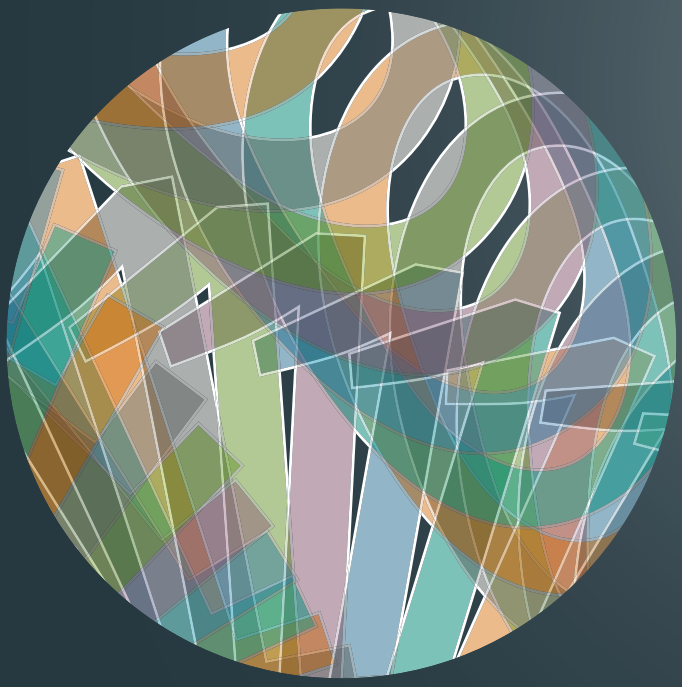
schweizerisches implantat-register
registre suisse des implants

SIRIS



Swiss National Hip & Knee Joint Registry

Report 2023

Annual Report of the SIRIS Registry Hip & Knee, 2012–2022

Ten Years of Swiss Hip and Knee Registry

ano

swiss orthopaedics

UNIVERSITÄT BERN

Hip and knee replacement results 2012 – 2022

SIRIS Report 2023

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

High quality requires adequate funding

Medical registries are important tools for quality assurance and the research, development and improvement of therapies, treatment processes and/or medical products. The data can be used to develop quality indicators (hospital-specific and national comparisons), which can in turn help to evaluate therapies and thus come up with evidence of their effectiveness. Furthermore, medical registries promote quality development in the healthcare system, enable the data-based advancement of care and service planning, and help to identify public health findings. The established SIRIS implant registry is a prime example of this.

H+ has been committed to the development of quality indicators and registries for many years, as these are an important basis for quality development in hospitals and clinics. However, the current funding system does not provide a separate or distinct source of funding for the development and operation of supporting products and processes to monitor quality in the Swiss healthcare system.

“It’s not the costs that are the problem; it’s the funding.”

The financial situation of hospitals and clinics is very tight. For years, the current compulsory health insurance hospital fees have not been able to cover effective operating costs: in the outpatient sector, underfunding is at around 30 percent, while in the inpatient sector, it stands at around 10 percent. The system is reaching its limits. Under these circumstances, it should be clear that the current funding of medical registries (including the SIRIS implant registries) via compulsory health insurance fees (the “single-fee principle”) is no longer sustainable. This has been recognized by the SIRIS Foundation, which is very welcome news for H+. Concrete solutions regarding funding the the shoulder registry’s operator costs should still be worked out by the end of 2023.

The path to an ideal registry landscape remains long: the extent to which the development of a national registry strategy, which began to be discussed a few years ago, will prove necessary and whether a national registry law may even be necessary to regulate responsibilities, duties, minimum requirements and financing, must be seriously examined. The fact is, such an important matter cannot simply be regulated via the Federal Health Insurance Act, as is currently being attempted.

This 2023 Annual Report demonstrates once again that transparency and high-quality data are the basis for quality development. With this in mind, I would like to thank all those involved in producing this report for their commitment, and I hope that it makes for interesting reading.

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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 2023 and all previous reports.

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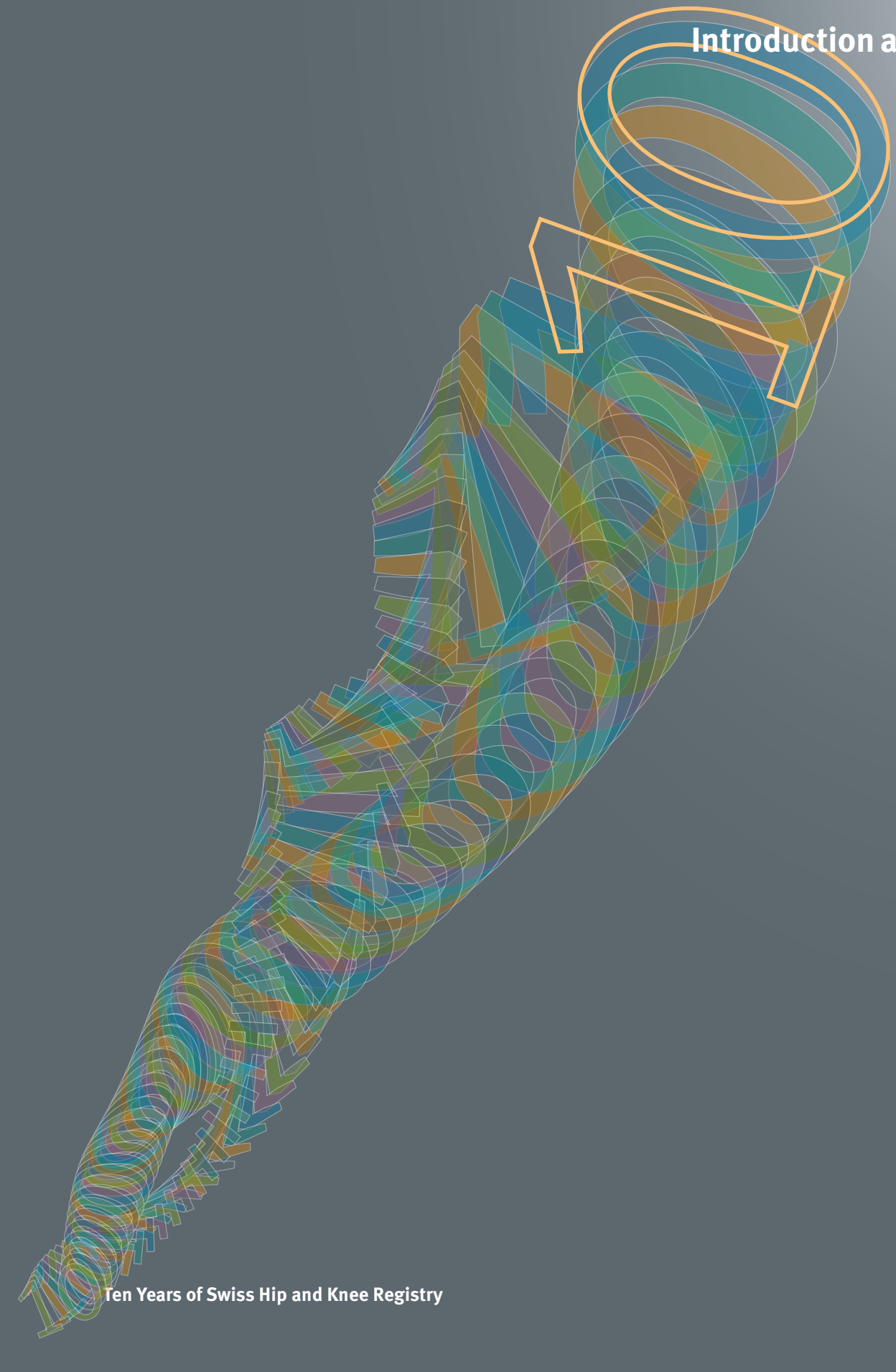
Introduction and methods



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. Registration in the SIRIS registry is mandatory for all Swiss hospitals that perform knee and hip arthroplasties, as they are bound to the ANQ's national quality agreement.

To ensure that all contributors and participants pursue a common goal, it is essential to clearly define the aim of the SIRIS registry, whereby this also influences the specific information that is contained in the registry, since there will be different requirements for each of the key stakeholders involved. The fact that a multi-partner association was required to launch the SIRIS registry meant that more than one point of view had to be considered for the registry to become successful and supported by all stakeholders. Although each partner naturally tends to focus more on one particular aspect that reflects their particular interest, one fundamental interest is common to all partners, namely the long-term well-being of the patient after a prosthetic joint replacement. The following paragraphs will explain the various perspectives of key stakeholders that were considered for the SIRIS development.

The patient's perspective. Since patients expect joint replacement surgery to provide them with long-lasting, pain-free mobility, the surgical procedure must be adapted to their level of activity and should be tissue-sparing and complication-free, followed by rapid rehabilitation. Hence, from the patient perspective, the registry data should be presented in such a way as to be readily comprehensible, allowing patients to find information of interest despite the complex methodology behind the analysis. While not all patients will read the registry reports, those who do may find the information helpful to better understand their past or future surgery and discuss it with their surgeon. The SIRIS registry should thus provide relevant and interesting information for patients to facilitate enhanced and more meaningful exchanges with their surgeons.

The surgeon's perspective. Surgeons are highly dedicated to avoiding surgical complications and shortcomings for their patients. In fact, the needs of patients and the goals of surgeons are fully aligned: the long-lasting, pain-free, and full function of the prosthesis. By choosing a particular prosthesis, surgeons integrate the performance of the implant with their expertise. The implants must be impeccably manufactured and versatile to avoid problems such as early loosening, wear particle disease, breakage, dislocation, infection, stiffness, or chronic pain and thus a long, problem-free implant life with the minimum amount of wear on the bearing surfaces is the ultimate goal. Hence, to add value from the surgeon's perspective, the registry should be able to identify problematic implants within a relatively short time frame and provide valuable early warnings to surgeons. However, entering individual clinical results into the SIRIS data collection system is not a welcome addition to surgeons' already intense daily schedule of activities. Furthermore, although surgeons certainly appreciate benchmarking their results, the public availability of the information at the individual surgeon's level remains a controversial aspect which may lead to biased entries in the system that could subsequently modify patient recruitment practices.

The industry's perspective. 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 is the most enduring strategy in this context because a single implant that causes failures

in a series of patients may lead to allegations of negligence that could ultimately destabilise the company. Hence, the aspect of economic viability coincides with the primary interest of the patients, namely the long-term well-being of the patient after prosthetic joint replacement. Since progress and technical innovation are extremely important for an industry dedicated to providing safe high-performance implants, the registry is regarded as an essential tool for post-market surveillance and clinical control that validates improvements in materials, designs, and concepts in real-life clinical settings. If the industry accepts quality as being the principal market-regulating factor, then the registry is a welcome tool and motivates industry participation. To date, the publication of two-year revision rates for registered implants in the SIRIS reports was met with great interest from involved providers (industry) and users (surgeons) of prosthetic replacements, whereby it is not the purpose of the registry to regulate the market but to define and provide quality assessment tools that are needed for market self-regulation.

The hospital's perspective. Hospitals aim to provide high-quality and safe care to a large number of patients at a reasonable cost. Hospitals are where surgeon/patient interaction takes place, with both parties sharing a common interest. Ideally, after a prosthetic replacement and successful rehabilitation process, patients should feel so well that they forget their treated joint in daily life (the forgotten joint concept). However, hospitals or departments also have an interest in ensuring that patients do not forget the institution where they were treated so successfully and that they return to the same hospital if necessary, including for reasons other than a prosthetic replacement. Furthermore, personal recommendations from satisfied patients are the very best publicity for hospitals and related medical institutions. The registry is perceived as an instrument for quality control, not only for the implants used but for the entire process, ranging from the preoperative consultation to the procedures in the operating room, as well as the postoperative follow-up. As institutions providing healthcare in today's competitive environment, hospitals are also very keen to uphold their reputation and the registry is an invaluable tool for this purpose. Additionally, since certain Swiss cantons even require SIRIS reports 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, which comprises is a strong motivation for participation in an environment where hospital mergers and closures are frequently discussed. Since 2020, performance benchmarks containing the two-year revision rates of institutions registered in SIRIS have been published online (https://www.anq.ch/de/fachbereiche/akutsomatik/messergebnisse-akutsomatik/step2/measure/20/) and are updated with every new report.

The insurer's perspective. Insurers and third-party payers are concerned about healthcare costs, and thus aim for short hospitalisation times, no expensive re-admissions for complications, and the patient's rapid return to work. Insurers are very conscious of cost when it comes to implant pricing, medical fees, and hospital bills. Because the insurer's objective is to provide equal benefits to all its clients within the available budget, the registry is perceived as an instrument that can provide information regarding the performance of surgeons and institutions and function as a cost-quality tool. Since revision surgeries cause significant additional (and possibly avoidable) costs, the focus of insurers remains the same as that of patients: long-lasting, pain-free function after prosthetic replacement.

The government's perspective. The government organises the healthcare system on behalf of all citizens. Therefore, the main challenge it faces is having to consider and bring together the needs and preferences of all players in the health economy. Although the government may not have any inherent financial interest in the running of the system at the Swiss federal level, the cantonal governments directly bear a major share of hospital costs and are very active participants in all debates concerning hospital treatments, including their outcomes and costs.

Governments also have an interest in assessing the overall situation concerning the quality of healthcare provision. While patients understandably tend to place their primary focus on receiving treatment that provides optimal and long-lasting results, the government certainly shares this aim but also has to focus on ensuring that high-quality treatment is cost-effective.

Governments, therefore, require data on the overall surgical performance for public health purposes to assess requirements and subsequently plan the macroeconomic policies related to healthcare. Hence, government health agencies are commissioned to ensure that the institutions under their supervision provide high-quality and complication-free healthcare to the general population, whereby the agencies also have an interest in benchmarking hospitals and keeping insurance and third-party payer costs down to a reasonable minimum.

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

1.2 Strong commitment

The 2023 SIRIS report represents a collaborative data collection effort involving all the institutional partners of SIRIS and includes the surgeons and operating teams of orthopaedic or surgical units performing hip replacement surgery (156 units) or knee replacement surgery (146 units). Streamlining, improving, and optimising data collection is a work in progress involving expert groups and all members, including industrial partners.

Coverage is one important indicator of the commitment of all parties involved in SIRIS, and it correlates with the accuracy of SIRIS reports. However, it is difficult to assess because any registration system aiming to be a benchmark will have some advantages and disadvantages. 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 from 2017 to 2021, as the data for 2022 is not yet available for inclusion in the SIRIS Report 2023. The data is available publicly and can be considered in relation to SIRIS data, although some details regarding coding and filtering definitions may differ. In 2021, the coverage of SIRIS was over 98% for primary hip and knee replacements (benchmark: for all reasons excluding trauma). The high coverage rates confirm that the commitment of all participating individuals and institutions remains strong, and further details regarding the coverage are provided in Chapter 2 Methods, Part 2.3 Coverage.

Officially only started in 2012, the SIRIS registry has thus achieved high coverage and continues to improve the content of reports that attract public attention. This not only demonstrates the 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 by the SIRIS team. The SIRIS 2023 report provides information on the state of hip and knee replacements in Switzerland and presents a wealth of new information. The report also provides important and verifiable information that we hope the healthcare community, third-party payers, and healthcare regulators will find useful.

Table 1.1
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

2. Methods

2.1 Maintenance and hosting of the registry

The SIRIS Registry (hip and knee) is hosted and maintained by SwissRDL at the Institute for Social and Preventive Medicine (ISPM), University of Bern. A dedicated team comprising a statistician/methodologist, data monitor, data management/IT specialists, and support staff is responsible for the management and maintenance, technical support, analysis, and reporting of the registry data. The data monitor supervises the data entries and supports and trains collaborators at the participating hospitals to ensure the correct and efficient running of the registry. The overall project management support at SwissRDL is jointly provided by the data monitor and the statistician/methodologist, and both positions are also members of the SIRIS Scientific Advisory Board that directs and oversees the registry and, among other things, produces this annual report.

SIRIS data are collected via an online documentation IT platform (accessible at siris.memdoc.org), and clinical data on primary arthroplasties, reoperations, and component revisions are recorded. Furthermore, clinics may also register post-operative follow-up data at their discretion. 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. While most participating surgical units use the online interface for documenting their operations, some large centres send data exports from their hospital information systems to SwissRDL via a web service client. The alternative registration approach, 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 barcodes on the implant tags although, 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 the exclusion of cases from analyses. Manual data entry of implants is therefore now restricted to multiple-choice drop-down menus only containing known implants while new implants may be registered by SwissRDL at the request of SIRIS users or upon notification by a producer. The clinical data of the SIRIS registry are stored on dedicated 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 that is physically separate from the clinical data of SIRIS. The patient's identification information is encrypted into a salted hash code to facilitate the linking of revisions performed at a different health facility to the corresponding primary arthroplasty. This is needed to calculate revision rates and for the continuous follow-up of implants.

To estimate the number of patients "at risk" of revision, all patient data from SIRIS are cross-checked with the database of the Swiss Central Compensation Office (ZAS Geneva) and the Federal Statistical Office (FSO Neuchâtel). As of 2022, SIRIS can annually verify – for the entire active reporting period – whether a patient has died or left Switzerland, whereas, in previous years, this information was only available with a 1-year time lag. Therefore, only patients confirmed alive and residing in Switzerland are considered "at risk" of revision while patients who have died or left the country during the observation period are accounted for proportionally in terms of the num-

ber of days from operation to death or leaving Switzerland. Fewer than 5% of patients had an unknown status or were foreigners operated on in Switzerland but not registered in ZAS. These patients are considered lost to follow-up after predetermined time intervals, unless actually revised in Switzerland, and are subsequently excluded from the analysis of (long-term) revision rates.

SwissRDL data protection complies with current standards and 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 the Federal authority. Patients must provide written informed consent before their data are entered into SIRIS, which is facilitated by participating surgeons and hospitals. Furthermore, patients have the right at any time to withdraw participation, check their data, and have their data completely deleted.

2.2 Data quality and completeness

The data for this report were exported from the database in June 2023. The consistency and completeness of SIRIS data are checked in part through systematic software-generated validation tests of the received data and, additionally, quarterly by the registry's statistician/methodologist after running it through an automated analysis script for producing master files, which also generates lists of likely data errors. These are then fed back to the data monitoring team which analyses root causes of confirmed problems and provides feedback to hospitals. The latter procedure, established in its current form in 2019, has already shown great potential for improving data quality. In addition to the ongoing data-quality checking routines, several specific methodological decisions are taken to report figures as accurately as possible. For example, when the information provided on a form and the registered implants contradict each other, and it has not yet been possible to verify the case (e.g. hemiarthroplasty is selected on the form, while total hip components are registered) the implant registration information is given priority and the case is (provisionally) counted as a total hip arthroplasty. In cases where such decisions had to be made and are likely to impact the overall results, this information is indicated in the relevant tables or figures.

Two updates of case report forms (CRF) have been implemented since the launch of SIRIS. The first version was used from 2012 to 2014 and an updated version was in use between 2015 and 2020. Some changes to the definition of existing variables (particularly for the type of arthroplasty of the knee) were introduced, as well as some new variables, notably the body mass index (BMI) and the morbidity state according to the ASA classification. The latter permits the answer option of

"unknown", which was inconsistently used among providers, including one reporting unknown ASA status in almost all cases, indicating issues with data collection. Other common problems include impossible or inconsistent responses, which are more frequently observed in some sections of the forms than in others, e.g. revisions relating to acetabular components in hemiarthroplasties. This could be due to a systematic misunderstanding of the meaning of certain response categories (i.e. confusion between revision of the acetabular component and conversion to total hip arthroplasties [THA] after a hemiarthroplasty) or because of random data entry errors likely aggravated by design issues such as long drop-down lists. To overcome this obstacle, the hospitals are now being closely monitored to reduce the incidence of missing and implausible values and a new case report form was introduced in 2021, to address several of these problems and update the content to 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, whereby each entry represents the hospital discharge 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 (www.bag.admin.ch) and detailed definitions are provided at www.bag.admin.ch. Codes I.1.8.F, I.1.9.F, and I.1.10.F can be used to identify primary hip prostheses of any kind and for any diagnosis, while codes I.1.15.F and I.1.16.F are used for knee prostheses. At the time of writing the 2023 report, only figures up to

Table 2.3
Retrospective coverage analysis 2017–2021 based on National Office of Public Health figures (BAG)
All SIRIS figures excluding Liechtenstein

	2017	2018	2019	2020	2021
Primary hip prostheses					
BAG	22,970	23,160	23,619	23,310	24,834
SIRIS*	20,992	21,739	22,462	22,747	24,344
Primary coverage (%)	91.4	93.9	95.1	97.6	98.0
Primary knee prostheses					
BAG	18,558	18,325	19,181	18,837	20,280
SIRIS**	17,108	17,440	18,546	18,588	19850
Primary coverage (%)	92.2	95.2	96.7	98.7	98.0
All primary hip and knee prostheses					
BAG	41,528	41,485	42,800	42,147	45,114
SIRIS	38,100	39,179	41,008	41,335	44,194
Primary coverage (%)	91.7	94.4	95.8	98.1	98.0

* 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)

2021 were available and we thus used the official FOPH/BAG figures to re-estimate the 2017 to 2021 figures. As shown in Table 2.3A, primary coverage peaked at 98.1% in 2020 and it currently stands at 98.0%. Furthermore, 2021 saw a surprising drop in coverage of knee arthroplasties, whilst primary coverage of hip arthroplasties kept improving and both now stand at 98%.

Having to rely on publicly available figures with a considerable time lag is suboptimal for a registry, and efforts to secure timelier access to the actual raw figures reported by the hospitals are currently underway. However, at the time of writing this report, no agreement had been reached with the FOPH/BAG.

SIRIS also accesses annual implant sales figures for Switzerland, specifically the number of femoral stems (indicator for hip arthroplasties) and tibia plateaus (indicator for knee arthroplasties) sold per year (data provided by the manufacturers). We consider this a generally reliable source of information, even though the analysis 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 among 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 and we thus consider coverage rates between 90% and 110% as the "target zone" for hospitals for this type of analysis. In previous years, the two different ways of calculating coverage rates were mostly in agreement. However, starting in 2021 and increasingly in 2022, we find that these figures are no longer in agreement with registry data or other sources, at least not on a calendar year basis and for specific hospitals.

We also rely on feedback from individual manufacturers in Swiss implant reporting and know that these high coverage rates are realistic. For instance, in specific implant reports, coverage rates tended to be as high as 99% for typical standard implants such as primary hip stems and as low as 60% for specific hemi-heads. The under-coverage of hemiarthroplasties is a well-known problem as they are frequently implanted as emergencies in trauma units instead of orthopaedic departments where participation in SIRIS is better implemented within standard procedures.

We have also seen clear progression of coverage at the hospital level since 2017, and all eligible units are currently submitting cases to SIRIS. In previous years, we had reasons to believe that the registry already had a higher, albeit not officially counted, coverage rate as cases created in the SIRIS online system needs to be completed – including by at least one implant registered for most types of procedures – before they can be submitted and be included in the analysis. A certain number of incomplete and unsubmitted cases are left in the system every year. The improvements in coverage since 2017 are, to a certain extent, due to SIRIS's collaboration with hospitals to help solve submission problems and the number of registered cases keeps increasing after each reporting period. In recent years, however, at least part of the gap in data entries could be explained by increasing difficulties in obtaining informed consent from patients. This is a topic to observe in the future as the refusal to sign informed consent poses a direct threat to an implant registry that, in order to fulfil its function, does need very high – ideally complete – coverage of all primary and revision procedures.

2.4 Statistical precision and outlier detection

The figures in this report are, whenever appropriate, accompanied by 95% confidence intervals. This interval indicates the plausible range within which the "true" value should lie with 95% probability, considering the random variation of samples of limited size. All confidence intervals are unadjusted for the various forms of clustering that may also affect precision, especially when results depend on small numbers of surgeons or hospitals. The latter aspect is a particular challenge for a medical registry in a small yet diverse country such as Switzerland and must be evaluated on a case-by-case basis (e.g. in outlier detection). In 2022, we started reporting a simple metric that we call the "case concentration score" which is simply the share of a particular implant combination or system accounted for by the hospital using it the most. We provide this information in the interest of transparency as the performance of implants that are used in a few places may not be an unbiased estimate of their true performance. Since the number of knee systems included in this report has also been widened to include more complicated designs, as long as these designs were used for cases of primary osteoarthritis, we also provide mean age figures for each system. Again, this is done in the interest of transparency, as knee systems used in younger patients tend to have higher revision risks.

We detect statistical outliers – i.e. units or products that perform markedly worse than expected – by several means. For clinics and individual 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. In other words, 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 result was entirely caused by random variation and thus the likelihood of observing a value outside this range (above or below the limits) would be 1 in 500 if it were just pure chance. Indeed, the specific likelihood of exceeding the upper boundary of a funnel plot by chance is only 1 in 1,000.

For implants, we use a much simpler method but also report the results with several caveats and additional context. In this report, we continue with a distinction between the 2-year evaluation and long-term evaluation, whereby the latter starts at 5 years follow-up and currently ends at 10 years follow-up. All implant combinations or systems with at least 500 cases and sufficient numbers at certain time points are subject to long-term evaluation. Furthermore, we identify three possible deviations from normal performance: (1) implants with elevated revision risk, i.e. 50% more revisions at any point between 5- and 9-years follow-up; (2) implants with long-term outlier status, i.e. 100% more revisions at any point between 5- and 9-years follow-up; and (3) implants with below average revision risk, i.e. having no more than 66% revision risk at 9 years follow-up. All of these boundaries are subject to further limitations on remaining numbers at risk and the spread of confidence intervals as specified in the relevant chapters. In the 2-year evaluation, 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, whereby the relevant threshold for inclusion in the analysis was at least 50 cases in the current evaluation time frame (i.e. all primary operations between 1.1.2017 and 31.12.2020). In this report, we refrained from ranking the implants by their 2-year revision rates and we excluded any potential outliers with confidence intervals so large that they overlap with the 95% confidence interval of the actual 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 this 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 we also provide additional analytical information such as risk-adjusted hazard ratios in this context. Additionally, we also benchmark implants within a moving time window (4 years) to ensure that results are not affected by period effects and represent "current" performance, albeit with a necessary 2-year time lag to allow for complete follow-up of at least 2 years. As implants come in markedly different group sizes, readers must pay attention to the reported 95% confidence intervals and any other contextual information – especially relating to the small numbers of clinics involved – indicated on the outlier watch board in this report.

To help readers understand the grouping decisions of implant combinations or systems, we include, for the first time, an additional online appendix in this report. The appendix lists all main implants and provides additional information on the group composition (e.g. included variants of a stem or cup) and whether or not there is a likelihood of so-called camouflage effects in which subgroups of reported groups may be improving or worsening the average result.

2.5 Evolving statistical methodology

The mainstay of statistical visualisation and reporting in joint registries is the well-established Kaplan-Meier method (KM) as KM figures allow for visually tracking the risk of revision of implants or groups of patients over time (failure curves). However, much debate has taken place regarding their suitability in the presence of competing risks and, in the context of joint registries, the one evident competing risk is the death of a patient as deceased patients will naturally not have their implant revised at any later time point. The risk of death is thus said to "compete" with the risk of revision. Within the constraints of the KM method, we account for death by declaring patients who died during their observation time as censored on the day of death. This already provides an important correction to the model as we do not falsely assume that these implants are still at risk of revision and thus unrevised. Hence, in 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, they either would or would not have experienced a revision like any of the surviving patients, although it can no longer be observed. This assumption is basically not testable and will frequently be false as the patients who died can never experience a revision and probably had a lower likelihood of this from the outset, possibly because they were particularly frail and had low mobility. Competing risks regression, which comes in the form of several 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 included a first special analysis in the chapter on hip fractures, where mortality rates are a special concern for every analysis, even in

the short term. We have only slightly expanded on the details of this analysis in this report but retain it as an additional perspective on the performance of implants used in very elderly groups of patients. These results also formed the basis for our decision to refrain from conducting the new long-term evaluation for implant combinations used for hip fractures.

2.6 Patient-reported outcome measures (PROMs)

The SIRIS registry benefitted from two local PROMs initiatives that were conducted on the SIRIS registry platform. Between 2017 and 2020, nine hospitals in the Cantons of Basel Stadt, Basel Landschaft, and Solothurn collected PROMs for elective total hip and total knee arthroplasties using the Core Outcomes Measures Index (COMI). Patients were followed up after 6 months and 2 years (follow-up ending in 2022).

Although the primary inclusion rate of all sites combined was comparatively low at just over 20% of eligible procedures, the analyses of participation patterns did not reveal any evident distortions in terms of SIRIS patient characteristics or, possibly more importantly, in terms of actually observable revision risk. There is therefore no suggestion, as far as is testable using the available data, that the included patients differed in any way from the excluded patients. Expressed as a missing data problem, we thus treat this as "a missing completely at random" scenario in which the number of cases available for analysis is reduced, but no significant bias is introduced into the results beyond some random variation. We also consider this scenario plausible because completion rates varied significantly throughout the project and between hospitals and were largely determined by local study administration arrangements rather than patient selection.

Six-month follow-up rates exceeded 80% in all but one COMI setting (up to 89% with the lowest success rate registering at 79%) while the 2-year follow-up rates exceeded 50% in all but one setting (up to 58% with the lowest success rate regis-

[1] Impellizzeri, FM, Mannion, AF, Naal, FD, Leunig, M. A Core Outcome Measures Index (COMI) for patients undergoing hip arthroplasty. The Journal of Arthroplasty 28 (2013) 1681–1686.

tering at 46%). We only used cases with valid pre- and post-operative responses at either 6 months or 2 years. In total, this study provided PROMs for up to 1,148 THAs with follow-up at 6 months and 745 with follow-up at 2 years, as well as 999 total knee arthroplasties (TKA) with 6 months follow-up and 576 at 2 years.

Another PROMs project in collaboration with SIRIS was initiated by the Cantonal Health Authority of Zürich and Swiss Orthopaedics in 2019. All hospitals receiving public funding for elective hip and knee arthroplasties must collect the minimal dataset (MDS) consisting of the 5-item version of the EQ5D quality of life questionnaire and a small selection of additional questions on joint-specific pain and satisfaction. Patients are followed up at 1 year.

The primary inclusion rate of all hospitals combined reached 72% in 2022 and is still rising as the initiative becomes more solidly embedded in local procedures. While the follow-up completion rates after 1 year currently stand at 66%, this figure is also expected to keep improving, whereby it is noteworthy that the completion rates differed substantially between hospitals, with some returning close to 100% of primary cases and over 90% follow-up. Related to this initiative, a small number of surgeons in other Cantons currently also collect MDS data as part of a Swiss Orthopaedics pilot project. The MDS forms currently provide up to 5,347 THAs and 4,156 TKAs with follow-up at 1 year. They also provide 734 partial knee arthroplasties with complete 1-year follow-up.

Although our initial interest was focused on the methodological lessons to be learned, the available datasets also allow for a preliminary examination of substantive PROMs results in SIRIS hip and knee data, whereby the main methodological lessons can be succinctly summarised. It is certainly possible to integrate PROMs into the SIRIS data collection framework and fairly high primary coverage is achievable with reasonable local effort. Follow-up success, on the other hand, can be more reliably achieved when it is centrally managed, as was the case in the COMI study, where the registry's service provider SwissRDL collected all follow-up data. In this report, we focus on the PROMs of both initiatives that can either be compared directly or be made comparable. Both datasets contain the same joint-specific satisfaction question and a simple joint-specific question about pain in the previous week using the same numerical scale. Furthermore, while both COMI and EQ5D can be condensed to summary scores, the former represents a joint-specific index of disability resulting from underlying conditions, whereas the latter is more of a classic quality of life measure, combining multi-domain items such as mobility, pain, and anxiety. Satisfaction can thus be compared directly as distributions at different time points. Although the pain score could be directly compared, the averages of a 0–10 scale are not necessarily particularly meaningful. Furthermore, while COMI and EQ5D summary scores cannot be directly compared, they can be converted into a new metric that is approximately comparable and we thus calculated a Treatment Effect (TE) , based on the following simple formula:

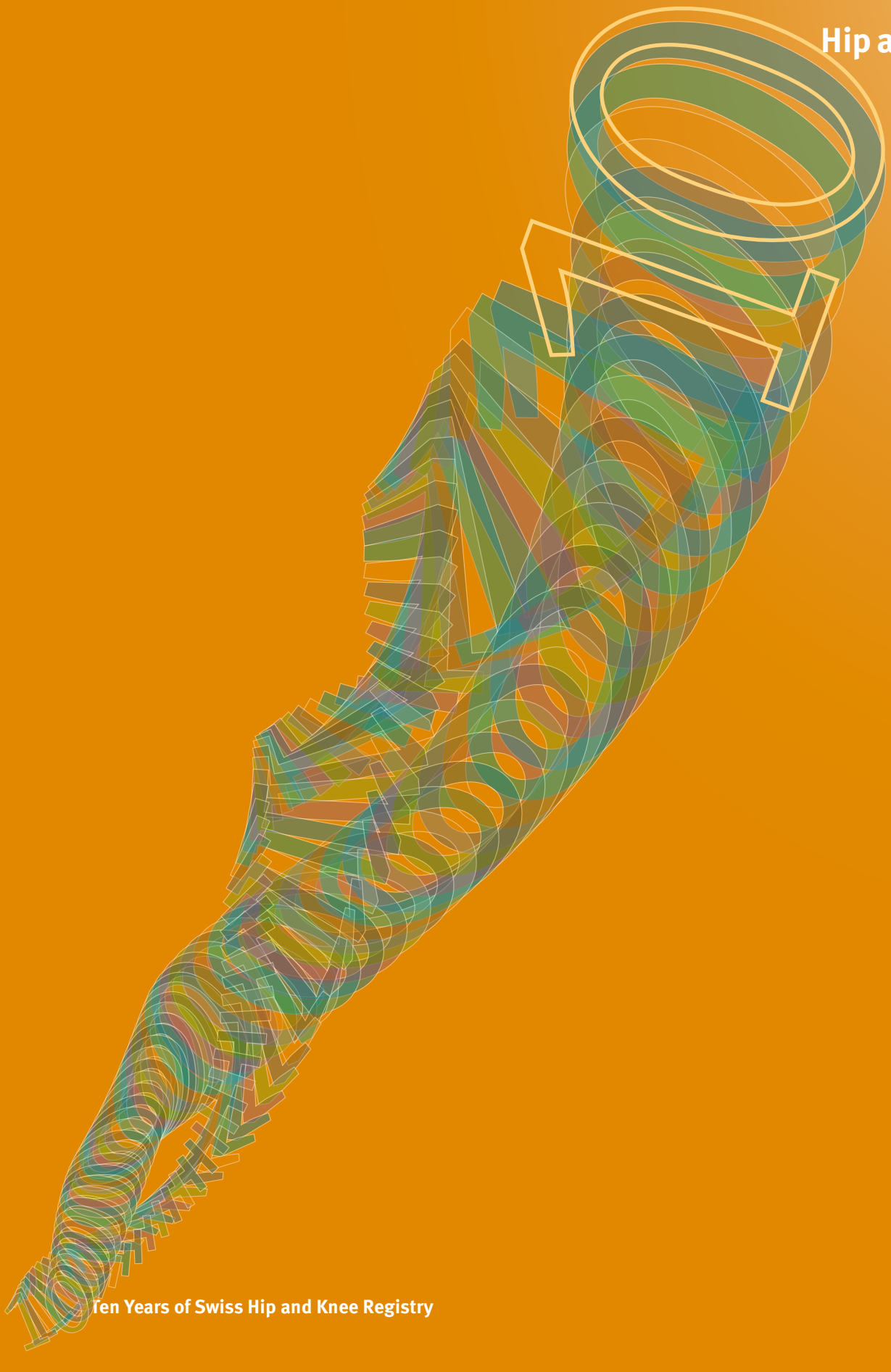
$$TE = \frac{\text{preoperative score - postoperative score}}{\text{preoperative score}}$$

[2] Huber J, Irlenbusch U, Kääb MJ, Reuther F, Kohut G, Judge A. Treatment effects of reverse total shoulder arthroplasty - a simple method to measure outcomes at 6, 12, 24 and 60 months for each patient. BMC Musculoskelet Disord. 2020 Jun 22;21(1):397. doi: 10.1186/s12891-020-03427-7. PMID: 32571282; PMCID: PMC7310507.

[3] Huber J, Dieppe P, Dreinhoefer K, Günther KP, Judge A. The Influence of Arthritis in Other Major Joints and the Spine on the One-Year Outcome of Total Hip Replacement: A Prospective, Multicenter Cohort Study (EUROHIP) Measuring the Influence of Musculoskeletal Morbidity. J Bone Joint Surg Am. 2017 Sep 6;99(17):1428-1437. doi: 10.2106/JBJS.16.01040. PMID: 28872524; PMCID: PMC5685421.

The calculations are performed on converted scales with 0 defined as no symptoms and positive values designating levels of symptoms. In other words, this metric is the relative symptom reduction expressed on a numerical scale, whereby 1 equals complete amelioration (= complete treatment success, e.g. no more pain reported), 0 represents the complete absence of effect (e.g. same pain reported as before treatment), and a negative value represents an outcome worse than the pre-operative state (e.g. more pain than before treatment). The analysis excludes patients who did not report pre-operative symptoms (= 0) and the scale can be presented as approximate percentage categories for comparisons between settings or types of procedures. On a technical note, this comparison of relative symptom reduction works because the underlying summary scores must have certain properties to be legitimate combinations of different ordinally scaled items, i.e. they must be quasi-continuous expressions of some underlying construct. However, readers are advised that this purely numerical analysis may differ from other clinical evaluations of treatment success. We used TE for both the pain score and the COMI/EQ5D summary scores.

Hip arthroplasty



Ten Years of Swiss Hip and Knee Registry

3. Hip arthroplasty

3.1 Introduction and summary

The overall volume of hip surgeries in relation to demography

Since its inception in 2012, SIRIS has registered 201,364 primary THAs, together with 9,419 linked and 16,929 unlinked revisions **(Table 3.1a).** In this context, linked revisions refer to revisions of primary implantations that were recorded in SIRIS since 2012, while unlinked revisions are performed on hip replacements implanted before the launch of SIRIS or involve implantations not registered in SIRIS for other reasons. During the same period, 22,666 HAs, predominantly for the treatment of fractures of the proximal femur, were implanted, of which 893 were revised (linked revisions). With the growing age of the register, the number of unlinked revisions is declining.

Table 3.1a

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

All documented operations

Year	Primary THA	Primary HA	Primary others or type unclear	Primary total	Annual growth rate primary	Linked Rev./ Reop. of THA[2]	Linked Rev./Reop. of HA[2]	Unlinked Rev./ Reop.[3]	Rev./Reop. total[4]	% Linked Rev./ Reop.
2012[1]	6,705	637	3	7,345		113	6	793	912	13.0
2013	16,900	1,933	4	18,837		405	39	1,869	2,315	19.2
2014	17,190	2,035	2	19,227	2.1%	573	60	1,894	2,528	25.0
2015	17,679	1,978	5	19,662	2.3%	721	64	1,810	2,596	30.2
2016	18,704	1,998	7	20,709	5.3%	836	85	1,712	2,636	34.9
2017	18,890	2,093	9	20,992	1.4%	864	78	1,675	2,622	35.9
2018	19,500	2,251	6	21,757	3.6%	967	101	1,569	2,638	40.5
2019	20,119	2,353	8	22,480	3.3%	1,105	105	1,514	2,726	44.4
2020	20,340	2,419	5	22,764	1.3%	1,233	106	1,452	2,795	47.9
2021	21,971	2,392	7	24,370	7.1%	1,307	116	1,324	2,748	51.8
2022	23,366	2,577	3	25,946	6.5%	1,295	133	1,317	2,751	51.9
All	**201,364**	**22,666**	**59**	**224,089**		**9,419**	**893**	**16,929**	**27,267**	**37.8**

[1] Does not represent a full year of data, as data collection in most hospitals started only in October 2012
[2] i.e. primaries already in SIRIS
[3] can be of THA and HA
[4] including linked revisions/reoperations of procedures that were classified as „primary others“ or of unclear type

Figure 3.1a

Age distribution at surgery of primary total hip arthroplasty and hemiarthroplasty

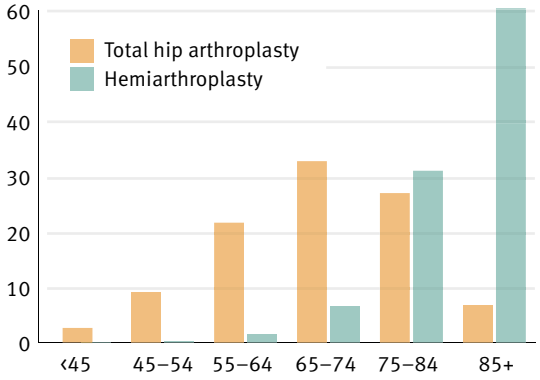
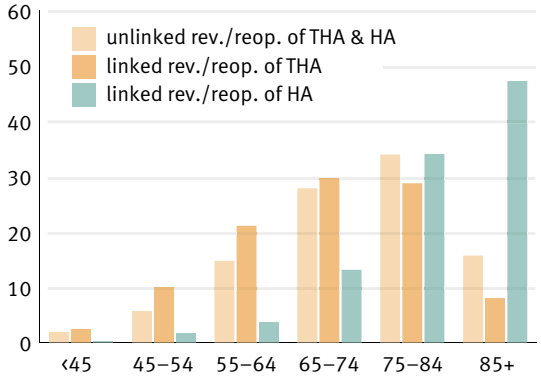


Figure 3.1b

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



The absolute number of hip procedures registered in SIRIS has been growing steadily, with the annual growth rates since 2013 averaging 3.6% **(Table 3.1a and Figure 3.1c).** The increase in the total number of procedures is caused, at least partially, by increased coverage in the registry and needs to be considered in relation to demographic changes in the Swiss population. For instance, between 2013 and 2020, it seems that this increase is broadly in line with the increase of the population particularly "at risk" of needing such procedures (50 to 89 years of age). In 2020, due to the Covid-19 pandemic-related restrictions, the increase dropped to 1.1%. In 2021, an increase of 8.0% was observed for THA, which can be interpreted as being a compensation for the previous year. However, in 2022 the trend of increased THA procedures continued, with a growth rate of 6.5%, which is approximately twice the increase in the pre-Covid-19 pandemic years. While the increased implantation rate in 2021 may be explained by a backlog demand caused by the restricted availability of THA during the Covid-19 pandemic, the cause for the 2022 increase is unclear.

In general, the implantations follow a seasonal pattern, with more implantations in Q1 and Q4, and a dip in Q3. During the Covid-19 pandemic, the seasonal pattern was not maintained, while in 2021 it was partially restored. In 2022 the seasonal pattern was restored again **(Table 3.1b and Figure 3.1d).**

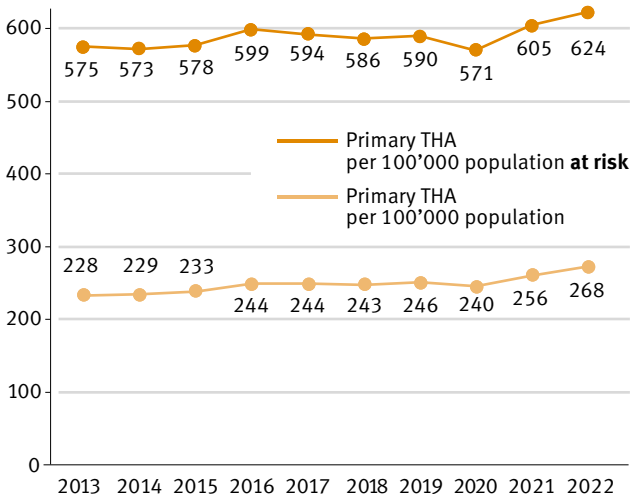
Comparing the incidence of implantation of hip prostheses with incidences in other healthcare systems can be challenging, and interpretations must thus be made cautiously. Incidences are usually presented as a fraction, where the numerator shows the number of all prostheses implanted during a given period and the denominator defines the base against which the numerator is evaluated. Since the definitions used in such indicators may differ, readers are advised to pay attention to any technical appendices or small print provided in publications. This report presents two calculations with different denominators, namely the overall population and the population "at risk" (i.e. those who belong to the age group in which this procedure is usually performed) **(Figure 3.1c).**

The coverage rate in 2022 was estimated to be at least 98%, based on 2021 official figures, whereas in 2020 it was estimated to be 97.6% and this increase in the coverage rate may explain some of the growth in 2022, while the remainder may be real growth. However, it remains unknown whether there is still a backlog from the Covid-19 pandemic period.

Figure 3.1c

Incidence of primary total hip arthroplasties registered in SIRIS

Per 100'000 residents and per 100'000 residents at risk*



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

Adjusted for estimated coverage SIRIS figures excluding Liechtenstein. Coverage rates 2013–2016 estimated at 91%; 2017–2021 based on federal health office data; 2022 estimated at 99%

Prosthetic replacement of the hip

Of the 78,849 documented primary THAs, implanted during the current 4-year moving window, between 01.01.2017 and 31.12.2020 with a completed 2 year follow-up until 31.12.2022, 65,595 were implanted for primary osteoarthrosis (AO). Of these, a total of 1,648 hips were revised, accounting for a 2-year revision rate of 2.5% (CI 2.4–2.7), whereby the risk of revision was higher in hips with secondary OA (3.9%) and even higher in hips treated for fractures (5.3%) **(Table 3.4a).**

For primary OA, the male/female ratio has remained stable over the last 6 years and hip implantations were slightly more frequent in women (53.2%), and their mean age of 70.7 years was higher than that of men (67.2 years). Since 2017, there was a slight increase in age at implantation of almost 1 year.

67.1% of THAs were performed in patients older than 65 years of age, of which 7.2% of implants were in patients aged over 85 years. Patients under 55 constituted 11.2% of the recipients and the distribution among the age groups has remained stable during the last 6 years **(Table 3.2a).**

Table 3.1b

Seasonal pattern of SIRIS submissions 2019–2022

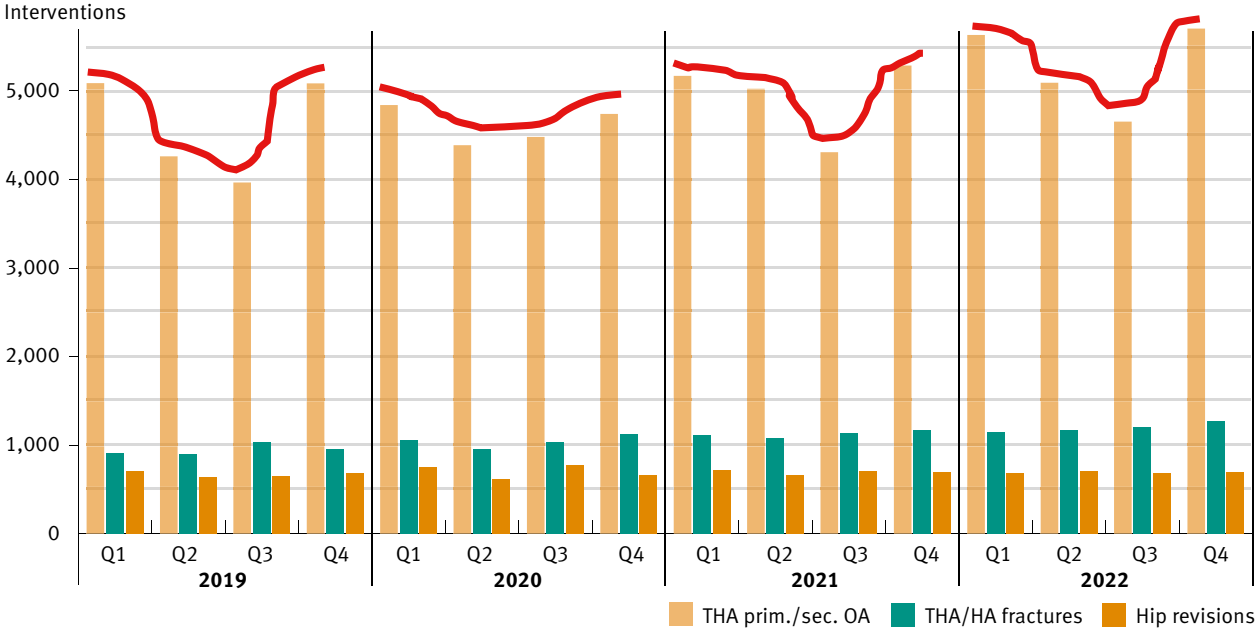
All documented operations

	2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
THA primary/secondary OA	5,106	4,275	3,987	5,091	4,840	4,403	4,493	4,757
THA/HA fractures	940	918	1,058	944	1,040	949	1,024	1,118
Hip revisions	721	663	659	683	746	610	776	663
	2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
THA primary/secondary OA	5,185	5,045	4,318	5,305	5,658	5,096	4,641	5,708
THA/HA fractures	1,102	1,064	1,135	1,159	1,138	1,165	1,211	1,271
Hip revisions	717	651	689	691	686	699	674	692

Figure 3.1d

Seasonal pattern of SIRIS submissions 2019 – 2022

Interventions



The most frequent complication of primary THAs for primary OA was infection (0.67%, n = 439), followed by periprosthetic fracture (0.49%, n = 321), femoral loosening (0.42%, n= 275), and dislocation (0.38%, n= 252) **(derived from Table 3.4b).** Approximately one-tenth of all revisions (0.31% or 203 of all primary THAs) were performed for malpositioning of either acetabular or femoral components.

The register covers a total of 22,666 cases operated for fractures of the hip between 2016 and 2022. This covers only fractures treated with prosthetic replacement, cases treated with internal fixation are not documented in SIRIS. The annual increase in recent years remained stable with an average of 8%. There is an increasing tendency to treat femoral neck fractures with THA instead of an HA. The reason is not clear. This could reflect a change of indication, or more patients with fractures needing a THA. In 2017, 38.5% of such fractures were treated with a THA, while by 2022 this increased to 47.3%. During the same period, the use of HA declined from 61.5% to 52.7%.

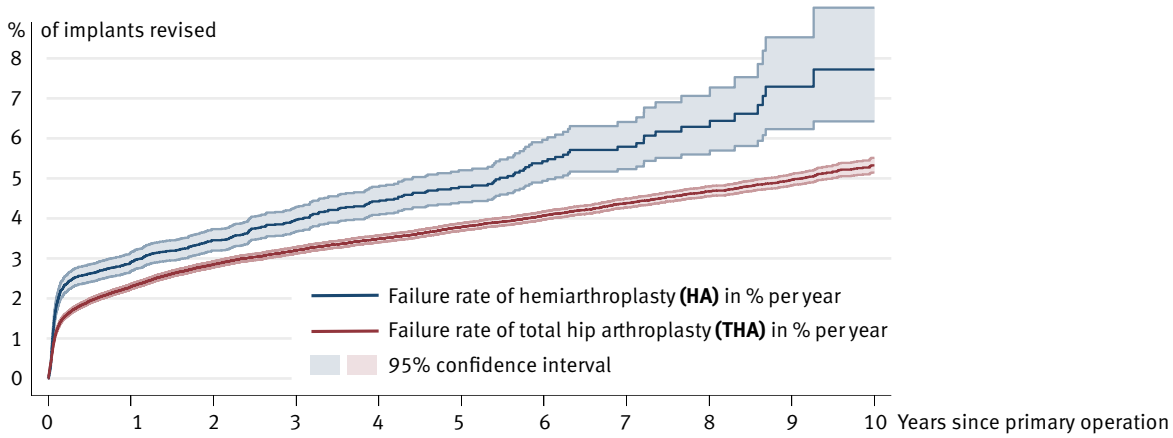
Women accounted for about two thirds of the cases (67.8%). Patients older than 65 incurred 91.3% of the fractures while the age group above 85 years accounted for 43.8% of the total **(Table 3.6a).**

At 2 years, the average revision rate for all THA is 2.8% (CI 2.8–2.9) and 3.5% (CI 3.2–3.7) for HA, while the 10-year revision rates are 5.3% (CI 5.1–5.5) and 7.7% (CI 6.4–9.3), respectively **(Figure 3.1e).** The comparison of different periods since 2015 shows a trend of decreasing revision rates in more recent years **(Figure 3.1f).** This is one of the desired effects of a registry.

Figure 3.1e

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

in percentages, 2012–2022, all services, all diagnoses.



Failure rate	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
HA	**2.9**(2.7-3.2)	**3.5**(3.2-3.7)	**4.0**(3.7-4.3)	**4.4**(4.1-4.8)	**4.8**(4.4-5.2)	**5.4**(4.9-6.0)	**5.8**(5.2-6.4)	**6.3**(5.6-7.1)	**7.3**(6.2-8.5)	**7.7**(6.4-9.3)
THA	**2.3**(2.2-2.4)	**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**(4.0-4.2)	**4.4**(4.3-4.5)	**4.7**(4.6-4.8)	**5.0**(4.8-5.1)	**5.3**(5.1-5.5)

N at risk	0 year	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
HA	22,666	13,641	9,928	6,540	4,420	2,909	1,838	1,132	634	296	59
THA	201,364	168,311	144,157	118,316	98,000	78,852	61,1386	44,595	29,925	16,580	4,584

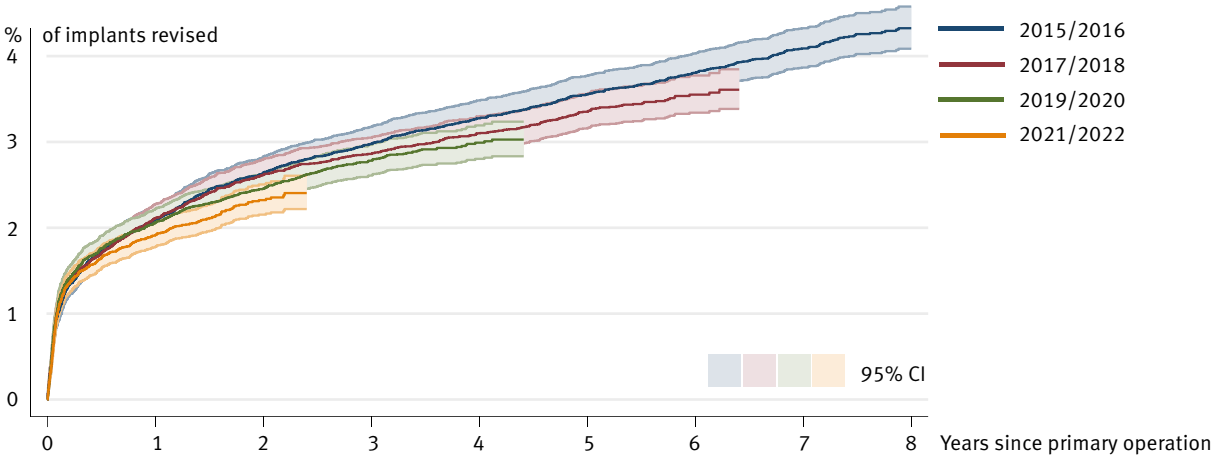
Implant-specific outcomes

The annual report analyses the early and long-term outcomes after implantation of a THA. The 2-year revision rates were calculated for a moving 4-year window which includes the last 4 years with a full 2-year follow-up. For this report, the data for implantations performed between 1.1.2017 and 31.12.2020 were analysed with a completed 2-year follow-up until 31.12.2022. This practice has the advantage that the burden of the past will not influence the results of the current performance of an implant, clinic, or surgeon. It also offers the possibility of comparing different periods, showing whether there is improvement or deterioration over time.

Figure 3.1f

Kaplan Meier estimate of cumulative postoperative revision risk after THA by time period

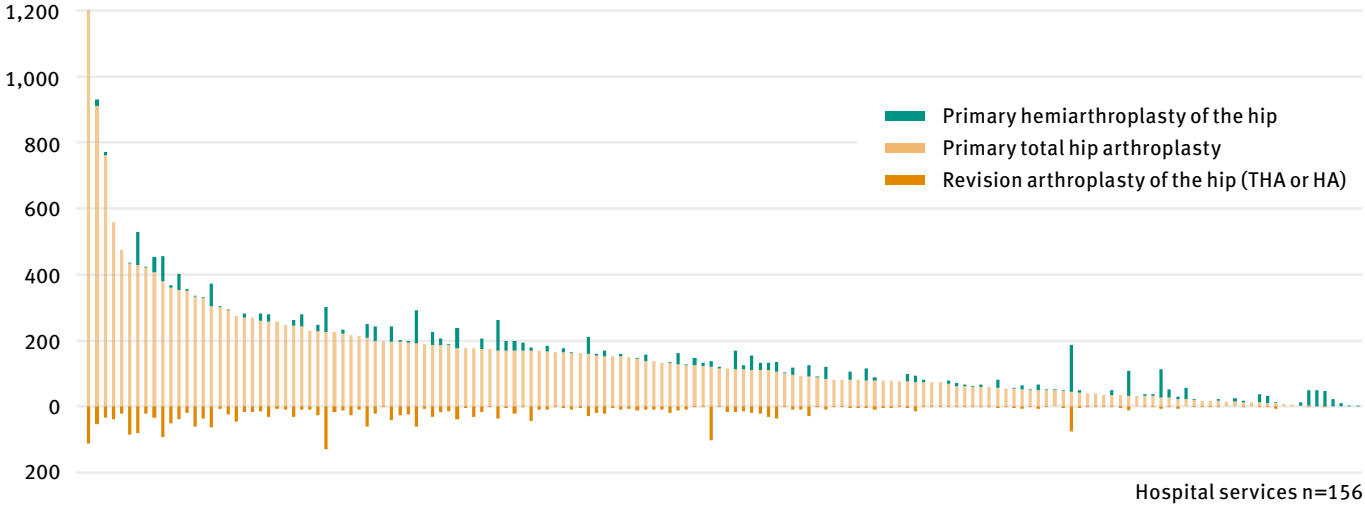
in percentages, 2015–2022, all services, all diagnoses, follow-up extended to 31 May 2023.



Failure rate	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
2015/2016	**2.1** (1.9-2.3)	**2.6** (2.5-2.8)	**3.0** (2.8-3.2)	**3.3** (3.1-3.5)	**3.6** (3.3-3.8)	**3.8** (3.6-4.0)	**4.1** (3.9-4.3)	**4.3** (4.1-4.6)
2017/2018	**2.1** (2.0-2.3)	**2.6** (2.4-2.8)	**2.9** (2.7-3.0)	**3.1** (2.9-3.3)	**3.4** (3.2-3.6)	**3.6** (3.3-3.8)		
2019/2020	**2.1** (1.9-2.2)	**2.5** (2.3-2.6)	**2.8** (2.6-3.0)	**3.0** (2.8-3.2)				
2021/2022	**1.9** (1.8-2.1)	**2.3** (2.2-2.5)						

Figure 3.1g

Cases per hospital sevice 2022: Total hip arthroplasty (THA) and hemiarthroplasty of the hip (HA)



To determine the long-term outcomes, the KM survival estimations and cumulative revision rates were calculated and the analysis included the detection of implants (minimal n ≥ 50 cases at risk) with elevated revision rates or outlier implants at any time between 5 and 10 years. An elevated revision rate was defined as a deviation of at least 50% above the group average at any time between year 5 and year 10 and lower bounds of the 95% confidence interval exceeding the upper bound of the group average. The outlier status was defined as a revision rate of twice the group average at any time between year 5 and year 9.

The KM survival estimations revealed four implant combinations with an elevated revision rate **(Figure 3.5a),** of which three were the same as in the 2022 report, one additional implant combination reaching the threshold in 2023, while one reached formal outlier status **(Figure 3.5b).** Of these five implant combinations, two were already identifiable as outliers at 2 years **(Table 3.5h).** The five implant combinations highlighted were implanted in 9.4% of cases (5,316 of 56,350 cases).

The 2-year revision rate is an important time point to gather initial results about the early performance of an implant, hospital, or surgeon as most complications occur within the first three months after implantation **(Figure 3.4a,b)** while loosening is not yet a problem **(Figure 3.4b).** Two years is also a standard period for early outlier detection, whereby 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 (primary THA for primary OA 2.5%). Nine uncemented stem/cup combinations have been identified as potential outliers at 2 years **(Figure 3.5j)** and they are further analysed and presented in the outlier watchlist at the end of this report.

Table 3.1c

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

		2017	2018	2019	2020	2021	2022
Primary total hip arthroplasty	N services	153	154	152	153	149	150
	M per service	87	86	87	94	117	122
Primary hemiarthroplasty of the hip	N services	136	125	126	125	105	110
	M per service	9	10	10	10	16	17
Revision arthroplasty (THA or HA)	N services	131	127	137	134	140	142
	M per service	9	9	10	12	12	11

Table 3.1d

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

Service volume		2017	2018	2019	2020	2021	2022
‹100	N procedures/%	3,190/**17.2**	3,040/**15.7**	2,236/**12.1**	2,829/**14.0**	2,355/**10.9**	2,431/**10.4**
	N services	79	74	64	73	61	56
100–199	N procedures/%	5,695/**30.6**	5,742/**29.7**	6,669/**33.3**	5,551/**27.5**	6,097/**27.9**	6,675/**28.6**
	N services	44	44	51	43	46	50
200–299	N procedures/%	4,499/**24.2**	4,242/**21.9**	4,424/**22.1**	4,995/**24.8**	5,185/**23.8**	5,751/**24.6**
	N services	19	19	20	22	24	26
›300	N procedures/%	5,213/**28.0**	6,303/**32.6**	6,522/**32.5**	6,800/**33.7**	8,178/**37.4**	8,509/**36.4**
	N services	11	15	15	15	18	18

Reporting of prostheses-related revision rates by hospitals

More than 150 hospital services in Switzerland provide hip arthroplasty procedures and SIRIS has achieved 100% participation of the institutions since 2018. There is a trend of fewer services, decreasing from 157 in 2016 to 150 in 2022 **(Table 3.1c)** and the number of services performing less than 100 primary THAs per year decreased from 85 to 56. At the same time, services with volumes from 100 to 199 and ›200 are increasing in numbers and cases, whereby there is a case concentration in the large centres **(Table 3.1d).** Overall, 36.4% of all procedures are performed in the 18 high-volume centres (› 300 cases/year), accounting for 12% of the services. A graphical overview of the distribution of THA, HA, and revision surgeries is shown in **Figure 3.1g,** whereby it is interesting to note that 10 services are performing HAs only.

Figures **3.1h and 3.1i** show funnel plots of risk-adjusted 2-year revision rates for THA and HA by hospital services with the results being restricted to patients with primary OA and risk-adjusted for age, sex, BMI, ASA, and Charnley scores, if available. On the funnel plots, each dot represents a hospital service centred on the national average. The

Figure 3.1h

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

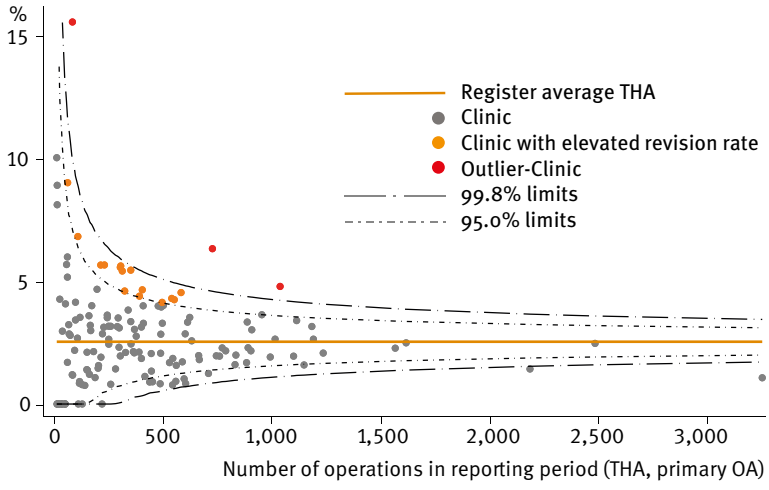
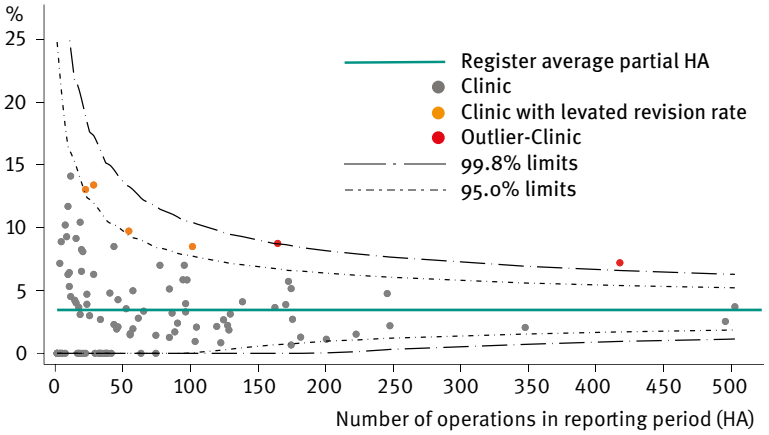


Figure 3.1i

2-year revision rate of primary hemiarthroplasty by service*



Interpretation of funnel plots

The yellow/green 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).

*Number of operations in the reporting period 01/2017–12/2020 (4-year moving average, follow-up to 12/2022). THA results restricted to patients with primary osteoarthritis (prim OA). Results are risk-adjusted for age, sex and BMI, ASA, Charnley Score if available.

vertical axis indicates the outcome, with dots higher up the axis showing services with higher revision rates, while the horizontal axis displays surgical activity with dots further to the right indicating the surgical units that performed more operations within the reported period.

Furthermore, the funnel plots include control limits to define the range within which the outcomes are expected to be and, following the convention, 99.8% control limits were used as the outer limit. In this context, it is worth noting that it is unlikely for a hospital to fall beyond these limits solely because of random variation (a 1 in 500 chance) and thus the main cause of variation within the control limits is likely to be random variation. As the plots show, although the spread of outcomes in Switzerland was relatively homogeneous, there were some exceptions. For THA, there were three services, i.e. one less than in 2021, that were detected as outliers and 14 institutions with an elevated revision risk. For HA, there was one outlier and four services with an elevated revision risk.

3.2 Primary total hip arthroplasty

Since 2017, SIRIS documented 124,186 primary THAs **(Table 3.2a).** The registry discriminates between THAs performed for primary OA (82.6%) – the largest group – and implantations for treating secondary OA, including post-traumatic hip joint degeneration, inflammatory diseases, avascular necrosis, and sequels of childhood diseases such as dysplasia and Perthes' disease (9.0%). The third group includes THAs for fractures of the hip (8.4%). For primary OA, the male/female ratio has remained stable over the years, whereby there was a slight increase in age at implantation of almost 1 year, particularly in men. Hip implantations were slightly more frequent in women (53.2%) and their mean age of 70.7 years was higher than that of men (67.2 years).

Table 3.2a
Primary total hip arthroplasty: Baseline patient characteristics by year

		2017	2018	2019	2020	2021	2022	2017–2022
N		**18,890**	**19,500**	**20,119**	**20,340**	**21,971**	**23,366**	**124,186**
Diagnosis [%]*	Primary OA	84.6	84.3	83.5	82.1	81.0	80.7	82.6
	Secondary OA	8.6	8.5	8.5	9.1	9.4	9.6	9.0
	Fracture	6.8	7.1	7.9	8.8	9.6	9.7	8.4
Women [%]		53.1	53.4	53.0	52.3	53.8	53.3	53.2
Mean age (SD)	All	68.5 (11.5)	68.9 (11.5)	69.1 (11.5)	69.0 (11.6)	69.2 (11.7)	69.5 (11.5)	69.0 (11.6)
	Women	70.3 (11.2)	70.6 (11.2)	70.8 (11.1)	70.6 (11.4)	70.8 (11.5)	71.0 (11.2)	70.7 (11.3)
	Men	66.5 (11.5)	66.9 (11.5)	67.1 (11.6)	67.1 (11.6)	67.4 (11.7)	67.7 (11.6)	67.2 (11.6)
Age group [%]	<45	2.6	2.3	2.5	2.5	2.7	2.4	2.5
	45–54	9.5	9.3	8.6	8.9	8.6	7.8	8.7
	55–64	21.7	21.5	21.6	21.9	21.3	22.0	21.7
	65–74	33.6	32.8	32.3	31.5	30.9	30.6	31.9
	75–84	26.2	27.2	27.8	27.9	28.7	29.5	27.9
	85+	6.3	6.9	7.3	7.3	7.8	7.7	7.2
N unknown BMI (%)		3,301 (17)	3,048 (16)	2,925 (15)	2,516 (12)	1,965 (9)	1,326 (6)	15,081 (12)
N known BMI		15,589	16,452	17,194	17,824	20,006	22,040	109,105
Mean BMI (SD)		27.1 (5.0)	27.2 (5.2)	27.0 (5.0)	26.9 (5.1)	26.9 (5.2)	26.9 (5.2)	27.0 (5.1)
BMI [%]	<18.5	1.8	2.1	2.1	2.3	2.2	2.2	2.1
	18.5–24.9	35.4	34.9	35.6	36.5	36.2	36.6	35.9
	25–29.9	38.8	38.1	39.1	38.1	37.5	36.8	38.0
	30–34.9	17.0	17.5	16.6	16.6	17.3	17.5	17.1
	35–39.9	5.2	5.4	5.1	4.8	5.0	5.2	5.1
	40+	1.7	2.0	1.5	1.7	1.8	1.7	1.7
N unknown ASA (%)		1,920 (10)	1,704 (9)	1,497 (7)	1,238 (6)	735 (3)	380 (2)	7,474 (6)
N known ASA		16,970	17,796	18,622	19,102	21,236	22,986	116,712
Morbidity	ASA 1	13.3	12.1	12.1	11.7	11.2	9.9	11.6
state [%]	ASA 2	60.0	59.5	59.1	59.0	57.9	58.9	59.0
	ASA 3	26.0	27.6	27.9	28.3	29.7	29.9	28.4
	ASA 4/5	0.6	0.9	0.9	1.0	1.2	1.3	1.0

*A diagnostic category could not be determined in 408 cases (0.33%). Percentages shown are of n=123,778 THAs with valid diagnostic group.

Overall, 67.1% of THAs were performed in patients older than 65 years of age and 7.2% of implants were in patients aged over 85 years, while patients under 55 constituted 11.2% of the recipients. The distribution among the age groups has shown minimal changes in the last 6 years and a slight decrease in patient groups aged between 45 and 54 and 65 and 74 years was compensated by an increase in the number of patients in older age groups **(Table 3.2a).**

Data on the BMI and the ASA scores were recorded since 2015. Data collection is still improving as the rate of unsubmitted data is continuing to decrease. The mean BMI was 27.0 kg/m2 for all patients, whereby 38.0% of THAs were performed in overweight patients (BMI 25–29.9) and 24.0% in obese patients (BMI >30) **(Table 3.2a).** Younger patients were observed to have higher BMIs and this observation applies to both male and female patients **(Figure 3.2a).** Moreover, the distribution of BMIs remained constant during the observation period.

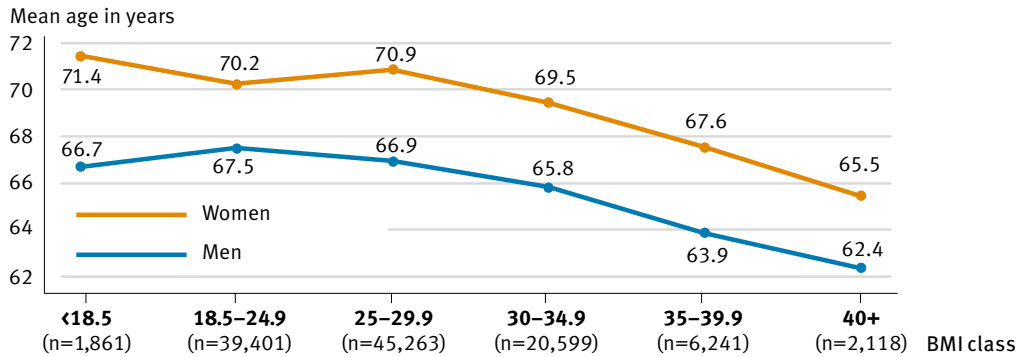
Most procedures were performed on healthy individuals, and 29.4% of the implantations were performed in ASA class ≥ 3 while the tendency toward a decrease in ASA 1 classified patients continued. Concurrently, the number of patients with ASA < 3 increased.

Patients treated for secondary OA were on average 5.4 years younger than those treated for primary OA. The prevalence of hip dysplasia among all secondary OA patients increased from 20.5% in 2015 to 25.3% in 2022, while 56.9% of the hips with secondary OA were treated for avascular necrosis. Compared to the other main diagnostic groups, there were more young patients treated for secondary OA (11.0% were younger than 45 years of age) **(Table 3.2b).**

Figure 3.2a

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

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



Considerably more women were affected by fractures than men, as women accounted for close to two-thirds (63.9%) of all patients sustaining hip fractures and the average age of women with fractures was 75.8 years compared to men at 72.8 years. More than 80% of fractures occur in patients over 65 and more than 55% in patients over 75 years. There was also a much higher proportion of patients in the fracture group belonging to ASA class ≥ 3. In Chapter 3.6ff., we provide a detailed analysis of patients with hip fractures, comparing treatment with THA to treatment with HA.

Table 3.2b

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

		Primary OA	Secondary OA	Fracture
N (2017–2022)*		**102,248**	**11,129**	**10,401**
Women [%]		51.6	57.4	63.9
Mean age (SD)	All	69.1 (10.9)	63.7 (15.3)	74.7 (10.9)
	Women	70.7 (10.5)	65.5 (15.2)	75.8 (10.4)
	Men	67.3 (11.0)	61.4 (15.1)	72.8 (11.6)
Age group [%]	<45	1.8	11.0	0.7
	45–54	8.4	16.8	3.7
	55–64	22.4	22.0	13.8
	65–74	33.5	21.8	26.6
	75–84	27.9	20.9	36.2
	85+	6.0	7.4	19.0
Diagnosis [%]	Osteoarthritis	100.0	0.0	0.0
	Inflammatory arthritis	0.0	4.5	0.0
	Developmental dysplasia	0.0	25.3	0.0
	Osteonecrosis	0.0	56.9	0.0
	Miscellaneous	0.0	13.4	2.2
	Fracture	0.0	0.0	97.8
N unknown BMI (%)		12,127 (12)	1,065 (10)	1,848 (18)
N known BMI		90,121	10,064	8,553
Mean BMI (SD)		27.3 (5.0)	26.7 (5.4)	24.2 (4.4)
BMI [%]	<18.5	1.5	2.8	7.3
	18.5–24.9	33.8	39	54.9
	25–29.9	39.2	35.1	28.7
	30–34.9	18.2	16.0	7.1
	35–39.9	5.5	4.9	1.4
	40+	1.8	2.1	0.5
N unknown ASA		6,320 (6)	528 (5)	601 (6)
N known ASA		95,928	10,601	9,800
Morbidity state	ASA 1	11.9	13.3	6.7
[%]	ASA 2	61.3	52.9	43.2
	ASA 3	26.1	32.3	45.8
	ASA 4/5	0.6	1.5	4.2

* Number of cases with clear diagnostic information (in 0.33% of cases we cannot determine the diagnosis).

Between 2017 and 2022, a total of 124,186 THAs were implanted in 150 orthopaedic units in Switzerland, whereby 15,540 hips (12.5%) were implanted in units performing fewer than 100 procedures per year. In 2022, 34.5% of the primary THAs (42,953) were implanted in 18 services that see more than 300 cases per year. In these large units, more complex procedures (secondary OA) were performed, and the patients were slightly younger on average **(Table 3.2c).**

Resurfacing the hip has largely been abandoned in Switzerland, only 24 cases were treated this way in the past 5 years **(Table 3.2d).** Table 3.2d compares previous surgeries, approaches, and fixation tech-

Table 3.2c

Primary total hip arthroplasty: Baseline patient characteristics by hospital service volume

Calculations of hospital service volume based on primary hip surgeries in each included year (2017–2022).

Hospital service volume		<100	100–199	200–299	300+
N (2017–2022)		**15,540**	**36,984**	**28,709**	**42,953**
Women [%]		52.8	53.5	52.3	53.7
Mean age (SD)	All	70.1 (11.1)	69.6 (11.3)	69.2 (11.3)	68.1 (12.0)
	Women	71.7 (10.9)	71.3 (10.9)	70.8 (11.1)	69.8 (11.8)
	Men	68.3 (11.1)	67.6 (11.5)	67.4 (11.3)	66.2 (12.0)
Age group [%]	<45	1.6	2.1	2.1	3.4
	45–54	8.0	8.1	8.7	9.6
	55–64	20.1	21.0	21.8	22.7
	65–74	32.1	32.3	32.3	31.2
	75–84	29.6	28.9	27.8	26.6
	85+	8.5	7.7	7.2	6.5
Diagnosis [%]	Primary OA	81.5	81.9	85.1	82.0
	Secondary OA	7.7	7.7	7.2	11.7
	Fracture	10.8	10.4	7.7	6.3
N unknown BMI (%)		2,723 (18)	4,983 (13)	3,658 (13)	3,717 (9)
N known BMI		12,817	32,001	25,051	39,236
Mean BMI (SD)		27.0 (5.0)	27.1 (5.1)	27.1 (5.2)	26.8 (5.0)
BMI [%]	<18.5	2.1	2.1	2.1	2.1
	18.5–24.9	36.1	34.9	35.3	37.0
	25–29.9	38.0	38.0	37.7	38.1
	30–34.9	17.5	17.5	17.4	16.5
	35–39.9	4.7	5.6	5.5	4.7
	40+	1.6	1.8	1.9	1.6
N unknown ASA (%)		522 (3)	2,306 (6)	1,905 (7)	2,741 (6)
N known ASA		15,018	34,678	26,804	40,212
Morbidity state [%]	ASA 1	12.3	11.3	11.4	11.8
	ASA 2	59.1	59.0	60.0	58.4
	ASA 3	27.4	28.6	27.7	29.0
	ASA 4/5	1.2	1.1	0.9	0.8

Table 3.2d

Primary total hip arthroplasty: Surgery characteristics by main diagnostic group

Main diagnostic group		Primary OA		Secondary OA		Fracture	
N (2017–2022)		N	%	N	%	N	%
Previous surgery	None	98,879	96.7	9,420	84.6	9,324	89.6
	Internal fixation femur			641	5.8	802	7.7
	Osteotomy femur			434	3.9	40	0.4
	Internal fixation acetabulum			74	0.7	87	0.8
	Osteotomy pelvis			258	2.3	7	0.1
	Arthrodesis			4	0.0	4	0.0
	Other previous surgery	3,369	3.3	385	3.5	172	1.7
Intervention	Total hip replacement (as entered on SIRIS form)	101,999	99.8	11,076	99.5	10,311	99.1
	Full hip resurfacing	24	0.0	2	0.0	0	0.0
	Other (other cat. and free text entr. recog. as THA)***	225	0.2	51	0.5	90	0.9
Approach	Anterior	53,492	52.3	5,057	45.4	5,668	54.5
	Anterolateral	30,882	30.2	3,687	33.1	2,626	25.2
	Posterior	13,291	13.0	1,507	13.5	1,269	12.2
	Lateral	4,087	4.0	651	5.8	631	6.1
	Other approach	496	0.5	227	2.0	207	2.0
Fixation	All uncemented	89,293	87.3	9,007	80.9	5,225	50.2
	Hybrid*	11,125	10.9	1,409	12.7	4,147	39.9
	All cemented	1,138	1.1	385	3.5	665	6.4
	Reverse hybrid**	463	0.5	176	1.6	203	2.0
	Reinforcement ring, femur uncemented	84	0.1	54	0.5	47	0.5
	Reinforcement ring, femur cemented	145	0.1	98	0.9	114	1.1

Main diagnostic group		Primary OA		Secondary OA		Fracture	
N (2021–2022)		N	%	N	%	N	%
Technology	Conventional	24,278	67.4	2,765	65.8	2,549	59.1
	Computer assisted cup			65	1.6	28	0.7
	Computer assisted stem			72	1.7	14	0.3
	Robotic assisted (image guided, CT based)			22	0.5	4	0.1
	Patient specific cutting blocks			15	0.4	2	0.1
	Intraoperative fluoroscopy/radiography			1,360	32.4	1,743	40.4
Add. intervention	None	35,302	96.3	3,763	87.4	3,792	86.6
	Acetabular roof reconstruction	420	1.2	130	3.0	50	1.1
	Central osseous reconstruction	315	0.9	104	2.4	79	1.8
	Proximal femur osteotomy	5	0.0	10	0.2	9	0.2
	ORIF/CRIF acetabulum	19	0.1	12	0.3	69	1.6
	Cerclage femur	243	0.7	102	2.4	229	5.3
	ORIF/CRIF femur	26	0.1	14	0.3	59	1.4
	Augments	5	0.0	8	0.2	3	0.1
	Other	389	1.1	244	5.7	201	4.6
	Total THA (multiple responses)	**36,004**		**4,201**		**4,314**	

* 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 dual mobility cup) . Such cases are routinely counted as THAs, but still retained in the „other“ category chosen by the user.

niques between the main diagnostic groups. The findings show that, with minimal variations, the fixation methods for all three diagnostic groups have remained stable over the last 5 years **(Figure 3.2b),** whereby relatively more acetabular reinforcement rings were used in the secondary OA group, reflecting more complex surgeries. Moreover, for the treatment of hip fractures, significantly more stems were cemented, and more hybrid fixations were used.

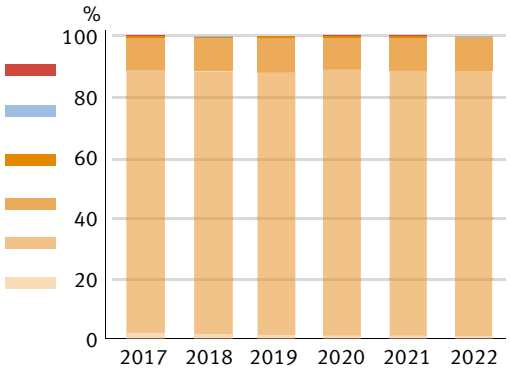
For primary OA, the anterior approach was by far the most commonly used, followed by the anterolateral approach. Since approaches first started to be recorded in 2015, the use of the anterior approach has gradually increased, reaching 56.9% in 2022, while the use of anterolateral, lateral, and posterior approaches has been declining **(Table 3.2e).** The approach chosen depends on the experience and training of the surgeon and the distri-

Figure 3.2b

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

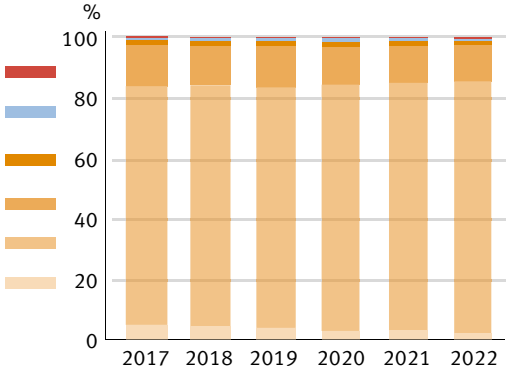
Primary osteoarthritis

2017	2018	2019	2020	2021	2022	
0.1	0.1	0.1	0.1	0.1	0.1	Reinforcement ring femur uncemented
0.1	0.1	0.1	0.2	0.2	0.1	Reinforcement ring femur cemented
0.6	0.5	0.4	0.4	0.5	0.3	Reverse hybrid
10.6	10.9	11.3	10.5	10.8	11.1	Hybrid
87.0	86.8	86.8	88.0	87.6	87.7	All uncemented
1.7	1.5	1.2	0.9	0.9	0.7	All cemented
15,851	**16,352**	**16,745**	**16,647**	**17,793**	**18,860**	N



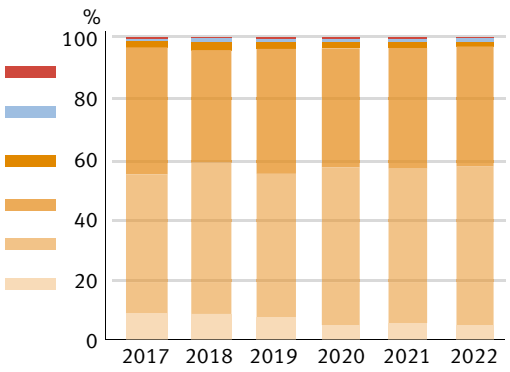
Secondary osteoarthritis

2017	2018	2019	2020	2021	2022	
0.4	0.6	0.3	0.4	0.5	0.6	Reinforcement ring femur uncemented
0.9	0.7	1.0	1.2	0.8	0.8	Reinforcement ring femur cemented
1.4	1.9	1.6	1.7	1.7	1.3	Reverse hybrid
13.6	12.8	13.7	12.4	12.1	11.9	Hybrid
78.9	79.6	79.5	81.4	81.9	83.2	All uncemented
4.9	4.5	3.9	2.9	3.0	2.2	All cemented
1,616	**1,650**	**1,714**	**1,846**	**2,060**	**2,243**	N



Fracture

2017	2018	2019	2020	2021	2022	
0.6	0.4	0.4	0.4	0.4	0.4	Reinforcement ring femur uncemented
0.7	1.2	1.3	1.2	1.1	1.0	Reinforcement ring femur cemented
2.0	2.7	2.1	1.9	1.9	1.5	Reverse hybrid
42.0	37.0	41.3	39.4	39.9	39.7	Hybrid
45.9	50.2	47.5	52.1	51.0	52.4	All uncemented
8.8	8.6	7.4	4.9	5.6	4.9	All cemented
1,266	**1,385**	**1,588**	**1,783**	**2,116**	**2,263**	N



bution of the approaches shows a major regional variability. To illustrate this phenomenon, the distribution by Canton is shown in **Figure 3.2c.**

The bearing is one of the most important factors for wear and implant survival. Improvement of bearing materials has led to a decrease in osteolysis and loosening. Currently, the most frequently used bearing in Switzerland is ceramic on highly crosslinked polyethylene (CoXLPE) and the use of CoXLPE continues to increase. In 2022, this combination was chosen in 57.8% of all primary hip implants for primary OA **(Table 3.2f).** Additionally, the combination of ceramic head and standard polyethylene (CoPE) has increased over the years and was used in 20.4% of implantations in 2022, whereas the combinations of metal on polyethylene (MoPE) and MoXLPE steadily decreased between 2017 and 2022. Although the use of ceramic on ceramic (CoC) bearings has remained relatively stable for several years, it decreased significantly in 2022 **(Table 3.2f).**

The share of unassignable bearing surfaces remains at 2% in 2022. The selection of the bearing surface depends, amongst other criteria, on the activity level and age of the patient and bearings with favourable wear characteristics, e.g. CoXLPE and CoC, were most frequently used in younger patients, whereas standard PE bearings combined with a metal or ceramic head were more commonly used in older patients **(Table 3.2g).**

In this registry, all uncemented fixations are standard for primary THAs in primary OA and account for 87.3% of all hips with primary OA. SIRIS shows that more than 90% of patients under the age of 75 received entirely cementless prostheses and, as age increases, increasing numbers of THAs were cemented stems, whereby approximately 40% of the stems in patients older than 85 years of age were cemented. Female patients received significantly more cemented stems than male patients **(Tables 3.2h,i).**

Table 3.2e

Surgical approach in total hip arthroplasty for primary osteoarthritis by year (in %)

	2017	2018	2019	2020	2021	2022	2017–2022
Anterior	48.0	49.1	50.3	52.8	55.7	56.9	52.3
Anterolateral	31.9	32.0	31.5	30.7	27.8	27.9	30.2
Lateral	5.8	4.9	4.6	3.7	2.9	2.5	4.0
Posterior	13.6	13.3	12.8	12.4	13.3	12.6	13.0
Other approach	0.6	0.6	0.7	0.5	0.3	0.2	0.5
Total [N]	**15,851**	**16,352**	**16,745**	**16,647**	**17,793**	**18,860**	**102,248**

Figure 3.2c

Relative share of total hip arthroplasty procedures using different surgical approaches by Swiss Canton and Principality of Liechtenstein (2017–2022)

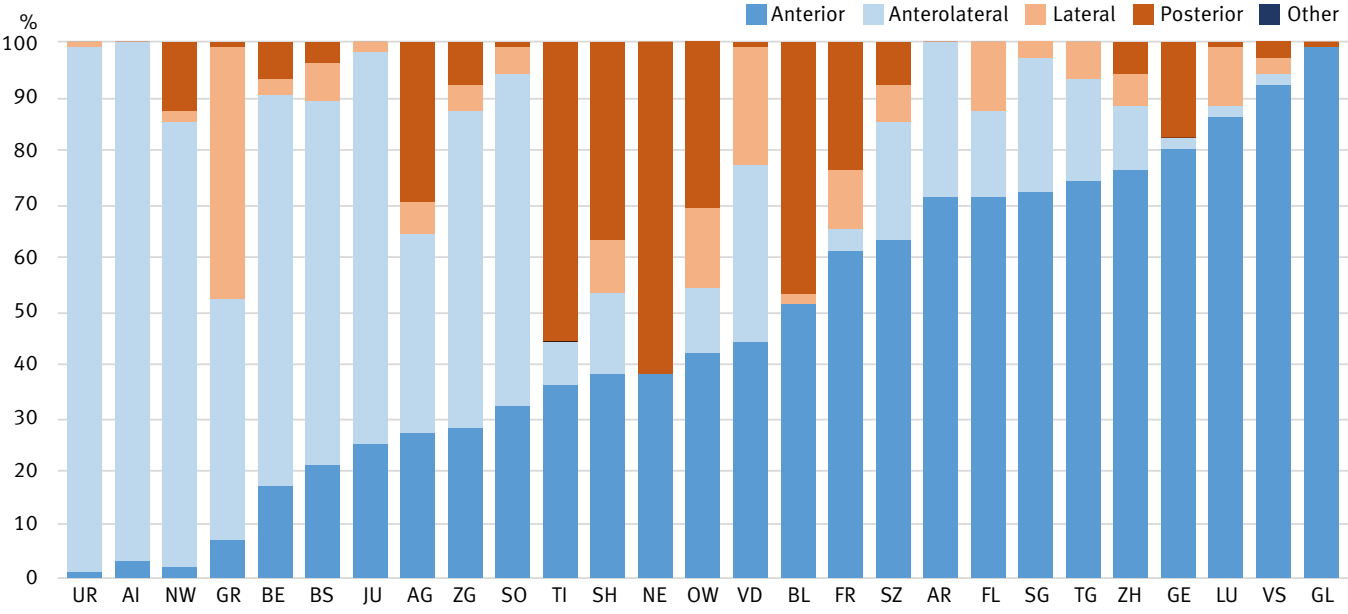


Table 3.2f

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

Year	2017	2018	2019	2020	2021	2022	2017–2022
Metal on polyethylene (PE) (MoPE)	2.3	2.2	2.2	1.8	2.5	1.8	2.1
Ceramic on PE (CoPE)	13.8	14.9	15.7	17.1	19.6	20.4	17.0
Metal on cross-linked PE (MoXLPE)	11.5	11.6	10.8	9.3	8.2	7.2	9.7
Ceramic on cross-linked PE (CoXLPE)	57.4	56.7	56.3	56.9	55.6	57.8	56.8
Metal on metal (MoM)	0.05	0.00	0.00	0.00	0.00	0.00	0.01
Ceramic on ceramic (CoC)	14.9	14.6	15.0	14.9	14.1	12.8	14.3
Other	0.01	0.01	0.00	0.00	0.00	0.02	0.01
N (bearing surface known)	15,545	16,083	16,367	16,366	17,482	18,385	100,228
N (bearing surface unknown)	306	269	378	281	311	475	2,020

* Femoral heads and acetabular inserts/monobloc cups

Table 3.2g

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

Age	<45	45–54	55–64	65–74	75–84	85+	All
Metal on polyethylene (PE) (MoPE)	0.1	0.5	0.6	1.2	3.7	9.1	2.1
Ceramic on PE (CoPE)	13.2	14.5	14.7	16.7	19.3	22.1	17.0
Metal on cross-linked PE (MoXLPE)	7.3	6.7	7.4	9.3	11.7	16.0	9.7
Ceramic on cross-linked PE (CoXLPE)	55.0	56.7	59.2	58.6	55.3	45.4	56.8
Metal on metal (MoM)	0.00	0.01	0.01	0.01	0.00	0.00	0.01
Ceramic on ceramic (CoC)	24.4	21.6	18.1	14.3	10.1	7.4	14.3
Other	0.00	0.00	0.01	0.00	0.01	0.00	0.01
N (bearing surface known)	1,755	8,432	22,527	33,603	27,911	5,995	100,223
N (bearing surface unknown)**	46	134	402	657	606	174	2,019

* Femoral heads and acetabular inserts/monobloc cups
** Please note that age is missing in 6 cases

Table 3.2h

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

Age	<45	45–54	55–64	65–74	75–84	85+	All
All cemented	0.3	0.3	0.3	0.6	1.8	5.0	1.1
All uncemented	96.9	97.2	96.2	91.2	78.4	58.0	87.3
Hybrid**	1.8	2.0	3.0	7.7	19.1	35.1	10.9
Reverse hybrid***	1.0	0.3	0.3	0.3	0.5	1.3	0.5
Reinforcement ring, femur cemented	0.00	0.11	0.10	0.09	0.19	0.45	0.14
Reinforcement ring, femur uncemented	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N	1,801	8,566	22,929	34,260	28,517	6,169	102,242

* Please note that age is missing in 6 cases

Table 3.2i

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

Gender	Women	Men	All
All cemented	1.5	0.7	1.1
All uncemented	82.5	92.5	87.3
Hybrid*	15.0	6.5	10.9
Reverse hybrid**	0.6	0.3	0.5
Reinforcement ring, femur cemented	0.20	0.08	0.14
Reinforcement ring, femur uncemented	0.1	0.1	0.1
N	52,777	49,471	102,248

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

3.3 Revision of total hip arthroplasty

While SIRIS has recorded all primary and revision hip procedures since 2012, some of the revisions recorded 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" and these form the basis for calculations of survival and first revision rates (see Chapter 3.4).

Table 3.3a shows the demographic data for all revisions performed since 2017, whether linked or unlinked, whereby the revisions since 2017 constituted 11.1% of all hip procedures (the overall revision burden) performed. Of the 15,476 THA revisions documented since 2017, 50.6% were performed on women **(Table 3.3a)** with the mean age at revision being 73.7 years. On average, men were 3 years younger than women when revised. The mean age increased in the last 2 years and, in both men and women, the mean age was higher than the average of the last 6 years. The age group <45 years account-

Table 3.3a

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

		2017	2018	2019	2020	2021	2022	2017–2022
N		**2,515**	**2,514**	**2,597**	**2,657**	**2,599**	**2,594**	**15,476**
Women [%]		49.6	51.1	51.5	48.7	52.5	50.1	50.6
Mean age (SD)	All	71.4 (11.9)	71.8 (11.9)	72.2 (11.5)	71.9 (12.2)	72.9 (12.0)	73.3 (12.0)	72.3 (11.9)
	Women	72.9 (12.0)	72.9 (12.1)	73.6 (11.3)	73.8 (11.9)	74.2 (11.9)	74.5 (11.6)	73.7 (11.8)
	Men	70.0 (11.7)	70.7 (11.5)	70.7 (11.5)	70.1 (12.2)	71.6 (11.9)	72.1 (12.2)	70.9 (11.9)
Age group [%]	<45	2.2	1.9	1.3	2.1	1.8	1.9	1.9
	45–55	7.8	7.7	6.3	7.0	6.2	5.5	6.7
	55–65	15.5	15.8	17.8	16.3	15.2	14.8	15.9
	65–75	30.3	29.3	28.2	26.8	25.5	24.9	27.5
	75–85	31.4	31.9	32.3	33.8	34.7	35.1	33.2
	85+	12.8	13.4	14.2	14.0	16.5	17.8	14.8
N unknown BMI (%)		496 (20)	486 (19)	491 (19)	438 (16)	293 (11)	230 (9)	2,434 (16)
N known BMI		2,019	2,028	2,106	2,219	2,306	2,364	13,042
Mean BMI (SD)		27.2 (5.5)	27.3 (5.6)	27.3 (5.6)	27.4 (5.8)	27.3 (5.7)	27.2 (5.9)	27.3 (5.7)
BMI [%]	<18.5	2.4	2.6	2.1	2.3	2.0	2.7	2.4
	18.5–24.9	36.2	34.5	36.9	33.8	36.7	36.3	35.7
	25–29.9	35.9	36.4	35.1	37.4	33.5	35.3	35.6
	30–34.9	17.6	17.8	16.6	16.7	18.3	16.4	17.2
	35–39.9	5.1	5.8	6.2	7.3	6.7	6.7	6.3
	40+	2.8	2.9	3.1	2.5	2.7	2.7	2.8
N unknown ASA (%)		339 (13)	261 (10)	247 (10)	226 (9)	112 (4)	85 (3)	1,270 (8)
N known ASA		2,176	2,253	2,350	2,431	2,487	2,509	14,206
Morbidity state	ASA 1	6.5	6.2	4.3	4.2	4.2	2.9	4.6
[%]	ASA 2	46.7	45.0	43.8	43.9	39.4	40.0	43.0
	ASA 3	44.5	46.0	48.2	48.3	52.1	52.5	48.7
	ASA 4/5	2.3	2.8	3.7	3.7	4.3	4.7	3.6

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

ed for 1.9%, and the age group between 45 and 54 accounted for 6.7% of revisions. In this context, it is worth highlighting that the revision rate of these age groups is continuously declining, and reached 5.5% in 2022. 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 3.3b).** Revision of both components was carried out in 18.4% of cases **(Table 3.3c).** Furthermore, uncemented revision was preferred and ac-

Table 3.3b

Reason for revision* of primary total hip arthroplasty

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

	N	%
Loosening femoral	3,270	21.1
Infection	3,397	22.0
Loosening acetabular	2,495	16.1
Periprosthetic fracture	2,886	18.6
Dislocation	1,963	12.7
Wear	1,206	7.8
Metallosis	768	5.0
Acetabular osteolysis	701	4.5
Position/Orientation of cup	824	5.3
Femoral osteolysis	634	4.1
Trochanter pathology	186	1.2
Status after spacer	341	2.2
Implant breakage	359	2.3
Blood ion level	216	1.4
Position/Orientation of stem	439	2.8
Impingement	158	1.0
Acetabular protrusion	144	0.9
Squeaking	91	0.6
Other	1,631	10.5
Total 2017–2022	**21,709**	

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

Table 3.3c

Distribution of selected subtypes of reasons for revision

2021/2022; new version of SIRIS proforma.

Periprosthetic fractures	N	%
Vancouver A	96	9.3
Vancouver B	793	76.9
Vancouver C	69	6.7
Acetabulum	245	23.8
Revisions	**1,031**	

Implant breakage	N	%
Femur	75	46.3
Acetabulum	78	48.1
Femoral head	26	16.0
Revisions	**162**	

Vancouver classification:

Type A Fracture in trochanteric area
Type B Fracture around stem or just below it
Type C Fracture occurring well below the tip of the stem

Table 3.3d

Type of revision* of total hip arthroplasty 2017 – 2022

	N	%
Exchange acetabular and femoral components	2,853	18.4
Exchange acetabular component and head	2,827	18.3
Exchange femoral component	2,436	15.7
Exchange head and inlay	1,627	10.5
Exchange acetabular component	825	5.3
Exchange femoral component and inlay	1,234	8.0
Component reimplantation (after spacer or Girdlestone)	874	5.6
Exchange head	782	5.1
Component removal, spacer implantation	556	3.6
Girdlestone	178	1.2
Exchange femoral component, inlay and osteosynthesis	242	1.6
Exchange inlay	164	1.1
Prosthesis preserving revision	145	0.9
Osteosynthesis	208	1.3
Other intervention	525	3.4
Total 2017–2022	**15,476**	**100.0**

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

counted for 61.5%, followed by fully cemented revision in 18.5% of cases **(Table 3.3d, Figure 3.3a).** In this context, the most frequently used approach was the posterior approach in 33.7% of cases **(Table 3.3e).**

Since 2021, acetabular and femoral periprosthetic fractures have been recorded separately, using the Vancouver classification for periprosthetic femoral fractures **(Table 3.3f).** Since then, a total of 1,031 periprosthetic fractures were recorded, of which 245 were acetabular fractures **(Table 3.3c). Table 3.3h,** all currently used implants for revision hip surgery are listed. Implant fractures are also recorded since 2021, whereby the data distinguishes between stem, acetabular implant, and femoral head fractures. A total of 162 implant fractures were recorded in the specified timeframe **(Table 3.3f).**

The implants used for revision are influenced by the age of the patient. The younger the patient, the more likely the revision was performed with an uncemented primary stem, and cemented primary stems were more frequently used in the elderly population **(Table 3.3g)** while uncemented primary stems were used in 21.2% of all revisions, mostly in younger patients. With increasing age, more uncemented revision stems were used. Overall, unce-

Table 3.3e

Approach of revision of total hip arthroplasty

2017 – 2022

	N	%
Posterior	5,211	33.7
Lateral	2,951	19.1
Anterolateral	2,441	15.8
Anterior	3,137	20.3
Transfemoral	1,033	6.7
Other approach	703	4.5

Table 3.3f

Revision of total hip arthroplasty: Component fixation by year

	2017	2018	2019	2020	2021	2022	2017–2022
All cemented	19.0	18.1	17.1	15.6	21.8	19.7	18.5
All uncemented	57.6	61.2	60.0	63.0	61.4	65.9	61.5
Hybrid**	9.0	7.5	9.0	8.4	4.2	4.3	7.1
Reverse hybrid*	8.4	7.0	6.8	7.0	4.5	3.6	6.2
Reinforcement ring	6.0	6.2	7.0	6.1	8.1	6.5	6.6
Total	**1,979**	**1,939**	**2,004**	**1,997**	**1,841**	**1,889**	**11,649**

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

Figure 3.3a

Revision of hip arthroplasty: Component fixation by year

Percentage per year

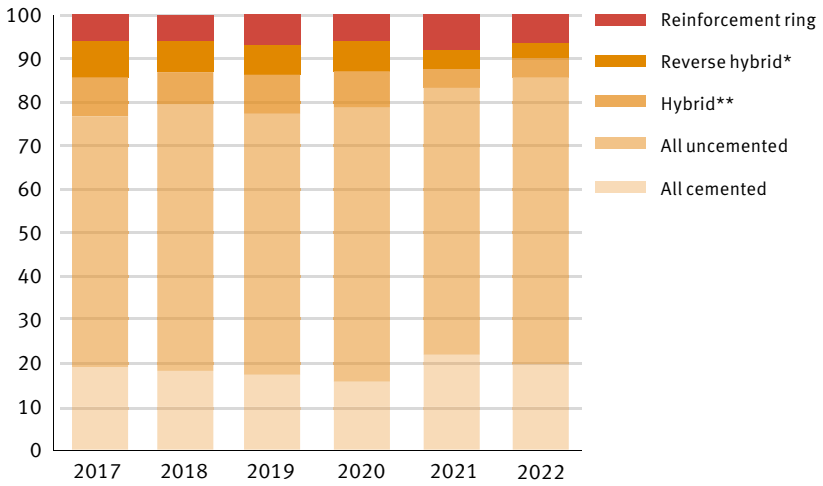


Table 3.3g

Hip revision: main components used by age at type of revision

All registered component revisions of four main types 2017–2022 with at least one FE/AC revision component with a known e-class.

	Category of implant	Age at revision						N
		<45	45-54	55-64	65-74	75-84	85+	
Type of revision of femoral components		%	%	%	%	%	%	
AC + FE revision	cem. primary stems	18.0	11.8	15.3	16.3	24.3	37.6	554
	uncem. primary stems	40.0	47.5	35.5	25.9	16.1	8.2	634
	short stems	16.0	3.9	6.1	4.9	4.3	3.5	128
	cem. revision stems	0.0	0.0	0.9	1.6	2.6	2.9	47
	uncem. revision stems	26.0	36.8	42.2	51.4	52.8	47.8	1,267
FE revision (with or without inlay)	cem. primary stems	24.1	15.3	19.6	21.4	23.7	31.6	841
	uncem. primary stems	48.3	44.8	33.3	22.4	12.8	2.8	665
	short stems	5.2	10.3	10.5	6.2	6.4	2.5	228
	cem. revision stems	0.0	1.0	1.1	0.8	2.4	3.0	64
	uncem. revision stems	22.4	28.6	35.4	49.1	54.7	60.1	1,762
Component reimplantation (after spacer)	cem. primary stems	10.5	7.5	13.2	13.9	21.2	24.2	133
	uncem. primary stems	26.3	31.3	31.1	21.9	18.3	11.3	189
	short stems	5.3	4.5	4.2	2.2	2.9	0.0	24
	cem. revision stems	5.3	0.0	0.6	0.7	1.2	0.0	7
	uncem. revision stems	52.6	56.7	50.9	61.3	56.4	64.5	477
Type of revison of acetabular components								
AC + FE revision	cem. primary cups	6.0	6.7	7.4	11.5	17.5	26.6	373
	uncem. primary cups	74.0	74.8	74.5	65.1	57.5	45.3	1,651
	revision cups	4.0	4.8	4.4	3.8	3.2	3.3	98
	AC roof ring or cage	16.0	13.8	13.7	19.6	21.9	24.9	513
AC revision (with or without head)	cem. primary cups	5.6	12.6	11.0	17.5	23.2	34.6	687
	uncem. primary cups	79.2	67.1	66.9	55.5	47.2	30.1	1,747
	revision cups	4.2	3.9	3.3	3.4	3.1	3.9	114
	AC roof ring or cage	11.1	16.4	18.8	23.6	26.6	31.4	819
Component reimplantation (after spacer)	cem. primary cups	4.8	8.8	11.9	11.4	17.6	15.3	110
	uncem. primary cups	61.9	66.2	66.1	64.3	56.6	49.2	511
	revision cups	4.8	0.0	2.4	1.8	3.3	0.0	18
	AC roof ring or cage	28.6	25.0	19.6	22.4	22.5	35.6	193

eclass 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. A small proportion of tumor systems such as MUTARS is excluded.

mented revision stems were used in almost 50% of all cases and short stems were found to increasingly be used in approximately 5% of cases, whereby, interestingly their use was not only in younger patients but also in those of older age groups.

In general, acetabular revisions were performed with uncemented primary cups (57.2%) although, surprisingly, revision cups are not frequently used (3.3%), whereas acetabular reinforcement rings or cages are used quite frequently (22.3%). **Table 3.3h** provides an overview of the implants used for revisions.

Table 3.3h

Hip revision, femoral components: Main brands used (30+)

All registered component revisions of four main types 2017-2021 with at least one FE/AC revision component with a known e-class.

Category of implants	Main brands	N
Cem. primary stems	SPII Lubinus	406
	Quadra-C	191
	Weber	189
	Centris	178
	Twinsys	171
	Corail (cem)	143
	Avenir	80
	MS-30	39
	Exeter V40	38
	Harmony	38
	Arcad SO	30
	Other stems	206
Uncem. primary stems	Corail collared	300
	Quadra-H	252
	Polarstem	186
	CLS Spotorno	161
	Corail	133
	Avenir	125
	Stellaris	93
	Twinsys	89
	Quadra-P	85
	Other stems	184
Short stems*	Amistem-C	158
	Optimys	132
	Fitmore	40
	Other stems	86
Cem. revision stems	ARCAD L XL	104
	Other stems	41
Uncem. revision stems	Revitan	813
	Corail collared	754
	Lima revision	394
	Wagner SL	369
	Mathys modular revision	316
	MRP-titan	264
	Quadra-R	186
	Redapt	125
	Alloclassic SLL	111
	Restoration modular	108
	Reclaim	101
	MP reconstruction	80
	Reef	72
	M-Vizion	53
	SLR-plus	33
	Other stems	43

eclass 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. A small proportion of tumor systems such as MUTARS is excluded.

* Please note that both Fitmore and Amistem are originally classified as a regular primary stems. We reclassified them as short stems.

Table 3.3i

Hip revision, acetabular components: Main brands used (30+)

All registered component revisions of four main types 2017-2021 with at least one FE/AC revision component with a known e-class.

Category of implants	Main brands	N
Cem. primary cups	DS evolution (cem)	278
	Polarcup	219
	Versacem	205
	Original Mueller	199
	Avantage	164
	Symbol DM cem	113
	Bi-Mentum	67
	2M	30
	Other cups	167
Uncem. primary cups	Pinnacle	439
	RM pressfit vitamys	369
	Allofit	346
	Symbol DMHA	333
	Polarcup	297
	Versafitcup DM	275
	TM	262
	Versafitcup trio/ccl.	187
	DS evolution	186
	Bi-Mentum	169
	Gyros	151
	Mpact	146
	Fitmore	133
	G7 hemispherical	133
	Avantage	115
	Mpact DM	111
	Delta ONE-TT	108
	R3	68
	Liberty	67
	Delta TT	62
	Trident II	49
	RM pressfit	36
	Ades DM	32
	Other cups	293
Revision cups	Pinnacle	104
	TMARS	46
	Delta revision TT	38
	MRS-titan	34
	Other cups	23
AC roof ring or cage	ZB reinforcement rings	1,026
	Burch-Schneider cage	350
	Original mueller rings	107
	Reinforcement cage	36
	Other cages	113

eclass 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.A small proportion of tumor systems such as MUTARS is excluded.

3.4 First revision of primary total hip arthroplasty

First revisions are those that 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 2 years after implantation and revisions in the longer term, currently up to 10 years after implantation. For long-term outcomes, KM survival estimations and cumulative revision rates were calculated.

The 2-year revision rate of an implant, hospital, or surgeon was calculated for primary THA for the treatment of primary OA. This is an international standard and useful to apply because hips with secondary OA often include hips with difficult anatomy, previous osteotomies, or unfavourable conditions leading to increased revision rates.

The revision rates were calculated for a moving 4-year window, which includes the last 4 years with a full 2-year follow-up. For this report, the data of implantations between 1.1.2017 and 31.12.2020

Table 3.4a

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall (moving average)		78,849	2,232	2.9	2.8	3.0
Diagnosis	Primary OA	65,595	1,648	2.5	2.4	2.7
	Secondary OA	6,826	260	3.9	3.4	4.4
	Fracture	6,022	302	5.3	4.7	5.9
Overall Primary OA		65,595	1,648	2.5	2.4	2.7
Gender	Women	33,752	875	2.6	2.4	2.8
	Men	31,843	773	2.5	2.3	2.6
Age group	<55	6,850	199	2.9	2.6	3.4
	55–64	14,651	335	2.3	2.1	2.6
	65–74	22,323	517	2.3	2.1	2.5
	75–84	17,870	486	2.7	2.5	3.0
	85+	3,896	111	2.9	2.4	3.5
BMI group	<18.5	851	14	1.7	1.0	2.8
	18.5–24.9	18,818	379	2.0	1.8	2.2
	25–29.9	22,218	507	2.3	2.1	2.5
	30–34.9	10,021	321	3.2	2.9	3.6
	35–39.9	3,071	110	3.6	3.0	4.3
	40+	994	56	5.7	4.4	7.3
	Unknown	9,622	261	2.7	2.4	3.1
Morbidity state	ASA 1	7,538	127	1.7	1.4	2.0
	ASA 2	36,941	859	2.3	2.2	2.5
	ASA 3	15,339	498	3.3	3.0	3.6
	ASA 4/5	334	8	2.4	1.2	4.8
	Unknown	5,443	156	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.

were analysed with a completed 2-year follow-up until 31.12.2022. This practice has the advantage that the burden of the past will not influence the results of the current performance of an implant, clinic, or surgeon. It also offers the possibility of comparing different periods and showing whether there is improvement or deterioration over time. The KM survival estimates and cumulative revision rates cover the entire run of the registry since 2012 and thus dual information is provided, namely the 2-year revision rate in a 4-year moving window, showing the performance of the last 4 years and the long-term results after 10 years. A revision is defined as any removal, addition, or exchange of any prosthetic component. Of the 78,849 documented primary THAs, 65,595 implanted for primary OA were analysed for the 4-year moving average, between 01.01.2017 and 31.12.2020, with a complete 2-year follow-up. Of these, 1,648 hips were revised, accounting for a 2-year revision rate of 2.5% (CI 2.4–2.7), whereby the risk of revision was higher in hips with secondary OA (3.9%) and even higher in hips treated for fractures (5.3%) **(Table 3.4a).** For fractures, the revision rate increased by 0.5% compared to the previous 4-year moving period.

The most frequent cause of revision of primary THA for primary OA was infection (26.6%), followed by periprosthetic fracture (19.5%), femoral loosening

Table 3.4b

Reason for early first revision of primary total hip arthroplasty

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022). Early first revisions are those occurring within 2 years of the primary arthroplasty.

	N	%*
Infection	439	26.6
Periprosthetic fracture	321	19.5
Loosening femoral	275	16.7
Dislocation	252	15.3
Loosening acetabular	141	8.6
Position/orientation of cup	105	6.4
Position/orientation of stem	98	5.9
Impingement	18	1.1
Acetabular protrusion	16	1.0
Spacer	14	0.8
Trochanter pathology	13	0.8
Osteolysis FE	11	0.7
Implant failure	10	0.6
Wear	8	0.5
Osteolysis AC	4	0.2
Squeaking	2	0.1
Other	182	11.0

* Multiple responses possible (percentages do not sum to 100)

Table 3.4bb

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022). Early first revisions are those occurring within 2 years of the primary arthroplasty.

	BMI <15		BMI 35–39.9		BMI 40+	
	N rev.	%*	N rev.	%*	N rev.	%*
Loosening femoral	203	16.6	15	13.6	11	19.6
Infection	284	23.3	46	41.8	24	42.9
Loosening acetabular	113	9.3	9	8.2	2	3.6
Periprosthetic fracture	251	20.6	14	12.7	10	17.9
Dislocation	194	15.9	17	15.5	8	14.3
Wear	7	0.6	0	0.0	0	0.0
Metalosis	0	0.0	0	0.0	0	0.0
Osteolysis AC	2	0.2	0	0.0	0	0.0
Position/orient. of cup	81	6.6	6	5.5	5	8.9
Osteolysis FE	11	0.9	0	0.0	0	0.0
Trochanter pathology	10	0.8	0	0.0	0	0.0
Spacer	8	0.7	1	0.9	2	3.6
Implant failure	8	0.7	0	0.0	1	1.8
Ion blood level	0	0.0	0	0.0	0	0.0
Position/orient. of stem	78	6.4	5	4.5	2	3.6
Impingement	15	1.2	0	0.0	1	1.8
Acetabular protrusion	13	1.1	0	0.0	0	0.0
Squeaking	1	0.1	0	0.0	0	0.0
Other	135	11.1	14	12.7	1	1.8

* Multiple responses possible (percentages do not sum to 100)

(16.7%), and dislocation (15.3%) **(Table 3.4b).** Approximately one-ninth of all revisions (12.3%) were undertaken for malpositioning of either acetabular or femoral components, while in relation to the overall number of 65,595 primary hips, 0.67% were revised for infection, 0.49% for periprosthetic fracture, 0.42% for femoral loosening, and 0.38% for malpositioning.

The majority of revisions occurred during the first 3 months postoperatively, including high and early peaks of periprosthetic fractures and dislocations. Although infection and aseptic loosing were more frequent complications, their curves were flatter but remained elevated over a longer period. **Figure 3.4a** shows the cause and frequency distribution (Kernel density estimation) for cemented and uncemented femoral implants, respectively. In cemented stems, dislocation was an early complication, as was infection whereas other complications occurred later and over a longer period, which is why the curves were flatter. In uncemented stems, periprosthetic fractures occurred early and at a higher frequency.

Table 3.4c gives an overview of the revision rates depending on stem fixation, bearing and approach, whereby the 2-year revision rate is 2.5% (1,648 of 65,595 primary OAs) on average. The parameters that are above average include all cemented fixation techniques (3.1%), MoPE (3.9%), and the use of a posterior approach (3.2%). The highest 2-year revision rate is observed in unspecified approaches that are not defined as one of the standard approaches (5.3%).

Table 3.4c

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

		Revised		95% CI	
	N at risk*	N	%**	lower	upper
Overall (moving average)	65,595	1,648	2.5	2.4	2.7
Fixation					
All cemented	858	26	3.1	2.1	4.5
All uncemented	57,165	1,413	2.5	2.4	2.6
Hybrid	7,422	197	2.7	2.4	3.1
Articulation					
Metal on polyethylene (MoPE)	1,385	53	3.9	3.0	5.0
Ceramic on polyethylene (CoPE)	9,911	262	2.7	2.4	3.0
Metal on cross-linked polyethylene (MoXLPE)	6,934	207	3.0	2.6	3.4
Ceramic on cross-linked polyethylene (CoXLPE)	36,565	854	2.4	2.2	2.5
Ceramic on ceramic (CoC)	9,559	237	2.5	2.2	2.8
Approach					
Anterior	32,851	792	2.4	2.3	2.6
Anterolateral	20,681	496	2.4	2.2	2.6
Lateral	3,108	72	2.4	1.9	3.0
Posterior	8,548	267	3.2	2.8	3.5
Other approach	407	21	5.3	3.5	8.1

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

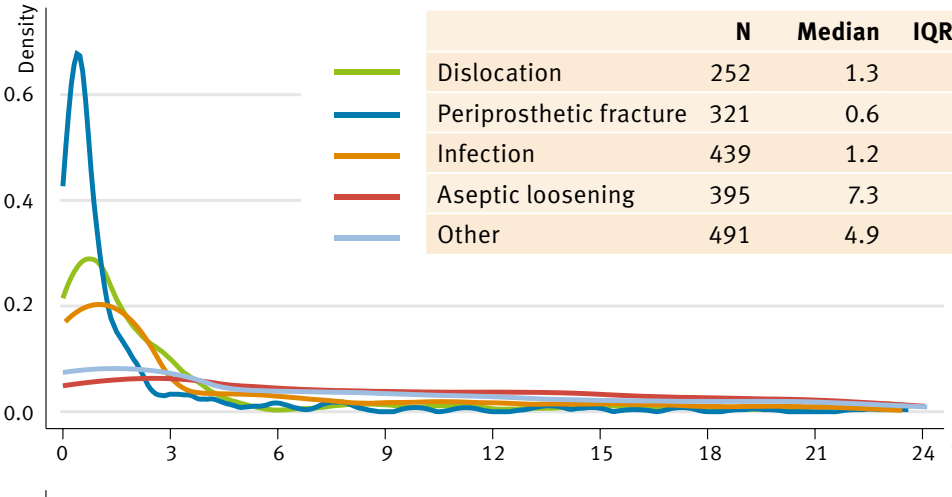
** Rates adjusted for effects of mortality and emigration.

Figure 3.4a

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

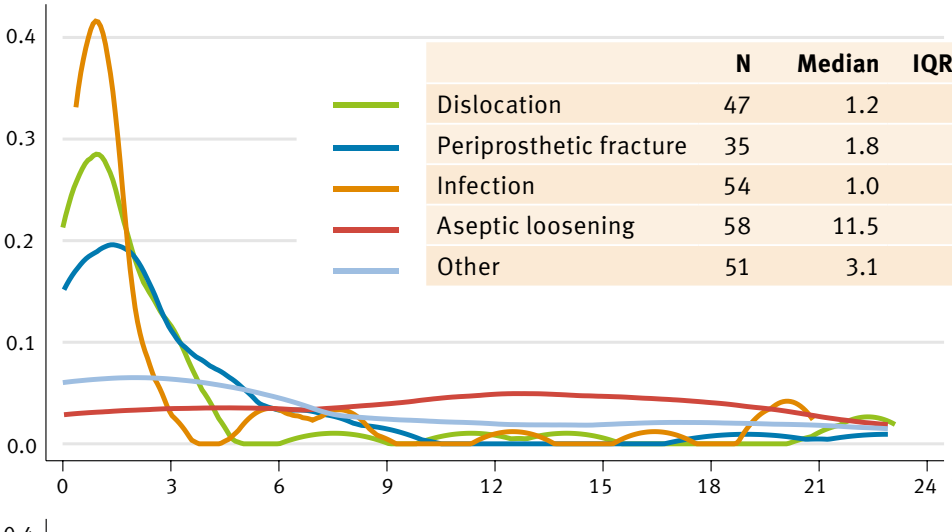
4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).
Early first revisions are those occurring within 2 years of the primary arthroplasty.

All revisions (N= 1,648)



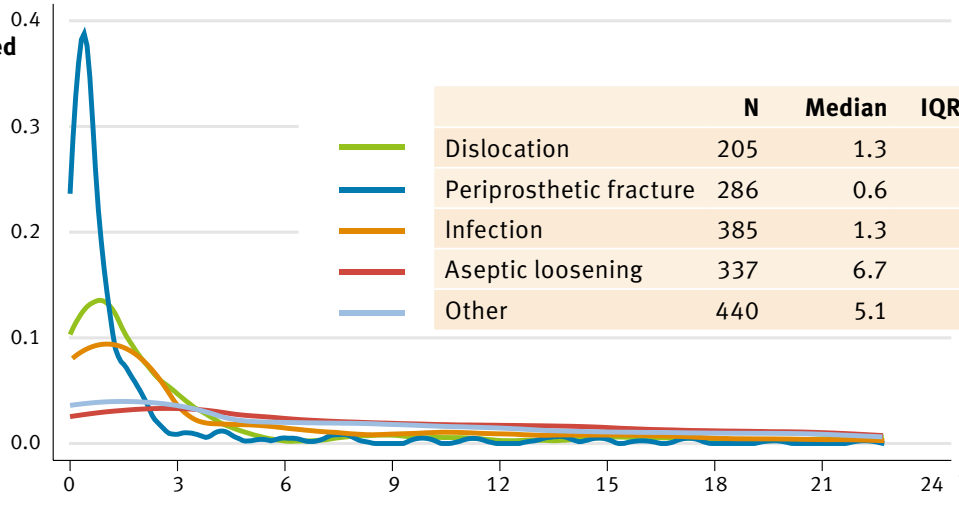
	N	Median	IQR 25%	IQR 75%
Dislocation	252	1.3	0.5	3.1
Periprosthetic fracture	321	0.6	0.3	1.5
Infection	439	1.2	0.7	5.9
Aseptic loosening	395	7.3	2.1	14.1
Other	491	4.9	0.7	11.8

Revisions femur cemented (N= 212)



	N	Median	IQR 25%	IQR 75%
Dislocation	47	1.2	0.6	2.8
Periprosthetic fracture	35	1.8	0.7	3.8
Infection	54	1.0	0.7	2.4
Aseptic loosening	58	11.5	5.1	15.9
Other	51	3.1	0.5	12.6

Revisions femur uncemented (N= 1,436)



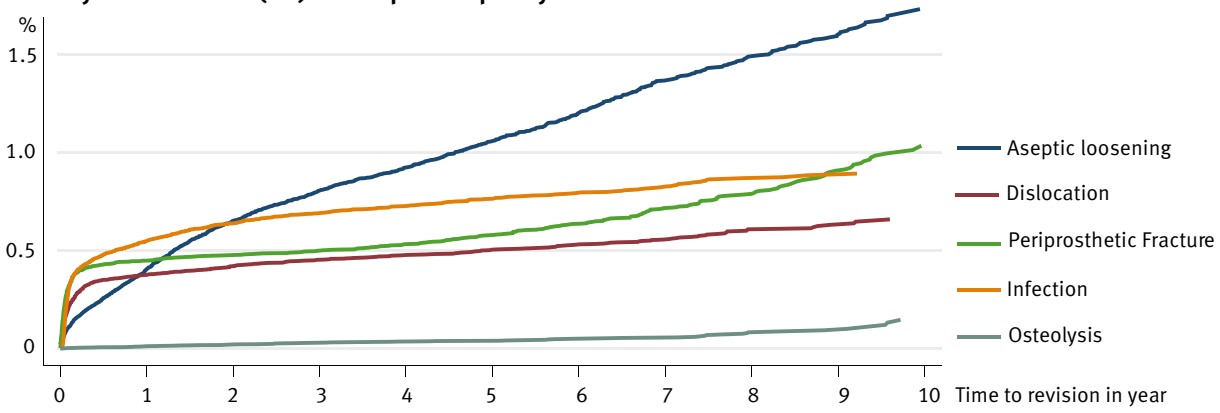
	N	Median	IQR 25%	IQR 75%
Dislocation	205	1.3	0.5	3.2
Periprosthetic fracture	286	0.6	0.3	1.3
Infection	385	1.3	0.7	6.0
Aseptic loosening	337	6.7	2.0	13.6
Other	440	5.1	0.7	11.8

Figure 3.4b

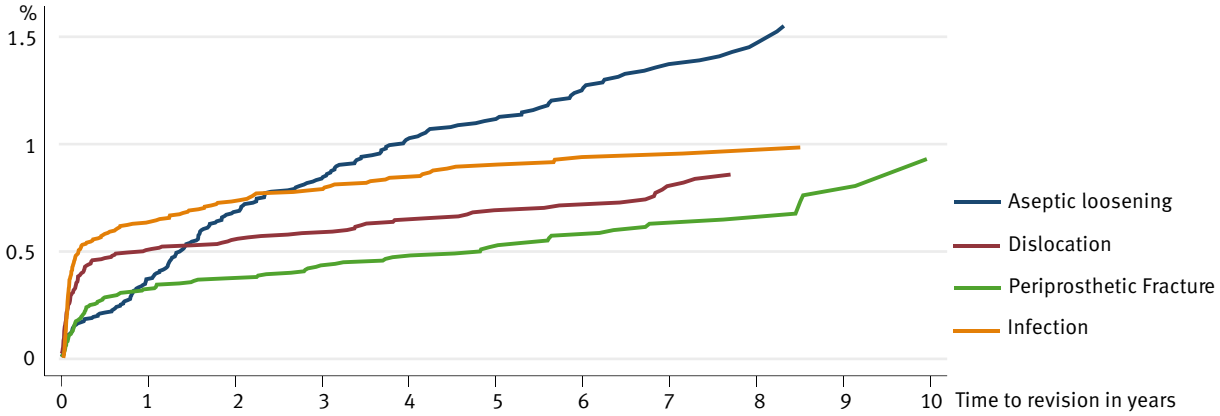
Cumulative incidence rates for different first revision diagnoses

Time since operation, 2012–2022, all services, % of implants revised.

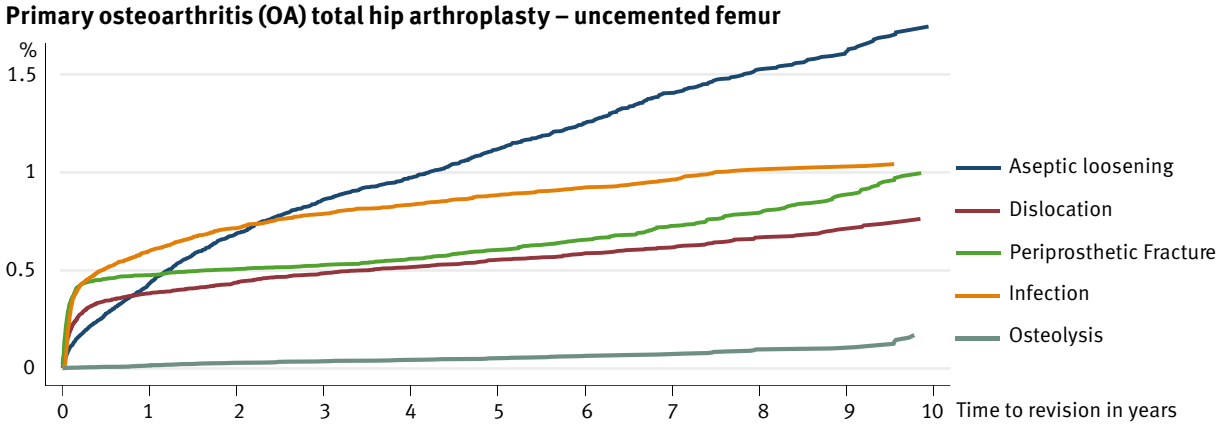
Primary osteoarthritis (OA) total hip arthroplasty



Primary osteoarthritis (OA) total hip arthroplasty – cemented femur



Primary osteoarthritis (OA) total hip arthroplasty – uncemented femur



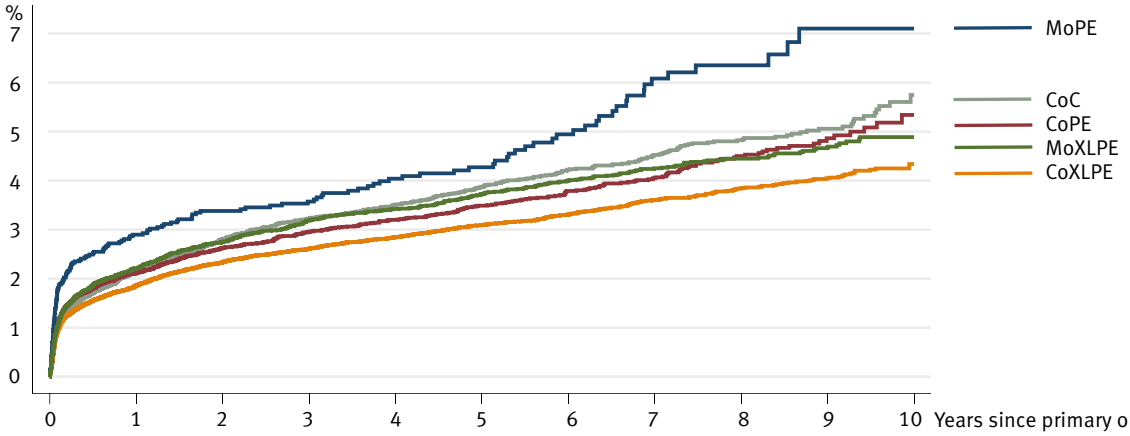
The 2-year revision rate for the current 4-year moving window was lowest for the combination of ceramic heads with highly CoXLPE (2.4%), followed by normal CoC (2.5%) **(Table 3.4c).**

The cumulative incidence rates show the long-term behaviour of implants. In this type of graphic, a line starts when the first relevant revision in the SIRIS dataset is observed and ends with the last recorded revision. **Figure 3.4b** presents the cumulative incidence rates overall and for cemented and/or uncemented femoral components which shows the proportion of implants having experienced at least

Figure 3.4c

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

Time since operation, 2012–2022, all services, diagnosis primary OA.

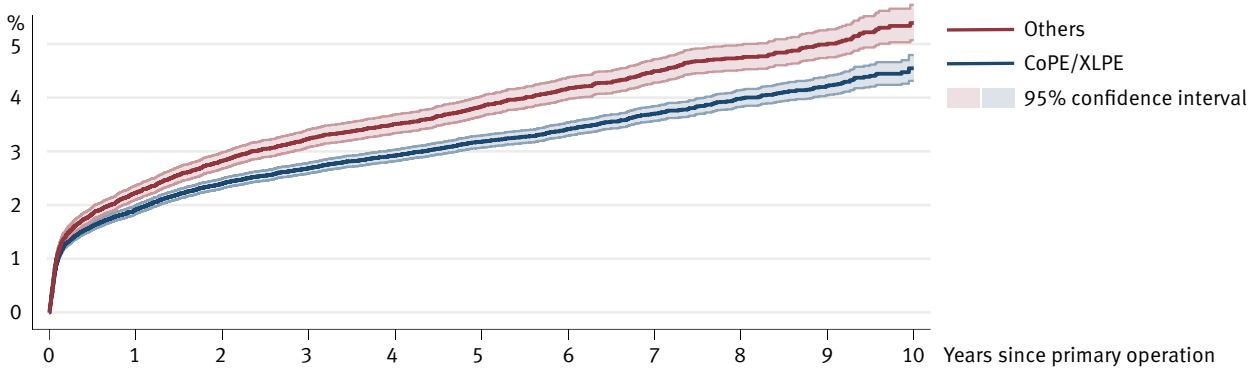


	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
MoPE	**2.9** (2.4-3.5)	**3.4** (2.8-4.0)	**3.6** (3.0-4.2)	**4.0** (3.4-4.8)	**4.3** (3.6-5.0)	**4.9** (4.2-5.8)	**6.1** (5.1-7.2)	**6.4** (5.3-7.6)	**7.1** (5.8-8.6)
CoPE	**2.1** (1.9-2.3)	**2.6** (2.4-2.8)	**3.0** (2.7-3.2)	**3.2** (3.0-3.4)	**3.5** (3.2-3.8)	**3.8** (3.5-4.1)	**4.0** (3.7-4.4)	**4.5** (4.1-4.9)	**5.3** (4.8-6.0)
MoXLPE	**2.2** (2.0-2.4)	**2.8** (2.5-3.0)	**3.2** (2.9-3.4)	**3.4** (3.2-3.7)	**3.7** (3.5-4.0)	**4.0** (3.7-4.3)	**4.3** (4.0-4.6)	**4.4** (4.1-4.8)	**4.9** (4.5-5.3)
CoXLPE	**1.9** (1.8-2.0)	**2.3** (2.2-2.4)	**2.6** (2.5-2.7)	**2.8** (2.7-3.0)	**3.1** (3.0-3.2)	**3.3** (3.2-3.4)	**3.6** (3.5-3.8)	**3.8** (3.7-4.0)	**4.3** (4.1-4.6)
CoC	**2.1** (2.0-2.3)	**2.8** (2.6-3.0)	**3.2** (3.0-3.5)	**3.5** (3.3-3.8)	**3.9** (3.6-4.2)	**4.2** (3.9-4.5)	**4.5** (4.2-4.9)	**4.8** (4.5-5.2)	**5.1** (4.7-5.5)

Figure 3.4d

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

Time since operation, 2012–2022, all services, diagnosis primary OA.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
CoPE	**1.9** (1.8-2.0)	**2.4** (2.3-2.5)	**2.7** (2.6-2.8)	**2.9** (2.8-3.0)	**3.2** (3.1-3.3)	**3.4** (3.3-3.5)	**3.7** (3.6-3.8)	**4.0** (3.8-4.1)	**4.5** (4.3-4.8)
Others	**2.2** (2.1-2.4)	**2.8** (2.7-3.0)	**3.2** (3.1-3.4)	**3.5** (3.3-3.7)	**3.8** (3.7-4.0)	**4.2** (4.0-4.4)	**4.5** (4.3-4.7)	**4.7** (4.5-5.0)	**5.4** (5.1-5.7)

one revision due to a certain underlying reason (e.g. revision due to loosening of a component). **Figure 3.4a** indicates that most reasons for revisions tend to arise relatively soon, as illustrated by a steep initial growth curve followed by very gradual growth in the long term. The exception is the loosening of components that is on a persistent and, in the long run, almost linear growth curve. While cemented stems have more dislocations, uncemented stems tend to have earlier periprosthetic fractures.

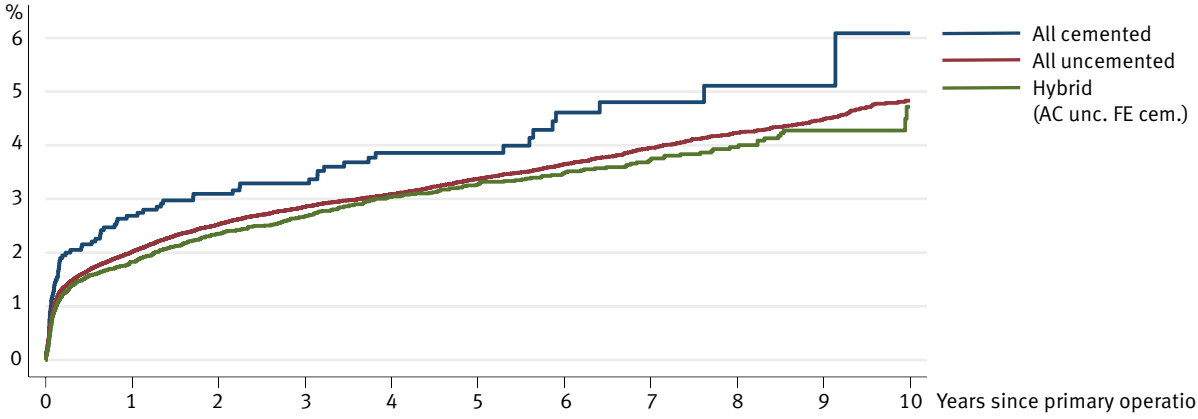
At 10 years, the estimated cumulative revision rate for ceramic on CoXLPE had the lowest revision rate of 4.3% (95% CI 4.1–4.6), while the highest revision rate of 7.1% (95% CI 5.8–8.6) was found for MoPE. Moreover, MoPE revisions showed an increase after 5 years, even though this result may not be fully generalisable due to relatively small numbers at risk **(Figure 3.4c).**

The fixation method also had an impact on the revision rate **(Figures 3.4d)** and hybrid fixation showed slightly fewer revisions (4.7%, 95% CI 4.8–5.0)

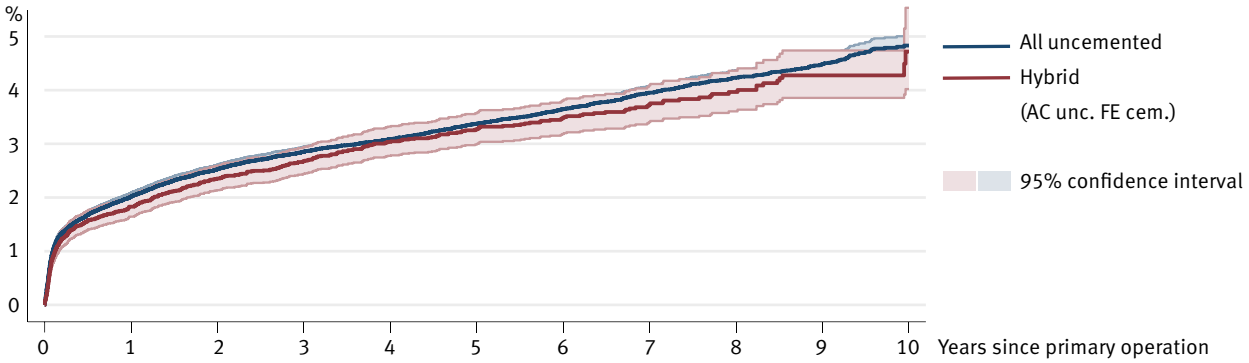
Figure 3.4e

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

Time since operation, 2012–2022, all services, diagnosis primary OA.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
All cem.	**2.7** (2.1-3.5)	**3.1** (2.4-4.0)	**3.3** (2.6-4.2)	**3.9** (3.1-4.9)	**3.9** (3.1-4.9)	**4.6** (3.6-5.9)	**4.8** (3.8-6.1)	**5.1** (3.9-6.6)	**6.1** (4.2-8.9)
All uncem.	**2.0** (1.9-2.1)	**2.5** (2.4-2.6)	**2.9** (2.8-2.9)	**3.1** (3.0-3.2)	**3.4** (3.3-3.5)	**3.6** (3.5-3.8)	**4.0** (3.8-4.1)	**4.2** (4.1-4.4)	**4.8** (4.6-5.0)
Hybrid	**1.8** (1.6-2.0)	**2.4** (2.1-2.6)	**2.7** (2.4-2.9)	**3.0** (2.8-3.3)	**3.3** (3.0-3.6)	**3.5** (3.2-3.8)	**3.7** (3.4-4.1)	**4.0** (3.6-4.4)	**4.7** (4.0-5.5)

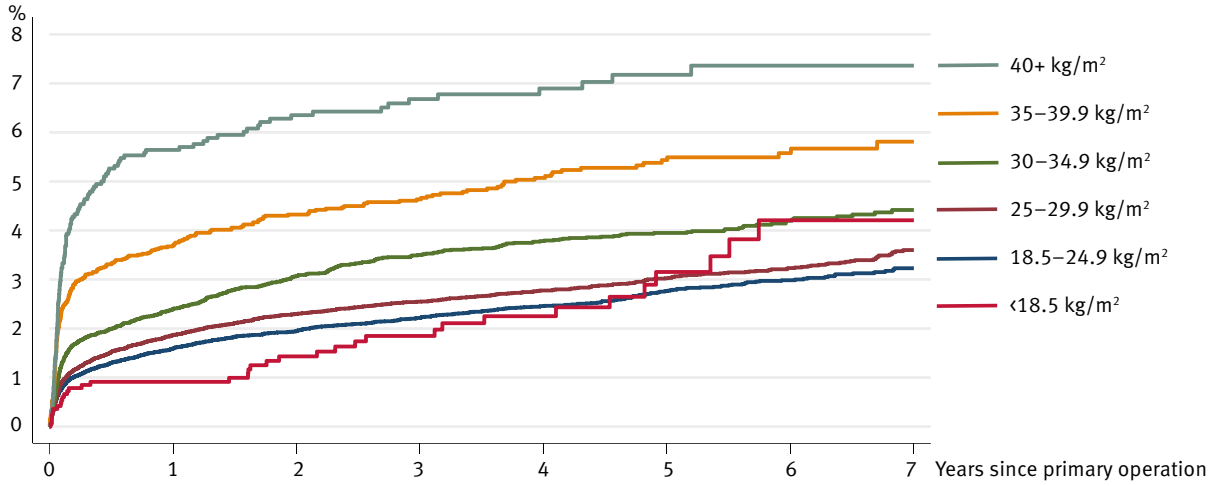


	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
All uncem.	**2.0** (1.9-2.1)	**2.5** (2.4-2.6)	**2.9** (2.8-2.9)	**3.1** (3.0-3.2)	**3.4** (3.3-3.5)	**3.6** (3.5-3.8)	**4.0** (3.8-4.1)	**4.2** (4.1-4.4)	**4.8** (4.6-5.0)
Hybrid	**1.8** (1.6-2.0)	**2.4** (2.1-2.6)	**2.7** (2.4-2.9)	**3.0** (2.8-3.3)	**3.3** (3.0-3.6)	**3.5** (3.2-3.8)	**3.7** (3.4-4.1)	**4.0** (3.6-4.4)	**4.7** (4.0-5.5)

Figure 3.4f

Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2022, all services, diagnosis primary OA.

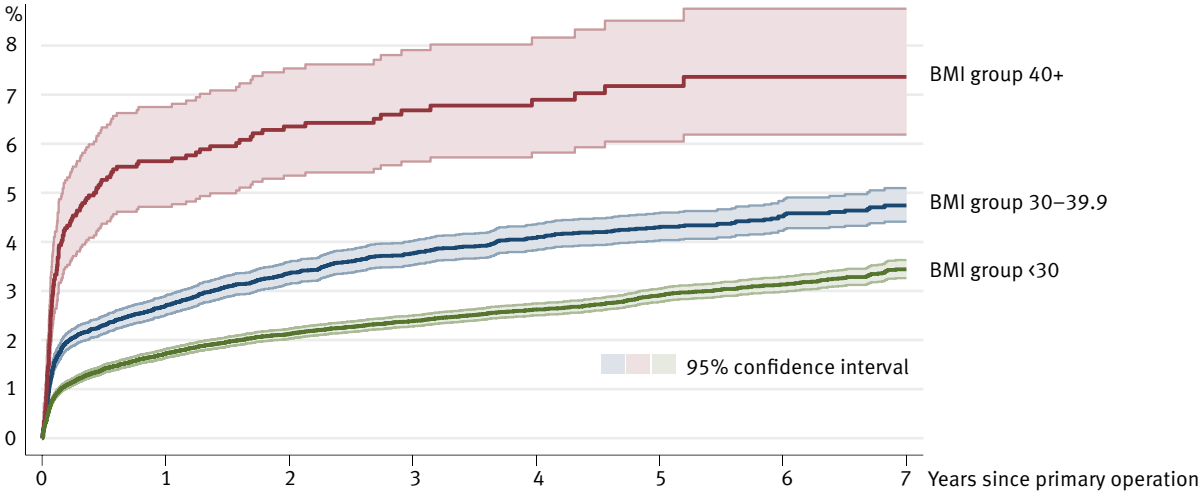


kg/m²	1 year	2 years	3 years	4 years	5 years	6 years	7 years
‹18.5	**0.9** (0.6-1.5)	**1.4** (0.9-2.2)	**1.8** (1.2-2.8)	**2.3** (1.5-3.3)	**3.2** (2.1-4.7)	**4.2** (2.8-6.3)	**4.2** (2.8-6.3)
18.5–24.9	**1.6** (1.5-1.7)	**1.9** (1.8-2.1)	**2.2** (2.1-2.4)	**2.5** (2.3-2.6)	**2.8** (2.6-3.0)	**3.0** (2.8-3.2)	**3.2** (3.0-3.5)
25–29.9	**1.9** (1.7-2.0)	**2.3** (2.2-2.4)	**2.5** (2.4-2.7)	**2.8** (2.6-3.0)	**3.0** (2.8-3.2)	**3.2** (3.0-3.4)	**3.6** (3.3-3.9)
30–34.9	**2.4** (2.2-2.6)	**3.1** (2.8-3.3)	**3.5** (3.2-3.8)	**3.8** (3.5-4.1)	**3.9** (3.7-4.3)	**4.2** (3.9-4.6)	**4.4** (4.1-4.8)
35–39.9	**3.7** (3.2-4.2)	**4.3** (3.8-4.9)	**4.6** (4.1-5.2)	**5.1** (4.5-5.7)	**5.4** (4.8-6.1)	**5.6** (4.9-6.3)	**5.8** (5.1-6.6)
40+	**5.6** (4.7-6.7)	**6.4** (5.4-7.5)	**6.7** (5.6-7.9)	**6.9** (5.8-8.2)	**7.2** (6.0-8.5)	**7.4** (6.2-8.8)	**7.4** (6.2-8.8)

Figure 3.4g

Estimated failure rates of primary total hip arthroplasty for different BMI

Time since operation, 2015–2022, all services, diagnosis primary OA.



BMI	1 year	2 years	3 years	4 years	5 years	6 years	7 years
30–39.9	**2.7** (2.5-2.9)	**3.4** (3.1-3.6)	**3.8** (3.5-4.0)	**4.1** (3.8-4.4)	**4.3** (4.0-4.6)	**4.5** (4.2-4.8)	**4.7** (4.4-5.1)
40+	**5.6** (4.7-6.7)	**6.4** (5.4-7.5)	**6.7** (5.6-7.9)	**6.9** (5.8-8.2)	**7.2** (6.0-8.5)	**7.4** (6.2-8.8)	**7.4** (6.2-8.8)
‹30	**1.7** (1.6-1.8)	**2.1** (2.0-2.2)	**2.4** (2.3-2.5)	**2.6** (2.5-2.7)	**2.9** (2.8-3.0)	**3.1** (3.0-3.3)	**3.4** (3.3-3.6)

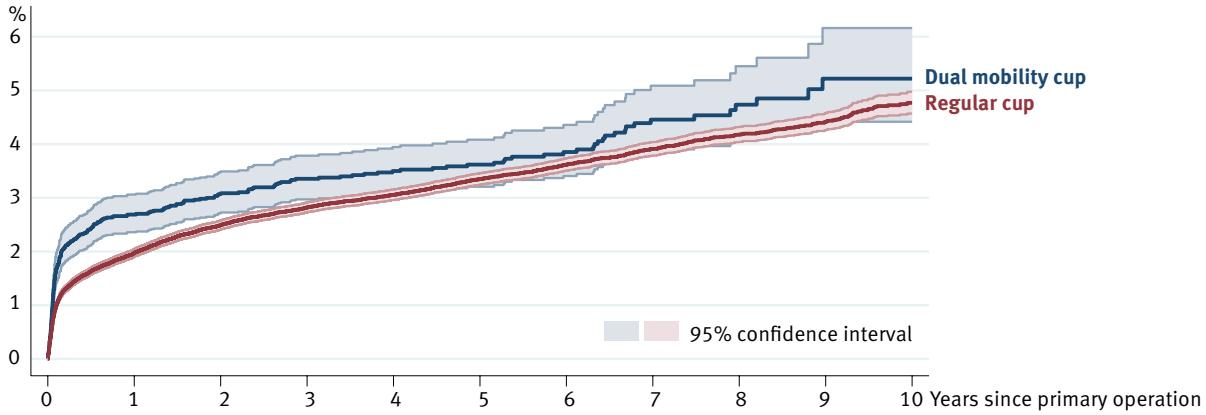
than uncemented (4.58%, 95% CI 4.6–5.0) or all cemented THAs (6.1%, 95% CI 4.2–8.9) at 10 years. However, a direct comparison of hybrid and uncemented fixation reveals that in terms of statistical significance (overlapping confidence intervals), the result at 10 years is inconclusive, although the revision rates for hybrid fixation tend to run below the revision rates for uncemented fixation for much of the observation time **(Table 3.4de).**

BMI, on the other hand, has a very clear impact on the risk of revision **(Table 3.4a and Figures 3.4e and f)** and revision rates rose with increasing BMI, whereby the 2-year revision rate for patients with BMI › 40 was 6.4% (95% CI 5.4–7.5) **(Table 3.4a)** which is more than three times higher than in patients of normal weight. The majority of complications occurred within the first 2 to 3 months post-surgery and the most frequent complication in patients with high BMI is infection, accounting for up to one-third of all complications in this population. This is followed by periprosthetic fracture, femoral loosening, and dislocation. Compared to the overall complication rate, only infections were more frequent, periprosthetic fractures and dislocations were approximately the same, and femoral and acetabular loosening were less frequent. While underweight patients initially have a lower revision risk, at 5 years, the revision rate starts to rise, and at 7 years the revision rates compare to those of patients with a BMI of between 30 and 34.9.

Figure 3.4h

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

Time since operation, 2012–2022, all services, diagnosis primary OA.

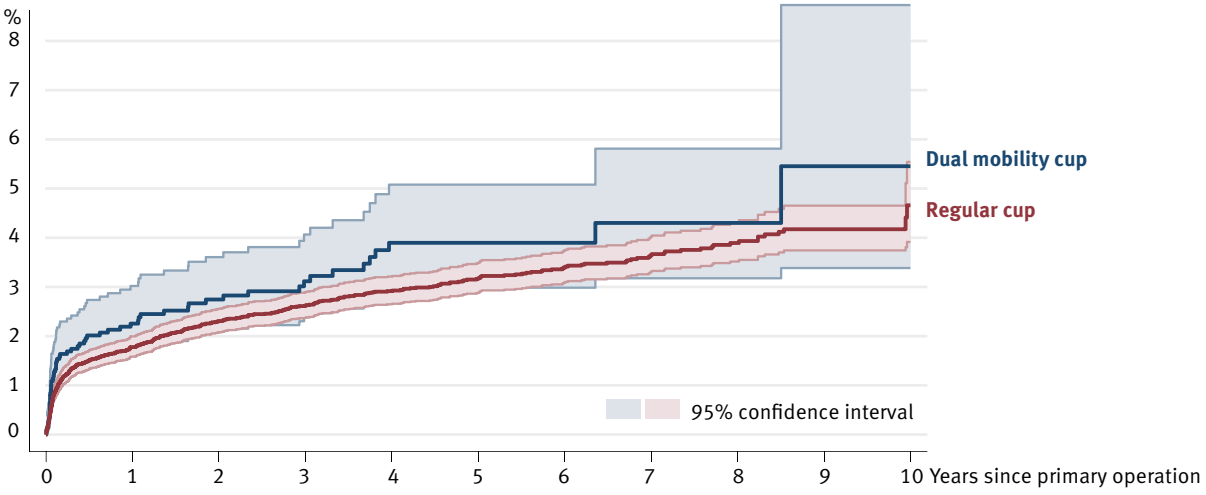


Uncemented	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
Regular cup	**2.0** (1.9-2.0)	**2.5** (2.4-2.6)	**2.8** (2.7-2.9)	**3.0** (2.9-3.1)	**3.3** (3.2-3.4)	**3.6** (3.5-3.7)	**3.9** (3.8-4.0)	**4.1** (4.0-4.3)	**4.7** (4.5-4.9)
Dual mobi. cup	**2.9** (2.5-3.2)	**3.3** (2.9-3.7)	**3.7** (3.3-4.1)	**3.9** (3.5-4.4)	**4.1** (3.6-4.5)	**4.3** (3.9-4.9)	**4.9** (4.3-5.6)	**5.2** (4.6-5.9)	**5.7** (4.9-6.6)

Figure 3.4i

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

Time since operation, 2012–2022, all services, diagnosis primary OA.



Hybrid	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
Regular cup	**1.8** (1.6-2.0)	**2.3** (2.1-2.5)	**2.6** (2.4-2.9)	**2.9** (2.6-3.2)	**3.1** (2.8-3.5)	**3.4** (3.1-3.7)	**3.6** (3.3-4.0)	**3.9** (3.5-4.3)	**4.6** (3.9-5.5)
Dual mobi. cup	**2.2** (1.6-2.9)	**2.8** (2.1-3.7)	**3.3** (2.5-4.2)	**4.0** (3.1-5.2)	**4.2** (3.2-5.5)	**4.2** (3.2-5.5)	**4.6** (3.4-6.2)	**4.6** (3.4-6.2)	**5.8** (3.7-9.0)

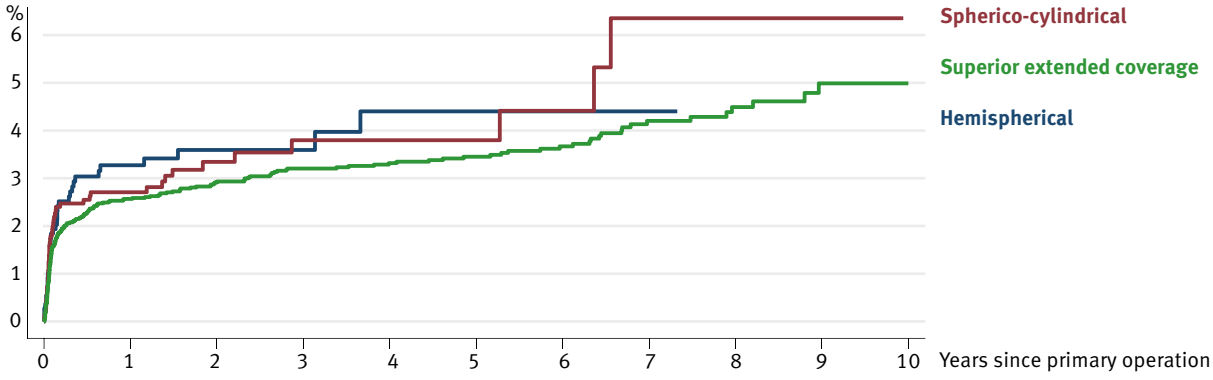
Dual mobility cups

Dual mobility cups are increasingly being used both for primary THA as well as in revisions. The main indication is to reduce the risk of dislocation, respectively revision for instability. Thus, their use is primarily indicated in patients with inherently increased risk for revision. The exact role of dual mobility cups is still debated, and several questions concerning their use are not yet fully answered. Compared to the average revision rate of regular cups, the average revision rate for all dual mobility cups is elevated for all periods **(Figure 3.4h)**, albeit without statistical significance. The revision rate for double mobility cups depends, amongst other factors, on the type of stem fixation, whereby hybrid fixation (cemented stem) is associated with a decreased revision rate for regular and dual mobility cups **(Figure 3.4i)** and the design of the cup has a major impact on the revision rate. There are three different design philosophies: hemispherical, spherico-cylindrical, and superior extended coverage. **Table 3.4d** shows SIRIS data on the currently used dual mobility cups. Comparison of these 3 types is possible until 6 years of follow-up. At this time uncemented dual mobility cups with superior extended coverage have the lowest revision rate with 3.7% (CI 3.2 – 4.2) and, at 10 years, it is 5.0% (CI 4.2–6.0). In the previous report we showed that the hemispherical cups performed not very favourably. This was based on the incorrect classification of all registered modular G7 cups as dual-mobility cups, when indeed more than half of those cups were used as regular cups. In particular, all of the cups used in the GTS plus G7 bispherical outlier combination were all regular cups. This misclassification is now corrected.

Figure 3.4j

Estimated failure rates of primary total hip arthroplasty for different types of dual mobility cups (primary OA and all uncemented fixation)

Time since operation, 2012–2022, all services, diagnosis primary OA.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
Hemispherical*	**4.1** (3.2-5.3)	**4.8** (3.8-6.1)	**5.6** (4.4-7.2)	**7.3** (5.6-9.5)	**8.1** (6.2-10.5)	**8.6** (6.5-11.3)	**8.6** (6.5-11.3)		
Spherico-cylindrical	**2.7** (2.0-3.7)	**3.3** (2.5-4.5)	**3.8** (2.8-5.2)	**3.8** (2.8-5.2)	**3.8** (2.8-5.2)	**4.4** (3.0-6.4)	**6.3** (3.9-10.3)	**6.3** (3.9-10.3)	
Sup. ext. coverage	**2.6** (2.2-3.0)	**2.9** (2.5-3.4)	**3.2** (2.8-3.7)	**3.3** (2.9-3.9)	**3.5** (3.0-4.0)	**3.7** (3.2-4.3)	**4.2** (3.6-4.9)	**4.5** (3.9-5.3)	**5.0** (4.2-6.0)

* The hemispherical group is not well represented in SIRIS data. It comprises Symbol/DS evolution cups as well as the modular G7 cups

Head sizes

Head size and bearing material influence wear, which in the long term can lead to osteolysis and loosening. Furthermore, head size has an impact on stability and hence the larger the head, the more stable the hip and the risk for dislocation is thus higher with small heads. Assessing head sizes only, heads with a diameter ≥ 40 mm have a significantly high revision rate of 12.9% at 10 years (**Fig. 3.4j).** Most ≥ 40 mm heads were used in CoC bearings. Bearings with 32 or 36 mm diameters had an identical revision rate, namely 4.6% at 10 years while 28 mm heads had a slightly higher revision rate with 5.5% at 10 years, just reaching statistical significance.

The relationship between head size and bearing was further analysed, whereby the combination of head sizes of 28, 32, and 36 mm against the bearings MoPE, MoXLPE, CoPE, CoXLPE, and CoC were examined and the results for each year are presented in **Table 3.4d.**

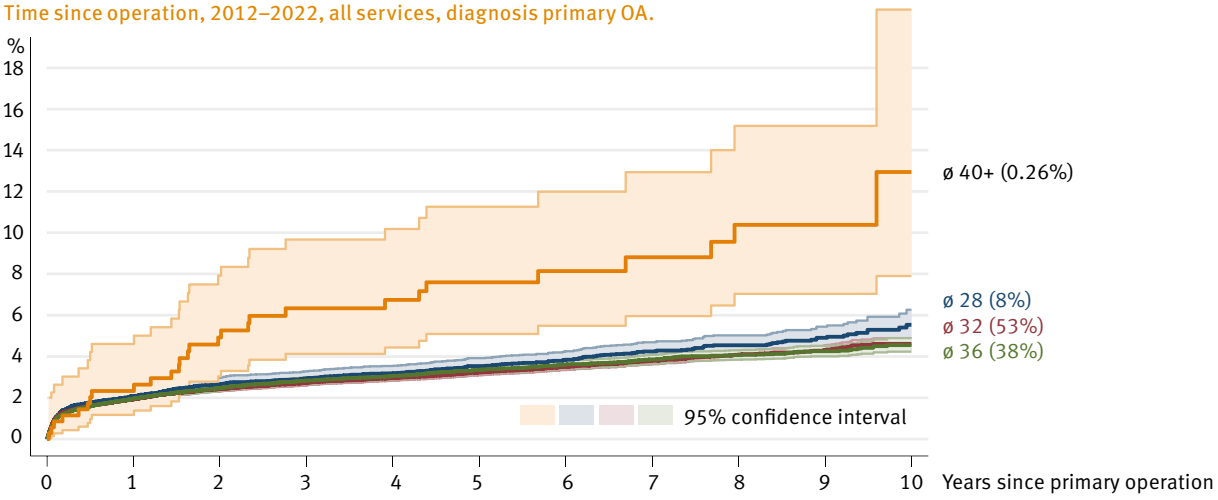
The combination of MoPE was only used with 32 mm heads and had the highest revision rate of 9.1% (CI 6.5–12.8) at 10 years while 28 mm metal heads in combination with PE were only used for dual mobility cups. The triple bearings of dual mobility cups are not part of this analysis and were excluded.

For all head sizes, CoXLPE had the lowest revision rates, with the 36 mm head showing the lowest rate of 4.0% (3.5–4.4) at 10 years. For MoXLPE, CoPE, and CoC the long-term results vary depending on the head size.

Figure 3.4k

Estimated failure rates of primary total hip arthroplasty for different types of head sizes (standard cups: primary OA & all uncemented fixation)

Time since operation, 2012–2022, all services, diagnosis primary OA.



Diameter ø	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
28 (8%)	**2.1** (1.8-2.4)	**2.6** (2.4-3.0)	**2.9** (2.6-3.3)	**3.2** (2.9-3.5)	**3.5** (3.2-3.9)	**3.8** (3.5-4.3)	**4.2** (3.8-4.7)	**4.5** (4.1-5.0)	**5.5** (4.9-6.3)
32 (53%)	**1.9** (1.8-2.0)	**2.4** (2.3-2.5)	**2.7** (2.6-2.9)	**3.0** (2.8-3.1)	**3.2** (3.1-3.4)	**3.5** (3.3-3.7)	**3.8** (3.6-4.0)	**4.1** (3.9-4.3)	**4.6** (4.4-4.9)
36 (38%)	**2.0** (1.8-2.1)	**2.5** (2.3-2.6)	**2.8** (2.7-3.0)	**3.1** (2.9-3.2)	**3.4** (3.2-3.5)	**3.6** (3.4-3.8)	**3.9** (3.7-4.1)	**4.1** (3.8-4.3)	**4.6** (4.2-4.9)
40+ (0.26%)	**2.3** (1.2-4.6)	**4.9** (3.0-7.9)	**6.3** (4.1-9.7)	**6.7** (4.4-10.2)	**7.6** (5.1-11.3)	**8.1** (5.5-12.0)	**8.8** (6.0-12.9)	**10.4** (7.0-15.2)	**12.9** (7.9-20.8)

Table 3.4d

Estimated failure rates of primary total hip arthroplasty for different types of head sizes by bearing surface (standard cups: primary OA & all uncemented fixation)

Time since operation, 2012–2022, all services, diagnosis primary OA, only showing combinations with 500+ cases.

Ø / bearing surface	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
28 / CoPE	**2.8** (2.1-3.7)	**3.5** (2.7-4.5)	**3.9** (3.1-5.0)	**4.1** (3.2-5.2)	**4.5** (3.6-5.7)	**4.8** (3.8-6.1)	**5.6** (4.5-7.0)	**6.8** (4.9-9.4)
28 / MoXLPE	**2.2** (1.7-2.9)	**2.6** (2.0-3.4)	**3.0** (2.4-3.8)	**3.1** (2.5-3.9)	**3.5** (2.8-4.3)	**3.9** (3.2-4.8)	**4.5** (3.7-5.5)	**5.5** (4.4-6.9)
28 / CoXLPE	**1.7** (1.4-2.1)	**2.3** (2.0-2.8)	**2.5** (2.1-2.9)	**2.8** (2.4-3.3)	**3.1** (2.7-3.7)	**3.4** (2.9-3.9)	**4.2** (3.6-4.8)	**4.9** (4.1-5.9)
28 / CoC	**2.0** (1.3-3.3)	**2.9** (1.9-4.3)	**3.2** (2.1-4.7)	**3.2** (2.1-4.7)	**4.0** (2.8-5.8)	**4.2** (2.9-6.1)	**4.6** (3.2-6.6)	**5.5** (3.5-8.4)
32 / MoPE	**3.9** (2.7-5.6)	**4.7** (3.4-6.7)	**4.7** (3.4-6.7)	**5.2** (3.7-7.2)	**5.5** (3.9-7.6)	**6.5** (4.7-9.0)	**9.1** (6.5-12.8)	**9.1** (6.5-12.8)
32 / CoPE	**1.8** (1.5-2.1)	**2.2** (1.9-2.5)	**2.5** (2.2-2.9)	**2.8** (2.5-3.2)	**3.1** (2.7-3.5)	**3.4** (3.0-3.9)	**4.2** (3.7-4.9)	**5.8** (4.7-7.2)
32 / MoXLPE	**2.6** (2.3-2.9)	**3.2** (2.8-3.6)	**3.7** (3.3-4.1)	**4.0** (3.5-4.4)	**4.3** (3.9-4.8)	**4.6** (4.1-5.1)	**5.0** (4.5-5.6)	**5.3** (4.8-6.0)
32 / CoXLPE	**1.8** (1.7-1.9)	**2.3** (2.1-2.4)	**2.5** (2.4-2.7)	**2.7** (2.6-2.9)	**3.0** (2.8-3.1)	**3.2** (3.0-3.4)	**3.8** (3.5-4.0)	**4.2** (3.9-4.5)
32 / CoC	**1.9** (1.6-2.2)	**2.5** (2.2-2.9)	**2.9** (2.5-3.3)	**3.2** (2.8-3.6)	**3.5** (3.0-4.0)	**3.8** (3.3-4.3)	**4.3** (3.8-5.0)	**5.1** (4.3-6.1)
36 / CoPE	**2.0** (1.7-2.3)	**2.5** (2.2-2.9)	**2.8** (2.4-3.2)	**2.9** (2.5-3.3)	**3.1** (2.7-3.5)	**3.3** (2.8-3.8)	**3.6** (3.1-4.2)	**4.1** (3.4-4.9)
36 / MoXLPE	**1.8** (1.4-2.2)	**2.4** (2.0-2.9)	**2.7** (2.3-3.3)	**3.0** (2.5-3.5)	**3.3** (2.7-3.9)	**3.5** (3.0-4.2)	**3.9** (3.3-4.6)	**4.3** (3.5-5.3)
36 / CoXLPE	**1.9** (1.7-2.1)	**2.3** (2.1-2.5)	**2.6** (2.4-2.9)	**2.9** (2.6-3.1)	**3.1** (2.9-3.4)	**3.3** (3.0-3.5)	**3.6** (3.3-4.0)	**4.0** (3.5-4.4)
36 / CoC	**2.1** (1.9-2.4)	**2.7** (2.5-3.0)	**3.2** (2.9-3.5)	**3.4** (3.1-3.8)	**3.8** (3.5-4.2)	**4.2** (3.8-4.6)	**4.8** (4.3-5.3)	**5.5** (4.8-6.2)

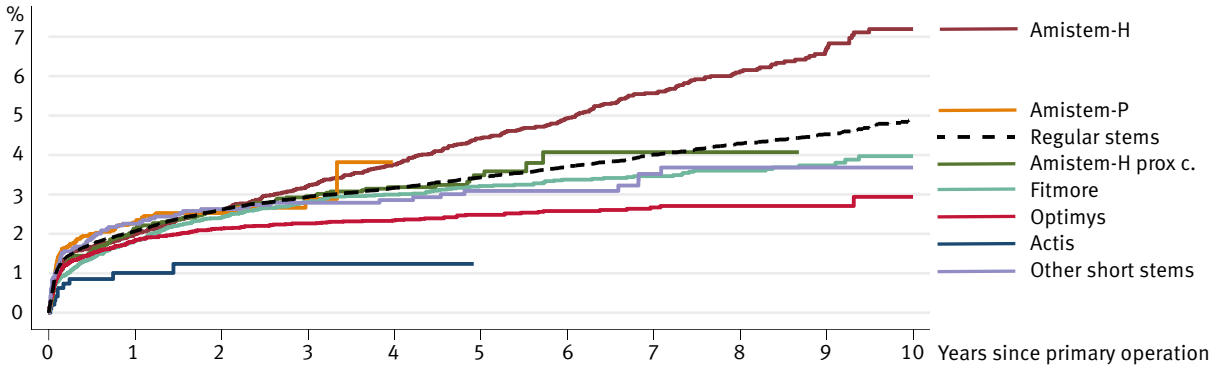
Short stems

The definition of a short stem is matter of debate. In particular, there is no consensus whether shortened stems with diaphyseal fixation should also be considered short stems. For this analysis, the classification of Erivan et al. was used, including shortened stems in the analysis[1]. Short stems are classified into five types: 1) cephalic, 2) isolated cervical, 3) calcar femorale, 4) metaphyseal, and 5) conventional metaphyseal-diaphyseal with shortened stems and 24 different short stems or shortened stems are currently used in Switzerland. For statistical analysis, only stems with more than 500 implantations were included, while the remaining short stems were summarized as "other". Compared to the standard uncemented stems, the short stems show a wide range of revision rates **(Figure 3.4l),** whereby the Calcar-guided short stems perform well. Type 5 short stems show a wide range of revision rates with some performing excellently and others less well. The reason for the heterogenous revision rates most likely is multifactorial, including the design of the stem, coating, bearing surface used, etc., and it is important to note that short stems do not universally perform well as a group. Hence, as in primary uncemented stems, each implant has to be assessed separately for its performance and longevity.

Figure 3.4l

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

Time since operation, 2012–2022, all services, diagnosis primary OA.



	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
Actis	**1.0** (0.5-1.9)	**1.2** (0.6-2.4)	**1.2** (0.6-2.4)	**1.2** (0.6-2.4)				
Amistem-H	**2.0** (1.7-2.3)	**2.6** (2.2-3.0)	**3.2** (2.8-3.6)	**3.8** (3.4-4.2)	**4.4** (4.0-4.9)	**4.9** (4.5-5.4)	**6.1** (5.6-6.7)	**7.2** (6.5-8.0)
Amistem-H prox c.	**2.1** (1.7-2.7)	**2.6** (2.1-3.2)	**3.0** (2.5-3.6)	**3.2** (2.7-3.8)	**3.5** (2.9-4.2)	**4.1** (3.2-5.1)		
Amistem-P	**2.3** (1.9-2.8)	**2.5** (2.1-3.1)	**2.9** (2.3-3.6)					
Fitmore	**1.8** (1.6-2.1)	**2.4** (2.2-2.7)	**2.8** (2.5-3.1)	**3.0** (2.7-3.3)	**3.2** (2.9-3.6)	**3.4** (3.1-3.7)	**3.6** (3.2-4.0)	**4.0** (3.5-4.5)
Optimys	**1.8** (1.7-2.0)	**2.1** (1.9-2.4)	**2.3** (2.1-2.5)	**2.3** (2.1-2.6)	**2.5** (2.2-2.7)	**2.6** (2.3-2.9)	**2.7** (2.4-3.0)	**2.9** (2.4-3.5)
Other short stems	**2.3** (1.7-2.9)	**2.6** (2.1-3.3)	**2.8** (2.2-3.5)	**2.9** (2.3-3.6)	**3.1** (2.4-3.9)	**3.1** (2.4-3.9)	**3.7** (2.9-4.7)	**3.7** (2.9-4.7)
Regular stems	**2.1** (2.0-2.2)	**2.6** (2.5-2.7)	**2.9** (2.8-3.1)	**3.2** (3.0-3.3)	**3.4** (3.3-3.6)	**3.7** (3.6-3.8)	**4.3** (4.1-4.5)	**4.9** (4.6-5.1)

[1] Erivan R, Villatte G, Dartus J, Mertl P, Piriou P, Tracol P, Vernizeau M, Mulliez A, Puch JM, Girard J, Descamps S, Boisgard S; French Hip; Knee Society. French Hip & Knee Society classification of short-stem hip prostheses: Inter- and intra-observer reproducibility. Orthop Traumatol Surg Res. 2022; 108: 103126.

3.5 Results of implants in total hip arthroplasty

One of the key elements of an implant register is to analyse the performance of the implant with regard to complications, early revisions and, most importantly, long-term survival. While short-term results largely reflect a surgeon's or a hospital's performance, long-term results depend more on the design and quality of the implants. A total hip replacement comprises at least three components, including the stem, cup, and head. Considering the modularity of the cup or a dual mobility system, it is sensible to focus investigations on combinations in current use and to compare those with each other as it could be that a cup works well with one stem but poorly with another – and vice versa. For this 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 2 years within a moving 4-year window and only combinations with n › 50 are presented. From a statistical point of view, although n = 50 may be considered the smallest "large" number useful for this type of analysis, it is nevertheless a number that will imply very low statistical precision in the absence of a very high revision rate which indicates wide confidence intervals and thus one revision more (or less) may be sufficient to categorise an implant as an outlier. Hence, there is always a trade-off between statistical stability and the necessity to identify possible low-volume outliers.

Since the launch of the registry, SIRIS has documented a total of 160 different brands of stem (including all currently identified sub-variants), of which 29 stems were implanted less than 10 times, while another 31 stems were used in 10 to 49 cases. Moreover, there were 126 different brands of cups of which 22 cups were implanted less than 10 times and another 26 cups were used in 10 to 49 cases. Furthermore, there were 1,235 different stem cup combinations, of which 235 combinations were used in more than 50 cases. It is noteworthy that almost half of all recognised combinations were registered less than 5 times and yet this remarkable diversity accounts for less than 1% of all registered THAs.

Since the 2022 report, a so-called case concentration score (CCS) is used, which indicates the percentage of implantations performed by the main user hospital service, and a higher share signifies an increased likelihood of biased figures due to local effects. Hence, a share of › 50% would suggest that reported results are likely dominated by data from one hospital service while a score of 100% indicates that the implant is used in one hospital only. For the current report, implantations from 2017 onwards were included for the 2-year analysis and, for this period, there were 80 combinations with more than 50 cases implanted.

Ten-year revision rates

Uncemented combinations for primary OA

Table 3.5a shows the 75% most frequently used stem and cup combinations and their evolution between 2017 and 2022. Sixteen stem/cup combinations cover 75% of the most frequently used uncemented combinations for primary OA **(Table 3.5a)** while two stems (Amistem-H and Quadra-H) were used in large numbers in 2017. Their use declined gradually since then and was replaced by the next-generation stems (Amistem-P and Quadra-P). **Table 3.5b** shows the revision rates for the period since 2012 for implantations carried out for primary OA, whereby only stem/cup combinations with n › 500 are included. The register now can provide an overview of the 10-year performance of implant combinations.

At 10 years, the average revision rate for all uncemented stem/cup combinations was 4.8% (CI 4.6–5.0).

The analysis included the detection of implants (minimal n ≥ 50 cases at risk) with elevated revision rates or outlier implants at any time between 5 and 10 years. In this context, three categories are presented, namely the elevated revision rate, outlier status, and revision rate below average. An elevated revision rate was defined as a deviation of at least 50% above the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average) while outlier status was defined as a revision rate of twice the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average). Furthermore, below average was defined as a revision rate of up to 66% of the group average throughout the entire time between 5 and 10 years (and upper bounds of the 95% confidence interval

Table 3.5a

Top 75% of primary total hip arthroplasty uncemented combinations (primary OA) 2017–2022

Stem component	Cup component	2017	2018	2019	2020	2021	2022	2017-2022
Actis	Pinnacle	0	28	119	185	221	406	**959**
Amistem-H prox coating	Versafitcup trio/ccl.	840	1,276	858	49	28	0	**3,051**
Amistem-P	Versafitcup trio/ccl.	0	1	381	1,180	1,224	1,202	**3,988**
Avenir	Allofit	1,104	1,161	1,136	1,038	713	614	**5,766**
Avenir	Fitmore	323	299	282	257	186	119	**1,466**
Corail	Pinnacle	1,110	1,140	1,147	1,235	1,252	1,067	**6,951**
Corail collared	Pinnacle	1,195	1,279	1,395	1,571	1,882	2,145	**9,467**
Fitmore	Allofit	550	508	527	561	617	680	**3,443**
Fitmore	Fitmore	432	594	620	623	577	608	**3,454**
Optimys	RM pressfit vitamys	1,675	1,749	1,830	2,105	2,485	2,996	**12,840**
Polarstem	Polarcup	202	217	189	209	173	217	**1,207**
Polarstem	R3	589	647	684	763	802	929	**4,414**
Quadra-H	Versafitcup trio/ccl.	942	1,049	938	741	473	182	**4,325**
Quadra-P	Versafitcup trio/ccl.	0	0	33	243	544	857	**1,677**
SBG	R3	207	209	198	196	196	42	**1,048**
Twinsys	RM pressfit vitamys	405	402	407	395	415	420	**2,444**
other combinations		4,065	3,467	3,554	3,140	3,637	3,810	**21,673**
Total		**13,639**	**14,026**	**14,298**	**14,491**	**15,425**	**16,294**	**88,173**

Table 3.5b

Long term evaluation: Failure rates of primary total hip arthroplasty uncemented combinations (primary OA)

Time since operation, 2012–2022.

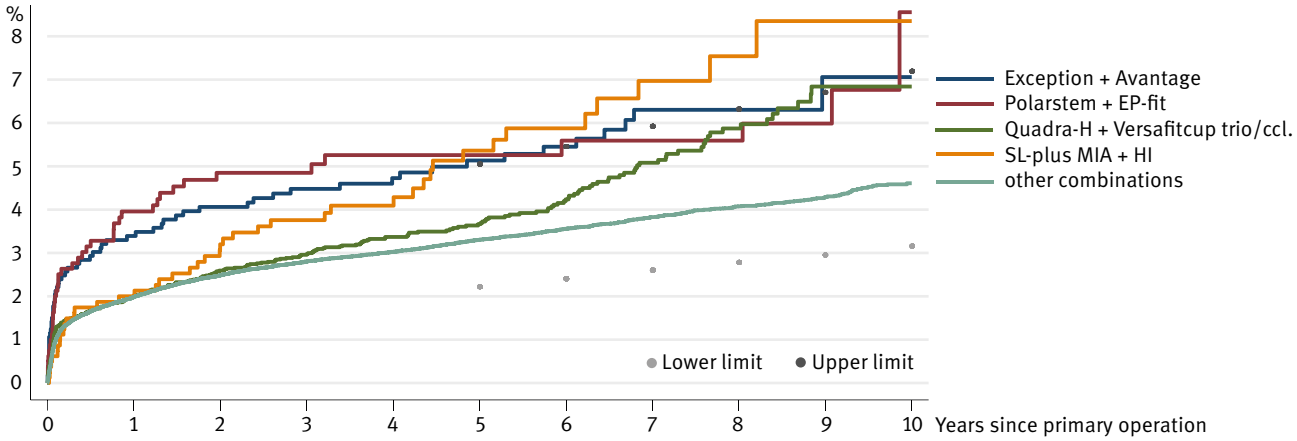
Stem component	Cup component	Total N	CCS*	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Actis	Pinnacle	959	32	**1.0** (0.5-2.0)	**1.3** (0.7-2.4)			
Alloclassic	Fitmore	724	67	**2.2** (1.4-3.6)	**4.2** (3.0-6.0)	**5.0** (3.6-6.9)	**5.9** (4.3-8.0)	**5.9** (4.3-8.0)
Amistem-H	Versafitcup trio/ccl.	7,332	15	**1.9** (1.6-2.3)	**3.1** (2.8-3.6)	**4.3** (3.9-4.8)	**5.5** (5.0-6.0)	**6.8** (6.2-7.6)
Amistem-H collared	Versafitcup trio/ccl.	554	100	**0.9** (0.4-2.2)	**1.8** (1.0-3.4)	**1.8** (1.0-3.4)	**3.0** (1.6-5.6)	
Amistem-H prox coat.	Versafitcup trio/ccl.	3,242	12	**2.1** (1.7-2.7)	**2.9** (2.3-3.5)	**3.3** (2.7-4.0)		
Amistem-P	Versafitcup trio/ccl.	3,989	15	**2.2** (1.8-2.7)	**2.6** (2.1-3.3)			
Avenir	Alloclassic	591	68	**1.9** (1.0-3.3)	**2.4** (1.4-4.0)	**2.8** (1.7-4.5)	**3.3** (2.1-5.2)	**4.6** (2.7-8.0)
Avenir	Allofit	10,280	12	**1.9** (1.7-2.2)	**2.6** (2.3-2.9)	**3.0** (2.7-3.4)	**3.5** (3.1-3.9)	**3.8** (3.4-4.4)
Avenir	Fitmore	2678	16	**3.2** (2.6-4.0)	**4.0** (3.4-4.9)	**4.3** (3.6-5.2)	**4.6** (3.8-5.5)	**4.6** (3.8-5.5)
CLS Spotorno	Allofit	1478	34	**2.6** (1.9-3.5)	**3.9** (3.0-5.0)	**4.4** (3.4-5.6)	**4.6** (3.6-5.9)	**5.7** (4.3-7.6)
CLS Spotorno	Fitmore	1799	23	**1.6** (1.1-2.3)	**2.2** (1.6-3.0)	2.9 (2.1-3.8)	**3.0** (2.2-3.9)	**3.1** (2.3-4.1)
Corail	Pinnacle	12,179	11	**2.1** (1.9-2.4)	**3.1** (2.8-3.4)	**3.7** (3.3-4.1)	**4.3** (3.9-4.7)	**5.7** (4.9-6.7)
Corail collared	Gyros	956	65	**2.0** (1.3-3.1)	**2.7** (1.8-3.9)	**2.7** (1.8-3.9)	**3.4** (2.2-5.2)	**3.4** (2.2-5.2)
Corail collared	Novae TH/Bi-Mentum	852	33	**1.4** (0.8-2.5)	**2.8** (1.2-6.7)	**2.8** (1.2-6.7)		
Corail collared	Pinnacle	11,752	23	**1.5** (1.2-1.7)	**2.1** (1.9-2.5)	**2.5** (2.1-2.8)	**2.9** (2.5-3.4)	**3.1** (2.6-3.6)
Exception	Avantage	1,135	78	**3.4** (2.5-4.6)	**4.5** (3.4-5.9)	**5.1** (3.9-6.7)	**6.3** (4.9-8.2)	**7.1** (5.2-9.6)
Fitmore	Allofit	6,782	66	**1.9** (1.6-2.2)	**2.9** (2.5-3.3)	**3.2** (2.8-3.7)	**3.6** (3.1-4.1)	**4.0** (3.5-4.7)
Fitmore	Fitmore	5,413	25	**1.9** (1.6-2.3)	**2.9** (2.4-3.4)	**3.4** (2.9-4.0)	**3.5** (3.0-4.1)	**4.3** (3.4-5.4)
Fitmore	RM pressfit vitamys	1,409	82	**1.2** (0.8-2.0)	**2.1** (1.5-3.1)	**2.4** (1.6-3.4)	**2.4** (1.6-3.4)	
Individual/custom hip	April ceramic	1,080	18	**1.8** (1.2-2.8)	**3.1** (2.1-4.4)	**3.8** (2.7-5.5)	**4.2** (2.9-6.1)	**4.2** (2.9-6.1)
Optimys	RM pressfit	704	19	**2.6** (1.7-4.1)	**2.8** (1.8-4.4)	**3.5** (2.2-5.4)	**4.0** (2.5-6.2)	
Optimys	RM pressfit vitamys	17,232	10	**1.8** (1.6-2.0)	**2.2** (2.0-2.5)	**2.4** (2.2-2.7)	**2.6** (2.3-2.9)	**2.9** (2.3-3.6)
Polarstem	EP-fit	802	52	**4.0** (2.8-5.6)	**4.8** (3.5-6.6)	**5.3** (3.9-7.2)	**5.6** (4.1-7.6)	**8.6** (5.2-13.9)
Polarstem	Polarcup	2,112	76	**2.1** (1.5-2.8)	**2.3** (1.7-3.0)	**2.3** (1.7-3.0)	**2.5** (1.9-3.4)	**2.7** (2.0-3.7)
Polarstem	R3	6,685	63	**1.1** (0.9-1.4)	**1.6** (1.4-2.0)	**1.7** (1.4-2.1)	**2.0** (1.7-2.5)	**2.5** (1.9-3.4)
Quadra-H	Mpact	526	44	**2.1** (1.2-3.8)	**2.6** (1.5-4.4)	**2.6** (1.5-4.4)		
Quadra-H	Versafitcup trio/ccl.	7,119	18	**2.0** (1.7-2.4)	**3.0** (2.6-3.4)	**3.7** (3.2-4.2)	**5.1** (4.4-5.8)	**6.8** (5.8-8.0)
Quadra-P	Versafitcup trio/ccl.	1,677	27	**1.3** (0.8-2.0)	**2.2** (1.0-4.5)			
SBG	R3	1,613	43	**1.3** (0.9-2.0)	**1.8** (1.3-2.6)	**2.3** (1.6-3.3)	**2.6** (1.8-3.9)	
SL-plus MIA	EP-fit	1,203	31	**2.0** (1.3-3.0)	**2.3** (1.6-3.3)	**2.6** (1.8-3.8)	**2.6** (1.8-3.8)	**3.1** (2.0-4.7)
SL-plus MIA	HI	811	47	**2.0** (1.2-3.2)	**3.8** (2.6-5.4)	**5.4** (3.9-7.4)	**7.0** (5.1-9.6)	**8.4** (5.9-11.8)
SL-plus MIA	R3	1,889	64	**0.8** (0.5-1.3)	**1.2** (0.8-1.8)	**1.3** (0.9-2.0)	**1.4** (0.9-2.1)	**2.2** (1.2-4.2)
SPS evolution	April ceramic	1,523	37	**4.9** (3.9-6.1)	**6.5** (5.3-7.9)	**6.8** (5.6-8.2)	**7.2** (5.9-8.8)	**7.2** (5.9-8.8)
Tri-Lock	Pinnacle	767	66	**1.2** (0.6-2.3)	**2.7** (1.8-4.2)	**3.1** (2.0-4.7)	**3.6** (2.4-5.4)	**3.6** (2.4-5.4)
Twinsys	RM pressfit vitamys	4,072	16	**2.2** (1.8-2.7)	**2.9** (2.4-3.5)	**3.4** (2.8-4.0)	**4.0** (3.3-4.8)	**4.8** (3.8-6.0)
other combinations		19,608		**2.6** (2.4-2.9)	**3.7** (3.4-4.0)	**4.5** (4.1-4.8)	**5.2** (4.8-5.6)	**6.2** (5.7-6.8)
CH average for group				**2.0** (1.9-2.1)	**2.8** (2.8-2.9)	**3.4** (3.3-3.5)	**3.9** (3.8-4.1)	**4.8** (4.6-5.0)

* Case concentration score. Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

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.

Figure 3.5a

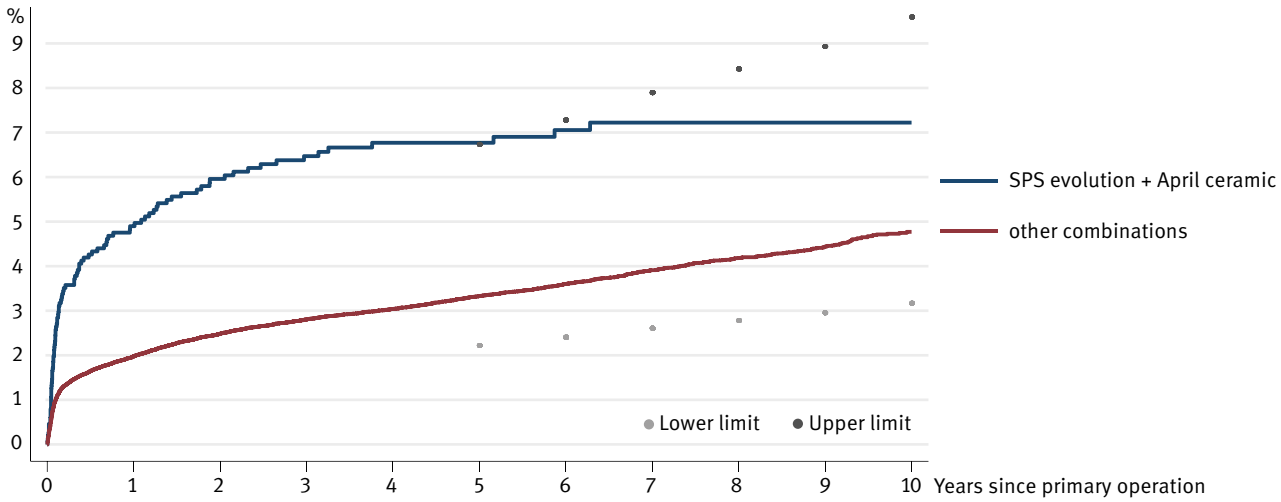
Implant combinations with elevated long-term revision rates (primary OA, uncemented THA)



An elevated revision rate was defined as a deviation of at least 50% above the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

Figure 3.5b

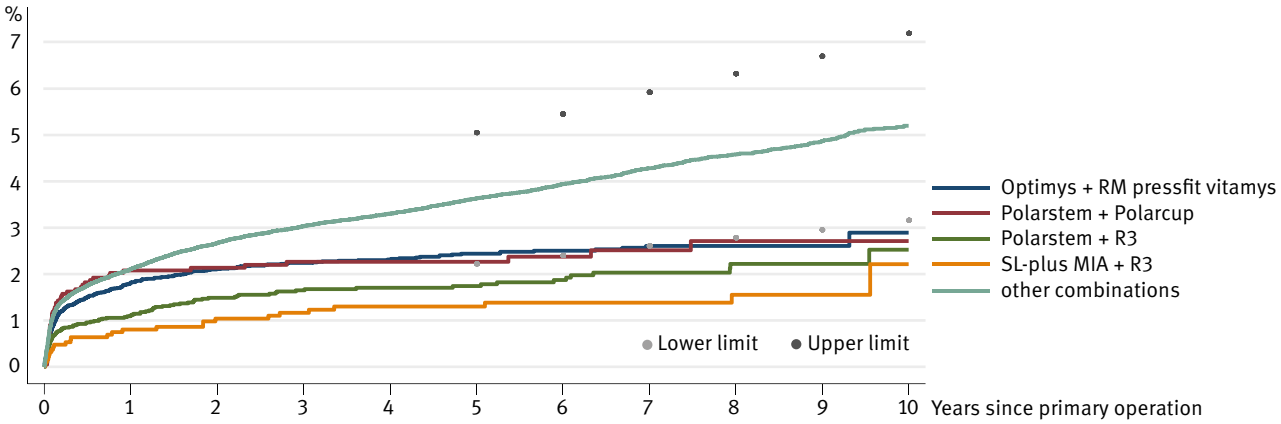
Implant combinations with long-term evaluation outlier status (primary OA, uncemented THA)



Outlier status was defined as a revision rate of twice the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

Figure 3.5c

Implant combinations with below-average long-term revision rates (primary OA, uncemented THA)



Below-average was defined as an 9-year/10-year revision rate of up to 66% of the group average (and upper bounds of the 95% confidence interval staying below the lower bound of the group average; and at least 25 cases at risk at 9 years/10 years). The dots indicate upper and lower limits.

staying below the lower bound of the group average). The KM estimate for implants with an elevated revision rate is shown in **Figure 3.5a,** and four implant combinations with an elevated revision rate were detected, three of which already had an elevated revision risk in 2022 (Exception/Avantage, Polarstem/EP-fit, and SL plus MIA/HI). The combination Polarstem/EP-fit has an outlier status at 2 years. In contrast, the combination Quadra-H/Versafitcup trio/ccl has a normal revision rate until 6 years, after which the revision rate increases until it reached the status of an implant combination with an elevated revision rate in 2022.

There is one outlier, SPS Evolution/April ceramic, which already has outlier status at 2 years as the revision rate amounts to 7.0% (CI 5.2–9.5). After a steep early rise of the revision rate, the curve flattens over subsequent years, although the outlier boundary is exceeded after 5 years. The high revision rate is mainly influenced by one centre with a conspicuous revision rate **(Figure 3.5b).**

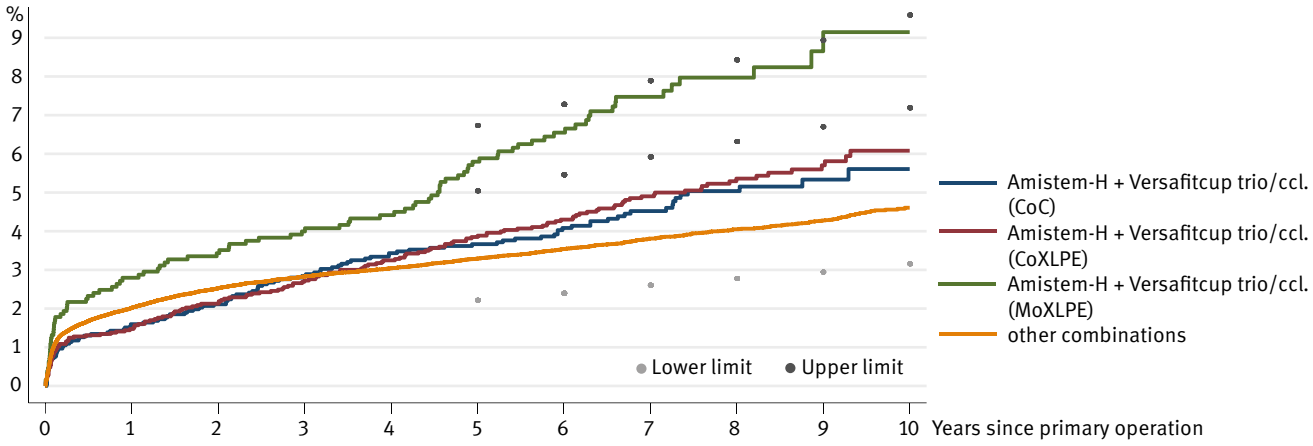
Figure 3.5c shows four implant combinations with a below-average revision rate. The curves of these well-performing implant combinations display two patterns: the first with an early revision rate but then an almost horizontal continuation, and the second with a very low initial revision rate followed by a flat rise.

The KM estimate of cumulative revision risk for all other uncemented implant combinations from **Table 3.5b** is shown in **Figure 3.5e.** These curves run between the upper and lower limits, corresponding to the elevated and below-average revision risk at 150% and 66% from the group average. The limits are graphically represented by dots from the 5-year mark onwards.

Most cup systems are modular allowing the use of different bearings. For the 75% most commonly used implant combinations, the revision rate depending on the bearing surface was calculated **(Table 3.5c).** Although there are differences between the various bearings, these do not reach statistical

Figure 3.5d

Implant combinations (primary OA, uncemented THA): Amistem variants with different bearing surfaces



Outlier status was defined as a revision rate of twice the group average at any time between year 5 and year 10 (and lower bounds of the 95% conf. interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

significance and only Amistem-H/Versafticup trio/ccl. combined with MoXLPE has a significantly elevated revision rate at 10 years. This is mainly due to early revisions, after which the curves are more parallel. Overall, the pattern is not uniform as shown by examples in which CoXLPE has more revisions than MoXLPE. However, there is a trend towards slightly more revisions using CoC bearings.

Figure 3.5d shows the KM curves for the different bearing combinations for Amistem-H/Versafitcup trio/ccl. compared to the average of the group, which indicates that the combination with MoXLPE has an excessively high revision rate that reaches outlier status after 9 years (crosses upper limit 2 = outlier boundary).

Table 3.5c (Part 1)

Long term evaluation: Failure rates of primary total hip arthroplasty uncemented combinations and different bearing surfaces (primary OA)

Stem component	Cup component	Total N	Bearing surface	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Actis	Pinnacle	538	CoPE	**1.1** (0.5-2.7)	**1.6** (0.7-3.6)			
Alloclassic	Fitmore	677	CoXLPE	**1.9** (1.1-3.3)	**3.9** (2.7-5.7)	**4.8** (3.4-6.7)	**5.7** (4.1-7.8)	**5.7** (4.1-7.8)
Amistem-H	Versafitcup trio/ccl.	2,385	CoC	**1.6** (1.2-2.2)	**2.8** (2.2-3.6)	**3.7** (3.0-4.5)	**4.5** (3.7-5.5)	**5.6** (4.5-6.9)
Amistem-H	Versafitcup trio/ccl.	3,129	CoXLPE	**1.5** (1.1-2.0)	**2.7** (2.2-3.4)	**3.9** (3.2-4.6)	**4.9** (4.2-5.8)	**6.1** (5.2-7.2)
Amistem-H	Versafitcup trio/ccl.	1,291	MoXLPE	**2.8** (2.0-3.9)	**4.0** (3.1-5.2)	**5.8** (4.6-7.3)	**7.5** (6.1-9.2)	**9.1** (7.3-11.5)
Amistem-H collared	Versafitcup trio/ccl.	543	CoC	**0.9** (0.4-2.2)	**1.9** (1.0-3.5)	**1.9** (1.0-3.5)	**3.0** (1.6-5.7)	
Amistem-H prox coat.	Versafitcup trio/ccl.	1,388	CoC	**1.4** (0.9-2.2)	**2.1** (1.5-3.0)	**2.5** (1.7-3.6)		
Amistem-H prox coat.	Versafitcup trio/ccl.	1,336	CoXLPE	**2.7** (2.0-3.7)	**3.3** (2.5-4.5)	**3.7** (2.8-4.9)		
Amistem-P	Versafitcup trio/ccl.	2,025	CoC	**1.6** (1.1-2.3)	**2.0** (1.4-2.8)			
Amistem-P	Versafitcup trio/ccl.	1,489	CoXLPE	**2.4** (1.8-3.4)	**2.6** (1.9-3.7)			
Avenir	Allofit	7,727	CoXLPE	**1.7** (1.4-2.0)	**2.3** (2.0-2.7)	**2.7** (2.3-3.1)	**3.2** (2.7-3.7)	**3.6** (3.0-4.2)
Avenir	Allofit	2,109	MoXLPE	**2.5** (1.9-3.3)	**3.3** (2.6-4.2)	**3.6** (2.9-4.6)	**3.9** (3.1-4.9)	**4.1** (3.2-5.2)
Avenir	Fitmore	1,997	CoXLPE	**3.3** (2.6-4.2)	**4.1** (3.3-5.2)	**4.5** (3.6-5.5)	**4.9** (3.9-6.1)	**4.9** (3.9-6.1)
Avenir	Fitmore	563	MoXLPE	**2.7** (1.6-4.4)	**3.5** (2.2-5.4)	**3.5** (2.2-5.4)	**3.5** (2.2-5.4)	**3.5** (2.2-5.4)
CLS Spotorno	Allofit	1,179	CoXLPE	**3.0** (2.1-4.1)	**4.4** (3.3-5.7)	**4.8** (3.6-6.2)	**5.1** (3.9-6.6)	**6.6** (4.5-9.5)
CLS Spotorno	Fitmore	844	CoXLPE	**1.9** (1.2-3.1)	**2.6** (1.7-4.0)	**3.5** (2.4-5.1)	**3.7** (2.5-5.4)	**3.7** (2.5-5.4)
CLS Spotorno	Fitmore	932	MoXLPE	**1.3** (0.7-2.3)	**1.9** (1.2-3.1)	**2.4** (1.5-3.7)	**2.4** (1.5-3.7)	**2.7** (1.7-4.1)
Corail	Pinnacle	1,811	CoC	**2.0** (1.5-2.8)	**3.3** (2.5-4.2)	**4.2** (3.3-5.3)	**4.5** (3.6-5.6)	**6.0** (4.4-8.1)
Corail	Pinnacle	4,527	CoPE	**2.3** (1.9-2.8)	**3.2** (2.7-3.8)	**3.4** (2.9-4.1)	**3.8** (3.2-4.5)	**5.2** (3.9-6.9)
Corail	Pinnacle	4,877	CoXLPE	**2.0** (1.7-2.5)	**2.9** (2.5-3.5)	**3.7** (3.1-4.3)	**4.2** (3.6-5.0)	**5.6** (4.3-7.2)
Corail	Pinnacle	603	MoXLPE	**1.8** (1.0-3.3)	**2.9** (1.8-4.6)	**3.2** (2.0-5.1)	**5.3** (3.4-8.2)	**7.5** (3.9-14.1)
Corail collared	Gyros	808	CoPE	**2.0** (1.2-3.2)	**2.8** (1.8-4.2)	**2.8** (1.8-4.2)	**3.6** (2.3-5.7)	**3.6** (2.3-5.7)
Corail collared	Novae TH/Bi-Mentum	675	CoPE	**1.6** (0.9-3.0)	**3.2** (1.4-7.5)	**3.2** (1.4-7.5)		
Corail collared	Pinnacle	1,952	CoC	**2.0** (1.4-2.7)	**2.7** (2.0-3.6)	**3.1** (2.4-4.1)	**3.6** (2.7-4.8)	**3.6** (2.7-4.8)

* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

Table 3.5c (Part 2)

Long term evaluation: Failure rates of primary total hip arthroplasty uncemented combinations and different bearing surfaces (primary OA)

Stem component	Cup component	Total N	Bearing surface	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Corail collared	Pinnacle	7,819	CoPE	**1.3** (1.1-1.6)	**2.0** (1.6-2.3)	**2.2** (1.8-2.6)	**2.6** (2.1-3.3)	
Corail collared	Pinnacle	1,631	CoXLPE	**1.5** (1.0-2.2)	**2.0** (1.4-2.8)	**2.4** (1.7-3.3)	**2.8** (1.9-3.9)	**3.1** (2.1-4.5)
Exception	Avantage	903	CoXLPE	**3.6** (2.6-5.0)	**4.6** (3.4-6.2)	**5.2** (3.9-7.0)	**6.4** (4.8-8.4)	**6.4** (4.8-8.4)
Fitmore	Allofit	4,737	CoXLPE	**1.7** (1.3-2.1)	**2.6** (2.1-3.1)	**2.9** (2.4-3.5)	**3.3** (2.8-4.0)	**3.6** (2.9-4.4)
Fitmore	Allofit	1,937	MoXLPE	**2.2** (1.6-3.0)	**3.2** (2.5-4.1)	**3.6** (2.9-4.6)	**3.8** (3.0-4.8)	**4.2** (3.3-5.3)
Fitmore	Fitmore	2,434	CoXLPE	**1.7** (1.2-2.3)	**2.5** (1.9-3.2)	**3.5** (2.7-4.6)	**3.5** (2.7-4.6)	**3.5** (2.7-4.6)
Fitmore	Fitmore	2,936	MoXLPE	**2.1** (1.6-2.7)	**3.2** (2.6-3.9)	**3.5** (2.8-4.2)	**3.6** (2.9-4.4)	**4.6** (3.5-6.1)
Fitmore	RM pressfit vitamys	1,277	CoXLPE	**1.1** (0.6-1.8)	1.6 (1.0-2.6)	**1.8** (1.2-2.8)	**1.8** (1.2-2.8)	
Individ./custom hip	April ceramic	1,062	CoC	**1.9** (1.2-2.9)	**3.1** (2.2-4.5)	**3.9** (2.7-5.6)	**4.3** (2.9-6.2)	**4.3** (2.9-6.2)
Optimys	RM pressfit vitamys	16,859	CoXLPE	**1.8** (1.6-2.0)	**2.2** (2.0-2.5)	**2.4** (2.2-2.7)	**2.6** (2.3-2.9)	**2.9** (2.3-3.7)
Optimys	RM pressfit	573	CoPE	**1.8** (1.0-3.3)	**2.0** (1.1-3.6)	**2.8** (1.6-4.9)	**3.3** (1.9-5.8)	
Polarstem	Polarcup	1,811	CoXLPE	**2.1** (1.5-2.9)	**2.3** (1.7-3.1)	**2.3** (1.7-3.1)	**2.6** (1.9-3.6)	**2.9** (2.0-4.0)
Polarstem	R3	6,525	CoXLPE	**1.1** (0.9-1.4)	**1.6** (1.3-2.0)	**1.7** (1.4-2.1)	**2.0** (1.6-2.4)	**2.2** (1.7-2.7)
Quadra-H	Versafitcup trio/ccl.	1,108	CoC	**1.5** (0.9-2.4)	**2.2** (1.5-3.4)	**2.6** (1.7-3.8)	**3.1** (2.0-4.5)	
Quadra-H	Versafitcup trio/ccl.	4,453	CoXLPE	**2.1** (1.7-2.6)	**3.2** (2.7-3.8)	**4.0** (3.4-4.7)	**5.8** (4.9-6.9)	**7.4** (5.9-9.2)
Quadra-H	Versafitcup trio/ccl.	1,410	MoXLPE	**2.3** (1.6-3.2)	**2.9** (2.1-3.9)	**3.5** (2.6-4.7)	**4.5** (3.4-6.0)	**5.9** (4.4-8.0)
Quadra-P	Versafitcup trio/ccl.	1,157	CoXLPE	**1.4** (0.8-2.4)	**1.7** (1.0-2.8)			
SBG	R3	815	CoC	**1.4** (0.8-2.5)	**1.6** (1.0-2.8)	**1.9** (1.1-3.3)	**2.7** (1.4-5.3)	
SBG	R3	788	CoXLPE	**1.3** (0.7-2.4)	**2.0** (1.2-3.4)	**2.7** (1.7-4.3)	**2.7** (1.7-4.3)	
SL-plus MIA	EP-fit	559	CoC	**2.7** (1.6-4.4)	**2.7** (1.6-4.4)	**2.9** (1.8-4.7)	**2.9** (1.8-4.7)	**2.9** (1.8-4.7)
SL-plus MIA	R3	1,869	CoXLPE	**0.8** (0.5-1.3)	**1.2** (0.8-1.8)	**1.3** (0.9-2.0)	**1.4** (0.9-2.1)	**2.3** (1.2-4.3)
SPS evolution	April ceramic	1,507	CoC	**4.9** (3.9-6.1)	**6.5** (5.3-7.9)	**6.8** (5.6-8.2)	**7.2** (5.9-8.8)	**7.2** (5.9-8.8)
Twinsys	RM pressfit vitamys	3,965	CoXLPE	**2.2** (1.8-2.7)	**2.9** (2.4-3.5)	**3.4** (2.8-4.1)	**4.0** (3.4-4.9)	**4.8** (3.8-6.1)
Twinsys	RM pressfit vitamys	3,965	CoXLPE	**2.2** (1.8-2.7)	**2.9** (2.4-3.5)	**3.4** (2.8-4.1)	**4.0** (3.4-4.9)	**4.8** (3.8-6.1)

* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

Figure 3.5e

All remaining implant combinations with average revision risks (primary OA, uncemented THA)

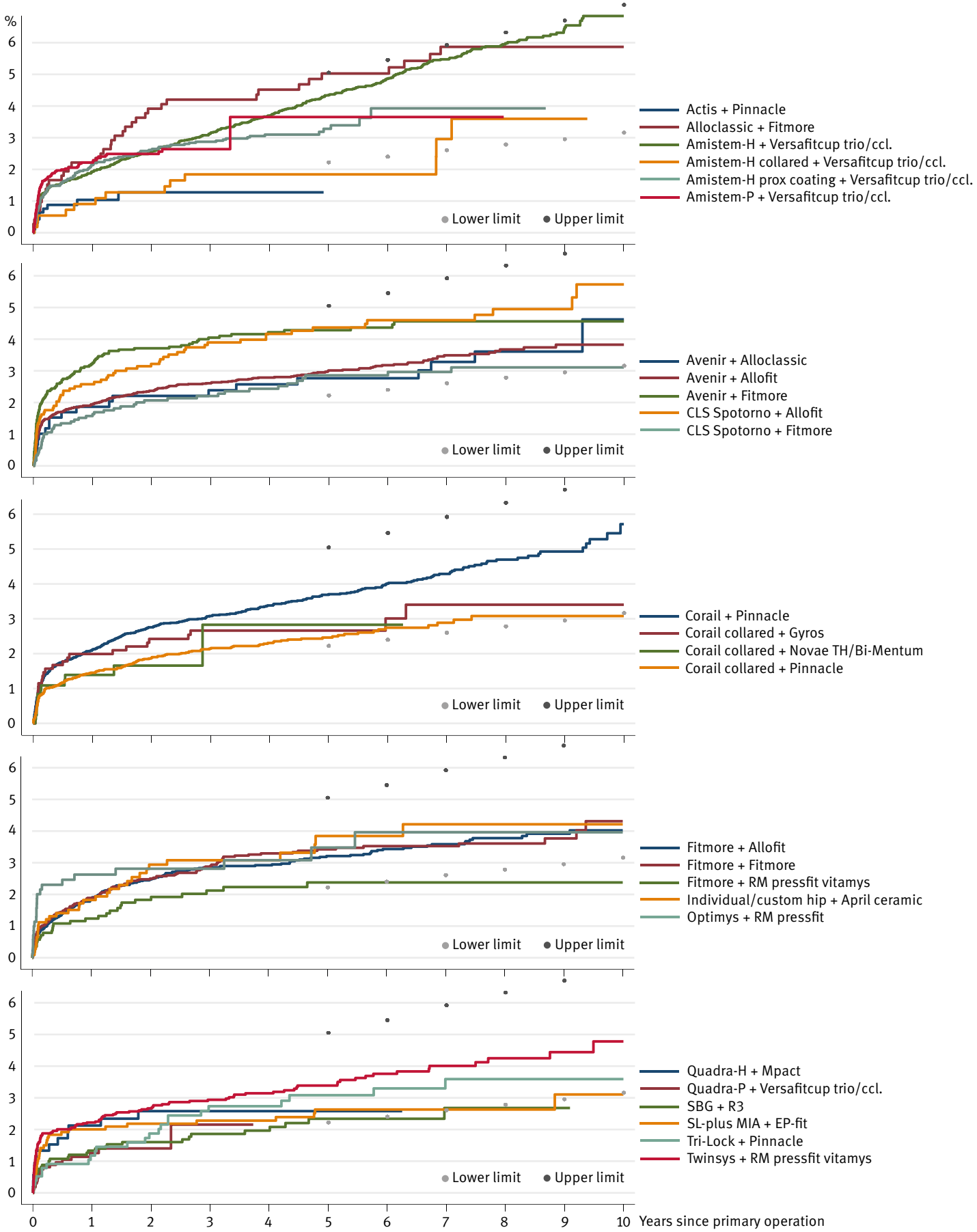


Figure 3.5e also showing upper and lower limits (corresp. to elevated and below-average version risk at 150% and 66% of the group average resp.).

Ten-year revision rates

Hybrid combinations for primary OA

Table 3.5d shows the 20 hybrid implant combinations thad cover 75% of all implantations while **Table 3.5e** shows the revision rates for the period since 2012 for hybrid implantations carried out for primary OA in which only stem/cup combinations with n › 500 are included. At 10 years, the average revision rate for all hybrid stem/cup combinations was 4.9 (CI 4.2–5.8) and there were no outliers, nor combinations with elevated mid-term revision rates, at this time point. While one implant combination (Corail [cem]/Pinnacle) had a below-average long-term revision rate **(Figure 3.5f),** as shown in **Figure 3.5g,** all remaining implants were within the upper and lower limits. Some curves run below the lower limit but are not implant combinations with below-average long-term revision rates because their confidence intervals are wide (small numbers), overlapping with the reference group, and therefore are not statistically different.

Table 3.5d

Top 75% of primary total hip arthroplasty hybrid combinations (primary OA)

2017–2022

Stem component	Cup component	2017	2018	2019	2020	2021	2022	2017–2022
Amistem-C	Mpact	15	26	27	31	15	20	**134**
Amistem-C	Versafitcup DM	14	23	27	28	26	24	**142**
Amistem-C	Versafitcup trio/ccl.	207	187	208	161	181	190	**1,134**
Avenir (cemented)	Allofit	62	130	97	94	94	95	**572**
Avenir (cemented)	Fitmore	11	29	53	54	77	131	**355**
Centris	RM pressfit vitamys	77	50	31	55	64	0	**277**
Corail (cemented)	Novae TH/Bi-Mentum	0	1	1	14	37	72	**125**
Corail (cemented)	Pinnacle	125	118	130	150	168	186	**877**
Harmony (cemented)	Liberty	24	27	24	14	26	13	**128**
MS-30	Allofit	29	43	48	43	69	230	**462**
MS-30	Fitmore	90	90	70	54	16	32	**352**
Original Mueller	Allofit	26	16	22	22	21	8	**115**
Original Mueller	Fitmore	44	37	30	20	19	5	**155**
Quadra-C	Versafitcup trio/ccl.	188	177	205	155	80	13	**818**
Quadra-P (cemented)	Versafitcup trio/ccl.	0	0	0	9	49	71	**129**
Twinsys (cemented)	RM pressfit	29	5	18	19	34	15	**120**
Twinsys (cemented)	RM pressfit vitamys	79	157	196	198	284	313	**1,227**
Weber	Allofit	95	77	48	38	31	30	**319**
Weber	Avantage	31	35	21	8	2	1	**98**
Weber	Fitmore	244	195	180	162	148	104	**1,033**
other combinations		357	436	486	419	511	562	**2,771**
Total		**1,747**	**1,859**	**1,922**	**1,748**	**1,952**	**2,115**	**11,343**

Table 3.5e

Long term evaluation: Failure rates of primary total hip arthroplasty hybrid combinations (primary OA)

Time since operation, 2012–2022.

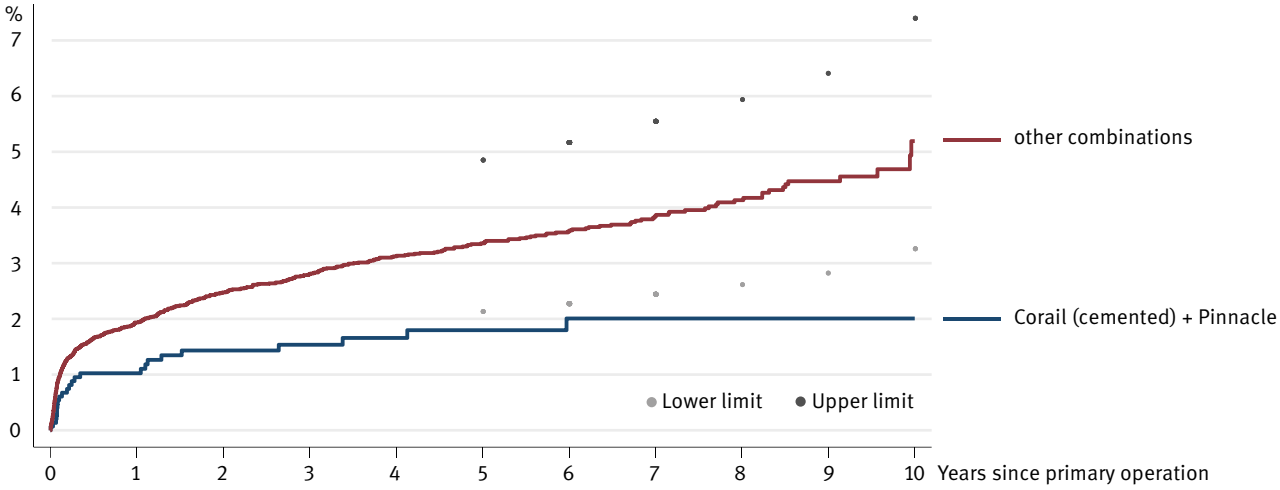
Stem component	Cup component	Total number	CCS*	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Amistem-C	Versafitcup trio/ccl.	2,176	24	**2.3** (1.7-3.0)	**2.9** (2.2-3.7)	**3.3** (2.6-4.2)	**3.8** (3.0-4.9)	**4.8** (3.5-6.5)
Avenir (cem)	Allofit	678	18	**1.9** (1.1-3.3)	**2.3** (1.3-3.8)	**2.3** (1.3-3.8)	**2.3** (1.3-3.8)	
Corail (cem)	Pinnacle	1,513	21	**1.0** (0.6-1.7)	**1.5** (1.0-2.4)	**1.8** (1.2-2.7)	**2.0** (1.3-3.1)	**2.0** (1.3-3.1)
MS-30	Allofit	663	60	**1.1** (0.5-2.3)	**1.7** (0.9-3.2)	**1.7** (0.9-3.2)	**1.7** (0.9-3.2)	**1.7** (0.9-3.2)
MS-30	Fitmore	810	55	**1.1** (0.6-2.2)	**1.5** (0.9-2.7)	**1.5** (0.9-2.7)	**1.9** (1.1-3.3)	**3.4** (1.6-7.4)
Quadra-C	Versafitcup trio/ccl.	1,034	32	**2.2** (1.5-3.4)	**3.1** (2.2-4.4)	**3.5** (2.5-5.1)	**3.5** (2.5-5.1)	
Twinsys (cem)	RM pressfit vitamys	1,410	19	**1.0** (0.6-1.8)	**1.5** (0.9-2.4)	**2.7** (1.6-4.5)	**3.3** (1.9-5.8)	
Weber	Allofit	748	28	**1.9** (1.1-3.2)	**2.8** (1.8-4.4)	**3.0** (2.0-4.6)	**4.0** (2.6-6.0)	**6.3** (3.4-11.5)
Weber	Fitmore	2,346	28	**1.5** (1.1-2.1)	**2.5** (2.0-3.3)	**3.4** (2.7-4.4)	**4.2** (3.3-5.3)	**4.7** (3.7-6.0)
other combinations		7,388		**2.3** (1.9-2.6)	**3.3** (2.9-3.8)	**4.0** (3.5-4.5)	**4.4** (3.8-5.0)	**6.0** (4.7-7.7)
CH average for group				**1.9** (1.7-2.1)	**2.7** (2.5-3.0)	**3.2** (3.0-3.5)	**3.7** (3.4-4.0)	**4.9** (4.2-5.8)

* Case concentration score. Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

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.

Figure 3.5f

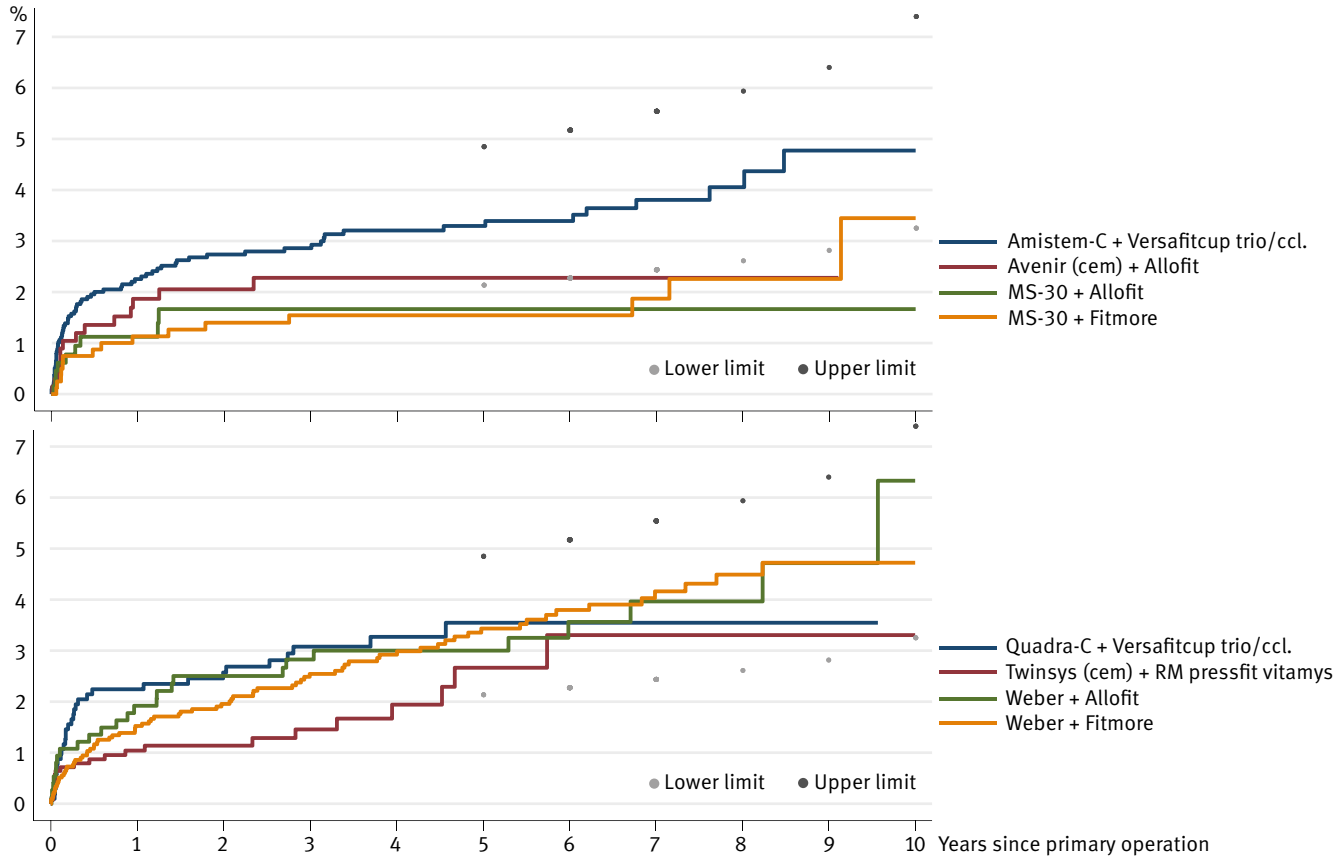
Implant combinations with below-average long-term revision rates (primary OA, hybrid THA)



Below-average was defined as a 9-year revision rate of up to 66% of the group average (and upper bounds of the 95% confidence interval staying below the lower bound of the group average; and at least 25 cases at risk at 9 years). The dots indicate upper and lower limits.

Figure 3.5g

All remaining implant combinations with average revision risks (primary OA, hybrid fixation THA)



Ten-year revision rates

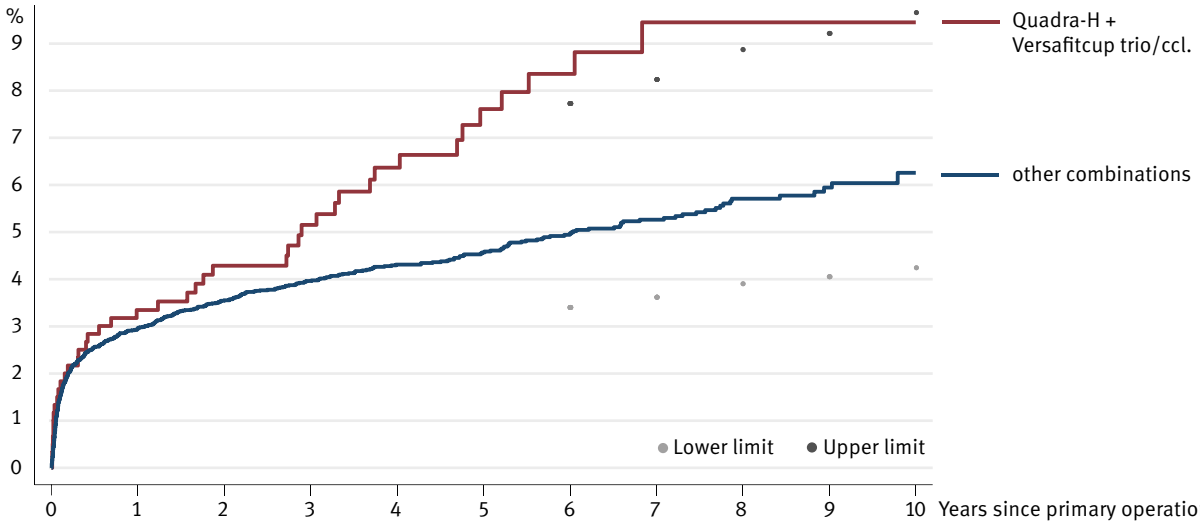
Uncemented combinations for secondary OA

Table 3.5f shows the 19 implant combinations that cover 75% of all implantations. The revision rates for the period since 2012 for uncemented implantations for secondary OA was 6.4% (CI 5.7–7.2) **(Table 3.5g)** and only stem/cup combinations with n › 500 are included. Although there were no outliers at 10 years, one combination (Quadra-H/Versafitcup Trio/ccl.) continued to have an elevated long-term revision rate **(Figure 3.5h).** Furthermore, there were no outliers at 10 years, nor combinations with a below-average long-term revision rate as all other implant combinations were within the upper and lower limits **(Figure 3.5i).** There were no combinations with below-average long-term revision rates.

Because of the relatively small numbers entered in the dataset, the data for all cemented and hybrid fixations for secondary OA are not presented while the results for THAs used to treat fractures are presented in Chapter 3.8.

Figure 3.5h

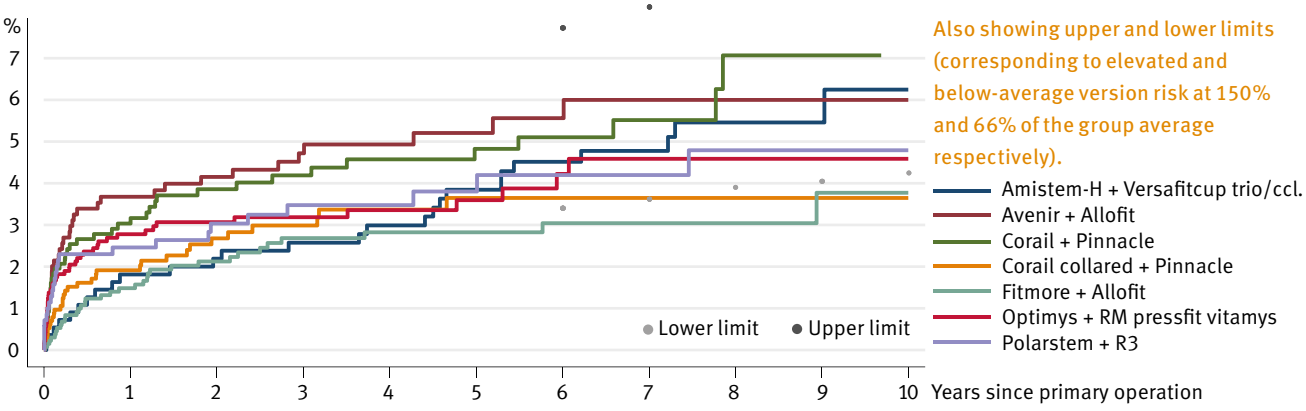
Implant combinations with elevated long-term revision rates (sec OA, uncemented THA)



An elevated revision rate was defined as a deviation of at least 50% above the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

Figure 3.5i

All remaining implant combinations with average revision risks (secondary OA, uncemented THA)



Also showing upper and lower limits (corresponding to elevated and below-average version risk at 150% and 66% of the group average respectively).

Table 3.5f

Top 75% of primary total hip arthroplasty uncemented combinations (secondary OA) 2017–2022

Stem component	Cup component	2017	2018	2019	2020	2021	2022	2017–2022
Actis	Pinnacle	0	1	9	15	36	68	**129**
Amistem-H prox coating	Versafitcup trio/ccl.	102	115	56	3	3	0	**279**
Amistem-P	Versafitcup trio/ccl.	0	1	41	111	117	98	**368**
Avenir	Allofit	71	90	91	102	54	67	**475**
Avenir	Fitmore	25	18	20	21	24	12	**120**
CLS Spotorno	Allofit	30	30	35	23	9	5	**132**
Corail	Pinnacle	96	66	76	79	110	89	**516**
Corail collared	Pinnacle	106	105	107	123	199	234	**874**
Fitmore	Allofit	134	121	123	131	173	177	**859**
Fitmore	Fitmore	31	32	58	52	37	46	**256**
Fitmore	RM pressfit vitamys	5	6	11	33	23	23	**101**
Individual/custom hip	April ceramic	19	22	20	18	35	23	**137**
Optimys	RM pressfit vitamys	107	149	145	179	218	259	**1,057**
Polarstem	Polarcup	1	2	19	30	29	46	**127**
Polarstem	R3	43	61	73	89	89	91	**446**
Quadra-H	Versafitcup trio/ccl.	80	79	69	51	42	12	**333**
Quadra-P	Versafitcup trio/ccl.	0	0	2	20	40	100	**162**
SBG	R3	14	22	22	33	18	6	**115**
Twinsys	RM pressfit vitamys	45	33	26	33	40	35	**212**
other combinations		349	331	343	337	368	448	**2,176**
Total		**1,258**	**1,284**	**1,346**	**1,483**	**1,664**	**1,839**	**8,874**

Table 3.5g

Long term evaluation: Failure rates of primary total hip arthroplasty uncemented combinations (secondary OA)

Time since operation, 2012–2022.

Stem component	Cup component	Total number	CCS*	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Amistem-H	Versafitcup trio/ccl.	555	14	**1.8** (1.0-3.3)	**2.6** (1.5-4.3)	**3.8** (2.5-5.9)	**4.8** (3.2-7.1)	**6.2** (4.1-9.4)
Avenir	Allofit	751	15	**3.7** (2.5-5.3)	**4.7** (3.4-6.6)	**5.2** (3.7-7.2)	**6.0** (4.3-8.4)	**6.0** (4.3-8.4)
Corail	Pinnacle	911	10	**2.9** (2.0-4.2)	**4.0** (2.9-5.6)	**4.6** (3.3-6.3)	**5.2** (3.8-7.2)	**9.4** (4.8-18.0)
Corail collared	Pinnacle	1,149	30	**1.9** (1.3-2.9)	**3.0** (2.1-4.3)	**3.6** (2.5-5.2)	**3.6** (2.5-5.2)	**3.6** (2.5-5.2)
Fitmore	Allofit	1,339	89	**1.5** (0.9-2.3)	**2.7** (1.9-3.8)	**2.8** (2.0-4.0)	**3.0** (2.1-4.3)	**3.8** (2.4-6.0)
Optimys	RM pressfit vitamys	1,387	19	**2.8** (2.0-3.8)	**3.2** (2.3-4.3)	**3.6** (2.6-4.9)	**4.6** (3.2-6.5)	
Polarstem	R3	701	79	**2.5** (1.5-3.9)	**3.5** (2.3-5.3)	**3.8** (2.5-5.7)	**4.2** (2.8-6.4)	**4.8** (3.1-7.4)
Quadra-H	Versafitcup trio/ccl.	599	26	**3.3** (2.2-5.1)	**5.2** (3.6-7.3)	**7.6** (5.5-10.4)	**9.4** (6.9-12.9)	**9.4** (6.9-12.9)
other combinations		6,339		**3.6** (3.1-4.1)	**4.6** (4.1-5.2)	**5.3** (4.7-6.0)	**6.2** (5.5-7.0)	**7.0** (6.1-8.0)
CH average for group				**3.0** (2.7-3.3)	**4.0** (3.7-4.4)	**4.7** (4.3-5.2)	**5.5** (5.0-6.0)	**6.4** (5.7-7.2)

* Case concentration score. Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

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.

Two-year revision rates

Uncemented combinations for primary OA

The 2-year revision rate is an important time point for gathering initial results about the early performance of an implant, especially since most complications occur within the first 3 months after implantation **(Figure 3.4a),** when loosening is not yet a problem **(Figure 3.4b).** At 2 years, therefore, the initial phase has passed and the long-term effects have not yet set in which makes it a good time point to observe and describe the performance of an implant.

The timeframe observed comprises a 4-year period with a full 2 years of follow-up. This 4-year period consecutively moves 1 year further every year and the use of a moving time window leads to results reflecting the actual trends and currently used implants more reliably and also eliminates the burden of the past. Furthermore, it allows for the comparison of periods and monitoring of the evolution of revision rates, newer implants, and surgical results. This also facilitates the registry's function of being an early warning system for hospitals and surgeons. Moreover, 2 years is also a standard period for reporting early clinical results.

As 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 (e.g. uncemented stem/cup combinations used in THAs with a diagnosis of primary OA). The outlier alert boundary is set at twice that reference revision rate and an implant is regarded as a potential outlier when its 2-year revision rate is 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 and is considered "highly likely" when both the estimated revision rate and the complete confidence interval exceed the outlier alert boundary. For an implant combination with high numbers, the confidence interval is usually narrow and, 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 and if confidence intervals overlap, they should be regarded as not statistically different. For this reason, implants for which the revision rate exceeds double the mean revision rate, while the confidence intervals overlap, are defined as potential outliers and if the lower confidence interval exceeds twice the mean revision rate, it is considered a definitive outlier.

In this context, it is also important to note that some components that perform well in one combination do not necessarily perform as well in another.

The average revision rate is calculated for all primary implants for primary OA per fixation group for the moving 4-year window period from 1.1.2017 to 31.12.2020, covering a total of 56,350 uncemented and 7,207 hybrid fixations. The average revision rate for uncemented THAs was 2.5% (CI 2.4–2.6) and 2.6% (CI 2.2–2.9) for hybrid fixation. Because of infrequent use and small numbers, the analysis for all cemented THAs was not possible. Furthermore, due to the 4-year moving window for the analysis of the 2-year revision rates, the results of some of the implant combinations may be different to those reported in 2022.

Table 3.5h shows the 2-year revision rates of all uncemented implant combinations for primary OA with n › 50, whereby 96% of all combinations are covered within this list. In total, 1,994 implantations are attributed to combinations not reaching the minimum of 50 cases in the 4-year period and

Important information on the use of the implant performance tables below

- Estimated revision rate exceeds the alert boundary, but we do not identify this implant combination as an outlier because the 95% confidence interval overlaps the confidence zone of the reference group.
- 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 3.5h (Part 1)

2-year evaluation: Revision rates of uncemented primary total hip arthroplasty combinations within 24 months (primary OA)

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CSS*	at risk N**	Revised N	Revised % (95% CI)***
Accolade II	Trident II	42	78	7	9.1 (4.5-18.2)
Actis	Pinnacle	44	332	6	1.8 (0.8-4.0)
Alloclassic	Alloclassic	98	105	3	2.9 (0.9-8.7)
Alloclassic	Allofit	86	139	2	1.5 (0.4-5.7)
Alloclassic	Fitmore	85	150	9	6.0 (3.2-11.3)
Amistem-H	Mpact	62	52	1	1.9 (0.3-12.9)
Amistem-H	Versafitcup trio/ccl.	16	784	19	2.4 (1.6-3.8)
Amistem-H collared	Versafitcup trio/ccl.	100	250	1	0.4 (0.1-2.8)
Amistem-H prox coating	Mpact	26	330	5	1.5 (0.6-3.6)
Amistem-H prox coating	Versafitcup DM	68	65	5	7.8 (3.3-17.7)
Amistem-H prox coating	Versafitcup trio/ccl.	13	3,023	80	2.7 (2.1-3.3)
Amistem-P	Mpact	32	154	7	4.6 (2.2-9.4)
Amistem-P	Versafitcup trio/ccl.	15	1,562	49	3.2 (2.4-4.1)
Ana.Nova alpha proxy	Ana.Nova alpha	98	152	1	0.7 (0.1-4.6)
Avenir	Ades DM	92	83	1	1.2 (0.2-8.2)
Avenir	Alloclassic	54	89	5	5.6 (2.4-13.0)
Avenir	Allofit	12	4,439	99	2.2 (1.8-2.7)
Avenir	Avantage	23	71	2	2.8 (0.7-10.8)
Avenir	Fitmore	25	1,161	49	4.3 (3.2-5.6)
Avenir	RM pressfit	100	50	1	2.0 (0.3-13.4)
Brexis	Xentrax	100	52	3	5.8 (1.9-16.8)
CLS Spotorno	Allofit	50	479	16	3.4 (2.1-5.4)
CLS Spotorno	Fitmore	32	532	6	1.1 (0.5-2.5)
Corail	Allofit	98	59	2	3.5 (0.9-13.2)
Corail	Fitmore	95	206	3	1.5 (0.5-4.5)
Corail	Pinnacle	13	4,632	136	3.0 (2.5-3.5)
Corail collared	Delta motion	57	51	0	. (.-.)
Corail collared	Gyros	54	591	17	2.9 (1.8-4.6)
Corail collared	Novae TH/Bi-Mentum	42	183	4	2.2 (0.8-5.8)
Corail collared	Pinnacle	29	5,440	93	1.7 (1.4-2.1)
Corehip	Plasmafit	76	169	0	0.0 (.-.)
Exacta	Jump system/JS traser	82	116	1	0.9 (0.1-6.0)
Exacta S	Jump system/JS traser	60	137	1	0.7 (0.1-5.1)
Exception	Allofit	44	129	3	2.3 (0.8-7.0)
Exception	Avantage	67	403	17	4.2 (2.7-6.7)
Exception	Exceed	95	87	4	4.6 (1.8-11.8)
Fitmore	Allofit	76	2,146	39	1.8 (1.3-2.5)
Fitmore	Fitmore	35	2,269	45	2.0 (1.5-2.7)
Fitmore	RM pressfit vitamys	89	568	10	1.8 (1.0-3.3)
GTS	G7 bispherical	94	89	10	11.5 (6.4-20.3)

* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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 3.5h (Part 2)

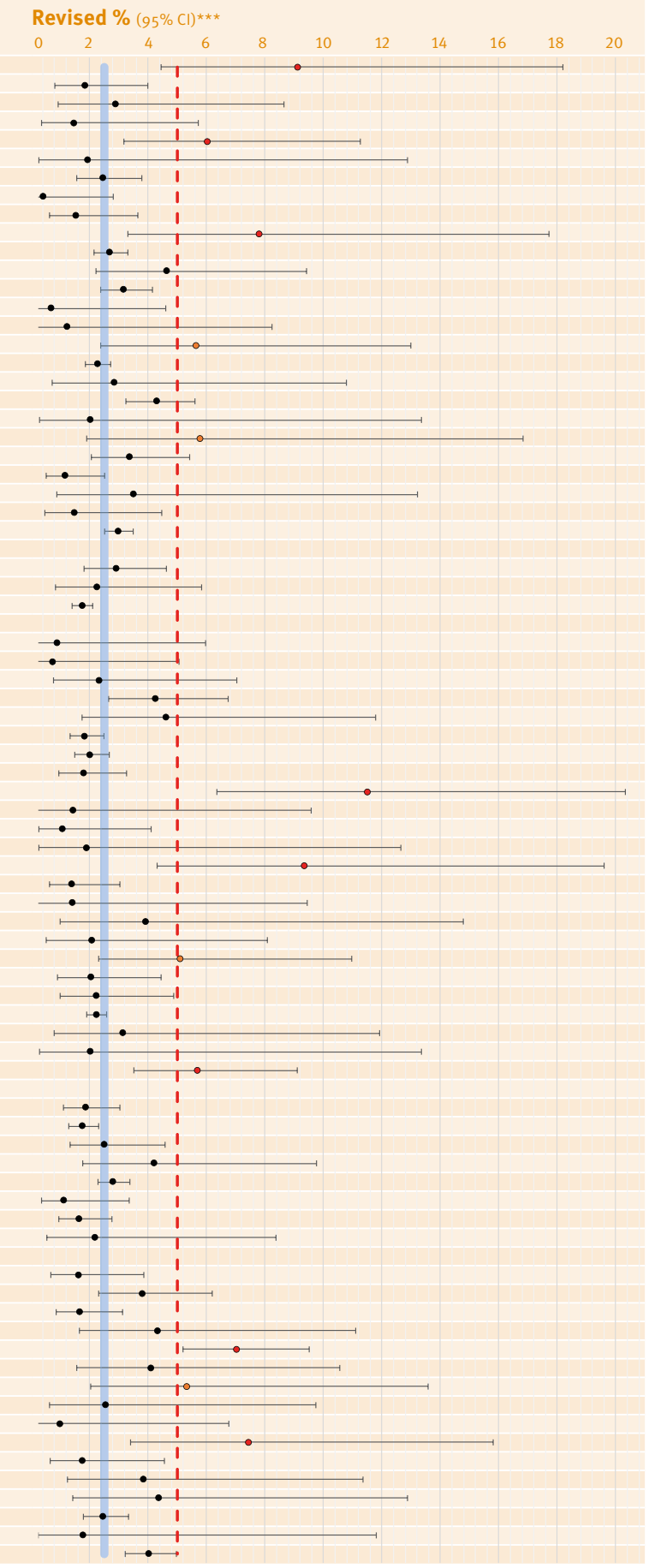
Stem component	Cup component	CSS*	at risk N**	Revised N	Revised % (95% CI)***
H-Max S	Delta PF	39	71	1	1.4 (0.2-9.6)
H-Max S	Delta TT	46	192	2	1.0 (0.3-4.1)
H-Max S	Symbol DMHA/DS evol.	62	53	1	1.9 (0.3-12.6)
Harmony	Symbol DMHA/DS evol.	100	65	6	9.3 (4.3-19.6)
Individual/custom hip	April ceramic	24	452	6	1.4 (0.6-3.0)
Individual/custom hip	Pinnacle	53	72	1	1.4 (0.2-9.5)
Metafix	Trinity	65	51	2	3.9 (1.0-14.8)
Minimax	Versafitcup trio/ccl.	33	97	2	2.1 (0.5-8.1)
Nanos	R3	37	118	6	5.1 (2.3-11.0)
Optimys	Anexys	29	303	6	2.0 (0.9-4.4)
Optimys	RM pressfit	29	271	6	2.2 (1.0-4.9)
Optimys	RM pressfit vitamys	10	7,359	163	2.2 (1.9-2.6)
Optimys	Symbol DMHA/DS evol.	31	64	2	3.1 (0.8-11.9)
Optimys	Trident II	100	50	1	2.0 (0.3-13.4)
Polarstem	EP-fit	89	282	16	5.7 (3.5-9.1)
Polarstem	HI	95	76	0	. (.-.)
Polarstem	Polarcup	72	817	15	1.8 (1.1-3.0)
Polarstem	R3	53	2,683	46	1.7 (1.3-2.3)
Quadra-H	Mpact	56	405	10	2.5 (1.3-4.6)
Quadra-H	Versafitcup DM	40	120	5	4.2 (1.8-9.8)
Quadra-H	Versafitcup trio/ccl.	19	3,670	101	2.8 (2.3-3.4)
Quadra-P	Versafitcup trio/ccl.	52	276	3	1.1 (0.4-3.4)
SBG	R3	42	810	13	1.6 (0.9-2.8)
SBG	Xentrax	100	94	2	2.2 (0.5-8.4)
SL-plus	HI	100	95	0	0.0 (.-.)
SL-plus MIA	EP-fit	35	308	5	1.6 (0.7-3.9)
SL-plus MIA	HI	48	402	15	3.8 (2.3-6.2)
SL-plus MIA	R3	72	554	9	1.6 (0.9-3.1)
SMS	Versafitcup trio/ccl.	89	94	4	4.3 (1.6-11.1)
SPS evolution	April ceramic	35	559	39	7.0 (5.2-9.5)
SPS evolution	April poly	35	98	4	4.1 (1.6-10.6)
SPS evolution	Liberty	37	76	4	5.3 (2.0-13.6)
Stelia-Stem	Ana.Nova hybrid	100	79	2	2.5 (0.6-9.7)
Stelia-Stem	BSC pressfit	100	104	1	1.0 (0.1-6.8)
Symbol	Symbol DMHA/DS evol.	86	81	6	7.4 (3.4-15.8)
Tri-Lock	Pinnacle	81	234	4	1.7 (0.7-4.6)
Twinsys	Anexys	41	79	3	3.8 (1.2-11.4)
Twinsys	RM pressfit	51	69	3	4.3 (1.4-12.9)
Twinsys	RM pressfit vitamys	18	1,609	39	2.4 (1.8-3.3)
Twinsys	Symbol DMHA/DS evol.	42	57	1	1.8 (0.2-11.8)
other combinations			1,994	79	4.0 (3.2-5.0)
CH average for group					**2.5 (2.4-2.6)**

Figure 3.5j

2-year evaluation: Revision rates of uncemented primary total hip arthroplasty combinations within 24 months (primary OA)

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component
Accolade II	Trident II
Actis	Pinnacle
Alloclassic	Alloclassic
Alloclassic	Allofit
Alloclassic	Fitmore
Amistem-H	Mpact
Amistem-H	Versafitcup trio/ccl.
Amistem-H collared	Versafitcup trio/ccl.
Amistem-H prox coating	Mpact
Amistem-H prox coating	Versafitcup DM
Amistem-H prox coating	Versafitcup trio/ccl.
Amistem-P	Mpact
Amistem-P	Versafitcup trio/ccl.
Ana.Nova alpha proxy	Ana.Nova alpha
Avenir	Ades DM
Avenir	Alloclassic
Avenir	Allofit
Avenir	Avantage
Avenir	Fitmore
Avenir	RM pressfit
Brexis	Xentrax
CLS Spotorno	Allofit
CLS Spotorno	Fitmore
Corail	Allofit
Corail	Fitmore
Corail	Pinnacle
Corail collared	Delta motion
Corail collared	Gyros
Corail collared	Novae TH/Bi-Mentum
Corail collared	Pinnacle
Corehip	Plasmafit
Exacta	Jump system/JS traser
Exacta S	Jump system/JS traser
Exception	Allofit
Exception	Avantage
Exception	Exceed
Fitmore	Allofit
Fitmore	Fitmore
Fitmore	RM pressfit vitamys
GTS	G7 bispherical
H-Max S	Delta PF
H-Max S	Delta TT
H-Max S	Symbol DMHA/DS evol.
Harmony	Symbol DMHA/DS evol.
Individual/custom hip	April ceramic
Individual/custom hip	Pinnacle
Metafix	Trinity
Minimax	Versafitcup trio/ccl.
Nanos	R3
Optimys	Anexys
Optimys	RM pressfit
Optimys	RM pressfit vitamys
Optimys	Symbol DMHA/DS evol.
Optimys	Trident II
Polarstem	EP-fit
Polarstem	HI
Polarstem	Polarcup
Polarstem	R3
Quadra-H	Mpact
Quadra-H	Versafitcup DM
Quadra-H	Versafitcup trio/ccl.
Quadra-P	Versafitcup trio/ccl.
SBG	R3
SBG	Xentrax
SL-plus	HI
SL-plus MIA	EP-fit
SL-plus MIA	HI
SL-plus MIA	R3
SMS	Versafitcup trio/ccl.
SPS evolution	April ceramic
SPS evolution	April poly
SPS evolution	Liberty
Stelia-Stem	Ana.Nova hybrid
Stelia-Stem	BSC pressfit
Symbol	Symbol DMHA/DS evol.
Tri-Lock	Pinnacle
Twinsys	Anexys
Twinsys	RM pressfit
Twinsys	RM pressfit vitamys
Twinsys	Symbol DMHA/DS evol.
other combinations	-



the revision rates were adjusted for effects of mortality and emigration from Switzerland. Eight stem/cup combinations were identified as potential outliers and were further analysed following the protocol described above and presented in the outlier watchlist at the end of this report. In the 2022 report, seven combinations were identified as potential outliers and changes in outlier status occurred in implant combinations used in small numbers. The numbers implanted may change from a given 4-year window to another with some implants reaching the threshold of 50 implantations, and others falling below that threshold. While SPS HA/April ceramic disappeared in the current report, Accolade/Trident II and Symbol/Symbol DMHA/DS evolution appeared in this report.

Figure 3.5j shows the alphabetical list of stem/cup combinations concerning the group average and outlier boundary being twice the value of the group average.

Two-year revision rates

Hybrid combinations for primary OA

The average 2-year revision rate for hybrid implantation for primary OA was 2.6% (CI 2.2–2.9) **(Figure 3.5k)** and the revision rates were adjusted for the 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 and the combination CCA/RM pressfit vitamys reached outlier status in 2022. Due to the moving window, the 2021 number at risk decreased from 71 to 53 with the same number of revisions (n = 4) which is sufficient to place the combination in an outlier status. This example shows the problem of implant combinations that are used in small numbers only.

Two-year revision rates

Uncemented combinations for secondary OA

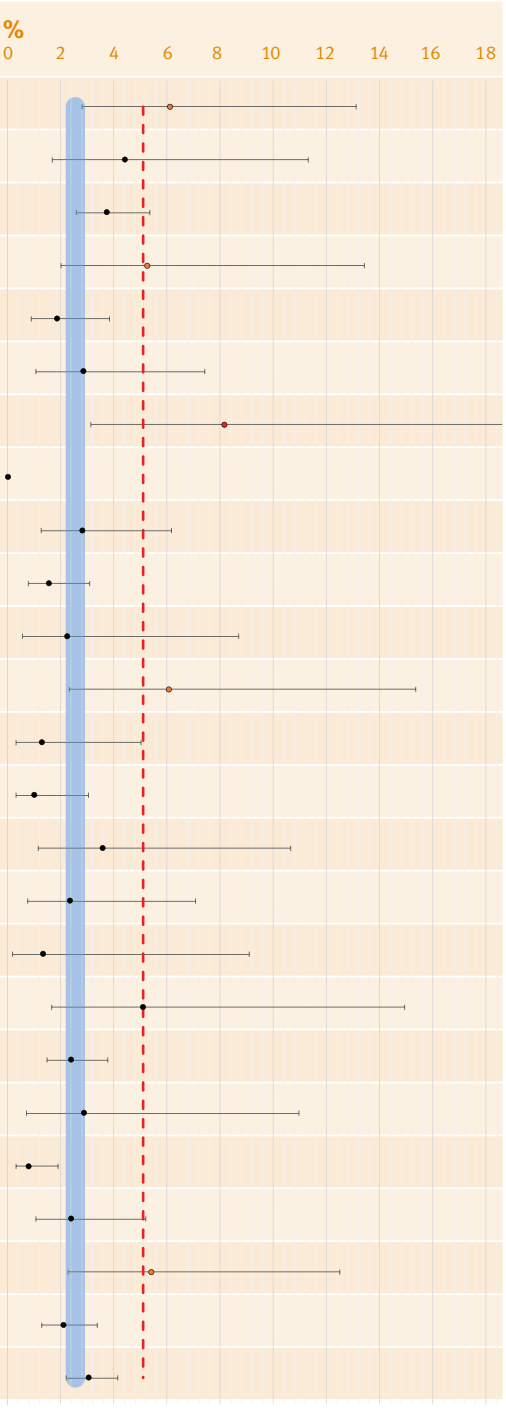
The 2-year revision rate for uncemented implantations for secondary OA was 3.6% (CI 3.1–4.2) and none of the implant combinations were considered to be outliers **(Figure 3.5l).**

Figure 3.5k

2-year evaluation: Revision rates of hybrid primary total hip arthroplasty combinations within 24 months (primary OA)

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CCS*	at risk N**	Revised N	Revised % (95% CI)***
Amistem-C	Mpact	31	99	6	6.1 (2.8-13.1)
Amistem-C	Versafitcup DM	24	92	4	4.4 (1.7-11.3)
Amistem-C	Versafitcup trio/ccl.	25	763	28	3.7 (2.6-5.4)
Arcad	April ceramic	45	76	4	5.3 (2.0-13.4)
Avenir (cemented)	Allofit	25	383	7	1.9 (0.9-3.8)
Avenir (cemented)	Fitmore	47	147	4	2.8 (1.1-7.4)
CCA	RM pressfit vitamys	70	53	4	8.2 (3.1-20.4)
Centris	RM pressfit	53	51	0	0.0 (.-)
Centris	RM pressfit vitamys	47	213	6	2.8 (1.3-6.2)
Corail (cem.)	Pinnacle	25	522	8	1.6 (0.8-3.1)
Harmony (cem.)	Liberty	65	89	2	2.2 (0.6-8.7)
Harmony (cem.)	Symbol DMHA/DS evol.	100	67	4	6.1 (2.3-15.3)
MS-30	Allofit	98	163	2	1.3 (0.3-5.0)
MS-30	Fitmore	48	304	3	1.0 (0.3-3.0)
Original Mueller	Allofit	30	86	3	3.6 (1.2-10.6)
Original Mueller	Fitmore	50	131	3	2.3 (0.8-7.1)
Quadra-C	Mpact DM	79	75	1	1.3 (0.2-9.1)
Quadra-C	Versafitcup DM	39	59	3	5.1 (1.7-14.9)
Quadra-C	Versafitcup trio/ccl.	29	725	17	2.4 (1.5-3.8)
Twinsys (cem.)	RM pressfit	21	71	2	2.9 (0.7-11.0)
Twinsys (cem.)	RM pressfit vitamys	26	630	5	0.8 (0.3-1.9)
Weber	Allofit	28	258	6	2.4 (1.1-5.2)
Weber	Avantage	98	94	5	5.4 (2.3-12.5)
Weber	Fitmore	25	781	16	2.1 (1.3-3.4)
other combinations			1,275	38	3.0 (2.2-4.2)
CH average for group					**2.6 (2.2-2.9)**



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

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

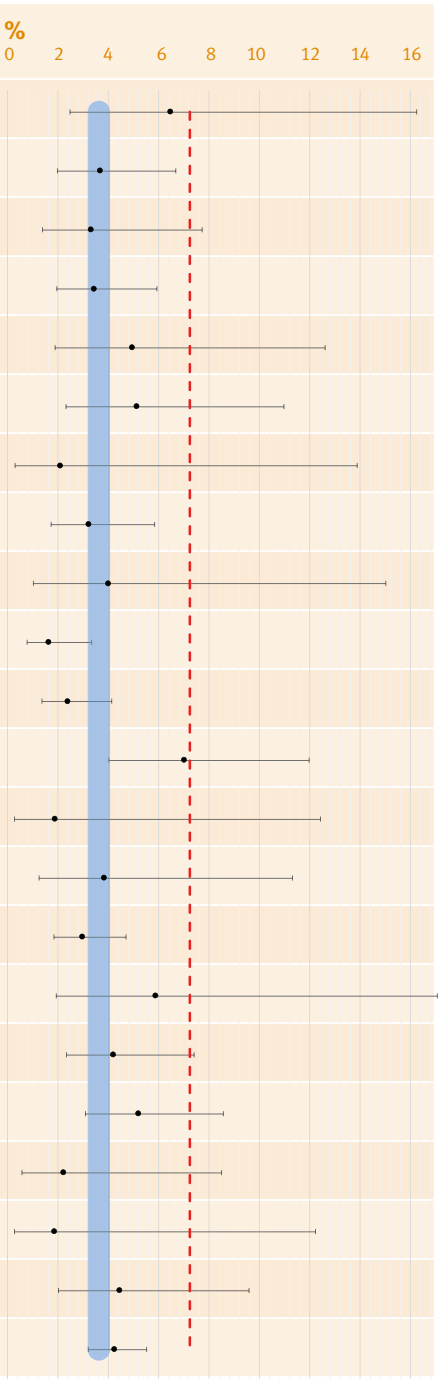
*** Rates adjusted for effects of mortality and emigration.

Figure 3.5l

2-year evaluation: Revision rates of uncemented primary total hip arthroplasty combinations within 24 months (secondary OA)

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CSS*	at risk N**	Revised N	Revised % (95% CI)***
Amistem-H	Versafitcup trio/ccl.	14	63	4	6.4 (2.5-16.2)
Amistem-H prox coating	Versafitcup trio/ccl.	17	276	10	3.6 (2.0-6.7)
Amistem-P	Versafitcup trio/ccl.	18	153	5	3.3 (1.4-7.7)
Avenir	Allofit	14	354	12	3.4 (2.0-5.9)
Avenir	Fitmore	25	84	4	4.9 (1.9-12.6)
CLS Spotorno	Allofit	54	118	6	5.1 (2.3-11.0)
CLS Spotorno	Fitmore	33	52	1	2.1 (0.3-13.9)
Corail	Pinnacle	13	317	10	3.2 (1.7-5.8)
Corail collared	Gyros	57	54	2	4.0 (1.0-15.0)
Corail collared	Pinnacle	43	441	7	1.6 (0.8-3.3)
Fitmore	Allofit	93	509	12	2.4 (1.4-4.1)
Fitmore	Fitmore	31	173	12	7.0 (4.0-12.0)
Fitmore	RM pressfit vitamys	96	55	1	1.9 (0.3-12.4)
Individual/custom hip	April ceramic	23	79	3	3.8 (1.2-11.3)
Optimys	RM pressfit vitamys	18	580	17	2.9 (1.8-4.7)
Polarstem	Polarcup	75	52	3	5.8 (1.9-17.1)
Polarstem	R3	77	266	11	4.2 (2.3-7.4)
Quadra-H	Versafitcup trio/ccl.	26	279	14	5.2 (3.1-8.6)
SBG	R3	49	91	2	2.2 (0.6-8.5)
SL-plus MIA	HI	52	56	1	1.8 (0.3-12.2)
Twinsys	RM pressfit vitamys	17	137	6	4.4 (2.0-9.6)
other combinations			1176	49	4.2 (3.2-5.5)
CH average for group					**3.6 (3.1-4.2)**



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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.

Fracture of the hip

Ten Years of Swiss Hip and Knee Registry

3.6 Treatment of hip fractures

Fractures of the hip include femoral neck fractures, other fractures of the proximal femur, and fractures of the acetabulum. While hip fractures occur more frequently in the elderly, they are also found in younger age groups, whereby in the latter group they are often due to rather severe accidents. The treatment varies from internal fixation of the femur or of the acetabulum to prosthetic replacement with either HA or THA, depending on the pathology, feasibility, and experience of the surgeon. Additionally, the patient's age, activity level, and comorbidities also influence the choice of treatment.

As indicated above, patients with hip fractures are generally of advanced age and hence this injury affects a special group of patients with substantial comorbidities and low remaining life expectancy. As a result, the mortality rate is high and 1-year mortality rates between 15% to 35% are reported

Table 3.6a

Fracture of the hip: Baseline patient characteristics by year

		2017	2018	2019	2020	2021	2022	2017–2022
N		**3,292**	**3,551**	**3,860**	**4,131**	**4,460**	**4,785**	**24,079**
Treatment with THA* [%]		38.5	39.0	41.1	43.2	47.4	47.3	43.2
Treatment with HA** [%]		61.5	61.0	58.9	56.8	52.6	52.7	56.8
Women [%]		69.4	68.3	69.1	67.1	67.0	66.9	67.8
Mean age (SD)	All	80.9 (10.8)	81.1 (10.5)	81.0 (10.7)	81.1 (10.7)	80.9 (10.7)	80.8 (10.7)	81.0 (10.7)
	Women	81.9 (10.0)	82.1 (10.0)	81.7 (10.1)	82.3 (10.0)	81.8 (10.3)	81.9 (10.0)	82.0 (10.1)
	Men	78.5 (12.0)	78.8 (11.2)	79.4 (11.7)	78.8 (11.6)	79.2 (11.4)	78.6 (11.7)	78.9 (11.6)
Age group [%]	<45	0.4	0.3	0.4	0.2	0.3	0.3	0.3
	45–54	1.8	1.7	1.8	1.9	1.6	1.8	1.8
	55–64	6.7	6.2	6.1	6.9	6.8	7.0	6.7
	65–74	15.2	14.4	15.3	14.7	14.7	13.9	14.7
	75–84	31.2	33.4	32.2	32.1	32.8	34.3	32.8
	85+	44.7	43.9	44.2	44.3	43.7	42.6	43.8
N unknown BMI (%)		941 (29)	931 (26)	891 (23)	778 (19)	716 (16)	592 (12)	4,849 (20)
N known BMI		2,351	2,620	2,969	3,353	3,744	4,193	19,230
Mean BMI (SD)		23.8 (4.3)	23.7 (4.4)	23.7 (4.3)	23.6 (4.4)	23.8 (4.3)	23.6 (4.2)	23.7 (4.3)
BMI [%]	<18.5	9.3	9.0	9.0	10.1	8.7	9.5	9.3
	18.5–24.9	56.5	57.7	57.4	56.7	56.7	56.5	56.9
	25–29.9	27.1	25.5	26.4	26.0	26.7	26.8	26.4
	30–34.9	5.2	6.5	5.5	5.6	6.4	6.1	5.9
	35–39.9	1.6	0.8	1.4	1.3	1.1	0.9	1.2
	40+	0.3	0.5	0.3	0.3	0.3	0.2	0.3
N unknown ASA (%)		280 (9)	220 (6)	276 (7)	247 (6)	201 (5)	131 (3)	1,355 (6)
N known ASA		3,012	3,331	3,584	3,884	4,259	4,654	22,724
Morbidity state	ASA 1	3.4	3.1	3.3	3.8	3.1	3.4	3.3
[%]	ASA 2	32.5	31.7	30.7	28.9	28.1	27.5	29.6
	ASA 3	57.2	58.6	58.5	60.0	60.2	60.3	59.3
	ASA 4/5	6.9	6.6	7.6	7.4	8.7	8.8	7.8

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

after index surgery. In Europe, recent work has shown that, on average, approximately 22% of patients die within the first year after a fracture of the proximal femur. While HA treatment is preferred in fragile, low-demand patients, THA is commonly performed in healthier and more active patients.

In the period between 1.1.2017 and 31.12.2020 with a complete 2-year follow-up until 31.12.2022, the registry recorded a total of 24,079 fractures of the hip, with an annual increase of 7–8% per year. The documented cases have risen by 1,710 cases since the 2022 report, representing an increase of approximately 8%. On average, 43.2% of patients were treated with THA and 56.8% with HA, although there is a clear trend towards treatment with THA, increasing from 38.5% in 2017 to 47.3% in 2022., whereby the age distribution has remained constant. Comprising 67.8% of cases, women were more frequently affected, and 91.3% of the patients were 65 years of age or older while the age group

Table 3.6b

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

		THA	HA
N (2017-2022)		**10,401**	**13,678**
Women [%]		63.9	70.8
Mean age (SD)	All	74.7 (10.9)	85.7 (7.6)
	Women	75.8 (10.4)	86.2 (7.2)
	Men	72.8 (11.6)	84.6 (8.2)
Age group [%]	‹45	0.7	0.1
	45–54	3.7	0.3
	55–64	13.8	1.3
	65–74	26.6	5.6
	75–84	36.2	30.1
	85+	19.0	62.7
N unknown BMI (%)		1,848 (18)	3,001 (22)
N known BMI		8,553	10,677
Mean BMI (SD)		24.2 (4.4)	23.3 (4.2)
BMI [%]	‹18.5	7.3	10.8
	18.5–24.9	54.9	58
	25–29.9	28.7	24.6
	30–34.9	7.1	4.9
	35–39.9	1.4	1.0
	40+	0.5	0.2
N unknown ASA		601 (6)	754 (6)
N known ASA		9,800	12,924
Morbidity state [%]	ASA 1	6.7	0.8
	ASA 2	43.2	19.3
	ASA 3	45.8	69.5
	ASA 4/5	4.2	10.4

above 85 accounted for 43.8% **(Table 3.6a).** Additionally, 2.1% of patients were younger than 55 years and 6.7% between 55 and 64 years. The majority of patients had a normal BMI.

Patients treated with HA are on average 11 years older than those treated with THA **(Table 3.6b)** and, as indicated earlier, younger patients were more likely to receive a THA. Overall, there were more HAs implanted than THAs. A total of 502 patients younger than 55 years of age sustained hip fractures and, of these, 90% (n = 455) were treated with THA. Interestingly, 47 patients younger than 55 received an HA, while 62.7% of HAs were implanted in patients aged 85 years and older. Of the patients over 85 years of age, 18.6% received a THA and 81.4% were treated with HA **(derived from Table 3.6b).**

Table 3.6c

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

Calculations of hospital service volume based om primary hip surgeries in each included year (2017-2022).

		<100	100–199	200–299	300+
N (2017–2022)		**5,444**	**8,204**	**5,087**	**5,344**
Treatment [%]	Total Hip Arthroplasty (THA)	30.7	46.9	43.3	50.1
	Hemi Hip Arthroplasty (HA)	69.3	53.1	56.7	49.9
Women [%]		69.8	67.8	67.1	66.6
Mean age (SD)	All	82.1 (9.8)	80.4 (10.8)	80.9 (10.8)	80.8 (11.0)
	Women	82.8 (9.4)	81.5 (10.2)	81.9 (10.2)	81.9 (10.3)
	Men	80.3 (10.6)	78.2 (11.7)	78.8 (11.7)	78.6 (12.1)
Age group [%]	<45	0.2	0.3	0.3	0.5
	45–54	1.1	1.9	2.0	2.1
	55–64	5.1	7.4	6.7	7.0
	65–74	13.4	15.8	14.6	14.3
	75–84	33.0	33.2	32.6	32.1
	85+	47.2	41.4	43.8	44.0
N unknown BMI (%)		1,546 (28)	1,802 (22)	817 (16)	684 (13)
N known BMI		3,898	6,402	4,270	4,660
Mean BMI (SD)		23.8 (4.2)	23.7 (4.4)	23.8 (4.4)	23.6 (4.2)
BMI [%]	<18.5	8.7	9.3	8.9	10.0
	18.5–24.9	56.3	57.1	57.1	56.9
	25–29.9	27.5	26.3	26.4	25.8
	30–34.9	6.2	5.5	6.1	6.0
	35–39.9	1.1	1.4	1.1	1.0
	40+	0.2	0.5	0.4	0.2
N unknown ASA (%)		235 (4)	779 (9)	229 (5)	112 (2)
N known ASA		5,209	7,425	4,858	5,232
Morbidity state [%]	ASA 1	3.7	3.4	3.1	3.1
	ASA 2	29.0	31.3	28.9	28.5
	ASA 3	58.5	58.0	60.3	60.9
	ASA 4/5	8.7	7.3	7.7	7.5

* Note that service volume is defined as the sum of primary procedures per year

One-third (34.1%) of all patients with a fracture were treated in a hospital with a volume of 100–199 primary hips per year **(Table 3.6c)** while 22.6% were treated in institutions that performed fewer than 100 primary hips per year. The average age distribution in the four categories (‹ 100 cases/year, 100–199, 200–299, › 300) was comparable, with an average patient age between 80.4 and 82.1 years. Hospitals with smaller numbers (‹ 100 per year) treated more octogenarians and it is interesting to note that the percentage of patients treated by HA in the low-volume institutions was significantly higher, with 69.8% compared to the average of 53.2% **(Table 3.6c)** which may indicate undertreatment, whereby the reason for this is unclear. One explanation may be that general surgeons not trained to perform THA participated in the treatment of hip fractures in these smaller institutions.

Of the patients diagnosed with fractures, 5.9% in the THA group and 1.1% in the HA group have had previous internal fixation. However, the time lapse between internal fixation and implantation of THA or HA is unknown. Most HA stems were cemented (85.8%) compared to 46.3% of stems in the THA group **(Tables 3.6d and e and Figure 3.6a).**

The most common approaches for both procedures were a direct anterior or anterolateral approach (**Tables 3.6d and f and Figures 3.6b).** In both HA and THA, the share of the anterior approach was the highest, being used distinctly more frequently for THAs.

Table 3.6d

Fracture of the hip: Surgery characteristics by main treatment group

		THA		HA	
N (2017–2022)		**N revised**	**%**	**N revised**	**%**
Previous surgery	None	9,324	89.6	13,333	97.5
	Internal fixation femur	802	5.9	154	1.1
	Osteotomy femur	40	0.3	13	0.1
	Internal fixation acetabulum	87	0.6	2	0.0
	Osteotomy pelvis	7	0.1	1	0.0
	Arthrodesis	4	0.0	0	0.0
	Other previous surgery	172	1.3	177	1.3
Approach	Anterior	5,668	54.5	5,936	43.4
	Anterolateral	2,626	25.2	4,008	29.3
	Posterior	1,269	12.2	1,936	14.2
	Lateral	631	6.1	1,608	11.8
	Other approach	207	2.0	190	1.4
Fixation	All uncemented / uncemented stem	5,225	50.2	1,856	13.6
	Hybrid*	4,147	39.9		
	All cemented / cemented stem	665	6.4	11,739	85.8
	Reverse hybrid**	203	2.0		
	Reinforcement ring, femur uncemented	47	0.5		
	Reinforcement ring, femur cemented	114	1.1		

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

Figure 3.6a

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

Relative distribution per year in %.

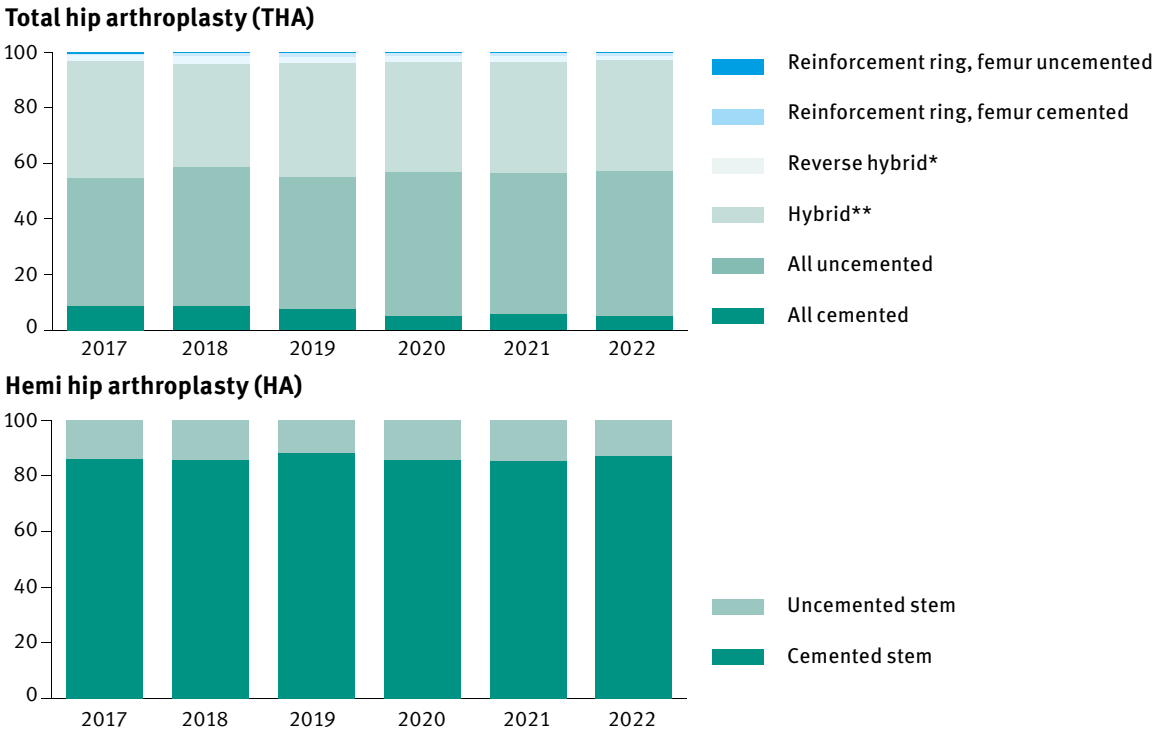


Table 3.6e

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

Relative distribution per year in %.

Total hip arthroplasty (THA)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Reinforcement ring, femur uncemented	0.6	0.4	0.4	0.4	0.4	0.4
Reinforcement ring, femur cemented	0.7	1.2	1.3	1.2	1.1	1.0
Reverse hybrid*	2.0	2.7	2.1	1.9	1.9	1.5
Hybrid**	42.0	37.0	41.3	39.4	39.9	39.7
All uncemented	45.9	50.2	47.5	52.1	51.0	52.4
All cemented	8.8	8.6	7.4	4.9	5.6	4.9
Total [N]	**1,266**	**1,385**	**1,588**	**1,783**	**2,116**	**2,263**

Hemi hip arthroplasty (HA)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Uncemented stem	13.9	14.3	11.9	14.3	14.7	12.8
Cemented stem	86.1	85.7	88.1	85.7	85.3	87.2
Total [N]	**2,016**	**2,157**	**2,265**	**2,336**	**2,314**	**2,507**

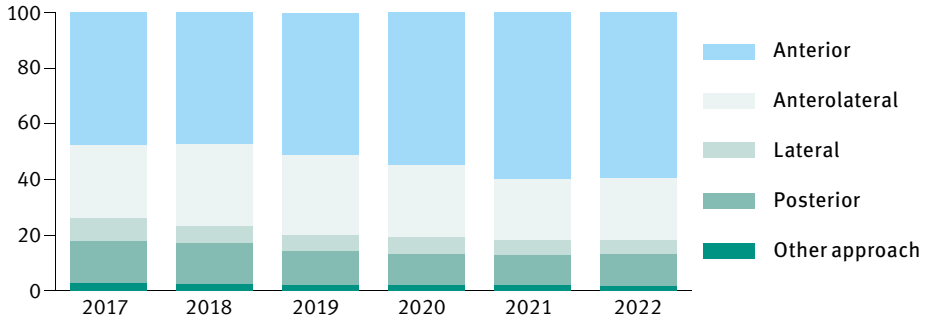
* acetabulum cemented, femur uncemented = Reverse hybrid
** acetabulum uncemented, femur cemented = Hybrid

Figure 3.6b

Fracture of the hip: Surgical approach by type of treatment by year

Relative distribution per year in % .

Total hip arthroplasty (THA)



Hemi hip arthroplasty (HA)

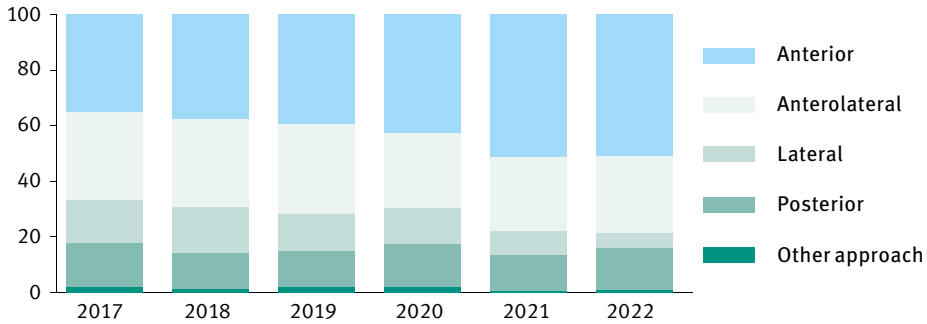


Table 3.6f

Fracture of the hip: Surgical approach by type of treatment by year

Relative distribution per year in %.

Total hip arthroplasty (THA)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Anterior	47.6	47.4	51.4	54.7	59.9	59.6
Anterolateral	26.2	29.5	28.5	26.1	22.0	22.2
Lateral	8.6	6.1	6.2	5.9	5.4	5.3
Posterior	14.9	14.7	12.0	11.4	10.9	11.2
Other approach	2.6	2.3	2.0	1.9	1.8	1.7
Total [N]	**1,266**	**1,385**	**1,588**	**1,783**	**2,116**	**2,263**

Hemi hip arthroplasty (HA)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Anterior	35.1	37.9	39.5	42.8	51.5	51.2
Anterolateral	31.8	31.4	32.5	27.0	26.5	27.4
Lateral	15.4	16.6	13.0	12.9	8.4	5.7
Posterior	15.8	12.9	13.1	15.5	12.9	14.8
Other approach	1.9	1.2	1.9	1.9	0.6	0.9
Total [N]	**2,026**	**2,166**	**2272**	**2,348**	**2,344**	**2,522**

Mortality

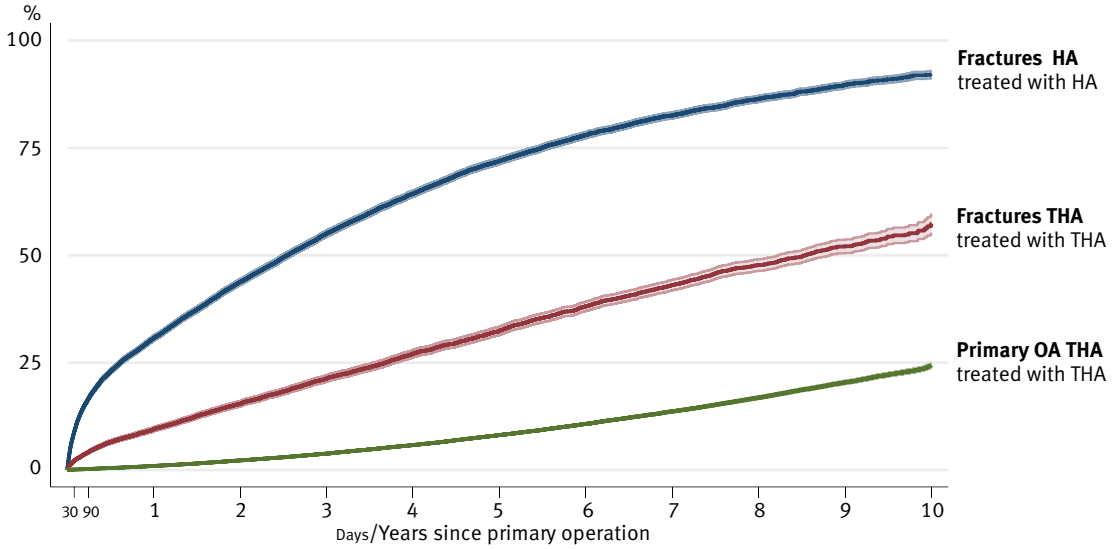
Due to the discrepancies in the patient target group characteristics outlined earlier (e.g. age and co-morbidities), the estimated mortality rates differed between the HA and THA groups and were substantially higher compared to patients treated for primary OA of the hip **(Figure 3.6c).** The 1-year mortality rate for patients treated with HA was 30.7% (CI 30.1–31.3) and 9.9% (9.0–10.0) in patients with THA fracture treatment. For the same 1-year period, the mortality rate for a primary THA was 0.9% (0.9–1.0) **(Figure 3.6c).** This is explained by the older age of the patients with HA, which was 85 years at the time of surgery as 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.

The 30-day mortality rate is an indicator of the effectiveness of the perioperative treatment of fractures of the proximal femur and the mortality rate was estimated by linking the SIRIS database with the Swiss CCO (Central Compensation Office, Geneva). In the literature, reported rates vary between 3% and 12%, whereby 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, specifically femoral neck fractures treated with HA. The distribution of the 30-day mortality rate was quite narrow between most Cantons, as shown by the overlapping 95% confidence intervals **(Table 3.6g and Figure**

Figure 3.6c

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, 2012–2022, all services. Cumulative mortality rates in percent (30 days= postoperative mortality).



Fractures	30 days	90 days	1 year	3 years	5 years	7 years	10 years
Treated with THA	**2.2** (2.0-2.4)	**4.2** (3.8-4.5)	**9.2** (8.7-9.8)	**21.3** (20.6-22.1)	**32.4** (31.4-33.4)	**43.0** (41.8-44.3)	**57.3** (55.1-59.6)
Treated with HA	**8.9** (8.5-9.3)	**16.7** (16.2-17.2)	**30.2** (29.5-30.8)	**55.1** (54.3-55.8)	**71.9** (71.2-72.7)	**82.5** (81.8-83.2)	**92.1** (91.2-93.0)
Primary OA							
Treated with THA	**0.1** (0.1-0.1)	**0.2** (0.2-0.3)	**0.9** (0.9-1.0)	**3.8** (3.7-3.9)	**8.1** (8.0-8.3)	**13.6** (13.4-13.9)	**24.3** (23.8-24.8)

3.6d). The average 30-day mortality rate in Switzerland is 8.9% (CI 8.5–9.3) and ranged from 4.5% to 12.5%. The hospital-based analysis indicates a clear distinction between the centres with the highest 30-day mortality rates and those with the lowest **(Figure 3.6e and Table 3.6h)** and the data show that five clinics had an increased 30-day mortality rate, while in four clinics the increase was statistically significant. These figures were unadjusted but additional regression analyses were performed to test the reliability. To verify that the observed differences between major centres were

Table 3.6g

Estimated postoperative mortality rates after treatment for fractures of the hip (HA): by canton

2012–2022, Kaplan-Meier estimates with 95% confidence intervals, only showing cantons with sufficient numbers (25 HAs annual average).

	30 days*	90 days
SZ	**4.5** (2.5-8.0)	**14.5** (10.6-19.6)
NE	**5.7** (3.8-8.6)	**10.8** (8.1-14.4)
JU	**5.9** (2.7-12.7)	**11.9** (6.9-20.0)
LU	**6.4** (5.0-8.2)	**13.6** (11.5-16.0)
TI	**6.8** (5.5-8.4)	**13.3** (11.4-15.4)
NW	**6.9** (3.5-13.3)	**13.9** (8.8-21.7)
VD	**7.1** (6.1-8.2)	**14.3** (13.0-15.8)
GR	**7.3** (5.5-9.8)	**15.9** (13.2-19.2)
AR	**7.3** (3.7-14.1)	**13.8** (8.5-21.8)
GE	**7.5** (6.2-9.1)	**16.8** (14.8-18.9)
UR	**7.8** (4.0-14.9)	**15.6** (9.9-24.2)
AG	**9.2** (7.8-10.8)	**17.0** (15.2-19.1)
BL	**9.3** (7.5-11.5)	**20.6** (17.9-23.6)
ZH	**9.5** (8.6-10.4)	**17.2** (16.0-18.4)
SG	**9.6** (8.0-11.6)	**16.3** (14.2-18.7)
SO	**9.7** (7.7-12.1)	**18.0** (15.4-21.1)
FR	**9.8** (7.6-12.8)	**16.4** (13.5-19.9)
TG	**10.2** (7.7-13.4)	**17.0** (13.9-20.8)
BE	**10.6** (9.5-11.8)	**18.3** (16.9-19.8)
BS	**11.1** (9.4-13.0)	**19.1** (16.9-21.5)
VS	**11.3** (8.2-15.7)	**17.6** (13.6-22.6)
SH	**12.4** (8.6-17.8)	**20.9** (15.9-27.2)
ZG	**12.5** (9.2-16.8)	**20.7** (16.5-25.8)

* Postoperative mortality

Figure 3.6d

30-day postoperative mortality rates (2012-2022) with 95% confidence intervals

Kaplan-Meier estimates, only showing cantons with sufficient precision.

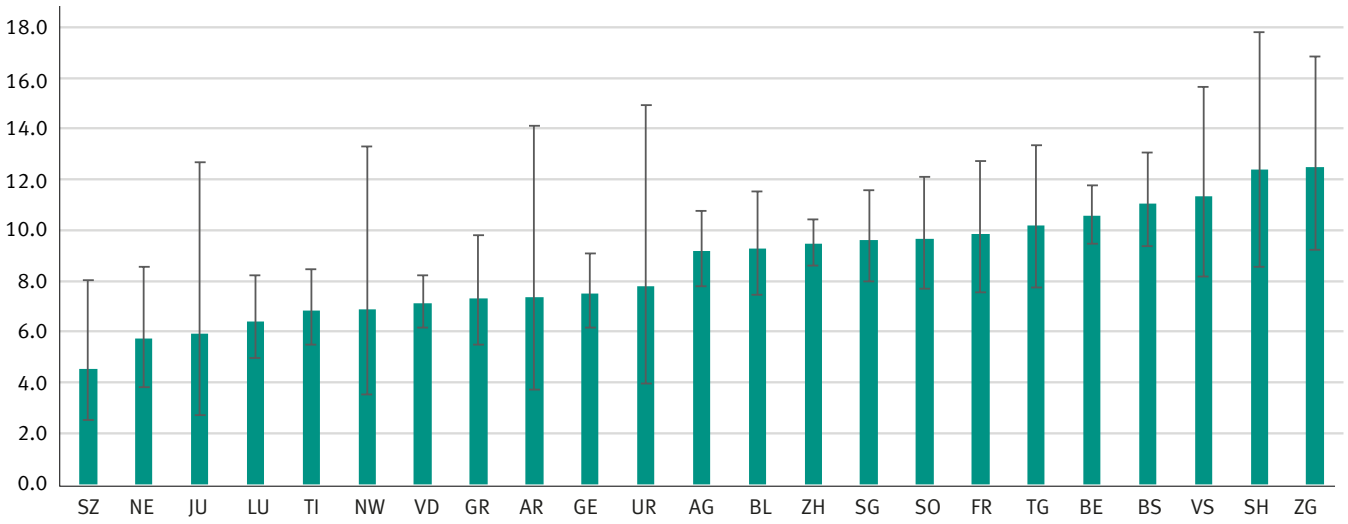


Table 3.6h

Estimated postoperative mortality rates after treatment for fractures of the hip (HA): by hospital

2012–2022

Clinic	30 days*	90 days
275	**4.8** (2.8-8.0)	**11.4** (8.2-15.8)
168	**4.8** (2.5-9.5)	**13.5** (9.1-19.8)
191	**5.3** (2.9-9.6)	**11.2** (7.4-16.6)
380	**5.6** (3.7-8.4)	**10.5** (7.8-14.1)
321	**5.6** (3.6-8.8)	**13.6** (10.2-17.9)
628	**5.6** (4.1-7.8)	**13.5** (11.0-16.5)
328	**6.2** (4.0-9.4)	**14.9** (11.5-19.3)
292	**6.3** (4.0-9.8)	**10.9** (7.8-15.1)
194	**6.8** (4.0-11.4)	**14.2** (10.0-20.0)
323	**7.1** (4.8-10.6)	**15.3** (11.8-19.7)
other (n=4,063)	**7.5** (6.7-8.3)	**14.8** (13.7-15.9)
264	**7.6** (5.0-11.6)	**17.3** (13.2-22.4)
233	**7.7** (4.9-12.0)	**12.5** (8.9-17.5)
283	**7.8** (5.2-11.6)	**14.9** (11.3-19.7)
266	**8.0** (5.3-11.9)	**19.5** (15.2-24.9)
1146	**8.0** (6.6-9.7)	**17.3** (15.2-19.7)
259	**8.3** (5.5-12.5)	**12.0** (8.5-16.7)
401	**8.5** (6.1-11.7)	**17.1** (13.7-21.1)
248	**8.5** (5.6-12.8)	**15.9** (11.9-21.1)
339	**8.6** (6.1-12.2)	**16.0** (12.5-20.4)
676	**8.8** (6.9-11.2)	**15.1** (12.6-18.0)
826	**8.8** (7.0-11.0)	**15.8** (13.5-18.5)
173	**8.8** (5.4-14.2)	**16.0** (11.3-22.4)

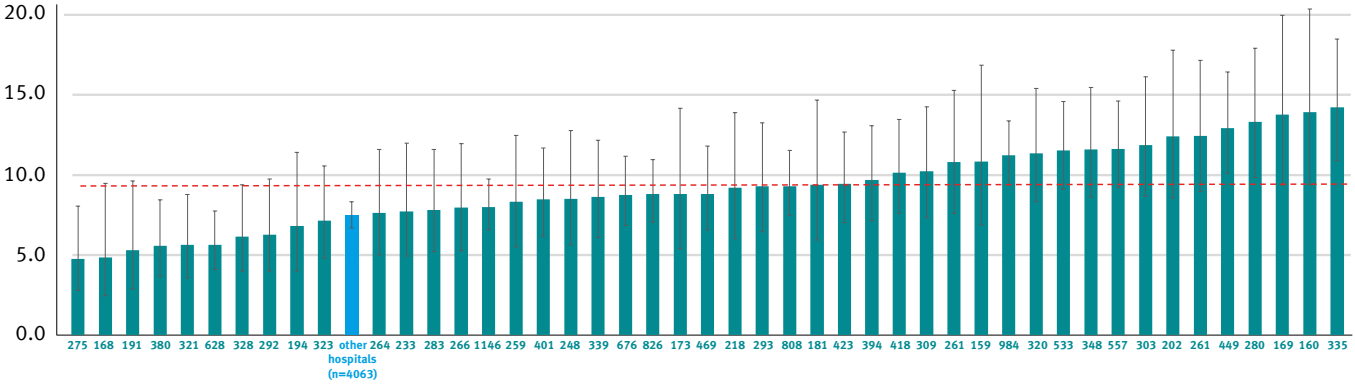
Clinic	30 days*	90 days
469	**8.8** (6.6-11.8)	**16.1** (13.1-19.8)
218	**9.2** (6.0-13.9)	**14.7** (10.7-20.2)
293	**9.3** (6.5-13.3)	**16.6** (12.8-21.4)
808	**9.3** (7.5-11.5)	**20.6** (18.0-23.6)
181	**9.4** (5.9-14.7)	**14.9** (10.5-21.0)
423	**9.5** (7.0-12.7)	**16.1** (12.9-19.9)
394	**9.7** (7.2-13.1)	**17.7** (14.3-21.9)
418	**10.1** (7.6-13.5)	**17.7** (14.3-21.7)
309	**10.2** (7.3-14.2)	**19.0** (15.0-23.9)
261	**10.8** (7.6-15.3)	**17.6** (13.4-22.8)
159	**10.8** (6.9-16.8)	**22.5** (16.7-29.9)
984	**11.2** (9.4-13.4)	**19.2** (16.8-21.8)
320	**11.4** (8.3-15.4)	**20.9** (16.8-25.8)
533	**11.5** (9.1-14.6)	**20.1** (16.9-23.8)
348	**11.6** (8.6-15.5)	**18.9** (15.1-23.4)
557	**11.6** (9.2-14.6)	**18.3** (15.3-21.8)
303	**11.9** (8.7-16.1)	**21.9** (17.6-27.1)
202	**12.4** (8.6-17.8)	**20.9** (15.9-27.2)
261	**12.5** (9.0-17.1)	**21.0** (16.5-26.5)
449	**12.9** (10.1-16.4)	**19.5** (16.1-23.5)
280	**13.3** (9.8-17.9)	**21.4** (17.0-26.7)
169	**13.8** (9.4-20.0)	**25.7** (19.8-33.1)
160	**13.9** (9.4-20.4)	**22.8** (17.0-30.1)
335	**14.2** (10.9-18.5)	**21.3** (17.3-26.1)

* Postoperative mortality

Figure 3.6e

30-day postoperative mortality rates of HA per hospital

2012–2022, with 95% confidence intervals, only showing hospitals with at least 150 procedures. X-axis is showing numbers of operations included in analysis. The average mortality rate in Switzerland is 8.9% (CI 8.5–9.3).



not due to known differences in the risk structure, a simple logistic regression model was applied 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. 5%). Moreover, 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 3.6h).**

After controlling for these known risk factors, four clinics featured statistically significant odds ratios, indicating that the risk of dying there after HA is considerably elevated. However, it is important to consider that this analysis only covers a subgroup of fractures of the proximal femur which had a THA or HA and the mortality rate after internal fixation of proximal femur fractures is not the topic of the SIRIS registry.

Table 3.6i

Results of logistic regression model predicting 30-day post-operative mortality after hemi-arthroplasty for fractures and testing effects of top 5 centres

N=15,800, using only cases with valid ASA.

Predictor	Odds ratio	Sig	95% CI
Age at operation	1.06	‹0.001	1.05-1.07
Male	1.6	‹0.001	1.43-1.80
Age at operation	1.06	‹0.001	1.05-1.07
Sex = Male	1.6	‹0.001	1.43-1.80
ASA 2 mild/moderate disturbance	0.99	0.978	0.36-2.72
ASA 3 severe disturbance	2.89	0.037	1.07-7.86
ASA 4 life-threatening	6.70	‹0.001	2.45-18.30
Centre with high rate No. 1	1.59	0.009	1.12-2.26
Centre with high rate No. 2	1.57	**0.104**	0.91-2.72
Centre with high rate No. 3	2.91	0.042	1.04-8.14
Centre with high rate No. 4	1.56	0.033	1.04-2.34
Centre with high rate No. 5	1.45	0.025	1.05-2.00

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

The 2-year revision rate after THA was 5.3% (95% CI 4.7–5.9) and higher than in HA patients with 3.4% (95% CI 3.0–3.8). Higher BMIs were risk factors for revision, whereby the risk is already observed at a BMI › 25 and is more pronounced after THA **(Table 3.7a).** It is noteworthy that an ASA 1 score is associated with a higher revision rate in HA, and that with increasing ASA scores, the revision risk decreases whereas for THA the opposite is expected. However, the number of patients with BMI › 30 and ASA 4/5 was small, and thus the statistical precision may be low.

In the HA group, uncemented stems had an increased risk for revision caused by a periprosthetic fracture and a posterior approach bore a higher risk of revision for both THA and HA, whereby for THA the effect was significantly higher (7.6% vs 5.0% as shown in **Table 3.7b).**

There are some limitations related to the terminology describing the pathology for the revision as the protrusion of an acetabular shell can have a diffe-

Table 3.7a

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

		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)		6,022	302	5.3	4.7	5.9	8,812	257	3.4	3.0	3.8
Gender	Women	3,874	193	5.2	4.5	5.9	6,274	181	3.3	2.8	3.8
	Men	2,148	109	5.4	4.5	6.5	2538	76	3.8	3.0	4.7
Age group	‹55	277	14	5.2	3.1	8.6	35	3	9.8	3.3	27.4
	55–64	839	48	5.9	4.5	7.7	124	5	4.3	1.8	10.1
	65–74	1,686	83	5.1	4.1	6.3	527	29	6.5	4.6	9.3
	75–84	2,150	108	5.2	4.3	6.3	2,630	93	4.0	3.3	4.9
	85+	1,070	49	5.1	3.9	6.7	5,496	127	2.7	2.3	3.2
BMI group	‹18.5	350	16	4.9	3.0	7.9	708	16	2.8	1.7	4.6
	18.5–24.9	2,593	106	4.3	3.5	5.2	3,855	84	2.5	2.0	3.1
	25–29.9	1,331	81	6.3	5.1	7.8	1,628	71	5.1	4.0	6.4
	30–34.9	342	29	8.9	6.3	12.5	301	19	6.8	4.4	10.5
	35–39.9	74	8	11.3	5.8	21.4	72	5	7.6	3.2	17.4
	40+	27	1	3.7	0.5	23.5	12	1	8.3	1.2	46.1
	Unknown	1,305	61	5.0	3.9	6.4	2,236	61	3.2	2.5	4.1
Morbidity state	ASA 1	399	13	3.3	1.9	5.6	70	4	6.2	2.4	15.7
	ASA 2	2,534	103	4.1	3.4	5.0	1722	47	3.0	2.3	4.0
	ASA 3	2,456	151	6.6	5.6	7.7	5,645	172	3.5	3.0	4.1
	ASA 4/5	184	8	4.9	2.5	9.7	801	16	2.6	1.6	4.3
	Unknown	449	27	6.5	4.5	9.3	574	18	3.7	2.3	5.9

* 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.

rent meaning than the protrusion of an HA. While the first situation 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 approximately 12% of HA cases, response categories related to the revision of an acetabular implant were chosen and these were interpreted and analysed as conversions.

Table 3.7b

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

	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)	6,022	302	5.3	4.7	5.9	8,812	257	3.4	3.0	3.8
All cemented / cemented stem	434	20	5.3	3.4	8.1	7,579	198	3.1	2.7	3.5
All uncemented / uncemented stem	2,959	149	5.2	4.4	6.1	1,195	58	5.5	4.2	7.0
Hybrid	2,404	118	5.2	4.3	6.2					
Anterior	3,052	135	4.7	4.0	5.5	3,436	99	3.4	2.8	4.1
Anterolateral	1,658	85	5.3	4.3	6.5	2,696	59	2.6	2.0	3.3
Lateral	397	13	3.5	2.0	5.9	1,268	39	3.7	2.7	5.1
Posterior	785	58	7.6	6.0	9.8	1,260	56	5.0	3.9	6.5
Other approach	130	11	9.4	5.3	16.3	152	4	3.3	1.2	8.7

* 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.

Periprosthetic fractures, dislocations, and infections were the three most common complications in both THA and HA **(Table 3.7c)** and infections were the most important cause of revision in the HA group, representing 33.1% of cases examined, while the most frequent cause for revision in THA were periprosthetic fractures (25.8%). Interestingly, the revision rate for dislocations in HA was similar to THA, with 24.1% in THA and 23.8% for HA, and the conversion of HA to THA with/without stem exchange accounted for 38.9% of all revisions. Furthermore, in 37.1% of the THAs, an exchange of the acetabular component was performed **(Table 3.7e).**

The revision rates of unipolar and bipolar heads for cemented stems show that bipolar heads had a higher revision rate in the first year whereas afterwards, the difference was insignificant. After 3 years, the revision rate of unipolar heads and bipolar heads remained identical **(Figure 3.7a)** and remained similar for up to 10 years. Because of the small remaining numbers at 10 years, the confidence intervals are wide and therefore the difference was not significant, as shown by the overlapping confidence intervals. The higher early revision rate of bipolar heads was due to the rate of dislocation that was significantly higher and also occurred earlier **(Table 3.7d).** Periprosthetic fractures were also more frequent in unipolar heads, as were infections.

Table 3.7c

Fracture of the hip: Reasons for early first revisions

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

	Total hip arthroplasty		Hemi hip arthroplasty	
	N	%	N	%
Periprosthetic fracture	78	25.8	53	20.6
Dislocation	72	23.8	62	24.1
Infection	71	23.5	85	33.1
Loosening femoral	41	13.6	25	9.7
Loosening acetabular	27	8.9		
Position/Orientation of cup	12	4.0		
Position/Orientation of stem	11	3.6	3	1.2
Acetabular protrusion	5	1.7	6	2.3
Trochanter pathology	2	0.7	1	0.4
Wear	1	0.3	4	1.6
Metallosis	1	0.3	0	0.0
Femoral osteolysis	1	0.3	0	0.0
Implant breakage	1	0.3	1	0.4
Impingement	1	0.3	0	0.0
Squeaking	1	0.3	0	0.0
Acetabular osteolysis	0	0.0	1	0.4
Other	28	9.3	30	11.7

Table 3.7d

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

	Unipolar heads		Bipolar heads	
	N	%	N	%
Infection	45	38.8	30	36.6
Periprosthetic fracture	21	18.1	7	8.5
Dislocation	21	18.1	28	34.1
Loosening femoral	8	6.9	11	13.4
Impingement	3	2.6	1	1.2
Wear	0	0.0	0	0.0
Acetabular osteolysis	0	0.0	1	1.2
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
Acetabular protrusion	0	0.0	0	0.0
Other	19	16.4	5	6.1

Early first revisions are those occurring within 2 years of the primary arthroplasty. Multiple responses possible (percentages do not sum to 100).

Table 3.7e

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

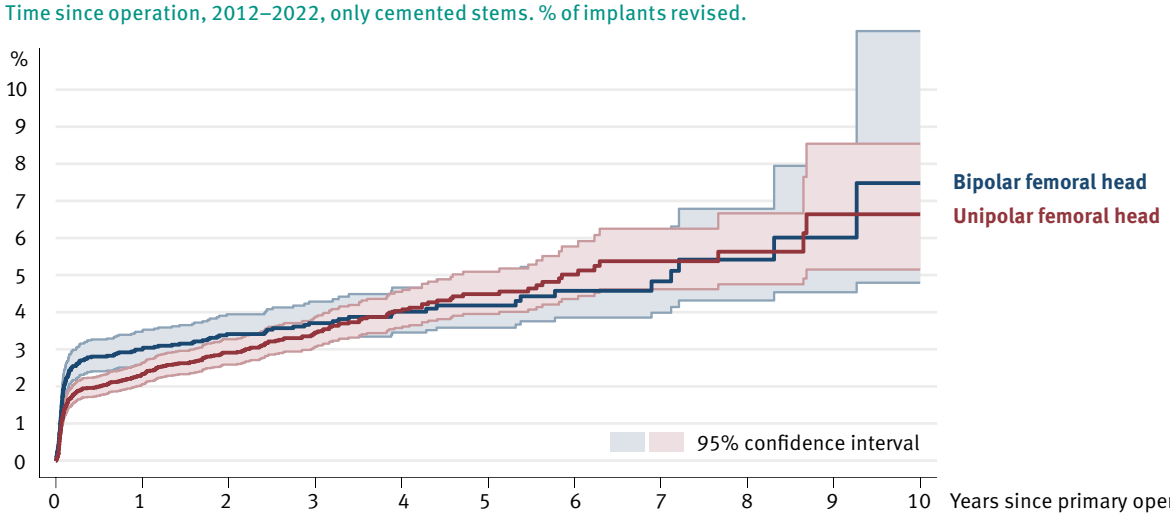
	Total hip arthroplasty		Hemi hip arthroplasty	
	N	%	N	%
Exchange acetabular and femoral components	42	13.9		
Exchange acetabular component	15	5.0		
Exchange acetabular component and head	55	18.2		
Exchange femoral component	63	20.9	38	14.8
Exchange femoral component and inlay	20	6.6	6	2.3
Exchange head	22	7.3	60	23.3
Exchange inlay	2	0.7	2	0.8
Exchange head and inlay	48	15.9	22	8.6
Conversion of hemi-prosthesis to THA without stem exchange			58	22.6
Conversion of hemi-prosthesis to THA with stem exchange			42	16.3
Component removal, spacer implantation	9	3.0	3	1.2
Component reimplantation (after spacer or Girdlestone)	2	0.7	3	1.2
Girdlestone	4	1.3	3	1.2
Exchange femoral component, inlay and osteosynthesis	9	3.0	6	2.3
Other intervention	11	3.6	14	5.4
Total	**302**	**100.0**	**257**	**100.0**

HA: in approx. 11% of cases response categories involving acetabular components were chosen. These were recoded to conversions.

Figure 3.7a

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

Time since operation, 2012–2022, only cemented stems. % of implants revised.



	1 year	2 years	3 years	4 years	5 years	7 years	8 years	10 years
Unipolar femoral head	**2.3** (2.1-2.6)	**2.9** (2.6-3.3)	**3.4** (3.1-3.8)	**4.0** (3.6-4.5)	**4.5** (4.0-5.1)	**5.4** (4.6-6.2)	**5.6** (4.8-6.7)	**6.6** (5.1-8.5)
Bipolar femoral head	**3.0** (2.6-3.5)	**3.4** (2.9-3.9)	**3.7** (3.2-4.3)	**4.0** (3.5-4.7)	**4.2** (3.6-4.9)	**4.8** (4.0-5.9)	**5.4** (4.3-6.8)	**7.5** (4.8-11.6)

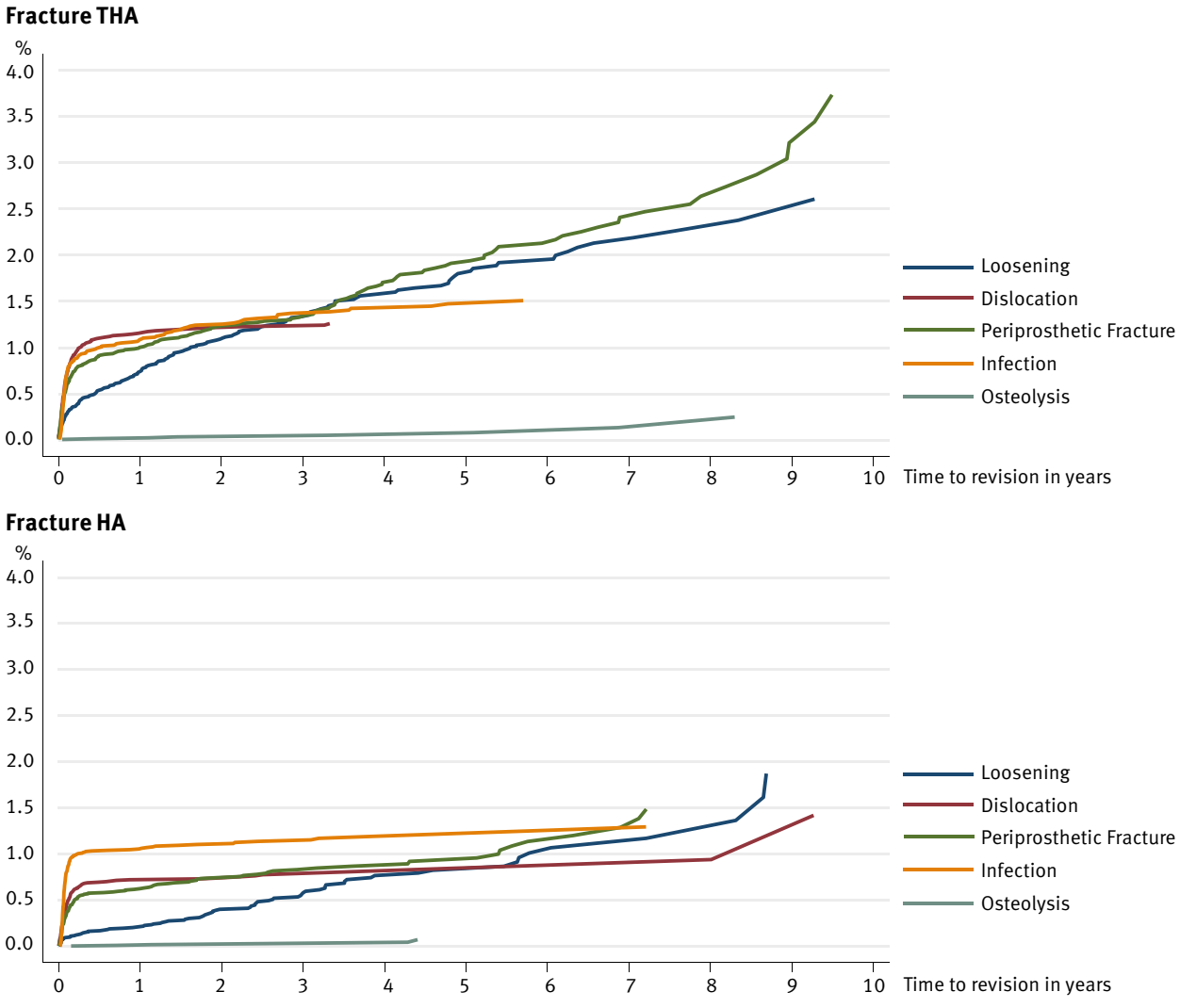
The cumulative incidence figures provide an additional perspective on the reasons for revision **(Figure 3.7b).** This perspective shows what proportion of implants have undergone at least one revision due to certain specific reasons (e.g. revision due to loosening of a component). In this type of graph, 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 as indicated by a steep initial spike followed by very gradual long-term growth. These observations are more frequent in THA while, on the other hand, incidents of loosening and periprosthetic fractures were the drivers of long-term revision rates in both THA and HA. After year 3, no dislocations were observed after THA, in contrast to HA where dislocations are observed for much longer.

Figure 3.7b

Fracture of the hip: Cumulative incidence rates for different first revision diagnoses

Time since operation, 2012–2021, all services, % of implants revised.



3.8 Results of implants after hip fracture

Overall, the revision rate for THA for the treatment of fractures is more than twice that of primary OA (5.3% vs 2.5%) and the demographics of THA after fractures are shown in Chapter 3.2. There are 21 uncemented stem/cup combinations, accounting for 75% of all cases **(Table 3.8a)** and the average 2-year revision rate (4-year moving average) was 5.3% (95% CI 4.4–6.2), whereby it is important to note that only implant combinations with n at risk › 50 were included in the analysis and the revision

Table 3.8a

Fracture of the hip: Top 75% of primary total hip arthroplasty uncemented combinations to treat fractures

2017–2022

Stem component	Cup component	2017	2018	2019	2020	2021	2022	2017–2022
Alloclassic	Fitmore	4	12	14	5	13	9	**57**
Amistem-H	Versafitcup trio/ccl.	53	6	1	0	0	0	**60**
Amistem-H prox coating	Versafitcup trio/ccl.	45	76	63	6	9	0	**199**
Amistem-P	Versafitcup trio/ccl.	0	2	15	83	87	115	**302**
Avenir	Allofit	52	67	70	79	69	65	**402**
Avenir	Fitmore	11	12	9	7	13	9	**61**
CLS Spotorno	Allofit	13	18	15	11	10	2	**69**
Corail	Pinnacle	43	35	61	68	76	66	**349**
Corail collared	Gyros	13	18	13	19	1	0	**64**
Corail collared	Liberty	0	1	0	13	53	4	**71**
Corail collared	Link bimobile	0	0	0	0	20	122	**142**
Corail collared	Novae TH/Bi-Mentum	4	3	5	26	59	67	**164**
Corail collared	Pinnacle	37	46	48	63	105	141	**440**
Fitmore	Allofit	12	15	18	15	26	20	**106**
Fitmore	Fitmore	10	14	15	21	14	26	**100**
Fitmore	RM pressfit vitamys	4	3	4	10	12	13	**46**
Optimys	RM pressfit	6	13	12	9	9	14	**63**
Optimys	RM pressfit vitamys	70	90	90	115	156	156	**677**
Optimys	Symbol DMHA/DS evol.	3	5	5	11	19	17	**60**
Polarstem	R3	9	14	13	16	10	23	**85**
Quadra-H	Versafitcup trio/ccl.	25	33	28	31	19	10	**146**
Twinsys	RM pressfit vitamys	43	29	24	26	34	30	**186**
other combinations	-	118	162	199	253	251	263	**1,246**
Total		**575**	**674**	**722**	**887**	**1,065**	**1,172**	**5,095**

Important information on the use of the implant performance tables below

- Estimated revision rate exceeds the alert boundary, but we do not identify this implant combination as an outlier because the 95% confidence interval overlaps the confidence zone of the reference group.
- 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.

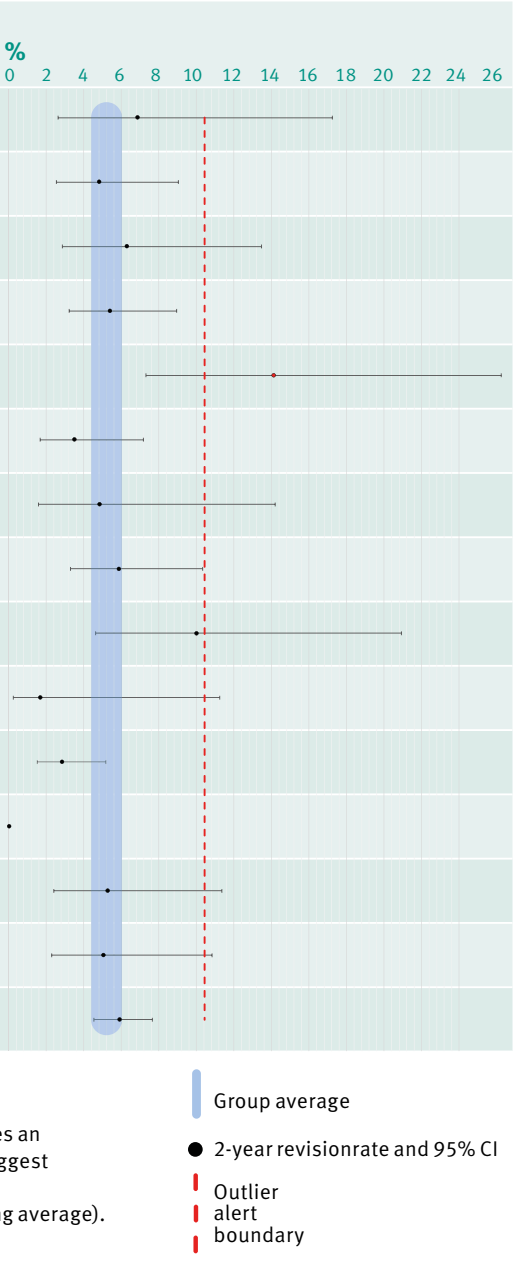
rates for combinations with n at risk › 50 are shown in **Figure 3.8a.** Compared to the 2022 report, only one of the two outliers retained its outlier status (CLS Spotorno/Allofit). An implant combination is considered an outlier when its revision rate is twice the average revision rate of the group and the lower boundary of the confidence interval exceeds the group average. Although Fitmore/Allofit's revision ratings improved, it still is the implant combination with the second highest revision rate and its change of status mainly depends on the baseline data that changes with the 4-year moving window. The num-

Figure 3.8a

2-year evaluation: Revision rates within 24 months of uncemented primary total hip arthroplasty combinations to treat fractures

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CCS*	at risk N**	Revised N	Revised % (95% CI)***
Amistem-H	Versafitcup trio/ccl.	27	60	4	6.8 (2.6-17.2)
Amistem-H prox. coating	Versafitcup trio/ccl.	19	190	9	4.8 (2.5-9.0)
Amistem-P	Versafitcup trio/ccl.	23	100	6	6.3 (2.9-13.5)
Avenir	Allofit	19	268	14	5.4 (3.2-8.9)
CLS Spotorno	Allofit	60	57	8	14.1 (7.3-26.2)
Corail	Pinnacle	11	207	7	3.5 (1.7-7.2)
Corail collared	Gyros	35	63	3	4.8 (1.6-14.2)
Corail collared	Pinnacle	15	194	11	5.9 (3.3-10.3)
Fitmore	Allofit	72	60	6	10.0 (4.6-20.9)
Fitmore	Fitmore	43	60	1	1.7 (0.2-11.2)
Optimys	RM pressfit vitamys	13	365	10	2.8 (1.5-5.2)
Polarstem	R3	33	52	0	0.0 (.-.)
Quadra-H	Versafitcup trio/ccl.	21	117	6	5.3 (2.4-11.4)
Twinsys	RM pressfit vitamys	18	122	6	5.0 (2.3-10.8)
other combinations			928	53	5.9 (4.5-7.7)
CH average for group					5.2 (4.4-6.1)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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

ber of implants at risk, together with the number of revised cases, may thus change with time and, as the numbers of implantations are low, one revision more or less may determine the outlier status.

Twenty stem/cup combinations covered 75% of hip fractures treated with hybrid fixation and 11 of these combinations were used fewer than 100 times in the observed period between 2016 and 2022 **(Table 3.8c).**

The revision rates for 10 combinations with n at risk > 50 are presented in **Figure 3.8b** and show that none of the implants reached potential outlier status.

Furthermore, the choice of implant combination for the treatment of hip fractures with HA is less variable than for THA and there are only 10 stem/head combinations accounting for 75% of all implantations **(Table 3.8b).** These combinations have been used rather frequently over the last 10 years

Table 3.8b

Fracture of the hip: Top 75% of primary total hip arthroplasty hybrid combinations to treat fractures

2017–2022

Stem component	Cup component	2017	2018	2019	2020	2021	2022	2017–2022
Amistem-C	RM pressfit vitamys	4	9	5	6	6	5	**35**
Amistem-C	Versafitcup DM	21	25	16	12	9	6	**89**
Amistem-C	Versafitcup trio/ccl.	71	53	86	94	107	101	**512**
Avenir (cem)	Allofit	19	16	30	33	40	49	**187**
Avenir (cem)	Fitmore	3	19	26	37	65	58	**208**
CCA	RM pressfit vitamys	5	10	19	9	10	19	**72**
Centris	RM pressfit	21	10	12	6	10	0	**59**
Centris	RM pressfit vitamys	34	35	30	32	53	0	**184**
Corail (cem)	Novae TH/Bi-Mentum	0	0	2	8	28	52	**90**
Corail (cem)	Pinnacle	22	14	37	39	76	118	**306**
MS-30	Allofit	1	0	0	0	10	27	**38**
MS-30	Fitmore	24	21	9	10	1	0	**65**
Quadra-C	Mpact	0	1	24	19	16	8	**68**
Quadra-C	Mpact DM	1	3	11	32	34	32	**113**
Quadra-C	Versafitcup DM	10	6	9	12	3	3	**43**
Quadra-C	Versafitcup trio/ccl.	78	64	72	64	35	21	**334**
Twinsys (cem)	RM pressfit	13	6	5	6	6	14	**50**
Twinsys (cem)	RM pressfit vitamys	43	43	69	72	75	117	**419**
Weber	Allofit	14	9	9	10	2	4	**48**
Weber	Fitmore	49	38	51	46	37	32	**253**
other combinations		114	139	145	171	231	236	**1,036**
Total		**547**	**521**	**667**	**718**	**854**	**902**	**4,209**

and it is worth noting that neither combination was used fewer than 300 times in the last 5 years. The revision rates for combinations with n at risk › 50, which are more than the above-mentioned 10 combinations, are shown in **Figure 3.8c.** Because of increasing numbers, some stem/head combinations could be separated for statistical analysis. An example of this is the Harmony/Symbios bibop combination. In 2022 it was analysed and reported as a single combination **(Figure 3.8c).** For the 2023 report, the analysis of the Harmony-related data could be split up into three different head types, of which one has a rather high revision rate, while none of the implants reached potential outlier status.

Table 3.8c

Fracture of the hip: top 75% stem/head combinations used in hemi hip arthroplasty (HA)

2017–2022

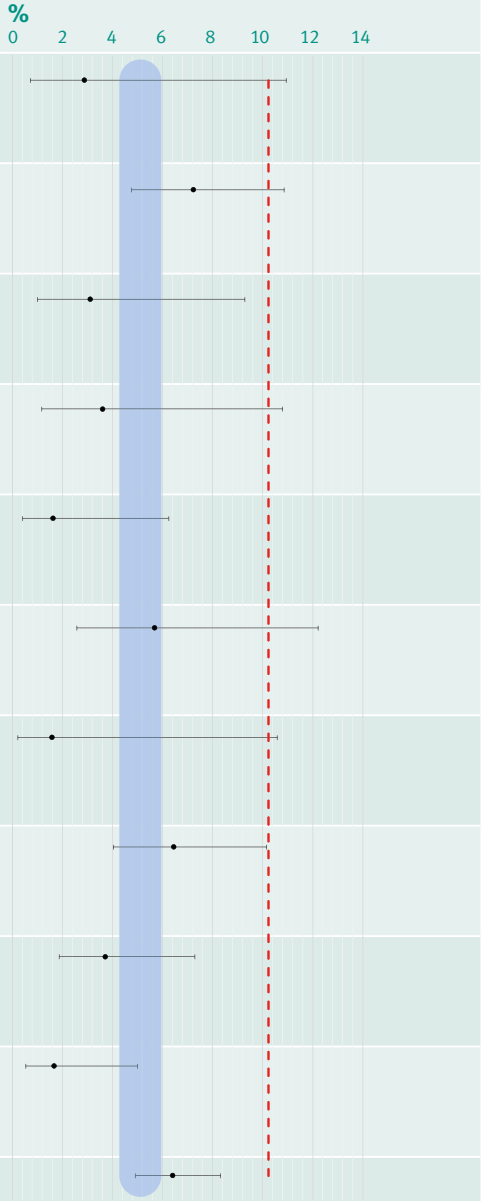
Stem component	Cup component	2016	2017	2018	2019	2020	2021	2016–2021
Amistem-C	Medacta bipolar head	69	94	92	114	151	155	**675**
Amistem-C	Medacta endohead	295	289	279	327	372	408	**1,970**
Avenir (cem)	ZB bipolar head	50	60	79	99	68	100	**456**
CCA	Hemihead SS	355	429	438	395	351	289	**2,257**
Centris	Hemihead SS	96	112	109	103	113	0	**533**
Corail (cem)	J&J modular head carthcart	63	43	85	105	173	243	**712**
Twinsys (cem)	Hemihead SS	100	71	97	122	121	232	**743**
Weber	ZB bipolar head	48	45	57	58	53	25	**286**
Weber	ZB unipolar head	158	253	225	168	140	149	**1,093**
other combinations		508	461	556	516	458	571	**3,070**
Total		**1,742**	**1,57**	**2,017**	**2,007**	**2,000**	**2,172**	**11,795**

Figure 3.8b

2-year evaluation: Revision rates within 24 months of hybrid primary total hip arthroplasty combinations to treat fractures

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CCS*	at risk N**	Revised N	Revised % (95% CI)***
Amistem-C	Versafitcup DM	72	74	2	2.9 (0.7-10.9)
Amistem-C	Versafitcup trio/ccl.	26	304	21	7.2 (4.8-10.9)
Avenir (cem)	Allofit	56	98	3	3.1 (1.0-9.3)
Avenir (cem)	Fitmore	47	85	3	3.6 (1.2-10.8)
Centris	RM pressfit vitamys	42	131	2	1.6 (0.4-6.3)
Corail (cem)	Pinnacle	24	112	6	5.7 (2.6-12.2)
MS-30	Fitmore	69	64	1	1.6 (0.2-10.6)
Quadra-C	Versafitcup trio/ccl.	54	278	17	6.4 (4.0-10.2)
Twinsys (cem)	RM pressfit vitamys	20	227	8	3.7 (1.9-7.3)
Weber	Fitmore	42	184	3	1.6 (0.5-5.0)
other combinations			874	52	6.4 (4.9-8.3)
CH average for group			717	37	5.1 (4.3-6.1)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

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

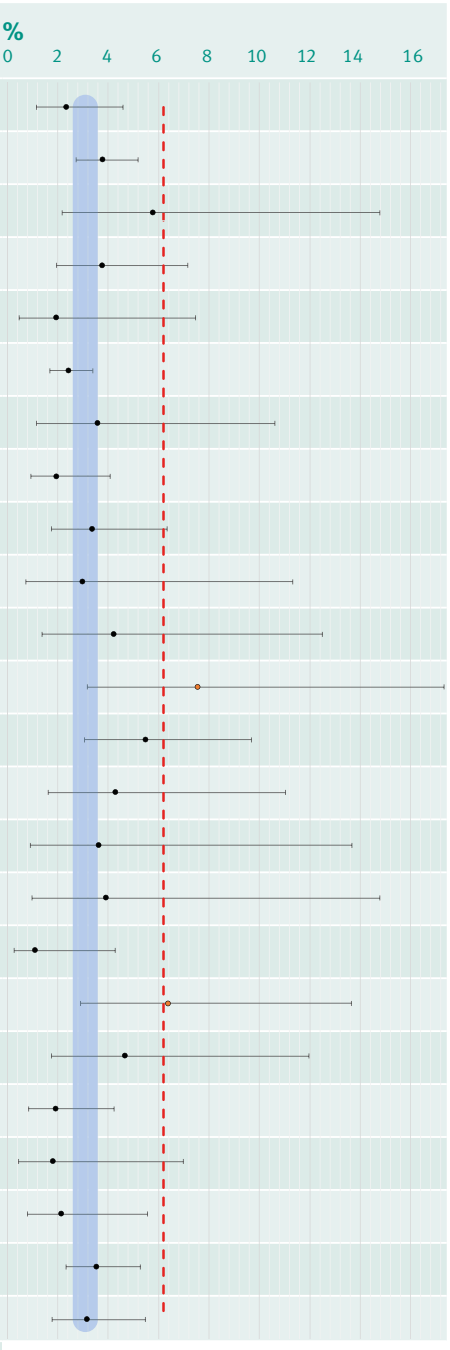
*** Rates adjusted for effects of mortality and emigration

Figure 3.8c

2-year evaluation: Revision rates of cemented primary HA components within 24 months

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Stem component	Cup component	CCS*	at risk N**	Revised N	Revised % (95% CI)***
Amistem-C	Medacta bipolar head	33	369	8	2.3 (1.2-4.6)
Amistem-C	Medacta endohead	38	1190	37	3.8 (2.7-5.2)
Arcad	Symbios bibop	88	84	4	5.8 (2.2-14.8)
Avenir (cemented)	ZB bipolar head	27	288	9	3.8 (2.0-7.2)
Avenir (cemented)	ZB unipolar head	29	112	2	1.9 (0.5-7.5)
CCA	Hemihead SS	31	1617	32	2.4 (1.7-3.4)
CCA	Mathys bipolar steel head	27	118	3	3.6 (1.2-10.6)
Centris	Hemihead SS	41	420	7	2.0 (0.9-4.1)
Corail (cemented)	J&J modular head carthcart	25	296	9	3.4 (1.8-6.4)
Corail (cemented)	S&N bipolar ballhead	100	70	2	3.0 (0.7-11.3)
Harmony (cem.)	Acropole bipolar head	100	77	3	4.2 (1.4-12.5)
Harmony (cem.)	OHST bipolar head	99	81	5	7.5 (3.2-17.3)
Harmony (cem)	Symbios bibop	100	225	11	5.5 (3.1-9.7)
MS-30	ZB bipolar head	58	101	4	4.3 (1.6-11.0)
MS-30	ZB unipolar head	89	62	2	3.6 (0.9-13.7)
Original Mueller	ZB bipolar head	31	87	2	3.9 (1.0-14.8)
Original Mueller	ZB unipolar head	32	231	2	1.1 (0.3-4.3)
Quadra-C	Medacta bipolar head	50	101	6	6.4 (2.9-13.6)
Quadra-C	Medacta endohead	54	100	4	4.7 (1.8-12.0)
Twinsys (cem)	Hemihead SS	35	390	6	1.9 (0.8-4.2)
Twinsys (cem)	Mathys bipolar steel head	40	124	2	1.8 (0.5-7.0)
Weber	ZB bipolar head	29	208	4	2.1 (0.8-5.6)
Weber	ZB unipolar head	27	804	23	3.5 (2.3-5.3)
other combinations			439	12	3.1 (1.8-5.5)
CH average for group					3.1 (2.7-3.6)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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

3.9 Competing risk

As indicated in Chapter 2 of this report, the widely-used KM method has known limitations when the risk of revision competes with other risks. In the context of joint registries, the one evident competing risk is the death of a patient and, as shown in this chapter, no other group of patients in this report was as affected by this risk as the recipients of prostheses after hip fractures. This especially applies to recipients of THA or HA after hip fracture as a patient who dies will not have their implant revised at any later point in time. The risk of death is thus said to "compete" with the risk of revision. Within the constraints of the KM method, we account for death by declaring patients who died during their observation time as "censored" from the day of death. While this approach is not incorrect, 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 KM method in the presence of the strong competing risk of death in SIRIS data, we produced a simple competing risks regression model that includes component revision as the primary endpoint, death as the competing risk, the type of the arthroplasty, together with age and sex as covariates of interest. The results are shown in **Table 3.9a.** In this context, the sub-hazard ratio (SHR) is the coefficient that indicates that fracture THAs are more likely to be revised than primary OA THAs by a factor of 1.90 whereas for fracture HAs, the factor is 1.28. Additionally, the likelihood of revision is reduced by a factor of 0.99 for each year of age, whereby it is important to note that the cumulative effect of this covariate can be considerable and these three factors were statistically highly significant. The results concerning what the (now accounted for) competing risk of death means for our interpretation are best illustrated by comparing standard KM results against the cumulative revision risk derived from the predicted values of this model. As shown previously, primary OA THA carried the lowest overall revision risk, while fracture THA had the highest and fracture HA lay somewhere in the middle **(Figure 3.9a).**

Table 3.9a

Results of competing risk regression* comparing primary OA THA, fracture THA and fracture HA

All cases 2012–2022. n= 204,703, n failed= 6,891, n competing= 31,761, competing risk= death of patient.

	SHR	robust std. error	sig	95% CI	
primary OA THA (reference category)					
fracture THA	1.90	0.07	‹0.001	1.80	2.05
fracture HA	1.28	0.06	‹0.001	1.17	1.40
Age at operation	0.99	0.001	‹0.001	0.99	0.99
Female	1.04	0.03	0.14	0.99	1.09

* Fine and Gray's proportional subhazards model

The predicted results of the competing risks regression model, here expressed specifically for the "typical" or average patient in those groups, showed little difference for the THAs **(Figure 3.9b)** and the 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 9 years of follow-up, did not significantly influence the results and, interestingly, the fracture THA decreased by one percentage point. However, in contrast, the impact on fracture HA in the group with the highest mortality rates is most impressive as, 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 thus 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 undergoes revision or dies). 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 10 years.

Figure 3.9a

Comparison of cumulative revision risk for generic groups with Kaplan-Meier method

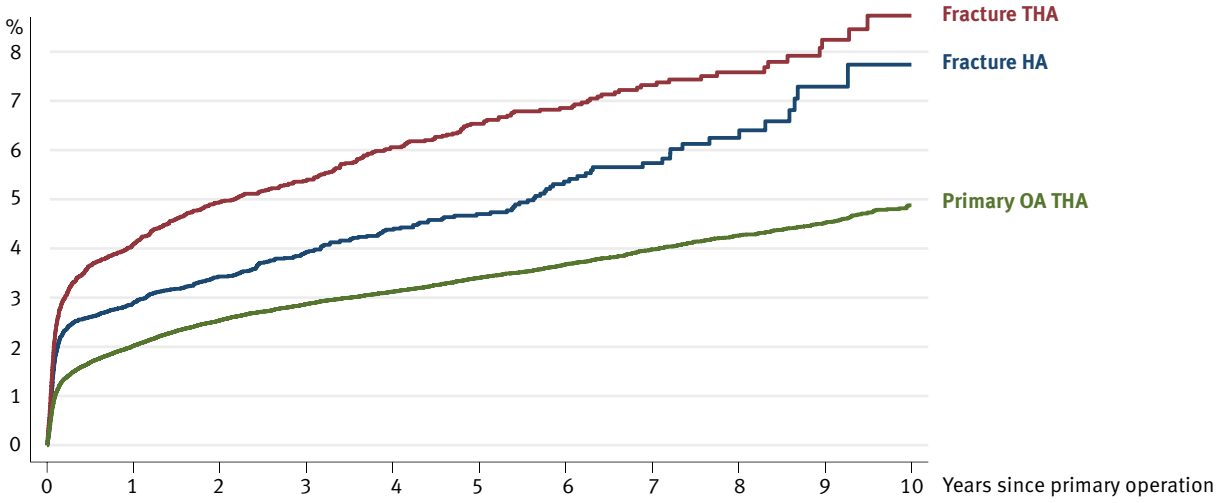
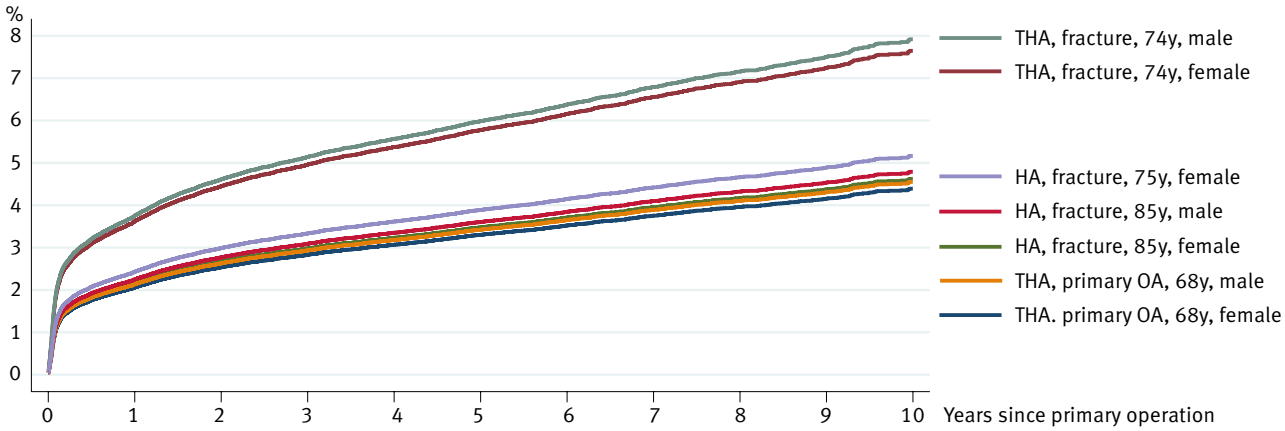


Figure 3.9b

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



PROMs in hip arthroplasty

3.10 Patient reported outcome measures (PROMs) in total hip arthroplasty

Two local initiatives have provided PROMs data for THAs registered in SIRIS. The COMI study was conducted between 2017 and 2020 in three Cantons (follow-up until 2022), while the MDS dataset has been in use in all hospitals in the Canton of Zürich, as well as several others, since 2019. The details of these initiatives and the main method chosen for making comparisons are described in Chapter 2 (Methods), Section 2.6 of this report. Here, it suffices to say that both initiatives captured representative patients from a typical mix of types of hospitals, exactly as would be seen in a national sample of PROMs.

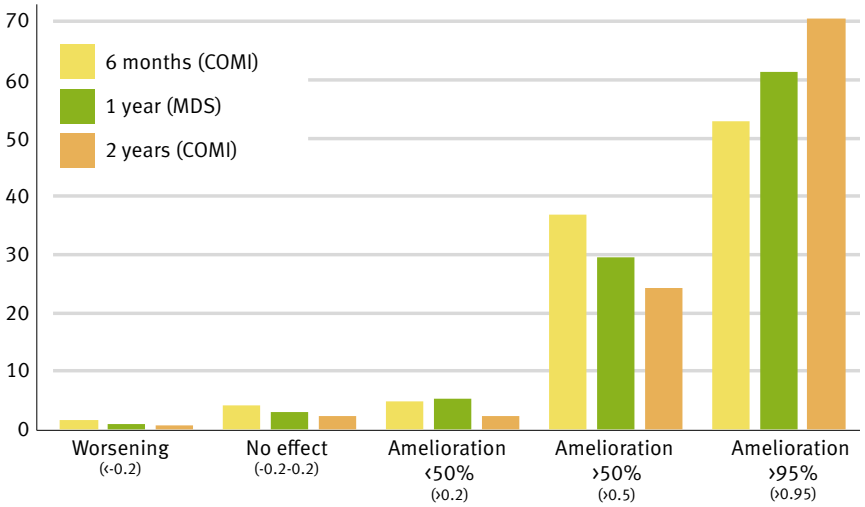
One of the main aims of hip arthroplasty is pain reduction, and hence joint-specific pain was measured in both datasets using the same 0–10 scale. In the MDS dataset, the pre-operative mean score was 6.67 (SD 2.0, median 7), while in the COMI dataset, it was 6.71 (SD 1.99, median 7). After the operation, this was reduced to 0.89 (SD 1.65, median 0) after 1 year and 0.69 (SD 1.57, median 0) after 2 years. The analysis included all THAs with a diagnosis of either primary or secondary osteoarthritis, regardless of revision status, and there was no statistically significant difference between diagnostic groups. However, calculating a Treatment Effect (TE) for this particular outcome in both datasets and at three different time points may provide a more meaningful metric to consider.

As shown in **Figure 3.10a**, a solid majority of patients (52.8%) in the COMI dataset had already achieved practically complete pain elimination after 6 months, whereby the equivalent value stood at 61.4% in the MDS dataset after 1 year and rose to 70.6% in the COMI dataset after 2 years. However, there is a small minority of patients for whom pain does not improve significantly (‹3% after 1 year) and a small minority even reports an increase in pain in the same period. Nevertheless, approximately 90% of patients report either excellent or good treatment results after 1 year, possibly rising to 95% after 2 years, highlighting how successful THAs are in reducing pain. As a result, only very few cases (0.6% and 0.3%) were excluded from this analysis because they apparently did not experience any pre-operative pain or provided incorrect responses concerning this aspect.

Figure 3.10a

Treatment effect pain: THA, primary and secondary osteoarthritis

Share of patients without reported pain (excluded): 0.6% MDS, 0.3% COMI.



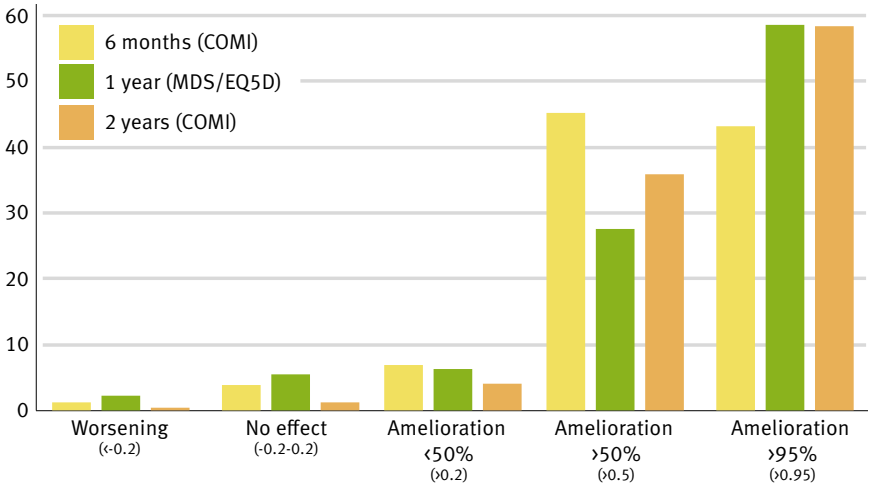
	6 months (COMI)	1 year (MDS)	2 years (COMI)
Worsening (‹-0.2)	1.5	0.9	0.7
No effect (-0.2 - 0.2)	4.1	2.9	2.3
Amelioration ‹50% (›0.2)	4.7	5.3	2.2
Amelioration ›50% (›0.5)	36.9	29.6	24.3
Amelioration ›95% (›0.95)	52.8	61.4	70.6
n	**1,144**	**5,257**	**737**

When comparing the summary COMI and EQ5D scores in the same way as for pain (see Chapter 2.6 for methodological details), we see slightly different distributions owing to the discrepancy in the underlying constructs used. Here, too, we observe a high pre-operative symptomatic burden and we thus selected one component question from each score as an example. Preoperatively, in the COMI dataset, 17.4% of the respondents stated that they were severely restricted in their daily activities while 51.5% were considerably restricted. In the MDS dataset, 39.3% of the respondents indicated that they were either severely restricted in their mobility or unable to move. As these are non-identical response items with different question wordings, we cannot expect identical distributions, although, in both datasets, we see these reported symptoms largely eliminated after the operation. Expressed as TEs on the respective summary scales, we observe that in the COMI dataset, 43.1% of the respondents report complete amelioration after 6 months, rising to 58.4% after 2 years **(Figure 3.10b).** In the MDS dataset, the equivalent value stands at 58.5% after 1 year. A small minority of 0.8% of the respondents in the MDS dataset – and none of the respondents in the COMI dataset – reported no apparent symptoms and were thus excluded from the analysis of treatment effect. It is likely that the higher share of MDS patients reporting no improvement or worsening conditions (combined 7.7%) after 1 year is a direct consequence of the more general nature of the EQ5D instrument. Unlike COMI, EQ5D is not joint-specific, and we must allow for the possibility that the patient's overall situation (e.g. expressed in the anxiety/depression question) cannot improve as a result of arthroplasty. Nevertheless, a total of 86% of respondents with excellent or good treatment outcomes after 1 year on a general quality of life (QOL) measure again highlight the value of THAs and suggest that for a majority of THA patients, the restrictions imposed by their untreated arthritis are the central determinants of reduced quality of life. In the more joint-specific COMI dataset, the equivalent value is 94.9% after 2 years.

Figure 3.10b

Treatment effect limitations/QOL: THA, primary and secondary osteoarthritis

Share of patients without reported limitations (excluded) 0.8% MDS, 0% COMI



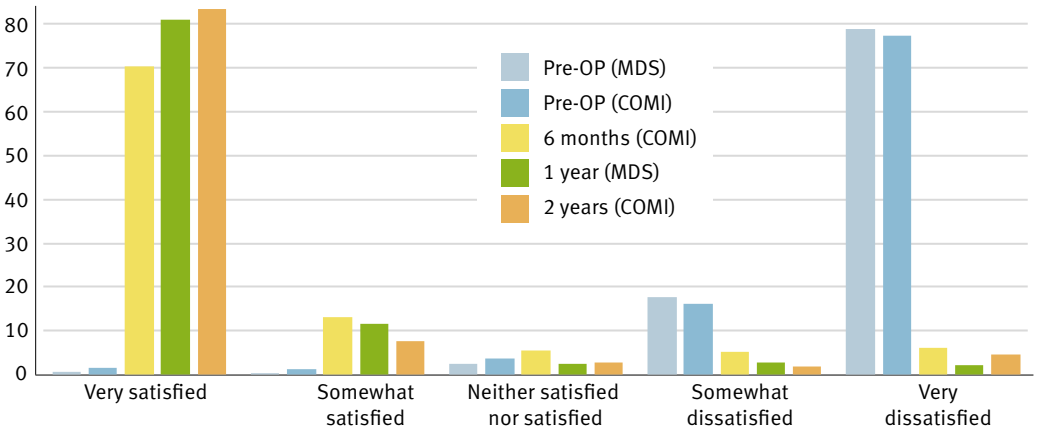
	6 months (COMI)	1 year (MDS/EQ5D))	2 years (COMI)
Worsening (‹-0.2)	1.1	2.3	0.4
No effect (-0.2 - 0.2)	3.8	5.4	1.2
Amelioration ‹50% (›0.2)	6.8	6.3	4.1
Amelioration ›50% (›0.5)	45.2	27.5	35.9
Amelioration ›95% (›0.95)	43.1	58.5	58.4
n	**1,148**	**5,352**	**741**

Another PROMs dimension covered in both datasets with identical questions is satisfaction before and after the operation and, as shown in **Figure 3.10c,** in both datasets more than 77% of respondents were very dissatisfied with their current situation at baseline while a further 16 to 17% were somewhat dissatisfied. In contrast, 6 months after the operation, 70% of the respondents were very satisfied with their situation while over 80% indicate their satisfaction with the outcome of the procedure after 1 or 2 years and only small minorities (approximately 5%) remain dissatisfied with their current situation at the longer follow-up intervals. The satisfaction question confirms what we derived from the pain and QOL measures and the satisfaction rates (combined) after THA can thus be assumed to be in the 90% range.

In conclusion, it should be noted that the same PROMs are also reported in the knee chapter, whereby the THA results are, on average, somewhat better than the total or partial knee results. However, with few exceptions, pre-operative measures are almost exactly at the same level in hip and knee patients. This indicates that hip and knee patient populations in SIRIS are comparable and that a direct collation of the outcome variables is thus appropriate.

Figure 3.10c

Satisfaction with current situation: THA, primary and secondary osteoarthritis



	Pre-Op (COMI)	Pre-Op (MDS)	6 months (COMI)	1 year (MDS)	2 years (COMI)
Very satisfied	0.5	1.7	70.2	80.8	83.4
Somewhat satisfied	0.4	1.3	13.1	11.5	7.5
Neither satisfied nor dissatisfied	2.5	3.7	5.4	2.6	2.7
Somewhat dissatisfied	17.7	16.2	5.1	2.9	1.8
Very dissatisfied	78.9	77.2	6.2	2.2	4.6
N	**1,145**	**5,347**	**1,145**	**5,347**	**670**

Knee arthroplasty

Ten Years of Swiss Hip and Knee Registry

4. Knee arthroplasty

4.1 Introduction and summary

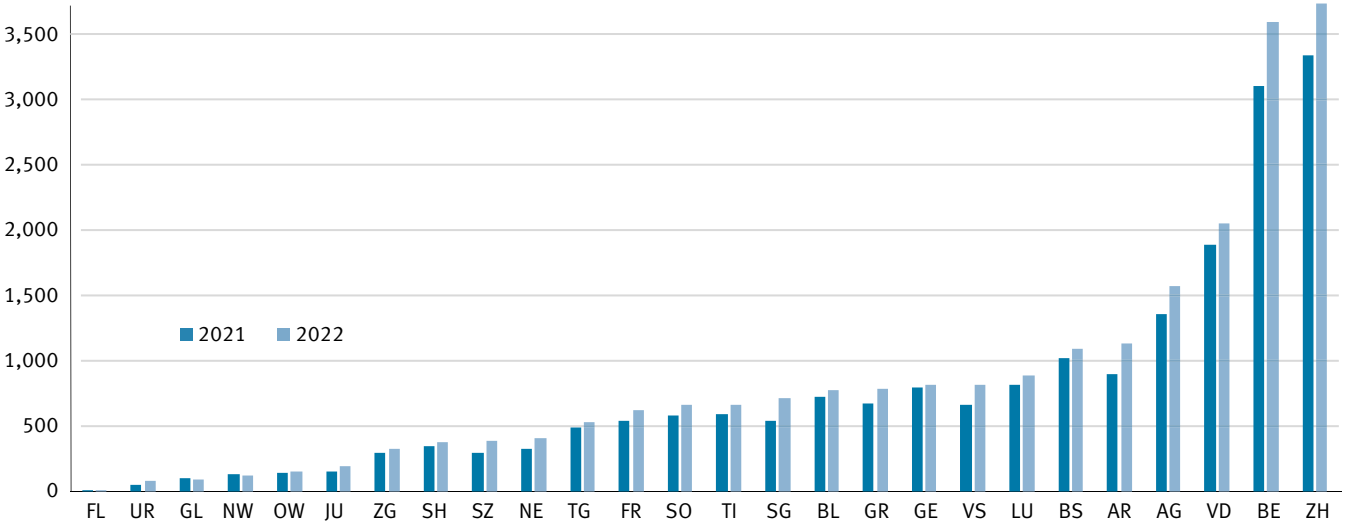
Incidence of knee arthroplasties

The number of TKA and PKA has steadily increased in recent years. Initially, this increase could be explained by the improving coverage rate, as the number of participating services and the data completeness both increased over time. However, the annual increase of 13.8% in 2022 is far above expectations, as the early problems with underreporting were solved years ago and the population at risk increased only by 3.0% during the same period **(Table 4.1a, Figure 4.1e).** The reason for such a pronounced increase of PKA and TKA between 2021 and 2022 is unclear and the development of this trend should be monitored in coming years.

Nevertheless, despite the lack of information concerning the causes, the increase is too pronounced not to be commented on. In this context, it is worth noting that a certain rebound after the restrictions on elective surgery during the Covid-19 pandemic could be expected in 2022. Particularly as elderly patients postponed their interventions, as they were afraid of catching Covid-19 during any hospitalisation. Considering the difference in incidence compared to THA, this would not explain the full number of additional knee arthroplasties. A real increase in the rate seems to be the most plausible explanation. One possible reason could be an effect that was also observed in Germany some years before. In Switzerland, the consensus that arthroscopy in degenerative meniscal tears or cartilage damages is of very limited use if no mechanical blockade is present gained wide acceptance and was also supported by the Swiss orthopaedic society (Kaelin R. et al., Schweiz Med Forum 2018;18(07):147-153, DOI: https://doi.org/10.4414/smf.2018.03207). In addition, arthroscopies were mainly shifted to the ambulatory sector, greatly impacting associated revenues. It is thus plausible that this relative banning of arthroscopy could have been partially compensated by earlier indication to knee arthroplasty. Furthermore, it should be noted that the confidence in TKA and PKA constantly increased in recent years, potentially pushing numbers, despite results and outcome being still less favourable than after THA. Moreover, numbers of knee arthroplasties are increasing in almost all coun-

Figure 4.1a

Case number growth 2021–2022 by Canton



tries in the western world. As the relatively more numerous generations of the baby boomers now is at risk for arthroplasty and desires to maintain an active lifestyle, requirements do increase. However, all these factors may lead to elevated rates in arthroplasties, but do not explain the jump of 13.8%.

Knee arthroplasty has a clear seasonal pattern in Switzerland, with highest levels in Q1 and Q4 and the lowest level of activities in Q3. This pattern only changed in 2020 due to the Covid-19 pandemic and was observed again from 2021 onwards **(Figure 4.1d).**

Table 4.1a

Total and partial knee arthroplasty (TKA, PKA)

All documented operations

Year	Primary TKA	Primary PKA	Primary others or type uncl.	Primary Total	Annual growth rate primary	Linked Rev./Reop. of TKA[2]	Linked Rev./Reop. of PKA[2]	Unlinked Rev./Reop. can be of TKA or PKA	Rev./Reop. Total[3]	% Linked Rev./Reop.
2012[1]	4,662	941	5	5,608		19	2	509	530	4.0
2013	12,674	2,403	12	15,089		179	50	1,250	1,482	15.5
2014	13,052	2,339	12	15,403	2.1%	393	107	1,116	1,616	30.9
2015	13,420	2,393	7	15,820	2.7%	589	122	1,072	1,784	39.9
2016	14,604	2,459	9	17,072	7.9%	831	193	1,136	2,164	47.3
2017	14,473	2,620	15	17,108	0.2%	944	260	1,089	2,297	52.4
2018	14,716	2,723	10	17,449	2.0%	1,036	286	1,091	2,416	54.7
2019	15,494	3,054	8	18,556	6.3%	1,192	298	1,055	2,548	58.5
2020	15,452	3,146	7	18,605	0.3%	1,311	394	1,048	2,755	61.9
2021	16,671	3,189	4	19,864	6.8%	1,332	399	1,022	2,758	62.8
2022	19,195	3,411	3	22,609	13.8%	1,513	442	942	2,901	67.4
All	**154,413**	**28,678**	**92**	**183,183**		**9,339**	**2,553**	**11,330**	**23,251**	**51.1**

[1] Does not represent a full year of data, as data collection in most hospitals started only in October 2012, [2] i.e. primaries already in SIRIS, [3] including linked revisions/reoperations of procedures that were classified as „primary others“ or of unclear type

Figure 4.1b

Age distribution at surgery of primary total and partial knee arthroplasty

All documented operations

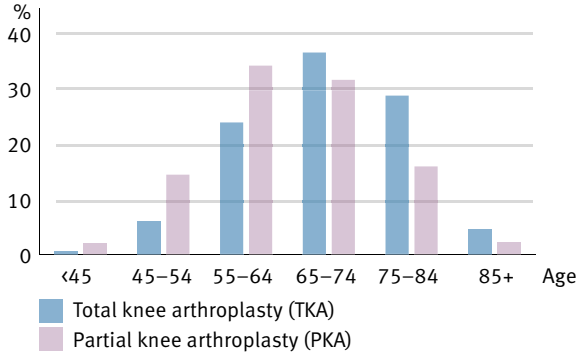
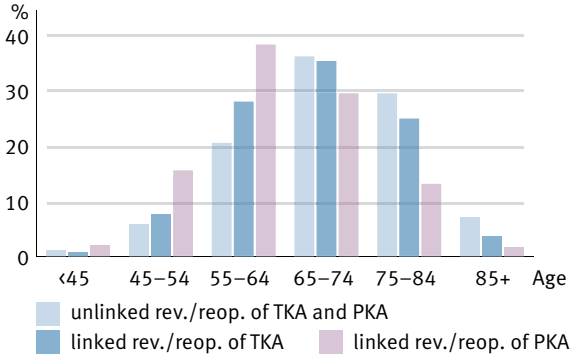


Figure 4.1c

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

All documented operations

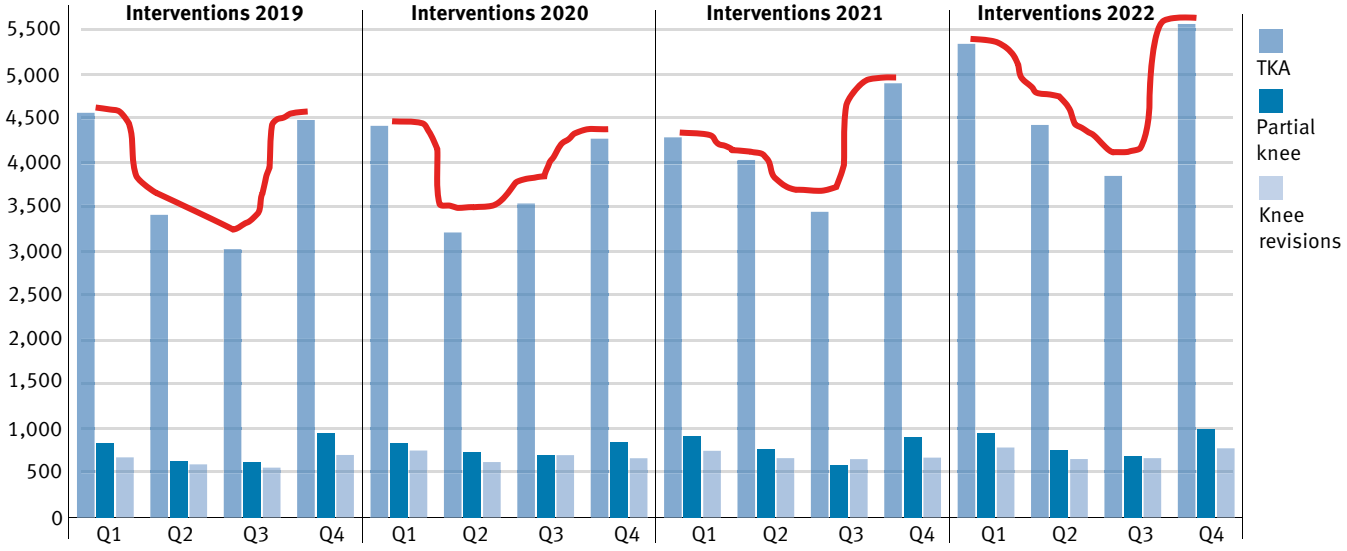


Regional variability

Development of knee arthroplasty between 2021 and 2022 showed quite a considerable regional variability **(Figure 4.1a).** the spread reached from an increase of 2.9% in Geneva to 45.5% in Uri. In the cantons with the largest numbers, Berne and Zurich, the increase in this period was 15.7% and 13.5% respectively. This relevantly influenced the total number of knee arthroplasties performed nationwide. It is interesting to note that Zurich did not seem to have increased numbers of TKA per 100,000 inhabitants significantly more than other cantons, despite minimal case numbers being introduced in 2018. Indirect signs for widening indications for knee arthroplasty, such as increasing numbers in particularly young or particularly old patients, as had been observed in the USA, could not be detected in the SIRIS dataset. The share of these extreme age groups did not change since 2017 **(Table 4.2a).** The share of PKA was constant over the past years and reached 15.6% overall. The proportion was 16.0% in 2021 and 15.0% in 2022. PKA numbers were therefore not predominantly responsible for the increase of knee arthroplasties discussed above.

Figure 4.1d

Seasonal pattern of SIRIS submissions 2019 – 2022



	2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TKA	4,566	3,415	3,028	4,485	4,419	3,216	3,543	4,274
Partial knee	840	636	623	955	843	741	708	854
Knee revisions	679	600	563	706	756	626	704	669

	2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TKA	4,289	4,034	3,449	4,899	5,344	4,429	3,854	5,568
Partial knee	918	773	593	905	955	759	699	998
Knee revisions	753	670	659	676	790	660	670	781

Primary and revision total knee arthroplasty

Since 2012, 183,183 primary knee arthroplasties were registered in Switzerland, of which 154,413 were TKA, and 28,678 were PKA. The proportion of PKA was 15.6% over the past 9 years. In 2022, 19,195 TKA and 3,411 PKA were performed, resulting in a share of PKA of 15.1%. Age at surgery was lower for PKA, with the age peak at 55-64 years, whereas the age peak for TKA was in the group 65–74 years **(Figure 4.1b).** The cumulative revision rate for PKA was higher than for TKA from the beginning on, reaching 13.0% (range 12.4–13.8%) at ten years follow-up, compared to 7.6% (7.4–7.8%) for TKA **(Figure 4.1i).**

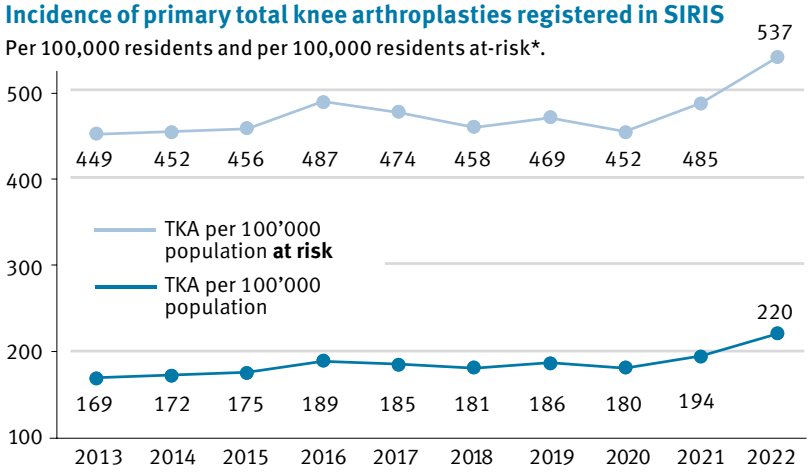
The lower revision rates observed for the early years of the registry can be explained by the fact that initially not all the revisions were registered, and some could not be correctly linked to the primary intervention. The data quality constantly increased over the years, making the numbers much more reliable from 2015 onward. The rate of linked revisions reached 67.4% in 2022, compared to 39.9% in 2015 **(Table 4.1a).** The revision rates for 2021/22 were lower than for the preceding periods, confirming an improvement seen for the first time in the last report, although not yet statistically significant **(Figure 4.1j).** This pattern represents one of the main goals of an implant registry: improving quality of arthroplasty over time.

Almost 150 hospital services in Switzerland performed knee arthroplasty, and SIRIS has achieved a 100% participation rate of the relevant institutions since 2018. In 2022, 145 hospitals registered TKA, 127 PKA, and 135 revisions of TKA and/or PKA. The median procedure figures per hospital **(Table 4.1b, c)** showed initially a relatively stable pattern between 2017 and 2021, but jumped upwards considerably in 2022. **Figure 4.1k** highlights the distribution of case numbers within service size categories. Comparing the numbers of knee arthroplasties performed in different services in Switzerland characterised by their volume (yearly numbers of procedures ‹ 100, 100–199, 200–300, › 300) was not meaningful due to variability of data **(Table 4.1b, c).** Simplifying the classification into centres with less than 200 and more than 200 interventions per year shows a clearer concentration over time towards larger centres **(Figures 4.1l).** In revision, the effect was less clear, perhaps because of smaller numbers. High-volume services tend to perform more PKA and revision TKA than smaller units, some centres seem to focus on PKA and/or revision TKA, perhaps reflecting a sort of sub-specialisation **(Figure 4.1k).**

Figure 4.1e

Incidence of primary total knee arthroplasties registered in SIRIS

Per 100,000 residents and per 100,000 residents at-risk*.



*Age group 50–89 years accounts for 97% of all recipients of TKA. Adjusted for estimated coverage. SIRIS figures excluding Liechtenstein.
Coverage rates 2013–2016 estimated at 92%; 2017–2021 based on federal health office data; 2022 estimated at 99%.

Figure 4.1f

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

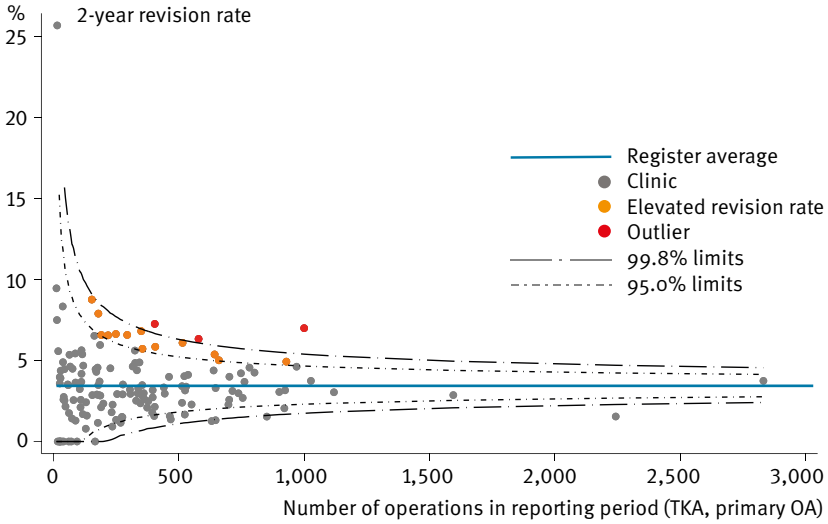


Figure 4.1g

Two-year revision rate of partial knee arthroplasty by service*

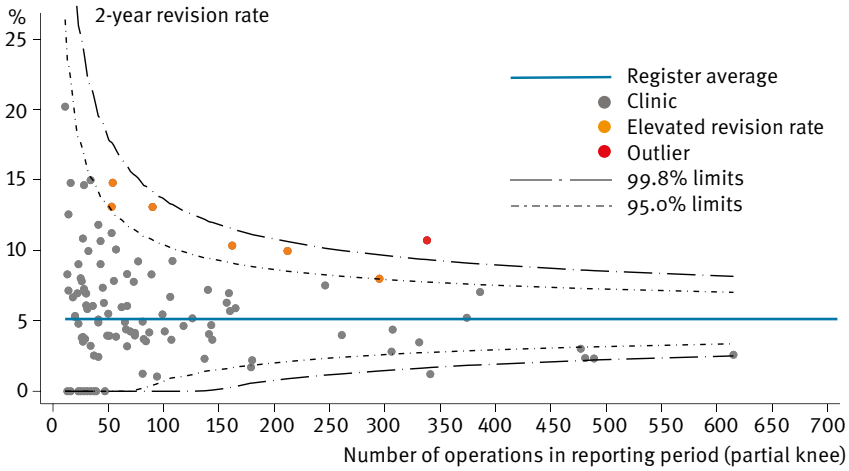
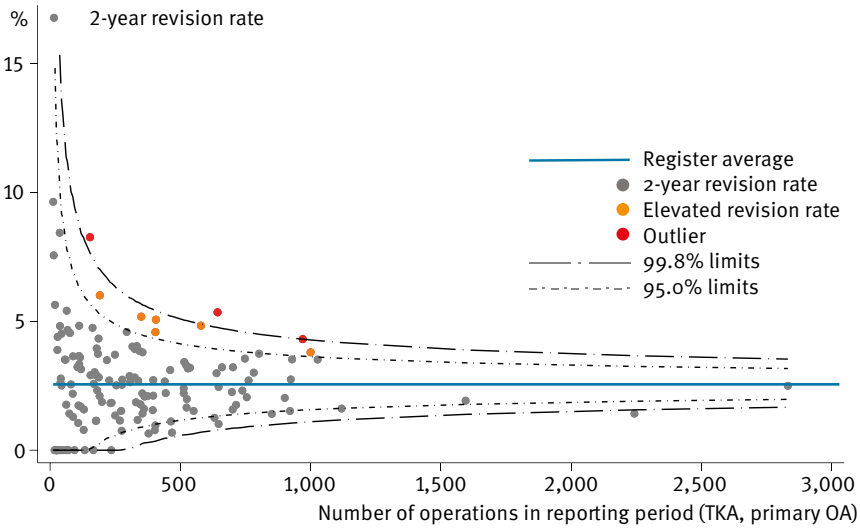


Figure 4.1h

Total knee arthroplasty without isolated secondary patella resurfacing



Interpretation of funnel plots

The blue 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

Clinics 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).

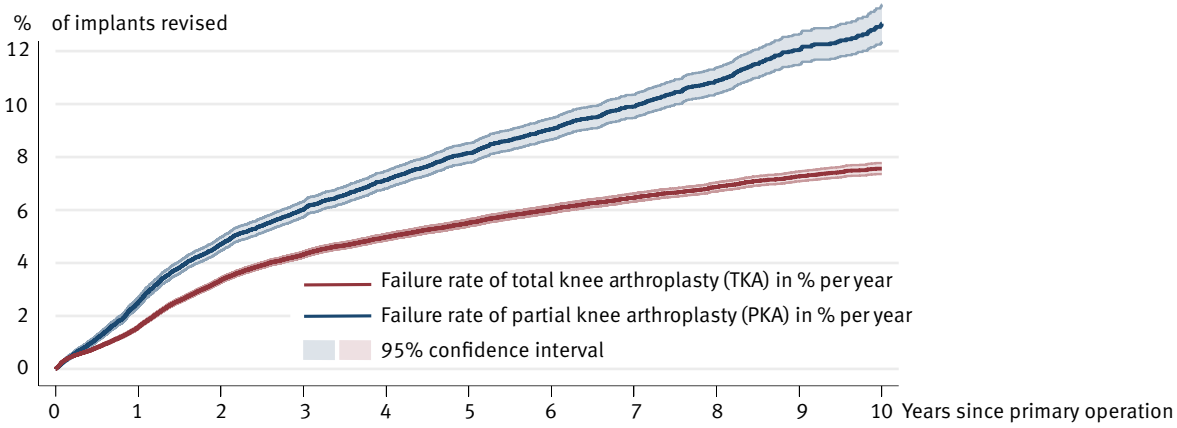
*Number of operations in the reporting period 01/2017–12/2020 (4-year moving average, follow-up to 12/2022)

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 4.1i

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

in percentages, 2012–2022, all services, all diagnoses.



Failure rate

	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
TKA	**1.6** (1.5-1.6)	**3.4** (3.3-3.4)	**4.3** (4.2-4.4)	**5.0** (4.9-5.1)	**5.5** (5.4-5.6)	**6.0** (5.9-6.2)	**6.5** (6.3-6.6)	**6.9** (6.7-7.0)	**7.3** (7.1-7.5)	**7.6** (7.4-7.8)
PKA	**2.5** (2.3-2.7)	**4.7** (4.5-5.0)	**6.0** (5.7-6.3)	**7.1** (6.8-7.5)	**8.1** (7.8-8.5)	**9.1** (8.7-9.5)	**9.9** (9.5-10.4)	**10.9** (10.4-11.4)	**12.1** (11.5-12.6)	**13.0** (12.4-13.8)

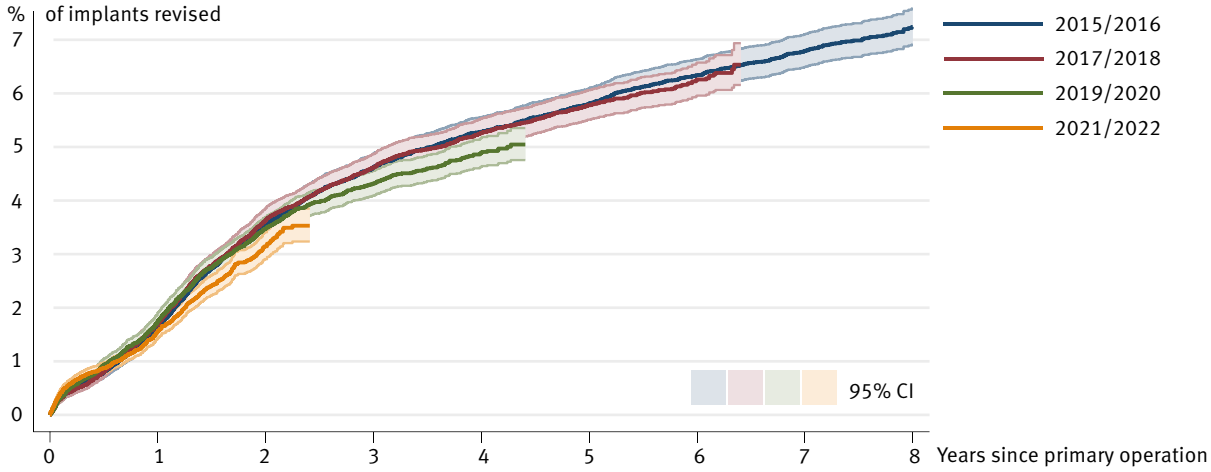
Number at risk

	0 year	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
TKA	162,236	137,516	116,247	95,481	80,417	65,306	51,665	38,541	26,583	16,278	6,815
PKA	29,989	25,482	21,758	17,659	14,637	11,924	9,458	7,216	5,179	3,254	1,396

Figure 4.1j

Kaplan Meier estimate of cumulative postoperative revision risk after total knee arthroplasty by time period

Time since operation, 2015–2022, all services, all diagnoses, follow-up extended to 31 May 2023.



Failure rate	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years
2015/2016	**1.6** (1.5-1.8)	**3.5** (3.3-3.8)	**4.6** (4.4-4.9)	**5.3** (5.0-5.6)	**5.8** (5.5-6.1)	**6.3** (6.0-6.6)	**6.8** (6.5-7.1)	**7.2** (6.9-7.6)
2017/2018	**1.7** (1.6-1.9)	**3.6** (3.4-3.9)	**4.6** (4.4-4.9)	**5.3** (5.0-5.5)	**5.8** (5.5-6.1)	**6.3** (6.0-6.6)		
2019/2020	**1.8** (1.6-1.9)	**3.5** (3.3-3.7)	**4.3** (4.1-4.6)	**4.9** (4.6-5.2)				
2021/2022	**1.6** (1.4-1.7)	**3.1** (2.9-3.4)						

Figures 4.1f, g, h shows funnel plots of risk-adjusted early revision rates (age and sex, BMI, ASA, and Charnley scores, if available) for TKA and PKA and revision TKA without isolated patella resurfacing. In this context, an early revision was defined as a surgical revision including an exchange of an implant within 2 years after index surgery. An additional implant, such as a secondary patella resurfacing, also counts as a revision. Each dot represents a hospital service. The vertical axis indicates the outcome, with dots higher up the axis showing services with higher revision rates. The horizontal axis portrays the surgical activity with dots further to the right indicating surgical units that performed more operations within the reported period. Funnel plots include control limits to define the

Table 4.1b

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

		2017	2018	2019	2020	2021	2022
Primary arthroplasty of the knee (TKA)	N services	149	151	148	146	145	145
	M per service	72	78	79	77	86	106
Primary partial arthroplasty of the knee	N services	127	129	127	128	127	127
	M per service	10	11	12	12	13	14
Revision arthroplasty of the knee (TKA or partial)	N services	130	134	133	130	134	135
	M per service	9.5	9	9	13	12	13

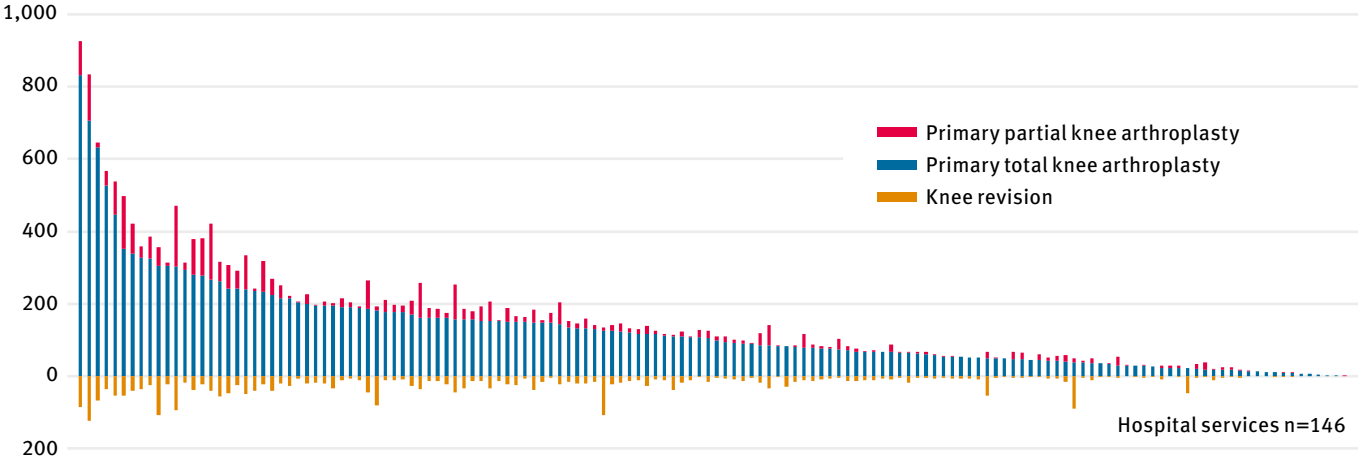
Table 4.1c

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

Service volume		2017	2018	2019	2020	2021	2022
‹100	N procedures/%	3,086/**21.5**	3,590/**24.5**	3,184/**20.5**	2,721/**17.7**	2,551/**15.4**	2,699/**14.1**
	N services	86	90	81	78	72	65
100–199	N procedures/%	4,810/**33.5**	4,327/**29.5**	4,523/**29.1**	4,698/**30.5**	4,778/**28.9**	5,551/**28.9**
	N services	39	35	37	39	40	42
200–299	N procedures/%	2,940/**20.5**	3,273/**22.3**	3,461/**22.3**	3,240/**21.0**	4,041/**24.4**	3,452/**18.0**
	N services	14	16	17	16	19	18
›300	N procedures/%	3,528/**24.6**	3,480/**23.7**	4,352/**28.0**	4,754/**30.8**	5,185/**31.3**	7,493/**39.0**
	N services	9	9	12	13	14	20

Figure 4.1k

Cases per hospital service 2022: total and partial knee arthroplasty



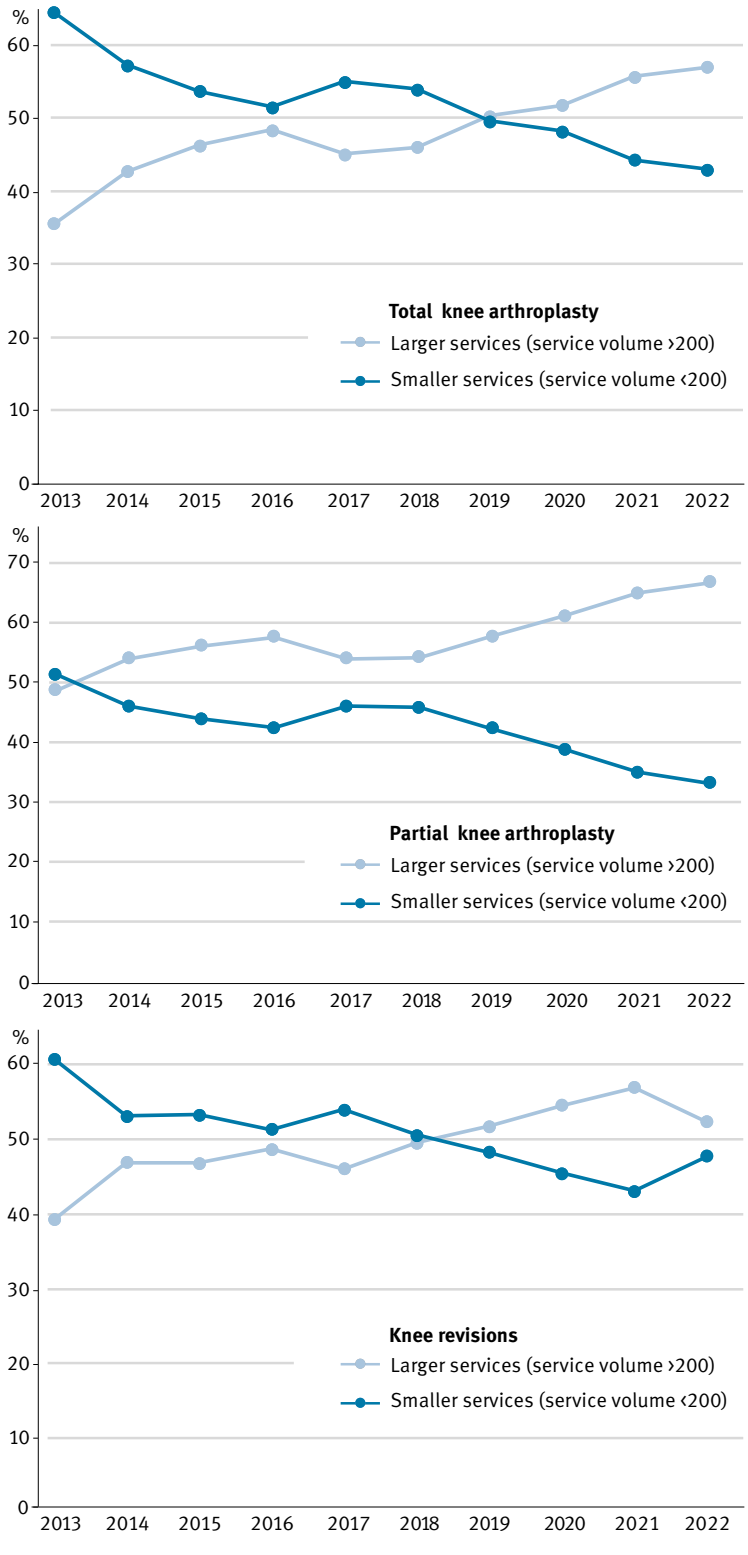
range of expected outcomes. The main cause of variation within the control limits is thus likely to be random variation. As the plots show, the spread of outcomes in Switzerland was relatively homogeneous, although there were exceptions, and there appears to be more variation with knee than with hip procedures. More potential (orange dots) and definite (red dots) outliers can be identified for TKA than for PKA. When isolated secondary patella resurfacing is ignored, the spread of results becomes less pronounced, especially because of the reduced number of potential outliers. This implies that secondary patella resurfacing still played a prominent role in determining clinical performance at two years regarding revision rates after TKA **(Figures 4.1f, g, h).**

In 2022, the total number of primary TKA registered in SIRIS reached 154,413 cases **(Table 4.1a),** whereby the share of women (59.2%) and the mean age of the patients (69.8 years) remained constant throughout the entire period. The share of younger patients (0.5% younger than 45 and 5.4% 45–54 years old) and patients older than 85 years old (4.6%) did not change significantly in recent years **(Table 4.2a).** Gender, mean age, age groups, BMI, and ASA classifications did not differ in low or high-volume hospitals **(Table 4.2c).** Most TKA were performed for primary OA (86.9% in 2022), although additional reasons (such as ligament lesions or infection) were introduced in 2015 as a possible underlying diagnosis for secondary OA, and despite the fact that the understanding of risk factors for knee OA has steadily increased in recent decades. One interesting finding is that the classification of primary and secondary OA in hospitals with more than 200 procedures per year varied remarkably and thus primary OA was registered between 51% and up to over 92% of the operated cases, indicating varying practice in coding of diagnosis **(Figure 4.2a).** In units with a high share of secondary OA, a meniscectomy was indi-

Figures 4.1l

Share of selected procedures performed in hospital services with different service volumes

Service volume is defined as the sum of primary procedures per year



cated frequently as a previous operation, although this group does not significantly influence demography nor outcome after knee arthroplasty and is thus included among primary OA cases to calculate revision rates.

Furthermore, younger patients tended to be obese more frequently. On average, women were older than men when TKA was performed, in all BMI groups, although the difference decreased with age and when the BMI exceeded 30 kg/m^2. The mean age at surgery was approximately 70 years for patients with a BMI under 30 kg/m^2 whereas surgery had to be performed between 5 and 6 years earlier when the patient's BMI was more than 40 kg/m^2 **(Figure 4.2b).** The difference in the younger patients was mainly men's higher share of post-traumatic OA The lower BMI in post-traumatic OA can also be depicted in **table 4.2b.** Hospital volume did not affect significantly patient demographics **(Table 4.2c).**

Of note is the fact that the knee replacement systems used varied significantly between hospitals, cantons, respectively regions. Traditionally, posterior stabilized (PS) knees were used more commonly in the western part of Switzerland, whereas in the German-speaking Cantons, cruciate retaining (CR) and cruciate sacrificing (CS), including ultra-congruent (UC) knees, were favoured. In contrast, the implantation of medial-pivot (MP) knees did not appear to follow a particular regional pattern in Switzerland but seemed to be preferred in specific hospitals. **Figures 4.2j and 4.2k** show the high variability of the different types of knee prostheses used in Switzerland and adaptions between the periods spanning 2017–2019 and 2020–2022, respectively. The share of medial pivot implants seemed to increase over time and replaced more traditional designs.

Fixation of TKA mostly was fully cemented. The proportion was 78.4 % in the past six years. Use of hybrid fixation of the components remained constant with 15.6%. Interestingly, cementless fixation represented only 3.7% of the TKA in 2017, but the share doubled within 3 years to 8.5% in 2022 **(Table and Figure 4.2e).** Stems were used in 8.2% of primary TKA, of which 75.6% were used on the tibial side, and 79.3% were cemented **(Table 4.2d).** Obesity (≥ 30kg/m^2) was not a reason for implanting a tibial stem use in Switzerland, despite recommendation in several studies. Stems were mainly associated with higher intrinsic stability of the knee system (SC/CCK or hinge type). Stems were also used more frequently in PS than in the CR, CS, or MP designs **(Figure 4.2d).**

The rate of mobile-bearing polyethylene liner (PE liner) did rapidly decrease over the past six years, from 41.2% in 2017 to 21.0% in 2022 **(Table and Figure 4.2g).** However, the bearing type showed a high regional variability **(Figure 4.2j).** The reduction in the use of mobile-bearings is not a general effect but differs considerably by region. In some cantons the share of mobile bearings even increased (e.g., Uri, Jura, Ticino, Principality of Liechtenstein) comparing the periods from 2017 to 2019 and 2020 to 2022 **(Figure 4.2j).**

The patella was not resurfaced in 67.2% of the primary TKA performed between 2017 and 2022 **(Table and Figure 4.2f).** However, the resurfacing rate increased continuously since 2017, from 28.8% to 36.8% in 2022. As for the type of knee system or regarding the selection between fixed and mobile bearings, there were considerable differences **(Figure 4.2i).** Some of these differences can be explained by the use of posterior stabilized knee systems, where resurfacing of the patella is recommended more often than in other TKA models. PS TKA are more popular in the western part of Switzerland, as well as in some particular centres. The continuous increase in primary patella resurfacing is thus not homogenous but underlies regional differences, correlated with the knee system used. In many cantons, the resurfacing rate

increased significantly from the period 2017–2019 to 2020–2022. Only in a few Cantons, such as Obwalden and Zug, the resurfacing rate decreased in the same period **(Figure 4.2i).** In Glarus, patella resurfacing never occurred since 2017.

Between 2017 and 2022, 69.4% of TKA in Switzerland were performed conventionally. The share of computer navigation was 10.6% and continuously decreased from 11.9% in 2017 to 9.2% in 2022. On the other hand, the use of patient-specific instrumentation (PSI) increased from 12.2% in 2017 to 19.6% in 2022. Robotic-assisted TKA (imageless and image-based) were classified as "other" and accounted for 3.5% of surgical interventions for the whole period, increasing from 1.0% in 2017 to 6.0% in 2022 **(Table and Figure 4.2h, Figure 4.2l).** In summary, surgeons used technical support in 30.6% of total knee arthroplasties over the past 6 years.

The first revision of knee arthroplasty

Of the 154,413 TKA implanted and registered since 2012, a total of 60,135 were at risk for an early revision within the first 2 years after index surgery. 2,090 TKA were revised resulting in a rate of 3.6% (3.4–3.7%) **(Table 4.4a).** Whereas revision rate was 3.4% (3.3–3.6%) in primary OA, the rate increased to 4.5% (4.0–5.0%) in secondary OA. This is partially an effect of the age difference at the index intervention, which was 70.2 years on average between 2017 and 2022 for primary OA, compared to 65.0 years for secondary OA **(Table 4.2b).** A second explanation could be that in secondary OA, more complex knee systems had to be used more frequently at the index surgery. The proportion of SC/CCK TKA was approx. 1.8% in primary and approx. 3.5% in secondary OA. For hinged systems the share almost tripled in secondary OA (approx. 4.5% versus approx. 1.5% in primary OA). Complete revision TKA was performed in 35.6% of the cases. In 16.5%, only the PE liner was exchanged. Secondary resurfacing of the patella alone was performed in 15.0% **(Table 4.3c).** A combined exchange of the PE liner with secondary patella resurfacing was conducted in 5.6% of the cases.

CR TKA were used in 4.1% of the revisions, whereas 19.8% were PS, 7.6% were classified as CS or UC implants, and in 30.1% of cases, a hinge-type prosthesis was used. With 33.7%, unlinked semi-constrained or CCK implants formed the largest group, whereas MP was only used in 2.0% of the revisions **(Table 4.3c).**

The vast majority of the revision implants were fully cemented (mean 92.6% from 2017 to 2022), reaching 92.2% in 2022 **(Figure 4.3b).** Revision TKA was associated with patella resurfacing with a mean of 66.3% between 2017 to 2022 **(Figure 4.3c).**

Compared to hip prostheses, the numbers of "unlinked" knee revisions and reoperations are falling faster. Overall, the share of linked revisions was

51.1%, steadily increasing over time and reaching 67.4% in 2022, including linked revisions of TKA and PKA **(Table 4.1a).** This increase in the proportion of linked revisions is most probably related to the fact that knee arthroplasties are revised earlier and more frequently than THA, particularly if PKA are included in the statistics.

Re-revision of knee arthroplasty

For the first time, re-revisions after the revision TKA were examined in the annual report of 2023, including re-revision after the conversion of PKA to TKA. Complete revision performed better regarding risk of repeated revision than partial revision from the first year onwards and up to 10 years after revision TKA **(Figure 4.4a).** Re-revision rate at 10 years was 22.1% for partial and 19.9% for complete revision, the difference not being statistically significant. This rate is almost three times higher than after primary TKA **(Figure 4.1i).** Re-revision rates reached 8.3% (7.6–9.0%) after two years for complete and 10.8% (9.5–12.3%) for partial revision, respectively, whereas the early revision rate after primary TKA was 3.6% (3.4–3.7%) **(Table 4.4b).** If only the PE liner was exchanged at revision, the early re-revision rate was 17.1% (15.6–18.7%), even rising to 29.0% (25.6–32.7%) at ten years.

Component reimplantation, which mostly is indicated after temporary spacers due to suspected or confirmed periprosthetic infection, had an early (two year) re-revision rate of 13.8% (11.5–16.5%). This is worse than after partial or complete revision without infection **(Figure 4.5a).** The re-revision rate increased over time up to 28.7% (24.2–33.8%) ten years after reimplantation.

Cumulative rates for all re-revisions after revision TKA are depicted in **Figure 4.5c.** Infection takes the lead early after re-revision, followed by the equally prevalent problems of femorotibial instability, patella problems, and loosening of the tibia. Joint stiffness seemed to play a minor role, as did isolated pain of unknown origin.

Isolated secondary patella resurfacing was associated with an early re-revision rate of 8.1% (7.1–9.2%), which is comparable to the results after complete revision. Secondary patella resurfacing combined with PE liner exchange led to 9.3% (7.4–11.7%) of re-revisions not significantly different

to isolated secondary patella resurfacing **(Figure 4.5b).** Ten-years results are still lacking, but at 7 years secondary patella resurfacing in combination with PE liner exchange performed better than secondary resurfacing alone. This was comparable to the re-revision rate after complete TKA revision **(Figure 4.4a).** It is unclear if PE wear played a role in cases with isolated patella resurfacing from 7 years after revision surgery onwards. The main reason for re-revision after secondary patella resurfacing, with or without PE liner exchange was femorotibial instability **(Figure 4.5d).** Astonishingly, (persistent) patella problems were the second most frequent reason, confirming that anterior knee pain after TKA often has other causes, which cannot be solved by secondary patella resurfacing alone. Loosening of the tibial component was an important cause of re-revision, whereas joint stiffness or isolated pain, fortunately, did not play an important role in this context **(Figure 4.5d).**

Re-revision rate after conversion of a PKA to TKA reached 10.4% (8.8-12.1%) after two years and 20.9% (17.6-24.7%) after 10 years, respectively. This is comparable to the re-revision rates after revision TKA and is far worse than the revision rate after primary TKA**.**

Primary and revision partial knee arthroplasty

Between 2017 and 2022, 18,143 PKA were implanted, accounting for 15.1% of all knee arthroplasties **(Table 4.1a and Table 4.7a).** This proportion remained constant over the past 5 years and is among the highest in the western world, although clearly less than in Denmark, where PKA rates were 26.0% in 2021. In 2022, a total number of 3,411 partial knee replacements was performed. 47.7% of recipients were women, and the overall mean age at surgery was mean 64.7 years, significantly younger than for TKA **(Tables 4.7a).** For PKA the age peak was in the group 55–64 years), whereas for TKA it was the age group 65–74 years **(Table 4.2a).** Hospitals with more than 100 interventions per year performed 85.5% of the PKA between 2017 and 2022 **(Table 4.7b).** Medial PKA represented 83.3% of cases, lateral PKA 6.1%, and patellofemoral replacement 6.6% **(Table 4.7c)**. Technical support in PKA is still rarely used in Switzerland, accounting for 10% of all cases between 2017 to 2022 **(Figure 4.7c).**

Of the 28,678 documented PKA implanted since 2012, 11,543 were at risk as they fell within the 4-year moving time window evaluated for primary surgery between 01.01.2017 and 31.12.2020, having two-year follow-up available at 31.12.2022. Of the implants at risk, 581 knees were revised, accounting for a 2-year revision rate of 5.1% (4.7–5.5%). Younger patients were much more at risk, with revision rates of 6.8% in the age group under 55 years, compared to 2.9% in the age group 75–84 years **(Table 4.8a).**

A total of 69.7% of the PKA revised were converted to TKA **(Table 4.8c).** PE liner was exchanged in 17.4% of revisions, followed by an isolated tibial revision in 4.0%.

4.2 Primary total knee arthroplasty

Since 2012, 154,413 TKA have been registered in SIRIS **(Table 4.1a).** Incidence of TKA has steadily grown over the years, but the yearly increase reached 13.8% in 2022. This is discussed more in detail in chapter 4.1.

Demography

The baseline figures in **Table 4.2a** indicate that most demographic variables showed little change in recent years. Namely the share of operations performed on women (59.7%) and the mean age at surgery of 69.6 years remained constant. Generally, women were older than men when receiving a TKA, with the difference steadily decreasing with age **(Figure 4.2b).** The difference in younger patients was mainly due to men's higher share of post-traumatic OA. Differences in patient demographics, including BMI and ASA status, were small and not significant between low or high-volume hospitals **(Table 4.2c).** The most frequent indication for TKA was classified as primary OA, representing 88.1% of the cases in

Figure 4.2a

Distributions of different diagnoses in hospitals ›200 cases (2022)

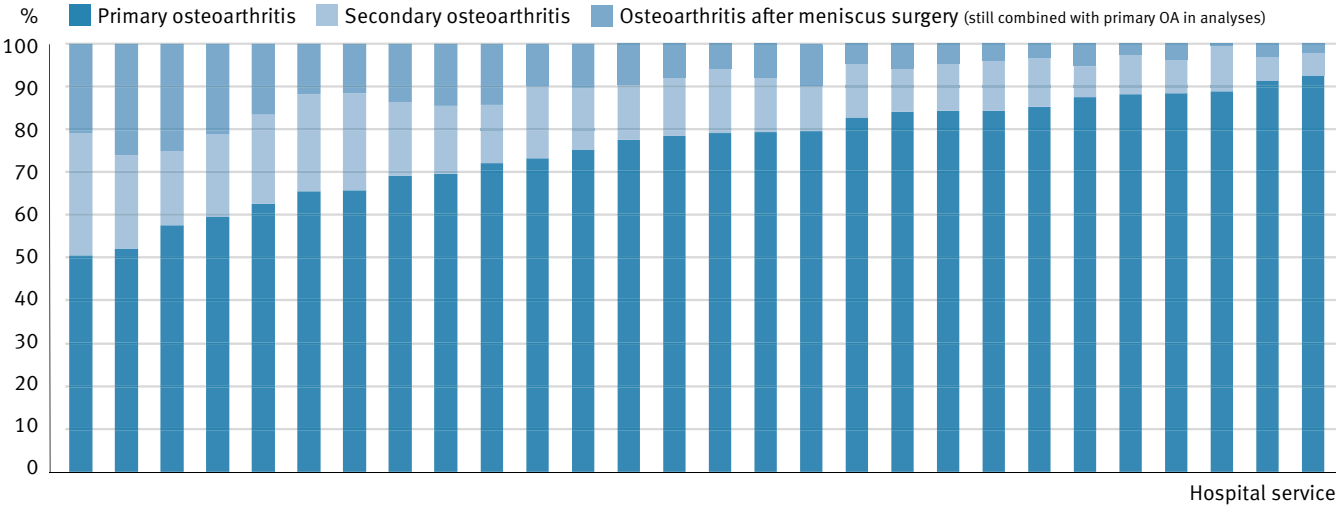


Figure 4.2b

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

All diagnoses. Please note that group sizes vary considerably.

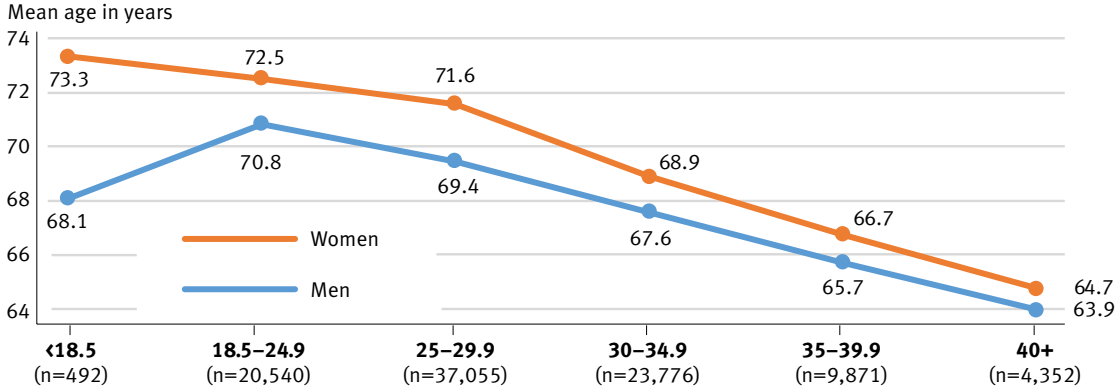


Table 4.2a

Primary total knee arthroplasty: Baseline patient characteristics by year

		2017	2018	2019	2020	2021	2021	2017–2022
N		**14,473**	**14,716**	**15,494**	**15,452**	**16,671**	**19,195**	**96,001**
Diagnosis [%]	Primary OA*	88.6	89.3	88.9	88.5	87.0	86.9	88.1
	Secondary OA	11.4	10.7	11.1	11.5	13.0	13.1	11.9
	Inflammatory origin	0.8	0.9	0.9	0.9	1.0	1.0	0.9
	Fracture	2.2	2.1	2.2	2.2	2.4	2.3	2.2
	Lesion of ligament	5.4	4.8	5.2	5.7	5.8	5.9	5.5
	Infection	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Osteonecrosis	1.7	1.7	1.5	1.4	1.9	1.9	1.7
	Other**	1.6	1.3	1.4	1.3	1.7	1.8	1.5
Women [%]		60.7	60.5	59.7	58.4	59.9	59.2	59.7
Mean age (SD)	All	69.4 (9.4)	69.4 (9.7)	69.8 (9.5)	69.5 (9.4)	69.6 (9.5)	69.8 (9.5)	69.6 (9.5)
	Women	70.0 (9.5)	69.9 (9.7)	70.5 (9.6)	70.1 (9.6)	70.1 (9.6)	70.4 (9.6)	70.2 (9.6)
	Men	68.4 (9.3)	68.6 (9.6)	68.9 (9.3)	68.7 (9.2)	68.8 (9.3)	69.0 (9.2)	68.8 (9.3)
Age group [%]	<45	0.5	0.5	0.4	0.5	0.5	0.5	0.5
	45–54	6.2	6.3	6.0	5.7	5.7	5.4	5.8
	55–64	23.7	24.3	23.0	24.6	24.6	24.5	24.1
	65–74	37.8	36.4	36.2	36.1	35.4	35.3	36.1
	75–84	27.4	27.8	29.3	28.9	29.5	29.8	28.8
	85+	4.4	4.8	5.1	4.2	4.4	4.6	4.6
N unknown BMI (%)		2,567 (18)	2,267 (15)	2,293 (15)	1,927 (12)	1,527 (9)	1,327 (7)	11,908 (12)
N known BMI		11,906	12,449	13,201	13,525	15,144	17,868	84,093
Mean BMI (SD)		29.5 (5.5)	29.5 (5.5)	29.5 (5.6)	29.2 (5.5)	29.2 (5.6)	29.2 (5.5)	29.3 (5.6)
BMI [%]	<18.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5
	18.5–24.9	20.9	20.6	20.8	22.3	22.0	22.3	21.6
	25–29.9	38.4	38.5	38.8	38.2	38.1	37.8	38.3
	30–34.9	24.9	25.4	24.8	24.6	24.8	24.7	24.8
	35–39.9	10.6	10.6	10.2	10.1	9.9	10.5	10.3
	40+	4.7	4.5	4.8	4.3	4.6	4.2	4.5
N unknown ASA (%)		1,409 (10)	1,190 (8)	1,162 (7)	1,019 (7)	573 (3)	440 (2)	5,793 (6)
N known ASA		13,064	13,526	14,332	14,433	16,098	18,755	90,208
Morbidity state	ASA 1	8.7	8.2	8.1	7.9	6.9	6.9	7.7
[%]	ASA 2	63.3	63.1	61.5	62.1	61.9	63.1	62.5
	ASA 3	27.6	28.2	29.9	29.6	30.8	29.5	29.4
	ASA 4/5	0.4	0.4	0.5	0.4	0.4	0.5	0.4

* As of SIRIS version 2021, and pending further review, this category includes the newly introduced category „secondary arthritis after meniscus surgery“. This category accounts for more than 6% of current entries, but shows large variability between hospitals.

** A small number of newly added cases with „secondary OA caused by patellar instability“ were added to this category.

the period from 2017 to 2022 **(Table 4.2a).** Since 2013, 13.1% (11,390) of all cases examined were classified as secondary OA. The mean age at surgery was significantly lower, at 65.0 years, compared to TKA for primary OA, where the mean age was 70.2 years **(Table 4.2b).** The share of women amounted to 47.3% for secondary and 61.4% for primary OA. Patients older than 65 years were less frequently classified as secondary OA. Younger age was the main difference between primary and secondary OA responsible for apparent differences in revision TKA (see Chapters 4.3 and 4.4). Other factors like BMI and ASA classification did not differ between the two groups.

The proportion of missing BMI values steadily decreased over the past years to 12% overall and fell to 7% in 2022. From the data available, we can calculate that the mean BMI was 29.3 kg/m² and that the distribution of values has remained steady over time. Obese patients (BMI ≥ 30 kg/m²) made up 39.6% of the TKA patients in Switzerland. The BMI inversely correlated with increasing age, i.e. obese patients were operated at younger ages.

Table 4.2b

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

Based on 95,850 cases with diagnostic information**

		Primary OA*	Secondary OA
N (2017–2022)		**84,460**	**11,390**
Women [%]		61.4	47.3
Mean age (SD)	All	70.2 (9.2)	65.0 (10.7)
	Women	70.6 (9.3)	66.5 (11.3)
	Men	69.7 (8.9)	63.6 (9.8)
Age group [%]	‹45	0.3	2.1
	45–54	4.7	14.1
	55–64	22.7	34.5
	65–74	37.1	28.7
	75–84	30.3	17.7
	85+	4.8	2.9
N unknown BMI (%)		10,697 (13)	1,184 (10)
N known BMI		73,763	10,206
Mean BMI (SD)		29.5 (5.6)	28.3 (5.1)
BMI [%]	‹18.5	0.5	0.9
	18.5–24.9	20.9	27
	25–29.9	38.0	40.4
	30–34.9	25.1	22.7
	35–39.9	10.8	7.1
	40+	4.8	2.4
N unknown ASA (%)		5,267 (6)	508 (4)
N known ASA		79,193	10,882
ASA state [%]	ASA 1	7.1	12.4
	ASA 2	62.5	62.1
	ASA 3	30.0	24.9
	ASA 4/5	0.4	0.6

* Including „arthritis after meniscus surgery“

** Number of cases with clear diagnostic information (in 0.2% of cases we cannot determine the diagnosis)

While the mean age at surgery was approximately 70 years for patients with a BMI under 30 kg/m², surgery had to be performed between 5 and 6 years earlier when the BMI was more than 40 kg/m² **(Figure 4.2b).** Younger patients tended to be more obese **(Figure 4.2b).** On average, women were older than men when a TKA was performed in all BMI groups, although the difference decreased when the BMI exceeded 30 kg/m².

The rate of unrecorded ASA classifications was 6% on average and continued to decrease over time, becoming as low as 2% in 2022. Most providers seem to have understood the relevance of BMI and ASA classification on outcomes after TKA, PKA, and revision TKA and collect the necessary data. Missing values would leed to overestimation of revision rates as these data allow for a risk adjustment most often favourable to the provider.

Table 4.2c

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 (2017-2022).

Hospital service volume		<100	100–199	200–299	300+
N (2017–2022)		**17,424**	**28,362**	**20,800**	**29,415**
Women [%]		60.2	59.3	60.5	59.3
Mean age (SD)	All	70.0 (9.7)	69.8 (9.5)	69.6 (9.5)	69.2 (9.5)
	Women	70.6 (9.7)	70.4 (9.6)	70.1 (9.5)	69.8 (9.6)
	Men	69.1 (9.7)	68.9 (9.2)	68.9 (9.3)	68.3 (9.1)
Age group [%]	<45	0.5	0.4	0.5	0.5
	45–54	6.0	5.5	5.6	6.3
	55–64	22.8	24.0	24.1	25.1
	65–74	35.3	35.8	36.8	36.5
	75–84	30.1	29.6	28.4	27.7
	85+	5.3	4.7	4.7	3.9
Diagnosis [%]	Primary OA	88.6	89.3	88.4	86.6
	Secondary OA	11.4	10.7	11.6	13.4
N unknown BMI (%)		2,818 (16)	2,973 (10)	2,029 (10)	4,088 (14)
N known BMI		14,606	25,389	18,771	25,327
Mean BMI (SD)		29.3 (5.5)	29.6 (5.6)	29.4 (5.6)	29.0 (5.5)
BMI [%]	<18.5	0.6	0.5	0.6	0.5
	18.5–24.9	21.2	20.1	21.3	23.4
	25–29.9	38.4	37.8	37.8	39.0
	30–34.9	25.1	25.7	25.3	23.5
	35–39.9	10.4	11.1	10.3	9.5
	40+	4.3	4.9	4.8	4.0
N unknown ASA (%)		967 (6)	1,241 (4)	1,342 (6)	2,243 (8)
N known ASA		16,457	27,121	19,458	27,172
ASA state [%]	ASA 1	8.1	7.5	6.9	8.3
	ASA 2	61.6	64.0	62.5	61.5
	ASA 3	29.8	28.0	30.2	29.9
	ASA 4/5	0.6	0.5	0.5	0.3

Table 4.2d

Primary total knee arthroplasty: Surgery characteristics

all diagnoses

N (2017–2022)	**N**	**%**
Previous surgery		
None	64,753	67.5
Knee arthroscopy	15,268	15.9
Meniscectomy	16,880	17.6
ACL reconstruction	4,701	4.9
Osteotomy tibia close to knee	2,597	2.7
Osteosynthesis tibia close to knee	1,329	1.4
Surgery for patella stabilization	1,165	1.2
Synovectomy	764	0.8
Osteotomy femur close to knee	436	0.5
Osteosynthesis femur close to knee	490	0.5
Surgery for treating infection	168	0.2
Surgery for tumor	43	0.0
Other	2,265	2.4
Intervention		
CS (cruciate sacrificing) / UCOR	24,817	25.9
PS (posterior stabilized)	27,040	28.2
PCR (posterior cruciate retaining)	24,772	25.8
BCR (bicruciate retaining)	976	1.0
Hinge type	1,802	1.9
SC/ CCK (semi-constr./constr.)	1,331	1.4
Medial Pivot*	14,461	15.1
Other	720	0.7
Technology		
Conventional	66,581	69.4
Computer assisted/navigated	10,193	10.6
Patient specific instrumentation	15,107	15.7
Minimally invasive (up to 2020)	3,292	3.4
Robotic-assisted (from 2021)	1,861	1.9
Other	1,569	1.6

*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.

N (2021–2022)	**N**	**%**
Additional Intervention		
None	33,552	95.4
Osteosynthesis FE	36	0.1
Osteosynthesis TI	28	0.1
Osteosynthesis PAT	1	0.0
Removal of metalware	468	1.3
Operation extensors	218	0.6
Reconstruction plasty	42	0.1
Tibial tubercle osteotomy	532	1.5
Other additional intervention(s)	389	1.1
Total TKA (multiple responses)	**35,177**	
Additional components		
Stem FE (cemented)*	605	1.7
Stem FE (uncemented)**	231	0.7
Stem TI (cemented)***	1,856	5.2
Stem TI (uncemented)***	368	1.0
Sleeve FE	19	0.1
Sleeve TI	58	0.2
Augments FE	44	0.1
Augments TI	79	0.2
Augments PAT	2	0.0
Bone homologous	11	0.0
Bone autologous	70	0.2
Cone FE	2	0.0
Cone TI	22	0.1
Total TKA (multiple responses)	**35,365**	

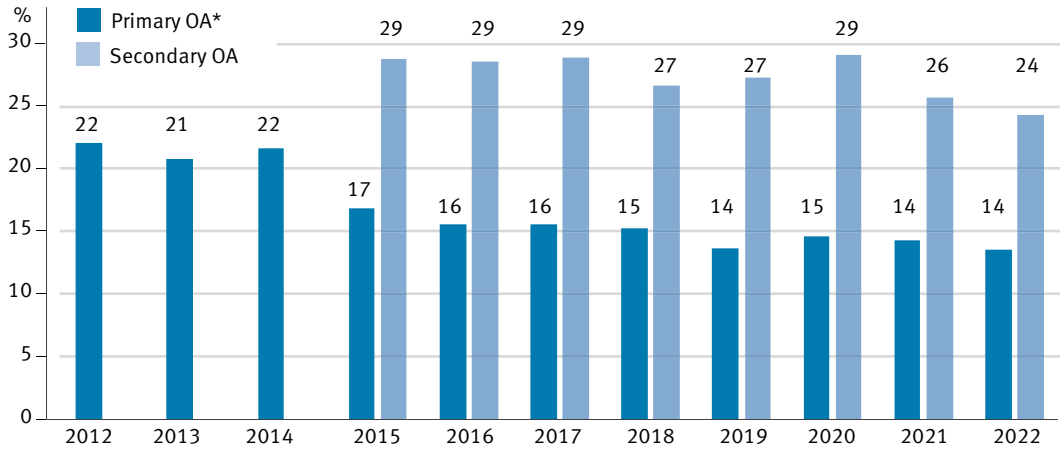
* 60% with cement restrictor
** 32% with coating
*** 25% with cement restrictor
**** 35% with coating

A bias towards primary OA is probable, as this reason ranges on top in the selection menu and thus possibly decreases the probability of selecting other diagnoses and alternatives mentioned below, even if more appropriate. The fact that the proportion of secondary OA varied remarkably between the 28 hospitals performing more than 200 TKA per year underscores this **(Figure 4.2a).** In hospital 1, the share of primary OA was only 51%, whereas hospital 28 classified 92% to be primary OA. Real discrepancies in patient demographics should not explain these considerable differences, as all other parameters were comparable. The increasing share of secondary OA in some hospitals can partially be explained by the introduction of more options with the 2015 version of the CFR. Increasing rates of secondary OA risk influencing revision rates, a benchmark established solely on arthroplasties performed for primary OA. A selection bias would lead to underestimation of revision rates, as secondary OA is known to be associated with higher revision risk and corresponding to more complex cases or cases with particular risks. Hospitals with higher rates of secondary OA also tended to classify more secondary OA after meniscal surgery. This new category was introduced in 2021 and was reported inconsistently **(Figure 4.2a).** The cases with previous meniscal surgery only are still counted among primary OA cases to calculate survival and revision rates.

Figure 4.2c

Share of TKA patients who had knee arthroscopy prior to arthroplasty (%)

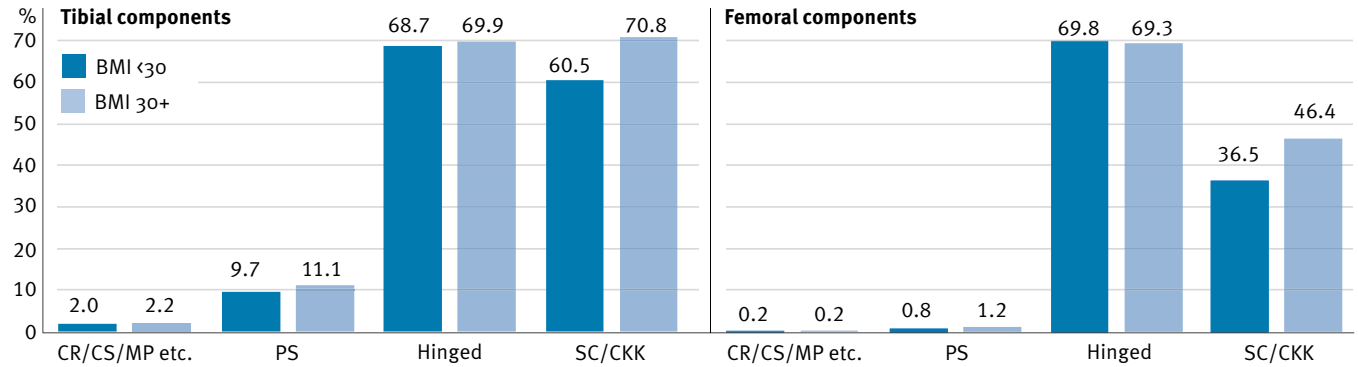
Sec. OA categories were different before 2015 and therefore cannot be compared.



* Including „arthritis after meniscus surgery"

Figure 4.2d

Share of cemented components with stems by BMI (%)



67.5% of the knees were never operated on before TKA, and for the remaining patients, the previous operations mostly comprised arthroscopies (15.9%), meniscectomy (17.6%), ACL reconstruction (4.9%), and osteotomies of the tibia (2.7%). Arthroscopies and meniscectomies were registered for half of the cases (51%) independently of each other, but in approximately 49% of the cases, they were registered in combination. This may lead to the conclusion that previously half of the meniscectomies were performed by arthroscopy, and the other half by open resection. The rate of arthroscopies preceding TKA in primary OA was constantly decreasing over the past 10 years, with the share being much higher in secondary OA **(Figure 4.2c).** Post-traumatic cases after tibial or femoral fractures close to the knee were responsible for only 1.9% of the TKA cases and other surgeries before TKA were rare (**Table 4.2d).**

Knee systems

The classification of the TKA systems was adapted in 2021 with the last revision of the CRF, because of previously confusing terms. Between 2017 and 2022, the share of cruciate-sacrificing/ultracongruent systems (CS/UCOR) was 25.9%, for posterior stabilized (PS) it was 28.2% and posterior cruciate-retaining (PCR/CR) it was 25.8%. A medial pivot (MP) was used in 15.1%, whereas constrained condylar knees or hinged implants were only used in 1.4% and 1.9% of cases, respectively. Bicruciate-retaining knees (BCR) were rarely used (1.0%) as well **(Table 4.2d).**

Of particular note is the fact that the knee replacement systems used varied significantly between cantons, regions, and hospitals. Traditionally, posterior stabilized (PS) knees were more present in the western part of Switzerland, whereas in the German-speaking cantons, cruciate-retaining (CR) and sacrificing (CS), including ultracongruent

Table 4.2e

Primary total knee arthroplasty: Component fixation

Percentage per year, all diagnoses.

Year	2017	2018	2019	2020	2021	2022	2017–2022
N	14,455	14,706	15,487	15,450	16,669	19,194	95,961
All uncemented	3.7	3.5	4.0	5.5	8.1	8.5	5.7
Reverse hybrid*	0.4	0.3	0.4	0.5	0.2	0.1	0.3
Hybrid**	15.6	14.2	14.0	16.3	16.2	17.0	15.6
All cemented	80.3	82.0	81.6	77.7	75.5	74.4	78.4

Figure 4.2e

Primary total knee arthroplasty: Component fixation by year

Percentage per year, all diagnoses.

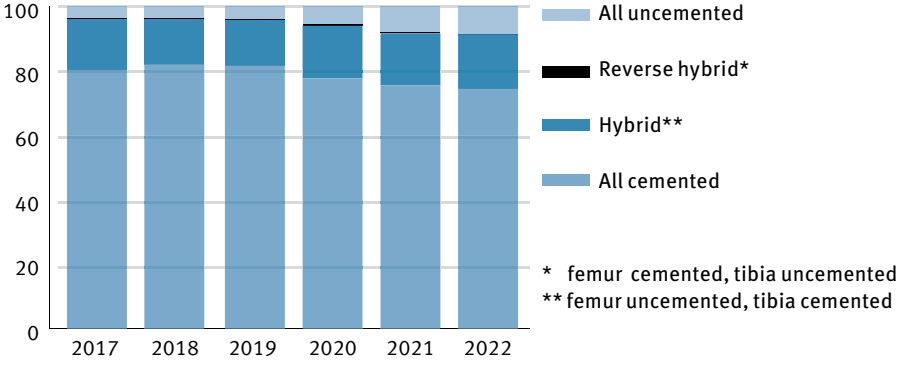


Table 4.2f

Primary total knee arthroplasty: Patellar component

Percentage per year, all diagnoses.

Year	2017	2018	2019	2020	2021	2022	2017–2022
N	14,455	14,706	15,487	15,50	16,669	19,194	95,961
No	71.2	70.0	67.9	68.2	65.0	63.1	67.3
Yes	28.8	29.9	32.1	31.8	35.0	36.8	32.7
Status after patellectomy	0.0	0.1	0.0	0.0	0.0	0.1	0.0

Figure 4.2f

Primary total knee arthroplasty: Patellar component

Percentage per year, all diagnoses

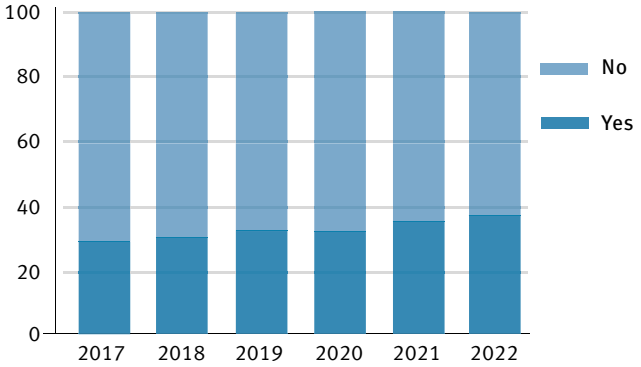


Table 4.2g

Primary total knee arthroplasty: Type of bearing

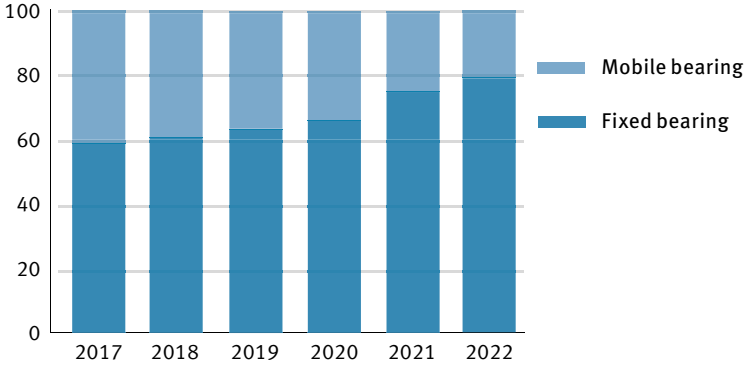
Percentage per year, all diagnoses.

Year	2017	2018	2019	2020	2021	2022	2017–2022
N	13,252	13,141	13,685	13,513	16,199	18,811	88,601
Mobile bearing	41.2	39.4	36.5	34.0	25.1	21.0	31.9
Fixed bearing	58.8	60.6	63.5	66.0	74.9	79.0	68.1

Figure 4.2g

Primary total knee arthroplasty: Type of bearing

Percentage per year, all diagnoses.



(UCOR) knees were favoured. Medial pivot (MP) knees did not seem to follow a particular regional pattern but seemed preferred in specific hospitals. **Figure 4.2k** shows the high variability of the different types of knee prostheses used in Switzerland and changes between the periods 2017–2019 and 2020–2022, respectively. The share of medial pivot implants seems to increase and replace more traditional designs such as PS, CR and CS/UCOR.

The rate of mobile-bearing polyethylene (PE) liner did rapidly decrease over the past six years, from 41.2% in 2017 to 21% in 2022 **(Figure 4.2i).** However, one must note that the choice of bearing type showed again a high variation in the different cantons of Switzerland, including the Principality of Liechtenstein **(Figure 4.2j).** The reduction of the mobile bearing system is not a general effect but is more because some hospitals in many cantons changed their knee systems. In contrast, the share of mobile bearing liners even increased in some cantons like UR, JU, TI and FL **(Figure 4.2j).**

Table 4.2h

Primary total knee arthroplasty: Technologies used

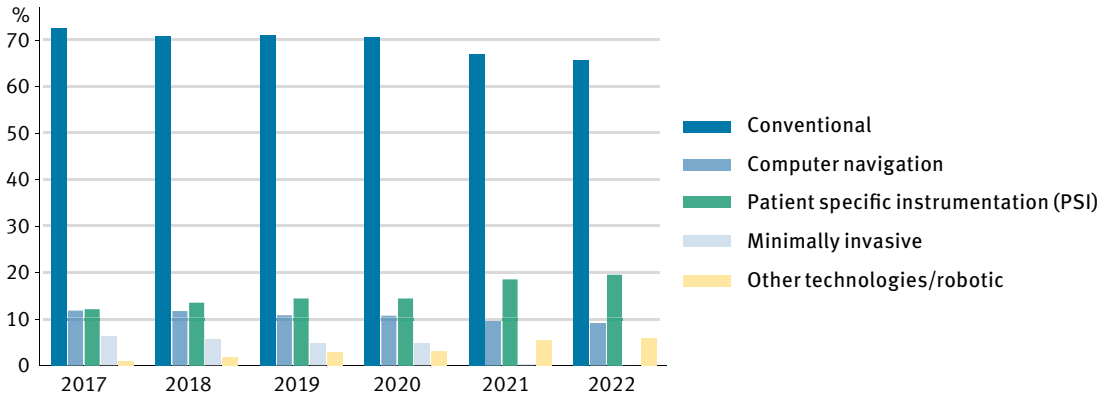
All diagnoses. Multiple responses possible (percentages do not sum to 100).

	2017	2018	2019	2020	2021	2022	2017–2022
N	14,473	14,716	15,494	15,452	16,671	19,195	96,001
Conventional	72.5	70.8	71.0	70.6	66.9	65.7	69.4
Computer navigation	11.9	11.8	10.9	10.8	9.7	9.2	10.6
PSI	12.2	13.6	14.5	14.5	18.6	19.6	15.7
Minimally invasive (up to 2020)	6.4	5.7	4.9	5.0			3.4
Other technologies/robotic	1.0	1.9	2.9	3.1	5.5	6.0	3.5

Figure 4.2h

Primary total knee arthroplasty: Technologies used

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



Fixation

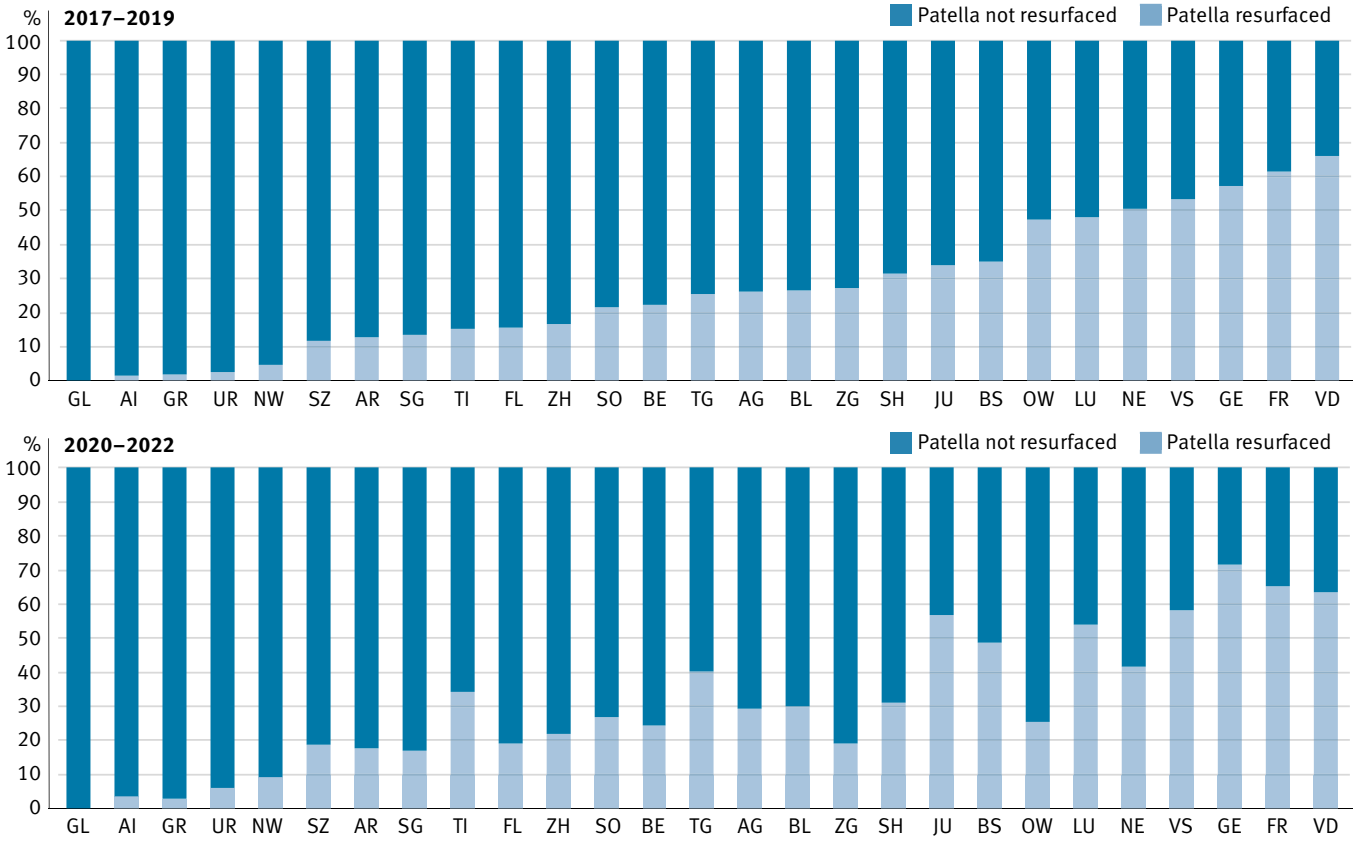
Most TKA in Switzerland were fully cemented, accounting for 78.4% over the past six years. Hybrid fixation of the components was used constantly, accounting for a mean of 15.6%. Interestingly, cementless fixation only comprised 5.7% of the TKA since 2017, although the share doubled in 3 years to 8.5% in 2022 **(Table and Figure 4.2e).**

Surgical technique

Between 2017 and 2022, 69.4% of the TKA in Switzerland were performed conventionally, and the share of computer navigation without imaging was 10.6%, continuously decreasing from 11.9% in 2017 to 9.2% in 2022. Patient-specific instrumentation (PSI) was used increasingly often, from 12.2% in 2017 to 19.6% in 2022. Robotic-assisted TKA (imageless and image-based) were classified as "other" and accounted for 3.5% for the whole period, increasing from 1.0% in 2017 to 6.0% in 2022 **(Table 4.2d, Table and Figure 4.2h).** In summary, surgeons did use technical support in 30.6% of TKA over the past six years. Compared to Australia, the share of technical support is still small in Switzerland, but has increased over the past four years due to more

Figures 4.2i

Share of TKA procedures with patella resurfacing by Swiss Canton and Principality of Liechtenstein: Comparing 2017–2019 with 2020–2022



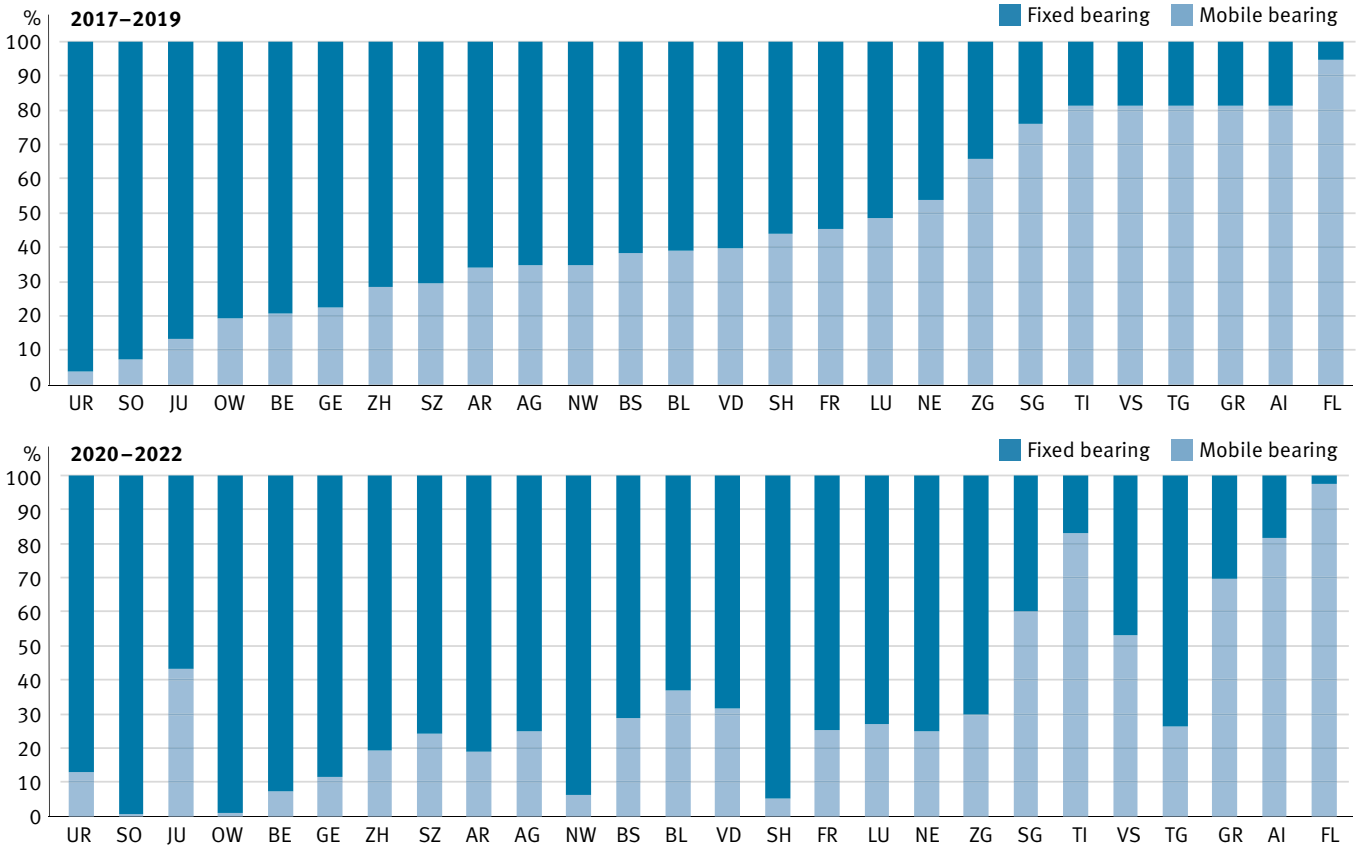
PSI TKA and the introduction of robotics in 2018 **(Figure 4.2h and 4.2l).** Minimally invasive surgery is no longer a topic in Switzerland. It was registered only in 3.4% of operations, but as it was ill defined, it was removed from the CRF in 2021.

Patella resurfacing

In 67.3% of primary TKA, the patella was not resurfaced during the period 2017 to 2022 **(Table and Figure 4.2f).** The resurfacing rate had increased continuously since 2017 from 28.8% to 36.8% in 2022. However, there were again considerable differences between the cantons **(Figures 4.2i).** Parts of these differences can be explained using posterior stabilized knees, where resurfacing of the patella is recommended more than in other TKA types, these being more popular in the western part of Switzerland and in some centres, as mentioned previously. The continuous increase for primary patella resurfacing was not homogenous, did not depend solely on the TKA type, and depends on regional differences. In some cantons, such as TG and GE, the resurfacing rate significantly increased from

Figures 4.2j

Share of TKA procedures with mobile bearing by Swiss Canton and Principality of Liechtenstein: Comparing 2017–2019 with 2020–2022



2017–2019 to 2020–2022. In others, such as OW or ZG, the resurfacing rate decreased in the same period **(Figures 4.2i).**

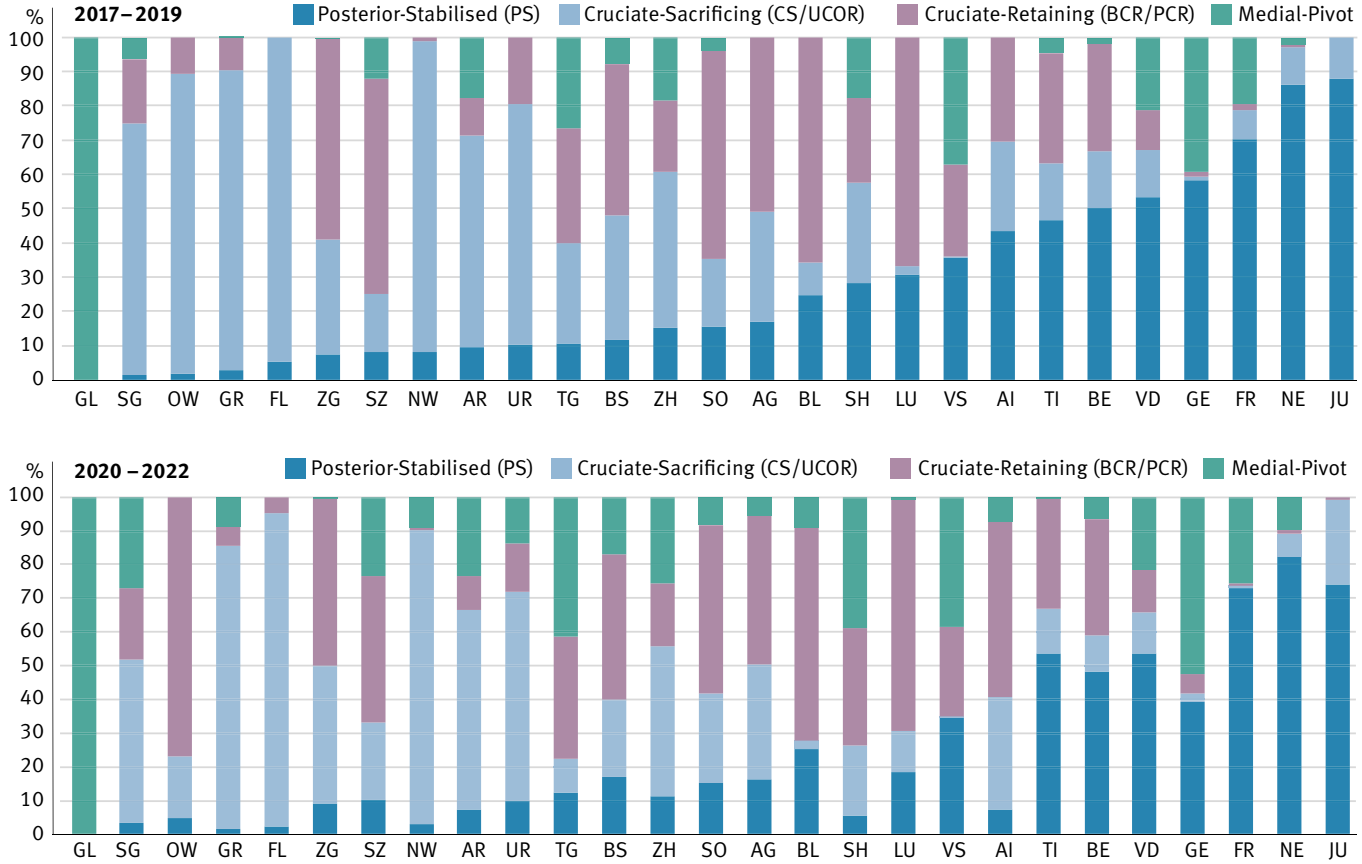
We refer to the annual report 2021 regarding more details about patella resurfacing. Particularly, it could be demonstrated that whether the primary patella is resurfaced or not is more dependent on the surgeon's personal preference than on knee system type or geographic region. The observed trend toward primary patella resurfacing in the past years might be explained by the surgeon's attempt to prevent early revision and improve the two-year outcome reported for himself and the hospital. The same effect could be observed in Australia over the past 10 years.

Additional interventions

Additional interventions when performing primary TKA were performed in only 4.6% of cases on average between 2017 to 2022, whereby the removal of internal fixation devices (1.3%) and osteotomies of the tibial tubercle (1.5%) were the most common additional surgical steps, with 1.1% being classified as "other" **(Table 4.2d).**

Figures 4.2k

Relative share of TKA procedures using CR, CS, PS, MP by Swiss Canton and Principality of Liechtenstein: Comparing 2017–2019 with 2020–2022



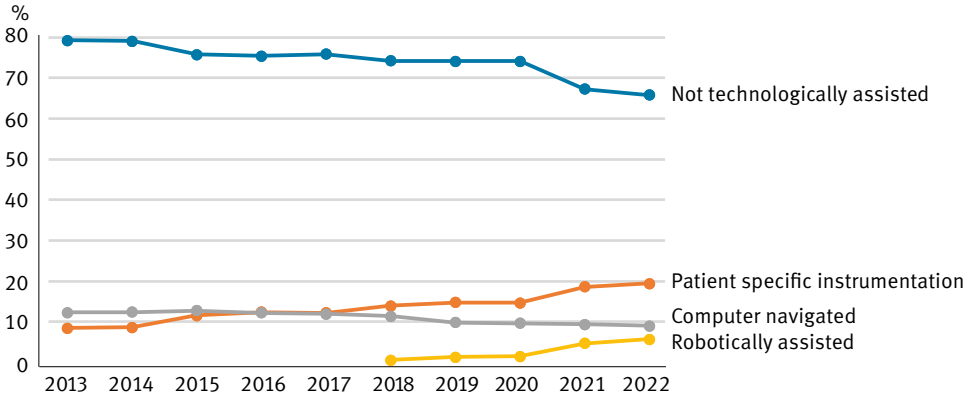
NB: Medial pivot was not available as a response category before SIRIS v2021. In the annual report 2020, only free text „other" responses were identified as and recoded to medial pivot. However, this missed a number of GMK Sphere total knee systems that were incorrectly registered as other types, mainly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

Additional components

More information about components in primary TKA were introduced on the 2021 version of the CRF. This led to a far better response **(Figure 4.4f Part 2).** Obviously, registration of additional components improved continuously since 2012, but was not matching the reality as far as the number of registered stems doubled with the introduction of the new CRF in 2021 **(Figure 4.4f Part 2).** The most common additional components were tibial stems in 6.2% of the cases, whereby 84% of them were cemented. Femoral stems were used in 2.4% of the primary TKA, 71% being cemented. Sleeves, cones, augments, or additional homologous or autologous bones were rarely necessary in primary TKA **(Table 4.2d).** Most of the stems were used in hinged or semi-constrained (constrained condylar knee) primary TKA systems, irrespective of the underlying BMI (separated into < or ≥ 30 kg/m²). Stems were also significantly more frequently used in PS than other knee types such as CR, CS, or MP **(Figure 4.2d).** BMI ≥ 30 kg/m² did not lead to more stems on the tibial side, which has been recommended for several years in the literature. Only in semi-constrained knee systems femoral and tibial stems were more often used in patients with a BMI ≥30 kg/m² **(Figure 4.2d).**

Figure 4.2l

Primary total knee arthroplasty: Technology assistance over time (%)



NB: robotically assisted cases before v2021 were derived from free text entries. „Other" responses were coded as „Not tech. assisted" unless they specifically mentioned robotic, PSI oder navigation".

4.3 Revision of primary total knee arthroplasty

SIRIS has been recording all revision knee procedures since 2012, irrespective of whether it was the first or any subsequent revision. A revision is defined as the addition or the exchange of any component, following international guidelines. This includes secondary patella resurfacing. Unlinked revisions cannot be linked to a primary knee arthroplasty registered in SIRIS. Revisions of index arthroplasties registered in SIRIS are named linked revisions. The share of linked revisions steadily increased from 4% in 2013 to 67.4% in 2022, corresponding to 51.1% overall **(Table 4.1a).** The proportion of unlinked revisions is higher in older (65–74, 75–84, and 85+ years) compared to younger patients, most probably due to index operations performed before implementation of SIRIS in 2012. Revision gets less frequent with age as activities may decrease and as elder patients tend to accept better less favourable results compared to younger individuals **(Table188**

4.1a). The linked revisions form the basis for calculations of survival and first revision rates (see Chapter 4.4).

Table 4.1a

Total and partial knee arthroplasty (TKA, PKA)

All documented operations

Year	Primary TKA	Primary PKA	Primary others or type uncl.	Primary Total	Annual growth rate primary	Linked Rev./Reop. of TKA[2]	Linked Rev./Reop. of PKA[2]	Unlinked Rev./Reop. can be of TKA or PKA	Rev./Reop. Total[3]	% Linked Rev./Reop.
2012[1]	4,662	941	5	5,608		19	2	509	530	4.0
2013	12,674	2,403	12	15,089		179	50	1,250	1,482	15.5
2014	13,052	2,339	12	15,403	2.1%	393	107	1,116	1,616	30.9
2015	13,420	2,393	7	15,820	2.7%	589	122	1,072	1,784	39.9
2016	14,604	2,459	9	17,072	7.9%	831	193	1,136	2,164	47.3
2017	14,473	2,620	15	17,108	0.2%	944	260	1,089	2,297	52.4
2018	14,716	2,723	10	17,449	2.0%	1,036	286	1,091	2,416	54.7
2019	15,494	3,054	8	18,556	6.3%	1,192	298	1,055	2,548	58.5
2020	15,452	3,146	7	18,605	0.3%	1,311	394	1,048	2,755	61.9
2021	16,671	3,189	4	19,864	6.8%	1,332	399	1,022	2,758	62.8
2022	19,195	3,411	3	22,609	13.8%	1,513	442	942	2,901	67.4
All	**154,413**	**28,678**	**92**	**183,183**		**9,339**	**2,553**	**11,330**	**23,251**	**51.1**

[1] Does not represent a full year of data, as data collection in most hospitals started only in October 2012, [2] i.e. primaries already in SIRIS,
[3] including linked revisions/reoperations of procedures that were classified as „primary others“ or of unclear type

Table 4.3a

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

		2017	2087	2019	2020	2021	2022	2017–2022
N		**1,943**	**1,996**	**2,130**	**2,244**	**2,220**	**2,313**	**12,846**
Women [%]		59.9	59.7	57.6	57.0	58.5	59.4	58.6
Mean age (SD)	All	69.2 (10.0)	69.3 (10.1)	69.6 (10.0)	69.4 (9.6)	70.2 (10.0)	70.4 (9.8)	69.7 (9.9)
	Women	69.7 (10.1)	70.0 (10.2)	70.3 (10.1)	69.9 (9.8)	70.8 (10.2)	71.1 (9.7)	70.3 (10.0)
	Men	68.3 (9.8)	68.3 (9.9)	68.6 (9.7)	68.8 (9.4)	69.3 (9.6)	69.4 (9.8)	68.8 (9.7)
Age group [%]	‹45	0.6	1.0	0.3	0.7	0.7	0.7	0.6
	45–54	7.9	6.7	6.8	5.4	4.6	4.7	6.0
	55–64	22.6	24.2	24.3	25.0	24.8	21.9	23.8
	65–74	38.1	36.2	35.4	36.7	33.5	34.3	35.7
	75–84	25.6	26.6	27.7	26.9	29.1	32.8	28.2
	85+	5.1	5.3	5.5	5.3	7.3	5.6	5.7
N unknown BMI (%)		448 (23)	429 (21)	400 (19)	387 (17)	256 (12)	240 (10)	2,160 (17)
N known BMI		1,495	1,567	1,730	1,857	1,964	2,073	10,686
Mean BMI (SD)		29.8 (5.9)	29.8 (5.8)	29.6 (5.7)	30.0 (6.0)	29.8 (5.7)	29.8 (6.2)	29.8 (5.9)
BMI [%]	‹18.5	0.5	0.6	0.6	0.8	0.5	0.9	0.6
	18.5–24.9	19.3	20.4	20.2	18.6	20.0	19.4	19.7
	25–29.9	36.7	35.7	36.4	35.6	35.7	35.9	36.0
	30–34.9	26.0	26.4	26.4	27.4	27.2	26.9	26.8
	35–39.9	13.2	12.0	12.3	11.5	11.4	10.3	11.7
	40+	4.3	4.9	4.0	6.0	5.3	6.5	5.3
N unknown ASA (%)		200 (10)	172 (9)	196 (9)	191 (9)	94 (4)	84 (4)	937 (7)
N known ASA		1,743	1,824	1,934	2,053	2,126	2,229	11,909
Morbidity state	ASA 1	6.8	6.0	5.3	4.1	4.1	4.3	5.0
[%]	ASA 2	52.6	52.0	51.7	52.7	50.7	48.1	51.2
	ASA 3	39.6	40.7	41.3	41.6	43.0	45.5	42.1
	ASA 4/5	1.0	1.3	1.7	1.6	2.2	2.1	1.7

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

Demography

Mean age at revision was 69.7% between 2017 and 2022, and 58.6% of the patients were women. A total of 56.2% were classified as ASA 1 or 2; the morbidity status was not recorded in 7.0% of cases in the whole period but only in 4% in 2022. Mean BMI was 29.8 kg/m², with BMI not recorded in 17% of cases between 2017 and 2022, missing in only 10% in 2022 **(Table 4.3a).**

To understand **Table 4.3b** concerning the reasons for revision of primary TKA, it is important to note that several reasons may be present concomitantly. Therefore, the percentages do not add up to 100%. Patella problems were the main cause for revision (27.9%), followed by infection in 20.8% and femorotibial instability in 18.4% of cases. Adding together loosening of the tibial (17.5%), femoral (11.2%), and patellar components (2.2%), loosening may take the lead, as it is implicated in 30.9% of all revisions. By contrast, wear of the inlay was responsible for only 5.4% of the revisions. Pain was frequently reported alongside other reasons (8.6%), whereas it should be reserved for pain of unknown origin. The proportion of isolated pain was 1.9% up to 2020. In the new version 2021 of the CRF, the wording was changed to "pain of unclear origin". It was thus reported less frequently, dropping from approximately 12% to approximately 5%. 10.5% of the causes were classified as "other" **(Table 4.3b).**

Table 4.3b

Reason for revision* of primary total knee arthroplasty

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

	N	%
Patella problems	3,579	27.9
Infection	2,669	20.8
Loosening tibia	2,252	17.5
Femorotibial instability	2,360	18.4
Loosening femur	1,437	11.2
Pain (of unclear origin)**	1,107	8.6
Wear of inlay	688	5.4
Joint stiffness/arthrofibrosis	770	6.0
Component malposition femur	542	4.2
Component malposition tibia	484	3.8
Loosening patella	283	2.2
Patellar instability	334	2.6
Periprosthetic fracture femur	287	2.2
Sizing femoral component	185	1.4
Periprosthetic fracture tibia	104	0.8
Sizing tibial component	69	0.5
Periprosthetic fracture patella	51	0.4
Other	1,354	10.5
Total 2017–2022	**18,555**	

* 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% up to 2020. In the new v2021 SIRIS proforma the wording was changed to „pain of unclear origin". It was thus reported less frequently (dropping from approx. 12% to approx. 5%)

Type of revision

Complete revision was performed in 35.6% of the cases. In 16.5%, only the PE liner was exchanged. Secondary resurfacing of the patella alone was performed in 15.0% **(Table 4.3c).** A combined exchange of the PE liner with secondary patella resurfacing was conducted in 5.6%. Internal fixation due to periprosthetic fractures on any level around the knee was reported only in 0.3% of cases. This seems to suffer from underreporting, as periprosthetic fractures are increasing in all Western countries because of demographic changes and rising activity levels. Many surgeons probably did not record internal fixation of a periprosthetic fracture, as this is not strictly a revision. SIRIS however registers any reoperation performed after arthroplasty.

Table 4.3c

Revision of total knee arthroplasty: Surgery characteristics

2017–2022		
Intervention type[a]	**N**	**%**
Complete revision	4,575	35.6
Exchange of PE	2,123	16.5
Subsequent patella prosthesis	1,921	15.0
Tibial revision	646	5.0
Reimplantation of prosthesis	760	5.9
Subsequent patella prosthesis with exchange of PE	721	5.6
Patella revision	562	4.4
Component removal with spacer implantation	489	3.8
Femoral revision	368	2.9
Prosthesis preserving revision	266	2.1
Osteosynthesis	39	0.3
Arthrodesis	50	0.4
Component removal without spacer implantation	23	0.2
Reconstruction after injury of extensor mechanism	25	0.2
Plastic reconstruction	5	0.0
Other	273	2.1
Type of arthroplasty		
SC / CCK (semi-const./constr.)	2,146	33.7
Hinge type	1,918	30.1
PS (posterior stabilized)	1,263	19.8
CS (cruciate sacrificing) / UCOR	482	7.6
PCR (posterior cruciate retaining)	259	4.1
Medial-Pivot[b]	125	2.0
BCR (bicruciate retaining)	26	0.4
Other	149	2.3
Technology		
Conventional	11,160	95.6
Computer assisted / navigation	185	1.6
Patient specific instrumentation	94	0.8
Minimally invasive (up to 2020)	189	1.6
Robotic assisted (from 2021)	6	0.1
Other	91	0.8

2021–2022		
Additional intervention	**N**	**%**
None	2,055	76.9
Osteosynthesis FE	28	1.1
Osteosynthesis TI	14	0.5
Osteosynthesis PAT	5	0.2
Removal of metalware	44	1.7
Operation extensors	144	5.4
Reconstruction plasty	41	1.5
Tibial tubercle osteotomy	226	8.5
Other additional intervention(s)	200	7.5
Total revisions (multiple responses)	**2,672**	
Additional components[c]		
Stem FE (cemented)*	525	44.8
Stem FE (uncemented)**	298	25.4
Stem TI (cemented)***	575	49.1
Stem TI (uncemented)****	297	25.4
Sleeve FE	62	5.3
Sleeve TI	173	14.8
Augments FE	468	40.0
Augments TI	224	19.1
Augments PAT	2	0.2
Bone homologous	21	1.8
Bone autologous	21	1.8
Cone FE	24	2.0
Cone TI	50	4.3
Total revisions (multiple responses)	**1,171**	

* 62% with cement restrictor
** 31% with coating
*** 58% with cement restrictor
**** 29% with coating

[a] includes a small proportion of reoperations that are not counted as component revisions in the evaluative parts of this report
[b] Entered as „other“ intervention and then recoded before 2021. As of form version 2021, SIRIS lists Medial Pivot as a separate main category
[c] After complete, FE, TI revisions or component reimplantations. Detailed data available since 2021, but main categories available since 2015.

Knee systems, surgical technique

Posterior cruciate-retaining (CR) TKAs were used in 4.1% of the revisions, 19.8% were posterior-stabilized (PS), 7.6% were classified as cruciate-sacrificing or ultracongruent implants (CS/UCOR), and in 30.1% a hinge-type prosthesis was used. With one third (33.7%) of the revisions, unlinked semi-constrained or CCK implants formed the biggest group, whereas a medial pivot (MP) was used only in 2.0% of the revisions between 2017 and 2022 **(Table 4.3c).** An arthrodesis was necessary for only 0.4% (n=50) of revisions in the past six years. At revision, technical assistance like computer navigation, PSI or robotics, did not play a significant role.

Fixation, patella resurfacing

Most of the implants were fully cemented (92.6% in mean from 2017 to 2022), reaching 92.2% in 2022 **(Figure 4.3b).** Revision TKA was associated with patella resurfacing in 66.3% on average and was done in 67.7% of the cases in 2022 **(Figure 4.3c).** One must note that the number leaving a patella replacement in place deriving from the primary TKA is unknown but may explain the deep rate of patella resurfacing at revision.

Additional components

In the case of revision TKA, 70.2% of the femoral components used were stemmed, and 36.2% of those were uncemented. In 74.5% tibial stems were used, of which 34.1% were uncemented. The share of tibial and femoral stems increased steadily since 2015, but showed a decline in 2022 **(Figure 4.3a).** Augments were used in 40% of the femoral and 19.1% of the tibial implants. The share of the femoral augments increased over time from 21.3% in 2015 to 40.7% in 2022, whereas the use of tibial augments remained below 20% **(Table 4.3c and Figure 4.3a).** Reinforcement of the metaphysis by cones or sleeves was performed in 7.3% for the femur and 19.1% for the tibia in 2021 and 2022 **(Table 4.3c)** and did not change since 2015 **(Figure 4.3a).**

Figure 4.3a

Revision of total knee arthroplasty: Selected additional components used in revisions (%)

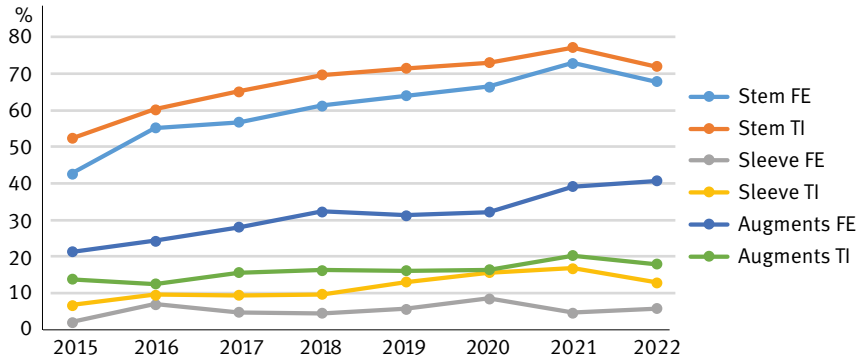
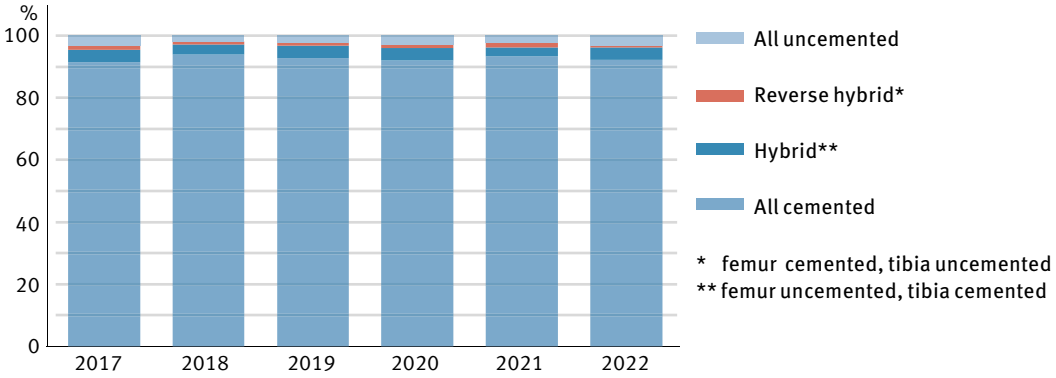


Figure 4.3b

Revision of total knee arthroplasty: Component fixation

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

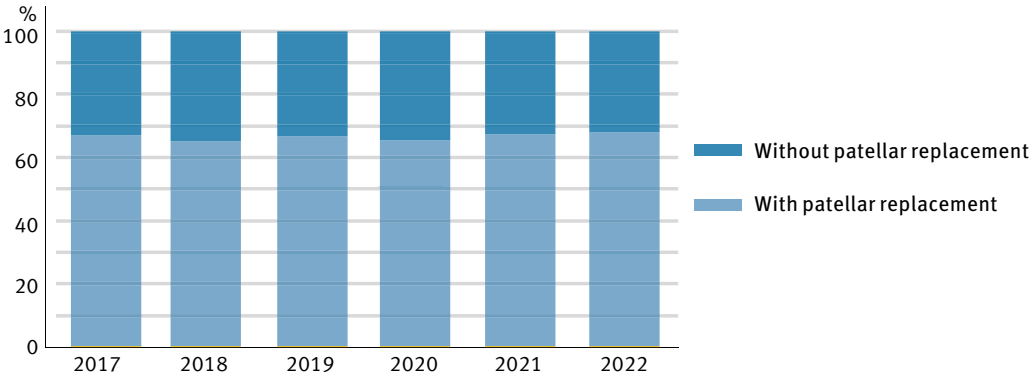


2017	2018	2019	2020	2021	2022	2017–2022	
1,020	1,071	1,070	1,115	1,038	1,035	6,349	N
3.2	2.0	2.1	2.9	2.2	3.0	2.6	All uncemented
1.3	0.8	1.1	1.2	1.5	0.8	1.1	Reverse hybrid*
4.1	3.4	4.0	3.9	2.9	4.1	3.7	Hybrid**
91.4	93.8	92.8	92.1	93.4	92.2	92.6	All cemented

Figure 4.3c

Revision of total knee arthroplasty: Patellar component

Percentage per year.



2017	2018	2019	2020	2021	2022	2017–2022	
1,526	1,576	1,604	1,637	1,572	1,638	9,553	N
32.9	34.9	33.4	34.6	32.8	32.1	33.4	Without patellar replacement
66.8	64.9	66.3	65.2	66.8	67.7	66.3	With patellar replacement
0.3	0.2	0.3	0.2	0.4	0.2	0.3	Status after patellectomy

4.4 First revision of a primary total knee arthroplasty

First revisions describe all revisions linked to primary implantations registered in SIRIS that occur for the first time. Re-revisions are therefore not included here but are integrated into Chapters 4.3 and 4.10. Overall, the share of linked revisions of PKA and TKA together was 51.1% and is steadily increasing over time, reaching 67.4% in 2022 **(Table and Figure 4.1a).**

Table 4.4a

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

		Primary	Revised within 24 months			
			Revised		95% CI	
		N at risk*	N	%**	lower	upper
Overall (moving average)		60,135	2,090	3.6	3.4	3.7
Diagnosis	Primary OA	53,284	1,796	3.4	3.3	3.6
	Secondary OA	6,703	292	4.5	4.0	5.0
Overall Primary OA		53,284	1,796	3.4	3.3	3.6
Gender	Women	32,783	1,058	3.3	3.1	3.5
	Men	20,501	738	3.7	3.4	4.0
Age	‹55	2,723	132	4.9	4.2	5.8
group [%]	55–64	12,032	529	4.5	4.1	4.9
	65–74	20,085	669	3.4	3.1	3.7
	75–84	15,866	417	2.7	2.4	2.9
	85+	2,572	49	2.0	1.5	2.6
BMI group	‹18.5	216	12	5.8	3.3	10.0
	18.5–24.9	9,260	280	3.1	2.8	3.5
	25–29.9	17,176	538	3.2	2.9	3.5
	30–34.9	11,359	396	3.6	3.2	3.9
	35–39.9	4,880	204	4.3	3.7	4.9
	40+	2,191	92	4.3	3.5	5.2
	BMI unknown	8,202	274	3.4	3.0	3.8
Morbidity	ASA 1	3,708	132	3.6	3.1	4.3
state	ASA 2	30,569	983	3.3	3.1	3.5
	ASA 3	14,430	539	3.8	3.5	4.2
	ASA 4/5	206	6	3.2	1.5	7.0
	ASA unknown	4,371	136	3.2	2.7	3.7

For benchmarking, the two-year revision rate of an implant, hospital, or surgeon was calculated for primary TKA to treat primary OA. Cases with isolated previous meniscus surgery were also included in this group. Other causes of secondary OA, such as previous ligament surgery, fracture fixation, osteotomy and inflammatory arthritis, etc., were excluded, as associated revision rates may be increased by the underlying diagnosis. Early revision rates were calculated for a moving four-year window. This report used the data pertaining to the period between 01.01.2017 and 31.12.2020, with a completed two-year follow-up on 31.12.2022.

Demography

Of the documented primary TKA implanted between 01.01.2017 and 31.12.2020 with a completed two-year follow-up, 60,135 operated knees were at risk for the first revision. Of these, 2,090 TKA were revised (revision burden), accounting for a two-year revision rate of 3.6% (CI 95% 3.4–3.7%). The revision rate was significantly higher for secondary (4.5%, 4.0–5.0%) than for primary OA (3.4%, 3.3–3.6%). This pattern mainly seems due to the younger age at primary TKA for secondary OA (mean age of 65.0 years for secondary compared to 70.2 years for primary OA) **(Table 4.2b).** Younger patients were predominantly at risk of early revision (4.9% for the age group under 55 and 4.5% for the age group 55–64 years). Increasing BMI did raise the early revision rate from 3.1% for the BMI group of 18.5–24.9 kg/m² to 4.3% in the › 40 kg/m² group (staying within the 95% confidence interval). Only 12 revisions were performed in patients with a BMI of less than 18.5 kg/m². The calculated revision rate in this group was 5.8% and the small number is reflected in the considerable variation from 3.3 to 10.0%. ASA classification did not play an important role **(Table 4.4a).**

* 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.

The main reasons for early revision were patella problems, 35.7% of the cases, followed by infection (20.1%) and femorotibial instability (17.4%) **(Table 4.4c).** When infection and periprosthetic fractures are excluded, surgical technical problems appeared to responsible for most early TKA revisions in Switzerland. Exact ratios are not available as multiple reasons could be selected per patient. In addition, still 11.0% of the reasons were classified as "other". To a large extent, this diverse group includes the same reasons as listed above, but with added details and includes numerous wound healing problems and more special reasons, such as liner dislocations. Periprosthetic fractures of the femur, tibia, and/or patella were rarely responsible for early revisions.Probably most cases treated with internal fixation only were not registered.

Patella problems are confirmed to be the most important reason for revision after TKA, taking the lead shortly after the first year after the index operation. **Figure 4.4a** is a Kernel density estimation that evaluates the frequency at a given time.

Table 4.4b

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022), all diagnoses.

	Primary TKA	Revised within 24 months			
		Revised		95% CI	
	N at risk[1]	N	%[2]	lower	upper
Overall (moving average)	60,135	2,090	3.6	3.4	3.7
Component fixation					
All cemented	48,320	1,679	3.6	3.4	3.7
All uncemented	2,505	116	4.7	3.9	5.6
Hybrid*	9,036	284	3.2	2.9	3.6
Reverse hybrid**	237	10	4.3	2.3	7.8
Patellar replacement					
With patellar replacement	18,446	557	3.1	2.8	3.4
Without patellar replacem.	41,628	1,530	3.8	3.6	3.9
Status after patellectomy	24	2	8.3	2.2	29.4

[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 4.4c

Reason for early first revision of primary total knee arthroplasty

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022). Early first revisions are those occurring within two years of the primary arthroplasty.
Multiple responses possible (percentages do not sum to 100).

	N	%
Patella problems	747	35.7
Infection	421	20.1
Femorotibial instability	363	17.4
Loosening tibia	188	9.0
Pain (of unclear origin)*	154	7.4
Joint stiffness/arthrofibrosis	177	8.5
Component malposition femur	84	4.0
Component malposition tibia	78	3.7
Loosening femur	73	3.5
Patellar instability	74	3.5
Wear of inlay	20	1.0
Loosening patella	28	1.3
Periprosthetic fracture femur	21	1.0
Sizing femoral component	28	1.3
Periprosthetic fracture tibia	17	0.8
Sizing tibial component	11	0.5
Periprosthetic fracture patella	15	0.7
Other	230	11.0
Total	**2,729**	

* Pain was frequently reported alongside other reasons.
The proportion of „isolated pain" was 3.2%.
The wording was adapted in v2021 and the share dropped accordingly in 2021

Both perspectives show that only infections were revised relatively early (median 5.7 months after index surgery) and most other reasons for revising a TKA were conducted relatively late (after one year), reflecting the usual pattern in patients with unsatisfactory results after TKA: "wait and see", the result could still improve with time. This stands in contrast to revisions after THA (compare chapter 3). After an average of almost one-year, stiff knees were revised, while on average, all the other reasons for early revisions were performed more than one year after TKA **(Figure 4.4a).** This pattern drives the revision rates upwards with ongoing time, in what might resemble logistic growth curves (slow increase followed by steeper growth and then a flattening out effect). Patella problems contributed to the revision rates observed in this fashion, causing a disproportionate number of revisions between 10.9 and 18.5 months after implantation, with the median at 14.4 months after primary TKA **(Figure 4.4a).**

Figure 4.4a

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).
Early first revisions are those occurring within 2 years of the primary arthroplasty.

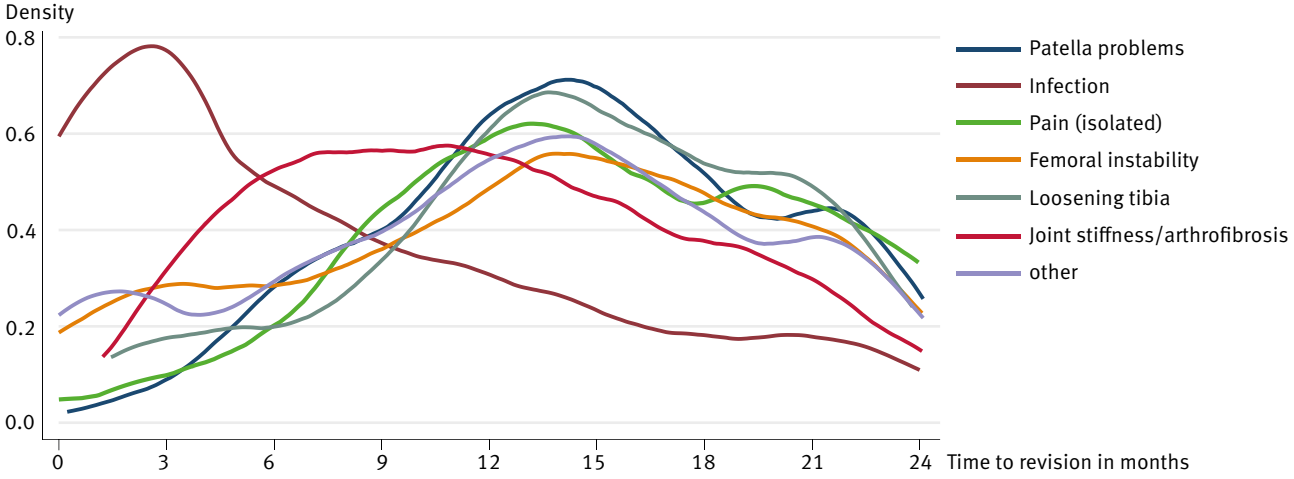


Table 4.4d

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

all diagnoses

	N	Median	IQR 25%	IQR 75%
Patella problems	747	14.4	10.9	18.5
Infection	421	5.7	1.6	12.3
Pain (isolated)	50	14.9	11.6	20.7
Femoral instability	363	13.9	8.0	18.3
Loosening tibia	188	14.5	11.0	19.2
Joint stiffness/arthrofibrosis	177	11.6	7.0	16.4
Other	1,183	13.2	8.0	17.7

Figure 4.4b

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

Time since operation, 2015–2022, all services, % of implants revised. Detailed reasons for revisions available since 2015.

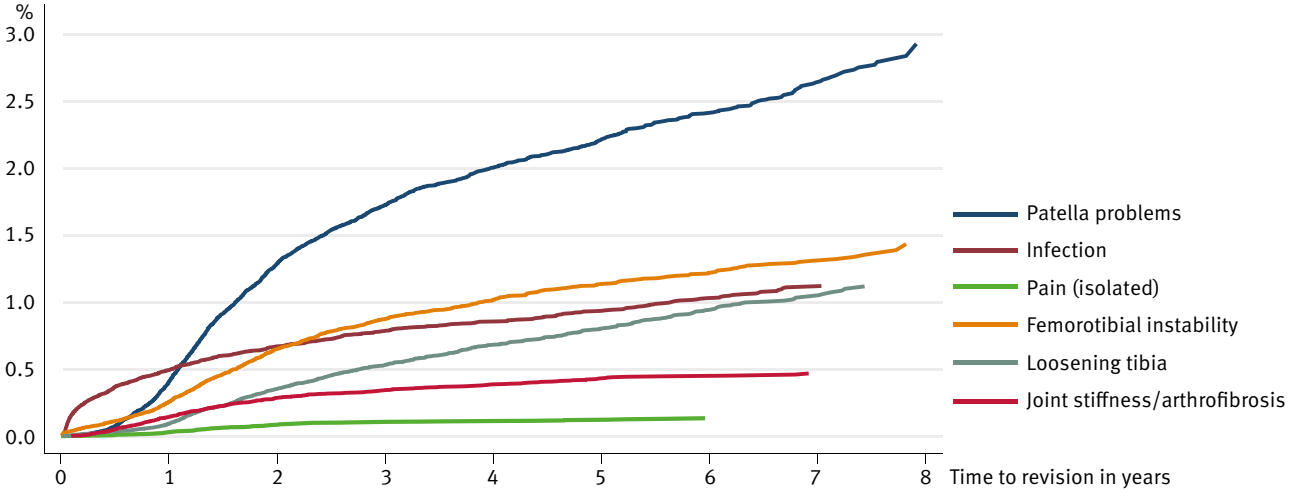
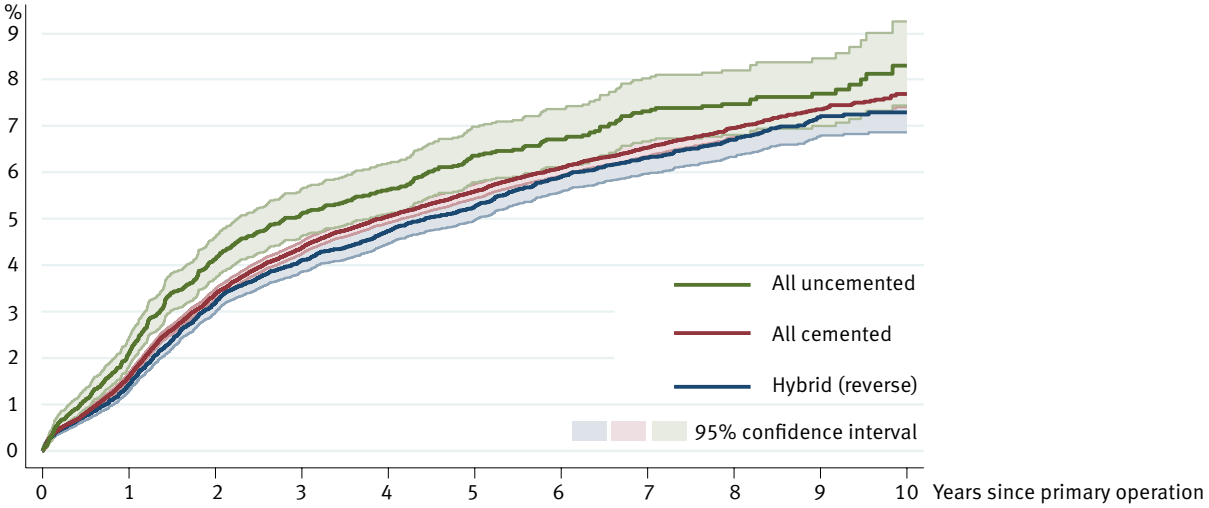


Figure 4.4c

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

Time since operation, 2012–2022, all services, all diagnoses.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
All cemented	**1.6** (1.5-1.7)	**3.4** (3.3-3.5)	**4.4** (4.2-4.5)	**5.1** (4.9-5.2)	**5.6** (5.4-5.7)	**6.1** (5.9-6.3)	**6.5** (6.3-6.7)	**7.0** (6.8-7.2)	**7.7** (7.4-8.0)
All uncemented	**2.1** (1.8-2.4)	**4.1** (3.7-4.6)	**5.1** (4.6-5.6)	**5.6** (5.1-6.2)	**6.4** (5.8-7.0)	**6.7** (6.1-7.4)	**7.3** (6.7-8.0)	**7.5** (6.8-8.2)	**8.3** (7.4-9.2)
(reverse) hybrid	**1.4** (1.3-1.6)	**3.2** (3.0-3.4)	**4.1** (3.9-4.4)	**4.7** (4.5-5.0)	**5.3** (5.0-5.6)	**5.9** (5.6-6.2)	**6.3** (6.0-6.7)	**6.7** (6.3-7.1)	**7.3** (6.9-7.7)

Knee systems

Regarding medium-term revision rates, CS/UCOR and PCR systems showed visible advantages after one year and becoming significant at six years follow-up, compared to medial pivot, PS systems and those classified as other **(Figure 4.4d).** The reason is unclear 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 may have been selected in more advanced disease with bone loss and/or partial ligament instability, e.g., in valgus arthritis knees. This effect is also well known in Australia, the so-called "CR continent", where PS knees have a higher revision rate due to a case selection, as mentioned above.

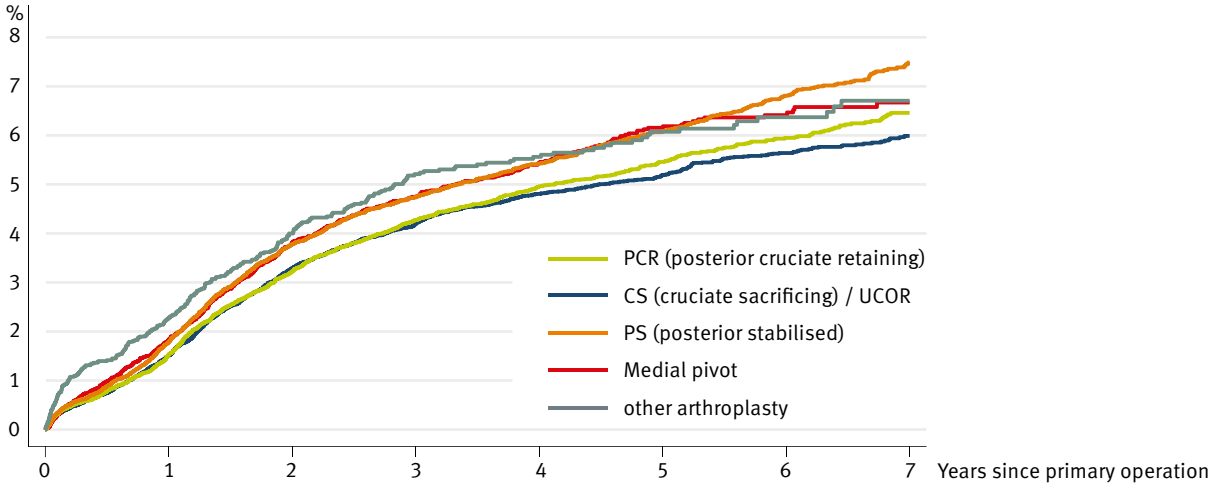
Fixation

Uncemented TKA were revised significantly more often (4.7%, 3.9–5.6%) than fully cemented TKA (3.6%, 3.4–3.7%) in the first 2 years after index surgery. Ignoring the statistically inconclusive reverse hybrid fixations, hybrid fixation seemed to perform best, with a 2-year revision rate at 3.2% (2.9–3.6%), but the difference was not significant **(Table 4.4b).** With increasing follow-up, uncemented implants had a continuously higher revision rate than fully cemented or hybrid fixated TKA, but the difference became statistically not significant from the sixth year after index surgery onward **(Figure 4.4c).** Ten years after surgery, the revision rate for uncemented TKA approximated that for cemented ones. Hybrid fixation remained best, though the difference was not significant. It seems that the

Figure 4.4d

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

Time since operation, 2015–2022, all services, all diagnoses.



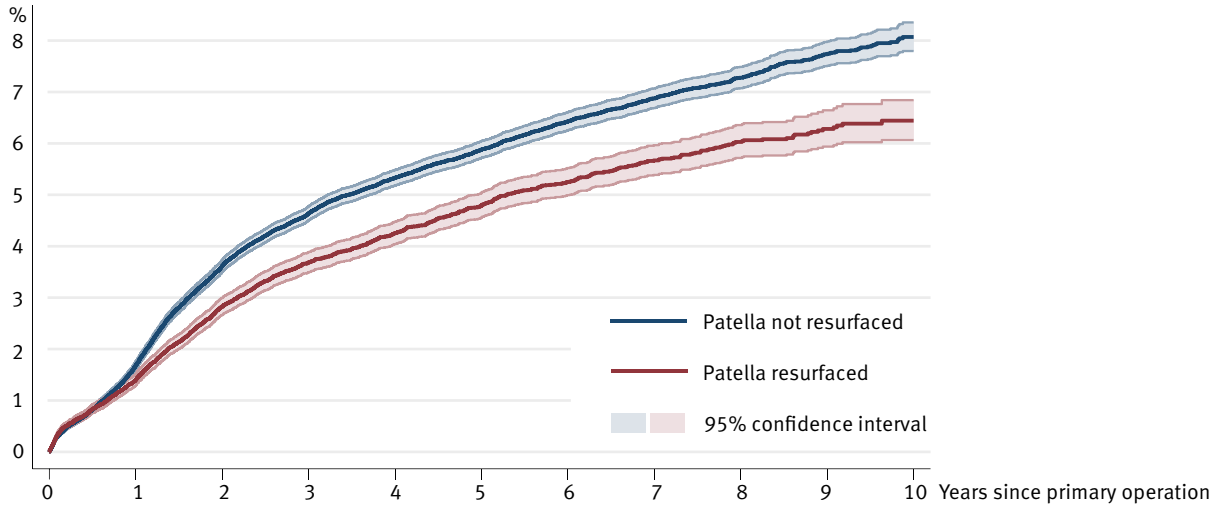
	1 year	2 years	3 years	4 years	5 years	6 years	7 years
PCR (posterior cruciate ret.)	**1.5** (1.4-1.7)	**3.2** (3.0-3.4)	**4.3** (4.0-4.5)	**5.0** (4.7-5.3)	**5.5** (5.2-5.8)	**5.9** (5.6-6.3)	**6.5** (6.1-6.9)
CS (cruciate sacr.)/UCOR	**1.5** (1.4-1.7)	**3.3** (3.1-3.5)	**4.2** (4.0-4.4)	**4.8** (4.5-5.1)	**5.2** (4.9-5.5)	**5.6** (5.3-6.0)	**6.0** (5.7-6.3)
PS (posterior stabilised)	**1.8** (1.6-1.9)	**3.8** (3.6-4.0)	**4.7** (4.5-5.0)	**5.4** (5.2-5.7)	**6.1** (5.8-6.4)	**6.8** (6.5-7.2)	**7.5** (7.1-7.9)
Medial Pivot	**1.8** (1.6-2.1)	**3.8** (3.5-4.2)	**4.7** (4.4-5.2)	**5.4** (5.0-5.9)	**6.2** (5.7-6.7)	**6.4** (5.9-7.0)	**6.7** (6.1-7.3)
other arthroplasty	**2.3** (1.9-2.7)	**4.0** (3.5-4.6)	**5.2** (4.6-5.9)	**5.6** (4.9-6.3)	**6.1** (5.4-6.8)	**6.4** (5.6-7.2)	**6.7** (5.9-7.6)

*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.

Figure 4.4e

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

Time since operation, 2012–2022, all services, all diagnoses.

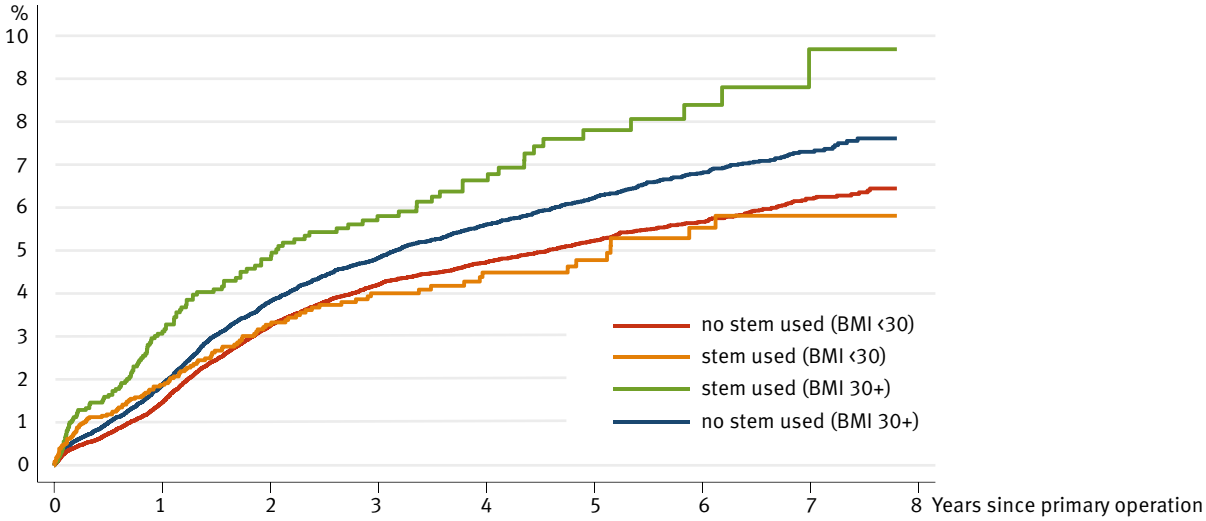


	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	10 years
Patella resurf.	**1.4** (1.3-1.5)	**2.8** (2.7-3.0)	**3.7** (3.5-3.9)	**4.3** (4.0-4.5)	**4.8** (4.6-5.0)	**5.3** (5.0-5.5)	**5.7** (5.4-6.0)	**6.0** (5.7-6.4)	**6.4** (6.1-6.8)
Patella not resurf.	**1.7** (1.6-1.8)	**3.6** (3.5-3.7)	**4.6** (4.5-4.8)	**5.3** (5.2-5.5)	**5.9** (5.7-6.0)	**6.4** (6.3-6.6)	**6.9** (6.7-7.1)	**7.3** (7.1-7.5)	**8.1** (7.8-8.4)

Figure 4.4f Part 1

Estimated failure rates of primary total knee arthroplasty: Use of stem

Time since operation, 2012–2022, all services, all diagnoses.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years
no stem used (BMI‹30)	**1.5** (1.4-1.6)	**3.3** (3.1-3.4)	**4.2** (4.0-4.4)	**4.7** (4.5-4.9)	**5.2** (5.0-5.5)	**5.7** (5.4-5.9)	**6.2** (5.9-6.5)
stem used (BMI‹30)	**1.9** (1.5-2.4)	**3.3** (2.7-4.0)	**4.0** (3.3-4.9)	**4.5** (3.7-5.5)	**4.8** (3.9-5.9)	**5.5** (4.4-6.9)	**5.8** (4.6-7.3)
stem used (BMI 30+)	**3.1** (2.4-3.9)	**4.8** (3.9-5.8)	**5.8** (4.8-7.0)	**6.6** (5.5-8.0)	**7.8** (6.4-9.5)	**8.4** (6.8-10.3)	**9.7** (7.4-12.6)
no stem used (BMI 30+)	**1.9** (1.8-2.0)	**3.8** (3.6-4.0)	**4.8** (4.6-5.1)	**5.6** (5.3-5.9)	**6.2** (5.9-6.5)	**6.8** (6.5-7.2)	**7.3** (6.9-7.7)

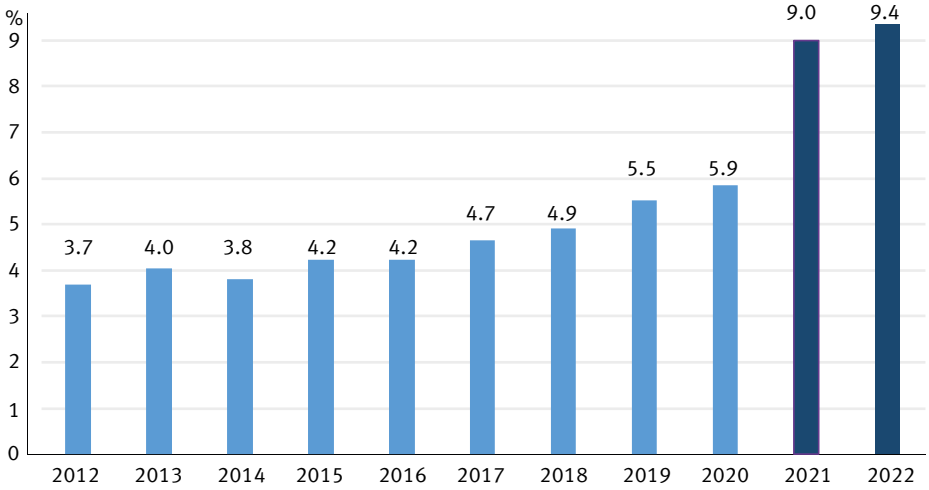
higher revision rate of uncemented TKA is an increased risk for up to three years after operation, perhaps reflecting missing osteointegration or failures due to malalignment and/or insufficient bone quality. From the 4th year after index surgery, the curve is moving parallel on a higher level than the cemented and hybrid fixed TKA. All curves seem to converge 7 years after surgery **(Figure 4.4c).** Again, in the cemented and uncemented groups, younger age (‹ 60 years) seemed to play an important role in early revision. One could assume that unsatisfactory results after primary TKA were better accepted by patients older at the time of surgery due to less functional demands and possibly more tolerance for inferior results.

Patella resurfacing

When considering TKA without and with primary patella resurfacing, early revision differed significantly from 2.8% (2.7–3.0%) to 3.6% (3.5–3.7%), respectively **(Figure 4.4e).** The gaping occurred shortly after the first year after surgery, which is the typical delay for secondary patella resurfacing **(Figure 4.4a).** Between 3 and 9 years after TKA, the revision rate developed parallel for TKA with unresurfaced and resurfaced patella, although the curve of TKA with patella resurfacing seemed to flatten from 8 years onwards which increases the gap again **(Figure 4.4e).** It seems that secondary resurfacing had only a narrow time window between one and three years after index surgery for the common complaint of anterior knee pain after primary TKA.

Figure 4.4f Part 2

Use of stems as a percentage of primary TKAs with cemented tibias



Figures 2012-2020 based on registered components (provisional analysis, which are likely incomplete)
Figures 2021-2022 based on SIRIS v2021 form responses plus registered components
Can be femoral or tibial stems; form responses suggest 3:1 TI stems to FE stems

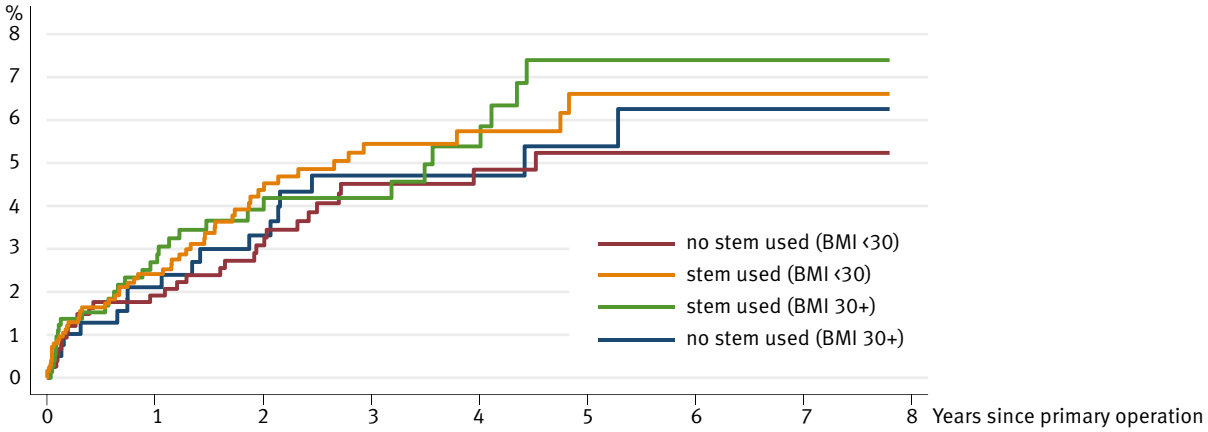
Additional components

Concerning the use of stems in primary TKA, the revision rate did not differ with or without the stem when the BMI was less than 30 kg/m² **(Figure 4.4.f).** According to the results in the registry, the use of stems in patients with BMI ≥ 30 kg/m² ended in an even higher revision rate compared to obese patients without stems **(Figure 4.4f).** This could not be expected, as literature is reporting significantly lower revision rates when using tibial stems in such cases. The contrary observed in SIRIS could speak for a certain selection bias with other influencing factors than BMI alone (e.g. osteoporosis). Definitive conclusions however may not be drawn, as further subgrouping would be necessary, but not possible due to small numbers. When only considering knee systems with higher intrinsic stability (semi-constrained/CCK or hinge type), stemmed implants also seem to perform less well than non-stemmed versions, independently of BMI **(Figure 4.4g).** This could again be consequence of a selection bias.

Figure 4.4g

Estimated failure rates of primary total knee arthroplasty: Use of stems (Hinged, SC/CCK)

Time since operation, 2015–2022, all services, all diagnoses, only cemented tibias



	1 year	2 years	3 years	4 years	5 years	6 years	7 years
no stem used (BMI<30)	**1.4** (1.3-1.5)	**3.2** (3.1-3.4)	**4.2** (4.0-4.4)	**4.7** (4.5-4.9)	**5.2** (5.0-5.5)	**5.7** (5.4-5.9)	**6.2** (5.9-6.5)
stem used (BMI<30)	**1.9** (1.5-2.5)	**3.3** (2.7-4.1)	**4.0** (3.3-4.9)	**4.5** (3.7-5.5)	**4.8** (3.9-5.9)	**5.6** (4.5-6.9)	**5.8** (4.6-7.4)
stem used (BMI 30+)	**3.1** (2.4-3.9)	**4.8** (3.9-5.9)	**5.8** (4.8-7.0)	**6.7** (5.5-8.0)	**7.8** (6.4-9.5)	**8.4** (6.9-10.3)	**9.8** (7.5-12.7)
no stem used (BMI 30+)	**1.8** (1.7-2.0)	**3.8** (3.6-4.0)	**4.8** (4.6-5.0)	**5.6** (5.3-5.9)	**6.2** (5.9-6.5)	**6.8** (6.4-7.1)	**7.3** (6.9-7.7)

4.5 Re-Revision of knee arthroplasty

For the first time, re-revisions after revision could be examined in the annual report of 2023, including re-revision after conversion of PKA to TKA. Complete revision performed better regarding risk of repeated revision than partial revision, from the first year onwards and up to 10 years postoperatively **(Figure 4.5a).**

Demography

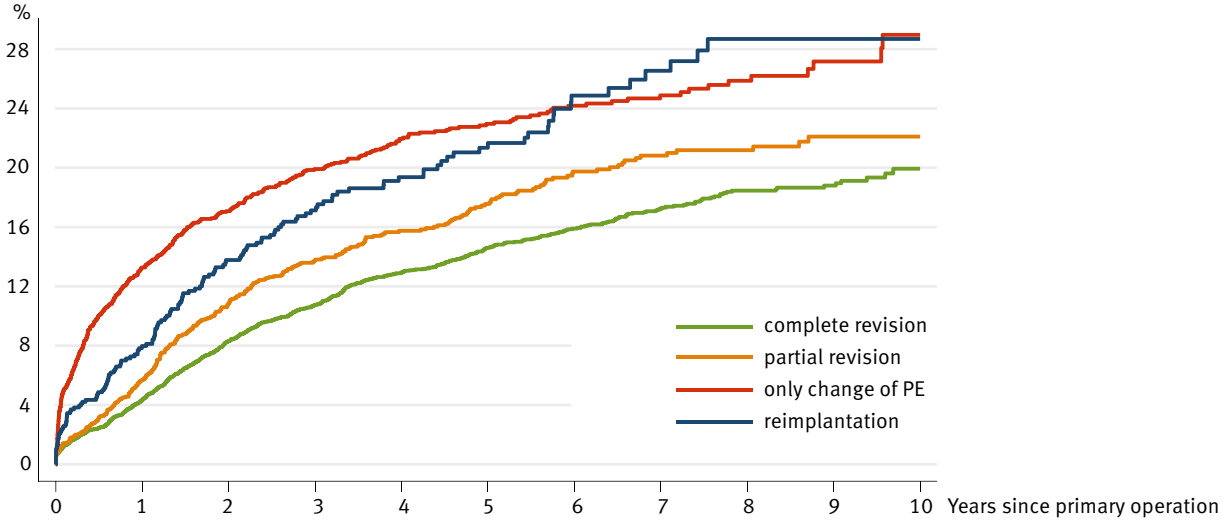
Re-revision rates reached 8.3% (7.6–9.0%) after two years for complete and 10.8% (9.5–12.3%) for partial revision, respectively, whereas the early revision rate after primary TKA was 3.6% (3.4–3.7%) **(Table 4.4a)**. Re-revision rate at 10 years was 22.1% for partial and 19.9% for complete revision, the difference not being statistically significant. This rate is almost three times higher than after primary TKA **(Figure 4.4c).** If only the PE liner was exchanged at revision, the early re-revision rate was 17.1% (15.6–18.7%), even rising to 29.0% (25.6–32.7%) at ten years.

Component reimplantation, which mostly is indicated after temporary spacers due to suspected or confirmed periprosthetic infection, had an early (two year) re-revision rate of 13.8% (11.5–16.5%). This is worse than after partial or complete revision without infection **(Figure 4.5a).** The re-revision rate increased over time up to 28.7% (24.2–33.8%) ten years after reimplantation.

Figure 4.5a

Estimated failure rates after revision of total knee arthroplasty: Types of revisions

Time since revision, 2012–2022. Start point of analysis: first registered component revision in SIRIS that meets the inclusion criteria. End point of analysis: next registered component revision



	1 year	2 years	3 years	4 years	6 years	8 years	10 years
complete revision	**4.4** (3.9-4.9)	**8.3** (7.6-9.0)	**10.7** (10.0-11.6)	**12.9** (12.1-13.9)	**15.9** (14.8-17.0)	**18.5** (17.2-19.8)	**19.9** (18.3-21.7)
partial revision	**5.7** (4.8-6.8)	**10.8** (9.5-12.3)	**13.7** (12.2-15.4)	**15.7** (14.1-17.6)	**19.7** (17.7-21.9)	**21.2** (19.0-23.6)	**22.1** (19.8-24.7)
only change of PE	**13.3** (12.0-14.7)	**17.1** (15.6-18.7)	**19.9** (18.3-21.6)	**22.0** (20.2-23.8)	**24.2** (22.3-26.2)	**25.9** (23.7-28.2)	**29.0** (25.6-32.7)
reimplantation	**8.0** (6.3-10.1)	**13.8** (11.5-16.5)	**17.1** (14.5-20.2)	**19.4** (16.5-22.7)	**24.9** (21.2-29.0)	**28.7** (24.2-33.8)	**28.7** (24.2-33.8)

Reimplantation refers to implantation of total knee system after spacer (revisions due to infection). Comprises linked and unlinked revisions. A small proportion of revisions of partial knees may be included because they cannot be reliably excluded when the revision is not linked to a primary SIRIS case

Cumulative rates for all re-revisions after revision TKA are depicted in **Figure 4.5c.** Infection takes the lead early after re-revision, followed by the equally prevalent problems of femorotibial instability, patella problems, and loosening of the tibia. Joint stiffness seemed to play a minor role, as did isolated pain of unknown origin.

Patella resurfacing

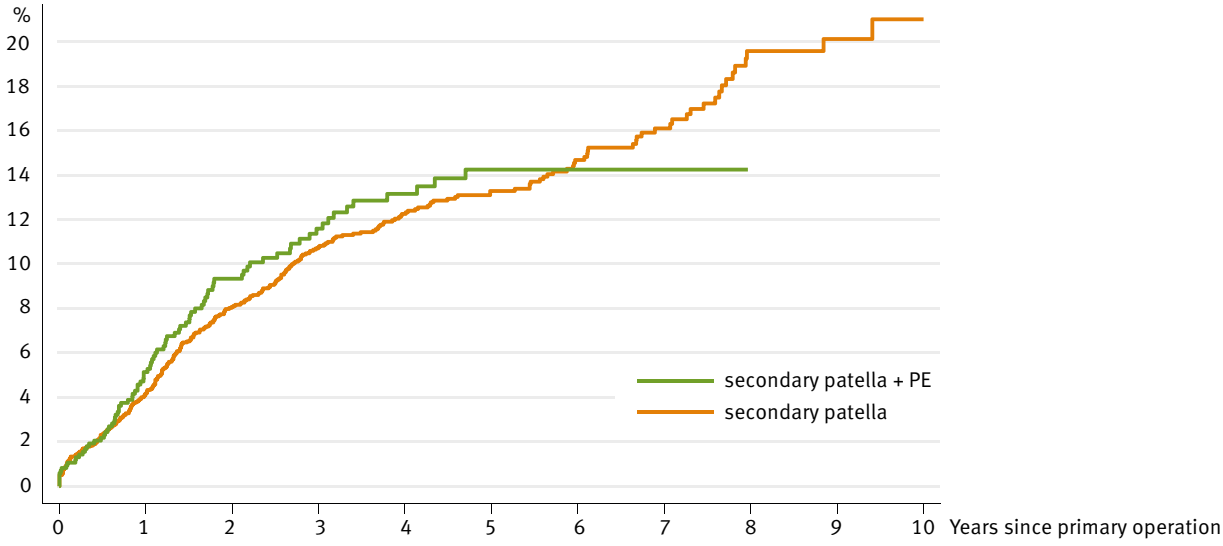
Isolated secondary patella resurfacing was associated with an early re-revision rate of 8.1% (7.1–9.2%), which is comparable to the results after complete revision. Secondary patella resurfacing combined with PE liner exchange led to 9.3% (7.4–11.7%) of re-revisions not significantly different to isolated secondary patella resurfacing **(Figure 4.5b).** Ten-years results are still lacking, but at 7 years secondary patella resurfacing in combination with PE liner exchange performed significantly better than secondary resurfacing alone. This was comparable to the re-revision rate after complete TKA revision (**Figure 4.5a and Figure 4.5b).** It is unclear if PE wear played a role in cases with isolated patella resurfacing from 7 years after revision surgery onwards.

The main reason for re-revision after secondary patella resurfacing, with or without exchange of PE liner was femorotibial instability **(Figure 4.5d).** Astonishingly, persistent patella problems were the second most common reason, confirming that anterior knee pain after TKA often has other causes which cannot be solved by secondary patella resurfacing alone. Loosening of the tibial component was an important cause of re-revision, whereas joint stiffness or isolated pain, fortunately, did not play an important role in this context **(Figure 4.5d).**

Figure 4.5b

Estimated failure rates after revision of total knee arthroplasty: Secondary patella replacement

Time since revision, 2012–2022. Start point of analysis: first registered component revision in SIRIS that meets the inclusion criteria. End point of analysis: next registered component revision.



	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
sec. patella	**4.2** (3.5-5.0)	**8.1** (7.1-9.2)	**10.8** (9.6-12.1)	**12.3** (10.9-13.7)	**13.3** (11.9-14.8)	**14.7** (13.1-16.4)	**19.6** (17.1-22.3)	**21.0** (18.0-24.5)
sec. patella (+PE)	**5.1** (3.8-6.9)	**9.3** (7.4-11.7)	**11.6** (9.3-14.3)	**13.2** (10.7-16.2)	**14.2** (11.6-17.5)	**14.2** (11.6-17.5)		

Comprises of linked and unlinked revisions. A small proportion of revisions of partial knees may be included because they cannot be reliably excluded when the revision is not linked to a primary SIRIS case

Re-revision after partial knee arthroplasty

Re-revision rate after conversion of a PKA to TKA reached 10.4% (8.8-12.1%) after two years and 20.9% (17.6-24.7%) after 10 years, respectively. This is comparable to the re-revision rates after re-vision TKA **(Table and Figure 4.5a)** and is far worse than the revision rate after primary TKA **(Table 4.4a).**

Figure 4.5c

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

Time since revision, 2015–2022, all services, % of implants re-revised. Detailed reasons for revisions available since 2015. Comprises of all complete revisions, partial revisions, reimplantations and PE replacements.

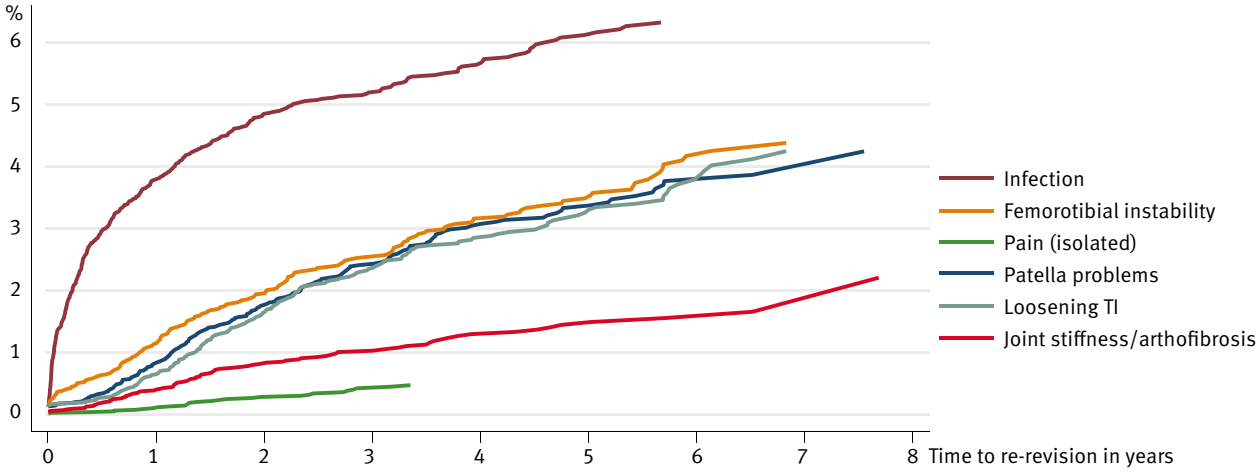
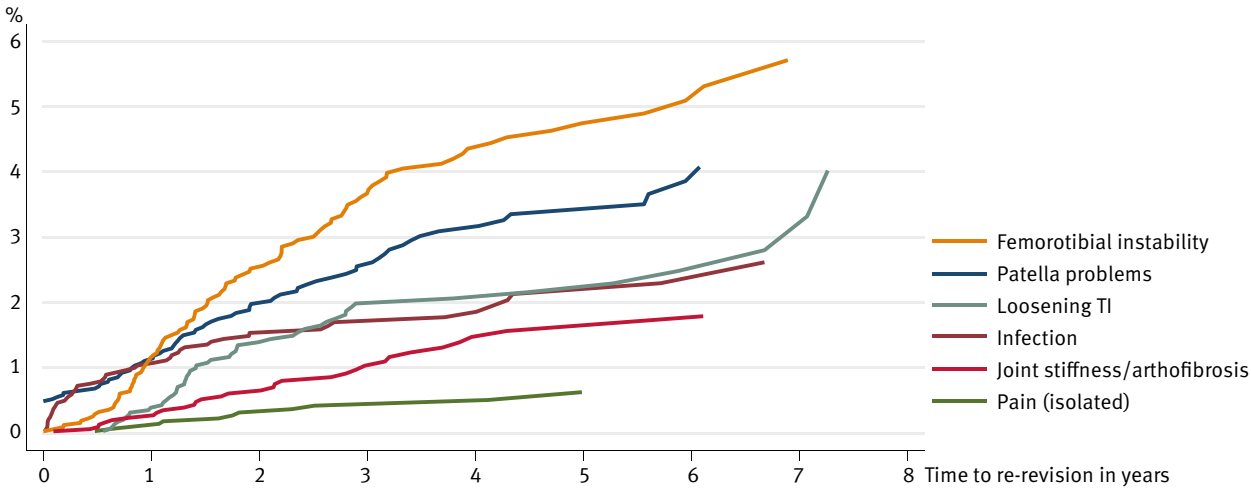


Figure 4.5d

Cumulative incidence rates for different re-revision diagnosis after secondary patella replacements (TKA)

Time since revision, 2015–2022, all services, % of implants re-revised. Detailed reasons for revisions available since 2015. Comprises of all secondary patella replacements (with or without PE replacement).



4.6 Results of implants in total knee arthroplasty

Table 4.6a shows Switzerland's most commonly used TKA systems, representing 75% (71,678) of the TKA from 2017 until 2022. 21,315 implants (25%) in this period belonged to the less common systems. Only 388 implant combinations (0.4%) could not be classified, reducing the missing systems by one-third compared to the SIRIS report of 2022.

The long-term evaluation for all systems, all diagnoses, and all fixation systems since 2012 is depicted in **Table 4.6b,** showing results up to 10 years after surgery. Primary TKA subsystems (such as CR or PS) were analysed separately if numbers were sufficient and differed considerably from the revision rates of the whole group. The 10-year revision rate for all systems was 7.6% (7.4–7.8%). Different implant combinations performed rather differently in the short, medium, and long terms **(Table 4.6b).** Higher confidence intervals reflect higher variability due to small numbers. Please take note of the case concentration score (CCS), indicating the share of the largest providing hospital, as individual providers may influence results of systems not widely used.

Table 4.6a

Top 75% of primary total knee arthroplasty systems*

All diagnoses, all component fixations 2017–2022.

	2017	2018	2019	2020	2021	2022	2017–2022
Attune CR-FB	730	677	677	841	1,244	1,689	5,858
Attune CR-RP	1,240	1,043	1,167	1,336	1,416	1,603	7,805
Attune PS-FB	524	567	544	461	498	654	3,248
Attune PS-RP	771	986	837	745	746	1,027	5,112
Balansys CR	171	236	294	355	517	914	2,487
Balansys PS	451	550	663	599	622	571	3,456
Balansys RP	728	574	521	443	320	309	2,895
Balansys UC	516	363	360	387	441	589	2,656
GMK sphere	1,364	1,720	2,019	2,075	2,459	3,013	12,650
Journey II	474	401	371	264	181	93	1,784
LCS complete cemented/hybrid	551	605	677	670	503	47	3,053
Persona CR-MC	379	522	705	971	1241	1796	5,614
Persona CR-UC	924	1,036	1,099	1,162	1,097	1,254	6,572
Persona PS/CPS	747	784	703	606	942	1,108	4,890
Sigma CR-FB	381	386	326	289	182	157	1,721
Triathlon PS	114	154	183	357	553	516	1,877
Other systems	4,283	3,967	4,122	3,747	3,547	3,649	23,315
Total	**14,348**	**14,571**	**15,268**	**15,308**	**16,509**	**18,989**	**94,993**

*Constrained/hinged systems were included if used for cases of primary OA including OA after meniscectomy

for the Table on the next page:
* Case concentration score. Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.
** Younger mean age signifies that the case mix is less "usual" and potentially biased towards higher revision risk

Table 4.6b

Long term evaluation: Failure rates of primary total knee arthroplasty systems (all diagnoses, all component fixations)

Time since operation, 2012–2022. Please note that if reported system involves multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

Knee system	Total number	CCS*	Mean age**	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Advance	2,031	19	68	**2.2** (1.7-3.0)	**5.1** (4.2-6.3)	**6.2** (5.1-7.5)	**7.2** (6.0-8.6)	**9.7** (6.7-14.1)
Attune CR-FB	7,016	16	69	**1.2** (1.0-1.5)	**3.9** (3.3-4.5)	**4.9** (4.3-5.7)	**6.2** (5.3-7.3)	
Attune CR-RP	10,967	11	69	**2.0** (1.7-2.3)	**5.4** (4.9-5.9)	**6.7** (6.1-7.3)	**7.6** (7.0-8.4)	
Attune PS-FB	4,792	16	70	**1.5** (1.2-1.9)	**4.0** (3.4-4.7)	**5.1** (4.4-5.9)	**6.8** (5.8-7.9)	
Attune PS-RP	6,376	16	70	**1.7** (1.4-2.1)	**4.7** (4.2-5.3)	**6.4** (5.7-7.2)	**8.2** (7.1-9.4)	
Balansys CR	3,111	14	70	**1.1** (0.8-1.6)	**3.1** (2.4-3.9)	**4.0** (3.2-5.2)	**4.8** (3.8-6.2)	**5.2** (4.0-6.8)
Balansys PS	4,658	54	69	**1.3** (1.0-1.7)	**3.4** (2.9-4.0)	**4.7** (4.0-5.5)	**5.7** (4.8-6.8)	**6.4** (5.3-7.8)
Balansys RP	6,383	14	70	**1.4** (1.1-1.7)	**4.1** (3.6-4.7)	**5.5** (4.9-6.1)	**6.9** (6.2-7.6)	**8.1** (7.2-9.2)
Balansys UC	4,899	23	70	**1.1** (0.8-1.5)	**4.1** (3.5-4.8)	**5.2** (4.5-6.0)	**6.7** (5.9-7.7)	**7.2** (6.3-8.3)
E.Motion FP/UC	1,741	82	69	**1.4** (0.9-2.1)	**3.4** (2.6-4.4)	**4.9** (3.9-6.3)	**6.3** (5.0-7.9)	**8.0** (6.0-10.5)
First/First REV	2,654	38	70	**1.7** (1.2-2.2)	**5.0** (4.2-5.9)	**6.1** (5.2-7.2)	**7.5** (6.4-8.8)	**7.9** (6.7-9.4)
GMK primary CR/UC-RP	2,586	19	70	**1.6** (1.1-2.1)	**4.1** (3.4-5.0)	**5.0** (4.2-6.0)	**5.9** (5.0-6.9)	**6.7** (5.6-8.1)
GMK primary PS	2,068	24	70	**1.2** (0.8-1.8)	**3.8** (3.0-4.7)	**5.2** (4.2-6.3)	**6.5** (5.4-7.8)	**7.7** (6.4-9.4)
GMK sphere	15,247	13	69	**1.8** (1.5-2.0)	**4.6** (4.3-5.1)	**6.1** (5.6-6.6)	**6.7** (6.1-7.3)	**8.1** (6.8-9.6)
ITotal	1,781	23	68	**0.7** (0.4-1.2)	**2.9** (2.2-4.0)	**3.5** (2.6-4.7)	**4.3** (3.0-6.1)	**5.4** (3.3-8.9)
Innex FB	1,729	42	71	**1.4** (0.9-2.1)	**4.3** (3.5-5.5)	**5.4** (4.4-6.6)	**6.2** (5.1-7.6)	**8.5** (6.8-10.7)
Innex RP	4,807	17	69	**1.7** (1.4-2.1)	**4.5** (4.0-5.2)	**5.6** (5.0-6.3)	**6.3** (5.6-7.1)	**7.7** (6.8-8.9)
Journey II	2,479	29	67	**3.2** (2.6-4.0)	**7.9** (6.8-9.1)	**9.7** (8.5-11.1)	**12.0** (10.3-13.8)	
LCS complete cemented/hybrid	6,643	23	70	**1.5** (1.2-1.8)	**4.6** (4.1-5.2)	**5.7** (5.1-6.4)	**6.4** (5.8-7.1)	**7.1** (6.4-7.9)
LCS complete cementless	2,886	27	69	**2.0** (1.6-2.6)	**5.4** (4.6-6.4)	**6.3** (5.4-7.3)	**6.9** (5.9-8.0)	**7.7** (6.5-9.1)
Legion	1,704	19	67	**1.8** (1.2-2.6)	**6.8** (5.5-8.3)	**9.0** (7.4-10.8)	**10.6** (8.7-12.7)	
NK flex	1,842	41	70	**1.3** (0.8-1.9)	**4.1** (3.2-5.1)	**5.2** (4.2-6.3)	**6.0** (5.0-7.3)	**6.7** (5.5-8.1)
Nexgen CR/LPS-Flex	2,104	14	70	**1.5** (1.1-2.2)	**3.5** (2.8-4.4)	**4.5** (3.6-5.5)	**5.0** (4.0-6.1)	**6.4** (5.2-7.8)
Origin PS	1,560	21	69	**1.9** (1.3-2.8)	**5.8** (4.3-7.9)			
Persona CR-MC	5,686	8	69	**1.3** (1.0-1.6)	**3.6** (3.0-4.3)	**4.5** (3.7-5.6)		
Persona CR-UC	8,650	38	70	**0.9** (0.8-1.2)	**2.7** (2.4-3.2)	**3.7** (3.3-4.3)	**4.2** (3.6-4.9)	
Persona PS/CPS	6,768	11	70	**1.7** (1.4-2.1)	**3.9** (3.4-4.5)	**5.1** (4.5-5.8)	**6.1** (5.3-6.9)	
RT-plus	1,097	13	77	**2.5** (1.7-3.7)	**4.3** (3.1-5.8)	**5.1** (3.8-6.9)	**5.5** (4.0-7.5)	**5.5** (4.0-7.5)
Sigma CR-FB	4,679	29	71	**0.8** (0.6-1.1)	**2.4** (2.0-2.9)	**3.2** (2.7-3.8)	**3.6** (3.0-4.2)	**4.1** (3.5-4.9)
Sigma CR-RP	2,246	40	68	**2.4** (1.9-3.2)	**5.7** (4.8-6.7)	**6.6** (5.6-7.7)	**7.0** (5.9-8.2)	**7.8** (6.6-9.2)
Sigma PS-FB	1,321	59	72	**1.0** (0.6-1.7)	**3.2** (2.3-4.4)	**3.9** (2.9-5.3)	**4.5** (3.4-6.0)	**5.4** (4.0-7.3)
Sigma PS-RP	1,653	11	70	**1.5** (1.0-2.3)	**3.8** (3.0-4.9)	**4.7** (3.7-5.8)	**5.4** (4.4-6.7)	**6.0** (4.9-7.4)
TC-plus primary FB	2,550	30	69	**1.5** (1.1-2.1)	**3.8** (3.1-4.7)	**4.6** (3.8-5.6)	**5.3** (4.4-6.4)	**5.8** (4.7-7.0)
TC-plus primary RP	1,901	32	70	**1.3** (0.9-1.9)	**3.9** (3.0-4.9)	**5.4** (4.3-6.6)	**6.9** (5.7-8.5)	**9.3** (7.4-11.7)
Triathlon CR/CS	1,657	42	69	**2.4** (1.7-3.3)	**5.9** (4.8-7.3)	**7.2** (5.9-8.7)	**8.4** (7.0-10.2)	**9.2** (7.4-11.3)
Triathlon PS	2,372	29	69	**2.3** (1.8-3.1)	**5.8** (4.7-7.1)	**6.8** (5.5-8.4)	**8.3** (6.6-10.3)	**9.1** (7.2-11.5)
Vanguard CR	1,158	28	67	**1.5** (0.9-2.4)	**4.2** (3.2-5.6)	**5.4** (4.1-7.0)	**6.6** (5.1-8.5)	**7.1** (5.5-9.2)
Vanguard PS	1,078	57	68	**1.9** (1.2-2.9)	**4.9** (3.8-6.4)	**6.9** (5.5-8.7)	**7.8** (6.2-9.8)	**8.4** (6.6-10.5)
Other systems	7,744		70	**2.0** (1.7-2.4)	**5.1** (4.6-5.7)	**6.7** (6.0-7.4)	**7.8** (7.1-8.6)	**9.9** (8.8-11.2)
CH average for group				**1.6** (1.5-1.7)	**4.3** (4.2-4.5)	**5.5** (5.4-5.7)	**6.5** (6.3-6.7)	**7.6** (7.4-7.8)

Figure 4.6a

Implant combinations with elevated long-term revision rates (all TKA)

An elevated revision rate was defined as a deviation of at least 50% above the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

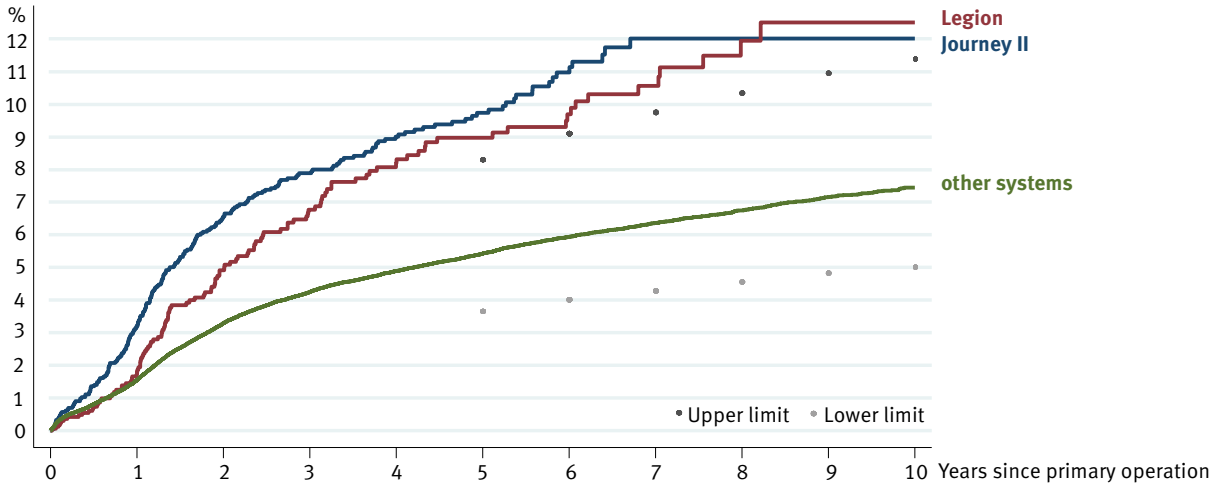
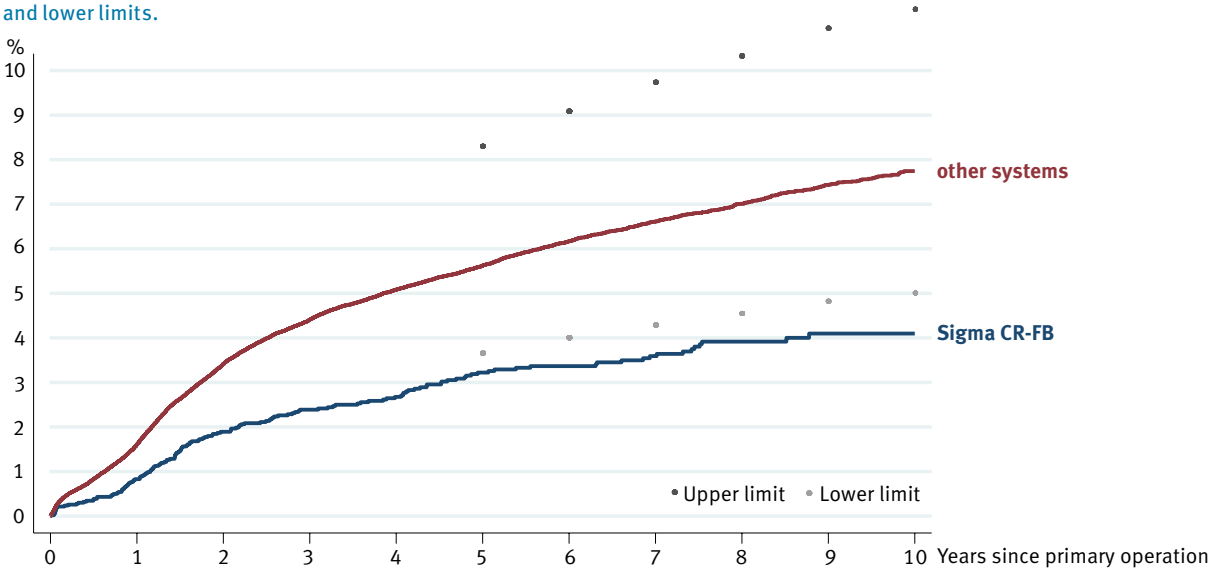


Figure 4.6b

Implant combinations with below-average long-term revision rates (all TKA)

Below-average was defined as an 9-year/10-year revision rate of up to 66% of the group average (and upper bounds of the 95% confidence interval staying below the lower bound of the group average; and at least 25 cases at risk at 9 years/10-years). The dots indicate upper and lower limits.



Knee systems and brands

Interesting is the fact that rotating platforms did perform worse in all knee systems, compared to other types of TKA with the same brand, except for the Medacta knee which performed best in long-term when compared to other Medacta knee systems. The revision rate after 10 years varied from 4.1% for the best to 9.7% for the worst system. Other systems, accounting for 25% of the TKA, grouped together because of small numbers, had an average revision rate at 10 years of 9.9% (8.8–11.2%). This means that none of the less commonly used systems would reach a place in the midfield ten years after primary TKA. Some problematic brands lack of ten years results. They had an acceptable revision rate at one year, but then significantly elevated revision rates up to seven years **(Table 4.6b and Figure 4.6a).** Both problematic systems were identified as potential outliers. None of the knee system used in Switzerland was classified as definitive outlier anymore.

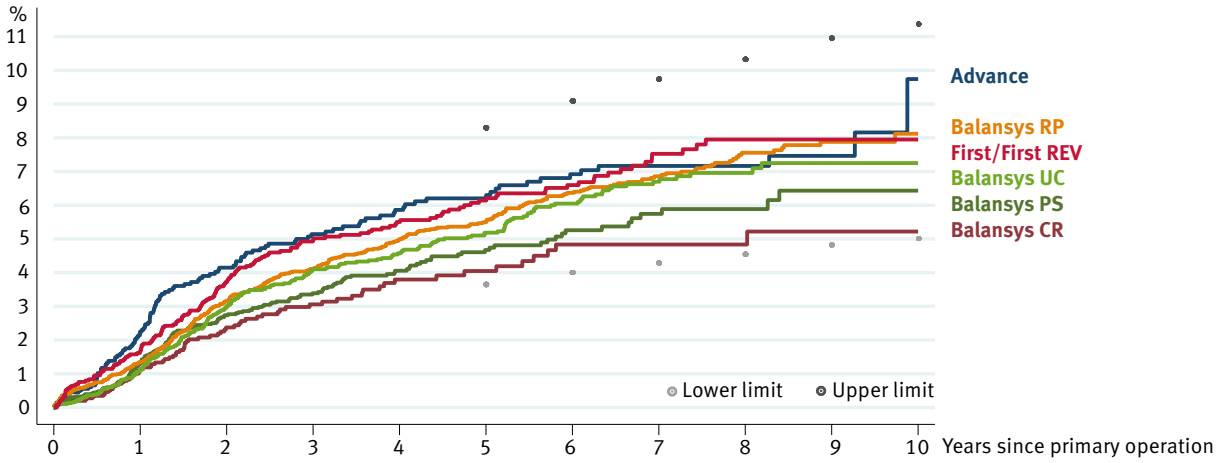
In contrast, one older TKA system performed significantly better than the Swiss average **(Figure 4.6c).** This does not speak automatically for a better performance as older systems were often used in older patients, inherently more reluctant to revision than younger and more active patients. The second-best implant regarding long-term revision rates was also an old brand. With one exception the newer systems did not lead to improved revision rates at mid and long-term. The remaining brands of TKA had revision risks in the margins of the lower and upper limits at 66% and 150% of the group average respectively **(Figures 4.6c).**

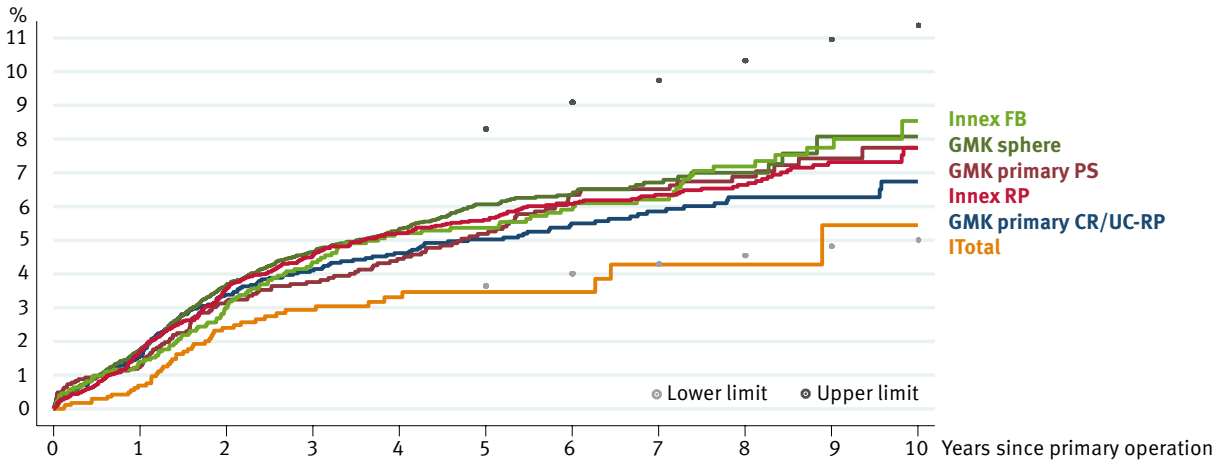
The two-year revision rate of the implants is shown in **Figure 4.6d,** reflecting the implants performed between 01.01.2017 and 31.12.2020, with a completed two-year follow-up by 31.12.2022. Of the 55 implant combinations used (the rest are summarised under "other systems"), one system must be considered as a potential outlier as the revision rate reached twice the average of all implants, but the lower confidence interval still overlapped. As usual, the potential outlier systems will result in an outlier report investigating the reasons for the observed deviations from the national average. One must note that the 2 systems mentioned being potential outlier systems in long term had elevated revision rates within the boundaries after 2 years. It seems that the surgeons and hospitals involved did change their way to resurface the patella as this was the main cause of the elevated revision rates in the past **(Figure 4.6d).** "Other systems", summarising TKA with smaller numbers, also had a significantly better 2-year revision rate, the mean lying below the average of all systems used in Switzerland.

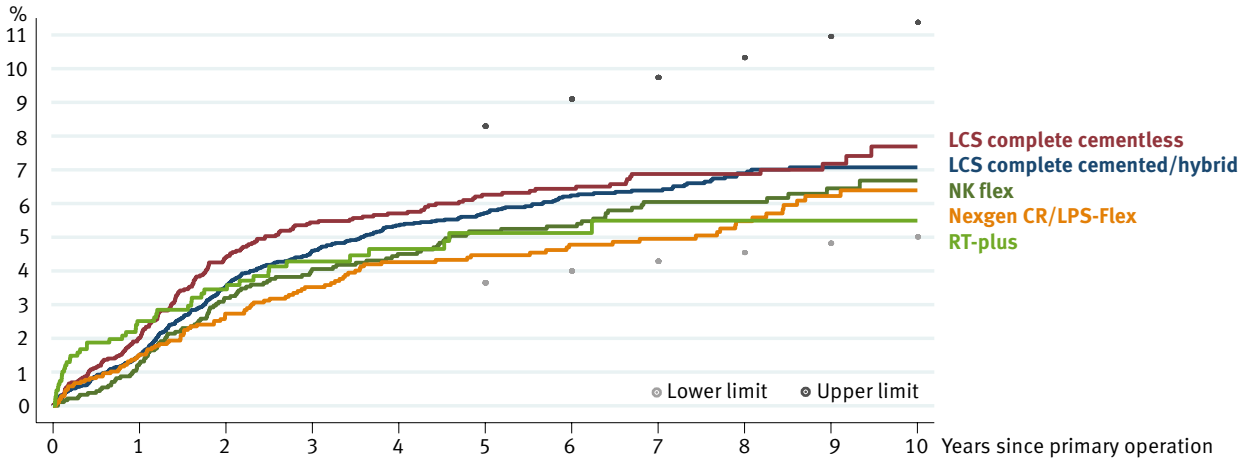
Figures 4.6c (Part 1)

All remaining implant combinations with average revision risks (all TKA)

Also showing upper and lower limits (corresponding to elevated and below-average version risk at 150% and 66% of the group average respectively).



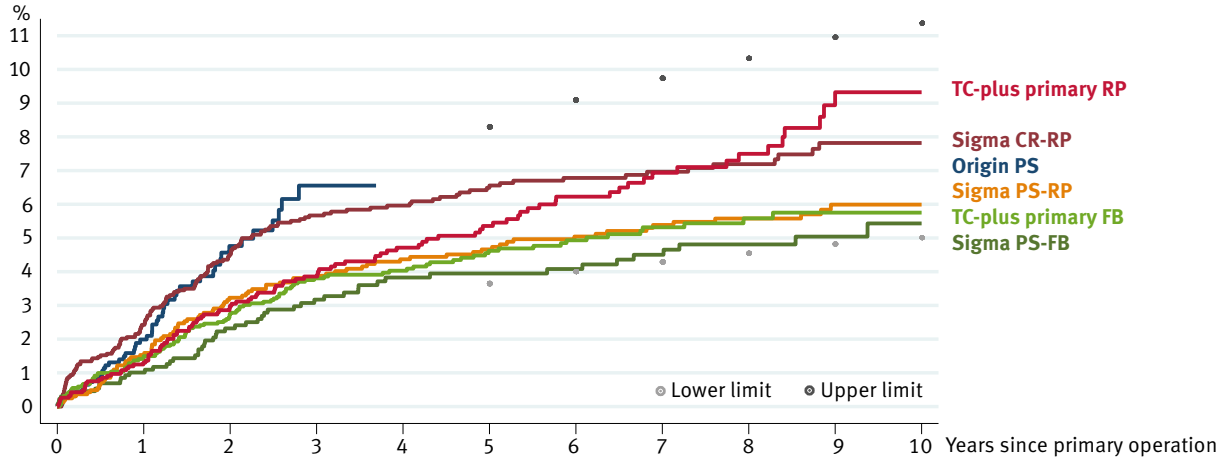


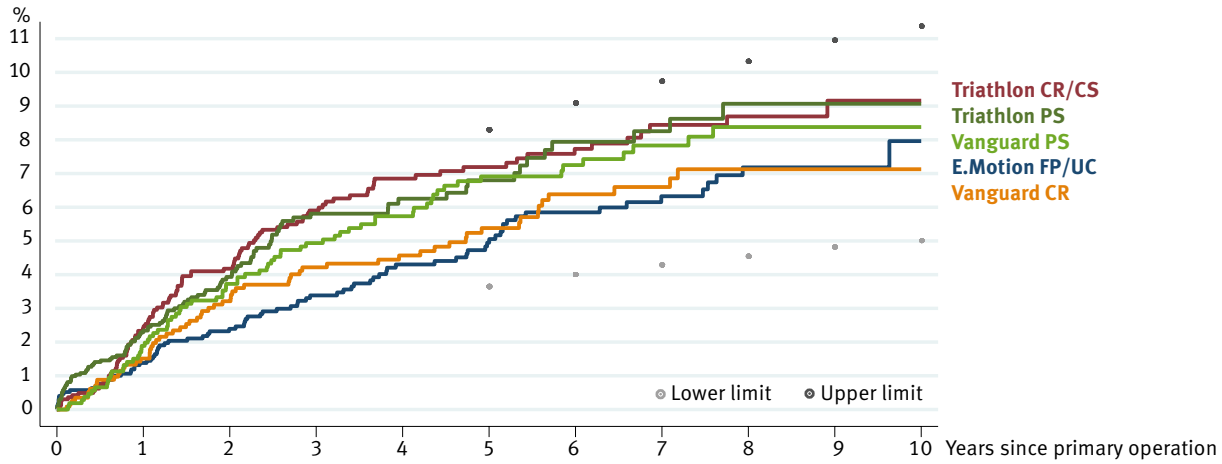


Figures 4.6c (Part 2)

All remaining implant combinations with average revision risks (all TKA)

Also showing upper and lower limits (corresponding to elevated and below-average version risk at 150% and 66% of the group average respectively).





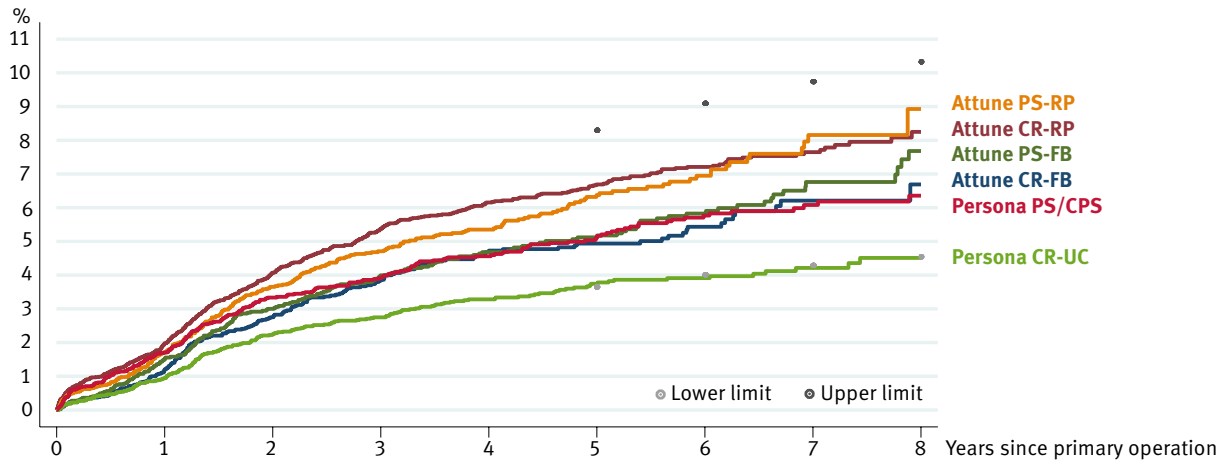


Figure 4.6d (Part 1)

Two-year evaluation: Revision rates of primary total knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Knee system	CCS*	Mean age	at risk N**	Revised N	Revised % *** (95% CI)
3D	56	68	113	3	2.7 (0.9-8.2)
Advance	47	68	666	37	5.7 (4.1-7.7)
Anatomic	53	69	217	3	1.4 (0.5-4.3)
Attune CR-FB	22	70	2,925	83	2.9 (2.3-3.6)
Attune CR-RP	9	69	4,786	217	4.7 (4.1-5.3)
Attune PS-FB	19	70	2,096	53	2.6 (2.0-3.4)
Attune PS-RP	16	70	3,339	125	3.8 (3.2-4.5)
Balansys CR	25	70	1,056	23	2.2 (1.5-3.3)
Balansys PS	45	70	2,263	65	2.9 (2.3-3.7)
Balansys RP	16	70	2,266	84	3.8 (3.1-4.6)
Balansys UC	28	70	1,626	51	3.2 (2.4-4.2)
E.Motion FP/UC	98	69	558	11	2.0 (1.1-3.6)
E.Motion PS	98	71	217	9	4.3 (2.2-8.0)
Endo-Modell SL	19	78	100	2	2.1 (0.5-8.1)
First/First REV	36	71	1,070	53	5.1 (3.9-6.6)
GKS prime flex	41	70	86	6	7.0 (3.2-14.9)
GMK hinge	19	75	156	4	2.6 (1.0-6.9)
GMK prim. CR/UC-FB	57	71	67	3	4.5 (1.5-13.4)
GMK prim. CR/UC-RP	28	69	642	22	3.5 (2.3-5.2)
GMK primary PS	22	71	428	11	2.6 (1.5-4.7)
GMK sphere	14	69	7,178	264	3.8 (3.3-4.2)
Gemini SL	80	68	128	1	0.8 (0.1-5.5)
Genus	100	73	62	5	8.1 (3.5-18.4)
HLS kneetec	76	69	111	3	2.8 (0.9-8.3)
ITotal	26	68	930	23	2.5 (1.7-3.8)
Innex FB	80	72	410	16	4.0 (2.5-6.4)
Innex RP	33	70	1,177	39	3.4 (2.5-4.6)
Journey II	22	68	1,510	95	6.4 (5.3-7.8)
LCS compl. cem./hybr.	33	70	2,503	88	3.6 (2.9-4.4)
LCS compl. uncem.	32	68	953	47	5.0 (3.8-6.6)
Legion	30	67	643	38	6.0 (4.4-8.2)
NK flex	45	70	309	13	4.3 (2.5-7.2)
Nexgen CR/LPS-Flex	23	68	471	15	3.2 (2.0-5.3)
Nexgen LCCK	17	71	180	5	2.9 (1.2-6.8)
Nexgen RHK	22	77	130	2	1.5 (0.4-6.0)

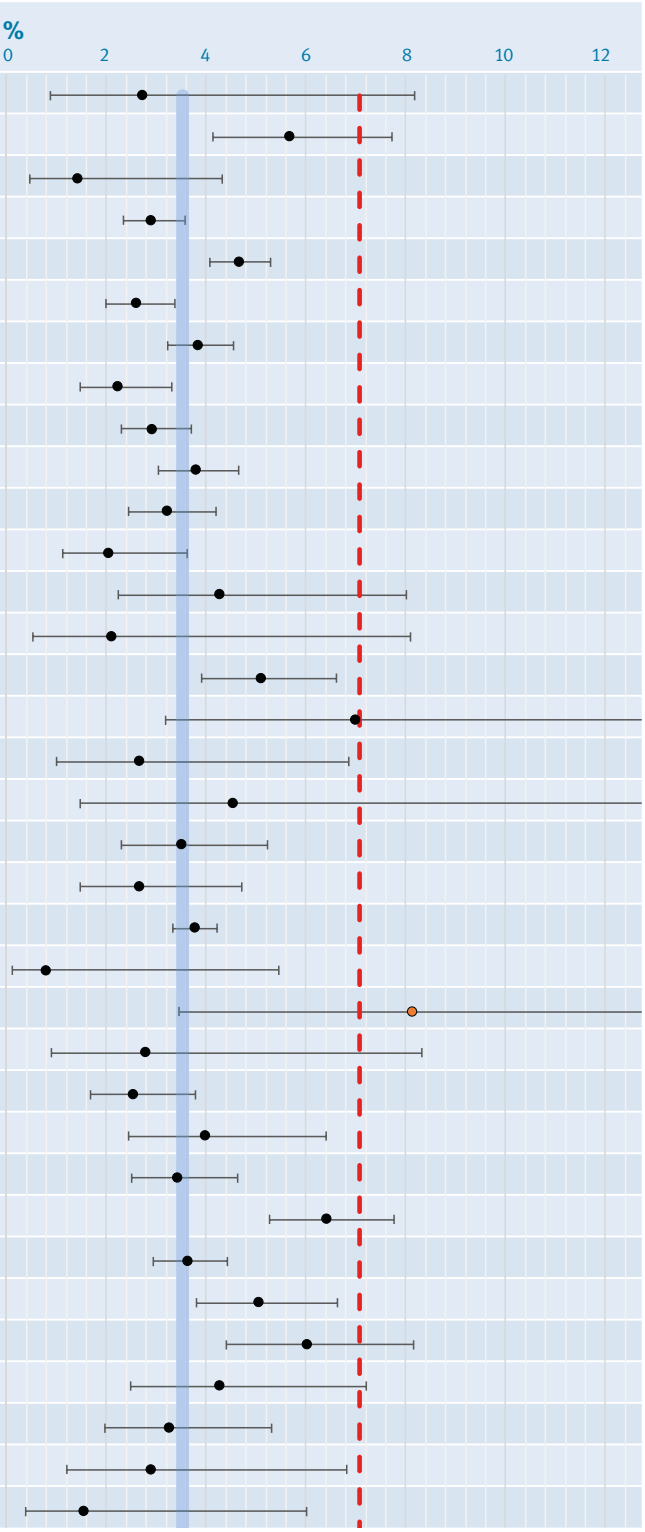
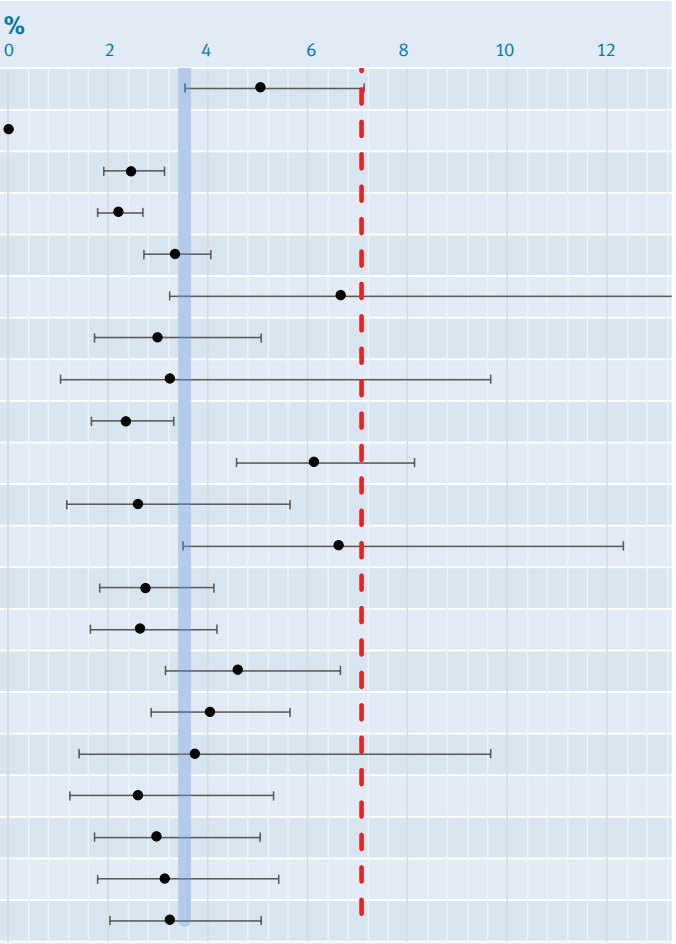


Figure 4.6d (Part 2)

Two-year evaluation: Revision rates of primary total knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Knee system	CCS*	Mean age	at risk N**	Revised N	Revised % ***(95% CI)
Origin PS	15	69	601	30	5.0 (3.5-7.1)
Persona CR	12	70	50	0	0.0 (.-.)
Persona CR-MC	12	69	2,577	62	2.5 (1.9-3.1)
Persona CR-UC	41	69	4,221	91	2.2 (1.8-2.7)
Persona PS/CPS	12	70	2,840	92	3.3 (2.7-4.1)
Physica KR/PS	50	69	107	7	6.6 (3.2-13.4)
RT-plus	15	77	450	13	3.0 (1.7-5.1)
Score	72	68	98	3	3.2 (1.0-9.7)
Sigma CR-FB	33	71	1,382	32	2.4 (1.7-3.3)
Sigma CR-RP	60	68	713	43	6.1 (4.6-8.1)
Sigma PS-FB	71	72	242	6	2.6 (1.2-5.7)
Sigma PS-RP	45	71	138	9	6.6 (3.5-12.3)
TC-plus primary FB	40	70	848	23	2.8 (1.8-4.1)
TC-plus primary RP	29	71	657	17	2.6 (1.6-4.2)
Triathlon CR/CS	56	68	583	26	4.6 (3.1-6.6)
Triathlon PS	25	69	808	32	4.0 (2.9-5.6)
U2	89	70	113	4	3.7 (1.4-9.7)
Unity	28	68	278	7	2.6 (1.2-5.3)
Vanguard CR	44	67	447	13	3.0 (1.7-5.0)
Vanguard PS	64	69	397	12	3.1 (1.8-5.4)
Other systems		72	573	18	3.2 (2.0-5.1)
CH average for group					3.5 (3.4-3.7)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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.

Group average

2-year revisionrate and 95% CI

Outlier alert boundary

Important information on the use of the implant performance tables below

- Estimated revision rate exceeds the alert boundary, but we do not identify this implant combination as an outlier because the 95% confidence interval overlaps the confidence zone of the reference group.
- 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.

Partial knee arthroplasty

4.7 Primary partial knee arthroplasty

Demography

Since 2012, a total of 28,678 primary PKA were registered **(Table 4.1a).** Between 2017 and 2022, a total of 18,143 PKA were performed, accounting for 15.8% of all knee arthroplasties in this period **(Table 4.1a and 4.7a).** This proportion remained constant over the past five years and is among the highest in the western world, although clearly less than in Denmark, where the proportion was 26.0% in 2021. The mean age at surgery was 64.7 years **(Table 4.7a)** from 2017 to 2022; 47.7% of patients were women. Only 9.9% of the osteoarthritis cases were classified as secondary, with osteonecrosis at 5.1%, followed by ligament lesions with 2.0% as the predominant underlying causes. 2.0% of partial knee replacements were performed on patients younger than 45 and 14.4% on patients 45–54 years old. 16.0% of PKA were performed on elderly patients aged of 75-84 years old. 2.2% of the patients were older than 85 years. Older patients are of special interest as surgical risks can be reduced remarkably by PKA compared to TKA. Overall, partial knee replacements were more frequently implanted in younger patients (peak in the age group 55–64 years), whereas the peak for TKA was in the age group of 65–74 years **(Table and Figure 4.1a).** The mean BMI was 28.4 kg/m² in the PKA group. BMI was not recorded in 13% of the cases. The ASA classification for the vast majority (81.8%) of patients was 1 or 2. The morbidity state was not recorded in 5% of cases **(Table 4.7a).**

Hospitals with more than 100 interventions per year performed 85.5% of the partial knee replacements between 2017 and 2022 **(Table 4.7b).** A total of 63.1% of the patients had not had any form of previous surgery, 20.7% had previously undergone arthroscopy of the knee, 23.6% had had a meniscectomy, 1.9% had had previous ACL reconstruction and 1.3% had undergone an osteotomy close to the knee, either at the tibia or at the femur **(Table 4.7c).** The rate of arthroscopy prior to PKA continuously decreased over the past 10 years, corresponding to the general decline of arthroscopy in knees with degenerative disease **(Figure 4.7a).**

Medial uni-compartmental replacement was performed in 83.3% of cases, lateral in 6.1% and patellofemoral replacement in 6.6% **(Table 4.7c).** In 1.0%, "other" was selected, meaning mainly combinations of PKA. In 3.1%, the type was incorrectly classified as a TKA (mentioned as "other, type unknown"), but the implant data identified them as PKA **(Table 4.7c).**

Surgical technique

Under surgical technique, "conventional" was selected in 75.1% of cases. Minimally invasive was selected in 14.6% of the instances, but the latter is now seen as a form of conventional technique and is no longer featured on the 2021 version of the CRF. It must be stated that any PKA is less invasive compared to TKA. Patient-specific instrumentation (PSI) was used in 6.2% and computer navigation in 2.0%. 323 PKA (1.8%) were assisted by robots, 2.4% were classified as other, with most of those cases being assisted by robots before introduction of this specification on the version 2021 of the CRF **(Table 4.7c).** In summary, technical support in PKA was still rare in Switzerland and was used only in 10% of all PKA between 2017 and 2022 **(Table 4.7c and Figure 4.8.c).** In 2022, the share reached 14.7% (Figure 4.7_J), far less than in TKA (see Chapter 4.2). This is hard to understand as the small surfaces of PKA components (mainly tibial component) are less forgiving for malalignement than larger implants, such as TKA, potentially causing more failures and revisions **(Table and Figure 4.1i).**

Table 4.7a

Primary partial knee arthroplasty: Baseline patient characteristics by year

		2017	2018	2019	2020	2021	2022	2017–2022
N		**2,620**	**2,723**	**3,054**	**3,146**	**3,189**	**3,411**	**18,143**
Diagnosis [%]	Primary OA*	90.7	91.1	90.5	91.1	88.8	88.7	90.1
	Secondary OA	9.3	8.9	9.5	8.9	11.2	11.3	9.9
	Inflammatory origin	0.2	0.1	0.1	0.2	0.3	0.3	0.2
	Fracture	1.0	1.0	0.6	0.8	0.8	0.9	0.8
	Lesion of ligament	1.8	1.6	2.1	2.1	2.4	2.1	2.0
	Infection	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	Osteonecrosis	4.6	5.0	5.5	4.5	5.6	5.2	5.1
	Other**	1.9	1.5	1.6	1.5	2.2	2.7	1.9
Women [%]		50.6	47.9	48.8	47.8	46.8	45.0	47.7
Mean age (SD)	All	64.2 (10.1)	64.8 (10.3)	64.7 (10.3)	64.6 (10.2)	64.5 (10.0)	65.1 (10.0)	64.7 (10.2)
	Women	63.9 (10.5)	64.8 (10.8)	64.6 (10.8)	64.3 (11.0)	64.3 (10.1)	64.7 (10.4)	64.4 (10.6)
	Men	64.5 (9.7)	64.8 (9.9)	64.8 (9.8)	64.9 (9.5)	64.7 (10.0)	65.3 (9.6)	64.9 (9.7)
Age group [%]	‹45	2.3	2.2	2.1	2.2	1.9	1.5	2.0
	45–54	15.9	14.1	14.5	14.2	14.5	13.3	14.4
	55–64	34.4	32.6	34.1	34.1	34.6	35.2	34.2
	65–74	30.6	32.2	30.6	31.2	31.8	31.0	31.2
	75–84	15.0	16.4	16.3	16.1	15.2	16.9	16.0
	85+	1.8	2.5	2.4	2.2	2.0	2.2	2.2
N unknown BMI (%)		476 (18)	450 (17)	441 (14)	347 (11)	297 (9)	258 (8)	2,269 (13)
N known BMI		2,144	2,273	2,613	2,799	2,892	3,153	15,874
Mean BMI (SD)		28.4 (4.7)	28.3 (4.6)	28.4 (5.0)	28.5 (4.9)	28.4 (5.0)	28.2 (4.7)	28.4 (4.8)
BMI [%]	‹18.5	0.4	0.5	0.5	0.5	0.3	0.2	0.4
	18.5–24.9	23.5	24.2	25.0	24.7	25.7	26.0	24.9
	25–29.9	42.9	43.7	41.7	40.9	40.0	42.5	41.9
	30–34.9	25.1	24.4	23.0	24.8	24.0	23.2	24.0
	35–39.9	6.1	5.6	8.1	7.4	8.0	6.6	7.0
	40+	2.1	1.6	1.8	1.8	1.9	1.5	1.8
N unknown ASA (%)		201 (8)	176 (6)	165 (5)	151 (5)	58 (2)	81 (2)	832 (5)
N known ASA		2,419	2,547	2,889	2,995	3,131	3,330	17,311
Morbidity	ASA 1	17.8	17.1	16.9	14.5	14.8	12.3	15.4
state [%]	ASA 2	65.9	66.1	65.1	68.5	65.9	66.6	66.4
	ASA 3	16.0	16.7	17.8	16.7	19.0	20.8	18.0
	ASA 4/5	0.3	0.2	0.2	0.2	0.3	0.3	0.2

* As of SIRIS version 2021, and pending further review, this category includes the newly introduced category „secondary arthritis after meniscus surgery“. This category accounts for more than 6% of current entries, but shows large variability between hospitals.

** A small number of newly added cases with „secondary OA caused by patellar instability“ were added to this category.

Fixation

Over the past six years, the use of cementless devices was at 13.5%, but this rate has seen some variation over time. More recently, a slight decline could be observed, from a previous peak in 2017 and 2018. The share of cementless implants was 12.8% in 2022. Hybrid fixation was used only in 1.6%, and reverse hybrid in 0.4% of the cases. The vast majority (84.4%) of PKA performed between 2017 and 2022 were fully cemented **(Figure 4.7b).**

Table 4.7b

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

Calculations of hospital service volume based on primary knee surgeries in each included year (2017–2022).

Hospital service volume*		<100	100–199	200–299	300+
N (2017–2022)		**2,631**	**4,494**	**4,080**	**6,938**
Women [%]		48.7	46.0	47.4	48.5
Mean age (SD)	All	64.4 (10.3)	64.3 (10.1)	64.8 (10.1)	64.9 (10.2)
	Women	64.2 (11.0)	64.0 (10.5)	64.3 (10.3)	64.8 (10.6)
	Men	64.6 (9.5)	64.5 (9.7)	65.3 (9.9)	65.0 (9.7)
Age group [%]	<45	2.0	2.0	2.2	1.9
	45–54	15.6	14.9	13.4	14.1
	55–64	34.1	35.8	33.6	33.6
	65–74	30.6	29.8	32.8	31.4
	75–84	15.0	15.6	15.7	16.9
	85+	2.6	1.9	2.3	2.1
Diagnosis [%]	Primary OA	92.1	90.6	89.2	89.5
	Secondary OA	7.9	9.4	10.8	10.5
N unknown BMI (%)		483 (18)	626 (14)	280 (7)	880 (13)
N known BMI		2,148	3,868	3,800	6,058
Mean BMI (SD)		28.6 (4.8)	28.8 (5.0)	28.3 (4.9)	28.1 (4.7)
BMI [%]	<18.5	0.4	0.4	0.3	0.5
	18.5–24.9	22.7	23.0	25.1	26.9
	25–29.9	43.1	40.4	42.4	42.0
	30–34.9	24.3	25.9	23.6	22.9
	35–39.9	7.6	8.1	7.0	6.2
	40+	1.9	2.2	1.6	1.5
N unknown ASA (%)		145 (6)	208 (5)	299 (7)	180 (3)
N known ASA		2,486	4,286	3,781	6,758
ASA state [%]	ASA 1	16.0	17.0	13.6	15.0
	ASA 2	68.0	65.8	66.8	65.9
	ASA 3	15.6	17.0	19.2	18.9
	ASA 4/5	0.4	0.2	0.4	0.2

* Note that hospital service volume is defined as the sum of primary procedures per year

Table 4.7c

Primary partial knee arthroplasty: Surgery characteristics All diagnoses, all component fixations, 2017–2022.

Previous surgery	N	%	Intervention	N	%
None	11,448	63.1	Unicompartment medial	15,111	83.3
Knee arthroscopy	3,752	20.7	Unicompartment lateral	1,103	6.1
Meniscectomy	4,277	23.6	Femoropatellar	1,193	6.6
ACL reconstruction	344	1.9	Other (including combinations)	180	1.0
Osteotomy tibia close to knee	234	1.3	Other* (type unknown)	556	3.1
Osteosynthesis tibia close to knee	92	0.5			
Surgery for patella stabilization	193	1.1	**Technology**	**N**	**%**
Synovectomy	106	0.6	Conventional	13,630	75.1
Osteotomy femur close to knee	24	0.1	Computer assisted/navig.	374	2.0
Osteosynthesis femur close to knee	32	0.2	PSI**	1,119	6.2
Surgery for treating infection	7	0.0	Minimally invasive (up to 2020)	2,651	14.6
Surgery for tumor	7	0.0	Robotic-assisted (from 2021)	323	1.8
Other	383	2.1	Other	434	2.4

* 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.
** PSI= Patient Specific Instrumentation

Figure 4.7a

Share of partial knee patients who had knee arthroscopy prior to arthroplasty (%)

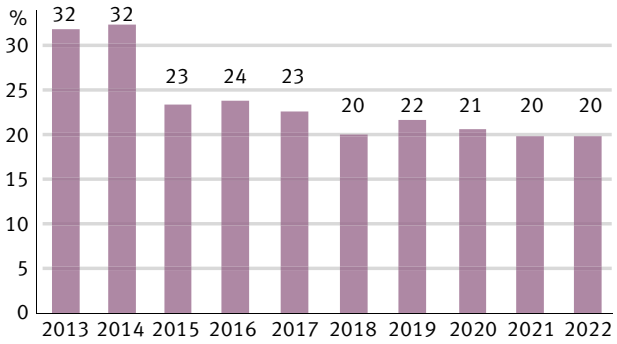
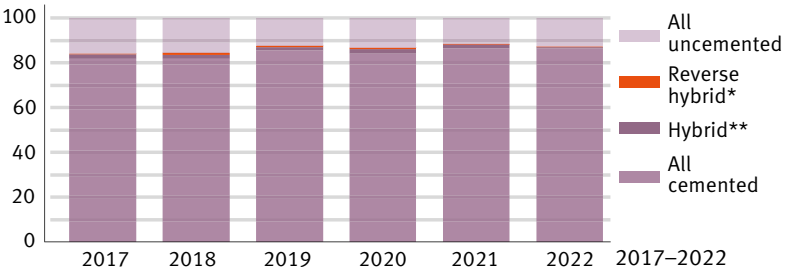


Figure 4.7b

Primary partial knee arthroplasty: Component fixation all diagnoses, in percent



2,447	2,546	2,891	2,920	2,981	3,165	16,950	N
15.9	15.8	12.4	13.4	11.7	12.8	13.5	All uncemented
0.3	0.7	0.6	0.4	0.2	0.2	0.4	Reverse hybrid*
1.9	1.8	1.6	1.9	1.8	0.8	1.6	Hybrid**
81.8	81.7	85.4	84.2	86.3	86.3	84.4	All cemented

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

4.8 First revision of primary partial knee arthroplasty

The first revisions of PKA or TKA cover all revisions linked to primary implantations registered in SIRIS occuring for the first time. Re-revisions were therefore not included here but are integrated into Chapters 4.3 and 4.5. Overall, the share of linked revisions was 51.1%, steadily increasing with time and reaching 67.4% in 2022, taking into account linked revisions of total and partial knee arthroplasties **(Figure 4.1a).**

Demography

Of the 28,678 documented PKA implanted since 2012, 11,543 were at risk for revision during the most recent four-year moving time window used for short-term outcomes. Of the implants at risk, 581 knees were revised, accounting for a two-year revision rate of 5.1% (4.7–5.5%). Younger patients were much more at risk (e.g., 6.8% in the age group under 55 years) than older patients (e.g., 2.9% in the age group 75–84 years) **(Table 4.8a).** Compared to the 2021 report, the revision rate of PKA has increased, as it did for TKA. The reason for this is likely the improved linkage rate, leading to the detection of formerly unrecognized revisions. Cumulative revision risks of the different systems are depicted in a Kaplan-Meier (KM) estimation in **Figures 4.8a, 4.8b, and 4.8c.**

Table 4.8a

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022). All diagnoses, all component fixations.

			Revised		95% CI	
		N at risk[1]	N	%[2]	lower	upper
Overall		11,543	581	5.1	4.7	5.5
Gender	Women	5,016	262	5.3	4.7	5.9
	Men	5,366	246	4.7	4.1	5.3
Age group	<55	1,623	108	6.8	5.6	8.1
	55–64	3,539	206	5.9	5.2	6.8
	65–74	3,289	135	4.2	3.5	4.9
	75–84	1,699	49	2.9	2.2	3.8
	85+	231	10	4.4	2.4	8.0

[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.

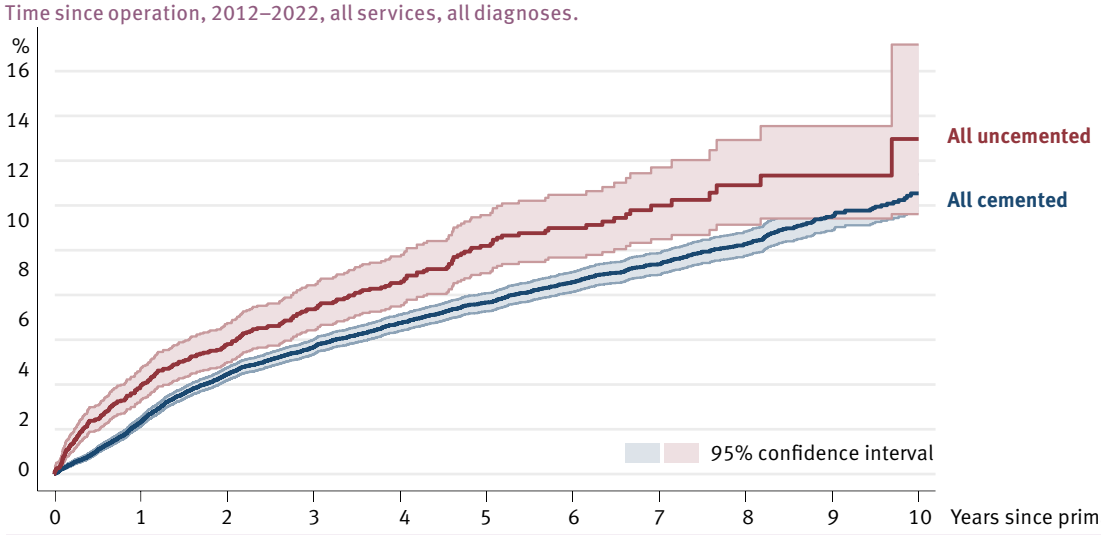
Fixation

Comparable to TKA, the revision rate in PKA also was higher for uncemented implants than in case of cemented fixation **(Figure 4.8a).** This effect can be expected as uncemented implants must osteointegrate, a critical issue in some cases, particularly regarding the tibial component. After the initial failures had been manifested, the failure curve of the uncemented implants remained largely parallel to that of the cemented implants **(Figure 4.8a).** The difference is significant from the early beginning, although the confidence intervals are larger

Figure 4.8a

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

Time since operation, 2012–2022, all services, all diagnoses.

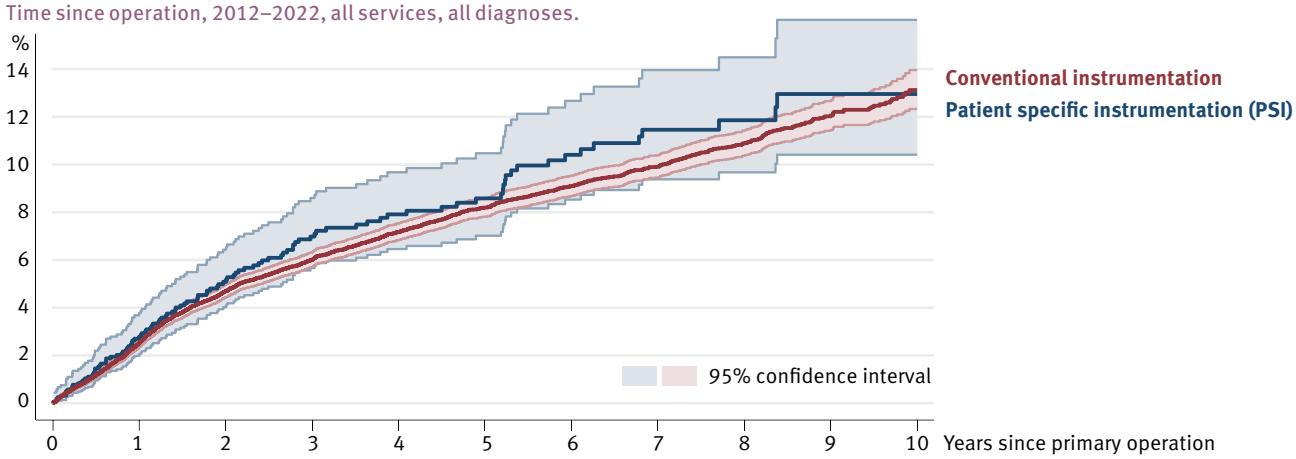


	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
All uncemented	**3.9** (3.3-4.7)	**5.8** (5.0-6.7)	**7.4** (6.4-8.4)	**8.5** (7.5-9.7)	**10.2** (9.0-11.6)	**11.0** (9.7-12.5)	**12.9** (11.1-14.9)	**15.0** (11.6-19.2)
All cemented	**2.3** (2.1-2.5)	**4.5** (4.2-4.8)	**5.7** (5.4-6.0)	**6.7** (6.4-7.1)	**7.7** (7.3-8.1)	**8.6** (8.1-9.0)	**10.3** (9.7-10.8)	**12.5** (11.7-13.4)

Figure 4.8b

Estimated failure rates of primary partial knee arthroplasty: conventional vs. patient specific instrumentation (PSI)

Time since operation, 2012–2022, all services, all diagnoses.



	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
Conventional	**2.5** (2.3-2.7)	**4.7** (4.4-5.0)	**6.0** (5.7-6.3)	**7.2** (6.8-7.5)	**8.2** (7.8-8.6)	**9.1** (8.7-9.5)	**10.9** (10.4-11.4)	**13.1** (12.3-14.0)
PSI	**2.8** (2.0-3.8)	**5.1** (4.0-6.4)	**7.0** (5.7-8.6)	**7.9** (6.5-9.7)	**8.6** (7.0-10.5)	**10.4** (8.5-12.7)	**11.9** (9.7-14.5)	**13.0** (10.4-16.1)

for uncemented PKA due to smaller numbers. The gap closed from the seventh year after surgery; the difference was no longer significant from eight years after index surgery onwards. Of note, patients with uncemented PKA were younger than those with cemented implants. This selection bias also influences the revision rate.

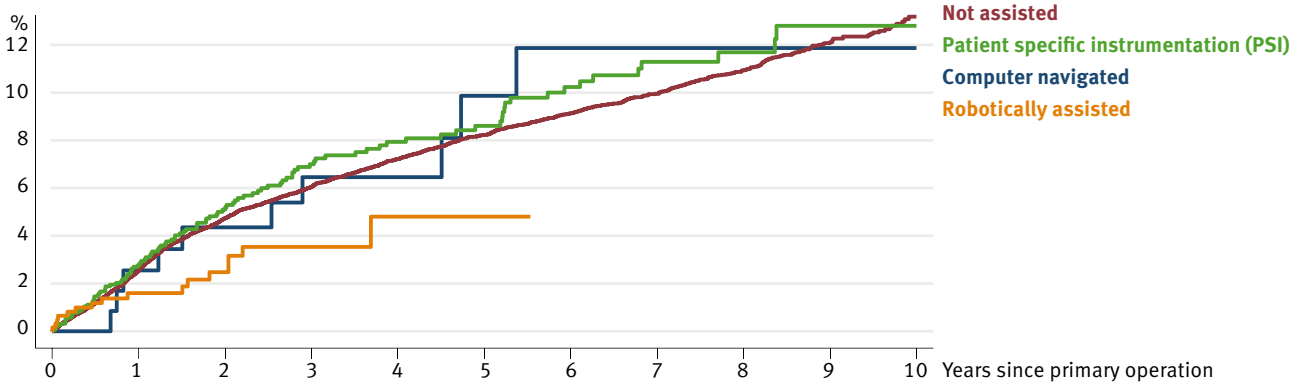
Surgical technique

There seemed to be no difference for PSI PKA compared to conventional technique. The small numbers for PSI led to large and overlapping confidence intervals (**Figure 4.8b). Figure 4.8c** confirms that conventional PKA had not different revision rates compared to PSI technologies nor conventional computer navigation. Only robotic assistance was associated with reduced revision rates up to 5 years follow-up.

Figure 4.8c

Estimated failure rates of primary partial knee arthroplasty: Technology assistance

Time since operation, 2012–2022, all services, all diagnoses.



	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
Not assisted	**2.5** (2.4-2.7)	**4.7** (4.5-5.0)	**6.0** (5.7-6.4)	**7.2** (6.9-7.6)	**8.2** (7.8-8.6)	**9.1** (8.7-9.6)	**10.9** (10.4-11.5)	**13.2** (12.4-14.0)
PSI	**2.8** (2.0-3.8)	**5.1** (4.0-6.4)	**7.0** (5.7-8.6)	**7.9** (6.5-9.7)	**8.6** (7.0-10.5)	**10.2** (8.4-12.5)	**11.7** (9.5-14.3)	**12.8** (10.3-15.9)
Computer navigated	**2.5** (0.8-7.7)	**4.4** (1.8-10.2)	**6.5** (3.1-13.1)	**6.5** (3.1-13.1)	**9.9** (5.1-18.7)	**11.9** (6.3-21.8)	**11.9** (6.3-21.8)	
Robotically assisted	**1.6** (0.8-3.1)	**2.5** (1.4-4.4)	**3.5** (2.1-5.9)	**4.8** (2.5-9.0)				

Demography of early revision after partial knee arthroplasty

The most frequent reason for early revision was loosening of the tibial component (29.8%, n = 173), followed by progression of osteoarthritis in 15.1%, pain of unclear origin in 11.5%, loosening of the femoral component in 11.0%, femorotibial instability in 9.8% as well as infection in 7.6% **(Table 4.8b).** Comparable to TKA, surgical technical problems such as instability, malpositioning, and sizing were responsible for most early revisions in partial knee arthroplasty. 12.7% of the revision reasons were classified as "other". Pain was often named in combination with other reasons (11.5%), whereas this diagnosis should be used only in case of pain of unknown origin. In only 7.0% of cases, pain was the single reason for revision, which still was higher than in TKA (approx. 5.0%).

Table 4.8b

Reason for early first revision of primary partial knee arthroplasty

all diagnoses, all component fixations. 4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

	N	%
Loosening tibia	173	29.8
Progression of unicomp. OA	88	15.1
Pain (of unclear origin)*	67	11.5
Loosening femur	64	11.0
Femorotibial instability	57	9.8
Infection	44	7.6
Patella problems	39	6.7
Periprosthetic fracture tibia	36	6.2
Component malposition tibia	29	5.0
Component malposition femur	21	3.6
Wear of inlay	15	2.6
Joint stiffness/arthrofibrosis	11	1.9
Patellar instability	5	0.9
Loosening patella	4	0.7
Periprosthetic fracture femur	4	0.7
Sizing femoral component	4	0.7
Sizing tibial component	3	0.5
Periprosthetic fracture patella	2	0.3
Other	74	12.7
Total	**685**	

* Pain was frequently reported alongside other reasons. The proportion of „isolated pain" was 7%.
Early first revisions are those occurring within 2 years of the primary arthroplasty. Multiple responses possible (percentages do not sum to 100)

Figure 4.8d

Cumulative incidence rates for different revision diagnosis of partial knee arthroplasty

Time since operation, 2015–2022, all services, % of implants revised. Detailed reasons for revisions available since 2015.

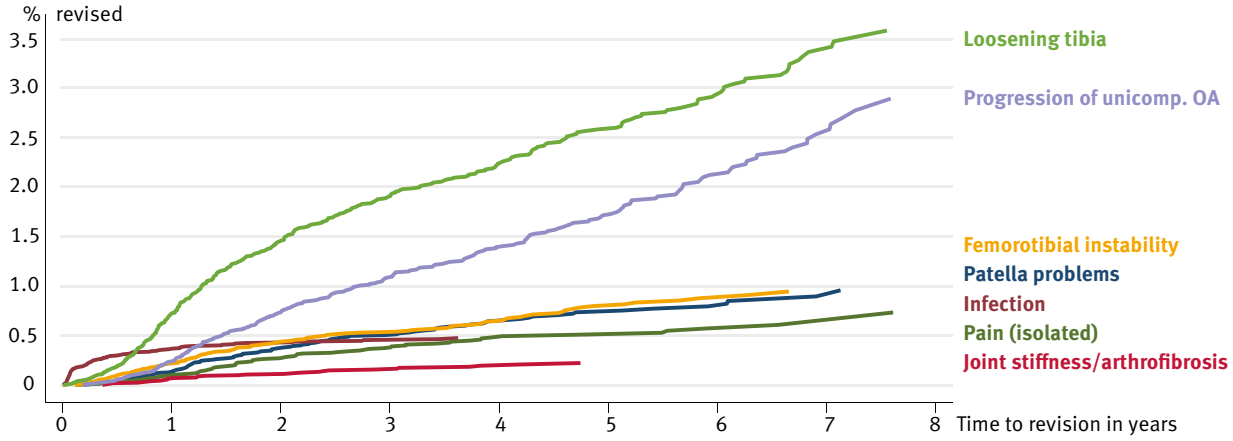


Figure 4.8e

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

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).
Early first revisions are those occurring within 2 years of the primary arthroplasty.

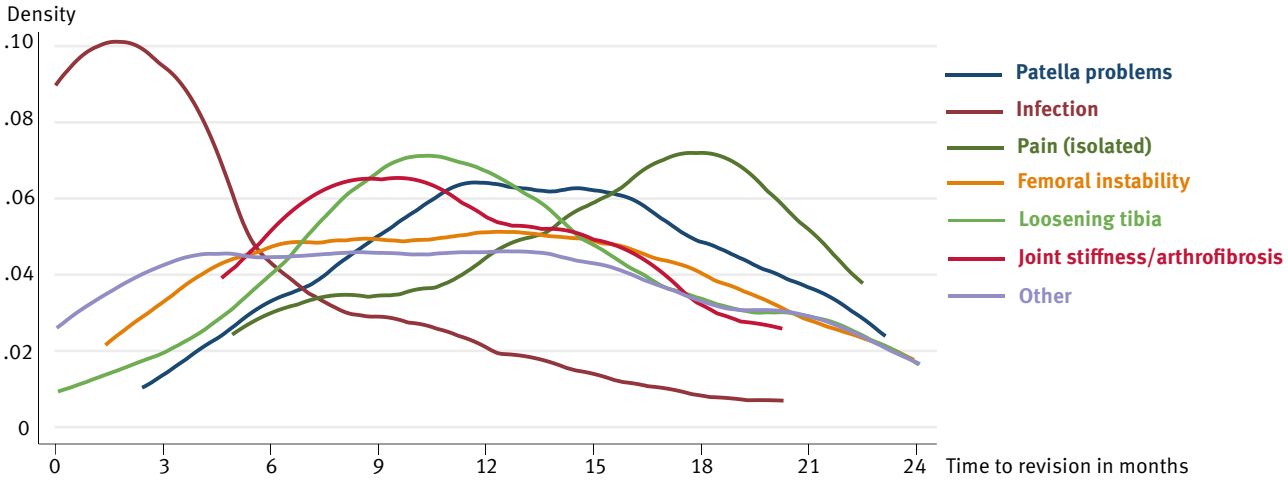


Table 4.8c

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

all diagnoses

	N	Median	IQR 25%	IQR 75%
Patella problems	39	13.7	9.7	18.5
Infection	44	2.3	0.8	7.5
Pain (isolated)	28	15.7	10.2	19.2
Femoral instability	57	12.8	6.6	16.0
Loosening tibia	173	11.6	8.3	16.0
Joint stiffness/arthrofibrosis	11	11.2	5.6	15.8
Other	290	10.7	5.6	16.2

Cumulative incidence for PKA revision shows what proportion of implants was subjected to at least one revision for a particular underlying cause (e.g., revision due to loosening of a component) **(Figure 4.8e).** Like in TKA, only infections were revised early after index surgery, on avergae after 2.3 months **(Figure 4.8e).** Afterwards, the predominant reason was loosening of the tibial component. Progression of the osteoarthritis increased 18 months after index surgery and got the second most reason for revision after PKA **(Figure 4.8d).** In consequence, tibial loosening and progression of OA drove up revisions from the first year after surgery up to the latest follow-up available. Isolated pain was the cause which provoked the latest response towards revision, in mean 15.7 months after PKA **(Figure 4.8e).**

Figure 4.8f

Cumulative incidence rates for different types of revisions of partial knee arthroplasty

Time since operation, 2012–2022, all services, % of implants revised.

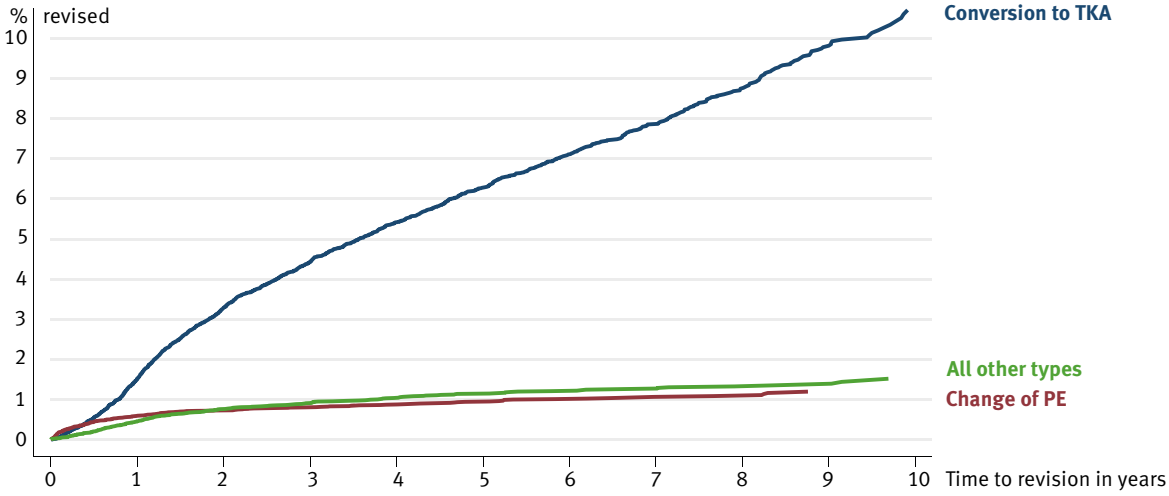
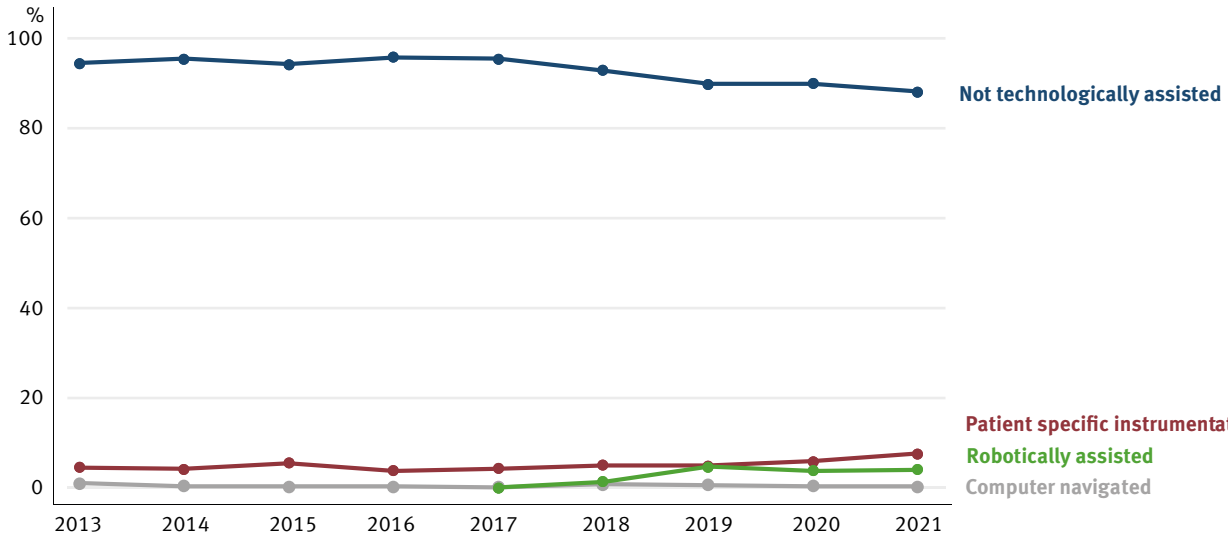


Figure 4.8g

Partial knee arthroplasty: Technology assistance over time (%)

Time since operation, 2012–2022, all services, % of implants revised.



NB: robotically assisted cases before v2021 were derived from free text entries. „Other“ responses were coded as „Not tech. assisted“ unless they specifically mentioned robotic, PSI oder navigation“.
There was a recognisable overlap of computer navigated and other responses, indicating that those cases were actually robotic-assisted

Type of early revision

Almost 70% (69.7%) of the revised PKA were converted to TKA **(Table 4.8d).** This share is far more than the reported 40.8% published in the 2021 SIRIS report. The reason is that many revisions locally registered as "complete TKA revisions" could be re-coded as conversion from PKA to TKA. The polyethylene liner was exchanged in 17.4% of PKA revisions, followed by isolated tibial revision in 4.0%. All the other revision types were rare; only 1.0% were named "other" **(Table 4.8d).** Conversions dominated the types of revisions by a clear margin **(Figure 4.8f),** except for the first six months after primary operations affecting nearly 2% of all primary partial knees. PE liner replacements and all other revisions did account for a similar share of revisions up to 10 years after PKA.

Table 4.8d

Type of early first revision of primary partial knee arthroplasty

all diagnoses, all component fixations. 4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022). Early first revisions are those occurring within two years of the primary arthroplasty.

	N	%
Conversion from unicomp. to total prosthesis*	404	69.7
Exchange of PE	101	17.4
Tibial revision	23	4.0
Subsequent patella prosthesis	6	1.0
Complete revision*	16	2.8
Femoral revision	10	1.7
Patella revision	2	0.3
Component removal with spacer implantation	4	0.7
Reimplantation of prosthesis	2	0.3
Subsequent partial prosthesis, second compartment	5	0.9
Subsequent patella prosthesis with exchange of PE	1	0.2
Other	6	1.0
Total	**580**	

* A large share of conversions is entered locally as „complete revisions". Such responses have been recoded as conversions if TKA components were registered or if a TKA was indicated on the revision proforma.

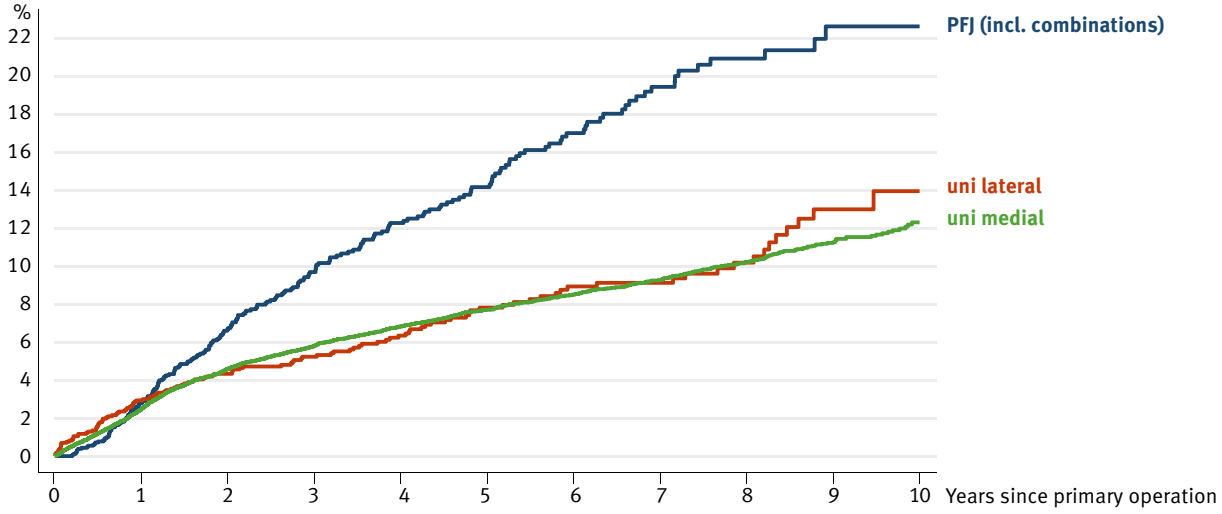
Patello-femoral partial arthroplasties

Patello-femoral partial arthroplasties (PFJ) had a significantly higher revision risk than either medial or lateral PKA, almost doubling the rate at 10 years **(Figure 4.8h).** The timing of the revisions shared similarities with medial or lateral PKA and TKA revisions.

Figure 4.8h

Estimated failure rates of primary partial knee arthroplasty: Types of arthroplasties

Time since operation, 2012–2022, all services, % of implants revised.

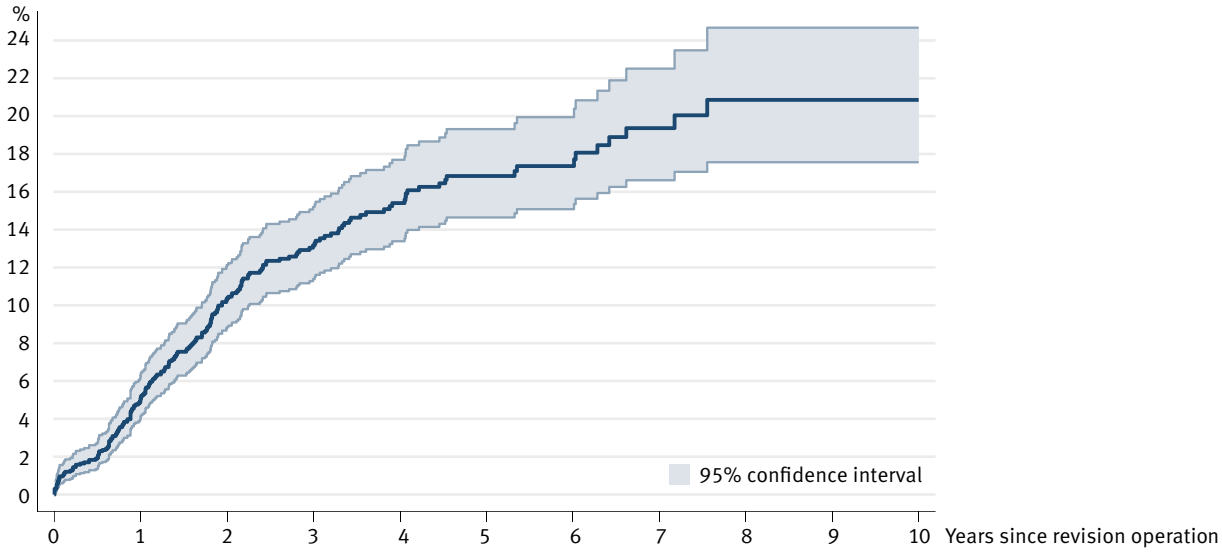


	1 year	2 years	3 years	4 years	5 years	6 years	8 years	10 years
PFJ (incl. combinations)	**2.8** (2.1-3.7)	**6.7** (5.5-8.0)	**9.7** (8.3-11.3)	**12.3** (10.6-14.2)	**14.2** (12.3-16.3)	**17.0** (14.8-19.5)	**20.9** (18.2-24.0)	**22.6** (19.4-26.3)
uni lateral	**2.9** (2.2-3.9)	**4.3** (3.4-5.5)	**5.2** (4.2-6.5)	**6.3** (5.2-7.8)	**7.8** (6.4-9.5)	**8.9** (7.4-10.8)	**10.2** (8.3-12.4)	**13.9** (10.9-17.7)
uni medial	**2.5** (2.3-2.7)	**4.6** (4.3-4.9)	**5.8** (5.5-6.1)	**6.8** (6.5-7.2)	**7.7** (7.3-8.1)	**8.5** (8.1-8.9)	**10.2** (9.7-10.8)	**12.3** (11.5-13.2)

Figure 4.8i

Estimated failure rates after conversion from partial knee to total knee arthroplasty

Time since revision, 2012–2022. Start point of analysis: first registered component revision in SIRIS that meets the inclusion criteria.End point of analysis: next registered component revision.

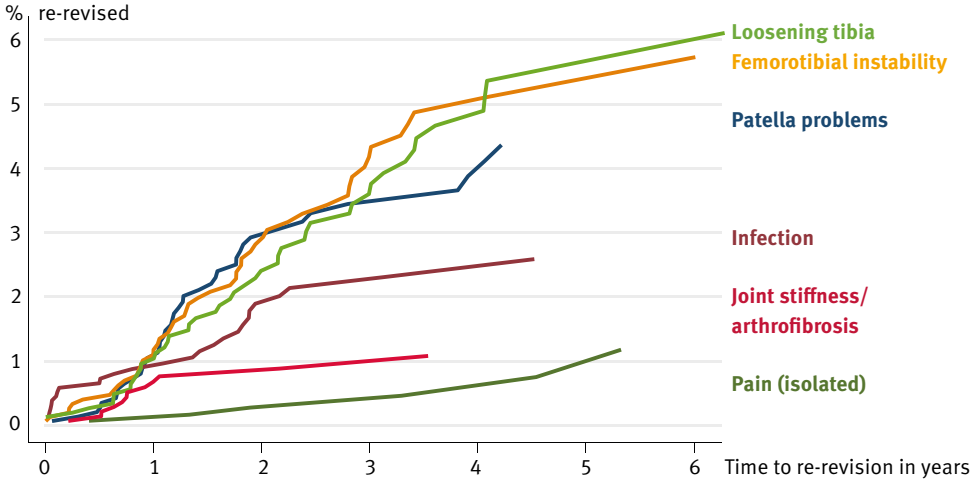


	1 year	2 years	3 years	4 years	5 years	6 years	7 years	9 years
Conversion to TKA	**5.1** (4.1-6.4)	**10.4** (8.8-12.1)	**13.2** (11.4-15.2)	**15.4** (13.4-17.7)	**16.8** (14.6-19.3)	**17.4** (15.1-19.9)	**19.4** (16.6-22.5)	**20.9** (17.6-24.7)

Figure 4.8j

Cumulative incidence rates for different re-revision diagnosis of conversions to primary total knee arthroplasty

Time since revision, 2012–2022, all services, % of implants re-revised. Detailed reasons for revisions available since 2015.



4.9 Results of implants in partial knee arthroplasty

Knee systems and brands

Table 4.9a shows the top 10 PKA systems used in Switzerland, accounting for 93% of all PKA, or 15,680 cases since 2017. Other systems were only used in 1,166 cases between 2017 and 2022; 84 implants (0.5%) could not be classified, 20% less than in the last annual report. The long-term revision rates are found in **Table 4.9b,** again with the share of implants for hospital services (case concentration score CCS) in the third column. For instance, Allegretto has been performed in only one hospital service since 2012. **Figure 4.9a** demonstrates a PKA system with an elevated revision rate starting

Table 4.9a

Top 10 (93%) of primary partial knee arthroplasty systems (all diagnoses, all component fixations) 2017–2022

Knee system	2017	2018	2019	2020	2021	2022	2017–2022
Allegretto	93	89	102	68	88	69	509
Balansys uni	308	280	354	298	350	418	2,008
GMK uni	184	196	223	205	157	153	1,118
Journey uni	127	92	89	88	75	47	518
Oxford cemented/hybrid	476	353	312	270	253	210	1,874
Oxford cementless	353	362	317	354	318	358	2,062
Persona partial knee	90	355	423	409	442	511	2,230
Physica ZUK	219	200	251	330	333	401	1,734
Restoris MCK	0	35	128	110	112	178	563
Sigma partial knee	424	422	497	601	616	504	3,064
Other systems	158	141	168	173	228	298	1,166
Total	**2,432**	**2,525**	**2,864**	**2,906**	**2,972**	**3,147**	**16,846**

Table 4.9b

Long term evaluation: Failure rates of primary partial knee arthroplasty systems

Time since operation, 2012–2022. All diagnoses, all component fixations. Please note that if reported system involves multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

Knee system	Total number	CCS*	Mean age**	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Allegretto	1,060	100	70	**0.4** (0.1-1.1)	**1.3** (0.7-2.2)	**3.0** (2.0-4.5)	**4.5** (3.2-6.5)	**5.1** (3.6-7.3)
Balansys UNI	3,389	49	65	**2.2** (1.7-2.7)	**5.2** (4.4-6.1)	**6.5** (5.6-7.6)	**7.5** (6.5-8.7)	**11.2** (9.3-13.5)
GMK uni	1,637	19	66	**3.3** (2.5-4.3)	**7.6** (6.4-9.2)	**9.6** (8.1-11.5)	**11.3** (9.5-13.5)	**13.3** (10.9-16.3)
Journey uni	1,025	12	64	**3.5** (2.5-4.9)	**9.4** (7.6-11.4)	**16.8** (14.3-19.6)	**19.5** (16.8-22.7)	**25.5** (21.1-30.5)
Oxford cemented/hybrid	4,120	21	65	**2.6** (2.2-3.2)	**5.6** (4.9-6.4)	**7.4** (6.6-8.4)	**9.3** (8.3-10.4)	**13.3** (11.5-15.2)
Oxford cementless	2,720	11	64	**4.0** (3.3-4.8)	**6.8** (5.9-8.0)	**9.2** (8.0-10.7)	**10.7** (9.1-12.4)	**14.3** (9.6-21.1)
Persona partial knee	2,230	15	65	**2.0** (1.5-2.8)	**5.2** (4.1-6.4)	**6.6** (5.2-8.4)		
Physica ZUK	3,547	19	65	**1.9** (1.5-2.4)	**5.5** (4.7-6.3)	**7.0** (6.1-8.1)	**8.9** (7.8-10.1)	**11.5** (9.8-13.4)
Restoris MCK	563	54	66	**1.3** (0.6-2.8)	**3.1** (1.7-5.6)			
Sigma partial knee	4,754	16	65	**2.4** (2.0-2.9)	**5.7** (5.0-**6.5**)	**7.2** (6.4-8.1)	**7.9** (7.0-8.9)	**9.9** (8.5-11.6)
Other systems	1,612		64	**3.3** (2.5-4.3)	**7.7** (6.3-**9.4**)	**10.5** (8.7-12.6)	**14.0** (11.7-16.8)	**21.9** (13.4-34.6)
CH average for group				**2.5** (2.3-2.7)	**5.8** (5.5-6.1)	**7.9** (7.5-8.3)	**9.4** (9.0-9.9)	**12.6** (11.8-13.4)

* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.
** Younger mean age signifies that the case mix is less "usual" and potentially biased towards higher revision risk.

right after surgery and staying above the average until 10 years follow-up. On the other hand, the Allegretto performed significantly better than the PKA average between 2012 and 2022 **(Figure 4.9b)** and demonstrates that an experienced surgeon can achieve excellent results even with an older implant design. All remaining systems for which the long-term evaluation was performed are shown in **Figures 4.9c.** Please note that this Kaplan-Meier (KM) graph also shows the relevant boundaries for elevated or better-than-average performance corresponding to elevated and below-average revision risk at 150% and 66% of the group average respectively.

Figure 4.9a

Implant combinations with long-term evaluation outlier status (all PK)

Outlier status was defined as a revision rate of twice the group average at any time between year 5 and year 10 (and lower bounds of the 95% confidence interval exceeding the upper bound of the group average; and at least 50 cases at risk at 5 years). The dots indicate upper and lower limits.

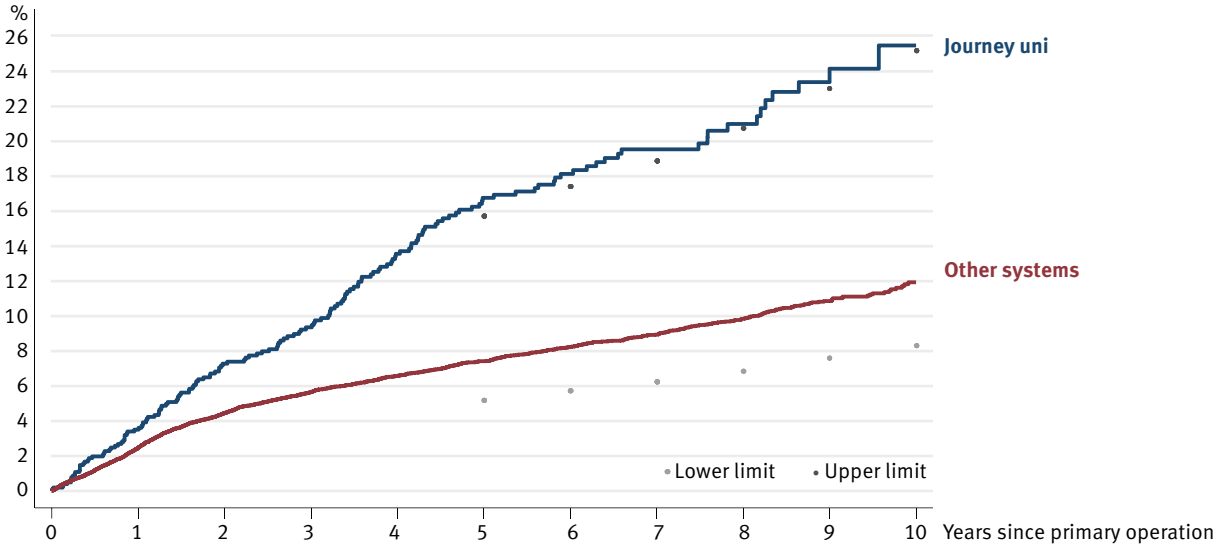
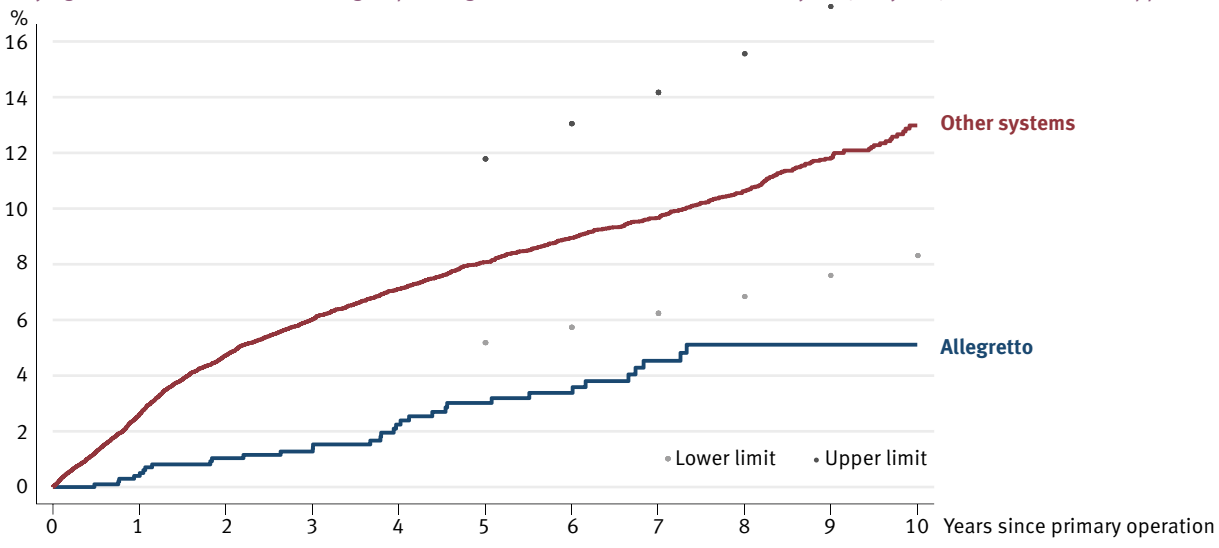


Figure 4.9b

Implant combinations with below-average long-term revision rates (PK)

Below-average was defined as an 9-year/10-year revision rate of up to 66% of the group average (and upper bounds of the 95% confidence interval staying below the lower bound of the group average; and at least 25 cases at risk at 9 years/10-years). The dots indicate upper and lower limits.



Early revision rate

Figure 4.9d shows the two-year revision rate of PKA in the moving four-year window from 01.01.2017 and 31.12.2020 with a completed two-year follow-up before 31.12.2022. All the top 10 PKA systems used performed within the borders, not exceeding twice the average revision rate. None had to be classified as potential or definitive outlier two years after PKA. The differences between the systems used were, however, considerable. Interestingly, "other systems", summarising different brands with smaller numbers, reached the classification definitive outlier (confidence interval outside the borders). One year ago, the group was identified as potential outlier which means that the results did worsen in the meantime. Based on these results, the rarely used systems are difficult to recommend.

Figures 4.9c

All remaining implant combinations with average revision risks (all PK)

Also showing upper and lower limits (corresponding to elevated and below-average version risk at 150% and 66% of the group average. respectively).

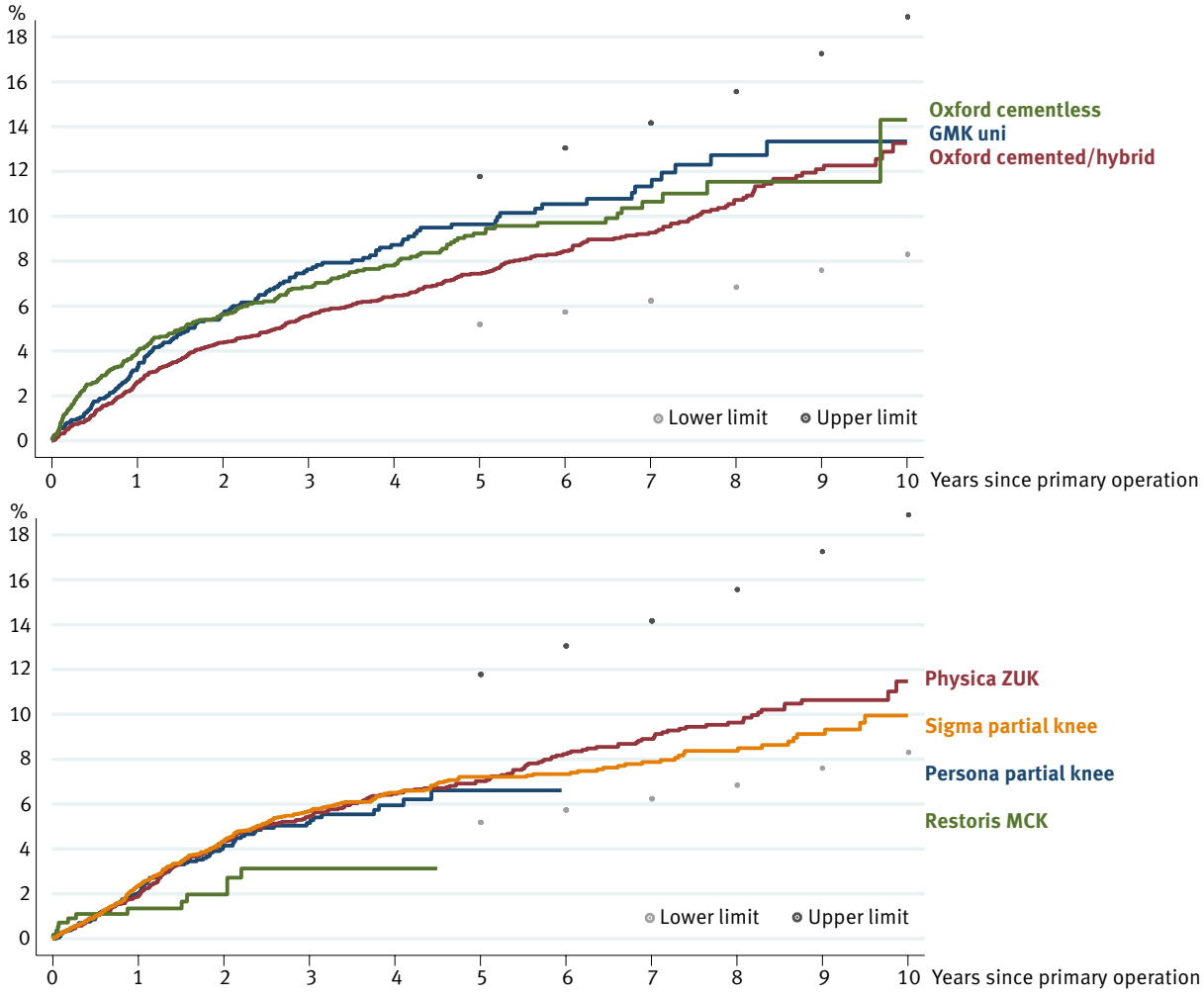
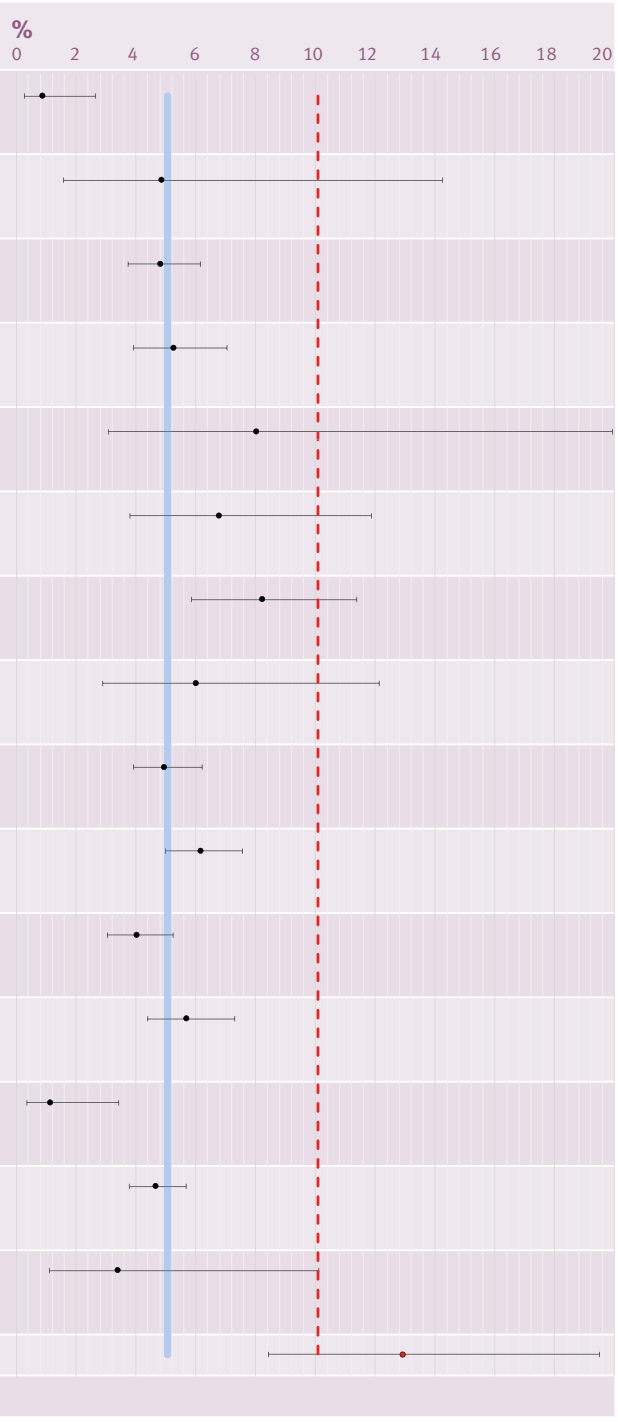


Figure 4.9d

Two-year evaluation: Revision rates of primary partial knee arthroplasty systems within 24 months

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Knee system	CCS*	Mean age	at risk N**	Revised N	Revised % ***(95% CI)
Allegretto	100	71	352	3	0.9 (0.3-2.6)
Alpina	69	66	62	3	4.8 (1.6-14.3)
Balansys UNI	49	66	1240	59	4.8 (3.7-6.2)
GMK uni	18	66	808	42	5.3 (3.9-7.1)
IBalance uni	36	60	53	4	8.0 (3.1-19.9)
IUni	21	62	165	11	6.8 (3.8-11.9)
Journey uni	12	63	396	32	8.2 (5.9-11.4)
Moto	57	69	118	7	6.0 (2.9-12.1)
Oxford cemented/hybrid	22	65	1411	69	4.9 (3.9-6.2)
Oxford cementless	11	64	1386	84	6.1 (5.0-7.5)
Persona partial knee	17	65	1277	50	4.0 (3.0-5.2)
Physica ZUK	27	65	1000	56	5.7 (4.4-7.3)
Restoris MCK	53	65	273	3	1.1 (0.4-3.4)
Sigma partial knee	17	65	1944	88	4.6 (3.8-5.7)
Triathlon PKR	42	62	92	3	3.4 (1.1-10.1)
Other systems		62	150	19	12.9 (8.4-19.5)
CH average for group					5.0 (4.6-5.5)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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.

Patella-femoral partial knee arthroplasty

For the second time, patella-femoral partial knee arthroplasties (PFJ) were analysed separately **(Table 4.9c).** Five systems used represented 97% of all PFJ or 1,272 implantations from 2017 to 2022. 42 PFJ were classified as "other", and 59 could not be classified at all (4.3%). **Table 4.9d** compares the most often system used to the others summarized in a second group. Three systems had two-year revision rates in the boundaries of the average of all PFJ used in Switzerland, one was worse, and one was better than the average **(Figure 4.9e).** Interestingly the summarised "other" 42 PFJ performed almost as well as the best one at two years.

Table 4.9c

Top 5 (95%) of primary patellofemoral joint systems

2017–2022, all diagnoses, all component fixations.

Knee system	2017	2018	2019	2020	2021	2022	2017–2022
Gender PFJ	72	103	102	161	109	166	713
Hemicap PF classic/wave (PFJ)	23	26	23	31	40	46	189
IBalance PFJ	37	30	17	24	17	30	155
Journey PFJ	17	20	18	20	18	9	102
Restoris MCK PFJ	0	4	24	25	28	32	113
Other systems	16	2	0	6	13	5	42
Total	**165**	**185**	**184**	**267**	**225**	**288**	**1,314**

Table 4.9d

Long term evaluation: Failure rates of primary patellofemoral joint systems

Time since operation, 2012–2022, all diagnoses, all component fixations. Please note that if reported systems involves multiple sub-variants, it is possible that the long-term performance of these sub-variants may be significantly different from their combined performance.

Knee system	Total number	CCS*	Mean age**	1 year (95% CI)	3 years (95% CI)	5 years (95% CI)	7 years (95% CI)	10 years (95% CI)
Gender PFJ	933	9	59	**2.2** (1.4-3.4)	**7.5** (5.7-9.8)	**11.9** (9.4-15.1)	**16.4** (12.8-20.9)	
Other systems	971		57	**3.3** (2.3-4.7)	**11.5** (9.5-14.0)	**16.1** (13.5-19.2)	**20.6** (17.3-24.4)	**24.1** (20.0-28.9)
CH average for group				**2.8** (2.1-3.6)	**9.6** (8.2-11.3)	**14.2** (12.3-16.3)	**18.7** (16.2-21.5)	**22.3** (19.0-26.0)

* Case concentration score. Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

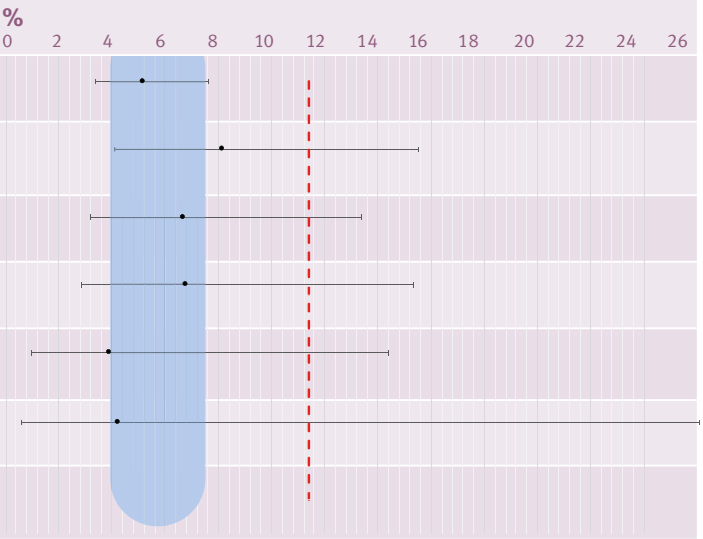
** Younger mean age signifies that the case mix is less "usual" and potentially biased towards higher revision risk

Figure 4.9e

Two-year evaluation: Revision rates of primary patellofemoral joint systems within 24 months

4-year moving average covering implants between 01.01.2017 and 31.12.2020, with two years follow-up (31.12.2022).

Knee system	CCS*	Mean age	at risk N**	Revised N	Revised %***(95% CI)
Gender PFJ	11	59	438	22	**5.1** (3.4-7.6)
Hemicap PF classic/wave (PFJ)	13	54	103	8	**8.1** (4.1-15.5)
IBalance PFJ	16	57	108	7	**6.6** (3.2-13.4)
Journey PFJ	19	55	75	5	**6.7** (2.8-15.4)
Restoris MCK PFJ	51	60	53	2	**3.8** (1.0-14.4)
Other systems		58	24	1	**4.2** (0.6-26.1)
CH average for group					**5.7** (4.3-7.6)



* Share of implants accounted for by main user hospital service. A higher share signifies an increased likelihood of biased figures due to local effects. A share of 50%+ would suggest that reported results are likely determined by one hospital service.

** 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.

Group average

2-year revisionrate and 95% CI

Outlier alert boundary

Important information on the use of the implant performance tables below

- Estimated revision rate exceeds the alert boundary, but we do not identify this implant combination as an outlier because the 95% confidence interval overlaps the confidence zone of the reference group.
- 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.

PROMs in knee arthroplasty

4.10 Patient reported outcome measures (PROMs) in total and partial knee arthroplasty

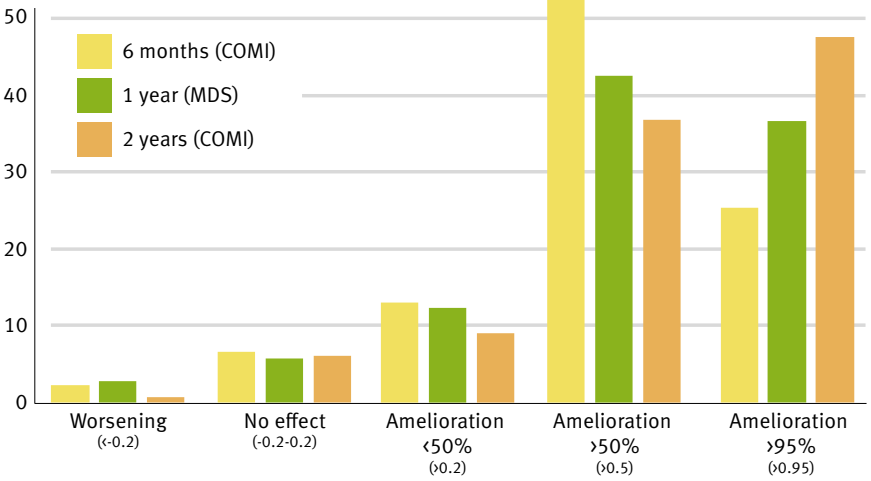
Two local initiatives have provided PROMs data for TKA registered in SIRIS, with one of them also including data on PKA. The COMI study was conducted between 2017 and 2020 in three cantons (follow-up until 2022) and the MDS dataset has been in use in all hospitals of the canton of Zurich, as well as several others, since 2019. The details of these initiatives, as well as the main method chosen for making comparisons, are described in Chapter 2 (Methods), Section 2.6 of this report. Here, it suffices to say that both initiatives captured representative patients from a typical mix of types of hospitals, exactly as would be seen in a national sample of PROMs.

It is noteworthy that both COMI (6 and 24 months after surgery) and MDS (1 year after surgery) can demonstrate how patients evaluate the outcome after knee arthroplasty. The score itself seems less important than the fact that the classical data of a joint registry profits greatly from being supplemented by PROMs, as complications and revisions are only one important endpoint. This is subjectively less important in the daily life of patients than factors such as pain relief, and the ability to function effectively in both everyday and professional activities including heavy labour and sports. Therefore, unsatisfactory results in this context are much more motivating and challenging than decreasing revision rates in a joint registry which has reached maturity.

PROMs after TKA and PKA

Joint-specific pain was measured in both datasets with the same numeric rating scale. In the MDS dataset, the pre-operative mean score was 6.64 (SD 1.97, median 7) for TKA and 6.24 (SD 1.83, median 7) for PKA, while in the COMI dataset, it was 6.75 (SD 2.0, median 7). After the operation, this was reduced to 1.71 (SD 2.07, median 1) after 1 year for TKA and 1.79 (SD 2.19, median 1) for PKA, and 1.41 (SD 1.98, median 1) after 2 years. The analysis included all TKA and PKA with a diagnosis of either primary or secondary OA, regardless of revision status. There was no statistically significant difference between diagnostic groups. Pain improved after TKA in most of the cases, regardless of the instrument used **(Figure 4.10a).** 2.2% of patients reported worsening after six

Figure 4.10a
Treatment effects pain: Total knee arthroplasty
All diagnoses. Share of patients without reported pain (excluded): 0.4% MDS, 0.5% COMI.



	6 months (COMI)	1 year (MDS)	2 years (COMI)
Worsening (‹-0.2)	2.2	2.7	0.6
No effect (-0.2 - 0.2)	6.6	5.7	6.1
Amelioration ‹50% (›0.2)	13.0	12.4	9.0
Amelioration ›50% (›0.5)	52.8	42.6	36.8
Amelioration ›95% (›0.95)	25.4	36.7	47.5
n	**996**	**4,108**	**668**

months, improving to 0.6% after two years. MDS after one year showed a worsening of pain in 2.7%. No effect was measured in 6.6% of cases after six months, 5.7% after one year, and 6.1% after two years. Improvements less than 50% were present in 13.0%, 12.4%, and 9.0% six months, one year and two years after surgery. Pain relief was therefore unsatisfactory in 21.8% (six months) and 20.8% (one year) after TKA and decreased to 15.7% at two years after surgery. The excellent group with pain reduction of more than 95% did significantly improve with time and reached 47.5% at the two-year follow-up **(Figure 4.10a).** Only 0.4% with MDS and 0.5% of COMI patients did not report pain before TKA and were excluded from calculation.

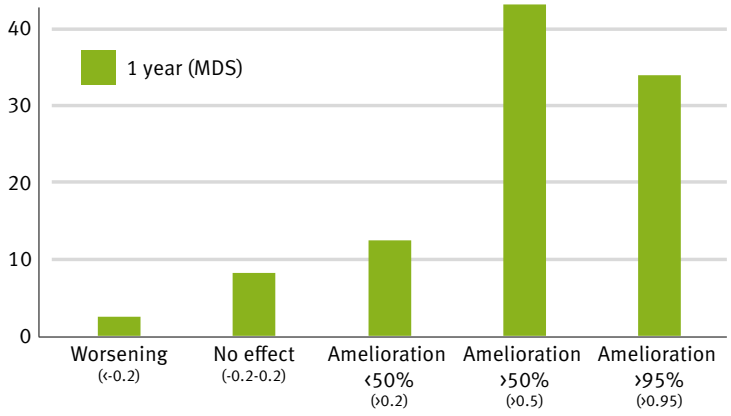
PKA were only evaluated with MDS. 0.2% of the patients did not report pain and were excluded. The share of unsatisfactory pain relief at one year was slightly higher (23.1%) than after TKA (20.8%) (Table and Figure 4.9_B). Pain relief of ›95% was also less common after PKA (33.9%) than after TKA (36.7%) at the one-year follow-up. In summary, good or excellent pain reduction appeared to be achievable in more than three-quarters of knee arthroplasties.

When comparing the summary COMI and EQ-5D scores in the same way as for pain (see chapter 2.6 for methodological details), we see slightly varied distributions, owing to the different underlying constructs used. Here, too, we observed a high preoperative symptomatic burden and selected one component question from each score as an example. In the COMI dataset, 16.8% of respondents stated that they were severely restricted in their daily activities and 49.2% they were considerably restricted. In the MDS dataset, 37.0% were either severely restricted in their mobility or unable to move before TKA, and 29.1% before PKA. As these are non-identical response items with different question wordings, we cannot expect identical distributions, although in both datasets we could observe that these reported symptoms were greatly reduced after the operation. Again, excellent results (amelioration by more than 95%) even improved with time after surgery **(Figure 4.10c).** The share of patients not reporting limitations was again very low. Patients one year after PKA reported a higher EQ-5D QoL (39.8%) than after TKA (37.4%) at one year in case of amelioration ›95%, but again the group with inferior outcomes according to EQ-5D QoL was larger than after TKA **(Figure 4.10d).**

Figure 4.10b

Treatment effect pain: Partial knee arthroplasty

All diagnoses. Share of patients without reported pain (excluded): 0.2% MDS.



	1 year (MDS)
Worsening (‹-0.2)	2.5
No effect (-0.2 - 0.2)	8.2
Amelioration ‹50% (›0.2)	12.4
Amelioration ›50% (›0.5)	43.1
Amelioration ›95% (›0.95)	33.9
n	**729**

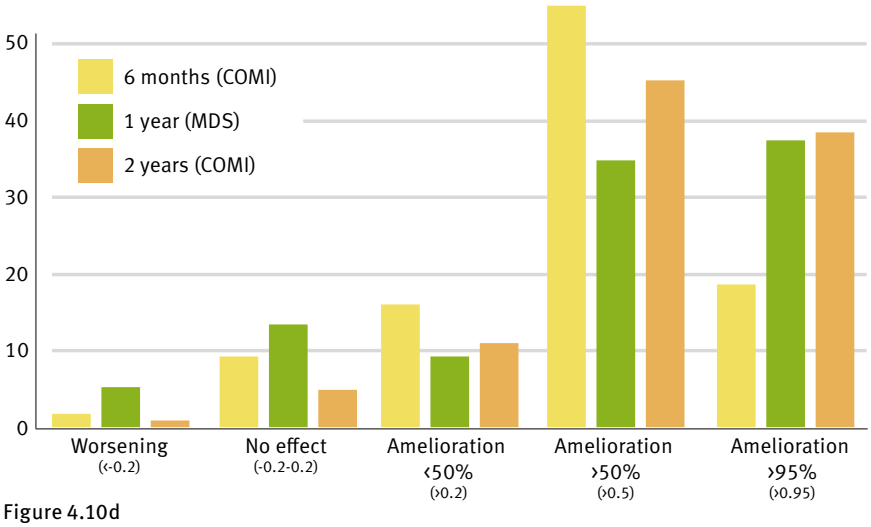
Considering satisfaction with the current situation, preoperatively 77.2% (COMI) and 74.6% (MDS) of the patients were very dissatisfied, respectively 17.3% and 17.5% were somewhat dissatisfied with their situation **(Figure 4.10e).** After six months, 45.9% were very satisfied, increasing to 62.5% after one year, and 65.5% after two years. The share of unsatisfied patients (addition of neither satisfied nor dissatisfied + somewhat dissatisfied + very dissatisfied) after TKA was 32.5% at six months and diminished to 16.2% and 18% at the one- and two-year follow-up. Before PKA, very dissatisfied (MDS 72.6%) and somewhat dissatisfied (MDS 19.5%) patients were comparable to TKA **(Figure 4.10f).** After one year 59.8% were very satisfied and 22.6% were somewhat satisfied. The share of unsatisfied patients at one year was 17.6%, which again is comparable to the TKA patients.

According to the limited PROMs results available, there was no advantage of PKA versus TKA for pain, EQ-5D QoL, or general satisfaction at 6, 12, or 24 months after surgery. The small advantage in improvement of quality of life in the group with an amelioration ›95% is negatively compensated by more pain and inferior results for EQ-5D QoL at

Figure 4.10c

Treatment effect limitations/QOL: Total knee arthroplasty

All diagnoses. Share of patients without reported limitations (excluded): 0.4% MDS, 0.1% COMI.

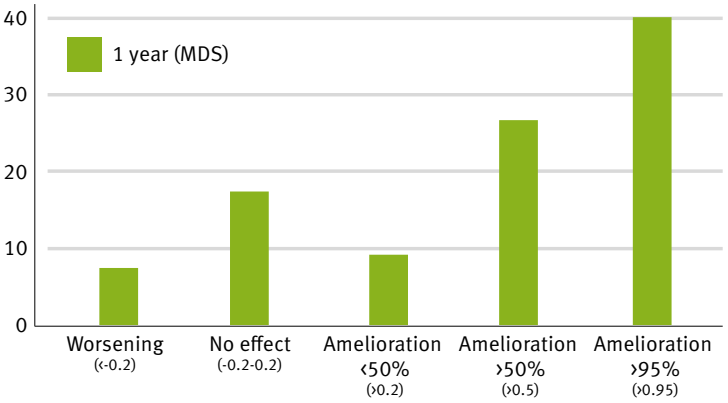


	6 months (COMI)	1 year (MDS)	2 years (COMI)
Worsening (‹-0.2)	1.8	5.2	0.8
No effect (-0.2 0.2)	9.1	13.4	4.9
Amelioration ‹50% (›0.2)	15.9	9.2	10.9
Amelioration ›50% (›0.5)	54.8	34.7	45.1
Amelioration ›95% (›0.95)	18.5	37.4	38.4
n	**1,001**	**4,138**	**670**

Figure 4.10d

Treatment effect limitations/QOL: Partial knee arthroplasty

All diagnoses. Share of patients without reported pain (excluded): 0.2% MDS.



	1 year (MDS)
Worsening (‹-0.2)	7.4
No effect (-0.2 - 0.2)	17.2
Amelioration ‹50% (›0.2)	9.1
Amelioration ›50% (›0.5)	26.5
Amelioration ›95% (›0.95)	39.8
n	**733**

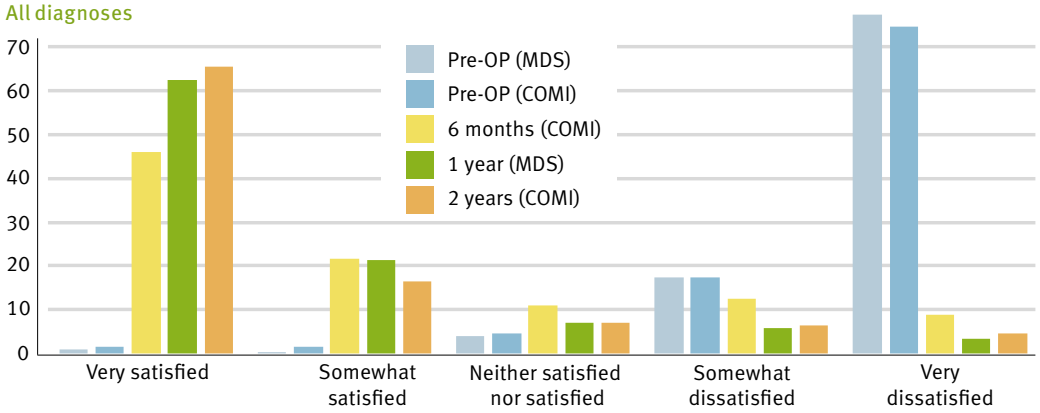
one year, which may reflect the early revision rate approximately twice as high after PKA than after TKA. One has to note that the evaluated PROMs do not have the potential to discriminate functional results after TKA or PKA.

It is important to note that the same PROMs are also reported in the hip chapter. Pre-operative measures are – with few exceptions – almost exactly at the same level in hip and knee patients. This indicates that hip and knee patient populations in SIRIS are highly comparable and a direct comparison of outcome variables is thus appropriate. Results of THA are, on average, somewhat better than after TKA or PKA.

Figure 4.10e

Satisfaction with current situation: Total knee arthroplasty

All diagnoses

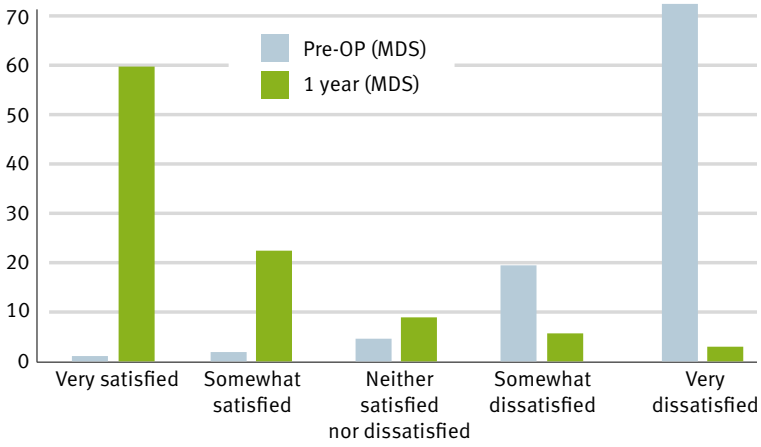


	Pre-Op (COMI)	Pre-Op (MDS)	6 months (COMI)	1 year (MDS)	2 years (COMI)
very satisfied	1.1	1.7	45.9	62.5	65.5
somewhat satisfied	0.3	1.7	21.6	21.4	16.5
neither satisfied nor dissatisfied	4.1	4.6	10.9	7.1	7.1
somewhat dissatisfied	17.3	17.5	12.6	5.7	6.4
very dissatisfied	77.2	74.6	9.0	3.4	4.5
n	**1,001**	**4,156**	**999**	**4,156**	**576**

Figure 4.10f

Satisfaction with current situation: Partial knee arthroplasty

All diagnoses



	Pre-Op (MDS)	1 year (MDS)
very satisfied	1.2	59.8
somewhat satisfied	1.9	22.6
neither satisfied nor dissatisfied	4.7	8.9
somewhat dissatisfied	19.5	5.6
very dissatisfied	72.6	3.1
n	**734**	**734**

SIRIS outlier watch list – hip implants

Implant or implant combination	Detected as outlier in report	Risk-adjusted hazard ratios for 2-year revision risk: for age and sex			for age, sex, BMI, ASA and Charnley Class (from 2015, if available)			Summary
		HR	lb95%	ub95%	HR	lb95%	ub95%	
Uncemented stem/cup combinations (primary osteoarthritis)								
Alloclassic + Fitmore	2022	1.49	1.02	2.17	1.26	0.60	2.64	It is very unlikely that this combination is an actual outlier combination. The outlier detection is based on an unusual number of revisions detected in cases from 2017. In fact, few uses were registered after 2019 (down from 100+ per year before 2016). It was mainly in use in one hospital and therefore there is a high likelihood of a local effect in 2017. This hospital stopped using the combination after 2020. Performance before the 2017 peak in revisions was unremarkable and none of the registered cases since 2019 had been revised by June 2023.
	2023	1.55	1.07	2.24	1.24	0.59	2.61	
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	2.14	1.02	4.51	2.30	1.03	5.15	Due to the reclassification of implants in 2022, we narrowed down the stem in this combination to the Amistem-H proximal coating variant. This particular combination was mainly used in one hospital and only between 2016 and 2019. A small absolute number of revisions was recorded against a moderate number of primary procedures, but the deviation from an average 2-year-revision rate is still very marked, albeit with very limited statistical precision. It is also noteworthy that the stem and the cup observed individually are performing adequately at two years. Combination is not currently in active use.
	2021	2.00	0.95	4.21	2.18	0.98	4.88	
Amistem-H prox coating + Versafitcup DM	2022	3.11	1.29	7.49	3.17	1.31	7.62	
	2023	3.14	1.30	7.54	3.22	1.34	7.76	
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	1.53	0.69	3.40	1.30	0.33	5.22	Not anymore identified as a potential outlier because of lack of statistical certainty. We already noted in past reports that it was unlikely that this combination represented a genuine outlier because current use is limited to one hospital where the performance is statistically inconclusive due to small numbers.
	2021	1.59	0.76	3.33	1.48	0.48	4.61	
GTS + Exceed	2019							Not anymore identified as a potential outlier. This combination is not in active use anymore.
GTS + G7 bi-spherical	2019							GTS + G7 bi-spherical is very likely a problematic stem-cup combination. It was practically in use in only one hospital and there were no further uses recorded since 2021. It is noteworthy that both stem and cup observed individually have been performing poorly. This combination is not in active use anymore.
	2020	5.27	3.22	8.62	3.39	1.52	7.57	
	2021	5.15	3.24	8.19	3.84	1.92	7.71	
	2022	5.15	3.28	8.09	3.96	2.06	7.63	
	2023	5.15	3.28	8.09	3.96	2.05	7.62	
(Harmony + Gyracup)	2020	3.97	1.98	7.94	3.55	1.76	7.13	Due to the reclassification of implants, this combination is now correctly identified as Harmony + Symbol DMHA/DS. evolution (Gyracup being an alternative brand name not actually used in Switzerland). It was in use in only one hospital and active use ceased in 2019 after an unusual number of revisions. Only original Symbol DMHA cups (none of the equivalent DS Evolution cups) were used in this outlier combination.
Harmony + Symbol DMHA/DS evolution	2022	3.67	1.83	7.35	3.20	1.60	6.42	
	2023	3.66	1.83	7.33	3.20	1.60	6.42	
Polarstem + EP-fit	2020	1.93	1.30	2.86	2.52	1.42	4.45	Polarstem and EP-FIT is a potential outlier combination, as its risk adjusted hazard ratio just exceeds the relevant threshold of two. In 2021 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.
	2021	1.89	1.30	2.74	2.31	1.39	3.84	
	2022	1.92	1.36	2.71	2.14	1.38	3.33	
	2023	1.94	1.40	2.68	2.11	1.41	3.16	
SPS evolution + April ceramic	2020	2.22	1.72	2.88	3.67	2.47	5.47	SPS Evolution + APRIL Ceramic is now a definitive 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. This combination, still in active use, exceeds the outlier boundary both at 2-years and long-term beyond 5 years. Recommended course of action: investigate causes of revisions where those are higher than average and observe future performance.
	2021	2.33	1.84	2.96	3.50	2.42	5.06	
	2022	2.50	2.01	3.11	3.50	2.51	4.88	
	2023	2.44	1.97	3.02	3.46	2.53	4.74	

Implant or implant combination	Detected as outlier in report	Risk-adjusted hazard ratios for 2-year revision risk						Summary
		for age and sex			for age, sex, BMI, ASA and Charnley Class (from 2015, if available)			
		HR	lb95%	ub95%	HR	lb95%	ub95%	
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 2021 with only 2 registered uses in that year. There were fewer than 50 eligible cases in the current reporting period and therefore the combination is not anymore listed in AR2023.
	2022	2.61	1.44	4.72	2.84	1.18	6.85	
SPS modular + April ceramic	2019							Not identified anymore as an outlier combination. The last registered use was in 2021.
	2020	2.95	1.94	4.49	1.61	0.23	11.50	
	2021	2.90	1.91	4.41	1.59	0.22	11.32	
Stelia-stem + Ana.nova hybrid	2019							Not identified anymore as an outlier combination. The last registered use was in 2019. It is still listed in the annual report with an unremarkable revision rate. This is due to the fact that years with particularly poor performance have been replaced with years with better performance in the evaluation period.
	2020	2.65	1.71	4.12	2.30	1.26	4.22	
	2021	2.60	1.68	4.04	2.20	1.20	4.01	
Twinsys + Selexys PC	2020	1.96	0.98	3.93	4.93	1.58	15.34	Not identified anymore as an outlier combination. The last use was registered in 2019.
Accolade II + Trident II	**2023**	2.96	1.54	5.69	2.60	1.08	6.26	Accolade II + Trident II was first registered in 2018 and only from Accolade II + Trident II was first registered in 2018 and only from 2019 in significant numbers. It reached the threshold for listing in the annual report only in the current reporting period. The risk-adjusted 2-year revision risk exceeds the critical value of 2, but statistical precision is still low. It is noteworthy that early implants from 2018 and 2019 faced a particularly high 2-year revision risk, whereas results for implants from 2020 onwards are at least inconclusive so far. Recommended course of action: investigate reasons for revision and observe future performance.
Symbol + Symbol DMHA/DS evol.	**2023**	2.62	1.31	5.23	2.40	1.19	4.81	Symbol + Symbol DMHA was first registered in 2019 and only in significant numbers in 2020 (only original Symbol DMHA cups were registered in this combination and none of the equivalent DS evolution cups). It reached the threshold for listing in the annual report only in the current reporting period. The risk-adjusted 2-year revision risk exceeds the critical value of 2, but statistical precision is still low. Recommended course of action: investigate reasons for revision and observe future performance.
Hybrid fixation stem/cup combinations (primary osteoarthritis)								
CCA + RM Pressfit vitamys	2020	1.83	0.75	4.45	1.91	0.60	6.07	CCA + RM Pressfit vitamys was not identified as a potential outlier in AR2022 because of lack of statistical certainty. In the current reporting period, it still exceeds the outlier boundary with just about sufficient precision in order to be detected as a potential outlier. This combination is still in active use, but it is clearly a borderline case in terms of statistical precision. Indeed, on the basis of current figures it can be projected that next year the number of primary cases will fall below the reporting threshold of 50. Recommended course of action: investigate reasons for revision, especially those pertaining to the CCA stem, and observe future performance.
	2021	2.05	0.91	4.63	1.86	0.59	5.91	
	2023	1.94	0.97	3.88	1.62	0.61	4.33	
PF + Fitmore	2020	0.84	0.27	2.61	1.04	0.14	7.45	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. This combination is not in active use anymore.
Twinsys cemented + RM pressfit	2019							Not anymore identified as a potential outlier. It remains in active use and recent performance has been average.
Weber + Alloclassic	2019							Not anymore identified as a potential outlier. Active use ended in 2020.
	2020	2.91	1.20	7.05	3.48	1.10	11.02	
Uncemented stem-cup combinations (fractures)								
CLS Spotorno + Allofit	2022	2.18	1.20	3.95	3.48	0.94	4.81	This combination is in active use in only a few hospitals. Most revisions are registered by its main user, which leads to the conclusion that the outlier status is a result of a local effect. Recommended course of action: investigate reasons for revisions and observe further performance locally. It is noteworthy that it is the performance of the stem that appears to be determining the outlier status whereas the cup's performance is unremarkable.
	2023	2.09	1.15	3.79	1.97	0.78	4.45	
Fitmore + Allofit	2022	1.37	0.77	2.43	1.87	0.88	3.98	It is unlikely that this combination is a genuine outlier and in the current reporting period the 2-year revision rate falls just below the boundary. Its performance is unremarkable in the main using hospital, as has been recent performance in general. The outlier status was caused by poor performance among several small volume users between 2016 and 2019.

SIRIS outlier watch list – knee implants

Implant or implant combination	Detected as outlier in report	Risk-adjusted hazard ratios for 2-year revision risk						Summary
		for age and sex			for age, sex, BMI, ASA and Charnley Class (from 2015, if available)			
		HR	lb95%	ub95%	HR	lb95%	ub95%	
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 and the last registered primary use was in 2019.
Journey II	2019							It is likely that Journey II was a problematic system in the sense that it registered above average revision rates in several reporting periods, in particular stemming disproportionately from some hospitals and surgeons. However, it was also reported in AR2022 that the revision rates kept improving through the reporting period. In the current period the 2-year revision rate fell below the outlier boundary.
	2020	2.17	1.81	2.61	2.10	1.69	2.61	
	2021	2.06	1.74	2.46	2.00	1.63	2.45	
	2022	1.93	1.64	2.29	1.81	1.48	2.20	
Physica KR	2019							As of 2022, we combined Physica PS and KR into one system in our reporting. It is likely that Physica KR/PS was 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. Active use ended in 2019 and in the current reporting period the 2-year revision rate fell just below the outlier boundary.
	2020	3.97	2.13	7.38	3.20	1.20	8.54	
	2021	3.80	2.04	7.07	3.06	1.14	8.17	
Physica PS	2019							
	2020	3.32	1.96	5.61	3.06	1.73	5.41	
	2021	3.11	1.84	5.25	2.91	1.65	5.51	
Physica KR/PS	2022	3.25	2.17	4.85	2.83	1.73	4.63	
Partial knee system								
Journey Uni	2020	1.82	1.38	2.39	1.56	0.96	2.53	It is likely that Journey Uni was a problematic knee system at least between 2015 and 2019, but there were signs of improvement in 2020. While the statistical precision within the report's main timeframe of interest (2-year revision rate) is relatively low, and the system actually fell below the outlier boundary in 2022 and 2023, the development of the revision risk beyond two years follow-up strongly suggests an unusual pattern. The system was identified as an outlier in the first round of long-term-evaluation (from 5 years) in 2022 and this was confirmed in 2023. It should also be noted that the better short-term revision position in 2022 and 2023 is mainly due to the inclusion of poorly performing "other systems" in the evaluation and thus a right-shift of the outlier boundary. Recommended course of action: investigate reasons for revisions and observe future performance.
	2021	1.81	1.39	2.35	1.68	1.10	2.58	
	2022	1.61	1.25	2.08	1.51	1.02	2.23	
	2023	1.57	1.23	2.0	1.40	0.96	2.03	

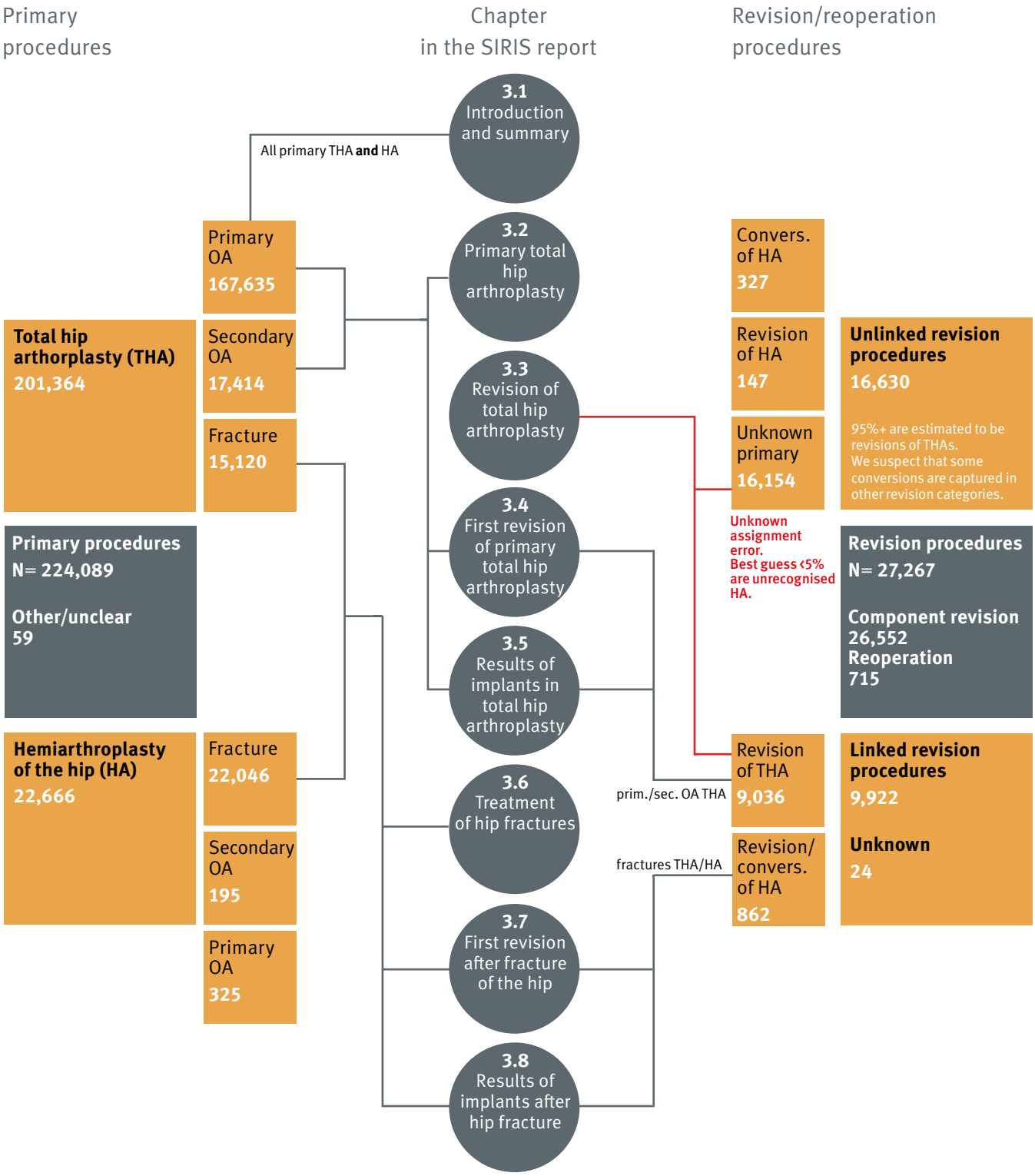
List of manufacturers and distributors

List of companies with implants registered in the SIRIS registry
2021

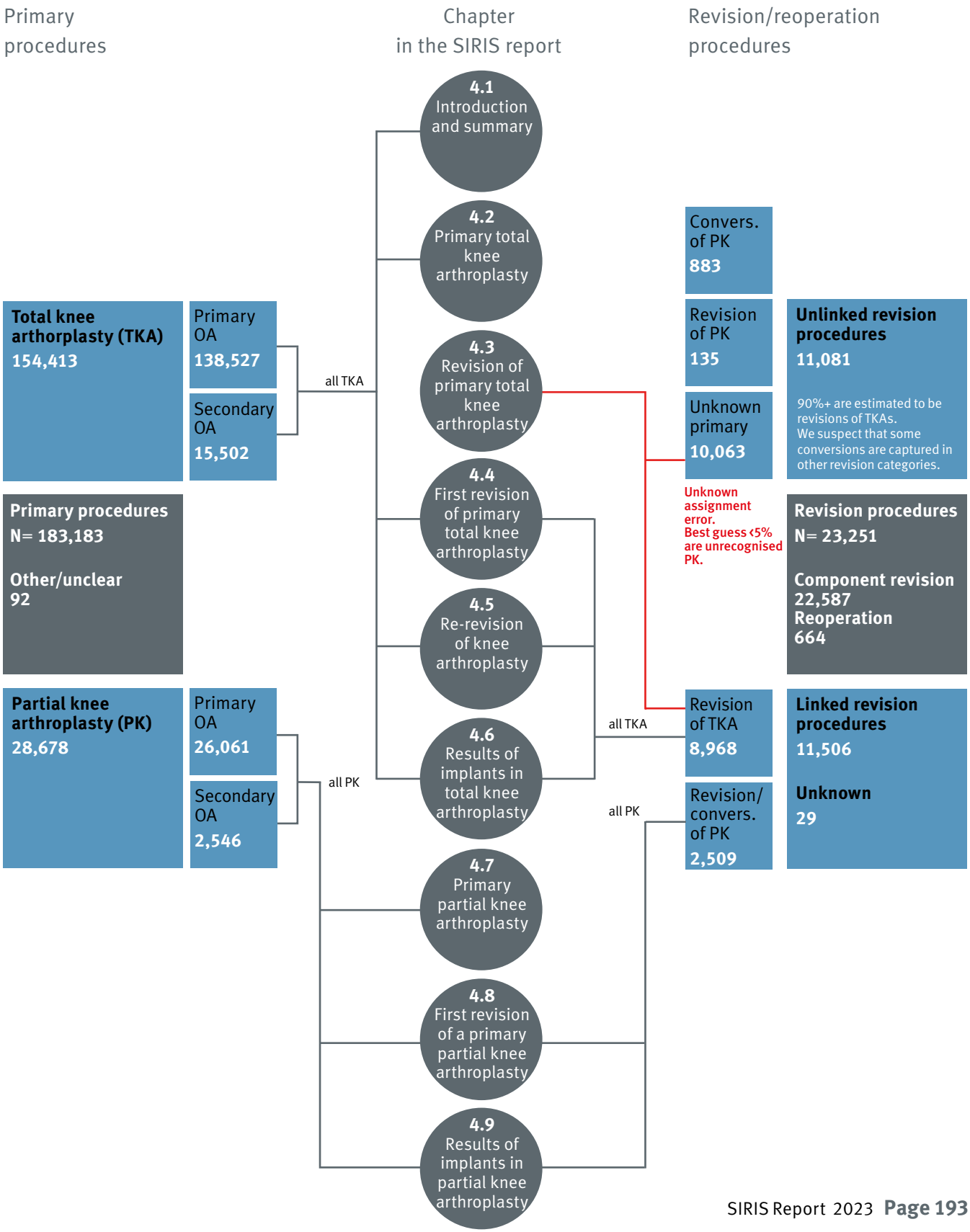
Company	Headquarters Switzerland	Corporate domicile
Amplitude Switzerland	Genf	France
Argomedical AG	Cham	Switzerland
Arthrex Swiss AG	Belp	Germany
Arthrosurface	-	USA
ATF	-	France
B. Braun Medical AG	Sempach	Germany
CeramTec	-	Germany
Conformis	-	Germany
Corin GSA GmbH	Solothurn	United Kingdom
Dedienne 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, enovis	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

SIRIS data and analyses

Hip – Overview of data structure (annual report 2023)



Knee – Overview of data structure (annual report 2023)



SIRIS data and analyses

Hip – Overview of of types of analyses for determining revision rates (annual report 2023)

Types of analysis / Report section	**Kaplan-Meier estimates** 2012–2022 **Adjusted for censoring events**	**2-year revision rates** (implants 2017–2020 with completed 2-year follow-up) **Adjusted for censoring events**	**Funnel plots of 2-year hospital revision rates** (implants 2017–2020 with completed 2-year follow-up) **Risk-adjusted and adjusted for censoring events**
Hip overview	All total hip arthroplasties (THA) All hemi arthroplasties (HA)		THA after primary osteoarthritis (primary OA). **ANQ online reporting, above 99.8%= outlier status** All hemi arthroplasties (HA)
First revision of primary THA	THA for various subgroups	THA for various subgroups	
First revision of THA/HA after fracture of the hip	HA with bipolar versus unipolar heads THA after fracture of the hip	HA for various subgroups THA for various subgroups	
Hip implants (minimal number in group)	Uncemented stem-cup combinations, THA after primary OA (500+) Hybrid fixation stem-cup combinations, THA after primary OA (500+) Uncemented stem-cup combinations, THA after **secondary** OA (500+) **Long-term evaluation 5–9 years: elevated revision rate or outlier**	Uncemented stem-cup combinations, THA after primary OA (50+) Hybrid fixation stem-cup combinations, THA after primary OA (50+) Uncemented stem-cup combinations, THA after **secondary** OA (50+) Uncemented stem-cup combinations, THA after fracture OA (50+) Hybrid fixation stem-cup combinations, THA after fracture (50+) Cemented stem-head combinations, HA after fracture (50+) **2-year evaluation (two times group average= outlier status)**	

SIRIS data and analyses

Knee – Overview of of types of analyses for determining revision rates (annual report 2023)

Types of analysis / Report section	**Kaplan-Meier estimates** 2012–2022 **Adjusted for censoring events**	**2-year revision rates** (implants 2017–2020 with completed 2-year follow-up) **Adjusted for censoring events**	**Funnel plots of 2-year hospital revision rates** (implants 2017–2020 with completed 2-year follow-up) **Risk-adjusted and adjusted for censoring events**
Hip overview	All total knee arthroplasties (TKA) All partial knee arthroplasties (PK)		TKA after primary osteoarthritis (primary OA). **ANQ online reporting, above 99.8%= outlier status** All partial knee arthroplasties (PK) TKA after primary OA without isolated patella resurfacing
First revision of primary TKA	TKA for various subgroups	TKA for various subgroups	
First revision of primary PK	PK for various subgroups	PK for various subgroups	
Re-revision after revision of TKA/PK	Re-revision after revised TKA for various subgroups Re-revision after conversion from PK to TKA		
Hip implants (minimal number in group)	Bicondylar total knee systems, all diagnoses (500+) Unicondylar partial knee systems, all diagnoses (500+) Patellofemoral joint systems, all diagnoses (500+) **Long-term evaluation 5–9 years: elevated revision rate or outlier**	Bicondylar total knee systems, all diagnoses (50+) Unicondylar partial knee systems, all diagnoses (50+) Patellofemoral joint systems, all diagnoses (50+) **2-year evaluation (two times group average= outlier status)**	

Online appendix for implants https://www.siris-implant.ch/en/Downloads&category=16

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 2013–2021.

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
HA	Hemiarthroplasty of the hip
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
OA	Osteoarthritis
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 2023 (144)

	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
AR		Berit Klinik AG
AR	Hirslanden Gruppe	Klinik Am Rosenberg AG
AR	Spitalverbund Appenzell (AR)	Spital Herisau
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	Swiss Medical Network SA Réseau de l'Arc	Hôpital de Saint-Imier
BE	Swiss Medical Network SA Réseau de l'Arc	Hôpital de Moutier
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 AG	Spital Burgdorf
BE	Spital Emmental AG	Spital 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
BS	Universitätsspital Basel	Standort Bethesda Spital AG
BS	Universitätsspital Basel	Standort Uni-Spital

	Group	Clinic
BL		Praxisklinik Rennbahn
BL	Hirslanden Gruppe	Klinik Birshof
BL	Kantonsspital Baselland	Bruderholz
BL		Ergolz Klinik
FL		Liechtensteinisches Landesspital
FR	Hôpital fribourgeois HFR	HFR Hôpital cantonal
FR	Swiss Medical Network	Clinique Générale Ste-Anne
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
LU		Schweizerisches Paraplegiker-Zentrum
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
NE		Clinique Volta SA
NW		Spital Nidwalden AG
OW		Kantonsspital Obwalden

	Group	Clinic
SG		Spital Linth
SG	Hirslanden Gruppe	Klinik Stephanshorn AG
SG	Spitalregion Fürstenland Toggenburg	Spital Wil
SG	Spitalregion Rheintal Werdenberg Sarganserland	Spital Altstätten
SG	Spitalregion Rheintal Werdenberg Sarganserland	Spital Grabs
SG	Kantonsspital Graubünden	Spital Walenstadt
SG	Kantonsspital St. Gallen	Kantonsspital St. Gallen
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	Gruppo ospedaliere Moncucco	Clinica Moncucco
TI	Gruppo ospedaliere Moncucco	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	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	Spital Brig
VS	Hôpital du Valais - Spital Wallis	Spital Visp
VS	Hôpital du Valais - Spital Wallis	Hôpital deSion
VS	Hôpital du Valais - Spital Wallis	Hôpital de Martigny
VS	Swiss Medical Network	Clinique de Valère
ZG		Zuger Kantonsspital
ZG	Hirslanden Gruppe	AndreasKlinik Cham Zug
ZH		Kantonsspital Winterthur
ZH	Swiss Medical Network	Klinik Pyramide am See
ZH		Schulthess Klinik
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	Stadtspital Zürich	Stadtspital Zürich Triemli
ZH	Stadtspital Zürich	Stadtspital Zürich Waid
ZH	Swiss Medical Network	Privatklinik Bethanien
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Ten Years of Swiss Hip and Knee Registry

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