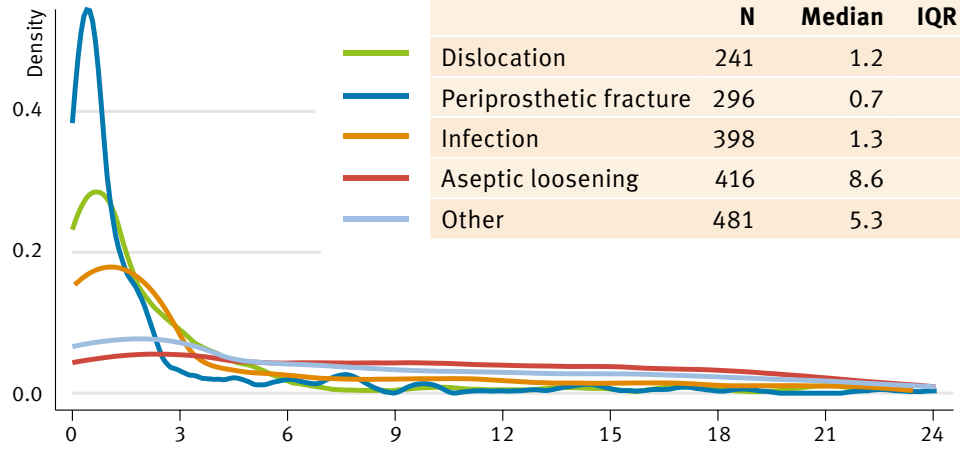
## Reason for early first revision by time interval since primary total hip arthroplasty

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Early first revisions are those occurring within 2 years of the primary arthroplasty

Figure a

**All revisions**

**(N= 1613)**

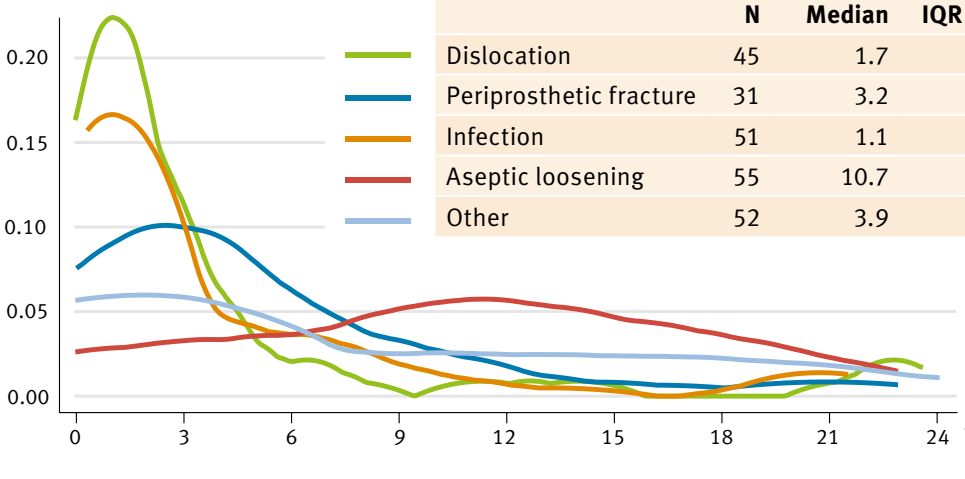



| | N | Median | IQR 25% | IQR 75% |
|---|---|---|---|---|
| Dislocation | 241 | 1.2 | 0.5 | 3.2 |
| Periprosthetic fracture | 296 | 0.7 | 0.3 | 1.8 |
| Infection | 398 | 1.3 | 0.7 | 6.4 |
| Aseptic loosening | 416 | 8.6 | 2.9 | 15.1 |
| Other | 481 | 5.3 | 0.9 | 13.0 |

Figure b

**Revisions femur cemented only**

**(N= 202)**

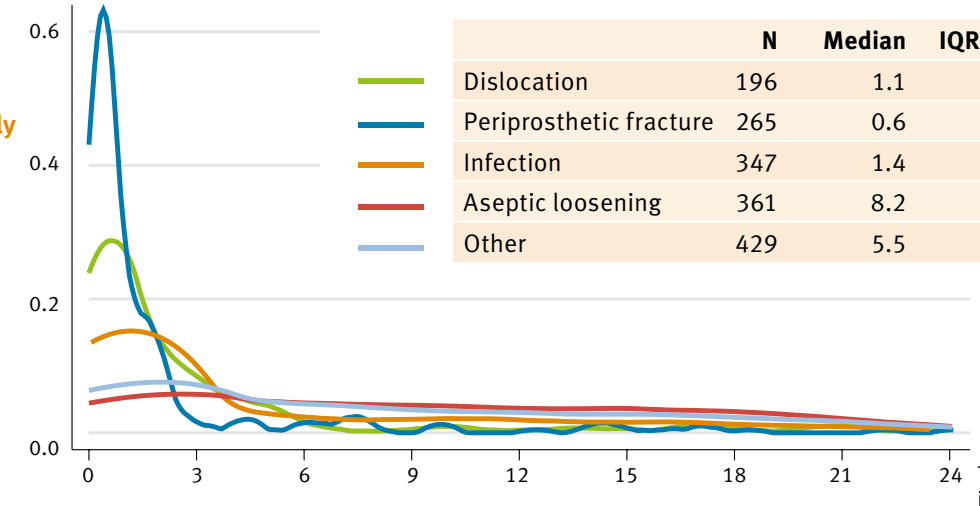



| | N | Median | IQR 25% | IQR 75% |
|---|---|---|---|---|
| Dislocation | 45 | 1.7 | 0.6 | 3.3 |
| Periprosthetic fracture | 31 | 3.2 | 1.3 | 7.7 |
| Infection | 51 | 1.1 | 0.7 | 5.1 |
| Aseptic loosening | 55 | 10.7 | 6.9 | 15.3 |
| Other | 52 | 3.9 | 0.4 | 12.7 |

Figure c

**Revisions femur uncemented only**

**(N= 1411)**




| | N | Median | IQR 25% | IQR 75% |
|---|---|---|---|---|
| Dislocation | 196 | 1.1 | 0.4 | 3.1 |
| Periprosthetic fracture | 265 | 0.6 | 0.3 | 1.6 |
| Infection | 347 | 1.4 | 0.7 | 7.4 |
| Aseptic loosening | 361 | 8.2 | 2.6 | 15.0 |
| Other | 429 | 5.5 | 1.2 | 13.0 |

prosthetic fractures and dislocations. Although infection and aseptic loosing were more frequent complications, their curves were flatter but remained 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 respectively. For cemented stems, dislocation was an early complication, but all other curves were flatter. Periprosthetic fractures occurred early on overall, but this depends entirely on their high peak in hips with uncemented stems.

Table 4.18 gives an overview of the revision rates depending on stem fixation, bearing and approach. The two-year revision rate is on average 2.6%. Parameters that are above average include all cemented fixation techniques (3.2%), metal on PE (3.5%), metal on XLPE (2.8%) and, ceramic on ceramic bearings (2.8%) and the use of a posterior approach. The highest two-years revision rate is attributed to approaches not defined as one of the standard approaches (other 5.0%)

The revision rate was lowest for the combination of ceramic heads with highly crosslinked polyeth-

Table 4.18

**First revision of primary total hip arthroplasty within 24 months according to stem fixation, bearing surface and approach**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

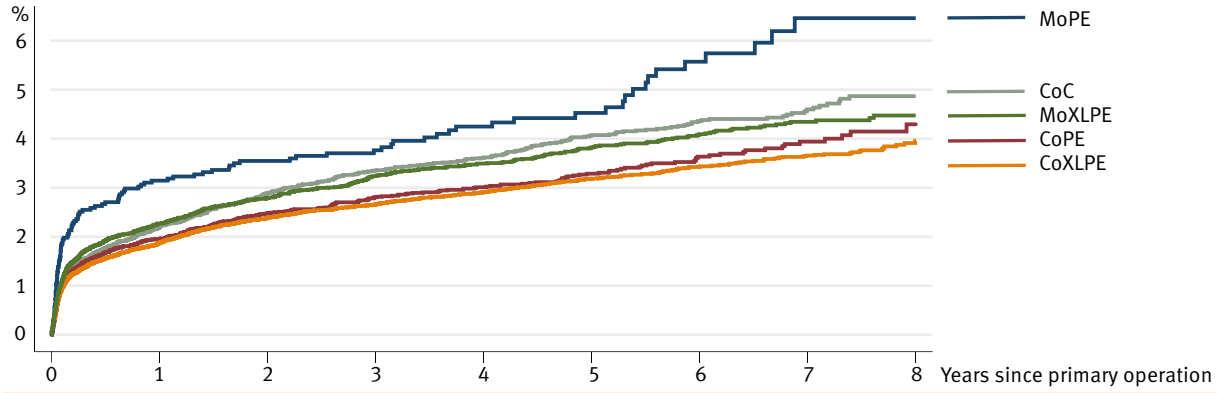
| | | Revised | | 95% CI | |
|---|---|---|---|---|---|
| | N at risk* | N | %** | lower | upper |
| Overall Primary OA (moving average) | 62,272 | 1,613 | 2.6 | 2.5 | 2.7 |
| **Stem fixation** | | | | | |
| All cemented | 941 | 30 | 3.2 | 2.3 | 4.6 |
| All uncemented | 53,968 | 1,390 | 2.6 | 2.5 | 2.7 |
| Hybrid | 7,222 | 182 | 2.6 | 2.2 | 3.0 |
| **Bearing surface** | | | | | |
| Metal on polyethylene (MoPE) | 1,341 | 46 | 3.5 | 2.6 | 4.6 |
| Ceramic on polyethylene (CoPE) | 8,206 | 210 | 2.6 | 2.3 | 3.0 |
| Metal on cross-linked polyethylene (MoXLPE) | 7,910 | 220 | 2.8 | 2.5 | 3.2 |
| Ceramic on cross-linked polyethylene (CoXLPE) | 33,918 | 826 | 2.5 | 2.3 | 2.6 |
| Ceramic on ceramic (CoC) | 9,473 | 263 | 2.8 | 2.5 | 3.2 |
| **Approach** | | | | | |
| Anterior | 28,514 | 709 | 2.5 | 2.3 | 2.7 |
| Anterolateral | 20,331 | 516 | 2.6 | 2.4 | 2.8 |
| Lateral | 4,035 | 77 | 1.9 | 1.6 | 2.4 |
| Posterior | 8,856 | 286 | 3.3 | 2.9 | 3.6 |
| Other approach | 472 | 23 | 5.0 | 3.3 | 7.4 |

* 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 4.6 a

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

Time since operation, 2012–2020, all services, diagnosis primary OA



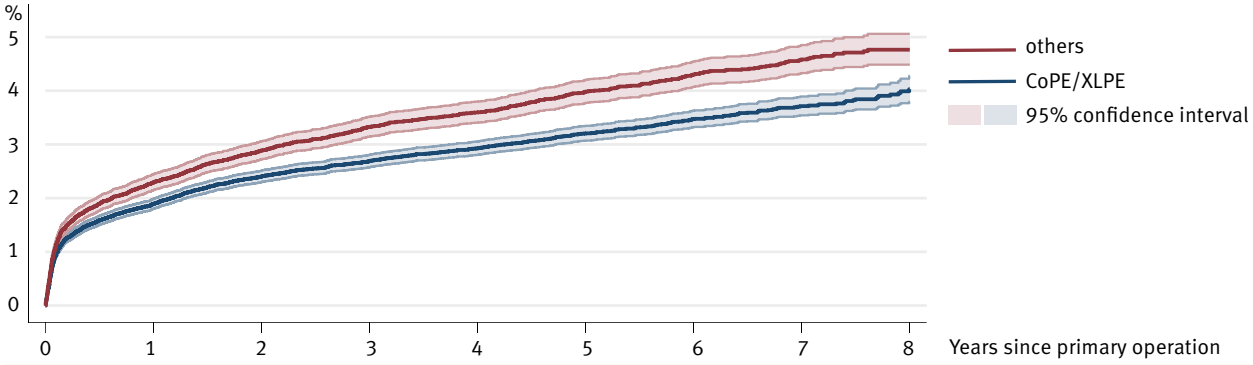

### Estimated cumulative revision rate

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| MoPE | **3.2** (2.6–3.9) | **3.6** (2.9–4.4) | **3.8** (3.1–4.6) | **4.3** (3.5–5.2) | **4.6** (3.8–5.5) | **5.6** (4.6–6.9) | **6.5** (5.2–8.1) | **6.5** (5.2–8.1) |
| CoPE | **2.0** (1.8–2.2) | **2.5** (2.2–2.7) | **2.8** (2.6–3.1) | **3.0** (2.7–3.3) | **3.3** (3.0–3.6) | **3.6** (3.3–4.0) | **3.9** (3.5–4.4) | **4.3** (3.8–4.9) |
| MoXLPE | **2.3** (2.1–2.5) | **2.8** (2.6–3.0) | **3.2** (3.0–3.5) | **3.5** (3.2–3.8) | **3.8** (3.5–4.1) | **4.1** (3.8–4.4) | **4.3** (4.0–4.7) | **4.5** (4.1–4.9) |
| CoXLPE | **1.9** (1.8–2.0) | **2.4** (2.3–2.5) | **2.7** (2.5–2.8) | **2.9** (2.8–3.1) | **3.2** (3.0–3.3) | **3.4** (3.3–3.6) | **3.7** (3.5–3.9) | **4.0** (3.7–4.2) |
| CoC | **2.2** (2.0–2.4) | **2.9** (2.6–3.1) | **3.3** (3.1–3.6) | **3.6** (3.3–3.9) | **4.1** (3.8–4.4) | **4.3** (4.0–4.7) | **4.6** (4.2–5.0) | **4.9** (4.4–5.3) |

Figure 4.6b

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

Time since operation, 2012–2020, all services, diagnosis primary OA




### Estimated cumulative revision rate

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| CoPE/XLPE | **1.9** (1.8-2.0) | **2.4** (2.3-2.5) | **2.7** (2.6-2.8) | **2.9** (2.8-3.1) | **3.2** (3.1-3.3) | **3.5** (3.3-3.6) | **3.7** (3.5-3.9) | **4.0** (3.8-4.3) |
| others | **2.3** (2.1-2.4) | **2.9** (2.7-3.1) | **3.3** (3.1-3.5) | **3.6** (3.4-3.8) | **4.0** (3.8-4.2) | **4.3** (4.1-4.5) | **4.6** (4.3-4.8) | **4.8** (4.5-5.1) |

Figure 4.7a

**Cumulative incidence rates for different first revision diagnoses (primary OA THA)**

Time since operation, 2012–2020, all services, % of implants revised

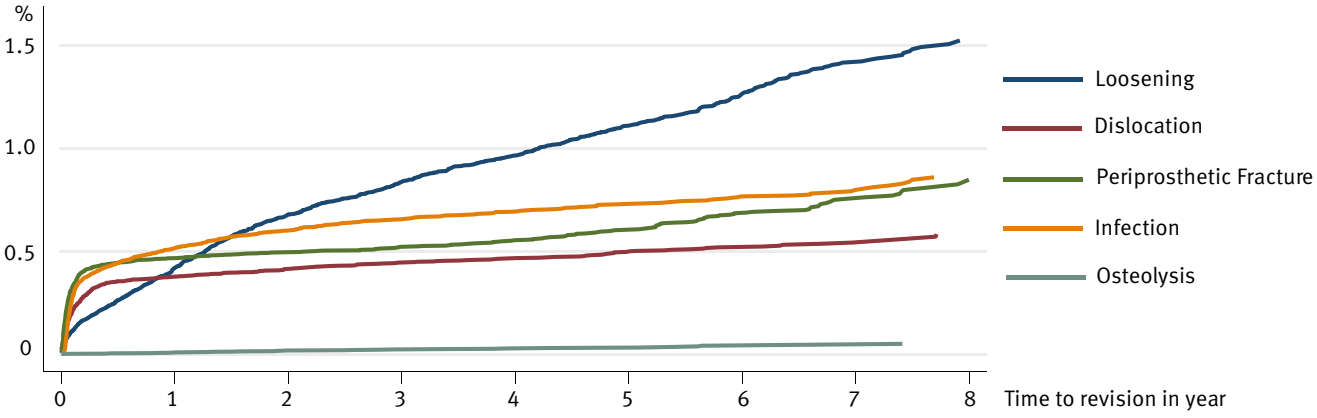



Figure 4.7b

**Cumulative incidence rates for different first revision diagnoses - primary OA THA (cemented femur)** Time since operation, 2012–2020, all services, % of implants revised

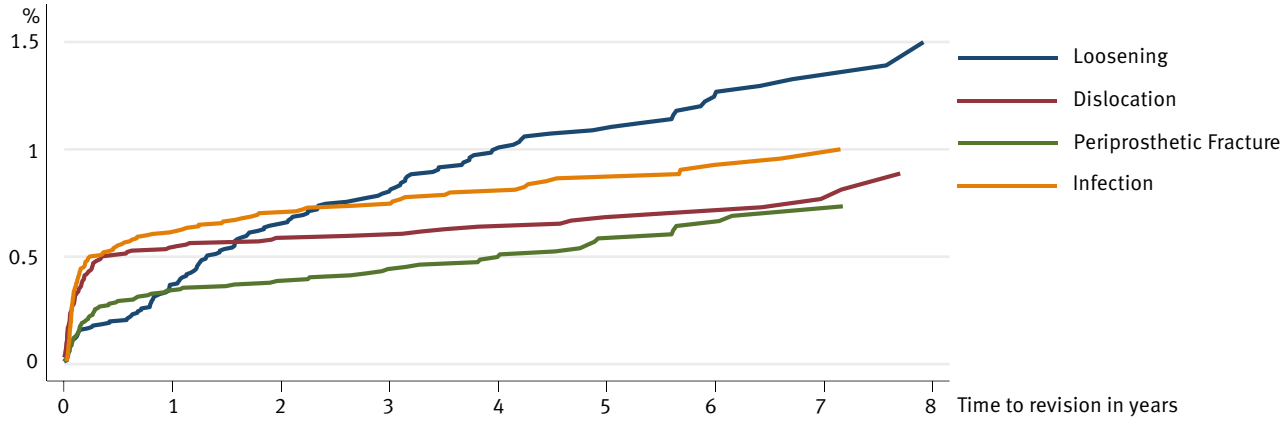
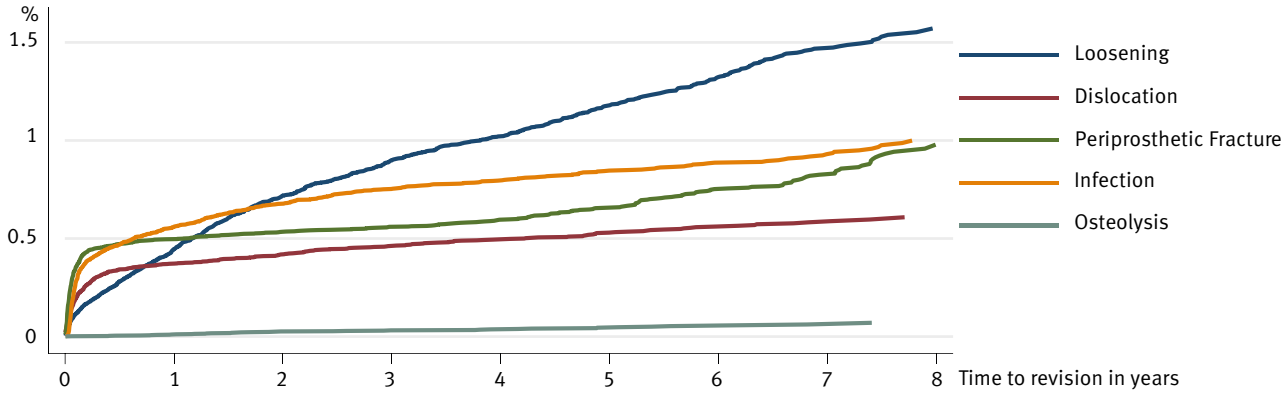



Figure 4.7c

**Cumulative incidence rates for different first revision diagnoses - primary OA THA (uncemented femur)** Time since operation, 2012–2020, all services, % of implants revised



ylene (CoXLPE) (2.5%) followed by normal polyethylene (CoPE) (2.6%) after two years (Table 4.18). At eight years, the estimated cumulative revision rate for ceramic on highly crosslinked PE (CoXLPE) had the lowest revision rate of 4% (95% CI 3.7–4.2). The highest revision rate was found for Metal on PE (MoPE) of 6.5% (95% CI 5.2–8.1). MoPE revisions showed a steep increase after 5 years, even though this result may not be fully generalisable due to relatively small numbers at risk (Figure 4.6).

Cumulative incidence figures (Figure 4.7a–c) show the proportion of implants having experienced a first 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 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.

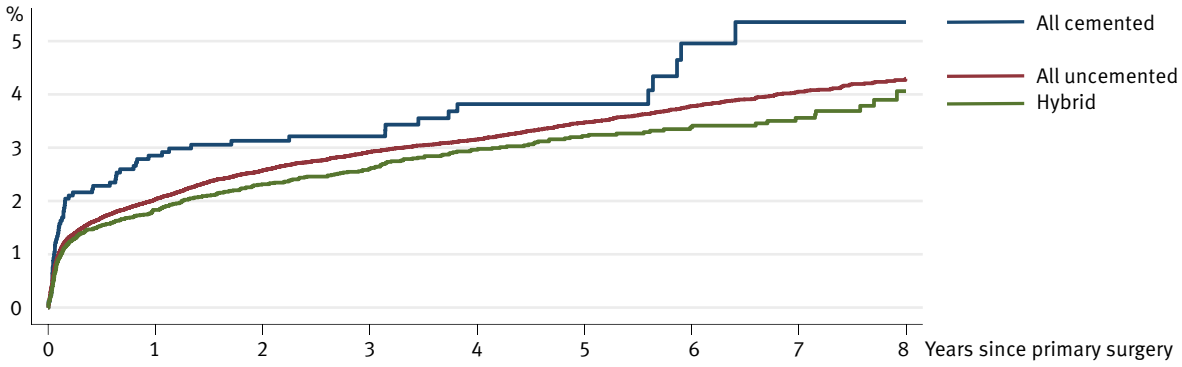
The fixation method was associated with the revision rate (Figure 4.8 and 4.9). Hybrid fixation showed fewer revisions (4.1%, 95% CI 3.5–4.7) than uncemented (4.3%, 95% CI 4.1–4.5) or all cemented THA (5.4%, 95% CI 3.9–7.3) at eight years. However, direct comparison of hybrid and uncemented reveals that in terms of statistical significance the result at eight years is inconclusive, although the revision burden for hybrid fixation tends to run below the of uncemented fixation for much of the observation time.

BMI, on the other hand, has a very clear impact on the risk of revision (Table 4.16, Figures 4.10 and 4.11). Revision rates rose with increasing BMI. The two-year revision rate for patients with BMI ›40 was 6.5% (95% CI 5.3–7.9). This is more than three times higher than in normal weight patients. The majori-

Figure 4.8

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

Time since operation, 2012–2020, all services, diagnosis primary OA



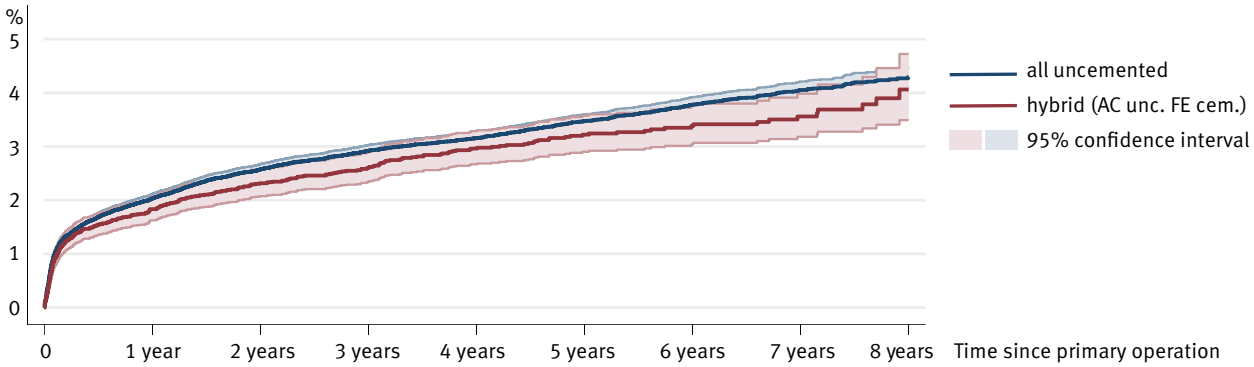

**Estimated cumulative revision rate**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| All cemented | **2.9** (2.2-3.8) | **3.1** (2.4-4.1) | **3.2** (2.5-4.2) | **3.8** (2.9-5.0) | **3.8** (2.9-5.0) | **5.0** (3.7-6.7) | **5.4** (3.9-7.3) | **5.4** (3.9-7.3) |
| All uncemented | **2.0** (2.0-2.1) | **2.6** (2.5-2.7) | **2.9** (2.8-3.0) | **3.2** (3.0-3.3) | **3.5** (3.4-3.6) | **3.8** (3.6-3.9) | **4.1** (3.9-4.2) | **4.3** (4.1-4.5) |
| Hybrid (AC unc. FE cem.) | **1.8** (1.6-2.1) | **2.3** (2.1-2.6) | **2.6** (2.3-2.9) | **3.0** (2.7-3.3) | **3.2** (2.9-3.6) | **3.4** (3.0-3.8) | **3.6** (3.2-4.0) | **4.1** (3.5-4.7) |

Figure 4.9

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

Time since operation, 2012–2020, all services, diagnosis primary OA



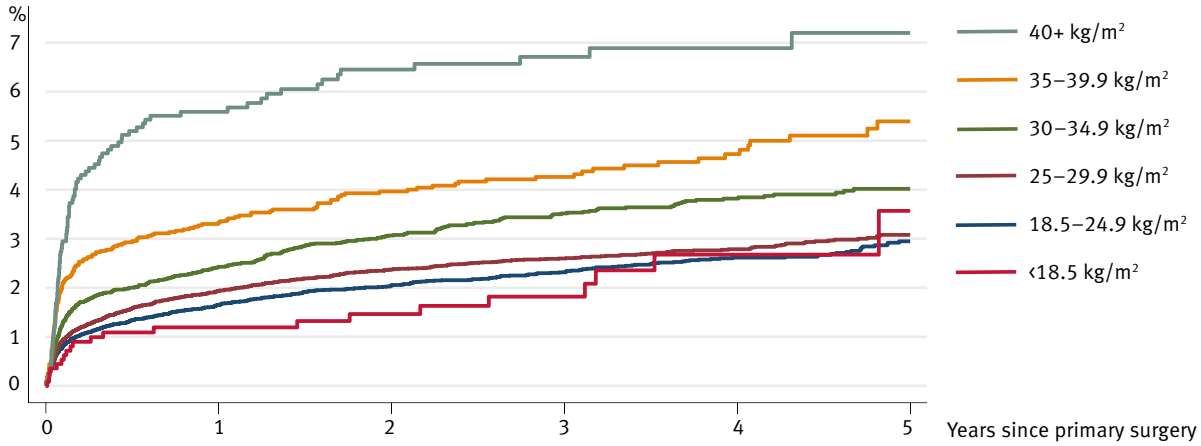

**Estimated cumulative revision rate**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| All uncemented | **2.0** (2.0-2.1) | **2.6** (2.5-2.7) | **2.9** (2.8-3.0) | **3.2** (3.0-3.3) | **3.5** (3.4-3.6) | **3.8** (3.6-3.9) | **4.1** (3.9-4.2) | **4.3** (4.1-4.5) |
| Hybrid (AC unc. FE cem.) | **1.8** (1.6-2.1) | **2.3** (2.1-2.6) | **2.6** (2.3-2.9) | **3.0** (2.7-3.3) | **3.2** (2.9-3.6) | **3.4** (3.0-3.8) | **3.6** (3.2-4.0) | **4.1** (3.5-4.7) |

Figure 4.10

## Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2020, all services, diagnosis primary OA



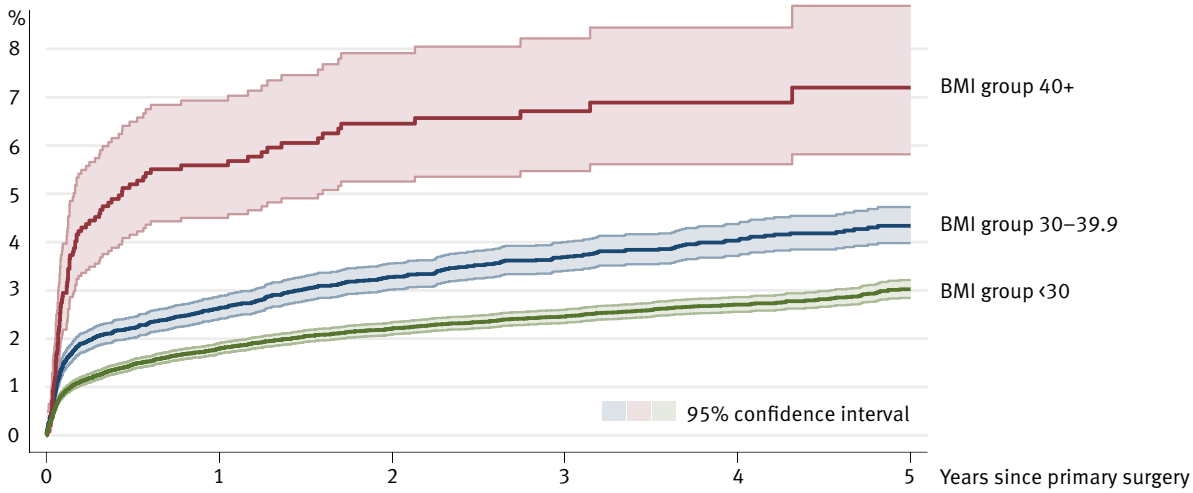

**Estimated cumulative revision rate**

| kg/m² | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| ‹18.5 | **1.2** (0.7–2.0) | **1.5** (0.9–2.4) | **1.8** (1.1–3.0) | **2.7** (1.6–4.4) | **3.6** (1.9–6.5) |
| 18.5–24.9 | **1.7** (1.5–1.8) | **2.0** (1.9–2.2) | **2.3** (2.1–2.5) | **2.6** (2.4–2.9) | **2.9** (2.7–3.2) |
| 25–29.9 | **1.9** (1.8–2.1) | **2.4** (2.2–2.6) | **2.6** (2.4–2.8) | **2.8** (2.6–3.0) | **3.1** (2.8–3.3) |
| 30–34.9 | **2.4** (2.2–2.7) | **3.1** (2.8–3.4) | **3.5** (3.2–3.9) | **3.8** (3.5–4.2) | **4.0** (3.6–4.4) |
| 35–39.9 | **3.3** (2.8–3.9) | **4.0** (3.4–4.6) | **4.3** (3.7–5.0) | **4.7** (4.0–5.5) | **5.4** (4.6–6.4) |
| 40+ | **5.6** (4.5–6.9) | **6.5** (5.3–7.9) | **6.7** (5.5–8.2) | **6.9** (5.6–8.4) | **7.2** (5.8–8.9) |

Figure 4.11

## Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2020, all services, diagnosis primary OA




| Estimated cumulative revision rate | | | | | |
|---|---|---|---|---|---|
| kg/m² | 1 year | 2 years | 3 years | 4 years | 5 years |
| <30 | **1.8** (1.7–1.9) | **2.2** (2.1–2.3) | **2.5** (2.3–2.6) | **2.7** (2.6–2.9) | **3.0** (2.8–3.2) |
| 30–39.9 | **2.6** (2.4–2.9) | **3.3** (3.0–3.6) | **3.7** (3.4–4.0) | **4.0** (3.7–4.4) | **4.3** (4.0–4.7) |
| 40+ | **5.6** (4.5–6.9) | **6.5** (5.3–7.9) | **6.7** (5.5–8.2) | **6.9** (5.6–8.4) | **7.2** (5.8–8.9) |

ty of complications occurred within the first two to three months. The most frequent complication in patients with high BMI is infection that accounts for up to one third of all complications in this population (Table 4.19). This is then followed by periprosthetic fracture, femoral loosening and dislocation. Compared to the overall complications, only infections were clearly more frequent, periprosthetic fractures and dislocations were roughly the same and femoral and acetabular loosening being less frequent.

Table 4.19

**Reason for early first revision of primary total hip arthroplasty (different levels of BMI)**

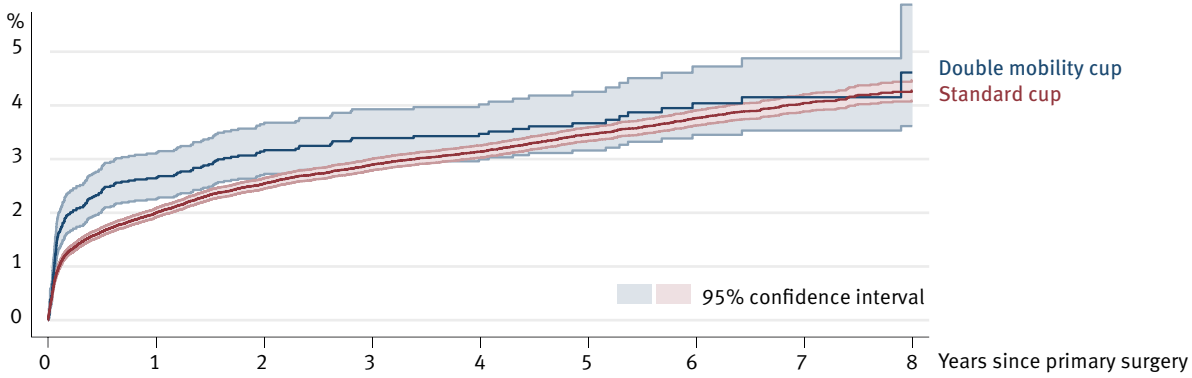
4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Early first revisions are those occurring within 2 years of the primary arthroplasty.
Multiple responses possible (percentages do not sum to 100).

| | BMI <35 | | BMI 35–39.9 | | BMI 40+ | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Loosening femoral | 210 | 19.1 | 18 | 15.8 | 9 | 13.4 |
| Infection | 240 | 21.8 | 41 | 36.0 | 24 | 35.8 |
| Loosening acetabular | 101 | 9.2 | 6 | 5.3 | 3 | 4.5 |
| Periprosthetic fracture | 204 | 18.5 | 19 | 16.7 | 12 | 17.9 |
| Dislocation/instability | 172 | 15.6 | 18 | 15.8 | 11 | 16.4 |
| Wear | 3 | 0.3 | 0 | 0.0 | 0 | 0.0 |
| Metalosis | 3 | 0.3 | 0 | 0.0 | 0 | 0.0 |
| Osteolysis AC | 2 | 0.2 | 0 | 0.0 | 0 | 0.0 |
| Position/orientation of cup | 62 | 5.6 | 4 | 3.5 | 6 | 9.0 |
| Osteolysis FE | 7 | 0.6 | 1 | 0.9 | 0 | 0.0 |
| Trochanter pathology | 16 | 1.5 | 2 | 1.8 | 0 | 0.0 |
| Spacer | 10 | 0.9 | 1 | 0.9 | 2 | 3.0 |
| Implant failure | 8 | 0.7 | 0 | 0.0 | 1 | 1.5 |
| Ion blood level | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Position/orientation of stem | 56 | 5.1 | 5 | 4.4 | 3 | 4.5 |
| Impingement | 15 | 1.4 | 2 | 1.8 | 1 | 1.5 |
| Acetabular protrusion | 11 | 1.0 | 0 | 0.0 | 0 | 0.0 |
| Squeaking | 5 | 0.5 | 0 | 0.0 | 0 | 0.0 |
| Other | 113 | 10.3 | 9 | 7.9 | 7 | 10.4 |

Figure 4.12

## Estimated failure rates of primary total hip arthroplasty for different types of cups (primary OA & all uncemented fixation)

Time since operation, 2012–2020, all services, diagnosis primary OA



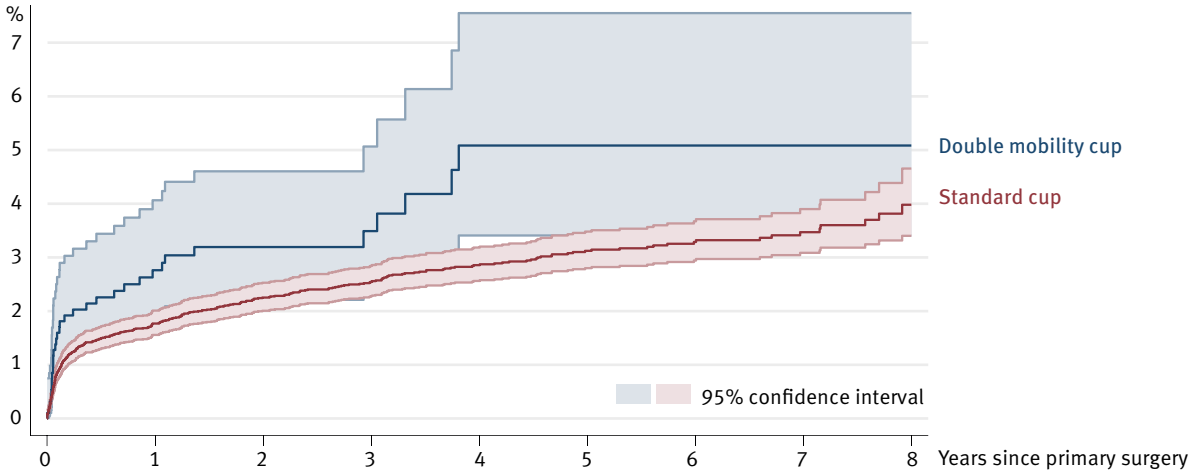

**Estimated cumulative revision rate**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| 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** (3.3-3.5) | **3.7** (3.6-3.8) | **4.0** (3.8-4.1) | **4.2** (4.0-4.4) |
| Double mobility cup | **2.6** (2.2-3.1) | **3.1** (2.7-3.6) | **3.4** (2.9-3.9) | **3.4** (3.0-4.0) | **3.6** (3.1-4.2) | **4.0** (3.4-4.7) | **4.0** (3.4-4.7) | **4.5** (3.5-5.7) |

Figure 4.13

## Estimated failure rates of primary total hip arthroplasty for different types of cups (primary OA & hybrid fixation)

Time since operation, 2012–2020, all services, diagnosis primary OA




**Estimated cumulative revision rate**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Standard cup | **1.8** (1.6–2.0) | **2.2** (2.0–2.5) | **2.5** (2.3–2.8) | **2.8** (2.5–3.2) | **3.1** (2.8–3.4) | **3.2** (2.9–3.6) | **3.4** (3.0–3.8) | **3.9** (3.4–4.6) |
| Double mobility cup | **2.8** (1.9–4.1) | **3.2** (2.2–4.6) | **3.5** (2.4–5.0) | **5.1** (3.4–7.5) | **5.1** (3.4–7.5) | **5.1** (3.4–7.5) | **5.1** (3.4–7.5) | **5.1** (3.4–7.5) |

**Double mobility cups**

To analyse subgroups reliably, a certain number of "at risk" patients are necessary to get correct and meaningful information. The current number of double mobility cups, also known as dual mobility cups, allows for a comparison against standard cups. 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 was no difference between a standard acetabular cup and a double mobility cup in the medium to long run, as long as an uncemented stem was used (Figure 4.12). For both cup types the revision rate at seven years was 4%. At eight years there were slightly more revisions of double mobility cups. However, the confidence intervals overlap, indicating no statistical difference. Hybrid fixation, however, had for all time periods a higher revision rate. Please consider the confidence intervals (Figure 4.13).

**Revision of first revision**

What is the revision risk after a first revision? To assess the re-revision rate in Switzerland and to analyse the particularities of Swiss management a separate analysis was conducted. For this analysis only the most important reasons for revisions were used, covering 76.2% of all revisions (infection, periprosthetic fracture, femoral loosening, dislocation). The re-revisions of stems and cups were analysed separately. The re-revision rate was much higher than the first revision rate after primary THA in primary OA and reached approx. 10% after two years (Figure 4.16). The curve of the uncemented revision stems flattened and reached 11.9% at eight years. Revisions with cemented primary stems and cups had the highest re-revision rate (up to 21.9% after eight years). However, note that CI are wide and spread out to right side of the curves. Also, the influence of competing risks rises with the age of the patients with time. Differences may therefore not be considered statistically significant given the numbers available for analysis. The use of uncemented primary cups was associated with the lowest re-revision rate, followed by revisions with acetabular cages.

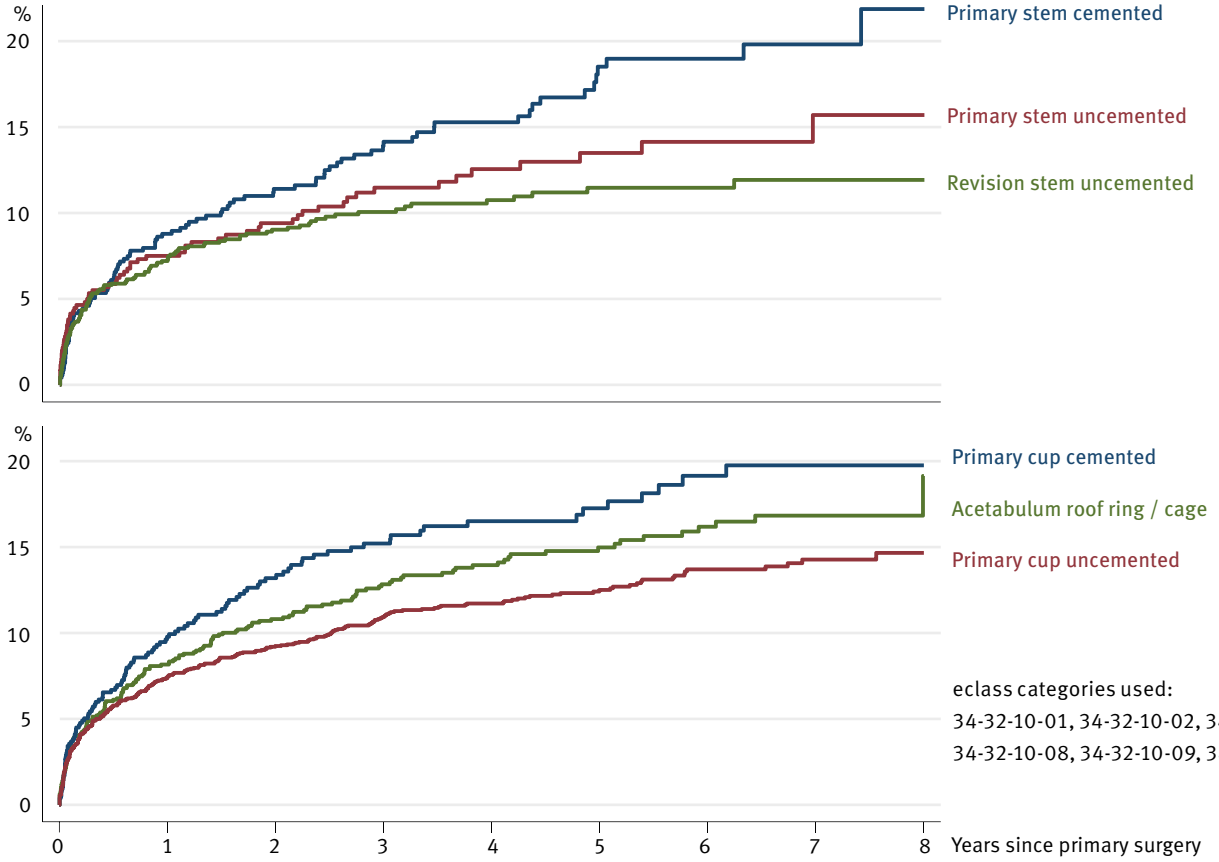
The implants classes used for revisions are shown in Table 4.20. Particularly in younger patients, primary stems and even short stems seemed to be the implants of choice. In contrast, uncemented revision stems were more often used in the elderly and for the revision of situations after spacer use. Cemented revision stems were rarely used.

Uncemented primary cups were used for the majority of revisions of the acetabulum. Table 4.21 provides an overview of the main implants (n=50+) used in first re-revisions.

Figure 4.14

## Estimated re-revision rates after four main types of hip revisions (AC/FE, FE, AC, component reimplantation): comparing main types of implants

Start point of analysis: first registered component revision in SIRIS that belongs to four main types 2012–2020 with at least one FE/AC revision component with a known e-class. End point of analysis: next registered component revision.




| Est. cumulative rev. rate | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Primary stem cem. | **8.8** (6.9-11.2) | **11.4** (9.2-14.2) | **14.1** (11.5-17.3) | **15.3** (12.5-18.6) | **18.5** (15.2-22.5) | **19.0** (15.5-23.1) | **19.8** (16.1-24.2) | **21.9** (16.9-28.1) |
| Primary stem uncem. | **7.5** (5.6-10.0) | **9.4** (7.3-12.2) | **11.5** (9.0-14.6) | **12.6** (9.9-15.9) | **13.5** (10.6-17.1) | **14.1** (11.1-18.0) | **15.7** (11.7-20.9) | **15.7** (11.7-20.9) |
| Rev. stem uncem. | **7.4** (6.1-9.0) | **9.0** (7.5-10.8) | **10.1** (8.4-12.0) | **10.8** (9.0-12.8) | **11.5** (9.6-13.7) | **11.5** (9.6-13.7) | **11.9** (9.9-14.3) | **11.9** (9.9-14.3) |
| Primary cup cem. | **9.8** (7.8-12.2) | **13.2** (10.9-16.0) | **15.2** (12.6-18.2) | **16.5** (13.8-19.7) | **17.3** (14.4-20.6) | **19.1** (15.9-23.0) | **19.8** (16.3-23.8) | **19.8** (16.3-23.8) |
| Primary cup uncem. | **7.4** (6.5-8.5) | **9.2** (8.2-10.4) | **10.9** (9.8-12.2) | **11.7** (10.5-13.1) | **12.5** (11.2-13.9) | **13.7** (12.3-15.3) | **14.3** (12.7-16.0) | **14.7** (13.0-16.6) |
| AC rr/cage | **8.2** (6.8-9.8) | **10.8** (9.2-12.7) | **12.8** (11.0-14.9) | **14.0** (12.0-16.2) | **15.0** (12.9-17.4) | **16.2** (13.9-18.8) | **16.8** (14.4-19.6) | **19.1** (14.6-24.9) |

Table 4.20

## Hip revision: main components used by age at revision

All registered component revisions of four main types 2015–2020 with at least one FE/AC revision component with a known e-class

| Type of revision | E-class category* | Age at revision | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Femoral components** | of implant | <45 | 45-54 | 55-64 | 65-74 | 75-84 | 85+ | N |
| AC + FE revision | cem. primary stems | 12.7 | 13.6 | 14.9 | 18.9 | 27.6 | 36.4 | 650 |
| | uncem. primary stems | 54.0 | 42.6 | 35.3 | 23.3 | 15.6 | 8.4 | 693 |
| | short stems | 11.1 | 2.1 | 2.9 | 1.9 | 1.4 | 0.9 | 59 |
| | cem. revision stems | 1.6 | 0.0 | 1.2 | 2.0 | 2.6 | 3.9 | 61 |
| | uncem. revision stems | 20.6 | 41.7 | 45.7 | 54.0 | 52.8 | 50.5 | 1,466 |
| FE revision (with or without inlay) | cem. primary stems | 17.0 | 21.8 | 23.3 | 24.2 | 26.6 | 30.1 | 943 |
| | uncem. primary stems | 45.8 | 41.7 | 34.6 | 20.0 | 10.3 | 3.1 | 644 |
| | short stems | 6.8 | 4.7 | 4.5 | 2.5 | 1.7 | 0.5 | 87 |
| | cem. revision stems | 0.0 | 0.5 | 1.3 | 1.0 | 2.2 | 2.8 | 63 |
| | uncem. revision stems | 30.5 | 31.3 | 36.3 | 52.3 | 59.2 | 63.5 | 1,937 |
| Component reimplantation (after spacer) | cem. primary stems | 6.9 | 10.4 | 13.6 | 12.6 | 21.8 | 24.6 | 144 |
| | uncem. primary stems | 37.9 | 27.3 | 28.3 | 24.6 | 19.8 | 5.3 | 214 |
| | short stems | 3.5 | 3.9 | 1.1 | 0.0 | 1.6 | 0.0 | 10 |
| | cem. revision stems | 3.5 | 0.0 | 0.5 | 1.7 | 1.2 | 1.8 | 11 |
| | uncem. revision stems | 48.3 | 58.4 | 56.5 | 61.1 | 55.6 | 68.4 | 533 |
| **Acetabular components** | | | | | | | | |
| AC + FE revision | cem. primary cups | 16.4 | 18.0 | 19.2 | 24.8 | 33.8 | 39.5 | 901 |
| | uncem. primary cups | 61.6 | 64.8 | 60.7 | 52.0 | 40.3 | 36.0 | 1,604 |
| | revision cups | 4.1 | 4.8 | 5.8 | 4.8 | 3.4 | 2.4 | 139 |
| | AC roof ring or cage | 17.8 | 12.4 | 14.3 | 18.4 | 22.5 | 22.1 | 617 |
| AC revision (with or without head) | cem. primary cups | 20.0 | 24.5 | 23.6 | 32.0 | 36.4 | 45.8 | 1,484 |
| | uncem. primary cups | 62.7 | 57.8 | 54.5 | 42.6 | 36.6 | 24.4 | 1,836 |
| | revision cups | 2.7 | 3.6 | 4.9 | 5.5 | 4.9 | 5.8 | 225 |
| | AC roof ring or cage | 14.7 | 14.2 | 17.0 | 19.9 | 22.2 | 24.1 | 905 |
| Component reimplantation (after spacer) | cem. primary cups | 16.1 | 24.1 | 21.7 | 23.3 | 26.5 | 36.1 | 250 |
| | uncem. primary cups | 64.5 | 55.7 | 59.9 | 56.2 | 52.2 | 34.7 | 554 |
| | revision cups | 3.2 | 2.5 | 3.3 | 3.0 | 4.1 | 1.4 | 33 |
| | AC roof ring or cage | 16.1 | 17.7 | 15.1 | 17.5 | 17.2 | 27.8 | 179 |

* E-class categories used: 34-32-10-01, 34-32-10-02, 34-32-10-03, 34-32-10-05, 34-32-10-06, 34-32-10-08, 34-32-10-09, 34-32-10-10, 34-32-10-11

Table 4.21

## Hip revision: main femoral and acetabular components used by age at revision

All registered component revisions of four main types 2015–2020 with at least one FE/AC revision component with a known e-class.

| E-class category* of implant | Main brands (50+) | N |
|---|---|---|
| **Cem. primary stems** | SPII Lubinus | 328 |
| | Weber | 292 |
| | Quadra | 222 |
| | Centris | 212 |
| | Amistem | 160 |
| | Twinsys | 147 |
| | Corail | 131 |
| | Avenir | 69 |
| | Exafit | 51 |
| **Uncem. primary stems** | Corail | 406 |
| | Quadra | 271 |
| | Polarstem | 193 |
| | CLS | 189 |
| | Avenir | 143 |
| | Stellaris | 102 |
| | Twinsys | 68 |
| | Amistem | 64 |
| **Short stems** | Optimys | 113 |
| | Fitmore** | 51 |
| **Cem. revision stems** | Arcad L XL | 121 |
| **Uncem. revision stems** | Revitan | 915 |
| | Modular revision | 858 |
| | Corail | 665 |
| | Revision femoral | 384 |
| | Wagner SL | 324 |
| | MRP-Titan | 244 |
| | Quadra R | 190 |
| | Reclaim | 147 |
| | Alloclassic SLL | 141 |
| | Reef | 83 |
| | Redapt | 65 |
| | Restoration modular | 65 |
| | SLR-Plus | 60 |

| E-class category of implant | Main brands (50+) | N |
|---|---|---|
| **Cem. primary cups** | Original Mueller | 826 |
| | Polarcup | 470 |
| | Versacem | 462 |
| | DS Evolution | 341 |
| | Avantage | 216 |
| | Symbol | 155 |
| | Ades DM | 82 |
| | Liberty DM | 72 |
| | Liberty | 54 |
| | CCB | 52 |
| **Uncem. primary cups** | Pinnacle | 515 |
| | Allofit | 410 |
| | RM Pressfit vitamys | 382 |
| | Polarcup | 357 |
| | TM | 284 |
| | Gyracup | 263 |
| | DS Evolution | 256 |
| | Versafitcup DM | 255 |
| | Gyros | 225 |
| | Fitmore | 213 |
| | Versafitcup Trio/CC light | 192 |
| | Delta one-TT | 141 |
| | Mpact | 133 |
| | Avantage | 103 |
| | Delta TT | 70 |
| | RM pressfit | 68 |
| | R3 | 65 |
| | Mpact DM | 64 |
| | Liberty DM | 50 |
| **Revision cups** | Tmars | 216 |
| | Pinnacle | 114 |
| | Delta revision TT | 52 |
| **AC roof ring or cage** | Ganz | 1,110 |
| | Burch-Schneider | 428 |
| | Original Mueller | 146 |

**please note that the Fitmore stem is originally classified as a regular uncemented primary stem even though we consider it technically a short stem.

## 4.4 Results of implants in total hip arthroplasty

The performance of implants could be shown separately for stems and cups. This would give a rough overview of the performance of an implant. However, a total hip replacement comprises at least three components, including stem, cup and head. Considering modularity of the cup or of a double mobility system, the analysis of the individual components is complex and of limited value. 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 frequently used implant combinations.

The analysis includes primary THA with the diagnosis of primary OA with a follow-up of at least two years within a moving four-year window. Only combinations with N>50 are presented. From a statistical point of view, N=50 may be considered the smallest "large" number useful for this type of analysis, but it is nevertheless a number that in the absence of a very high revision rate will imply very low statistical precision. This implies wide confidence intervals. One revision more or less may be enough to categorise an implant as a potential outlier. There is always a trade-off between statistical stability and the necessity to identify possible low volume outliers. Since the start of the registry SIRIS documented a total of 131 different brands of stems. 24 stems were implanted less than 10 times. Another 26 stems were used in 10 to 49 cases. There were 474 different stem cup combinations, of which 104 combinations were used in more than 50 cases. For the current report only implantations from 2015 onwards were included. For this time period there were 66 combinations with more than 50 cases implanted.

Table 4.22

**Top 10 of uncemented implant combinations, primary total hip arthroplasty**

2015–2020, diagnosis primary OA

| Stem component | Cup component | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|
| Corail | Pinnacle | 1,962 | 2,073 | 2,285 | 2,396 | 2,519 | 2,738 | 13,973 |
| Optimys | RM pressfit vitamys | 1,273 | 1,465 | 1,672 | 1,749 | 1,829 | 2,096 | 10,084 |
| Amistem* | Versafitcup Trio/CC light | 1,568 | 1,661 | 1,589 | 1,430 | 943 | 50 | 7,241 |
| Avenir | Allofit | 1,032 | 1,086 | 1,098 | 1,162 | 1,139 | 1,035 | 6,552 |
| Quadra** | Versafitcup Trio/CC light | 606 | 796 | 940 | 1,046 | 931 | 728 | 5,047 |
| Fitmore | Allofit | 699 | 656 | 550 | 507 | 526 | 560 | 3,498 |
| Polarstem | R3 | 503 | 530 | 588 | 633 | 681 | 762 | 3,697 |
| Fitmore | Fitmore | 463 | 413 | 433 | 591 | 616 | 617 | 3,133 |
| twinSys | RM pressfit vitamys | 324 | 353 | 387 | 399 | 404 | 389 | 2,256 |
| Avenir | Fitmore | 331 | 352 | 319 | 299 | 286 | 256 | 1,843 |
| Other combinations | | 3,748 | 3,768 | 3611 | 3,541 | 4,192 | 4844 | 23,704 |
| Total | | 12,509 | 13,153 | 13,472 | 13,753 | 14,066 | 14,075 | 81,028 |

* AMIStem refers to AMIStem-H variants (including proximal coating & collared); starting in 2018 it is progressively replaced by AMIStem-P. In 2019, 380 uses of AMIStem-P + Versafitcup CC Trio were registered and in 2020 already 1,175.

** Quadra refers to Quadra-H variants

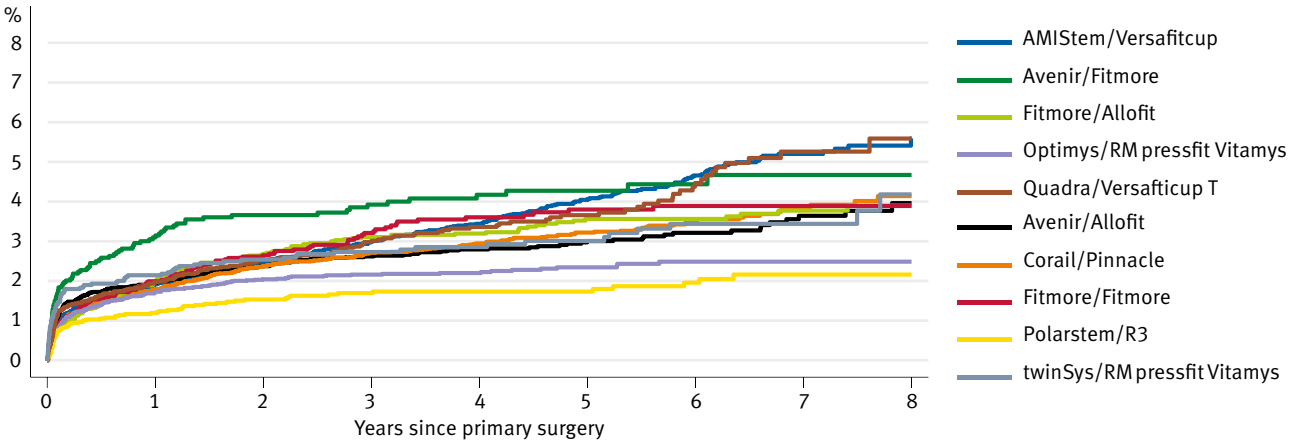
Please note that if reported stem-cup combinations involve multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

The ten most frequently used uncemented combinations (Table 4.22) cover 71% of all THAs used for primary OA. Figure 4.15 shows the KM estimate of cumulative revision risk for the ten most frequently used implant combinations. The confidence intervals are shown in the table. Two different trajectories of failure rates can be observed. After an initial rather sharp rise of revisions the curve flattens at about two years and only shows a minor increase over the next five years. Implant combinations showing this pattern were Polarstem/R3, Optimys/RM Vitamys and Fitmore/Fitmore. The other pattern also has an initial sharp increase, but then continues as a steadily rising curve. Examples of this pattern were Avenir/Allofit, Corail/Pinnacle and AMIStem/Versafitcup Trio/CC/light. The future revision rate of implants with this pattern may need close monitoring in the future.

Figure 4.15

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

Time since operation, 2012–2020, all services, diagnosis primary OA




**Cumulative revision rate**

| Stem/Cup | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Corail/Pinnacle | **1.8** (1.6-2.0) | **2.4** (2.1-2.6) | **2.7** (2.5-3.0) | **2.9** (2.7-3.2) | **3.2** (2.9-3.5) | **3.5** (3.2-3.9) | **3.8** (3.4-4.2) | **4.1** (3.6-4.7) |
| Optimys/RM pressfit Vitamys | **1.7** (1.5-2.0) | **2.0** (1.8-2.3) | **2.2** (1.9-2.5) | **2.2** (1.9-2.5) | **2.3** (2.1-2.7) | **2.5** (2.2-2.9) | **2.5** (2.2-2.9) | **2.5** (2.2-2.9) |
| Amistem*/Versafitcup Trio/CC l. | **1.9** (1.7-2.2) | **2.4** (2.2-2.7) | **3.0** (2.7-3.3) | **3.4** (3.1-3.8) | **4.0** (3.7-4.5) | **4.7** (4.2-5.2) | **5.2** (4.7-5.8) | **5.6** (4.9-6.3) |
| Avenir/Allofit | **2.0** (1.7-2.3) | **2.4** (2.1-2.7) | **2.6** (2.3-3.0) | **2.8** (2.4-3.2) | **3.0** (2.6-3.4) | **3.2** (2.8-3.7) | **3.6** (3.1-4.2) | **4.0** (3.3-4.7) |
| Quadra**/Versafticup Trio/CC l. | **2.0** (1.6-2.3) | **2.5** (2.2-3.0) | **3.0** (2.6-3.5) | **3.4** (2.9-3.9) | **3.7** (3.1-4.3) | **4.5** (3.8-5.3) | **5.3** (4.4-6.3) | **5.6** (4.6-6.9) |
| Fitmore/Allofit | **2.0** (1.6-2.4) | **2.7** (2.3-3.1) | **3.1** (2.7-3.6) | **3.2** (2.7-3.7) | **3.6** (3.1-4.1) | **3.6** (3.1-4.1) | **3.8** (3.2-4.4) | **3.9** (3.3-4.6) |
| Polarstem/R3 | **1.2** (0.9-1.5) | **1.5** (1.2-1.9) | **1.7** (1.3-2.1) | **1.7** (1.4-2.2) | **1.7** (1.4-2.2) | **2.0** (1.5-2.5) | **2.2** (1.7-2.8) | **2.2** (1.7-2.8) |
| Fitmore/Fitmore | **2.0** (1.6-2.5) | **2.6** (2.2-3.2) | **3.2** (2.7-3.9) | **3.6** (3.0-4.3) | **3.8** (3.2-4.5) | **3.9** (3.2-4.7) | **3.9** (3.2-4.7) | **3.9** (3.2-4.7) |
| Twinsys/RM pressfit Vitamys | **2.1** (1.7-2.7) | **2.5** (2.0-3.2) | **2.7** (2.2-3.4) | **2.9** (2.3-3.5) | **3.0** (2.4-3.7) | **3.4** (2.7-4.3) | **3.4** (2.7-4.3) | **4.2** (3.1-5.7) |
| Avenir/Fitmore | **3.1** (2.5-3.9) | **3.7** (3.0-4.5) | **3.9** (3.2-4.8) | **4.2** (3.4-5.1) | **4.3** (3.5-5.3) | **4.4** (3.6-5.5) | **4.7** (3.7-5.8) | **4.7** (3.7-5.8) |

* AMIStem refers to AMIStem-H variants (including proximal coating & collared); starting in 2018 it is progressively replaced by AMIStem-P.

** Quadra refers to Quadra-H variants

Table 4.23

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Stem-cup combinations with at least 50 implants. Covering approx. 94% of registered primary OA THAs, uncemented, alphabetic order.

| Stem component | Cup component | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | % | lb | ub |
| Alloclassic Stems | Alloclassic Cups | 174 | 5 | 2.9 | 1.2 | 6.8 |
| Alloclassic Stems | Allofit Cups | 188 | 5 | 2.7 | 1.1 | 6.4 |
| Alloclassic Stems | Fitmore Cups | 319 | 16 | 5.1 | 3.1 | 8.1 |
| Amistem | MPact | 337 | 8 | 2.4 | 1.2 | 4.7 |
| Amistem | Versafitcup DM | 80 | 6 | 7.6 | 3.5 | 16.1 |
| Amistem | Versafitcup Trio/CC l. | 6,248 | 144 | 2.3 | 2.0 | 2.7 |
| Ananova Alpha proxy | Ananova Alpha | 94 | 0 | 0.0 | | |
| Avenir | Ades DM | 59 | 0 | 0.0 | | |
| Avenir | Alloclassic Cups | 297 | 8 | 2.7 | 1.4 | 5.3 |
| Avenir | Allofit Cups | 4,377 | 98 | 2.3 | 1.9 | 2.7 |
| Avenir | Fitmore Cups | 1,301 | 49 | 3.8 | 2.9 | 5.0 |
| CLS Stems | Allofit Cups | 570 | 19 | 3.4 | 2.2 | 5.2 |
| CLS Stems | Fitmore Cups | 739 | 15 | 2.0 | 1.2 | 3.4 |
| Corail | Allofit Cups | 72 | 2 | 2.9 | 0.7 | 11.0 |
| Corail | Delta Motion | 104 | 1 | 1.0 | 0.1 | 6.7 |
| Corail | Fitmore Cups | 91 | 2 | 2.2 | 0.6 | 8.5 |
| Corail | Gyros | 554 | 16 | 2.9 | 1.8 | 4.7 |
| Corail | Pinnacle | 8,715 | 194 | 2.2 | 2.0 | 2.6 |
| Corail | RM Pressfit | 67 | 1 | 1.5 | 0.2 | 10.3 |
| Custom Hip | April Ceramic | 269 | 7 | 2.6 | 1.3 | 5.4 |
| Exception | Allofit Cups | 66 | 2 | 3.0 | 0.8 | 11.6 |
| Exception | Avantage Cups | 543 | 20 | 3.7 | 2.4 | 5.7 |
| Exception | Exceed Cups | 73 | 4 | 5.5 | 2.1 | 13.9 |
| Fitmore Stems | Allofit Cups | 2,412 | 74 | 3.1 | 2.5 | 3.9 |
| Fitmore Stems | Fitmore Cups | 1,900 | 43 | 2.3 | 1.7 | 3.1 |
| Fitmore Stems | RM Pressfit vitamys | 576 | 12 | 2.1 | 1.2 | 3.7 |
| GTS | G7 bi-spherical | 110 | 15 | 13.8 | 8.5 | 21.8 |
| Harmony | April Ceramic | 63 | 1 | 1.6 | 0.2 | 10.7 |
| Harmony | April Poly | 61 | 1 | 1.7 | 0.2 | 11.4 |
| Harmony | Symbol Cups | 67 | 3 | 4.5 | 1.5 | 13.3 |
| H-Max S | Delta PF Cups | 188 | 5 | 2.7 | 1.1 | 6.3 |
| H-Max S | Delta PF Cups | 197 | 2 | 1.0 | 0.3 | 4.0 |
| Minimax | Versafitcup Trio/CC l | 104 | 2 | 2.0 | 0.5 | 7.6 |
| Nanos | R3 | 80 | 2 | 2.5 | 0.6 | 9.6 |
| Optimys | Allofit Cups | 89 | 1 | 1.1 | 0.2 | 7.7 |

| Stem component | Cup component | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | % | lb | ub |
| Optimys | Anexys Cluster | 83 | 0 | 0.0 | | |
| Optimys | Anexys Flex | 140 | 3 | 2.3 | 0.7 | 6.9 |
| Optimys | RM Pressfit | 278 | 5 | 1.8 | 0.8 | 4.3 |
| Optimys | RM Pressfit vitamys | 6,158 | 133 | 2.2 | 1.8 | 2.6 |
| Optimys | Selexys PC | 64 | 1 | 1.6 | 0.2 | 10.7 |
| Polarstem | EP-Fit | 152 | 12 | 7.9 | 4.6 | 13.5 |
| Polarstem | HI | 70 | 1 | 1.4 | 0.2 | 9.8 |
| Polarstem | Polarcup | 830 | 26 | 3.1 | 2.1 | 4.6 |
| Polarstem | R3 | 2,254 | 37 | 1.7 | 1.2 | 2.3 |
| Quadra | Mpact | 120 | 5 | 4.2 | 1.8 | 9.9 |
| Quadra | Versafitcup DM | 110 | 5 | 4.6 | 1.9 | 10.7 |
| Quadra | Versafitcup Trio/CC l. | 3,388 | 92 | 2.8 | 2.2 | 3.4 |
| SBG | HI | 108 | 4 | 3.8 | 1.4 | 9.7 |
| SBG | R3 | 761 | 13 | 1.7 | 1.0 | 2.9 |
| SBG | Xentrax-Cup | 108 | 2 | 1.9 | 0.5 | 7.4 |
| SL-Plus | EP-Fit | 524 | 9 | 1.7 | 0.9 | 3.3 |
| SL-Plus | HI | 492 | 18 | 3.7 | 2.4 | 5.9 |
| SL-Plus | R3 | 788 | 8 | 1.0 | 0.5 | 2.0 |
| SPS Evolution | April Ceramic | 569 | 33 | 5.9 | 4.2 | 8.1 |
| SPS Evolution | AprilL Poly | 124 | 4 | 3.2 | 1.2 | 8.4 |
| SPS HA | April Ceramic | 84 | 7 | 8.3 | 4.1 | 16.7 |
| SPS Modular | April Ceramic | 77 | 5 | 6.5 | 2.8 | 15.0 |
| Stelia-Stem | Ananova Hybrid | 183 | 11 | 6.1 | 3.4 | 10.7 |
| Stelia-Stem | BSC-Cup pressfit | 56 | 0 | 0.0 | | |
| Trendhip | Plasmafit Plus | 70 | 0 | 0.0 | | |
| Tri-Lock | Pinnacle | 369 | 3 | 0.8 | 0.3 | 2.6 |
| Twinsys | Anexys Flex | 62 | 2 | 3.3 | 0.8 | 12.5 |
| Twinsys | RM Pressfit | 130 | 4 | 3.1 | 1.2 | 8.0 |
| Twinsys | RM Pressfit vitamys | 1,463 | 43 | 3.0 | 2.2 | 4.0 |
| **Group average** | | | | **2.6** | **2.5** | **2.7** |

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

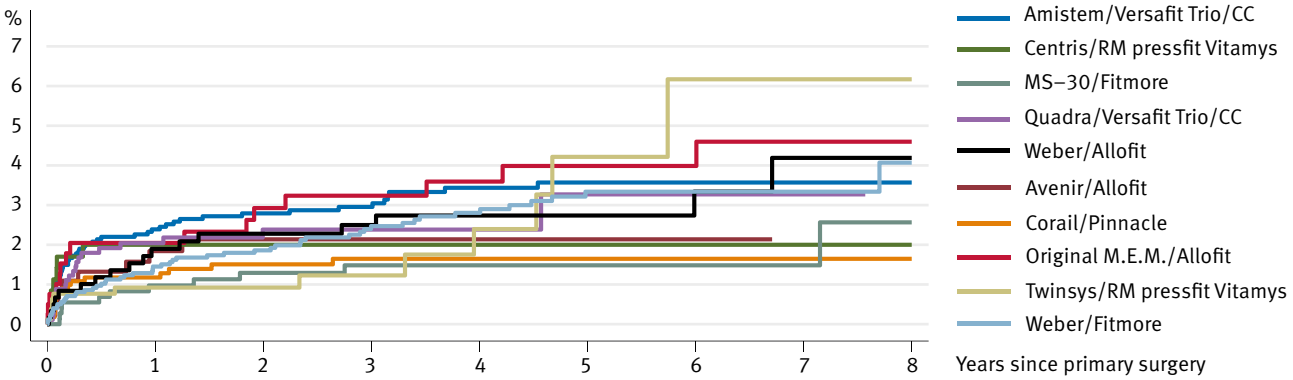
** Rates adjusted for effects of mortality and emigration.

Please note that AMIStem refers to AMIStem-H variants (including proximal coating & collared); starting in 2018 it is progressively replaced by AMIStem-P. Quadra refers to Quadra-H variants.

Figure 4.16

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

Time since operation, 2012–2020, all services, diagnosis primary OA




**Cumulative revision rate**

| Stem | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Weber/Fitmore | **1.5** (1.0-2.1) | **1.9** (1.3-2.6) | **2.5** (1.8-3.3) | **2.8** (2.1-3.7) | **3.3** (2.5-4.4) | **3.3** (2.5-4.4) | **3.3** (2.5-4.4) | **4.1** (2.7-6.2) |
| Amistem*/Vers Trio/CC l. | **2.4** (1.8-3.2) | **2.8** (2.1-3.7) | **3.0** (2.2-3.9) | **3.4** (2.6-4.5) | **3.6** (2.7-4.7) | **3.6** (2.7-4.7) | **3.6** (2.7-4.7) | **3.6** (2.7-4.7) |
| Corail/Pinnacle | **1.2** (0.7-2.0) | **1.5** (0.9-2.5) | **1.6** (1.0-2.6) | **1.6** (1.0-2.6) | **1.6** (1.0-2.6) | **1.6** (1.0-2.6) | **1.6** (1.0-2.6) | **1.6** (1.0-2.6) |
| Quadra**/Vers Trio/CC l. | **2.0** (1.3-3.2) | **2.4** (1.5-3.7) | **2.4** (1.5-3.7) | **2.4** (1.5-3.7) | **3.3** (1.8-6.0) | **3.3** (1.8-6.0) | | |
| Twinsys/RM pressfit Vitam. | **0.9** (0.4-1.9) | **0.9** (0.4-1.9) | **1.2** (0.6-2.6) | **2.4** (1.1-5.2) | **4.2** (2.0-8.7) | **6.2** (2.8-13.4) | **6.2** (2.8-13.4) | |
| MS-30/Fitmore | **1.0** (0.5-2.0) | **1.3** (0.7-2.5) | **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) | **2.6** (1.0-6.2) |
| Weber/Allofit | **1.9** (1.1-3.4) | **2.3** (1.3-3.9) | **2.5** (1.5-4.2) | **2.7** (1.7-4.5) | **2.7** (1.7-4.5) | **3.3** (1.9-5.7) | **4.2** (2.3-7.5) | **4.2** (2.3-7.5) |
| Avenir/Allofit | **1.8** (0.9-3.7) | **2.1** (1.1-4.1) | **2.1** (1.1-4.1) | **2.1** (1.1-4.1) | **2.1** (1.1-4.1) | | | |
| Orig M.E.M./Allofit | **2.0** (1.0-4.1) | **2.9** (1.6-5.2) | **3.2** (1.8-5.6) | **3.6** (2.1-6.1) | **4.0** (2.4-6.7) | **4.0** (2.4-6.7) | **4.6** (2.7-7.7) | **4.6** (2.7-7.7) |
| Centris/RM pressfit Vitamys | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | **2.0** (1.0-4.2) | |

Table 4.24

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

2015–2020, diagnosis primary OA

| Stem component | Cup component | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|
| Weber | Fitmore Cups | 304 | 246 | 237 | 184 | 175 | 152 | 1,298 |
| Amistem* | Versafitcup Trio/CC light | 182 | 289 | 198 | 178 | 205 | 156 | 1,208 |
| Corail | Pinnacle | 107 | 147 | 122 | 118 | 132 | 146 | 772 |
| Quadra** | Versafitcup Trio/CC light | 65 | 83 | 183 | 173 | 202 | 151 | 857 |
| Twinsys | RM Pressfit vitamys | 53 | 75 | 71 | 150 | 196 | 193 | 738 |
| MS-30 Stems | Fitmore Cups | 116 | 118 | 90 | 86 | 64 | 52 | 526 |
| Weber | Allofit Cups | 84 | 93 | 74 | 51 | 40 | 37 | 379 |
| Avenir | Allofit Cups | 29 | 62 | 58 | 122 | 90 | 93 | 454 |
| Original Mueller | Allofit Cups | 57 | 29 | 22 | 16 | 20 | 22 | 166 |
| Centris | RM Pressfit vitamys | 49 | 44 | 75 | 49 | 30 | 52 | 299 |
| Other combinations | | 627 | 501 | 505 | 588 | 657 | 596 | 3,474 |
| Total | | 1,673 | 1,687 | 1,635 | 1,715 | 1,811 | 1,650 | 10,171 |

*Amistem refers to Amistem-C variants. ** Quadra refers to Quadra-C variants. Please note that if reported stem-cup combinations involve multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

Table 4.23 covers 94% of all uncemented 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 was missing and therefore not included in the analysis. The overall revision rate of uncemented primary THA for the moving four-year window time period from 1.1.2015 to 31.12.2018 averaged 2.6% (CI 2.5 – 2.7).

Table 4.24 and Figure. 4.16 show the results of hybrid implant combinations with a minimum of 50 implantations. Overall, 286 different hybrid combinations were used. Of these 202 combinations were used in less than 10 cases.

The overall revision rate for hybrid fixation in primary OA during the moving four-year window time period from 1.1.2015 to 31.12.2018 averaged 2.5% (CI 2.2 – 2.9) (Table 4.24).

Table 4.24

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)
Stem-cup combinations with at least 50 implants. Covering approx. 78% of registered primary OA THAs, hybrid fixation, alphabetic order.

| Stem component | Cup component | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | % | lb | ub |
| Amistem | Versafitcup Trio/CC light | 946 | 29 | 3.1 | 2.2 | 4.4 |
| Arcad SO | April Ceramic | 111 | 3 | 2.7 | 0.9 | 8.1 |
| Avenir | Allofit Cups | 270 | 5 | 1.9 | 0.8 | 4.5 |
| CCA | RM Pressfit vitamys | 70 | 4 | 5.9 | 2.3 | 15.0 |
| Corail | Pinnacle | 495 | 9 | 1.9 | 1.0 | 3.6 |
| Centris | RM Pressfit | 92 | 0 | 0.0 | | |
| Centris | RM Pressfit vitamys | 215 | 5 | 2.3 | 1.0 | 5.5 |
| Harmony Cemented | Liberty | 74 | 1 | 1.4 | 0.2 | 9.2 |
| MS-30 | Allofit Cups | 137 | 1 | 0.7 | 0.1 | 5.1 |
| MS-30 | Fitmore Cups | 409 | 5 | 1.2 | 0.5 | 3.0 |
| Original Mueller | Allofit Cups | 124 | 6 | 4.9 | 2.2 | 10.6 |
| Original Mueller | Fitmore Cups | 163 | 2 | 1.2 | 0.3 | 4.8 |
| Quadra | Versafitcup Trio/CC light | 506 | 13 | 2.6 | 1.5 | 4.5 |
| Weber | Allofit Cups | 303 | 10 | 3.4 | 1.8 | 6.1 |
| Weber | Avantage Cups | 63 | 2 | 3.2 | 0.8 | 12.3 |
| Weber | Fitmore Cups | 970 | 17 | 1.8 | 1.1 | 2.9 |
| Twinsys | RM Pressfit | 90 | 2 | 2.2 | 0.6 | 8.6 |
| Twinsys | RM Pressfit vitamys | 349 | 3 | 0.9 | 0.3 | 2.7 |
| **Group average** | | | | **2.5** | **2.2** | **2.9** |

* 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.
Please note that Amistem refers to Amistem-C variants. Quadra refers to Quadra-C variants.

## 4.5 Estimating performance and detecting outliers (2-year revision rate)

An important function of an implant registry is to monitor the performance of implants. Knowledge about the performance helps identify and select high-performing implant combinations for optimal treatment, and it can help identify prostheses which have higher than expected revision rates.
This is the third SIRIS report presenting the early revision rate of THA within the first two years after the index surgery. However, the period of time considered for analysis moved by only six months compared to the previous report; from 01.01.2015 to 31.12.2018 in order to cover the actually observed two-year result (as opposed to estimated results). The 2020 report allowed for longer follow-up into 2020 despite the primary scope of the report being limited to 2019. As this led to confusion, it was decided to re-align primary scope and follow-up time.

The use of a moving time window leads to results reflecting current trends and currently used implants more reliably and also eliminates the less reliable early years of the registry (before 2015) from the analyses. In general, the lower coverage rates of early years were associated with underestimates of revision rates, biasing "early" implants somewhat against more recent implants. This also facilitates the registry's function of being a learning system for hospitals and surgeons.
Inspired by procedures used in other registries, the following definition for a potential outlier was adopted: An implant may be considered a "statistical

### Important information on the use of the implant performance tables below

Implants ranked by upper end of the 95% confidence interval. This is the upper end of the plausible range in which the true 2-year revision rate of an implant could lie with 95% certainty after allowing for random variation in the occurrence of revisions.

At the bottom of the list are the implants without any registered revisions (statistical evaluation not yet possible).

🔴=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. Observed revision rates may be determined by local factors and performance may differ significantly between locations. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

Figure 4.17 (Part 1)

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| Stem component | Cup component | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | % | lb | ub |
| SL-Plus | R3 | 788 | 8 | 1.0 | 0.5 | 2.0 |
| Polarstem | R3 | 2254 | 37 | 1.7 | 1.2 | 2.3 |
| Tri-Lock | Pinnacle | 369 | 3 | 0.8 | 0.3 | 2.6 |
| Optimys | RM Pressfit vitamys | 6158 | 133 | 2.2 | 1.8 | 2.6 |
| Corail | Pinnacle | 8715 | 194 | 2.2 | 2.0 | 2.6 |
| Amistem | Versafitcup Trio/CC l. | 6248 | 144 | 2.3 | 2.0 | 2.7 |
| Avenir | Allofit Cups | 4377 | 98 | 2.3 | 1.9 | 2.7 |
| SBG | R3 | 761 | 13 | 1.7 | 1.0 | 2.9 |
| Fitmore Stems | Fitmore Cups | 1900 | 43 | 2.3 | 1.7 | 3.1 |
| SL-Plus | EP-Fit | 524 | 9 | 1.7 | 0.9 | 3.3 |
| Quadra | Versafitcup Trio/CC l. | 3388 | 92 | 2.8 | 2.2 | 3.4 |
| CLS Stems | Fitmore Cups | 739 | 15 | 2.0 | 1.2 | 3.4 |
| Fitmore Stems | RM Pressfit vitamys | 576 | 12 | 2.1 | 1.2 | 3.7 |
| Fitmore Stems | Allofit Cups | 2412 | 74 | 3.1 | 2.5 | 3.9 |
| Twinsys | RM Pressfit vitamys | 1463 | 43 | 3.0 | 2.2 | 4.0 |
| H-Max S | Delta TT Cups | 197 | 2 | 1.0 | 0.3 | 4.0 |
| Optimys | RM Pressfit | 278 | 5 | 1.8 | 0.8 | 4.3 |
| Polarstem | Polarcup | 830 | 26 | 3.1 | 2.1 | 4.6 |
| Corail | Gyros | 554 | 16 | 2.9 | 1.8 | 4.7 |
| Amistem | Mpact | 337 | 8 | 2.4 | 1.2 | 4.7 |
| Avenir | Fitmore Cups | 1301 | 49 | 3.8 | 2.9 | 5.0 |
| CLS Stems | Allofit Cups | 570 | 19 | 3.4 | 2.2 | 5.2 |
| Avenir | Alloclassic Cups | 297 | 8 | 2.7 | 1.4 | 5.3 |
| Custom Hip | April Ceramic | 269 | 7 | 2.6 | 1.3 | 5.4 |
| Exception | Avantage Cups | 543 | 20 | 3.7 | 2.4 | 5.7 |
| SL-Plus | HI | 492 | 18 | 3.7 | 2.4 | 5.9 |
| H-Max S Femoral | Delta PF Cups | 188 | 5 | 2.7 | 1.1 | 6.3 |
| Alloclassic Stem | Allofit Cups | 188 | 5 | 2.7 | 1.1 | 6.4 |
| Corail | Delta Motion | 104 | 1 | 1.0 | 0.1 | 6.7 |
| Alloclassic Stem | Alloclassic Cups | 174 | 5 | 2.9 | 1.2 | 6.8 |
| Optimys | Anexys Flex | 140 | 3 | 2.3 | 0.7 | 6.9 |
| SBG | Xentrax-Cup | 108 | 2 | 1.9 | 0.5 | 7.4 |
| Minimax | Versafitcup Trio/CC l. | 104 | 2 | 2.0 | 0.5 | 7.6 |
| Optimys | Allofit Cups | 89 | 1 | 1.1 | 0.2 | 7.7 |
| Twinsys | RM Pressfit | 130 | 4 | 3.1 | 1.2 | 8.0 |
| SPS Evolution | April Ceramic | 569 | 33 | 5.9 | 4.2 | 8.1 |
| Alloclassic Stem | Fitmore Cup | 319 | 16 | 5.1 | 3.1 | 8.1 |

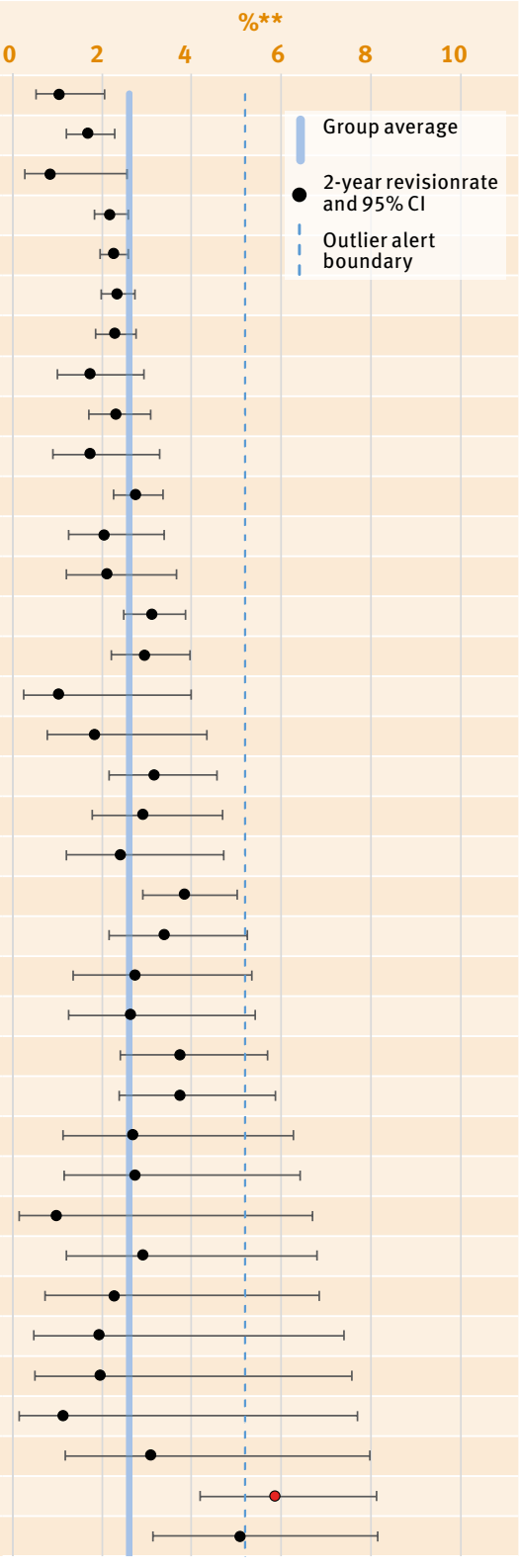
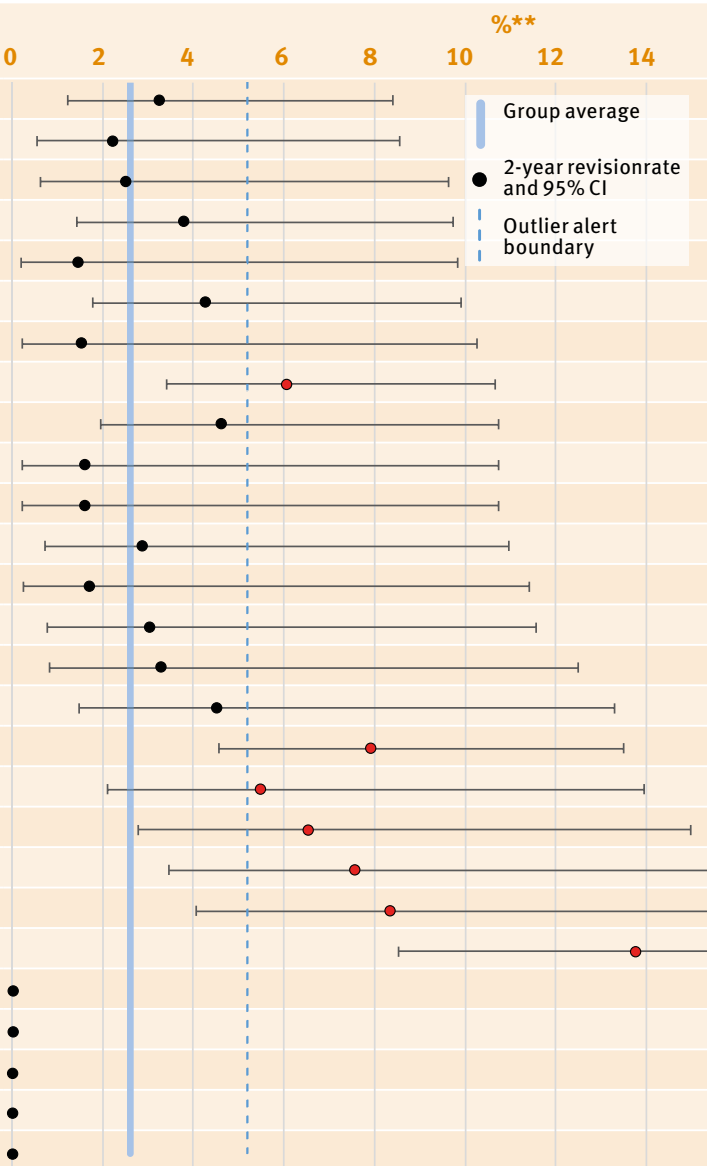


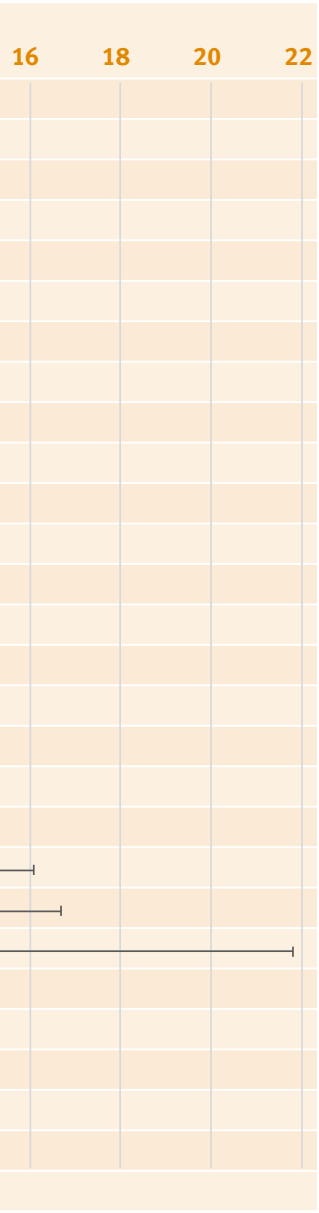
Figure 4.19 (Part 2)

| Stem component | Cup component | at risk* N | Revised N | Revised % | 95% CI lb | 95% CI ub |
|---|---|---|---|---|---|---|
| SPS evolution | April poly | 124 | 4 | 3.2 | 1.2 | 8.4 |
| Corail | Fitmore | 91 | 2 | 2.2 | 0.6 | 8.5 |
| Nanos | R3 | 80 | 2 | 2.5 | 0.6 | 9.6 |
| SBG | HI | 108 | 4 | 3.8 | 1.4 | 9.7 |
| Polarstem | HI | 70 | 1 | 1.4 | 0.2 | 9.8 |
| Quadra | Mpact | 120 | 5 | 4.2 | 1.8 | 9.9 |
| Corail | RM pressfit | 67 | 1 | 1.5 | 0.2 | 10.3 |
| Stelia | Ananova hybrid | 183 | 11 | 6.1 | 3.4 | 10.7 |
| Quadra | Versafitcup DM | 110 | 5 | 4.6 | 1.9 | 10.7 |
| Harmony | April ceramic | 63 | 1 | 1.6 | 0.2 | 10.7 |
| Optimys | Selexys PC | 64 | 1 | 1.6 | 0.2 | 10.7 |
| Corail | Allofit | 72 | 2 | 2.9 | 0.7 | 11.0 |
| Harmony | April poly | 61 | 1 | 1.7 | 0.2 | 11.4 |
| Exception | Allofit | 66 | 2 | 3.0 | 0.8 | 11.6 |
| Twinsys | Anexys flex | 62 | 2 | 3.3 | 0.8 | 12.5 |
| Harmony | Symbol | 67 | 3 | 4.5 | 1.5 | 13.3 |
| Polarstem | EP-FIT | 152 | 12 | 7.9 | 4.6 | 13.5 |
| Exception | Exceed | 73 | 4 | 5.5 | 2.1 | 13.9 |
| SPS modular | April ceramic | 77 | 5 | 6.5 | 2.8 | 15.0 |
| Amistem | Versafitcup DM | 80 | 6 | 7.6 | 3.5 | 16.1 |
| SPS HA | April ceramic | 84 | 7 | 8.3 | 4.1 | 16.7 |
| GTS | G7 bi-spherical | 110 | 15 | 13.8 | 8.5 | 21.8 |
| Ananova A. | Ananova alpha | 94 | 0 | 0.0 | | |
| Avenir | Ades DM | 59 | 0 | 0.0 | | |
| Optimys | Anexys cluster | 83 | 0 | 0.0 | | |
| Stelia | BSC-cup pressfit | 56 | 0 | 0.0 | | |
| Trendhip | Plasmafit plus | 70 | 0 | 0.0 | | |
| **Group average** | | | | **2.6** | **2.5** | **2.7** |




* 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.

Please note that AMIStem refers to Amistem-H variants (including proximal coating & collared); starting in 2018 it is progressively replaced by Amistem-P. Quadra refers to Quadra-H variants.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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 with a diagnosis of primary osteoarthritis). The outlier alert boundary was set at twice that reference revision rate. An implant was regarded as a potential outlier when its two-year revision rate was higher than the outlier alert boundary, regardless of the extent of the statistical confidence interval. The outlier status comes with varying degrees of statistical probability. The outlier status was considered "highly likely" when both the estimated revision rate and the complete confidence interval exceeded the outlier alert boundary. For implant combination with high numbers, the confidence interval usually is narrow. As numbers get smaller, the statistical precision decreases which results in wider confidence intervals. The confidence interval describes the range in which the true mean of a population is expected with the stated probability (typically 95%). For practical purposes, any position within the confidence interval should be seen as a plausible value. If confidence intervals overlap, they should be regarded as statistically not different. For that reason, implants, where the revision rate exceeds the double of the mean revision rate, are defined as potential outliers. If the lower confidence interval exceeds twice mean revision rate it is considered a definitive outlier.

Some components which perform well in one combination do not necessarily perform as well in another. Since 2015, 474 different stem cup combinations were used, of which 104 combinations were used in more than 50 cases.

The average revision rate is calculated for all primary implants for primary OA per fixation group. The average revision rate for uncemented THAs was 2.6% (CI 2.5 to 2.7) and 2.5% (CI 2.2 to 2.9) for hybrid fixation. Because of infrequent use and small numbers, the analysis for all cemented THAs was skipped. Due to the four-year moving window for the analysis of the two-year revision rates, the results of some of the implant combinations may be different to those reported in 2020.

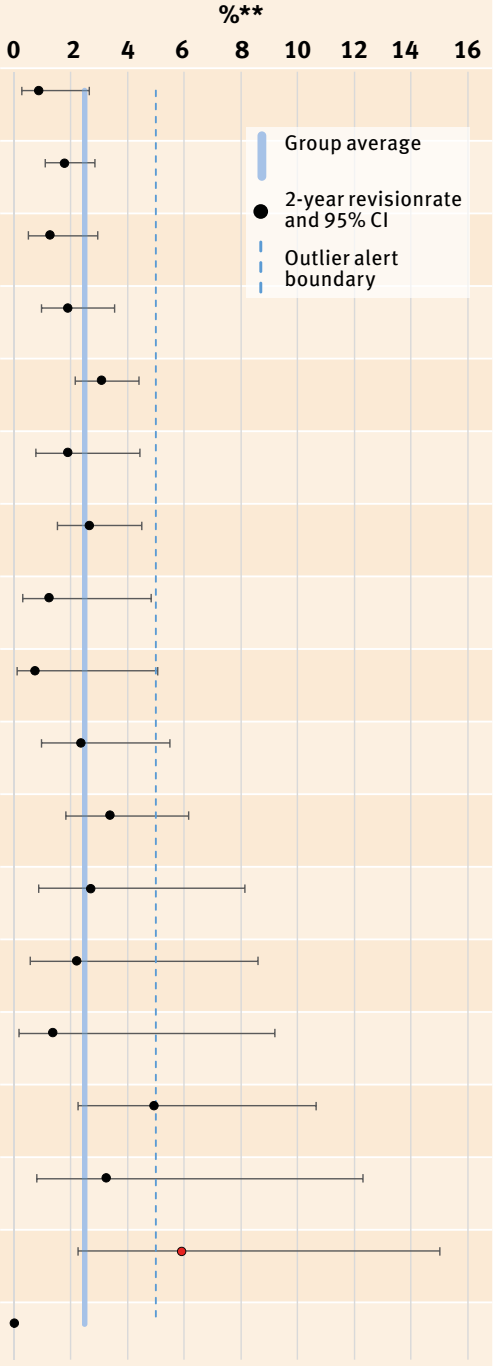
Figures 4.17 and 4.18 show the two-year revision rates of all combinations (N >50). The revision rates were adjusted for effects of mortality and departure from Switzerland. Combinations of implants outside the outlier boundary (revision rate twice the revision rate of the group) are potential outliers. Eight stem/cup combinations have been identified as potential outliers. They are further analysed following the protocol described above and presented in the outlier watchlist at the end of this report.

Figure 4.18

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| Stem component | Cup component | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | % | lb | ub |
| Twinsys RM | RM pressfit vitamys | 349 | 3 | 0.9 | 0.3 | 2.7 |
| Weber | Fitmore | 970 | 17 | 1.8 | 1.1 | 2.9 |
| MS-30 | Fitmore | 409 | 5 | 1.2 | 0.5 | 3.0 |
| Corail | Pinnacle | 495 | 9 | 1.9 | 1.0 | 3.6 |
| Amistem | Versafitcup trio/CC l. | 946 | 29 | 3.1 | 2.2 | 4.4 |
| Avenir | Allofit | 270 | 5 | 1.9 | 0.8 | 4.5 |
| Quadra | Versafitcup trio/CC l. | 506 | 13 | 2.6 | 1.5 | 4.5 |
| Original Mueller | Fitmore | 163 | 2 | 1.2 | 0.3 | 4.8 |
| MS-30 | Allofit | 137 | 1 | 0.7 | 0.1 | 5.1 |
| Centris | RM pressfit vitamys | 215 | 5 | 2.3 | 1.0 | 5.5 |
| Weber | Allofit | 303 | 10 | 3.4 | 1.8 | 6.1 |
| Arcad SO | April ceramic | 111 | 3 | 2.7 | 0.9 | 8.1 |
| Twinsys | RM pressfit | 90 | 2 | 2.2 | 0.6 | 8.6 |
| Harmony cem. | Liberty | 74 | 1 | 1.4 | 0.2 | 9.2 |
| Original Mueller | Allofit | 124 | 6 | 4.9 | 2.2 | 10.6 |
| Weber | Avantage | 63 | 2 | 3.2 | 0.8 | 12.3 |
| CCA | RM pressfit vitamys | 70 | 4 | 5.9 | 2.3 | 15.0 |
| Centris | RM pressfit | 92 | 0 | 0.0 | | |
| **Group average** | | | | **2.5** | **2.2** | **2.9** |




* 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.
Please note that Amistem refers to Amistem-H variants (including proximal coating & collared); starting in 2018 it is progressively replaced by Amistem-P. Quadra refers to Quadra-H variants

# 5. Fracture of the hip

# 5. Fracture of the hip

## 5.1 Treatment of hip fractures

Fractures of the hip 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 also 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 with substantial comorbidities and low remaining life expectancy. The mortality rate is therefore

Table 5.1
**Fracture of the hip: Baseline patient characteristics by year**

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| N | | **3,010** | **31,19** | **3,232** | **3,488** | **3,812** | **4,026** | **20,687** |
| Treatment with THA* [%] | | 37.1 | 38.3 | 38.5 | 38.9 | 41.0 | 43.0 | 39.7 |
| Treatment with HA** [%] | | 62.9 | 61.7 | 61.5 | 61.1 | 59.0 | 57.0 | 60.3 |
| Women [%] | | 70.4 | 69.5 | 69.8 | 68.2 | 69.2 | 67.2 | 69.0 |
| Mean age (SD) | All | 80.9 (10.7) | 80.7 (10.7) | 81.0 (10.7) | 81.1 (10.4) | 81.1 (10.6) | 81.2 (10.6) | 81.0 (10.6) |
| | Women | 81.6 (10.1) | 81.4 (10.1) | 81.9 (9.9) | 82.2 (9.9) | 81.8 (10.0) | 82.4 (9.9) | 81.9 (10.0) |
| | Men | 79.2 (11.7) | 79.1 (11.9) | 78.7 (11.9) | 78.8 (11.1) | 79.5 (11.7) | 78.9 (11.6) | 79.0 (11.6) |
| Age group [%] | ‹45 | 0.3 | 0.5 | 0.3 | 0.2 | 0.4 | 0.1 | 0.3 |
| | 45–54 | 2.0 | 1.8 | 1.8 | 1.7 | 1.7 | 1.8 | 1.8 |
| | 55–64 | 6.0 | 5.9 | 6.5 | 6.2 | 6.1 | 6.8 | 6.3 |
| | 65–74 | 16.0 | 16.4 | 15.3 | 14.4 | 15.2 | 14.8 | 15.3 |
| | 75–84 | 31.9 | 33.3 | 31.2 | 33.5 | 32.3 | 32.2 | 32.4 |
| | 85+ | 43.8 | 42.1 | 44.9 | 44.0 | 44.3 | 44.4 | 44.0 |
| N unknown BMI (%) | | 1,068 (35) | 935 (30) | 930 (29) | 912 (26) | 884 (23) | 761 (19) | 5,490 (27) |
| N known BMI | | 1,942 | 2,184 | 2,302 | 2,576 | 2,928 | 3,265 | 15,197 |
| Mean BMI (SD) | | 23.9 (4.7) | 23.9 (4.6) | 23.8 (4.3) | 23.7 (4.4) | 23.7 (4.3) | 23.6 (4.3) | 23.8 (4.4) |
| BMI [%] | ‹18.5 | 9.9 | 9.1 | 9.4 | 9.1 | 8.9 | 10.1 | 9.4 |
| | 18.5–24.9 | 54.7 | 55.2 | 56.6 | 57.8 | 57.4 | 56.9 | 56.6 |
| | 25–29.9 | 27.4 | 26.9 | 27.1 | 25.5 | 26.4 | 25.8 | 26.4 |
| | 30–34.9 | 5.8 | 6.9 | 5.1 | 6.3 | 5.5 | 5.6 | 5.8 |
| | 35–39.9 | 1.6 | 1.6 | 1.5 | 0.8 | 1.4 | 1.2 | 1.3 |
| | 40+ | 0.5 | 0.4 | 0.3 | 0.5 | 0.3 | 0.3 | 0.4 |
| N unknown ASA (%) | | 328 (11) | 237 (8) | 275 (9) | 215 (6) | 272 (7) | 241 (6) | 1,568 (8) |
| N known ASA | | 2,682 | 2,882 | 2,957 | 3,273 | 3,540 | 3,785 | 19,119 |
| Morbidity state | ASA 1 | 4.2 | 3.1 | 3.4 | 3.0 | 3.3 | 3.7 | 3.4 |
| [%] | ASA 2 | 32.8 | 33.3 | 32.5 | 31.8 | 30.6 | 29.0 | 31.5 |
| | ASA 3 | 56.9 | 56.3 | 57.3 | 58.7 | 58.5 | 60.0 | 58.1 |
| | ASA 4/5 | 6.0 | 7.2 | 6.9 | 6.4 | 7.5 | 7.3 | 6.9 |

*THA= Total Hip Arthroplasty. **HA= Hemi Hip Arthroplasty

high. One-year mortality rates after index surgery between 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, low demand patients HA treatment is preferred, THA is commonly performed in healthier and more active patients. To get a more comprehensive perspective on current treatment and outcome of fractures of the hip, the data of this cohort of patients is recorded and analysed in this separate chapter of the SIRIS report.

As in the other chapters of the SIRIS annual report a four-year moving window was used for analysis and reporting. The rationale behind it can be found in the introduction to chapter 4. Since 2015, the

Table 5.2

**Fracture of the hip: Baseline patient characteristics by type of treatment**

| Type of treatment | | THA | HA |
|---|---|---|---|
| N (2015–2020) | | **8213** | **12474** |
| Women [%] | | 65.0 | 71.6 |
| Mean age (SD) | All | 74.3 (10.8) | 85.4 (7.8) |
| | Women | 75.3 (10.3) | 85.8 (7.4) |
| | Men | 72.4 (11.5) | 84.4 (8.6) |
| Age group [%] | <45 | 0.7 | 0.1 |
| | 45–54 | 4.0 | 0.3 |
| | 55–64 | 13.6 | 1.4 |
| | 65–74 | 28.6 | 6.5 |
| | 75–84 | 35.3 | 30.5 |
| | 85+ | 17.9 | 61.2 |
| N unknown BMI (%) | | 1,939 (24) | 3,551 (28) |
| N known BMI | | 6,274 | 8,923 |
| Mean BMI (SD) | | 24.2 (4.5) | 23.4 (4.3) |
| BMI [%] | <18.5 | 7.8 | 10.6 |
| | 18.5–24.9 | 54.9 | 58 |
| | 25–29.9 | 27.8 | 25.5 |
| | 30–34.9 | 7.4 | 4.8 |
| | 35–39.9 | 1.6 | 1.1 |
| | 40+ | 0.5 | 0.2 |
| N unknown ASA (%) | | 665 (8) | 903 (7) |
| N known ASA | | 7,548 | 11,571 |
| Morbidity state [%] | ASA 1 | 7.2 | 1.0 |
| | ASA 2 | 46.0 | 22.1 |
| | ASA 3 | 43.6 | 67.5 |
| | ASA 4/5 | 3.2 | 9.4 |

registry has captured a total of 20,687 fractures of the hip, with approximately 40% treated with THA and 60% with HA. The documented cases have increased by 4,158 cases since the 2020 report. Proportions remained constant. Women were more frequently affected with 69% of fractures occurring in female patents. 91.7% of the patients were older than 65 years. The age group above 85 accounted for 44% (Table 5.1). 2.1% were younger than 55 years and 6.3% between 55 and 64. The majority of patients had a normal BMI.

434 patients younger than 55 years of age sustained hip fractures. Of these 89% (n=386) were treated with THA. Of the patients over 85 years of age 23% received THA and 77% were treated with HA (derived from 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 (2015–2020).

| Hospital service volume (fracture) | | <50 | 51–99 | 100–149 | 150+ |
|---|---|---|---|---|---|
| N (2015–2020) | | **2,703** | **2,552** | **3,288** | **12,144** |
| Treatment with THA [%] | | 16.2 | 39.8 | 43.7 | 43.8 |
| Treatment with HA [%] | | 83.8 | 60.2 | 56.3 | 56.2 |
| Women [%] | | 71.2 | 69.2 | 69.6 | 68.2 |
| Mean age (SD) | All | 82.8 (9.3) | 81.0 (10.2) | 80.6 (10.7) | 80.7 (10.9) |
| | Women | 83.5 (8.8) | 81.8 (9.7) | 81.3 (10.1) | 81.7 (10.2) |
| | Men | 81.1 (10.3) | 79.0 (11.0) | 78.8 (11.8) | 78.7 (11.9) |
| Age group [%] | <45 | 0.0 | 0.2 | 0.2 | 0.4 |
| | 45–54 | 0.9 | 1.3 | 2.0 | 2.0 |
| | 55–64 | 3.9 | 6.4 | 6.8 | 6.6 |
| | 65–74 | 12.1 | 16.1 | 16.4 | 15.5 |
| | 75–84 | 33.2 | 32.8 | 33.0 | 32.0 |
| | 85+ | 49.7 | 43.3 | 41.6 | 43.5 |
| N unknown BMI (%) | | 873 (32) | 934 (37) | 1,013 (31) | 2,670 (22) |
| N known BMI | | 1,830 | 1,618 | 2,275 | 9,474 |
| Mean BMI (SD) | | 23.8 (4.2) | 24.0 (4.8) | 23.8 (4.6) | 23.7 (4.4) |
| BMI [%] | <18.5 | 8.8 | 8.8 | 9.6 | 9.6 |
| | 18.5–24.9 | 56.7 | 54.7 | 56.3 | 57.0 |
| | 25–29.9 | 27.3 | 27.3 | 26.9 | 26.0 |
| | 30–34.9 | 5.8 | 7.0 | 5.1 | 5.8 |
| | 35–39.9 | 1.1 | 1.8 | 1.6 | 1.2 |
| | 40+ | 0.2 | 0.4 | 0.5 | 0.3 |
| N unknown ASA (%) | | 176 (7) | 113 (4) | 550 (17) | 729 (6) |
| N known ASA | | 2,527 | 2,439 | 2,738 | 11,415 |
| Morbidity state [%] | ASA 1 | 2.7 | 4.9 | 3.4 | 3.3 |
| | ASA 2 | 29.6 | 33.5 | 33.2 | 31.1 |
| | ASA 3 | 60.2 | 54.6 | 57.2 | 58.6 |
| | ASA 4/5 | 7.5 | 6.9 | 6.2 | 7.0 |

The number of treated patients varied between services. Services were classified by the number of cases treated per year. Close to 60% (12,44 cases) of femoral neck fractures were treated in services with more than 150 arthroplasties/year (Table 5.3). 13% were treated in institutions which did less than 50 cases/year. The age distribution in the four categories (‹50 cases /year, 51–99, 100–149, ›150) was comparable to an average age between 80.7 and 82.8 years. Hospitals with smaller numbers (‹50 per year) treated more octogenarians. It is interesting to note that the percentage of patients treated by HA in the low volume institutions was significantly higher with 83.8% compared to high volume institutions at 56.2% (Table 5.3) and may indicate undertreatment. The reason for this is unclear. One explanation may be that in these institutions patients were also treated by general surgeons not trained to perform THA.

Of the patients diagnosed with fractures, 4.9% in the THA group and 1.3% 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 were cemented (85.9%) compared to 48.9% of stems in the THA group (Tables 5.4 and 5.5. Figures 5.1a/b).

The most common approaches for both procedures were a direct anterior or an anterolateral approach (Tables 5.4 and 5.6, Figures 5.2a/b). In both HA and THA the share of the anterior approach was the highest, used distinctly more for THAs.

Table 5.4
**Fracture of the hip: Surgery characteristics by treatment group**

| Main treatment group | | THA | | HA | |
|---|---|---|---|---|---|
| N (2015–2020) | | N | % | N | % |
| Previous surgery | None | 7,344 | 89.4 | 12,083 | 96.9 |
| | Internal fixation femur | 609 | 4.9 | 161 | 1.3 |
| | Osteotomy femur | 43 | 0.3 | 13 | 0.1 |
| | Internal fixation acetabulum | 53 | 0.4 | 1 | 0.0 |
| | Osteotomy pelvis | 7 | 0.1 | 1 | 0.0 |
| | Arthrodesis | 5 | 0.0 | 1 | 0.0 |
| | Other previous surgery | 178 | 1.4 | 215 | 1.7 |
| Approach | Anterior | 3,983 | 48.5 | 4,560 | 36.6 |
| | Anterolateral | 2,254 | 27.5 | 3,715 | 29.8 |
| | Posterior | 1,140 | 13.9 | 1,888 | 15.2 |
| | Lateral | 665 | 8.1 | 2,061 | 16.6 |
| | Other approach | 166 | 2.0 | 226 | 1.8 |
| Fixation | All uncemented | 3,988 | 48.6 | 1,724 | 13.8 |
| | Hybrid* | 3,261 | 39.7 | | |
| | All cemented | 666 | 8.1 | 10,711 | 85.9 |
| | Reverse hybrid** | 161 | 2.0 | | |
| | Reinforcement ring, femur uncemented | 45 | 0.5 | | |
| | Reinforcement ring, femur cemented | 92 | 1.1 | | |

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

Figure 5.1a

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

Relative distribution per year in %

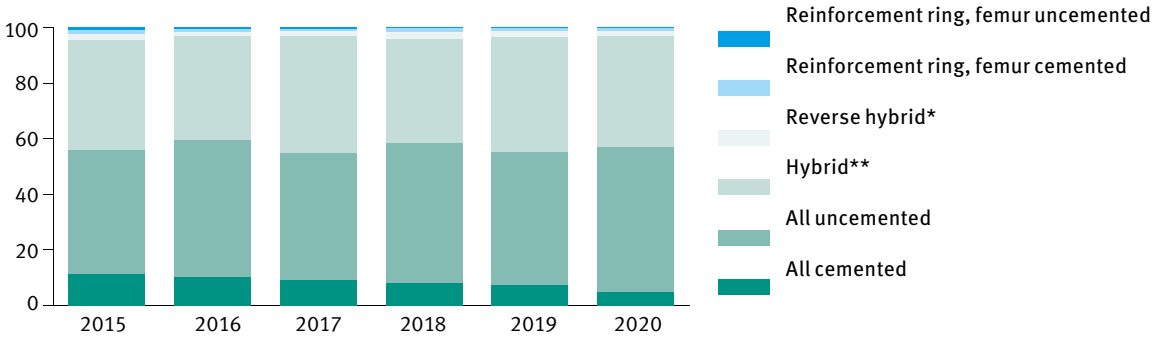



Figure 5.1b

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

Relative distribution per year in %

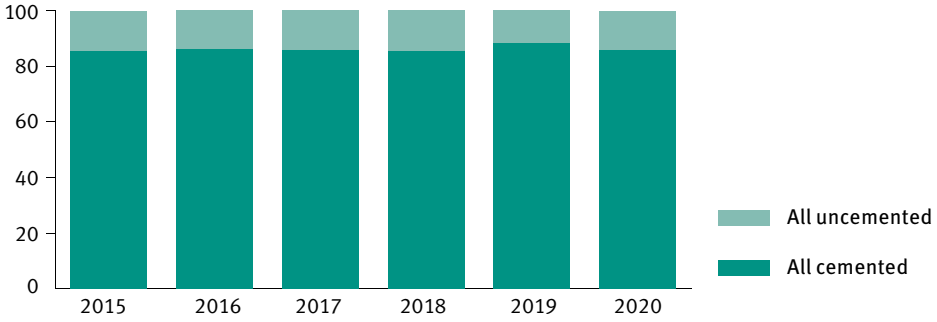



Table 5.5

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

Relative distribution per year in %

| Total hip arthroplasty (THA) | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Reinforcement ring, femur uncemented | 0.9 | 0.8 | 0.6 | 0.4 | 0.4 | 0.3 |
| Reinforcement ring, femur cemented | 1.6 | 0.9 | 0.7 | 1.2 | 1.2 | 1.1 |
| Reverse hybrid* | 2.1 | 1.4 | 1.8 | 2.7 | 1.9 | 1.9 |
| Hybrid** | 39.4 | 37.5 | 42.3 | 37.6 | 41.4 | 39.7 |
| All uncemented | 44.8 | 49.3 | 45.4 | 50.2 | 47.9 | 52.0 |
| All cemented | 11.2 | 10.1 | 9.2 | 8.0 | 7.2 | 4.9 |
| **Total [N]** | **1,118** | **1,196** | **1,245** | **1,358** | **1,563** | **1,733** |

| Hemi hip arthroplasty (HA) | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| All uncemented | 14.7 | 13.8 | 14.1 | 14.5 | 11.9 | 14.3 |
| All cemented | 85.3 | 86.2 | 85.9 | 85.5 | 88.1 | 85.7 |
| **Total [N]** | **1,890** | **1,917** | **1,981** | **2,123** | **2,243** | **2,281** |

* acetabulum cemented, femur uncemented = Reverse hybrid
** acetabulum uncemented, femur cemented = Hybrid

Figure 5.2a

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

Relative distribution per year in %

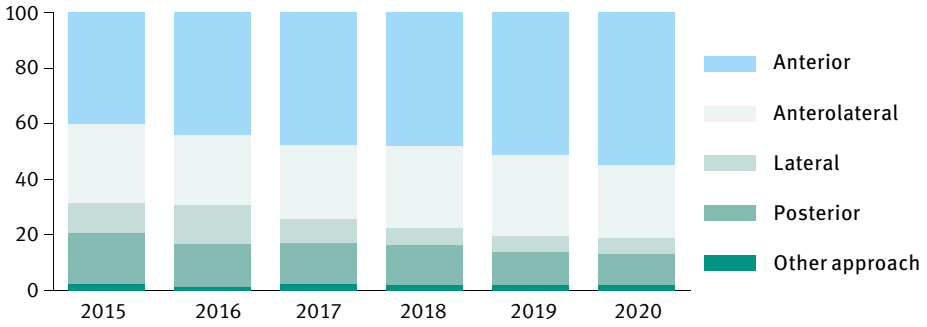



Figure 5.2b

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

Relative distribution per year in %

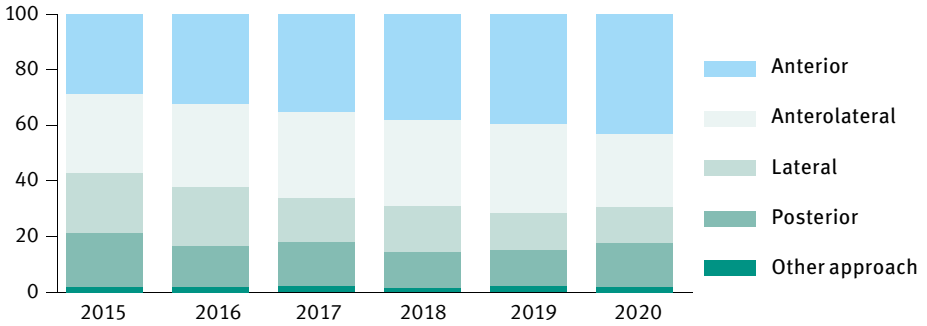



Table 5.6

**Fracture of the hip: Surgical approach by year**

Relative distribution per year in %

| Total hip arthroplasty (THA) | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Anterior | 40.1 | 44.1 | 47.7 | 47.9 | 51.6 | 55.3 |
| Anterolateral | 28.5 | 25.3 | 26.7 | 29.6 | 28.9 | 25.9 |
| Lateral | 10.8 | 13.8 | 8.5 | 6.0 | 6.0 | 5.7 |
| Posterior | 18.1 | 15.3 | 14.7 | 14.3 | 11.7 | 11.3 |
| Other approach | 2.5 | 1.4 | 2.4 | 2.1 | 1.9 | 1.9 |
| **Total [N]** | **1,113** | **1,196** | **1,245** | **1,358** | **1,563** | **1,733** |

| Hemi hip arthroplasty (HA) | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Anterior | 29.0 | 32.3 | 35.4 | 38.2 | 39.8 | 43.0 |
| Anterolateral | 28.3 | 30.1 | 31.1 | 31.0 | 32.0 | 26.6 |
| Lateral | 21.7 | 21.0 | 15.5 | 16.6 | 13.1 | 13.0 |
| Posterior | 19.2 | 14.7 | 16.1 | 13.0 | 13.2 | 15.5 |
| Other approach | 1.9 | 1.9 | 2.0 | 1.3 | 2.0 | 1.9 |
| **Total [N]** | **1,868** | **1,923** | **1,987** | **2,130** | **2,249** | **2,293** |

**Mortality**

For the reasons mentioned above and linked to patient characteristics in the subgroup of hip fractures, the estimated mortality rates were 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 patients treated with HA 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 whose mean age was 85 years at the time of surgery. Patients selected for a THA were on average 11 years younger. Certainly, there is a selection bias, in that more active and healthier patients were treated with THA.

Table 5.7

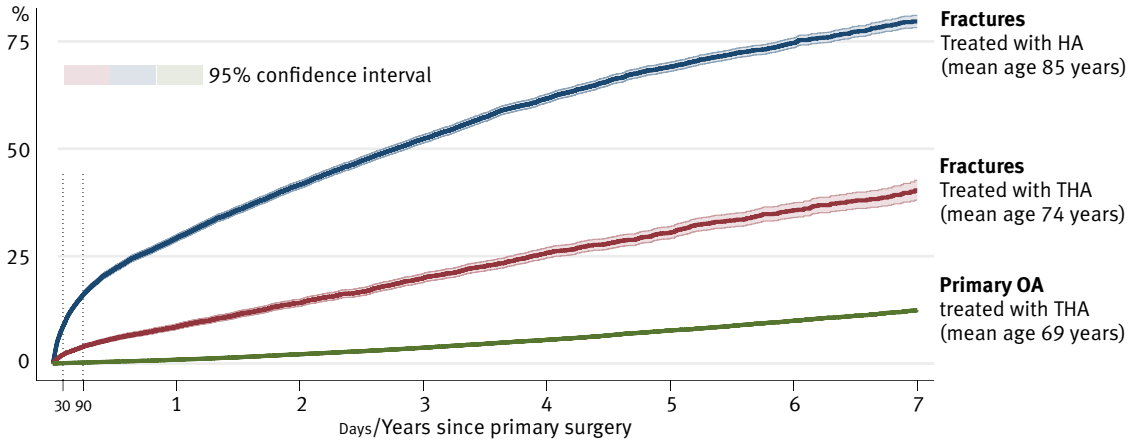
**Cement brands used in hemiarthroplasty (HA) for fracture (2015–2020)**

| Brand | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|
| Palacos | 1,125 | 1,163 | 1,286 | 1,363 | 1,410 | 1,424 | 7,771 |
| Optipac | 232 | 189 | 145 | 331 | 474 | 453 | 1,824 |
| Refobacin | 64 | 139 | 101 | 23 | 37 | 24 | 388 |
| SmartSet | 35 | 14 | 50 | 41 | 17 | 6 | 163 |
| Other | 107 | 126 | 103 | 46 | 14 | 7 | 403 |
| **Total** | **1,563** | **1,631** | **1,685** | **1,804** | **1,952** | **1,914** | **10,549** |

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**

Time since operation, 2012–2019, all services




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

| Fractures | 30 days | 90 days | 1 year | 3 years | 5 years | 7 years |
|---|---|---|---|---|---|---|
| Treated with THA (mean age 74 years) | **2.1** (1.8-2.4) | **3.9** (3.5-4.4) | **8.5** (7.9-9.2) | **19.9** (18.9-21.0) | **30.4** (29.1-31.9) | **40.3** (38.1-42.7) |
| Treated with HA (mean age 85 years) | **8.7** (8.2-9.2) | **16.1** (15.5-16.7) | **29.2** (28.4-30.0) | **52.3** (51.4-53.3) | **69.1** (68.0-70.2) | **79.6** (78.2-81.1) |
| **Primary OA** | | | | | | |
| Treated with THA (mean age 69 years) | **0.1** (0.1-0.1) | **0.2** (0.2-0.3) | **0.9** (0.8-1.0) | **3.7** (3.6-3.8) | **7.7** (7.5-7.9) | **12.4** (12.0-12.8) |

The 30-days mortality is an indicator for the effectiveness of the perioperative treatment of fractures of the proximal femur. Mortality rate was estimated by linking the SIRIS database with the Swiss death registry. In the literature, reported rates vary between three and twelve percent. Advances in recent treatment modalities including treatment within the first 24 hours, preoperative medical optimisation and specialised medical care (geriatric traumatology) have led to decreasing 30-day mortality rates. This report analyses the mortality rate of a subgroup of fractures of the proximal femur, namely femoral neck fractures treated with HA. The 30-day mortality rate differed considerably from canton to canton and between hospitals. It ranged from less than 5% to more than 15% (Figure 5.4). These figures were unadjusted but additional regression analyses have been conducted to test the reliability of these figures. In order to verify that the observed differences between major centres were not due to known differences in the risk structure, a simple logistic regression model was performed using the most likely confounders and binary predictors for the three centres with the highest 30-day mortality rates. The model shows that the risk of death increased with each year of age at operation (approx.

Figure 5.4a

**30-day postoperative mortality rates in cantons (2012–2019)**

2012–2019, Kaplan-Meier estimates with 95% confidence intervals, only showing cantons with sufficient numbers

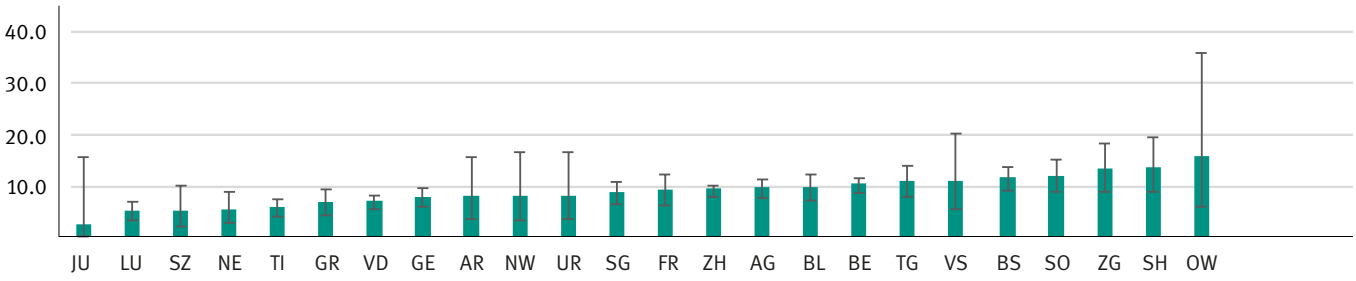
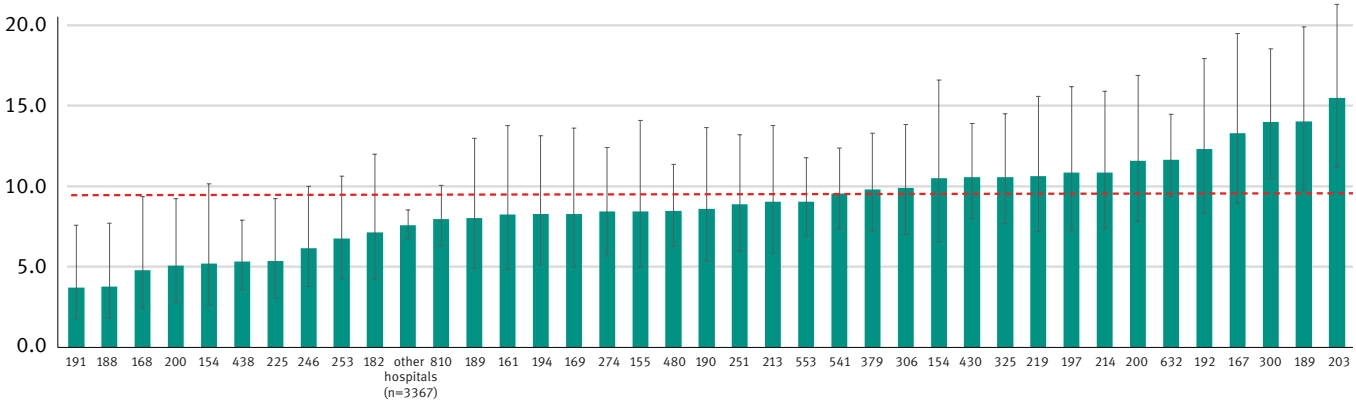



Figure 5.4b

**30-day postoperative mortality rates per hospital (2012–2019) with 95% confidence intervals**

2012–2019, with 95% confidence intervals, 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 8.7% (CI 8.2-9.2)



5%). Men were more likely to die than women and patients rated as having a life-threatening condition were considerably more likely to die within 30 days of surgery (Table 5.8). Still, even after controlling for these known risk factors, two of the three clinics featured statistically significant odds ratios of around 1.7, indicating that the risk of dying there after hemiarthroplasties is considerably elevated. However, it must be kept in mind that this analysis only covers a subgroup of fractures of the proximal femur and the mortality rate after osteosynthesis of proximal femur fracturs is not known.

Table 5.8

**Results of logistic regression model predicting 30-day post-operative mortality after hemi-arthroplasty for fractures and testing effects of top 3 centres**

N=8952, using only cases with valid ASA

| Predictor | Odds ratio | Sig | 95% CI |
|---|---|---|---|
| Age at operation | 1.06 | ‹0.001 | 1.05–1.07 |
| Sex = Male | 1.57 | ‹0.001 | 1.34–1.83 |
| ASA | | | |
| mild/moderate disturbance | 1.28 | 0.732 | 0.31–5.35 |
| severe disturbance | 3.67 | 0.07 | 0.89–15.0 |
| life-threatening | 9.33 | 0.002 | 2.27–38.41 |
| | | | |
| **Centre with high rate No. 1** | 1.75 | 0.008 | 1.16–2.65 |
| **Centre with high rate No. 2** | 1.79 | 0.014 | 1.28–2.84 |
| **Centre with high rate No. 3** | 1.58 | 0.077 | 0.95–2.64 |

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

To represent the current treatment and to minimise the problem of overaged data the two-year revision rates were carried out within a four-year moving window, including the last four years with full two-year follow-up. Implantations between 1.1.2015 and 31.12.2018 were analysed with completed two-year follow-up until 31.12.2020. 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 comparisons 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 by means of Kaplan-Meier survival estimates.

The two-year revision rate after THA was 4.7% (95%CI 4.2 to 5.4) and higher than in HA patients with 3.3% (95% CI 2.9 to 3.7). Higher BMI and ASA scores were risk factors for revision (Table 5.9).

Table 5.9

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)
BMI and ASA class data only available from 2015 onwards.

| | | 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) | | 4,918 | 223 | 4.7 | 4.2 | 5.4 | 7,934 | 221 | 3.3 | 2.9 | 3.7 |
| Gender | Women | 3,222 | 129 | 4.1 | 3.5 | 4.9 | 5,701 | 155 | 3.1 | 2.6 | 3.6 |
| | Men | 1,696 | 94 | 5.9 | 4.9 | 7.2 | 2,233 | 66 | 3.7 | 2.9 | 4.8 |
| Age group | <55 | 248 | 10 | 4.1 | 2.2 | 7.4 | 25 | 2 | 10.3 | 2.7 | 35.2 |
| | 55–64 | 677 | 38 | 5.8 | 4.3 | 7.9 | 116 | 9 | 8.7 | 4.6 | 16.0 |
| | 65–74 | 1,432 | 73 | 5.2 | 4.2 | 6.6 | 554 | 26 | 5.5 | 3.7 | 8.0 |
| | 75–84 | 1,722 | 70 | 4.2 | 3.4 | 5.3 | 2,454 | 85 | 3.9 | 3.2 | 4.9 |
| | 85+ | 838 | 32 | 4.2 | 3.0 | 5.9 | 4,783 | 99 | 2.4 | 2.0 | 2.9 |
| Overall (2015–2019) | | 279 | 13 | 5.0 | 2.9 | 8.4 | 565 | 14 | 3.0 | 1.8 | 5.1 |
| BMI group | <18.5 | 1,964 | 78 | 4.2 | 3.3 | 5.2 | 3,098 | 68 | 2.6 | 2.0 | 3.2 |
| | 18.5–24.9 | 1,016 | 47 | 4.7 | 3.6 | 6.2 | 1,385 | 55 | 4.7 | 3.6 | 6.0 |
| | 25–29.9 | 282 | 15 | 5.6 | 3.4 | 9.1 | 262 | 12 | 5.1 | 2.9 | 8.8 |
| | 30–34.9 | 62 | 5 | 8.4 | 3.6 | 19.1 | 59 | 3 | 5.3 | 1.7 | 15.4 |
| | 35–39.9 | 21 | 5 | 25.0 | 11.2 | 50.2 | 16 | 0 | 0.0 | | |
| | 40+ | 1,289 | 60 | 4.9 | 3.8 | 6.3 | 2,525 | 68 | 3.1 | 2.4 | 3.9 |
| | Unknown | 320 | 10 | 3.2 | 1.7 | 5.8 | 82 | 3 | 3.7 | 1.2 | 11.1 |
| Morbidity state | ASA 1 | 2,141 | 87 | 4.1 | 3.4 | 5.1 | 1,703 | 42 | 2.8 | 2.0 | 3.7 |
| | ASA 2 | 1,891 | 104 | 5.8 | 4.8 | 7.0 | 4,878 | 144 | 3.4 | 2.9 | 4.0 |
| | ASA 3 | 135 | 4 | 3.5 | 1.3 | 9.0 | 648 | 15 | 3.2 | 1.9 | 5.4 |
| | ASA 4/5 | 426 | 18 | 4.6 | 2.9 | 7.1 | 599 | 16 | 3.1 | 1.9 | 5.1 |
| | 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.

However, the number of patients with BMI >30 and ASA 4/5 were small, and conclusions must be drawn cautiously.

In both groups uncemented stems had an increased risk for revision caused by a periprosthetic fracture. A posterior approach bore a higher risk of revision for THA, whereas for HA the approach seemed to play a minor role (Table 5.10).

The reasons for first revisions have some imperfections related to terminology. Protrusion of an acetabular shell can have a different meaning than protrusion of the HA. While the first implies 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. In about 12% of HA cases, response categories actually related to revision of an acetabular implant were chosen. These were interpreted and analysed as conversions. The conversion of HA to THA with/without stem exchange accounted for 33.5% of all revision cases (Table 5.13).

Table 5.10

**Fracture of the hip: First revisions within 24 months according to stem fixation and approach**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| | 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) | 4,918 | 223 | 4.7 | 4.2 | 5.4 | 7,934 | 221 | 3.3 | 2.9 | 3.7 |
| All cemented | 468 | 20 | 4.7 | 3.0 | 7.2 | 6,782 | 169 | 2.9 | 2.5 | 3.4 |
| All uncemented | 2,338 | 112 | 4.9 | 4.1 | 5.9 | 1,131 | 52 | 5.3 | 4.0 | 6.9 |
| Hybrid | 1,927 | 79 | 4.3 | 3.4 | 5.3 | 0 | 0 | | | |
| Anterior | 2,218 | 92 | 4.3 | 3.5 | 5.3 | 2,682 | 69 | 3.0 | 2.4 | 3.8 |
| Anterolateral | 1,356 | 55 | 4.2 | 3.3 | 5.5 | 2,386 | 69 | 3.3 | 2.6 | 4.2 |
| Lateral | 473 | 18 | 4.1 | 2.6 | 6.4 | 1,468 | 45 | 3.7 | 2.8 | 4.9 |
| Posterior | 762 | 47 | 6.4 | 4.8 | 8.4 | 1,236 | 37 | 3.4 | 2.5 | 4.7 |
| Other approach | 104 | 11 | 11.9 | 6.7 | 20.5 | 138 | 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.

Periprosthetic fractures, dislocations and infections were the three most common complications in both THA and HA (Table 5.11). Infections (35.3%) were the most important cause in the HA group. Interestingly, the dislocation rate in HA was similar to THA, with 24.2% in THA and 21.3% for HA.

Comparing the revision rates of unipolar and bipolar heads shows that the latter had a higher revision rate in the first two years. After three years the revision rate of unipolar heads exceeded that of bipolar heads (Figure 5.5). However, the difference was not significant as shown by the overlapping confidence intervals (CI). The higher early revision rate of bipolar heads was due to the rate of dislocation that was 10 percentage points higher and also occurring earlier (Table 5.12). Periprosthetic fractures were also more frequent in HA.

Table 5.11

**Fracture of the hip: Reasons for early first revisions**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Early first revisions are those occurring within 2 years of the primary arthroplasty.
Multiple responses possible (percentages do not sum to 100).

| | Total hip arthroplasty | | Hemi hip arthroplasty | |
|---|---|---|---|---|
| | N | % | N | % |
| Dislocation | 54 | 24.2 | 47 | 21.3 |
| Periprosthetic fracture | 52 | 23.3 | 48 | 21.7 |
| Infection | 51 | 22.9 | 78 | 35.3 |
| Loosening femoral | 26 | 11.7 | 18 | 8.1 |
| Loosening acetabular | 23 | 10.3 | | |
| Other | 22 | 9.9 | 27 | 12.2 |
| Position/Orientation of cup | 9 | 4.0 | | |
| Position/Orientation of stem | 7 | 3.1 | 3 | 1.4 |
| Acetabular protrusion | 6 | 2.7 | 5 | 2.3 |
| Trochanter pathology | 2 | 0.9 | 2 | 0.9 |
| Femoral osteolysis | 1 | 0.4 | 0 | 0.0 |
| Impingement | 1 | 0.4 | 0 | 0.0 |
| Squeaking | 1 | 0.4 | 0 | 0.0 |
| Wear | 0 | 0.0 | 2 | 0.9 |
| Metallosis | 0 | 0.0 | 0 | 0.0 |
| Acetabular osteolysis | 0 | 0.0 | 1 | 0.5 |
| 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 |
| Total | **255** | | **232** | |

Table 5.12

**Fracture of the hip: Reasons for early first revisions (unipolar vs. bipolar hemi heads)**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Early first revisions are those occurring within 2 years of the primary arthroplasty. Multiple responses possible (percentages do not sum to 100).
Cemented stems only

| | Unipolar heads | | Bipolar heads | |
|---|---|---|---|---|
| | N | % | N | % |
| Loosening femoral | 7 | 6.9 | 7 | 10.9 |
| Infection | 43 | 42.2 | 25 | 39.1 |
| Periprosthetic fracture | 16 | 15.7 | 7 | 10.9 |
| Dislocation | 19 | 18.6 | 18 | 28.1 |
| Wear | 0 | 0.0 | 0 | 0.0 |
| Acetabular osteolysis | 0 | 0.0 | 1 | 1.6 |
| Femoral osteolysis | 0 | 0.0 | 0 | 0.0 |
| Trochanter pathology | 0 | 0.0 | 0 | 0.0 |
| Status after spacer | 0 | 0.0 | 0 | 0.0 |
| Implant breakage | 0 | 0.0 | 0 | 0.0 |
| Blood ion level | 0 | 0.0 | 0 | 0.0 |
| Position/Orientation of stem | 0 | 0.0 | 0 | 0.0 |
| Impingement | 2 | 2.0 | 1 | 1.6 |
| Acetabular protrusion | 0 | 0.0 | 0 | 0.0 |
| Other | 15 | 14.7 | 8 | 12.5 |
| **Total** | **102** | | **67** | |

Table 5.13

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

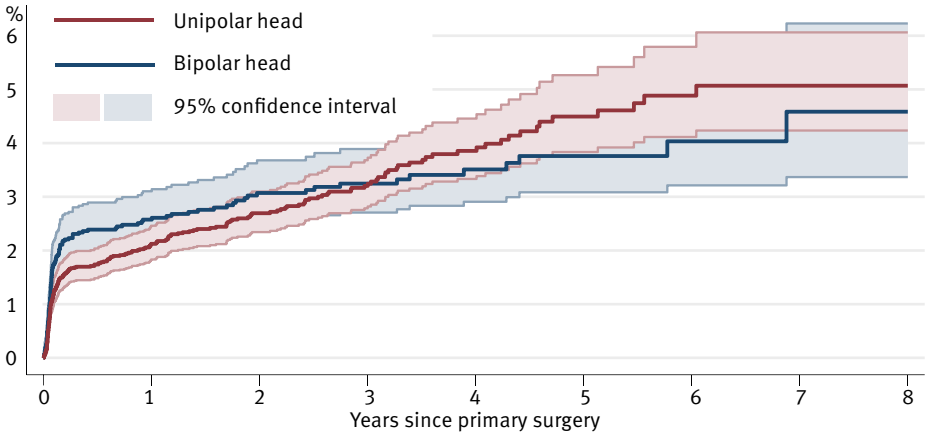
4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
HA: in approx. 11% of cases response categories involving acetabular components were chosen.
These were recorded as conversions.

| | Total hip arthroplasty | | Hemi hip arthroplasty | |
|---|---|---|---|---|
| | N | % | N | % |
| Exchange acetabular and femoral components | 32 | 14.3 | | |
| Exchange acetabular component | 13 | 5.8 | | |
| Exchange acetabular component and head | 47 | 21.1 | | |
| Exchange femoral component | 46 | 20.6 | 38 | 17.2 |
| Exchange femoral component and inlay | 11 | 4.9 | 6 | 2.7 |
| Exchange head | 16 | 7.2 | 56 | 25.3 |
| Exchange inlay | 2 | 0.9 | 3 | 1.4 |
| Exchange head and inlay | 32 | 14.3 | 18 | 8.1 |
| Conversion of hemi-prosthesis to THA without stem exchange | | | 42 | 19.0 |
| Conversion of hemi-prosthesis to THA with stem exchange | | | 32 | 14.5 |
| Component removal, spacer implantation | 5 | 2.2 | 2 | 0.9 |
| Component reimplantation (after spacer or Girdlestone) | 3 | 1.3 | 3 | 1.4 |
| Girdlestone | 4 | 1.8 | 6 | 2.7 |
| Exchange femoral component, inlay and osteosynthesis | 7 | 3.1 | 4 | 1.8 |
| Other intervention | 5 | 2.2 | 11 | 5.0 |
| **Total** | **223** | **100.0** | **221** | **100.0** |

Figure 5.5

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

Time since operation, 2012–2020, only cemented stems. % of implants revised.




### Cumulative revision rate

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Unipolar head | **2.1** (1.8-2.5) | **2.7** (2.3-3.1) | **3.2** (2.8-3.7) | **3.9** (3.3-4.5) | **4.5** (3.8-5.3) | **4.9** (4.1-5.8) | **5.1** (4.2-6.1) | **5.1** (4.2-6.1) |
| Bipolar head | **2.6** (2.1-3.1) | **3.1** (2.6-3.7) | **3.2** (2.7-3.9) | **3.5** (2.9-4.2) | **3.8** (3.1-4.6) | **4.0** (3.2-5.1) | **4.6** (3.4-6.2) | **4.6** (3.4-6.2) |

## 5.3 Results of implants by HA after hip fractures

The basic results of THA after fracture are shown in chapter 4. 126 different stem head combinations were used for the treatment with HA. 88 combinations were used in less than 10 cases each. The ten most frequently used combinations, accounting for 75% of all cases, are shown in Table 5.14. The average two-year revision rate (four-year moving average) was 2.9% (95% CI 2.5 to 3.4). The revision rates for the most frequent combinations are shown in Table 5.15.

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 5.6 and 5.7). This perspective shows what proportion of implants have

Table 5.14

**Fracture of the hip: top 10 stem/head combinations used in hemi hip arthroplasty (HA)**

2015–2020

| Stem component | Head component | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|
| CCA | Mathys Hemi Head Steel | 287 | 339 | 334 | 407 | 426 | 378 | 2,171 |
| Amistem | Medacta Endo Head | 151 | 205 | 292 | 281 | 276 | 321 | 1,526 |
| Weber | Zimmer Biomet Unipolar Head | 179 | 190 | 155 | 250 | 221 | 166 | 1,161 |
| Centris | Mathys Hemi Head Steel | 60 | 87 | 86 | 108 | 100 | 102 | 543 |
| Twinsys | Mathys Hemi Head Steel | 35 | 82 | 94 | 67 | 91 | 117 | 486 |
| Amistem | Medacta Bipolar Head | 57 | 58 | 67 | 94 | 89 | 111 | 476 |
| Original Mueller | Zimmer Biomet Unipolar Head | 103 | 50 | 52 | 63 | 58 | 56 | 382 |
| Corail | Modular Head Carthcart | 42 | 40 | 63 | 41 | 83 | 97 | 366 |
| Harmony cemented | Symbios Bipop | 66 | 76 | 87 | 84 | 49 | 4 | 366 |
| Avenir | Zimmer Biomet Bipolar Head | 11 | 17 | 49 | 60 | 79 | 98 | 314 |
| Other combinations | | 574 | 480 | 388 | 324 | 434 | 394 | 2,594 |
| Total | | **1,565** | **1,624** | **1,667** | **1,779** | **1,906** | **1,844** | **10,385** |

Figure 5.6

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

Time since operation, 2012–2020, all services, % of implants revised

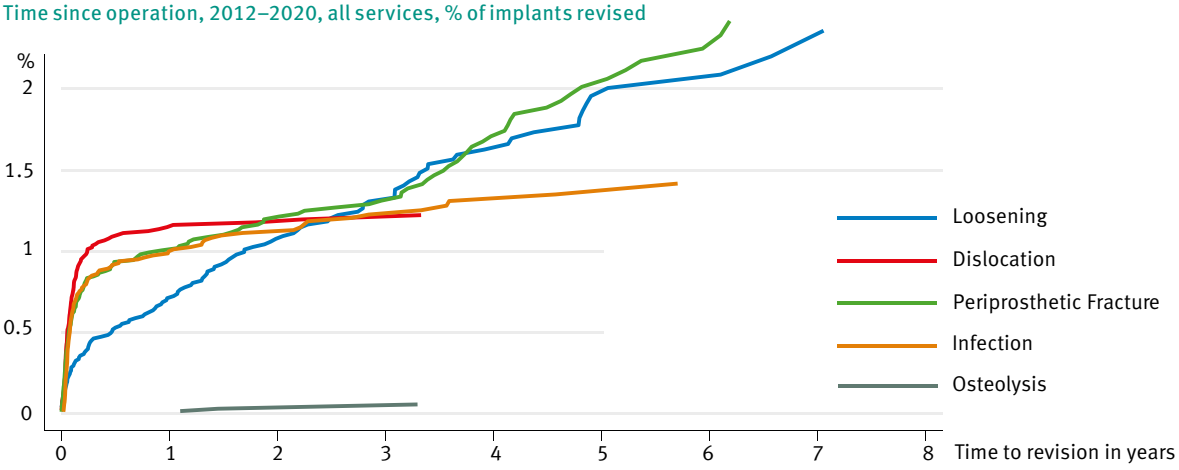
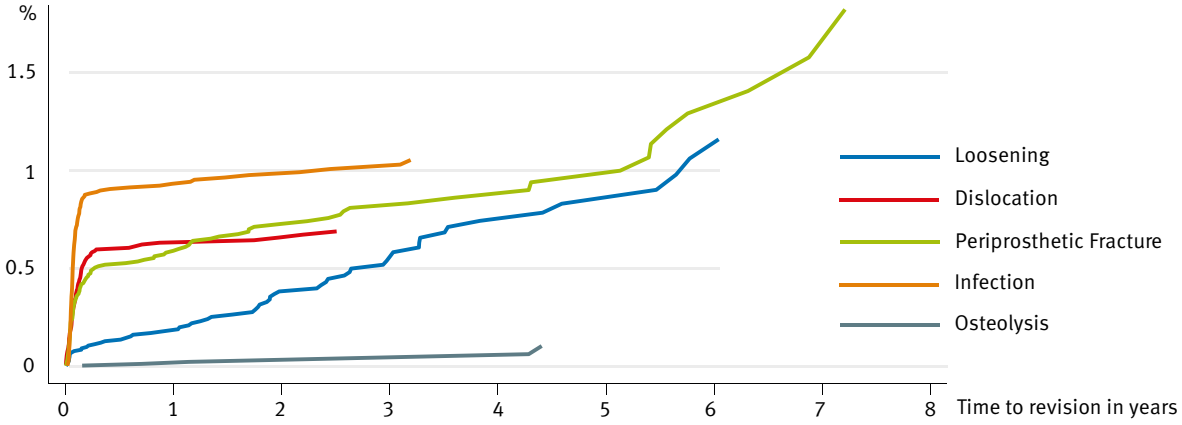


Figure 5.7

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

Time since operation, 2012–2020, all services, % of implants revised




## Important information on the use of the implant performance tables below

Implants ranked by upper end of the 95% confidence interval. This is the upper end of the plausible range in which the true 2-year revision rate of an implant could lie with 95% certainty after allowing for random variation in the occurrence of revisions.

At the bottom of the list are the implants without any registered revisions (statistical evaluation not yet possible).

●=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. Observed revision rates may be determined by local factors and performance may differ significantly between locations. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

experienced a first revision due to 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.
It highlights 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, on the other hand, were the drivers of long-term revision rates in both THA and HA. None of the implants reached potential outlier status (Table 5.16).

Table 5.15

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)
Stem-head combinations with at least 50 implants. Covering approx. 93% of registered fracture HAs, alphabetic order.

| Stem component | Head component | At risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|---|
| | | N | N | %** | lower | upper |
| Amistem | Medacta Bipolar Head | 277 | 7 | 2.8 | 1.3 | 5.8 |
| Amistem | Medacta Endo Head | 929 | 27 | 3.4 | 2.4 | 5.0 |
| Arcad SO | Symbios Bipop | 145 | 5 | 4.0 | 1.7 | 9.3 |
| Avenir | Zimmer Biomet Bipolar Head | 137 | 5 | 4.3 | 1.8 | 10.3 |
| Avenir | Zimmer Biomet Unipolar Head | 117 | 1 | 1.0 | 0.1 | 6.8 |
| CCA | Mathys Bipolar Head Steel | 138 | 6 | 5.3 | 2.4 | 11.7 |
| CCA | Mathys Hemi Head Steel | 1,369 | 28 | 2.5 | 1.7 | 3.6 |
| Centris | Mathys Hemi Head Steel | 342 | 7 | 2.6 | 1.2 | 5.3 |
| Corail | S&N Bipolar Head | 58 | 2 | 3.5 | 0.9 | 13.4 |
| Corail | Modular Head Carthcart | 186 | 7 | 4.1 | 2.0 | 8.4 |
| CS-Plus | Medacta Bipolar Head | 69 | 1 | 1.7 | 0.2 | 11.4 |
| Harmony Cemented | Symbios Bipop | 313 | 12 | 4.3 | 2.5 | 7.5 |
| MS-30 Stems | Zimmer Biomet Bipolar Head | 83 | 4 | 5.2 | 2.0 | 13.3 |
| MS-30 Stems | Zimmer Biomet Unipolar Head | 75 | 0 | 0.0 | | |
| Original Mueller | Zimmer Biomet Bipolar Head | 200 | 5 | 3.0 | 1.3 | 7.2 |
| Original Mueller | Zimmer Biomet Unipolar Head | 268 | 4 | 1.7 | 0.6 | 4.5 |
| Quadra | Medacta Bipolar Head | 81 | 1 | 1.3 | 0.2 | 8.6 |
| Quadra | Medacta Endo Head | 104 | 1 | 1.2 | 0.2 | 8.0 |
| Twinsys | Mathys Bipolar Head Steel | 57 | 2 | 4.2 | 1.1 | 15.8 |
| Twinsys | Mathys Hemi Head Steel | 278 | 7 | 2.7 | 1.3 | 5.7 |
| Weber | Zimmer Biomet Bipolar Head | 201 | 4 | 2.1 | 0.8 | 5.5 |
| Weber | Zimmer Biomet Unipolar Head | 774 | 24 | 3.8 | 2.5 | 5.6 |
| Group average | | | | 2.9 | 2.5 | 3.4 |

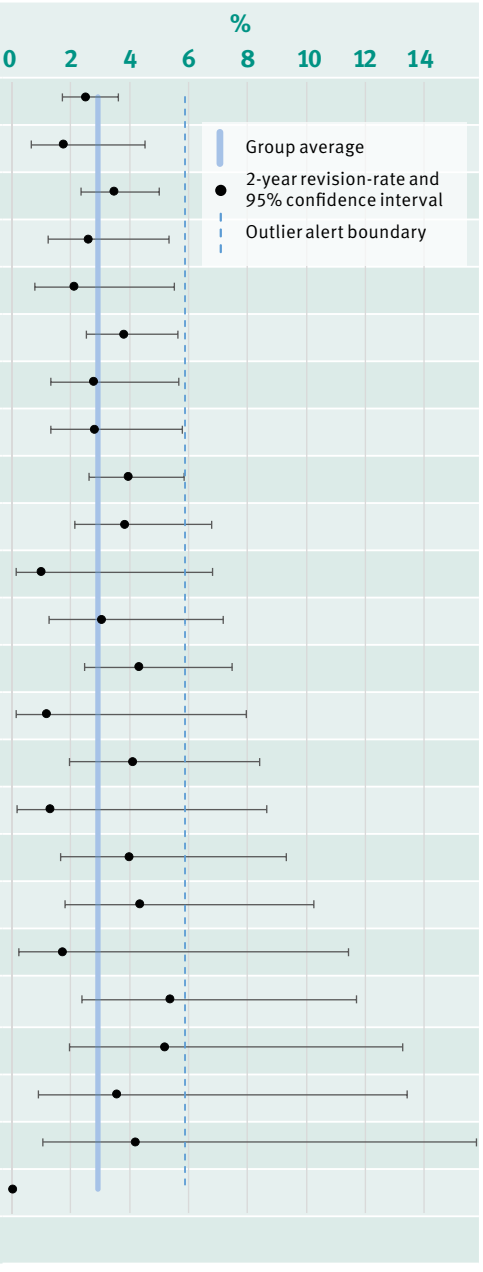
* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

Table 5.16

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| Stem component | Head component | At risk N* | Revised N | Revised %** | 95% CI lower | 95% CI upper |
|---|---|---|---|---|---|---|
| CCA | Medacta Endo Head | 1,369 | 28 | 2.5 | 1.7 | 3.6 |
| Original Mueller | ZB Unipolar Head | 268 | 4 | 1.7 | 0.6 | 4.5 |
| Amistem | Medacta Endo Head | 929 | 27 | 3.4 | 2.4 | 5.0 |
| Centris | Mathys Hemi Head Steel | 342 | 7 | 2.6 | 1.2 | 5.3 |
| Weber | ZB Bipolar Head | 201 | 4 | 2.1 | 0.8 | 5.5 |
| Weber | ZB Unipolar Head | 774 | 24 | 3.8 | 2.5 | 5.6 |
| Twinsys | Mathys Hemi Head Steel | 278 | 7 | 2.7 | 1.3 | 5.7 |
| Amistem | Medacta Bipolar Head | 277 | 7 | 2.8 | 1.3 | 5.8 |
| Weber | ZB Unipolar Headd | 733 | 24 | 3.9 | 2.6 | 5.8 |
| Harmony | Symbios Bipop | 321 | 11 | 3.8 | 2.1 | 6.8 |
| Avenir | ZB Unipolar Head | 117 | 1 | 1.0 | 0.1 | 6.8 |
| Original Mueller | ZB Bipolar Head | 200 | 5 | 3.0 | 1.3 | 7.2 |
| Harmony | Symbios Bipop | 313 | 12 | 4.3 | 2.5 | 7.5 |
| Quadra | Medacta Endo Head | 104 | 1 | 1.2 | 0.2 | 8.0 |
| Corail | ModularKopf Carthcart | 186 | 7 | 4.1 | 2.0 | 8.4 |
| Quadra | Medacta Bipolar Head | 81 | 1 | 1.3 | 0.2 | 8.6 |
| Arcad SO | Symbios Bipop | 145 | 5 | 4.0 | 1.7 | 9.3 |
| Avenir | ZB Bipolar Heads | 137 | 5 | 4.3 | 1.8 | 10.3 |
| CS-PLUS | Medacta Bipolar Head | 69 | 1 | 1.7 | 0.2 | 11.4 |
| CCA | Medacta Bipolar Head | 138 | 6 | 5.3 | 2.4 | 11.7 |
| MS-30 Stem | ZB Bipolar Head | 83 | 4 | 5.2 | 2.0 | 13.3 |
| Corail | S&N Bipolar Head | 58 | 2 | 3.5 | 0.9 | 13.4 |
| Twinsys | Mathys Bipolar Head Steel | 57 | 2 | 4.2 | 1.1 | 15.8 |
| MS-30 | ZB Unipolar Head | 75 | 0 | 0.0 | | |
| Group Average | | | | 2.9 | 2.5 | 3.4 |




* 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

## 5.4 Competing risks

As has been outlined in the methods chapter of this report, the omnipresent Kaplan-Meier method has known limitations when the risk of revision is competing with other risks. In the context of joint registries, the one obvious competing risk is death of a patient and as has been shown in this chapter, no other group of patients in this report was as affected by this as the recipients of prostheses after hip fractures. A patient who dies will not have his implant revised at any later point in time. Risk of death is said to "compete" with the risk of revision in patients. Within the constraints of the Kaplan-Meier method we account for death by declaring patients who died during their observation time as "censored" from the day of death. This approach is not wrong, but it may be based on the unrealistic assumption that death is an event that occurs entirely independently of revision.

As a first step towards quantifying the potential bias of the Kaplan-Meier method in the presence of the strong competing risk of death in SIRIS data, we have produced a very simple competing risks regression model. It includes component revision as the primary endpoint, death as the competing risk, and the type of the arthroplasty as well as age and sex as covariates of interest. Results are shown in Table 5.17. SHR stands for subhazard ratio. It is the coefficient that tells us here that fracture THAs are more likely to be revised than primary OA THAs by a factor of 1.87. For fracture HAs that factor is 1.27. Also, for each year of age the likelihood of revision is reduced by a factor of 0.99. It should be kept in mind that the cumulative effect of this covariate can be considerable. These three factors were statistically highly significant.

Results in terms of what the now accounted for competing risk of death means for our interpretation are best shown by comparing standard KM results against the cumulative revision risk derived from the predicted values of this model. As has been shown before, primary OA THA carried the lowest overall revision risk, whilst fracture THA had the highest. Fracture HA lay somewhere in the middle (Figure 5.8). The predicted results of the competing

Table 5.17

**Comparison of cumulative revision risk for generic groups under presence of competing risk of dying**

All cases 2012–2019 (current limit of mortality data)

n=137,277, n failed=4,160, n competing=14,476, competing risk = death of patient

| Primary OA THA (reference category) | SHR | robust std. error | sig. | 95% confidence intervall | |
|---|---|---|---|---|---|
| Fracture THA | 1.87 | 0.10 | <0.001 | 1.69 | 2.07 |
| Fracture HA | 1.27 | 0.08 | <0.001 | 1.13 | 1.43 |
| Age at operation | 0.99 | 0.00 | <0.001 | 0.99 | 0.99 |
| Female | 1.03 | 0.03 | 0.34 | 0.97 | 1.10 |

* Fine and Gray's proportional subhazards model

risks regression model, here expressed specifically for the "typical" or average patient in those groups, showed little difference for the THAs (Figure 5.9). Primary OA THA is hardly changed by the adjustment for competing risks. This is to be expected as the relatively low mortality of this group, even after seven years follow-up, did not have the weight to influence results much. Fracture THA was actually shifted by one percentage point downwards. But the impact on fracture HA, the group with very high mortality rates, is most impressive. After adjustment, the model suggests that this group probably did not face a higher revision risk than the primary OA THA group. The KM curve is misleading in the sense that it shows us what happens if we only look at the survivors after each loss to the risk set (i.e. after a patient is revised or died). The regression model, on the other hand, shows us what is predicted to happen to a typical fracture HA patient who is 85 years old and has a high risk of dying during the observation time spanning seven years.

Figure 5.8
**Fracture of the hip: cumulative incidence rates for different revision diagnoses (fracture HA)**

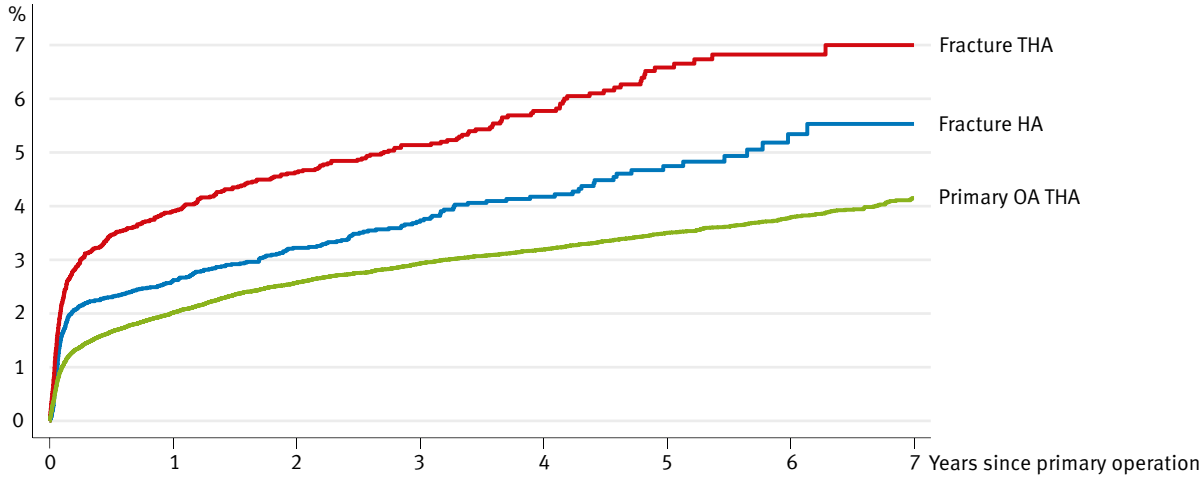
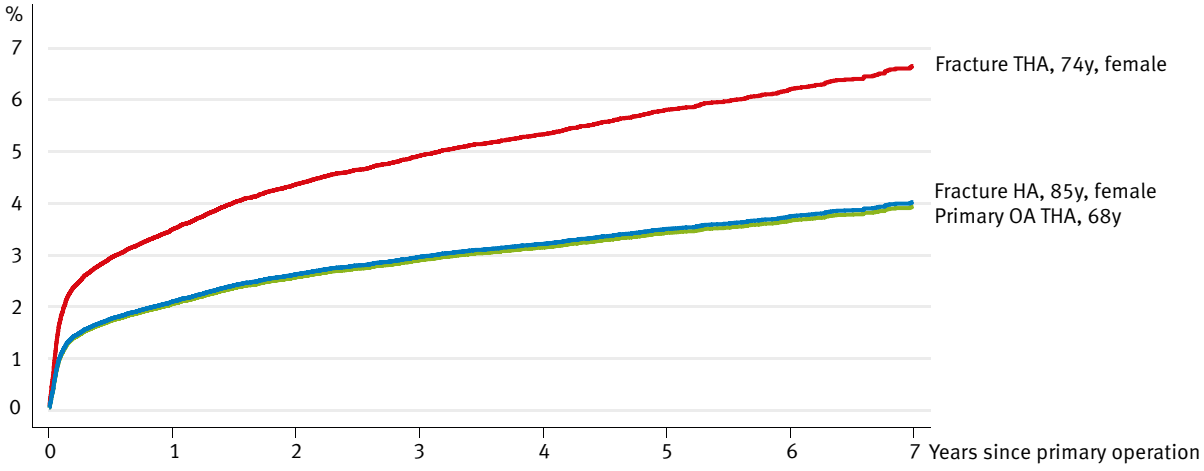



Figure 5.9
**Comparison of cumulative revision risk for typical patients under presence of competing risk of dying**



# 6. Knee arthroplasty

# 6. Knee arthroplasty

## 6.1 Primary total knee arthroplasty

Starting in 2012, 118,001 total knee arthroplasties (TKA) have been registered in the Swiss national joint registry SIRIS. Morbidity state (ASA classification) and the Body Mass Index (BMI) have been recorded since 2015. One problem of continuing data collections is that the outdated data have the same weight as new data and past or current problems may be over- or underestimated. In order to overcome the problem of overaged (antiquated) data it was decided that some analyses are carried out within a four-year moving window, including the last four years with full two-year follow-up. For this report the data of implantations from 1.1.2015 to 31.12.2018 were analysed with completed two-year follow-up until 31.12.2020 (the scope of this report). However, for Kaplan-Meier survival estimates and the calculation of cumulative revision rates the entire period from 2012 onwards were used in order to extend the follow-up period to its maximum. Comparing previous Annual Reports, the observant reader may find that the numbers of implantations per year may have increased. This is because even after longer periods of time, implantations that occurred in previous years were eventually uploaded for documentation. Therefore, the coverage rate also improves over time. The participating services are advised to follow the proposed deadlines for data entry, but there are always some that lag behind.

Baseline figures in Table 6.1 highlight that a number of variables showed very little variability in recent years. Namely, the share of operations performed on women, 60.3%, and the mean age at surgery of 69.5 years were constant during the whole period of time, as was the share of TKAs for primary OA (88.7%).

The share of TKAs in younger patients (younger than 45: 0.5% and 45–54 years old: 6.2%) and patients older than 85 years (4.6%) remained consistently low over the whole period of time, which is an indirect sign that indications for TKA were not expanding, although the Swiss health care system features ample supply of hospitals and orthopaedic surgeons.

The proportion of missing BMIs decreased to 17% overall and fell to 12% in 2020 which underlines

Figure 6.1

**Primary total knee arthroplasty: Mean age at primary arthroplasty depending on BMI class**

All diagnoses. Please note that group sizes vary considerably.

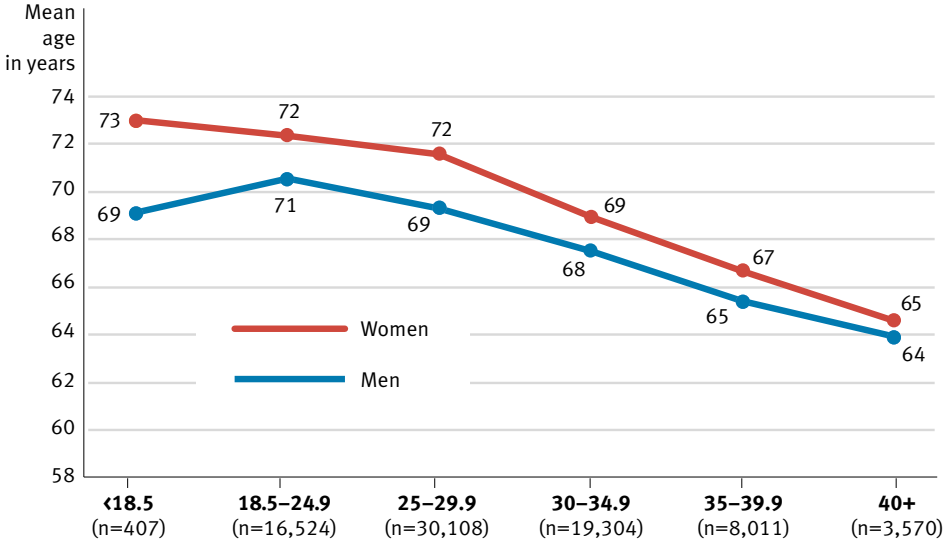


Table 6.1

## Primary total knee arthroplasty: Baseline patient characteristics by year

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| **N** | | **13,302** | **14,503** | **14,362** | **14,624** | **15,451** | **15,362** | **87,604** |
| Diagnosis [%] | Primary OA | 88.2 | 88.7 | 88.6 | 89.2 | 88.9 | 88.5 | 88.7 |
| | Secondary OA | 11.8 | 11.3 | 11.4 | 10.8 | 11.1 | 11.5 | 11.3 |
| | Inflammatory origin | 1.2 | 1.2 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 |
| | Fracture | 2.3 | 2.0 | 2.2 | 2.1 | 2.1 | 2.2 | 2.2 |
| | Lesion of ligament | 4.8 | 5.1 | 5.4 | 4.8 | 5.2 | 5.7 | 5.2 |
| | Infection | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | Osteonecrosis | 2.2 | 1.7 | 1.8 | 1.7 | 1.5 | 1.4 | 1.7 |
| | Other | 1.4 | 1.5 | 1.6 | 1.3 | 1.5 | 1.3 | 1.4 |
| Women [%] | | 61.6 | 61.4 | 60.7 | 60.5 | 59.6 | 58.3 | 60.3 |
| Mean age (SD) | All | 69.5 (9.7) | 69.4 (9.6) | 69.4 (9.4) | 69.4 (9.7) | 69.8 (9.5) | 69.5 (9.4) | 69.5 (9.5) |
| | Women | 70.2 (9.7) | 70.0 (9.5) | 70.0 (9.5) | 69.9 (9.7) | 70.5 (9.7) | 70.1 (9.6) | 70.1 (9.6) |
| | Men | 68.4 (9.5) | 68.4 (9.5) | 68.4 (9.3) | 68.6 (9.6) | 68.9 (9.3) | 68.7 (9.2) | 68.6 (9.4) |
| Age group [%] | ‹45 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.5 | 0.5 |
| | 45–54 | 6.5 | 6.6 | 6.2 | 6.3 | 5.9 | 5.7 | 6.2 |
| | 55–64 | 23.3 | 23.3 | 23.8 | 24.3 | 23.1 | 24.6 | 23.8 |
| | 65–74 | 36.9 | 37.6 | 37.8 | 36.3 | 36.2 | 36.0 | 36.8 |
| | 75–84 | 28.1 | 27.7 | 27.3 | 27.7 | 29.3 | 28.9 | 28.2 |
| | 85+ | 4.7 | 4.2 | 4.4 | 4.8 | 5.1 | 4.2 | 4.6 |
| N unknown BMI (%) | | | 2,889 (20) | 2,561 (18) | 2,246 (15) | 2,271 (15) | 1,904 (12) | 1,5165 (17) |
| N known BMI | | | 11,614 | 11,801 | 12,378 | 13,180 | 13,458 | 72,439 |
| Mean BMI (SD) | | 29.4 (6.2) | 29.5 (5.6) | 29.5 (5.7) | 29.5 (5.9) | 29.5 (5.8) | 29.3 (5.7) | 29.4 (5.8) |
| BMI [%] | ‹18.5 | 0.5 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.5 |
| | 18.5–24.9 | 21.2 | 21.2 | 20.8 | 20.5 | 20.9 | 22.2 | 21.1 |
| | 25–29.9 | 39.5 | 38.8 | 38.5 | 38.5 | 38.8 | 38.2 | 38.7 |
| | 30–34.9 | 24.2 | 24.6 | 24.9 | 25.3 | 24.7 | 24.6 | 24.7 |
| | 35–39.9 | 10.1 | 10.5 | 10.6 | 10.6 | 10.2 | 10.1 | 10.3 |
| | 40+ | 4.5 | 4.6 | 4.7 | 4.5 | 4.8 | 4.3 | 4.6 |
| N unknown ASA (%) | | 1,675 (13) | 1,496 (10) | 1,402 (10) | 1,182 (8) | 1,162 (8) | 1,014 (7) | 7,931 (9) |
| N known ASA | | 11,627 | 13,007 | 12,960 | 13,442 | 14,289 | 14,348 | 79,673 |
| Morbidity state [%] | ASA 1 | 12.0 | 9.7 | 8.7 | 8.2 | 8.2 | 7.9 | 9.0 |
| | ASA 2 | 61.2 | 62.5 | 63.2 | 63.0 | 61.5 | 62.0 | 62.2 |
| | ASA 3 | 26.5 | 27.5 | 27.7 | 28.3 | 29.9 | 29.6 | 28.3 |
| | ASA 4/5 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 |

that surgeons are now realising the importance of BMI as a central risk factor in knee arthroplasty. From the data available, we can calculate that the mean BMI was 29.4 kg/m² and that the distribution of values over time has remained steady.

Obese patients (BMI ≥ 30 kg/m²) made up 39.6% of the total knee arthroplasty patients in Switzerland. The BMI inversely correlated with increasing age. Obese patients were operated at a younger age. (Figure 6.1). On average, women were older than men when a TKA was performed in all BMI groups although the difference decreased when BMI exceeded 30 kg/m². Whereas mean age at surgery was about 70 years for BMI under 30 kg/m² surgery had to be performed 5–6 years earlier when BMI was more than 40 kg/m². The rate of unrecorded ASA classification was 9% on average over the period and continued to decrease in 2020.

Table 6.2

**Baseline patient characteristics of primary total knee arthroplasty by hospital service volume**

Calculations of hospital service volume based on primary hip surgeries in each included year (2015–2020).

| Hospital service volume | | <100 | 100–199 | 200–299 | 300+ |
|---|---|---|---|---|---|
| **N (2015–2020)** | | **19,566** | **25,801** | **18,028** | **24,209** |
| Women [%] | | 61.0 | 59.5 | 60.5 | 60.4 |
| Mean age (SD) | All | 69.9 (9.7) | 69.6 (9.6) | 69.6 (9.5) | 69.0 (9.5) |
| | Women | 70.6 (9.6) | 70.2 (9.6) | 70.1 (9.6) | 69.6 (9.6) |
| | Men | 68.9 (9.7) | 68.8 (9.4) | 68.7 (9.3) | 68.0 (9.2) |
| Age group [%] | <45 | 0.5 | 0.5 | 0.5 | 0.6 |
| | 45–54 | 6.1 | 6.0 | 5.9 | 6.7 |
| | 55–64 | 22.6 | 23.8 | 23.7 | 24.7 |
| | 65–74 | 35.9 | 36.3 | 37.5 | 37.6 |
| | 75–84 | 29.7 | 28.8 | 27.7 | 26.6 |
| | 85+ | 5.2 | 4.6 | 4.8 | 3.8 |
| Diagnosis [%] | Primary OA | 89.0 | 89.5 | 88.2 | 88.0 |
| | Secondary OA | 11.0 | 10.5 | 11.8 | 12.0 |
| N unknown BMI (%) | | 4,108 (21) | 4,163 (16) | 2,552 (14) | 4,342 (18) |
| N known BMI | | 15,458 | 21,638 | 15,476 | 19,867 |
| Mean BMI (SD) | | 29.4 (5.7) | 29.7 (6.0) | 29.5 (6.0) | 29.1 (5.6) |
| BMI [%] | <18.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | 18.5–24.9 | 20.9 | 19.9 | 20.4 | 23.3 |
| | 25–29.9 | 38.6 | 38.0 | 38.6 | 39.6 |
| | 30–34.9 | 25.2 | 25.6 | 25.2 | 23.2 |
| | 35–39.9 | 10.4 | 11.1 | 10.5 | 9.3 |
| | 40+ | 4.4 | 4.9 | 4.8 | 4.1 |
| N unknown ASA (%) | | 1,468 (8) | 1,980 (8) | 1,908 (11) | 2,575 (11) |
| N known ASA | | 18,098 | 23,821 | 16,120 | 21,634 |
| ASA state [%] | ASA 1 | 10.2 | 9.5 | 7.8 | 8.4 |
| | ASA 2 | 61.8 | 64.3 | 62.0 | 60.5 |
| | ASA 3 | 27.5 | 25.8 | 29.7 | 30.8 |
| | ASA 4/5 | 0.5 | 0.4 | 0.4 | 0.3 |

Table 6.3

## Primary total knee arthroplasty: Baseline patient characteristics by main diagnostic group

Number of cases with clear diagnostic information
(in 0.3% of cases we cannot determine the diagnosis)

| | | Primary OA | Secondary OA |
|---|---|---|---|
| **N (2015–2020)** | | **77,500** | **9,884** |
| Women [%] | | 62.1 | 46.5 |
| Mean age (SD) | All | 70.1 (9.2) | 64.7 (10.8) |
| | Women | 70.5 (9.3) | 66.6 (11.5) |
| | Men | 69.6 (9.0) | 63.1 (9.9) |
| Age group [%] | <45 | 0.3 | 2.3 |
| | 45–54 | 5.0 | 15.5 |
| | 55–64 | 22.5 | 33.8 |
| | 65–74 | 37.9 | 28.1 |
| | 75–84 | 29.6 | 17.2 |
| | 85+ | 4.7 | 3.1 |
| N unknown BMI (%) | | 13,708 (18) | 1,418 (14) |
| N known BMI | | 63,792 | 8,466 |
| Mean BMI (SD) | | 29.6 (5.8) | 28.3 (5.6) |
| BMI [%] | <18.5 | 0.5 | 0.8 |
| | 18.5–24.9 | 20.4 | 26 |
| | 25–29.9 | 38.4 | 41.1 |
| | 30–34.9 | 25.0 | 22.5 |
| | 35–39.9 | 10.8 | 6.8 |
| | 40+ | 4.9 | 2.3 |
| N unknown ASA (%) | | 7,257 (9) | 644 (7) |
| N known ASA | | 70,243 | 9,240 |
| ASA state [%] | ASA 1 | 8.4 | 14.0 |
| | ASA 2 | 62.3 | 61.7 |
| | ASA 3 | 28.9 | 23.9 |
| | ASA 4/5 | 0.4 | 0.4 |

Table 6.4

## Primary total knee arthroplasty: Surgery characteristics

all diagnoses

| N (2015–2020) | N | % |
|---|---|---|
| Previous surgery | | |
| None | 58,232 | 66.5 |
| Knee arthroscopy | 14,610 | 16.7 |
| Meniscectomy | 14,721 | 16.8 |
| ACL reconstruction | 3,686 | 4.2 |
| Osteotomy tibia close to knee | 2,639 | 3.0 |
| Osteosynthesis tibia close to knee | 1,145 | 1.3 |
| Surgery for patella stabilization | 1,058 | 1.2 |
| Synovectomy | 699 | 0.8 |
| Osteotomy femur close to knee | 445 | 0.5 |
| Osteosynthesis femur close to knee | 429 | 0.5 |
| Surgery for treating infection | 150 | 0.2 |
| Surgery for tumor | 36 | 0.0 |
| Other | 2,611 | 3.0 |
| Intervention | | |
| CS (cruciate sacrificing) / UCOR | 25,403 | 29.0 |
| PS (posterior stabilised) | 24,990 | 28.5 |
| PCR (posterior cruciate retaining) | 22,671 | 25.9 |
| BCR (bicruciate retaining) | 1,087 | 1.2 |
| Hinge type | 1,444 | 1.6 |
| SC / CCK semi-constrained | 892 | 1.0 |
| CCK constrained condylar knee | 456 | 0.5 |
| Other (Medial-Pivot)* | 9,582 | 10.9 |
| Other | 1,002 | 1.1 |
| Technology | | |
| Conventional | 62,773 | 71.7 |
| Computer assisted | 10,283 | 11.7 |
| Patient specific instrumentation | 11,382 | 13.0 |
| Minimally invasive | 5,034 | 5.7 |
| Other | 1,651 | 1.9 |

*Medial pivot was not available as a response category before SIRIS v2021. In the annual report 2020, only free text "other" responses were identified as and recoded to medial pivot.
However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly CS/UCOR.
In this report, all GMK Sphere knee systems are counted as medial pivot, regardless of the type chosen locally at data entry.

Gender, mean age, age groups and BMI did not differ between low or high-volume hospitals (Table 6.2) as also the share of secondary arthritis was similar, 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 osteoarthritis (88.7% in in the period from 2015 to 2020), even though more pathologies (such as ligament lesions or infections) were introduced in 2015 as possible underlying causes for secondary osteoarthritis (Table 6.1). A bias towards primary osteoarthritis (OA) is possible, as this reason ranges highest in the selection menu and thus possibly prevents thinking about other diagnoses and alternatives. Since 2015, 11.3% (9,884 cases) were classified as secondary OA. The mean age at surgery was significantly lower with 64.7 years compared to TKA in primary OA with 70.1 years. The share of women was 46.5% for secondary and 62.1% for primary OA. Whereas the rate in young patients was only 0.3% in the ‹45y group, 5.0% in the group 45-54y and 22.5% in the group 55–64y for primary OA, more young patients needed TKA for secondary OA (2.3% in the ‹45y group, 15.5% in the group 45–54y and 33.8% in the group 55–64y). Patients older than 65 years had less OA classified as secondary. BMI and ASA classification on the other hand did not differ in the two groups (Table 6.3).

Table 6.5

**Primary total knee arthroplasty: Component fixation**

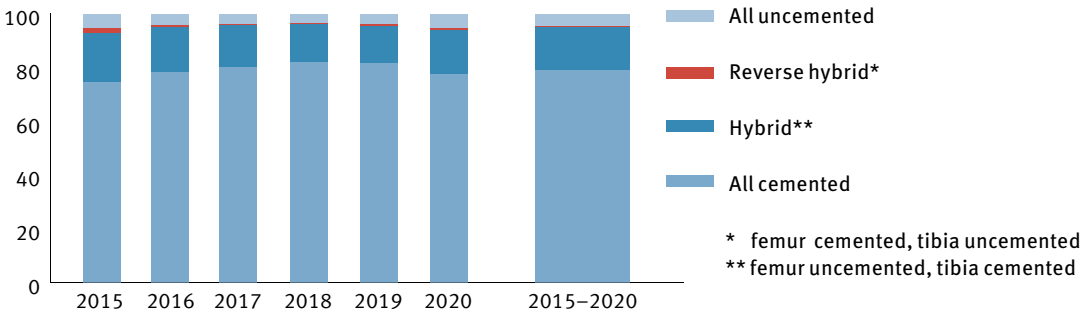
all diagnoses

| Component fixation [%] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| N | 13,280 | 14,473 | 14,340 | 14,610 | 15,446 | 15,356 | 87,505 |
| All uncemented | 5.3 | 4.3 | 3.7 | 3.5 | 3.9 | 5.5 | 4.4 |
| Reverse hybrid* | 1.9 | 0.5 | 0.4 | 0.3 | 0.4 | 0.6 | 0.6 |
| Hybrid** | 18.2 | 16.7 | 15.7 | 14.2 | 13.9 | 16.3 | 15.8 |
| All cemented | 74.6 | 78.4 | 80.3 | 82.1 | 81.7 | 77.7 | 79.2 |

Figure 6.2

**Primary total knee arthroplasty: Component fixation by year**

Percentage per year



66.5% of the knees were never operated on before TKA. Previous operations were mostly arthroscopies (16.7%) and meniscectomy (16.8%), ACL reconstruction (4.2%) 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 6.4).

In total knee arthroplasty the rate of all cemented fixations has remained high (Table 6.5 and Figure 6.2), the use of cementless fixation was low in total knee arthroplasties with 4.4% in the period from 2015 to 2020 but increased from 3.9% in 2019 to 5.5% in 2020. Hybrid fixation (cemented tibial and cementless femoral component) accounted for 15.8%.

Table 6.6
**Primary total knee arthroplasty: Type of bearing**
all diagnoses

| Type of bearing [%] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| N | 12,369 | 13,501 | 13,128 | 13,042 | 13,661 | 13,430 | 79,131 |
| Mobile bearing | 45.7 | 42.8 | 41.3 | 39.2 | 36.4 | 33.8 | 39.8 |
| Fixed bearing | 54.3 | 57.2 | 58.7 | 60.8 | 63.6 | 66.2 | 60.2 |

Figure 6.3
**Primary total knee arthroplasty: Type of bearing**
Percentage per year

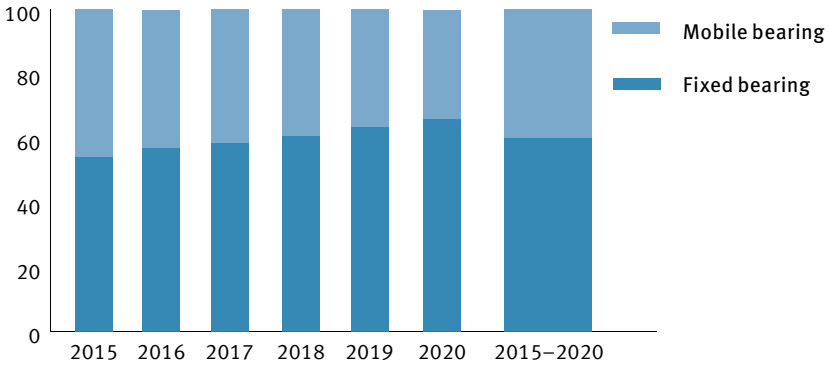
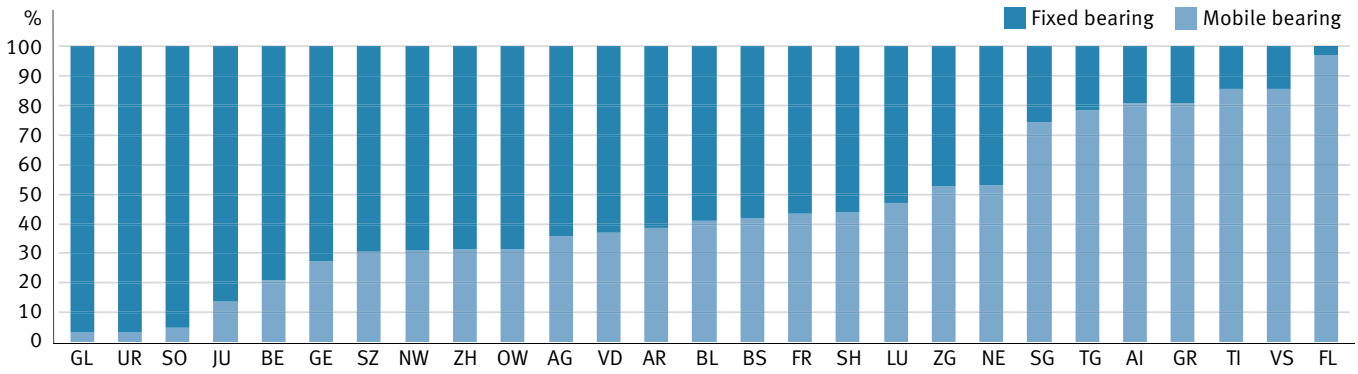



Figure 6.4
**Primary total knee arthroplasty: Share of TKA procedures with mobile bearing by Swiss Canton and Principality of Liechtenstein (2015–2020)**



The rate of mobile bearing polyethylene (PE) has continuously decreased over the past six years and stood at 33.8% in 2020 (Table 6.6 and Figure 6.3). One must note, however, that the choice of the bearing type showed a high variation in the different Cantons of Switzerland including the Principality of Liechtenstein. Thus the use of mobile bearings ranged from 3.1% to 97.2% (Figure 6.4). The same regional differences could be observed for the biomechanical type of arthroplasty (Figure 6.8). Traditionally, posterior stabilised (PS) knees were more used in the western part of Switzerland, whereas in the German speaking Cantons cruciate retaining (CR) and sacrificing (CS) including ultracongruent (UC) knees were still favoured. Medial pivot knees did not seem to follow a particular regional pattern in Switzerland but seem to be favoured in individual Cantons or hospitals. Their share of all TKAs was 10.9%. One has to note that medial pivot was not available as a response category before SIRIS version 2021. In the annual report 2020, only free text „other“ responses were identified as and recoded to medial pivot. However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly CS/UCOR. In this report, all GMK Sphere knee systems were counted as medial pivot, regardless of the type chosen locally at data entry. All other types were rare in primary TKA such as bicruciate-retaining (1.2%), hinge (1.6%) or constrained knees (1.5%) (Table 6.4). The classification of the type of TKA was adapted with the revision of the registration forms in 2021 because of confusing terms.

Between 2015 and 2020, 71.7% of the TKA in Switzerland were performed conventionally. The share of computer navigation was 11.7%, but has slightly decreased from 12.8% in 2015 to 10.9% in 2020. Patient-specific instrumentation (PSI) has increased from 11.3% in 2015 to 14.5% in 2020. Robotic assisted TKA (imageless and image-based) were classified as “other” and accounted for 1.9% for the whole period, 3.0% and 3.1% in 2019 and 2020 respectively (Table 6.7 and Figure 6.5). In summary, surgeons did use technical support in 28.3% of total knee arthroplasties over the past six years. Minimally invasive surgery was only used in 5.9% of operations and will not be mentioned anymore in future reports as it was removed from the new SIRIS 2021 forms.

Table 6.7

## Primary total knee arthroplasty: Technologies used

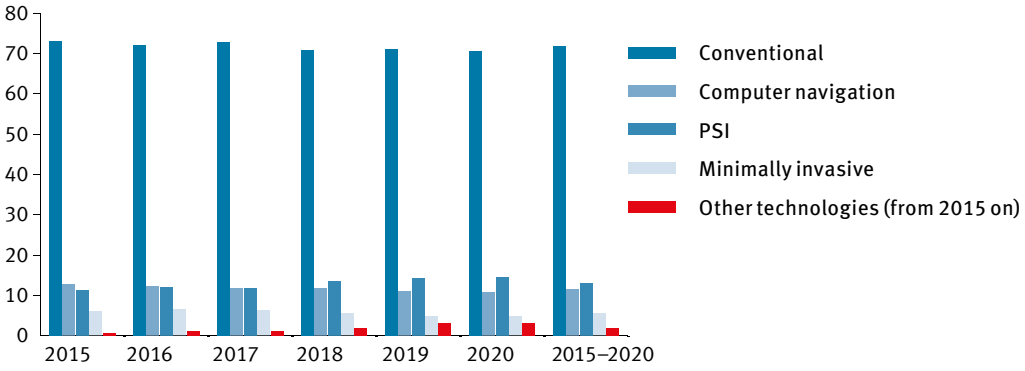
All diagnoses. Multiple responses possible (percentages do not sum to 100)

| Technology [%] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2019 |
|---|---|---|---|---|---|---|---|
| N | 13,304 | 14,500 | 14,359 | 14,622 | 15,453 | 15,358 | 87,596 |
| Conventional | 72.9 | 72.1 | 72.8 | 70.8 | 71.0 | 70.5 | 71.7 |
| Computer navigation | 12.8 | 12.3 | 11.9 | 11.8 | 11.0 | 10.9 | 11.7 |
| PSI | 11.3 | 12.1 | 11.9 | 13.5 | 14.4 | 14.5 | 13.0 |
| Minimally invasive | 6.1 | 6.6 | 6.3 | 5.7 | 4.9 | 5.0 | 5.7 |
| Other technologies | 0.6 | 1.2 | 1.1 | 1.9 | 3.0 | 3.1 | 1.9 |

Figure 6.5

## Primary total knee arthroplasty: Technologies used

Percentage per year



## 6.2 Patella resurfacing

Whether to resurface the patella or not remains a controversial topic in knee arthroplasty and depends on many different factors such as pattern of OA, intraoperative findings, type of TKA, brand, education of the surgeon, personal preference, and so on. Evidence is also lacking in many respects because of the diversity of reasons leading to anterior knee pain. This is still the most frequent complaint of patients after TKA. However, anterior knee pain is not necessarily induced by patella problems. Often the patella is not the cause of the pain but it is a sign of mechanical overload due to other underlying causes. For example, as a consequence of a pronounced anterior femoral contact point in CR knees in the presence of an insufficient posterior cruciate ligament, or of malrotation of the femoral or tibial component or other forms of instability. In these cases, a secondary resurfacing of the patella will not solve the problem and may explain, why less than 50% of the patients seem to benefit from this revision according to literature.

In Australia, surgeons tend to perform more patella resurfacings with time in primary TKA because of the registry and the wish to prevent revisions such as secondary resurfacing due to anterior knee pain, which would negatively influence their revision rate. However, this change in behaviour can never be the intention of a joint registry.

Looking at the literature, Longo UG et al. (2018) found in a meta-analysis and systematic review of 13 randomised trials from 1993 to 2015 a revision rate of 1% in case of a resurfaced patella (17/1636) and of 6.9% for non-resurfaced patella (118/1699). Pain and function were significantly better in the group with resurfaced patellae with an odds ratio of 1.52 (CI 0.68–2.35) for the Knee Society Score (KSS) for pain (p=0.004). The odds ratio was 4.35 (CI 3.12-5.49) for the KSS score function (p<0.00001). Grassi et al. (2017) , on the other hand, reviewed 10 meta-analyses between 2005 to 2015 in this field and could not find one technique with a clear advantage. Nevertheless, non-resurfacing never showed better results than resurfacing. Revision rates were higher in the non-resurfaced group in

[1] Longo UG, Ciuffreda M, Mannering N, D'Andrea V, Cimmino M, Denaro V. Patellar Resurfacing in Total Knee Arthroplasty: Systematic Review and Meta-Analysis. J Arthroplasty. 2018 Feb;33(2):620-632. doi: 10.1016/j.arth.2017.08.041. Epub 2017 Sep 6. PMID: 29032861.

[2] Candrian C, Grassi A, Filardo G, Vannini F. Comment on "No superior treatment for primary osteochondral defects of the talus. Dahmen J, et al. KSSTA 2017 Jun 27 PMID:28656457". Knee Surg Sports Traumatol Arthrosc. 2017 Dec;25(12):3982-3983. doi: 10.1007/s00167-017-4700-x. Epub 2017 Sep 4. PMID: 28871367.

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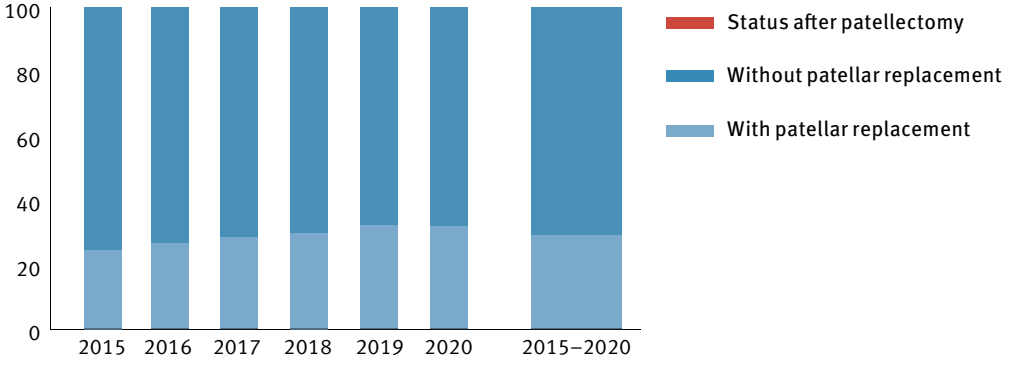
four meta-analyses. However, this could be the effect of a selection bias, as secondary patella resurfacing is a technically easy revision and is well accepted by patients suffering from anterior knee pain after TKA. None of the included meta-analyses did document revision after patella resurfacing. In fact, the complication and revision rate after primary resurfacing of the patella is considerable higher and reaches up to 12% due to fractures, necrosis of the patella, wear of the button, subluxation and/or tilting of the patella, malpositioning of the button, over- or understuffing, or maltracking. If the patella is not resurfaced at the primary intervention, mainly anterior knee pain can be a consequence, which seems to be more often the case than after primary resurfacing (Parvisi J et al., 2005) . This anterior knee pain can lead to secondary patella resurfacing in up to 10–12% in older TKA designs.

Unfortunately, secondary resurfacing is not an overwhelmingly successful procedure as at most 50% of patients profit from such a revision (Thomas C et al, 2018 ; Correiea J et al., 2012 ; Toro-Ibarquen AN et al., 2016 ). Well accepted is the selective resurfacing in rheumatoid arthritis (Scott WN, Kim H, 2001 ; Robertsson O et al., 2000) or in case of preoperative patella pain, wear of the cartilage with grade IV damages or deformed patella (Rodriguez-Merchán EC, Gómez-Cardero P, 2010 ). Patella subluxation and/or thin patella due to abrasive bone wear are also accepted as reason for primary resurfacing. This short overview may document the controversial discussion for this topic even in times with newer TKA designs which seem to be more patella friendly. Additionally, culture and tradition in different countries, hospitals and knee schools also play an important role. In some countries eco-

Table 6.8
**Primary total knee arthroplasty: Patellar component**
all diagnoses

| Patellar component [%] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| N | 13,280 | 14,473 | 14,340 | 14,610 | 15,446 | 15,356 | 87,505 |
| Without patellar replacement | 75.5 | 73.5 | 71.5 | 70.3 | 67.9 | 68.1 | 71.0 |
| With patellar replacement | 24.4 | 26.5 | 28.4 | 29.7 | 32.1 | 31.9 | 29.0 |
| Status after patellectomy | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |

Figure 6.6
**Primary total knee arthroplasty: Patellar component**
Percentage per year



nomic factors influence the behaviour of the surgeon, e.g. when the fee for a total knee replacement is only paid if the patella was resurfaced.

All this may explain the considerable differences in the rate of patella resurfacing in primary TKA found in Switzerland between Cantons, hospitals and surgeons (Figure 6.7) which cannot be explained by type of knee system or brand alone. To clarify the complexity of the "patella problem" the scientific advisory board of SIRIS decided to dedicate this special chapter to patella resurfacing.

In 71% of primary TKA cases, the patella was not resurfaced between 2015 and 2020 (Table 6.8). The resurfacing rate increased continuously since 2015 from 24.4% to 31.9% in 2020. However, there were considerable differences between the Cantons (Figure 6.7). Parts of these differences can be explained by the use of posterior stabilised knees, where resurfacing of the patella is recommended more than in other TKA models, being more popular in the western part of Switzerland and in some centres. Figure 6.8 shows the high variability of the

Figure 6.7

**Proportion of total knee arthroplasty procedures with patella resurfacing by Swiss Canton and Principality of Liechtenstein (2015 – 2020)**

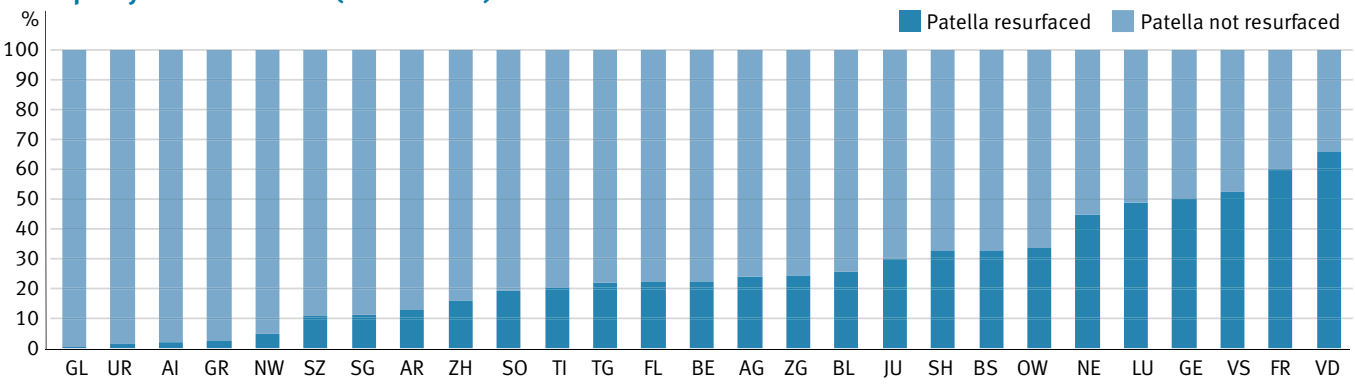
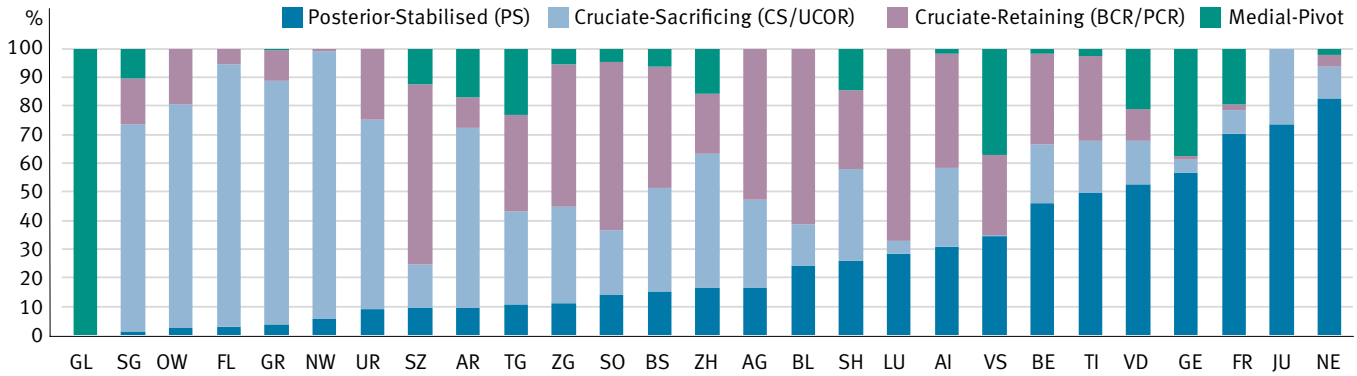



Figure 6.8

**Relative proportion of total knee arthroplasty procedures usin CR, CS PS, MP by Swiss Canton and Principality of Liechtenstein (2015 – 2020)**



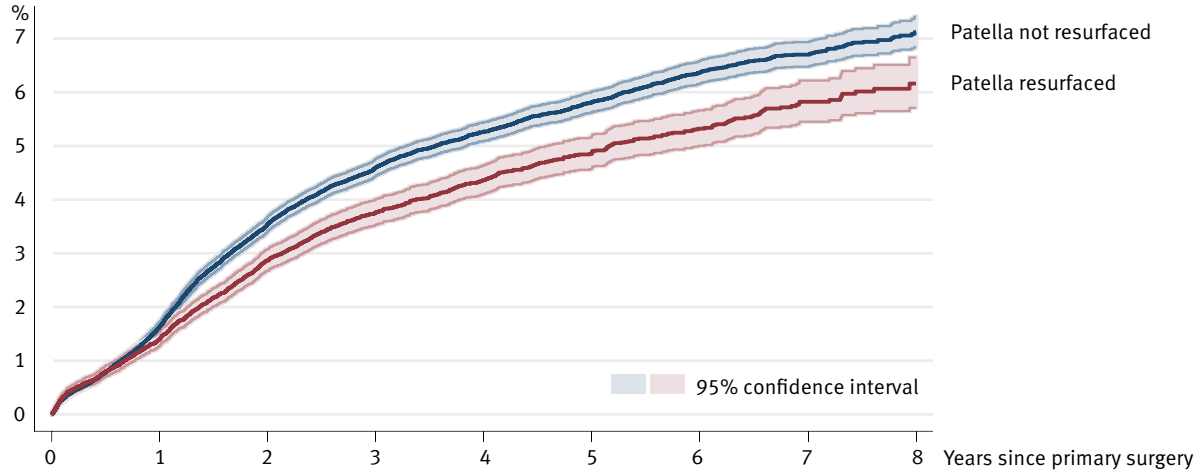

NB: Medial pivot was not available as a response category before SIRIS v2021. In the annual report 2020, only free text "other" responses were identified as and recoded to medial pivot. However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly CS/UCOR. In this report, all GMK Sphere knee systems are counted as medial pivot, regardless of the type chosen locally at data entry.

different types of knee prostheses (posterior-stabilised PS, cruciate-sacrificing CS/ UCOR, cruciate-retaining BCR/PCR and medial-pivot MP) used in Switzerland.

A non-surfaced patella was more prone to early revision (3.5%) than a TKA with replacement (2.9%), the difference being statistically significant (Figure 6.9). This could be expected, as secondary patellar resurfacing is an isolated treatment option in painful TKA with a non-resurfaced patella, even though it might not or only partially resolve the problem of the underlying cause of anterior knee pain. Interesting is the fact that early after surgery revision rate seemed to be similar in resurfaced and non-resurfaced patellae. Non-resurfaced patellae were revised mainly between the first and second year after index surgery. From the third year on, revision rates in both groups developed parallel up to eight years after primary TKA (Figure 6.9). Three years and more after primary TKA, whether or not the patella was resurfaced during primary surgery therefore did not play a significant role anymore.

Figure 6.9

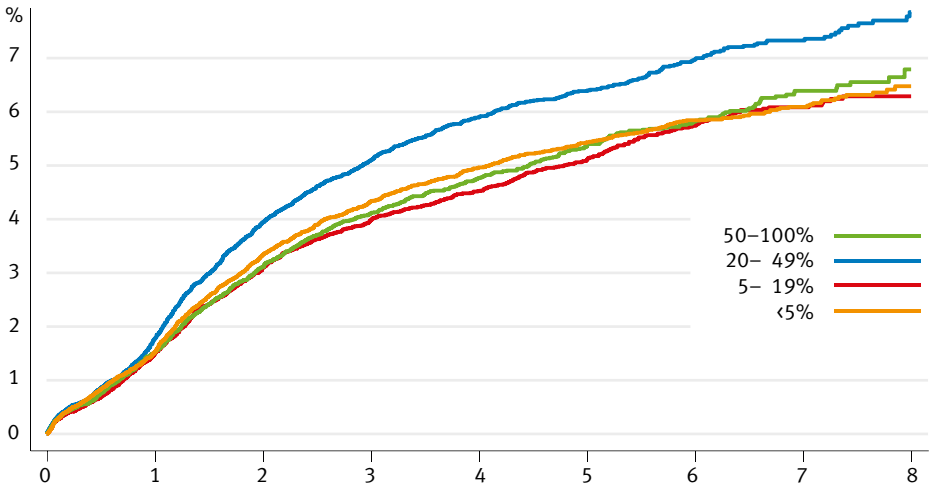
**Estimated failure rates of primary total knee arthroplasty: status of patella after primary operation**




| Cumulative revision rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Patella resurfaced | **1.4** (1.3-1.5) | **2.9** (2.7-3.1) | **3.8** (3.5-4.0) | **4.4** (4.1-4.6) | **4.9** (4.6-5.2) | **5.3** (5.0-5.7) | **5.8** (5.5-6.2) | **6.2** (5.7-6.6) |
| Patelle not resurfaced | **1.6** (1.6-1.7) | **3.5** (3.4-3.7) | **4.6** (4.4-4.8) | **5.3** (5.1-5.4) | **5.8** (5.6-6.0) | **6.4** (6.2-6.6) | **6.7** (6.5-6.9) | **7.1** (6.8-7.4) |

Figure 6.10

## Estimated failure rates of primary total knee arthroplasty: comparing surgeons with different patella preferences



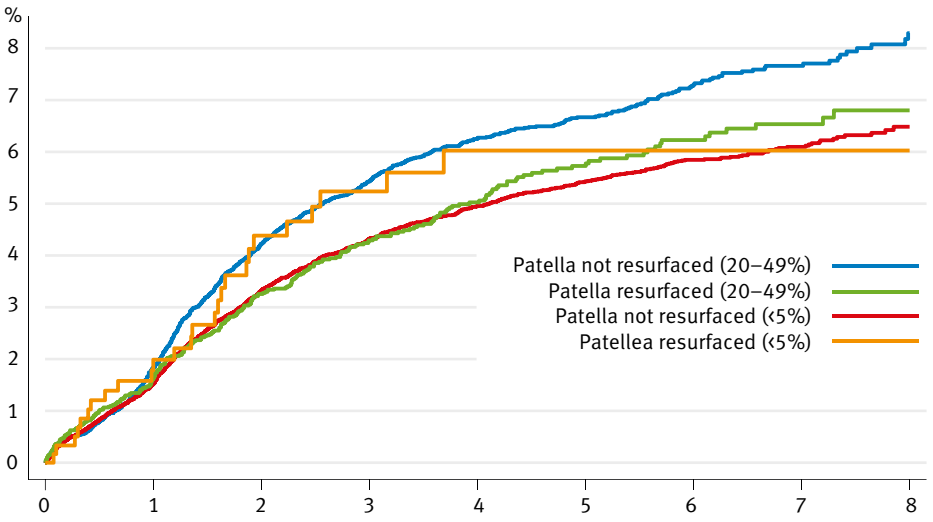

**Share of primary patella resurfacing**

| | Surgeons | % |
|---|---|---|
| <5% | 175 | 34.38 |
| 5– 19% | 125 | 24.56 |
| 20– 49% | 88 | 17.29 |
| 50–100% | 121 | 23.77 |
| **Total** | **509** | **100** |

| Cumulative revision rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| <5% | **1.5** (1.4-1.7) | **3.3** (3.1-3.5) | **4.3** (4.1-4.6) | **5.0** (4.7-5.2) | **5.4** (5.2-5.7) | **5.8** (5.5-6.2) | **6.1** (5.8-6.4) | **6.5** (6.1-6.9) |
| 5-19% | **1.5** (1.4-1.6) | **3.1** (2.9-3.3) | **4.0** (3.7-4.2) | **4.5** (4.3-4.8) | **5.1** (4.8-5.4) | **5.7** (5.4-6.1) | **6.1** (5.7-6.5) | **6.3** (5.9-6.7) |
| 20-49% | **1.8** (1.6-2.0) | **3.9** (3.7-4.2) | **5.1** (4.8-5.4) | **5.9** (5.6-6.3) | **6.4** (6.0-6.8) | **7.0** (6.6-7.4) | **7.3** (6.9-7.8) | **7.9** (7.3-8.4) |
| 50-100% | **1.5** (1.4-1.7) | **3.1** (2.9-3.4) | **4.1** (3.8-4.4) | **4.8** (4.5-5.1) | **5.4** (5.0-5.7) | **5.8** (5.4-6.2) | **6.4** (5.9-6.9) | **6.8** (6.2-7.4) |

Figure 6.11

## Estimated failure rates of primary total knee arthroplasty: status of patella after primary operation ("rarely resurfacing" surgeons vs. "relatively frequently" resurfacing surgeons)



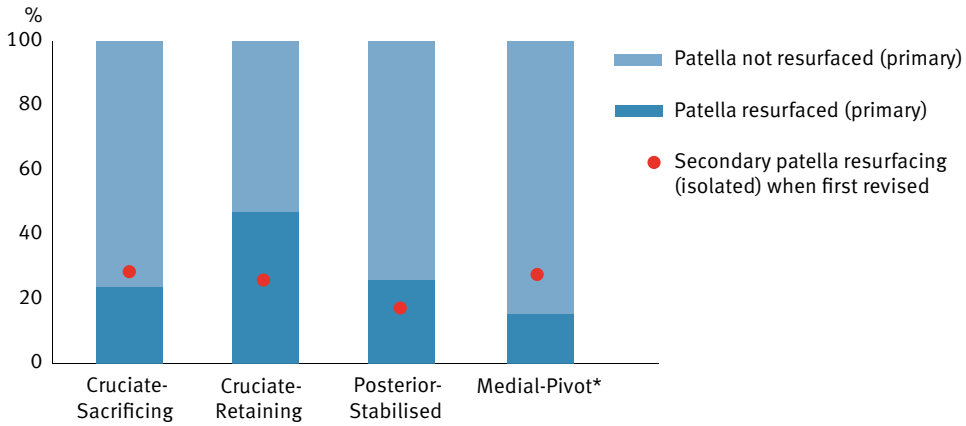

| Cumulative revision rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Patella res. (<5%) | **2.0** (1.1-3.6) | **4.4** (2.9-6.7) | **5.2** (3.5-7.8) | **6.0** (4.1-8.8) | **6.0** (4.1-8.8) | **6.0** (4.1-8.8) | **6.0** (4.1-8.8) | |
| Patella not res. (<5%) | **1.5** (1.4-1.7) | **3.3** (3.1-3.5) | **4**.3 (4.1-4.6) | **5.0** (4.7-5.2) | **5.4** (5.2-5.7) | **5.8** (5.5-6.2) | **6.1** (5.8-6.4) | **6.5** (6.1-6.9) |
| Patella res. (20–49%) | **1.6** (1.3-1.9) | **3.3** (2.8-3.7) | **4.3** (3.8-4.9) | **5.0** (4.5-5.7) | **5.7** (5.1-6.5) | **6.2** (5.5-7.0) | **6.5** (5.8-7.4) | **6.8** (6.0-7.7) |
| Patella not res. (20–49%) | **1.8** (1.6-2.1) | **4.2** (3.9-4.6) | **5.4** (5.1-5.8) | **6.3** (5.8-6.7) | **6.7** (6.2-7.1) | **7.3** (6.8-7.8) | **7.7** (7.1-8.2) | **8.3** (7.6-9.0) |

In order to highlight Swiss surgeons' different preferences for primary patella resurfacing, we formed four groups expressed in percent of total knee arthroplasties involving resurfacing:

1. "rarely" (‹ 5%),
2. "infrequently" (5–19%),
3. "relatively frequently" (20–49%) or
4. "the vast majority" (›50%).

Interestingly, in three groups the overall revision rate did not differ for up to eight years after index surgery. The group of surgeons with a primary resurfacing rate of 20-49% ("relatively frequently"), though, featured an increased revision rate from the first year after TKA (Figure 6.10), followed by a continuously diverging tendency up to eight years. This is of special interest as only 17% (n=88) of the surgeons did follow this strategy, which was therefore the smallest group. It seemed to be the case that a clear resurfacing strategy led to fewer consecutive revisions regardless of whether the strategy recommended resurfacing rarely or in the majority of cases. Primary resurfacing would be successful as well if performed in clearly indicated, rather rare cases (‹19%), or then in the clear majority of primary TKA (›50%). Primary patella resurfacing in 20 to 49% of cases, seemingly without a clear concept, on the other hand, did lead to increased revision rates.

Figure 6.12
**Patella resurfacing in the main types of total knee prostheses**




| | Patella resurfaced at primary procedure | | Secondary patella resurfacing (isolated) when first revised | |
|---|---|---|---|---|
| | yes | no | yes | no |
| Cruciate-Sacrificing (CS) | 15.3 | 84.7 | 28.8 | 71.2 |
| Cruciate-Retaining (BCR/PCR) | 25.9 | 74.1 | 26.3 | 73.8 |
| Posterior-Stabilised (PS) | 46.9 | 53.1 | 17.8 | 82.2 |
| Medial-Pivot* | 23.8 | 76.2 | 27.8 | 72.2 |

* Medial pivot was not available as a response category before SIRIS v2021. In the annual report 2020, only free text "other" responses were identified as and recoded to medial pivot. However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly CS/UCOR. In this report, all GMK Sphere knee systems are counted as medial pivot, regardless of the type chosen locally at data entry.

If the patella was not resurfaced surgeons who rarely resurface (<5%) performed best and had the smallest revision rate eight years after surgery (Figure 6.1). TKAs without patella resurfacing conducted by "relatively frequent resurfacers" (20–49%) had the highest overall revision risk. For TKAs with resurfaced patellae performed by the relatively frequent resurfacing group the risk was similar to that of not resurfaced TKAs performed by the "rarely" group. Interestingly, if that group resurfaces patella (small numbers!), then the revision risk was initially rather high as well, which might indicate lack of experience with patella resurfacing if performed rarely.

Comparing the main types of TKA, in 46.9% of PS knees primary patella resurfacing was performed, which confirms data in literature and international joint registers. CS knees had primary resurfacing in 15.3% of cases, followed by medial pivot with 23.8% and CR knees with 25.9%. It could be expected that secondary resurfacing, if revised, was less frequent in PS knees as almost 50% were already resurfaced at the index surgery (Figure 6.12). Nevertheless, the rate of secondary resurfacing was still 17.8%. In the other knee types, secondary patella resurfacing was seen more frequently as the un-resurfaced groups were relatively bigger. However, the rate of 26.3 – 28.8% was still surprisingly high. It is interesting to see that even including revisions with secondary patella resurfacing, most knees will remain without patella resurfacing. This may indicate that the attitude to resurface all patellae at primary surgery may not be the optimal treatment and suggest overtreatment.

Figure 6.13

**Main types of total knee prostheses: comparing surgeons with different patella preferences**

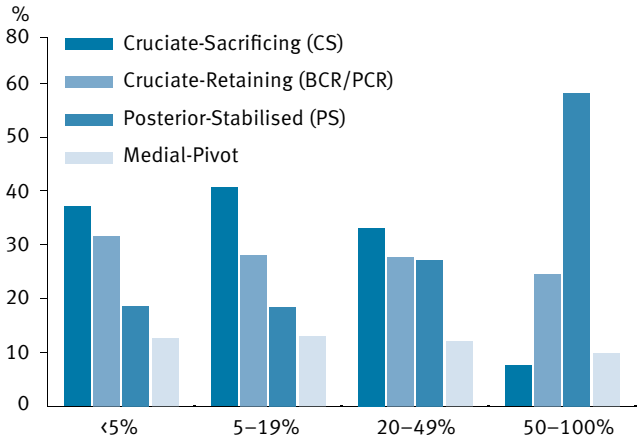
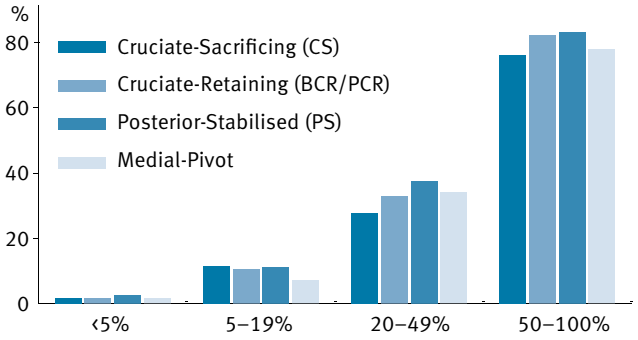



Figure 6.14

**Primary patella resurfacing in the main types of total knee prostheses: comparing surgeons with different patella preferences**



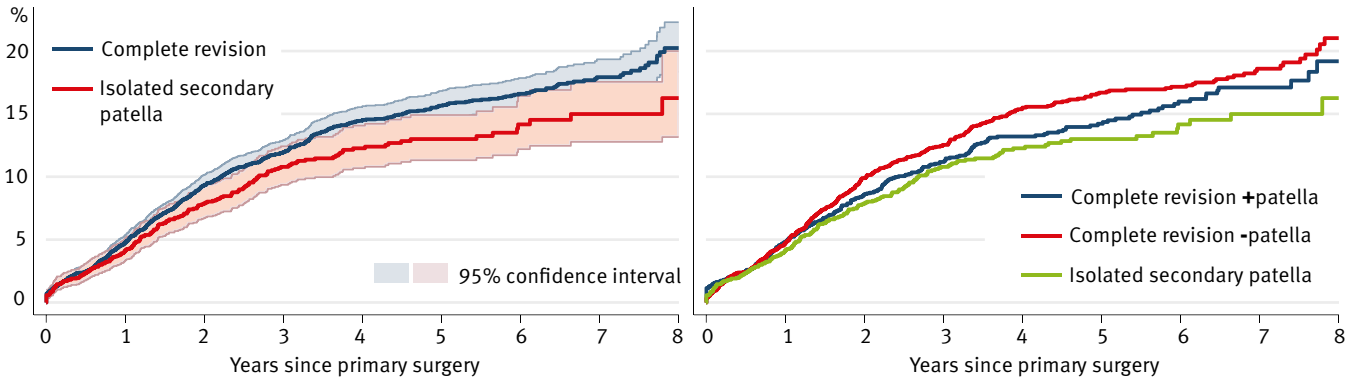
Figures 6.13 and 6.14 show impressively that surgeon preference is not entirely dependent on the types of systems used. Certainly, the 50–100% "majority resurfacers" prefer PS systems, but this was not an exclusive choice. Likewise, the <5% "rare resurfacers" used relatively rarely PS systems, but to some extent they also did. Furthermore, rare resurfacers did rarely resurface the patella irrespectively of the knee type, the same general behaviour was true for all the other groups. Interestingly, the 20–49% group with the highest revision rate overall appeared to be very indifferent across types, both in terms of what they used and how often they resurfaced.

The re-revision rate was higher after complete revision than after revisions that only involved isolated secondary patella resurfacing (Figure 6.15 – first KM). This could be expected as patella resurfacing is technically not really demanding whereas in the complete revisions all the more complex cases including instability, stiffness, periprosthetic infection or fracture are included. When this complexity is respected the re-revision rate after a simple secondary patella resurfacing of 7.9% after two years and 16.3% after eight years seems to be disappointingly high and only 1.4 percentage points and 3.9 percentage points lower than after complete revision. This suggests that patella resurfacing alone was not entirely successful and might not have addressed the underlying problem completely. When comparing the results of complete revision without and with secondary patella resurfacing (Figure 6.15 – second KM) the rate of re-revision was higher when the patella was not addressed at revision

Figure 6.15

**Estimated re-revision rates after isolated secondary patella resurfacing vs. complete revisions with or without patella resurfacing**

Start point of analysis: first registered component revision in SIRIS that meets the inclusion criteria.
End point of analysis: next registered component revision




| Cumulative rev.-rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Isolated sec. patella | **4.1** (3.3-5.1) | **7.9** (6.7-9.2) | **10.8** (9.4-12.4) | **12.3** (10.7-14.1) | **13.0** (11.3-14.9) | **14.2** (12.2-16.4) | **15.0** (12.8-17.6) | **16.3** (13.2-20.0) |
| Complete revision | **4.8** (4.3-5.4) | **9.3** (8.6-10.1) | **11.9** (11.1-12.9) | **14.5** (13.5-15.6) | **15.6** (14.6-16.8) | **16.6** (15.4-17.9) | **17.9** (16.6-19.3) | **20.2** (18.3-22.3) |
| Complete revision + patella | **4.8** (4.1-5.7) | **8.6** (7.5-9.8) | **11.2** (9.9-12.6) | **13.2** (11.8-14.8) | **14.2** (12.7-16.0) | **16.0** (14.2-18.0) | **17.1** (15.1-19.4) | **19.2** (16.3-22.6) |
| Complete revision - patella | **4.7** (4.1-5.6) | **9.9** (8.8-11.0) | **12.5** (11.3-13.9) | **15.5** (14.1-17.0) | **16.7** (15.2-18.3) | **17.2** (15.6-18.8) | **18.6** (16.9-20.5) | **21.0** (18.6-23.7) |

of TKA. This tendency increased with time after revision without being statistically significant but would nevertheless support resurfacing of the patella in case of TKA revision.

Interesting is the comparison of the rate of primary and secondary patella resurfacing in different knee systems and different brands (Figure 6.16). As expected, it has been longstanding experience and is in accordance with results of studies or joint registries that the primary resurfacing rate of CR and CS/UCOR knees was lower than that of PS knees. GMK Sphere medial pivot seemed to stand in between.

The differences between the various CR and CS/UCOR brands were considerable for primary and secondary patella resurfacing. A higher primary resurfacing rate did not automatically imply a low secondary patella resurfacing rate (if revised!) and vice versa. Within the CS/UCOR type LCS CS/UCOR had the lowest primary, Persona CS/UCOR the lowest secondary resurfacing rate. Within the CR knees balanSys CR had the lowest primary and Persona CR the lowest secondary resurfacing rate of 3.2%. In the single medial Pivot knee system that has seen widespread use in Switzerland, the primary resurfacing rate was 21.9%, the secondary 34.9%.

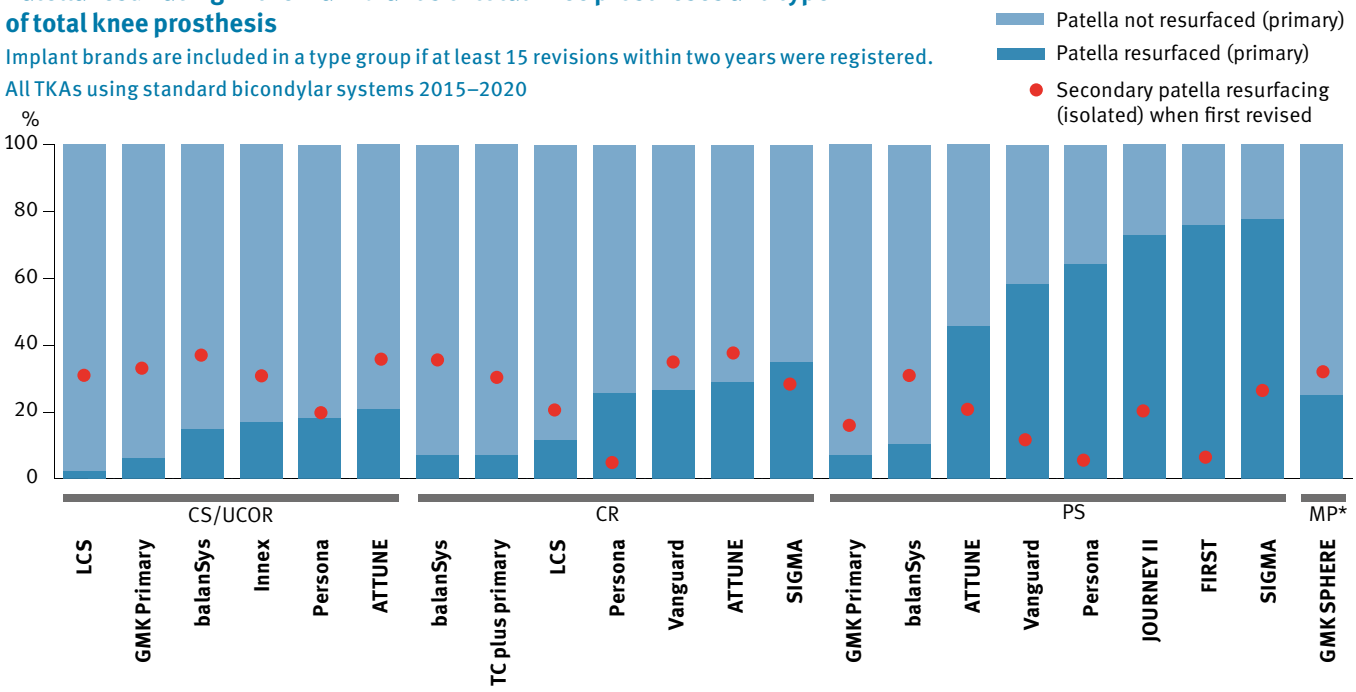
For the PS knees one would expect a high primary resurfacing rate for an older system like Sigma PS, which was 77.8%, but the secondary revision rate was still 23.5%. This could lead to the recommendation that with Sigma PS the patella should be resur-

Figure 6.16

**Patella resurfacing in the main brands of total knee prostheses and type of total knee prosthesis**

Implant brands are included in a type group if at least 15 revisions within two years were registered.

All TKAs using standard bicondylar systems 2015–2020




* Medial pivot was not available as a response category before SIRIS v2021. In the annual report 2020, only free text "other" responses were identified as and recoded to medial pivot. However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly CS/UCOR. In this report, all GMK Sphere knee systems are counted as medial pivot, regardless of the type chosen locally at data entry.

faced during primary systematically as the non-resurfacing would lead inevitably lead to an even higher resurfacing rate with a growing revision rate. The same is true for a modern system like Journey II where the rate for primary resurfacing was 73%, and for secondary 18.5%. The lowest primary resurfacing rate in PS knees had GMK PS with 7.1%, which also had a low secondary resurfacing rate of 15%. The lowest secondary resurfacing rate in a PS system was observed in Persona PS with 5.7% and First PS with 6.5%.

Comparing all the systems and brands for the patella, GMK PS had the lowest combined primary and secondary patella resurfacing rate of 7.1% and 15.0% respectively.

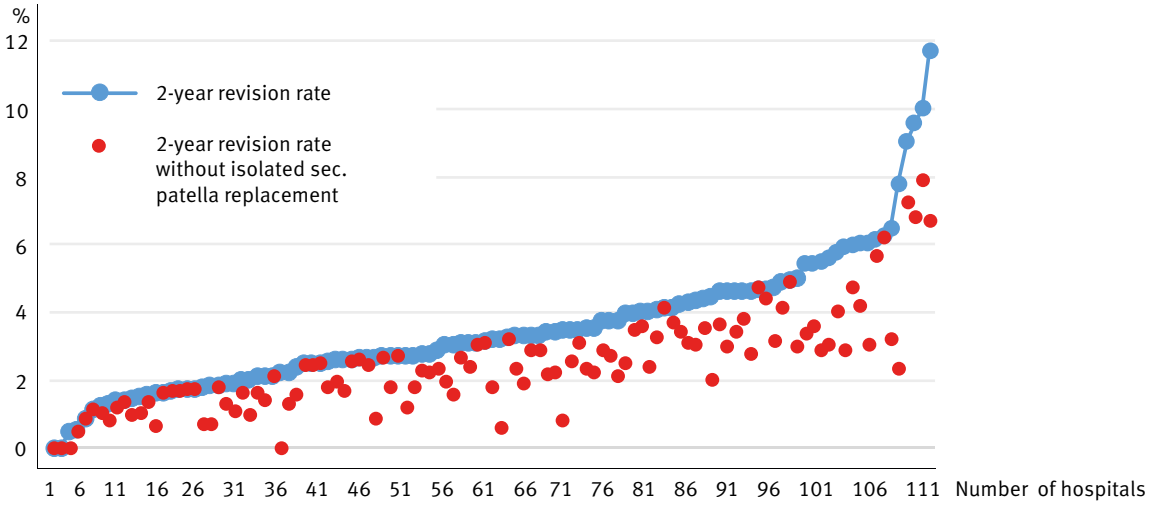
When taking the low rate of secondary patella resurfacing as a hint for a patella friendly design, Persona performed best in all the three systems (CS/UCOR, CR and PS) with CS/UCOR being the riskiest system for a secondary resurfacing within this brand in 18.6% of cases.

When analysing revision of primary TKA within the first two years after surgery, secondary patella resurfacing was responsible for the majority of early revisions. Figure 6.17 shows the risk-adjusted two-year revision rate with (in bright blue) and without (in red) isolated secondary patella resurfacing. In some hospitals secondary resurfacing seemed not to play a significant role whereas in others the resurfacing was considered as a sort of standard care

Figure 6.17

**Risk-adjusted 2-year revision rates with and without isolated secondary patelle replacement**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)



in unsatisfactory results after primary TKA (see mainly hospitals on the right side of the graph). Figure 3.14 in the summary chapter of this report highlights what the omission of isolated secondary patella resurfacing means for the funnel plot of TKA hospital results. Taking into account all the first revisions after primary TKA, patella problems were responsible for 26.3% of the reasons for revision and were the most common single cause (Table 6.11). When taking the secondary resurfaced patellae only, then patella pain was the reason in 83.6%, which could be expected (Table 6.9).

In conclusion Switzerland reflects the worldwide discussions about patella resurfacing in primary TKA like a biotope: small country, small numbers but using almost all the existing TKA systems and brands in hospitals and regions which have a great variety in knee philosophies, preferred systems and brands. Looking closer, the TKA type or brand clearly played a smaller role than surgeons' preferences. There are more or less patella friendly TKA systems and brands expressed in low rates of primary and secondary patella resurfacing. Astonishingly, not all of the modern knee systems were patella friendly and not all of the older implants systematically unfriendly. Both rare (‹5%) and majority patella resurfacing (›50%) surgeons realised comparable results using the same systems. Resurfacing in defined indications led to comparable results whereas a missing strategy which might be reflected in a resurfacing rate of 20–49% led to elevated revision rates.

The data of the Swiss Joint registry do not justify increasing or decreasing the rate of patella resurfacing. The increasing rate of resurfacing from 2015 from 24.4% to 31.9% in 2020 in general is an observation but one would not find any arguments for or against it in terms of rates of complication, revision or re-revision rates.

The topic "patella in TKA" remains complex as the anterior knee pain is one of the most common complaints after primary TKA irrespectively if the patella was resurfaced or not. When not resurfaced, secondary resurfacing is an option which does not exist when the patella was replaced at the primary procedure. Nevertheless, only about 50% of the patients profit from a secondary resurfacing. Resurfacing itself may lead to a variety of new complications due to malpositioning, fracture, necrosis, loosening, maltracking and therefore contribute to the significant re-revision burden detected in this registry.

Table 6.9

## Reason for early first revision of primary total knee arthroplasty involving secondary patella resurfacing

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow up (31.12.2020) . Early first revisions are those occurring within 2 years of the primary arthroplasty Multiple responses possible (percentages do not sum to 100). All diagnoses.

| | 2015–2020 | |
|---|---|---|
| | N | % |
| Patella problems | 542 | 83.6 |
| Femorotibial instability | 45 | 6.9 |
| Infection | 3 | 0.5 |
| Loosening tibia | 0 | 0.0 |
| Pain* | 63 | 9.7 |
| Joint stiffness/arthrofibrosis | 47 | 7.3 |
| Component malposition femur | 2 | 0.3 |
| Component malposition tibia | 1 | 0.2 |
| Loosening femur | 0 | 0.0 |
| Patellar instability | 25 | 3.9 |
| Wear of inlay | 8 | 1.2 |
| Loosening patella | 2 | 0.3 |
| Periprosthetic fracture femur | 0 | 0.0 |
| Sizing femoral component | 0 | 0.0 |
| Periprosthetic fracture tibia | 0 | 0.0 |
| Sizing tibial component | 0 | 0.0 |
| Periprosthetic fracture patella | 3 | 0.5 |
| Other | 48 | 7.4 |
| **Total** | **789** | |

* Pain was frequently reported alongside other reasons. The proportion of "isolated pain" was 2.9%.

## 6.3 Revision of primary total knee arthroplasty

Since 2015, the documentation has included recording of the morbidity state (ASA classification) and the Body Mass Index (BMI). In order to overcome the problem of overaged (antiquated) data, analyses are carried out within a four-year moving window, including the last four years with full two-year follow-up. For this report the data of implantations from 1.1.2015 until 31.12.2018 were analysed with completed two-year follow-up until 31.12.2020. Whenever possible calculations have included all the registered revisions since 2012. In this period of time, 11,614 revisions were performed.

The mean age at revision was 69.2 years, 58.8% were women. 58.3% were classified as ASA 1 or 2, the morbidity status was not recorded in 10% of cases. The mean BMI was 29.8 kg/m² with BMI not recorded in 22% of cases (Table 6.10).

Table 6.10
**Revision* of total knee arthroplasty: Baseline patient characteristics by year**

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| N | | **1,552** | **1,839** | **1,930** | **1,961** | **2,108** | **2,224** | **11,614** |
| Women [%] | | 59.1 | 59.8 | 60.1 | 59.8 | 57.8 | 56.9 | 58.8 |
| Mean age (SD) | All | 68.9 (10.6) | 69.0 (10.3) | 69.1 (10.0) | 69.2 (10.1) | 69.6 (10.0) | 69.5 (9.6) | 69.2 (10.1) |
| | Women | 69.1 (11.0) | 69.8 (10.3) | 69.6 (10.1) | 69.9 (10.2) | 70.3 (10.1) | 69.9 (9.8) | 69.8 (10.2) |
| | Men | 68.6 (10.1) | 67.7 (10.1) | 68.2 (9.8) | 68.3 (10.0) | 68.6 (9.7) | 68.8 (9.3) | 68.4 (9.8) |
| Age group [%] | ‹45 | 1.4 | 0.9 | 0.6 | 1.0 | 0.3 | 0.6 | 0.8 |
| | 45–54 | 8.5 | 7.4 | 8.1 | 6.7 | 7.0 | 5.5 | 7.1 |
| | 55–64 | 23.0 | 24.5 | 22.7 | 24.5 | 24.1 | 24.9 | 24.0 |
| | 65–74 | 35.4 | 36.4 | 38.2 | 36.0 | 35.3 | 36.8 | 36.4 |
| | 75–84 | 26.6 | 24.9 | 25.5 | 26.5 | 27.8 | 27.0 | 26.4 |
| | 85+ | 5.2 | 5.9 | 5.0 | 5.3 | 5.6 | 5.2 | 5.3 |
| N unknown BMI (%) | | 408 (26) | 484 (26) | 451 (23) | 427 (22) | 397 (19) | 386 (17) | 2,553 (22) |
| N known BMI | | 1,144 | 1,355 | 1,479 | 1,534 | 1711 | 1,838 | 9,061 |
| Mean BMI (SD) | | 29.6 (5.8) | 30.0 (7.4) | 29.8 (5.9) | 29.8 (5.8) | 29.6 (5.7) | 30.0 (6.0) | 29.8 (6.1) |
| BMI [%] | ‹18.5 | 0.8 | 0.9 | 0.5 | 0.6 | 0.6 | 0.8 | 0.7 |
| | 18.5–24.9 | 21.3 | 18.2 | 19.1 | 20.5 | 20.4 | 18.6 | 19.6 |
| | 25–29.9 | 36.7 | 37.3 | 37.1 | 35.6 | 36.6 | 35.5 | 36.4 |
| | 30–34.9 | 24.7 | 26.8 | 25.9 | 26.5 | 26.1 | 27.4 | 26.3 |
| | 35–39.9 | 11.6 | 11.7 | 13.1 | 12.1 | 12.2 | 11.6 | 12.1 |
| | 40+ | 4.9 | 5.1 | 4.4 | 4.8 | 4.1 | 6.0 | 4.9 |
| N unknown ASA (%) | | 214 (14) | 224 (12) | 199 (10) | 167 (9) | 195 (9) | 189 (8) | 1,188 (10) |
| N known ASA | | 1,338 | 1,615 | 1,731 | 1,794 | 1,913 | 2,035 | 10,426 |
| Morbidity state | ASA 1 | 7.4 | 7.6 | 6.8 | 6.1 | 5.4 | 4.1 | 6.1 |
| [%] | ASA 2 | 52.4 | 52.2 | 52.4 | 51.7 | 51.6 | 52.9 | 52.2 |
| | ASA 3 | 38.8 | 38.6 | 39.7 | 40.9 | 41.3 | 41.5 | 40.3 |
| | ASA 4/5 | 1.4 | 1.6 | 1.0 | 1.3 | 1.6 | 1.6 | 1.4 |

* includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report

To understand Table 6.11 regarding the reasons for TKA revisions, it is important to note that several reasons can be combined. Therefore, the percentage does not sum up to 100%.

Patella problems were the main reason for revisions (26.3%), followed by infection in 19.8% and then loosening of the tibia in 18.9% of cases. Adding together loosening of the femur (11.8%) and loosening of the patella (2.2%), loosening takes the lead, being responsible for 32.9% of all revisions. On the other hand, wear of inlay was responsible for only 5.8% of the revisions of TKAs. Instability was the cause for revision in 17.5%. Almost eleven percent (10.9%) of the causes were classified as "other" (Table 6.11).

A deeper understanding of the TKA revisions over time can be gained by looking at cumulative incidence rates (Figure 6.18). 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 and covers the observation period since 2015. This perspective shows what proportion of implanted TKA have experienced at least one revision and for which underlying reasons (e.g. revision due to loosening of a component). Figure 6.19 is a Kernel-Density estimation, which is used to estimate the probability density function of a random variable (frequency at a given time). It shows the temporal ordering of various underlying reasons of early revisions (<=2 years), as it is limited to revisions occurring during the moving average timeframe.

Both perspectives show that while infections were revised relatively early (median 5.8 months after index surgery), most other reasons for revising a TKA were performed 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, contributed to the revision rates observed in this fashion, causing a disproportionate number of revisions between one and three years after implantation (median 14.6 months after primary TKA).

Table 6.11

**Reason for revision* of primary total knee arthroplasty**

Multiple responses possible (percentages do not sum to 100). The reasons for revisions categories as listed below are only available from 2015 onwards

| | N | % |
|---|---|---|
| Patella problems | 3,057 | 26.3 |
| Loosening tibia | 2,191 | 18.9 |
| Infection | 2,304 | 19.8 |
| Femorotibial instability | 2,035 | 17.5 |
| Pain** | 1,342 | 11.6 |
| Loosening femur | 1,370 | 11.8 |
| Wear of inlay | 672 | 5.8 |
| Joint stiffness/arthrofibrosis | 671 | 5.8 |
| Component malposition femur | 516 | 4.4 |
| Component malposition tibia | 467 | 4.0 |
| Loosening patella | 256 | 2.2 |
| Patellar instability | 276 | 2.4 |
| Periprosthetic fracture femur | 232 | 2.0 |
| Sizing femoral component | 166 | 1.4 |
| Periprosthetic fracture tibia | 91 | 0.8 |
| Sizing tibial component | 61 | 0.5 |
| Periprosthetic fracture patella | 46 | 0.4 |
| Other | 1,263 | 10.9 |
| Total 2015–2020 | **17,016** | |

* includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report

** Pain was frequently reported alongside other reasons. The proportion of "isolated pain" was 1.9%.

Figure 6.18

## Cumulative incidence rates for different first revision diagnoses of primary total knee arthroplasty

Time since operation, 2015–2020, all services, % of implants revised

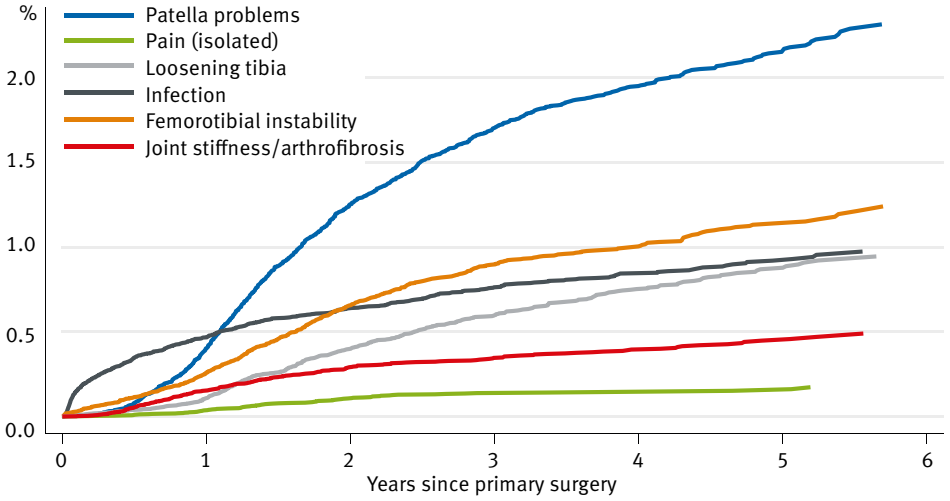
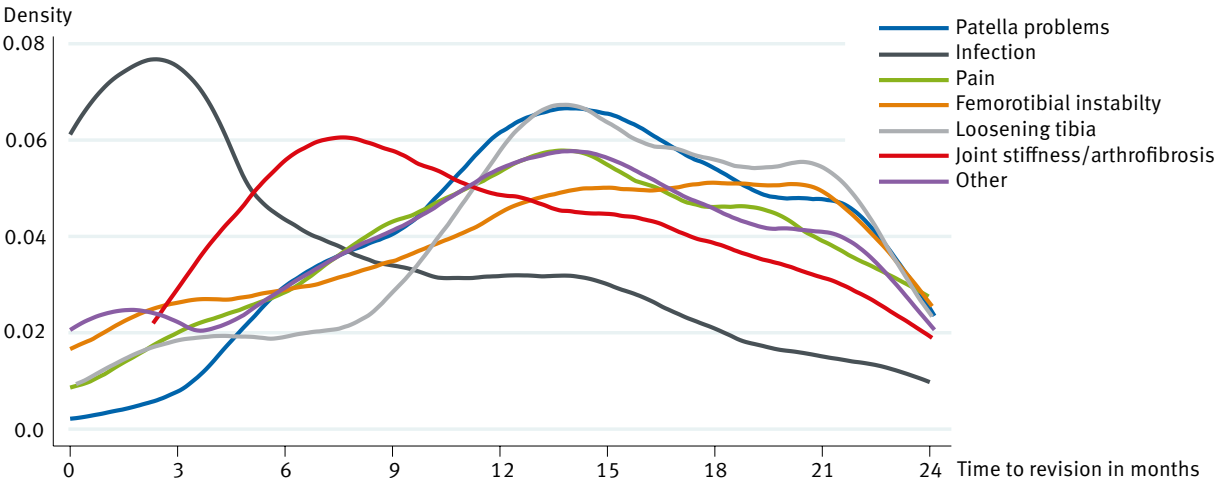



Figure 6.19

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

Median time interval between primary total knee arthroplasty and early first revision (in months) according to reason.
4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Early first revisions are those occurring within 2 years of the primary arthroplasty. All diagnoses.




| | N | Median | IQR 25% | IQR 75% |
|---|---|---|---|---|
| Patella problems | 709 | 14.6 | 10.7 | 18.8 |
| Infection | 340 | 5.8 | 1.3 | 12.9 |
| Pain (isolated) | 64 | 14.4 | 10.0 | 18.6 |
| Femoral instability | 355 | 14.4 | 8.3 | 19.2 |
| Loosening tibia | 226 | 14.8 | 11.6 | 19.6 |
| Joint stiffness/arthrofibrosis | 160 | 11.3 | 7.1 | 16.9 |
| Other | 1,142 | 13.4 | 8.3 | 18.0 |

Complete revision was performed in 37.2% of the cases, in 16.2% PE was exchanged. Secondary resurfacing of the patella was performed in 15.4% (Table 6.12). Osteosynthesis was reported only in 0.3% of cases, which seems to be underreported, as periprosthetic fractures are increasing in all western societies because of demographic changes and rising 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 was probably not recorded reliably, even though it should be.

Posterior cruciate retaining TKAs were used in 4.8% of the revisions, 22.4% were stabilised posteriorly, 9.4% were classified as cruciate sacrificing or ultracongruent implants and in 24.7% a hinge type prosthesis was used. Unlinked-semiconstrained or CCK implants formed the biggest group (34.5%), whereas medial pivot was used only in 1.4% (Table 6.10). An arthrodesis was necessary in only 0.3% (n=36) of revisions in the past six years.

In revision surgery, computer navigation, PSI or minimally invasive techniques did not play an important role. The rate of fully cemented implants was high, reaching 92.1% in 2020 (Table 6.13 and Figure 6.20). Revision-TKA was associated with patella resurfacing in 64.6% of cases. This rate did not significantly change in the past six years (Table 6.14 and Figure 6.21).

Table 6.12

**Revision of total knee arthroplasty: Surgery characteristics**

2015 to 2020

| Intervention type | N | % |
|---|---|---|
| complete revision | 4,315 | 37.2 |
| exchange of PE | 1,887 | 16.2 |
| subsequent patella prosthesis | 1,784 | 15.4 |
| tibial revision | 655 | 5.6 |
| reimplantation of prosthesis | 694 | 6.0 |
| subsequent patella prosthesis with exchange of PE | 580 | 5.0 |
| patella revision | 449 | 3.9 |
| component removal with spacer implantation | 409 | 3.5 |
| femoral revision | 310 | 2.7 |
| prosthesis preserving revision | 112 | 1.0 |
| osteosynthesis | 31 | 0.3 |
| arthrodesis | 36 | 0.3 |
| component removal without spacer implantation | 31 | 0.3 |
| reconstruction after injury of extensor mechanism | 29 | 0.2 |
| plastic reconstruction | 8 | 0.1 |
| other | 284 | 2.4 |
| **Type of arthroplasty** | | |
| Hinge type | 1,476 | 24.7 |
| PS (posterior stabilised) | 1,334 | 22.4 |
| SC / CCK semi-constrained | 1,185 | 19.9 |
| CCK constrained condylar knee | 871 | 14.6 |
| CS (cruciate sacrificing) / UCOR | 560 | 9.4 |
| PCR (posterior cruciate retaining) | 285 | 4.8 |
| BCR (bicruciate retaining) | 33 | 0.6 |
| Other (Medial-Pivot)** | 83 | 1.4 |
| Other | 139 | 2.3 |
| **Technology** | | |
| Conventional | 10,079 | 94.4 |
| Computer assisted | 211 | 2.0 |
| Patient specific instrumentation | 84 | 0.8 |
| Minimally invasive | 273 | 2.6 |
| Other | 94 | 0.9 |

* includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report

** Entered as „other“ intervention and then recoded. As of form version 2021, SIRIS lists Medial Pivot as a separate main category

Table 6.13

## Revision of primary total knee arthroplasty: Component fixation

Component fixation only applicable when new components were implanted

| Component fixation | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| N | 814 | 920 | 1,015 | 1,061 | 1,056 | 1,110 | 5,976 |
| All uncemented | 3.2 | 3.8 | 3.3 | 2.0 | 2.0 | 2.9 | 2.8 |
| Reverse hybrid* | 1.5 | 1.3 | 1.3 | 0.8 | 1.1 | 1.2 | 1.2 |
| Hybrid** | 6.0 | 3.4 | 4.1 | 3.3 | 4.0 | 3.9 | 4.0 |
| All cemented | 89.3 | 91.5 | 91.3 | 93.9 | 92.9 | 92.1 | 92.0 |

Figure 6.20

## Revision of total knee arthroplasty: Component fixation

Component fixation only applicable when new components were implanted

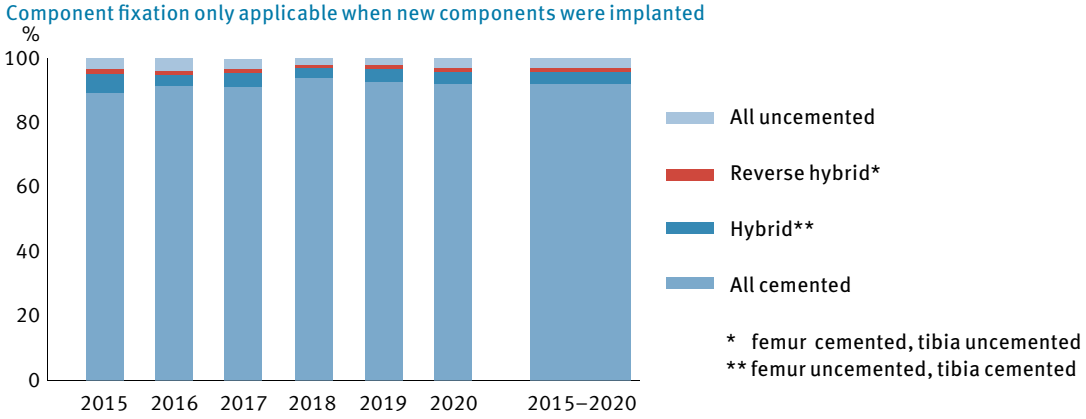


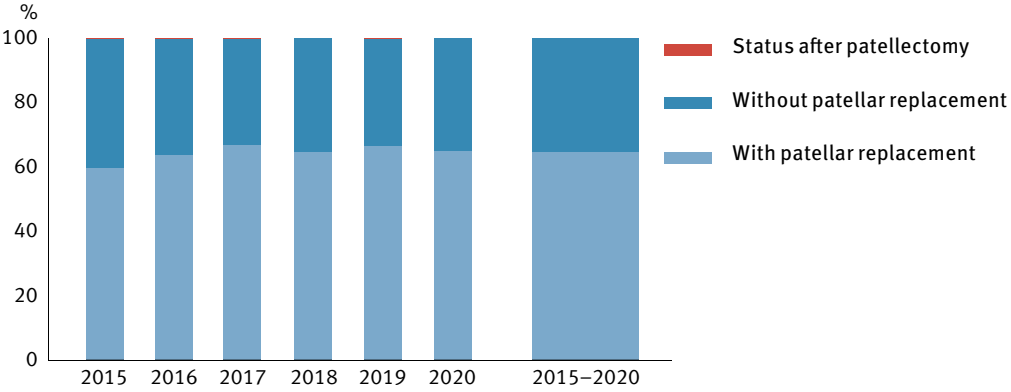

Table 6.14

## Revision of primary total knee arthroplasty: Patellar component

| Patellar component [%] | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| N | 1,184 | 1,338 | 1,513 | 1,547 | 1,586 | 1,620 | 8,788 |
| Without patellar replacement | 40.0 | 35.9 | 33.0 | 35.2 | 33.2 | 34.9 | 35.1 |
| With patellar replacement | 59.5 | 63.8 | 66.8 | 64.6 | 66.5 | 64.9 | 64.6 |
| Status after patellectomy | 0.5 | 0.4 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 |

Figure 6.21

## Revision of total knee arthroplasty: Patellar component



## 6.4 First revision of a primary total knee arthroplasty

This is the third SIRIS report presenting the early revision rate of THA within the first two years after the index surgery. However, the period of time considered for analysis moved by only six months compared to the previous report; from 01.01.2015 to 31.12.2018 in order to cover the actually observed two-year result (as opposed to estimated results).

The 2020 report allowed for longer follow-up into 2020 despite the primary scope of the report being limited to 2019. As this led to confusion, it was decided to re-align primary scope and follow-up time. The use of a moving time window leads to results reflecting current trends and currently used implants more reliably and also eliminates the less reliable early years of the registry (before 2015) from the analyses. In general, the lower coverage rates of early years were associated with underestimates of

Table 6.15
**First revision of primary total knee arthroplasty within 24 months: Baseline patient characteristics**
4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020)

| | | Primary | Revised within 24 months | | | |
|---|---|---|---|---|---|---|
| | | | Revised | | 95% CI | |
| | | N at risk* | N | %** | lower | upper |
| Overall (moving average) | | 56,783 | 1,988 | 3.6 | 3.4 | 3.7 |
| Diagnosis | Primary OA | 50,153 | 1,718 | 3.5 | 3.3 | 3.7 |
| | Secondary OA | 6,630 | 270 | 4.2 | 3.7 | 4.7 |
| Overall Primary OA | | 50,153 | 1,718 | 3.5 | 3.3 | 3.7 |
| Gender | Women | 31,497 | 1,063 | 3.4 | 3.2 | 3.6 |
| | Men | 18,656 | 655 | 3.6 | 3.3 | 3.9 |
| Age group [%] | ‹55 | 2,724 | 146 | 5.5 | 4.7 | 6.4 |
| | 55–64 | 11,268 | 522 | 4.7 | 4.4 | 5.1 |
| | 65–74 | 19,194 | 615 | 3.3 | 3.0 | 3.5 |
| | 75–84 | 14,593 | 389 | 2.7 | 2.5 | 3.0 |
| | 85+ | 2,351 | 46 | 2.0 | 1.5 | 2.7 |
| BMI group | ‹18.5 | 169 | 7 | 4.4 | 2.1 | 9.0 |
| | 18.5–24.9 | 8,109 | 281 | 3.5 | 3.2 | 4.0 |
| | 25–29.9 | 15,459 | 496 | 3.3 | 3.0 | 3.6 |
| | 30–34.9 | 10,108 | 367 | 3.7 | 3.3 | 4.1 |
| | 35–39.9 | 4,416 | 165 | 3.8 | 3.3 | 4.4 |
| | 40+ | 1,966 | 75 | 3.9 | 3.1 | 4.8 |
| | BMI unknown | 9,854 | 326 | 3.4 | 3.0 | 3.8 |
| Morbidity state | ASA 1 | 4,021 | 156 | 3.9 | 3.4 | 4.6 |
| | ASA 2 | 28,157 | 908 | 3.3 | 3.1 | 3.5 |
| | ASA 3 | 12,599 | 480 | 3.9 | 3.6 | 4.3 |
| | ASA 4/5 | 166 | 7 | 4.4 | 2.1 | 9.1 |
| | ASA unknown | 5,138 | 166 | 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.

revision rates, biasing "early" implants somewhat against more recent implants. This also facilitates the registry's function of being a learning system for hospitals and surgeons.

Inspired by procedures used in other registries, the following definition for a potential outlier was adopted: 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. The outlier alert boundary was set at twice that reference revision rate. An implant was regarded as a potential outlier when its two-year revision rate was higher than the outlier alert boundary, regardless of the extent of the statistical confidence interval. The outlier status comes with varying degrees of statistical probability. The outlier status was considered "highly likely" when both the estimated revision rate and the complete confidence interval exceeded the outlier alert boundary. For implant combination with high numbers, the confidence interval usually is narrow. As numbers get smaller,

Table 6.16

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

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020) . All diagnoses

| | Primary TKA | Revised within 24 months | | | |
|---|---|---|---|---|---|
| | | Revised | | 95% CI | |
| | N at risk[1] | N | %[2] | lower | upper |
| Overall (moving average) | 56,783 | 1,988 | 3.6 | 3.4 | 3.7 |
| Component fixation | | | | | |
| All cemented | 44,755 | 1,600 | 3.7 | 3.5 | 3.8 |
| All uncemented | 2,373 | 105 | 4.5 | 3.7 | 5.4 |
| Hybrid* | 9,152 | 274 | 3.0 | 2.7 | 3.4 |
| Reverse hybrid** | 421 | 9 | 2.2 | 1.1 | 4.1 |
| Patellar replacement | | | | | |
| With patellar replacement | 15,486 | 475 | 3.1 | 2.9 | 3.4 |
| Without patellar replacem. | 41,184 | 1,510 | 3.7 | 3.6 | 3.9 |
| Status after patellectomy | 31 | 3 | 9.7 | 3.2 | 27.1 |

[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.

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

Table 6.17

## Reason for early first revision of primary total knee arthroplasty

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Early first revisions are those occurring within 2 years of the primary arthroplasty. Multiple responses possible (percentages do not sum to 100). All diagnoses.

| | N | % |
|---|---|---|
| Patella problems | 709 | 35.7 |
| Femorotibial instability | 355 | 17.9 |
| Infection | 340 | 17.1 |
| Loosening tibia | 226 | 11.4 |
| Pain* | 221 | 11.1 |
| Joint stiffness/arthrofibrosis | 160 | 8.0 |
| Component malposition femur | 94 | 4.7 |
| Component malposition tibia | 73 | 3.7 |
| Loosening femur | 66 | 3.3 |
| Patellar instability | 57 | 2.9 |
| Wear of inlay | 25 | 1.3 |
| Loosening patella | 33 | 1.7 |
| Periprosthetic fracture femur | 16 | 0.8 |
| Sizing femoral component | 25 | 1.3 |
| Periprosthetic fracture tibia | 12 | 0.6 |
| Sizing tibial component | 4 | 0.2 |
| Periprosthetic fracture patella | 8 | 0.4 |
| Other | 223 | 11.2 |
| Total 2015–2020 | 2,647 | |

* Pain was frequently reported alongside other reasons. The proportion of "isolated pain" was 3.2%.

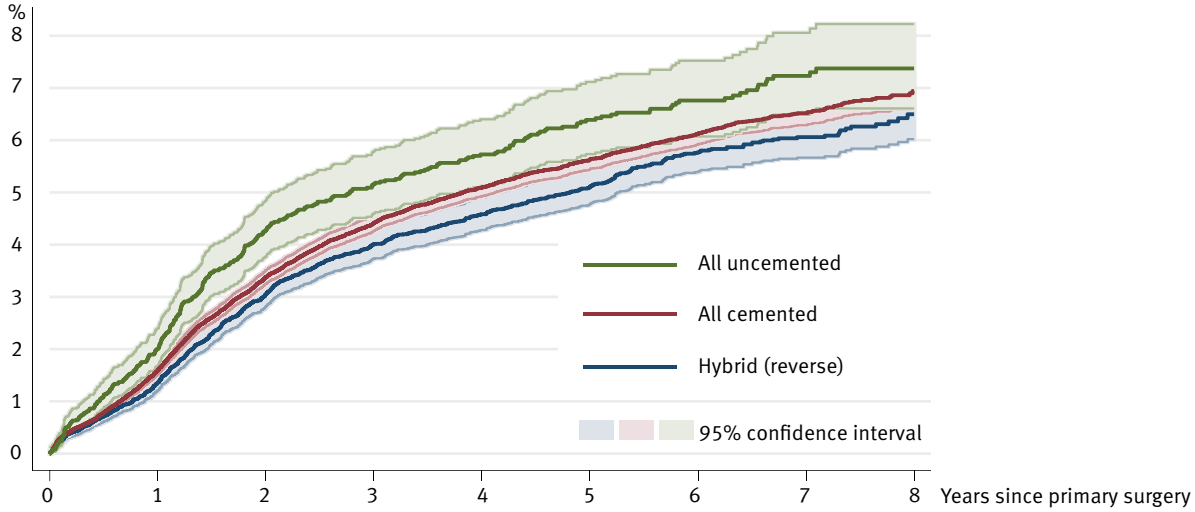
the statistical precision decreases which results in wider confidence intervals. The confidence interval describes the range in which the true mean of a population is expected with the stated probability (typically 95%). For practical purposes, any position within the confidence interval should be seen as a plausible value. If confidence intervals overlap, they should be regarded as statistically not different. For that reason, implants, where the revision rate exceeds the double of the mean revision rate, are defined as potential outliers. If the lower confidence interval exceeds twice mean revision rate it is considered a definitive outlier.

Of the 118,001 documented primary TKAs implanted since 2012, there were 56,783 at risk for a revision from 01.01.2015 to 31.12.2018, with a completed two-year follow-up. Of these, 1,988 knees were revised accounting for the two-year revision rate of 3.6% (CI 95% 3.4–3.7%). The revision rate was higher for secondary (4.2, CI 95% 3.7–4.7%) than for primary arthritis (3.5%, CI 95% 3.3–4.7%). This seems to be connected mainly to the younger age at surgery for the secondary arthritis (mean age 64.7 years for secondary compared to 70.1 years for TKA in primary arthritis). Younger patients were predominantly at risk of early revision (5.5% in the age group under 55 years of age). Increasing BMI did slightly raise the early revision rate from 3.5% (18.5-24.9 kg/m²) to 3.9% in the group ›40 kg/m² (staying within the 95% confidence interval). Only seven revisions were performed in patients with BMI less than 18.5kg/m². The calculated revision rate was 4.4%, the small number being reflected in the considerable variation from 2.1 to 9.0%. ASA classification did not play an important role (Table 6.15).

Figure 6.22

**Estimated failure rates of primary total knee arthroplasty for different fixation methods**

All diagnoses




**Cumulative revision rates**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| All cemented | **1.6** (1.5-1.7) | **3.4** (3.3-3.5) | **4.4** (4.3-4.6) | **5.1** (4.9-5.3) | **5.6** (5.4-5.8) | **6.1** (5.9-6.3) | **6.5** (6.3-6.8) | **6.9** (6.7-7.2) |
| All uncemented | **2.0** (1.7-2.4) | **4.3** (3.8-4.8) | **5.2** (4.6-5.8) | **5.7** (5.1-6.4) | **6.4** (5.7-7.1) | **6.8** (6.1-7.5) | **7.2** (6.5-8.1) | **7.4** (6.6-8.2) |
| Hybrid (reverse) | **1.4** (1.2-1.5) | **3.0** (2.8-3.3) | **4.0** (3.7-4.3) | **4.6** (4.3-4.9) | **5.1** (4.8-5.5) | **5.8** (5.4-6.2) | **6.1** (5.7-6.5) | **6.5** (6.0-7.0) |

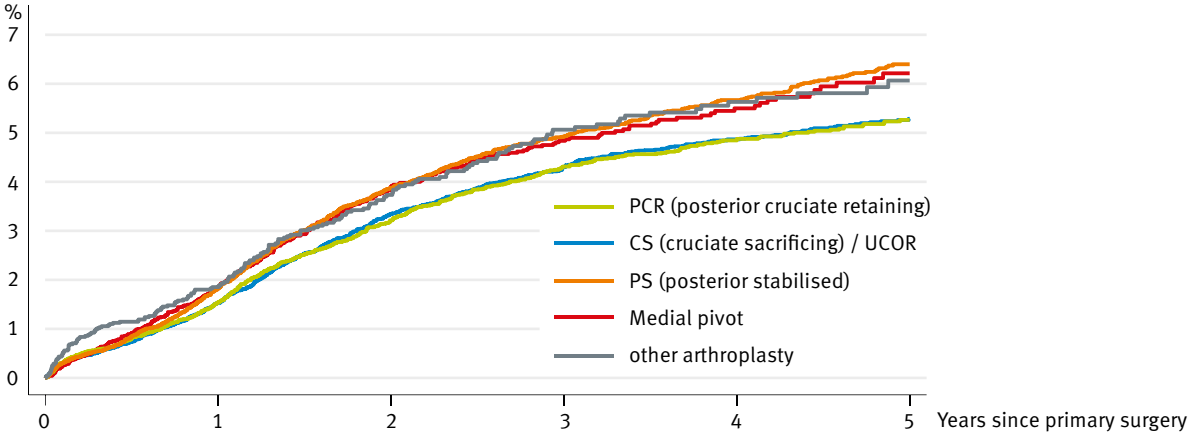
Completely cementless TKA seemed to have been revised slightly more often (4.5%) than fully cemented TKA (3.7%) in the first two years after index surgery, although the difference was not significant as the numbers were still within the confidence intervals of both groups. Ignoring the statistically inconclusive reverse hybrid fixations, hybrid fixation with cemented tibial and uncemented femoral component performed best (3.0%) (Table 6.16). Again, in the cemented and cementless groups younger age (‹ 60 years) seemed to play an important role for early revision. One could assume that unsatisfactory results after primary TKA were better accepted by patients being older at time of surgery due to less functional demands and possibly more acceptance for inferior results. Taking the whole registry data set into account, the uncemented fixations led to more early revisions from the beginning and seemed to stay parallel on a higher level from two years to eight years after index surgery (Figure 6.22).

The main reasons for early revision were patella problems in 35.7%, followed by instability (17.9%) and infection (17.1%) (Table 6.17). When infection and periprosthetic fractures were excluded, surgical technical problems were responsible for the vast majority of early TKA revisions in Switzerland. Exact ratios are not available as multiple reasons could be selected per patient. In addition, 11.2% of the reasons were classified as “other”. To a large extent this diverse group contains the same reasons as listed above, but with added details, and included 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

Figure 6.23

**Estimated failure rates of primary total knee arthroplasty for different implant types**

All diagnoses




**Cumulative revision rates**

| | 1 year | 2 years | 3 years | 4 years | 5 years |
|---|---|---|---|---|---|
| PCR (posterior cruciate retaining) | **1.5** (1.4-1.7) | **3.2** (3.0-3.5) | **4.3** (4.0-4.6) | **4.9** (4.5-5.2) | **5.3** (4.9-5.7) |
| CS (cruciate sacrificing) / UCOR | **1.5** (1.4-1.7) | **3.3** (3.1-3.6) | **4.3** (4.0-4.6) | **4.9** (4.6-5.2) | **5.3** (4.9-5.7) |
| PS (posterior stabilized) | **1.8** (1.7-2.0) | **3.9** (3.6-4.2) | **4.9** (4.6-5.3) | **5.7** (5.3-6.0) | **6.4** (6.0-6.8) |
| Medial Pivot | **1.9** (1.6-2.2) | **3.9** (3.5-4.4) | **4.8** (4.3-5.4) | **5.5** (4.9-6.2) | **6.2** (5.5-7.0) |
| other arthroplasty | **1.9** (1.5-2.3) | **3.7** (3.2-4.4) | **5.1** (4.4-5.9) | **5.6** (4.9-6.5) | **6.1** (5.2-7.1) |

Table 6.18

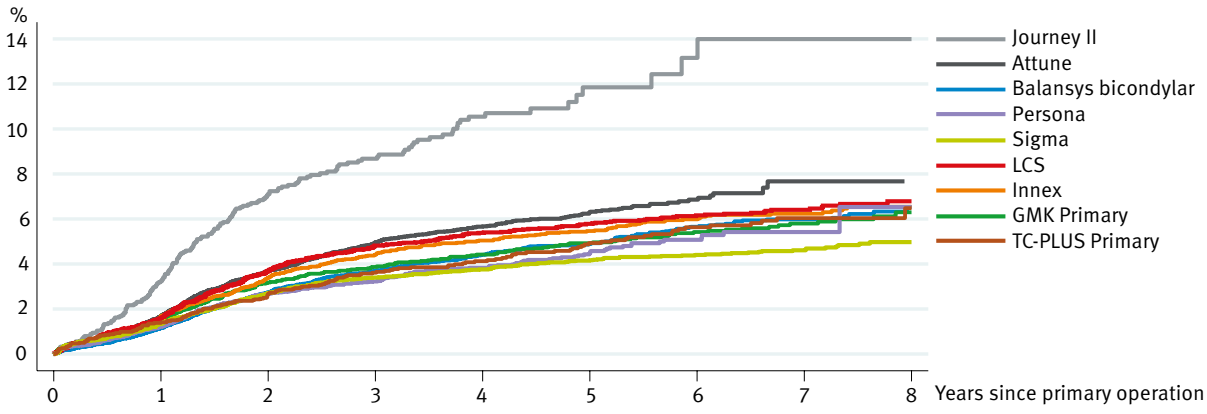
## Top 10 implants, primary total knee arthroplasty

2015–2020, all diagnoses, all component fixations, only unlinked bicondylar total knee systems

| Cup component | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|
| Attune | 2,549 | 3,147 | 3,247 | 3,225 | 3,164 | 2,954 | 18,286 |
| Persona | 1,253 | 1,652 | 2,001 | 2,323 | 2,493 | 2,694 | 12,416 |
| Balansys bicondylar system | 1,827 | 1,876 | 1,856 | 1,716 | 1,834 | 1,768 | 10,877 |
| GMK sphere | 807 | 1,120 | 1,356 | 1,719 | 2,004 | 2,053 | 9,059 |
| LCS | 913 | 853 | 879 | 857 | 867 | 810 | 5,179 |
| Sigma | 1,105 | 892 | 683 | 601 | 615 | 559 | 4,455 |
| Innex | 838 | 682 | 573 | 431 | 333 | 235 | 3,092 |
| TC-plus primary | 457 | 479 | 414 | 334 | 382 | 369 | 2,435 |
| GMK primary | 553 | 546 | 398 | 277 | 194 | 145 | 2,113 |
| Journey II | 169 | 396 | 468 | 397 | 368 | 238 | 2,036 |
| Other | 2,274 | 2,343 | 2,007 | 2,180 | 2,473 | 2,681 | 13,958 |
| **Total** | **12,745** | **13,986** | **13,882** | **14,060** | **14,727** | **14,506** | **83,906** |

Figure 6.24

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




### Cumulative revision rates

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Journey II | **3.2** (2.6-4.1) | **7.1** (6.0-8.4) | **8.7** (7.4-10.1) | **10.5** (9.1-12.3) | **11.9** (10.0-14.0) | **13.2** (10.7-16.1) | **14.0** (11.2-17.4) | |
| Attune | **1.7** (1.5-1.9) | **3.7** (3.4-4.0) | **5.0** (4.6-5.3) | **5.7** (5.3-6.1) | **6.3** (5.9-6.8) | **6.9** (6.3-7.4) | **7.7** (6.8-8.7) | |
| Balansys bicondylar | **1.2** (1.0-1.3) | **2.8** (2.5-3.1) | **3.7** (3.4-4.1) | **4.4** (4.0-4.8) | **4.9** (4.5-5.3) | **5.7** (5.2-6.2) | **6.0** (5.5-6.5) | **6.5** (5.8-7.3) |
| Persona | **1.2** (1.0-1.4) | **2.7** (2.4-3.0) | **3.2** (2.9-3.6) | **3.8** (3.4-4.3) | **4.5** (4.0-5.0) | **5.1** (4.5-5.7) | **5.4** (4.7-6.2) | |
| Sigma | **1.3** (1.1-1.6) | **2.7** (2.4-3.1) | **3.4** (3.0-3.8) | **3.8** (3.4-4.2) | **4.2** (3.7-4.6) | **4.4** (4.0-4.9) | **4.6** (4.1-5.1) | **5.0** (4.4-5.6) |
| LCS | **1.6** (1.3-1.9) | **3.7** (3.3-4.1) | **4.8** (4.4-5.3) | **5.4** (4.9-5.9) | **5.8** (5.2-6.4) | **6.2** (5.6-6.8) | **6.4** (5.8-7.1) | **6.8** (6.1-7.5) |
| Innex | **1.7** (1.4-2.1) | **3.4** (3.0-3.9) | **4.4** (3.9-5.0) | **5.0** (4.5-5.7) | **5.5** (4.9-6.1) | **6.0** (5.4-6.7) | **6.2** (5.6-7.0) | **6.5** (5.8-7.3) |
| GMK Primary | **1.3** (1.0-1.7) | **3.2** (2.7-3.8) | **3.9** (3.3-4.5) | **4.4** (3.8-5.1) | **4.9** (4.3-5.7) | **5.4** (4.7-6.2) | **5.8** (5.0-6.7) | **6.3** (5.4-7.3) |
| TC-plus primary | **1.4** (1.1-1.8) | **2.7** (2.2-3.3) | **3.6** (3.0-4.3) | **4.1** (3.5-4.9) | **4.9** (4.2-5.8) | **5.6** (4.8-6.6) | **6.0** (5.1-7.1) | **6.5** (5.3-7.9) |

Please note that if reported systems involve multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

with exchange of one or more components, and many cases with internal fixation were apparently not registered.

Comparing the different knee systems, CS/UCOR and PCR knees showed advantages compared to medial pivot, PS systems and those classified as other, being visible after one year and getting significant at four years after primary TKA (Figure 6.23). The reason is not clear so far, and could be partly explained by selection bias. At least in the German speaking part of Switzerland less constrained knees were implanted routinely and medial pivot and PS was selected in more advanced arthritis with bone loss and/or partial ligament instability. This effect is well known in Australia, a "CR continent", where PS knees have a clearly higher revision rate as well due to this case selection.

Kernel density estimation shows that only infection did lead 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 early revisions took place more than one years after TKA on average (Figure 6.19).

Of the 29 knee systems used in Switzerland for primary TKA, three were identified as potential outliers. One of these critical implants belonged to the top ten group used in Switzerland with results that get worse even five to seven years after surgery (Figure 6.24, Tables 6.19 and 6.20). Most of the systems reached group averages but some were better than average. It should be noted that given small implantation numbers of some systems, very few additional revisions could considerably change the performance. As usual, the potential outlier systems will result in outlier reports in order to further investigate the reasons for the observed deviations from the national average.

## Important information on the use of the implant performance tables below

Implants ranked by upper end of the 95% confidence interval. This is the upper end of the plausible range in which the true 2-year revision rate of an implant could lie with 95% certainty after allowing for random variation in the occurrence of revisions.

At the bottom of the list are the implants without any registered revisions (statistical evaluation not yet possible).

●=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. Observed revision rates may be determined by local factors and performance may differ significantly between locations. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

Table 6.19

## Revision rates of primary total knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2015 and 31.12.2018,
with two years follow-up (31.12.2020). Systems with at least 50 implants.
Covering approx. 99% of registered TKAs, alphabetic order.
All diagnoses, all component fixations, only unlinked bicondylar total knee systems.

| Knee system | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|
| | N | N | %** | lb | ub |
| 3D | 154 | 3 | 1.9 | 0.6 | 5.9 |
| Advance | 408 | 21 | 5.3 | 3.5 | 8.0 |
| Advance stature | 422 | 25 | 6.0 | 4.1 | 8.7 |
| Anatomic | 193 | 5 | 2.7 | 1.1 | 6.3 |
| Attune | 12,167 | 452 | 3.8 | 3.5 | 4.2 |
| Balansys bicondylar system | 7,275 | 194 | 2.7 | 2.4 | 3.1 |
| E.motion FP/UC | 542 | 7 | 1.3 | 0.6 | 2.7 |
| E.motion PS | 324 | 21 | 6.6 | 4.3 | 9.9 |
| First | 1,073 | 42 | 4.0 | 3.0 | 5.4 |
| First revision | 157 | 6 | 3.9 | 1.8 | 8.6 |
| Gemini SL | 144 | 5 | 3.5 | 1.5 | 8.2 |
| GMK primary | 1,774 | 50 | 2.9 | 2.2 | 3.8 |
| GMK sphere | 5,002 | 182 | 3.7 | 3.2 | 4.3 |
| HLS kneetec deep dish | 63 | 2 | 3.2 | 0.8 | 12.1 |
| HLS kneetec | 159 | 2 | 1.3 | 0.3 | 5.0 |
| Innex | 2,523 | 96 | 3.9 | 3.2 | 4.7 |
| iTotal (unclear) | 63 | 3 | 4.8 | 1.6 | 14.2 |
| iTotal CR | 436 | 6 | 1.4 | 0.6 | 3.1 |
| Journey II | 1,430 | 113 | 8.0 | 6.7 | 9.6 |
| LCS | 3,502 | 119 | 3.5 | 2.9 | 4.1 |
| Legion | 654 | 35 | 5.5 | 4.0 | 7.6 |
| Nexgen | 555 | 17 | 3.1 | 1.9 | 5.0 |
| NK flex | 556 | 24 | 4.4 | 2.9 | 6.4 |
| Persona | 7,229 | 195 | 2.8 | 2.4 | 3.2 |
| Physica KR | 61 | 6 | 10.6 | 4.9 | 22.2 |
| Physica PS | 130 | 13 | 10.2 | 6.1 | 17.0 |
| Score | 69 | 1 | 1.5 | 0.2 | 10.1 |
| Sigma | 3,281 | 103 | 3.2 | 2.6 | 3.9 |
| TC-plus primary | 1,684 | 41 | 2.5 | 1.8 | 3.3 |
| Triathlon CR | 610 | 31 | 5.2 | 3.7 | 7.4 |
| Triathlon PS | 453 | 18 | 4.1 | 2.6 | 6.4 |
| Unity | 140 | 3 | 2.2 | 0.7 | 6.6 |
| Vanguard | 1,066 | 35 | 3.3 | 2.4 | 4.6 |
| Group average | | | 3.5 | 3.4 | 3.7 |

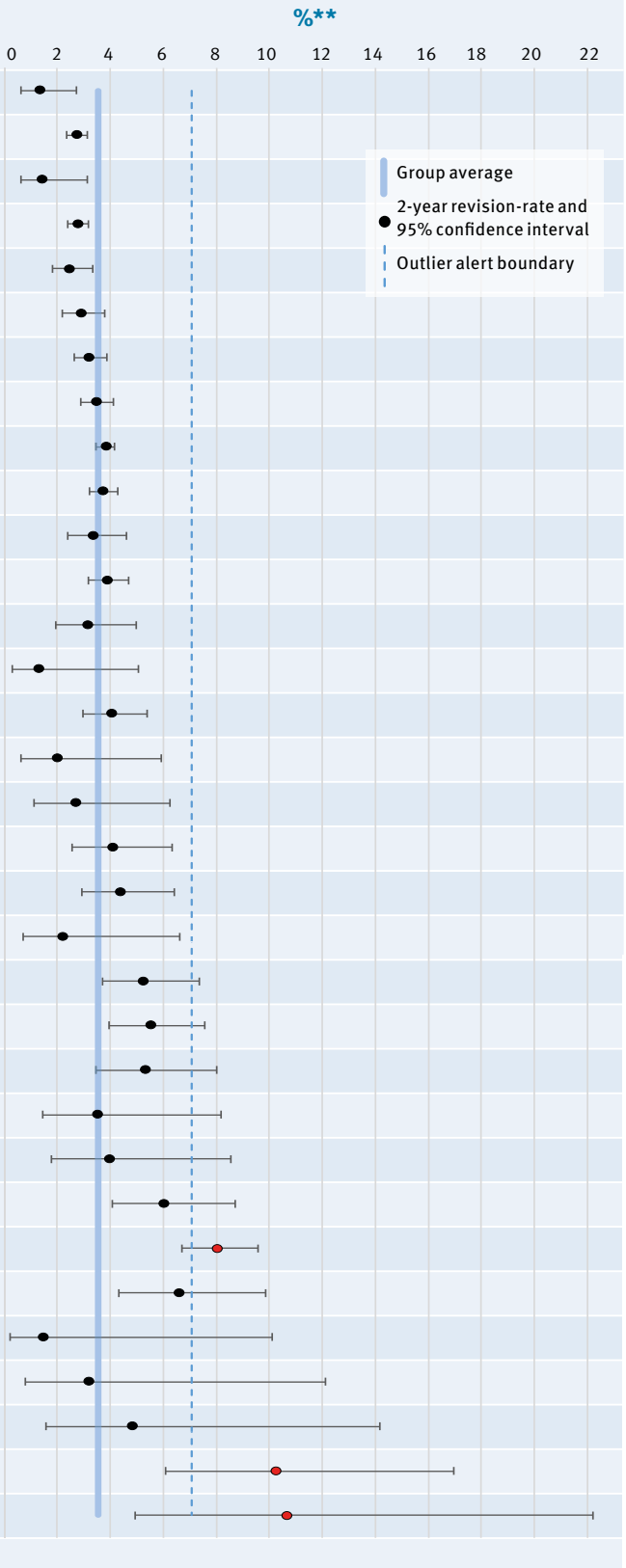
* Number of patients with at least two years follow-up (i.e. primary prosthesis in moving average).
** Rates adjusted for effects of mortality and emigration.

Table 6.20

## 2-year revision rates of primary total knee arthroplasty systems

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
If an implant has „unclear“ added to ist name, it means that we have been unable to identify to which of two or more known variants it belongs. All diagnoses, all component fixations, only unlinked bicondylar total knee systems.

| Knee system | N at risk* | N revised | % | 95% CI low | 95% CI up |
|---|---|---|---|---|---|
| E.motion FP/UC | 542 | 7 | 1.3 | 0.6 | 2.7 |
| Balansys bicondylar syst. | 7,275 | 194 | 2.7 | 2.4 | 3.1 |
| iTotal CR | 436 | 6 | 1.4 | 0.6 | 3.1 |
| Persona | 7,229 | 195 | 2.8 | 2.4 | 3.2 |
| TC-plus primary | 1,684 | 41 | 2.5 | 1.8 | 3.3 |
| GMK primary | 1,774 | 50 | 2.9 | 2.2 | 3.8 |
| Sigma | 3,281 | 103 | 3.2 | 2.6 | 3.9 |
| LCS | 3,502 | 119 | 3.5 | 2.9 | 4.1 |
| Attune | 12,167 | 452 | 3.8 | 3.5 | 4.2 |
| GMK sphere | 5,002 | 182 | 3.7 | 3.2 | 4.3 |
| Vanguard | 1,066 | 35 | 3.3 | 2.4 | 4.6 |
| Innex | 2,523 | 96 | 3.9 | 3.2 | 4.7 |
| Nexgen | 555 | 17 | 3.1 | 1.9 | 5.0 |
| HLS kneetec | 159 | 2 | 1.3 | 0.3 | 5.0 |
| First | 1,073 | 42 | 4.0 | 3.0 | 5.4 |
| 3D | 154 | 3 | 1.9 | 0.6 | 5.9 |
| Anatomic | 193 | 5 | 2.7 | 1.1 | 6.3 |
| Triathlon PS | 453 | 18 | 4.1 | 2.6 | 6.4 |
| NK flex | 556 | 24 | 4.4 | 2.9 | 6.4 |
| Unity | 140 | 3 | 2.2 | 0.7 | 6.6 |
| Triathlon CR | 610 | 31 | 5.2 | 3.7 | 7.4 |
| Legion | 654 | 35 | 5.5 | 4.0 | 7.6 |
| Advance | 408 | 21 | 5.3 | 3.5 | 8.0 |
| Gemini SL | 144 | 5 | 3.5 | 1.5 | 8.2 |
| First revision | 157 | 6 | 3.9 | 1.8 | 8.6 |
| Advance stature | 422 | 25 | 6.0 | 4.1 | 8.7 |
| Journey II | 1,430 | 113 | 8.0 | 6.7 | 9.6 |
| E.motion PS | 324 | 21 | 6.6 | 4.3 | 9.9 |
| Score | 69 | 1 | 1.5 | 0.2 | 10.1 |
| HLS kneetec deep dish | 63 | 2 | 3.2 | 0.8 | 12.1 |
| iTotal | 63 | 3 | 4.8 | 1.6 | 14.2 |
| Physica PS | 130 | 13 | 10.2 | 6.1 | 17.0 |
| Physica KR | 61 | 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.

# 7. Partial knee arthroplasty

# 7. Partial knee arthroplasty

## 7.1 Primary partial knee arthroplasty

Since the beginning of recording in 2012, 21,751 primary partial knee arthroplasties (PKA) were registered, of which 16,178 PKA were implanted within the period since 2015. Since 2015, documentation included recording of the morbidity state (ASA classification) and the Body Mass Index (BMI). In order to overcome the problem of overaged (antiquated) data, analyses were carried out within a four-year moving window, including the last four years with full two-year follow-up. For this report, implantations between 1.1.2015 and 31.12.2018 were analysed with complete two-year follow-up until 31.12.2020. However, for Kaplan-Meier survival estimates and the calculation of cumulative revision rates the entire period from 2012 onwards was used in order to extend the follow-up period to its maximum.

Between 2015 and 2020, the implantation of 16'178 PKA was performed, which accounts for 15.6% of all knee arthroplasties (Table 3.3 "Overview"). This proportion remained constant over the past five years and is the highest in the international community, although in almost all western countries including Australia the rate of partial knees has significantly increased, closing the gap to Switzerland. Partially, this effect is connected to increased technical support during surgery by PSI or robotics, whereas the high rate of PKA in Switzerland seems to be rooted in local surgical tradition.

The mean age at surgery was 64.6 years (Table 7.1) in the period from 2015 to 2020, 49.2% of patients were women. Only 9.1% of the osteoarthritis cases were classified as secondary, with osteonecrosis at 5.1% being the most prominent followed by ligament lesions with 1.8% as the predominant underlying causes. 2.1% of partial knee replacements were performed on patients younger than 45 years and 14.7% on 45–54 years old. In elderly patients, 16% of partial knee replacements were performed on 75–84 years old. 2.2% of the patients were older than 85. Overall, partial knee arthroplasties were more frequently implanted in younger pati-

Table Overview

**Total and partial knee arthroplasty (TKA, PKA)**

All documented operations

| Year | Primary TKA | Primary PKA | Primary others or type uncl. | Primary total | «Linked» Rev./Reop. of TKA** | «Linked» Rev./Reop. of PKA | «Unlinked» Rev./Reop. of TKA & PKA | Rev./Reop. Total | % «Linked» Rev./Reop. |
|---|---|---|---|---|---|---|---|---|---|
| **2012*** | 4,673 | 918 | 17 | 5,608 | 19 | 2 | 508 | 529 | 4.0 |
| **2013** | 12,683 | 2,369 | 32 | 15,084 | 172 | 49 | 1,247 | 1,468 | 15.1 |
| **2014** | 13,049 | 2,286 | 39 | 15,374 | 390 | 101 | 1,116 | 1,607 | 30.6 |
| **2015** | 13,304 | 2,377 | 15 | 15,696 | 581 | 117 | 1,065 | 1,763 | 39.6 |
| **2016** | 14,500 | 2,441 | 15 | 16,956 | 828 | 187 | 1,138 | 2,153 | 47.1 |
| **2017** | 14,359 | 2,582 | 29 | 16,970 | 927 | 255 | 1,097 | 2,279 | 51.9 |
| **2018** | 14,622 | 2,674 | 26 | 17,322 | 1,019 | 269 | 1,073 | 2,361 | 54.6 |
| **2019** | 15,453 | 3,002 | 15 | 18,470 | 1,169 | 286 | 1,060 | 2,515 | 57.9 |
| **2020** | 15,358 | 3,102 | 11 | 18,471 | 1,280 | 377 | 1,065 | 2,722 | 60.9 |
| **All** | **118,001** | **21,751** | **199** | **139,951** | **6,385** | **1,643** | **9,369** | **17,397** | **46.1** |

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

** i.e. primaries already in SIRIS

Table 7.1

## Primary partial knee arthroplasty: Baseline patient characteristics by year

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|---|
| **N** | | **2,377** | **2,441** | **2,582** | **2,674** | **3,002** | **3,102** | **16,178** |
| Diagnosis [%] | Primary OA | 90.6 | 91.7 | 90.6 | 91.2 | 90.5 | 91.0 | 90.9 |
| | Secondary OA | 9.4 | 8.3 | 9.4 | 8.8 | 9.5 | 9.0 | 9.1 |
| | Inflammatory origin | 0.4 | 0.0 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 |
| | Fracture | 0.6 | 0.7 | 1.0 | 0.9 | 0.6 | 0.8 | 0.8 |
| | Lesion of ligament | 1.5 | 1.4 | 1.7 | 1.6 | 2.1 | 2.1 | 1.8 |
| | Infection | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Osteonecrosis | 5.7 | 5.0 | 4.6 | 5.0 | 5.5 | 4.5 | 5.1 |
| | Other | 2.1 | 2.0 | 2.9 | 1.9 | 2.0 | 2.6 | 2.3 |
| Women [%] | | 51.8 | 49.2 | 50.5 | 47.8 | 48.9 | 47.9 | 49.2 |
| Mean age (SD) | All | 64.7 (10.2) | 64.3 (10.0) | 64.2 (10.2) | 64.9 (10.3) | 64.7 (10.3) | 64.6 (10.2) | 64.6 (10.2) |
| | Women | 64.4 (10.7) | 63.9 (10.3) | 63.9 (10.6) | 64.8 (10.8) | 64.7 (10.8) | 64.2 (11.0) | 64.3 (10.7) |
| | Men | 65.0 (9.7) | 64.6 (9.7) | 64.6 (9.7) | 64.9 (9.8) | 64.8 (9.8) | 65.0 (9.5) | 64.8 (9.7) |
| Age group [%] | <45 | 2.2 | 1.9 | 2.3 | 2.1 | 2.0 | 2.2 | 2.1 |
| | 45–54 | 14.1 | 15.2 | 15.8 | 14.0 | 14.6 | 14.4 | 14.7 |
| | 55–64 | 33.1 | 34.8 | 34.4 | 32.7 | 34.0 | 34.1 | 33.9 |
| | 65–74 | 32.0 | 30.8 | 30.4 | 32.3 | 30.6 | 31.0 | 31.2 |
| | 75–84 | 16.3 | 15.3 | 15.2 | 16.5 | 16.3 | 16.1 | 16.0 |
| | 85+ | 2.3 | 2.0 | 1.8 | 2.5 | 2.4 | 2.3 | 2.2 |
| N unknown BMI (%) | | 713 (30) | 553 (23) | 468 (18) | 443 (17) | 434 (14) | 339 (11) | 2,950 (18) |
| N known BMI | | 1,664 | 1,888 | 2114 | 2,231 | 2,568 | 2,763 | 13,228 |
| Mean BMI (SD) | | 28.2 (4.8) | 28.4 (4.7) | 28.5 (4.8) | 28.4 (5.4) | 28.5 (5.6) | 28.5 (4.9) | 28.4 (5.1) |
| BMI [%] | <18.5 | 1.0 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 |
| | 18.5–24.9 | 26.3 | 24.9 | 23.6 | 24.0 | 24.7 | 24.8 | 24.7 |
| | 25–29.9 | 42.2 | 42.7 | 42.7 | 43.7 | 41.6 | 40.9 | 42.2 |
| | 30–34.9 | 21.3 | 23.0 | 25.0 | 24.6 | 23.2 | 24.6 | 23.8 |
| | 35–39.9 | 7.6 | 7.0 | 6.2 | 5.7 | 8.2 | 7.4 | 7.1 |
| | 40+ | 1.6 | 1.9 | 2.1 | 1.6 | 1.8 | 1.7 | 1.8 |
| N unknown ASA (%) | | 293 (12) | 253 (10) | 199 (8) | 175 (7) | 161 (5) | 152 (5) | 1,233 (8) |
| N known ASA | | 2,084 | 2,188 | 2,383 | 2,499 | 2,841 | 2,950 | 14,945 |
| Morbidity | ASA 1 | 21.9 | 20.2 | 17.8 | 17.1 | 16.8 | 14.5 | 17.8 |
| state [%] | ASA 2 | 64.0 | 64.7 | 65.7 | 66.0 | 65.1 | 68.3 | 65.8 |
| | ASA 3 | 14.0 | 15.0 | 16.2 | 16.7 | 17.9 | 16.9 | 16.3 |
| | ASA 4/5 | 0.1 | 0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |

ents (peak in the age group 55–64 years), whereas the peak for total knee arthroplasty was in the age group 65–74 years (Table 6.1). The mean BMI was 28.4 kg/m² in the partial knee replacement group. BMI was not recorded in 18% of the cases.

The ASA classification for the vast majority (83.6%) of patients was 1 or 2. Morbidity state was not recorded in 8% of cases (Table 7.1). Hospitals with more than 100 interventions per year performed 81.3% of the partial knee replacements (Table 7.2).

61.7% of the patients not had surgery before their partial knee replacement; 21.8% had had previous arthroscopy of the knee; 22.7% a meniscectomy; 1.6% previous ACL reconstruction; 1.7% had under-

Table 7.2

**Baseline patient characteristics of primary partial knee arthroplasty by hospital service volume**

Calculations of hospital service volume based on primary hip surgeries in each included year (2015-2020).

| | | <100 | 100–199 | 200–299 | 300+ |
|---|---|---|---|---|---|
| **N (2015–2020)** | | **3,028** | **4,032** | **3,650** | **5,468** |
| Women [%] | | 49.7 | 47.2 | 48.7 | 50.8 |
| Mean age (SD) | All | 64.6 (10.3) | 64.2 (10.0) | 64.6 (10.1) | 64.8 (10.3) |
| | Women | 64.3 (11.0) | 63.9 (10.4) | 64.4 (10.5) | 64.7 (10.9) |
| | Men | 64.9 (9.6) | 64.5 (9.7) | 64.9 (9.8) | 65.0 (9.7) |
| Age group [%] | <45 | 2.2 | 2.0 | 2.1 | 2.2 |
| | 45–54 | 14.6 | 15.0 | 14.3 | 14.6 |
| | 55–64 | 34.0 | 35.8 | 33.5 | 32.6 |
| | 65–74 | 30.7 | 30.2 | 32.9 | 31.0 |
| | 75–84 | 15.8 | 15.1 | 14.7 | 17.5 |
| | 85+ | 2.8 | 1.8 | 2.5 | 2.0 |
| Diagnosis [%] | Primary OA | 92.0 | 92.5 | 88.1 | 91.0 |
| | Secondary OA | 8.0 | 7.5 | 11.9 | 9.0 |
| N unknown BMI (%) | | | | | |
| N known BMI | | 758 (25) | 856 (21) | 472 (13) | 864 (16) |
| Mean BMI (SD) | | 2,270 | 3,176 | 3,178 | 4,604 |
| BMI [%] | <18.5 | 28.8 (5.5) | 28.7 (4.8) | 28.3 (5.0) | 28.1 (5.0) |
| | 18.5–24.9 | 0.6 | 0.4 | 0.6 | 0.6 |
| | 25–29.9 | 22.2 | 22.5 | 25.4 | 26.8 |
| | 30–34.9 | 42.2 | 41.9 | 42.2 | 42.4 |
| | 35–39.9 | 24.9 | 25.2 | 23.3 | 22.5 |
| | 40+ | 8.1 | 8.0 | 6.6 | 6.2 |
| N unknown ASA (%) | | 2.1 | 2.0 | 1.9 | 1.4 |
| N known ASA | | 191 (6) | 329 (8) | 445 (12) | 268 (5) |
| ASA state [%] | ASA 1 | 2,837 | 3,703 | 3,205 | 5,200 |
| | ASA 2 | 18.3 | 20.5 | 16.1 | 16.6 |
| | ASA 3 | 67.3 | 65.7 | 64.5 | 65.8 |
| | ASA 4/5 | 14.2 | 13.7 | 18.9 | 17.5 |
| | | 0.2 | 0.1 | 0.4 | 0.1 |

gone an osteotomy close to the knee at the tibia or the femur (Table 7.3). Medial uni-compartmental replacement was performed in 84% of cases, lateral in 6.1% and patello-femoral replacement in 6.3%. In 0.6% "other" was selected, meaning mainly combinations of PKA. In 2.9% the type was incorrectly classified as a TKA but the implant data identified them as PKA (Table 7.3).

For the surgical technique conventional was selected in 68.8% of cases and minimal invasive in 24.4% as, but the latter is now seen as form of conventional technique as well and is not featured anymore on the new SIRIS version 2021 forms. Patient specific instrumentation (PSI) was used in 4.9%, computer navigation in 2%. 2.2% were classified as other with the vast majority of those cases being

Table 7.3

**Primary partial knee arthroplasty: Surgery characteristics**

All diagnoses, all component fixations

| N (2015–2020) | N | % |
|---|---|---|
| **Previous surgery** | | |
| None | 9,987 | 61.7 |
| Knee arthroscopy | 3,534 | 21.8 |
| Meniscectomy | 3,679 | 22.7 |
| ACL reconstruction | 262 | 1.6 |
| Osteotomy tibia close to knee | 229 | 1.4 |
| Osteosynthesis tibia close to knee | 70 | 0.4 |
| Surgery for patella stabilization | 175 | 1.1 |
| Synovectomy | 62 | 0.4 |
| Osteotomy femur close to knee | 24 | 0.1 |
| Osteosynthesis femur close to knee | 29 | 0.2 |
| Surgery for treating infection | 8 | 0.0 |
| Surgery for tumor | 4 | 0.0 |
| Other | 394 | 2.4 |
| **Intervention** | | |
| Unicompartment medial | 13,592 | 84.0 |
| Unicompartment lateral | 982 | 6.1 |
| Femoropatellar | 1,027 | 6.3 |
| Other (incuding combinations) | 102 | 0.6 |
| Other (type unknown)* | 472 | 2.9 |
| **Technology** | | |
| Conventional | 11,131 | 68.8 |
| Minimally invasive | 3,943 | 24.4 |
| Patient specific instrumentation | 790 | 4.9 |
| Computer assisted | 319 | 2.0 |
| Other | 361 | 2.2 |

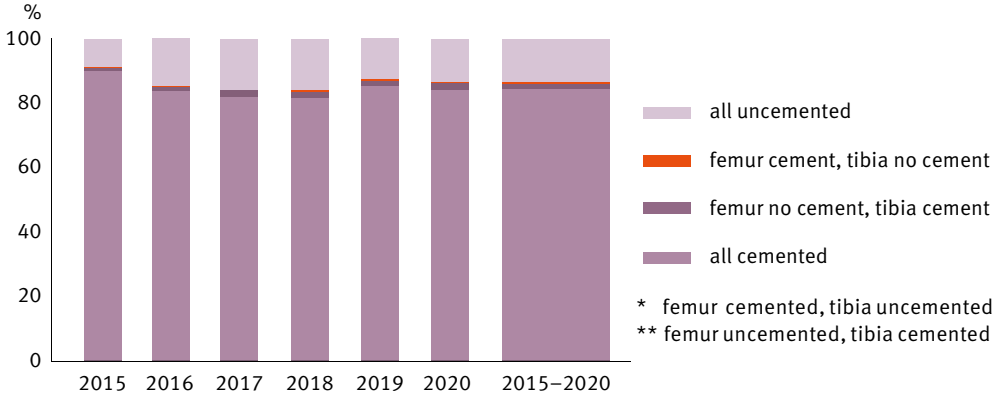
* In those cases TKA categories were chosen on the data entry form but partial knee systems registered. We consider implant registration more reliable than form entry and therefore recognise them as partial knee procedures

performed assisted by robots (Table 7.3). Robotic assistance is now a new response category on the 2021 forms. Over the past six years the use of cementless fixations stood at 13.6%, but this rate has seen some variation over time, more recently a slight decline from a previous peak in 2018. Hybrid fixation was used in 1.5% of the cases. The vast majority (84.4%) of partial knee replacements performed between 2015 and 2020 were fully cemented (Table 7.4).

Table 7.4
**Primary partial knee arthroplasty: Component fixation**
All diagnoses

| Component fixation | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2015–2020 |
|---|---|---|---|---|---|---|---|
| **N** | **2,234** | **2,287** | **2,408** | **2,498** | **2,845** | **2,879** | **15,151** |
| All uncemented | 8.9 | 14.7 | 15.8 | 15.9 | 12.5 | 13.5 | 13.6 |
| Reverse hybrid* | 0.3 | 0.5 | 0.3 | 0.7 | 0.6 | 0.5 | 0.5 |
| Hybrid** | 0.8 | 1.0 | 2.0 | 1.8 | 1.6 | 1.9 | 1.5 |
| All cemented | 90.0 | 83.8 | 81.9 | 81.5 | 85.3 | 84.1 | 84.4 |

Figure 7.1
**Primary partial knee arthroplasty: Component fixation**
All diagnoses



## 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 21,751 documented partial knee arthroplasties (PKA) implanted since 2012, 10,074 were at risk as they fell within the four-year moving average time window for primary surgery between 01.01.2015 to 31.12.2018 and had at least two years follow-up by 31.12.2020. Of these, 471 knees were revised, accounting for a two-year revision rate of 4.8%. Younger patients were much more at risk (e.g. 6.5% in the age group under 55 years) than older patients (e.g. 2.9% in the age group 75–84 years) (Table 7.5). Compared to the report 2020 the revision rate of PKA has increased remarkably. The reason for this is likely the improved

Table 7.5

**First revision of primary partial knee arthroplasty within 24 months overall and according to baseline characteristics**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). All diagnoses, all component fixations.

| | | Revised | Revised within 24 months | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% CI | |
| | | N at risk[1] | N | %[2] | lower | upper |
| Overall | | 10,074 | 471 | 4.8 | 4.4 | 5.2 |
| Gender | Women | 4,483 | 216 | 4.9 | 4.3 | 5.6 |
| | Men | 4,590 | 189 | 4.2 | 3.6 | 4.8 |
| Age group | <55 | 1,405 | 90 | 6.5 | 5.4 | 8.0 |
| | 55–64 | 3,102 | 164 | 5.4 | 4.6 | 6.2 |
| | 65–74 | 2,909 | 106 | 3.7 | 3.1 | 4.5 |
| | 75–84 | 1,456 | 42 | 2.9 | 2.2 | 4.0 |
| | 85+ | 198 | 3 | 1.5 | 0.5 | 4.6 |

[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 early first revision of primary partial knee arthroplasty**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Early first revisions are those occurring within 2 years of the primary arthroplasty.
Multiple responses possible (percentages do not sum to 100). All diagnoses, all component fixations.

| | N | % |
|---|---|---|
| Loosening tibia | 141 | 29.9 |
| Pain* | 84 | 17.8 |
| Progression of unicomp. OA | 60 | 12.7 |
| Loosening femur | 42 | 8.9 |
| Infection | 37 | 7.9 |
| Patella problems | 36 | 7.6 |
| Femorotibial instability | 34 | 7.2 |
| Periprosthetic fracture tibia | 23 | 4.9 |
| Component malposition tibia | 21 | 4.5 |
| Wear of inlay | 15 | 3.2 |
| Component malposition femur | 13 | 2.8 |
| Joint stiffness/arthrofibrosis | 9 | 1.9 |
| Loosening patella | 5 | 1.1 |
| Patellar instability | 4 | 0.8 |
| Periprosthetic fracture femur | 4 | 0.8 |
| Sizing femoral component | 3 | 0.6 |
| Sizing tibial component | 3 | 0.6 |
| Periprosthetic fracture patella | 0 | 0.0 |
| Other | 67 | 14.2 |
| Total 2015–2020 | 601 | |

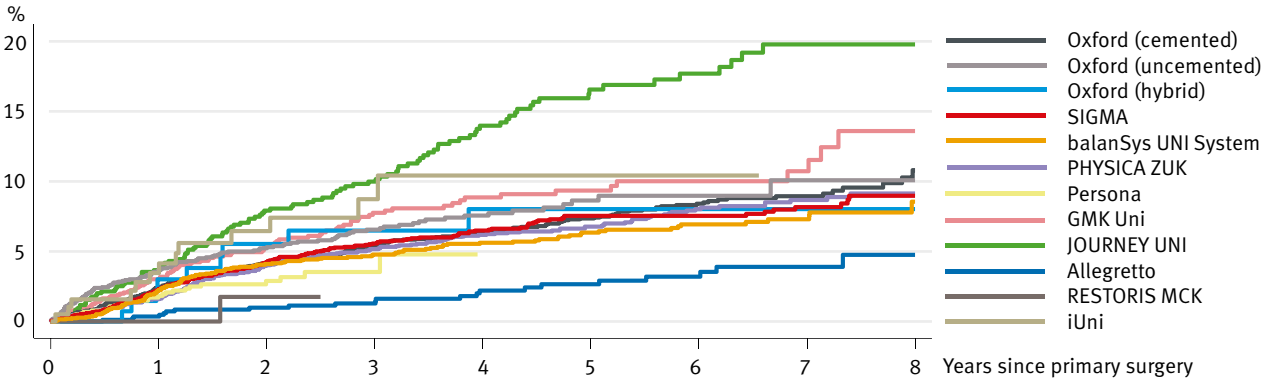
*Pain was frequently reported alongside other reasons. The proportion of „isolated pain“ was 8.5%.

linkage rate, leading to the detection of formerly unrecognised revisions. Cumulative revision risks of the different systems are depicted in a Kaplan-Meier estimation in Figure 7.2.

The most frequent reason for early revision was loosening of the tibia (29.9% = 141 cases), followed by pain in 17.8%, progression of osteoarthritis in 12.7%, loosening of the femur in 8.9% as well as infection in 7.9%. Similar to TKA, surgical technical problems such as instability, malpositioning, sizing were responsible for the majority of early revisions in partial knee arthroplasty (Table 7.6). 14.2% of the revision reasons were classified as "other". 40.8% of the failed PKA were converted to total knee arthroplasty (Table 7.7), followed by complete revision in 26.1% of cases. The actual share of conversions is probably even higher, as complete revisions include a currently unknown proportion of conversions that were incorrectly classified by users. Exchange of the polyethylene was performed in 15.9% of revisions, then followed by tibial revision in 5.7%. All the other revision types were rare, only

Figure 7.2

**Estimated failure rates of primary partial knee arthroplasty for top 10 systems**




**Cumulative revision rates**

| | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Oxford (cemented) | **2.5** (2.0-3.1) | **4.1** (3.5-4.9) | **5.5** (4.7-6.3) | **6.3** (5.5-7.3) | **7.4** (6.4-8.4) | **8.4** (7.3-9.6) | **8.9** (7.8-10.2) | **10.8** (9.0-13.0) |
| Oxford (uncemented) | **3.7** (2.9-4.6) | **5.3** (4.3-6.5) | **6.6** (5.4-7.9) | **7.6** (6.3-9.1) | **8.6** (7.1-10.5) | **9.0** (7.3-11.0) | **10.1** (7.6-13.3) | **10.1** (7.6-13.3) |
| Oxford (hybrid) | **3.0** (1.1-7.8) | **5.5** (2.7-11.3) | **6.5** (3.3-12.6) | **8.0** (4.1-15.2) | **8.0** (4.1-15.2) | **8.0** (4.1-15.2) | **8.0** (4.1-15.2) | |
| SIGMA | **2.3** (1.8-2.9) | **4.2** (3.6-5.0) | **5.6** (4.8-6.5) | **6.5** (5.6-7.5) | **7.5** (6.5-8.7) | **7.5** (6.5-8.7) | **8.2** (7.0-9.5) | **9.0** (7.6-10.6) |
| balanSys UNI System | **2.2** (1.7-2.9) | **4.1** (3.4-5.0) | **4.8** (4.0-5.8) | **5.6** (4.7-6.7) | **6.3** (5.3-7.6) | **6.9** (5.8-8.3) | **7.3** (6.1-8.7) | **8.6** (6.7-10.9) |
| PHYSICA ZUK | **1.6** (1.2-2.2) | **4.0** (3.3-4.9) | **5.2** (4.3-6.1) | **6.2** (5.3-7.3) | **6.8** (5.8-7.9) | **8.0** (6.9-9.3) | **8.7** (7.4-10.1) | **9.1** (7.8-10.8) |
| Persona | **1.8** (1.2-2.9) | **2.9** (1.9-4.3) | **3.5** (2.3-5.3) | | | | | |
| GMK Uni | **3.0** (2.2-4.1) | **5.3** (4.1-6.8) | **7.8** (6.2-9.6) | **8.9** (7.2-10.9) | **9.3** (7.5-11.6) | **10.0** (8.0-12.4) | **10.7** (8.4-13.6) | **13.6** (10.0-18.3) |
| JOURNEY UNI | **3.7** (2.6-5.2) | **7.9** (6.2-10.1) | **10.0** (8.0-12.4) | **14.0** (11.5-16.9) | **16.6** (13.7-19.9) | **17.7** (14.7-21.3) | **19.8** (16.3-23.9) | **19.8** (16.3-23.9) |
| Allegretto | **0.4** (0.1-1.1) | **1.0** (0.5-2.0) | **1.3** (0.7-2.4) | **2.2** (1.3-3.7) | **2.7** (1.6-4.3) | **3.2** (2.0-5.1) | **3.9** (2.5-6.1) | **4.8** (2.9-7.9) |
| RESTORIS MCK | **0.0** (.-) | **1.8** (0.2-11.8) | | | | | | |
| iUni | **3.5** (1.6-7.6) | **6.5** (3.5-11.8) | **8.7** (4.9-15.3) | **10.4** (5.9-18.1) | **10.4** (5.9-18.1) | | | |

Please note that if reported systems involve multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

2.6% were named as "other" (Table 7.7). Pain was often named in combination with other reasons as a typical symptom for revision after PKA (17.8%). Only in 8.5% of cases was pain the single reason for revision, which nevertheless was clearly higher than in TKA (1.9%).

Cumulative incidence for PKA revision 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 (Figure 7.3). The timing of the revisions shares similarities with TKA revisions. Infections occurred relatively early (first year with a peak at 3 months) while all other revision causes were mostly associated with revisions from the second year onwards. Loosening of the tibial component started early after index surgery and had its initial peak at one year (Figure 7.4). However, the cumulative incidence chart (Figure 7.3) shows very clearly that after the two-year pe-

Table 7.7

**Type of early first revision of primary partial knee arthroplasty**

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Early first revisions are those occurring within 2 years of the primary arthroplasty. All diagnoses, all component fixations

| | N | % |
|---|---|---|
| Conversion from unicomp. to total prosthesis | 192 | 40.8 |
| Complete revision | 123 | 26.1 |
| Exchange of PE | 75 | 15.9 |
| Tibial revision | 27 | 5.7 |
| Subsequent patella prosthesis | 10 | 2.1 |
| Reimplantation of prosthesis | 9 | 1.9 |
| Femoral revision | 7 | 1.5 |
| Patella revision | 6 | 1.3 |
| Component removal with spacer implantation | 6 | 1.3 |
| Subsequent partial prosthesis, second compartment | 3 | 0.6 |
| Subsequent patella prosthesis with exchange of PE | 1 | 0.2 |
| Other | 12 | 2.6 |
| **Total** | **471** | |

Figure 7.3

## Cumulative incidence rates for different revision diagnosis of partial knee arthroplasty

Time since operation, 2012–2020, all services, % of implants revised. Detailed reasons for revisions available since 2015

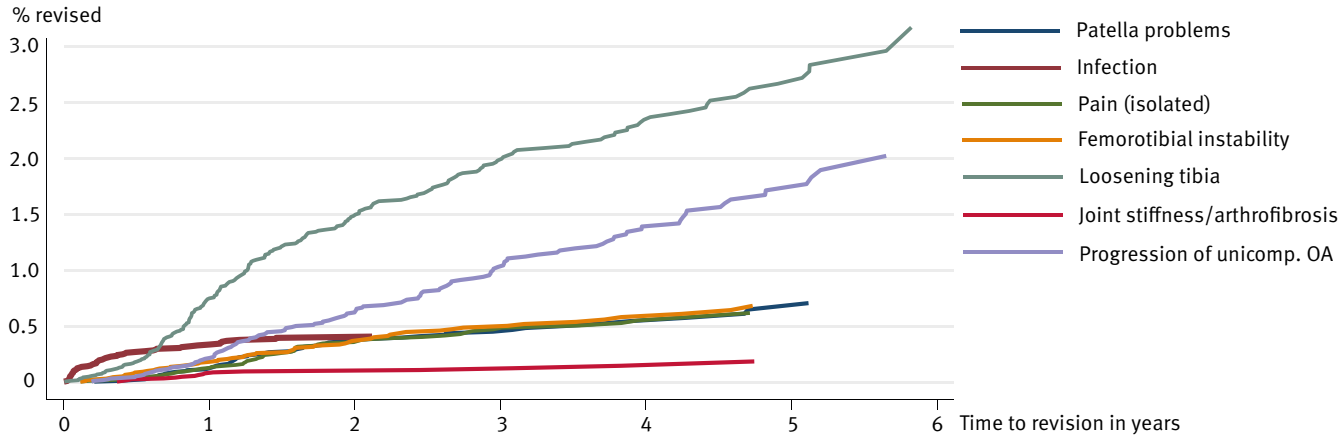
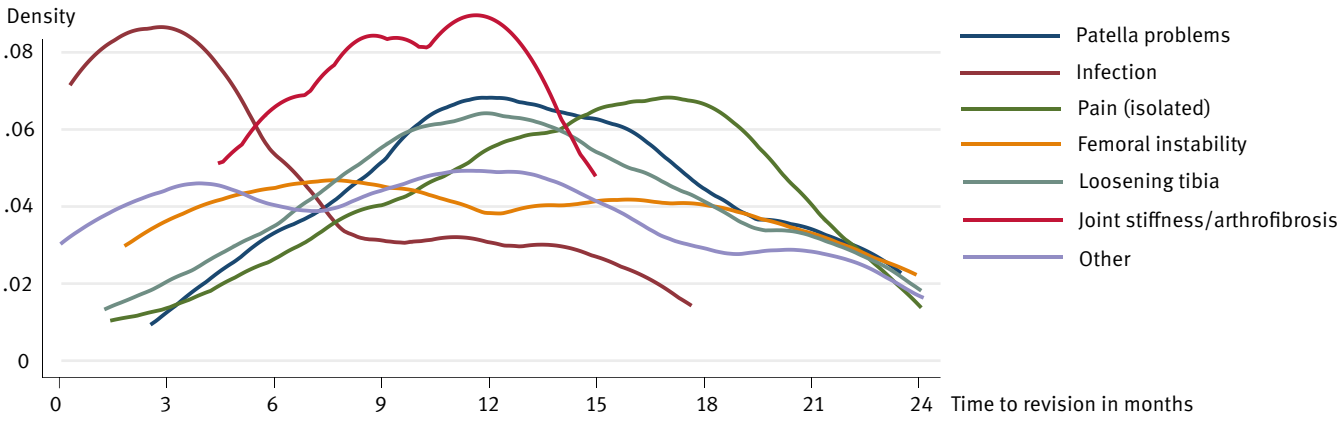



Figure 7.4

## Time interval between primary partial knee arthroplasty and first revision by main reason

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
Early first revisions are those occurring within 2 years of the primary arthroplasty




| | N | Median | IQR 25% | IQR 75% |
|---|---|---|---|---|
| Patella problems | 36 | 13.7 | 9.7 | 17.8 |
| Infection | 37 | 3.5 | 0.9 | 9.7 |
| Pain (isolated) | 40 | 15.0 | 9.8 | 18.5 |
| Femoral instability | 34 | 12.5 | 5.6 | 18.7 |
| Loosening tibia | 141 | 12.7 | 9.0 | 17.1 |
| Joint stiffness/arthrofibrosis | 9 | 9.8 | 5.6 | 11.7 |
| Other | 233 | 10.9 | 4.6 | 15.4 |

riod of early revisions, it was loosening of the tibia and progression of OA that was driving the long term revision rates up.

Cemented PKA implants were revised less often than cementless implants during the first eight years after surgery, which was statistically significant most clearly early after surgery. This effect can be expected early after surgery as cementless implants have to osteointegrate which might be critical in some cases. After the initial disadvantage was established, the failure curve of the uncemented implants remained largely parallel to that of the cemented implants (Figure 7.5).

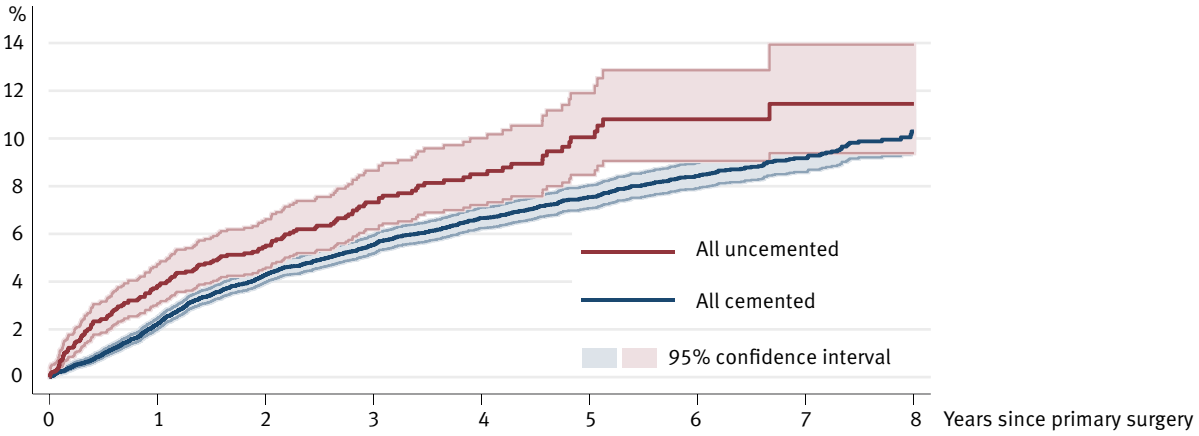
Computer navigation seemed to perform better early after surgery but from five years after surgery the revision rate was higher than with conventional techniques (Figure 7.6). Numbers for computer navigated PKA were small, which explains the broad and increasing confidence interval with time. Results are therefore currently inconclusive.

PSI seems to be associated with a very similar revision burden as conventional techniques (Figure 7.6).

The two-year revision rates for PKA are presently only shown for systems used more than 50 times (n at risk >50). In Switzerland, 23 PKA systems were used, but only thirteen systems reached the threshold of 50 cases. The outlier alert boundary was set at twice the average overall revision rate. One of the thirteen systems was classified as possible outlier (Table 7.8, 7.9, 7.10). Detailed instruction on the interpretation is given in the legends of the figures.

Figure 7.5

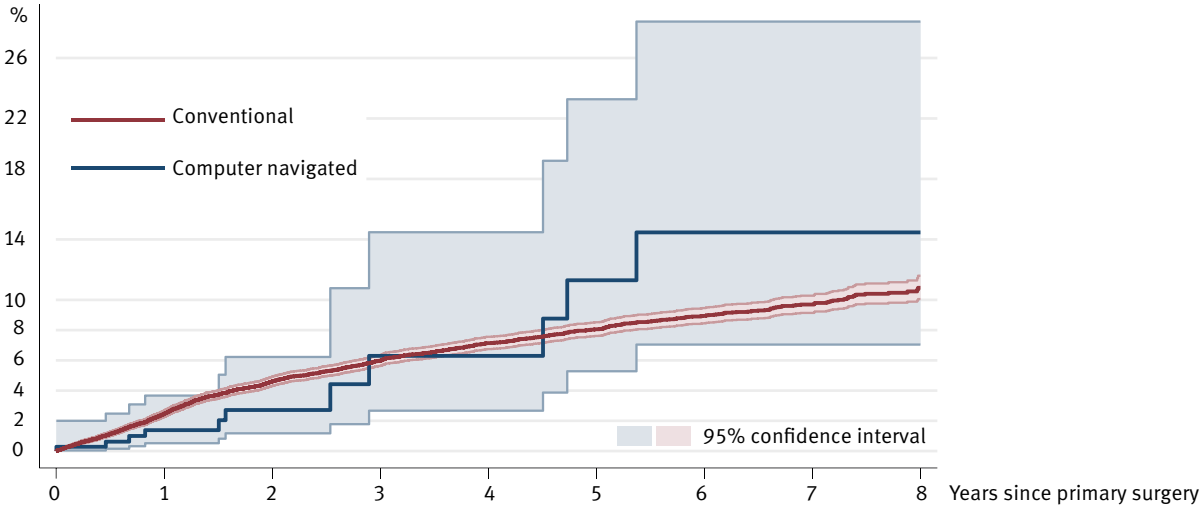
**Estimated failure rates of primary partial knee arthroplasty for main types of component fixation**




| Cumulative rev. rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| All cemented | **2.2** (2.0-2.5) | **4.3** (4.0-4.6) | **5.5** (5.2-5.9) | **6.7** (6.2-7.1) | **7.5** (7.1-8.0) | **8.4** (7.9-9.0) | **9.2** (8.6-9.8) | **10.3** (9.5-11.1) |
| All uncemented | **3.8** (3.1-4.7) | **5.5** (4.6-6.6) | **7.3** (6.2-8.6) | **8.5** (7.2-10.0) | **10.1** (8.5-11.9) | **10.8** (9.1-12.9) | **11.5** (9.4-13.9) | **11.5** (9.4-13.9) |

Figure 7.6

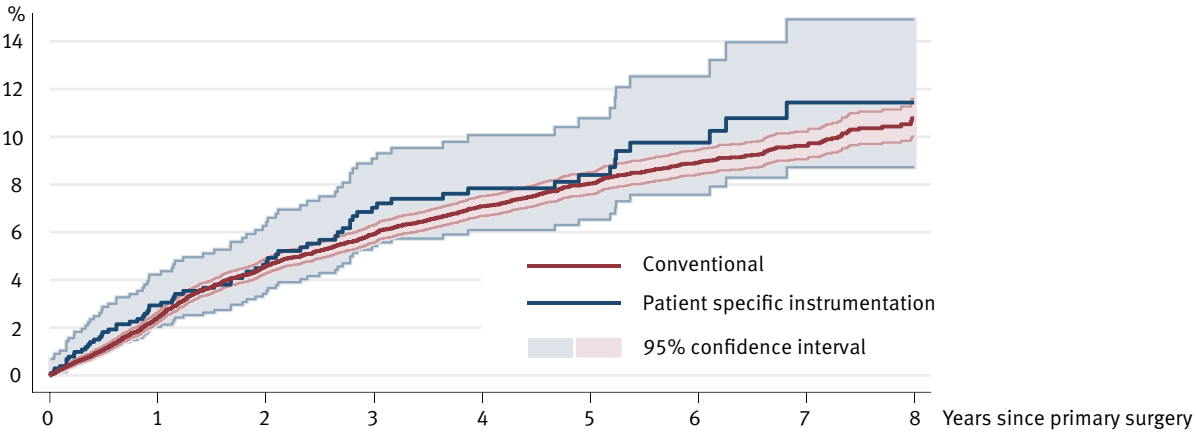
## Estimated failure rates of primary partial knee arthroplasty: conventional vs. computer navigated




| Cumulative rev. rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Conventional | **2.5** (2.3-2.7) | **4.6** (4.3-4.9) | **6.0** (5.6-6.3) | **7.1** (6.7-7.6) | **8.1** (7.6-8.5) | **8.9** (8.4-9.5) | **9.7** (9.1-10.3) | **10.8** (10.1-11.6) |
| Computer nav. | **1.4** (0.5-3.7) | **2.7** (1.2-6.2) | **6.3** (2.7-14.5) | **6.3** (2.7-14.5) | **11.3** (5.3-23.3) | **14.5** (7.0-28.4) | **14.5** (7.0-28.4) | |

Figure 7.7

## Estimated failure rates of primary partial knee arthroplasty: conventional vs. patient specific instrumentation




| Cumulative rev. rates | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| Conventional | **2.4** (2.2-2.7) | **4.6** (4.3-4.9) | **5.9** (5.6-6.3) | **7.1** (6.7-7.5) | **8.0** (7.6-8.5) | **8.9** (8.4-9.4) | **9.6** (9.1-10.2) | **10.8** (10.0-11.6) |
| Pat. spec. instr. | **2.9** (2.0-4.2) | **4.6** (3.4-6.3) | **7.0** (5.4-9.1) | **7.8** (6.1-10.1) | **8.4** (6.5-10.8) | **9.8** (7.6-12.5) | **11.4** (8.7-14.9) | **11.4** (8.7-14.9) |

Table 7.8

## Revision rates of partial knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020). Systems with at least 50 implants. Covering approx. 97% of registered partial knees, alphabetic order. All diagnoses, all component fixations, only unicondylar partial knee systems excluding patellofemoral systems

| Partial knee system | at risk* | Revised | | 95% CI | |
|---|---|---|---|---|---|
| | N | N | %** | lb | ub |
| Allegretto | 404 | 2 | 0.5 | 0.1 | 2.0 |
| Alpina | 85 | 4 | 4.7 | 1.8 | 12.1 |
| Balansys UNI system | 1,165 | 41 | 3.6 | 2.6 | 4.8 |
| GMK uni | 662 | 24 | 3.6 | 2.5 | 5.4 |
| iUni | 99 | 8 | 8.1 | 4.1 | 15.5 |
| Journey UNI | 432 | 40 | 9.4 | 7.0 | 12.6 |
| Oxford (cemented) | 1,696 | 71 | 4.2 | 3.4 | 5.3 |
| Oxford (hybrid) | 65 | 3 | 4.7 | 1.5 | 13.8 |
| Oxford (uncemented) | 1,189 | 70 | 5.9 | 4.7 | 7.5 |
| Persona | 432 | 12 | 2.8 | 1.6 | 4.9 |
| Physica ZUK | 1,136 | 55 | 4.9 | 3.8 | 6.4 |
| Sigma | 1,572 | 67 | 4.4 | 3.5 | 5.5 |
| Triathlon PKR | 67 | 2 | 3.0 | 0.8 | 11.6 |
| Group average | | | 4.5 | 4.1 | 5.0 |

* 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.

## Important information on the use of the implant performance tables below

Implants ranked by upper end of the 95% confidence interval. This is the upper end of the plausible range in which the true 2-year revision rate of an implant could lie with 95% certainty after allowing for random variation in the occurrence of revisions.

At the bottom of the list are the implants without any registered revisions (statistical evaluation not yet possible).

● =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).

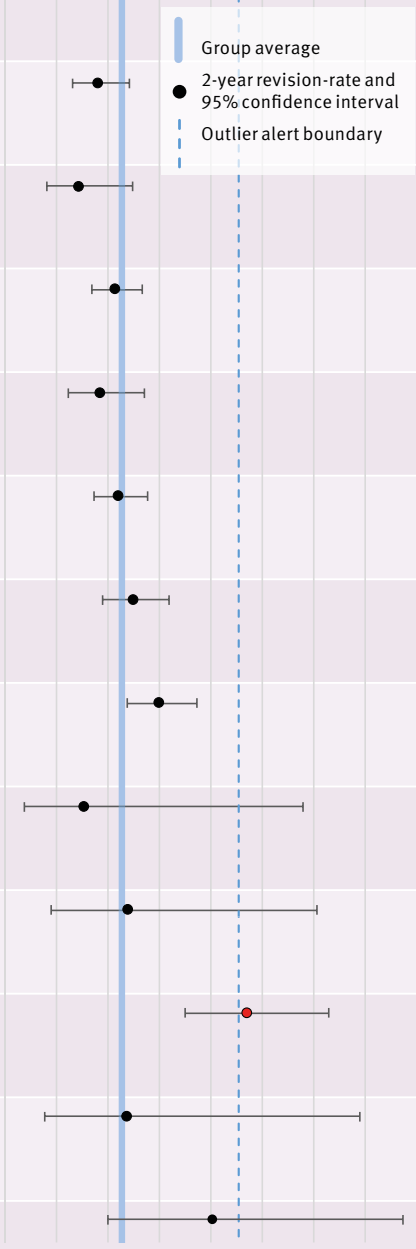
Please be aware that relatively rare implant combinations are frequently used in only a small number or indeed only in one hospital in Switzerland. Observed revision rates may be determined by local factors and performance may differ significantly between locations. Manufacturers of detected outlier implants and the hospitals where they were used (and revisions occurred) have been informed by SIRIS.

Table 7.9

## Revision rates of partial knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2015 and 31.12.2018, with two years follow-up (31.12.2020).
All diagnoses, all component fixations, only unicondylar partial knee systems excluding patellofemoral systems.

| Partial knee system | Revised | at risk* | | 95% CI | | %** |
|---|---|---|---|---|---|---|
| | N | N | % | lower | upper | 0 2 4 6 8 10 12 14 |
| Allegretto | 404 | 2 | 0.5 | 0.1 | 2.0 | |
| Balansys UNI system | 1,165 | 41 | 3.6 | 2.6 | 4.8 | |
| Persona | 432 | 12 | 2.8 | 1.6 | 4.9 | |
| Oxford (cemented) | 1,696 | 71 | 4.2 | 3.4 | 5.3 | |
| GMK uni | 662 | 24 | 3.6 | 2.5 | 5.4 | |
| Sigma | 1,572 | 67 | 4.4 | 3.5 | 5.5 | |
| Physica ZUK | 1,136 | 55 | 4.9 | 3.8 | 6.4 | |
| Oxford (uncemented) | 1,189 | 70 | 5.9 | 4.7 | 7.5 | |
| Triathlon PKR | 67 | 2 | 3.0 | 0.8 | 11.6 | |
| Alpina | 85 | 4 | 4.7 | 1.8 | 12.1 | |
| Journey UNI | 432 | 40 | 9.4 | 7.0 | 12.6 | |
| Oxford (hybrid) | 65 | 3 | 4.7 | 1.5 | 13.8 | |
| iUni | 99 | 8 | 8.1 | 4.1 | 15.5 | |
| Group average | | | 4.5 | 4.1 | 5.0 | |




* 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 7.10

## Top 10 implants, primary partial knee arthroplasty

2015–2020, all diagnoses, all component fixations, only unicondylar partial knee systems excluding patellofemoral systems

| Knee system | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|
| Oxford | 666 | 800 | 810 | 704 | 617 | 617 | 4,214 |
| Sigma | 322 | 413 | 424 | 413 | 496 | 591 | 2,659 |
| Balansys UNI system | 296 | 284 | 304 | 281 | 354 | 296 | 1,815 |
| Physica ZUK | 429 | 291 | 217 | 199 | 250 | 330 | 1,716 |
| Persona | | | 89 | 343 | 406 | 382 | 1,220 |
| GMK uni | 157 | 124 | 184 | 197 | 222 | 202 | 1,086 |
| Journey UNI | 102 | 113 | 127 | 90 | 89 | 87 | 608 |
| Allegretto | 118 | 104 | 93 | 89 | 101 | 67 | 572 |
| Restoris MCK | | | | 25 | 75 | 96 | 196 |
| iUni | 12 | 18 | 30 | 39 | 40 | 50 | 189 |
| Other | 59 | 72 | 73 | 71 | 105 | 105 | 485 |
| Total | 2,161 | 2,219 | 2,351 | 2,451 | 2,755 | 2,823 | 14,760 |

# SIRIS outlier watch list

| Implant or implant combination | Detected as outlier in report | Risk-adjusted hazard ratios for 2-year revision risk (4-year moving window) | | | | | | Summary |
|---|---|---|---|---|---|---|---|---|
| | | for age and sex | | | for age, sex, BMI, ASA and Charnley Class* | | | |
| | | HR | lb95% | ub95% | HR | lb95% | ub95% | |
| **Uncemented stem-cup combinations** | | | | | | | | |
| AMIStem + Mpact | 2019 | | | | | | | 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. |
| AMIStem + Versafitcup DM | 2020<br>2021 | 2.00 | 0.95 | 4.21 | 2.18 | 0.98 | 4.88 | It is unclear whether AMIStem + Versafitcup DM is a particularly problematic combination. It was in active use in two hospitals between 2017 and 2019, but only in one of them an unusual number of revisions was recorded against a small volume of operations. No further uses were registered in 2020. |
| Corail + Delta motion | 2019 | | | | | | | 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. |
| Exception + Exceed | 2020<br>2021 | 1.59 | 0.76 | 3.33 | 1.48 | 0.48 | 4.61 | It would appear unlikely that Exception + Exceed represents an outlier combination. It is in active use in only one hospital where a small number of revisions was recorded against a small volume of operations. Recent performance is statistically inconclusive due to small numbers. Recommended course of action: observe further cases. |
| GTS + Exceed | 2019 | | | | | | | Not anymore identified as a potential outlier. This combination is not in active use anymore. |
| GTS + G7 bi-spherical | 2019<br>2020<br>2021 | 5.15 | 3.24 | 8.19 | 3.84 | 1.92 | 7.71 | GTS + G7 bi-spherical is very likely a problematic stem-cup combination and remained in active use in 2020. It was practically only used in one hospital, however. |
| Harmony + Gyracup | 2020 | | | | | | | HARMONY + GYRACUP was not identified as a potential outlier combination anymore. After an unusual number of revisions in 2019 in the one hospital where it was in active use, active use ceased in early 2020. |
| Polarstem + EP-fit | 2020<br>2021 | 1.89 | 1.30 | 2.74 | 2.31 | 1.39 | 3.84 | POLARSTEM and EP-FIT is a potential outlier combination, as its risk adjusted hazard ratio just exceeds the relevant threshold of two. In 2020 it was in active use in two hospitals and it is noteworthy that an unusual number of infections was recorded as reasons for revisions. Without those infections, the combination's performance would have been average. Recommended course of action: investigate reasons for revisions and observe further performance. |
| SPS evolution + April ceramic | 2020<br>2021 | 2.33 | 1.84 | 2.96 | 3.50 | 2.42 | 5.06 | 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 in more than one hospital. 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 HA + April ceramic | 2021 | 2.61 | 1.44 | 4.73 | 2.85 | 1.18 | 6.87 | SPS HA + April ceramic appears to be following the same pattern as the other SPS/April ceramic combinations, although only actively used in significant numbers in two hospitals and only rarely between 2017 and 2019. Active use practically stopped in 2020 with only 3 registered uses. |
| SPS modular + April ceramic | 2019<br>2020<br>2021 | 2.90 | 1.91 | 4.41 | 1.59 | 0.22 | 11.32 | 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, ceased with no operations recorded in 2019/2020. |
| Stelia-stem + Ana.nova hybrid | 2019<br>2020<br>2021 | 2.60 | 1.68 | 4.04 | 2.20 | 1.20 | 4.01 | Stelia-stem + Ana.nova hybrid appears to be a problematic stem-cup combination based on its performance in the early years of its use. Its last active use was registered in 2019, however. |
| Twinsys + Selexys PC | 2020 | | | | | | | TwinSys + seleXys PC was a rarely used combination after 2015 and its performance in this limited use was very likely problematic. The last use was registered in 2019. |

| Implant or implant combination | Detected as outlier in report | Risk-adjusted hazard ratios for 2-year revision risk (4-year moving window) for age and sex HR | lb95% | ub95% | for age, sex, BMI, ASA and Charnley Class* HR | lb95% | ub95% | Summary |
|---|---|---|---|---|---|---|---|---|
| **Hybrid fixation stem-cup combinations** | | | | | | | | |
| CCA + RM Pressfit vitamys | 2020<br>2021 | 2.05 | 0.91 | 4.63 | 1.86 | 0.59 | 5.91 | 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 very 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. Only few uses were registered in 2020. |
| PF + Fitmore | 2020 | | | | | | | PF Stems + Fitmore Cups was 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. |
| Twinsys + RM pressfit | 2019 | | | | | | | Not anymore identified as a potential outlier. The active use of this combination has ceased. |
| Weber + Alloclassic | 2019<br>2020 | | | | | | | It is likely that Weber + Alloclassic (hybrid fixation) represented a problematic stem-cup combination. However, it was 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. Active use practically ended in 2019/2020 with only one use registered per year. |
| **Total knee systems** | | | | | | | | |
| E.motion PS | 2019 | | | | | | | Not anymore identified as a potential outlier. The outlier status in 2019 was caused by early implants. Performance has been improving over time. |
| Journey II | 2019<br>2020<br>2021 | 2.06 | 1.74 | 2.46 | 2.00 | 1.63 | 2.45 | It is likely that Journey II represents a problematic system in the sense that it consistently 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. |
| Physica KR | 2019<br>2020<br>2021 | 3.80 | 2.04 | 7.07 | 3.06 | 1.14 | 8.17 | 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. No further uses were registered in 2020. |
| Physica PS | 2019<br>2020<br>2021 | 3.11 | 1.84 | 5.25 | 2.91 | 1.65 | 5.15 | 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. No further uses were registered in 2020. |
| **Partial knee system** | | | | | | | | |
| Journey Uni | 2020<br>2021 | 1.81 | 1.39 | 2.35 | 1.68 | 1.10 | 2.58 | 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. |

# 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 |
| HR | Hazard ratio |
| IQR | Interquartile range |
| KLM | Kaplan Meier estimate |
| lb/ub | Lower, upper bound (of a convidential ratio) |
| MCL | Medical Collateral (Inner Knee) Ligament |
| PROMs | Patient Reported Outcome Measures |
| SD | Standard Deviation |
| SHR | Subhazard ratio |
| Sig | Significance |
| THA | Total Hip Arthroplasty |
| TKA | Total Knee Arthroplasty |
| UKA | Unicompartmental Knee Arthroplasty |

# Participating hospitals (154)

| | Group | Clinic |
|---|---|---|
| AG | | Kantonsspital Aarau |
| AG | | Kantonsspital Baden |
| AG | | Spital Muri |
| AG | | Spital Zofingen |
| AG | Asana Gruppe | Spital Leuggern |
| AG | Asana Gruppe | Spital Menziken |
| AG | Gesundheitszentrum Fricktal | Spital Rheinfelden |
| AG | Hirslanden Gruppe | Klinik Aarau |
| AG | Swiss Medical Network | Privatklinik Villa im Park |
| AI | | Kantonales Spital und Pflegezentrum Appenzell |
| AR | | Berit Klinik AG |
| AR | Hirslanden Gruppe | Klinik Am Rosenberg AG |
| AR | Spitalverbund Appenzell (AR) | Spital Herisau |
| AR | Spitalverbund Appenzell (AR) | Spital Heiden |
| BE | | Klinik Hohmad |
| BE | | Spitalzentrum Biel |
| BE | Hirslanden Gruppe | Klinik Beau-Site |
| BE | Hirslanden Gruppe | Klinik Linde AG |
| BE | Hirslanden Gruppe | Salem-Spital |
| BE | Hirslanden Gruppe | Klinik Permanence |
| BE | Hôpital du Jura bernois | Saint-Imier |
| BE | Hôpital du Jura bernois | Hôpital de Moutier SA |
| BE | Insel Gruppe | Spital Aarberg |
| BE | Insel Gruppe | Inselspital, Unispital Bern |
| BE | Insel Gruppe | Spital Münsingen |
| BE | Insel Gruppe | Spital Riggisberg |
| BE | Insel Gruppe | Spital Tiefenau |
| BE | Lindenhofgruppe | Lindenhofspital |
| BE | Lindenhofgruppe | Sonnenhofspital |
| BE | Spital Emmental | Standort Burgdorf |
| BE | Spital Emmental | Standort Langnau |
| BE | Spitäler fmi | Spital Frutigen |
| BE | Spitäler fmi | Spital Interlaken |
| BE | Spital Region Oberaargau SRO | Spital Langenthal |
| BE | Spital STS | Spital Thun |
| BE | Spital STS | Spital Zweisimmen |
| BE | Swiss Medical Network | Privatklinik Siloah |
| BS | | Merian Iselin Klinik für Orthopädie und Chirurgie |
| BL | | Praxisklinik Rennbahn |
| BL | Hirslanden Gruppe | Klinik Birshof |
| BL | Kantonsspital Baselland | Liestal |
| BL | Kantonsspital Baselland | Bruderholz |
| BS | Universitätsspital Basel | Standort Betesda |
| BS | Universitätsspital Basel | Standort Uni-Spital |
| FL | | Liechtensteinisches Landesspital |
| FR | Hôpital fribourgeois HFR | HFR Hôpital cantonal |
| FR | Hôpital fribourgeois HFR | HFR Riaz |
| FR | Hôpital fribourgeois HFR | HFR Tafers |
| FR | Swiss Medical Network | Clinique Générale Ste-Anne |
| GE | | Clinique Vert Pré |
| GE | | Hôpital de La Tour |
| GE | | Hôpitaux universitaires de Genève HUG |
| GE | Hirslanden Gruppe | Clinique La Colline SA |
| GE | Hirslanden Gruppe | Clinique des Grangettes SA |
| GE | Swiss Medical Network | Clinique Générale-Beaulieu |
| GL | | Kantonsspital Glarus |
| GR | | Flury Stiftung Spital Schiers |
| GR | | Gesundheitszentrum Unterengadin |
| GR | | Kantonsspital Graubünden |
| GR | | Regionalspital Surselva AG |
| GR | | Spital Davos |
| GR | | Spital Oberengadin |
| GR | | Spital Thusis |
| GR | Klinik Gut | Standort Fläsch |
| GR | Klinik Gut | Standort St. Moritz |
| JU | Hôpital du Jura | Site de Delémont |
| LU | Hirslanden Gruppe | Klinik St. Anna AG |
| LU | Hirslanden Gruppe | St. Anna in Meggen |
| LU | Luzerner Kantonsspital LUKS | Luzern |
| LU | Luzerner Kantonsspital LUKS | Sursee |
| LU | Luzerner Kantonsspital LUKS | Wolhusen |
| NE | Réseau hospitalier neuchâtelois | La Chaux-de-Fonds |
| NE | Réseau hospitalier neuchâtelois | Pourtalès |
| NE | Swiss Medical Network | Clinique Montbrillant |
| NE | Swiss Medical Network | Hôpital de la Providence |
| NW | | Kantonsspital Nidwalden |
| OW | | Kantonsspital Obwalden |

| | Group | Clinic |
|---|---|---|
| SG | | Spital Linth |
| SG | Hirslanden Gruppe | Klinik Stephanshorn AG |
| SG | Spitalregion Fürstenland Toggenburg | Spital Wattwil |
| SG | Spitalregion Fürstenland Toggenburg | Spital Wil |
| SG | Spitalregion Rheintal Werdenberg Sarganserland | Spital Altstätten |
| SG | Spitalregion Rheintal Werdenberg Sarganserland | Spital Grabs |
| SG | Spitalregion Rheintal Werdenberg Sarganserland | Spital Walenstadt |
| SG | Kantonsspital St. Gallen | Kantonsspital St. Gallen |
| SG | Kantonsspital St. Gallen | Spital Flawil |
| SG | Kantonsspital St. Gallen | Spital Rorschach |
| SG | Swiss Medical Network | Rosenklinik |
| SH | Spitäler Schaffhausen | Kantonsspital Schaffhausen |
| SH | Swiss Medical Network | Privatklinik Belair |
| SO | Solothurner Spitäler AG | Bürgerspital Solothurn |
| SO | Solothurner Spitäler AG | Kantonsspital Olten |
| SO | Solothurner Spitäler AG | Spital Dornach |
| SO | Swiss Medical Network | Privatklinik Obach AG |
| SZ | | Spital Lachen |
| SZ | | Spital Schwyz |
| SZ | AMEOS | Spital Einsiedeln |
| TG | | Klinik Seeschau |
| TG | Spital Thurgau AG | Kantonsspital Frauenfeld |
| TG | Spital Thurgau AG | Kantonsspital Münsterlingen |
| TI | | Clinica Luganese Moncucco |
| TI | | Clinica Santa Chiara |
| TI | Ente Ospedaliero Cantonale | Ospedale Regionale di Bellinzona e Valli |
| TI | Ente Ospedaliero Cantonale | Ospedale Regionale di Locarno - La Carità |
| TI | Ente Ospedaliero Cantonale | Ospedale Regionale di Lugano-Civico |
| TI | Ente Ospedaliero Cantonale | Ospedale Regionale di Lugano - Italiano |
| TI | Ente Ospedaliero Cantonale | Ospedale Regionale di Mendrisio |
| TI | Swiss Medical Network | Clinica Ars Medica |
| UR | | Kantonsspital Uri |
| VD | | CHUV Centre hospitalier universitaire vaudois |
| VD | | Clinique de la Source |
| VD | | Clinique La Prairie |
| VD | Clinique CIC Suisse SA | Clinique CIC Montreux |
| VD | Ensemble Hospitalier de la Côte EHC | Hôpital de Morges |
| VD | Etablissements Hospitaliers du Nord Vaudois eHnv | Hôpital de Saint-Loup |
| VD | Etablissements Hospitaliers du Nord Vaudois eHnv | Hôpital Yverdon-les-Bains |
| VD | Groupement Hospitalier de l'Ouest Lémanique (GHOL) | Hôpital de Nyon |
| VD | Hirslanden Gruppe | Clinique Bois-Cerf |
| VD | Hôpital intercantonal de la Broye HIB | Payerne |
| VD | Hôpital Riviera-Chablais HRC | Centre hospitalier de Rennaz |
| VD | Pôle Santé du Pays-d'Enhaut | Hôpital du Pays-d'Enhaut |
| VD | Réseau Santé Balcon du Jura RSBJ | Site des Rosiers |
| VD | Swiss Medical Network | Clinique de Genolier |
| VD | Swiss Medical Network | Clinique de Montchoisi |
| VS | Clinique CIC Valais | Clinique CIC Saxon |
| VS | Hôpital du Valais - Spital Wallis | Standort Brig |
| VS | Hôpital du Valais - Spital Wallis | Standort Visp |
| VS | Hôpital du Valais - Spital Wallis | Site Sion |
| VS | Hôpital du Valais - Spital Wallis | Site Martigny |
| VS | Swiss Medical Network | Clinique de Valère |
| ZG | | Zuger Kantonsspital |
| ZG | Hirslanden Gruppe | AndreasKlinik Cham Zug |
| ZH | | Kantonsspital Winterthur |
| ZH | | Klinik Pyramide am See |
| ZH | | Schulthess Klinik |
| ZH | | Spital Affoltern |
| ZH | | Spital Bülach |
| ZH | | Spital Limmattal |
| ZH | | Spital Männedorf |
| ZH | | Spital Uster |
| ZH | | Spital Zollikerberg |
| ZH | | Universitätsspital Zürich |
| ZH | | Universitätsklinik Balgrist |
| ZH | Adus-Medica AG | Adus Klinik |
| ZH | GZO | Spital Wetzikon |
| ZH | Hirslanden Gruppe | Klinik Hirslanden |
| ZH | Hirslanden Gruppe | Klinik Im Park |
| ZH | See-Spital | Standort Horgen |
| ZH | See-Spital | Standort Kilchberg |
| ZH | Stadtspital Zürich | Stadtspital Zürich Triemli |
| ZH | Stadtspital Zürich | Stadtspital Zürich Waid |
| ZH | Swiss Medical Network | Privatklinik Bethanien |
| ZH | Swiss Medical Network | Privatklinik Lindberg |

# Manufacturers and distributors

**List of companies with implants registered in the SIRIS registry**
2020

| Company | Headquarters Switzerland | Corporate domicile |
|---|---|---|
| **Amplitude Switzerland** | Genf | France |
| **Argomedical AG** | Cham | Switzerland |
| **Arthrex Swiss AG** | Belp | Germany |
| **Arthrosurface** | - | USA |
| **ATF** | - | France |
| **B. Braun Medical AG** | Sempach | Germany |
| **CeramTec** | - | Germany |
| **Conformis** | - | Germany |
| **Corin GSA GmbH** | Solothurn | United Kingdom |
| **Dedienne Santé** | - | France |
| **DePuy Synthes Johnson&Johnson** | Zuchwil/Zug | USA |
| **Exactech International Operation AG** | - | USA |
| **Heraeus Medical Schweiz AG** | Zürich | Germany |
| **Implantcast Suisse SA** | Basel | Germany |
| **Lima Switzerland** | Rotkreuz | Italy |
| **Link Implants AG** | Bern | Germany |
| **Mathys (Schweiz) GmbH, DJO** | Bettlach | Switzerland |
| **Medacta International SA** | Frauenfeld | Switzerland |
| **OHST Medizintechnik AG** | - | Germany |
| **Permedica ORTHOPAEDICS (I)** | Scairolo di Collina d'Oro | Italy |
| **Peter Brehm GmbH (Schweiz)** | Dietikon | Germany |
| **PLUSOrtho Prothetik GmbH** | Oftringen | Switzerland |
| **Smith&Nephew Orthopaedics AG** | Baar | United Kingdom |
| **Stemcup Medical Products AG** | Zürich | Switzerland |
| **Stryker Osteonics SA** | Biberist | USA |
| **Swiss Synergy AG** | Baar | Switzerland |
| **Symbios Orthopédie SA** | Yverdon-les-Bains | Switzerland |
| **United Orthopedic Corporation Suisse SA** | Yverdon-les-Bains | Switzerland |
| **Zimmer Biomet** | Winterthur | USA |

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