Akademiska sjukhuset
Alingsås
ArtClinic Göteborg
ArtClinic Jönköping
Arvika
Bollnäs
Borås
Capio Artro Clinic
Carlanderska
Danderyd
Eksjö
Elisabethkliniken
Enköping
Eskilstuna
Falun
Gällivare
Gävle
Halmstad
Halmstad Capio Movement
Helsingborg
Huddinge
Hudiksvall
Hässleholm
Jönköping
Kalmar
Karlshamn
Karlskoga
Karlstad
Karolinska
Kullbergska
Kungälv
Lidköping
Lindesberg
Ljungby
Luleå-Hermelinen
Lund
Lycksele
Mora
Motala
Mölndal
Nacka
Norrköping
Norrtälje
Nyköping
OrthoCenter IFK kliniken
OrthoCenter Stockholm
Ortopediska huset
Oskarshamn
Piteå
S:t Göran
Sabbatsberg
Sahlgrenska
Skellefteå
Skene
Skövde
Sollefteå
Sophiahemmet
Sunderby
Sundsvall
Södersjukhuset
Södertälje
Torsby
Trelleborg
Uddevalla
Umeå
Varberg
Visby
Värnamo
Västervik
Västerås
Växjö
Ängelholm
Ängelholm - Aleris
Örebro
Örnsköldsvik
Östersund

Annual Report 2019

Swedish Knee Arthroplasty Register

Lund University
Department of Clinical Sciences, Orthopedics
Skåne University Hospital, Lund
Sweden

Primary knee arthroplasties 1975-2018
Revision knee arthroplasties 1975-2017
Knee osteotomies 2013-2018

To our contact surgeons

Besides the annual report which the register has produced for decades, we have for the last years also provided the profession and patients with data on the internet. It is gratifying that our websites seem to be quite popular. Our patient website (www.gangbar.se) was most popular having 25,000 unique visits during the first half of 2019. The register website (www.knee.se) attracted almost 5,000 unique visitors during the same period, of which half were from other countries than Sweden. The statistics webpage which was completed in 2017 and includes both perioperative- as well as PROM-data had 2,300 unique visits during the period. On the statistics webpage, it is possible to compare hospital results with that of counties/regions and the whole country while making selections that include different time periods, implant models and gender. The number of visitors and that the average visitor stayed on the webpage for 12 minutes indicates great interest in results from the register.

In 2020, new stricter rules will take effect in the EU concerning medical equipment in class 3 (covering knee implants). This means that it must be possible to identify part numbers and LOT (batch) numbers of implants in individual patients. The SKAR has for the last 18 years registered both LOT and part numbers for the implants inserted. This means that the SKAR can quickly identify a patient having an implant from a specific batch, in case it becomes necessary to perform additional clinical controls. That the SKAR has done this for 19 years shows its engagement concerning patient safety.

For the fourth year we account for adverse events that occurred within 90 days of the primary knee replacement. These events are based on ICD- and procedure codes registered when knee arthroplasty patients after their primary surgery are treated within the healthcare system. The codes to be used were decided on in cooperation with the National Patient Register of the National Board of Health and Welfare which performes the calculations.
Although there may be sources of error such as differences in coding procedures among the hospitals and counties, we are convinced that the data still yield useful information on how common adverse events are following knee arthroplasty surgery and may indicate where additional analyses and improvement measures are motivated.

Your dedicated work over the years with accurate reporting, focus on quality and sharing of the information is a prerequisite for the register having high coverage of reliable data that can be implemented into clinical practice.

The structure of the annual report is similar to that of last year :

The first part summarizes the register procedures, the epidemiology, and the general results.

The second part contains information on the data reported to the register in 2018 as well as analyses covering the 10-year period 2008-2017.

The third part concerns the osteotomy registry.

The fourth part is specifically prepared for each individual hospital. It is only delivered to the contact surgeon in charge on an USB-stick. It provides PDF files with compilations of what was reported by the unit for 2018 (sorted by ID and date of surgery) and it is our hope that this information will be compared to other available hospital information in order to identify and correct any registration errors.

Additionally the USB stick contains the annual report, an Excel file with all the reported surgeries by the hospital, graphical presentation of the hospital revision rate as compared to that of the national average.
As previously mentioned, it is important that the information is spread to your colleagues so it can be analyzed, discussed and used for initiating improvement efforts.

Again we use this opportunity to remind you that the registration is prospective and that a reported revision can only be included in the analyses if the primary procedure was reported previously according to normal routines. This means that if a primary operation is discovered only because of a revision at a later time, neither the primary operation nor the revision will be included in the analyses.

As from 2020, the plan is to start the process of combining the Swedish knee and hip register in a common register (the Swedish Arthroplasty Register is the working name). This means that the routines for reporting to and from the register will be reviewed although it is not expected that major changes will happen during the first year.

The register office in Lund would like to thank all contact surgeons, operation staff and secretaries for their important contribution throughout the years and ask you to carefully review and distribute the information presented.

Lund, September 6th, 2019.

On behalf of the Swedish Knee Arthroplasty Register

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Introduction

The beginning – In the early seventies, knee arthroplasty was an uncommon procedure restricted for those with severe disability. Little information was to be found in the literature while there was an abundant choice of implants which were continuously being modified. In this setting, the Swedish Orthopedic Association initiated a nationwide multicenter study in 1975, to prospectively monitor knee arthroplasty surgery. The orthopedic surgeons realized that it would be impossible for an individual surgeon to base his choice of optimal operative methods or implants on his own experience. The aim was to collect, analyze and render information that could warn against suboptimal techniques and implants.

Number of units – The vast improvement in quality of life for the majority of patients quickly made the surgery a success and the technique dispersed to more hospitals and surgeons. Since the start of the registration in 1975, participation has been voluntary. 24 units reported during the first year increasing to 51 in 1985 and to 82 in 1996. In the late nineties, the number of units diminished somewhat due to the merger of hospitals. In 2017, 72 orthopedic units reported to the register, i.e. all units that routinely performed knee arthroplasty surgery in Sweden.

Volumes – Since the registration started, there has been an exponential increase in the number of operations (see page 18). However, in 2013-15 the number diminished slightly to increase again in 2016 by 9%, by 6.5% in 2017 and by 3.2% in 2018 to 15,430 primaries. We consider it likely that the volumes will continue to increase as the incidence in Sweden still is lower than in countries such as USA and Germany (see page 19). Further, even without an additional increase in age specific incidence, the expected changes in the age distribution of the population will increase the demand for surgery.

Patient Reported Outcome – The SKAR began early evaluating PROMs and put in effort searching for the most relevant instrument for patients undergoing knee arthroplasty surgery which resulted in a thesis published in 2001. Recently there has been a renewed interest in PROMs by the authorities for the purpose of quality improvement. Thus, in 2008 the register started gathering PROM data from Skåne and since then, 21 units from other parts of the country have joined. Results can be found on the pages 68-77.

Registration of osteotomies – Osteotomies have been prospectively registered since 2013. This year the registration has a separate section on page 78.

Reporting to the register – The SKAR recommends that the form (see page 85) is filled out in the operation theater and that one set of the stickers found in the implant and cement packages are stuck on the backside. The form is then sent to the register office in Lund where the information is entered into the database. The hospitals are requested to send the forms to the registry at least once a month. In the case of revisions, a copy of the operation report and discharge letter is required. The majority of the units observe the recommendations.
The reason for not having introduced decentralized computer registration is that we consider it important that the registration is done in the operation room. This would call for improved computer solutions as well as a better flow of information from the implant distributors to the register in order to maintain an up-to-date part-number database. In our view, the paper-based system has at present essential advantages such as less workload at the surgical units, the most reliable information and fewer input errors. Further, during data entry, register staff can check part numbers against a local database and in the case of new numbers turning up, contact the distributors.
However, decentralized Internet data entering is used for PROMs. Those units that have decided to participate in the PROM project have an access to a specific Web application for this purpose.

Annual report – Each annual report accounts for primary arthroplasties reported during the previous year (in this report 2018). Analyses concerning the revision rate end one year earlier (2017). The reason for this is that only a few errors in the registration of revisions can have a large impact on the final result and an extra year allows for as complete and correct information as possible. As revisions are often complicated, the forms, discharge letters and operation reports have to be examined thoroughly. Supplementary information is often needed before the reason for and the type of revision is reasonably clear. It also happens that unit's send completing information after discovering, by examining the annual report and the accompanying lists, that their previous reporting had been incomplete. The register is trying to improve the

response times so that waiting an extra year will not be needed. However, this will demand an increased effort from the register staff as well as a quicker response from the hospitals when asked to complete their reporting or provide supplementary information.

10-year analyses – Some have wondered why the register most often accounts for a 10-year revision rate while the registration has been going on for more than 40 years. – There are several reasons: The main reason is that the interest usually focuses on relatively modern techniques and implants. Another reason is that survival analyses allow for inclusion of patients during the entire observation period. I.e. implants have been inserted in the beginning as well as in the end of the observation period. This implies that the first part of a revision (survival) curve includes operations performed both during the first and last part of the observation period. The end of the curve (to the right), only includes operations inserted during the first part of the period. The result is that the latter part of the curve represents older techniques and implants as well as mainly the younger patients (those more likely to live to the end of the observation period). In summary, this means that without special selections it is difficult to interpret curves that stretch over long time periods. A description of how the register compares implants can be found on page 16.

Cooperation – The Nordic countries cooperate through the framework of NARA (Nordic Arthroplasty Register Association) and have built a common database allowing for analyses of a combined dataset from Denmark, Norway, Sweden and Finland). The SKAR and the Australian Joint Replacement Registry also have common research projects. Further, the SKAR cooperates with other international organizations such as ISAR (International Society of Arthroplasty Registries) and OECD (Organisation for Economic Co-operation and Development) as well as with individual scientists in different countries. Besides collaborative projects resulting in interesting findings, they give the participants insight into each other´s methods for registration, selection, analyses and reporting. In turn this hopefully will result in the registers approaching each other so that it will be easier to compare their results in scientific papers and reports in the future.

The reporting form – Knee arthroplasty surgeries as well as osteotomies are reported on a very similar one page form that is used for both primaries and revisions (see page 85 and 89). One set of the stickers that are found in the packages for the parts, that are implanted in the patient (prosthesis, cement, osteotomy plates, bone substitute...) and which contain the part- and lot numbers, should be placed on the back of the form.

Data quality – In order to use register data for scientific studies and quality improvement, it is of greatest importance that the information found in the register is complete and valid. A description of how the register validates the information can be found on pages 6-7.

The benefit of the register for health care –
The register started as a research project and during the first 5 years it was supported by grants from the Medical Research Council and for the next 6 years by a variety of research grants. After a period of financial support by the National Board of Health and Welfare, the Swedish Association of Local Authorities and Regions became responsible for distribution of funds to the National Quality registers.

The annual report has been produced for years in order to inform decision makers, the profession, patients and other interested about the knee arthroplasty surgery with respect to demography, epidemiology, processes and outcome. The aim has been to provide ground for informed decisions which again have been reflected in a clear and sound improvement of quality.

The Office for the National Quality Registers announced in July 2017 that the annual report first and foremost was to describe the benefit of the register for the health care and how the register can be used to improve the healthcare. This information can be found on pages 8-9.

Unfortunately, the authorities have also reduced the funding of the registry by more than 30% since 2016. This is already affecting the register activity and will probably result in future structural changes of the register.

Definitions

Revision is defined as a new operation in a previously resurfaced knee in which one or more of the components are exchanged, removed or added (incl. arthrodesis or amputation). This implies that soft tissue operations such as arthroscopy and lateral release are not considered revisions. The reason for this stringent definition is that not all surgeons consider minor surgeries to be related to the arthroplasty or be a complication why reporting of such procedures is inconsequent.

TKA (Total or Tricompartmental Knee Arthroplasty) is defined as a knee arthroplasty in which the femoral component has a flange and thus all three compartments of the knee are affected. Even in cases where a patellar button is absent, the flange resurfaces half of the femoropatellar compartment and the arthroplasty is still considered to be a TKA.

Bicompartmental arthroplasty (historical) uses two components, one on the femoral and one on the tibial side to resurface both the femorotibial compartments (medial and lateral) but not the femoropatellar compartment. Thus, this implant has no femoral flange and is not meant to allow for resurfacing of the patella.

UKA (Unicompartmental Knee Arthroplasty) implies an arthroplasty that separately resurfaces the medial or lateral femorotibial compartment. (med. UKA or lat. UKA). If 2 UKA implants are used to resurface both femorotibial compartments the arthroplasty is named bilateral UKA.

Patello-femoral arthroplasty is an arthroplasty which resurfaces the femoropatellar compartment. Even if this arthroplasty is unicompartmental by definition, it is accounted for separately.

Partial Replacement Knee Arthroplasty (PRKA) are implants (e.g. buttons) that only replace a part of a knee compartment.

Hinged implants. As the name implies these implants only allow for flexion and extension through a fixed axis.

Linked implants (Linked/Rotating hinge) have a mechanical coupling between the femoral and tibial components allowing for flexion and extension as well as for a varying amount of rotation.

Stabilized implants. Even if the hinges and the linked implants are extremely stabilizing, the term stabilized implants is used for a group of prostheses that are a kind of TKA but use the form of the femoral and tibial components to restrict movement in valgus, varus and rotation. The posterior cruciate sacrificing type most often has an eminence in the middle part of the tibial polyethylene that can be contained by a box in the femoral component that lies between the medial and lateral sliding surfaces. By a camshaft-like property, the femoral component is forced to slide back during flexion, which simulates the effect of the posterior cruciate ligament. The fit between polyethylene and metal is such that it allows for some rotation. In so-called super stabilized implants the congruency has been increased by making the eminence larger with a total fit against the box of the femoral component thus, restricting the rotation and varus/valgus movement. Intermediary forms also occur. Stabilized implants are most often used for revision but also for the more difficult primary arthroplasties.

The ordinary TKA can be made somewhat more stabilized by increasing the congruency between the sliding surfaces. In these instances, there is a slight eminence of the polyethylene that fits against the femoral component. However, the term stabilized is only used for those implants that are more stabilized than usual by use of the above mentioned camshaft construction.

TKA-revision models are TKA that are mainly used for revisions or difficult primaries. These are typically stabilized implants that often are used with stems. Many have proper names making them easy to distinguish from common TKA's. However, due to the modularity of the modern TKA, a TKA brand may represent either a common TKA or a stabilized stemmed TKA depending on which components have been assembled. For the primary surgeries, this implies that some TKA brands are only used for standard cases while others also may be used for difficult primary cases. This can result in bias when comparing models. In order to make comparison of revision rates after primary surgery as fair as possible, the SKAR classifies certain TKA as being "revision models" and excludes them from the analyses. Accordingly, revision models with identifiable names are excluded (e.g. NexGen-LCCK, AGC-Dual Articular and F/S-Revision) as well as those modular TKA's that have been inserted using extra-long stems (longer than 5 cm).

For those interested there is an excellent article on the history and the developement of the TKA; Robinson RP; The Early Innovators of Today's Resurfacing Condylar Knees. J of Arthroplasty 2005 (suppl 1); 20: 1.

Completeness concerning primaries reported in 2017

It is difficult to estimate the proportion of knee arthroplasties performed in Sweden that are reported to the SKAR. However, we can compare the SKAR with the National Patient Register (NPR), an inpatient register, based on ICD- and surgical coding although it complicates the comparison that the registers focus on different variables (operations vs. admissions) and that laterality is inconsequently recorded in the NPR.

A further issue is when surgeries are reported to the NPR not as being performed at a specific hospital but by an administrative body containing many hospitals.

The SKAR completeness was estimated by comparing it to the NPR and assuming that the true number of admissions is the combined number of admissions in both registers. There is a possibility for patients having knee arthroplasty surgery without being registered in any of the registers but they are presumably few. Using this method, we found that the SKAR had captured 97.0% of all admissions and the NPR 91.4%.

Below is a list of the units containing the combined number of operations from both registers as well as the completeness for each of the hospitals. Those who do not reach 96% completeness are marked in red. Units with low coverage are encouraged to investigate if they missed reporting any surgeries or if their surgical coding was erroneous.

Hospital 2017	Number	SKAR-percent	NPR percent
Akademiska	90	94.4	98.9
Alingsås	194	99.5	97.9
Art Clinic Göteborg	108	99.1	36.1
Art Clinic Jönköping	90	100.0	38.9
Arvika	190	92.6	97.9
Blekingesjukhuset*	299	98.7	99.0
Bollnäs (Aleris)	326	99.7	95.7
Capio Artro Clinic Sth.	242	100.0	99.6
Carlanderska	223	100.0	0.0
Danderyd	195	94.9	98.5
Eksjö	211	99.5	100.0
Elisabethsjukhuset	6	100.0	100.0
Enköping	368	99.2	99.2
Eskilstuna Mälarsjh.	68	100.0	97.1
Falun	216	99.5	21.3
Gällivare	58	93.1	100.0
Gävle	88	96.6	95.5
Hallands sjukhus**	17	0.0	100.0
Halmstad	185	100.0	99.5
Halmstad Capio Movement	434	100.0	0.9
Helsingborg	20	95.0	100.0
Huddinge	117	94.9	100.0
Hudiksvall	56	98.2	92.9
Hässleholm	773	99.0	99.6
Kalmar	103	97.1	99.0
Karlskoga	39	100.0	100.0
Karlstad	116	100.0	99.1
Karolinska Solna	66	87.9	98.5
Kullbergska	246	98.0	98.8
Kungälv	208	99.0	97.1
Lindesberg	416	100.0	100.0
Ljungby	149	90.6	98.0
Luleå-Hermelinen	19	100.0	0.0
Lund	45	95.6	97.8
Lycksele	155	96.8	98.7
Löwenströmska (Ortho Center)	465	99.4	98.9

Hospital 2017	Number	SKAR-percent	NPR percent
Mora	197	99.0	98.0
Motala	603	99.3	99.7
Nacka	179	96.6	95.5
Norrköping Vrinnevisjh.	176	99.4	100.0
Norrtälje	158	96.2	99.4
NU-sjukvården***	252	98.0	98.8
Nyköping	106	96.2	98.1
Ortho Center IFK-Kliniken	157	99.4	52.2
Ortopediska Huset	734	98.0	92.0
Oskarshamn	372	99.5	99.7
Piteå	306	98.4	98.0
Ryhov	13	84.6	100.0
S:t Göran	542	95.8	96.9
Sahlgrenska****	504	74.8	98.6
Skaraborgs sjukhus*****	334	96.7	97.6
Skellefteå	79	97.5	98.7
Sollefteå	210	98.1	99.5
Sophiahemmet	226	97.3	98.7
Sundsvall	5	100.0	100.0
Södersjukhuset	286	98.6	100.0
Södertälje	150	98.0	97.3
Södra Älvsborgs sjukhus**	205	95.6	97.1
Torsby	133	95.5	98.5
Trelleborg	791	99.2	99.6
Umeå	130	92.3	95.4
Varberg	213	100.0	99.1
Visby	103	94.2	92.2
Värnamo	199	96.5	98.5
Västervik	84	96.4	100.0
Västerås	292	91.8	95.2
Växjö	77	100.0	100.0
Ängelholm	350	98.0	98.9
Örebro	11	72.7	100.0
Örnsköldsvik	172	99.4	98.8
Östersund	173	94.8	96.5
Övriga vårdenheter	5	20.0	100.0

* Blekingesjukhuset is the combined name for the hospitals in Karlshamn and Karlskrona.
** Hallands sjukhus includes Halmstad and Varberg (which both are in the list) as well as Kungsbacka.
*** NU-Sjukvården includes Uddevalla and Norra Älvsborgs sjukhus (NÄL).
**** Sahlgrenska also includes Mölndal and Östra.
***** Skaraborgs sjukhus includes Lidköping, Skövde, Falköping and Mariestad.
****** Södra Älvsborgs sjukhus includes Borås and Skene.

Validation of data quality

Background

The SKAR has been validated using a mail survey to patients (Robertsson et al. 1999) as well as by yearly comparisons against data in the National Patient Register (NPR) since 2007. All Swedish hospitals that routinely perform knee arthroplasty surgery report to the register and for several years the comparisons against the NPR have shown around 97% completeness (see previous page).

January 1st, 2009, the register added 13 new variables concerning operative technique, prophylactic treatment and additional data about the patient. Such information is difficult to validate by comparison to other registries and in order to judge the accuracy in the reporting it has to be validated at the reporting hospital by review of patient records. This is essential to discover problems that can be addressed by targeted improvement measures at the register or at the hospitals.

The aim

The aim of validating the data quality is to investigate the accuracy of the information in the register as compared to that in hospital records. This provides us with knowledge regarding the quality of the entered data and helps us assess if the information has the quality allowing for reliable statistical analyses and process measures.

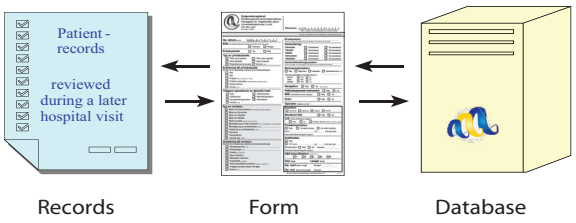
Method of validation at the hospital level

Nine hospitals that performed more than 50 arthroplasties a year were randomly selected from around the country. The hospitals were each asked to produce patient records (incl. op- and anesthesia reports) for 25 consecutive primary knee arthroplasty operations performed after March 1st 2010.

In this way it was possible to examine 225 surgeries. This was considered an adequate statistical selection as the data quality in the SKAR has been found to be good. Thus, by assuming the information for a variable to be correct in at least 90 percent of cases, 180 surgeries would allow for estimating the accuracy in the reporting within a reasonable confidence interval.

During the winter 2011/2012 the hospital was visited by staff from the SKAR that together with the local contact secretary/contact physician filled in a new reporting form using the information found in the hospital records.

The data of the new form filled in on location were compared to the original paper form that had been sent to SKAR as well as to what had been entered into the register database.



Patient data gathered during the hospital visit are compared to the form prevousoy sent to the register and again to the information that was entered into the register database.

Since this validation of the nine hospitals in 2010, 26 additional hospitals were validated 2012-2016. Depending on the resources of the register, the number of hospitals visited has varied from 3 to 8 a year. The approach has been the same as for the original validation with the exception that revisions and re-operations were also included.

Results

A summary of the validation results 2010-2016 is shown in the table on the next page. In all, information on 957 surgeries has been validated (900 primaries, 53 revisions and 4 re-operations). Only one revision was missing in the SKAR.

The majority of the hospitals had electronic medical records althogh paper records also existed. The majority of the anesthesia records were paper forms that had been scanned, although completely computerized anesthesia records existed.

Summary

No hospital visits for validation were performed during the last 2 years because of reduced financial resources. We hope to be able to resume the validation and continue until all the reporting units have been visited.

Besides being an important quality control, the validation visits have resulted in improved routines and understanding between register- and hospital staff which has facilitated cooperation and in turn improved the registration.

Summary of data validation 2010-2016

Overview of variables:	Difference between the original form and the SKAR database	Difference between the original form and hospital records	Information on reported data is not found
Number	**n (%)**	**n (%)**	**n (%)**
3,832 Essential data (date, hospital, laterality, diagnosis)	15 (<1)	27 (<1)	0 (0)
7,533 Part No and/or fixation	63 (<1)	8 (<1)	196 (2.6)
900 Information on previous surgery	5 (<1)	122 (13.6)	6 (<1)
4,770 Surgical variables	6 (<1)	105 (2.2)	27 (<1)
6,78 Prophylaxis	23 (<1)	318 (4.8)	48 (<1)
Specific variables:			
Number	**n (%)**	**n (%)**	**n (%)**
953 Planned length of AB treatment	3 (<1)	44 (4.7)	19 (2)
Number	**λ minutes**	**more than 15 min**	**n (%)**
953 Preop admin of AB (minutes)	0.5	170 (18.7)	46 (5.1)
Number	**λ days**	**more than 1 week**	**n (%)**
953 Planned thromboprhylaxis (days)	0.8	32 (3.5)	36 (3.9)
Number	**n (%)**	**n (%)**	**n (%)**
953 Type of anaesthesia	2 (<1)	43 (4.6)	16 (1.7)
Number	**λ cm/kg**	**λ cm/kg**	**n (%)**
953 Height	0.5	1.2	21 (2.2)
953 Weight	0.2	0.8	23 (2.5)
Number	**λ start (minutes)**	**λ start (minutes)**	**n (%)**
953 Surgery time	0	4.8	35 (3.8)
Number	**λ end (minutes)**	**λ end (minutes)**	**n (%)**
953 Surgery time	0	14.5	35 (3.8)
Number	**n (%)**	**n (%)**	**n (%)**
953 ASA	0	65 (7)	15 (1.6)

The value of the register for healthcare

Background

The Swedish knee project (The Swedish Knee Arthroplasty Register / SKAR) was initiated in 1974 by the Swedish Orthopedic Society and is the oldest Swedish quality register and the first national arthroplasty register in the world. It has been a model for registries in other countries and the international interest has resulted in the annual report being published in English for over 15 years and being downloaded more than 1,000 times a year. Scientific articles have been published and results of studies have been presented regularly at national and international meetings. The register cooperates with other registers, authorities and individual researchers, in and outside Sweden.

In 2018, almost 15,500 primary knee arthroplasties were performed to the cost of more than 1 billion SEK. Additionally almost 1,000 revisions were performed (approx. 200 million SEK). Using a fraction of this cost for quality control and improvement work within the field of knee arthroplasty surgery seems reasonable.

The basic value

The main function of the register has been to describe the knee arthroplasty surgery performed in the Swedish health care system. What patients are treated, what methods and implants are used, how the results are affected and how the patients experience their treatment. Without such information it is not possible for the profession or decision makers to realize that their own routines may not be the most optimal or cost-effective. The patients gain knowledge on what the can expect, why some methods are preferred and if and when it is appropriate to have surgery.

As the only orthopedic register, SKAR has for the last 19 years registered both Part- and Lot numbers for the inserted components. This means that SKAR can quickly identify a part from a specific production batch in a patient, in case this becomes necessary. As of 2020 the EU will have stricter rules concerning medical equipment in class 3 (covering knee implants) that requires that implants can be identified in patients this way. That the SKAR has done it for 19 years shows its engagement concerning patient safety.

The register contributes to new knowledge by performing research. E.g. a recently published study showing that the routinely used antibiotic for patients allergic to penicillin, does not seem to provide the same cover as the ordinary prophylaxis which may change praxis in Sweden with respect to the handling of patients that state they have reacted to penicillin (see publication list on page 93).

Feedback

Collecting data on its own does not contribute to better healthcare. The information has to be compiled, analyzed, summarized and reported.

The register reports in several ways; verbally, in print and on the internet. At annual meetings, contact surgeons from the participating hospitals are informed. Each unit receives their own data annually so they have the opportunity to check their own results. By publication of annual reports and scientific articles, as well as through participation in national and international conferences the register disseminates information to professionals, administrators and other interested bodies.

The register has a web-site (www.knee.se) where annual reports can be downloaded and a list of publications are available. There is also a secure server where the contact physicians at the participating units can access the information that their unit has delivered to the registry and which includes information on primaries having been revised elsewhere. The register website (www.knee.se) has an open statistics section in which it is possible to get information for the country as a whole as well as for individual counties and hospitals.

There is also a separate website for patients (www.gangbar.se) where they can find practical information before surgery on how they can prepare themselves, what they can expect and how they can exercise when they come home after surgery. During the first 6 months of 2018, the website had almost 27,000 visits by 19,000 users which indicates that the patients are interested in the information provided.

Is the information from the registry used?

If not utilized, information on its own does not result in a better health care. That the register actually is being used at the hospitals providing data was shown 2011 in a survey among the contact surgeons. 73% stated that they had distributed information from the registry to their colleagues at the hospital and 53% stated that their presentations had in fact resulted in changes at their hospitals. This is gratifying because the register on its own cannot effectuate changes at the hospitals unless the changes are rooted locally.

The survey also shows that the hospitals around the country have trust in the results provided and the data reported to the registry.

Indirect signs of register data being used can be seen by how inferior implants have disappeared from the market, in the improved compliance to recommended prophylactic routines when the register started registering the prophylaxis as well as the diminishing revision rate over the years that has resulted in Sweden having the world lowest proportion of revisions.

Improvement projects

In order to use register data for improvement projects there have to be outcomes that are possible to improve. It may be about the hospital having more revisions than on average, poor compliance to recommended prophylactic routines, less or more use of certain methods than other hospitals or deviant patient reported outcome.

A printed version of the annual report is sent to all contact surgeons, heads of departments and academic representatives. In many cases the information in the annual report can be used directly as a basis for local improvement initiatives but sometimes additional information is needed. We can only ascertain that the register is contacted by a number of hospitals every year that want supplementary information in order to carry out local quality controls or improvement initiatives.

Identifying prioritized fields for improvement

In order to find processes that can be improved it has to be possible to describe how improvement should occur.

It is apparent for indicators such as implant survival, patient health and satisfaction that it is possible to aim for 100%. As no hospital has such results, every hospital can theoretically improve, although it obviously is most important for those with results inferior to the average.

For many other indicators it is more difficult, such as the distribution of diagnoses, implants and surgical methods used, prophylaxis, type of anesthesia, ASA grade etc. E.g., as compared to other countries we consider it favorable that surgery of younger patients is unusual in Sweden, because the younger have a high failure rate. However, we do not know if the reason is, that the younger in Sweden have less need for knee arthroplasty surgery or if there is less tendency to offer them surgery. In case of a hospital having a higher proportion of younger patients, we do not know if this is because younger patients to a higher degree attend or are being referred to that hospital. Thus, we are not able to tell if the proportion is proper or not. The same applies for surgical methods, e.g. the use of CAS (computer aided surgery), for which we have no prerequisites to recommend that a specific proportion of patients should be treated using the method.

The information we deliver can however be important for head of departments and administrators which may discover that their hospital to a larger extent than other hospitals is using an expensive method and can examine the reasons and if they are warranted.

A focus area is prosthetic infection which today is the most common and serious complication after knee arthroplasty surgery. A contributing factor may be latent diabetes or poorly controlled type 2 diabetes which we plan to study in a pilot project. The register has also started gathering microbial culture results in order to increase the precision in the registration of infections and to map the antibiotic resistance evolution.

Research is needed to find other improvement areas than those that we consider obvious, and in that case the register is mainly a hypothesis generator. Even without providing specific targets, the information on processes and indicators, provided by the registry, may stimulate to new guidelines being introduced and monitored. However, in order to create national guidelines consensus is needed among experts in workgroups created specifically for that purpose.

Summary

We consider the register itself being a large improvement project that since the start has contributed to the continuous improvement of outcome after knee arthroplasty and leading to Sweden having the lowest revision rate in the world. As compared to one of our closest neighboring countries this implies reduced costs by at least SEK 100 million/year.

Information fed back from the registry has warned against inferior techniques and implants, stimulated hospitals and surgeons to improve processes and routines, disclosed regional differences etc. It is important that this control of quality and improvement work continues as new implants and techniques are continuously being introduced that need monitoring and evaluation.

Adverse events within 90 days of knee arthroplasty 2015-2017

Introduction

Resurfacing a damaged joint considerably improves quality of life, making joint replacements among the most cost-effective interventions. Although the procedure is considered safe with few complications, some patients experience health problems that may have been caused by, or become symptomatic as a result of the surgery.

Of historical and practical reasons, the Knee Arthroplasty Register (SKAR) has focused on reoperations in the knee and not registered other health issues. However, the national patient register (NPR) does that by registering ICD- and procedure codes for all patients treated in the official health system.

The SKAR has together with Registerservice, of the National Board of Health and Welfare, examined the codes that occur in the NPR during admission for, and after knee arthroplasty in order to identify codes that may represent adverse events when they occur during the hospital stay or in readmissions within 90 days of surgery.

This resulted in the classifaction of adverse events used here, which also was taken into use for knee surgery by the National Board of Health and Welfare in their publication "Öppna Jämförelser - Säker vård" as well as when accounting for adverse events on the website "Vården i Siffror" (https://vardenisiffror.se/),

Description

Patients having primary total knee arthroplasty for osteoarthritis during 2015-2017 were included. If both knees were operated within 90 days only the latter was included and only one knee in the case of simultaneous bilateral surgery. The SKAR sent data on registered patients to the NPR which performed the match. For all the patients it was examined if they had received diagnostic and/or procedure codes that corresponded to the definition of adverse events, during or after the hospital stay and up to 90 days after the primary surgery.

The codes were classified into the following groups:

A) Surgical procedure codes that include reoperations of knee implants and other procedures that may represent a complication.

DA) Diagnostic codes that imply surgical complications.

DB) Diagnostic codes that cover knee related diseases that may have been used for complications after knee arthroplasty surgery.

DC) Diagnostic codes covering cardiovascular events that may be related to the surgery.

DM) Diagnostic codes concerning other medical events not related to the knee but that may be related to the surgery if they occur shortly afterwards.

Additionally it was checked if patients had died during the first 90 days.

The codes and information on how they were used can be found on page 91.

Error sources

The definition of an adverse event is based on diagnostic and procedure codes and there may be differences between counties and units in how carefully the coding has been performed. However, information on death is not dependent on coding.

Inadequate registration in the NPR of secondary surgical dates during the primary hospital stay can result in an adverse event not being included.

Occasional units performing knee arthroplasty surgery do not report to the NPR. For these, adverse events occurring during the primary admission will not be included..

As the information in the NPR on laterality of the surgery is uncertain a complication in the opposite knee will count as an adverse event. However, we consider it unlikely that a complication or a procedure will be registered in the opposite knee within 90 days of surgery.

Finally it is important to realize that many adverse events (especially the medical ones) do not need to be causally related to the surgery. E.g. a patient might have a heart attack or die even without having an arthroplasty. This implies that regional differences in general health, access to health care and preventive medicine may influence the outcome.

Results

In the following pages we show for the different counties and units what adverse events occurred within 90 days (surgical, cardiovascular, other medical, death and all adverse events). Note that only one adverse event is counted for a patient within each group while the same patient can occur in multiple groups.

WOMEN in the counties

Adverse surgical events within 90 days (A, DA & DB)

County	Surgeries	Events	Risk/1000
Blekinge	412	5	12.1
Dalarna	672	24	35.7
Gotland	121	3	24.8
Gävleborg	772	12	15.5
Halland	1,175	31	26.4
Jämtland	232	9	38.8
Jönköping	759	18	23.7
Kalmar	801	27	33.7
Kronoberg	286	14	49.0
Norrbotten	479	9	18.8
Skåne	2,981	63	21.1
Stockholm	4,274	112	26.2
Sörmland	486	14	28.8
Uppsala	756	21	27.8
Värmland	659	23	34.9
Västerbotten	491	31	63.1
Västernorrland	484	18	37.2
Västmanland	365	10	27.4
Västra Götaland	2,972	68	22.9
Örebro	651	15	23.0
Östergötland	816	41	50.2
The Country	20,644	568	27.5

MEN in the counties

Adverse surgical events within 90 days (A, DA & DB)

County	Surgeries	Events	Risk/1000
Blekinge	357	13	36.4
Dalarna	553	20	36.2
Gotland	107	6	56.1
Gävleborg	621	9	14.5
Halland	972	30	30.9
Jämtland	158	4	25.3
Jönköping	634	21	33.1
Kalmar	647	28	43.3
Kronoberg	247	5	20.2
Norrbotten	402	12	29.9
Skåne	2,155	62	28.8
Stockholm	3,226	100	31.0
Sörmland	387	9	23.3
Uppsala	554	20	36.1
Värmland	538	22	40.9
Västerbotten	385	31	80.5
Västernorrland	361	15	41.6
Västmanland	234	6	25.6
Västra Götaland	2,409	77	32.0
Örebro	482	19	39.4
Östergötland	621	23	37.0
The Country	16,050	532	33.1

Adverse cardiovascular events within 90 days (DC)

County	Surgeries	Events	Risk/1000
Blekinge	412	2	4.9
Dalarna	672	8	11.9
Gotland	121	0	0.0
Gävleborg	772	10	13.0
Halland	1,175	4	3.4
Jämtland	232	4	17.2
Jönköping	759	2	2.6
Kalmar	801	2	2.5
Kronoberg	286	2	7.0
Norrbotten	479	1	2.1
Skåne	2,981	21	7.0
Stockholm	4,274	21	4.9
Sörmland	486	0	0.0
Uppsala	756	7	9.3
Värmland	659	1	1.5
Västerbotten	491	3	6.1
Västernorrland	484	5	10.3
Västmanland	365	7	19.2
Västra Götaland	2,972	22	7.4
Örebro	651	2	3.1
Östergötland	816	4	4.9
The Country	20,644	128	6.2

Adverse cardiovascular events within 90 days (DC)

County	Surgeries	Events	Risk/1000
Blekinge	357	3	8.4
Dalarna	553	3	5.4
Gotland	107	1	9.3
Gävleborg	621	10	16.1
Halland	972	3	3.1
Jämtland	158	3	19.0
Jönköping	634	1	1.6
Kalmar	647	5	7.7
Kronoberg	247	3	12.1
Norrbotten	402	4	10.0
Skåne	2,155	19	8.8
Stockholm	3,226	20	6.2
Sörmland	387	2	5.2
Uppsala	554	4	7.2
Värmland	538	9	16.7
Västerbotten	385	3	7.8
Västernorrland	361	4	11.1
Västmanland	234	3	12.8
Västra Götaland	2,409	18	7.5
Örebro	482	5	10.4
Östergötland	621	6	9.7
The Country	16,050	129	8.0

Other adverse medical events within 90 days. (DM)

County	Surgeries	Events	Risk/1000
Blekinge	412	2	4.9
Dalarna	672	3	4.5
Gotland	121	1	8.3
Gävleborg	772	5	6.5
Halland	1,175	6	5.1
Jämtland	232	5	21.6
Jönköping	759	8	10.5
Kalmar	801	11	13.7
Kronoberg	286	2	7.0
Norrbotten	479	2	4.2
Skåne	2,981	27	9.1
Stockholm	4,274	62	14.5
Sörmland	486	2	4.1
Uppsala	756	7	9.3
Värmland	659	6	9.1
Västerbotten	491	12	24.4
Västernorrland	484	6	12.4
Västmanland	365	2	5.5
Västra Götaland	2,972	26	8.7
Örebro	651	4	6.1
Östergötland	816	10	12.3
The Country	20,644	209	10.1

Other adverse medical events within 90 days. (DM)

County	Surgeries	Events	Risk/1000
Blekinge	357	7	19.6
Dalarna	553	3	5.4
Gotland	107	0	0.0
Gävleborg	621	6	9.7
Halland	972	6	6.2
Jämtland	158	5	31.6
Jönköping	634	2	3.2
Kalmar	647	29	44.8
Kronoberg	247	2	8.1
Norrbotten	402	0	0.0
Skåne	2,155	34	15.8
Stockholm	3,226	64	19.8
Sörmland	387	4	10.3
Uppsala	554	6	10.8
Värmland	538	6	11.2
Västerbotten	385	23	59.7
Västernorrland	361	10	27.7
Västmanland	234	3	12.8
Västra Götaland	2,409	34	14.1
Örebro	482	3	6.2
Östergötland	621	8	12.9
The Country	16,050	255	15.9

WOMEN in the counties
Death within 90 days

County	Surgeries	Events	Risk/1000
Blekinge	412	1	2.4
Dalarna	672	0	0.0
Gotland	121	1	8.3
Gävleborg	772	0	0.0
Halland	1,175	1	0.9
Jämtland	232	0	0.0
Jönköping	759	0	0.0
Kalmar	801	0	0.0
Kronoberg	286	0	0.0
Norrbotten	479	0	0.0
Skåne	2,981	2	0.7
Stockholm	4,274	1	0.2
Sörmland	486	1	2.1
Uppsala	756	0	0.0
Värmland	659	0	0.0
Västerbotten	491	1	2.0
Västernorrland	484	1	2.1
Västmanland	365	0	0.0
Västra Götaland	2,972	2	0.7
Örebro	651	0	0.0
Östergötland	816	4	4.9
The Country	20,644	15	0.7

MEN in the counties
Death within 90 days

County	Surgeries	Events	Risk/1000
Blekinge	357	1	2.8
Dalarna	553	2	3.6
Gotland	107	0	0.0
Gävleborg	621	1	1.6
Halland	972	1	1.0
Jämtland	158	1	6.3
Jönköping	634	1	1.6
Kalmar	647	3	4.6
Kronoberg	247	0	0.0
Norrbotten	402	2	5.0
Skåne	2,155	7	3.2
Stockholm	3,226	2	0.6
Sörmland	387	0	0.0
Uppsala	554	1	1.8
Värmland	538	1	1.9
Västerbotten	385	0	0.0
Västernorrland	361	1	2.8
Västmanland	234	1	4.3
Västra Götaland	2,409	4	1.7
Örebro	482	2	4.1
Östergötland	621	0	0.0
The Country	16,050	31	1.9

All adverse events within 90 days (incl. death)

County	Surgeries	Events	Risk/1000
Blekinge	412	10	24.3
Dalarna	672	32	47.6
Gotland	121	4	33.1
Gävleborg	772	24	31.1
Halland	1,175	40	34.0
Jämtland	232	17	73.3
Jönköping	759	27	35.6
Kalmar	801	39	48.7
Kronoberg	286	17	59.4
Norrbotten	479	12	25.1
Skåne	2,981	102	34.2
Stockholm	4,274	179	41.9
Sörmland	486	16	32.9
Uppsala	756	35	46.3
Värmland	659	30	45.5
Västerbotten	491	45	91.6
Västernorrland	484	27	55.8
Västmanland	365	17	46.6
Västra Götaland	2,972	115	38.7
Örebro	651	20	30.7
Östergötland	816	55	67.4
The Country	20,644	863	41.8

All adverse events within 90 days (incl. death)

County	Surgeries	Events	Risk/1000
Blekinge	357	22	61.6
Dalarna	553	27	48.8
Gotland	107	7	65.4
Gävleborg	621	25	40.3
Halland	972	39	40.1
Jämtland	158	13	82.3
Jönköping	634	25	39.4
Kalmar	647	57	88.1
Kronoberg	247	9	36.4
Norrbotten	402	17	42.3
Skåne	2,155	116	53.8
Stockholm	3,226	174	53.9
Sörmland	387	15	38.8
Uppsala	554	30	54.2
Värmland	538	37	68.8
Västerbotten	385	54	140.3
Västernorrland	361	28	77.6
Västmanland	234	13	55.6
Västra Götaland	2,409	128	53.1
Örebro	482	27	56.0
Östergötland	621	34	54.8
The Country	16,050	897	55.9

The unadjusted tables, for the counties above and for the hospitals on the following pages, show the adverse events occurring during the primary stay or within 90 days or surgery.

It can be seen that adverse events are more common for men in all the groups. This is also true after adjustment for age (not shown). As compared to last year the number of events is fewer in all the groups. Surgical events which may include aspirations, wound problems, manipulation under anesthesia, hematoma etc. occur in 3.0% of the patients. The "true revisions" in which implant components are added, removed or exchanged, and which the SKAR focuses on, account for less than one fifth of the adverse events the first three months. Cardiovascular events occur in 0.7% and other adverse medical events in 1.3% while only 0.13% die within the first 90 days. The overall risk for a patient for experiencing a least one adverse event during this time is 4.8%.

It may be helpful to have access to this information when patients are informed about possible risks associated with the surgery.

It can be problematic to compare the number of adverse events between hospitals and counties as there may be a variation in how events are coded. Anyhow, the numbers provide useful information of how common adverse events are at the different locations and may indicate where additional analyses and improvement measures are indicated.

Age- and sex adjusted results for the counties
Death within 90 days

County	Surgeries	Events	Risk/1000
Blekinge	769	2	2.4
Dalarna	1,225	2	1.5
Gotland	228	1	4.8
Gävleborg	1,393	1	0.8
Halland	2,147	2	1.0
Jämtland	390	1	2.5
Jönköping	1,393	1	0.6
Kalmar	1,448	3	2.2
Kronoberg	533	0	0.0
Norrbotten	881	2	2.0
Skåne	5,136	9	1.7
Stockholm	7,500	3	0.5
Sörmland	873	1	1.2
Uppsala	1,310	1	0.9
Värmland	1,197	1	1.0
Västerbotten	876	1	1.2
Västernorrland	845	2	2.1
Västmanland	599	1	1.5
Västra Götaland	5,381	6	1.1
Örebro	1,133	2	2.0
Östergötland	1,437	4	2.6
The Country	36,694	46	1.3

Age- and sex adjusted results for the counties
All adverse events within 90 days (incl. death)

County	Surgeries	Events	Risk/1000
Blekinge	769	31	39.9
Dalarna	1,225	58	47.8
Gotland	228	12	53.0
Gävleborg	1,393	48	34.8
Halland	2,147	79	36.9
Jämtland	390	30	76.5
Jönköping	1,393	51	36.6
Kalmar	1,448	98	67.6
Kronoberg	533	26	49.5
Norrbotten	881	28	32.2
Skåne	5,136	216	42.0
Stockholm	7,500	364	48.5
Sörmland	873	31	35.4
Uppsala	1,310	65	49.8
Värmland	1,197	68	56.5
Västerbotten	876	100	113.8
Västernorrland	845	55	64.5
Västmanland	599	30	49.3
Västra Götaland	5,381	245	45.5
Örebro	1,133	46	40.9
Östergötland	1,437	89	61.6
The Country	36,694	1,760	48.0

The tables above show age- and gender adjusted results for the counties concerning death as well as all adverse events. It can be seen for all adverse events that there is considerable variation between the counties in spite of the adjstment. This is also true for the number of deaths which are differently registered and not affected by differences in coding.

The following tables show the unadjusted number of adverse events in the different hospitals. It might be of interest for individual hospitals to receive information om which of their patients were affected. However, as the SKAR only receives aggregated information from the PAR we unfortunately do not have access to this information.

Adverse surgical events within 90 days (A, DA & DB)

Hospital (men & women)	Surgeries	Events	Risk/1000
Akademiska sjukhuset	251	19	75.7
Alingsås	539	15	27.8
Art Clinic Gbg	169	2	11.8
Art Clinic Jönköping	119	0	0.0
Arvika	490	17	34.7
Bollnäs	896	10	11.2
Borås	198	8	40.4
Capio Artro Clinic	214	3	14.0
Carlanderska	496	2	4.0
Danderyd	317	10	31.5
Eksjö-Nässjö	561	17	30.3
Enköping	1,059	22	20.8
Eskilstuna	152	10	65.8
Falun	654	22	33.6
Frölunda Spec.	123	1	8.1
Gällivare	148	4	27.0
Gävle	289	6	20.8
Halmstad	520	29	55.8
Halmstad Capio	1,200	18	15.0
Helsingborg	124	2	16.1
Huddinge	325	15	46.2
Hudiksvall	208	5	24.0
Hässleholm	1,910	64	33.5
Jönköping	272	5	18.4
Kalmar	255	6	23.5
Karlshamn	769	18	23.4
Karlskoga	239	5	20.9
Karlstad	394	19	48.2
Karolinska	171	10	58.5
Kullbergska sjukhuset	503	12	23.9
Kungälv	480	19	39.6
Lidköping	694	25	36.0
Lindesberg	832	28	33.7
Ljungby	307	13	42.3
Luleå-Hermelinen	34	1	29.4
Lund	162	4	24.7
Lycksele	290	17	58.6
Mora	571	22	38.5
Motala	1,010	47	46.5
Mölndal	1,142	32	28.0
Nacka-Proxima/Aleris	470	5	10.6
Norrköping	427	17	39.8
Norrtälje	339	19	56.0
Nyköping	218	1	4.6
Ortho Center Stockh.(Löw)	1 251	11	8.8
OrthoCenter IFK Klin	383	3	7.8
Ortopediska huset	1,728	21	12.2
Oskarshamn	927	33	35.6
Piteå	699	16	22.9
S:t Göran	1,201	49	40.8
Sabbatsberg	23	0	0.0
Skellefteå	265	11	41.5
Skene	298	6	20.1
Skövde	289	12	41.5
Sollefteå	388	18	46.4
Sophiahemmet	289	8	27.7
Sundsvall	55	1	18.2
Södersjukhuset	763	47	61.6
Södertälje	409	14	34.2
Torsby	313	9	28.8
Trelleborg	2,163	33	15.3
Uddevalla	570	20	35.1
Umeå	321	34	105.9
Varberg	427	14	32.8
Visby	228	9	39.5
Värnamo	441	17	38.5
Västervik	266	16	60.2
Västerås	599	16	26.7
Växjö	226	6	26.5
Ängelholm	776	22	28.4
Örebro	62	1	16.1
Örnsköldsvik	402	14	34.8
Östersund	390	13	33.3
The Country	36,694	1,100	30.0

Adverse cardiovascular events within 90 days (DC)

Hospital (men & women)	Surgeries	Events	Risk/1000
Akademiska sjukhuset	251	2	8.0
Alingsås	539	2	3.7
Art Clinic Gbg	169	1	5.9
Art Clinic Jönköping	119	0	0.0
Arvika	490	4	8.2
Bollnäs	896	13	14.5
Borås	198	5	25.3
Capio Artro Clinic	214	2	9.3
Carlanderska	496	4	8.1
Danderyd	317	3	9.5
Eksjö-Nässjö	561	1	1.8
Enköping	1,059	9	8.5
Eskilstuna	152	0	0.0
Falun	654	6	9.2
Frölunda Spec.	123	2	16.3
Gällivare	148	0	0.0
Gävle	289	5	17.3
Halmstad	520	2	3.8
Halmstad Capio	1,200	3	2.5
Helsingborg	124	2	16.1
Huddinge	325	1	3.1
Hudiksvall	208	2	9.6
Hässleholm	1,910	14	7.3
Jönköping	272	2	7.4
Kalmar	255	2	7.8
Karlshamn	769	5	6.5
Karlskoga	239	0	0.0
Karlstad	394	5	12.7
Karolinska	171	1	5.8
Kullbergska sjukhuset	503	1	2.0
Kungälv	480	5	10.4
Lidköping	694	7	10.1
Lindesberg	832	7	8.4
Ljungby	307	5	16.3
Luleå-Hermelinen	34	1	29.4
Lund	162	3	18.5
Lycksele	290	3	10.3
Mora	571	5	8.8
Motala	1,010	7	6.9
Mölndal	1,142	11	9.6
Nacka-Proxima/Aleris	470	2	4.3
Norrköping	427	3	7.0
Norrtälje	339	1	2.9
Nyköping	218	1	4.6
Ortho Center Sth.(Löw)	1,251	3	2.4
OrthoCenter IFK Klin	383	1	2.6
Ortopediska huset	1,728	3	1.7
Oskarshamn	927	3	3.2
Piteå	699	4	5.7
S:t Göran	1,201	14	11.7
Sabbatsberg	23	0	0.0
Skellefteå	265	3	11.3
Skene	298	0	0.0
Skövde	289	0	0.0
Sollefteå	388	5	12.9
Sophiahemmet	289	0	0.0
Sundsvall	55	2	36.4
Södersjukhuset	763	7	9.2
Södertälje	409	4	9.8
Torsby	313	1	3.2
Trelleborg	2,163	16	7.4
Uddevalla	570	2	3.5
Umeå	321	0	0.0
Varberg	427	2	4.7
Visby	228	1	4.4
Värnamo	441	0	0.0
Västervik	266	2	7.5
Västerås	599	10	16.7
Växjö	226	0	0.0
Ängelholm	776	4	5.2
Örebro	62	0	0.0
Örnsköldsvik	402	2	5.0
Östersund	390	7	17.9
The Country	**36,694**	**257**	**7.0**

Other adverse medical events within 90 days. (DM)

Hospital (men & women)	Surgeries	Events	Risk/1000
Akademiska sjukhuset	251	4	15.9
Alingsås	539	5	9.3
Art Clinic Gbg	169	0	0.0
Art Clinic Jönköping	119	0	0.0
Arvika	490	3	6.1
Bollnäs	896	8	8.9
Borås	198	5	25.3
Capio Artro Clinic	214	0	0.0
Carlanderska	496	4	8.1
Danderyd	317	20	63.1
Eksjö-Nässjö	561	5	8.9
Enköping	1,059	9	8.5
Eskilstuna	152	1	6.6
Falun	654	5	7.6
Frölunda Spec.	123	0	0.0
Gällivare	148	0	0.0
Gävle	289	2	6.9
Halmstad	520	5	9.6
Halmstad Capio	1,200	4	3.3
Helsingborg	124	2	16.1
Huddinge	325	14	43.1
Hudiksvall	208	1	4.8
Hässleholm	1,910	30	15.7
Jönköping	272	2	7.4
Kalmar	255	8	31.4
Karlshamn	769	9	11.7
Karlskoga	239	1	4.2
Karlstad	394	6	15.2
Karolinska	171	7	40.9
Kullbergska sjukhuset	503	1	2.0
Kungälv	480	9	18.8
Lidköping	694	10	14.4
Lindesberg	832	6	7.2
Ljungby	307	4	13.0
Luleå-Hermelinen	34	0	0.0
Lund	162	7	43.2
Lycksele	290	4	13.8
Mora	571	1	1.8
Motala	1,010	7	6.9
Mölndal	1,142	7	6.1
Nacka-Proxima/Aleris	470	0	0.0
Norrköping	427	11	25.8
Norrtälje	339	6	17.7
Nyköping	218	4	18.3
Ortho Center Sth.(Löw)	1,251	5	4.0
OrthoCenter IFK Klin	383	4	10.4
Ortopediska huset	1,728	10	5.8
Oskarshamn	927	28	30.2
Piteå	699	2	2.9
S:t Göran	1,201	19	15.8
Sabbatsberg	23	0	0.0
Skellefteå	265	10	37.7
Skene	298	3	10.1
Skövde	289	5	17.3
Sollefteå	388	6	15.5
Sophiahemmet	289	2	6.9
Sundsvall	55	0	0.0
Södersjukhuset	763	29	38.0
Södertälje	409	14	34.2
Torsby	313	3	9.6
Trelleborg	2,163	19	8.8
Uddevalla	570	8	14.0
Umeå	321	21	65.4
Varberg	427	3	7.0
Visby	228	1	4.4
Värnamo	441	3	6.8
Västervik	266	4	15.0
Västerås	599	5	8.3
Växjö	226	0	0.0
Ängelholm	776	3	3.9
Örebro	62	0	0.0
Örnsköldsvik	402	10	24.9
Östersund	390	10	25.6
The Country	**36,694**	**464**	**12.6**

Death within 90 days

Hospital (men & women)	Surgeries	Events	Risk/1000
Akademiska sjukhuset	251	1	4.0
Alingsås	539	2	3.7
Art Clinic Gbg	169	0	0.0
Art Clinic Jönköping	119	0	0.0
Arvika	490	1	2.0
Bollnäs	896	0	0.0
Borås	198	1	5.1
Capio Artro Clinic	214	0	0.0
Carlanderska	496	0	0.0
Danderyd	317	0	0.0
Eksjö-Nässjö	561	0	0.0
Enköping	1,059	0	0.0
Eskilstuna	152	0	0.0
Falun	654	1	1.5
Frölunda Spec.	123	0	0.0
Gällivare	148	0	0.0
Gävle	289	1	3.5
Halmstad	520	1	1.9
Halmstad Capio	1,200	1	0.8
Helsingborg	124	1	8.1
Huddinge	325	0	0.0
Hudiksvall	208	0	0.0
Hässleholm	1,910	4	2.1
Jönköping	272	1	3.7
Kalmar	255	1	3.9
Karlshamn	769	2	2.6
Karlskoga	239	0	0.0
Karlstad	394	0	0.0
Karolinska	171	0	0.0
Kullbergska sjukhuset	503	0	0.0
Kungälv	480	0	0.0
Lidköping	694	1	1.4
Lindesberg	832	2	2.4
Ljungby	307	0	0.0
Luleå-Hermelinen	34	0	0.0
Lund	162	2	12.3
Lycksele	290	1	3.4
Mora	571	1	1.8
Motala	1,010	2	2.0
Mölndal	1,142	0	0.0
Nacka-Proxima/Aleris	470	0	0.0
Norrköping	427	2	4.7
Norrtälje	339	0	0.0
Nyköping	218	1	4.6
Ortho Center Sth.(Löw)	1,251	0	0.0
OrthoCenter IFK Klin	383	0	0.0
Ortopediska huset	1,728	0	0.0
Oskarshamn	927	2	2.2
Piteå	699	2	2.9
S:t Göran	1,201	1	0.8
Sabbatsberg	23	0	0.0
Skellefteå	265	0	0.0
Skene	298	1	3.4
Skövde	289	0	0.0
Sollefteå	388	1	2.6
Sophiahemmet	289	0	0.0
Sundsvall	55	0	0.0
Södersjukhuset	763	2	2.6
Södertälje	409	0	0.0
Torsby	313	0	0.0
Trelleborg	2,163	1	0.5
Uddevalla	570	1	1.8
Umeå	321	0	0.0
Varberg	427	0	0.0
Visby	228	1	4.4
Värnamo	441	0	0.0
Västervik	266	0	0.0
Västerås	599	1	1.7
Växjö	226	0	0.0
Ängelholm	776	0	0.0
Örebro	62	0	0.0
Örnsköldsvik	402	1	2.5
Östersund	390	1	2.6
The Country	**36,694**	**46**	**1.3**

All adverse events within 90 days (incl. death)

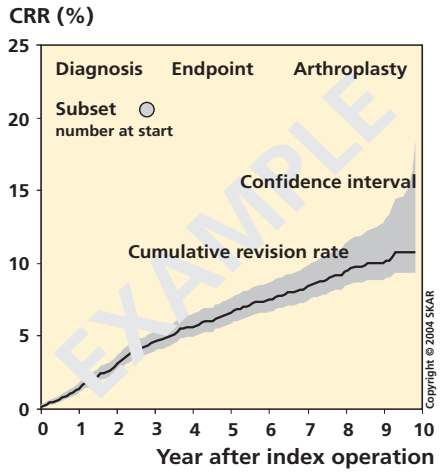
Hospital (men & women)	Surgeries	Events	Risk/1000
Akademiska sjukhuset	251	25	99.6
Alingsås	539	23	42.7
Art Clinic Gbg	169	3	17.8
Art Clinic Jönköping	119	0	0.0
Arvika	490	25	51.0
Bollnäs	896	28	31.3
Borås	198	19	96.0
Capio Artro Clinic	214	5	23.4
Carlanderska	496	10	20.2
Danderyd	317	32	100.9
Eksjö-Nässjö	561	23	41.0
Enköping	1,059	40	37.8
Eskilstuna	152	11	72.4
Falun	654	32	48.9
Frölunda Spec.	123	3	24.4
Gällivare	148	4	27.0
Gävle	289	14	48.4
Halmstad	520	36	69.2
Halmstad Capio	1,200	25	20.8
Helsingborg	124	6	48.4
Huddinge	325	29	89.2
Hudiksvall	208	7	33.7
Hässleholm	1,910	104	54.5
Jönköping	272	9	33.1
Kalmar	255	14	54.9
Karlshamn	769	32	41.6
Karlskoga	239	6	25.1
Karlstad	394	30	76.1
Karolinska	171	16	93.6
Kullbergska sjukhuset	503	14	27.8
Kungälv	480	31	64.6
Lidköping	694	40	57.6
Lindesberg	832	40	48.1
Ljungby	307	20	65.1
Luleå-Hermelinen	34	2	58.8
Lund	162	13	80.2
Lycksele	290	22	75.9
Mora	571	27	47.3
Motala	1,010	60	59.4
Mölndal	1,142	49	42.9
Nacka-Proxima/Aleris	470	7	14.9
Norrköping	427	29	67.9
Norrtälje	339	24	70.8
Nyköping	218	6	27.5
Ortho Center Sth.(Löw)	1,251	19	15.2
OrthoCenter IFK Klin	383	7	18.3
Ortopediska huset	1,728	32	18.5
Oskarshamn	927	60	64.7
Piteå	699	23	32.9
S:t Göran	1,201	78	64.9
Sabbatsberg	23	0	0.0
Skellefteå	265	24	90.6
Skene	298	10	33.6
Skövde	289	17	58.8
Sollefteå	388	28	72.2
Sophiahemmet	289	10	34.6
Sundsvall	55	3	54.5
Södersjukhuset	763	69	90.4
Södertälje	409	32	78.2
Torsby	313	12	38.3
Trelleborg	2,163	66	30.5
Uddevalla	570	31	54.4
Umeå	321	53	165.1
Varberg	427	18	42.2
Visby	228	11	48.2
Värnamo	441	20	45.4
Västervik	266	22	82.7
Västerås	599	30	50.1
Växjö	226	6	26.5
Ängelholm	776	28	36.1
Örebro	62	1	16.1
Örnsköldsvik	402	24	59.7
Östersund	390	30	76.9
The Country	**36,694**	**1 760**	**48.0**

How the register compares implants

Survival analyses are used for graphical presentation of data. The curves show the Cumulative Revision Rate (CRR) which describes what percentage of the operated patients was expected to become revised with time. The calculation is based on the sum of all the revisions and expresses the rate for surviving patients. Most often the time axis shows a 10-year period. However, it has to be kept in mind that patients are continuously being added during this time. Thus, all the patients have not been followed for the whole period. This implies that if 1,000 patients were operated on each year (and nobody dies), a 10-year study would include 10,000 patients of which only 1,000 had been followed for more than 9 years. The last part of the curve (at the right) therefore expresses the long-term rate of revision for patients operated more than 9 years earlier. As the number of these patients is relatively small, the 95% confidence interval becomes large. When the number of patients at risk is small (at the right of the curve), each revision has a large effect (e.g. 50% are revised when 2 patients are left at risk and one of them has a revision). For this reason, the Register cuts the curves when less than 40 patients are left at risk.

Survival statistics are used to calculate how long an implant is left unrevised. With increasing observation time, the fraction of deceased patients increases (figure below). These patients are not disregarded because they were at risk of becoming revised during their lifetime and are thus allowed to deliver data for the period they lived. The probability for each revision is related to the number of remaining unrevised patients. The sum of all the probabilities is the cumulative risk of revision which specifies the risk for a surviving patient of becoming revised at a given time.

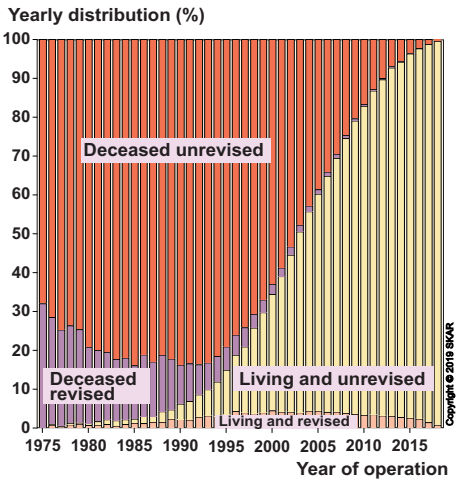
Cox regression allows for taking into account different factors that may vary within groups. The results are expressed as risk ratios (RR) between factors. If a factor is a category (e.g. implant model), one category is defined as a reference with a risk of 1 to which the other categories are compared. An implant or a unit with the risk of 1.2 thus has a 20% increased risk of becoming revised etc. For numerical variables (e.g. age) the risk ratio relates to the change in risk if the variable increases by one unit (e.g. 1 year). When comparing groups where uneven distribution of factors can be expected (e.g. age in cemented vs. uncemented implants) the Cox regression is especially important.



CRR curve example.

It is important to note that as the individual patient also is at risk of dying, the real proportion of revisions is lower than the CRR. As the figure below shows, almost 80% of the patients that were operated in 1980 have deceased without having been revised while more than half of the few still alive have been revised.

Estimating differences between units in risk of revision is complicated by their varying volumes. The reason is that units performing few operations are more likely to have overly good or bad results. Therefore, the register received help from RCSyd statisticians to calculate risks using a "shared gamma frailty model" which takes volume into consideration. Still it has to observed that the units may have different "case-mix", e.g. patients with different grades of joint destruction, differences in general health, activity etc.. Such factors, which we at are unable to take into account, may influence the risk of revision and thus the results of individual units.



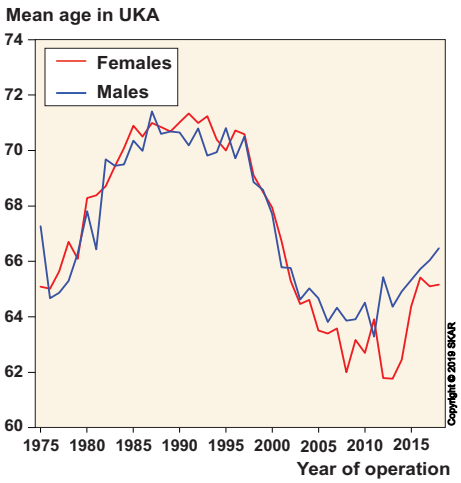
The present status for each yearly batch of patients operated since 1975.

Gender and age distribution

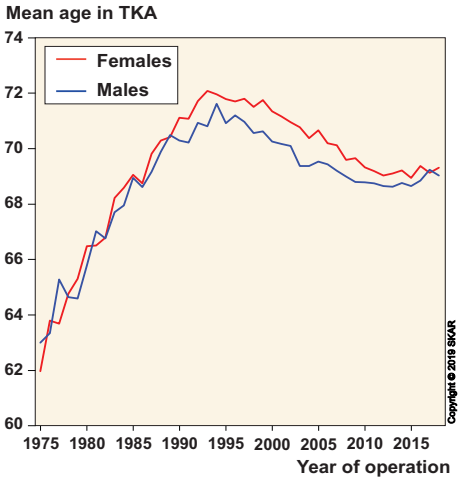
Between 1975 and 1994, the mean age at primary operation increased from 65 years to almost 72 years. The main reason was a relatively large increase in number of operations among the older age groups. Probable explanations are improvements in anesthetic techniques as well as a changed age distribution of the population. After 1994 the proportion of patients less than 65 years of age increased and the mean age started to decrease. This tendency has not continued the last few years and the mean age in 2018 was 68.8 years (figure on the right).

When TKA and UKA are analyzed separately, it is apparent that when TKA was introduced in the seventies it was used for younger patients than the UKA, which at the time was the standard treatment (figures below and on the next page). However, in the late nineties the mean age at UKA surgery fell considerably which coincided with the introduction of mini-invasive surgery. An interpretation of these observations may be that new technology to a larger extent is being tested in younger patients.

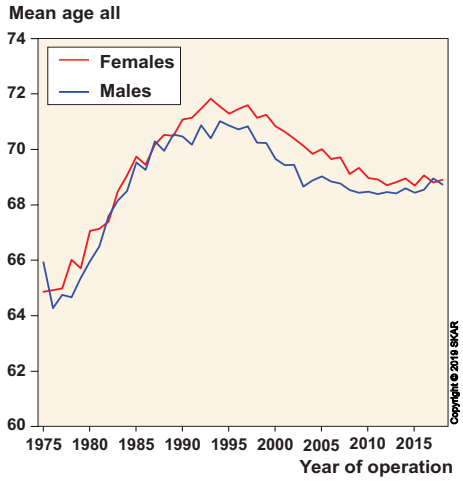
When comparing a series of patients operated on during different periods, the changes in the mean age make it necessary to account for age by use of regression or to analyze different age groups separately.



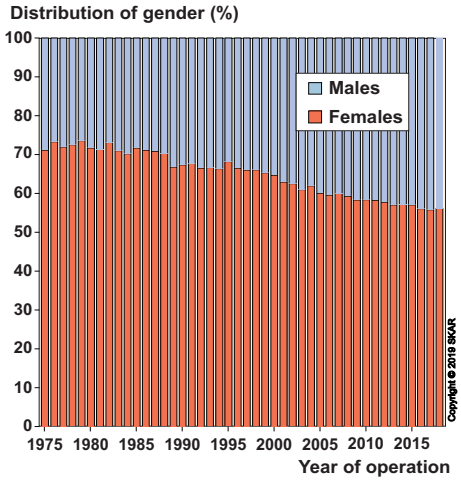
For UKA, the mean age of patients at surgery has decreased sharply in recent years coinciding with the introduction of mini-invasive surgery.



The mean age at surgery was lower for TKA than UKA when TKA was introduced in the seventies (cp the figures above).



The mean age of patients at surgery (all types of implants) increased until the mid-nineties when it started to decrease.



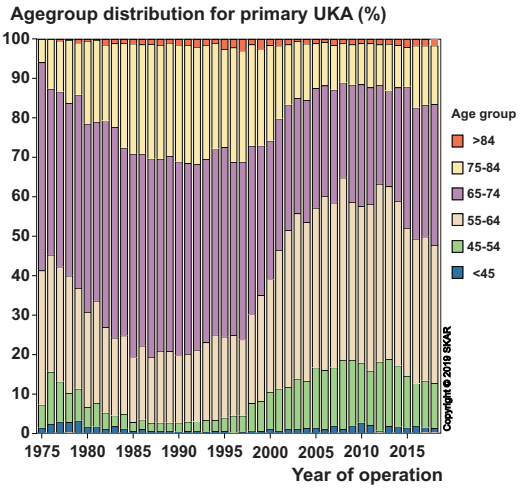
The proportion of males has increased slightly over the years.

Knee arthroplasty is more common in females than in males. At the start of the registration, females accounted for about 70% of the operations. As the figure above shows, the proportion of men has been slowly increasing and in 2018 they accounted for 44%. Separate analyses of OA and RA show that it is mainly in OA that the proportion of men has increased. In RA men account only for one fourth of the operations and the proportion has not changed.

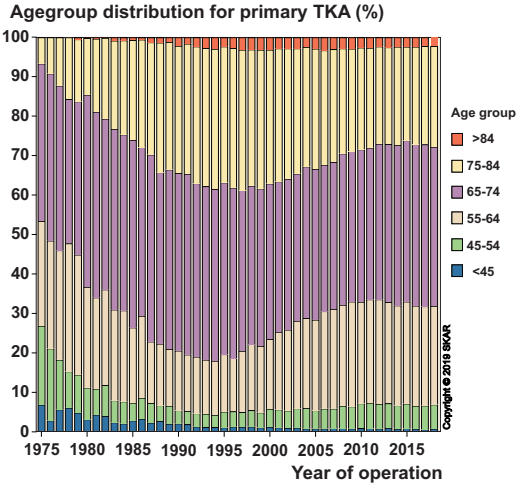
The figure to the right shows the relative number of operations performed in the different age groups over a period of thirty five years. In a somewhat different manner than the mean age (previous page) it shows how the relative proportion of the older groups increased until the mid-nineties after which their proportion again started to diminish.

The figures below show the age distribution for UKA respective TKA. It is evident that when the registration began in the seventies, the relative proportion of the young age groups was higher for TKA than for UKA.

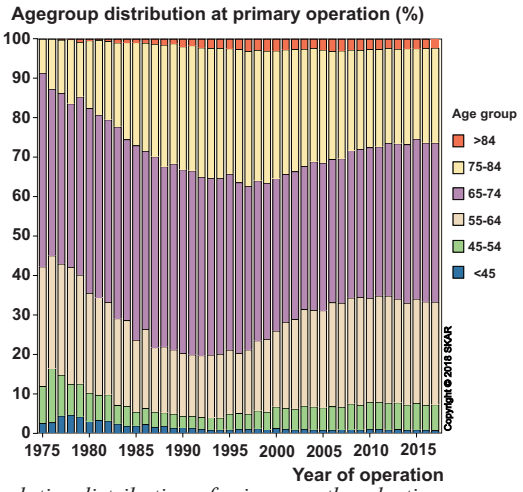
In UKA the relative proportion of patients less than 65 years of age doubled during 1998-2002, i.e. during the time when mini-invasive surgery caught on in Sweden. However, it has to be kept in mind that the actual number of UKA´s has diminished since 1993 in contrast to the TKA´s where it has increased more than fourfold. This implies that although the relative number of TKA among younger age groups did not increase as much as for UKA, the actual number in 2018, of TKA patients, younger than 65 years of age, had increased 7.8 times as compared to 1993 while the number of UKA patients under 65 only had increased 1.8 times during the same period.



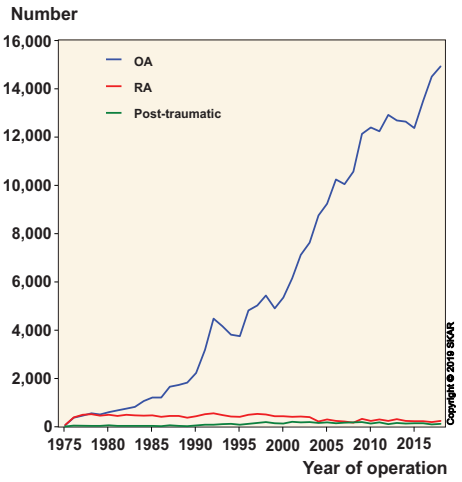
The relative distribution of primary UKA arthroplasties among different age groups.



The relative distribution of primary TKA arthroplasties among different age groups.



The relative distribution of primary arthroplasties among different age groups (all types of implants).



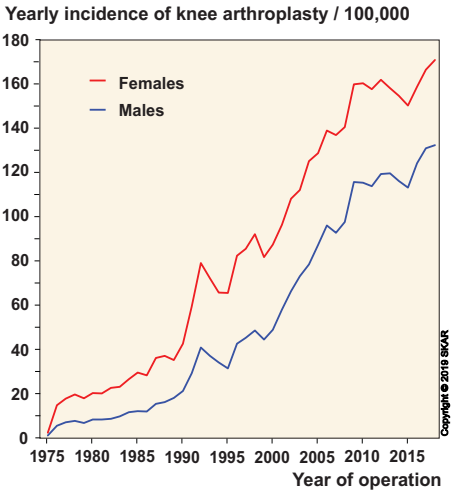
The yearly number of arthroplasties for different diagnoses

In the eighties, the use of knee arthroplasty really started to increase (graph above) mainly because of the increased treatment of osteoarthritic patients. On the other hand, the number of operations for rheumatoid arthritis lessened, especially during recent years which may be explained by the advancement of new types of medical treatment. The number of operations for post-traumatic conditions has only increased slightly during the years. During the last decade, these three diagnoses were stated as the reason for primary surgery in 98% of cases.

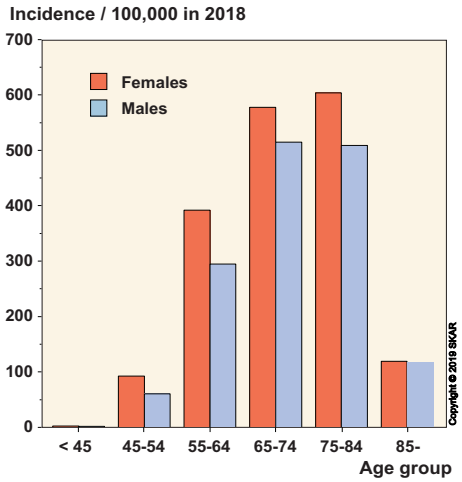
Incidence and prevalence

The incidence of knee arthroplasty is found by dividing the number of primary knee arthroplasties by the number of inhabitants. As the graph to the right shows, the rise in incidence that began in the late eighties leveled off in 2009. A part of the increase in incidence over time reflects aging of the population as knee arthroplasty is mainly used in the elderly.

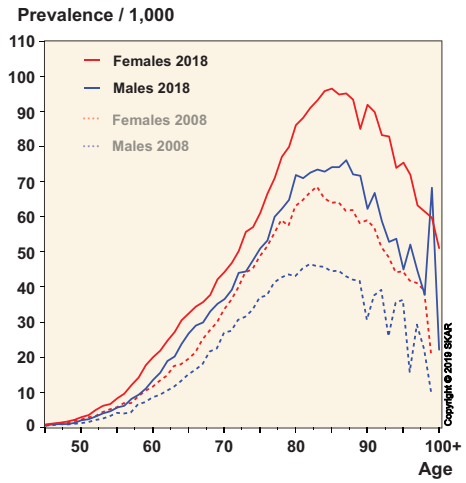
The figure below shows the incidence among different age groups during 2018. It is highest in the group of with those 65-84 years of age. At this age, knee arthroplasty is 7 times more common than among those 45-54 years old and 5 times more common than among those 85 years or older. In 2018, as well as 2017, women were overrepresented in all the age groups but the oldest. A table showing the incidence for the different age groups can be found on page 22.



Incidence of primary knee arthroplasty per 100,000 inhabitants (all types of implants).



Incidence of primary knee arthroplasty in 2018 per 100,000 inhabitants (males and females) in the different age groups.



The prevalence of knee arthroplasty in 2008 and 2018. One of fourteen elderly women has a knee arthroplasty.

As the incidence is so dependent on age, and because the age distribution may vary among different nations, it is difficult to compare different countries without performing some form of age standardization.

The increase in the number of operations causes a rise in the number of patients walking around with knee implants. The figure below on the left shows the prevalence, i.e. the number of patients per 1,000 inhabitants in different age groups that were alive with at least one knee implant. As a quarter of the patients have bilateral implants the prevalence of implants is higher than that of patients.

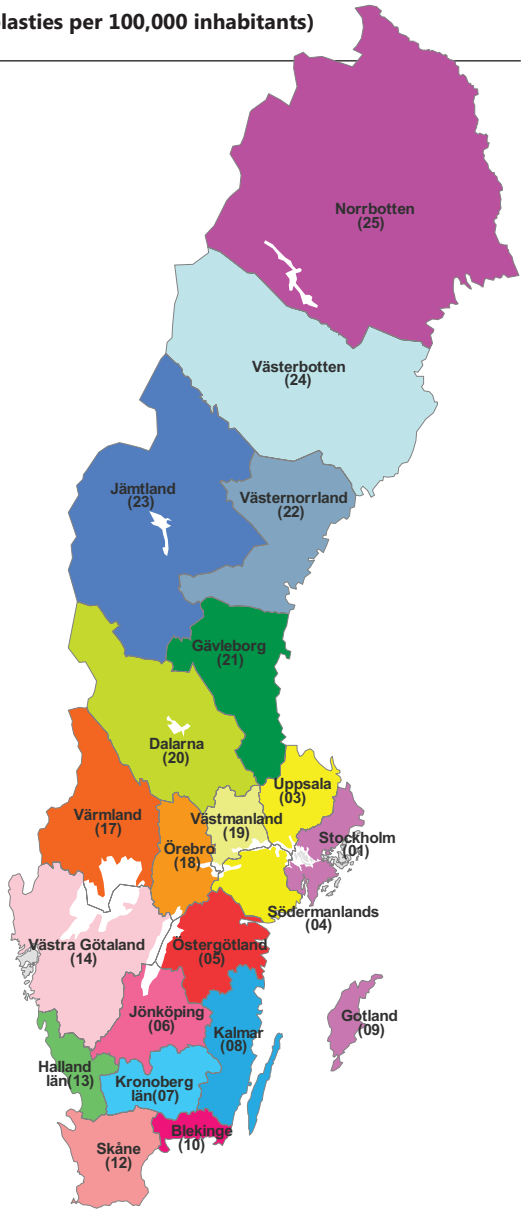
For both men and women in 2018, the prevalence peaks around 80-85 years of age at which almost 10% of the women and almost 8% of the men had at least one knee arthroplasty. Comparing the prevalence in 2018 with that in 2008, it can be seen that it has increased in all age groups. The fact that a large proportion of the older population is walking around with knee-, hip- or other types of joint implants, will probably result in an increase need for revisions in the future as well as as an increased risk of periprosthetic fractures when such patients are exposed to trauma.

The incidence in the counties 2012-2018 (knee arthroplasties per 100,000 inhabitants)

County and number of inhabitants 2018

No	County	Inhabitants
01	Stockholm	2,326,134
03	Uppsala	372,663
04	Södermanland	293,018
05	Östergötland	459,540
06	Jönköping	359,031
07	Kronoberg	198,703
08	Kalmar	244,103
09	Gotland	58,922
10	Blekinge	159,528
12	Skåne	1,353,427
13	Halland	327,089
14	Västra Götaland	1,700,298
17	Värmland	280,941
18	Örebro	300,580
19	Västmanland	272,512
20	Dalarna	286,678
21	Gävleborg	286,092
22	Västernorrland	245,711
23	Jämtland	130,043
24	Västerbotten	269,310
25	Norrbotten	250,896

Mean population during the year (www.scb.se)



Knee arthroplasties per 100,000 inhabitants

County	2012	2013	2014	2015	2016	2017	2018
01 Stockholm	103.9	104.9	99.4	93.2	111.4	124.1	124.6
03 Uppsala	154.9	174.8	142.9	161.6	123.3	131.2	136.3
04 Södermanland	151.7	157.2	161.9	145.6	140.3	189.8	175.1
05 Östergötland	157.5	154.2	135.0	132.9	137.0	151.9	153.0
06 Jönköping	168.4	147.6	172.4	153.7	150.2	131.3	168.0
07 Kronoberg	158.7	115.3	150.4	154.5	175.1	155.0	165.1
08 Kalmar	168.4	175.9	167.0	172.4	174.6	196.0	199.9
09 Gotland	165.9	178.3	134.6	106.4	150.8	178.4	218.9
10 Blekinge	178.8	177.7	161.6	165.6	206.5	196.3	185.5
12 Skåne	125.8	137.3	142.6	144.4	158.4	167.8	159.5
13 Halland	177.3	165.6	168.4	155.4	177.0	199.6	192.0
14 Västra Götaland	132.0	130.7	125.6	127.8	126.0	124.1	133.8
17 Värmland	179.9	180.3	195.4	184.5	181.5	184.0	193.6
18 Örebro	146.3	120.3	116.8	104.6	152.6	126.6	109.5
19 Västmanland	156.7	125.4	134.8	109.1	118.4	144.4	161.1
20 Dalarna	217.0	231.4	199.5	174.7	199.8	171.4	180.3
21 Gävleborg	191.4	188.6	213.6	206.1	202.3	174.3	211.1
22 Västernorrland	145.4	141.3	132.3	141.3	155.3	199.4	148.5
23 Jämtland	175.0	138.5	95.6	120.4	145.3	171.8	187.6
24 Västerbotten	123.1	126.2	118.1	117.9	120.5	146.7	139.2
25 Norrbotten	165.7	150.2	131.0	120.9	144.3	157.4	193.3
The whole country	140.8	139.1	135.5	131.8	141.5	148.7	151.6

Information on domicile is by the Swedish Tax Agency

For age-standardized incidence see page 37

The incidence in the counties 2012-2018 (knee arthroplasties per 100,000 inhabitants)

Incidence for women

County	2012	2013	2014	2015	2016	2017	2018
01 Stockholm	130.4	123.0	113.3	106.4	126.9	145.5	147.1
03 Uppsala	178.6	193.1	170.6	186.2	134.5	155.9	143.8
04 Södermanland	176.8	180.4	184.5	154.4	159.7	209.7	203.4
05 Östergötland	182.6	172.5	159.9	156.9	154.1	165.7	184.5
06 Jönköping	202.3	174.4	202.1	176.1	164.5	143.9	178.1
07 Kronoberg	183.1	148.4	166.7	168.3	186.1	166.9	181.3
08 Kalmar	209.0	201.2	193.1	199.7	206.7	205.3	227.5
09 Gotland	162.7	208.1	128.5	114.5	169.2	171.1	254.1
10 Blekinge	188.9	187.5	182.3	168.9	235.6	219.5	186.8
12 Skåne	140.1	154.4	166.0	169.6	177.9	188.5	176.0
13 Halland	197.8	188.4	186.6	173.0	190.2	227.9	204.0
14 Västra Götaland	146.9	148.2	140.7	146.4	140.8	137.6	154.3
17 Värmland	202.9	190.1	233.5	204.5	194.4	197.5	219.8
18 Örebro	157.7	129.6	135.7	127.0	176.9	137.7	119.4
19 Västmanland	173.6	140.3	157.5	128.1	148.0	165.1	173.0
20 Dalarna	242.1	260.7	222.4	195.0	217.1	186.4	187.0
21 Gävleborg	207.7	206.4	232.6	221.4	221.6	195.7	236.5
22 Västernorrland	163.6	165.4	149.7	155.2	181.0	221.6	170.9
23 Jämtland	206.2	179.4	107.9	153.6	156.1	175.4	216.6
24 Västerbotten	150.9	151.4	132.5	137.4	138.9	159.0	158.8
25 Norrbotten	190.6	170.8	150.2	142.1	162.6	179.5	218.9
The whole country	162.1	158.3	154.8	150.3	158.9	166.5	171.1

Information on domicile is by the Swedish Tax Agency

The incidence calculations for the counties are based on the number of knee arthroplasties their inhabitants received, irrespective of if the surgery was performed in their home county or elsewhere. While the calculations do not consider differences in the age distribution, age-standardized calculations for the year 2018 can be found on page 37.

The calculations are based on information from the Swedish tax authorities concerning the domicile of patients at the time of surgery. Note that that only surgeries on patients that are Swedish residents are considered.

Incidence for men

County	2012	2013	2014	2015	2016	2017	2018
01 Stockholm	76.9	86.5	85.4	79.9	95.7	102.7	102.1
03 Uppsala	131.0	156.5	115.0	136.9	112.0	106.4	128.8
04 Södermanland	126.3	133.7	139.3	136.9	120.9	170.1	146.9
05 Östergötland	132.6	136.1	110.3	109.3	120.2	138.4	122.2
06 Jönköping	134.6	120.8	143.0	131.6	136.0	118.9	158.1
07 Kronoberg	134.8	82.8	134.5	141.1	164.5	143.6	149.4
08 Kalmar	127.8	150.5	141.0	145.4	143.0	186.8	172.8
09 Gotland	169.1	148.0	140.7	98.2	132.3	185.7	183.6
10 Blekinge	169.1	168.1	141.4	162.4	178.5	174.0	184.4
12 Skåne	111.3	119.9	118.7	118.9	138.6	146.9	143.0
13 Halland	156.6	142.7	150.1	137.7	163.7	171.5	180.0
14 Västra Götaland	117.0	113.1	110.4	109.1	111.3	110.6	113.6
17 Värmland	156.9	170.5	157.4	164.7	168.7	170.7	167.8
18 Örebro	134.7	110.9	97.9	82.3	128.2	115.6	99.6
19 Västmanland	139.8	110.4	112.1	90.3	89.1	124.0	149.3
20 Dalarna	191.9	202.3	176.8	154.6	182.8	156.7	173.8
21 Gävleborg	175.1	170.8	194.7	190.9	183.2	153.2	186.1
22 Västernorrland	127.2	117.2	115.1	127.5	129.9	177.5	126.6
23 Jämtland	143.9	97.9	83.4	87.6	134.7	168.3	159.4
24 Västerbotten	95.6	101.4	103.8	98.8	102.5	134.7	120.2
25 Norrbotten	141.7	130.3	112.4	100.4	126.8	136.3	168.9
The whole country	119.4	119.7	116.2	113.2	124.2	131.0	132.4

Information on domicile is by the Swedish Tax Agency

Incidence in different age groups over time (number of arthroplasties/100,000 inhabitants)

Women

Age group	1976-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018
<45	1.0	1.0	1.1	1.6	1.7	2.4	2.1	2.2
45-54	12.9	13.0	19.0	34.6	58.7	87.6	85.0	92.7
55-64	44.1	76.9	112.8	153.7	236.1	318.5	348.3	393.3
65-74	100.1	225.3	331.0	396.1	520.4	563.8	535.9	579.9
75-84	76.0	217.0	337.5	406.7	528.8	609.8	590.0	606.1
>84	7.1	35.0	65.0	87.4	105.1	121.0	113.2	119.5
Total	23.0	50.9	74.4	93.2	128.6	156.2	157.8	171.1

Men

Age group	1976-1987	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	2018
<45	0.4	0.5	0.5	0.8	1.2	1.5	1.4	1.7
45-54	5.3	6.2	10.1	19.0	37.6	50.1	52.5	60.8
55-64	19.4	45.3	69.5	101.9	175.4	253.3	277.7	296.2
65-74	45.5	124.9	197.8	267.9	395.8	453.3	464.9	516.8
75-84	39.5	142.8	211.6	272.7	390.1	484.0	482.8	511.0
>84	8.7	34.4	64.9	68.9	111.7	119.3	119.4	118.2
Total	9.3	25.1	38.0	53.2	85.6	112.5	121.0	132.4

Number of primary arthroplasties per unit and year

Hospital	1975-2013	2014	2015	2016	2017	2018	Total	Percent
Akademiska sjukhuset	3,002	86	108	88	85	91	3,460	1.2
Alingsås	2,220	204	193	160	200	179	3,156	1.1
Art Clinic Göteborg	.	.	16	55	108	140	319	0.1
Art Clinic Jönköping	10	13	29	24	90	146	312	0.1
Arvika	1,687	193	171	189	193	213	2,646	0.9
Avesta	67	.	.	.	.	.	67	0.0
Boden	1,622	.	.	.	.	.	1,622	0.6
Bollnäs	3,433	402	353	344	325	367	5,224	1.8
Borås	2,932	78	72	74	69	114	3,339	1.2
Capio Artro Clinic	.	.	.	.	242	392	635	0.2
Carlanderska	645	137	136	156	224	323	1,621	0.6
Dalslands Sjukhus	81	.	.	.	.	.	81	0.0
Danderyd	3,439	185	185	187	185	189	4,370	1.5
Eksjö (Höglandssjukh.)	3,108	211	202	221	217	299	4,258	1.5
Elisabethsjukhuset	827	7	1	7	6	13	861	0.3
Enköping	2,911	373	392	346	365	381	4,768	1.7
Eskilstuna	1,893	41	42	55	69	81	2,181	0.8
Fagersta	71	.	.	.	.	.	71	0.0
Falköping	1,688	.	.	.	.	.	1,688	0.6
Falun	5,211	356	205	270	215	170	6,427	2.3
Frölunda Spec.	1,308	120	124	.	.	.	1,552	0.5
Gällivare	1,523	68	46	53	54	88	1,832	0.6
Gävle	3,410	129	132	147	85	76	3,979	1.4
Halmstad	3,370	190	186	208	185	198	4,337	1.5
Halmstad Capio Movement	1,700	250	430	417	434	467	3,698	1.3
Helsingborg	1,797	45	67	41	19	16	1,985	0.7
Huddinge	2,960	166	159	168	111	107	3,671	1.3
Hudiksvall	1,651	60	87	74	56	62	1,990	0.7
Hässleholm	8,148	683	669	707	883	891	11,981	4.2
Jönköping	2,942	168	141	135	11	.	3,397	1.2
Kalix	215	.	.	.	.	.	215	0.1
Kalmar	2,656	91	89	90	100	86	3,112	1.1
Karlshamn	3,093	242	249	305	295	278	4,462	1.6
Karlskoga	2,031	124	124	104	39	7	2,429	0.9
Karlskrona	1,117	.	.	.	.	.	1,117	0.4
Karlstad	4,299	193	182	162	132	117	5,085	1.8
Karolinska	2,680	101	91	98	59	55	3,084	1.1
Kristianstad	1,297	.	1	.	.	.	1,298	0.5
Kristinehamn	252	.	.	.	.	.	252	0.1

(cont.)

Number of primary arthroplasties per unit and year (cont.)

Hospital	1975-2013	2014	2015	2016	2017	2018	Total	Percent
Kullbergska sjukhuset	2,572	201	153	157	244	220	3,547	1.2
Kungsbacka	38	.	.	.	.	.	38	0.0
Kungälv	2,154	197	215	197	207	199	3,169	1.1
Köping	1,605	.	.	.	.	.	1,605	0.6
Landskrona	1,918	.	.	.	.	.	1,918	0.7
Lidköping	2,157	199	234	224	250	171	3,235	1.1
Lindesberg	2,181	172	162	319	424	493	3,751	1.3
Linköping	1,735	.	.	.	.	.	1,735	0.6
Linköping medical cent	15	.	.	.	.	.	15	0.0
Ljungby	1,873	151	141	150	135	169	2,619	0.9
Ludvika	339	.	.	.	.	.	339	0.1
Luleå	9	4	7	11	19	19	69	0.0
Lund	2,769	98	82	122	43	52	3,166	1.1
Lycksele	821	93	42	130	150	143	1,379	0.5
Löwenströmska*	3,562	403	431	444	463	681	5,984	2.1
Malmö	2,240	.	.	.	1	.	2,241	0.8
Mora	2,251	150	186	203	195	203	3,188	1.1
Motala	4,980	470	512	552	605	653	7,772	2.7
Mölndal	2,525	387	405	505	378	401	4,601	1.6
Nacka	203	.	.	.	.	.	203	0.1
Nacka-Proxima	785	111	143	154	173	223	1,589	0.6
Norrköping	2,760	140	129	160	175	153	3,517	1.2
Norrtälje	1,378	85	94	123	152	164	1,996	0.7
Nyköping	1,787	100	101	74	102	89	2,253	0.8
OrthoCenter IFK klin.**	1,016	108	113	129	162	171	1,699	0.6
Ortopediska huset	4,039	418	460	625	719	656	6,917	2.4
Oskarshamn	2,992	268	276	316	370	374	4,596	1.6
Piteå	2,775	259	245	279	305	373	4,236	1.5
S:t Göran	7,744	387	424	470	521	466	10,012	3.5
Sabbatsberg (Aleris)	2,012	141	23	.	.	.	2,176	0.8
Sahlgrenska	1,546	4	1	.	.	.	1,551	0.5
Sala	115	.	.	.	.	.	115	0.0
Sandviken	301	.	.	.	.	.	301	0.1
Sergelkliniken	160	.	.	.	.	.	160	0.1
Simrishamn	1,021	.	.	.	.	.	1,021	0.4
Skellefteå	1,557	107	119	80	77	86	2,026	0.7
Skene	1,689	104	97	131	127	129	2,277	0.8
Skövde	3,137	115	120	114	73	20	3,579	1.3
Sollefteå	1,505	89	93	102	206	151	2,146	0.8
Sophiahemmet	1,698	98	138	127	229	185	2,475	0.9
Spenshult	1,450	155	.	.	.	.	1,605	0.6
Sunderby	398	.	.	.	.	.	398	0.1
Sundsvall	3,057	95	44	12	5	15	3,228	1.1
Säffle	484	.	.	.	.	.	484	0.2
Söderhamn	279	.	.	.	.	.	279	0.1
Södersjukhuset	5,219	316	281	320	284	227	6,647	2.3
Södertälje	1,563	110	113	163	149	145	2,243	0.8
Torsby	1,772	114	130	108	134	130	2,388	0.8
Trelleborg	7,129	759	791	823	850	814	11,166	3.9
Uddevalla	3,946	207	187	244	247	242	5,073	1.8
Umeå	3,084	104	147	111	120	138	3,704	1.3
Varberg	3,120	149	127	185	214	177	3,972	1.4
Visby	1,579	70	60	76	97	115	1,997	0.7
Vänersborg-NÄL	939	.	.	.	.	.	939	0.3
Värnamo	2,221	163	148	142	193	208	3,075	1.1
Västervik	2,071	94	90	99	81	94	2,529	0.9
Västerås	3,315	246	177	217	273	194	4,422	1.5
Växjö	2,368	109	115	101	77	94	2,864	1.0
Ystad	1,169	.	.	.	.	.	1,169	0.4
Ängelholm - Aleris	.	.	.	.	.	82	82	0.0
Ängelholm	2,464	233	221	338	345	242	3,843	1.3
Örebro	3,413	54	30	47	8	3	3,555	1.2
Örnsköldsvik	2,208	88	115	143	172	142	2,868	1.0
Östersund	2,480	106	120	141	164	178	3,189	1.1
Östra sjukhuset	2,100	.	.	.	.	.	2,100	0.7
Total	**215,088**	**13,147**	**12,924**	**14,053**	**14,974**	**15,430**	**285,616**	**100**

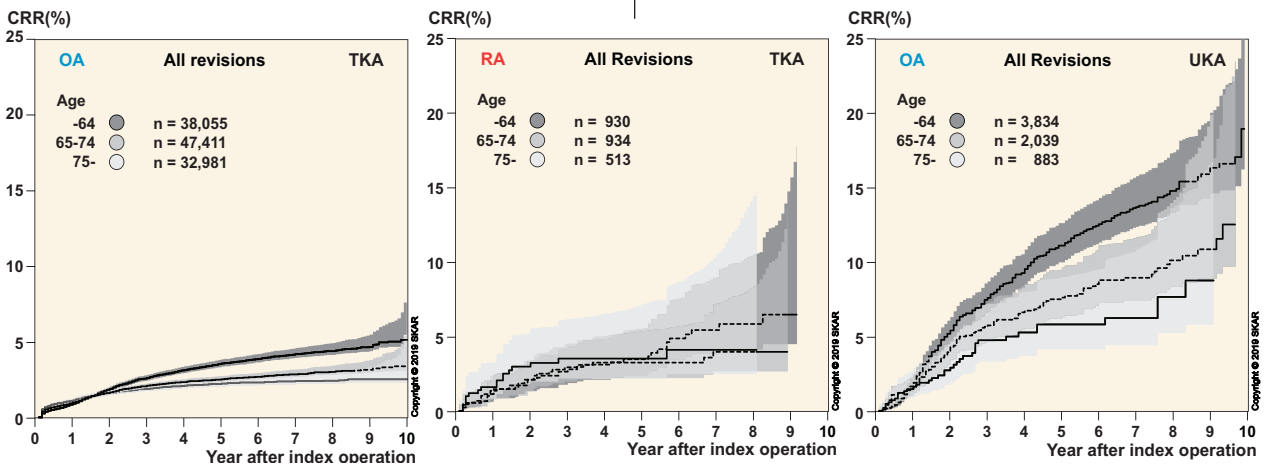
* Lövenströmska was taken over by Stockholms Specialistvård in 2001 and OrthoCenter Stockholm in 2008.

** Gothenburg Medical Center was replaced by OrthoCenter IFK kliniken in 2008.

Factors that influence the revision rate

Primary disease – Early it became evident that patients with rheumatoid arthritis (RA) and osteoarthritis (OA) were different with respect to outcome. Therefore, the registry always showed outcome for these diagnoses separately. However, the modern medical treatment of RA has resulted in a reduced need for knee arthroplasty for these patients (fig. page 18) making statistical differences more difficult to detect.

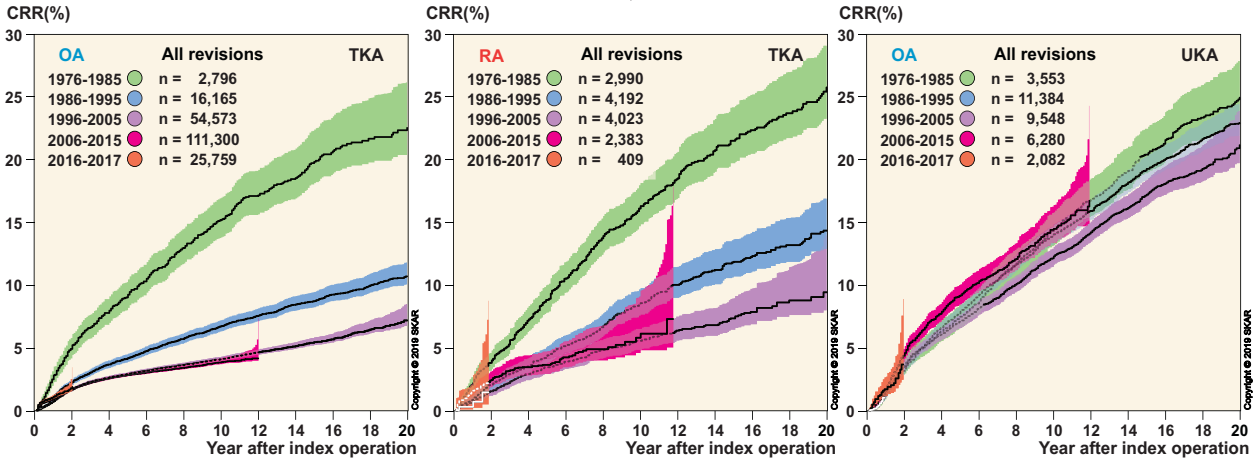
Age – The effect of age at primary surgery can be illustrated by dividing patients into separate age groups. This shows for both TKA and UKA that that the risk is higher for the younger groups (see figures below). Possible explanations are that the younger have higher physical activity, higher expectancy of pain relief and/or a health condition that better allows for revision surgery.



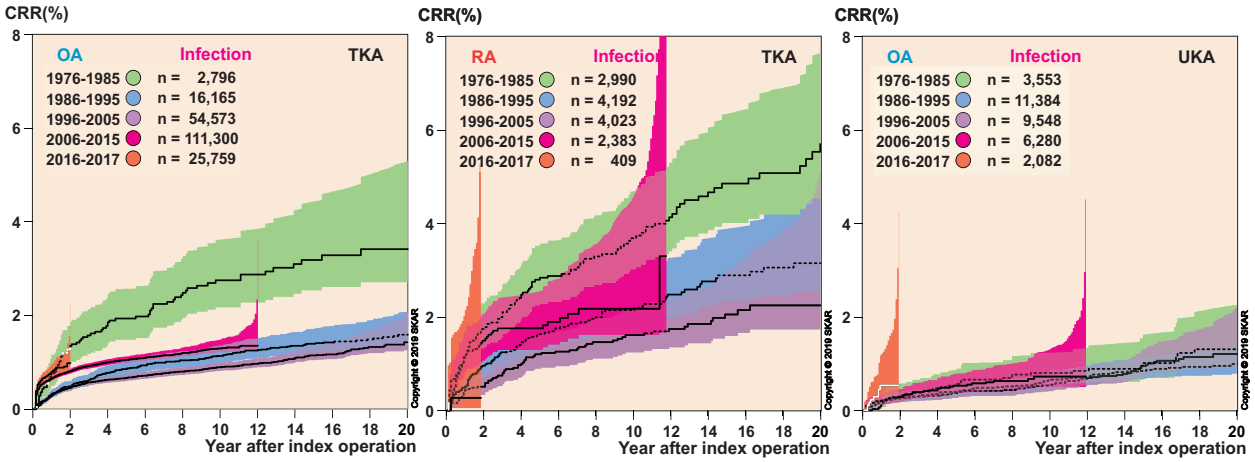
The CRR (2008–2017) for the 3 age groups (<65, 65–75, >75) shows an increase in revision rate with younger age. In TKA/OA those younger than 65 have 1.5 times the risk of those over 75 and 1.9 times higher risk in UKA/OA. The difference in TKA/RA is not significant.

Year of operation – For TKA we see a large reduction in risk for revision during the first 3 decades that is not as obvious for UKA (figures below). However, during the period 2006-2015 the number of early revisions inreased, a tendency that continued in the period 2016-2017. This mainly because of an increase in early revisions for infection (see next page).

For UKA, the reduction in CRR during the first 3 decades was not at all as markant as for TKA. But as for TKA, the number of early rvisions increased during 2006-2015 and 2016-2017. The reason is mainly that since the late nineties the proportion of younger patients has increased (see page 18) and they have a higher risk of revision higher risk of revision.



CRR for surgeries performed during four 10-year periods and during 2016-2017. For TKA, the risk for the 2 first periods is considerably higher than for the later ones while the risk for early revision increased in the latest 2 periods which can be explained by increased number of early revisions for manifest or suspected infection. For UKA/OA the reduction of risk with time is not as obvious as for TKA and the CRR has increased in the latest 2 periods which is mainly explained by a higher proportion of younger patients having surgery.



Comparing the CRR, using only revision for infection as end-point, there is an improvement during the first decades for both TKA and UKA. However, the risk has increased again during the period 2006-2015 and in 2016-17.

When the Knee Register estimates the risk of revision due to infection, it counts the first revision due to infection in the affected knee. It does not matter if it is the primary or any subsequent revision. During the first decades we saw a reduction in this risk both for OA and RA. However, for TKA the risk increased significantly in the period 2006-2015 as compared to earlier, a trend which continues in 2016-17, now even for UKA.

The increase is mainly due to early insert exchanges performed for infections or suspected infections probably as the surgeons have become more proactive in suspected early infections.

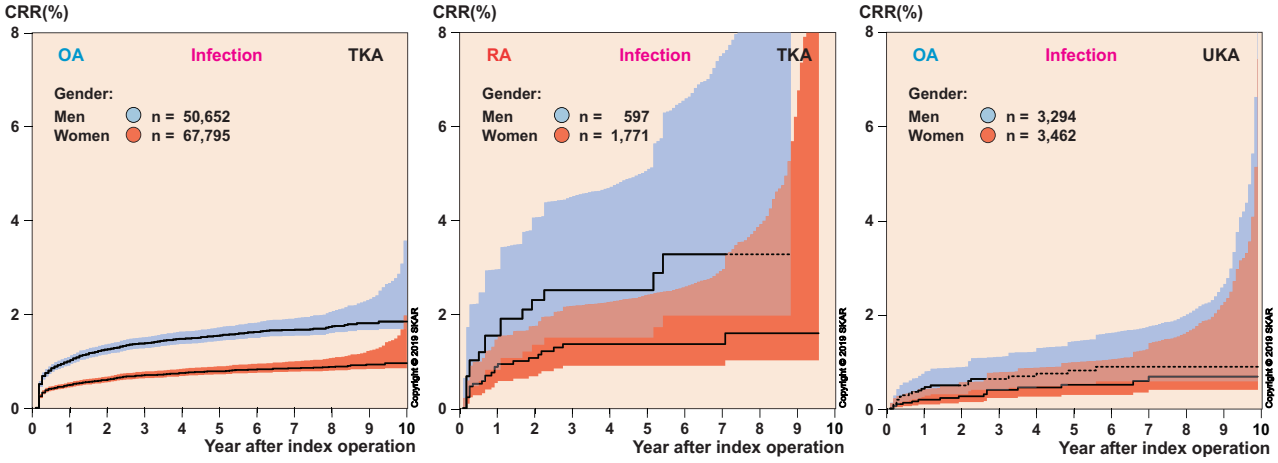
TKA´s have a significantly higher risk of infection than UKA´s (RR 1.9) and patients with RA have a higher risk than those with OA (RR 1.8). If changes of inserts are excluded the differences diminish somewhat (RR 1.5 and RR 1.7).

.

Gender – It is somewhat complicated to evaluate the effect of gender on the risk of revision as males and females have somewhat different revision pattern. Early revision for infection is more common in males (figures below) but early revision for loosening and patellar pain in women. Due to their higher risk of revision for infection, men have somewhat higher 10-year CRR for all type of revisions (RR 1.1).

The difference between the sexes becomes still larger when the endpoint only includes revisions for infection (see figures with text below).

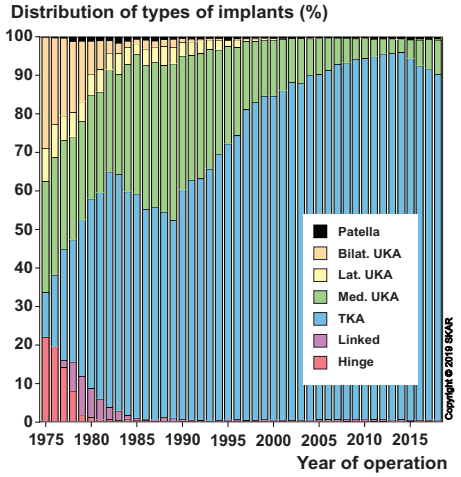
While it is well known that RA patients have a higher risk of infection, being ascribed to the effect of corticosteroid and immunosuppressive medications, it is not obvious why men, more often have their knee arthroplasties revised for infection.



CRR (2008–2017) using the end-point; revision for infection shows men having a higher risk than women (TKA/OA: RR 2.0 and TKA/RA: RR 2.1). In UKA, which has a lower risk of infection than TKA, men also have a higher risk (RR 1.6).
In TKA, patients with RA are more affected than those with OA (RR 1.8).

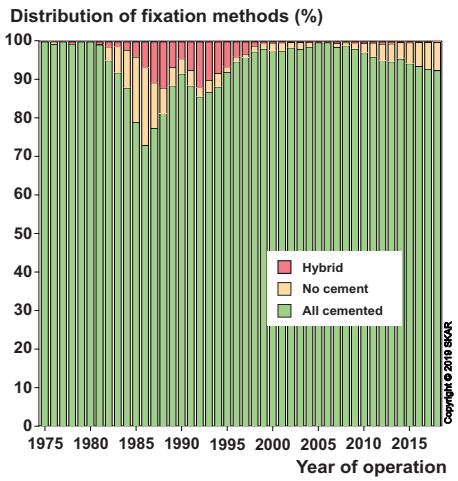
Type of implant – The modern condylar tricompartmental knee implant (TKA) was developed in the seventies when hinged and unicondylar implants were already available. When the register started in 1975, TKA had just been introduced in Sweden, why hinges and UKA's were used for the majority of the primary surgeries at the time (figure right). It was also common to use two UKA's in the same knee (bilateral UKA) when the disease affected more than one compartment. As the use of TKA increased, the surgeons quit using bilateral UKA's as well as hinges, linked and stabilized implants in other than difficult primary cases, trauma, malignancies and revisions. Today, uncomplicated primary cases are mainly treated with TKA although UKA are sometimes used in unicompartmental arthritis. The use of UKA has diminished over the years, both proportionally as well as in number of surgeries and since the millennium UKA being used on the lateral side is uncommon.

The reason for the lessened use of UKA may be that as compared to TKA it has higher risk of revision (see figures on page 24). However, it has to be kept in mind that in an UKA, only one compartment in the knee is resurfaced. Thus, besides that the unresurfaced compartments of the knee may be affected by disease this implies that it can be tempting to offer a revision of an UKA to a TKA in patients with knee pain of unclear reason. An advantage of the UKA is that the risk of revision for infection is considerably lower than for TKA (RR 0.5) as well as the need for revision with stabilized implants, arthrodesis or amputation (see page 39).

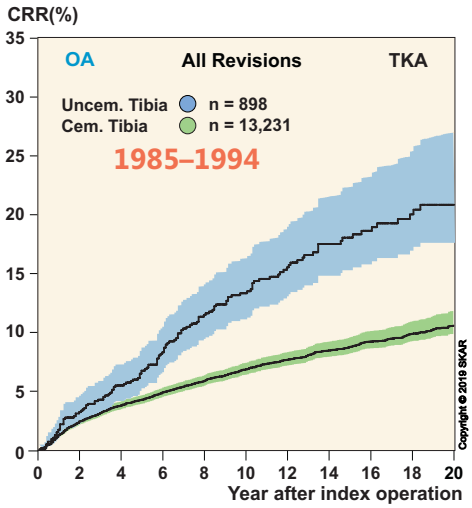


The relative yearly distribution of implant types used for primary surgery.

Use of bone-cement – As the figure below shows, bone cement has been used for the majority of arthroplasties since the nineties. In recent years we have seen a slight increase in the use of uncemented implants, of which two thirds were inserted at one hospital. During the latest 10-year period, we found no significant difference in CRR based on if the tibia component was cemented or not. However, for the period 1985–1994 with follow-up until 2017, the risk is higher for cases in which the tibia was uncemented (see figure right).



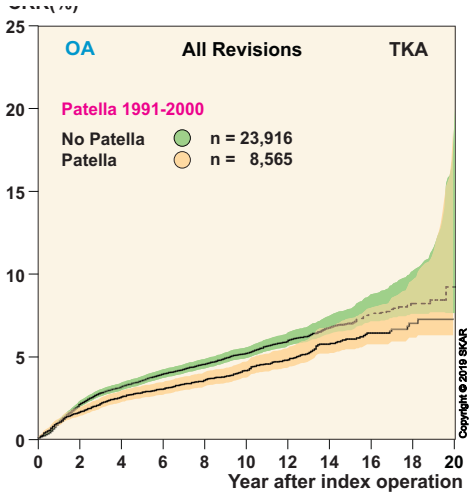
The relative yearly distribution regarding the use of cement for fixation.



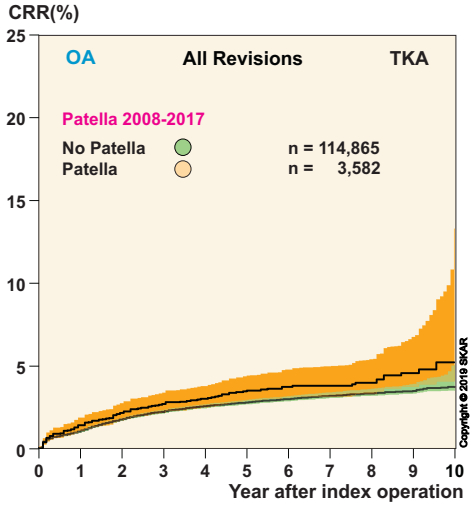
The CRR for TKA inserted 1985-1994 in which the tibial component was fixed with or without cement.

Cox regression, adjusting for age, gender, year of operation and the use of a patellar button shows that the risk for TKA with an uncemented tibial component was 1.6 (1.3-1.9) times higher than for those cemented. This may be because the implants at the time were not suited for uncemented use but is still in agreement with registers in Finland, England, New-Zealand and California which also have found increased risk of revision for uncemented implants.

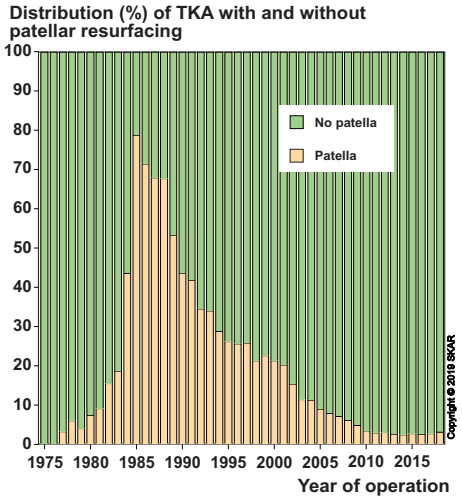
Patellar resurfacing in TKA – Estimating how the use of a patellar button affects the revision rate is complex. The use of a patellar button varies with the brand of prosthesis used and its use also has lessened in recent years. During the eighties, when patellar button was used in just over half of the cases, its use had a negative effect. Since then its use has diminished so that it was only used in 2.6% of the TKA cases in 2017 (see figure right). In our 2002 annual report (for the period 1991-2000) we observed for the first time that TKA with a patellar button had a lower risk of revision than those without. The figure below shows the 10-year CRR for TKA inserted during that period. One can see that the TKA without a patellar button had a significantly higher revision rate than those without (RR x 1.3 (CI 1.1-1.4)).



CRR for TKA/OA inserted during the 10-year period 1991-2000, with and without patellar component respectively. TKA without patella has a higher CRR



CRR for TKA/OA inserted during the current 10-year period, 2008-2017 with and without patellar component respectively. TKA with patella has a higher CRR.



The figure shows the yearly distribution regarding the use of patellar button in TKA.

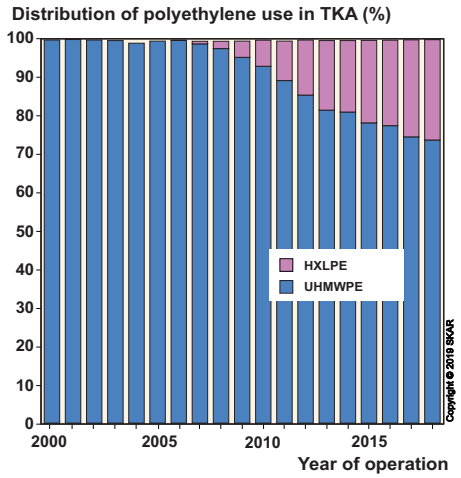
In 2007 the advantage of using a patellar button started to decrease and in 2010 (for surgeries performed 1999-2008) we could not find an advantage of using a button. However, for the current period 2008-2017 (figure left, below) we find the opposite of that observed during 1991-2000; TKA with a patellar button now have a higher risk of revision than TKA without a button (RR x 1.3 (CI 1.1-1.5)).

One can only speculate on the reasons for these variations in findings. The insertion of the button takes time and there is an additional component that has to stay fixed to bone and that can wear. This increases the possibility of infection, loosening and wear. Thus, changes in the quality of the poly as well as fixation may explain changes in CRR over time. On the other hand, a number of TKA without a button have a secondary one due to patellar pain. So if the femoral components have become more "patellar friendly" or if the surgeons have discovered that patellar additions not always are successful, the number of such secondary patellar resurfacing would decrease improving the results of those without a primary button as compared to those that received one.

It may be debated if one should take the use of patellar button into consideration when units and implants are compared with respect to risk of revision. We have decided to show in the figures the total CRR of all TKA together (with and without a button) giving a general picture of the results for certain groups of patients and implants. When comparing the risk-ratios of implants (page 48-51), we separately account for the results of TKA with, and without a button and when comparing the risk of revision for the different hospitals (page 56-59), we include the use of patellar button in the regression analysis.

Types of polyethylene – As can be seen from the figure to the right, the Swedish orthopedic surgeons started relatively late to replace the standard UHMWPE polyethylene with the newer highly crosslinked types (HXLPE. In 2006 when the new poly variants were introduced for TKA in Sweden, they were already being used for a quarter of all TKA cases in Australia according to the 2019 annual report of the AOANJRR (https://aoanjrr.sahmri.com).

94 percent of the implants that used highly crosslinked polyethylene through 2018 were Triathlon (X3 poly) and PFC (XLK poly). So far, we at the Swedish Knee Arthroplasty Register have not seen any signs of reduction of the revision frequency for those Triathlon or PFC implants using HXLPE polyethylene. However, the AOANJRR has previously reported a lower revision frequency for HXLPE poly (Steiger et al. 2015) but the effect was dependent on the brand used and was true for NexGen and Natural II knees but not for the Triathlon or Scorpio NRG. They had no information on the PFC.



Bilden visar den årliga fördelningen mellan den gamla UHMWPE plasten och de nya korslänkade plasttyperna (XLP)

It is important to realize that the methods used to increase the durability of the different polyethylene types by radiation and/or doping by antioxidants are different and it still remains to be seen how the revision rate will be affected in the longer term.

Implant model (brand) – The implant model is what generates the most interest and which is most often connected to the results of knee arthroplasties. As can be seen from what has been said previously, the results are not only affected by the model or design of the implants but also by other factors such as the so called "case-mix". In the analyses, we try to limit the effect of the case-mix on results by adjusting for factors such as diagnosis, gender, age and the time period during which the operations were performed. However, there is a multitude of patient related factors that we do not adjust for, such as grade of joint disease, activity, expectations and socioeconomic factors just to mention a few.

An additional important factor, which the register is unable to adjust for, is the surgical routine of the individual surgeons. It is obvious that surgeons may be more or less competent with respect to arthroplasty surgery, which may influence the results for specific models, especially if use of that model has been limited to a few surgeons or hospitals. Just as it may be claimed that deviating results are being influenced by surgical skill, it could be debated if it is at all fair to account for the results of specific models.

Responding to this, we can only say that the risk of revision for specific brands shows what its users could bring about with that particular model. The final result is determined by a combination of factors including design, material, durability, accompanying instruments, user-friendliness, safety marginal (how the implant behaves if it is not inserted exactly) together with the surgeons skill and training in using the instruments/implant as well as selecting the appropriate patients for the surgery. The producers together with the distributors have an opportunity to influence many of these factors. Therefore, it cannot be considered inappropriate to associate the model to the result, in spite of the outcome being affected not only by design, material and durability.

Historically, the most commonly used implants in Sweden have also been those with the lowest CRR. This may be due to a good design but also due to the increased surgical routine when the same implant is used often.

Models that have been found to have considerably inferior results have most often been withdrawn from the Swedish market. An exception is the Oxford implant that initially had inferior results but that after modifications and increased training of surgeons showed improved results leading to continued use.

Type of operations and implants in 2018

Types of primary arthroplasties

	Number	Percent
Linked	58	0.4
TKA	13,885	90.0
UKA Medial	1,373	8.9
UKA Lateral	52	0.3
Fem-Pat	54	0.3
Partial (PRKA)	8	0.1
Total	15,430	100

In primary knee arthroplasty the TKA is the standard treatment which accounted for 90% of the surgeries in 2017 (table above). The use of UKA increased a little and accounted for good 9% of the cases. The use of femoro-patellar and especially partial implants is still very limited.

72 hospitals performing elective knee arthroplasties reported to the registry during 2018 which are all the hospitals performing elective knee arthroplasty surgery. Although a few reports may not yet have been turned in, their effect on the total number of operations is expected to be negligible. This summer, 15,430 primaries had been reported for 2018 which is 3.2% more than at the same time in 2017 (14,957).

Primary TKA implants

	Number	Percent
NexGen MBT	7,002	50.4
PFC-MBT	2,800	20.2
Triathlon	1,705	12.3
PFC-APT	919	6.6
Genesis II	384	2.8
Legion/GenII Prim	355	2.6
NexGen TM	232	1.7
Persona	138	1.0
Attune	46	0.3
Journey	31	0.2
PFC-RP	11	0.1
Other*	262	1.9
Total :	13,885	100

*Mainly revision models (see separate table) except 17 knees for which part numbers are missing

As compared to last year, the number of TKA increased by 1.4%. As last year, 3 TKA brands dominate. NexGen from Zimmer was used in good half of the primaries, PFC from DePuy in 20% and Triathlon from Stryker in 12%. The use of other brands was less and the Vanguard from Biomet was not reported as used at all during 2018. The group "Others" mainly stands for revision models (see table right).

After having diminished for many years the use of UKA has increased again since 2014 and accounted in 2018 for 8% of the primary knee arthroplasties. The Oxford model was used in 70% of the cases, an increase from 66% in 2017.

Primary UKA implants

	Number	Percent
Oxford	997	70.0
Link	146	10.2
ZUK	119	8.4
Triathlon PKR	93	6.5
Sigma PKR	35	2.5
Persona PK	22	1.5
Ibalance	11	0.8
Missing	2	0.1
Total	1,425	100

Ordinary TKA implants, used with stems longer than 5 cm on either side, are defined as being revision models. Together with specific revision brands they are not included in our survival analyses for TKA's as such implants are mainly used for difficult cases and not for typical OA cases.

Besides these revision models, 51 linked implants were used for primary arthroplasty, mainly rotating hinges for treatment of malignancies, fractures and other difficult cases.

TKA revision implants for primary surgery

	Number	Percent
Triathlon revision	97	39.6
PFC Revision	87	35.5
NexGen Revision	53	21.6
Legion/Genesis II Rev.	8	3.3
Total	245	100

58 linked prostheses not included (27 RotaLink, 22 NexGen RHK and 9 other)

974 revisions were reported in 2018 of which 239 were secondary (not the first revision). In 771 cases the primary was a TKA, in 187 it was an UKA, in 8 cases a Femoro-Patellar implant and in 8 a linked implant.

The annual report together with accompanying lists of reported surgeries are sent to the contact surgeons each year. This usually results in some extra revisions becoming reported. As a few missed revisions can have a large effect on the results and because revisions are complicated procedures for which supplementary information is often needed, our survival analyses end 2017.

The most common implants in the counties in 2018

TKA in the counties

	Model 1	n	Model 2	n	Model 3	n	Other
01 Stockholm	NexGen	1,830	PFC Sigma	895	Triathlon	221	99
03 Uppsala	PFC Sigma	457	Other	4	Missing	1	
04 Södermanland	PFC Sigma	234	NexGen	70	Other	8	5
05 Östergötland	NexGen	332	Legion/Genesis II	143	Persona	71	4
06 Jönköping	NexGen	616	Other	1			
07 Kronoberg	PFC Sigma	158	Other	12	NexGen	1	
08 Kalmar	NexGen	550	Other	1			
09 Gotland	PFC Sigma	100	Triathlon	13	Other	2	
10 Blekinge	NexGen	257	Other	1			
12 Skåne	Triathlon	1,470	PFC Sigma	235	NexGen	134	158
13 Halland	NexGen	745	Other	9			
14 Västra Götaland	NexGen	1,242	PFC Sigma	668	Other	26	27
17 Värmland	NexGen	417	Other	1			
18 Örebro	Genesis II	384	NexGen	72	Journey	22	2
19 Västmanland	NexGen	176	Other	3			
20 Dalarna	NexGen	214	PFC Sigma	133	Other	4	
21 Gävleborg	PFC Sigma	450	NexGen	14			
22 Västernorrland	NexGen	286	Other	2			
23 Jämtland	NexGen	163	Other	5			
24 Västerbotten	Legion/Genesis II	211	NexGen	114	Persona	6	5
25 Norrbotten	PFC Sigma	389	Other	10	NexGen	1	1

The table above shows that 11 of 21 reported having used only one ordinary TKA model (revision models not included) while only few counties used 3 models. When "Other" is used instead of an implant name, it generally stands for revision models.

UKA in the counties

	Model 1	n	Model 2	n	Model 3	n	Other
01 Stockholm	Oxford	212	Link	70	Triathlon PKR	63	61
03 Uppsala	Oxford	15	ZUK	3			
04 Södermanland	Oxford	72					
05 Östergötland	Oxford	239	Sigma PKR	7			
06 Jönköping	Oxford	33					
07 Kronoberg	Oxford	90					
08 Kalmar	Link	3					
09 Gotland							
10 Blekinge	Oxford	19					
12 Skåne	Link	40	Oxford	32	Triathlon PKR	16	
13 Halland	ZUK	62	Oxford	24			
14 Västra Götaland	Oxford	93	ZUK	13			
17 Värmland	Oxford	41	Övriga	1			
18 Örebro	ZUK	20					
19 Västmanland	Triathlon PKR	14					
20 Dalarna	Oxford	21					
21 Gävleborg	Link	32					
22 Västernorrland	Oxford	20					
23 Jämtland	Oxford	8					
24 Västerbotten	Persona PK	22	Link	1			
25 Norrbotten	Oxford	78					

In 2018, eight counties reported 50 or more UKA's (Stockholm, Södermans län, Östergötland, Kronoberg, Skåne, Halland,Västra Götaland and Norrboten). Three counties reported between 25 and 50 UKA's, and nine reported from 1 to 24 procedures. Gotland did not report any UKA procedures.

Bone cement and minimally invasive surgery in 2018

Use of cement in primary surgery

	Primary TKA	Primary UKA
No component without cement	12,814	470
Only the femoral component without cement	7	52
Only the tibial component without cement	11	13
The femur- and tibial components without cement	1,014	886
Unknown	39	4
Total	13,885	1,425

	Primary TKA		Primary UKA	
	Number	Percent	Number	Percent
Palacos R+G (gentamicin)	6,312	49.1	301	55.9
Optipac Refobacin	6,037	46.9	191	35.4
Refobacin Bone Cement (genta)	348	2.7	27	5
Smartset GHV gentamycin	122	0.9	12	2.2
Copal (genta+vanco)	14	0.1		
Refobacin Revision Cement (genta+clinda)	5	0	5	0.9
Copal (genta+clinda	2	0		
Unknown	31	0.2	3	0.6
Subtotal	12,871	100	539	100
All components without cement	1,014		886	
Total	13,885		1,425	

Type of bone cement

In Sweden, the use of bone cement is the most common method for fixing components to the bone. Cementless fixation has again become slightly more common. It was used in 7% of the TKA's in 2018 while 0.1% were hybrids. However, in UKA cementless fixation was used in 62% of the cases and as hybrids in 4.6%. The reason is the popularity of the Oxford cementless variant which was used in 95% of the Oxford cases.

Practically all the cement that was used for the primary knee arthroplasties contained gentamicin.

Since 2007, almost all the hospitals have sent stickers for the cement used, allowing for reliable identification of the cement brands (see table above).

The mixing system may have an effect on the cement quality. Thus, in cases where a separate mixing system (not a part of the cement package) is used we are interested in receiving the part numbers.

Minimally invasive surgery (MIS) in UKA

For UKA, we have registered the use of mini-arthrotomy since 1999. Our definition of MIS implies that the surgeon gains access to the knee joint by the use of a small arthrotomy (no specific length) without dislocating / everting the patella.

From the start of the registration in 1999, the popularity of minimally invasive surgery for UKA quickly increased and reached maximum in 2007 when it was being used in 61% of cases. Some implants are more often used with MIS than others (see table below).

In 2018, 43% of the UKA were inserted using MIS.

The type of incision for 1,425 primary UKA's

	Standard incision	Mini-incision	Unknown
Oxford	444	552	1
Link	142		4
ZUK	103	16	
Triathlon PKR	58	35	
Sigma PKR	35		
Persona PK	18	4	
Ibalance UKA	5	6	
Missing	2		
Total	807	613	5

When MIS initally started to become popular there were signs that MIS was associated with a higher revision rate, which may have been caused by an initial learning curve. This tendency disappeared and with the present 17-year follow-up, we cannot see that miniarthrotomy negatively affects the overall revision rate.

The use of patella button for TKA in 2018

The use of patellar resurfacing has been decreasing since the mid-eighties so that it is now only used in 2.9% of the TKA cases. During 2018 a button was most commonly used in the counties of Gävlsborg and Västerbotten but not at all in Värmland Västmannland and Jämtland (see figure below).

It is not only in Sweden that geographical variations are to be found. The Australian arthroplasty register in the 2009 annual report also found substantial regional differences in the use of patellar buttons (https://aoanjrr.sahmri.com/home).

In Sweden, the use of a patella button has also been heavily related to the implant brand used although this effect has diminished as its use has become more uncommon. In 2018, a button was most often used in primary arthroplasty together with the Legion/Genesis II and PFC-MBT.

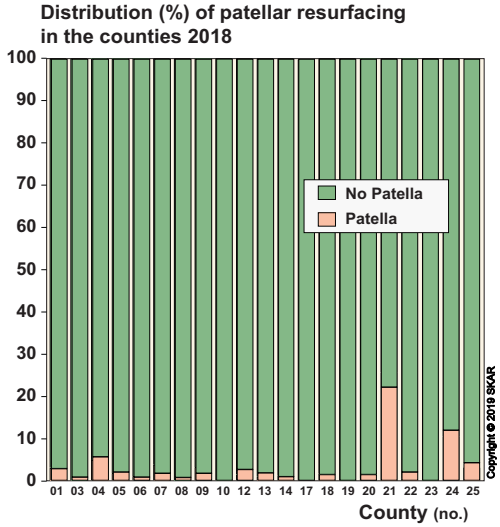
In Sweden, females have their patella resurfaced slightly more often in TKA than males. Thus, in the whole material, from 1975 to the end of 2018, 11.9% of the women had their patella resurfaced compared to 8.6% of the men, which is a significant difference. It has been attempted to explain this difference by femoro-patellar pain being more common in women.

In 2018, 2.1% of the men had a patella button compared to 3.5% of the women which also is a significant difference.

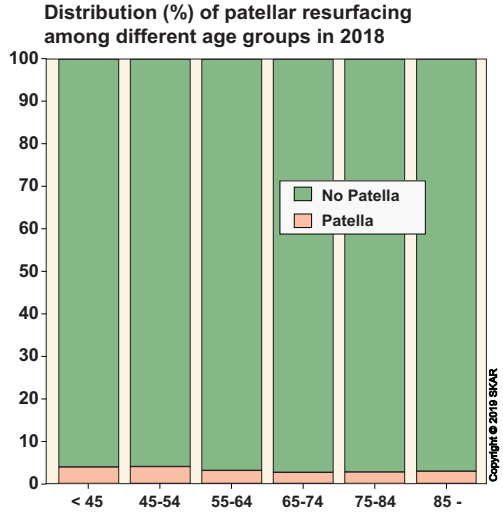
Use of patella button with different TKA implants

	No patella button	%	Patella button	%
NexGen MBT	6,884	98.3	118	1.7
PFC MBT	2,646	94.5	154	5.5
Triathlon	1,662	97.5	43	2.5
PFC-APT	900	97.9	19	2.1
GenesisII	377	98.2	7	1.8
Legion/Genesis II	324	91.3	31	8.7
NexGen TM	223	96.1	9	3.9
Persona	136	98.6	2	1.4
Attune	46	100	0	0.0
Journey	31	100	0	0.0
PFC-RP	11	100	0	0.0
Missing	16	94.1	1	5.9
Other	239	94.5	14	5.5
Total	13,487	97.1	398	2.9

Looking at the relative use of patella button among the different age groups in 2018 (see figure below), it can be seen patellar resurfacing is slightly more common in the youngest age groups. This is less obvious than it was in 2017, but the proportions have varied in recent years because the low number of young patients. How the risk of revision is influenced by the use of a patella button is discussed on page 27 where curves can be found showing the CRR during the current period of 2008-2017, for TKA with and without a button respectively.



The figure shows the relative proportion of TKA with and without patella button in the different counties. (a list and a chart for the counties is on page 20 and a list on page 36).



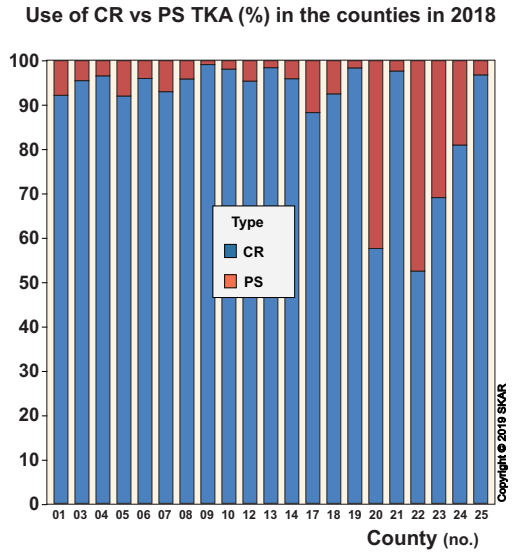
The figure shows the relative proportion of TKA with and without patella button in the different age-groups.

Posterior stabilized prostheses during 2018

As explained on page 4, there are TKA types called posterior stabilizing (PS) as they simulate the effect of the posterior cruciate ligament by an eminence in the middle part of the tibial polyethylene that is contained by a box between the medial and lateral sliding surfaces in the femoral component. The construct limits the anterior posterior slide but allows for some rotation. The type assumes resection of the posterior cruciate if present.

Those advocating the use of PS claim that it allows for better flexion and more normal knee movement than the cruciate retaining (CR) type which spares the posterior cruciate ligament.

The disadvantage of PS is that the increased stability may result in increased stress on the polyethylene as well as the bone surfaces and thus theoretically increase the risk of wear and loosening. Use of PS is common in other countries such as the USA. However, in Sweden surgeons have hitherto preferred using the CR implants at least for knees with intact posterior cruciate and without gross deformity.

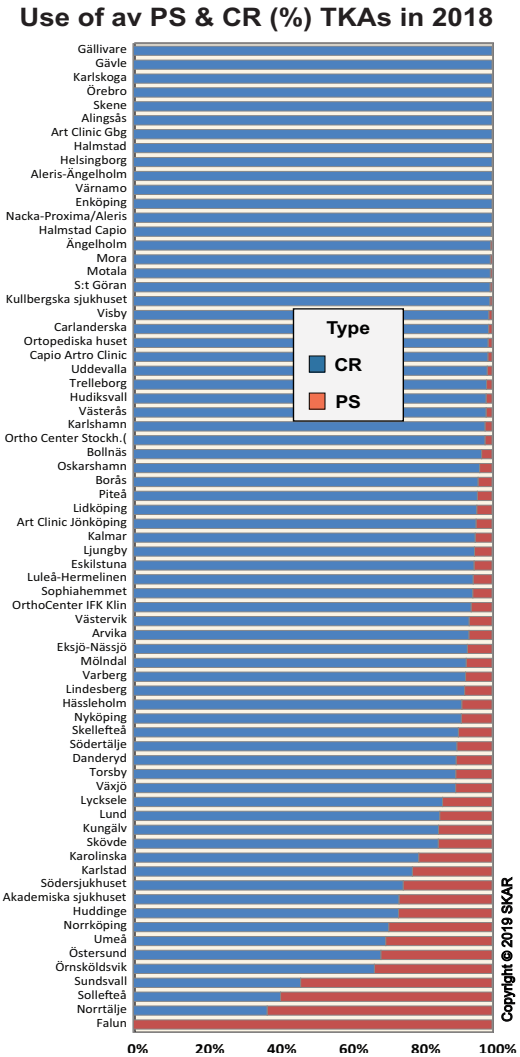


The figure shows the relative use of CR and PS implants in the different counties.

As can be seen from the figure above, the counties are different with respect to their use of PS implants. During 2018, PS implants were most commonly used in 4 counties; Västernorrland, Dalarna, Jämtland and Västerbotten (a list and a chart for the counties can be found on page 20 and a list on page 36).

During 2018, just less than 8% of the primary TKAs were PS (including revision and stemmed implants). The proportion has increased since the turn of the millennium when it was used in 1% of cases.

As can be seen from the figure below the use of PS knees varies among the hospitals with one unit exclusively using PS implants, 3 units using PS for more than 50% of cases and 13 exclusively using CR implants.



The figure shows the relative use of CR and PS implants in the different hospitals.

We do not have any good explanation why the use of PS implants differs so much among the hospitals. Common for those 4 units that mostly used PS knees was that they almost only used the NexGen MBT implant (see table on next page). However, looking at the whole country, 91% of the NexGen MBT implants were of the CR type. (cont.)

Posterior stabilized prostheses cont. –
There was no significant difference in use of PS implants depending on gender. The relative use of PS implants in the different age groups was relatively similar although PS was more common in the youngest and oldest age groups (see figure right).

The relative proportion of CR and PS implants among the brands used for primary TKA in 2018

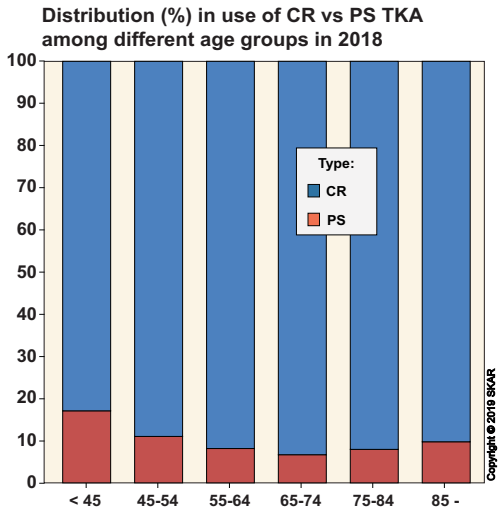
	CR	%	PS	%
NexGen MBT	6,406	91.5	596	8.5
PFC-MBT	2,692	96.4	101	3.6
Triathlon	1,698	99.6	7	0.4
PFC-HPT	919	100.0	0	0.0
Genesis II	372	96.9	12	3.1
Legion/GenII Prim	302	85.1	53	14.9
NexGen TM	138	59.5	94	40.5
Persona	138	100.0	0	0.0
Attune	45	97.8	1	2.2
Journey	9	29.0	22	71.0
PFC-RP	3	27.3	8	72.7
Others	83	30.9	186	69.1
Totalt	12,805	92.2	1,080	7.8

Unfortunately it is not straight forward to compare the results of CR and PS implants. The reason is that because of their greater stability, many surgeons reserve the use of PS knees for cases having insufficient ligaments and/or greater deformity.

Even though some hospitals exclusively use one or the other type, the comparison is not straightforward as it is possible that more difficult cases are referred from hospitals exclusively using CR knees to hospitals that have more experience with PS knees.

An additional complicating factor is that the use of PS knees is more common in some implant brands as compared to others (see table above).

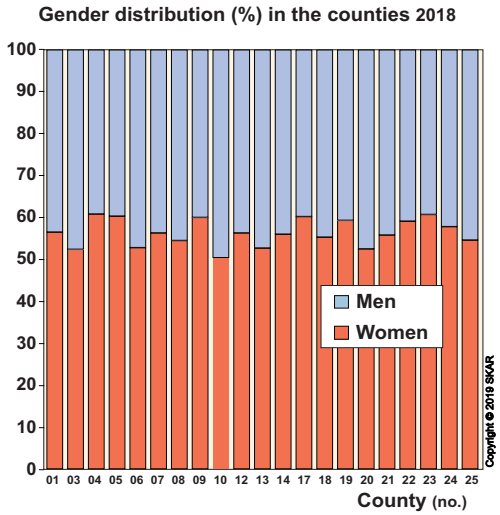
It is probably necessary to perform a randomized trial in order to estimate the differences in survival between the types.



The figure shows the relative use of cruciate retaining (CR) and posterior stabilized (PS) implants among the different age groups.

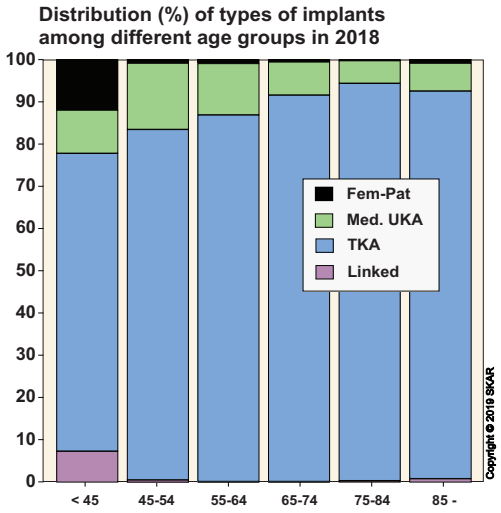
Please note that tibial components that in order to increase stability use an anterior lip or an extra concave polyethylene (deep dish) are not considered being PS implants. Some can be used both with an intact cruciate ligament as well as when the cruciate is insufficient or absent. However, there are several versions having different degree of conformity and in Sweden relatively few of the more stabilizing versions for substituting the posterior cruciate ligament have been used.

Gender distribution in the counties



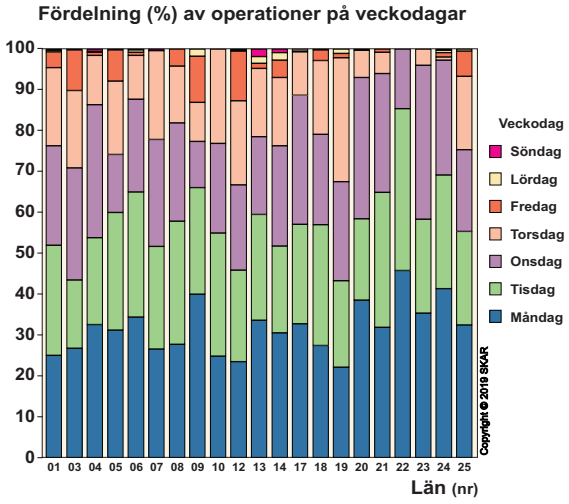
The proportion of females having surgery in the different counties was similar, varying between 50.5% and 59.4% .

Type of implants in different age groups



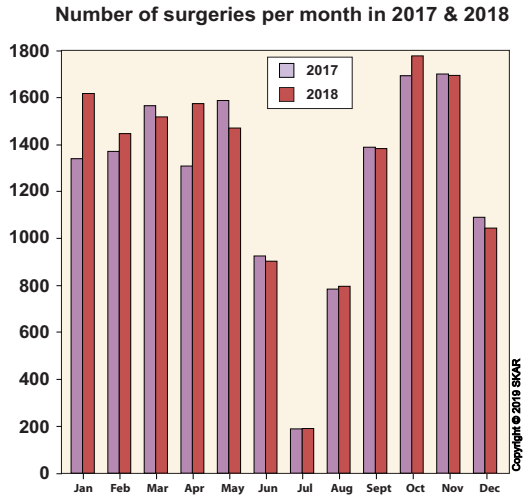
Uncommon models are most often used in younger patients. The use of linked implant in primaries is limited, but these are mainly used for serious conditions (tumors. trauma etc.)

Distribution of primary surgery on weekdays and months



Distribution of surgery on weekdays during 2018. Surgery on Fridays and weekends is uncommon.

Knee arthroplasty is not often performed on Fridays and weekends. Among other, the reasons are reduced working hours on Fridays as well as reduced means for rehabilitation in combination with reduced number of available hospital beds during weekends. This results in arthroplasty surgery being concentrated during the first part of the week so that the patients can be discharged not later than Friday.



The mean number of primary knee arthroplasties inserted each month.

All the counties perform at least 87% of their surgeries Monday to Thursday. Skåne, Gotland and Uppsala are the counties performing the highest proportion of their surgeries on Fridays.

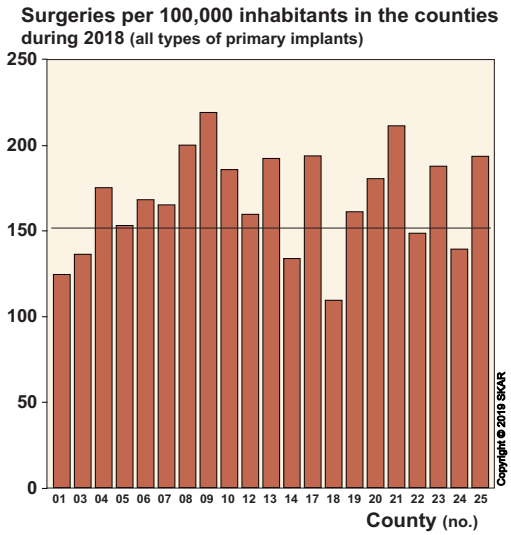
The figure above shows the number of surgeries during the different months of 2017 and 2018. It is evident how the production drops during the summer as around Christmas.

Age distribution and incidence in the counties 2018

County, number of inhabitants and incidence in 2018

Nr	County	No. of inhabitants	no. of primaries	Incidence/ 100.000
01	Stockholm	2,326,134	2,898	124.6
03	Uppsala	372,663	508	136.3
04	Södermanland	293,018	513	175.1
05	Östergötland	459,540	703	153.0
06	Jönköping	359,031	603	168.0
07	Kronoberg	198,703	328	165.1
08	Kalmar	244,103	488	199.9
09	Gotland	58,922	129	218.9
10	Blekinge	159,528	296	185.5
12	Skåne	1,353,427	2,159	159.5
13	Halland	327,089	628	192.0
14	Västra Götaland	1,700,298	2,275	133.8
17	Värmland	280,941	544	193.6
18	Örebro	300,580	329	109.5
19	Västmanland	272,512	439	161.1
20	Dalarna	286,678	517	180.3
21	Gävleborg	286,092	604	211.1
22	Västernorrland	245,711	365	148.5
23	Jämtland	130,043	244	187.6
24	Västerbotten	269,310	375	139.2
25	Norrbotten	250,896	485	193.3
Country		**10,175,214**	**15,430**	**151.6**

(mean yearly no. of inhabitants: www.scb.se)

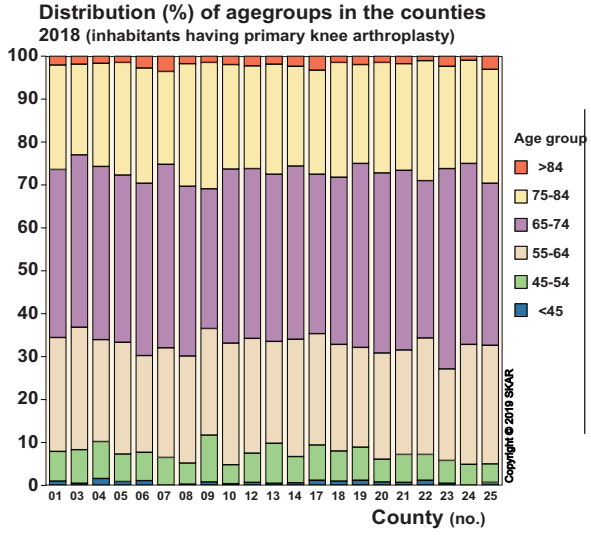


Incidence (no. of arthroplasties per 100.000 inhabitants)

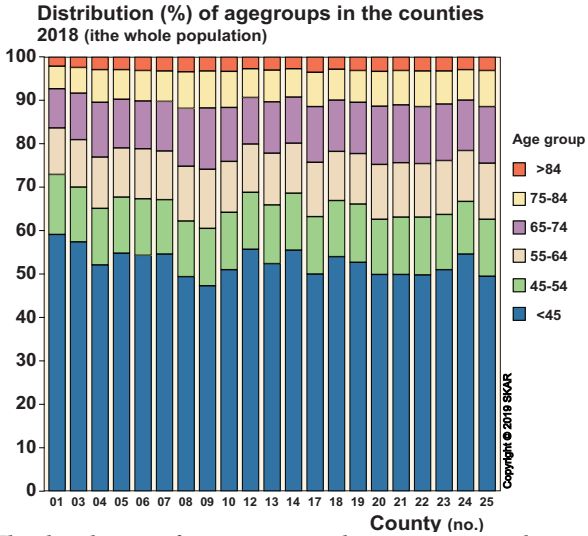
The table and figure above show the number of primary knee arthroplasties per 100,000 inhabitants in each county in 2018. They are based on the domicile of patients at surgery. The incidence (not age-standardized) is highest in Gotland and Gävleborg county and lowest in the county of Örebro.

The figure below shows for each county, the relative proportion of age groups having a primary arthroplasty. The proportion of patients less than 65 years of age was highest in Gotland but lowest in Jämtland. Gotland and Kalmar had the highest proportion of patients 75 years and older.

How many younger or older inhabitants have surgery is partially affected by how many they are. The figure below as well as the table next page show for each county the relative proportion of inhabitants in each of the age groups. It can be seen that Stockholm county has the highest proportion of inhabitants less than 45 years of age (59%) while Gotland has the highest proportion of those 65 years and older (26%). When the 2 figures are compared, a correlation can be seen between the number of inhabitants in the different age groups and of those having surgery, although the correlation is not always consistent.



The agedistribution at primary surgery varies somewhat between the counties.



The distribution of age-groups in the counties according to information from the SCB (Statistics Sweden)

Age standardized incidence in 2018

Distribution (%) of age groups in the counties in 2018 (whole population)

Age group:	0-44	45-54	55-64	65-74	75-84	85-
01 Stockholm	59.1	13.8	10.7	9.0	5.2	2.1
03 Uppsala	57.4	12.6	10.9	10.7	6.0	2.4
04 Södermanland	52.1	13.1	11.8	12.6	7.5	3.0
05 Östergötland	54.8	12.9	11.3	11.2	6.8	2.9
06 Jönköping	54.3	13.0	11.5	11.1	6.9	3.2
07 Kronoberg	54.6	12.6	11.2	11.4	7.0	3.3
08 Kalmar	49.4	12.9	12.6	13.3	8.4	3.5
09 Gotland	47.3	13.2	13.6	14.2	8.5	3.3
10 Blekinge	51.0	13.2	11.8	12.4	8.2	3.4
12 Skåne	55.8	13.1	11.1	10.7	6.6	2.8
13 Halland	52.4	13.5	11.8	11.9	7.3	3.0
14 Västra Götaland	55.5	13.1	11.5	10.7	6.4	2.8
17 Värmland	50.0	13.2	12.5	12.8	7.9	3.5
18 Örebro	54.0	12.9	11.3	11.8	7.1	2.9
19 Västmanland	52.7	13.3	11.7	11.8	7.4	3.1
20 Dalarna	49.9	12.7	12.6	13.5	8.0	3.3
21 Gävleborg	49.9	13.3	12.5	13.3	7.9	3.1
22 Västernorrland	49.8	13.3	12.4	13.1	8.2	3.2
23 Jämtland	51.0	12.7	12.4	13.0	7.6	3.2
24 Västerbotten	54.6	12.1	11.7	11.6	7.1	2.9
25 Norrbotten	49.5	13.1	13.0	13.1	8.3	3.1
Country	54.9	13.2	11.5	11.0	6.6	2.8
ESP (European Standard Population)	54.0	14.0	12.5	10.5	6.5	2.5

The age distribution differs in the counties (table above from the SCB). For a meaningful comparison of incidence, i.e. how common it is for the inhabitants of the counties of having knee replacement, the age distribution has to be taken into account because a younger population does not have the same need for arthroplasties as an older one. This can be achieved by age standardization in which the incidence is recalculated to what it would have been if the age distribution had been the same in all the counties.

To make it possible to compare different countries we used a 2013 recommendation to the European Commission on a new ”EU-27 + EFTA standard population” (Report of Eurostat’s task force ISBN 978-92-79-31094-2).

The distribution of age groups according to this European standard population is shown in the last line of the table above and the age standardized incidence in the table to the right.

It can be seen that the age-standardized incidence is lowest 105.6 in Örebro county and highest 183.3 in Gävleborg. In 2017 Örebro also had the lowest incidence while Halland, which this year has the third highest incedence, was at the top.

In 2015 Uppsala had 50% higher incidence than Stockholm but the 2 counties have since 2016 had roughly the same incidene.

We have really no good explanation for the large differences between counties in how often their inhabitants are provided with a knee arthroplasty or the variation between years.

Age standardized incidence in the counties
(primaries per 100.000 inhabitants in 2018)

Nr	County	Incidence
1	Stockholms län	146.1
3	Uppsala län	144.8
4	Södermanlands län	161.0
5	Östergötlands län	152.1
6	Jönköpings län	164.6
7	Kronobergs län	179.5
8	Kalmar län	169.9
9	Gotlands län	182.1
10	Blekinge län	167.1
12	Skåne län	163.5
13	Hallands län	180.5
14	Västra Götalands län	136.5
17	Värmlands län	171.4
18	Örebro län	105.6
19	Västmanlands län	151.9
20	Dalarnas län	155.2
21	Gävleborgs län	183.3
22	Västernorrlands län	129.7
23	Jämtlands län	164.4
24	Västerbottens län	147.3
25	Norrbottens län	165.6
	Country	151.9

Implants for primary arthroplasty 2008–2017

In the tables below, the implants used during the investigated period 2008-2017 are listed. One must observe that the individual models, especially in case of modular types, may include several different implant variants. During the 10-year period, NexGen was the most commonly used model, followed by the PFC and Triathlon. Vanguard in fourth place was not registered at all during 2018.

Implants for primary TKA

	Number	Percent
NexGen Metal Backed Tib.	51,900	42.1
NexGen All Poly Tib.	3,323	2.7
NexGen Trabicular Metal	1,740	1.4
NexGen unspecified	1	0.0
Natural	1	0.0
Persona	94	0.1
Vanguard I-Beam modular	8,384	6.8
Vanguard Finned modular	2,053	1.7
Vanguard unspecified	68	0.1
AGC	2,536	2.1
PFC Sigma_MBT	21,497	17.4
PFC Sigma_HPT	11,571	9.4
PFC Rotating Platform	830	0.7
PFC Unspecified	23	0.0
Triathlon MBT	11,872	9.6
Triathlon unspecified	97	0.1
Duracon	1,211	1.0
Profix	1,518	1.2
Genesis II	1,382	1.1
Legion/Genesis II	894	0.7
Journey	158	0.1
Attune	69	0.1
F/S MIII	105	0.1
Link Gemini	68	0.1
Other*	1,843	1.5
Model missing	113	0.1
Total	123,351	100

* For "Other" (revision) models. see table right.

Among the UKA's, 3 models accounted for the majority of surgeries during the period.

Implants for primary UKA

	Number	Percent
Oxford	3,653	52.4
Link	1,457	20.9
ZUK	908	13.0
Triathlon PKR	297	4.3
Genesis	238	3.4
MillerGalante	231	3.3
Sigma PKR	126	1.8
Preservation	25	0.4
Persona PK	20	0.3
Ibalance	15	0.2
Model missing	4	0.1
Total	6,974	100

Implants that are specifically made for use in revision surgery or standard models with extra-long stems (5cm or longer) are classified as revision models. When used for primary surgery they are excluded from the analyses concerning standard models. The same applies for hinges and linked implants. The most common types are listed below.

Revision Models* for primary TKA

	Number	Percent
NexGen revision	557	30.2
Triathlon revision	518	28.1
PFC revision	455	24.7
Vanguard revision	123	6.7
Legion/Genesis II rev	62	3.4
Profix revision	51	2.8
Duracon revision	40	2.2
AGC revision	37	2.0
Total	1,843	100

* "Revision models" are implants made specifically for revisions. or ordinary models with extra long stems (longer than 5 cm).

Hinged implants (primary)

	Number	Percent
Nexgen RHK	208	34.8
Link Endo RHK	206	34.4
MUTARS Tumor impant	53	8.9
S-ROM Noiles RHK	40	6.7
Stryker/Howmedica RHK	34	5.7
METS	30	5.0
Stanmore	7	1.2
Biomet RHK	6	1.0
Smith&Nephew HK	4	0.7
Other	7	1.2
Model missing	3	0.5
Total	601	100

Femoro-patellar implants are uncommon. Only 460 cases using 7 different brands were reported during the 10 year period.

Femoro-Patellar implants

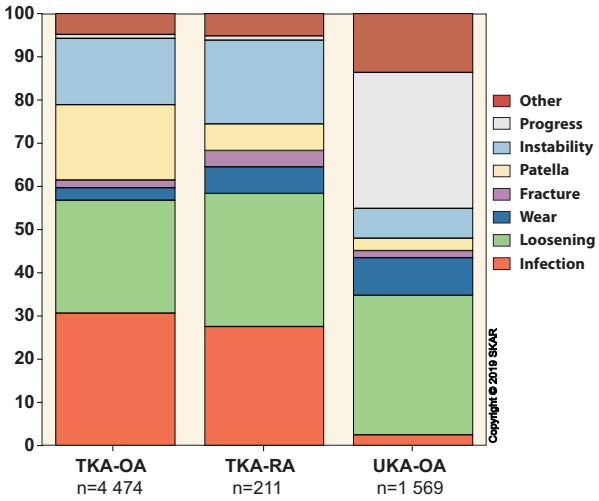
	Number	Percent
Zimmer P-F	302	65,7
PFC P-F	79	17,2
Avon	48	10,4
Link P-F	15	3,3
Journey P-F	6	1,3
Vanguard P-F	6	1,3
LCS P-F	1	0,2
Model misisng	3	0,7
Total	460	100

Revisions during 2008–2017

During the 10-year period, 6,701 first time revisions were performed. In 90 cases the primary was a linked implant, in 4,918 cases a TKA, in 1,616 an UKA, in 75 a P-F implant and in 2 a partial implant (PKRA). The reasons for the revisions in which the primary was a TKA/OA, TKA/RA and UKA/OA are shown in the figure to the right. Note that some primary operations may have been performed before the accounted 10-year period. Infection and loosening are now equally often the reason for revision of TKAs while loosening previously dominated. ”Progress” in TKA mainly reflects revisions performed for femoropatellar arthrosis/arthritis. ”Patella” includes all kinds of problems associated with the patella in patients that had their primaries inserted with or without a patellar button (excluding loosening and wear). Please note that the distribution of the indications does not have to reflect the risk for revision. The sharp increase in the number of primaries over the years leads to overrepresentation of early revisions that include infection.

The tables show the different types of revisions (first) that were performed during 2008-2017. There are separate tables depending on if the primary surgery was TKA/OA, TKA/ RA or UKA/OA. It should be noted that in revision surgery, only one type of revision can be stated. This implies that exclusive patellar surgery is listed, but not patellar surgery done in combination with exchange of other components.

Distribution (%) of indications for revision 2008-2017



For TKA the proportion of revisions in which the poly is exchanged has increased as compared to previously (28% in OA and 24% in RA) which is because of increased aggressively in revision of early infections. Extensive revisions using linked implants seem more common in RA.

For UKA, it is satisfying to note that revisions using a new UKA are few, as these types of revisions have been found to have a very high rate of re-revision.

Type of revision in which the primary was a TKA/OA

	Number	Percent
Linked (rot. hinge)	428	9.6
TKA	1,222	27.3
Exchange of femur comp.	45	1.0
Exchange of tibia comp.	272	6.1
Exchange of disc/insert	1,250	27.9
Patella addition	773	17.3
Patella removal	9	0.2
Patella exchange	28	0.6
Total implant removal	396	8.9
Arthrodesis	8	0.2
Amputation	36	0.8
Other	4	0.1
Missing	3	0.1
Total	4,474	100

Type of revision in which the primary was a UKA/OA

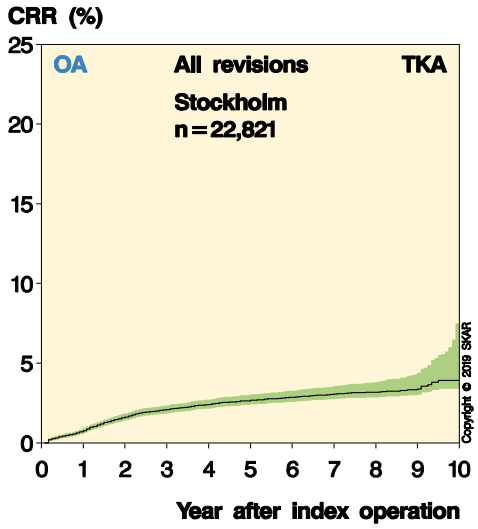
	Number	Percent
Linked (rot. hinge)	31	2.0
TKA	1,419	90.4
UKA	2	0.1
Exchange of femur comp.	5	0.3
Exchange of tibia comp.	9	0.6
Exchange/reposition of poly	78	5.0
Patella addition	4	0.3
Total implant removal	18	1.1
Amputation	2	0.1
Missing	1	0.1
Total	1,569	100

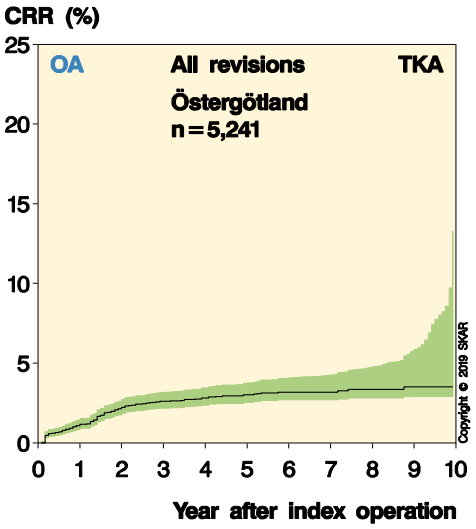
Type of revision in which the primary was a TKA/RA

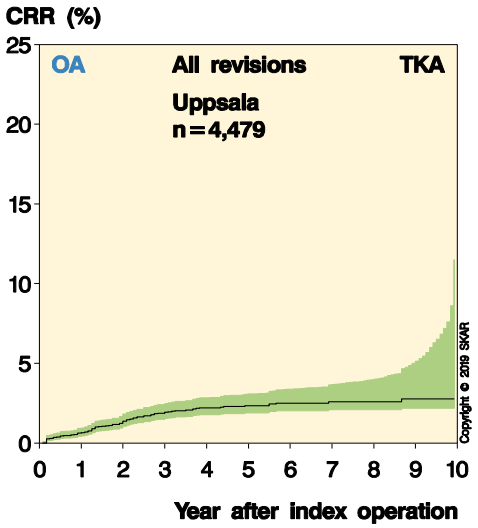
	Number	Percent
Linked (rot. hinge)	44	20.9
TKA	61	28.9
Exchange of femur comp.	5	2.4
Exchange of tibia comp.	7	3.3
Exchange of disc/insert	51	24.2
Patella addition	16	7.6
Total implant removal	19	9.0
Arthrodesis	1	0.5
Amputation	6	2.8
Missing	1	0.5
Total	211	100

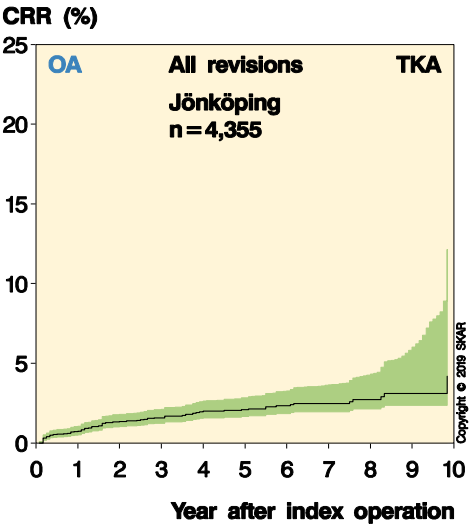
When evaluating the survival curves it should be noted that as the part of the curve to the right contains implants with long follow-up it also to a larger extent reflects older models.

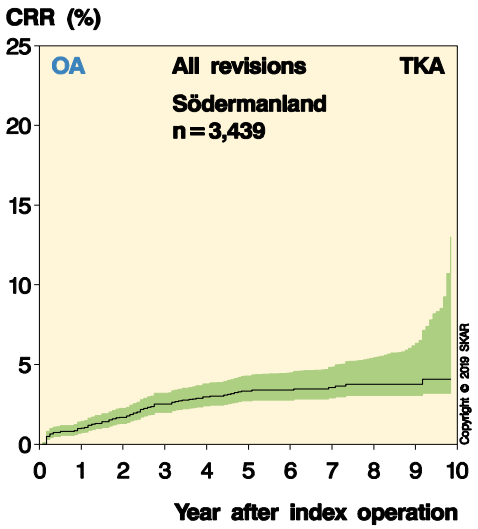
CRR in the counties after primary TKA for OA 2008–2017

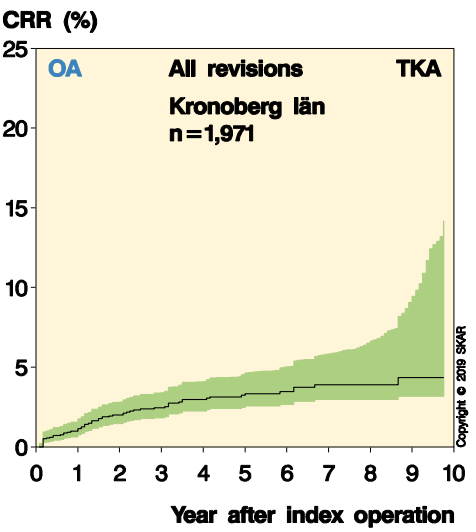




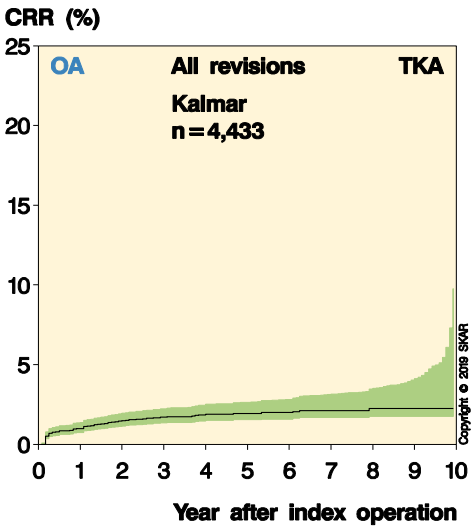


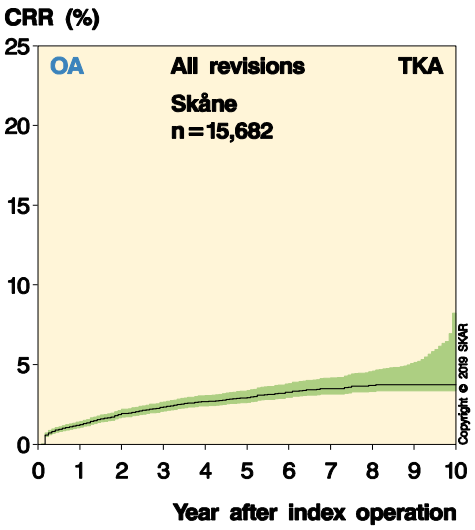


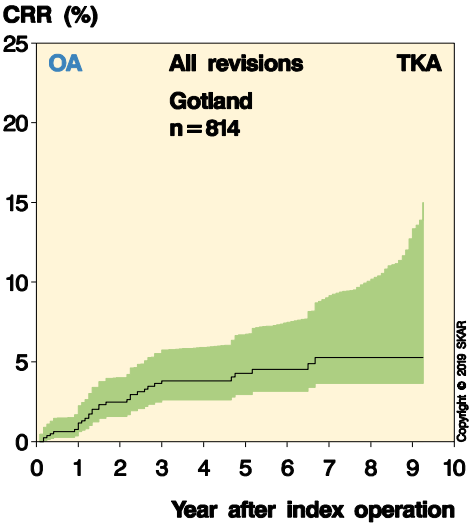


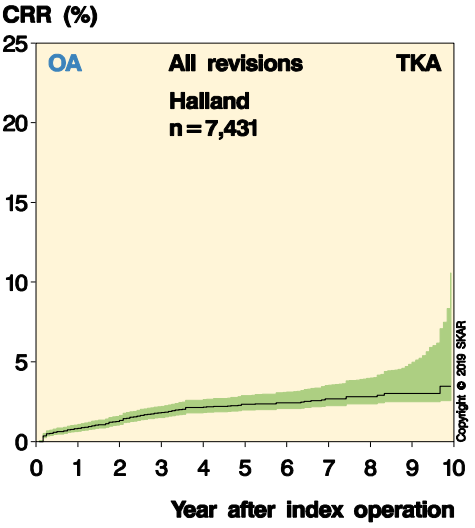


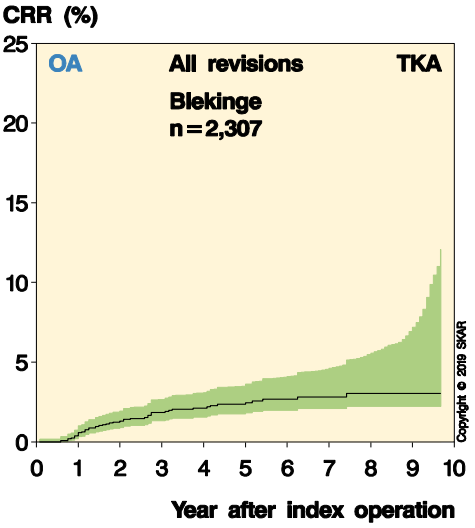
The curves are cut when less than 40 patients are left "at risk"

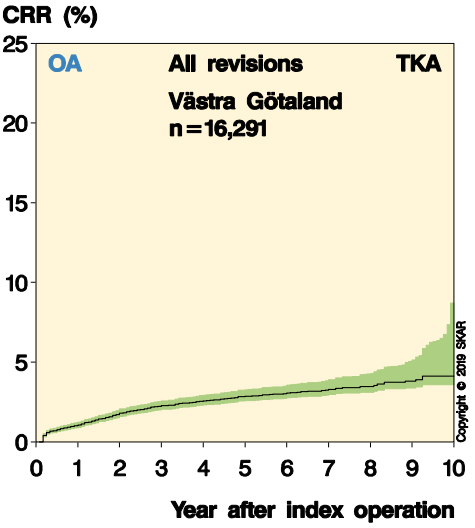






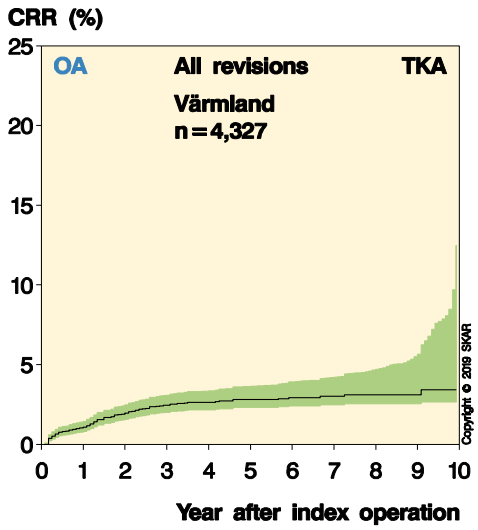


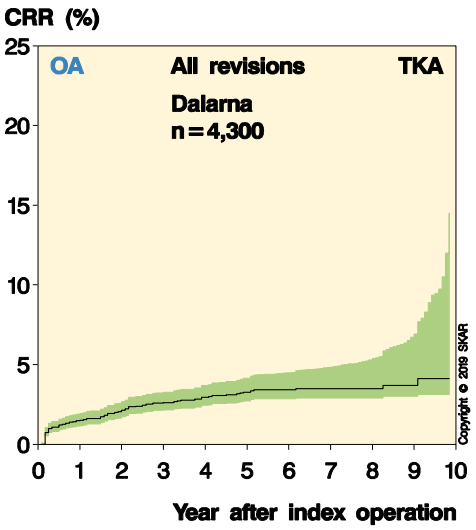


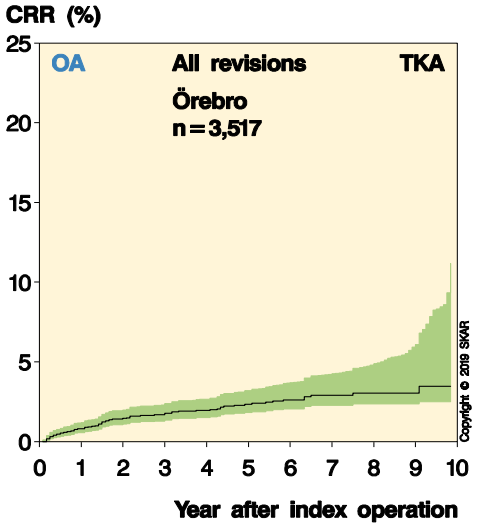


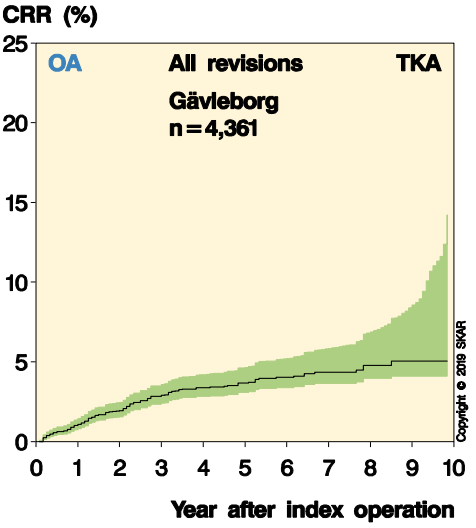
The curves are cut when less than 40 patients are left "at risk"

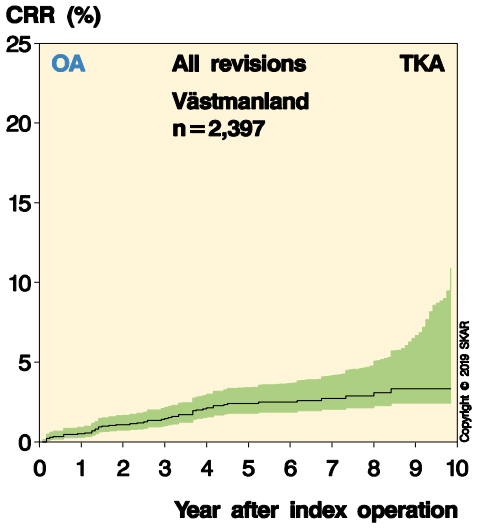
CRR in the counties after primary TKA for OA 2008–2017

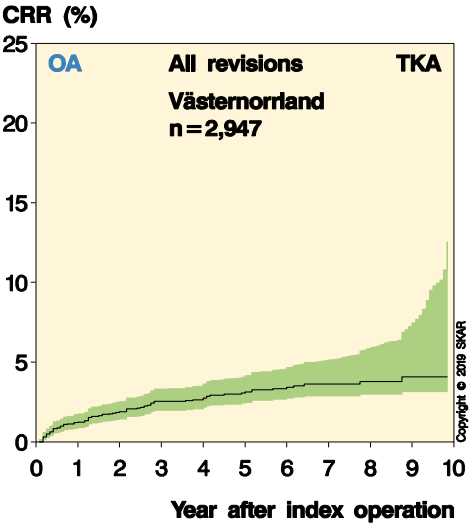




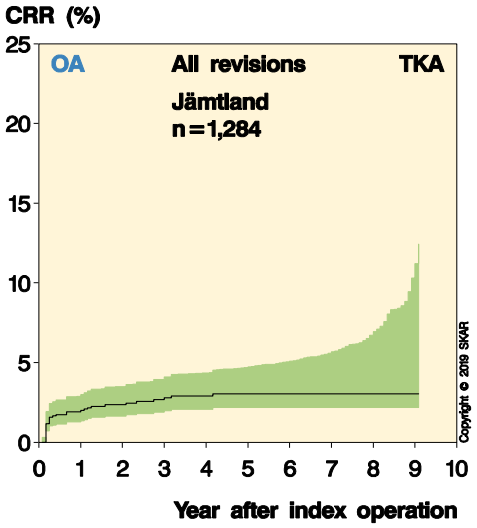


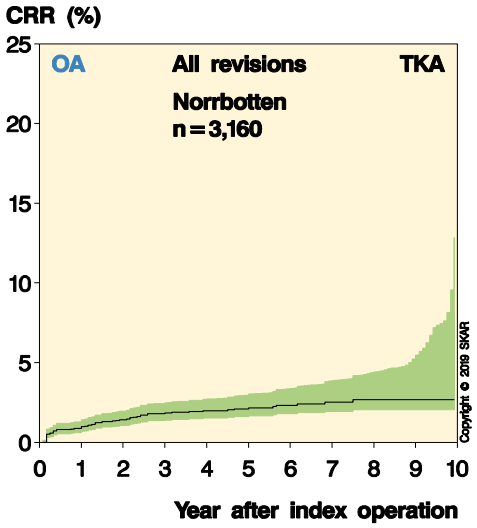


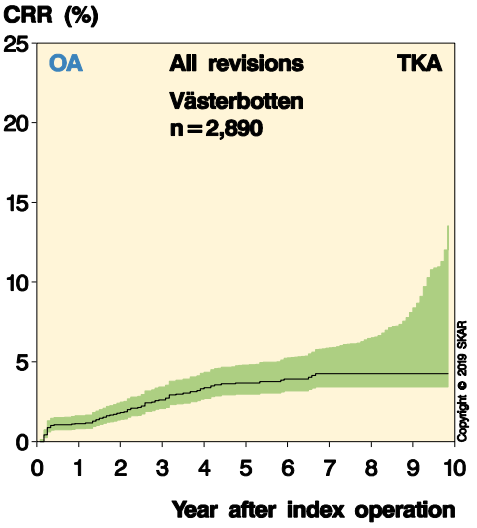




The curves are cut when less than 40 patients are left "at risk"

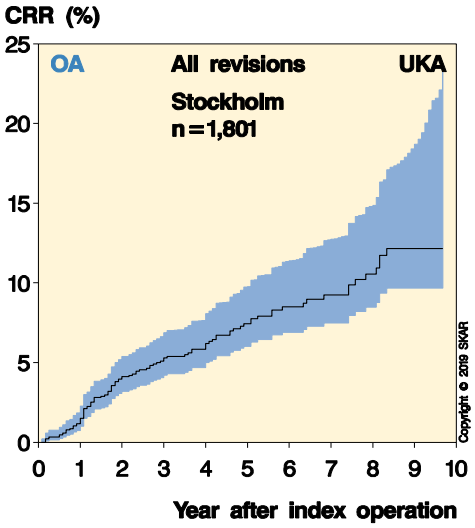


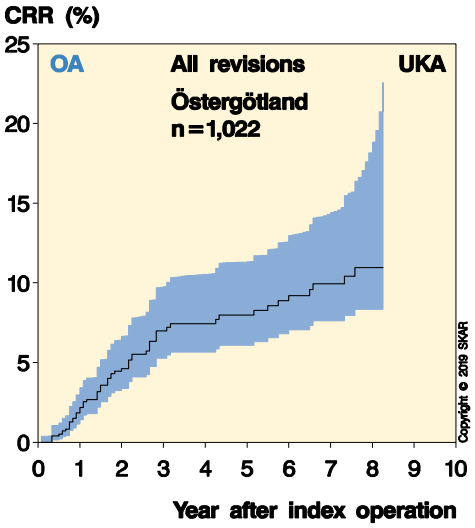


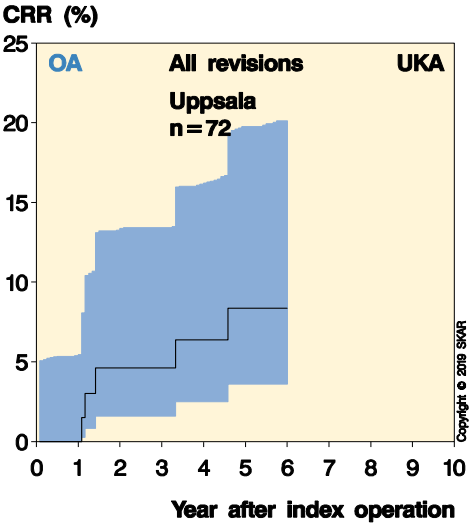


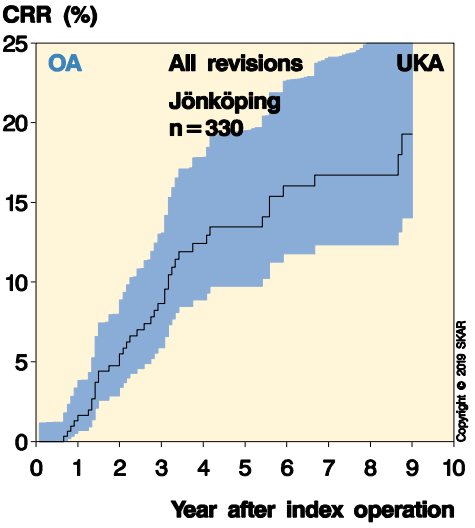
The curves are cut when less than 40 patients are left "at risk"

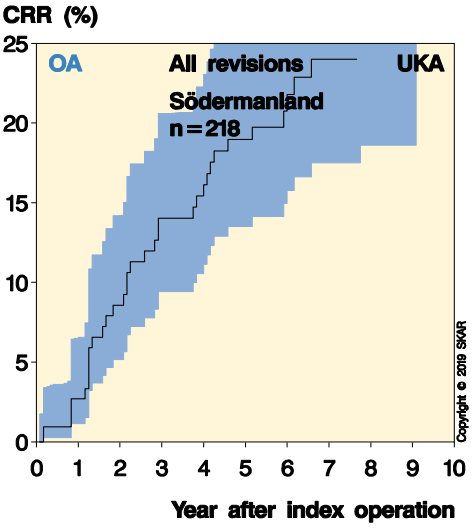
CRR in the counties after primary UKA for OA 2008–2017

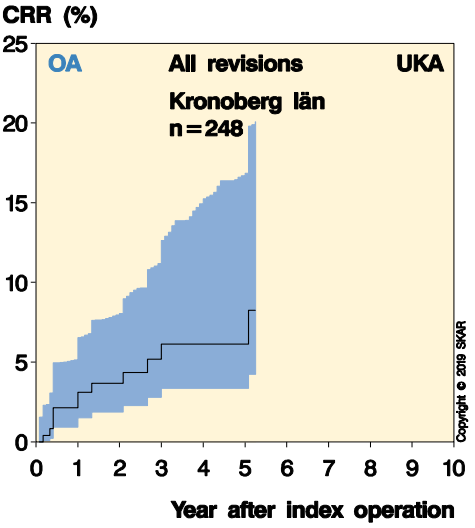




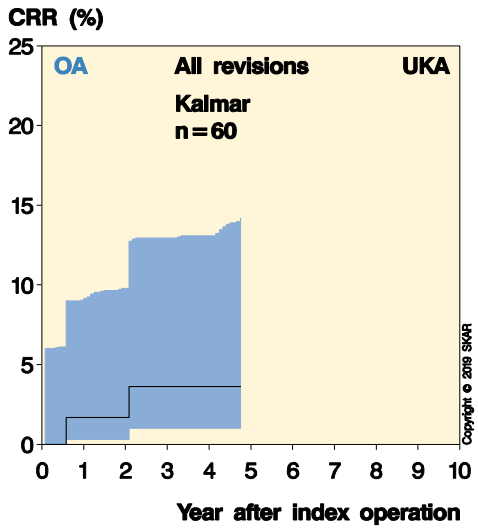


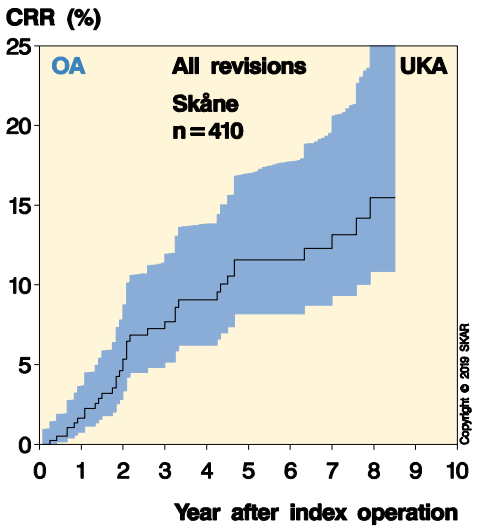


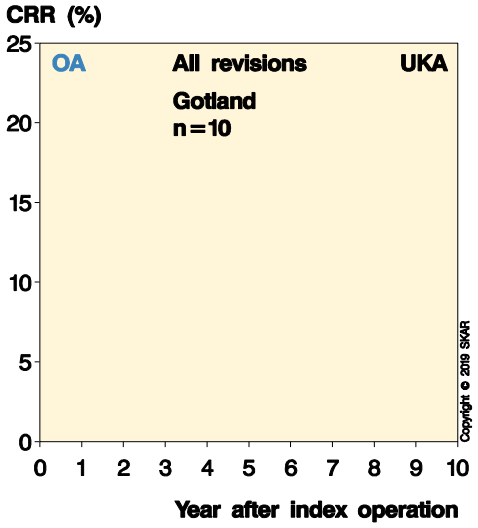


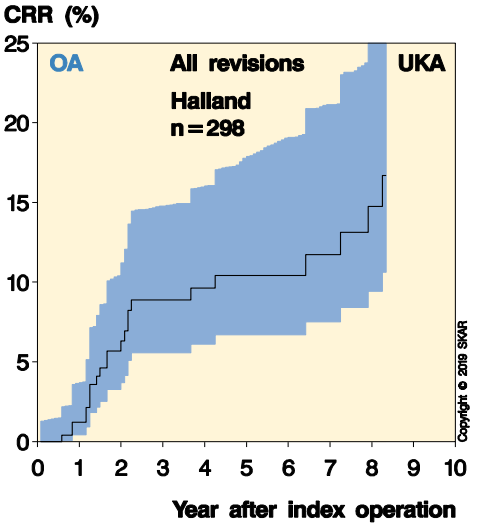


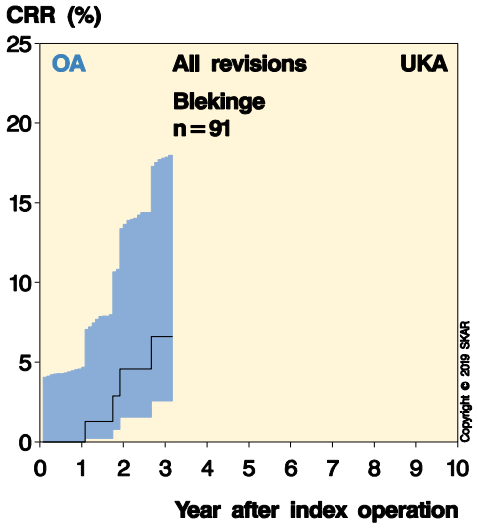
The curves are cut when less than 40 patients are left "at risk"

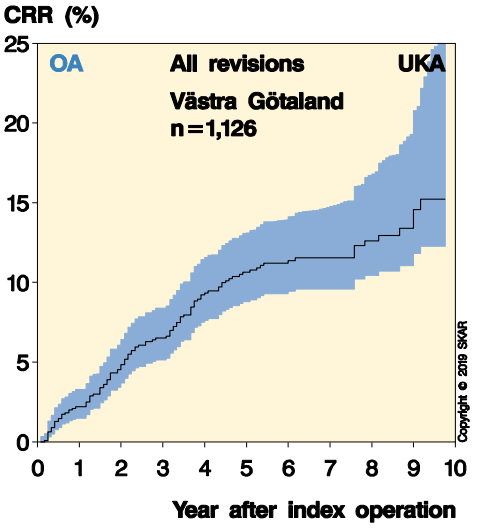






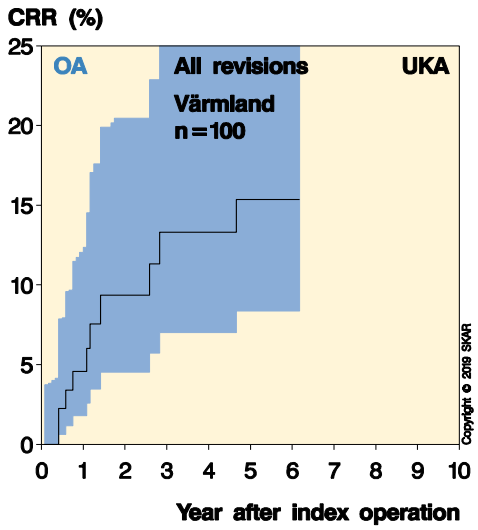


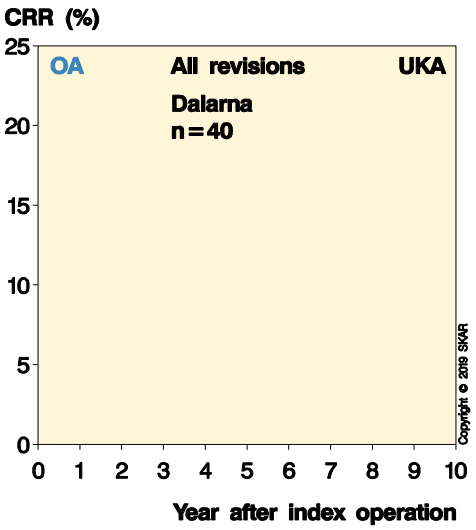


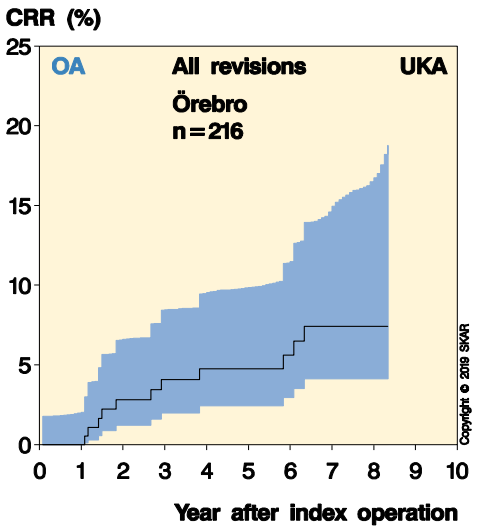


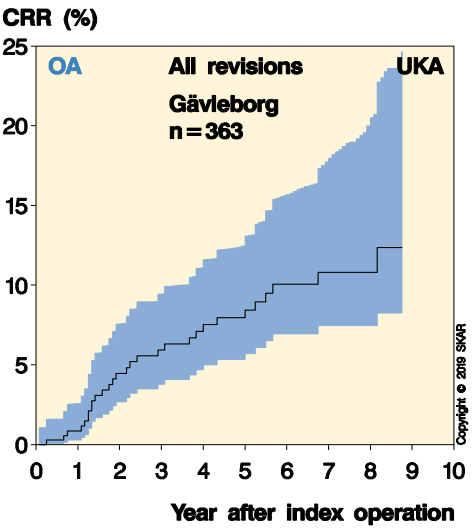
The curves are cut when less than 40 patients are left "at risk"

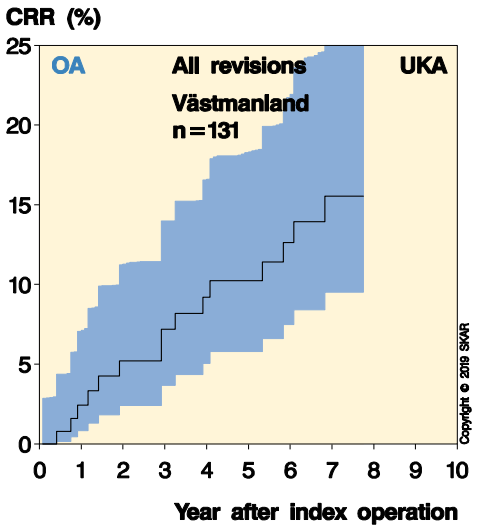
CRR in the counties after primary UKA for OA 2008–2017

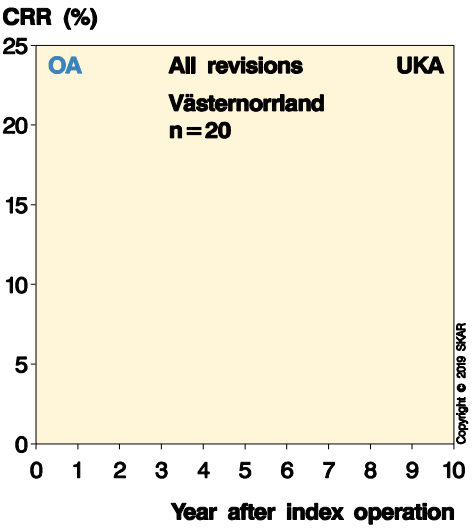




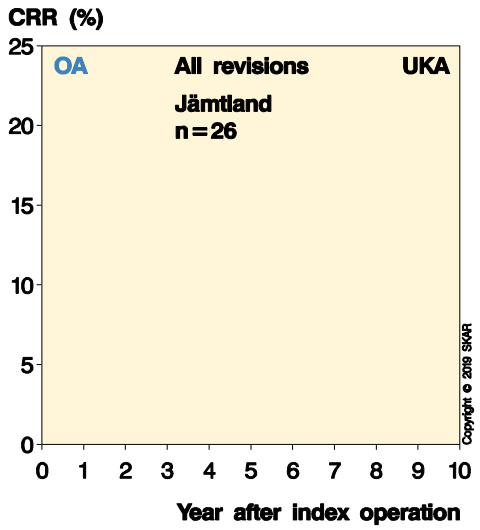


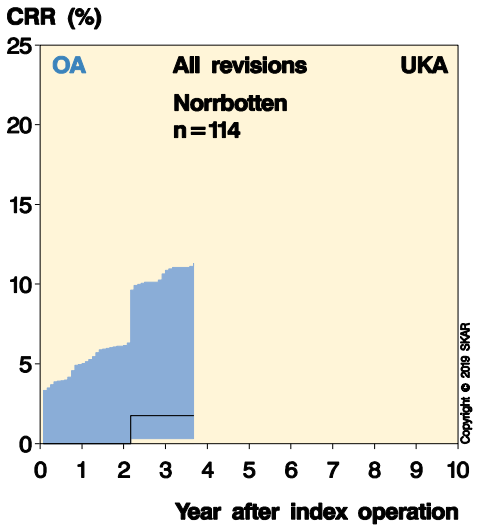


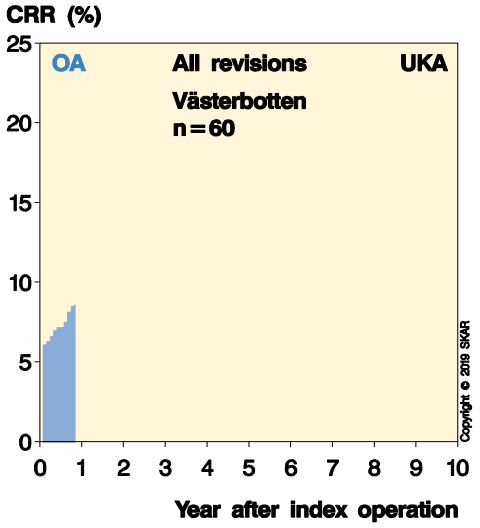




The curves are cut when less than 40 patients are left "at risk"







The curves are cut when less than 40 patients are left "at risk"

The relative risk for implants used in primary arthroplasty during 2008–2017

In order to account for results of relatively modern implants with reasonably long follow-up, the registry uses the latest 10-year period available for analysis. When an implant has been put on the list, it stays on the list as long as there are reasonable numbers to be analyzed even if its use has ceased. One must realize that individual models may represent different variants depending on modularity and marketing. Still, there are usually a few combinations that dominate within each brand.

The PFC Sigma-MBT is as previously used as the reference for TKAs as it is a relatively well defined brand, i.e. it mainly consists of the same type of femur, together with the same type of tibia baseplate and insert.

The risk of revision is one of the many measures of outcome. Although not accounted for here, the type of the revision should also be considered. Deliberately avoiding the use of patellar button in primary surgery and instead preparing for secondary resurfacing when needed, may increase the risk of revision, at least in the short term. Therefore, we separately account for OA/TKA when used with and without a patellar button and also make separate calculations in which isolated exchanges of inserts due to infection are not considered being revisions. The explanation for doing so is discussed together with the tables on page 50-51.

Below you will find Cox regression tables for TKA/OA and UKA/OA, in which the different models are compared to a reference implant. For TKA the reference is as described above the PFC-MBT but for UKA it is the Endo-Link.

For TKA implants inserted for OA (table below, left), this year it are the F/S MIII, Genesis II/Legion, Journey, PFC RP and the combination of "Other" models that have significantly higher risk than the reference PFC-MBT. The F/S MIII was used in Sweden from 1989 until 2008. The PFC rotating platform was introduced at the start of the millennium and became most popular during 2009-2010 after which its use sharply diminished with only 11 inserted in 2018. However, the Journey as well as the Genesis II/Legion combination were relatively recently introduced (2008 and 2013 respectively) and are still in use.

At the other end, the NexGen MBT and NexGen TM as well as the PFC-Sigma MBT have lower risk than the reference.

As last year, we show separate result for 2 variants of the Vanguard brand depending on if it used a tibial baseplate with an I-Beam stem or a baseplate with a Finned stem which was introduced in 2010. Last year we found the Finned version to have significantly higher risk than the PFC-MBT reference while this year, the difference was not

The risk of revision (RR) with 95% confidence interval. For TKA the reference is PFC-Sigma MBT and for UKA Link. The Cox regression adjusts for differences in gender, age and year of operation.

OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	20,661		ref.	
AGC Anat	2,456	0.55	1.07	0.85-1.35
Duracon	1,162	0.25	1.20	0.88-1.62
F/S MIII	102	0.04	2.12	1.05-4.28
GenesisII	1,343	0.20	0.74	0.47-1.17
Genesis II/Legion	856	0.04	1.61	1.02-2.56
Journey	153	0.01	2.37	1.23-4.58
NexGen MBT	50,102	0.01	0.87	0.78-0.96
NexGen APT	3,254	0.21	0.86	0.69-1.08
NexGen TM	1,605	0.03	0.70	0.51-0.97
PFC RP	773	<0.01	1.81	1.37-2.40
PFC-Sigma HPT	11,246	<0.01	0.70	0.60-0.82
Profix	1,445	0.75	1.05	0.78-1.42
Triathlon MBT	11,460	0.88	1.01	0.88-1.17
Vanguard I-Beam	8,071	0.46	1.06	0.91-1.23
Vanguard Finned	1,966	0.07	1.29	0.98-1.70
Other	1,792	<0.01	1.77	1.38-2.25
Gender (male is ref.)		<0.01	0.88	0.82-0.95
Age (per year)		<0.01	0.98	0.97-0.98
Year of op. (per year)		0.16	1.01	1.00-1.03

OA / UKA	n	p–value	RR	95% CI
Link	1,428		ref.	
Oxford	3,559	0.93	1.01	0.81-1.25
MillerGalante	220	0.77	1.06	0.72-1.55
Genesis	234	0.06	1.40	0.98-2.00
Sigma PKR	120	0.40	0.65	0.24-1.76
ZUK	851	0.96	1.01	0.75-1.35
Triathlon PKR	283	0.11	1.43	0.92-2.22
Other	61	0.47	1.36	0.60-3.08
Gender (male is ref.)		0.83	1.02	0.86-1.21
Age (per year)		<0.01	0.97	0.96-0.98
Year of op. (per year)		0,07	0,96	0,93-1,00

Red is significant difference with higher risk ratio.
Green is significant difference with lower risk ratio.

The risk of revision (RR) with 95% confidence interval for OA/TKA inserted respectively without and with a patellar button. PFC-Sigma MBT is used as reference.

Without patella button OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	20,097		ref.	
AGC Anat	2,026	0.13	1.21	0.94-1.54
Duracon	979	0.56	1.11	0.78-1.57
F/S MIII	98	0.07	2.01	0.95-4.26
GenesisII	1,325	0.13	0.69	0.42-1.12
Genesis II/Legion	810	0.04	1.65	1.03-2.65
Journey	148	<0.01	2.52	1.30-4.88
NexGen MBT	49,384	0.03	0.89	0.80-0.99
NexGen APT	3,189	0.38	0.90	0.72-1.14
NexGen TM	1,551	0.06	0.73	0.53-1.02
PFC RP	608	<0.01	1.80	1.31-2.47
PFC-Sigma HPT	10,786	<0.01	0.72	0.61-0.84
Profix	1,312	0.59	1.09	0.80-1.49
Triathlon MBT	11,261	0.52	1.05	0.91-1.21
Vanguard I-Beam	7,637	0.07	1.15	0.99-1.34
Vanguard Finned	1,925	0.06	1.31	0.99-1.73
Other	1,729	<0.01	1.84	1.43-2.35
Gender (male is ref.)		<0.01	0.9	0.83-0.97
Age (per year)		<0.01	0.98	0.97-0.98
Year of op. (per year)		0.13	1.01	1.00-1.03

With patella button OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	564		ref.	
AGC Anat	430	<0.01	0.21	0.10-0.46
Duracon	183	0.23	0.62	0.29-1.34
F/S MIII	4	0.35	2.63	0.34-20.10
GenesisII	18	0.16	2.80	0.66-11.87
Genesis II/Legion	46	0.99	1.01	0.13-7.62
Journey	*5*	*0.98*	.	.
NexGen MBT	718	0.08	0.61	0.36-1.05
NexGen APT	65	0.08	0.16	0.02-1.22
NexGen TM	54	0.18	0.25	0.03-1.90
PFC RP	165	0.18	0.61	0.30-1.25
PFC-Sigma HPT	460	0.02	0.42	0.20-0.86
Profix	133	0.08	0.39	0.13-1.12
Triathlon MBT	199	0.02	0.27	0.09-0.78
Vanguard I-Beam	434	<0.01	0.06	0.01-0.25
Vanguard Finned	41	0.90	0.91	0.22-3.85
Other	63	0.41	0.55	0.13-2.30
Gender (male is ref.)		<0.01	0.56	0.39-0.81
Age (per year)		<0.01	0.97	0.95-0.99
Year of op. (per year)		0.17	0.94	0.86-1.03

Implants lacking sufficient numbers for analysis are shown in italics

significant. As it seems that the use of the Vanguard implant has halted in Sweden (no primary reported in 2018) this is probably mainly of historical interest.

Women had a reduced 10-year risk of revision (all types) as compared to men. This may be explained by the higher risk that men have being revised for infection, which often is an early postoperative complication. As last year, the risk of revision decreases with increasing age while we no longer can see significant effect with increase in the year of surgery. The reason for the latter may be that the number of insert exchanges in manifest or suspected infections, which increased in the start of the millennium, has reached a steady state, On the next page we have performed the same analysis but without considering such insert exchanges being revisions.

With respect to UKA inserted for OA (table on the previous page) 2 models, Oxford and Link, account for74% of the surgeries. None of the UKA models had a significantly different risk as compared to the reference model Endo-Link. The risk diminishes with increasing age of patients at surgery while there is no significant effeect with inreasing year of surgery.

Above, the TKA implants have been divided into those without (left) and with (right) a patellar button. This reduces the number of implants available for each of the analyses, especially for the group in which a patellar button was used.

In TKA's not using a patellar button, it are still the PFC-Sigma APT and the NexGen MBT that have significantly lower risk of revision than the reference as when all TKA's are analyzed (table on the previous page). Those implants having significantly higher risk are also the same with the exemption of F/S MIII which only includes few cases as it has not been used since 2008.

The number of TKA's using a patellar button, is small which makes it more difficult to show and even interpret significant differences. However, it is interesting to see that the AGC, Vanguard I-Beam and the Triathlon have a lower risk than the reference when used together with a button.

The relative risk for implants used in primary arthroplasty during 2008–2017 if the exchange of insert, in case of infection, is not considered to be a revision

The SKAR defines a revision being a secondary surgery (reoperation) in a resurfaced knee during which implant components are exchanged, added or removed. The reason for other types not being considered is that it had been noted that some surgeons did not report reoperations that they did not consider implant related which resulted in underreporting of soft tissue surgeries. Thus, the register decided to use a strict definition of revision, surely related to the implant.

It has been claimed that the strict definition may treat certain implants unfairly. The reason is that almost half of the revisions for infection are synovectomies during which the insert is also exchanged (defining them as revisions). However, a synovectomy in a knee with an implant in which the insert cannot be exchanged is not counted as a revision, which may favor the type. Thus, the argument has been made that an exchange of insert in infection should not be considered a revision but a synovectomy. On the opposite it can be claimed that infected TKA´s with fixed inserts will be treated with a complete exchange of components, as a comprehensive synovectomy is not considered possible without removal of the insert. This could result in a reversed bias if the exchanges of an insert is not considered being a revision.

Not being able to give a definite answer regarding what is the most reasonable, we decided to produce additional tables in which the exchange of insert (for infection) is not considered being revision. It has to be observed that such exclusion reduces the number of revisions, which in turn reduces the sensitivity of the statistical calculations. During the 10-year period this lead to exclusion of 865 TKA and 13 UKA revisions. However, any later revisions of these knees will count instead.

For TKA/OA, without considering patella resurfacing (table below), we see, in comparison to the table on page 48, that it is the same implants having a significantly increased risk with addition of the AGC and the Vanguard I-Beam. In case of the AGC, PFC Sigma APT, the NexGen-APT and the Monoblock NexGen TM (2/3 of the TMs) it is not possible to exchange the insert. These do not benefit from the exclusion of insert exchanges, why their risk as compared to the other implants will be negatively affected. Thus, AGC has become worse than the reference while PFC APT and NexGen TM are no longer better.

Before the exclusion, the risk of revision was lower for women than for men but afterwards it has become higher. This could indicate that women have a higher risk of revision for other reasons than manifest or suspected early infection.

The risk of revision (RR) with 95% confidence interval. For TKA the reference is PFC-Sigma MBT and for UKA Link.
The exchange of insert, in case of infection is not considered to be a revision.

OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	20,661		ref.	
AGC Anat	2,456	<0.01	1.44	1.14-1.84
Duracon	1,162	0.06	1.38	0.99-1.92
F/S MIII	102	<0.01	2.81	1.39-5.70
GenesisII	1,343	0.24	0.70	0.38-1.28
Genesis II/Legion	856	<0.01	2.24	1.31-3.85
Journey	153	<0.01	3.39	1.75-6.56
NexGen MBT	50,102	0.11	0.90	0.80-1.02
NexGen APT	3,254	0.17	1.18	0.93-1.50
NexGen TM	1,605	0.17	0.79	0.56-1.11
PFC RP	773	<0.01	2.03	1.51-2.74
PFC-Sigma HPT	11,246	0.91	0.99	0.83-1.17
Profix	1,445	0.16	1.26	0.91-1.75
Triathlon MBT	11,460	0.91	1.01	0.85-1.20
Vanguard I-Beam	8,071	0.04	1.19	1.01-1.42
Vanguard Finned	1,966	0.07	1.36	0.98-1.89
Other	1,792	<0.01	1.59	1.18-2.16
Gender (male is ref.)		0.04	1.09	1.01-1.19
Age (per year)		<0.01	0.96	0.96-0.97
Year of op. (per year)		0.67	1.00	0.98-1.02

OA / UKA	n	p–value	RR	95% CI
Link	1,428		ref.	
Oxford	3,559	0.92	0.99	0.80-1.23
MillerGalante	220	0.81	1.05	0.72-1.53
Genesis	234	0.07	1.39	0.98-1.99
Sigma PKR	120	0.42	0.66	0.24-1.80
ZUK	851	0.94	1.01	0.76-1.36
Triathlon PKR	283	0.10	1.44	0.93-2.24
Other	61	0.46	1.36	0.60-3.08
Gender (male is ref.)		0.70	1.03	0.87-1.23
Age (per year)		<0.01	0.97	0.96-0.98
Year of op. (per year)		0.05	0.96	0.92-1.00

Red is significant difference with higher risk ratio.
Green is significant difference with lower risk ratio.

The risk of revision (RR) with 95% confidence interval for OA/TKA inserted respectively without and with a patellar button. The exchange of insert in case of infection is not considered to be a revision

Without patella button OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	20,097		ref.	
AGC Anat	2,026	<0.01	1.63	1.26-2.10
Duracon	979	0.24	1.25	0.86-1.83
F/S MIII	98	0.01	2.69	1.27-5.70
GenesisII	1,325	0.20	0.66	0.35-1.24
Genesis II/Legion	810	<0.01	2.43	1.41-4.16
Journey	148	<0.01	3.58	1.85-6.95
NexGen MBT	49,384	0.19	0.92	0.81-1.04
NexGen APT	3,189	0.08	1.23	0.97-1.57
NexGen TM	1,551	0.24	0.81	0.58-1.15
PFC RP	608	<0.01	1.98	1.41-2.79
PFC-Sigma HPT	10,786	0.92	1.01	0.85-1.20
Profix	1,312	0.10	1.33	0.95-1.86
Triathlon MBT	11,261	0.58	1.05	0.88-1.25
Vanguard I-Beam	7,637	<0.01	1.29	1.09-1.54
Vanguard Finned	1,925	0.08	1.36	0.97-1.90
Other	1,729	<0.01	1.62	1.19-2.22
Gender (male is ref.)		0.02	1.11	1.02-1.21
Age (per year)		<0.01	0.96	0.96-0.97
Year of op. (per year)		0.61	1.01	0.98-1.03

With patella button OA / TKA	n	p–value	RR	95% CI
PFC-Sigma MBT	564		ref.	
AGC Anat	430	<0.01	0.30	0.13-0.70
Duracon	183	0.63	0.81	0.35-1.89
F/S MIII	4	0.25	3.36	0.43-26.27
GenesisII	18	0.43	2.24	0.30-16.93
Legion/Genesis Prim	*46*	*0.98*	.	.
Journey	*5*	*0.99*	.	.
NexGen MBT	718	0.56	0.83	0.45-1.53
NexGen APT	65	0.15	0.23	0.03-1.74
NexGen TM	54	0.30	0.34	0.05-2.62
PFC RP	165	0.60	0.81	0.37-1.77
PFC-Sigma HPT	460	0.21	0.62	0.29-1.32
Profix	133	0.17	0.42	0.12-1.44
Triathlon MBT	199	0.03	0.20	0.05-0.86
Vanguard I-Beam	434	<0.01	0.09	0.02-0.37
Vanguard Finned	41	0.65	1.40	0.32-6.09
Other	63	0.80	0.83	0.19-3.59
Gender (male is ref.)		0.07	0.69	0.46-1.03
Age (per year)		<0.01	0.96	0.94-0.98
Year of op. (per year)		0.27	0.94	0.85-1.05

Implants lacking sufficient numbers for analysis are shown in italics

In case of UKA (table previous page right), there were only 13 exchanges of inserts during the 10-year period for manifest or suspected infection (of which 8 later were revised for other reasons). Thus, the results are similar to those in the table on page 48.

Above, we have (as on page 49) divided the TKA for OA into those that were inserted without, respective with, a patellar button.

When the table above left (without a patella button) is compared to the the table when all the TKA's were included (table on the previous page to the left), we find no difference in what implants have a significantly higher revision rate than the reference PFC MBT and there are still no implants with a significantly lower risk.

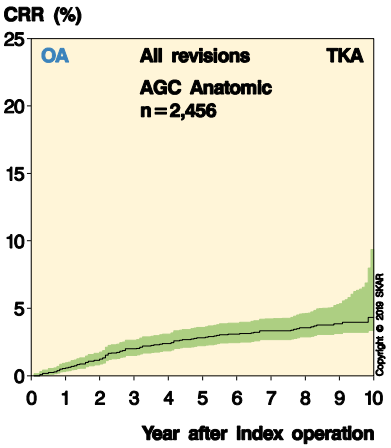
As compared to the table on page 49 in which change of inserts for infection were considered revisions the difference is that the NexGen MBT and the PFC-Sigma APT are no longer better than the reference while the AGC, F/S MII and Vanguard I-beam have become significantly inferior.

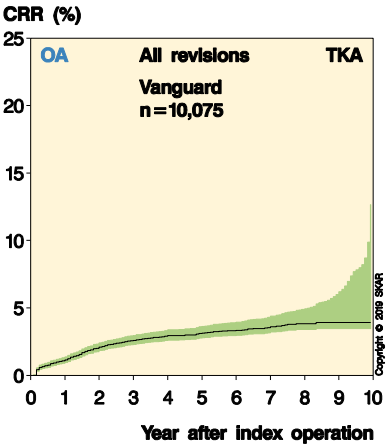
The table above concerns TKA's in which a patellar button was used. When this table is compared to the same table on page 49 the difference is that the PFC APT a no longer has significantly lower risk than the reference PFC MBT.

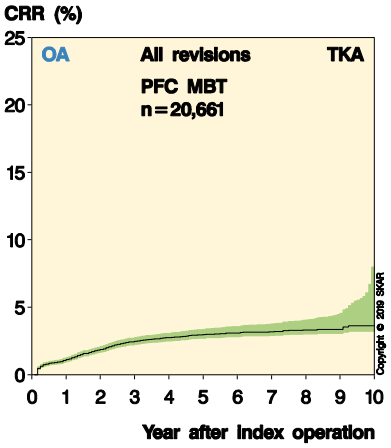
However, as has been mentioned, the number of TKA implants with patellar button is small making it difficult to show and even interpret significant differences.

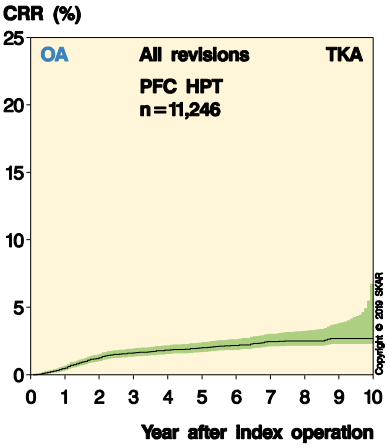
In summary one can establish that excluding an exchange of insert in infected cases does affect the results and that the effect negatively affects non-modular implants as compared to modular ones. One explanation may be that a number of debridement's without exchange of inserts in non-modular TKA's have succeeded in curing the infection (if not cured, a later revision would probably have been performed). Another possibility is that the increased aggressiveness in opening the knee and performing debridement when an insert can be exchanged may have resulted in unnecessary surgeries.

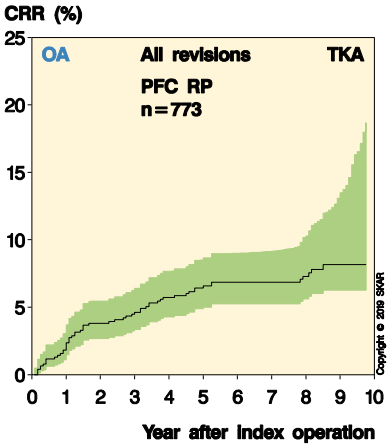
CRR for commonly used TKA implants for OA 2008–2017

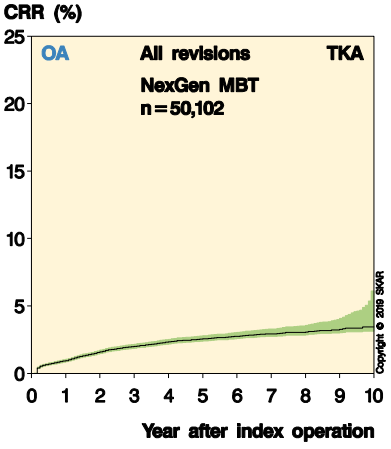


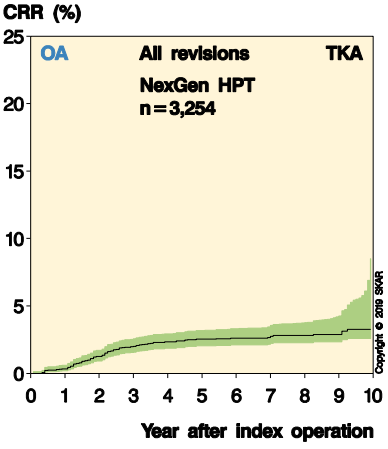


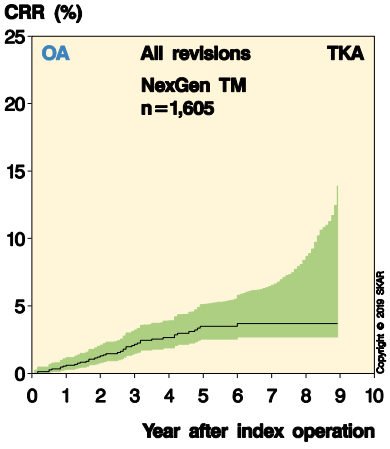


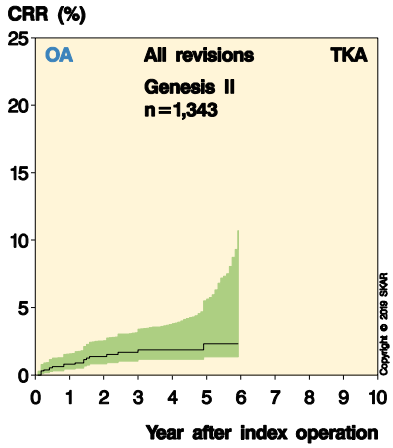











CRR (%)
OA
All revisions
TKA
Genesis II
n=1,343
Year after index operation
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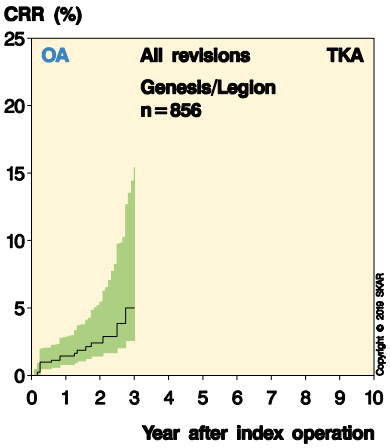
CRR (%)
OA
All revisions
TKA
Genesis/Legion
n=856
Year after index operation
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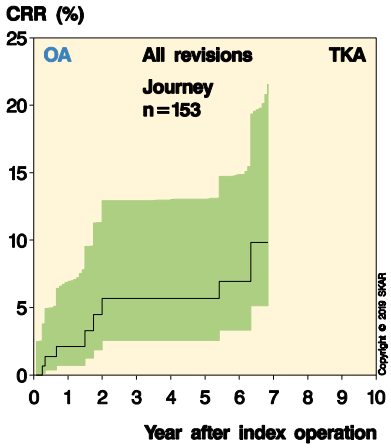
CRR (%)
OA
All revisions
TKA
Journey
n=153
Year after index operation
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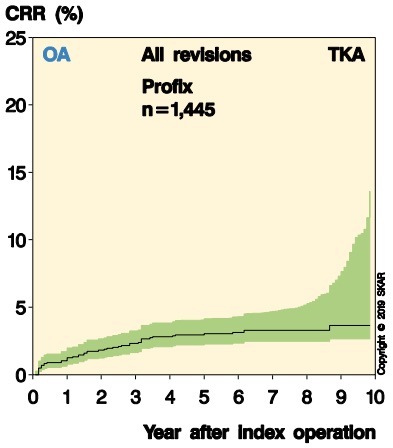
CRR (%)
OA
All revisions
TKA
Profix
n=1,445
Year after index operation
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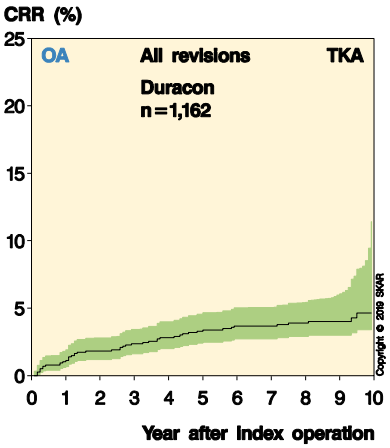
CRR (%)
OA
All revisions
TKA
Duracon
n=1,162
Year after index operation
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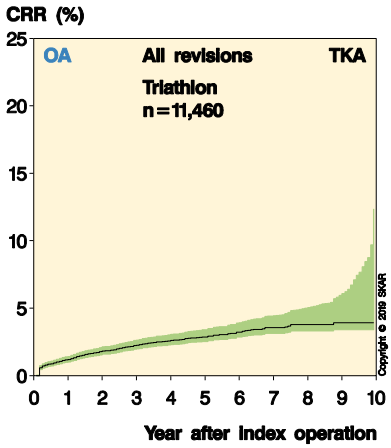
CRR (%)
OA
All revisions
TKA
Triathlon
n=11,460
Year after index operation
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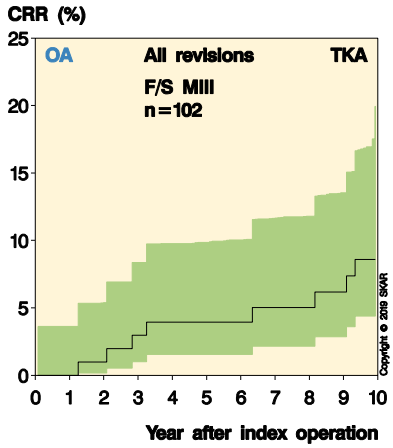
CRR (%)
OA
All revisions
TKA
F/S MIII
n=102
Year after index operation
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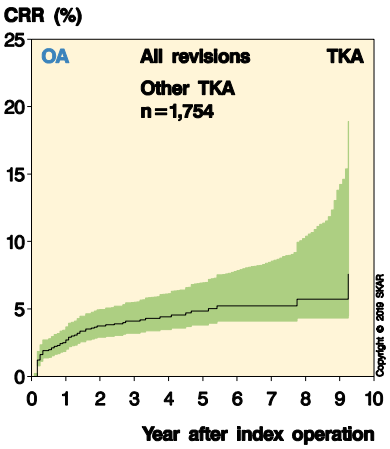
CRR (%)
OA
All revisions
TKA
Other TKA
n=1,754
Year after index operation
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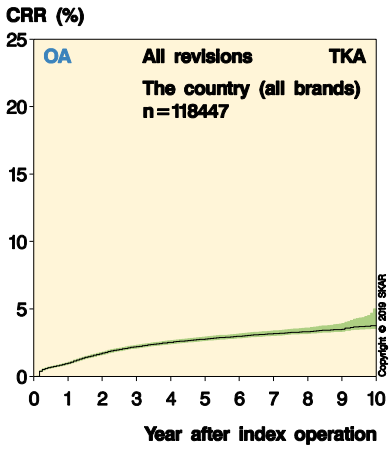
CRR (%)
OA
All revisions
TKA
The country (all brands)
n=118447
Year after index operation
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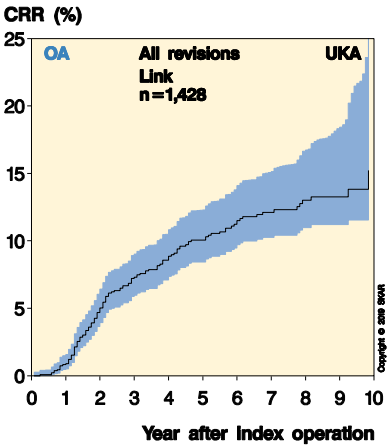
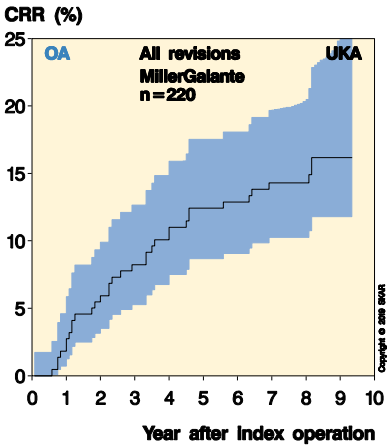
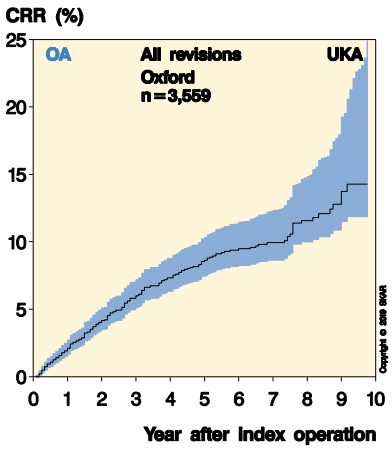
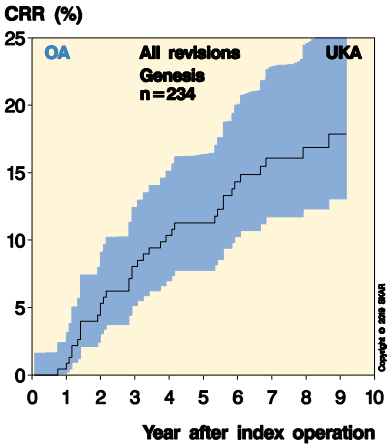
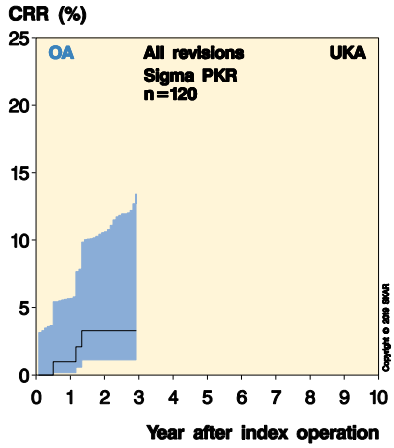
CRR for commonly used UKA implants for OA 2008–2017

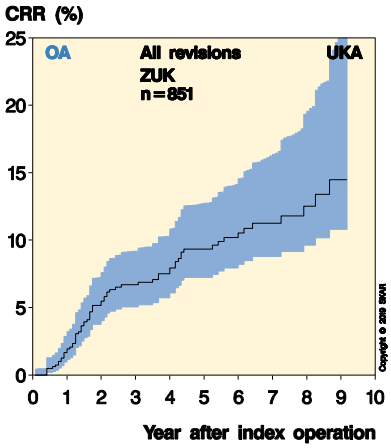


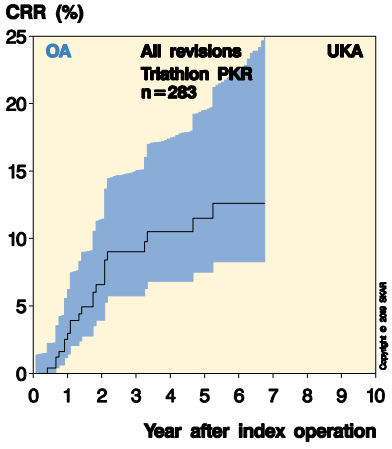


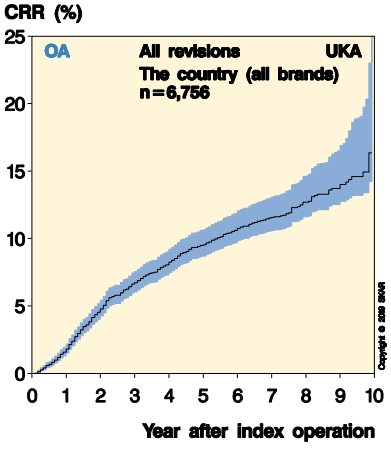












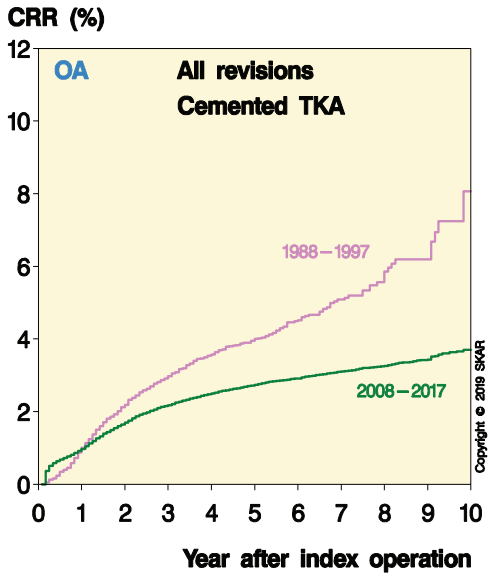
Changes in risk of revision over time (TKA for OA)

The figure below shows the overall risk of revision for the current 10-year period, 2008-2017, as compared to the period 1988-1997. It can be observed that the risk for the current period is considerably lower than for the earlier period.

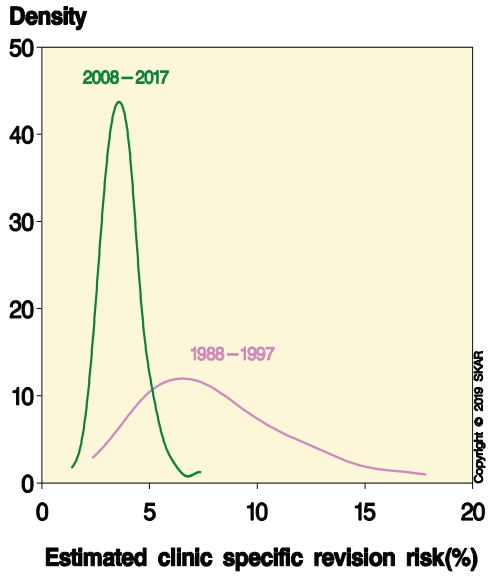
When the absolute specific risk of revision for the units is plotted for both periods (figure below left), it can be seen that the risk has become lower and the distribution has diminished. This implies that the results have improved overall and at the same time the results for the different units have become more similar (less variance in the results).

However, when looking on the relative specific risk of revision (figure below) it can be seen that the curves for the two periods are similar in shape. This implies that the relative difference between the units has not changed between the two periods and that some units still have a 1.5-2 times higher or lower risk than the average unit. The figures also illustrate the fact that irrespective of improvement, there will always be units with better, or worse, results than the average.

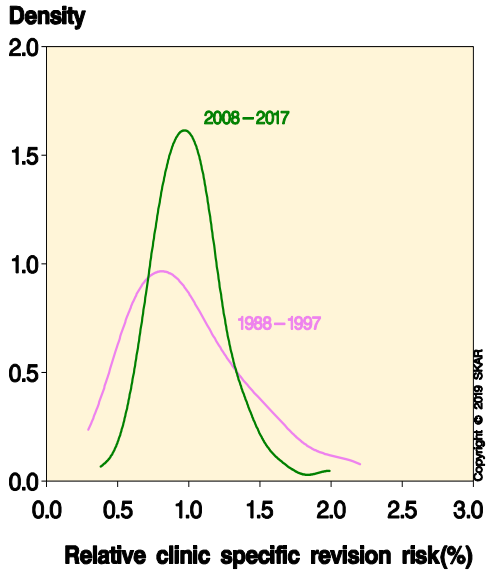
The register is requested to account for hospital specific results which can be found on the next pages. This year, there were 8 hospitals having significantly better results than the average hospital and 9 with inferior results. One can only speculate on the causes for these differences. An unfortunate choice of implants, methods or surgeons may be the explanation, as well as a selection of patients with a higher risk profile (case-mix). We find it appropriate to point out that the results are based on historical data in which the last implants were inserted 2 years ago and the first 12 years ago. Thus, the results do not necessarily reflect the current risk for patients undergoing surgery.



Total CRR for cemented TKA in OA during the 2 periods 1988–1997 and 2008–2017 shows a considerable reduction in CRR over time.



Plotting the estimated absolute hospital specific risk of revision shows that the absolute distribution has diminished between 1988-1997 and 2008–2017 (x-axis = absolute risk of revision)



Plotting the relative hospital specific risk of revision, as compared to the national mean, shows that the distribution of relative risk among the hospitals has not changed between 1988–1997 and 2008–2017 (x-axis = relative risk).

Relative risk of revision for hospitals 2008–2017 (cemented and uncemented TKA for OA)

The true average result of a certain treatment can only be determined for defined groups of previously treated patients. However, such results only reflect historical circumstances and cannot automatically be used to predict future results. The observed average result of a hospital treatment is not constant. Different selections of patients that get the same treatment have different average results. Thus, the hospital specific variability has to be taken into consideration if comparisons of hospitals are to be meaningful.

The table below shows the number of primary TKA for OA performed at each hospital during the analyzed period and how many of these were revised. The RR (relative risk of revision) is shown with its 95% confidence interval. The RR describes each hospital's deviation from the national average in multiplicative terms. It has been calculated using "the shared gamma frailty model" which takes into consideration that units performing few operations more easily suffer far too optimistic or pessimistic risk estimates. Thus, the method "shrinks" such estimates towards the national mean, relative to the amount of information they are based on. For further information; Glidden DV & Vittinghoff E. Modelling clustered survival data from multicenter clinical trials. Statistics in Medicine 2004; 23: 369-388.

Finally the observed rank for the hospital is shown together with a 95% confidence interval for its ranking, i.e. what rank places lie within the confidence interval. The calculations were performed using Monte Carlo simulation. For further information; Goldstein H, Spiegelhalter DJ. League tables and their limitations: statistical issues in comparisons of institutional performance. J R Statist Soc (A) 1996;159:384-43.

It is the location for the hospital that decides where the operation is registered. This implies that in spite of any name or ownership changes, the whole period is analyzed for the particular location.

Only units performing more than 50 TKAs for OA during the 10-year period were included (cemented and uncemented). The results are adjusted for differences in age and gender as well as for differences in use of a patellar button.

Units with significantly better or worse results than the national average are shown in green and red respectively.

Relative risk of revision for units

Code	Hospital	no. of TKA	Revised	RR	95% CI	Rank	95% CI
52012	Alingsås	1,888	13	0.40	0.27-0.60	1	1-5
11015	Nacka-Proxima	1,239	12	0.56	0.37-0.84	2	1-24
10010	Sabbatsberg (Aleris)	711	8	0.59	0.37-0.93	3	1-34
11002	Huddinge	1,184	16	0.64	0.43-0.93	4	2-34
25011	Oskarshamn	2,614	39	0.67	0.50-0.88	5	2-29
50480	Carlanderska	1,165	16	0.67	0.46-0.98	6	2-39
12481	Elisabethsjukhuset	381	6	0.70	0.43-1.13	7	2-55
52013	Skene	952	15	0.71	0.48-1.05	8	2-46
12010	Enköping	3,192	52	0.73	0.57-0.94	9	4-35
11001	Karolinska	950	18	0.75	0.52-1.08	10	3-50
22010	Jönköping	1,318	24	0.75	0.54-1.05	11	3-47
42015	Halmstad Capio Movement	2,804	49	0.76	0.59-0.98	12	5-39
22012	Värnamo	1,305	25	0.76	0.54-1.07	13	3-48
50020	OrthoCenter IFK klin.*	1,088	21	0.78	0.55-1.11	14	3-53
25010	Kalmar	909	15	0.79	0.53-1.16	15	3-57
42011	Varberg	1,484	28	0.81	0.59-1.11	16	5-53
65012	Gällivare	628	11	0.81	0.53-1.24	17	3-63
11013	Löwenströmska**	3,870	80	0.82	0.66-1.01	18	8-42
61012	Hudiksvall	674	12	0.83	0.55-1.25	19	3-64
22405	Art Clinic Jönköping	142	0	0.83	0.46-1.53	20	2-74
55011	Karlskoga	987	20	0.84	0.59-1.19	21	5-59
42420	Spenshult	1,313	33	0.85	0.63-1.15	22	6-56
56010	Västerås	2,241	47	0.85	0.66-1.11	23	8-52

(cont.)

Relative risk of revision for units (continued)

Code	Hospital	no. of TKA	Revised	RR	95% CI	Rank	95% CI
27011	Karlshamn	2,306	47	0.87	0.67-1.13	24	9-54
13011	Nyköping	870	18	0.87	0.60-1.26	25	5-64
65013	Piteå	2,475	52	0.87	0.68-1.12	26	9-53
62011	Örnsköldsvik	1,157	23	0.87	0.62-1.22	27	6-62
52011	Borås	808	18	0.87	0.60-1.27	28	5-64
10011	S:t Göran	3,487	75	0.89	0.72-1.11	29	12-53
62010	Sundsvall	752	18	0.90	0.63-1.30	30	6-67
41011	Trelleborg	6,637	144	0.91	0.77-1.07	31	16-49
23010	Växjö	951	23	0.93	0.66-1.30	32	8-67
55012	Lindesberg	1,901	37	0.94	0.70-1.25	33	11-63
28011	Ängelholm	1,885	39	0.94	0.71-1.24	34	11-64
50498	Art Clinic Göteborg	171	1	0.94	0.53-1.67	35	3-75
54010	Karlstad	1,677	39	0.94	0.71-1.25	36	12-63
55010	Örebro	629	17	0.94	0.65-1.37	37	7-70
10911	Capio Artro Clinic Sthlm.	215	1	0.95	0.53-1.70	38	3-76
57011	Mora	1,638	38	0.97	0.73-1.29	39	13-66
56012	Köping	156	5	0.98	0.59-1.61	40	5-75
53010	Falköping	432	14	0.99	0.66-1.47	41	9-73
42010	Halmstad	1,830	46	0.99	0.76-1.29	42	15-66
22011	Eksjö (Höglandssjukh.)	1,590	36	1.00	0.75-1.34	43	15-69
64010	Skellefteå	877	23	1.03	0.73-1.44	44	13-72
10016	Ortopediska huset	4,423	113	1.03	0.86-1.23	45	25-62
53011	Lidköping	1,685	40	1.05	0.79-1.38	46	19-70
54014	Torsby	1,042	27	1.05	0.76-1.45	47	16-72
10013	Södersjukhuset	2,690	75	1.06	0.86-1.32	48	26-68
21014	Motala	3,877	104	1.06	0.88-1.28	49	28-66
24010	Västervik	910	24	1.07	0.77-1.50	50	17-73
54012	Arvika	1,608	42	1.08	0.83-1.42	51	22-72
10015	Sophiahemmet	746	23	1.09	0.78-1.54	52	17-74
50071	Frölunda Spec.	889	29	1.10	0.80-1.50	53	19-73
13012	Kullbergska sjukhuset	2,151	64	1.11	0.88-1.39	54	28-71
64011	Lycksele	735	19	1.11	0.77-1.59	55	17-75
11010	Danderyd	1,252	35	1.11	0.83-1.49	56	23-73
21013	Norrköping	1,364	37	1.11	0.84-1.48	57	23-73
30001	Malmö	54	3	1.11	0.65-1.90	58	8-77
63010	Östersund	1,284	35	1.13	0.84-1.51	59	24-74
51010	Uddevalla	1,897	52	1.14	0.88-1.46	60	28-73
50010	Östra sjukhuset	143	7	1.16	0.72-1.85	61	14-77
51011	Mölndal	2,600	70	1.17	0.94-1.46	62	35-73
41012	Helsingborg	276	9	1.18	0.76-1.84	63	16-77
12001	Akademiska sjukhuset	906	33	1.19	0.88-1.60	64	27-75
41001	Lund	352	11	1.23	0.80-1.87	65	20-77
57010	Falun	2,662	86	1.24	1.01-1.51	66	42-74
28012	Hässleholm	6,477	198	1.24	1.08-1.42	67	48-72
61011	Bollnäs	2,792	89	1.25	1.02-1.52	68	44-74
53013	Skövde	1,061	35	1.26	0.94-1.69	69	35-76
11011	Södertälje	1,191	40	1.28	0.97-1.69	70	38-76
64001	Umeå	1,278	49	1.29	1.00-1.66	71	41-76
26010	Visby	814	31	1.32	0.97-1.79	72	39-77
23011	Ljungby	1,020	37	1.35	1.02-1.80	73	43-77
13010	Eskilstuna	418	18	1.38	0.96-2.00	74	36-78
11012	Norrtälje	863	33	1.45	1.08-1.96	75	49-78
62013	Sollefteå	1,037	42	1.54	1.18-2.02	76	58-78
61010	Gävle	895	41	1.59	1.21-2.10	77	60-78
51012	Kungälv	1,511	82	1.98	1.61-2.44	78	75-78

* Gothenburg Medical Center was discontinued and OrthoCenter IFK kliniken was started in 2008.

** Löwenströmska was taken over by Stockholms Specialistvård in 2001 and by OrthoCenter Stockholm in 2008.

Only units that inserted more than 50 TKA for OA during the period are listed

Relative risk of revision for hospitals 2008–2017 (cemented and uncemented TKA for OA) if the exchange of insert, in case of infection, is not considered to be a revision

As described on page 4, the SKAR defines a revision as being a reoperation in which implant components are exchanged, added or removed.

The reason for this is that shortly after the start of the register it was noted that many surgeons did not report those reoperations which they did not interpret as directly related to the prior knee arthroplasty. This resulted in different types of soft tissue surgeries never being reported and therefore the register decided to use a stricter definition of revision which definitely was implant related.

As previously mentioned (page 50) it can be claimed that for infected cases this definition may be a disadvantage for certain implant brands and consequently those hospitals using these brands. The reason is that one third of all revisions for infection are debridement surgeries during which the insert is exchanged (classifying them as revisions). However, a debridement in a knee with a monobloc tibia, in which no insert can be exchanged, will not count as a revision which in turn may favor the type. Thus, the argument has been made that exchange of an insert, in the case of an infection, should not be considered a revision but a debridement. On the other hand it can be claimed that infected TKA´s with fixed inserts are generally treated with a complete exchange of components, as a comprehensive debridement is not considered possible without removal of an insert. This would result in a reversed bias if the exchange of an insert is not considered as a revision. However, on page 48-51 we saw that excluding exchange of the tibia insert affects the results of at least some implants with monobloc tibia.

Therefore, in the table below, we also provide risk calculations when an exchange of insert for infection is not, considered as being a revision. Comparing it to the table on the previous page, it can be seen that Sabbatsberg, Huddinge, Carlanderska och Enköping no longer are significant better than the average. However, of these only Enköping used monobloc tibia components in any number (42%). Jönköping, Piteå och Trelleborg are now added to those better than the average, but the 2 first used few monobloc components (Piteå 10%).

In the other end, Falun Hässleholm and Norrtälje are no longer worse than the average while Ortopediska huset and Visby have become that. Of these, Falun, Ortopediska huset and Visby used relatively many monobloc tibia components (17%, 17% och 39%).

Thus, it seems that modularity of the tibia, allowing for change of insert, may have an effect on the risk of revision. However, the use of monobloc tibias has diminished from 37% of cases in 2008 to 9% in 2017 and, if the trend continues, the problem with hospital results being biased by modularity will also diminish.

Relative risk of revision for units. Exchange of insert, in case of infection, is not considered to be a revision.

Code	Hospital	no. of TKA	Revised	RR	95% CI	Rank	95% CI
52012	Alingsås	1,888	11	0.45	0.30-0.69	1	1-12
11015	Nacka-Proxima	1,239	9	0.58	0.37-0.91	2	1-32
25011	Oskarshamn	2,614	26	0.61	0.44-0.85	3	1-27
10010	Sabbatsberg (Aleris)	711	7	0.64	0.40-1.02	4	1-44
42015	Halmstad Capio Movement	2,804	30	0.65	0.48-0.89	5	2-30
22010	Jönköping	1,318	15	0.67	0.45-0.99	6	1-40
65013	Piteå	2,475	30	0.71	0.52-0.96	7	2-38
41011	Trelleborg	6,637	85	0.72	0.58-0.88	8	4-30
11002	Huddinge	1,184	15	0.72	0.49-1.06	9	2-48
50480	Carlanderska	1,165	13	0.72	0.48-1.08	10	2-50
12481	Elisabethsjukhuset	381	5	0.72	0.44-1.19	11	1-58
25010	Kalmar	909	9	0.73	0.47-1.14	12	2-53
24010	Västervik	910	10	0.76	0.49-1.18	13	2-57
62011	Örnsköldsvik	1,157	14	0.77	0.52-1.15	14	3-54
42011	Varberg	1,484	20	0.78	0.54-1.11	15	3-52
50020	OrthoCenter IFK klin.	1,088	16	0.79	0.54-1.16	16	3-55
62010	Sundsvall	752	11	0.79	0.52-1.21	17	3-59
54010	Karlstad	1,677	24	0.8	0.57-1.11	18	4-53
11001	Karolinska	950	16	0.8	0.55-1.17	19	3-57
52011	Borås	808	12	0.81	0.53-1.23	20	3-61
52013	Skene	952	14	0.81	0.55-1.21	21	3-60
42420	Spenshult	1,313	25	0.82	0.59-1.14	22	5-53
22012	Värnamo	1,305	22	0.83	0.58-1.19	23	5-58

(cont.)

(Cont.)
Relative risk of revision for units. Exchange of insert, in case of infection, is not considered to be a revision

Code	Hospital	no. of TKA	Revised	RR	95% CI	Rank	95% CI
55011	Karlskoga	987	15	0.83	0.56-1.23	24	4-61
65012	Gällivare	628	9	0.86	0.55-1.35	25	4-68
57010	Falun	2,662	45	0.88	0.67-1.14	26	10-55
12010	Enköping	3,192	48	0.88	0.68-1.14	27	10-55
22405	Art Clinic Jönköping	142	0	0.89	0.48-1.63	28	2-75
53011	Lidköping	1,685	24	0.89	0.64-1.25	29	8-61
55012	Lindesberg	1,901	26	0.92	0.67-1.28	30	10-63
64010	Skellefteå	877	15	0.92	0.63-1.36	31	7-68
61012	Hudiksvall	674	11	0.93	0.61-1.43	32	6-70
22011	Eksjö-Nässjö (Höglandssjukh.)	1,590	24	0.93	0.67-1.31	33	10-66
54014	Torsby	1,042	17	0.94	0.64-1.36	34	8-68
56010	Västerås	2,241	41	0.95	0.72-1.25	35	14-62
63010	Östersund	1,284	21	0.95	0.67-1.35	36	9-67
55010	Örebro	629	14	0.96	0.64-1.42	37	8-70
42010	Halmstad	1,830	35	0.98	0.73-1.31	38	15-66
57011	Mora	1,638	29	0.99	0.72-1.35	39	14-68
12001	Akademiska sjukhuset	906	22	1	0.71-1.41	40	13-70
13011	Nyköping	870	17	1	0.69-1.46	41	11-72
50498	Art Clinic Göteborg	171	1	1.01	0.56-1.81	42	4-77
51011	Mölndal	2,600	45	1.01	0.78-1.32	43	18-66
10015	Sophiahemmet	746	16	1.01	0.69-1.49	44	11-72
53010	Falköping	432	12	1.02	0.67-1.54	45	10-73
11013	Löwenströmska	3,870	80	1.02	0.83-1.26	46	23-63
56012	Köping	156	5	1.04	0.63-1.71	47	7-76
10911	Capio Artro Clinic	215	1	1.04	0.58-1.86	48	5-78
30001	Malmö	54	2	1.06	0.61-1.85	49	6-77
27011	Karlshamn	2,306	45	1.06	0.82-1.39	50	22-69
23010	Växjö	951	22	1.06	0.75-1.51	51	16-73
28011	Ängelholm	1,885	35	1.08	0.81-1.45	52	21-71
28012	Hässleholm	6,477	131	1.08	0.91-1.28	53	31-65
50010	Östra sjukhuset	143	5	1.09	0.66-1.80	54	10-77
21014	Motala	3,877	83	1.1	0.90-1.36	55	30-68
10011	S:t Göran	3,487	73	1.1	0.89-1.37	56	29-68
11010	Danderyd	1,252	27	1.11	0.80-1.53	57	21-73
13010	Eskilstuna	418	10	1.12	0.73-1.73	58	14-77
21013	Norrköping	1,364	30	1.17	0.86-1.59	59	27-75
41012	Helsingborg	276	7	1.18	0.74-1.89	60	15-78
10013	Södersjukhuset	2,690	66	1.18	0.94-1.48	61	35-72
13012	Kullbergska sjukhuset	2,151	54	1.19	0.93-1.52	62	33-73
54012	Arvika	1,608	36	1.2	0.90-1.60	63	30-75
53013	Skövde	1,061	26	1.22	0.88-1.70	64	29-76
51010	Uddevalla	1,897	44	1.24	0.95-1.62	65	35-75
10016	Ortopediska huset	4,423	108	1.24	1.03-1.49	66	44-73
64011	Lycksele	735	17	1.25	0.86-1.82	67	26-77
50071	Frölunda Spec.	889	29	1.29	0.94-1.76	68	34-77
11011	Södertälje	1,191	33	1.32	0.98-1.78	69	38-77
41001	Lund	352	10	1.33	0.86-2.05	70	26-78
11012	Norrtälje	863	23	1.35	0.96-1.90	71	36-78
23011	Ljungby	1,020	29	1.36	1.00-1.87	72	40-78
64001	Umeå	1,278	44	1.39	1.06-1.82	73	47-77
61011	Bollnäs	2,792	80	1.43	1.16-1.77	74	55-77
26010	Visby	814	28	1.45	1.05-1.99	75	46-78
51012	Kungälv	1,511	48	1.53	1.18-1.99	76	57-78
61010	Gävle	895	32	1.57	1.16-2.12	77	56-78
62013	Sollefteå	1,037	38	1.72	1.30-2.28	78	64-78

* Gothenburg Medical Center was discontinued and OrthoCenter IFK kliniken was started in 2008.

** Löwenströmska was taken over by Stockholms Specialistvård in 2001 and by OrthoCenter Stockholm in 2008.

Only units that inserted more than 50 TKA for OA during the period are listed

Patient characteristics and case-mix at knee arthroplasty surgery

The table shows what was reported for primary knee arthroplasties in 2018. Topmost is the average for the country as a whole after which the hospitals are classified as being university hospitals, private hospitals or "other" based on if their reported number of surgeries was less than 100, 100-300 or more than 300. The first column shows the total number reported and the second column the proportion of complete reports. The rest of the information is based only on complete reports and shows the proportion of patients having their surgery for OA, of women, of those younger than 55, those with BMI of 35 and over and those having been classified with ASA III or higher. Please note that the percentages may be misleading for units having reported few surgeries.

Among the university hospitals we can see that some units have a higher proportion of surgeries for other diagnoses than OA, of women and that of sicker patients (ASA ≥3) while other university hospitals do not seem to differ so much from the national average. Overall, the university hospitals have a higher proportion of patients younger than 55 years.

The private hospitals generally report a lower proportion of patients with ASA ≥3, Bollnäs-Aleris, Motala-Aleris and S:t Görans being the exemption.

The County hospitals, not classified as university hospitals, do not differ from the national average with a few exceptions. The proportion of patients with BMI of 35 and over is almost twice the national average in Västerås. The proportion of patients with ASA ≥3 is twice the national average in Danderyd, Södersjukhuset and Södertälje while it is less than half in Hässleholm and Kullbergska.

The variation in patient characteristics is large and it does not seem to be possible to generalize based on if the unit is a university or private hospital or by the number of reported surgeries.

Patient characteristics and case-mix

Hospital 2018	Number of reports	Complete reports %	% OA	% Women	% <55 years	% BMI 35+	% ASA ≥3
Country	**15,431**	**99.9**	**96.7**	**56.1**	**7.4**	**9,0**	**17.1**
University hospitals							
Akademiska	91	100	91.2	59.3	9.9	14.3	27.5
Huddinge	107	100	89.7	67.3	5.6	18.7	52.3
Karolinska Solna	55	99.6	74.6	56.4	21.8	13.0	67.3
Lund	52	100	50.0	61.5	19.2	28.9	69.2
Umeå	138	100	92.0	55.1	3.6	12.3	25.4
Örebro	3	100	100	66.7	0.0	0.0	0.0
Private units							
Art Clinic Göteborg	140	99.9	100	51.4	13.6	1.4	6.4
Art Clinic Jönköping	146	100	97.3	51.4	4.1	2.1	0.7
Bollnäs Aleris	367	100	97.6	54.5	6.3	2.5	22.3
Capio Artro Clinic Sthlm.	392	100	97.7	57.9	12.5	4.3	3.1
Carlanderska	323	100	99.1	45.8	11.2	8.7	2.5
Elisabethkliniken	13	100	100	23.1	15.4	0,0	16.7
Hermelinen-Luleå	19	100	94.7	26.3	0.0	26.3	5.3
Motala Aleris	653	99.9	96.3	59.6	8.3	8.6	23
Movement Halmstad	467	99.9	99.8	51.8	8.1	7.1	15.2
Nacka Aleris	223	100	100	68.2	5.4	7.6	4.9
OrthoCenter IFK-kliniken	176	100	96.6	39.2	9.7	1.7	6.3
OrthoCenter Sthlm	676	100	97.8	52.4	5.6	2.5	1.8
Ortopediska huset	656	99.9	98.9	56.6	8.1	4.0	4
Sophiahemmet	185	100	99.5	35.1	18.4	6.5	8.1
St Göran	467	100	98.1	57.2	6.6	9.6	40.9
Ängelholm Aleris	82	100	96.3	56.1	9.8	9.8	7.3

A previous surgery of the index knee (not shown in the table) was reported for 17.6% of the patients. Meniscal surgery was most common (7.2%) followed by arthroscopy (5.2%), cruciate ligament surgery (2.6%), osteotomy (1.3%), osteosynthesis (0.8%) and "other" (0.5%). For 3% of the surgeries, more than one previous surgery was stated.

The previous surgeries reported are not comprehensive but illustrate what the surgeon knew at the time of the primary arthroplasty.

Patient characteristics and case-mix

Hospital 2018	Number of reports	Complete reports %	% OA	% Women	% <55 years	% BMI 35+	% ASA ≥3
< 100 operations/year							
Eskilstuna	81	100	91.4	70.4	7.4	25.9	30.9
Gällivare	88	100	92.1	62.5	6.8	14.8	26.1
Gävle	76	100	96.1	56.6	4.0	21.1	32.9
Helsingborg	16	100	93.8	50.0	0.0	31.3	75.0
Hudiksvall	62	100	98.4	62.9	6.5	11.3	22.6
Kalmar	86	100	95.4	55.8	0.0	4.7	17.4
Karlskoga	7	100	100	42.9	0.0	0.0	14.3
Nyköping	89	100	95.5	47.2	6.7	10.1	15.7
Skellefteå	86	99.7	97.7	60.5	5.8	10.5	23.3
Skövde	20	100	95.0	60.0	0.0	15	15.0
Sundsvall	15	98.7	78.6	60.0	0.0	6.7	26.7
Västervik	94	100	98.9	59.6	4.3	7.5	10.6
Växjö	94	100	96.8	58.5	5.3	8.5	26.6
100-300 operations/year							
Alingsås	179	100	99.4	59.2	3.9	8.4	14.0
Arvika	213	100	99.0	60.6	4.7	12.2	17.4
Borås	114	100	97.3	61.4	3.5	15.8	36.8
Danderyd	189	100	91.0	58.2	6.9	14.9	36.5
Eksjö-Nässjö	299	100	97.3	52.5	7.4	4.7	12.0
Falun	170	100	94.7	51.8	8.2	7.7	21.8
Halmstad	198	99.8	97.5	53.5	9.1	16.8	16.2
Karlshamn	278	100	97.5	50.4	4.3	9.4	14.8
Karlstad	117	99.8	95.7	62.4	10.3	9.5	13.7
Kullbergska sjukhuset	220	100	97.3	62.7	8.6	12.3	3.6
Kungälv	199	99.9	99.0	59.8	8.5	13.6	11.6
Lidköping	171	100	95.9	62.0	5.9	11.7	11.7
Ljungby	169	100	97.0	55.0	8.3	11.2	13.6
Lycksele	143	100	96.5	58.7	6.3	13.3	10.5
Mora	203	99.9	98.0	53.2	3.5	9.9	17.2
Norrköping	153	100	94.8	63.4	5.2	7.2	16.3
Norrtälje	164	100	98.8	57.9	6.1	9.2	13.1
Skene	129	100	98.5	63.6	8.5	3.1	9.3
Sollefteå	151	100	96.7	61.6	6.6	11.3	15.9
Södersjukhuset	227	100	93.0	60.4	12.8	9.3	42.7
Södertälje	145	100	99.3	62.1	6.9	11.0	40.0
Torsby	130	100	100	57.7	14.6	11.5	26.2
Uddevalla	242	100	93.8	57.0	0.8	8.3	29.8
Varberg	177	100	97.2	54.2	10.2	9.0	18.1
Visby	115	100	93.0	60.0	12.2	17.4	25.2
Värnamo	208	100	96.2	54.3	7.7	10.1	20.2
Västerås	194	100	93.8	59.3	9.8	18.0	30.9
Ängelholm	242	99.8	95.5	62.0	8.3	11.6	10.3
Örnsköldsvik	142	100	95.1	56.3	3.5	13.4	25.4
Östersund	178	99.9	95.5	60.7	5.1	6.8	23.6
> 300 operations/year							
Enköping	381	100	98.7	51.3	6.0	9.2	18.1
Hässleholm	891	99.9	96.0	50.8	6.6	6.4	7.1
Lindesberg	493	100	98.4	55.4	7.5	9.5	17.0
Mölndal	401	99.9	92.8	62.3	6.7	6.0	12.7
Oskarshamn	374	100	98.4	52.9	6.7	13.1	14.7
Piteå	373	100	95.4	54.2	4.3	13.1	18.2
Trelleborg	814	100	98.9	60.0	7.4	10.8	21.3

Prophylactic antibiotics for knee arthroplasties

The table shows what was reported for primary knee arthroplasties in 2018.

Topmost is the average for the country as a whole after which the hospitals are classified as being university hospitals, private hospitals or "other" based on if their reported number of surgeries was less than 100, 100-300 or more than 300.

The first column shows the total number reported and the second the proportion of complete reports. The rest of the information is based only on complete reports. Please note that the percentages may be misleading for units having reported only few surgeries. The choice of the variables shown in the other columns is based on the 2018 recommendations by the PRISS project (Prosthetic Related Infections Shall be Stopped). As a Swedish study (Robertsson et al. 2017) found that patients recieving Clindamycin had a higher risk of revision for infection than those receiving Cloxacillin, the recommendations were revised. They can be found at www. patientforsakringen.se.

The columns "% having Cloxacilline, Cefotaxim or Clindamycin", "% with dose 2g x 3, 2g x 2 or 600mg x 2" and "% having AB within 45-30 min" show the proportion of surgeries in which antibiotics are given according to the current PRISS routines. The column "% having AB within 45-15 min" shows the proportion for which the dose was given within the previously recommended time interval which has been shown in earlier reports.

All the hospitals now report that they use Cloxacillin as their first choice. The reduction between 2017 and 2018 in the use of Clindamicin for prophylaxis has been marginal (7.5% vs 7.1%). Cefotaxim was reported being used in 0.5% of surgeries.

At the start of surgery a reasonable tissue concentration of the antibiotic should have been reached in order to counteract any bacteria in the field. Due to the short half-life of Cloxacilline it is important that it is administrated within a correct time interval. However, an earlier study from the register found imperfect routines concerning prophylactic antibiotics in 2007 (Stefánsdóttir A et al. 2009).

The registry started to register the time for delivery of the first dose in 2009 after which some improvement in the routines was noted with 87% of patients in 2011 being reported to having received the dose

Prophylactic antibiotics

Hospital 2018	Number of reports	Complete reports %	% having Cloxacillin Cefotaxim or Clindamycin	% with dose 2g x 3, 2g x 2 or 600mg x 2	% having AB within 45-15 min	% having AB within 45-30 min
Country	**15,431**	**99.6**	**99.7**	**92.9**	**80.9**	**38.9**
University hospitals						
Akademiska	91	96.7	98.9	88.6	20.2	0.0
Huddinge	107	98.8	100	88.5	69.5	31.4
Karolinska Solna	55	98.8	100	89.1	71.7	47.2
Lund	52	95.5	100	87.5	56.3	31.2
Umeå	138	98.8	99.3	95.6	87.4	29.6
Örebro	3	100	100	100	66.7	0.0
Private units						
Art Clinic Göteborg	140	99.0	100	100	78.7	9.6
Art Clinic Jönköping	146	99.5	100	97.2	97.9	35.4
Bollnäs Aleris	367	99.9	100	98.9	89.9	29.0
Capio Artro Clinic	392	99.7	99.5	75.1	94.1	38.7
Carlanderska	323	99.5	100	98.1	87.9	31.1
Elisabethkliniken	13	97.4	100	23.1	16.7	16.7
Hermelinen-Luleå	19	100	100	89.5	100	10.5
Motala Aleris	653	99.8	100	97.9	91.8	45.6
Movement Halmstad	467	99.5	100	95.9	82.6	11.3
Nacka Aleris	223	99.3	100	95.1	87.6	47.3
OrthoCenter IFK-kliniken	176	99.8	98.3	93.1	93.7	81.1
OrthoCenter Sthlm	676	100	100	97.2	97.6	48.1
Ortopediska huset	656	99.6	100	97.6	87.2	32.4
Sophiahemmet	185	99.3	100	79.4	80.1	48.6
St Göran	467	98.8	100	96.6	88.6	34.6
Ängelholm Aleris	82		100	92.7	93.7	8.9

within the recommended 45-15 minutes. However during 2013-2018 the proportion has lessened to 80%. Only Orthocenter-IFK has implemented the latest PRISS recommendation and in 2018, only 39% of the patients had their preoperative dose 45-30 min. prior to surgery. The adaption of the prior and present recommendation is still low at the Akademiska sjukhuset.

Prophylactic antibiotics

Hospital 2018	Number of reports	Complete reports %	% having Cloxacillin Cefotaxim or Clindamycin	% with dose 2g x 3, 2g x 2 or 600mg x 2	% having AB within 45-15 min	% having AB within 45-30 min
< 100 operations/year						
Eskilstuna	81	99.2	98.8	88.8	72.2	38.0
Gällivare	88	100	100	95.5	77.3	21.6
Gävle	76	100	98.7	96.0	85.5	32.9
Helsingborg	16	97.9	100	87.5	73.3	40.0
Hudiksvall	62	98.9	100	91.9	86.7	50.0
Kalmar	86	100	100	96.5	89.5	22.1
Karlskoga	7	100	100	85.7	71.4	42.9
Nyköping	89	99.6	100	87.5	72.7	35.2
Skellefteå	86	100	100	95.4	68.6	31.4
Skövde	20	100	100	100	45.0	10.0
Sundsvall	15	100	100	86.7	66.7	40.0
Västervik	94	99.6	100	96.8	52.7	40.9
Växjö	94	96.8	100	100	80.2	18.6
100-300 operations/year						
Alingsås	179	99.8	99.4	97.8	65.2	55.6
Arvika	213	98.9	100	98.6	68.9	48.5
Borås	114	99.7	100	96.5	60.2	31.9
Danderyd	189	99.1	99.5	83.4	75.0	37.5
Eksjö-Nässjö	299	99.8	100	97.7	84.9	60.3
Falun	170	99.5	100	94.7	82.4	49.4
Halmstad	198	99.3	100	91.4	81.0	31.8
Karlshamn	278	99.5	98.9	98.6	81.4	27.4
Karlstad	117	99.1	100	96.6	72.8	47.4
Kullbergska sjukhuset	220	99.7	100	93.6	83.0	40.8
Kungälv	199	99.8	100	96.5	78.8	53.5
Lidköping	171	99.8	100	93.6	95.9	57.1
Ljungby	169	99.8	100	95.9	91.1	67.3
Lycksele	143	99.3	100	95.1	70.7	44.3
Mora	203	99.8	99.5	20.3	88.6	55.0
Norrköping	153	99.6	100	96.1	62.3	41.1
Norrtälje	164	99.2	100	95.7	77.5	30.0
Skene	129	99.2	100	94.6	73.8	42.1
Sollefteå	151	99.6	99.3	96.7	83.9	42.3
Södersjukhuset	227	98.8	99.6	94.3	62.1	37.9
Södertälje	145	98.2	100	96.5	87.7	44.2
Torsby	130	99.0	100	97.7	81.1	61.4
Uddevalla	242	99.6	100	96.3	63.2	41.8
Varberg	177	99.8	100	80.8	63.1	33.5
Visby	115	99.1	99.1	94.7	82.1	38.4
Värnamo	208	99.2	99.5	97.1	87.2	46.3
Västerås	194	99.0	99.5	95.3	75.0	41.5
Ängelholm	242	99.3	100	92.5	79.3	40.1
Örnsköldsvik	142	99.8	100	97.2	78.7	50.5
Östersund	178	99.8	98.9	93.7	85.3	29.4
> 300 operations/year						
Enköping	381	99.9	100	94.7	84.5	41.0
Hässleholm	891	100	100	85.9	66.2	24.0
Lindesberg	493	100	100	92.1	72.0	42.7
Mölndal	401	99.8	100	93.5	74.5	41.1
Oskarshamn	374	100	100	90.4	72.1	53.3
Piteå	373	100	100	96.0	93.6	39.5
Trelleborg	814	100	100	98.0	85.5	31.6

Antithrombotic prophylaxis for knee arthroplasties

The table ”Antithrombotic prophylaxis” shows what the hospitals reported having administrated for primary knee arthroplasties in 2018.

Topmost is the average for the country as a whole after which the hospitals are classified as being university hospitals, private hospitals or "other" based on if their reported number of surgeries was less than 100, 100-300 or more than 300.

The first column shows the total number reported and the second the proportion of complete reports. The rest of the information is based only on complete reports. Please note that the percentages may be misleading for units having reported only few surgeries. As there is no national or international consensus concerning the "best practice" for drug selection, or when to start or end the treatment, we only show what is most commonly reported.

The choice of variables in the three next columns is based on what was reported as being the most common routines. They show respectively the proportion of primary knee arthroplasties in which it was planned to start the prophylaxis postoperatively, the proportion in which an injection was used (Fragmin, Innohep och Klexane) and the proportion for which the planned duration for the treatment was 8-14 days.

As it can be seen in the table, it is most common to start the antithrombotic prophylaxis postoperatively and only few units report that they more commonly start preoperatively.

For 63% of the surgeries it was reported that the intention was to use injectable drugs, which is lower than in recent years when the proportion has varied between 76% and 83%. In some cases (3.1%) the intention was reoprted to use a combination of both injectable and per-oral drugs.

The duration of the planned prophylaxis has been relatively constant since SKAR started registering this variable in 2009 with 73-79% of the surgeries having a planned duration of 8-14 days (see previous reports). However, during the last couple of years we have observed a shorter prophylaxis (1-7 days) being planned for a larger proportion of the patients (ca 19%).

Antithrombotic prophylaxis

Hospital 2018	Number of reports	Complete reports %	Percent starting postoperatively	Percent having injection	Percent treated for 8-14 days
Country	**15,431**	**99.2**	**90.8**	**63.2**	**75.3**
University hospitals					
Akademiska	91	100	87.9	4.4	92.7
Huddinge	107	98.8	99.1	96.3	90.3
Karolinska Solna	55	95.2	70.6	100	0.0
Lund	52	96.2	86.0	100	70.8
Umeå	138	100	97.8	2.2	98.6
Örebro	3	100	100	66.7	66.7
Private units					
Art Clinic Göteborg	140	99.5	92.8	0.7	98.6
Art Clinic Jönköping	146	100	97.3	2.1	93.2
Bollnäs Aleris	367	99.7	98.4	71.1	95.0
Capio Artro Clinic	392	99.3	92.1	84.0	95.3
Carlanderska	323	99.4	92.6	2.5	87.1
Elisabethkliniken	13	100	100	100	92.3
Hermelinen-Luleå	19	100	100	0.0	0.0
Motala Aleris	653	99.5	98.5	98.5	97.2
Movement Halmstad	467	99.6	97.4	97.9	0.2
Nacka Aleris	223	99.3	98.7	96.4	97.3
OrthoCenter IFK-kliniken	176	99.6	93.2	1.7	92.0
OrthoCenter Sthlm	676	99.9	96.0	82.3	98.5
Ortopediska huset	656	99.7	97.3	16.6	98.2
Sophiahemmet	185	98.7	94.5	97.3	62.6
St Göran	467	97.8	85.4	81.3	91.2
Ängelholm Aleris	82	99.6	95.1	6.1	78.8

Antithrombotic prophylaxis

Hospital 2018	Number of reports	Complete reports %	Percent starting postoperatively	Percent having injection	Percent treated for 8-14 days
< 100 operations/year					
Eskilstuna	81	98.8	96.3	7.5	92.2
Gällivare	88	99.6	93.2	23.9	82.8
Gävle	76	99.3	90.8	82.9	94.6
Helsingborg	16	100	87.5	93.8	93.8
Hudiksvall	62	99.5	87.1	100	92.7
Kalmar	86	98.1	94.2	96.5	88.9
Karlskoga	7	100	100	14.3	100
Nyköping	89	99.7	95.5	2.3	96.4
Skellefteå	86	100	96.5	100	100
Skövde	20	100	100	15.0	90.0
Sundsvall	15	100	93.3	0.0	100
Västervik	94	98.6	88.0	97.8	93.3
Växjö	94	98.6	28.0	85.0	96.7
100-300 operations/year					
Alingsås	179	100	93.3	100	97.8
Arvika	213	99.7	90.1	5.6	91.9
Borås	114	98.8	85.0	31.3	91.9
Danderyd	189	98.4	92.0	95.7	91.0
Eksjö-Nässjö	299	95.5	99.3	99.3	98.6
Falun	170	99.4	95.8	100	1.8
Halmstad	198	98.3	95.4	99.5	1.0
Karlshamn	278	99.6	96.0	97.8	96.0
Karlstad	117	99.7	91.5	7.7	96.5
Kullbergska sjukhuset	220	100	92.7	5.0	95.8
Kungälv	199	99.3	91.5	2.5	89.7
Lidköping	171	99.6	94.7	2.4	90.0
Ljungby	169	99.2	23.7	76.9	92.7
Lycksele	143	99.3	9.1	100	100
Mora	203	99.0	95.1	4.4	96.9
Norrköping	153	100	93.5	100	64.1
Norrtälje	164	99.0	86.5	84.1	62.9
Skene	129	99.0	99.2	22.8	95.3
Sollefteå	151	98.9	88.7	99.3	92.1
Södersjukhuset	227	97.5	90.6	62.1	95.8
Södertälje	145	99.8	80.0	98.6	72.9
Torsby	130	99.5	94.6	10.0	81.1
Uddevalla	242	100	95.9	99.2	96.3
Varberg	177	99.2	85.9	97.7	7.6
Visby	115	99.1	92.2	37.4	12.5
Värnamo	208	99.8	90.9	99.5	98.6
Västerås	194	97.9	90.7	7.3	92.3
Ängelholm	242	99.7	93.8	88.4	88.8
Örnsköldsvik	142	99.8	91.6	7.8	95.7
Östersund	178	100	95.5	100	97.8
> 300 operations/year					
Enköping	381	98.8	93.4	8.4	93.4
Hässleholm	891	99.9	97.9	3.0	2.7
Lindesberg	493	98.7	76.3	25.4	70.3
Mölndal	401	97.4	91.9	3.3	95.6
Oskarshamn	374	98.8	85.6	99.2	97.8
Piteå	373	99.4	68.6	33.8	95.1
Trelleborg	814	99.8	97.7	100	3.0

Surgical technique for knee arthroplasties

The table ”Surgical technique” shows what the hospitals reported for having used in their primary knee arthroplasties in 2018.

Topmost is the average for the country as a whole after which the results for the respective hospitals are shown. They have been classified depending on if they are university hospitals, private hospitals or for the others depending on if their reported number of surgeries was less than 100, 100-300 or more than 300.

The first column shows the total number reported and the second the proportion of complete reports. The rest of the information is based only on complete reports. Please note that the percentages may be misleading for units having reported only few surgeries.

There are no national guidelines or "best practice" concerning the use of the "surgical techniques" we register.

For other variables than the median operating time the table shows the proportion of surgeries performed using the method.

Spinal anesthesia is most common (67.2%) while the increase that we have seen in the proportion having general anesthesia in recent years seems to have stagnated (31.6% in 2017, 32.1% in 2018). Twelve hospitals reported having performed more than 80% of their arthroplasties using general anesthesia.

The use of drains has decreased from 26% in 2011 to less than 1 % in 2018. The proportion of surgeries performed using tourniquet continued to decrease from 90% in 2011 to little over 37% in 2018.

LIA, with or without a catheter being left in the knee, was used in the majority of the surgeries.

The median time for performing a primary varied between units from 35 minutes to almost two hours. For TKA's it was overall 70 min., for UKA's 61 min., for femoropatellar arthroplasties 60 min., for linked implants 139 min. and for partial implants 55 min. Since 2009, the median operating time for TKA's has varied between 70 and 82 min. and for UKA's between 61 and 80 min..

Bone transplantation is uncommon in primary arthroplasty and almost exclusively using auto transplantation. It was reported in 1% of the primaries and was slightly more commonly used in the femur (57%) than in the tibia (46%).

Computer aided surgery (CAS) was only reported for 6 cases by 4 units (15 in 2017).
No UKA's were reported using CAS.
The number of cases using custom made instru-

Surgical technique

Hospital 2018	Number of reports	Complete reports %	Percent having General anesthesia	Percent Drainage	Percent Tourniquet	Percent LIA	Median Op-time
Country	**15,431**	**99.2**	**32.1**	**0.9**	**37.7**	**96.7**	**70**
University Hospitals							
Akademiska	**91**	**99.3**	**18.7**	**0.0**	**85.7**	**95.5**	**91**
Huddinge	**107**	**100**	**18.7**	**0.9**	**16.8**	**88.8**	**125**
Karolinska Solna	**55**	**100**	**21.8**	**21.8**	**100**	**81.8**	**93**
Lund	**52**	**100**	**38.5**	**0.0**	**25.0**	**86.5**	**96**
Umeå	**138**	**98.1**	**18.1**	**1.5**	**53.0**	**61.9**	**90**
Örebro	**3**	**100**	**100**	**0.0**	**66.7**	**100**	**102**
Private units							
Art Clinic Göteborg	**140**	**99.7**	**100**	**0.0**	**10.7**	**98.6**	**62**
Art Clinic Jönköping	**146**	**100**	**98.6**	**0.0**	**9.6**	**98.6**	**79**
Bollnäs Aleris	**367**	**100**	**88.3**	**0.0**	**68.1**	**97.8**	**51**
Capio Artro Clinic	**392**	**100**	**95.9**	**0.0**	**0.5**	**97.2**	**60**
Carlanderska	**323**	**100**	**15.5**	**0.0**	**40.6**	**95.1**	**63**
Elisabethkliniken	**13**	**100**	**0.0**	**0.0**	**100**	**100**	**90**
Hermelinen-Luleå	**19**	**100**	**5.3**	**5.3**	**0.0**	**100**	**65**
Motala Aleris	**653**	**99.9**	**5.4**	**2.2**	**37.1**	**99.2**	**41**
Movement Halmstad	**467**	**100**	**2.6**	**0.0**	**5.1**	**99.1**	**61**
Nacka Aleris	**223**	**99.7**	**100**	**0.0**	**2.3**	**95.7**	**60**
OrthoCenter IFK-kliniken	**176**	**99.9**	**7.4**	**0.0**	**0.6**	**100**	**82**
OrthoCenter Sthlm	**676**	**99.8**	**3.0**	**0.2**	**7.3**	**98.7**	**59**
Ortopediska huset	**656**	**99.7**	**3.8**	**0.3**	**69.9**	**99.1**	**48**
Sophiahemmet	**185**	**99.4**	**93.0**	**22.8**	**42.2**	**96.2**	**70**
St Göran	**467**	**99.2**	**19.9**	**0.2**	**95.5**	**95.3**	**66**
Ängelholm Aleris	**82**	**100**	**80.5**	**0.0**	**1.2**	**100**	**59**

ments/cutting blocks was 68 (<0,5%) or only good one third of the 181 (1.2%) that were reported in 2017. Use of such instruments was reported by16 units (15 in 2017). Most of those only performed a few surgeries, each.

Surgical technique

Hospital 2018	Number of reports	Complete reports %	Percent having General anaesthesia	Percent Drainage	Percent Tourniquet	Percent LIA**	Median Op-time
< 100 operations/year							
Eskilstuna	81	100	12.4	0.0	0.0	98.8	92
Gällivare	88	100	6.8	0.0	13.6	98.9	95
Gävle	76	100	31.6	0.0	96.1	98.7	69
Helsingborg	16	100	18.8	0.0	0.0	100	102
Hudiksvall	62	100	19.4	0.0	45.2	91.9	82
Kalmar	86	100	15.1	0.0	0.0	89.5	81
Karlskoga	7	100	42.9	0.0	42.9	100	127
Nyköping	89	99.6	4.5	0.0	25.3	97.8	84
Skellefteå	86	100	1.2	1.2	98.8	100	89
Skövde	20	100	30.0	0.0	32.9	75.0	89
Sundsvall	15	100	6.7	6.7	0.0	93.3	126
Västervik	94	100	39.4	1.0	7.5	97.9	94
Växjö	94	100	37.2	0.0	25.5	90.4	80
100-300 operations/year							
Alingsås	179	100	9.5	1.1	0.0	96.7	84
Arvika	213	100	4.2	0.0	5.6	98.1	55
Borås	114	100	16.7	0.0	82.5	99.1	96
Danderyd	189	100	14.8	0.0	73.5	90.0	89
Eksjö-Nässjö	299	100	20.1	0.0	23.8	99.0	68
Falun	170	100	21.8	2.9	97.7	99.4	85
Halmstad	198	99.3	12.2	4.6	86.7	100	87
Karlshamn	278	99.9	93.2	0.0	91.7	99.3	69
Karlstad	117	99.1	19.7	0.0	0.9	98.3	72
Kullbergska sjukhuset	220	100	5.5	0.5	29.6	98.6	71
Kungälv	199	100	22.6	0.0	24.1	97.0	84
Lidköping	171	100	14.6	1.2	37.3	97.1	79
Ljungby	169	99.9	35.5	0.6	7.2	96.5	62
Lycksele	143	99.9	6.3	0.7	96.5	93.0	95
Mora	203	100	5.9	0.0	99.0	96.1	56
Norrköping	153	100	13.1	0.0	7.2	97.4	88
Norrtälje	164	99.9	36.0	1.2	54.9	85.9	78
Skene	129	99.7	17.8	0.8	65.6	100	96
Sollefteå	151	98.9	5.3	0.0	88.3	98.7	76
Södersjukhuset	227	99.7	16.3	1.3	1.8	94.3	75
Södertälje	145	99.7	95.2	1.4	1.4	93.8	65
Torsby	130	100	6.9	0.0	25.4	100	60
Uddevalla	242	99.9	9.1	0.0	12.8	99.2	84
Varberg	177	100	24.3	0.0	7.9	97.7	85
Visby	115	100	14.8	0.9	0.0	98.3	110
Värnamo	208	100	9.6	0.0	0.0	96.2	91
Västerås	194	99.9	12.9	0.0	0.5	88.7	74
Ängelholm	242	99.8	63.2	7.4	26.6	87.6	69
Örnsköldsvik	142	100	6.3	0.7	95.1	98.6	87
Östersund	178	100	9.0	0.0	51.7	100	95
> 300 operations/year							
Enköping	381	99.9	14.2	0.0	92.1	99.5	75
Hässleholm	891	99.9	92.3	0.0	0.9	99.8	39
Lindesberg	493	99.8	98.0	0.0	0.4	98.0	79
Mölndal	401	99.1	20.3	0.5	1.5	92.2	79
Oskarshamn	374	100	14.4	0.5	82.1	88.0	72
Piteå	373	100	5.1	0.3	93.6	99.5	64
Trelleborg	814	100	28.5	0.0	51.0	99.8	70

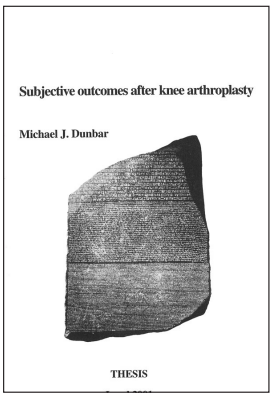
Patient reported outcome before and after knee arthroplasty

History

The SKAR started early on to ask patients about their opinion of their knee surgery. In 1997, 94% of all living patients that had undergone a knee arthroplasty answered a mail survey concerning non-reported revisions and patient satisfaction (Robertsson 2000).

In 1998, different patient questionnaires were tested in order to find the most suitable for use after knee arthroplasty and the SF-12 and Oxford-12 were found to be the most relevant. (Dunbar 2001).

We also found that the number of questions affected the answering rate and the proportion of complete answers. Further, non-responders were more often unsatisfied than responders.



PROM was the subject for a dissertation in 2001 based on data from the knee register.

Using self-administrated disease specific or general health questionnaires to evaluate results of surgery turned out to be more complicated than expected. There are many reasons for this, including among others that there is no clear definition of what outcome can be expected after knee arthroplasty (the aim of the surgery may vary), the initial health status and the expectations of the patients differ and observed changes in health over time need not be related to the surgery of the joint. We have also found that the observed proportion as well as which patients do not experience pain relief one year after total knee arthroplasty is dependent on the type of questionnaire used (W-Dahl et al 2014).

A national pre- as well as post-operative registration of PROM requires a large amount of resources both at a hospital and register level. Without a well-defined purpose it is difficult to choose a fitting instrument as well as decide if the response rate can be expected to be adequate. Therefore the SKAR has awaited international consensus on the matter.

The pilot project

The project started within the Region of Skåne where PROMs are used as a quality measure of the care provided. In the 2011 report we accounted for PROM data gathered 2008-2009 for TKA patients operated at the arthroplasty center in Trelleborg, which is jointly used by the university hospitals in Lund and Malmö. In 2012 Hässleholm was included and in 2013 the remaining hospitals in Skåne (Lund, Malmö, Helsingborg and Ängelholm). At the turn of the year 2012/2013, Norrköping, Motala and Oskarshamn joined the project and since then 12 additional hospitals.

On the following pages, there is a compilation of PROM data for each of the participating hospitals.

The PROM-project

More and more units have joined the pilot project which now can be considered permanent. In 2014 Kalmar, Karolinska sjukhuset i Solna and Ortho-Center Stockholm joined and Kungälv, Mölndal and Piteå at the turn of the year 2014/2015. In 2016 Alingsås, Bollnäs, Eksjö, Karlskoga, Lindesberg and Södertälje joined, in 2017 Norrtälje and Ortopediska huset and in 2018 Hudiksvall, Nacka and Västervik. Mölndal and Ortopediska huset have chosen not to register the disease specific KOOS but only the EQ-5D, VAS pain and satisfaction with the surgery one year postoperatively. Additional units have expressed their interest and initiated the task of engaging their hospitals in the project and finding resources for the data gathering. During 2018 PROM data were registered for approximately 50% of the primary surgeries.

Instruments used for the evaluation

EQ-5D is a general health instrument measuring quality of life based on the answers of 5 different questions (mobility, usual activities, self-care, pain/discomfort, anxiety/depression). Each of the questions can be answered by 1= no problem, 2= moderate problem and 3= extreme problem.

The EQ-5D index is calculated from the answers by use of a tariff for the normal population to weight the answers. However, lacking a Swedish tariff the British has been used instead. The lowest value is -0.594 and the highest 1.0 which represents a fully healthy individual. The index is intended to be used for health economic calculations although it has also been used to estimate quality of care which

has proved to be somewhat problematic because of the lack of a normal distribution as recently was reported in the Läkartidningen (36, 2011). If one wants to perform statistical analyses using a single value as a measure of the health related quality of life it is possible to use the EQ-VAS. It measures the self-perceived general health of the patient on a scale (0-100) from the best (100 to the worst imaginable health status (0) (www.euroqol.org).

KOOS is a disease specific questionnaire consisting of 42 questions and is designed to be used for short and long time follow-up after knee trauma or osteoarthritis. KOOS consists of 5 subscales; Pain, other Symptoms, Activity in Daily Life function (ADL), Sport and Recreation function (Sport/Rec) and knee related Quality of life (QoL). Standardized answer options are given (5 Likert boxes) and each question gets a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each subscale (www.koos.nu).

OMERACT-OARSI criteria. As a PROM mean value conceals both good and bad results, these criteria can be used to evaluate the proportion of patients that improved from before, to 1 year after surgery. They are based on the combination of absolute and releatve change in WOMAC pain, function and total score at 1 year after surgery (Pham et al. 2004). A responder (high) is a patient that has improved 50% or more and has an improvement of 20 points or more in WOMAC pain or function. In case of a patient not achieving this, he can still be classified as a responder (low) if the improvement is 20% or more and there is an improvement of 10 points or more in two of the WOMAC pain, function or total score.
We converted KOOS to WOMAC before classifying each patient according to the OMERACT-OARSI criteria one year after surgery into responders (high and low) or non-responders. The proportions are presentet as percentage. Please note that percentages for units with few surgeries may be misleading.

The Visual Analog Scale (VAS) is used to have the patients to estimate their knee pain by marking their pain score on a 0-100 scale (VAS) in which 0 = no pain and 100 = worst imaginable pain.

Patient satisfaction with the arthroplasty surgery one year postoperatively was also evaluated using a 0-100 scale (VAS) in which 0 = the highest imaginable satisfaction and 100 = the worst imaginable satisfaction. The satisfaction (VAS) score was categorized into 5 groups; very satisfied (0-20), satisfied (21-40), moderately satisfied (41-60), unsatisfied (61-80) and very unsatisfied (81-100).

The Charnley classification is a simple method for judging comorbidity. The modified Charnley classification consists of four classes; class A which stands for a unitlateral knee disease, class B means bilateral disease which is divided into B1 if the knee which is not subject for the present surgery is not healthy and has not been resurfaced with an arthroplasty and B2 if it has been operated with an arthroplasty. Class C stands for multiple joint diseases and/or another disease that affects the walking ability. The patients answer four questions that the classification is based on. The proportion of patients with Charnley class C is shown for each hospital in the table on page 74-75.

Patient selection
Only primary TKA's are included. Diagnoses other than OA are excluded as well as the second knee in case of both knees having had an arthroplasty during the one year follow-up period (left knee in case of simultaneous bilateral arthroplasty). Additionally only patients with complete pre- and one year postoperative data (EQ-5D, EQ-VAS and KOOS) were included. The number pf TKA's reported as well as the number of available PROM reports is shown in the tables on page 71, 74 and 75. A corresponding selection was used for UKA although we on pages 76-77 only account for units having reported PROMs for 10 or more UKAs.

Case-mix
A summary of case-mix factors such as gender, age, diagnosis, BMI and comorbidity is shown for the respective hospitals on page 60-61.

Logistics
The patients filled in the questionnaires at the outpatient visit approximately 2-6 weeks prior to surgery. One year postoperatively the same questionnaire was mailed to the patients together with the question on satisfaction with the knee arthroplasty.

Results

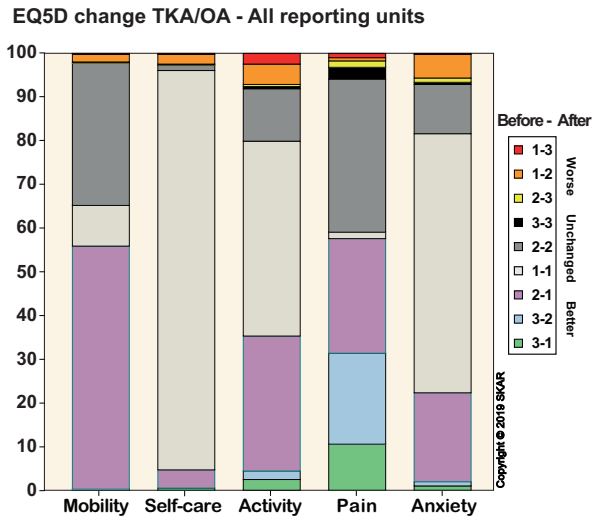
EQ5D

In order to visualize the change in general health from surgery until one year postoperatively we have classified 9 combinations of pre- and postoperative EQ-5D answers that are possible for the instrument.

A preoperative answer of extreme problems can be unchanged at the follow-up (3-3) or there can be an improvement from extreme to moderate (3-2) or from extreme to none (3-1).

Moderate problems can stay unchanged (2-2), worsen into extreme (2-3) or improve to none (2-1). Finally no problems preoperatively can stay unchanged (1-1), worsen to moderate (1-2) or become extreme (1-3).

The figure below shows for each of the 9 possible combinations the change from before surgery until one year after. It can be seen that just over half of the patients improved their mobility and experienced pain relief while only a third improved in their daily activities, a fifth had reduced anxiety and only a few improved in self-care. The results are similar to those of previous years.



The distribution (%) i for the different combinations of pre- and postoperatve (1-year) change for each of the EQ-5D questions. (1=no problem, 2=some or moderate problems 3=extreme problems)

Clinically relevant differences

In order for changes in points to be considered clinically relevant, the change on the VAS scale has to be 15-20 points and 8-10 points for each of the KOOS 5 subscales.

EQ-VAS

When patients operated in 2016 estimated their general health, both pre- and postoperatively, the difference between the units was relatively small (0-17 points). This was true for units with a relatively high (≥75%) response rate (Bollnäs, Eksjö, Hässleholm, Kalmar, Kungälv, Mölndal, Ortho-Center Stockholm, Oskarshamn och Trelleborg) as well as for units having few patients and/or low response rate. The EQ-VAS for the units can be found in the table to the right.

VAS – Knee pain

When patients operated in 2017 estimated their knee pain, both pre- and postoperatively, the diffence between the units that had a relatively high response rate (see EQ-VAS above) was also relatively small both preoperatively (0-9 points) as well as 1 year postoperatively (0-6 points). For the other units the differences between the units were also similar; 1-13 points preoperatively and 3-9 points one year postoperatively.

The table to the right shows the VAS knee pain and EQ-VAS with both pre- and postoperative values for patients operated in 2017. For patients operated in 2018 only the preoperative values are availiable.

VAS – Satisfaction with the surgery

One year postoperatively, 70 % of the patients operated in 2017 had reported their satisfaction with their arthroplasty surgery.

The table on page 72 shows the number of complete reports, together with the mean and standard deviation (SD) for the satisfaction with the surgery one year postoperatively.

As described on page 69, the patient satisfaction one year after surgery was categorized into 5 groups based on the VAS scale marking. Using this definition, 87% of the patients operated in 2017 reported that they were satisfied or very satisfied with the surgery.

The figure on page 72 shows that among the hospitals with a relatively complete reporting, the highest proportion of satisfied patients was in Kalmar (97%) Oskarshamn (93%), Eksjö (92%) följt av OrthoCenter Stockholm (87%), Mölndal (87%),Kungälv (86%), Bollnäs (86%), Trelleborg (85%) and Hässleholm (84%). For the other hospitals the proportion of satisfied patients varied from 77-100%

TKA/OA - Results for VAS–pain and EQ–VAS preoperatively and 1 year postoperatively.

			VAS pain 0–100 (best - worst)		EQ-VAS 0–100 (worst - best)	
Group	Patients n	Complete reports	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)
All hospitals 2017	4,721	70	64 (18)	17 (20)	65 (22)	77 (20)
All hospitals 2018	6,496	82	64 (20)		63 (23)	
Hospital :						
Alingsås						
2017	186	65	65 (18)	16 (20)	67 (22)	78 (19)
2018	171	86	61 (20)		65 (22)	
Bollnäs						
2017	258	82	61 (20)	17 (20)	61 (20)	76 (18)
2018	314	97	66 (18)		62 (23)	
Eksjö						
2017	177	79	61 (18)	16 (17)	61 (18)	79 (17)
2018	250	90	62 (19)		65 (20)	
Helsingborg						
2017	18	39	67 (19)	20 (24)	42 (23)	61 (20)
2018	15	67	71 (9)		60 (25)	
Huddinge						
2017	79	58	72 (17)	21 (21)	59 (26)	68 (23)
2018	79	66	69 (20)		55 (24)	
Hudiksvall						
2018	58	76	67 (16)	18(21)	63 (24)	
Hässleholm						
2017	614	79	62 (19)	20 (21)	71 (21)	77 (20)
2018	701	98	65 (18)		66 (22)	
Kalmar						
2017	87	77	65 (19	11 (14)	72 (20)	80 (18)
2018	79	78	67 (18)		62 (24)	
Karlskoga						
2017	22	59	74 (15)	21 (27)	63 (20)	79 (17)
2018						
Karolinska						
2017	34	47	70 (19)	17 (22)	60 (25)	73 (14)
2018	34	74	67 (20)		56 (18)	
Kungälv						
2017	158	77	67 (20)	18 (22)	62 (22)	76 (19)
2018	150	88	68 (18)		63 (24)	
Lindesberg						
2017	355	55	65 (16)	17 (20)	66 (22)	78 (19)
2018	443	49	65 (18)		61 (22)	
Lund						
2017	25	36	64 (18)	16 (21)	65 (19)	69 (27)
2018	24	13	69 (15)		61 (26)	
Motala						
2017	359	72	66 (17)	17 (19)	61 (22)	76 (19)
2018	372	87	69 (16)		61 (22)	
Mölndal						
2017	320	77	63 (20)	18 (21)	61 (22)	75 (19)
2018	340	77	63 (21)		63 (23)	
Nacka						
2018 (feb-dec)	178	49	68 (18)		65 (23)	
Norrköping						
2017	144	67	70 (15)	26 (26)	62 (21)	74 (18)
2018	137	87	71 (15)		61 (24)	
Norrtälje						
2017	115	45	64 (19)	16 (20)	64 (21)	75 (17)
2018	135	45	60 (20)		66 (21)	
OrthoCenter Sthlm						
2017	389	81	67 (18)	15 (18)	65 (22)	80 (16)
2018	566	92	65 (17)		64 (21)	
Ortopediska huset						
2017 (okt-dec)	227	49	61 (18)	14 (17)	69 (20)	82 (16)
2018	605	87	60 (22)		65 (22)	
Oskarshamn						
2017	315	85	63 (19)	13 (16)	63 (22)	77 (19)
2018	347	91	64 (18)		65 (22)	
Piteå						
2017	232	58	68 (17)	17 (19)	62 (22)	74 (19)
2018	272	65	68 (18)		61 (22)	
Södertälje						
2017	137	51	69 (17)	16 (22)	62 (23)	76 (21)
2018	138	75	44 (35)		55 (24)	
Trelleborg						
2017	679	76	64 (19)	17 (19)	68 (22)	78 (19)
2018	693	87	66 (18)		66 (23)	
Västervik						
2018	93	59	72 (18)		51 (20)	
Ängelholm Aleris						
2017	167	27	64 (14)	13 (15)	55 (27)	76 (24)
2018	109	77	28 (29)		42 (32)	
Ängelholm						
2017	86	34	69 (19)	18 (24)	62 (22)	83 (15)
2018	161	55	62 (26)		60 (25)	

TKA/OA - Satisfaction one year after surgery (2017)
VAS (0-100) (worst - best)

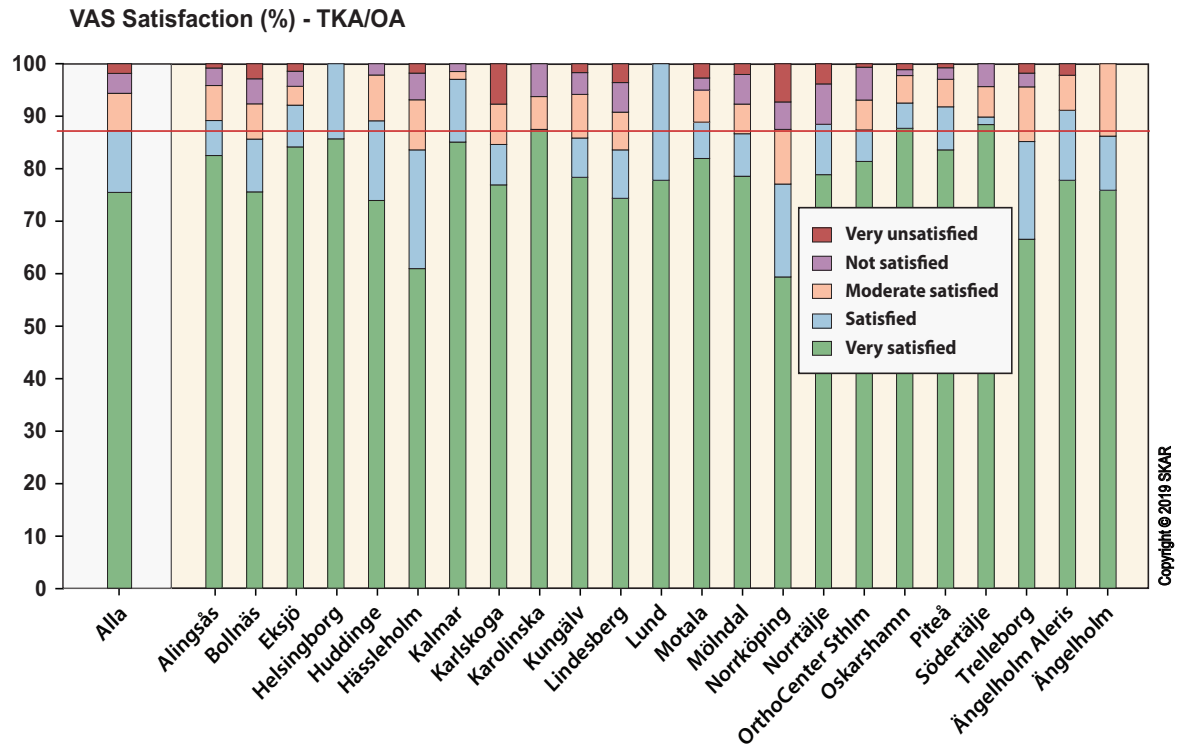
Hospital 2017	Number of reports	Complete reports (%)	Postop Mean (SD)
All units	4,721	70	16 (22)
Alingsås	186	65	13 (20)
Bollnäs	258	81	18 (24)
Eksjö	177	76	14 (19)
Helsingborg	18	39	11 (11)
Huddinge	79	58	18 (18)
Hässleholm	614	79	20 (22)
Kalmar	87	77	11 (15)
Karlskoga	22	59	18 (29)
Karolinska	34	44	12 (22)
Kungälv	158	76	16 (22)
Lindesberg	355	55	18 (25)
Lund	25	36	14 (22)
Motala	359	72	14 (22)
Mölndal	320	77	16 (23)
Norrköping	144	67	25 (29)
Norrtälje	115	45	17 (27)
OrthoCenter Sthlm	389	81	15 (23)
Ortopediska huset*	227	49	11 (17)
Oskarshamn	315	85	11 (17)
Piteå	232	58	12 (18)
Södertälje	137	51	11 (20)
Trelleborg	679	73	19 (22)
Ängelholm	86	34	16 (18)
Ängelholm Aleris	167	27	13 (19)

* enbart oct-dec

KOOS

The differences were small between those units having a relatively high response rate in 2016 (Bollnäs, Eksjö, Hässleholm, Kalmar, Kungälv, OrthoCenter Stockholm, Oskarshamn and Trelleborg). However, the patients in Eksjö reported somewhat less problems with postoperative sport and recreation function than those in Hässleholm, Kungälv, OrthoCenter Stockholm and Trelleborg. Further, the Eksjö patients reported higher knee related postoperative QOL than the patients in Kungälv. For units with few patients and/or low response rate the results vary and are difficult to interpret. The preoperative KOOS values in 2018 are similar to those reported in 2017.

The results for the KOOS 5 subscales are shown as mean and standard deviation for all patients as well as for the respective hospitals. For patients operated in 2017 both the pre- and postoperative results are shown but for patients operated in 2018 only preoperative results are available (see table on page 74-75).



Proportion (%) of satisfied patients one year after surgery (in 2017) for all reporting units together (to the left) as well as for each unit seperately.

OMERACT-OARSI responders

In 89% of the reported surgeries in 2017, the patients became classified as responders acting to the OMERACT-OARSI criteria with 79% being high responders (see figure below). For the units with relatively high response rate the proportion of responders was 87-93%. In Kalmar and Orthocenter Stockholm, 93% were responders of which respectively 87% and 85% were high responders. In Eksjö and Oskarshamn, the corresponding result was 91% with 80% and 81% being high responders respectively. For units with few surgeries and/or low response rate the proportion of responders ranged between 78-100% of which high responders were 71-94%.

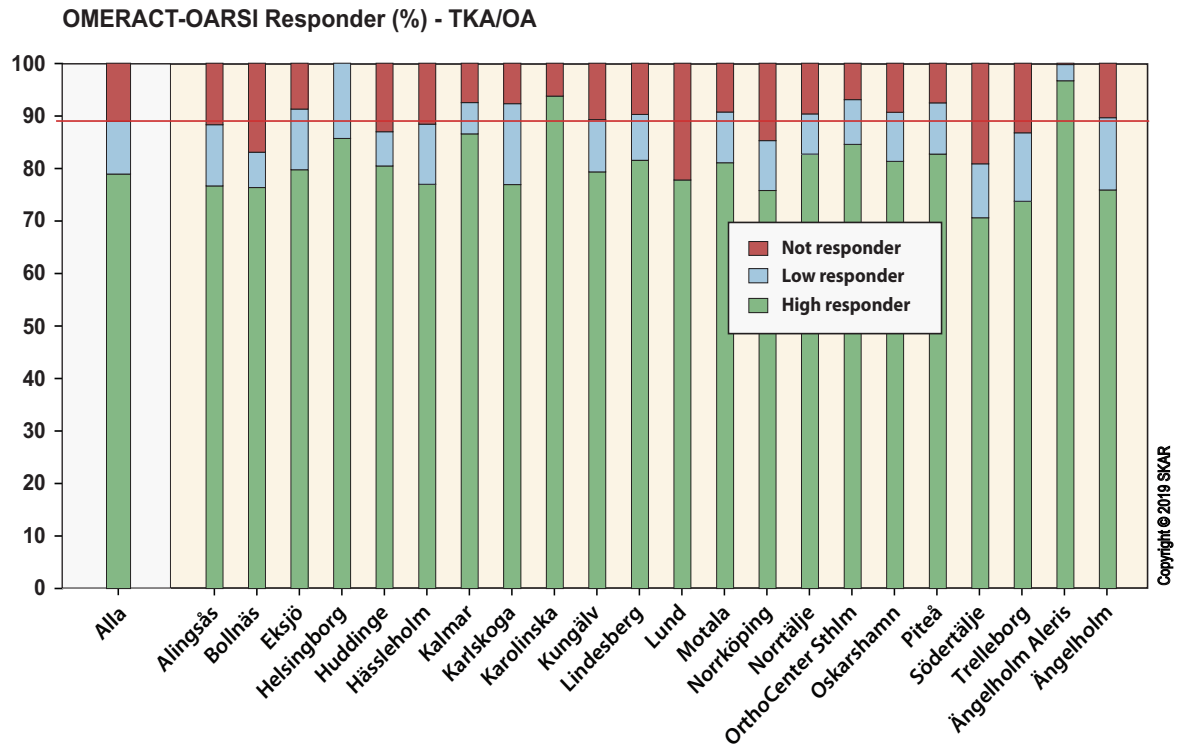
Summary

The result of the compilations showed again small variations between groups in spite of some differences in case-mix. However, it is worthwhile to point out that 97% of the patients in Kalmar and 92% of those in Eksjö reported that they were very satisfied or satisfied one year after their knee arthroplasty surgery. Additionally, 93% of the patients in Kalmar and 91% of those in Oskarshamn were classified as OMERACT-OARSI responders.

The results vary for units performing few surgeries as well as those with low response rate which makes it difficult to interpret and compare results between units as well as between different years of surgery.

The reasons for a low response rate vary. Further, the data entering requires carfulness and accuracy. In 2016, the register we became able to automatically link the PROM data to the SKAR database. However, in order for a PROM to become linked to a specific surgery, the ID and the side operated have to match and the answering date has to be within a specified time interval before and after the date of surgery.

This year, additional hospitals have started registrating PROM in the common database. However, gathering a representative material with one year follow-up will take more than 2 years. Only then, the participating units can begin comparing their results to that of others. Still, the PROM project will serve as a basis for continued discussion regarding evaluation of patient reported outcomes in registries and hospitals and how the results can be used for clinical improvement.



Proportion (%) of OMERACT-OARSI responders one year after surgery (in 2017) for all reporting units together (to the left) as well as for each unit seperately.

TKA/OA - Results for KOOS preoperatively (surgeries 2017 & 2018) as well as 1 year postoperatively (surgeries 2018)

				Pain		Symtoms		ADL		Sports/Rec.		QoL	
Group	Patients n	Complete reports %	Charnley C patients %	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)
All *													
2017	4 721	70	42.2	41 (16)	81 (18)	46 (17)	78 (17)	47 (17)	80 (19)	12 (14)	39 (26)	22 (14)	65 (24)
2018	5 551	81	45.7	40 (15)		46 (18)		46 (17)		11 (15)		21 (14)	
Sjukhus													
Alingsås													
2017	186	65	35	42 (15)	82 (19)	48 (17)	79 (18)	48 (16)	81 (20)	14 (16)	37 (27)	24 (13)	65 (26)
2018	171	86	46.2	44 (15)		48 (18)		49 (16)		13 (14)		24 (15)	
Bollnäs													
2017	257	82	35.6	41 (16)	81 (19)	45 (16)	76 (17)	47 (16)	79 (18)	11 (15)	41 (26)	20 (12)	65 (23)
2018	314	97	41.1	41 (15)		46 (18)		47 (17)		13 (15)		21 (13)	
Eksjö													
2017	177	79	36	44 (15)	85 (16)	51 (17)	81 (16)	51 (15)	86 (17)	14 (14)	48 (28)	25 (12)	72 (22)
2018	250	90	44.3	42 (14)		48 (16)		47 (15)		14 (18)		24 (14)	
Helsingborg													
2017	18	39	71.4	44 (6)	82 (15)	50 (15)	81 (12)	40 (5)	76 (16)	4 (4)	25 (18)	18 (6)	62 (32)
2018	15	67	70	39 (16)		46 (18)		34 (17)		7 (13)		16 (11)	
Huddinge													
2017	79	58	47.8	34 (19)	77 (20)	41 (17)	70 (18)	38 (21)	69 (25)	10 (18)	32 (27)	19 (15)	54 (27)
2018	79	66	57.7	38 (15)		45 (19)		40 (15)		10 (15)		20 (14)	
Hudiksvall													
2018	58	76	53.3	38 (13		48 (17)		43 (16)		9 (11)		19 (11)	
Hässleholm													
2017	698	82	39	41 (15)	81 (18)	48 (17)	78 (15)	46 (16)	79 (18)	12 (14)	37 (28)	25 (14)	65 (23)
2018	701	98	45.6	39 (15)		46 (18)		44 (16)		10 (13)		21 (14)	
Kalmar													
2017	87	77	32.8	43 (16)	85 (15)	51 (18)	81 (16)	49 (15)	83 (15)	13 (16)	42 (25)	23 (13)	71 (23)
2018	79	78	54.8	44 (15)		53 (19)		46 (14)		11 (12)		23 (14)	
Karlskoga													
2017	22	59	38.5	34 (19)	80 (23)	37 (20)	72 (26)	41 (17)	77 (23)	5 (7)	42 (32)	20 (13)	63 (30)
2018													
Karolinska													
2017	34	47	80	34 (15)	74 (24)	43 (21)	72 (20)	36 (14)	68 (26)	9 (22)	16 (20)	13 (13)	58 (31)
2018	34	74	45.8	42 (20)		48 (22)		46 (20)		11 (18)		19 (11)	
Kungälv													
2017	158	77	47.1	39 (18)	82 (18)	45 (20)	77 (17)	46 (19)	80 (19)	11 (15)	36 (29)	22 (15)	63 (23)
2018	150	88	55	40 (17)		47 (20)		45 (17)		10 (14)		21 (14)	
Lindesberg													
2017	355	55	34	40 (13)	82 (18)	46 (17)	77 (17)	46 (14)	81 (18)	10 (12)	40 (29)	21 (12)	67 (24)
2018	443	49	46.9	39 (15)		43 (18)		46 (16)		9 (13)		19 (13)	
Lund													
2017	25	36	33.3	42 (14)	82 (21)	43 (18)	72 (11)	47 (11)	79 (21)	11 (11)	39 (35)	24 (11)	67 (30)
2018	24	13	33.3	36 (12)		55 (15)		39 (16)		2 (3)		10 (7)	

TKA/OA - Results for KOOS preoperatively (surgeries 2017 & 2018) as well as 1 year postoperatively (surgeries 2017)

				Pain		Symtoms		ADL		Sports/Rec.		QoL	
Group	Patients n	Complete reports %	Charnley C patients %	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)
Hospital (cont.) :													
Motala													
2017	359	72	40,2	39 (16)	81 (19)	43 (18)	79 (18)	44 (16)	79 (19)	9 (11)	36 (26)	20 (12)	64 (23)
2018	372	87	45,9	38 (14)		42 (16)		43 (16)		10 (15)		20 (14)	
Mölndal													
2017	320	77	44,5										
2018	340	77	46,1										
Nacka													
2018 (feb-dec)	178	49	40	38 (14)		40 (16)		45 (13)		10 (12)		20 (12)	
Norrköping													
2017	144	67	46,3	38 (13)	74 (21)	42 (15)	72 (19)	43 (13)	73 (22)	9 (12)	27 (25)	19 (13)	54 (25)
2018	137	87	46,2	36 (14)		41 (18)		41 (16)		9 (12)		18 (11)	
Norrtälje													
2017	115	45	45,1	40 (14)	83 (20)	47 (18)	77 (18)	47 (15)	82 (15)	13 (18)	36 (27)	23 (13)	64 (23)
2018	135	45	47,7	43 (15)		52 (19)		50 (16)		12 (13)		25 (13)	
OrthoCenter Sthlm													
2017	389	81	40	41 (15)	83 (17)	46 (18)	79 (16)	49 (16)	83 (16)	13 (13)	40 (27)	22 (13)	65 (22)
2018	566	92	40,7	43 (16)		47 (18)		48 (17)		12 (15)		21 (15)	
Ortopediska huset													
2017 (okt-dec)	227	49	40,7										
2018	605	87	37,1										
Oskarshamn													
2017	315	85	42,4	42 (16)	85 (16)	47 (18)	80 (15)	46 (16)	84 (17)	12 (16)	46 (28)	21 (14)	69 (23)
2018	347	91	48	43 (15)		48 (17)		47 (16)		13 (16)		23 (13)	
Piteå													
2017	232	58	47,4	38 (14)	83 (17)	44 (17)	80 (15)	43 (14)	81 (17)	11 (16)	43 (28)	19 (12)	67 (24)
2018	272	65	44,9	38 (14)		44 (17)		43 (15)		10 (15)		19 (12)	
Södertälje													
2017	137	51	50	38 (16)	74 (24)	43 (19)	71 (22)	43 (18)	72 (25)	8 (11)	32 (27)	19 (14)	57 (26)
2018	138	75	58,4	37 (16)		44 (17)		41 (18)		10 (16)		20 (14)	
Trelleborg													
2017	679	76	46,3	42 (17)	81 (19)	48 (18)	77 (18)	49 (18)	80 (19)	13 (16)	38 (28)	24 (14)	66 (24)
2018	693	87	43	41 (16)		47 (18)		46 (18)		12 (17)		22 (13)	
Västervik													
2018	93	59	48,2	35 (14)		45 (20)		42 (17)		11 (17)		19 (13)	
Ängelholm Aleris													
2017	167	27	59	39 (16)	84 (14)	45 (20)	77 (16)	44 (17)	82 (17)	9 (9)	39 (26)	20 (13)	67 (21)
2018	109	77	52,2	40 (15)		46 (16)		45 (16)		12 (15)		21 (13)	
Ängelholm													
2017	86	34	62,1	43 (19)	81 (17)	47 (17)	80 (13)	46 (18)	80 (19)	10 (10)	39 (28)	21 (11)	63 (22)
2018	161	55	50,6	38 (17)		43 (18)		42 (18)		9 (15)		19 (15)	

* All except Mölndal and Ortopediska huset which do not report KOOS but Charnley dass

UKA

Patient repored result for UKAs are presented on this and next page for those units reporting. The number of UKAs varies between units as well as for the different years, from 0 to little more than 200 cases with a varying response rate between 0-96%. Motala accounts for approximately 40% of the reported UKA results. The outcome is similar as that for TKAs with small differences between units pre- and postoperatively. 89% of the UKA patients reported that they were satisfied or very satisfied with the surgery and 92% were classified as OMERACT-OARSI responders of which 84% were high responders.

UKA/OA - Satisfaction one year after surgery (2017)
Proportion of very satisfied or satisfied (VAS 0-40)

Hospital	Number of reports	Complete reports (%)	Postop: very satisfied or satisfied (%)
All reporting units	**400**	**61**	**89**
Eksjö	17	71	92
Huddinge	19	68	92
Kungälv	33	70	78
Lindesberg	18	0	
Motala	163	64	90
OrthoCenter Sthlm	21	67	100
Piteå	39	59	91
Trelleborg	31	74	78
Ängelholm Aleris	34	32	100

UKA/OA - Results for VAS–pain and EQ–VAS preoperatively and 1 year postoperatively.

			VAS pain 0–100 (best - worst)		EQ-VAS 0–100 (worst - best)	
Group	Patients n	Complete reports %	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)
All reporting units						
2017	400	61	65 (17)	15 (19)	63 (23)	79 (18)
2018	578	82	65 (20)		61 (23)	
Hospital :						
Bollnäs						
2017	25	76	58 (20)	14 (24)	63 (22)	78 (26)
2018	27	96	58 (16)		61 (20)	
Eksjö						
2017	17	71	58 (19)	21 (15)	73 (20)	77 (19)
2018	22	95	63 (17)		57 (25)	
Huddinge						
2017	19	68	60 (25)	12 (14)	66 (22)	76 (18)
2018	12	67	77 (11)		49 (27)	
Hässleholm						
2018	12	92	61 (24)		67 (22)	
Kungälv						
2017	33	70	62 (16)	18 (22)	57 (22)	73 (18)
2018	42	83	64 (20)		61 (22)	
Lindesberg						
2017	18	0				
2018	20	40	73 (8)		62 (16)	
Motala						
2017	163	64	68 (13)	16 (21)	63 (22)	78 (19)
2018	219	83	68 (17)		64 (21)	
Mölndal						
2018	13	92	72 (11)		55 (19)	
OrthoCenter Sthlm						
2017	21	67	64 (20)	7 (9)	72 (22)	89 (11)
2018	68	94	67 (15)		61 (23)	
Ortopediska huset						
2018	13	92	45 (29)		75 (18)	
Piteå						
2017	39	59	73 (16)	8 (12)	57 (24)	78 (15)
2018	69	58	74 (16)		56 (22)	
Trelleborg						
2017	31	81	65 (16)	25 (21)	69 (22)	79 (15)
2018	33	94	62 (23)		67 (17)	
Ängelholm Aleris						
2017	34	32	55 (15)	1 (1)	54 (27)	92 (6)
2018	28	79	30 (33)		34 (32)	

UKA/OA - Results for KOOS preoperatively (surgeries 2017 & 2018) as well as 1 year postoperatively (surgeries 2017)

				Pain		Symtoms		ADL		Sports/Rec.		QoL	
Group	Patients n	Complete reports %	Charnley C patients %	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)	Preop mean (SD)	Postop mean (SD)
All *													
2017	400	61	42	41 (15)	84 (17)	48 (16)	81 (16)	49 (16)	84 (17)	14 (16)	43 (27)	23 (14)	67 (23)
2018	578	82	39	40 (15)		48 (18)		46 (16)		12 (14)		20 (13)	
Hospital													
Bollnäs													
2017	25	76	42,1	45 (14)	82 (25)	48 (16)	82 (20)	52 (17)	85 (22)	19 (17)	51 (33)	27 (14)	78 (26)
2018	27	96	24	47 (12)		52 (13)		51 (11)		17 (13)		22 (10)	
Eksjö													
2017	17	71	57,1	44 (22)	82 (17)	53 (20)	79 (19)	59 (23)	80 (18)	22 (29)	44 (25)	30 (21)	77 (19)
2018	22	95		43 (16)		46 (16)		47 (16)		13 (12)		21 (15)	
Huddinge													
2017	19	68	45,5	45 (15)	88 (15)	49 (18)	80 (18)	52 (17)	86 (18)	12 (18)	54 (24)	21 (18)	76 (18)
2018	12	67	75	35 (25)		41 (25)		40 (27)		14 (20)		17 (13)	
Hässleholm													
2018	12	92	27,3	39 (14)		55 (17)		52 (20)		12 (15)		22 (15)	
Kungälv													
2017	33	70	50	43 (16)	82 (19)	50 (18)	80 (14)	50 (15)	82 (16)	10 (12)	34 (28)	23 (12)	73 (18)
2018	42	83	44,1	41 (16)		50 (18)		45 (16)		11 (16)		19 (16)	
Lindesberg													
2017	18	0											
2018	20	40	25	33 (18)		36 (17)		44 (18)		5 (6)		13 (7)	
Motala													
2017	163	64	43,3	39 (13)	85 (17)	46 (16)	82 (16)	46 (14)	84 (17)	12 (13)	40 (27)	22 (13)	78 (19)
2018	219	83	36,8	40 (15)		46 (17)		46 (16)		11 (14)		21 (12)	
Mölndal													
2018	13	92	25										
OrthoCenter Sthlm													
2017	21	67	42,9	43 (18)	87 (11)	49 (22)	84 (10)	52 (21)	86 (16)	23 (17)	55 (23)	23 (12)	89 (11)
2018	68	94	35,9	40 (14		49 (18)		46 (14)		11 (12)		19 (12)	
Ortopediska huset													
2018	13	92	30										
Piteå													
2017	39	59	47,8	36 (16)	88 (14)	39 (14)	82 (13)	43 (17)	84 (16)	4 (7)	43 (24)	15 (11)	78 (15)
2018	69	58	56,4	35 (13)		43 (21)		43 (16)		10 (15)		16 (11)	
Trelleborg													
2017	31	81	44	42 (13)	80 (18)	55 (14)	78 (18)	49 (14)	78 (20)	16 (18)	42 (26)	23 (13)	79 (15)
2018	33	94	32,3	45 (16)		54 (18)		49 (19)		20 (19)		24 (17)	
Ängelholm Aleris													
2017	34	32	37,5	45 (15)	90 (11)	54 (11)	85 (12)	51 (18)	91 (10)	15 (13)	57 (28)	30 (14)	92 (6)
2018	28	79	33,3	41 (19)		50 (21)		49 (17)		11 (12)		22 (12)	

* All except Mölndal and Ortopediska Huset which do not report KOOS but Chamley class

The knee osteotomy register

Joint preserving surgery – Knee osteotomy

High tibial osteotomy was introduced in Sweden in 1969 as a standard treatment for unicompartmental osteoarthritis by Göran Bauer Professor in Lund. However, after the modern knee implants were introduced in the seventies they quickly became the most common surgical option for osteoarthritis. Since then, the number of osteotomies has constantly diminished. Björn Tjörnstrand estimated 1981 in his thesis; ”Osteotomy for medial gonarthrosis”, that that one third of the surgical knee reconstructions were osteotomies while the SKAR in 1994 estimated that they accounted for 20%.

Of the osteotomies performed around the knee joint, Tibia osteotomy is the most common, most often being used for medial osteoarthritis while its use for lateral arthritis is less common. Osteotomies of the femur are more infrequent and are used mostly for serious congenital or acquired deformities as well as sometimes for lateral osteoarthritis.

There are several osteotomy methods and there are different types of fixation which often depend on the method used.

The ”closed wedge” osteotomy is a ”minus osteotomy” in which a bone wedge, of a size that relates to the correction needed, is removed. The osteotomy can be fixed with one or more staples, a plate and screws or with an external frame.

Closed wedge osteotomy using a staple for fixation.. The inserted picture above shows the wedge that is removed before the osteotomy is closed..

The open wedge osteotomy is a ”plus osteotomy” in which a wedge is opened up in order to gain the decided amount of correction. The osteotomy can be fixed internally, most commonly with plate and screws, with staples or with an external frame. When the osteotomy is opened up during surgery a bone autograft or synthetic bone substitute may be used to fill the gap (see the left figure below). If an external frame is used for fixation it is possible to gradually open the osteotomy over a few weeks which is the biological procedure used for bone lengthening which has the name hemicallostasis (see figure to the right below).

Finally there is also the curved or dome osteotomy which is rarely used in Sweden.

Open wedge osteotomy with staple fixation

Open wedge osteotomy with external fixation

The results after osteotomy are related to how the surgery gains and maintains the optimal correction. Thus the operation demands careful preoperative planning with respect to the correction needed, that the correction aimed for is achieved during surgery and that the fixation is stable so it can preserve the level of correction during bone healing.

Each of the different techniques has their pros and cons and there has been a continuing development of the procedures and the postoperative care with the aim of improving results.

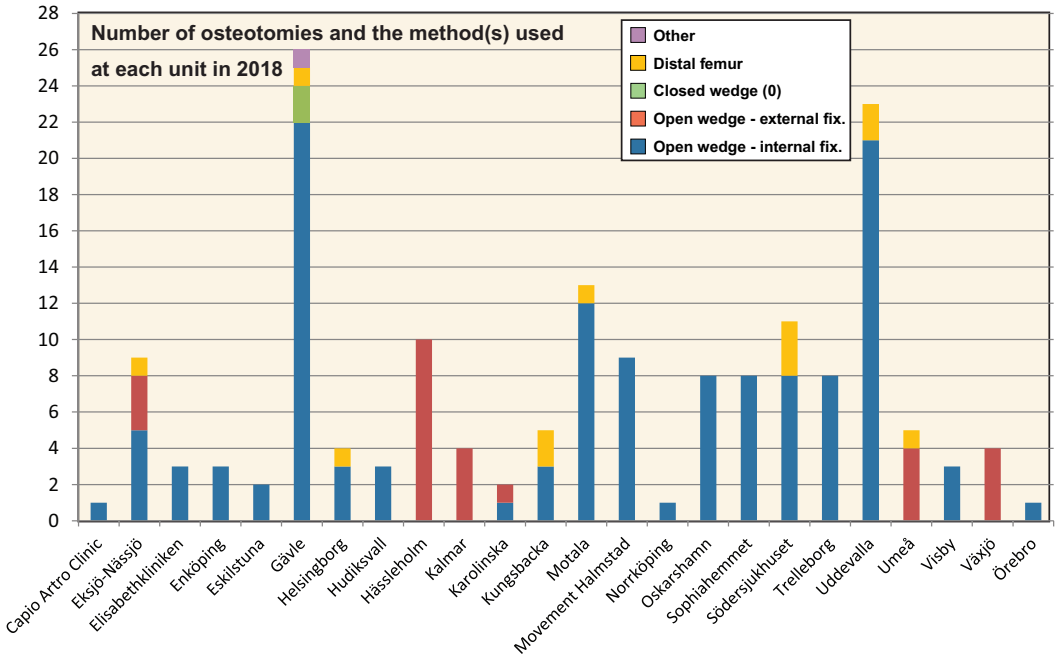
The choice of method and technique may have an effect on the short- and long-term risk for complications as well as influence a later knee replacement with respect to techniques used and outcome. The health economical perspective is also important for the health providers, the society and not least the patients.

Sweden became the first country in the world to start a national osteotomy registration as a complement to the knee arthroplasty registry (W-Dahl et al. 2014).

Australia started registering osteotomies in 2016 and New Zealand has plans of analogous registration together with their respective arthroplasty registries. They have harmonized their reporting form with the Swedish form which facilitates future cooperation and comparisons. In Great Britain a separate register of osteotomies was initiated in 2014 with a financial help from the industry (Elson et al. 2015).

In 2018, 163 osteotomies were reported from 24 hospitals. As the figure below shows, only 5 hospitals reported having performed 10 or more osteotomies during the year. The hospital performing most was Gävle that did 26. As compared to 2017 the number of reported osteotomies was one less from somewhat fewer hospitals.

It is difficult to know how many of the osteotomies performed in the country are captured by the register. The surgical codes NGK59 and NFK59, which are used for osteotomies performed on the femur and tibia, also apply to osteotomies performed for other reasons than disease or damage in the knee. According to information from the Health Authorities, the Patient Register found approx. 400 different diagnoses that had been used in combination with these surgical codes. Of these, 148 were main diagnoses used in combination with the surgical code NGK59. Sixty five percent of the surgeries had main diagnoses that could be attributed to osteoarthritis or instability. We collected the number of NGK59 from the Health Authority statistics for the years 2014-2017 for which the surgeries were made for osteoarthritis or instability. Assuming that the osteotomy register mainly captures these diagnoses, we estimate the completeness in the osteotomy register to have been 76-87% during 2014-2017.



Patient characteristics and case-mix in knee osteotomy surgery

Results

The following pages show the results for the knee osteotomies that were reported in 2018.

The knee osteotomy register gathers similar information as the knee arthroplasty register concerning the patients (BMI, ASA and previous surgeries), the use of antibiotics, antithrombotic prophylaxis as well as the surgical technique.

Patient characteristics

67% of the patients were males and the median age was 51 years that can be compared to the median age in 2018 for TKA patients (70) and UKA (65.6). A good half of the patients were reported as beging healthy (ASA class I) and having a mean BMI of 28. The majority had medial osteoarthritis of grade 1-2 according to the Ahlbäck classification and the median axis deviation was 7 degrees. Patients having distal femur osteotomy were younger, most were women and the axis deviation was somewhat greater than for those having proximal tibia osteotomy (see below).

Patient characteristics - osteotomies

	All* n=163	Prox. Tibia n=151 (93%)	Dist. Femur n=12 (7%)
Age (years)			
median (range)	51 (21-72)	52 (22-72)	33 (21-49)
Gender			
Men - n (%)	109 (67)	107 (71)	2
Women - n (%)	54 (33)	44 (29)	10
Preop HKA angle, n=161			
median (range)	7 (0-25)	7 (0-18)	9 (0-25)
ASA classification, n=159			
ASA I - n (%)	87 (53)	81 (54)	6
ASA II - n (%)	71 (44)	67 (44)	4
ASA III-IV - n (%)	5 (3)	3 (2)	2
Compartment affected, n=161			
Medial n (%)	151 (93)	148 (98)	3
Lateral n (%)	12 (7)	3 (2)	9
Diagnosis OA:	149 (91)	141 (93)	8
OA grade, n=147			
Ahlbäck 1 - n (%)	72 (49)	68 (45)	4
Ahlbäck 2 - n (%)	59 (40)	55 (36)	4
Ahlbäck 3 - n (%)	16 (11)	16 (11)	0

Body Mass Index

BMI group	Number	Percent
<25	34	20.9
25-29.9	78	47.9
30-34.9	36	22.1
35-39.9	14	8.5
40+	1	0.6
Missing	0	0
Total	163	100

Previous surgery

When reporting previous surgery of the index knee, it is possible to mark more than one alternative. Previous surgery was reported for 63% of the patients and more than one surgery for 15%. This can be compared to the knee arthroplasty patients of which 20% were reported to have had previous surgery and 3% more than one. What is reported cannot be considered a comprehensive description of previous surgeries but illustrates what was known at the time of the primary osteotomy.

Previous surgery in the index knee

Surgery	Number	Percent
None	59	36.2
Fracture surgery	2	1.2
Meniscal surgery	43	26.4
Cruciate surgery	18	11.1
Arthroscopy	37	22.7
Other	2	1.2
Missing	2	1.2
Total	163	100

Reason for and type of osteotomy

The majority of the surgeries (91%) were performed for osteoarthritis. The most common method was open wedge with internal fixation followed by open wedge with external fixation. Two closed wedge osteotomies were reported in 2018 (none in 2016 and 2017) but for a long time this was the standard treatment for osteoarthritis in Sweden.

Reason for the osteotomy

Diagnosis	Number	Percent
Osteoarthritis	149	91.4
Acquired deformity	1	0.6
Congenital deformity	4	2.5
Instability	3	1.8
Osteonecrosis	1	0.6
Other	5	3.1
Missing	0	0.0
Total	163	100

Type of osteotomy

Type	Number	Percent
Open wedge intern fixation	125	76.7
Open wedge extern fixation	23	14.1
Closed wedge	2	1.2
Curved/Dome	1	0.6
Distal femur	12	7.4
Missing	0	0.0
Total	163	100

Technique and prophylaxis for knee osteotomies

Open wedge osteotomy with internal fixation

Many different plates were reported for fixation of the osteotomies. The Tomofix plate was the most commonly used plate for open wedge osteotomies, but three types of plates were used fore more than 90% of the osteotomies using this technique (see below).

Type of fixation in open wedge osteotomy with internal fixation

Type	Number	Percent
Tomofix	77	61.6
CountourLock	1	0.8
Puddu	20	16.0
iBalance	7	5.6
PEEKPower	18	14.4
Other	1	0.8
Missing	1	0.8
Total	125	100

Transplantation of bone

No bone transplantation was reported in good half of the open wedge osteotomies that used internal fixation,. In case of bone transplantation, synthetic bone was most commonly used followed by bank bone and auto transplantation (see table). OSferion was the most commonly used synthetic bone.

Transplantation of bone in open wedge osteotomy with internal fixation

Bone transplantate	Number	Percent
None	70	56.0
Auto transplantation	5	4.0
Bank bone	13	10.4
Synthetic bone	37	29.6
Missing	0	0.0
Total	125	100
Synthetic bone:		
DePuy/Synthes Chronos	9	
Osferion	23	
Quickset	2	
Other	2	
Missing	1	

Open wedge osteotomy with external fixation

For this type of osteotomies, the Orthofix external fixation was used for the majority of surgeries (see below).

Type of fixation in open wedge osteotomy with external fixation

Type	Number
Orthofix	18
Monotube	4
Taylor Spatial frame	1
Missing	0
Total	23

Distal femur osteotomy

Different methods and techniques were used for this relatively uncommon osteotomy (see below).

Type of fixation for distal femur osteotomy

Type	Number
ContourLock	0
Tomofix	8
Puddu	3
Monotub	1
Missing	0
Total	12

Simultaneous surgery

An additional simultaneous surgery was reported to have been performed together with the osteotomy in 23 (14%) cases. Arthroscopy was the most common simultaneous procedure (see below).

Simultaneous surgery with the osteotomy

Surgery	Number	Percent
None	133	81.5
Arthroscopy	12	7.4
Cruciate surgery	5	3.1
Meniscal surgery	0	0.0
Other	6	3.7
Missing	7	4.3
Total	163	100

Type of anesthesia

General anesthesia which was used in 65% of cases was the most common method (see table).

.

Type of anesthesia

Type	Number	Percent
General	106	65.0
Epidural	1	0.6
Spinal	55	33.8
Missing	1	0.6
Total	163	100

Operating time

After excluding osteotomies performed with another simultaneous surgery, the median operating time was shorter for open wedge osteotomies with external fixation (48 min, 17-93) than for those with internal fixation (63 min, 26-189). The median time for distal femur osteotomies was 90 min, 50-177). The table below shows the median operating times including those osteotomies done with simultaneous surgeries.

Operating time

Type of osteotomy(n)	Median (min)	Range (Min)
Open wedge internal	66	(2-189)
Open wedge external	48	(17-124)
Distal femur	90	(50-177)
Closed wedge	69	(67-71)
Curved/Dome	156	

Computer aided surgery (CAS)

No osteotomies were reported to have ben performed with the help of navigation.

Antithrombotic prophylaxis

Innohep and Fragmin were the most commonly used substances. When Fragmin, Innohep or Klexane was used, the prophylaxis more often started postoperatively. Five percent of the osteotomy patients did not receive any antithrombotic prophylaxis at all (see table), unlike the knee arthroplasty patients which almost always receive prophylaxis.

Thromboprophylaxis

Substance - time	Number	Percent
No prophylaxis	8	4.9
Fragmin preop	7	4.3
Fragmin postop	59	36.2
Inohep preop	2	1.2
Inohep postop	66	40.5
Klexane preop	5	3.1
Klexane postop	10	6.1
Eliqvis	6	3.7
Total	163	100

Tromboprophylaxis - length of treatment

The planned length of treatment varied but 76% of the patients were planned to have 8-14 days of treatment (see table).

Thromboprophylaxis - length of treatment

Days	Number	Percent
No prophylaxis	8	4.9
1-7	12	7.4
8-14	124	76.1
15-21	3	1.8
22-28	15	9.2
29-35	0	0.0
>35	0	0.0
Missing	1	0.6
Total	163	100

Antibiotic drugs

Cloxacilline or Clindamicin were used in all the surgeries for which a substance name was reported. Clindamycin was used in 6% of the surgeries which is somewhat lower proportion than seen for knee arthroplasties (7%). As use of Clindamicin has been found to be linked to higher risk of infection in total knee arthroplasty (Robertsson et al. 2017), the PRISS recommandations were updated in Aptil 2018 (www.patientforsakringen.se).

Antibiotic drug

Substance	Number	Percent
Cloxacilline	152	93.3
Clindamicin	10	6.1
Other	1	0.6
Missing	0	0.0
Total	163	100

Cloxacillin dosage

For 56% of the osteotomies it was reported that the intention was to use 2g x 3 within 24 hours while 26% were planned having a single 2g dose (see below).

Cloxacillin dose

Dose	Number	Percent
Cloxacilline 2gx1	39	25.7
Cloxacilline 2gx2	22	14.5
Cloxacilline 2gx3	85	55.9
Cloxacilline 2gx4	3	2.0
Cloxacilline 1gx3	2	1.3
Other	1	0.0
Missing	0	0.6
Total	152	100

Antibiotic - time of administration

At the start of surgery a reasonable tissue concentration of the antibiotic should have been reached in order to counteract any bacteria in the field. Due to the short half-life of Cloxacilline it is important that it is administrated within a correct time interval.

In November 2017 updated PRISS recommendations were published (see page 62 and www.patientförsakringen.se) which considered the optimal time interval being 45-30 min before start of surgery which was a narrower interval than the 45-15 min. previously recommended.

For 36% of the osteotomies it was reported that the preoperative dose had been given within the currently PRISS recommended time interval (table below) while 62% lied within the previously recommended time interval.

Antibiotic - time of administration (PRISS recommendation)

Min. before surgery	Number	Percent
0-29	52	31.9
30-45	58	35.6
>45	39	23.9
Start after surgery	9	5.5
No antibiotic administered	1	0.6
Missing	4	2.5
Total	163	100

Tourniquet and drainage

Use of tourniquet is popular among Swedish orthopedic surgeons and it was used in 61% of the osteotomies (table below) as compared to 38% of the knee arthroplasties. Drainage was used in 11% of the osteotomies as compared to less than 1% of the knee arthroplasties.

Tourniquet and drainage

Tourniquet	Number	Percent
Yes	18	11.0
No	145	89.0
Missing	0	0.0
Total	163	100

Drainage	Number	Percent
Yes	100	61.4
No	61	37.4
Missing	2	1.2
Total	163	100

Re-operations

Since the start of the osteotomy register in 2013, more than 50 re-operations have been reported. The main reasons for the additional surgery have been pain/irritation from the plate, pseudarthrosis/late healing and over- or under correction.

Instructions for filling out the SKAR form;

Patient ID:
12 digits (preferably stamp or stickers)

Hospital and hospital number:
Should be pre-printed upper left.
This implies the hospital were the operation was performed

/The hospital which is responsible
Specified only if necessary beside the Hospital name.
Only in the case of the operation being performed by the assignment of another hospital (to which the patients and surgeons belong to).

Date of surgery:
Year-month-day

Side:
Mark the side operated. If both knees are operated on, use two forms, one for each knee.

Primary arthroplasty:
Mark "Yes" or "No".
Revision is defined as a surgery in which implant components are exchanged, added or removed. Note that this includes arthrodesis and amputation during which a previously inserted implant is removed.

Type of primary arthroplasty:
Mark one alternative with the exception if more than one type of surgery is performed in the same knee (e.g. medial and lateral UKA).

Reason for primary arthroplasty:
Mark the reason for the surgery or write the reason as free text. (OA = Osteoarthritis, RA = Rheumatoid arthritis)
In the case of more than one reason, then indicate the main reason for the operation (e.g. underlining)

Previous surgery of the index knee (for primaries only):
Mark "No" or specify the type of surgery. Note that only previous surgeries, known by the surgeon at the time, are to be specified. It is not the intention that information is to be searched in old patient charts.

Type of revision:
What has been performed during surgery. More than one alternative can be chosen, or if necessary, written as a free text.

Reason for the revision:
Mark the type of revision or write as free text.
In the case of more than one reason, then indicate the main reason for the operation (e.g. underlining).

Implant name:
Does not have to be specified if the implant stickers are attached to the back of the form.

Cemented parts
Mark the use of cement for relevant parts. Note that "stem" includes both fixed and modular stems.

Cement name:
Instead of the name of the cement we prefer the stickers for the cement to be attached to the lower back of the form. If separate stickers are avialable for the mixing system please include them.

Bone transplantation:
Mark "No" or use the relevant alternatives for the type of bone that has been use. Further mark the location in which the bone transplant was placed.

Navigation:
Mark "Yes" or "No". If Yes, specify what system was used (e.g. Aesculap, Brain Lab). Preferably the model, if available.

Custom made instruments
Mark "Yes" or "No" if the operation has been using instruments or saw blocks specially made for the patient based on MRI or CT.

MIS (Minimal Invasive Surgery):
This implies a (small) arthrotomy used to gain access to the joint without the patella having to be everted. This is to be filled in for both TKA and UKA.

Drainage:
Mark "Yes" or "No", specifying if a surgical drain has been left in the knee or not.

Surgeon:
The initials of the surgeon or his code. (Voluntary)

Anesthesia:
Mark the type of anesthesia used (more than one is allowed if relevant)

Tourniquet:
Mark "Yes" or "No", specifying if a tourniquet was used during the whole, or a part of the operation.

LIA (local infiltration analgesia):
Mark "Yes" or "No". If Yes, specify if a catheter was left in the knee for a later injection.

Antithrombotic prophylaxis:
Mark one of the three alternatives. If Yes, then also inform of the drug used, the dose (e.g. Klexane 40 mg x 1) as well as the planned length of treatment (e.g. 10 days).

Antibiotic prophylaxis:
Mark "Yes" or "No". In case of a prophylaxis being used, specify the name of the drug (e.g. Ekvacillin), the dose (e.g. 2g) and the number of times per day it is to be given.
Specify the exact time at which the preoperative injection was started (e.g. 07:45). In case the injection was given after the operation started, then also specify the time.
Finally, always state the planned length of treatment (e.g. 2 days).

ASA classification (American Society of Anaesthesiologists classification):
State the ASA class which the anesthesia staff recorded for the patient in the charts, prior to surgery.

Weight of the patient:
State in kg.

Height of the patient:
State in cm.

Start of surgery:
The time when the knife goes through the skin (e.g. 11:35)

End of surgery:
The time when closing of the skin was completed (ex. 13:15).

On the reverse side:
Attach the stickers at their intended spot:
The uppermost for the femoral components (e.g. stem, augments, ..)
The middle part for the tibial components (e.g. insert, stem, ..)
The bottom part for cement and other components (patellar button, ..)

IN CASE OF REVISION:
Do not forget to enclose a copy of the operation report and the discharge letter.

The Swedish Knee Arthroplasty Register
Remissgatan 4, Wigerthuset, floor 1
Lund University Hospital
SE-221 85, Lund
Phone. +46-(0)46-171345

Patient ID: 19 _____-____
(Unique social security number which includes date of birth)

From: Hospital name (institution No.) /

To be used when implant components are inserted, added, exchanged or removed

Date of surgery (y.m.d) 20 __ __ __ __ __

Side (in case of bilateral operation please use 2 forms, one for each side)
☐ 1 Left ☐ 2 Right

Primary arthroplasty ☐ 1 Yes ☐ 2 No

Type of primary arthroplasty:
☐ 1 TKA incl. patella ☐ 2 TKA excl. patella
☐ 3 UKA Medial ☐ 4 UKA Lateral
☐ 5 Patello-femoral ☐ 6 Other (what).....

Reason for primary arthroplasty:
If more than one reason, mark the main reason
☐ 1 OA
☐ 2 RA
☐ 3 Fracture (recent (not older than 3 months))
☐ 4 Fracture sequelae (damage by earlier fracture)
☐ 5 Osteonecrosis
☐ 6 Other (what) .....

Previous surgery of the index knee:
☐ 0 No ☐ 1 Osteosynthesis
☐ 2 Osteotomy ☐ 3 Menisceal surgery
☐ 4 Cruciate lig. surgery ☐ 5 Arthroscopy
☐ 6 Other (what) .....

Implant name: .....
(not needed when implant stickers are provided on the other side)

Cemented parts:

Femur	☐ 1 **Cemented**	☐ 2 **Not Cemented**
Tibia	☐ 1 **Cemented**	☐ 2 **Not Cemented**
Patella	☐ 1 **Cemented**	☐ 2 **Not Cemented**
Femoral stem	☐ 1 **Cemented**	☐ 2 **Not Cemented**
Tibial stem	☐ 1 **Cemented**	☐ 2 **Not Cemented**

Cement / mixing system .....
(not needed when sticker(s) for the cement are provided on the other side)

Bone transplantation:
☐ 0 **No** ☐ 1 **Pat. own** ☐ 2 **Biobank** ☐ 3 **Synthetic bone** (what) .....
When used, the bone was used in the :

Femur	☐ 0 No	☐ 1 Yes
Tibia	☐ 0 No	☐ 1 Yes
Patella	☐ 0 No	☐ 1 Yes

Navigation: ☐ 0 No ☐ 1 Yes system used: .....

Custom Made Instruments: ☐ 0 No ☐ 1 Yes

MIS: (minimally invasive surgery) ☐ 0 No ☐ 1 Yes

Drainage: ☐ 0 No ☐ 1 Yes

Surgeon (initials or code) : .....

Type of revision:
☐ 1 Total exchange (all previously inserted components exchanged)
☐ 2 Exchange of Femoral component
☐ 3 Exchange of Tibial component
☐ 4 Exchange of Patellar button
☐ 5 Exchange of poly/insert
☐ 6 Total implant removal (all previously inserted components)
☐ 7 Removal of component(s) (what) .....
☐ 8 Addition of component(s) (what) .....
☐ 9 Arthrodesis
☐ 10 Amputation
☐ 11 Other (what) .....

Reason for the revision:
If more than one reason, mark the main reason
☐ 1 Loosening (where) .....
☐ 2 Poly wear (where) .....
☐ 3 Fracture (periprosthetic)
☐ 4 Deep infection
☐ 5 Suspected infection
☐ 6 Instability (not of the patella)
☐ 7 Femoropatellar problem (pain, disclocation etc.)
☐ 8 Suboptimal situs of the previous implant
☐ 9 Other (what) .....

Anesthesia:
☐ 1 General ☐ 2 Epidural ☐ 3 Spinal ☐ 4 Other .....

Tourniquet: ☐ 0 No ☐ 1 Yes

LIA: (local infiltration analgesia)
☐ 0 No ☐ 1 Yes ☐ 2 Catheter left in knee (for later injection)

Antithrombotic prophylaxis:
☐ 0 No ☐ 1 Yes start pre-op. ☐ 2 Yes start post-op.
Name:..... dose:..... no. per day:.....
Planned length of treatment (days): .....

Prophylactic antibiotics:
☐ 0 No
☐ 1 Yes: Name:..... dose:..... no. per day:.....
Start Preop. ☐ 0 No ☐ 1 Yes **Time:** ..... : .....
Planned length of treatment (days): .....

ASA classification: (according to anesthesiologist)
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Weight (kg): ..... **Height:** (cm): .....

Start of surgery (skin incision) **Time:** ..... : .....

End of surgery (skin closed) **Time:** ..... : .....

Remember to put stickers on the back !!!

Put stickers for parts used on femur here
(femoral component, stem, augments ....)

Put stickers for parts used on tibia here
(tibia component, insert, stem, augments ....)

remember the cement sticker!

Put other stickers here
(cement, patellar button ....)

<u>In case of revision:</u>
Send a copy of op. report and discharge letter

Instructions for filling out the Knee Osteotomy Register form;

Patient ID:
12 digits (preferably stamp or stickers)

Hospital and hospital number:
Should be pre-printed upper left.
This implies the hospital were the operation was performed

/The hospital which is responsible
Specified only if necessary beside the Hospital name.
Only in the case of the operation being performed by the assignment of another hospital (to which the patients and surgeons belong to).

Date of surgery:
Year-month-day

Side:
Mark the side operated. If both knees are operated on, use two forms, one for each knee.

Primary Osteotomy:
Mark "Yes" or "No".
Revision is defined as a re-operation of a prevous osteotomy. However, knee arthroplasty is not to be reported on this form but on the arthroplasty form.

Type of primary knee osteotomy:
Mark an alternative för the method/technique used.

Reason for the primary osteotomy:
Mark the reason for the surgery or write the reason as free text. OA = Osteoarthritis. In the case of more than one reason, then indicate the main reason for the operation (e.g. underlining).

Preoperative HKA angle:
Note the varus, respektive the valgus hip-kne-ankle angle as measured preoperatively on long X-rays.

Preoperative X-ray grading of OA:
Note the preoperative X-ray grading of the osteoarthritis stage according to the Ahlbäck system.

Previous surgery of the index knee (for primaries only):
Mark "No" or specify the type of surgery. Note that only previous surgeries, known by the surgeon at the time, are to be specified. It is not the intention that information is to be searched in old patient charts.

Type of re-operation:
Mark if the re-operation was re-osteotomy or removal of osteosynthesismaterial and/or write som other surgery as a free text..

Reason for the revision:
Mark the type of re-operation or write as free text.
In the case of more than one reason, then indicate the main reason for the operation (e.g. underlining).

Name of the fixation:
For external fixation provide the name of the intstrument and place any stickers concerning the pins on the back of the form.
For nternal fixation a neme does not have to be specified if the iimplant stickers are attached to the back of the form.

Bone transplantation:
Mark "No" or use the relevant alternatives for the type of bone that has been use. If a synthetic bone was used place any enclosed stickers on the back of the form.

Navigation:
Mark "Yes" or "No". If Yes, specify what system was used (e.g. Aesculap, Brain Lab). Preferably the model, if available.

Angulation gauge/meter
Write the name of any mechanical gauge that was used to evaluate the amount of correction during surgery

Drainage:
Mark "Yes" or "No", specifying if a surgical drain has been left in the knee or not.

Other coincident surgery during the osteotomy:
State what other surgery was performed at the same time as the osteotomy (e.g. arthroscopy, cruciat ligament reconstruction).

Surgeon:
The initials of the surgeon or his code. (Voluntary)

Anesthesia:
Mark the type of anesthesia used (more than one is allowed if relevant)

Tourniquet:
Mark "Yes" or "No", specifying if a tourniquet was used during the whole, or a part of the operation.

Antithrombotic prophylaxis:
Mark one of the three alternatives. If Yes, then also inform of the drug used, the dose (e.g. Klexane 40 mg x 1) as well as the planned length of treatment (e.g. 10 days).

Antibiotic prophylaxis:
Mark "Yes" or "No". In case of a prophylaxis being used, specify the name of the drug (e.g. Ekvacillin), the dose (e.g. 2g) and the number of times per day it is to be given.
Specify the exact time at which the preoperative injection was started (e.g. 07:45). In case the injection was given after the operation started, then also specify the time.
Finally, always state the planned length of treatment (e.g. 2 days).

ASA classification (American Society of Anaesthesiologists classification):
State the ASA class which the anesthesia staff recorded for the patient in the charts, prior to surgery.

Weight of the patient:
State in kg.

Height of the patient:
State in cm.

Start of surgery:
The time when the knife goes through the skin (e.g. 11:35)

End of surgery:
The time when closing of the skin was completed (ex. 13:15).

On the reverse side:
For any ostesynthesis material, pins and synthetic bone that was used during surgery, place enclosed stickers on the back of the form.

IN CASE OF REVISION:
Do not forget to enclose a copy of the operation report and the discharge letter.

The Swedish
Knee Osteotomy Register
Remissgatan 4, Wigerthuset, floor 1
Lund University Hospital
SE-221 85, Lund
Phone. +46-(0)46-171345

Patient ID: |1|9|_|_|_|_|_|_|-|_|_|_|_|
(Unique social security number which includes date of birth)

From: Hospital name (institution No.) /

To be used for osteotomies around the knee

Date of surgery (y.m.d) |2|0|_|_| |_|_| |_|_|

Side (in case of bilateral operation please use 2 forms, one for each side)
☐ 1 Left ☐ 2 Right

Primary osteotomy ☐ 1 Yes ☐ 2 No

Type of primary knee osteotomy
☐ 1 Open wedge HTO - internal fixation
☐ 2 Open wedge HTO - external fixation
☐ 3 Closed wedge HTO
☐ 4 Curved / Dome HTO
☐ 5 Distal femur osteotomy
☐ 6 Other (what).....

Reason for the primary knee osteotomy
If more than one reason, mark the main reason
☐ 1 OA medially
☐ 2 OA laterally
☐ 3 Congenital deformity
☐ 4 Acquired deformity (not OA)
☐ 5 Osteonecrosis.
☐ 6 Other (what) .....

Preoperative HKA angle:
..... º Varus ..... º Valgus

Preoperative X-ray grading of OA:
☐ 0 Ahlbäck 1 ☐ 1 Ahlbäck 2
☐ 2 Ahlbäck 3 ☐ 3 Ahlbäck 4
☐ 4 Ahlbäck 5

Previous surgery of the index knee:
☐ 0 Nej ☐ 1 Osteosynthesis
☐ 2 Fracture surgery ☐ 3 Menisceal surgery
☐ 4 Cruciate lig. surgery ☐ 5 Arthroscopy
☐ 6 Other (what) .....

Type of re-operation:
☐ 1 Re-osteotomi
☐ 2 Removal of osteosynthesis material
☐ 3 Other type (what) .....

Reason for re-operation:
If more than one reason, mark the main reason
☐ 1 Loss of correction
☐ 2 Correction was to small
☐ 3 Correction was to large
☐ 4 Delayed healing
☐ 5 Pseudarthrosis
☐ 6 Other (what) .....

Name of the fixation: .....
(ot needed when implant stickers are provided on the other side)

Bone transplantation:
☐ 0 **No** ☐ 1 **Pat. own** ☐ 2 **Biobank** ☐ 3 **Synthetic bone** (whatt)
.....

Navigation: ☐ 0 Yes ☐ 1 No what system .....

Angulation guide: ☐ 0 Nej ☐ 1 Ja what.....

Drainage: ☐ 0 No ☐ 1 Yes

Other coincident surgery
☐ 1 Arthroscopy
☐ 2 Cruciate ligament reconstruction
☐ 3 Other (what) .....

Surgeon (initials or code) :.....

Anesthesia:
☐ 1 General ☐ 2 Epidural ☐ 3 Spinal ☐ 4 Other .....

Tourniquet: ☐ 0 No ☐ 1 Yes

Antithrombotic prophylaxis:
☐ 0 No ☐ 1 Yes start pre-op. ☐ 2 Yes start post-op.
Name:..... dose:..... no. per day:.....
Planned length of treatment (days): .....

Prophylactic antibiotics:
☐ 0 No
☐ 1 Yes: Name:..... dose:..... no. per day:.....
Start Preop. ☐ 0 No ☐ 1 Yes **Time:**..... : .....
Planned length of treatment (days): .....

ASA classification: (according to anesthesiologist)
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Weight (kg): ..... **Height:** (cm): .....

Start of surgery (skin incision) **Time:** ..... : .....

End of surgery (skin closed) **Time:** ..... : .....

Remember
stickers on the back side !!

In case of revision:
Send a copy of the op.report & discharge letter

Put stickers for inserted parts here
(plates, screws bone substitute ....)

ICD10- and NOMESCO codes used for definition of unwanted events

DA - Surgical diagnoses

If the codes occur as a main- or secondary diagnosis during the first admission or as the main diagnosis at a later admission

Exact code	Exact code
G978	T840
G979	T840G
M966G	T843
M968	T843G
M969	T844
T810	T844G
T812	T845
T813	T845G
T814	T847
T815	T847G
T816	T848
T817	T848G
T818	T849
T818W	T888
T819	T889

DB - Diagnoses for knee related events

If the codes occur as a main- or secondary diagnosis during the first admission or as a secondary diagnosis at a later admission	If the codes occur as the main diagnosis after the first admission
Exact code	Exact code
G573	M235
G574	M240
M000	M245
M000G	M246
M002G	M256
M008G	M659G
M009G	M860G
M220	M861G
M221	M866
M236	M866G
M244G	M895G
M621G	
M662G	
M663G	
M843G	
S342	
S800	
S810	
S830	
S831	
S834L	
S834M	
S835R	
S835S	
S835X	
S840	
S841	

DC - Cardiovascular diagnoses

If the codes occur as a main- or secondary diagnosis during the first admission or as the main diagnosis at a later admission

Exact code	Starts with
I260	I21..
I269	I24..
I460	I60..
I461	I61..
I469	I62..
I490	I63..
I649	I65..
I770	I66..
I771	I72..
I772	I74..
I819	I82..
I978	
I979	
J809	
J819	
T811	

A - Surgical intervention codes

If the codes occur during the first admission at a date ofter the primary surgery date or as the main intervention code at a later date

Exact code	Starts with
NFQ09	NGA..
NFQ19	NGC..
NFQ99	NGE..
NGB59*	NGG..
NGF01	NGH..
NGF02	NGJ..
NGF10	NGL..
NGF11	NGS..
NGF12	NGU..
NGF91	NGW..
NGF92	QDB..
NGK09	QDG..
NGK19	
NGM09	
NGQ09	
NGT09	
NGT19	
QDA10	
QDE35	
TNG05	
TNG10	

*enbart vid återinläggning

DM - Diagnoses for other medical events

If the codes occur as a main- or secondary diagnosis during the first admission or as a secondary diagnosis at a later admission		If the codes occur as the main diagnosis after the first admission	
Exact code	Börjar på	Exact code	Börjar på
J952	L89	K590	J20..
J953	I80	N991	J21..
J955	J13		J22..
J958	J14		K29..
J959	J15		
J981	J16		
N990	J17		
N998	J18		
N999	K25		
R339	K26		
	K27		
	N17		

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The Svedish Knee Arthroplasty Register

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Annual Report 2018

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The english version of the annual report contains selected tables and graphs. The online swedish version contain all the tables and graphs and is published on the website www.shpr.se.

[1] This chapter includes total and hemi-prosthesis operations performed due to acute fractures as well as sequelae after previous hip fractures.

Wordlist

Osteoarthritis exercise program	The osteoarthritis exercise program provides core treatment during osteoarthritis, which means information and training.
ASA classification	American Society of Anaesthesiologist physical status classification: classification of patients based on the physical health status of the patient. The higher value of the ASA classification, the poorer the physical health status.
Aseptic loosening	Loosening that is not caused by an infection.
Bilateral prosthesis	Prosthesis in both the right and left hips.
Bipolar head	Composite femoral head where a smaller head is fixated on the prosthesis cone, and a larger head is snapped on to the smaller head. The result is that movement can take place in two joints, one between the smaller and the larger head, and one between the larger head and the acetabular cup.
BMI	Body Mass Index. BMI = weight/length^2
Case-mix profile	Case-mix or distribution of patient characteristics at each unit respectively.
CE	Conformité Européenne (in free translation: European conformity).
Charnley class	Musculoskeletal comorbidity measure. Class A refers to unilateral hip disease, class B refers to bilateral hip disease, and class C refers to multiple hip disease or other medical conditions that affect the walking ability.
Completeness	Completeness rate.
Coverage	Affiliation rate.
Cox regression	Regression model used to study potential associations between survival rate and one or more predictors.
CPUA	Central Data Controlling Responsibility
CT	Computer Tomography
Standard patient	A man or a woman with primary osteoarthritis who have undergone a total arthroplasty and who is 55-85 years old, with an ASA class of I or II, and with a BMI between 20 and 30.
DMC	Dual Mobility Cup
Elective	Planned operation.
Unit	Hospital
One-stage procedure	Operation carried out in one session.
Etikprövningsmyndigheten (EPM)	The Swedish Ethical Review Authority
EQ-5D	A standardised instrument, questionnaire, to measure general health.
HA	Hydroxyapatite
Hazard ratio (HR)	The relation in risk for an event between two studied groups.
Hybrid total arthroplasty	Uncemented cup and cemented stem.
ICD-10	Code system that classifies diagnoses.
Incidence	The number of events in a certain population during a delimited time.
DAIR	Debridement, Antibiotics, Implant Retention; measure taken during deep infection where one seeks to keep bone-anchored prosthesis components by debriding, rinsing, and administrating antibiotics to heal the infection.
ISAR	International Society of Arthroplasty Registries.
Kaplain-Meier	Statistical technique for survival analysis that makes use of both observed survival rates for implants that are revised during the observation time, and observed survival rates for implants that remain at the end of the study period.
Confidence interval (CI)	An estimate of uncertainty by using a lower and an upper limit.
Consumption	Refers to the number of hip arthroplasties per 100 000 inhabitants regardless of where the operation has been carried out.
KVÅ code	Code system that classifies interventions and other measures.
Lateral position	A lateral position during operation.
Likert	A scale where the respondent's different attitudes are measured. Likert scales usually have five levels, but seven levels also exist.
Log rank test	Statistical hypothesis test to compare the difference between two or several survival distributions (Kaplan-Meier), where the hypothesis is that the distributions are equal.
Dislocation	Dislocation of a joint.
Landstingens ömsesidiga försäkringsbolag (Löf)	The mutual insurance company of the Swedish county councils.
Medical Device Regulation (MDR)	Regulation on medical devices within the EU.
NARA	Nordic Arthroplasty Register Association.

Nationella programområden (NPO)	A national system for knowledge management in Swedish healthcare.
ODEP	The Orthopaedic Data Evaluation Panel
Reverse hybrid total arthroplasty	Cemented cup and uncemented stem.
Osteolysis	Resorption of bone matrix.
Internal fixation	Plates, screws, or nails used to treat a fracture.
Adverse event	An unexpected negative event, in this case, as a consequence of a hip arthroplasty, for example an infection.
Patient Register	The Patient Register of the National Board of Health and Welfare.
Postmarket surveillance	Monitoring of safety aspects regarding medicines or medical devices after launch.
Prevalence	Refers to the proportion of individuals in a population who suffer from a certain disease or have a certain condition.
Primary osteoarthritis	Osteoarthritis developed without any known cause.
Production	Refers to the number of total hip arthroplasties per 100 000 inhabitants regardless of where the patient being operated on lives.
PROM	Patient-reported outcome measures
p-value	Given that the hypothesis that two or more groups have the same average is true, the p-value is the probability to have an outcome at least as extreme as the outcome that is actually observed.
RCT	Randomized Clinical Trial
Reoperation	All open procedures of which revisions form a part.
Revision	Exchange or extraction of one or more inserted prosthesis components.
Risk Ratio (RR)	The probability that some event will be observed in one group relative to the probability that it will be observed in another group.
RSA	Radiostereometry
SD	Standard Deviation
Secondary osteoarthritis	Osteoarthritis developed as a consequence of a known disease or injury.
Sequelae	Impairment after disease, injury, or trauma.
SHAR	Swedish Hip Arthroplasty Register
SHPR	Svenska Höftprotesregistret (Swedish)
Sveriges kommuner och regioner (SKR)	Swedish Association of Local Authorities and Regions
Closed reposition	Reposition a body part or a fracture to the right position.
SODA	Secure On-line Data Access
THA	Total Hip Arthroplasty
Thromboembolic events	Generic term for lung embolism and deep venous thrombosis.
Two session procedure	Operation carried out in two sessions.
Unilateral prosthesis	Prosthesis only in one hip (the right or the left hip).
Unipolar head	Femoral head that is fixated to the prosthesis cone, which articulates against acetabulum.
Vancouver classification	Classification system for periprosthetic fractures. Type A: Trochanteric fractures that do not affect the prosthesis. Type B: Fracture in direct proximity to the prosthesis, subdivided into B1 (good bone-anchoring), B2 (loosening of the prosthesis), and B3 (loosening of the prosthesis and/or osteolysis). Type C: Fracture distally of the prosthesis.
VARA	Validation of register data after hip arthroplasty; research study.
VAS	Visual analogue scale. Instrument for self-assessment.

1 Introduction

This year the Swedish Hip Arthroplasty Register celebrates its 40-year anniversary. Peter Herberts took the initiative to start the register after a successful pilot project. We have successfully conducted quality register management since 1979. The influence of the registry on Swedish hip arthroplasty has been many-faceted and today there is a strong national alignment and adherence to the recommendations of the register. It is with pride we now present the registry's annual report for 2018.

The Swedish Hip Arthroplasty Register is a national quality register, the purpose of which is to improve care provision for patients who undergo hip arthroplasty in Sweden. The aim is to register all hip arthroplasties that have taken place, both in public and private sector establishments, and regardless of the condition that led to the operation. The Register was set up in 1979, and this report covers procedures carried out up through to December 31st, 2018, making this the 40th operating year for the Register.

Annual production

Production continued to increase during 2018 (Figure 1.1 and 1.2). 18,629 primary total hip arthroplasties were carried out, equivalent to 360 procedures per 100,000 inhabitants over 40 years of age, and 4,298 primary hemiarthroplasties were carried out, which is on the same stable level as the average production during the past ten years. A total of 2,504 reoperations were registered, of which 2,129 were revisions.

Validation process and completeness

The Register data is subject to continuous validation and quality control. We use a range of methods to assure and maintain a high level of data quality and to improve areas in which there are shortcomings. A key feature of the validation process is the annual completeness analysis, which is carried out through linkage with the Patient Register of the National Board of Health and Welfare. The analysis covers all primary procedures, divided into total arthroplasties and hemiarthroplasties. Since last year, we have also performed a completeness analysis of revisions. As it is often well into the autumn before the Patient Register data for the preceding year is available, we have published a completeness analysis for the 2017 operating year. The outcome for the country was that 98% of all total arthroplasties, 96% of all hemiarthroplasties, and 92% of all revisions were registered in the Hip Arthroplasty Register. In the Register follow-up routine using patient-reported outcomes – the PROMs programme (patient-reported outcome measures) – the response rate for patients with osteoarthritis who underwent surgery in 2017 was 81% preoperatively, and 82% at the one-year follow-up.

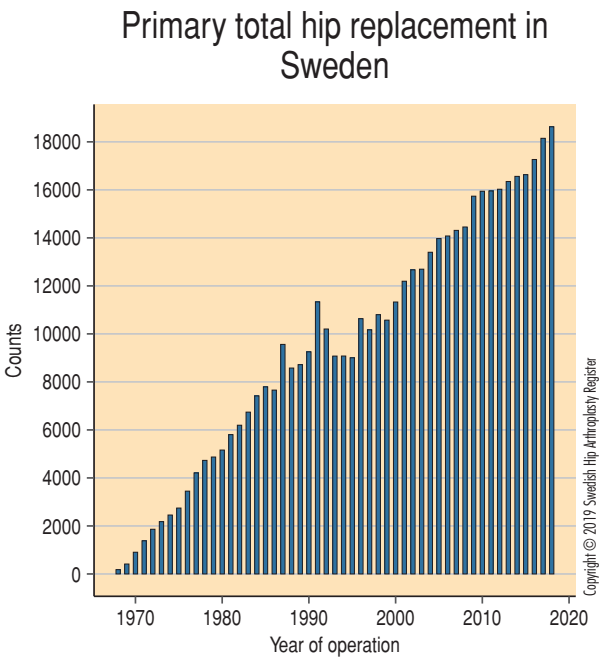


Figure 1.1.

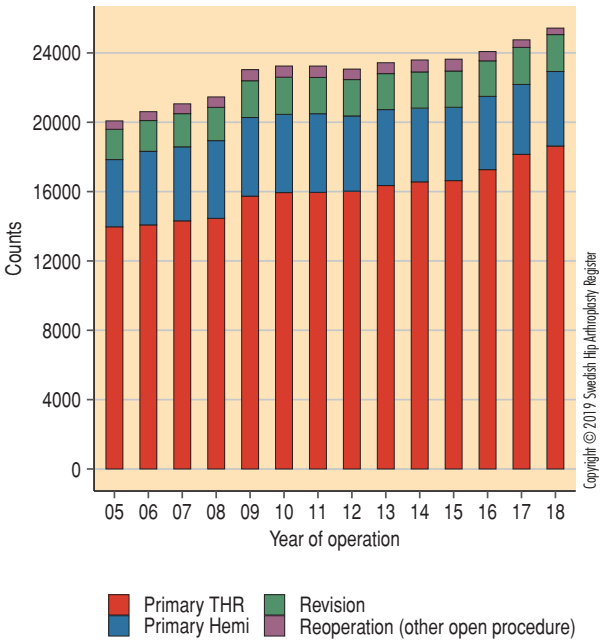


Figure 1.2.

Illustration

The Swedish Hip Arthroplasty Register's 40-year anniversary was celebrated with a jubilee symposium the 13-14th of June, which was attended by nearly 130 participants. The program of the event was very ambitious with many international participants and speakers. In the evening of the 13th of June, a jubilee dinner was held at the Göteborg Opera. In conjunction with the symposium, the retirements of Henrik Malchau and Johan Kärrholm were also acknowledged and their fantastic contributions to the development of orthopaedics were praised.

In-depth analyses and improvement work

As usual, this year's report contains a range of in-depth analyses. Among other things, we have updated the definition of the standard patient and analysed this in a ten-year perspective. Compared to the previous definition there are only minor changes. The update of the data used as a basis for the definition of the standard patient supports the idea that the choice of diagnosis and the earlier chosen limits for age and ASA class are well founded. Regarding BMI, we find no reason for excluding patients with a BMI under 18.5. The standard patient is now defined as a woman or a man, 55 to 84 years old, with primary osteoarthritis, a BMI under 30, and with ASA class I or II.

The Hip Arthroplasty Register and clinical research

It is heartening to see a continued high level of interest in conducting research using the Hip Arthroplasty Register. This is manifested, for instance, by the fact that 19 PhD students are affiliated to the Register. The PhD students base whole or parts of their thesis work on data from the Hip Arthroplasty Register, and they represent seven Swedish universities. During 2018, 20 scientific articles were published from the register and we had over 80 presentations in national and international meetings. Since 1986, when Lennart Ahnfeldt defended the first dissertation based on hip registry data, an additional 25 PhD students have defended a thesis based on data from the registry and under supervision of Register staff. This year's report contains summaries of four dissertations using registry data (Ted Eneqvist, Susanne Hansson, Volker Otten and Martin Magnéli).

Register Director Professor Ola Rolfson

Cooperation between the registers of the musculoskeletal diseases

The national quality registers within the musculoskeletal diseases have taken the initiative, in a joint effort, to deepen the cooperation between the registers. We strive to lay the groundwork for a powerful registry-based research and quality improvement organisation. The registers of the musculoskeletal diseases are at present scattered on different authorities with a Central Data Controller Responsibility. To take advantage of the full potential of the registries there is a need for consolidation. The Swedish Hip and Knee Arthroplasty registers have decided, as a way to consolidate, to join the registers with the aim of creating the Swedish Arthroplasty Register in the beginning of 2020.

Thank you to all co-workers

A basic prerequisite if the Hip Arthroplasty Register is to work is that units register and provide the requisite information. We appreciate the work and commitment on the part of contact secretaries and contact doctors throughout the country. We are very grateful for all the contributions received during the past year. Hip, hip hooray!

Göteborg, August 2019

Register Management Team

2 Data quality and validation process

The Register data are subject to continuous validation and quality control. We use a range of methods to assure and maintain a high level of data quality and to improve areas in which there are shortcomings.

2.1 Completeness analysis

A key aspect of the validation work is the annual completeness analysis, which is conducted by linking data with the National Board of Health and Welfare's Patient Register. The method is explained in Tables 2.1.1 and 2.1.2. The analysis covers all primary operations, divided into total hip arthroplasties and hemiarthroplasties. As there is a delay before Patient Register data for the previous year is available, a completeness analysis is published for the 2017 operating year. There are units which, in conjunction with subsequent checks or a reoperation, have discovered that an operation has not been registered in the Hip Arthroplasty Register and ex post facto registration takes place. This happens in fewer than 50 operations per year. To illustrate this, we reported in the 2012 Annual Report that 15,978 total hip arthroplasties had been carried out during 2012, but now 16,027 total hip arthroplasties have been registered for that year. To examine trends in the reporting rate, we have commissioned figures for the past 10 years (2008–2017). The completeness rate throughout the whole period was more than 97%, and since 2010, it has been 98–99% (Figure 2.1.1). The reporting rate is also very good for hemiarthroplasties with 95.6% in 2017. During the 10-year period, completeness for hemiarthroplasties has been around 96% or higher.

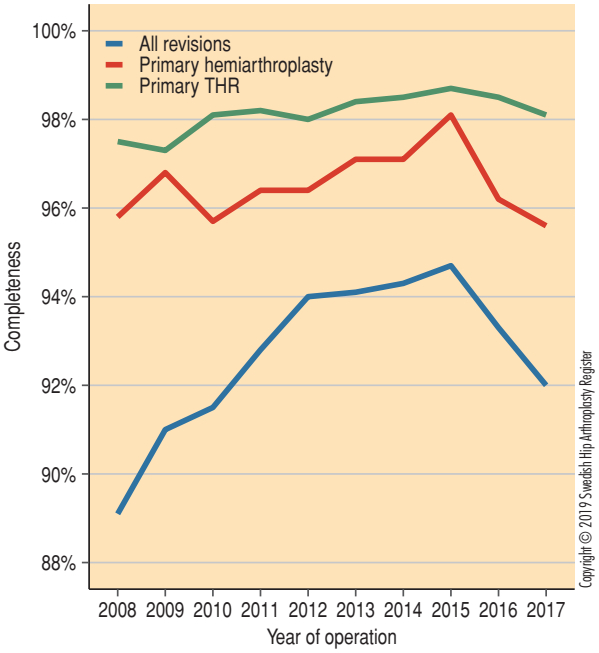


Figure 2.1.1

In last year's report, we reported on completeness rates for revisions for the first time. In order to conduct the analysis, we have linked the Hip Arthroplasty Register data for the operations that we have categorised as revisions, i.e. removal, replacement, or addition of a prosthesis component, with the Patient Register of the National Board of Health and Welfare. Correct NOMESCO codes for revisions comprises codes in the NFC group (secondary hip arthroplasties), NFU 09 (extraction of a total hip arthroplasty or hemiarthroplasty), or NFU 19 (extraction of a total hip prosthesis). Of the 2,116 revisions that were registered during 2017, 1,930 could be matched to the Patient Register. In addition, a further 185 had been assigned a revision code. This results in a completeness rate of 92%. Viewed over the entire period, reporting has gradually improved from just under 90% to at most 94.7% in 2015 (Figure 2.1.1). Södermanland was the county with the best figure in 2017 with an impressive 100%, closely followed by Uppsala (99%). Gotland only reported 68% of the revisions during 2017. Whether the 185 operations with a revision code that were found in the Patient Register really were revisions, we do not know but they indicate that there is a scope for improvement of the reporting.

On a whole the completeness rate in 2016 and 2017 was slightly poorer compared with the completeness rate in 2015, which so far is the best in the history of the registry. Of course, the changes that were made in conjunction with the platform change in the beginning of 2017 may have influenced the registration. We call for accuracy and good registration routines – many units have a 100% completeness rate for all types of operations.

2.2 Completeness analysis per unit

In the report, we present completeness rates for total hip arthroplasties, hemiarthroplasties, and revisions per hospital for the 2017 operating year (Tables 2.2.1, 2.2.2 and 2.2.3). In the current analysis, we have access to information on hospital level for the entire period 2008–2017, and if there is interest in data for 2008-2016, which is not shown in the tables, we would be happy to make it available. Units with values less than one standard deviation below the national average are marked in red in the table. In 2017, this was the case for 20 units for total hip arthroplasties, 9 units for hemiarthroplasties, and 13 units for revisions. The deviations are small for the majority of hospitals, although there is a clear scope for improvement at a number of units despite the high national average.

Completion analysis total arthroplasties and hemiarthroplasties
Total arthroplasties and hemiarthroplasties respectively are compared with the corresponding selection from the Patient Register. The completeness is calculated as a percentage with: *Numerator* All total arthroplasties and hemiarthroplasties respectively in the Hip Arthroplasty Register. *Denominator* All total arthroplasties and hemiarthroplasties respectively in the Hip Arthroplasty Register, or total arthroplasties and hemiarthroplasties respecitvely in the Patient Register.
About the comparison Here all total arthroplasties and hemiarthroplasties respectively in the Hip Arthroplasty Register are compared with all total arthroplasties and hemiarthroplasties respectively in the Patient Register.
Selection from the Hip Arthroplasty Register All primary total arthroplasties and hemiarthroplasties respectively in the Hip Arthroplasty Register are included.
Selection from the Patient Register All care events with measure codes NFB29, NFB39, NFB49, NFB62 or NFB99 for total arthroplasties and NFB09 or NFB19 for hemiarthroplasties are included.
Procedure One operation per surgery date is included. If one patient undergoes more than one hip arthroplasty on the same date, only one operation is included.
Matching criterion Operations are matched on personal identity numbers, and the date of surgery in the Hip Arthroplasty Register should lie in the interval between admission date and date of discharge for the care event in the Patient Register.

Table 2.1.1

Completeness analys revisions
Revisions of hip prostheses are compared with the corresponding selection from the Patient Register. The completeness rate is calculated as a percentage with: *Numerator* All revisions of hip prostheses in the Hip Arthroplasty Register. *Denominator* All revisions of hip prostheses in the Hip Arthroplasty Register, or revisions of hip prostheses in the Patient Register.
Selection from the Hip Arthroplasty Register All revisions of hip prostheses.
Selection from the Patient Register All operations in open or closed care with measure codes NFC*, NFU09 or NFU19.
More on data management One operation per surgery date is included. If more than one operation is carried out on the same patient the same date, only one operation is included in the comparison.
Matching criterion Operations are matched on personal identity numbers, and the date of surgery in the Hip Arthroplasty Register should lie in the interval between admission date and date of discharge for the care event in the Patient Register.

Table 2.1.2

2.3 PROM programme data quality

From 2008, all units in Sweden that carry out hip arthroplasties are registered in a follow-up routine for patient-reported outcome – the PROM programme. The preoperative questionnaire response rate, which for obvious reasons is intended for elective patients, has been very high.

Since the input functionality in the old PROM-database required responses to all questions, the registered questionnaires are complete. The contact secretaries can complete incomplete forms by contacting the patient by telephone or letter. If the questionnaire was not complete, the responses could not be registered in the database. In our new platform (Stratum), which was launched in January 2017, it is possible to register incomplete PROM questionnaires but the system issues a warning when not all questions are answered. Since our new platform Stratum was launched, in January 2017, the response rate has decreased. We suspect that a change of routines for input and mailings has contribute to the decrease and hope that the teething problems that arose in the transition from the old to the new platform now have been overcome. In 2017, the response rate was 81.4% preoperatively and 81.8% postoperatively (table 2.3.1).

2.4 Missing variables

For patients who underwent total hip arthroplasty electively, we have selected the variables diagnosis, ASA, BMI, fixation, and articulation to illustrate the data quality in the Register in terms of how high a proportion of the registered operations that have the information in question. A number of boxes on the registration form are compulsory (personal identity number, operation date, side, and diagnosis). Consequently, there is no missing data. As regards ASA and BMI (requires weight and height), these were complete for 98.9% and 98.4% of the registrations respectively in 2018. Fixation (fully cemented, uncemented, hybrid, or reverse hybrid) requires information about the fixation method for both cup and stem. Here complete information was available for all registrations in 2018. Articulation is a calculation variable that requires that both a femoral head and a cup component be entered, and that information about the nature of the component is included in the Register. In the case of registrations during 2018, we could make an articulation calculation in 99.8% of the cases.

In the case of fracture patients who underwent total hip arthroplasty or hemiarthroplasty during 2018, we have chosen to report ASA, BMI, occurrence of dementia (Yes, Suspected, No), diagnosis and fixation (Table 2.4.1). The fact that BMI was missing in 26% of the cases can be explained. In the case of fracture patients, it is in many instances not feasible to measure or produce information about current weight. Information about dementia is missing in 13% of the registrations.

2.5 Validation processes

In addition to the completeness analysis described above, the following validation processes are described in the Hip Arthroplasty Register:

- When registering, there are compulsory fields that cannot be left empty, otherwise the data cannot be saved.
- The web module for input contains automatically generated checks of, for example, personal identity number, side, unit, implant combinations, and fixation type.
- Control reports are generated automatically if operation data for one or more variables are missing. In these cases, each unit is contacted and then either complements the data directly or sends a copy of the medical records to the Register for further checks.
- Contact secretaries and contact doctors receive reconciliation reports twice a year in order to check that operations that have been reported concur with actual production. Each unit is urged to check its register extract against the local patient administration system.
- For all reoperations, medical notes are sent on a routine basis to the Register for input of the detailed information. In conjunction with registration of the detailed information, a register coordinator checks to ensure the data that has been registered is complete and correct.
- As regards PROM data, checks are made on received and missing registrations via a semi-automated statistics package. Reconciliation is also carried out each year, where each unit has access to information about the number of operations and the number of completed preoperative assessment forms.

Completeness for total arthroplasties in 2017

Unit	Number[1)]	Hip Arthroplasty Register, %[2)]	Patient Register, %[3)]
University hospital or regional hospital			
Karolinska/Huddinge	194	97	94.5
Karolinska/Solna	119	93	100
Linköping	38	92.7	95.1
SU/Mölndal	615	97.9	97.6
SUS/Lund	133	97.8	94.9
SUS/Malmö	37	100	94.6
Umeå	79	96.3	95.1
Uppsala	255	100	96.5
Örebro	45	95.7	100
County hospital			
Borås-Skene	276	92	96
Danderyd	311	99	98.1
Eksjö	203	100	99.5
Eskilstuna	129	98.5	96.2
Falun	250	99.2	60.7
Gävle	204	98.6	92.3
Helsingborg	92	98.9	97.8
Hässleholm-Kristianstad	825	99.6	99.5
Jönköping	205	98.6	97.6
Kalmar	173	96.6	97.8
Karlskrona-Karlshamn	275	99.3	99.6
Karlstad	189	99	96.3
Norrköping	272	100	99.3
Sundsvall	42	95.5	90.9
Södersjukhuset	356	98.3	98.9
Uddevalla-NÄL	409	98.8	99.5
Västerås	511	94.1	95.4
Växjö	117	98.3	95.8
Östersund	273	98.6	99.3
Local hospital			
Alingsås	206	99	100
Arvika	207	98.6	99
Enköping	413	99.8	99
Gällivare	92	100	98.9
Hudiksvall	95	99	96.9
Karlskoga	45	100	97.8
Katrineholm	248	98.4	96.8
Kungälv	197	98.5	98.5
Lidköping-Skövde	437	98.6	95.7
Lindesberg	613	100	99.7
Ljungby	195	100	98.5
Lycksele	323	99.4	98.5
Mora	253	98.1	98.8
Norrtälje	153	98.7	98.1
Nyköping	195	98	97.5
Oskarshamn	293	98.7	99.7
Piteå	401	99	99.3
Skellefteå	148	98	98.7
Sollefteå	325	99.7	99.1
Sunderby	28	39.4	97.2
Södertälje	172	97.2	98.3
Torsby	136	97.8	97.1
Trelleborg	671	99.9	99.4
Visby	128	93.4	97.1
Värnamo	131	99.2	97
Västervik	131	97.8	97.8
Ängelholm-Aleris Specialistvård Ängelholm	220	98.7	98.2
Örnsköldsvik	166	100	99.4
Private hospital			
Aleris Specialistvård Bollnäs	278	99.3	96.4
Aleris Specialistvård Motala	635	99.7	99.2
Aleris Specialistvård Nacka	234	98.7	98.3
Art Clinic Göteborg	75	100	30.7
Art Clinic Jönköping	71	100	28.2
Capio Artro Clinic	259	100	100
Capio Movement*	328	-	0
Capio Ortopediska Huset	605	95.3	91.7
Capio S:t Göran	595	96.6	96.4
Carlanderska*	207	-	0
Frölundaortopeden*	8	-	0
Hermelinen Specialistvård*	22	-	0
Ortho Center IFK-kliniken	177	97.8	46.4
Ortho Center Stockholm	623	98.6	98.7
Sophiahemmet	265	97.1	97.1
Halmstad-Varberg	441	98.7	98.7
Country	18 073	98.1	93.3

Table 2.2.1

Red marking indicates values that lie below the lower confidence interval in relation to the national average.

[1)] Refers to the number of registrations in the Swedish Hip Arthroplasty Register.

[2, 3)] Refers to the proportion of registrations that are found in both registries or only in the Swedish Hip Arthroplasty Register.

**Since these units have not reported any operations to the National Patient Register at the National Board of Health and Welfare, completeness cannot be presented*

Data for other care units are not presented separately in the table, but are included in the summary for the state.

Completeness for hemiarthroplasties in 2017

Unit	Number[1)]	Hip Arthroplasty Register, %[2)]	Patient Register, %[3)]
University hospital or regional hospital			
Karolinska/Huddinge	77	95.1	93.8
Karolinska/Solna	60	95.2	**87.3**
Linköping	80	95.2	98.8
SU/Mölndal	263	**92.3**	93.3
SUS/Lund	137	97.2	95.7
SUS/Malmö	156	100	94.9
Umeå	64	100	95.3
Uppsala	113	99.1	96.5
Örebro	46	97.9	95.7
County hospital			
Borås-Skene	87	**81.3**	**92.5**
Danderyd	192	98.5	96.4
Eksjö	54	98.2	96.4
Eskilstuna	70	98.6	94.4
Falun	146	98.6	94.6
Gävle	72	96	**88**
Helsingborg	154	100	93.5
Hässleholm-Kristianstad	125	99.2	**90.5**
Jönköping	48	100	95.8
Kalmar	71	**94.7**	94.7
Karlskrona-Karlshamn	95	100	92.6
Karlstad	124	98.4	92.9
Norrköping	80	98.8	93.8
Sundsvall	81	**92**	**90.9**
Södersjukhuset	237	98.3	95
Uddevalla-NÄL	202	99.5	93.6
Västerås	7	**77.8**	**66.7**
Växjö	38	**90.5**	97.6
Ystad	51	**94.4**	**90.7**
Östersund	68	95.8	95.8

Unit	Number[1)]	Hip Arthroplasty Register, %[2)]	Patient Register, %[3)]
Local hospital			
Alingsås	34	97.1	**91.4**
Gällivare	23	100	**91.3**
Hudiksvall	40	95.2	**88.1**
Karlskoga	51	100	98
Kungälv	64	98.5	93.8
Lidköping-Skövde	108	97.3	**90.1**
Lindesberg	8	100	100
Ljungby	21	100	95.2
Lycksele	26	96.3	**74.1**
Mora	49	98	96
Norrtälje	21	95.5	100
Skellefteå	35	97.2	94.4
Sunderby	46	**45.1**	99
Södertälje	16	100	93.8
Torsby	24	96	**92**
Visby	19	**73.1**	100
Värnamo	29	100	96.6
Västervik	41	100	**90.2**
Örnsköldsvik	73	97.3	96
Private hospital			
Aleris Specialistvård Motala	27	100	**88.9**
Capio S:t Göran	140	96.6	94.5
Halmstad-Varberg	131	99.2	95.5
Country	4 027	95.6	93.9

Table 2.2.2
Red marking indicates values that lie below the lower confidence interval in relation to the national average.

[1)] Refers to the number of registrations in the Swedish Hip Arthroplasty Register.
[2)] Refers to the proportion of registrations that are found in both registries or only in the Swedish Hip Arthroplasty Register.
[3)] Refers to the proportion of registrations that are found in both registries or only in the National Patient Register.

Data for other care units are not presented separately in the table, but are included in the summary for the state.

Completeness revisions in 2017

Unit	Number[1)]	Hip Arthroplasty Register, %[2)]	Patient Register, %[3)]
University hospital or regional hospital			
Karolinska/Huddinge	81	91	95.5
Karolinska/Solna	43	**87.8**	93.9
Linköping	46	92	**84**
SU/Mölndal	140	**85.9**	93.3
SUS/Lund	116	95.9	95
Umeå	86	95.6	98.9
Uppsala	121	99.2	98.4
Örebro	46	97.9	93.6
County hospital			
Borås-Skene	25	**53.2**	100
Danderyd	119	95.2	92.8
Eksjö	23	100	95.7
Eskilstuna	49	100	**81.6**
Falun	43	97.7	**77.3**
Gävle	69	94.5	91.8
Helsingborg	37	97.4	**86.8**
Hässleholm-Kristianstad	103	100	95.1
Jönköping	41	97.6	**78.6**
Kalmar	15	93.8	**87.5**
Karlstad	58	93.5	**88.7**
Norrköping	24	100	95.8
Sundsvall	29	**80.6**	**88.9**
Södersjukhuset	82	100	100
Uddevalla-NÄL	57	100	93
Västerås	74	93.7	**87.3**
Växjö	33	97.1	97.1
Östersund	46	97.9	91.5

Unit	Number[1)]	Hip Arthroplasty Register, %[2)]	Patient Register, %[3)]
Local hospital			
Alingsås	6	**85.7**	**85.7**
Hudiksvall	7	100	**85.7**
Karlskrona-Karlshamn	50	96.2	96.2
Kungälv	20	100	95
Lidköping-Skövde	73	96.1	**78.9**
Lindesberg	31	100	96.8
Ljungby	6	100	100
Mora	6	100	**50**
Norrtälje	16	**88.9**	100
Nyköping	22	100	**72.7**
Piteå	48	96	96
Skellefteå	15	**88.2**	**88.2**
Sunderby	6	**28.6**	100
Visby	13	**68.4**	**84.2**
Västervik	17	**65.4**	**88.5**
Private hospital			
Aleris Specialistvård Motala	28	**84.8**	97
Capio S:t Göran	62	**79.5**	96.2
Halmstad-Varberg	59	**85.5**	**85.5**
Country	2 117	92	91.9

Table 2.2.3

Red marking indicates values that lie below the lower confidence interval in relation to the national average.

[1)] Refers to the number of registrations in the Swedish Hip Arthroplasty Register.

[2)] Refers to the proportion of registrations that are found in both registries or only in the Swedish Hip Arthroplasty Register.

[3)] Refers to the proportion of registrations that are found in both registries or only in the National Patient Register.

** Since these units have not reported any operations to the National Patient Register at the National Board of Health and Welfare, completeness cannot be presented.*

Data for other care units are not presented separately in the table, but are included in the summary for the state.

PROM data quality

	2014	2015	2016	2017
All elective total arthroplasties				
Total number of operations	14 602	14 602	15 166	15 992
Deceased within one year (as first event)	115	118	132	123
Reoperated within one year (as first event)	234	233	276	274
Part of the one-year postoperative follow-up	14 253	14 251	14 758	15 595
Preoperative response	12 175	11 967	12 512	13 025
Proportion of all, %	83.4	82	82.5	81.4
One-year postoperative response	12 564	12 662	12 825	12 759
Proportion of those who are part of the follow-up routine, %	88.1	88.8	86.9	81.8
Preoperative and one-year postoperative response	10 614	10 522	10 673	10 458
Proportion of those who are part of the follow-up routine, %	74.5	73.8	72.3	67.1
All total arthroplasties due to primary osteoarthritis				
Total number of operations	13 369	13 442	13 997	14 765
Deceased within one year (as first event)	87	100	104	95
Reoperated within one year (as first event)	205	195	239	247
Part of the one-year postoperative follow-up	13 077	13 147	13 654	14 423
Preoperative response	11 276	11 127	11 680	12 147
Proportion of all, %	84.3	82.8	83.4	82.3
One-year postoperative response	11 615	11 790	11 947	11 869
Proportion of those who are part of the follow-up routine , %	88.8	89.7	87.5	82.3
Preoperative and one-year postoperative response	9 894	9 854	10 029	9 794
Proportion of those who are part of the follow-up routine, %	75.7	75	73.5	67.9

Table 2.3.1

Data quality of variables

Operation year	2014	2015	2016	2017	2018
Available data for all operations with an elective total hip arthroplasty					
Total number of operations	14 835	14 807	15 343	16 100	16 458
Articulation, %	99.8	99.9	99.9	99.8	99.8
ASA, %	98.1	98.8	99.2	99.4	98.9
BMI, %	96.8	98.3	98.7	98.8	98.4
Diagnosis, %	100	100	100	100	100
Fixation, %	100	99.9	99.9	98.2	100
Available data for all hip arthroplasties due to fracture					
Total number of operations	6 193	6 228	6 292	6 156	6 446
Articulation, %	96.7	96.8	95	95.5	95.2
ASA, %	69.5	71.8	72.9	73.5	73.4
BMI, %	64.8	64.3	62.7	90.5	86.5
Diagnosis, %	100	100	100	100	100
Fixation, %	100	99.9	99.8	99.4	99.8

Table 2.4.1

3 Epidemiology, availability and gender aspects

3.1 Total hip arthroplasty in Sweden

Incidence

Ever since work with the Hip Arthroplasty Register began, the incidence of total hip arthroplasties has increased steadily in Sweden. During 2018, 18,629 total hip arthroplasties were carried out in Sweden, which is equivalent to 360 procedures per 100,000 inhabitants aged 40 years and older. This represents an increase of 7 units since 2017. In an international comparison, including those countries that report the procedure rate in national quality registers, Sweden is among those with the highest incidence. An obvious explanation for the increasing incidence is the rise in average life expectancy and a higher proportion of elderly people in the population.

Prevalence

We have also studied how prevalence has changed over the years. As the calculation requires information about possible date of death, we have not been able to include those who underwent surgery before 1992, as prior to that arthroplasties were not registered on an individual level. In the analysis, we have included all patients who have undergone a total hip arthroplasty since 1992. We report both the prevalence of prosthesis bearers who recieved a prosthesis unilaterally or bilaterally, as well as the prevalence of bilateral prosthesis bearers. The prevalence is stated as the number of prosthesis bearers per 100,000 inhabitants aged 40 years and older at the end of each year.

At the end of 2018, 181,438 people had undergone at least one total hip arthroplasty since 1991. This means that 3.5% of the population aged 40 and over was a hip prosthesis bearer, an increase of 0.1 percentage points compared with the previous year. Of these, 48,890 people (27%) had a bilateral arthroplasty. Viewed for the whole of the Swedish population in 2018, 1.8% underwent at least one primary hip arthroplasty after 1991. At the end of 2018, the prevalence among those aged 40 and over was lower in men (3.0%) compared with in women (4.0%).

Of those who had undergone a procedure on either hip in 1992, 15% were still alive at the end of 2017. The more time after 1992 that is studied, the more exact this reflects the 'true" prevalence figure. The number of people who underwent an operation before 1992, and who were still alive at the end of 2018, is relatively low, albeit not negligible.

Number of persons with at least one hip prosthesis in Sweden

Number per age group	2003	2008	2013	2018
< 40	730	834	838	889
40–49	1 847	2 601	3 415	3 263
50–59	7 889	9 162	11 027	13 618
60–69	19 051	28 400	34 520	34 761
70–79	31 056	40 366	52 231	68 010
80–89	25 053	34 032	40 913	49 352
90 +	3 414	5 920	9 303	11 545
Total	89 040	12 1315	15 2247	181 438
Prevalens per 100 000 > = 40	1 975	2 554	3 063	3 484
Men				
< 40	297	386	385	432
40–49	883	1 340	1 837	1 757
50–59	3 822	4 579	5 733	7 173
60–69	8 554	13 041	16 036	16 643
70–79	12 455	16 372	21 654	28 932
80–89	7 972	11 104	14 095	17 519
90 +	710	1 405	2 266	2 859
Total	34 693	48 227	62 006	75 315
Prevalence per 100 000 > = 40	1 605	2 098	2 563	2 951
Women				
< 40	433	448	453	457
40–49	964	1 261	1 578	1 506
50–59	4 067	4 583	5 294	6 445
60–69	10 497	15 359	18 484	18 118
70–79	18 601	23 994	30 577	39 078
80–89	17 081	22 928	26 818	31 833
90 +	2 704	4 515	7 037	8 686
Total	54 347	73 088	90 241	106 123
Prevalence per 100 000 > = 40	2 315	2 980	3 537	3 997

Table 3.1.1 Number of people in Sweden with at least one hip prosthesis who have had surgery after 1991.

Number of persons with bilateral hip prostheses in Sweden

Number per age group	2003	2008	2013	2018
< 40	157	187	187	166
40–49	330	518	680	662
50–59	1 461	1 891	2 393	3 115
60–69	3 788	6 503	8 468	8 971
70–79	5 258	9 051	13 964	19 159
80–89	3 318	6 457	9 802	14 047
90 +	299	806	1 781	2 770
Total	14 611	25 413	37 275	48 890
Prevalence per 100 000 > = 40	323	535	750	940

Table 3.1.2 Number of people in Sweden with bilateral hip prosthesis who have had surgery after 1991.

3.2 County council production and geographical inequality

"The aim within the healthcare system is to provide good health and care on equal terms for the whole population. Healthcare should be provided with due respect shown for the equal value of all people and the dignity of each individual. Individuals who are in greatest need of the healthcare system should be given priority." This quote is taken from the Healthcare Act (SFS 2017:30).

An important aspect of equality is geographical disparities in how healthcare is provided and run throughout the country. Equality can in the broad sense be related to where the patient lives. The 21 county councils/regions have powers of autonomy with regard to healthcare provision, although they are also required to comply with the Healthcare Act. For a number of years, we have shown an interest in geographical disparities in procedure rate and results. Our 'Sweden maps" have revealed a surprisingly large variation between the county councils.

Production and consumption per 100,000 inhabitants per county council

These figures are based on data from the Hip Arthroplasty Register, population statistics from Statistics Sweden, and the National Tax Agency address register as of December 31, 2018. Production refers to the total number of hip arthroplasties per 100,000 inhabitants, regardless of where the patient lives. Consumption refers to the total number of hip arthroplasties per 100,000 inhabitants, regardless of where the operation was carried out. Consumption thus means that the county councils"/regions" inhabitants have access to hip arthroplasty regardless of whether the procedure is carried out in their home area or in another part of the country.

The spread of production and consumption figures per 100,000 inhabitants shows a considerable variation between providers (private sector units are included geographically). Production is 145–262 per 100,000 inhabitants, and consumption is 140– 282 per 100,000 inhabitants. This means that the county councils that produce the most have an 81% higher level of production compared with the county council that produces the least. As regards consumption, the incidence is more than 100% higher in the county council area with the highest incidence compared with the county council area that has the lowest incidence. Even if an adjustment is made for differences in age structure (the proportion of the population 40 years or older), there are considerable disparities in consumption.

3.3 Gender aspects, elective patients

In 57-58% of all total arthroplasties performed during the last ten years, the patient has been a woman. The figures have been adjusted to account for gender difference in the population. The average age in conjunction with an operation was, without exception, higher for women, 69 years, and this has been the case a consecutive number of years. The average age for men was just under 67 years. Women are overrepresented in the fracture diagnosis group, and fracture patients are usually older, which could be a contributing factor to the difference. It is, however, known from scientific studies that women with osteoarthritis undergo surgery at a later stage of the disease, without any conclusive reasons being found for why this is the case.

A greater proportion of men undergo surgery when they are younger – 41% of the men are under the age of 65 compared with 31% of the women. On the other hand, 29% of the women are over the age of 75 compared with 21% of the men. The age group 65–75 years accounts for approximately 40% regardless of gender (Figure 3.3.3 a-b). The changes over time are quite small.

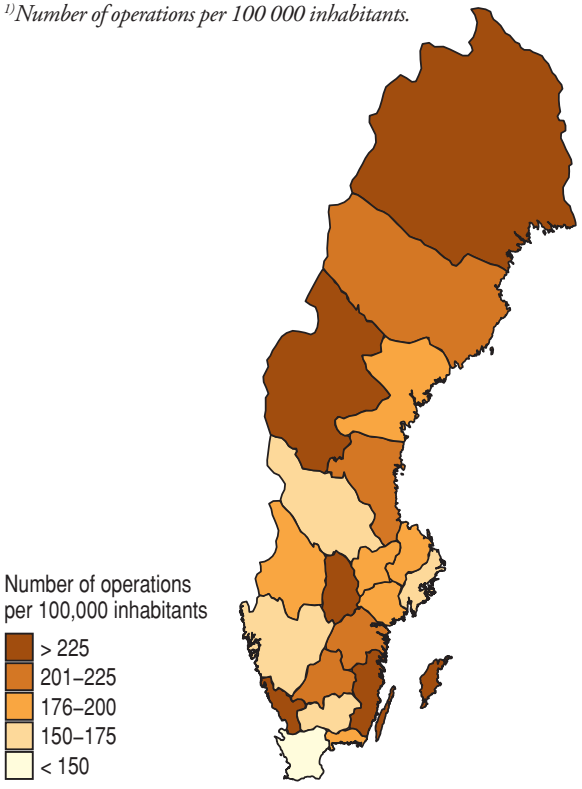
Osteoarthritis is by far the most common diagnosis for both genders and the numbers have increased for both genders since 2001 (figure 3.3.4a-b). The proportion of women has increased. Total hip arthroplasties due to fixation failure after hip fractures have fallen ('Complication trauma"). This is most pronounced for women and is explained by the fact that Swedish orthopaedic surgeons have for the past 15 years operated on hip fracture patients with hemiarthroplasties to a far greater extent than with internal fixation. A relatively large group also undergo total hip arthroplasty as primary treatment ('Acute trauma, hip fracture"). For the group 'Inflammatory joint disease" there is a substantial decrease. 2001-2002, 576 operations with this underlying diagnosis were performed on female patients, and 2017-2018 only 176. The corresponding

Production

County	Operations	Inhabitants	Number[1)]
Stockholm	3 966	2 344 124	169
Uppsala	664	376 354	176
Södermanland	583	294 695	198
Östergötland	936	461 583	203
Jönköping	805	360 825	223
Kronoberg	329	199 886	165
Kalmar	615	244 670	251
Gotland	138	59 249	233
Blekinge	318	159 684	199
Skåne	1 971	1 362 164	145
Halland	864	329 352	262
Västra Götaland	2 627	1 709 814	154
Värmland	515	281 482	183
Örebro	776	302 252	257
Västmanland	497	273 929	181
Dalarna	444	287 191	155
Gävleborg	613	286 547	214
Västernorrland	491	245 453	200
Jämtland	315	130 280	242
Västerbotten	544	270 154	201
Norrbotten	618	250 497	247
Country	18 629	10 230 185	182

Table 3.2.1

[1)]Number of operations per 100 000 inhabitants.

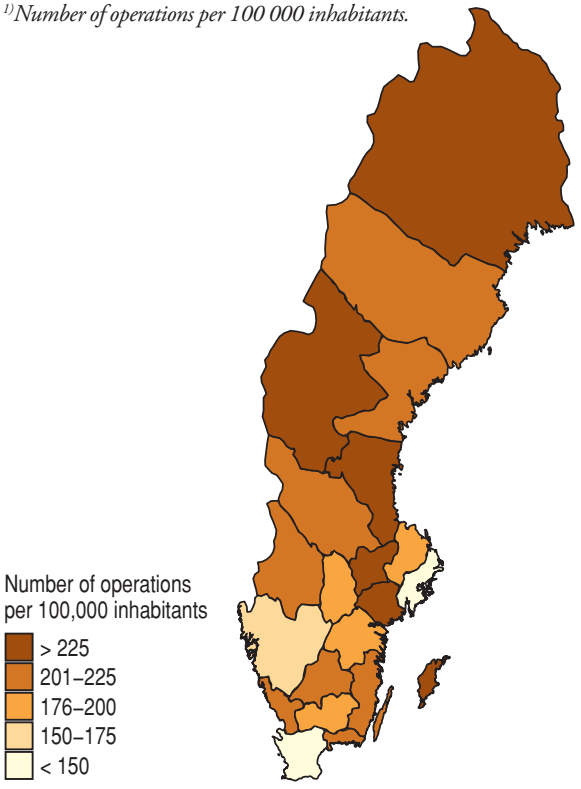


Consumption

County	Operations	Inhabitants	Number[1)]
Stockholm	3 271	2 344 124	140
Uppsala	691	376 354	184
Södermanland	715	294 695	243
Östergötland	826	461 583	179
Jönköping	741	360 825	205
Kronoberg	384	199 886	192
Kalmar	518	244 670	212
Gotland	142	59 249	240
Blekinge	335	159 684	210
Skåne	2 026	1 362 164	149
Halland	689	329 352	209
Västra Götaland	2 694	1 709 814	158
Värmland	627	281 482	223
Örebro	552	302 252	183
Västmanland	673	273 929	246
Dalarna	647	287 191	225
Gävleborg	727	286 547	254
Västernorrland	538	245 453	219
Jämtland	368	130 280	282
Västerbotten	573	270 154	212
Norrbotten	631	250 497	252
Country	18 629	10 230 185	182

Table 3.2.2

[1)]Number of operations per 100 000 inhabitants.

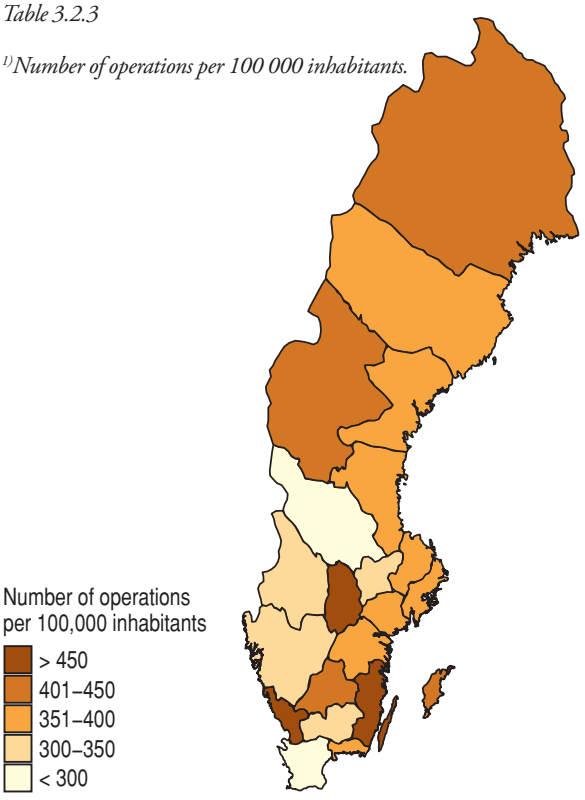


Production for patients 40 years of age or older

County	Operations	Inhabitants	Number[1)]
Stockholm	3 914	1 107 591	353
Uppsala	655	180 635	363
Södermanland	580	156 551	370
Östergötland	928	233 443	398
Jönköping	800	183 792	435
Kronoberg	329	101 416	324
Kalmar	613	135 917	451
Gotland	137	34 077	402
Blekinge	316	86 694	365
Skåne	1 940	681 209	285
Halland	861	174 555	493
Västra Götaland	2 605	855 584	304
Värmland	515	154 536	333
Örebro	769	154 577	497
Västmanland	493	143 444	344
Dalarna	443	157 923	281
Gävleborg	610	157 752	387
Västernorrland	490	136 089	360
Jämtland	314	70 565	445
Västerbotten	537	136 700	393
Norrbotten	614	138 718	443
Country	18 463	5 181 768	356

Table 3.2.3

[1)]Number of operations per 100 000 inhabitants.

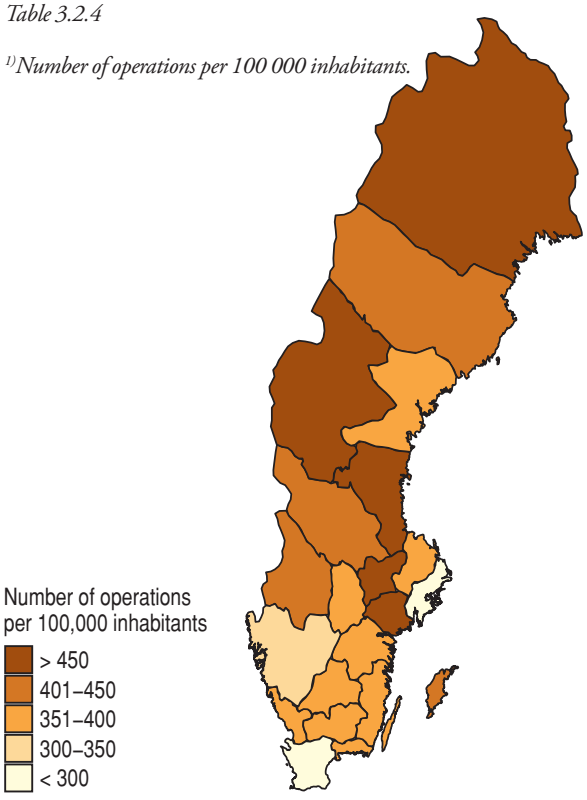


Consumption for patients 40 years of age or older

County	Operations	Inhabitants	Number[1)]
Stockholm	3 223	1 107 591	291
Uppsala	687	180 635	380
Södermanland	711	156 551	454
Östergötland	820	233 443	351
Jönköping	734	183 792	399
Kronoberg	382	101 416	377
Kalmar	516	135 917	380
Gotland	141	34 077	414
Blekinge	332	86 694	383
Skåne	1 996	681 209	293
Halland	685	174 555	392
Västra Götaland	2 676	855 584	313
Värmland	627	154 536	406
Örebro	546	154 577	353
Västmanland	666	143 444	464
Dalarna	645	157 923	408
Gävleborg	721	157 752	457
Västernorrland	536	136 089	394
Jämtland	365	70 565	517
Västerbotten	567	136 700	415
Norrbotten	626	138 718	451
Country	18 463	5 181 768	356

Table 3.2.4

[1)]Number of operations per 100 000 inhabitants.



numbers for men were 224 and 71. More effective pharmaceutical treatment for these patients ought to be the explanation. An increase in acute trauma has been noted in men, rising from 338 to 1,216. Increased use of total hip arthroplasty as fracture treatment, and a higher proportion of men among hip fracture patients could explain this.

The choice of surgical approach does not appear to be affected by the patient's gender (Figure 3.3.5). The most common is a posterior approach followed by a direct lateral approach, both in a lateral position. However, Swedish orthopaedic surgeons prefer cemented arthroplasty for women and uncemented arthroplasty for men (Figure 3.3.6). Fracture as a diagnosis, osteoporosis, and high age – all more common in women – are reasons why cemented arthroplasty is a better option.

The patient's degree of morbidity is registered according to the ASA classification (Figure 3.3.7). Gender differences are small, with slightly more men in ASA class I and III, and more women in ASA class II. Generally, the changes are very small compared with the previous time period. The disparities can be attributed to different diagnosis patterns and different ages at the time of the procedure.

The majority of men and women are overweight when they undergo surgery. Men are overrepresented in the overweight group whilst women are overrepresented in the normal weight group (Figure 3.3.8). In comparison with 2008, the proportions of underweight and normally weighted have increased somewhat for both genders, but the proportion of severely obese is still at the same level.

3.4 Gender aspects, fracture patients

The proportion of men who undergo an arthroplasty as the primary fracture treatment is steadily increasing. In 2000, the men constituted 20% and in 2018, the proportion had increased to 35%. This development is seen in several demographic studies of hip fractures. The general view is that the increase in men's life expectancy leads to an increased risk of fracture.

The average age for men with a hip fracture has stabilised at 81 years, whilst for women it is approaching 83 years, compared to 82 years in 2005. The number of women over the age of 100 years who underwent hip arthroplasty was three in 2005 compared with 25 in last year. Four men were over the age of 100 in 2018 but none in 2005 when registration started.

Men have a worse prognosis following a hip fracture than women. The register shows that 16-17% of the men who undergo hip arthroplasty due to a hip fracture died within 90 days of the injury. The proportion for women is 8%. In the population, an 85-year-old has on average a remaining life expectancy of 5.5 years (men) and 6.5 years (women) and a hip fracture is therefore a sign of poorer health and represents a tangible threat to life. Male gender is a risk factor for reoperation according to analyses in Chapter 12, Fracture treatment with total hip arthroplasty or hemiarthroplasty.

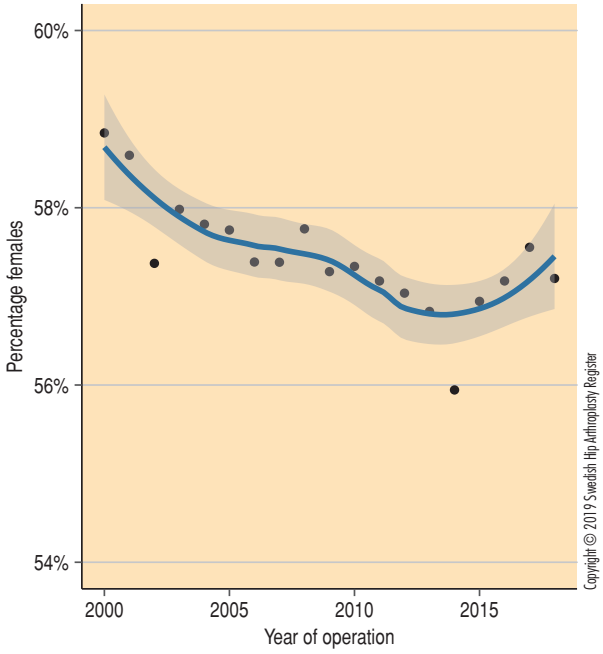


Figure 3.3.1. Proportion women among total hip arthroplasties over time.

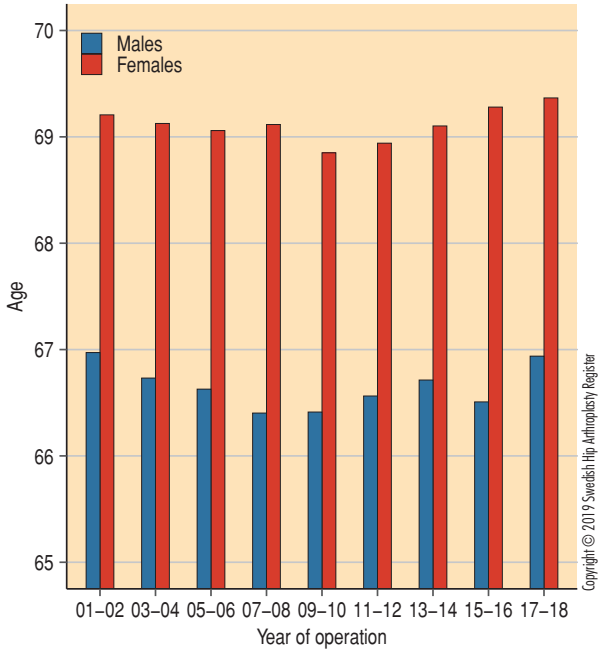


Figure 3.3.2. Mean age for men and women with total hip arthroplasty, 2year intervals 2001-2018.

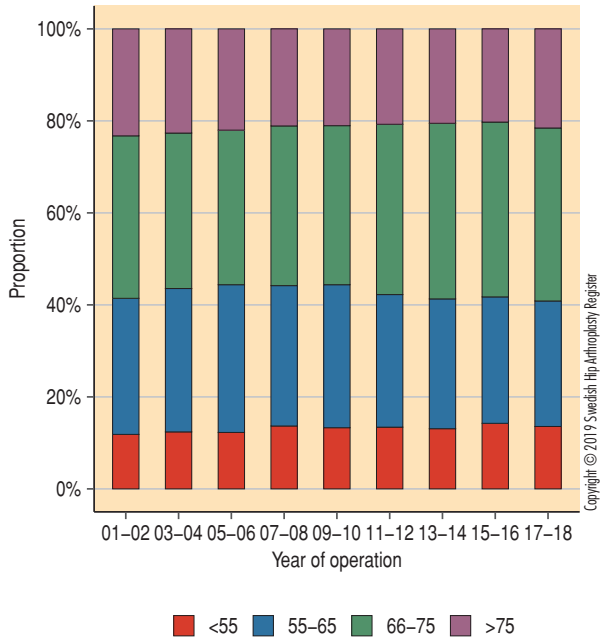


Figure 3.3.3a. Agedistribution divided into four age groups for men, presented by 2year intervals for the period 2001-2018.

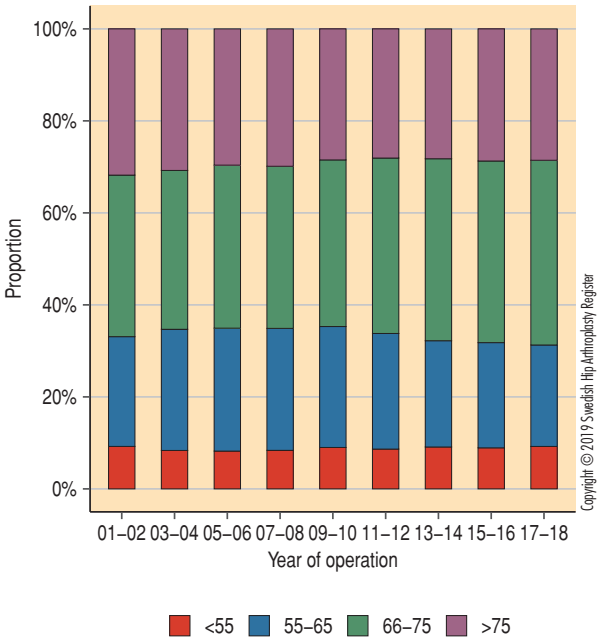


Figure 3.3.3b. Agedistribution divided into four age groups for women, presented by 2year intervals for the period 2001-2018.

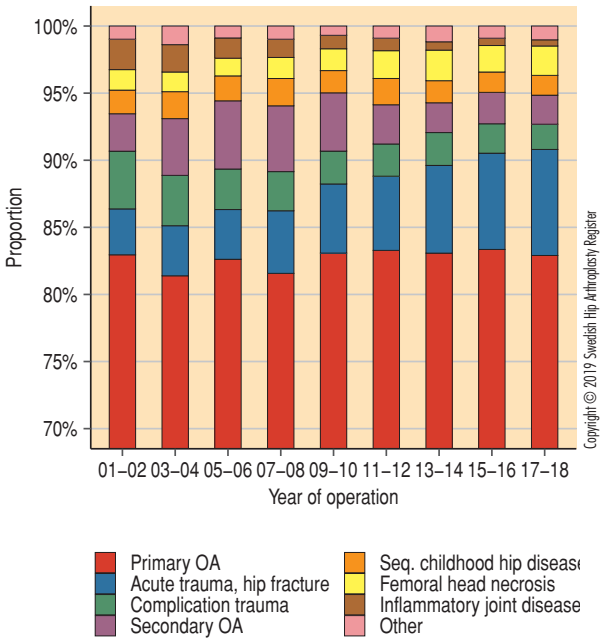


Figure 3.3.4a. The distribution of diagnoses for men, presented by 2year intervals for the period 2001-2018. Note that the y axis does not start at 0%.

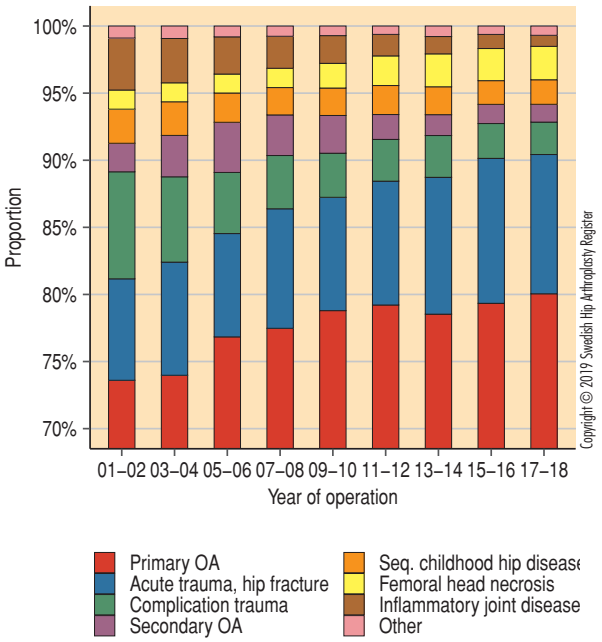


Figure 3.3.4b. The distribution of diagnoses for women, presented by 2year intervals for the period 2001-2018. Note that the y axis does not start at 0%.

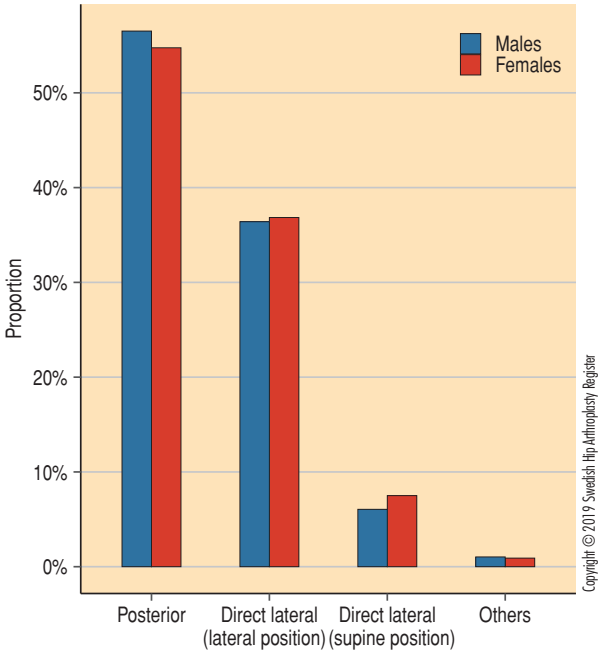


Figure 3.3.5. The distribution of surgical approaches for men and women during 2016-2018.

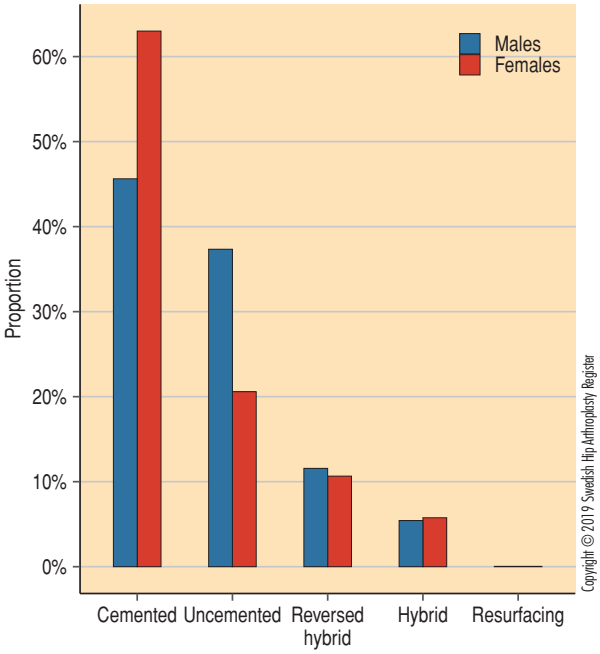


Figure 3.3.6. The distribution of fixation types for men and women during 2016-2018.

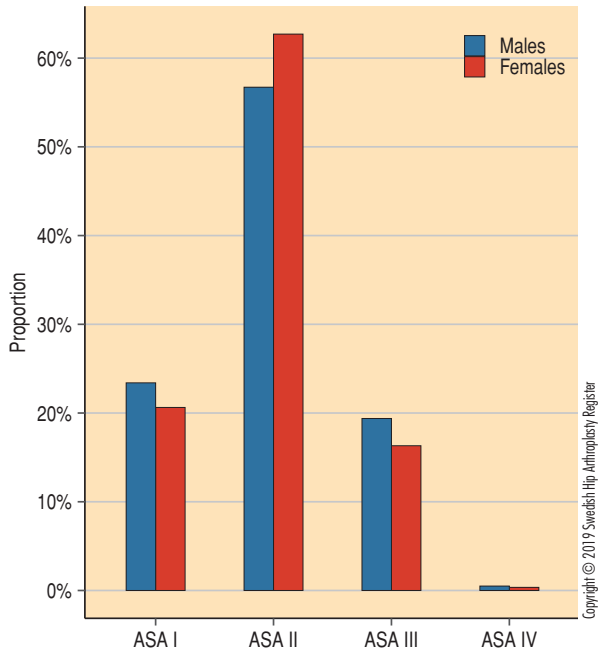


Figure 3.3.7. The distribution of ASA classes for men and women during 2016-2018.

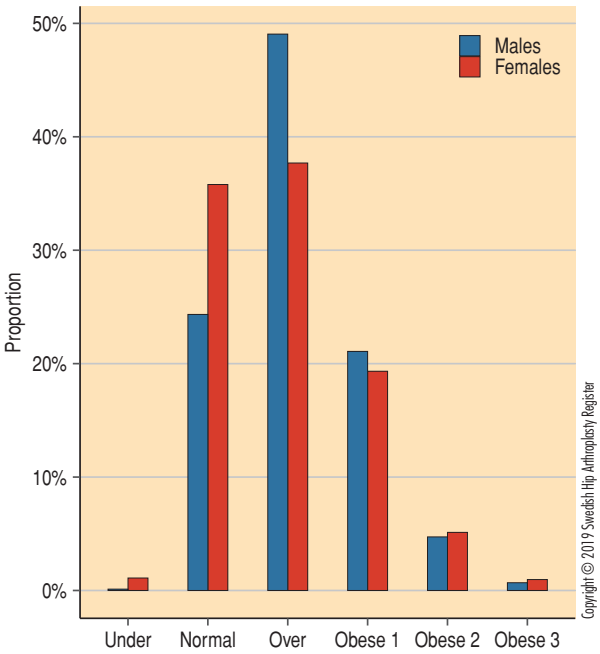


Figure 3.3.8. The distribution of BMI for men and women during 2016-2018. (Underweight is defined by BMI < 18.5, normal weight 18.5–24.9, overweight 25.0–29.9, obese 1 30.0–34.9, obese 2 35.0–399 and obese 3 > 40).

4 Register development, improvement work and research

4.1 40 years with the Swedish Hip Arthroplasty Register

The Swedish Hip Arthroplasty Register turns 40 years. To celebrate the jubilee we arranged a jubilee symposium the 13-14th of June which was attended by almost 130 participants. The jubilee program was very extensive and there were many international participants and speakers. In the evening on the 13th of June, a jubilee dinner was held at the Göteborg Opera. In conjunction with the jubilee, the retirements of Henrik Malchau and Johan Kärrholm were recognized and their outstanding contributions to orthopaedics were praised.

The register began as a pilot project in the mid 70's and in 1979; the registry was established as the world's first national quality registry for hip arthroplasty. Most Swedish orthopaedic units contributed to the pilot. When the registry started, primary total arthroplasties were reported on an aggregated hospital level while the reporting of reoperations was based on personal identity numbers (Swedish: personnummer). In 1992, the routine was changed so that the registration of primary hip arthroplasties also was based on personal identity numbers.

Some years after the start, all units that carry out hip arthroplasty in Sweden had joined the registry. The profession soon learned to appreciate feedback of results and to follow the recommendations of the registry. The first large study with medium and long-term follow-up based on registry data identified several implants with a poorer implant survival, as a result the usage of some implants was stopped (Malchau et al. 1993). The study highlighted the importance of choice of implant and fixation and also showed the importance of systematic monitoring of implant survival in a quality registry.

Annual user meetings

In 1992, we began to arrange annual meetings for contact doctors together with the Swedish Knee Arthroplasty Register. These user meetings have contributed to the communication with the profession and have conveyed recommendations based on our results. We would like to argue that the registry has contributed in fostering generations of Swedish hip surgeons in a tradition of stepwise introduction of new implants and techniques (Malchau 1995). Today, six different stems account for more than 92% of all stem components used in Sweden. Regarding cups, ten different cups make up 82% of the production (Kärrholm et al. 2017).

Platform designer

The registry database was digitised in 1990 and as the first national quality register, we launched a web based system for data input in 1999. The original platform, designed by Roger Salomonsson, was used up to 2017 when we migrated all data to a modern platform designed by the same designer. Today, more than 20 national quality registers use this new generic registry platform that is called Stratum.

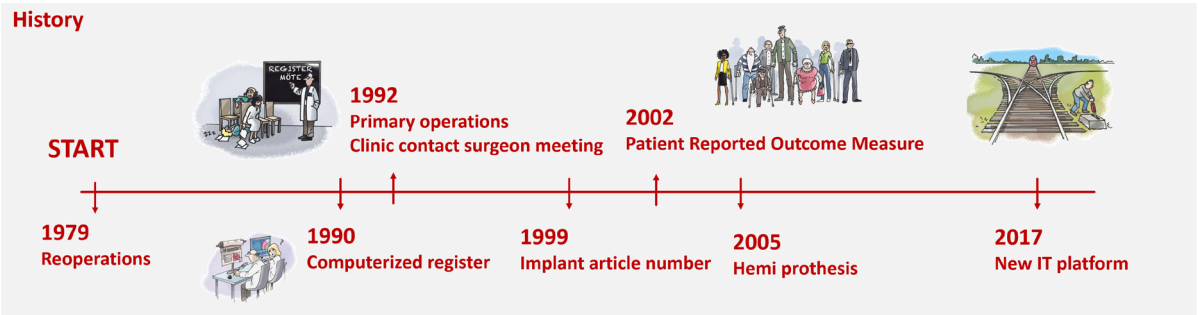
Completeness

Completeness analyses on an individual level are carried out annually through linkage to the Patient Register of the National Board of Health and Welfare since 2006. This is an important step to ensure that the results reflect the whole arthroplasty population and are generalizable.

The completeness rate has been 97-99% for primary total arthroplasties, 93-95% for revisions, and 95-98% for hemiarthroplasties during the last ten years (Kärrholm et al. 2017).

The PROMs-programme

The first twenty years of registry management focused on implant survival as the primary outcome variable. To not be revised with a change of prosthesis or to not be reoperated in any other way is, however, not a decisive indicator of the success of the operation (Söderman et al. 2001, Rolfson et al. 2011). The quality of hip arthroplasty is defined by whether it has helped the patient when it comes to alleviating pain, improving function and health related quality of life. Therefore, the registry started a follow-up program with patient-reported outcome measures (PROMs) in 2002. Göran Garellick led the development and the routine was successively adopted by all hospitals carrying out hip arthroplasties in Sweden. To include PROMs in a national quality register demanded a strict organisational and technological support system to collect this



Professor Henrik Malchau

Professor Johan Kärrholm

large amount of data. The short standardised form contains questions on pain, health status (EQ-5D), patient reported Charnley-category, smoking habits, earlier physiotherapy and patient education efforts. At one, six, and ten-year follow-up the same questions are asked with an additional question on satisfaction with the result of the operation. The response rate has varied between 80-90% during the whole time-period considered (Rolfson et al. 2011).

Results from the PROMs-programme

The PROMs-programme confirms that elective total arthroplasty in Sweden is effective in alleviating pain for most patients and improving health status for patients with degenerative hip disease. Among patients who were operated in 2017, 92% of the patients reported a pain reduction, 83% reported improvement in health related quality of life, and 87% were satisfied with the result of the operation one year after it had taken place. The program has however also identified a small number of patients who have not improved their health related quality of life or that express dissatisfaction with the result of the operation. To investigate this further, we have carried out several studies on PROMs-data. For instance, we have shown that mental health (Rolfson et al. 2009, Greene et al. 2016), other comorbidities (Gordon et al. 2014, Greene et al. 2015), and socioeconomic status (Greene et al. 2014) is associated with patient-reported outcomes. The registry has also identified relationships between surgical factors, such as choice of surgical approach and fixation, and PROMs (Lindgren et al. 2014). Furthermore, we have shown that poor PROMs at one-year follow-up after total hip arthroplasty is a risk factor for a subsequent reoperation (Eneqvist et al. 2018). Registry data has also shown a considerable variation between units; despite adjusting for patient properties, the patient reported outcome varies considerably between different caregivers (Garellick et al. 2015). It is positive that a considerable national trend towards improvement of PROM results has taken place over the last decade (Garellick et al. 2015).

Pioneers in the registration of hemiarthroplasties

Cecilia Rogmark took the initiative and led the work with the inclusion of hemiarthroplasties in the Swedish Hip Arthroplasty Register in 2005. This was yet another pioneering work and there are still very few other hip arthroplasty registries, which encompasses hemiarthroplasties. Due to the well-established routines for data input it was easy for the units to include hemiarthroplasties and the national completeness rate, on a patient level, reached 95% already from the outset (Kärrholm et al. 2018).

The early results indicated that the direct lateral approach was related to a decreased risk for dislocation, which had a dramatic effect on the choice of approach in Sweden (Leonardsson et al. 2012). The exceptionally high usage of cemented fixation for hemiarthroplasties is well supported by our results. Without differences in mortality, uncemented stem fixation has an increased risk of reoperation regardless of reason for the reoperation, a result that is mainly explained by an increased risk of periprosthetic fractures (Leonardsson et al. 2012). We think that these registry findings have contributed in maintaining cement fixation as the method of choice for hemiarthroplasties and thereby have avoided the international trend towards uncemented fixation in this exposed patient group.

Until 2012, hemiarthroplasties were presented separately from the total arthroplasties in the registry reports. Since the annual report for 2012, all hip arthroplasty due to hip fracture or sequelae after hip fracture treatment, regardless of if it was a total arthroplasty or a hemiarthroplasty, have been presented together. The homogeneity of the implant selection is considerable; three stems account for more than 90% of the production (Kärrholm et al. 2018).

Research using the Swedish Hip Arthroplasty Register

During the last decade, we have undertaken a strategic work within the registry to improve the infrastructure in order to increase and strengthen the research activity. This has been successful, which can be noted by the fact that we currently have more than 20 PhD students, representing seven universities, that base whole or parts of their research on data from the registry. Over the last 10 years, 150 scientific articles have been published by the registry, and only during 2018, we held more than 80 presentations in national and international meetings. Since 1986, when Lennart Ahnfeldt defended the first dissertation based on data in the Swedish Hip Arthroplasty Register, an additional 24 PhD students have defended dissertations based on data from the registry.

The future for the Swedish Hip Arthroplasty Register

The Swedish Hip Arthroplasty Register's importance for the hip arthroplasty in Sweden does not depend on individual great discoveries. It is based on continuous in-depth analyses, continuous communication with the profession, and open reporting of results on the unit level. A homogeneous use of well-documented implants and methods have resulted in an outstanding implant survival. These efforts will continue in the future, but will perhaps take a new form.

There are 13 national quality registers with a focus on musculoskeletal diseases today. Enthusiasts within each subspecialty respectively have started each register and the registries have developed largely independently of each other. This has resulted in large differences when it comes to the functionality, data acquisition, and result reporting of the registries. On the one hand, this has pushed the development forward and kept the primary target group, that is health care and hospital personnel, involved in the development of the different registries. On the other hand, the abundance of the registry methods being used makes it complicated for the profession, caregivers, decision-makers, politicians, and patients to use and contribute to the registries. This sectioning is now hindering the development of the full potential of the orthopaedic registries. We have reached a critical point where we are limited by the diversity and realise the potential advantages with consolidation.

Representatives from all the registries of the musculoskeletal diseases have formed a working group and started a consolidation project. The goal is to consolidate the national quality registries of the musculoskeletal diseases into a common organisation with different sub registries. We strive to lay the foundation for a powerful registry-based research environment to improve the quality within the field of the musculoskeletal diseases.

The first important step in the consolidation project is to form a Swedish Arthroplasty Register that combines the Swedish Knee Arthroplasty Register and the Swedish Hip Arthroplasty Register into one register. The steering committees for the two registries plan to commence this new combined Swedish Arthroplasty Register in the beginning of 2020. The two oldest national quality registries in Sweden will make history, once again.

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4.2

Energetic administrator at the Hip Arthroplasty Register for three decades

During her 29 years at the Hip Arthroplasty Register Kajsa Erikson experienced a revolutionising technology development and thanks to the international collaborations of the registry she became an urbane traveller. With unfailing energy, she took on both local and global work assignments.

She soon celebrates her 70th birthday, is petite, smart and fast-paced. When she left the register in spring 2018, she was 68 but she continues to work, now as an administrative support for the operation management of the orthopaedic unit in Mölndal.
- I think it is quite fun. Sometimes there is a little more to do than what you had in mind, but that's okay, she says.

Kajsa Erikson 1991.

It was in May 1989 that she began at the Swedish Hip Arthroplasty Register in Gothenburg. Then the registry had been in existence for ten years and earlier data had been entered in the registry by punching operators in a data central. Now there were personal computers. Kajsa's job consisted in entering information about reoperations, which she had extracted from copies of medical records, in a form on one of these computers.

The journal copies came from the whole country. Primary operations were registered only if the patient had been reoperated, afterwards. The registry office was located in an old and worn-down buildings. Previously it had housed a nursing school at the Sahlgrenska hospital.
- We had to put bath towels in the windows because of the draft, Kajsa says.

Revolutionising internet registration

In 1992, registration of primary operations started in earnest. Units with a computer stored information on a disc that was sent by registered post. Those who did not have a computer sent paper forms instead. It was Kajsa's colleague Marie Hagman, who handled the registration of primary operations at the registry.

In 1999, registration via the internet began. Then administrative personnel at the units could log in to and enter information directly into the registry. This was revolutionising.
- The Swedish Hip Arthroplasty Register was the first register in the world using internet registration, says Kajsa.

The success of the registry when it comes to medical quality attracted international attention and there were study visits from near and far. Kajsa lent a helping hand with the practical arrangements and was also given tasks during the conferences which were organised by the International Society of Arthroplasty Registries. She was also involved in the Nordic Arthroplasty Register Association. There was a lot of travelling to different parts of the world and she got to know the top names with an international reputation in orthopaedics. She liked working at a successful quality register.
- I guess it was the works, that things had turned out so well somehow, that we were a role model and world leading after all.

Close contact with contact secretaries

At home, she continued to enter data on reoperations from copies of medical records. The reoperations are relatively few. It has proven to work best to let few persons at the registry, who know this part well, do the registration. At the same time, she was instrumental in creating a close collaboration with the contact secretaries of the orthopaedic units. They were invited to national meetings every two or three years and training sessions were arranged for new contact secretaries.
- They have many duties in the daily healthcare routine and then they are supposed to register on top of that. This makes it important to tell them that they make a difference, Kajsa says.

Gradually Kajsa had three new colleagues who all worked with the administration of the registry. By chance, they were named Karin all three: Karin Lindborg, Karin Pettersson and Karin Davidsson. The registry changed premises in Gothenburg several times and in 2009 with joint efforts together with the National Diabetes Registry we took the initiative to form Centre

Kajsa Erikson worked as an administrator at the Swedish Hip Arthroplasty Register 1989-2018.

of Registers Västra Götaland. In 2013, a new building on Medicinareberget with a panorama view of Gothenburg was inaugurated.

Monitoring in the north and in the south

Kajsa and her colleagues also travelled around the country and monitored. This meant that they visited selected orthopaedic units and controlled that data in the medical records matched data in the registry. They started by testing the method at Kungälvs sjukhus as it was easy accessible by bus, but later also longer journeys were undertaken. They used to go through all operations carried out a certain year at the unit in question.

- In Lycksele the temperature outdoors was minus 35 degrees. It was a little different but it worked out well in the end, says Kajsa.

She believes the monitoring made a difference, not only as a selective measure, but also because those doing the registration probably shaped up a little when they knew that the job could be checked.

The international involvement has meant a lot to Kajsa, but there is still no place like home. In the autumn of 2018, she broke her arm in Stockholm during icy conditions. She had fractured both the wrist and the elbow but instead of seeking care in Stockholm, she boarded the train back home to Gothenburg and the orthopaedic unit in Mölndal. For three hours, she counted the minutes before the train arrived. However, things worked out in the end, once again.

Charlotta Sjöstedt

4.3 Cooperation between the registries of the musculoskeletal diseases

The national quality registries of the musculoskeletal diseases have taken the initiative, in a joint effort, to deepen the cooperation between the registries. We strive to lay the groundwork for a powerful registry-based research and quality improvement organisation. The specific goals are:

- To harmonise variables and metadata and to standardise data gathering for the national quality registries of the musculoskeletal diseases.
- To develop strategies and tools to introduce new implants, treatments, and other interventions within the field of musculoskeletal diseases.
- To develop a general application to carry out registry-based randomized clinical trials for the musculoskeletal diseases
- To develop and introduce registry-based tools for knowledge management in healthcare.
- To establish methods for identifying the patient's path through the healthcare and monitor the development through the all stages of the musculoskeletal conditions. To identify patients with multiple musculoskeletal comorbidities.
- To create an infrastructure which lays the groundwork for the registry-based research in the musculoskeletal diseases in the future.

Quality register pioneers

The musculoskeletal diseases are the most common reason for care contact in Sweden and the resulting costs of care and diminished work capacity are enormous. Sweden has been a pioneer in establishing quality registries to assess care and treatment of the musculoskeletal diseases. Today there are more than 13 registries connected to the musculoskeletal diseases. These function as completely independent registries without any organisational link to each other. Swedish quality registries today are government funded and each registry carries out its fund requests, activity accounting, and central data controlling responsibility as a separate entity. As each registry is completely independent, there is today no explicit strategy for alignment when it comes to variables, IT platform, data management, and knowledge management to ease research and quality improvement cooperation between registries. The registries of the musculoskeletal diseases are currently scattered on different authorities with central data controlling responsibility. To be able to reach their full potential the registries need to cooperate more in the future.

During 2018, the county councils of Sweden jointly introduced a national system for knowledge management in healthcare (Swedish: nationella programområden (NPO)). To create a common registry organisation for the registries of the musculoskeletal diseases is in good agreement with this initiative.

A common work group

We have established a common work group, which consists of one representative from each quality registry, one project leader, and one representative of the NPO of the musculoskeletal diseases. During a two-year period, we will investigate and prepare judicial, technical, and economical aspects of merging of the registries in one organisation. This work will include research projects involving more than one registry, the development of modules to carry out registry-based randomised controlled studies and method development for knowledge management in practice. The five-year vision is:

- Continued cooperation of registry development.
- Sharing fundamental functions between the registries.
- Having common variable definitions and metadata.
- Having common methods for validation and monitoring of data.
- Making sure there are active expert groups within each registry to ensure development within each sub specialty.
- Having common research and knowledge management tools.
- Share the method for gathering and using PROMs.

Future importance of the initiative

Consolidation of the registries of the musculoskeletal diseases and the implementation of a wide-ranging research infrastructure within the field will improve the healthcare for the patients. The evidence for treatment is today low within large parts of the field of musculoskeletal diseases, the quality and methods differ depending on geographical location in the country.

4.4

At Ortho Center Stockholm quality improvement has top priority

Fewer and fewer patients need a reoperation after undergoing a hip arthroplasty at Ortho Center Stockholm. At the same time, the care has been made more efficient. The work with quality improvement is a top priority and the Swedish Hip Arthroplasty Register a very valuable tool. The unit reports results from the registry on its website.

Here patients and other interested can read that 91% of the patients who have undergone a hip arthroplasty at the unit are satisfied with the result after one year. It also says that the corresponding share for the country as a whole is 85 percent. Chief physician Per-Juan Kernell often discusses quality with his patients. He usually emphasises that the unit operates on healthier patients than many others, but even when taking this into consideration the results are good.

– Quality pays off for all parties. Patients become more satisfied and I think going to work is more fun, he says.

Ortho Center Stockholm carried out 739 hip arthroplasties in 2018. The operations take place at Löwenströmska sjukhuset in Upplands Väsby. According to the contract with Region Stockholm, the unit should only operate on patients who apart from the hip are healthy otherwise or patients with a well-controlled diabetes or a well-controlled blood pressure. The idea is that these less severe cases can be operated on at a slightly lesser cost outside of the large hospitals, which have access to intensive care and other resources. The contract also stipulates that Ortho Center account for the cost of eventual complications, which arise within two years after a hip arthroplasty. If there is a suspicion of an infection, Ortho Center is not to carry out the reoperation, instead it is carried out at another hospital that sends the bill to Ortho Center. This is of course a strong incitement to keep a high quality level.

– If we do not provide high quality care in the end, then we are out of business. If we would get a big wave of revisions, then the costs would bring us down, says Per-Juan Kernell.

The same doctor through the whole process

An important part of the quality work is that the patient responsible doctor takes care of the patient through the whole care period. The doctor who inserts a hip prosthesis also meets the patient before and after the operation.

– I never try to push away the eventual problems of this patient to somebody else. It is my patient and I feel a commitment and a drive. I have a responsibility to pull this through, says Per-Juan Kernell

Ortho Center Stockholm has carried through several improvement programs over the last years. Among other things, the objective has been to shorten the hospital stay after hip arthroplasty. Three years ago, the average hospital stay was 2.7 days. Now it is 1.1 days. All parts of the care have been streamlined. The information to the patients is key. They should know what is to be expected and how to behave to get the best result.

It is also important that the patients are well prepared medically. For example, blood counts and blood pressure should be as good as possible before the operation.

– Patients who are optimised before the operation experience less complications and infections, says Per-Juan Kernell.

Per-Juan Kernell

The optimised patients have more blood available. That decreases the need for blood transfusions. The unit has also developed the surgical technique that is being used and is more thorough when it comes to the haemostasis. This has also led to a diminished need of blood supplementing. At present, one bag of blood is administered per month compared to several bags per week earlier.

The registry leads the way

Ortho Center Stockholm has its own registry and patient questionnaires used in quality work, still the Swedish Hip Arthroplasty Register is a very important tool.

– Each year it is almost like Christmas when the annual report of the registry arrives. All the surgeons are genuinely interested in the results and try to understand them. Of course, we compare ourselves with other units, says Per-Juan Kernell

After the arrival of the annual report and the registry's annual meeting for contact doctors at Arlanda has taken place, a meeting is held at the unit. One discusses the results, the international outlook, and the new recommendations of the registry.

– We listen to what the registry says and change our policies. We are aided in the decision-making on the way forward for our company.

Charlotta Sjöstedt

4.5 Adverse events after hip arthroplasty

Martin Magnéli

Martin Magnéli defended his dissertation "Adverse events following surgery of the hip" the 16th of May 2019. The largest study of the dissertation is carried out in cooperation with the Swedish Hip Arthroplasty Register and is the basis of three out of four papers.

The English term "adverse event" is common within patient safety research and in Swedish, it is translated into care injury and if it is "preventable care injury". The terms complication and adverse events are used also in Swedish. In the Patient Safety Act, care injury is defined as suffering, bodily or mental injury or illness, and death that could have been prevented if adequate measures had been undertaken during the patient's contact with healthcare.

The VARA-study

The study 'Validation of register data after hip arthroplasty" (VARA) was designed with the aim of validating the measurement instrument for adverse events used by the registry and the so-called "Öppna jämförelser" of the Swedish Association of Local Authorities and Regions. This multicentre study included 2,000 patients selected from the registry. The patients had undergone an operation in some of the four regions Stockholm, Skåne, Västerbotten, or Västra Götaland. Patients who underwent an acute or elective total or hemiarthroplasty were part of the study. The patients were selected by weighted selection. The aim of the weighted selection was to choose patients with a large probability of experiencing an adverse event. Both prolonged hospital stays as well as readmissions are associated with adverse events. That is why we selected patients with a long hospital stay and readmissions. In the same way, patients with a diagnosis code, which indicates different adverse events, for example dislocation of the prosthesis, were selected.

The personal identity numbers of all included patients were linked with the Patient Register of the National Board of Health and Welfare and in that way a time line over the different care contacts of all patients could be created. Medical records from all inpatient care and unplanned outpatient care on hospitals within 90 days after the operation were ordered from the whole country, and a so-called global trigger tool analysis of the medical notes was undertaken. In total, more than 5,000 care events were analysed. All the adverse events that were found were registered and became the basis for the following three papers.

Paper 1, validation and incidence

The registry has reported the frequency of adverse events in the country and for different units in earlier annual reports. This frequency is calculated using the diagnosis codes registered in the Patient Register of the National Board of Health and Welfare and is as a result not based on hip arthroplasty registry data. In case a patient at a care event after the index operation in the Patient Register has a diagnosis code, which indicates an adverse event, this patient is deemed to have suffered an adverse event. Thus, the instrument can only detect adverse events from readmissions. The aim of this paper was to validate this instrument.

The results from the journal review in the VARA-study were compared with the instrument results from the same patients. Sensitivity (the number of patients with an adverse event as indicated by the instrument divided by the number of patients with an adverse event in the review of the medical records) and specificity (the number of patients without an adverse event as indicated by the instrument divided by the number of patients without an adverse event in the review of the medical records) were calculated. The cumulative incidence for adverse events was then calculated, adjusting for the fact that the selection was stratified.

We found adverse events for 59% of the patients. The sensitivity of the instrument was 6% and the specificity was 95%. The incidence for an adverse event within 30 days was 28%, and within 90 days 30%. For the acute patients the 30 day-incidence was 51% and for the elective patients it was 17%. 54% of the identified adverse events had been diagnosed correctly.

The conclusion of this paper is that adverse event following hip arthroplasty is relatively common and a lot more common for those patients who have undergone an acute operation compared to those who have been operated electively, and that the instrument used to measure adverse events cannot measure this with any convincing degree of accuracy.

Paper 2, reports of patients" injuries to the patient injury insurance

The mutual insurance company of the county councils insures all patients in publicly funded care in Sweden (Swedish: Landstingens ömsesidiga försäkringsbolag (Löf)). Orthopaedics accounts for approximately a third of the patients" care injuries (preventable adverse events) that are reimbursed by Löf. This paper investigates what proportion of the patients who suffered a severe preventable adverse event who reported it to Löf and who were reimbursed.

We carried out an investigation of all patients in the VARA-study who had reported a care injury to Löf and compared the results with the results from the VARA-study. Hereby, we could calculate what proportion who had suffered a preventable adverse event who reported it and who as a result were reimbursed in the population.

Seven percent reported a care injury and were reimbursed by Löf. A patient who had undergone an elective operation had a 60 times higher probability of being reimbursed compared to those who had undergone an acute operation. Infection of the prosthesis was the most common reason for a reimbursement and 24% of those with an infection of the prosthesis were reimbursed. 58 out of 62 reports of a care injury in the study resulted in a reimbursement from Löf.

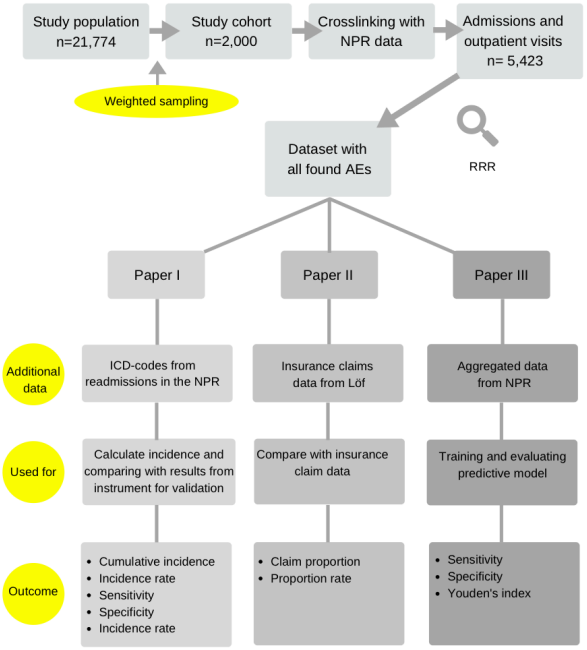
The conclusion of this paper is that only a fraction of the patients who suffer a severe preventable adverse event report this to Löf.

Paper 3, a new model for measuring adverse events

In the first paper of the VARA-study, an instrument for measuring adverse events based on diagnosis codes was validated. It turned out that only 54% of the identified adverse events had a correct diagnosis code. Diagnosis codes are among other things used for economical compensation. Caregivers choosing the diagnosis code that gives the best economical pay-off is a known phenomenon. The aim of this paper was to develop a new model to measure adverse events after a hip arthroplasty. The idea behind the new model was to be able to base it on administrative data without diagnosis codes.

The data set from the VARA-study was partitioned in a training set and a validation set. The training data set was used to train a number of different statistical models to classify if a patient has suffered an adverse event or not. The logistic model with so called splines for age, length of hospital stay, number of readmissions, and acute visits had the best precision and was chosen to be tested on the validation data set.

The new model had a higher precision than the one based on diagnosis codes when tested on all patients and on acute and elective cases respectively, both 30 days and 90 days after operation. It also had a better precision when measuring all adverse events, avoidable adverse events and severe avoidable adverse events.



The conclusion of this paper was that the new model has a higher precision, and that the variables used are easy to measure and stable.

4.6 Summary of dissertation "Clinical results after hip fracture – with special focus on hip arthroplasty"

Susanne Hansson, specialist doctor, scope of practice Orthopaedics, Skånes universitetssjukhus

Approximately a third of all hip fractures in Sweden are treated with some kind of hip prosthesis. Despite hip fracture being a huge problem for people all over the world we do not know enough about the outcome for the patients who have had a fracture of the hip, especially lacking is information about what the patients think themselves. Many studies have focused on the surgical outcome and less attention has been given the investigation of the medical complications, which can afflict patients after the operation. The real incidence of complications after a hip fracture operation has not been enough studied.

Dislocated fractures of the femoral neck are generally treated with an arthroplasty, either a hemiarthroplasty or a total arthroplasty. The advantage with a hemiarthroplasty is that the head is larger compared to a total arthroplasty, and thereby the risk of dislocation is reduced. The operating time is also shorter, which decreases the blood loss compared with a total arthroplasty. On the other hand, the head in a hemiarthroplasty articulates directly against the patient's own cartilage, which increases the risk for so-called erosion. In some studies, total arthroplasties have been shown to give a better function compared to hemiarthroplasties and the patients with a total prosthesis have been more satisfied, while in other studies any difference has not been shown.

The first paper in Susanne Hansson's dissertation is based on all patients who have undergone operation due to hip fracture, regardless of the type of fracture and operating method, at Skånes universitetssjukhus in Malmö during one year. The other three papers are based on data from the Swedish Hip Arthroplasty Register. In paper III and IV the data in the Hip Arthroplasty Register was linked to the data in the Patient Register of the National Board of Health and Welfare, and with the data in the LISA database of Statistics Sweden. Based on the existence of specific diagnosis codes and measure codes in the Patient Register, complications after hip arthroplasty due to hip fracture could be studied. Information on income, education, and marital status was collected from Statistics Sweden to be able to compare the patients in a better way.

The papers of the dissertation

In the first paper of the dissertation, medical records were re-

viewed. Information on medical complications (for example pneumonia or myocardial infarction) within six months after the operation, and complications of the hip (for example deep infection of the prosthesis or dislocation) within the first year was gathered. Information on patient reported outcome was gathered through a form, which was sent to the patients after one year.

Most patients reported that they were satisfied with the outcome after one year, but that they still had moderate pain in the hip. Only a third thought they had been offered enough rehabilitation and only a third reported that they had regained the function they had before the hip fracture. This goes against the aim of the healthcare that all patients with a hip fracture are to regain their previous function. The risk of remaining pain after one year, and decreased satisfaction with the result of the operation was associated with the existence of some kind of complication, both medical and hip complications. Only the incidence of medical complications, not age or how severe the fracture was, was associated with a poorer function after one year.

Papers II-IV compared total arthroplasty with hemiarthroplasty according to different models. Patients with a total prosthesis had a lower risk for reoperation and medical complications but a higher risk for complications of the hip. Patients with a total prosthesis also had lower mortality. That a total prosthesis means a higher risk of complication of the hip may be explained by the higher risk of dislocation. The patients having a hemiarthroplasty are often older and frailer. Despite efforts to adjust for this, the differences when it comes to medical complications and mortality may depend on the fact that the patients with a total prosthesis are more vital. This can be difficult to measure in a registry but is evident for the doctor who meets the patient and decides which type of prosthesis the patient should have.

Some form of complication had afflicted half of the patients in the third paper. One third were afflicted by a medical complication and one fifth by a complication of the hip. The same patient could be afflicted by several complications. The most common medical complications were cardiovascular disease, lung disease, and urinary tract infection. The most common complications of the hip were femoral fracture, infection of the hip, and dislocation.

All in all the total prosthesis seems to function better than the hemiprosthesis when treating hip fracture, but a just comparison of the two types of prostheses is hard to perform. A complication after a hip fracture has a large impact on the outcome. That is why it is just as important to improve the general care of patients with a hip fracture, as it is to optimise the treatment choice.

4.7 Patient-reported outcome measures in patients who have undergone hip arthroplasty and lumbar spine surgery

Ted Eneqvist

The spine-hip dilemma

Normally both hip arthroplasty carried out due to osteoarthritis in the hip and lumbar spine surgery due to spinal stenosis are favourable procedures with an improved health related quality of life, less pain, and satisfied patients after each surgical intervention respectively. There is however one group of patients who both have symptoms of osteoarthritis in the hip and spinal stenosis in the lumbar spine at the same time. Symptoms of osteoarthritis in the hip and spinal stenosis of the lumbar spine can be similar, which can make it difficult to sort out from where the patients" main symptom stems. This is usually called the "spine-hip dilemma", and is surprisingly common. These patients may need both hip arthroplasty and lumbar spine surgery with a varying time between each procedure. The results after hip arthroplasty and lower back surgery in this patient group have been investigated to a relatively limited extent. When there is a degenerative disease in both the hip and the lumbar spine it is disputed which operation to begin with.

In Ted Eneqvist's dissertation "The clinical utility of patient-reported outcome measures in total hip replacement and lumbar spine surgery", which was defended in June 2018, the patient reported outcomes for the patients who have undergone both these procedures are investigated.

The first paper compared patient-reported outcome after hip arthroplasty due to osteoarthritis between those who had undergone an earlier operation in the lumbar spine due to spinal stenosis and those who only had undergone an arthroplasty. Those patients who had undergone both lumbar spine surgery and hip arthroplasty had a poorer health related quality of life, more pain, and a reduced satisfaction after the hip arthroplasty compared to the patients who only had undergone an arthroplasty.

In paper two, the reverse scenario was investigated. The outcome after lumbar spine surgery due to spinal stenosis in patients who had undergone an earlier hip arthroplasty due to osteoarthritis are compared to patients who only had undergone lumbar spine surgery. The results showed that patients who first had undergone an arthroplasty and then underwent lumbar spine surgery had more back pain than patients who only had undergone back surgery. Regarding health-related quality of life, bone pain, or satisfaction with the lumbar spine operation the results were similar between the groups.

Overall patients who have undergone both hip arthroplasty and lumbar spine surgery risk to not improve in the same way

as the patients who only have undergone hip arthroplasty or lumbar spine surgery. The knowledge of this is important to pass on to the patients prior to an eventual operation in order to create the right expectations on the result of the operation.

In paper three patient-reported outcome in patients who had undergone both hip arthroplasty and lumbar spine surgery, where the procedures have at most been two years apart in time, were investigated. Those patients who underwent lumbar spine surgery before hip arthroplasty reported a better outcome than those where the order in time of the operations was the other way around. A time-period of two years was chosen to increase the probability that the patients had problems both with the hip and the back at the time of the first operation. It is more common that the patients start with lumbar spine surgery and continue with hip arthroplasty than the other way around, which may be signalling that hip arthroplasty may have a protective effect and reduces the need of a future operation of the lumbar spine. These patients had clearly improved only after the second operation, regardless of which operation that came first, which suggests that they were in need of both procedures. It is probably impossible to create a golden rule for where surgery should start, since so many factors affect which order is the most advantageous for each patient. An algorithm for decision support has been created to facilitate the decision on where surgery should begin. It is important to inform these patients that there is a risk that they have a future need of surgery in both the hip and the lumbar spine.

Prediction of patients with an increased risk of reoperation

Complications after hip arthroplasty are relatively rare and few patients need a reoperation after a hip arthroplasty. Because of this and that the number of hip arthroplasties increase successively; the need for follow-up with a doctor visit after each hip arthroplasty has been questioned. As a result, many caregivers have started to abandon routine follow-ups after hip arthroplasty, both nationally in Sweden but also internationally. There is a small group of patients who need a reoperation due to, for example, infection, loosening of the prosthesis, or that the prosthesis is dislocated. Earlier studies have shown that patient-related and surgical factors such as age, gender, and type of implant, are the factors which affect the risk of reoperation the most. Recently, studies have shown that also patient reported outcome measures after operation could predict the risk of reoperation.

When it comes to whether patient reported-outcome measures one year after hip arthroplasty could predict the risk for the future need of a reoperation, data shows that the degree of hip pain and satisfaction were the factors which affected the prediction of the risk for a future reoperation the most. The model that was constructed had a moderate ability to predict the risk of a future reoperation. There is a possibility to increase the predictive power of the model by incorporating additional variables. Using this type of model it is possible to create an application that automatically reads-off registry data and identifies patients who have a higher risk of needing a reoperation. These patients could be offered follow-up and a closer contact with their orthopaedic unit. In that way preventive measures could be taken earlier, reducing the suffering of the patient, and saving public resources.

Could a change from EQ-5D-3L to EQ-5D-5L give a better view of the patient-reported outcome after hip arthroplasty?

Ever since the Swedish Hip Arthroplasty Register started to register patient reported outcome measures in 2002, the PROM-instrument EQ-5D-3L has been in use. This is the most common PROM-instrument and it is used in large parts of the world. EQ-5D-3L is a so-called generic instrument and it can be used to measure the outcome after several different interventions such as hip arthroplasty, diabetes, heart failure, and more. Recently, the instrument has been criticised for not being able to describe a moderate impact on health status, which makes it difficult for the instrument to measure small changes over time for interventions with good results such as for example hip arthroplasty. When patients report that they do not have any problems in the five dimensions that the questions relate to even when their health status could be moderately affected, it is called a ceiling effect and is clearly visible among those who have undergone a hip arthroplasty. Therefore, it can be hard to separate those who have recovered completely and those who have moderate residual symptoms or other health issues, by using EQ-5D-3L. A new instrument, EQ-5D-5L has been developed in order to describe the outcome after an intervention in a more nuanced way.

When patients have reported outcome both in the new and in the old version of EQ-5D, before and after hip arthroplasty, the outcome is described in a more nuanced way and the ceiling effects are reduced with the new version. A template has been created to translate the old results to the new version, which makes analyses over time possible.

Summary

- Patients who undergo both hip and lumbar spine surgery have poorer patient reported outcome than those patients who only undergo one of the procedures.
- The patients who undergo lumbar spine surgery before hip arthroplasty have better patient-reported outcome after the last operation compared to those patients who undergo hip arthroplasty and then lumbar spine surgery.
- Patients with symptoms of both spinal stenosis and osteoarthritis of the hip need both hip arthroplasty and lumbar spine surgery to achieve good results.
- It is possible to predict the risk for the need of a future reoperation, using patient-reported outcome measures one year after hip arthroplasty.
- The new version of EQ-5D with five response options on each question is better in describing health-related quality of life in patients who have undergone a hip arthroplasty, compared with the old version with three response options. The correlation between self-assessed health as measured by a VAS (visual analogue scale) and the different health dimensions in the two different versions of EQ-5D follow a logical pattern.

4.8 The uncemented cup – stability, wear, and osteolysis

Volker Otten

During the last 20 years, there has been a massive increase in the proportion of uncemented prostheses. The prosthesis must be stable enough so that the surrounding bone can grow on its surface directly, thereby giving long-term stability. With the aim of improving the initial stability of uncemented cups screws, pegs, or surface coatings with hydroxyapatite (HA), are often used. It is not clear whether these reinforcements with today's prostheses design and material, offer any advantages, or if they even involve risks in the end, such as osteolysis. It is however difficult to detect and quantify osteolysis with ordinary X-rays, but computer tomography (CT) can identify the bone loss and measure its scope.

Prostheses with an increased mobility relative the bone (migration), within 1-2 years after the operation, have an increased risk of loosening. In order to detect, in an early stage, how much wear new prostheses sustain and how easily they are loosened, there is a need for measurement methods with high precision. Radio-Stereometric Analysis (RSA) has been the gold standard, but the method is only available at a few research centres and demands dedicated X-ray laboratories. Olivecrona and co-workers have taken the RSA-principles further with computer tomography, with high precision. However, the new method was not yet validated with RSA. It was important to compare the two methods, since the new technique can be used routinely in the healthcare.

The 12th of April 2019, Volker Otten, consultant orthopaedic surgeon at Norrlands universitetssjukhus in Umeå, defended his dissertation with the title: "The uncemented cup in THA, stability, wear and osteolysis". The dissertation is based on data from a migration study, which compares uncemented cups with and without screws, a methodology comparison between classic RSA and CT-based migration measurement, CT-assisted periprosthetic analysis of osteolysis, and data from the Swedish Hip Arthroplasty Register on uncemented cups.

The following questions were investigated in this dissertation:

1. Does the usage of screws, pegs, and HA affect the stability of the cup or long-term clinical results?
2. Does screw holes in the cup affect the risk of bone loss?
3. Could RSA-migration studies be followed-up with computer tomography without loss in precision?
4. Does registry data show differences in the risk of reoperation in the short or long-term for cups with or without screw holes?

Forty-eight hips (45 patients) from a prospective randomized study were examined 14-17 years after the primary operation. Migration, wear, and bone loss were assessed using conventional X-rays, RSA, and computer tomography.

The first paper showed that screws, pegs, and HA does not improve long-term cup stability and does not affect the wear.

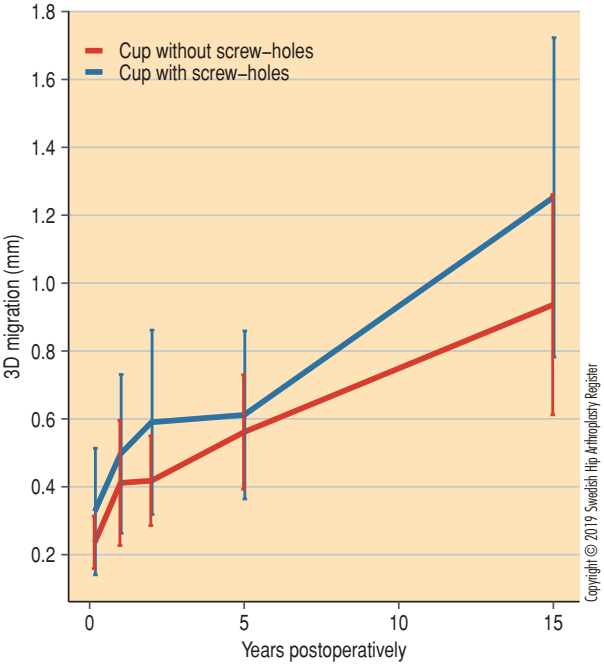


Figure 4.8.1. 3D migration as measured by RSA of uncemented cups with and without screw fixation.

The second paper compared the precision of repeated RSA-examinations and the difference in precision between RSA and computer tomography examinations of migration measurement. Computer tomography and RSA have a similar reliability, and computer tomography may therefore replace RSA in migration studies.

	Rotation (degrees)			Translation (mm)			
	X (Transversal axis)	Y (Longitudinal axis)	Z (Sagittal axis)	X (Transversal axis)	Y (Longitudinal axis)	Z (Sagittal axis)	MTPM
CT vs RSA comparison							
95 % CI	0.96	1.27	0.59	0.38	0.36	0.44	0.61
99 % CI	1.15	1.51	0.70	0.46	0.43	0.52	0.71
RSA double investigation							
95 % CI	0.96	0.88	0.41	0.30	0.11	0.22	0.37
99 % CI	1.19	1.06	0.50	0.37	0.13	0.26	0.45

*Table 4.8.1. Relative motion of the prosthesis expressed in 6 degrees of freedom. The confidence interval (CI) is calculated by "mean of absolute values ± 1.96 * SD" for 95% CI and "means of absolute values ± 2.575 * SD" for 99% CI.*

The third paper investigated the incidence of osteolysis surrounding the cup more closely. On conventional X-rays clear-cut osteolytic changes were detected in 7/48 cases. Computer tomography showed osteolysis in all cases, and three different types of bone defects could be discerned. The bone loss surrounding cups with screw holes appeared greater than around cups with no holes.

	Median	Interval	P-value
Press-fit and press-fit+hydroxyapatite surface coating	3.48	1.21–50.42	0.032[a]
Press-fit+3 screws and press-fit+3 pegs	5.96	1.75–45.66	
Press-fit	2.92	1.83–7.03	0.010[a]
Press-fit+3 screws and press-fit+3 pegs	5.96	1.75–45.66	
All	4.04	1.21–50.42	

Table 4.8.2. The volume (cm^3) of the osteolytic lesion around the cup.

a) Mann-Whitney U Test.

In the fourth paper, the perspective was widened with a registry study to be able to study the risk for reoperation. It turned out that the risk of aseptic loosening of modern uncemented cups was very low and that screw fixation did not offer any advantages during standard operations but rather seemed to increase the risk for reoperation due to other causes.

	Two-year implant survival (95 % CI)		Unadjusted HR (95 % CI)		Adjusted HR (95 % CI)	
Revision of the cup due to aseptic loosening						
Without screwholes	99.9 (99.8–99.9)	p=0,550	0.8 (0.4–1.7)	p=0,551	0.6 (0.2–1.8)	p=0,383
With screwholes	99.9 (99.8–99.9)		1.0 (ref)		1.0 (ref)	
Revison of the cup regardless of cause						
Without screwholes	98.6 (98.4–98.8)	p=0,093	0.8 (0.7–1.0)	p=0,094	0.6 (0.5–0.8)	p=0,002
With screwholes	98.4 (98.2–98.7)		1.0 (ref)		1.0 (ref)	
Revision (cup or stem) regardless of cause						
Without screwholes	98.0 (97.7–98.2)	p=0,092	0.9 (0.7–1.0)	p=0,092	0.6 (0.5–0.8)	p=0,001
With screwholes	97.7 (97.4–98.0)		1.0 (ref)		1.0 (ref)	

Table 4.8.3. Implant survival after 2 years and HR for revision within 2 years after the primary operation. The survivals of the uncemented cup with and without screw holes are compared with a log-rank test. HR is adjusted in a Cox regression model with gender, age, surgical approach, type of stem fixation, HA coating of the cup, size and material of the femoral head, and the design of the femoral head as covariates.

In summary, the results of this dissertation show that reinforcement with screws, pegs, or HA do not increase cup stability. It could be shown that migration and wear measurements on patients who are part of a RSA-study could be made with high precision also using computer tomography. On computer tomography scans it is furthermore, possible to detect three types of osteolysis, and the osteolysis surrounding cups with screw holes is slightly larger than the osteolysis surrounding cups with no screw holes. Finally, data from the Swedish Hip Arthroplasty Register shows that the usage of uncemented cups with no possibility of screw fixation do not increase the risk for reoperation.

5 International perspective on registry work

5.1 International studies

Sweden has several research collaborations with other international registries. For example, we have investigated the differences in mobilizing instructions after hip arthroplasty in a collaboration with the Nordic registries. The article, which has been published in Acta Ortopaedica (Gromov, Kirill et al. "Varying but reduced use of postoperative mobilization restrictions after primary total hip arthroplasty in Nordic countries: a questionnaire-based study"), showed that there, for example, were differences between different Nordic countries when it comes to postoperative restrictions, and that these differences could not be explained by differences in the choice of approach. In Denmark, where the majority of operations are carried out using a posterior approach, 50% of the hospitals reported that they did not apply any restrictions. In Sweden, the corresponding proportion was 38%.

The Swedish Hip Arthroplasty Register was represented at many international meetings during 2018, which among others were organised by the American Academy of Orthopaedic Surgeons, the European Federation of National Associations of Orthopaedics and Traumatology, the International Hip Society, the European Hip Society, and the International Society of Arthroplasty Registries. Researchers and registry co-workers affiliated to the Swedish Hip Arthroplasty Register were represented at these meetings and contributed with scientific presentations.

The growing international collaboration during the last years has had a positive influence both on research, operations, and not least for the patients.

Figure 5.1.1. Collaborations in Sweden and other Nordic countries.

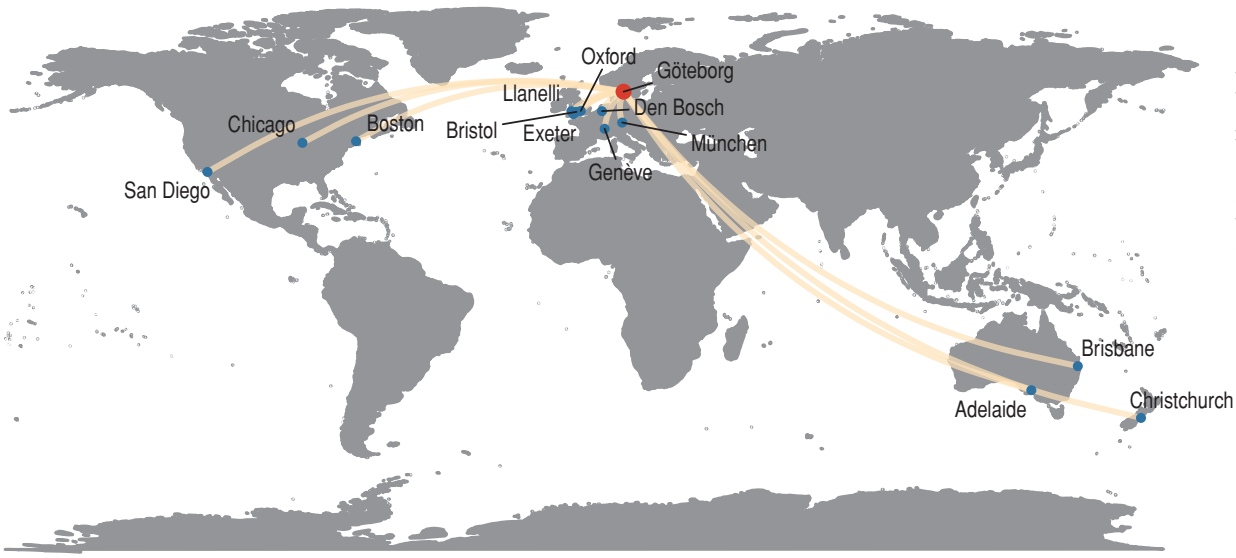


Figure 5.1.2. International collaborations.

5.2 The ISAR-conference 2018

The eighth scientific meeting of the International Society of Arthroplasty Registries (ISAR) was arranged in Leiden, the Netherlands, 1–3 of June 2019. Leiden spans 500 years of history, by being both the hometown of Rembrandt, and the site of IKEA's headquarters. The Swedish Hip Arthroplasty Register contributed with several scientific presentations and invited talks.

The 14th annual meeting of the organisation was held in conjunction with the ISAR-conference. Henrik Malchau was the treasurer for the society and Ola Rolfson was elected president. As a result, both participated in ISARs board meetings during the year.

A good argument for an international cooperation between quality registries is that only 20–40% of the world's joint implants are reported to be satisfactorily evaluated. That is, a majority are launched and used without scientific support for their safety and performance.

The meeting covered methodology and statistical sessions, and scientific presentations on arthroplasty in the knee, hip, shoulder, and ankle, as well as fracture treatment. Organisational issues, such as the International Prostheses Library and early detection of joint prostheses with inferior outcome was discussed. Where the responsibility of identifying and reporting such implants lies is not clear. The industry representative emphasised the responsibility of the manufacturer and spoke about partnership with the registries. Many register co-workers expressed a willingness to inform the public, due to a urge for transparency and to enable an increased patient influence, but also as a professional responsibility as a physician. The registries are, however, not to be regarded as supervisory authorities.

One important session dealt with international frameworks, among others the Medical Devices Regulation (MDR) of the EU. Rob Nelissen, orthopaedic surgeon and registry holder in the Netherlands, is the appointed expert in the Medical Device Coordination Group that includes orthopaedics. This new regulatory framework will hopefully acknowledge registries as a knowledge source evaluating what is called class III-implants. The definition is that such implants support life functions or hinders deterioration of the health, but represent at the same time a potential risk for illness or injury. These implants therefore demand the highest degree of safety control. Among other things, manufacturers are nowadays obliged to send regular safety reports to the regulatory body of the EU. Which function the registries are to have in this system is a question for the imminent future. Already up and running is the Orthopaedic Data Evaluation Panel (ODEP), which in cooperation with the manufacturers monitors how implants work in actual healthcare. On top of that, the individual registries carry out analyses, as for example "New implants" in the annual reports of the Swedish Hip Arthroplasty Register. Within the framework of MDR the manufacturers must also be able to show evidence for that their implants have clinical advantages for the patient during the product's whole lifetime. Post market surveillance will play an even greater role in this system, as the gathering of patient reported outcome. A model where the registries support the industry in defining what "advantage" is supposed to mean could be envisioned. "Incident" also needs a definition – in what way did the implant fail, for which reason, and what was the outcome as regards the patient?

We also discussed how units and surgeons with differing results could be identified. In the UK, mortality rates are now reported on surgeon level, that is a patient can control how many that die after his/her potential surgeon has treated them. What this really says about the quality of the care, compared to the case-mix of patients who are admitted to the surgeon/hospital, would be hard to interpret for the individual. The result regarding reoperations can however be viewed only by the individual surgeon. The interpretation of data is obscured by the fact that it can actually be another doctor who carries out the operation. Younger doctors might operate under the responsibility of a consultant and then the operation is attributed to the consultant. In Michigan, USA, the surgeon has since 2018 access to his/her own data, and can follow if he/she for example gets a better or poorer result (in the form of revisions) after changing to another prosthesis brand. The system has received a positive welcoming.

Finally, we were given some insights into the skeletal problems of Tyrannosaurus Rex, thanks to palaeontologist Anne Schulp. Very interesting!

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6 Primary prosthesis

The information in the primary prosthesis chapter includes operations from year 2000. The Register's report is built upon a large number of analyses. For the sake of clarity, they are not always presented in their entirety. This year's report presents most of the results, such as Kaplan–Meier survival analysis or regression analysis, usually Cox proportional hazard regression. The Kaplan–Meier statistic, which is used in the annual report, describes the proportion of patients, which after a certain number of years, are still alive and have not been affected. Data is presented in proportions, including a 95% confidence interval (C.I.). Regression data is presented with the help of risk ratio (risk ratio, relative risk). Risk ratio describes the degree of increased or decreased probability of the selected outcome (typically revision) compared to the reference group. The risk for the reference group is routinely set to 1.0. If the risk ratio for getting a revision is 2.0, it means that the probability is doubled for the group in question. An increased or decreased probability should be related to the outcome in the reference group. The clinical meaning of a doubled probability has an entirely different significance if in one out of 1000 cases the reference group is revised within 10 years, compared to a reference group, which is revised, by 100 of 1000 cases. In the first scenario a doubling indicates that two hips are expected to suffer a revision in the study group. In the other case, the expected number is 200. Risk ratio is shortened to RR and indicated here with one decimal and a 95% confidence interval (C.I.). The further away the upper and lower limits of the confidence interval are from 1.0, the safer it is to say that the risk for the study group differs from the risk for the comparison group.

6.1 Demographics

During recent years, the number of registered primary prostheses has, more or less, increased by each year. In 2018, 18,629 primary prostheses were reported, which is an increase of 3% in comparison to the previous year. In 2018, the mean age for men was 67.6 years and 70.1 years for women. From 2000 until 2010–2011, average age decreased for both sexes. During the following years the mean age has successively increased until 2017. The same trend is noticeable even when fracture diagnosis is excluded (Figure 6.1.1).

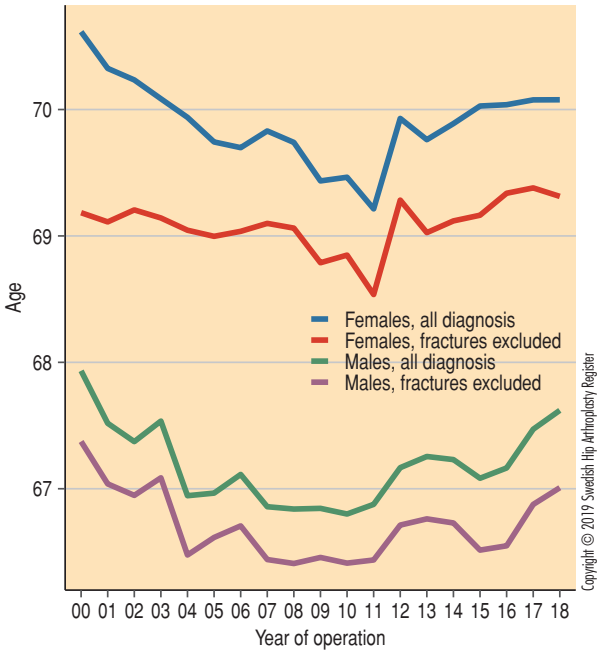

Figure 6.1.1 Trends for mean age.

6.2 Diagnosis

The most common reason for total hip arthroplasty is primary osteoarthritis. Since year 2000, the proportion of patients operated with total hip arthroplasty due to primary osteoarthritis has increased from 75% and was 81% in 2018. Men dominate this diagnostic group while the relative proportion of women is higher in all the major groups of secondary osteoarthritis. The proportion of patients with an inflammatory joint disease has been substantially reduced since year 2000, and in 2018, 0.6% were operated due to this diagnosis. Figure 6.2.1 illustrates the age distribution for the most common diagnosis groups. In general, the mean age at a total hip arthroplasty is higher among women than in men. The only exception is sequelae after hip disease during adolescence (childhood sequelae), where the mean age for both sexes is rather similar.

6.3 BMI and ASA classification

Reporting of Body Mass Index (BMI) and American Society of Anaesthesiology Physical Status Classification System (ASA class) to the Swedish Hip Arthroplasty Register began in 2008. For the first year, there was data for 82% and 90% of cases regarding BMI and ASA, respectively, and reporting has continued to improve. In 2018, BMI was reported in 96% and ASA class in 98% of cases. During the last five years, the mean value for BMI has stayed relatively constant (Table 6.3.1). Possibly, there is a slight tendency towards increasing proportion of patients with different degrees of obesity (BMI ≥ 30). Comparison of BMI between diagnostic groups shows, that overweight tends to be most common in groups with primary osteoarthritis, and normal weight and underweight in groups with fracture (Table 6.3.2). Regarding ASA class, the proportion of healthy patients (class I) continues to decrease as the proportion of patients mainly in class III-V (serious or life-threatening illness) increases (Table 6.3.1). The healthiest patients (according to ASA) can be found in the group with sequelae after hip disease during childhood and the sickest can be found in the group that undergo operation due to fracture (Table 6.3.2). The trend towards an increasing number of patients with higher ASA class over time could partially be explained by the fact that the proportion of patients with fracture is increasing, although it is also possible, that there are other causes like a wider definition of indication underlying this change.

As the various diagnostic groups differ, for example, with respect to age, these groups also have different distribution of BMI and ASA class. The highest mean value for BMI can be found in the group with primary osteoarthritis and the lowest in the fracture group. The highest proportion of patients with ASA class III/IV can be found in the fracture group, and the lowest proportion in the group with sequelae after hip disease during childhood.

Distribution of BMI and ASA classification

selected diagnosis groups

	Primary osteo-arthritis, %	Acute trauma, hip fracture, %	Idiopathic necrosis, %	Complication or sequelae after fracture or other trauma, %	Sequelae after childhood disease in the hip, %	Other, %
BMI						
Underweight < 18.5	0.6	5.3	1.8	5.7	1.9	2.1
Normal weight 18.5–24.9	30.4	51.7	35.1	53.4	32	40.6
Overweight 25–29.9	42.9	33.5	32.3	29.4	38.5	35.3
Obesity class I 30–34.9	20.4	7.6	18.9	8.3	17.7	17.8
Obesity class II–III 35+	5.5	1.7	10.9	3.1	9.6	4.1
ASA classification						
Healthy (I)	21.7	9.6	14.6	12.2	38.2	16.7
Mild systemic disease (II)	60.8	51.7	54.7	46.2	52.3	47.7
Serious/lifethreatening systemic disease (III–V)	17.5	38.7	30.8	41.6	9.5	35.6

Table 6.3.1

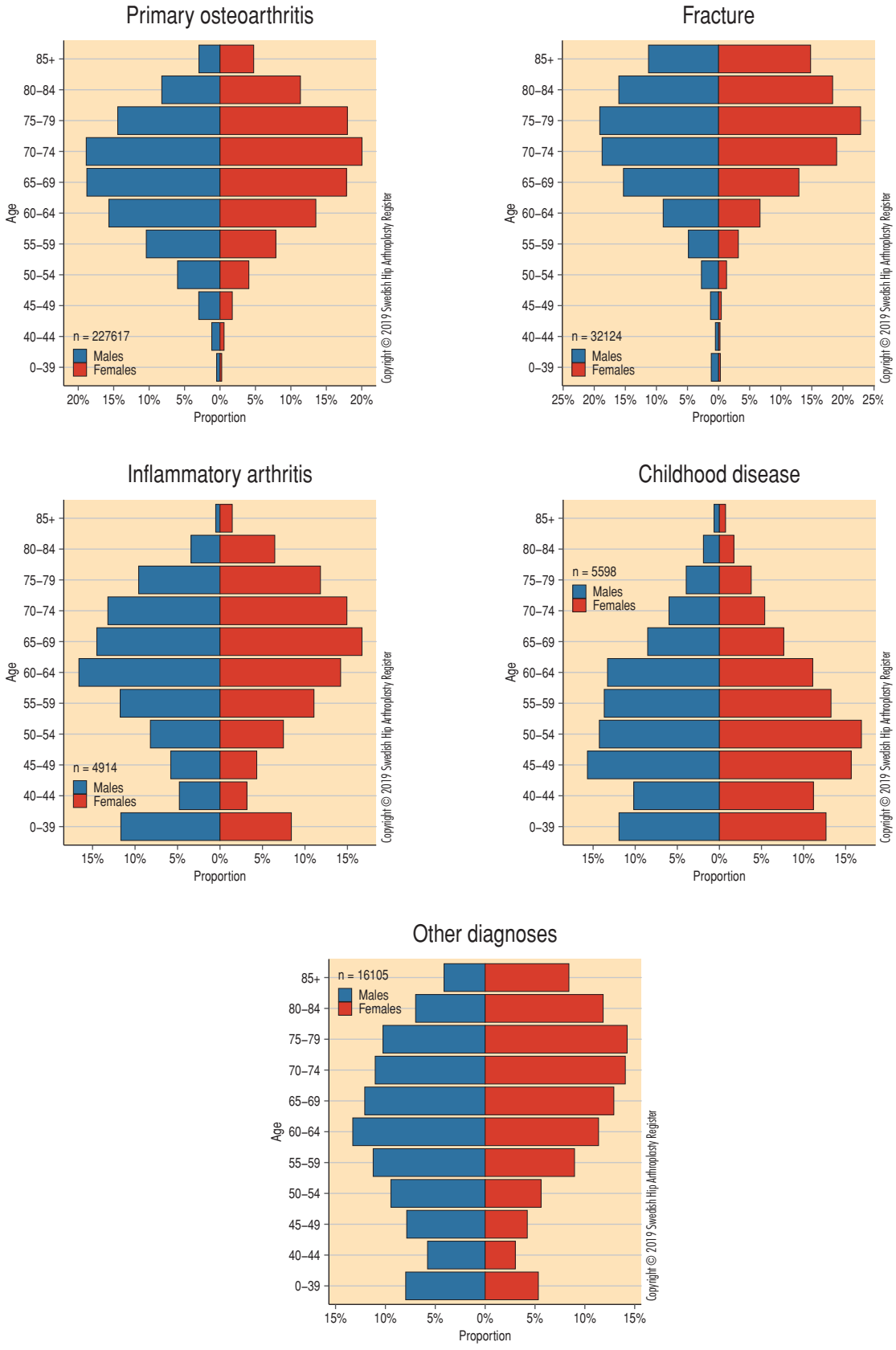

Figure 6.2.1. Age and gender distribution for different diagnosis groups.

Time trends BMI and ASA classification selected years

2014–2018

	2014	2015	2016	2017	2018
BMI					
Existing observations/missing observations					
Men	16 563/818	16 633/600	17 266/578	18 148/540	18 629/681
Women	16 563/818	16 633/600	17 266/578	18 148/540	18 629/681
Average – median					
Men	27.5–26.9	27.6–27.1	27.7–27.2	27.5–27.1	27.6–27.2
Women	26.7–26.1	26.7–26.1	26.7–26.1	26.8–26.2	26.8–26.2
Underweight < 18.5					
Men, %	0.4	0.5	0.3	0.3	0.3
Women, %	1.7	2	1.8	1.6	1.8
Normal weight 18.5–24.9					
Men, %	27.6	26.2	26.8	26.9	26.5
Women, %	38.1	38.2	38.2	37.5	37.7
Overweight 25–29.9					
Men, %	48.2	48.8	47.4	48.3	48
Women, %	37.1	36.7	36.9	36.8	36.4
Obesity class I 30–34.9					
Men, %	19	19.7	20	19.5	20.2
Women, %	16.9	17	17.8	18.3	18.1
Obesity class II–III 35+					
Men, %	4.6	4.8	5.3	4.7	4.8
Women, %	6	6	5.1	5.7	5.7
ASA classification					
Existing observations/missing observations					
Men	16 563/352	16 633/234	17 266/189	18 148/183	18 629/325
Women	16 563/352	16 633/234	17 266/189	18 148/183	18 629/325
Healthy (I)					
Men, %	23	23.4	22.5	21.6	21.8
Women, %	20.8	19.9	19.4	18.8	19.3
Mild systemic disease (II)					
Men, %	56.4	55	55.6	55.6	55.5
Women, %	60.2	60.3	60.4	61.8	61.6
Serious/lifethreatening systemic disease (III–V)					
Men, %	20.6	21.6	21.9	22.8	22.7
Women, %	18.9	19.8	20.2	19.4	19.2

Table 6.3.2

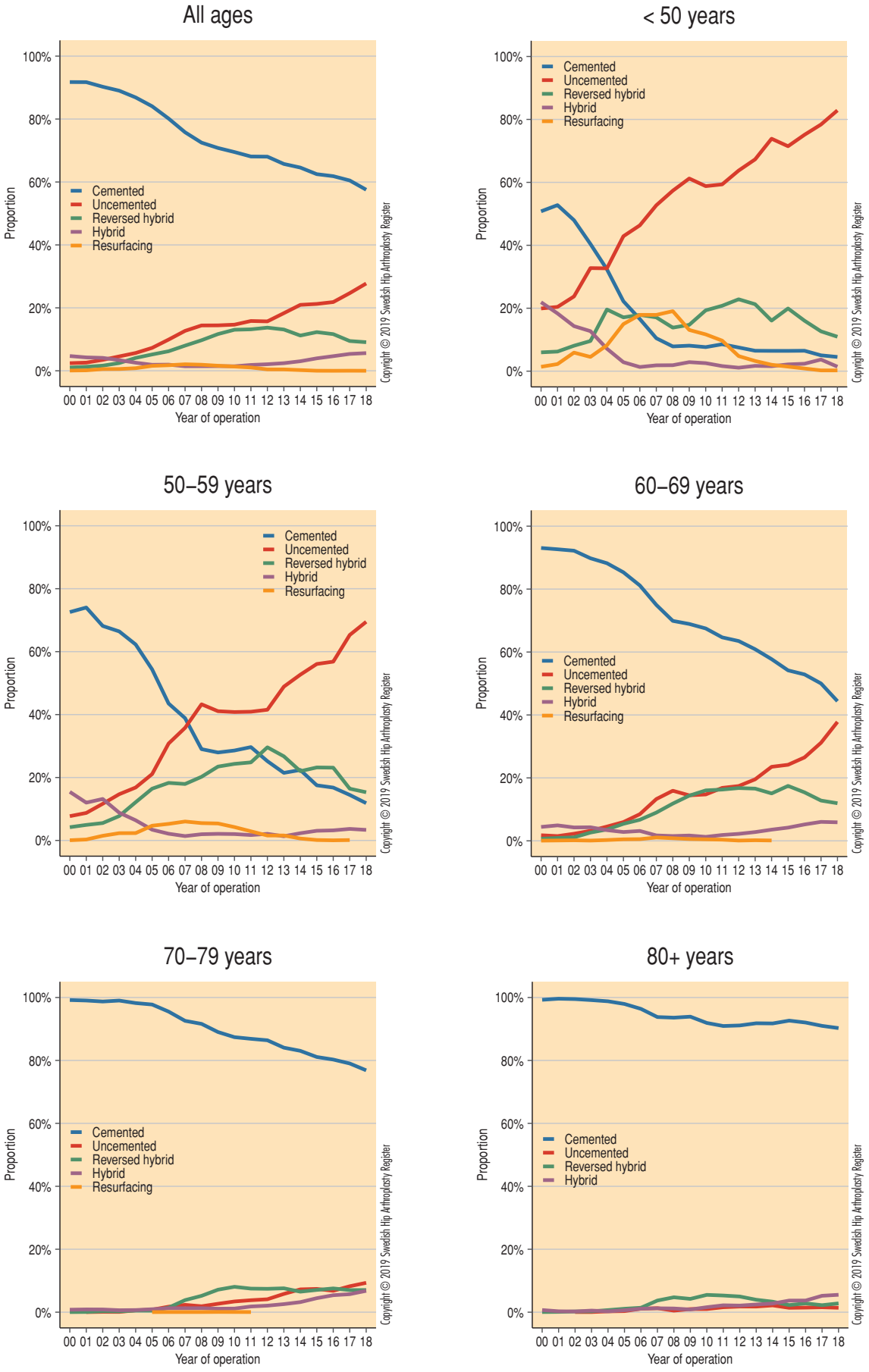

Figure 6.4.1 Trends for fixation methods.

6.4 Prosthesis selection

Cemented fixation is more common in Sweden than in other Scandinavian countries. Poor results with uncemented fixation during the 1990s resulted in completely cemented fixation reaching a peak of 93% at the turn of the millennium. Hereafter, cemented fixation has declined every year (Figure 6.4.1). During 2018, the proportion of cemented prostheses was 57.5%. Completely uncemented fixation has instead be-come increasingly common. In year 2000, completely uncemented prostheses accounted for 2.4% of all cases. The corresponding proportion in 2018 was 27.7%. The increase of uncemented fixation has mainly taken place in patients younger than 60 years but also in patients who are 60 and older. Since 2012, the proportion of hybrid prostheses (cemented cup, uncemented stem) has decreased. The proportion of hybrid prosthesis (uncemented cup, cemented stem) has been small during a 10-year period and increased during 2007–2010 to about 1.5%. Subsequently, a slow increase has occurred, up to 5.6% in 2018. The increased usage of uncemented implants in Sweden, especially among patients older than 70 years, may be seen as remarkable as existing data from several international registers do not support use of uncemented fixation for this patient group. One can speculate that increased demands on production and the fact that uncemented fixation often is regarded as demanding less resources in the form of operating theatres might be a partial explanation of this phenomenon. If the hypothesis is true, as surgeon one should take other factors in consideration, such as increased risk of periprosthetic fractures and increased risk of dislocation when using uncemented fixation. One may assume that these factors, in their turn, lead to an increase in resource use.

Resurfacing prostheses were used two times during surgery in 2018. In a discussion during the Swedish Hip and Knee Association's annual meeting, in the fall of 2018, there was a consensus among present members that the scientific evidence for the benefit of resurfacing prostheses is lacking. In combination with the problems that have been reported when resurfacing prostheses have been used, this is the basis for the association's recommendation that resurfacing prostheses should not be offered, with the exception for use in clinical studies.

In the absence of data supporting the use of uncemented implants in elderly patients, the use of such implants in patients older than 70 years should be limited.

6.5 Most commonly used prosthesis

In 2018, five of the most popular cemented cups accounted for 91.9% of the total number of cemented cups inserted in Sweden. Regarding stems, Lubinus SP II, Exeter and MS 30 are the dominating implants. Together they constitute more than 98.7% of all cemented stems. Selection of uncemented cups shows a greater variation, five typical uncemented cups accounted for 67.5% of the total. The proportion of cups with trabecular coatings continues to increase. Given the uncertainty, which arose when individual studies reported on formation of radiological zones around certain cups with trabecular titanium coating, and on an increased risk for dislocation for trabecular tantalum cups, in the register, we would once again like to urge

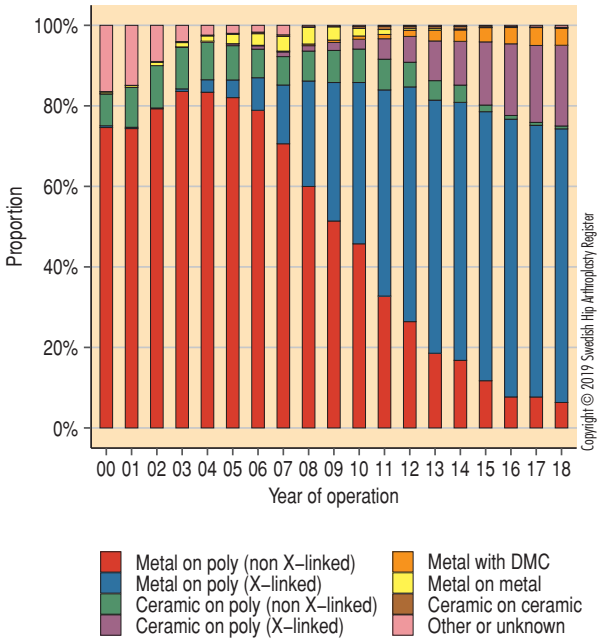

Figure 6.6.1 Trends for articulation.

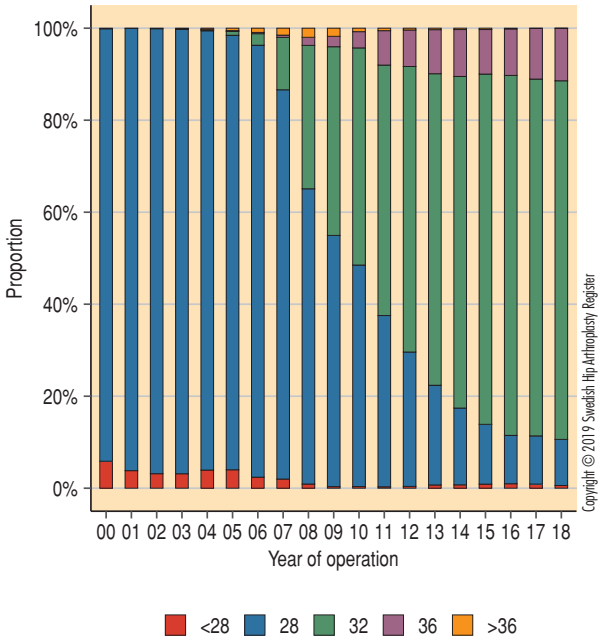

Figure 6.6.2 Trends for femoral head size.

caution when using trabecular cups if other options are feasible. According to a newly published study, the risk of dislocation was less when an elevated liner was used for patients with trabecular tantalum cups. Diversification is more pronounced among cups compared to uncemented stems. Since 2009, the Corail stem has been the most commonly used uncemented stem. The Corail stem was accounted for 38.6% of all uncemented stem designs reported to the register during 2018.

6.6 Articulation

For uncemented cups, almost exclusively highly cross-linked polyethylene liners are being used (98,3% of all operations in 2018). As regards cemented cups, highly cross-linked polyethylene was used in 82.9% of cases during 2018. The proportion of cups with highly cross-linked polyethylene continues to increase (Figure 6.6.1). During 2018, highly cross-linked polyethylene was used in 88% of all hip replacement procedures. The combination of ceramic femoral head–ceramic insert also shows a small increase, from 19.1% in 2017 to 20% in 2018. Femoral heads with a diameter of 32 mm are used more often. The proportion of femoral heads with 36 mm diameter was 11.4% during 2018. The trends regarding the choice of the different articulations and head sizes are visualized in Figures 6.6.1 and 6.6.2.

6.7 Implant combinations

The most common implant combinations are presented in tables 6.7.1-6.7.7. In the cemented group, the use of the combination of Lubinus SP II stem and Lubinus cup is most common. In the uncemented group, the combination of Corail-Pinnacle and W/Gription 100 is increasing. There are also changes in the group for reversed hybrids and hybrids. With several of these combinations, implants from different manufacturers are used. This practise has developed over a long time, although it is not recommended by most of the manufacturers. There is also long-term data for several of the implant combinations that have proven to function well. On the Swedish market, there are many manufacturers/importers that provide cups only from a specific manufacturer, but do not provide a stem from the same producer.

6.8 Surgical approach

Since 2005, posterior approach in lateral position and direct lateral approach in supine or lateral position have dominated in Sweden. During 2018, one of these surgical approaches was used in 98.6% of performed total arthroplasties. The posterior approach in lateral position is still the most common (54.4%). Direct lateral approach on the lateral position was used in

15 most common implants

Cup (Stem)	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Lubinus x-link (SPII standard)	4 617	3 080	4 021	4 595	4 588	4 681	20 965	24
Exeter Rim-fit (Exeter standard)	3 382	1 598	1 651	1 647	1 534	1 629	8 059	9.2
Lubinus (SPII standard)	64 517	2 316	1 448	1 024	1 087	1 018	6 893	7.9
Marathon (Exeter standard)	5 718	1 088	1 002	937	945	796	4 768	5.5
Pinnacle W/Cripton 100 (Corail standard)	143	248	342	493	918	1 153	3 154	3.6
ZCA XLPE (MS-30 polished)	7 028	524	740	358	235	258	2 115	2.4
Exeter Rim-fit (MS-30 polished)	518	120	55	477	750	674	2 076	2.4
Avantage (SPII standard)	546	277	297	378	478	516	1 946	2.2
Trident hemi (Exeter standard)	317	154	273	408	505	485	1 825	2.1
Exeter Rim-fit (Corail standard)	160	148	205	330	395	471	1 549	1.8
IP Link (SPII standard)	123	165	222	351	364	319	1 421	1.6
Trilogy (CLS)	3 449	220	223	277	322	324	1 366	1.6
Continuum (CLS)	492	210	194	262	266	247	1 179	1.4
Pinnacle W/Cripton 100 (Corail high offset)	66	123	137	124	266	525	1 175	1.3
Pinnacle 100 (Corail standard)	806	172	177	149	286	239	1 023	1.2
Other	107 237	6 120	5 646	5 456	5 209	5 294	27 725	28.7
Total	199 119	16 563	16 633	17 266	18 148	18 629	87 239	

Table 6.7.1

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common cemented implants

Cup (Stem)	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Lubinus x-link (SPII standard)	4 617	3 080	4 021	4 595	4 541	4 681	20 918	39.3
Exeter Rim-fit (Exeter standard)	3 382	1 598	1 651	1 647	1 524	1 629	8 049	15.1
Lubinus (SPII standard)	64 516	2 316	1 448	1 024	1 083	1 017	6 888	12.9
Marathon (Exeter standard)	5 718	1 088	1 001	937	902	796	4 724	8.9
ZCA XLPE (MS-30 polished)	7 028	524	740	358	235	258	2 115	4
Exeter Rim-fit (MS-30 polished)	518	120	55	477	750	674	2 076	3.9
Avantage (SPII standard)	544	277	297	378	476	515	1 943	3.6
IP Link (SPII standard)	123	165	222	351	364	319	1 421	2.7
Marathon (SPII standard)	361	143	139	172	183	192	829	1.6
ZCA (MS-30 polished)	280	338	216	118	56	39	767	1.4
Contemporary Hoded Duration (Exeter standard)	5 901	187	147	127	200	104	765	1.4
Polarcup cementerad (SPII standard)	197	63	87	81	95	89	415	0.8
Lubinus x-link (Exeter standard)	74	30	30	70	68	68	266	0.5
ZCA XLPE (Exeter standard)	980	100	50	2	0	0	152	0.3
Avantage (MS-30 polished)	47	10	14	35	42	35	136	0.3
Other	60 681	655	263	292	274	300	1 784	2.8
Total	154 967	10 694	10 381	10 664	10 793	10 716	53 248	

Table 6.7.2

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common uncemented implants

Cup (Stem)	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Pinnacle W/Cripton 100 (Corail standard)	143	248	342	493	918	1 153	3 154	15.5
Trilogy (CLS)	3 449	220	223	277	322	324	1 366	6.7
Continuum (CLS)	492	210	194	262	266	247	1 179	5.8
Pinnacle W/Cripton 100 (Corail high offset)	66	123	137	124	266	525	1 175	5.8
Pinnacle 100 (Corail standard)	806	172	177	149	284	238	1 020	5
Exceed ABT Ringlock (Bi-Metric X por HA NC)	503	227	261	233	144	126	991	4.9
Trident hemi (Accolade II)	167	181	146	140	182	179	828	4.1
Trilogy IT (Bi-Metric X por HA NC)	162	169	181	167	127	129	773	3.8
Pinnacle W/Cripton 100 (Corail coxa vara)	26	41	89	94	144	225	593	2.9
Continuum (Wagner Cone)	134	134	110	78	143	124	589	2.9
Continuum (Corail standard)	155	129	152	196	47	22	546	2.7
Pinnacle W/Gription Sector (Corail standard)	7	35	59	77	140	156	467	2.3
Regenerex (Bi-Metric X por HA NC)	345	124	127	131	38	38	458	2.3
Trident AD WHA (Accolade II)	32	101	84	57	81	87	410	2
Allofit (CLS)	1 524	61	80	75	84	104	404	2
Other	13 304	1 295	1 168	1 213	1 217	1 490	6 383	29.9
Total	21 315	3 470	3 530	3 766	4 403	5 167	20 336	

Table 6.7.3

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common hybrid implants

Cup (Stem)	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Trident hemi (Exeter standard)	317	154	273	408	505	485	1 825	46
Pinnacle sector (SPII standard)	5	1	36	56	62	48	203	5.1
Trilogy (SPII standard)	1 218	108	65	13	3	3	192	4.8
Tritanium (Exeter standard)	49	28	31	30	41	62	192	4.8
Trident AD LW (Exeter standard)	34	12	17	29	46	39	143	3.6
Trilogy IT (SPII standard)	0	20	36	22	27	35	140	3.5
Continuum (MS-30 polished)	54	36	22	45	6	1	110	2.8
Pinnacle W/Gription Sector (Exeter standard)	0	9	13	18	26	40	106	2.7
Pinnacle W/Gription Sector (MS-30 polished)	0	0	2	0	25	53	80	2
Continuum (SPII standard)	33	14	8	12	15	25	74	1.9
TMT revision (SPII standard)	32	14	13	9	17	15	68	1.7
Pinnacle 100 (SPII standard)	15	3	23	5	9	16	56	1.4
Pinnacle W/Cripton 100 (Exeter standard)	3	5	5	9	12	22	53	1.3
Pinnacle W/Cripton 100 (SPII standard)	0	6	6	8	17	15	52	1.3
ADES dual mobility (MS-30 polished)	0	2	14	6	12	16	50	1.3
Other	3 030	91	94	131	133	172	621	15.9
Total	4 790	503	658	801	956	1 047	3 965	

Table 6.7.4

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common reverse hybrid implants

Cup (Stem)	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Exeter Rim-fit (Corail standard)	160	148	205	328	375	471	1 527	16.4
Lubinus x-link (Corail standard)	222	118	132	257	211	212	930	10
Marathon (Corail standard)	1 274	224	228	232	94	120	898	9.7
Marathon (ABG II HA)	419	116	141	152	133	71	613	6.6
Lubinus (Corail standard)	1 455	168	136	91	69	69	533	5.7
Exeter Rim-fit (Corail high offset)	46	31	62	76	134	181	484	5.2
Lubinus x-link (Corail coxa vara)	59	33	61	98	128	112	432	4.7
Lubinus x-link (Bi-Metric X por HA NC)	129	95	117	84	74	52	422	4.5
Marathon (Corail high offset)	695	149	127	110	10	21	417	4.5
Marathon (Bi-Metric X por HA NC)	689	97	77	75	49	23	321	3.5
Lubinus x-link (M/L Taper)	34	46	96	85	21	13	261	2.8
Lubinus x-link (Corail high offset)	16	15	30	36	52	69	202	2.2
Lubinus (Corail coxa vara)	498	80	59	9	13	11	172	1.9
ZCA XLPE (Corail standard)	403	47	88	13	0	0	148	1.6
Lubinus x-link (CLS)	27	18	32	33	36	23	142	1.5
Other	9 713	470	451	330	289	244	1 784	18.3
Total	15 839	1 855	2 042	2 009	1 688	1 692	9 286	

Table 6.7.5

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common cup components

Cup	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Lubinus x-link	5 224	3 458	4 563	5 348	5 259	5 306	23 934	27.4
Exeter Rim-fit	4 300	1 968	2 056	2 623	2 919	3 041	12 607	14.5
Marathon	10 152	1 881	1 777	1 730	1 624	1 288	8 300	9.5
Lubinus	68 537	2 657	1 735	1 187	1 244	1 147	7 970	9.1
Pinnacle W/Cripton 100	245	429	581	731	1 372	2 004	5 117	5.9
Trident hemi	1 522	506	656	737	787	767	3 453	4
Continuum	1 394	758	646	774	630	608	3 416	3.9
ZCA XLPE	12 574	787	951	388	239	259	2 624	3
Avantage	880	351	366	478	615	626	2 436	2.8
Trilogy	9 397	570	384	312	334	332	1 932	2.2
Pinnacle 100	1 208	248	273	300	504	468	1 793	2.1
IP Link	142	194	244	389	383	332	1 542	1.8
Trilogy IT	266	289	309	283	215	228	1 324	1.5
Exceed ABT Ringlock	588	257	292	274	245	250	1 318	1.5
ZCA	1 301	523	299	135	58	40	1 055	1.2
Other	81 389	1 687	1 501	1 577	1 720	1 933	8 418	9.3
Total	199 119	16 563	16 633	17 266	18 148	18 629	87 239	

Table 6.7.6

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

15 most common stem components

Stem	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
SPII standard	84 164	6 514	6 539	6 872	7 093	7 082	34 100	39.1
Exeter standard	43 245	3 375	3 313	3 429	3 482	3 357	16 956	19.4
Corail standard	6 971	1 671	1 853	2 120	2 406	2 636	10 686	12.2
MS-30 polished	8 892	1 178	1 095	1 062	1 144	1 174	5 653	6.5
CLS	9 519	630	648	750	820	819	3 667	4.2
Bi-Metric X por HA NC	5 909	861	837	727	458	422	3 305	3.8
Corail high offset	2 089	489	533	534	647	934	3 137	3.6
Corail coxa vara	1 520	399	425	493	622	671	2 610	3
Accolade II	258	363	349	340	412	479	1 943	2.2
M/L Taper	279	242	254	218	128	149	991	1.1
Wagner Cone	1 132	203	168	134	203	191	899	1
ABG II HA	2 569	193	188	199	187	115	882	1
Accolade straight	1 740	72	89	31	37	37	266	0.3
Echo Bi-Metric (FPP)	0	0	35	87	6	82	210	0.2
SP-CL	0	1	10	27	80	79	197	0.2
Other	30 832	372	297	243	423	402	1 737	1.8
Total	199 119	16 563	16 633	17 266	18 148	18 629	87 239	

Table 6.7.7

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

37.1% of all surgeries and the proportion for direct lateral approach on the supine position was 7.1%. Mini-approach and Watson–Jones approach and direct lateral/posterior approach in combination with trochanteric flip osteotomy are only used sporadically. The proportion of the three most used surgical approaches shows no significant variation during the last five years (Figure 6.8.1). Table 6.8.1 shows the proportion of reoperations within two years related to the approach used. Here, instead of revision, reoperation has been used to include open reductions following dislocations and fractures which have been treated with only osteosynthesis. The highest frequency for reoperations is found in the two groups operated with a mini-approach. In both groups, the proportion of uncemented implants is high, which is likely to affect the risk for reoperation (Table 6.8.1). The slightly higher risk of reoperation within two years in the group for lateral approach may be explained by the fact that more patients with secondary osteoarthritis and especially with hip fracture undergo operation with a lateral approach. The relationship between patient demographics, comorbidity, implant selection and choice of surgical approach is complex. Therefore, the data presented should be seen as descriptive.

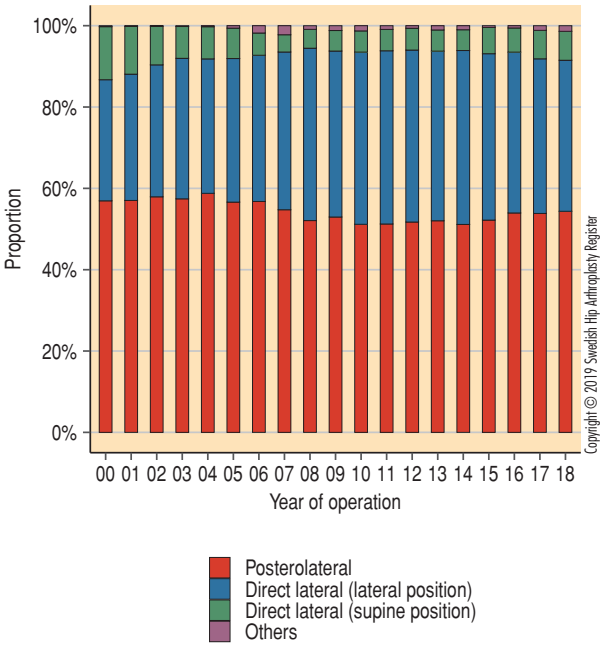

Figure 6.8.1 Trends for approach.

92% of all total arthroplasties are performed with a posterior approach or a lateral approach, both in a lateral position. The risk of early reoperation seems to not be affected by the choice of these two approaches if all operations are included. On the other hand, the choice of surgical approach can affect different subgroups and display different risk profiles, something that we have shown earlier for operations of patients with a fracture diagnosis.

Demography, fixation method, and proportion of reoperated patients in relation to surgical approach

2000–2018

Surgical approach	Number	Proportion of women, %	Proportion with primary osteoarthritis, %	Proportion of operations with uncemented cup, %	Proportion of operations with uncemented stem, %	Proportion reoperated, %
Posterior approach in lateral position (Moore)	153 387	57.5	81.5	18.1	21.8	2.1
Direct lateral approach						
Lateral position (Gammer)	108 931	59.7	77.7	20.4	24.7	2.3
Supine position (Hardinge)	18 702	63.5	77.3	4.6	25.9	2.2
Mini-approach						
MIS/1-approach, back	519	55.5	79.6	48.7	58.6	2.3
MIS/1-approach, front	807	62.5	85.7	68.6	65.3	3.5
MIS/2-approach	46	47.8	82.6	54.3	60.9	6.5
Watson-Jones (original)	593	53.6	77.2	44.2	56.8	2.1
Trocanteric osteotomy						
Direct lateral	457	61.5	65	25.4	31.1	3.6
OCM-approach	52	30.8	92.3	90.4	94.2	1.9
No data	2 864	60.1	67.9	16.6	11.4	2.6

Table 6.8.1

Number of primary total hip arthroplasties per unit and year

Unit	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Aleris Specialistvård Bollnäs	508	312	306	279	278	338	1 513	1.7
Aleris Specialistvård Elisabethsjukhuset	1 209	2	0	0	0	0	2	0
Aleris Specialistvård Motala	1 795	520	580	585	635	609	2 929	3.4
Aleris Specialistvård Nacka	720	119	218	244	234	244	1 059	1.2
Aleris Specialistvård Sabbatsberg	2 045	141	24	0	0	0	165	0.2
Aleris Specialistvård Ängelholm	16	82	131	91	62	65	431	0.5
Alingsås	2 498	178	198	194	207	191	968	1.1
Art Clinic Göteborg	0	0	25	45	75	109	254	0.3
Art Clinic Jönköping	16	14	20	36	71	137	278	0.3
Arvika	1 584	217	195	196	208	216	1 032	1.2
Bollnäs	2 839	0	0	0	0	0	0	0
Borås	2 552	170	159	133	121	161	744	0.9
Capio Artro Clinic	0	0	0	0	259	358	617	0.7
Capio Movement	1 509	229	304	339	328	367	1 567	1.8
Capio Ortopediska Huset	4 320	374	477	467	610	635	2 563	2.9
Capio S:t Göran	6 086	423	508	578	596	559	2 664	3.1
Carlanderska	1 086	157	145	172	208	265	947	1.1
Danderyd	4 832	343	331	325	312	256	1 567	1.8
Eksjö	2 608	207	243	233	203	253	1 139	1.3
Enköping	2 831	342	347	354	413	442	1 898	2.2
Eskilstuna	1 437	97	109	108	129	135	578	0.7
Falköping	2 459	0	0	0	0	0	0	0
Falun	3 954	325	254	254	250	175	1 258	1.4
Frölunda Specialistsjukhus	756	97	83	0	0	0	180	0.2
Frölundaortopeden	0	0	0	4	8	13	25	0
Gothenburg Medical Center	121	0	0	0	0	0	0	0
Gällivare	1 392	96	93	91	92	119	491	0.6
Gävle	2 522	223	253	251	210	179	1 116	1.3
Halmstad	3 018	241	236	206	199	205	1 087	1.2
Helsingborg	1 322	109	182	124	92	46	553	0.6
Hermelinen Specialistvård	8	7	12	11	23	20	73	0.1
Hudiksvall	1 931	146	138	138	98	96	616	0.7
Hässleholm	9 305	783	776	789	782	769	3 899	4.5
Jönköping	2 675	210	160	129	208	261	968	1.1
Kalix	385	0	0	0	0	0	0	0

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Number of primary total hip arthroplasties per unit and year, continued

Unit	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Kalmar	2 533	160	174	173	173	179	859	1
Karlshamn	2 516	240	259	241	235	284	1 259	1.4
Karlskoga	1 785	162	186	139	45	31	563	0.6
Karlskrona	552	28	31	35	40	34	168	0.2
Karlstad	3 174	248	219	199	192	179	1 037	1.2
Karolinska/Huddinge	3 194	265	241	189	194	183	1 072	1.2
Karolinska/Solna	2 997	184	196	113	120	107	720	0.8
Katrineholm	2 887	260	221	193	248	260	1 182	1.4
Kristianstad	149	64	31	40	49	49	233	0.3
Kristinehamn	61	0	0	0	0	0	0	0
Kungälv	2 483	205	185	202	197	175	964	1.1
Köping	1 690	0	0	0	0	0	0	0
Landskrona	1 382	0	0	0	0	0	0	0
Lidköping	2 007	281	280	307	292	200	1 360	1.6
Lindesberg	2 280	202	214	426	613	689	2 144	2.5
Linköping	1 407	67	70	63	39	82	321	0.4
Linköping Medical Center	27	0	0	0	0	0	0	0
Ljungby	1 873	172	152	165	195	198	882	1
Lycksele	3 379	302	334	324	323	318	1 601	1.8
Mora	2 435	207	241	278	253	269	1 248	1.4
Motala	2 731	0	0	0	0	0	0	0
Norrköping	2 901	258	248	266	272	245	1 289	1.5
Norrtälje	1 494	115	128	159	153	169	724	0.8
Nyköping	2 004	159	148	138	196	188	829	1
NÄL	0	0	2	47	39	36	124	0.1
Ortho Center IFK-kliniken	741	133	127	164	179	234	837	1
Ortho Center Stockholm	3 722	442	495	535	623	732	2 827	3.2
Oskarshamn	2 541	233	289	308	294	289	1 413	1.6
Piteå	3 532	337	329	374	401	444	1 885	2.2
Simrishamn	787	0	0	0	0	0	0	0
Skellefteå	1 595	122	126	128	148	148	672	0.8
Skene	1 251	152	125	118	155	173	723	0.8
Skövde	2 144	136	162	207	146	105	756	0.9
Sollefteå	1 682	109	139	194	325	317	1 084	1.2
Sophiahemmet	2 930	213	219	221	267	266	1 186	1.4

(the table continues on the next page)

Number of primary total hip arthroplasties per unit and year, continued

Unit	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Spenshult	1 229	97	0	0	0	0	97	0.1
SU/Mölndal	3 365	594	600	602	614	586	2 996	3.4
SU/Sahlgrenska	1 388	6	5	2	3	2	18	0
SU/Östra	1 191	0	0	0	0	0	0	0
Sunderby	1 132	34	40	35	27	35	171	0.2
Sundsvall	2 459	158	84	49	42	40	373	0.4
SUS/Lund	1 498	203	180	207	134	120	844	1
SUS/Malmö	1 572	34	22	29	37	50	172	0.2
Säffle	338	0	0	0	0	0	0	0
Södersjukhuset	4 714	419	391	412	358	275	1 855	2.1
Södertälje	1 683	97	119	130	174	182	702	0.8
SöS Sab	64	0	0	0	0	0	0	0
Torsby	1 290	97	118	129	138	120	602	0.7
Trelleborg	6 196	627	664	724	679	696	3 390	3.9
Uddevalla	4 359	390	374	402	372	377	1 915	2.2
Umeå	1 061	98	103	97	79	78	455	0.5
Uppsala	3 910	284	237	258	262	222	1 263	1.4
Varberg	2 983	213	187	273	242	292	1 207	1.4
Visby	1 467	122	136	136	129	138	661	0.8
Värnamo	1 818	122	133	176	131	154	716	0.8
Västervik	1 555	109	97	128	131	147	612	0.7
Västerås	3 583	436	377	422	516	497	2 248	2.6
Växjö	1 684	151	148	133	116	131	679	0.8
Ystad	652	0	0	0	1	3	4	0
Ängelholm	1 517	96	0	64	157	173	490	0.6
Örebro	2 319	151	74	62	45	56	388	0.4
Örnsköldsvik	2 016	144	203	183	166	134	830	1
Östersund	2 871	261	263	291	278	315	1 408	1.6
Total	199 119	16 563	16 633	17 266	18 148	18 629	87 239	

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

Number of primary total hip arthroplasties per diagnosis and year

2000–2018

Diagnosis	2000–2013	2014	2015	2016	2017	2018	Total[1)]	Proportion, %[2)]
Primary osteoarthritis	156 935	13 369	13 442	13 997	14 765	15 109	70 682	81
Acute trauma, hip fracture	13 601	1 405	1 527	1 616	1 645	1 790	7 983	9.2
Complication or sequelae after fracture or other trauma	8 468	445	419	403	431	374	2 072	2.4
Idiopathic necrosis	3 314	416	360	391	425	444	2 036	2.3
Other secondary osteoarthritis	6 220	302	308	305	310	307	1 532	1.8
Sequelae after childhood disease in the hip	4 134	283	282	281	290	328	1 464	1.7
Inflammatory joint disease	4 215	168	152	132	128	119	699	0.8
Tumour	1 175	111	85	81	80	88	445	0.5
Other acute trauma	364	38	36	35	42	47	198	0.2
Other	182	10	8	7	27	22	74	0.1
Missing	511	16	14	18	5	1	54	0.1
Total	199 119	16 563	16 633	17 266	18 148	18 629	87 239	

[1)] Refers to the number of primary total hip arthroplasty carried out the last five years.
[2)] Refers to the proportion of the total number of primary total hip arthroplasties carried out during the last five years.

Number of primary total hip arthroplasties per diagnosis and age group

2000–2018

Diagnosis	< 50 years		50–59 years		60–75 years		> 75 years			
	Number	Pro-por-tion, %	Number	Pro-por-tion, %	Number	Pro-por-tion, %	Number	Pro-por-tion, %	Totalt	Pro-por-tion, %
Primary osteoarthritis	7 853	55.7	31 541	81.6	127 388	83.9	60 835	74.4	227 617	79.5
Acute trauma, hip fracture	107	0.8	744	1.9	10 186	6.7	10 547	12.9	21 584	7.5
Complication or sequelae after fracture or other trauma	399	2.8	996	2.6	3 934	2.6	5211	6.4	10 540	3.7
Other secondary osteoarthritis	1 675	11.9	1 607	4.2	3 010	2	1 460	1.8	7 752	2.7
Sequelae after childhood disease in the hip	2 176	15.4	1 642	4.2	1 478	1	302	0.4	5 598	2
Idiopathic necrosis	786	5.6	808	2.1	2 185	1.4	1 571	1.9	5 350	1.9
Inflammatory joint disease	869	6.2	930	2.4	2 368	1.6	747	0.9	4 914	1.7
Tumour	155	1.1	278	0.7	782	0.5	405	0.5	1 620	0.6
Other acute trauma	21	0.1	37	0.1	205	0.1	299	0.4	562	0.2
Other	41	0.3	39	0.1	89	0.1	87	0.1	256	0.1
Missing	20	0.1	32	0.1	162	0.1	351	0.4	565	0.2
Total	14 102	100.0	38 654	100.0	151 787	100.0	81 815	100.0	286 358	

Number of primary total hip arthroplasties per diagnosis and age uncemented

2000–2018

Diagnosis	< 50 years		50–59 years		60–75 years		> 75 years			
	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Total	Proportion, %
Primary osteoarthritis	4 484	56.5	12 857	85.4	15 726	90.4	1 053	82.8	34 120	81.9
Sequelae after childhood disease in the hip	1 359	17.1	780	5.2	323	1.9	23	1.8	2 485	6
Other secondary osteoarthritis	1 002	12.6	662	4.4	532	3.1	30	2.4	2 226	5.3
Idiopathic necrosis	499	6.3	298	2	238	1.4	26	2	1 061	2.5
Inflammatory joint disease	333	4.2	161	1.1	172	1	17	1.3	683	1.6
Complication or sequelae after fracture or other trauma	192	2.4	201	1.3	177	1	64	5	634	1.5
Acute trauma, hip fracture	19	0.2	65	0.4	189	1.1	40	3.1	313	0.8
Other	18	0.2	10	0.1	8	0	2	0.2	38	0.1
Other acute trauma	7	0.1	7	0	14	0.1	7	0.6	35	0.1
Tumour	11	0.1	9	0.1	4	0	2	0.2	26	0.1
Missing	10	0.1	6	0	6	0	8	0.6	30	0.1
Total	7 934	100.0	15 056	100.0	17 389	100.0	1 272	100.0	41 651	

Number of primary total hip arthroplasties per diagnosis and age cemented

2000–2018

Diagnosis	< 50 years		50–59 years		60–75 years		> 75 years			
	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Total	Proportion, %
Primary osteoarthritis	926	41.1	10 404	74.6	95 488	82.5	56 595	74.3	163 413	78.5
Acute trauma, hip fracture	65	2.9	599	4.3	9 353	8.1	10 020	13.1	20 037	9.6
Complication or sequelae after fracture or other trauma	123	5.5	628	4.5	3 444	3	4 866	6.4	9 061	4.4
Other secondary osteoarthritis	267	11.9	577	4.1	2 014	1.7	1 337	1.8	4 195	2
Inflammatory joint disease	316	14	624	4.5	1 970	1.7	696	0.9	3 606	1.7
Idiopathic necrosis	144	6.4	347	2.5	1 608	1.4	1 431	1.9	3 530	1.7
Sequelae after childhood disease in the hip	257	11.4	438	3.1	828	0.7	243	0.3	1 766	0.8
Tumour	130	5.8	259	1.9	736	0.6	391	0.5	1 516	0.7
Other acute trauma	10	0.4	27	0.2	165	0.1	259	0.3	461	0.2
Other	8	0.4	26	0.2	67	0.1	79	0.1	180	0.1
Missing	5	0.2	18	0.1	127	0.1	300	0.4	450	0.2
Total	2 251	100.0	13 947	100.0	115 800	100.0	76 217	100.0	208 215	

Number of primary total hip arthroplasties per type of fixation and age

2000–2018

Fixation type	< 50 years		50–59 years		60–75 years		> 75 years			
	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Total	Proportion, %
Cemented	2 251	16	13 947	36.1	115 800	76.3	76 217	93.2	208 215	72.7
Uncemented	7 934	56.3	15 056	39	17 389	11.5	1 272	1.6	41 651	14.5
Reverse hybrid	2 213	15.7	7 016	18.2	13 399	8.8	2 497	3.1	25 125	8.8
Hybrid	652	4.6	1 705	4.4	4 681	3.1	1 717	2.1	8 755	3.1
Resurfacing	1 002	7.1	881	2.3	258	0.2	2	0	2 143	0.7
Missing	50	0.4	49	0.1	260	0.2	110	0.1	469	0.2
Total	14 102	100.0	38 654	100.0	151 787	100.0	81 815	100.0	286 358	

Number of primary total hip arthroplasties per type of surgical approach and year

2000–2018

Type of surgical approach	2000–2013	2014	2015	2016	2017	2018	Total	Proportion, %
Posterior approach in lateral position (Moore)	107 032	8 469	8 680	9310	9770	10126	46355	53.1
Direct lateral approach in lateral position (Gammer)	74 402	7 083	6 805	6824	6900	6917	34529	39.6
Direct lateral approach in supine position (Hardinge)	13 163	846	1 074	1 025	1270	1324	5539	6.3
Other	1 705	163	71	95	192	248	769	0.9
Missing	2 817	2	3	12	16	14	47	0.1
Total	199 119	16 563	16 633	17 266	18148	18629	87239	

Number of primary total hip arthroplasties per type of cement and year

2000–2018

Type av cement	2000–2013	2014	2015	2016	2017	2018	Total	Proportion, %
Refobacin Bone Cement	42 514	5 917	5 943	6 378	5 840	5 872	29 950	34.5
Palacos R+G	41 714	4 414	4 208	4 108	4 695	4 361	21 786	25.1
CMW with Gentamycin	363	70	73	91	118	292	644	0.7
Cemex Genta Green	148	224	56	0	5	3	288	0.3
Copal G+V	0	11	25	26	76	60	198	0.2
Copal G+C	79	7	9	10	22	93	141	0.2
Other	70 149	51	67	51	37	35	241	0.3
(wholly or partly cementless)	44 039	5 865	6 233	6 577	7 052	7 908	33 635	38.7
Total	199 006	16 559	16 614	17 241	17 845	18 624	86 883	

7 Primary prosthesis – in-depth analyses

7.1 The standard patient in a ten-year perspective

The standard patient was launched as a concept in the annual report for 2012. The aim was to define a patient group with a small risk of having early complications, defined as reoperation within two years after primary hip arthroplasty, on the basis of age, sex, BMI and ASA class. Access to data on BMI and ASA class was deemed to be of great importance in predicting the most probable outcome. The reporting of these parameters to the Swedish Hip Arthroplasty Register was commenced in 2008. During this year, a completeness of 82.3% of all operations was reached for BMI and the completeness for ASA class was 89.8%. The reporting improved gradually. In 2012, these proportions had increased to 94.5% and 87.5% respectively, and in 2018, they reached 96.3% and 98.3% respectively.

Earlier analyses

The standard patient was as a concept to correspond to a patient group with a low probability of having a reoperation within two years of the primary operation. Furthermore, the concept was to encompass both men and women, be easy to use, and encompass a large enough population enabling the creation of a just measure of comparison between operating units. Based on statistical analysis combined with clinical consideration our definition of the standard patient was a man or a woman, aged 55-84.9 years with primary osteoarthritis, a BMI between 18.5 and 29.9, and an ASA class of I or II. We also found that self-reported Charnley class did not provide any extra information regarding the possibility of predicting risk for reoperation within two years.

The intention of this year's analysis

The aim of this in-depth analysis is to review the statistical and clinical basis for the concept of the standard patient against the background of eleven years of reporting of BMI and ASA class and as a result a larger number of patients. We would also like to illustrate what the risk profile looks like in a longer perspective, based on the risk for reoperation within ten years.

In 2012-2013, a question on smoking was added in the PROM-programme. In 2017, the number of response options was increased to four. Even though the number of observations due to the shorter time-period for collecting data are limited, we have investigated how smoking affects the outcome. The number of response options has however been reduced to three (never smoked, ex-smoker, smoker).

Definitions, selection, and classification of variables

This year's analysis is based on all total hip arthroplasties carried out on patients with complete data regarding sex, age, diagnosis, BMI, and ASA class. For the patients operated bilaterally, only the first operated hip is included (n = 130,077). For those patients who also have reported Charnley class in the PROM-programme (n = 98,856) and those who have responded to the question on smoking (n = 55,918), the analysis has been extended accordingly. The number of included hip arthroplasties and distribution per variable is shown in table 7.1.1.

In the first two regression analyses, based on the outcomes reoperation within two and ten years respectively, and with the maximal number of observations (excluding Charnley class and smoking, table 7.1.2), five variables are included, of which two are treated as linear (age, BMI). We have chosen to group these variables despite the fact that this measure results in a slight information loss, since the intention is to define a tool, which is easy to use clinically.

Result – reoperation within two years

The risk of having a reoperation within two years is higher for patients in the age groups 50-54 years, and 85 years and older. For patients under 50 years of age, the risk is however on par with that of the control group, the age group 70-74 years of age. As expected, the risk increases with increasing BMI and increasing ASA class. There was no statistically significant increased risk for patients with a low BMI. This group is however small and makes up only 1.3% of cases (table 7.1.1). Within the group secondary osteoarthritis, all sub groups, apart from sequelae after disease in the hip during adolescence, are associated with an increased risk. The group operated due to sequelae after trauma/fracture have an especially large risk increase. A comparison of this group (n = 3,979) and others (n = 126,098) shows that the reoperation frequency due to infection is more than doubled, for periprosthetic fractures almost quadrupled (1.9 vs 0.5%), and considerably increased regarding dislocation and loosening (0.9 vs 0.5%, and 1.0 vs 0.6%). These patients should as a result receive special attention and be operated by more experienced orthopaedic surgeons.

Choice of limits for the definition of low risk

The result of this analysis lays the groundwork for a selection of properties, which are supposed to form the basis for the definition of the standard patient. Data supports the idea that it is reasonable to keep the definitions from before. Admittedly, overweight (BMI 25-29.9) is associated with a certain risk increase compared to normal weight (18.5-24.9), and ASA class II means a higher risk than ASA class I, but if the definition is made too tight, too few patients are included, and the result is no longer the standard patient. As table 7.1.1 shows, the group "overweight" patients is large. They make up the largest BMI-group (41.7%) and more than half of those having an arthroplasty have ASA class II (58%).

It would be possible to include patients with sequelae after hip disease during adolescence or a BMI under 18.5 in the concept the standard patient. As regards the first case, 96.1% of these patients have the diagnosis "dysplastic coxarthrosis" (M16.3 or M16.0). The others are sequelae after Perthe's disease, hip epiphysiolysis, and juvenile osteochondrosis. Within this group some cases with complicated or very complicated anatomical conditions are residing, which despite good outcomes in most cases in this diagnosis group suggests that this group should not be included in the standard patient concept. Regarding patients with a primary osteoarthritis and a BMI under 18.5 within the age, BMI, and ASA class limits we cannot see why they should be excluded from the concept of the standard patient.

Results – reoperation within ten years

In the adjusted ten-year analysis, the influence of the risk factors remains and all sub categories tend to have lower values for all factors except for the age factor. All age groups except the group 80-84 years of age now show a statistically significant increase compared to the reference group 70-74 years of age. In the younger groups, the result is made worse due to an increased incidence of reoperation because of loosening. In the group 75-79 years of age, where the difference is close of being not significant, there is a small relative increase of the number of reoperations due to all of the four most common reasons for reoperation (infection, loosening, dislocation, and periprosthetic fracture).

The standard patient

A continued analysis of only the group categorised as the standard patient (table 7.1.3), shows that age within the group does not have a decisive association on the outcome, while patients with a BMI classified as overweight and ASA class II have a risk increase of approximately 20 percent for reoperation within two years compared to normal weight patients and patients with ASA class I respectively. After five years, the risk for the two youngest age groups (55-59, 60-64) has increased, and after ten years, the risk has increased also for the group 65-69 years of age compared to the control group. The risk increase is most clear-cut in the group 55-59 years of age.

In a direct comparison we find that the survival after two years is 98.7 ± 0.1% for the standard patient, and 97.0 ± 0.1% for other patients (figure 7.1.1) corresponding to a risk reduction of approximately 55% in the regression analysis (table 7.1.3). The risk reduction is more pronounced for women than what it is for men, which in part could be explained by the fact that women more often get cemented implants, and in part by other reasons. Over time, there is a certain equalisation between the groups, probably because the age factor becomes more important.

Charnley class and smoking

Already in the analysis in 2012, we could show that Charnley class did not influence the risk of having a reoperation within two years after adjusting for potential covariates. In this year's analysis with an increased number of observations, we find the same thing. The initial regression analysis comprises 3,323 patients who smoke every day or more seldom (table 7.1.2). Among these patients, there is an approximate 40 percent increased risk of early reoperation. In the group ex-smokers (n = 8,220), there is a 20 percent increased risk, where calculated differences are close of being not significant. Within the group the standard patient, the number of observations is approximately half. Here, there is a 50 percent risk increase for smokers, however not statistically significant (table 7.1.3).

A high BMI and ASA class III or higher results in a higher risk for early reoperation. In the longer perspective, the age of the patient becomes increasingly important, probably due to an association between age and activity level.

Patients undergoing a total hip arthroplasty due to sequelae after earlier trauma or fracture, have higher risk when it comes to early reoperation.

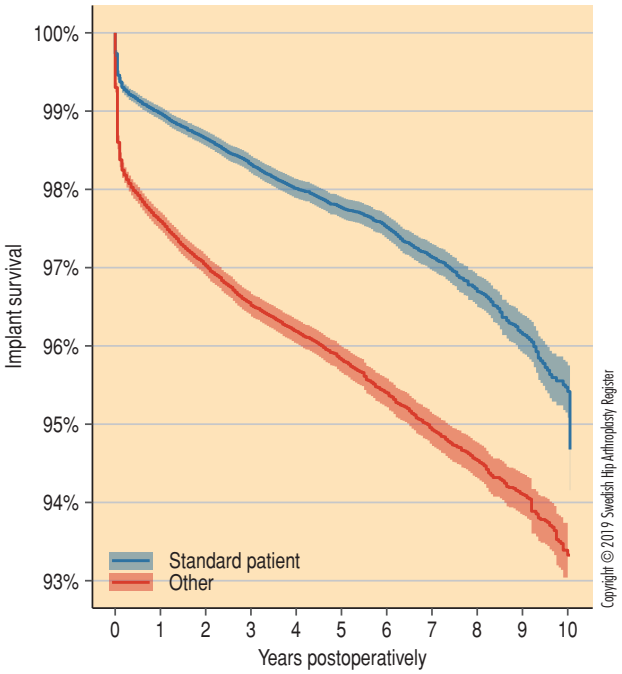

Figure 7.1.1 Survival curves for patients with primary osteoarthritis, 55-84 years of age, BMI < 30, and ASA class I or II (the standard patient), and for patients that do not meet one or several of these criteria. Primary operation 2008-2018.

The update of the data making up the basis for the definition of the standard patient, confirms that the choices of diagnosis and limits for age and ASA class are well balanced. Regarding BMI, we find no reason for excluding patients with a BMI under 18.5. The standard patient is now defined as a man or a woman, 55-84 years of age at surgery with primary osteoarthritis, with a BMI under 30, and with ASA class I or II.

Demography – patients, for explorative analysis*)

	Number of hip arthroplasties (patients) 1992–2018 *365 901 (297 745)*		
	BMI and ASA classification 2008–2018	**Charnley class 2008–2018**	**Data on smoking 2012–2018**
Number of patients with complete data	130 077	98 856	55 918
Age, average SD	68.2 *10.9*	67.6 *10.6*	67.7 *10.6*
<50 years	7 136 *5.5*	5 594 *5.7*	3 154 *5.6*
50–54 years	7 136 *5.5*	5 833 *5.9*	3 453 *6.2*
55–59 years	11 113 *8.5*	9 079 *9.2*	5 067 *9.1*
60–64 years	22 159 *17.0*	17 865 *18.1*	9 426 *16.9*
65–69 years	19 368 *14.9*	15 026 *15.2*	8 450 *15.1*
70–74 years	24 710 *19.0*	18 877 *19.1*	11 383 *20.4*
75–79 years	20 065 *15.4*	14 533 *14.7*	8 311 *14.9*
80–84 years	12 211 *9.4*	8 419 *8.5*	4 658 *8.3*
85– years	6 179 *4.8*	3 630 *3.7*	2 016 *3.6*
Gender			
Proportion of women, %	57.2	56.3	56.2
BMI, average *SD*	27.0 *4.5*	27.3 *4.4*	27.3 *4.4*
< 18.5	1 715 *1.3*	787 *0.8*	403 *0.7*
18.5–24.9	44 247 *34.0*	31 361 *31.7*	17 615 *31.5*
25–29.9	54 278 *41.7*	42 675 *43.2*	24 051 *43.0*
30–34.9	22 994 *17.7*	18.549 *18.8*	10.760 *19.2*
≥ 35	6 843 *5.3*	5 484 *5.5*	3 089 *5.5*
ASA class			
I	30 192 *23.2*	24 913 *25.2*	13 450 *24.1*
II	75 445 *58.0*	58 730 *59.4*	33 498 *59.9*
III–	24 440 *18.8*	15 213 *15.4*	8 970 *16.1*
Diagnosis during primary operation			
Primary osteoarthritis	104 785 *80.6*	88 874 *89.9*	50 660 *90.6*
Acute hip fracture/trauma	9 950 *7.6*	149 *0.2*	60 *0.1*
Sequelae fracture/trauma	3 979 *3.1*	2 023 *2.0*	1 049 *1.9*
Inflammatory joint disease	1 367 *1.1*	1 094 *1.1*	474 *0.8*
Sequelae childhood disease	2 596 *2.0*	2 103 *2.1*	1 104 *2.0*
Idiopathic necrosis	2 950 *2.3*	2 166 *2.2*	1 342 *2.4*
Other secondary osteoarthritis	4 450 *3.4*	2 447 *2.5*	1 229 *2.2*
Charnley class			
I	–	47 251 *47.8*	27 597 *49.4*
II	–	12 707 *12.9*	7 095 *12.7*
III	–	38 898 *39.3*	21 226 *38.0*
Smoking			
Never been a smoker	–	–	44 376 *79.4*
Ex-smoker	–	–	8 220 *14.7*
Smoker, not daily	–	–	560 *1.0*
Daily smoker	–	–	2 763 *4.9*

Table 7.1.1

**Absolute numbers and percentages if not otherwise stated.*

Risk analysis based on Cox regression (adjusted data)*)

	Relative risk (hazard ratio) for reoperation, 95 % C.I.	
	≤ 2 years	≤ 10 years
Age		
< 50 years	1.0 *0.8–1.2*	1.4 *1.2–1.7*
50–54 years	1.3 *1.1–1.6*	1.6 *1.4–1.8*
55–59 years	1.1 *0.9–1.3*	1.4 *1.2–1.5*
60–64 years	1.1 *0.95–1.2*	1.2 *1.1–1.4*
65–69 years	1.0 *0.9–1.2*	1.2 *1.1–1.3*
70–74 years	1	1
75–79 years	1.1 *0.99–1.3*	1.2 *1.04–1.3*
80–84 years	1.1 *0.9–1.2*	1.1 *0.96–1.2*
85– years	1.3 *1.1–1.6*	1.3 *1.1–1.5*
Gender		
Man	1.5 *1.3–1.6*	1.4 *1.3–1.5*
BMI		
< 18.5	0.9 *0.6–1.2*	0.9 *0.7–1.2*
18.5–24.9	1	1
25–29.9	1.1 *1.02–1.2*	1.1 *1.001–1.2*
30–34.9	1.6 *1.4–1.7*	1.4 *1.2–1.5*
≥ 35	2.1 *1.8–2.5*	1.6 *1.4–1.8*
ASA class		
I	1	1
II	1.3 *1.2–1.5*	1.2 *1.1–1.3*
III–	2.3 *1.9–2.4*	1.8 *1.6–2.0*
Primary operation diagnosis		
Primary osteoarthritis	1	1
Acute hip fracture/trauma	1.9 *1.7–2.2*	1.7 *1.5–1.9*
Sequelae fracture/trauma	3.2 *2.7–3.7*	2.7 *2.4–2.1*
Inflammatory joint disease	1.5 *1.1–2.1*	1.4 *1.05–1.7*
Sequelae childhood disease	1.1 *0.9–1.6*	1.1 *0.9–1.3*
Idiopathic necrosis	2.1 *1.7–2.5*	1.8 *1.5–2.1*
Other secondary osteoarthritis	1.7 *1.5–2.1*	1.5 *1.3–1.4*
Charnley class#)		
I	1	1
II	1.1 *0.9–1.2*	1.0 *0.9–1.1*
III	1.1 *0.98–1.2*	1.1 *0.98–1.1*
Smoking#)		
Never been a smoker	1	–¤
Ex-smoker	1.2 *1.01–1.47*	–¤
Smoker, daily or less often	1.4 *1.1–1.8*	–¤

Table 7.1.2

*) *Number of observations per group according to table 7.1.1.*

#) *In total fewer observations with information on Charnley class and smoking, which means that the other risk calculations are not valid for these analyses.*

¤) *The 10 year follow-up is missing.*

Risk variation and total risk reduction over time for the standard patient

			Relative risk (hazard ratio) for reoperation, 95 % C.I.		
	Number	%	≤ 2 years	≤ 5 years	≤ 10 years
Only the standard patient*)					
Age					
55–59 years	6 289	10.6	1.1 0.9–1.5	1.3 1.1–1.7	1.4 1.2–1.7
60–64 years	12 698	21.3	1.0 0.8–1.2	1.3 1.05–1.5	1.2 1.05–1.5
65–69 years	10 890	18.3	0.9 0.8–1.2	1.2 0.97–1.4	1.2 1.01–1.4
70–74 years	13 599	22.8	1	1	1
75–79 years	10 281	17.3	1.1 0.9–1.4	1.2 0.96–1.4	1.2 0.98–1.4
80–84 years	5 842	9.8	1.0 0.8–1.3	1.1 0.84–1.4	1.1 0.85–1.3
BMI					
< 18.5	472	0.8	1.3 0.6–2.8	1.2 0.56–2.2	1.0 0.5–1.9
18.5–24.9	34 453	41.4	1	1	1
25–29.9	34 453	57.8	1.2 1.03–1.4	1.2 1.04–1.4	1.2 1.04–1.3
ASA class					
I	17 664	29.6	1	1	1
II	41 935	70.4	1.2 1.04–1.5	1.2 1.07–1.4	1.2 1.06–1.4
Smoking#)					
Never been a smoker	23 068	79.9	1	–o)	–o)
Ex-smoker	4 291	14.9	1.0 0.7–1.4	–o)	–o)
Smoker, daily or less often	1 525	2.6	1.5 0.99–2.2	–o)	–o)
Standard patient and other patients					
Standard patient, all	59 599	45.8	0.45 0.41–0.48	0.50 0.47–0.54	0.55 0.52–0.59
Other patients, all	70 478	54.2	1	1	1
Standard patient, woman	39 946	53.7	0.41 0.37–0.47	0.51 0.47–0.57	0.56 0.51–0.61
Other patients, woman	34 505	46.3	1	1	1
Standard patient, man	25 094	54.9	0.48 0.43–0.48	0.50 0.45–0.55	0.54 0.50–0.59
Other patients, man	30 532	45.1	1	1	1

Table 7.1.3

**)Adjusted data, both genders.*

#)In total, fewer observations with information on smoking, which means that the other risk calculations are not valid for this analysis. Percentages based on those who have responded to the question.

o)No, or too few observations.

7.2 Primary prostheses with an incomplete documentation in Sweden

During the 1980s, the Swedish Hip Arthroplasty Register recieved international recognition due to the possibility of tracing deviating results both on hospital level and on an implant level. This made continuous improvement work possible, where a more strict selection of implants and a more streamlined process surrounding the operation contributed to the successive decrease of the risk of revision until it became among the lowest in the world. In this year's report, we have changed the term "new implants" to "implants with an incomplete documentation". The reason is that we, in a wider sense, want to focus on prostheses, which have been in existence for more than 10 years and that are still to be found on the market, despite a lower survival than desirable. We also intend to focus on implants or implant variations, which have been in use for a relatively long time, but where any nation specific evaluation has not been undertaken.

Evaluation of implants in other registries

The possibility of systematically defining deviating results using a well-functioning registry has been developed in several countries. In the UK, an expert group, "the Orthopaedic Data Evaluation Panel" (ODEP) was formed to create guidelines for the evaluation of new implants. The criteria thus created have attracted international attention. A similar organisation also exists within the Australian and the Dutch arthroplasty registries. The degree of evidence is divided into several classes in ODEP. The highest level in this grading (13A*), means that at least 500 hip arthroplasties carried out at three or more centres by more than three different surgeons who have not participated in the development of the prosthesis, are to have been followed-up during 13 years. The upper 95-percent confidence interval in a reversed Kaplan–Meier curve (1-prosthesis survival) should be lower than 6.5% in the defined group. The indications of revision and the number of deceased should be known. Up to 20% consored observations (lost to follow-up) are accepted. The system has now and then been criticised by International Society of Arthroplasty Registers (ISAR) from a methodological viewpoint, which has meant that the methodology partly has been revised and probably has improved.

A similar system exists in the Australian arthroplasty register where the evaluation is divided into three steps. The first step consists of an automated screening. Here prostheses, which compared to all other prostheses in the same group have at least a doubled risk of revision, are identified. In step two, these implants are investigated concerning possible reasons for a poorer outcome, as for example deviating patient selection. Detailed statistical analyses are also performed. If needed, an expert panel can make additional analyses and assessments before presentation in the annual report of the registry (for details see www.odep.org.uk and Acta Orthop 2013; 84(4): 348-352).

A new legal framework within the EU for implants (MDR)

So far, the marketing of a prosthesis in Sweden has demanded a CE marking. CE stands for Conformité Européenne. The legal framework for CE marking is described in the now around 25 years old "Medical Device Directive". So-called notified bodies, organisations, which among other things oversee that manufacturers produce and release products on the market that fulfil the EU-regulations, have issued CE marking. This certification has not been sufficient for technical medical products, and especially not for class III, in which endo prostheses belong. Several prostheses have emerged on the market, which have not met the standard to be expected, and that in some cases have caused serious complications. Due to these shortcomings, the legal framework is now under revision after several years of preparatory work. The abbreviation MDD has been changed to MDR (Medical Device Regulation), which reflects that MDR will be a valid European law. The law is expected to go into effect in 2020. The regulatory framework is extensive and touches also upon clinical benefit, risks and traceability. It encompasses not only completely new implants but also if manufacturers want to market a new size of an existing prosthesis. The demand on the manufacturer, in the new regulatory framework, to show that the new prosthesis benefits the patient in a clinically clear way combined with low risk for complications, is important. In practice, this means that clinical usage without limitations cannot be allowed before the follow-up of a sufficiently large group of patients during a sufficient amount of time. Furthermore, the clinical result based on patient reported data must meet today's standard and at the same time, the risk of complications should be low. What the detailed legal framework will look like and how implants already introduced on the market will be handled is not entirely clear at the moment. The concept also includes the creation of a data bank (European Databank on Medical Devices, EUDAMED) where all information about a prosthesis will be collected, and to which complications can be reported. This new framework is welcome as the benefits for the patients are large through an increase of the safety level and through the decreased risk of future implant related problems. The framework also means that it will be more complicated, time-consuming, and probably also more expensive to introduce new implants and innovations. On the other hand, the need for well-designed clinical studies will also increase. Prices will probably also be affected but to what extent is not clear right now.

The situation in Sweden

In Sweden, we have had a restrictive stance towards change of standard implants during a long time. This stance has proved successful since the clinical results of the majority of the new implants, which are introduced on the market, at best, are on par with already existing ones, and several of them have poorer results. In a few cases, this cautious attitude can mean that implants with better properties than existing standard are introduced late in Swedish healthcare. This drawback is of relatively

little importance considering the good results, which have been noted for the most used prosthesis types in Sweden, and the sometimes disastrous consequences the insertion of a new and unknown implant in a large group of patients can have.

Today, there are no preclinical tests, which in a safe way can assess whether a new prosthesis works better or worse than an existing one. Since the prostheses used today in Sweden have a very high standard, it is mainly in selected patient groups a difference could be made by further implant development. A change of standard implant also means certain risk-taking since new routines must be learned. Against this background, it seems evident that a change of implant only should be made in the cases where there is a clinical need and the replacing implant has documented advantages. Service and price also matter, even if the price of the implant often make up a small part of the total cost.

The choice of control group in our analysis

The procedure surrounding implant evaluation is not entirely simple and self-evident. Most registries use the outcome revision, irrespective of reason and of which component that is revised. Some registries multiply the number of observed components with the number of observational years, which means that the change of reasons for revision over time is not taken into account. To the extent comparison with other prostheses is made, the control group may correspond to all other implants, all other implants of the same product category, or a selected reference group. Sometimes a fixed limit corresponding to for example 90%-prosthesis survival after 10 years is used. So far, an established standard has thus not been in place. Such a standard is also not easy to establish since the conditions vary considerably between different registries regarding the total number of observations, the number of different implants that are used within the catchment area of the registry, the length of the follow-up, and the scope of the data capture of the individual registry. Moreover, exact limits for quality are constructed based on what is deemed acceptable at a certain point in time. Today's accepted standard is not necessarily the same 10 to 20 years later.

Control group – choice of outcome

In this year's follow-up of reviewed implants, we have used the same selection criteria for the reference group, in principle, which was introduced in the annual report for 2015. In order to get data that are more reliable in the control group, the time period has been prolonged with one year. This means that the observation time does not start in 2008 but one year earlier, that is at the same time as was used in last year's report. Hereafter, we intend to let the reference values be based on a time interval, which is moved one year forward for each annual report. The only difference compared to earlier reports is that this interval has increased in size from 11 to 12 years.

The outcomes are based on cup or stem revision. When evaluating the cup, the outcome is change of cup and/or liner or extraction irrespective if the stem has been changed or not. The same principle applies to stems. Revision due to infection is excluded, as this outcome mainly reflects care process and case-mix. Possibly the surface structure of the implant or other properties could affect the risk of infection. As long as this remains unclear however, we have chosen to exclude revision due to infection.

Control group – definitions

This year's control groups thus encompasses prostheses inserted with start in 2007. The idea behind the inclusion of only the last years is to try to make the analysis as representative of today's operations as possible. Over the last decade, the healthcare processes surrounding arthroplasty have witnessed wide-ranging changes, which probably have affected the risk for complications in ways that are hard to overview and adjust for. By excluding operations carried out more than 12 years ago, we think the comparison is made more just.

In order for an implant to qualify for being included in the control group, three basic demands are to be met. The implant survival after 10 years based on cup or stem revision, all causes excluding infection, should surpass 95% based on at least 50 observations at the end of the observational time. Demand number two is that 50 prostheses should have been inserted during the last two years, and demand number three is that at least one of these should have been inserted during the last year (presently in 2018).

Control group – included implants

The implants included in each control group respectively are presented in table 7.2.1. Compared to the annual report of the previous year, Marathon XLPE is now part of the control group for cemented cups, since it fulfils the demands by a large margin. The other cups in the control group are the same as in the annual report of the previous year (Contemporary Hooded Duration, Lubinus older plastic type, ZCA made of older plastic type or XLPE).

In the group of uncemented cups, almost all cups in the control group have extra cross-linked plastic (98%), which corresponds to today's standard. In Sweden, highly cross-linked polyethylene plastic was introduced several years earlier for uncemented cups compared to cemented cups, due to more pronounced problems with osteolysis around uncemented cups. Compared with the previous year, the control group has been extended with Pinnacle Sector. An interesting observation, which is difficult to explain, is that the use of the Trilogy cup, with the best numeric 10-year survival, is gradually decreasing (figure 7.2.1).

The Lubinus SP II-stem, followed by the Exeter stem, dominate the group cemented stems. In both cases, only stems of standard length are included. The exact stem length is missing in the registry for a majority of the MS30 and CPT stems, which is why the same selection has not been possible

for these implants. The CPT stem has the lowest implant survival in this control group (95.9 ± 1.6%), and had a poorer outcome compared to the others in the last in-depth analysis (annual report of 2013). However, it is used relatively seldom, during 2018, 44 operations were reported.

In the control group for uncemented stems there are five main groups, of which two (Corail and Bi-Metric) consist of several variants. In both these groups there has however been implant specific problems. Regarding Bi-Metric, there have been corrosion around the cone of the prosthesis (annual report of 2017) and regarding the Corail stem loosening of the proximal part of the prosthesis. These problems have so far, been very rare however, which means that the influence on the total picture of a well-functioning implant so far has been marginal.

Definition and use of implants with incomplete documentation

The implants accounted for have been introduced from 2007 and onwards in the majority of cases. In most cases, fewer than 50 implants have passed ten-year follow-up. Implants, which have been reported in fewer than 50 cases during the last two years or not at all during 2018, have been excluded. In the future, we hope to be able to report results also for some of these implants, especially those with no long-term follow-up.

Those implants reviewed here may have a longer documentation abroad, but since completeness rate and the risk of revision can vary between countries, we believe a domestic analysis can be valuable. The starting year that is reported in tables 7.2.2 and 7.2.3 corresponds to the first year more than ten prostheses of this type are inserted. For a specific implant all data starts with this year. Individual prostheses inserted before the "starting year" thus have been excluded. In the control group, the starting year has been set to 2007 in order to make the time-periods considered as equal as possible. We would like to point out that in earlier analyses the ZCA cup has had a poorer outcome due to increased risk of revision caused by dislocation. With an increased observational time, this drawback has more than well been compensated by the fact that the ZCA cup is more seldom revised due to loosening. When an implant is assessed, the observational time thus plays a big part, something we have shown also in other contexts.

When "new" implants are introduced on the Swedish market this should take place according to an established plan. It always takes some time to get used to new instruments and the insertion technique may vary. Furthermore, most cases should be followed-up in a structured way. Among the uncemented cups that are presented in table 7.2.2, we find however that 14 units only have inserted six to nine each, and as many as 42 units only have inserted one to five implants per unit during the last two years (figure 7.2.2). In some cases this could be explained by the fact that the cup in question is a variation on a basic concept, such as for example Pinnacle or Trident. In other cases, a large experience of revision surgery may exist, as for example for the TMT cup, or a surgeon with a long experience

Composition of the control groups

Type of component and period of analysis	Number	Implant survival at 10 years, *2 SEM*[1)]
Cemented cup 2007–2018		
Contemporary hooded duration	7 045	95.4 *0.8*
Lubinus older plastic	42 397	97.7 *0.2*
Marathon XLPE new	18 450	99.0 *0.3*
ZCA older plastic	1 258	96.8 *2.8*
ZCA XLPE	14 916	97.4 *0.4*
All	**84 066**	**97.5** ***0.2***
Uncemented cup 2007–2018		
Allofit	1 493	98.3 *2.0*
Pinnacle sector	1 241	96.1 *2.3*
Trident hemi	4 840	95.9 *2.0*
Trident AD LW	1 203	97.5 *1.4*
Trident AD WHA	1 280	96.9 *1.4*
Trilogy±HA	7 477	98.5 *0.4*
All	**17 534**	**98.0** ***0.4***
Cemented stem 2007–2018		
CPT (CoCr alloy)	1 006	95.9 *1.6*
Exeter 150 mm	38 712	98.0 *0.3*
Lubinus SPII 150 mm	74 686	98. 8 *0.2*
MS-30	13 370	98. 1 *0.6*
All	**127 774**	**98.4** ***0.1***
Uncemented stem 2007–2018		
Accolade Straight	1 762	96.7 *1.5*
Bi-Metric[2)]	8 983	98.0 *0.4*
CLS	10 342	98.2 *0.4*
Corail[3)]	26 862	97.8 *0.4*
Wagner Cone	1 755	97.7 *1.3*
All	**49 704**	**97.9** ***0.2***

Table 7.2.1. Implants in the control groups during analysis of reviewed implants in tables 7.2.2–7.2.4. For cups, only cup revisions, and for stems, only stem revisions have been included. All causes except infection are included.

[1)] Cup and stem survival respectively excluding revision due to infection.

[2)] Several variants are included (X por HA NC, por HA, and HA FMRL).

[3)] Several variants are included (standard, high offset, coxa vara).

Reviewed cups, number of revisions, and implant survival

	Starting year	Number		Follow-up, years	Cup revisions[1] number, %		Implant survival[1, 2] cup/liner, 2 SEM	
		total	followed 2 years	average, *max*	total	≤ 2 years	2 years	5 years
Cup cemented								
ADES cemented	2013	345	160	1.9 *5.1*	4 *0.5*	2 *0*	99.4 *0.6*	–
Avantage Cemented	2007	3 291	1 553	2.4 *11.9*	49 *1.8*	38 *1.4*	98.5 *0.5*	97.5[3] *0.8*
Exceed ABT E-poly	2014	455	383	4.4 *7.8*	4 *0.9*	1 *0.2*	99.5 *0.7*	98.9 *1.2*
Exeter X3 RimFit	2010	16 907	10 388	3.1 *8.4*	65 *0.4*	44 *0.3*	99.7 *0.1*	99.4[4] *0.2*
Lubinus X-linked	2010	29 158	17 684	2.8 *8.9*	119 *0.4*	84 *0.3*	99.6 *0.1*	99.3[4] *0.1*
Koncentrisk X-linked IP	2011	1 684	892	2.3 *7.8*	11 *0.7*	7 *0.4*	99.4 *0.4*	98.2 *1.8*
Polar cup	2010	786	435	2.2 *6.9*	5 *0.9*	4 *0.7*	99.0 *0.8*	98.7 *1.0*
Control group[5]	2007	84 066	73 430	6.2 *12.0*	1 138 *1.4*	373 *0.4*	99.5 *0.1*	99.0 *0.1*
Cup uncemented								
ADES uncemented new	2013	345	160	1.9 *5.1*	4 *1.2*	2 *0.6*	99.4 *0.8*	–
Continuum	2010	4 810	3 412	3.4 *9.2*	73 *1.5*	55 *1.1*	98.7 *0.4*	98.1[3] *0.5*
Delta TT	2012	573	258	2.8 *7.1*	4 *0.7*	4 *0.7*	99.2 *0.8*	99.2 *0.8*
Exceed ABT Ringloc	2011	1 905	1 382	3.6 *8.3*	10 *0.5*	7 *0.4*	99.6 *0.3*	99.5 *0.4*
G7 PPS	2015	244	76	1.2 *3.8*	2 *0.8*	2 *0.8*	98.3 *2.6*	–
Pinnacle 100	2007	2 998	1 982	4.0 *11.9*	34 *1.1*	12 *0.4*	99.4 *0.3*	98.5 *0.6*
Pinnacle W/Gription 100	2011	5 362	1 934	1.8 *7.3*	36 *0.7*	30 *0.6*	99.2 *0.3*	98.7 *0.5*
Pinnacle W/Gription sector	2014	925	285	1.6 *5.4*	6 *0.6*	6 0.6	98.2 *0.6*	–
Regenerex	2008	942	803	4.6 *10.4*	7 *0.8*	2 *0.2*	99.5 *0.5*	98.8 *0.9*
TM revision	2008	543	409	4.5 *11.8*	18 *3.3*	14 *2.6*	97.3 *1.4*	96.6[3] *1.9*
Trilogy IT	2011	1 589	1 064	2.9 *7.2*	35 *2.2*	30 *1.9*	97.9 *0.8*	97.4[3] *0.9*
Tritanium	2010	796	628	4.5 *9.1*	11 *1.4*	2 *0.3*	99.6 *0.5*	98.5 *1.0*
Control group[5]	2007	17 534	13 538	5.5 *12.0*	187 *1.1*	85 *0.5*	99.5 *0.1*	99.0 *0.2*

Table 7.2.2. Cups introduced on the Swedish market from 2007 and onwards, and that have been used in more than 50 hip arthroplasties during the last two years, and furthermore, which have been in use during 2018. A bold caption of the cup name signifies that the two or five year survival is poorer than for the control group (log-rank test).

[1] All causes except infection.
[2] Data is only presented for a minimum of 50 observations.
[3] A poorer outcome compared to the control group. p < 0.0005, log rank test.
[4] Better survival compared to the control group. p < 0.0005, log rank test.
[5] See table 7.2.1

of a certain implant operates at another unit. Nevertheless, even if there may exist several highly plausible explanations for this picture, there is however a remarkably large number of units, which use implants with an uncertain documentation only occasionally.

Cemented cups

The cemented cups analysed this year are more or less the same as those analysed last year (table 7.2.2). None of them has a documented 10-year survival in the registry based on at least 50 observations. Exceed ABT E1 (non-flanged) has returned due to an increased usage. Two of the cups with plastic radiated with a high dosage to increase wear resistance, have a significantly better prosthesis survival compared to the control group. The exceptionally low revision frequency for these cups is interesting. However, it remains to be seen if this means a better result in a longer perspective, and if that is the case how generalizable this observation is. The manufacturing processes differ between different producers, and this is probably true when it comes to the quality of the new plastic as well.

As before, Avantage performs poorer than the control group. If this could be explained entirely by patient related risk factors is hard to tell (see in-depth analysis in the annual report of 2017). The reason for the poorer outcome of the Avantage cup remains unclear, even if case-mix surely plays a part. This cup is chosen more often for older patients with a hip fracture compared to the control group (table 7.2.4). The other two dual mobility cups that are part of the analysis (ADES, Polar cup) also show this case-mix pattern, but are not associated with inferior survival. These two designs have added to the table for comparison. Both ADES and the Polar cup have however been used in fewer cases and have a shorter follow-up. Moreover, the comparison may be flawed, since we do not have complete indicators for comorbidity during this period. Based on ASA class, the differences are however relatively small. In the group that have been given Avantage, 56.3% of the patients are classed as ASA III or higher, in the groups operated with Polar cup and cemented ADES respectively, the proportions are slightly lower, 46.9% and 44.5%, and in the control group considerably lower (20.6%).

Uncemented cups

Among the uncemented cups, one dual mobility cup has been added (ADES uncemented) and one has been excluded (R3), as it was not in use at all during 2018. As before, three cups are worse off (Continuum, Trilogy IT, TMT Revision, $p < 0.0005$, log-rank test). In all cases, dislocation is the most common cause of revision and regarding TMT Revision and Trilogy IT almost the only cause. These cups could possibly be harder to position correctly and/or be constructed in a way that facilitates dislocation. These theories remain speculative however, and if possible, the reason behind the problem of dislocation should be studied in randomised clinical trials in order to survey possible causes.

To get a somewhat more nuanced picture we present detailed demographic, and implant related data, and choice of surgical approach for each cup respectively, in the report of this year. For comparison, we have used the Trilogy cup, whose use has diminished gradually despite having a better survival, at least in a five-year perspective (figure 7.2.3 and figure 7.2.4).

Here there are certain differences between the groups, which could have some effect on the outcome (table 7.2.5). The proportion of patients classed as ASA III is higher for the group who has been given Trilogy IT and TMT cups, and the latter group has a higher proportion of secondary osteoarthritis as well. Smaller sized heads are also more common when using the TMT cup, and when using the older variant of the Trilogy cup, a consequence of the fact that these cups have been in use for a longer period of time. A posterior approach is the most common choice for the Trilogy IT and TMT cups. The use of liner differs considerably between the groups. Liner of the standard type has been used above all with the Continuum cup (73.9%) and Trilogy IT (27.8%), and only in 4.5% of the cases when inserting the older model of the Trilogy cup.

In an attempt to nuance the picture, we have studied the risk of non-infectious cup revision during the first five years in a Cox regression model. In an unadjusted model, we find a statistically significant risk increase, which varies between 2.1 (risk ratio for Continuum, 95%-confidence limits = 1.5-3.0) and 3.7 (TMT: 2.1-6.6). Trilogy IT lies in between (3.2, 2.2-5.0). The original Trilogy model is the reference (risk ratio = 1). After adjusting for the choice of liner, the risk increase for the latter two remains but not for Continuum (1.3 0.8-2.0). Additional adjustment for age, gender, diagnosis (primary/secondary osteoarthritis), stem fixation (cemented/uncemented), surgical approach (posterior, lateral, others), and head size (≤ 28 mm, 32 mm/≥ 36 mm) affect the picture somewhat but the increased risk for cup revision remains for two of the implants (adjusted risk ratio, all the above mentioned variables included: Trilogy IT: 2.7, 1.7-4.4; TMT: 2.5, 1.4-4.6; Continuum 1.3, 0.8-2.2). Adjusting also for ASA class and BMI, or excluding hips with 22 mm caput sizes, only affects the result marginally.

Hence, if we try to take into consideration the factors we know of and can adjust for, both the Trilogy IT and the TMT cups have an increased risk of non-infectious cup revision during the first five years after the primary operation. We also find that the use of a liner with some kind of built-in protection against dislocation decreases the risk of revision considerably during the five first postoperative years (adjusted risk ratio in the analysis: liner with protection against dislocation/standard liner: 0.4, 0.2-0.6).

In summary, it could not be shown that any of the three trabecular tantalum cups on the Swedish market have led to an improved implant survival compared with the version of the Trilogy cup, which was launched in Sweden during the mid-1990s. Two of them even exhibit an increased risk of revision, although care always has to be taken when assessing registry analyses since the results may have been influenced by factors of which we are not aware.

Our results align relatively well with several international studies, but not with all. Against this background the use of these implants in primary operations could be questioned, at least to the extent that presently is the case. The choice of lipped liners seems to have a beneficial effect on the early outcome. If this holds also in the longer perspective is not clear, as secondary effects due to impingement between the neck of the prosthesis and the elevated rim of the cup cannot be ruled out.

New cemented stems

During recent years, no completely new stem, which fulfils the review criteria, have been introduced. Nevertheless, we have conducted an analysis of the Lubinus SP II-stem of length 130 mm also this year and furthermore added the short Exeter stem (125 mm). We follow the SP II-stem since the question has arisen if a stem length of 150 mm can be switched for a stem length of 130 mm without increasing the risk of revision. A possible advantage with the shorter variant could be that a potential future revision is facilitated. Theoretically, the transition of load to the femur would be more beneficial, but any safe data based on clinical material is missing, and it is not clear if such a potential difference has a clinical significance.

From 1999, the first year the registry could separate implant components on a more detailed level, 1,700 SP II with length 130 mm have been reported, of which the majority have been inserted starting in 2014. This year's analysis, starting in 2007, includes 1,628 operations. The number of Lubinus SP II with a short stem are thus relatively few. During the years 2007-2018, they accounted for 2.1% of all SP II stems used in primary arthroplasty.

The short Exeter stem is in the registry since 2005 when four stems were reported, followed by two additional ones in 2006. Theoretically, this stem with its smaller area in contact with cement could present a deviating result. Since 2007, 897 stems of 125 mm length have been reported, which corresponds to 2.2% of all Exeter stems inserted in the period 2007-2018. In the short perspective, the short SP II-stem as well as the short Exeter stem seem to work well with approximately the same two-year survival as the control group.

New uncemented stems

Compared to the annual report of 2017, three variants of the Bi-Metric stem are now part of the control group. Furthermore, the ABG II-stem has been excluded since the 10-year survival lies just below the acceptable limit, which means 95% implant survival based on stem revision due to a non-infectious cause. It also has a poorer result compared to the control group with an increased percentage of stem revisions due to loosening, dislocation, and periprosthetic fracture where the last cause is the most prominent. An increased risk of revision of the ABG II-stem due to periprosthetic fracture has also been pointed out earlier in a study from the Nordic registry collaboration (NARA, Nordic Arthroplasty Register Association).

Two of the stems, which are evaluated here (Accolade II and M/L Taper) exhibit a slightly higher stem survival than the control group. The SP-CL-stem, which was introduced onto the Swedish market in 2014 and 2015, is still in very moderate use. So far, only one revision due to non-infectious cause has been reported. The majority of these implants are part of different studies, the results of which should be available before a decision can be made on increased usage, preferably in the form of a multi-centre study.

The majority of the implants that have been added to the Swedish market since 2007, show good or acceptable results, but some of them are not on par with today's standard. The reason for this could be adverse patient selection or other causes not apparent in a registry analysis.

The Avantage cup still exhibits an increased risk of revision. The reason is unclear but will become easier to assess when long-term results are made available for other designs of dual mobility cups.

None of the two cups with trabecular tantalum surface or the Trilogy IT shows a lower risk of cup revision compared to the original Trilogy cup. Two of them even have a lower cup survival despite adjusting for differences between the groups regarding demography, approach, caput, liner design, and stem fixation.

The ABG II-stem exhibits an increased risk of stem revision compared with a concurrent control group, mainly due to the increased risk of periprosthetic fracture.

The introduction of highly cross-linked plastic for cemented cups has not been associated with negative outcomes; on the contrary, we see the opposite for many of them.

Studied stems, number of revisions, and implant survival

	Starting year	Number		Follow-up, years	Cup revisions[1] number, %		Implant survival[1, 2] cup/liner, 2 SEM	
		total	followed 2 years	average, *max*	total	≤ 2 years	2 years	5 years
Stem cemented								
Exeter 125 mm	2007	897	395	2.0 *11.2*	4 *0.4*	3 *0.3*	99.6 *0.5*	–
Lubinus SP II 130 mm	2007	1 628	730	2.0 *11.9*	7 *0.4*	3 *0.2*	99.8 *0.2*	–
Control group[5]	2007	127 774	99 517	5.2 *12.0*	893 *0.7*	308 *0.2*	99.7 *0.03*	99.4 *0.05*
Stem uncemented								
ABG II	2007	2 815	2 437	6.4 *12.0*	88 *3.1*	50 *1.8*	98.1 *0.5*	97.6[3] *0.6*
Accolade II	2012	2 201	1 275	2.6 *6.9*	8 *0.4*	8 *0.4*	99.6 *0.3*	99.6[4] *0.3*
Echo Bi-Metric	2013	333	184	2.0 *6.0*	4 *1.2*	4 *1.2*	98.5 *1.6*	–
M/L Taper	2012	1 270	953	3.3 *6.8*	4 *0.3*	3 *0.2*	99.7 *0.3*	99.6[4] *0.4*
SP-CL	2015	197	37	1.3 *3.8*	1 *0.5*	1 *0.5*		
Control group[5]	2007	49 704	37 151	4.8 *11.0*	499 *1.1*	355 *0.8*	99.2 *0.1*	98.8 *0.1*

Table 7.2.3. Stems introduced on the Swedish market from 2007 (or earlier, but in that case only inserted during a few operations) and that have been used in more than 50 hip arthroplasties during the last two years, and furthermore, which have been in use during 2018. None of the stems have a poorer result than the control group (log-rank test).

[1] All causes except infection.
[2] Data is only presented for a minimum of 50 observations.
[3] A poorer survival compared to the control group. $p < 0.0005$, log rank test.
[4] A somewhat better survival compared to the control group. $p < 0.05$, log rank test.
[5] See table 7.2.1.

Demography and reason for revision for implants that deviate from the control group, and other implant selected for comparison[#)]

Type of implant	Age	Gender	Diagnosis, %	Reason for revision number, % av total[1), 3)]			
	Average, *SD*	Women, %	Primary osteo-arthritis/fracture + sequelae/other secondary osteo-arthritis	Loosening/ osteolysis	Dislocation	Peripros-thetic fracture	Other[1)]
Cemented cup							
Avantage Cemented	75.6 *10.8*	62.9	20/66/14	10 *(0.3)*	20 *(0.6)*	14 (0.4)	8 (0.2)
ADES[2)]	74.2 *11.5*	61.4	32/57/11	1 *(0.3)*	2 *(0.6)*	1 (0.3)	0
Polar cup[2)]	76.1 *9.3*	63.2	13/77/10	1 *(0.1)*	5 *(0.6)*	2 (0.3)	0
Control group	71.1 *8.8*	61.4	83/11/6	585 *(0.7)*	454 *(0.5)*	54 (0.1)	34 (0.04)
Uncemented cup							
Continuum	60.3 *10.3*	48.2	85/3/12	8 *(0.2)*	55 *(1.1)*	2 (0.04)	8 (0.2)
TM revision	60.4 *14.0*	44.6	51/6/43	1 *(0.2)*	16 *(2.9)*	0	1 (0.2)
Trilogy IT	62.5 *11.2*	43.5	83/4.0/13	1 *(0.1)*	31 *(2.0)*	1 (0.1)	2 (0.1)
Control group	60.2 *11.1*	46.8	81/4/15	68 *(0.4)*	76 *(0.4)*	15 (0.1)	28 (0.2)
Uncemented stem							
ABG II HA	59.3 *8.7*	48.4	90/1/9	25 *(0.9)*	9 *(0.3)*	52 (1.8)	2 (0.1)
Control group	60.3 *10.4*	47.6	85/3/12	562 *(0.4)*	170 *(0.1)*	368 (0.3)	140 (0.1)

Table 7.2.4. Demographic data and reason for revision for those cups and stems, which have been analysed in table 7.1.2 and 7.1.3, and differ from them in a significant way by a poorer implant survival. Two dual mobility cups (ADES cemented and Polar cup) that not have deviating results have been included for comparison.

[#)] Year of surgery and number of operated according to tables 7.2.2 och 7.2.3.
[1)] Excluding infection.
[2)] Implant survival within expected interval, data is presented for comparison.
[3)] During analysis of cups, only cup revisions are included, and during analysis of stems, only stem revisions are included.

Patient demography and implant related variables for primary hip arthroplasties where the studied cups with a trabecular/porous surface have been used. Data for the Trilogy cup (control) is shown for comparison. Only operations between 2007 and 2018 are included.

	Studied cups			Control
	Trilogy IT	TM revision	Continuum	Trilogy ± HA
Number	1 589	543	4 810	7 477
Follow-up average, max, *SD*	3.0 *7.2* *1.8*	4.5 *10.8* *2.8*	3.4 *9.2* *2.1*	6.2 *11.0* *3.1*
Age average, *SD*	*62.5* *11.3*	60.4 *14.0*	60.6 *10.3*	59.1 *10.8*
Proportion of women, %	43.5	44.6	48.2	47.3
BMI				
Number of reported cases, *%*	1 584 *99.7*	519 *95.6*	4 639 *96.4*	6 500 *86.9*
Average, *SD*	*27.5* *4.6*	27.8 *5.4*	28.0 *4.7*	27.4 *4.5*
ASA class				
Number of reported cases, *%*	1 585 *99.7*	523 *96.3*	4 747 *98.7*	6 606 *88.4*
I, %	25.9	23.7	31.8	39.6
II, %	46.6	53.3	56.4	49.9
≥ III, %	27.5	23.0	11.8	10.5
Primary operation diagnosis, %				
Primary osteoarthritis	82.6	51.4	85.0	78.5
Fracture/trauma including sequelae	4.1	6.1	2.9	5.4
Other secondary osteoarthritis	13.3	42.5	12.1	16.1
Femoral head material metal/ceramics, %	70.9/29.1	83.6/16.4	85.0/14.9	95.6/4.4
Head size, %				
22 mm	-	0.7	-	0.3
28 mm	0.3	30.2	3.9	12.4
32 mm	82.1	61.1	78.5	76.9
≥ 36 mm	17.6	7.9	17.6	10.4
Type of liner, %				
Standard	27.8	4.2	73.9	4.5
With protection from dislocation (all variations)	72.1	88.2	25.9	95.3
Unknown or cemented DMC	0.2	7.6	0.2	0.2
Surgical approach, %				
Direct lateral in supine or lateral position	14.6	16.9	73.1	68.2
Posterior	85.3	82.4	25.7	30.8
Other	0.1	0.7	1.2	1.0
Cemented stem %	11.6	26.3	7.9	12.8
Cup revision non-infectious cause, %				
All observations	2.2	3.3	1.5	1.1
Within 5 years	2.2	2.9	1.5	0.8

Table 7.2.5 Patient demographics and implant related variables for primary hip arthroplasties where a cup made out of trabecular tantalum has been used. Data for the Trilogy cup with a porous titanium surface is shown for comparison.

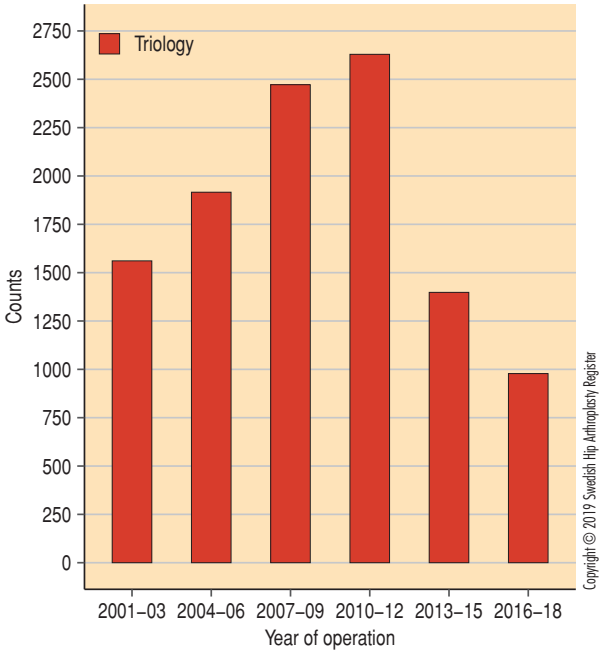

Figure 7.2.1. The number of reported operations where a Trilogy cup with a porous titanium surface has been used. The diagram shows the total number for each three-year period respectively. During the last period (2016–2018) more than 300 cups/year were inserted.

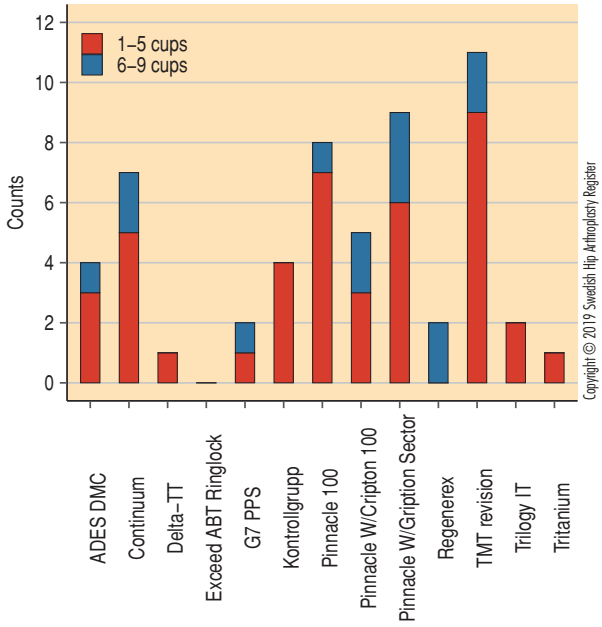

Figure 7.2.2. Units that have reported insertion of one to five and six to nine uncemented cups respectively of those types presented in table 7.2.2 over the last two years (2017–2018).

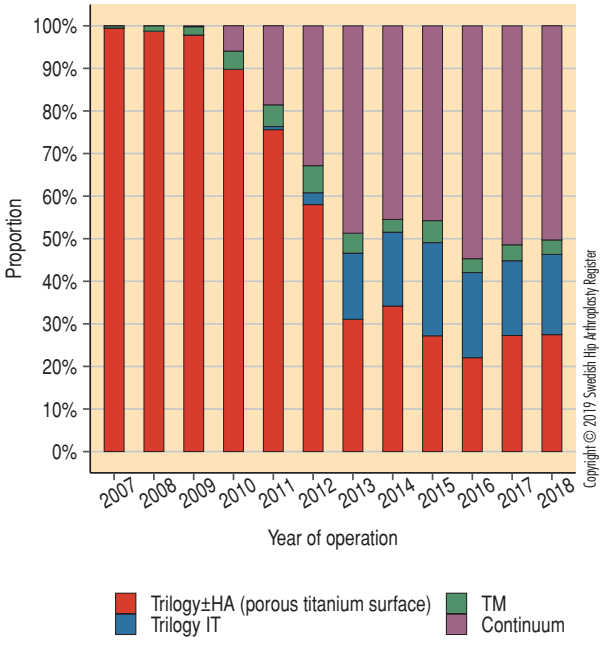

Figure 7.2.3 Relative distribution between the use of the Trilogy cup with a porous titanium surface and 3 different cups with a surface of trabecular tantalum during the years 2007–2018.

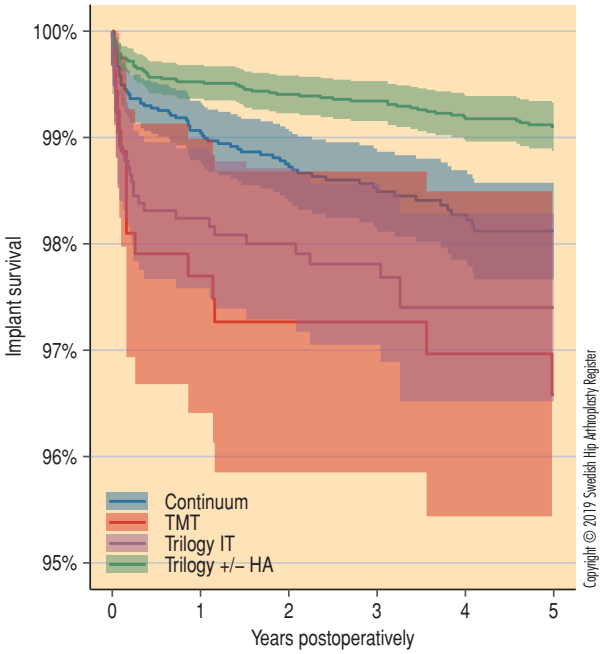

Figure 7.2.4. Cup survival based on non-infectious reason for cup revision. Trilogy±HA = green line, Continuum = blue line, TMT Revision = red line, Trilogy IT = purple line.

8 Reoperation

8.1 Definition and trends

Reoperation encompasses all types of surgical interventions, which are associated to an inserted hip prosthesis, regardless if any parts of it have been changed, extracted, or have not been touched. The proportion of all reoperations relative to the sum of the number of primary arthroplasties and the number of reoperations during one year, have tended to decrease since 2000 when it was 14.1%. In 2017, it had dropped to 10.4%, and in 2018, it was 9.8%. The low proportion during the last year could however partly be explained by a certain delay of the reporting (figure 8.1.1). The number of reoperations carried out increased from 1,861 in 2000 to just above 2,700 in 2009, and remained relatively constant until 2015. In 2016, the number dropped to 2,585 with a weak tendency of additional reduction during the following two years (figure 8.1.2). The reason behind this decrease is not known, it could be real, but it could also be the result of underreporting of the reoperations where no parts of the prosthesis are changed or extracted, for example irrigation and debridement due to infection, or internal fixation of a Vancouver type C fracture.

The relationship between reoperations and primary operations provides some guidance to what extent reoperations affect the resource use of hip arthroplasty in the healthcare in a country or in a certain area, but is not appropriate to use for other means, due to its sensitivity for fluctuations in the number of primary operations carried out. The quotient is also influenced by many other factors such as patient flow between healthcare areas, the attitude among doctors towards carrying out reoperations, and by the period of time hip arthroplasties have been carried out within a healthcare area. When comparing national registries, which have been active for a longer period of time, this quotient can however be interesting. Except for the Swedish one, almost all national registries collect data on revisions and not on all reoperations (figure 8.1.3).

The reporting of reoperations is poorer than for primary operations. This is especially true of reoperations where the implant is left untouched. As we have previously pointed out, the increase of the number of reoperations, which do not affect the implant (other reoperations), that we see after the turn of the millennium, probably could be explained by the fact that the data capture, at this time and during around ten years thereafter, not only encompasses cases that have been reported to the Swedish Hip Arthroplasty Register, but also operations which have been identified during linkage with the Patient Register, or indirectly via the Drug Register. Since the 'other" reoperations, which actually are carried out provide important information, especially when it comes to the assessment of the occurrence of deep prosthesis infection and periprosthetic fracture, it is very important that they are reported. Through a collaboration with the Swedish Fracture Register and continued validation via the Patient Register, and regarding infections via the Drug Register as well, we hope that the completeness will be continuously improved. We also hope that an increased awareness in the professional community regarding the importance of reporting these measures also will make a difference.

The distribution of reoperations between hospitals

The majority of reoperations are carried out in county hospitals followed by local hospitals (figure 8.1.4 A-D). During

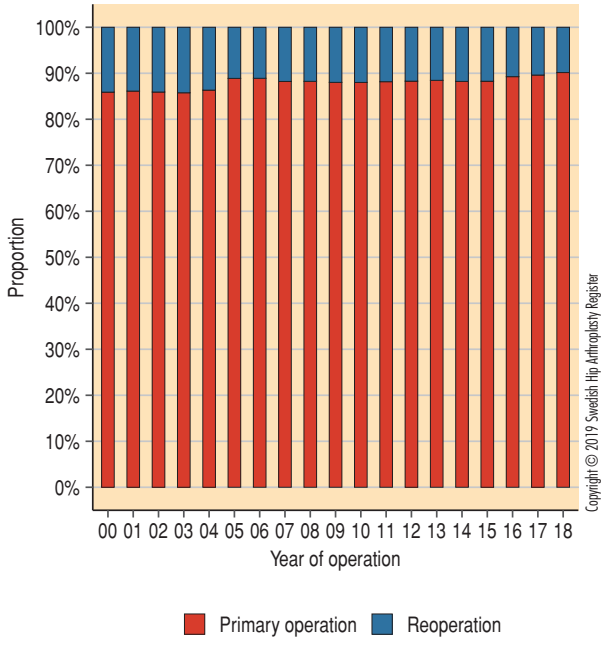

Figure 8.1.1 Distribution of reoperations (revisions+other reoperations) and primary total hip arthroplasties during the period 2000–2018.

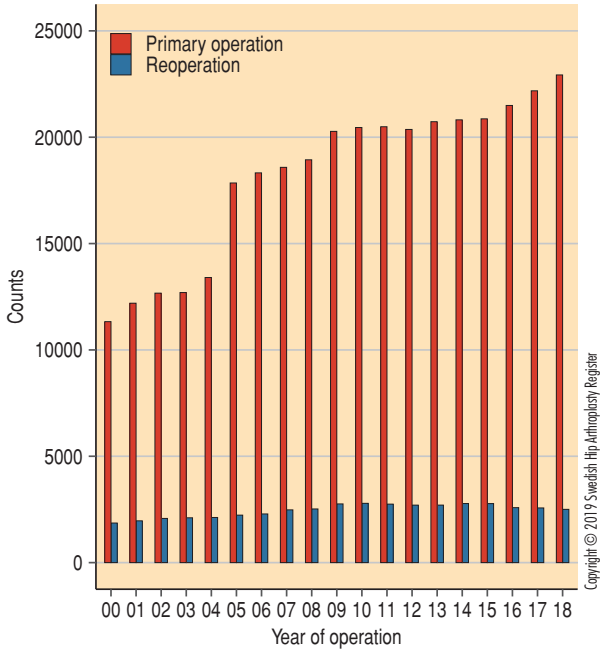

Figure 8.1.2. The number of reoperations during the period 2000–2018.

the period 2000-2018, these operations were carried out at 98 different units, of which some only have been active during parts of the period. Local hospitals carried out just under 40%, county hospitals around 27%, private hospitals about 22%, and university or regional hospitals around 11% of all operations. The variation of the number of primary operations and reoperations per unit during the whole period is large. For primary arthroplasties, the span is between 25 and 13,204, and for reoperations between 1 and 2,161.

Demography

The demography of patients undergoing a reoperation has changed over time. The changes that have taken place since 1981 were described in the annual report for 2015. We found that the average age had increased by almost three years between the periods 1981-1995 and 2011-2015, and that the proportion of patients aged 85 years or more had increased from 3.1% to 11.4%.

This year's report compares 3 periods (2008-2010, 2012-2014, 2016-2018, table 8.1.1). Moreover, the corresponding data for primary arthroplasties is shown for comparison. During the last 11 years, the age distribution during reoperation has been relatively static. Numerically more women than men undergo a reoperation, although this difference is not as great as it is for a primary operation, which reflects that men are reoperated on more frequently, a difference that is not found in all registries. The proportion of patients with a BMI of 30 or higher increased from 24.1% to 27.2% between the periods 2008-2010 and 2016-2018. If the patient group that underwent a primary arthroplasty 2016-2018 is compared with the group who underwent a reoperation during the same period, it is found that the proportion of those with a BMI of 30 or higher is larger in the latter group (24.1% in the primary group, 27.2% in the reoperation group). In general, patients undergoing a reoperation have a higher degree of comorbidity than those undergoing a primary arthroplasty. Furthermore, the proportion of those with an ASA class of III increases for each period studied. During the most recent period, 41.5% of the reoperations are carried out on patients with an ASA class of III or higher. The corresponding proportion for primary operations is approximately half of that during the same period. The distribution of diagnoses also differs between the two groups.

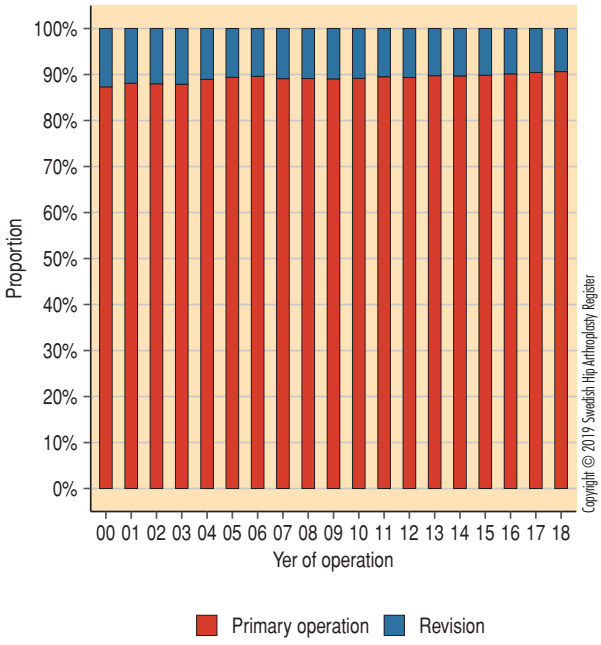

Figure 8.1.3. The distribution between revisions and primary hip arthroplasties during the period 2000–2018.

Cause of reoperation irrespective of measure

In general, a reoperation could mean that implants are changed, inserted, extracted, or are not affected by any of these measures (figure 8.1.5), and in the latter case it is called an "other reoperation". In figure 8.1.6, causes behind all these three types of reoperation that account for at least 1% of the cases divided into three-year periods are shown starting with 1998. During "two-stage" operations, only the cause of session one has been counted. The most common cause of reoperation is loosening. The proportion of this cause has however decreased from 58.5% 1998-2000 to 35.2% during the period 2006-2018. The proportion of reoperations due to infection has increased from 9.3% to 28.9% during the same period, and the proportion of reoperations due to periprosthetic fracture has also increased from 10.3% to 14%, with a certain variation over the whole time period of 21 years. Revision due to dislocation/instability lies relatively stable between 12.0% (2010-2012) and 14.6% (2004-2006) without any clear-cut trend. Wear and osteolysis constitute relatively small proportions of all reoperations (2.9 and 1.8% respectively during the whole period). These are cases where wear or osteolysis have been deemed being the main reason why a reoperation was carried out. Interestingly, these causes taken together have a peak during the period 2004 to 2006 (7.2%, 437 operations) which has gradually decreased to 2.5% (161 operations) during the last three years. This reduction could be the result of a successive transition to better plastic materials and possibly also due to an increased use of heads made out of ceramic materials.

Reoperation due to infection

Starting with the three-year period 2001-2003, infection and periprosthetic fracture have been the two most common causes of reoperation when the implant is not affected (figure 8.1.7). As previously has been pointed out, the frequency variations could partly be explained by the varying quality of the data capture. However, the increased number of reoperations and the increasing proportion of cause infection should be assessed against an increasing proportion of primary surgeries, a more active approach to surgical intervention in suspected infection and as a secondary effect of a reduction in the proportion of surgeries due to luxation (open reposition without implant replacement). A more correct picture emerges when the number of reoperations due to infection, regardless if the implant is affected or not, is related to the number of all other hip arthroplasties carried out during a defined period (figure 8.1.8). In

Figure 8.1.4 A-D Distribution of reoperations and primary total hip replacements between different types of hospitals between 2000 and 2018. Most of the reoperations were carried out at county hospitals, which are five times more numerous than university hospitals.
A = University Hospital, B = County Hospital, C = Rural Hospital, D = Private Hospital

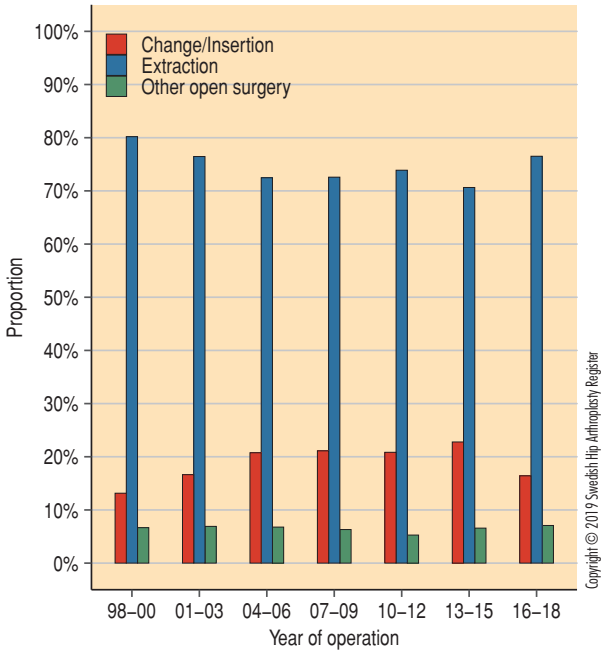

Figure 8.1.5. Distribution between change of prosthesis/insertion, extraction, and "other" reoperations where the implant is not affected.

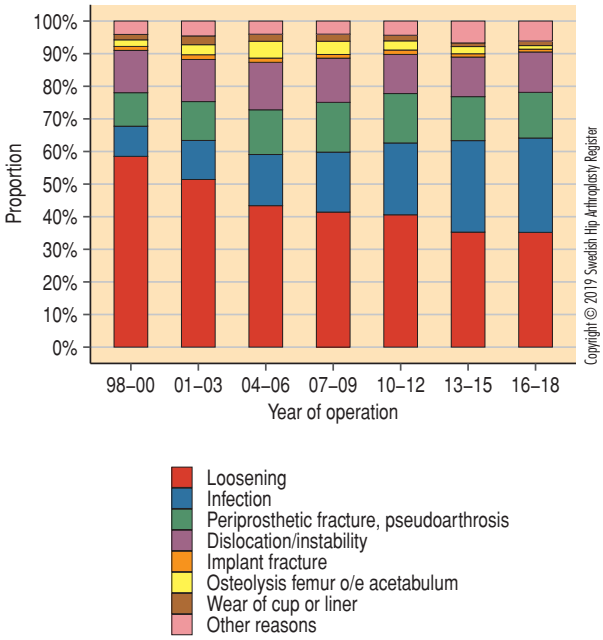

Figure 8.1.6. Reasons for reoperation (irrespective of whether the implants are changed, extracted, or are left untouched) during the period 1998–2018 divided into three-year periods. Reasons reported for less than 1% are not presented.

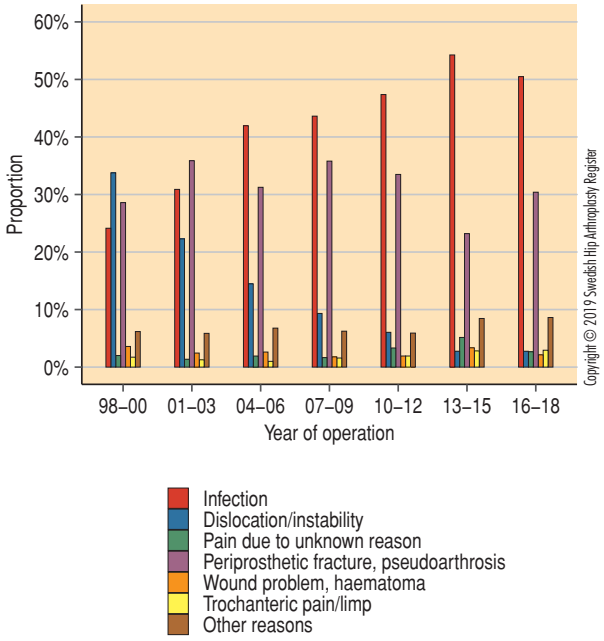

Figure 8.1.7. Reasons for other reoperations (implants are left untouched) during the period 1998–2018 divided into three-year periods. Reasons reported for less than 1% are not presented.

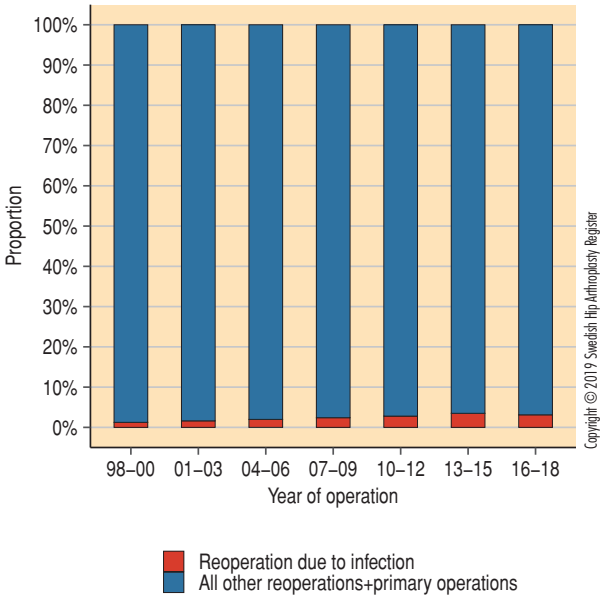

Figure 8.1.8. The proportion of reoperations that are carried out per three-year period due to infection related to all operations regardless of cause + the number of primary operations during the same period.

the annual reports of 2016 and 2017, we showed that the result measured as risk of an additional reoperation due to infection is far worse if the head is not changed, and when applicable also the liner. Probably, it is not only the change of components by themselves that make the difference. A change of head and when applicable also liner, probably indicates that the joint really has been opened, and that a surgeon with knowledge of arthroplasty has been involved, since a certain basic knowledge in this field is needed in order to be able to identify the right components and to be able to extract and insert a new liner for example. With a knowledge of arthroplasty comes probably also a knowledge of how to carry out the art of debridement and rinsing in these cases. Thus, it is quite safe to say that a change of head and liner not only reflects the specific measure, but also that the operation overall has been carried out in a more optimal way. The decrease of the proportion of reoperations due to infection without change of components should probably be viewed against this background.

Reoperation due to periprosthetic fracture

Fracture is the second most common cause of reoperation with no change or extraction of the prosthesis or its parts. During 1998-2018, 8,203 reoperations due to periprosthetic fracture of the femur were registered. Other cases are acetabular fracture (n = 21), fracture under resurfacing prosthesis (n = 57), fracture during operation (n = 5), or pseudoarthrosis (n = 248). In the 7,607 cases when the location of the fracture is reported, trochanteric fracture accounts for 4.5%, fracture at the same height as that of the prosthesis (Vancouver type B) accounts for 61.3%, and fracture distally of the prosthesis accounts for 34.2% (Vancouver type C). However, it should be noted that trochanteric fractures often are treated without operation and as a result are not reported to the registry, and that Vancouver C fractures more often are underreported than Vancouver B fractures, since they more often are treated with internal fixation and no revision. The linkage with the Patient Register, as mentioned above, however ought to mean that this underreporting will decrease.

Measure and cause of reoperation without implant change/extraction

At the end of the 1990s, the most common cause of reoperation where no existing implants were changed or extracted, was dislocation, reflecting a relatively high frequency of open reduction (figure 8.1.7, 8.1.9). However, the proportion of dislocation (open reduction) decreased after the turn of the millennium and accounted for only 2.8% during the period 2016 to 2018. A more active stance, when it comes to dislocation problems with a lower threshold for carrying out a revision, probably is the reason behind this change. Moreover, modular components are used more often, enabling change of head and when applicable liner.

During the last 21 years, fracture reconstruction without change or extraction of implant has accounted for 22.8 to maximally 35.9% of the procedures (figure 8.1.9). The proportion of wound revisions with or without debridement and irrigation has increased along with the increasing number of infections, even if infection is not demonstrated in a minority of cases. Operation with an acetabular wedge augment, which until 2005 was a relatively common measure (around 50 operations per year as an isolated procedure), has decreased successively. In 2018, one case was registered. In total, exploration of the hip was carried out in 169 operations with no other measure reported. In less than half of the cases (40.8%) infection was suspected, in 45 cases (26.6%) uncertain pain was reported, and in the rest of the cases the causes are diverse. In 15 cases, no cause is reported.

Make sure all reoperations are reported, also those where no part of the prosthesis is changed. The reoperation frequency is one of our most important quality parameters.

Patients undergoing a reoperation are more often males, have more frequently secondary osteoarthritis, and a higher BMI and ASA class compared to the distribution seen for primary hip arthroplasty. Furthermore, during the last ten years patients with BMI over 30, and ASA class III are overrepresented among those who undergo reoperations.

The two most common reoperation procedures without implant change or extraction are debridement and irrigation due to infection, and osteosynthesis due to periprosthetic fracture.

Since 2010, around 3% of the operations carried out on the population who undergo or have undergone total hip arthroplasty, have been performed due to infection.

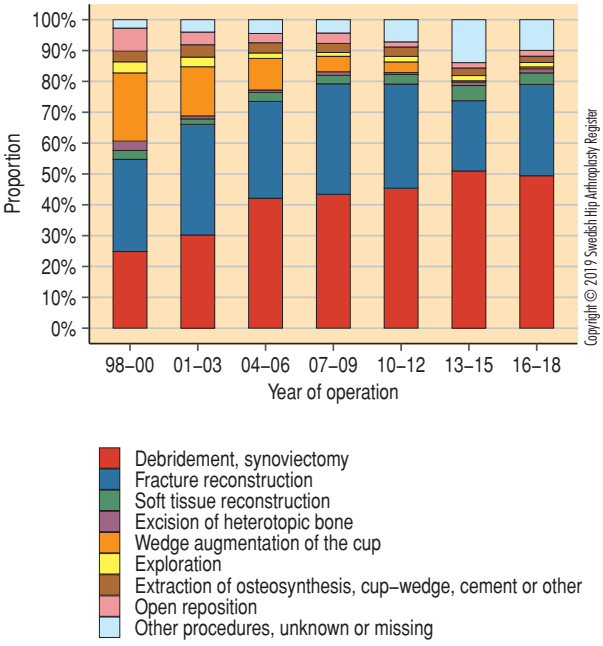

Figure 8.1.9. Measure taken during other reoperation.

Demography at reoperation starting with the first year of registration of BMI and ASA classification. Primary operations carried out during the last period 2016–2018 for comparison.

	Reoperation			Primary operation
	2008–2010	2012–2014	2016–2018	2016–2018
Number	7 152	7 240	6 854	54 043
Age				
Average, *SD*	71.9 *11.3*	71.5 *11.4*	72.1 *10.9*	69.0 *10.7*
< 55 years, %	7.4	7.8	7.0	10.2
55–69 years, %	30.8	31.6	28.5	36.7
70–84 years, %	50.0	49.5	52.9	48.0
>= 85 years, %	11.8	11.5	11.5	5.1
Gender				
Proportion of women, %	53.7	50.2	51.4	58.1
BMI				
Number of reported cases, *%*	5 098 *71.5*	6 263 *86.5*	6 298 *91.9*	52 244 *96.7*
Average, *SD*	27.1 *5.7*	27.3 *5.6*	27.4 *5.8*	27.1 *4.5*
< 18,5 %	2.0	1.8	1.4	1.1
18,5–24,9 %	34.2	32.0	33.4	33.2
25–29,9 %	39.7	41.8	38.0	41.4
30–34,9 %	18.1	17.1	19.6	18.8
> 35 %	6.0	7.4	7.6	5.5
ASA class				
Number of reported cases, *%*	6 028 *83.3*	6 785 *93.7*	6 585 *96.1*	53 346 *98.7*
I, %	13.2	11.0	8.2	20.3
II, %	52.6	50.9	50.3	58.9
III–, %	34.2	38.1	41.5	20.8
Primary operation diagnosis				
Primary osteoarthritis	70.4	72.1	74.5	81.2
Fracture/trauma including sequelae	10.0	10.9	9.8	11.8
Inflammatory joint disease	6.7	5.5	4.1	0.7
Sequelae childhood disease	4.4	3.6	3.3	1.7
Idiopathic necrosis	1.7	1.9	2.6	2.3
Other secondary osteoarthritis	3.0	3.5	4.4	2.3
No data	3.8	2.5	1.3	0

Table 8.1.1. Distribution of gender, age, BMI, and ASA during all types of reoperations during three periods from 2008 to 2018. Data for patients who underwent a primary arthroplasty 2015-2018 are shown for comparison. Diagnosis data may differ from previous year partly due to a new classification of ICD-10 codes.

8.2 Reoperation within two years

Reoperation within two years is used as a quality indicator for primary hip arthroplasties. The distribution of cause of early reoperation has however varied, especially during the first year (figure 8.2.1). In the beginning of the 2000s, dislocation and deep infection were about just as common. The proportion of reoperations due to dislocation has however decreased while the proportion of reoperations due to infection has increased. This could reflect that we have become better at identifying and taking action in order to prevent dislocations. The increased proportion of infections could also mean that we have a more active attitude towards surgical treatment of infection. Another explanation could be an increased awareness of reporting reoperations where no implant changes are made. If there is an increased incidence for infection on top of that, is not easily decided, but of course it cannot be ruled out.

The proportion of patients having a reoperation within two years has since 2010 varied between 1.6 and 2.4%. It should however be noted that patients who were operated during 2017 and 2018 have not passed the two years limit when data was analysed for this report, and the proportion of patients having a reoperation within these two years will increase.

Reoperation within two years encompasses all forms of additional surgery after a total hip arthroplasty. This variable mainly reflects early and serious complications. This variable is thereby a faster indicator and easier to use for clinical improvement work compared to the 10-year survival, which is an important but slow, and to some degree, historical indicator. Reoperation within two years is chosen by the Local Authorities and Regions of Sweden and the Board of Health and Welfare, as a national quality indicator for total hip arthroplasty and is part of "Vården i siffror" (https://vardenisiffror.se/). The indicator should be seen as one of the most important and most easily influenced measures of outcome that the Swedish Hip Arthroplasty Register reports on.

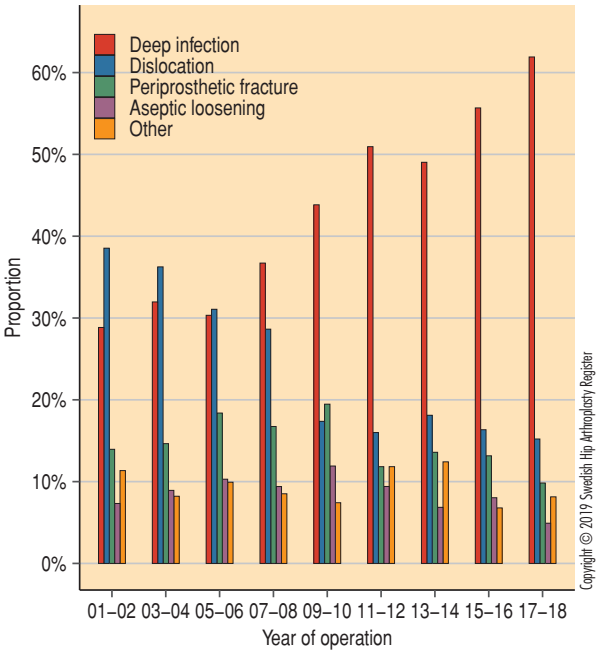

Figure 8.2.1. The distribution of reasons for reoperation within two years after the primary operation divided into six time periods between 2001 and 2018.

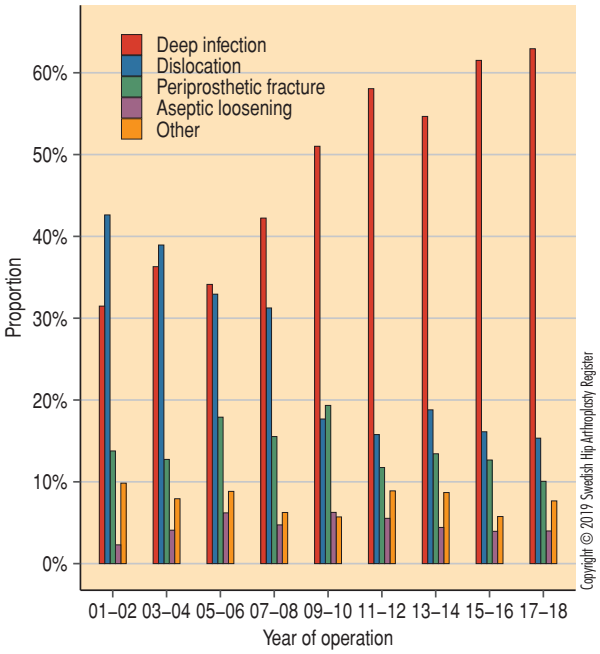

Figure 8.2.2. The distribution of the most common reasons for reoperation during the first year after the primary operation divided into different time periods between 2001 and 2018.

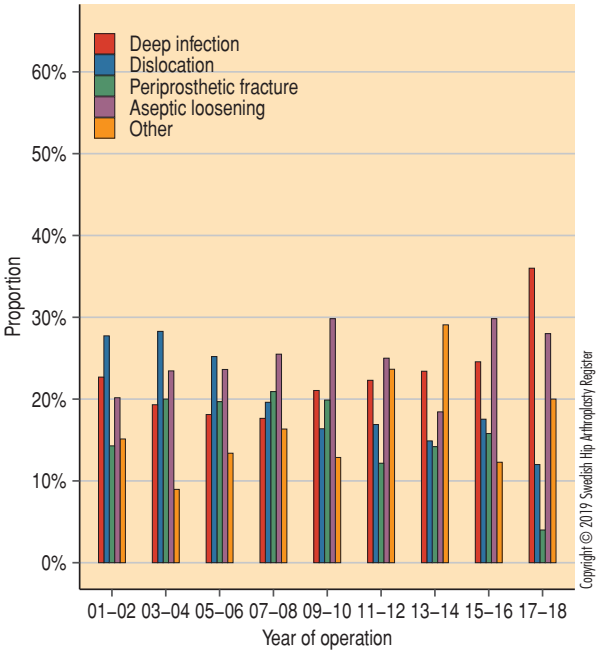

Figure 8.2.3. The distribution of the most common reasons for reoperation during the second year after the primary operation divided into different time periods between 2001 and 2018.

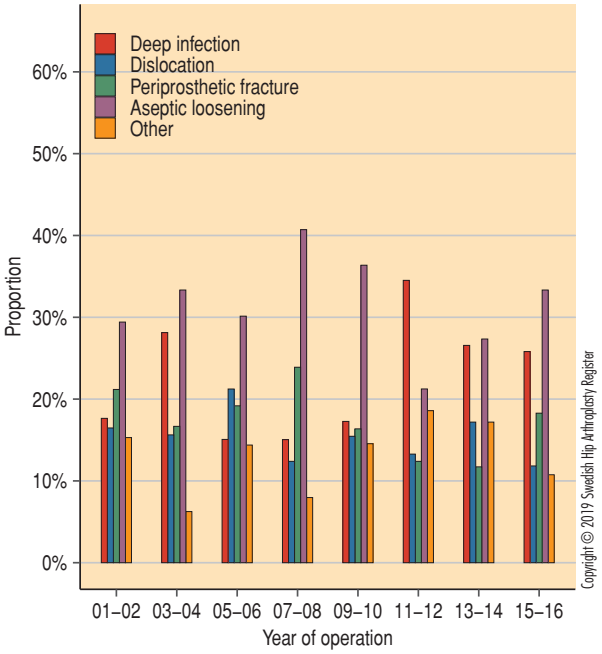

Figure 8.2.4. The distribution of the most common reasons for reoperation during the third year after the primary operation divided into different time periods between 2001 and 2016.

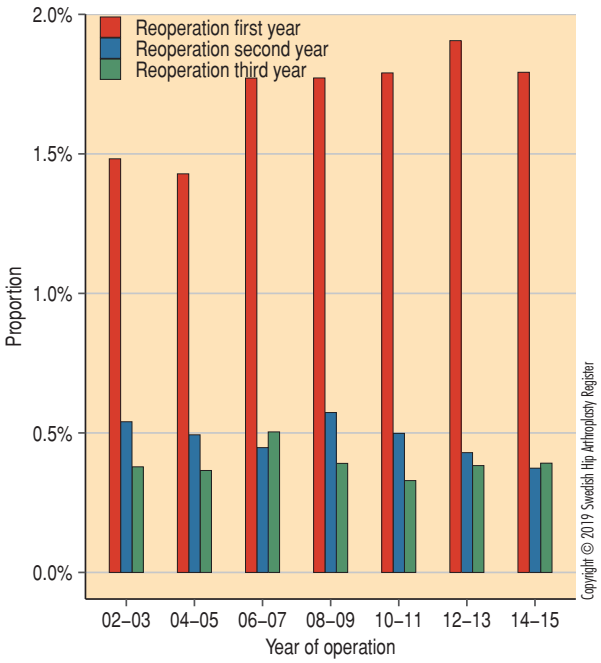

Figure 8.2.5. The proportion of reoperations during the first, second, and third year after the primary operation related to the year of the primary operation. Years of primary operation where the observational time is not yet long enough, have been excluded.

Reoperations within two years per unit, primary operation
2015–2018

	Primary op.	Reoperation[1]		Deep infection		Dislocation		Fracture		Other	
Unit	**Number**	**Number**	**Proportion, %[2]**	**Number**	**Proportion, %[2]**	**Number**	**Proportion, %[2]**	**Number**	**Proportion, %[2]**	**Number**	**Proportion, %[2]**
University hospital or regional hospital											
Karolinska/Huddinge	807	20	2.8	10	1.3	2	0.3	4	0.6	4	0.6
Karolinska/Solna	536	33	6.5	15	2.8	7	1.4	3	0.7	5	1
Linköping	254	9	3.7	3	1.2	6	2.6	0	0	0	0
SU/Mölndal	2 402	50	2.3	30	1.4	12	0.6	4	0.2	4	0.2
SUS/Lund	641	13	2.2	5	0.8	3	0.5	1	0.2	4	0.7
SUS/Malmö	138	3	2.7	0	0	2	1.6	0	0	1	1.2
Umeå	357	13	4	10	2.9	1	0.3	1	0.4	1	0.4
Uppsala	979	28	3.1	17	1.9	3	0.3	2	0.2	6	0.7
Örebro	237	11	5.3	6	2.7	1	0.4	2	1	2	1.2
County hospital											
Borås	574	10	1.8	9	1.6	1	0.2	0	0	0	0
Danderyd	1 224	44	3.7	22	1.8	12	1	10	0.8	0	0
Eksjö	932	33	3.7	30	3.4	1	0.1	1	0.1	0	0
Eskilstuna	481	12	2.9	9	2	0	0	1	0.3	2	0.7
Falun	933	32	3.8	13	1.4	0	0	3	0.4	16	2
Gävle	893	16	2	8	0.9	2	0.2	0	0	6	0.8
Halmstad	846	27	3.4	16	1.9	5	0.6	2	0.3	1	0.1
Helsingborg	444	16	3.7	8	1.8	5	1.2	3	0.7	0	0
Hässleholm	3 116	44	1.5	32	1.1	1	0	6	0.2	5	0.2
Jönköping	758	17	2.5	11	1.6	1	0.1	1	0.1	4	0.7
Kalmar	699	7	1.1	2	0.3	1	0.1	1	0.1	3	0.5
Karlskrona	140	4	3	0	0	3	2.2	0	0	1	0.9
Karlstad	789	26	3.5	23	3	1	0.1	2	0.3	0	0
Kristianstad	169	1	0.7	1	0.7	0	0	0	0	0	0
Norrköping	1 031	9	1.1	4	0.4	0	0	0	0	5	0.6
NÄL	124	1	1.8	0	0	0	0	0	0	1	1.8
Skövde	620	27	4.5	22	3.7	0	0	4	0.7	1	0.2
Sunderby	137	3	2.7	1	1.1	2	1.5	0	0	0	0
Sundsvall	215	8	3.8	3	1.4	3	1.4	0	0	2	0.9
Södersjukhuset	1 436	36	2.7	19	1.3	5	0.4	12	1	0	0
Uddevalla	1 525	36	2.5	29	2	2	0.1	3	0.2	2	0.2
Varberg	994	12	1.4	4	0.5	2	0.3	3	0.3	3	0.4
Västerås	1 812	48	2.9	28	1.7	11	0.6	3	0.2	3	0.2

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Reoperations within two years per unit, primary operation, continued
2015–2018

	Primary op.	Reoperation[1]		Deep infection		Dislocation		Fracture		Other	
Unit	Number	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]
Växjö	528	22	4.7	17	3.4	3	0.8	0	0	2	0.5
Östersund	1 147	31	2.8	19	1.7	3	0.3	4	0.4	3	0.3
Local hospital											
Alingsås	790	16	2.1	15	1.9	0	0	0	0	1	0.1
Arvika	815	36	4.8	24	3	3	0.6	6	0.9	3	0.4
Enköping	1 556	22	1.6	10	0.7	6	0.4	2	0.2	4	0.3
Frölunda Specialists-jukhus	83	2	2.4	1	1.2	0	0	0	0	1	1.2
Gällivare	395	3	0.8	3	0.8	0	0	0	0	0	0
Hudiksvall	470	9	2.2	4	0.9	2	0.5	1	0.2	2	0.5
Karlshamn	1 019	27	3	9	1	11	1.2	2	0.2	5	0.7
Karlskoga	401	13	3.3	10	2.5	0	0	3	0.8	0	0
Katrineholm	922	31	3.9	22	2.6	3	0.4	1	0.1	5	0.8
Kungälv	759	22	3.1	18	2.6	0	0	2	0.3	2	0.3
Lidköping	1 079	24	2.3	9	0.8	9	0.9	0	0	6	0.6
Lindesberg	1 942	21	1.3	11	0.7	4	0.2	3	0.2	2	0.1
Ljungby	710	15	2.3	11	1.6	3	0.4	0	0	1	0.2
Lycksele	1 299	22	2	12	1	2	0.2	4	0.3	4	0.5
Mora	1 041	10	1.1	6	0.6	2	0.2	0	0	2	0.3
Norrtälje	609	15	3.1	6	1	2	0.4	1	0.2	6	1.4
Nyköping	670	20	3.1	16	2.5	1	0.2	0	0	2	0.3
Oskarshamn	1 180	12	1.2	11	1.1	0	0	0	0	1	0.2
Piteå	1 548	8	0.6	0	0	4	0.3	1	0.1	1	0.1
Skellefteå	550	8	1.6	2	0.4	1	0.2	2	0.4	3	0.6
Skene	571	7	1.3	3	0.6	1	0.2	1	0.2	2	0.4
Sollefteå	975	17	2	9	1	4	0.4	2	0.2	2	0.4
Södertälje	605	21	3.6	15	2.5	1	0.2	2	0.4	3	0.5
Torsby	505	17	3.7	13	2.7	2	0.4	0	0	1	0.4
Trelleborg	2 763	34	1.5	10	0.4	10	0.4	10	0.4	3	0.1
Visby	539	11	2.3	3	0.6	2	0.5	1	0.2	5	1.1
Värnamo	594	8	1.5	2	0.3	5	0.9	0	0	0	0
Västervik	503	6	1.3	6	1.3	0	0	0	0	0	0
Ängelholm	394	4	1	4	1	0	0	0	0	0	0
Örnsköldsvik	686	6	1	4	0.6	1	0.1	0	0	1	0.2

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Reoperations within two years per unit, primary operation, continued
2015–2018

	Primary op.	Reoperation[1]		Deep infection		Dislocation		Fracture		Other	
Unit	Number	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]	Number	Proportion, %[2]
Private hospital											
Aleris Specialistvård Bollnäs	1 201	13	1.5	6	0.7	1	0.1	2	0.2	4	0.5
Aleris Specialistvård Motala	2 409	37	1.7	20	0.9	4	0.2	2	0.1	10	0.5
Aleris Specialistvård Nacka	940	15	1.8	5	0.6	3	0.4	6	0.7	1	0.1
Aleris Specialistvård Sabbatsberg	24	0	0	0	0	0	0	0	0	0	0
Aleris Specialistvård Ängelholm	349	4	1.2	2	0.6	2	0.6	0	0	0	0
Art Clinic Göteborg	254	3	1.2	1	0.4	0	0	1	0.4	0	0
Art Clinic Jönköping	264	0	0	0	0	0	0	0	0	0	0
Capio Artro Clinic	617	10	2.1	5	0.9	1	0.2	1	0.2	2	0.6
Capio Movement	1 338	25	2	18	1.5	3	0.2	1	0.1	3	0.2
Capio Ortopediska Huset	2 189	18	1	7	0.4	3	0.1	2	0.1	5	0.3
Capio S:t Göran	2 241	39	1.9	14	0.7	5	0.2	11	0.6	5	0.3
Carlanderska	790	7	1	5	0.7	1	0.1	0	0	1	0.2
Frölundaortopeden	25	0	0	0	0	0	0	0	0	0	0
Hermelinen Specialistvård	66	0	0	0	0	0	0	0	0	0	0
Ortho Center IFK-kliniken	704	6	1.2	5	1	0	0	0	0	1	0.3
Ortho Center Stockholm	2 385	32	1.6	15	0.8	9	0.5	5	0.2	3	0.1
Sophiahemmet	973	18	1.9	6	0.6	3	0.4	8	0.9	1	0.1
Country	70 676	1 400	2.2	805	1.2	217	0.3	159	0.3	192	0.3

Table 8.2.1. Units with fewer than 20 primary operations during the time period considered are excluded.

[1] Refers to the number of patients with short-term complication, which can differ from the sum of the number of complications as each patient may have more than one type of complication.

[2] All proportions are calculated by using a competing risk analysis at two years follow-up.

Reoperations within two years per unit – trend

2015–2018

Unit	2011–2014	2012–2015	2013–2016	2014–2017	2015–2018
	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]
University hospital or regional hospital					
Karolinska/Huddinge	2	2.1	1.9	2.2	2.8
Karolinska/Solna	3.4	4.7	4.4	5.3	6.5
Linköping	2.7	2.7	3.4	2.1	3.7
SU/Mölndal	2.4	2.1	2.3	2.2	2.3
SUS/Lund	2.8	2.6	2.8	2.2	2.2
SUS/Malmö	1.4	1.3	0.9	3.3	2.7
Umeå	5.9	4.9	4.4	4	4
Uppsala	3.8	3.7	3.8	4	3.1
Örebro	2.4	3.3	3.6	3.7	5.3
County hospital					
Borås	3.3	2.8	2.9	2.1	1.8
Danderyd	4	3.7	4.1	4.1	3.7
Eksjö	2	2.5	2.6	3.1	3.7
Eskilstuna	3.3	3	2.9	2.8	2.9
Falun	1.9	2	2.2	2.7	3.8
Gävle	4.4	2.7	2.5	2.1	2
Halmstad	3.2	3.2	2.6	2.8	3.4
Helsingborg	2.6	2.5	2	2.4	3.7
Hässleholm	2	1.6	1.6	1.7	1.5
Jönköping	1.4	1.5	2.1	2.3	2.5
Kalmar	1.6	1.5	1.8	1.4	1.1
Karlskrona	3.8	3.9	3.2	2.2	3
Karlstad	5.1	4.1	4	3.3	3.5
Kristianstad	5	4.1	3.3	3.6	0.7
Norrköping	1.3	1.2	1.7	1.2	1.1
NÄL	-	*	2	1.8	1.8
Skövde	1.8	2.8	3.7	4	4.5
Sunderby	3.8	3.5	3.5	3.8	2.7
Sundsvall	3.7	3	3.6	3.9	3.8
Södersjukhuset	3.4	3.5	3.3	3.5	2.7
Uddevalla	1.6	2.1	2.2	2.7	2.5
Varberg	1.5	1.5	1.9	1.5	1.4
Västerås	3.7	3.2	2.9	3.1	2.9
Växjö	1.9	1.6	2.7	2.6	4.7
Östersund	2.6	2.5	2.2	2.8	2.8

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Reoperations within two years per unit – trend, continued
2015–2018

Unit	2011–2014	2012–2015	2013–2016	2014–2017	2015–2018
	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]	Proportion, %[1)]
Local hospital					
Alingsås	1.9	1.7	1.9	1.8	2.1
Arvika	1.8	2.7	3.3	4.1	4.8
Enköping	2.3	2.2	1.8	1.8	1.6
Frölunda Specialistsjukhus	0.6	0.9	1.2	1.1	2.4
Gällivare	1	0.8	1.3	0.8	0.8
Hudiksvall	2.5	2.6	2.5	2.3	2.2
Karlshamn	1.8	2.3	2.8	2.8	3
Karlskoga	1.4	1.7	2.7	3.4	3.3
Katrineholm	1.8	1.9	2.7	3.5	3.9
Kungälv	2.7	2.9	2.9	2.9	3.1
Lidköping	1.1	1.3	1.5	2.1	2.3
Lindesberg	0.9	0.9	1.4	1.1	1.3
Ljungby	1.8	2.3	3	2.8	2.3
Lycksele	2	1.8	2.2	1.9	2
Mora	1.3	1.6	1.3	1.4	1.1
Norrtälje	2.9	2.7	2.4	3	3.1
Nyköping	6.1	4.5	3.6	3.4	3.1
Oskarshamn	0.9	0.9	1.2	1	1.2
Piteå	1	1	0.6	0.6	0.6
Skellefteå	1.8	2.1	2	2.2	1.6
Skene	1.6	1.7	1.5	0.9	1.3
Sollefteå	0.8	1	2.1	2.3	2
Södertälje	5.3	6	6.6	4	3.6
Torsby	2.3	3.4	2.9	3	3.7
Trelleborg	1.4	1.3	1.3	1.4	1.5
Visby	3.7	3.2	3.1	2.5	2.3
Värnamo	1.4	2	1.6	1.4	1.5
Västervik	2.4	0.9	1.3	1.5	1.3
Ängelholm	1.4	1.6	1.8	1.3	1
Örnsköldsvik	1.1	1	1.1	0.9	1

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Reoperations within two years per unit – trend, continued
2015–2018

Unit	2011–2014 Proportion, %[1)]	2012–2015 Proportion, %[1)]	2013–2016 Proportion, %[1)]	2014–2017 Proportion, %[1)]	2015–2018 Proportion, %[1)]
Private hospital					
Aleris Specialistvård Bollnäs	2	2	1.5	1.4	1.5
Aleris Specialistvård Motala	2.2	1.9	2	1.7	1.7
Aleris Specialistvård Nacka	2.4	2.4	2.5	2	1.8
Aleris Specialistvård Sabbatsberg	0.8	0.8	0.6	0	0
Aleris Specialistvård Ängelholm	1	1.3	1.3	1.1	1.2
Art Clinic Göteborg	–	0	1.4	2.1	1.2
Art Clinic Jönköping	0	0	0	0	0
Capio Artro Clinic	–	–	–	2	2.1
Capio Movement	4.6	4.1	3.6	3.1	2
Capio Ortopediska Huset	1.1	1	1.1	0.9	1
Capio S:t Göran	3.5	2.7	2.1	2	1.9
Carlanderska	2	1.3	1.5	1.2	1
Frölundaortopeden	–	–	*)	*)	0
Hermelinen Specialistvård	*)	0	0	0	0
Ortho Center IFK-kliniken	0.2	0.4	0.5	0.9	1.2
Ortho Center Stockholm	2.7	2.5	1.7	1.5	1.6
Sophiahemmet	1.7	1.9	1.6	2.2	1.9
Country	2.3	2.2	2.3	2.2	2.2

Table 8.2.2.
[1)] All proportions are calculated using a competing risk analysis at two years follow-up.
[2)] Fewer than 20 operations during this period.

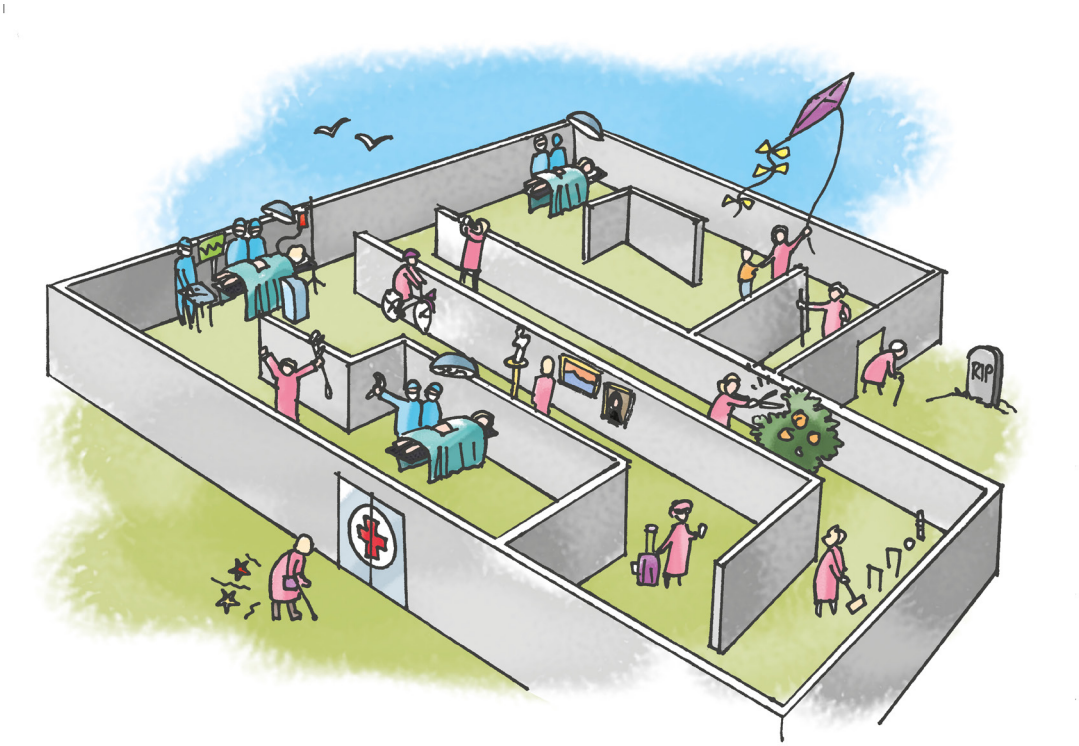
8.3 Revision

Revision of a hip prosthesis means that a patient who has been operated with a hip arthroplasty undergoes a subsequent operation where parts of, or the whole prosthesis, is changed or extracted. One exception is two-stage procedures where two operations are registered as one procedure in diagrams and analyses (if not otherwise stated). If for example a primary prosthesis is revised in two sessions, the extraction date will become the time for revision of the primary arthroplasty, while the date for the insertion of the new prosthesis becomes the starting point for continued observation of e.g. a first-time revision. If the prosthesis is extracted for good (no prosthesis insertion is registered at the last date of observation, in this year's report 31.12.2018) the operation is classified as a permanent prosthesis extraction, where the missing prosthesis insertion after previous extraction thus decides if the extraction is to be counted as permanent or not. This means that certain extractions taking place during the latter part of 2018, where insertion is planned during 2019 probably will be wrongly classified as permanent. This problem is illustrated more thoroughly below. (See the section "Reason for re-revision related to previous cause of revision").

Since 1979, revisions (and other reoperations) have been reported on an individual level, which means that there is a possibility to extract more complete data starting with this year compared to the registration of primary arthroplasties where data was linked to personal number for the first time in 1992. Until 1991, primary arthroplasties were reported only in terms of aggregated data per unit.

Since 2000, the number of primary operations as well as the number of revisions have increased, but the increase in primary operations has been higher. During 2000, 11,327 primary arthroplasties and 1,573 revisions (12.2% revisions) were reported. During 2018, the corresponding numbers were 18,629 and 1,863 (9.1%). The relative proportion of revisions thus has decreased by more than 3 percentage points. The relative reduction of revisions applies both to first revision and to multiple revisions (figure 8.3.1 A-B). The distribution between first and multiple revisions, and between different types of multiple revisions has not changed in a considerable way (figure 8.3.1 C-D). Probably there has been no larger change in indications during the 19 years the period comprises, which supports the idea of a substantial improvement of the results even if a more sophisticated analysis is needed to determine this.

Patients who undergo revision are different demographically (as those having a reoperation) from the patients who have undergone a primary arthroplasty. In general they are older, more often men, have a secondary osteoarthritis more often, and a higher degree of comorbidity (table 8.3.1). Some of these tendencies are accentuated even more in those patients undergoing multiple revisions. Among the patients who have had at least one revision and are forced to undergo yet another revision, the degree of comorbidity is elevated (measured here as ASA class), and an even larger proportion of them have initially been operated due to secondary osteoarthritis. The average BMI is relatively similar between the groups. In the group of patients who have undergone at least two revisions,



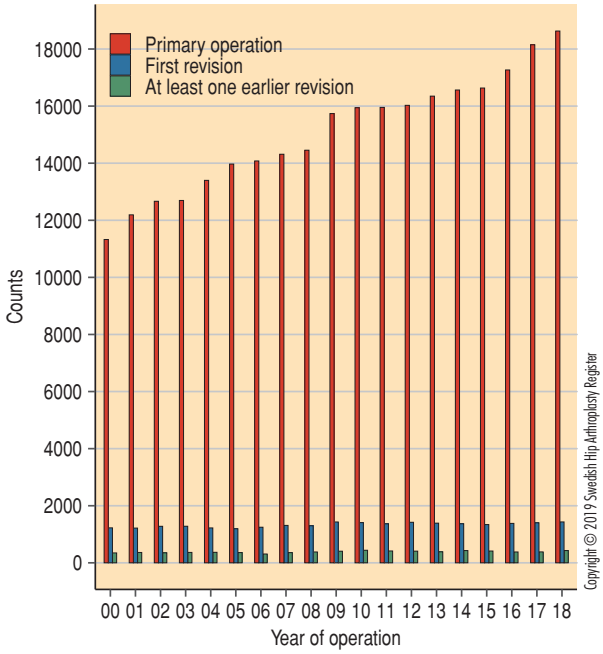


Figure 8.3.1a. The number of primary hip arthroplasties, and first and multiple revisions respectively during 2000-2018. The increase in the number primary arthroplasties is greater than the increase in the number of revisions.

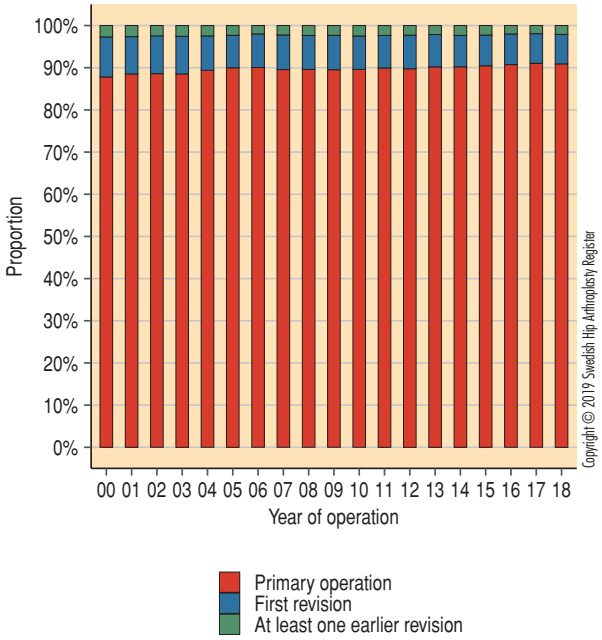


Figure 8.3.1b. Percentage distribution of primary arthroplasties, and first and multiple revisions during 2000-2018. The proportion of revisions during the period decreased from 11.9% in 2000 to 8.7% in 2018.

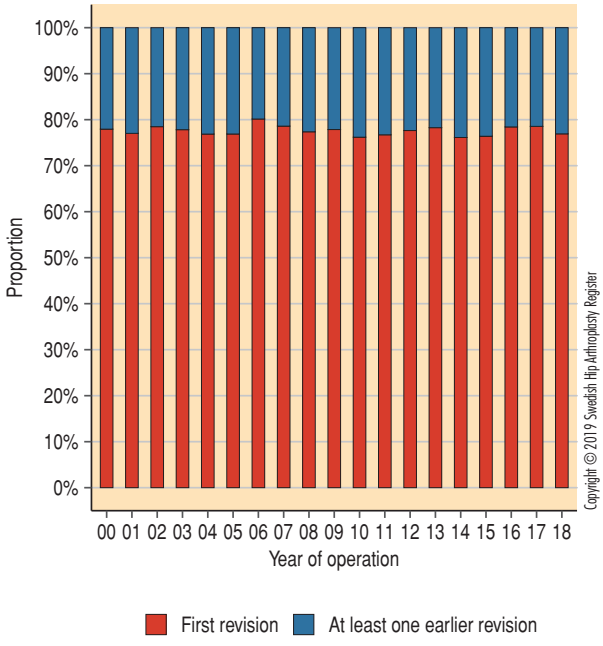


Figure 8.3.1c. Percentage distribution of first and multiple revisions during 2000-2018. The multiple revisions have varied in a relatively constant interval during the period considered, and have accounted for a little over 20% of all revisions.

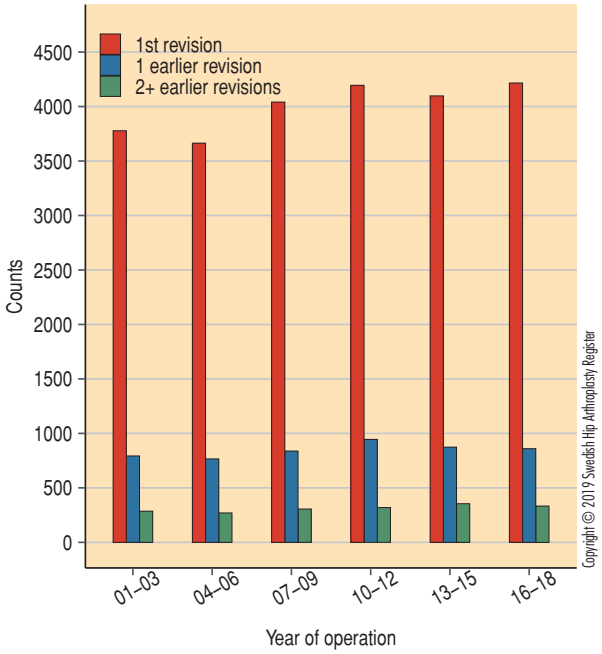


Figure 8.3.1d. The number of revisions that have been preceded by no, one, or at least two earlier reivions during 2000-2018. The distribution between these types of operations is relatively constant over time without an apparent tendency towards an increase of the number of multiple revisions.

Demography at first, second, and multiple revision, and at primary operation 2009–2018

	Number of earlier revisions			Primary operation
	None	1	≥2	
Number	13 940	2 982	1 111	167 250
Age				
Average, *SD*	71.7 *11.0*	72.0 *11.0*	70.9 *11.1*	68.7 *10.8*
< 55 years %	7.3	7.1	9.6	10.1
55–69 years %	30.4	29.6	30.7	39.4
70–84 years %	51.9	52.0	50.1	45.4
>= 85 years %	10.4	11.2	9.5	5.1
Gender				
Proportion of women, %	52.0	48.9	48.1	58.1
BMI				
Number, *% of all in the interval*	12 620 *90.5*	2 651 *88.9*	969 *87.2*	158 316 *94.7*
Average, *SD*	27.2 *5.6*	27.2 *5.8*	27.2 *5.1*	27.1 *4.6*
< 18.5 %	1.3	1.5	2.3	1.2
18.5–24.9 %	33.3	34.1	32.3	33.3
25–29.9 %	41.0	39.8	38.4	39.6
30–34.9 %	17.9	17.8	18.6	18.2
35–39.9 %	5.0	5.1	6.7	4.6
≥ 40 %	1.5	1.8	1.8	0.9
ASA class				
Number, *% of all in the interval*	13 425 *96.3*	2 853 *95.7*	1 047 *94.2*	163 376 *97.7*
I, %	11.7	9.8	6.1	22.1
II, %	53.3	49.1	44.8	58.4
III–, %	35.0	41.1	49.1	19.5
Primary operation diagnosis				
Primary osteoarthritis	76.1	70.1	60.9	80.8
Fracture including sequelae	8.4	8.2	12.5	11.2
Inflammatory joint disease	4.6	7.6	11.1	1.1
Sequelae childhood disease	3.5	5.5	5.6	1.8
Idiopathic necrosis	2.0	2.0	1.6	2.2
Other secondary osteoarthritis	5.5	6.5	8.3	2.9

Table 8.3.1. Gender and age distribution during first, second, and multiple revision starting with the year 2009. Data for primary operations are shown for comparison.

the proportion of those with a BMI of 30 or higher is however somewhat higher.

During 2018, primary arthroplasties were carried out at 81 units. In 59 of these, revisions were also carried out, and in 44 of those patients who had undergone a revision of the same hip at least once before, were operated. Table 8.3.2 displays the units, which carry out revisions grouped after the number of revisions carried out per year. Furthermore, the number of primary arthroplasties based on the same grouping is shown. During the years 2017 and 2018, only two and three units respectively, carried out at least 49 revisions regardless if it was a first revision or a multiple revision. The majority of revisions were however carried out at units with less experience of these operations. However, most of the units, which have a low volume of multiple revisions, carry out first time revisions, which increases the volume and the possibility for gaining experience. Most often, a low volume of both first and multiple revisions however go hand in hand, which is evident from the first rows and especially regarding the column to the far right. Here, it is shown that 19 units carried out only between one and nine revisions during 2018 regardless if it was a first-time revision or a multiple revision. During 2018, these 19 units carried out 71 revisions in total (just under 4 per year), where the most common cause for operation was cup revision (n = 29), followed by caput and/or liner change (n = 28).

It should be pointed out that low volume of registered revisions for an individual unit not necessarily must mean a healthcare quality that is not up to standards. We know that the reporting of revisions is not optimal from a few units, which means that the registry does not know the true volume. Furthermore, certain revisions do not demand a special competence and in some cases, a surgeon with a long experience of revision surgery may have changed work place. In general, it should however be an advantage to maintain a certain volume of revisions as the setting of indications and choice of technique may be difficult. Further, the occurrence of perioperative complications and unexpected finds and events is not unusual. In these cases, an experienced and for the task well-trained personnel as well as availability of special instruments, a bone bank, and a sufficiently large assortment of implants are key factors for success.

The registry has pointed out that restructuring within the healthcare service has meant that university and regional hospitals in particular, carry out primary arthroplasties of a standard nature to a decreasing extent. This is not good from a teaching and research and development point of view. Certainly, some of this activity could be outsourced; nevertheless, it has proven increasingly difficult to carry out clinical research projects, due to among other things logistical reasons, when almost all primary arthroplasties must be carried out at units with a limited space for other things than pure healthcare. To illustrate the situation, we display the number of primary arthroplasties in relation to the total number of operations carried out at one and the same hospital unit. At most units, 60-90% are primary arthroplasties, in some cases the total volume is however low and percentages do not give a true picture.

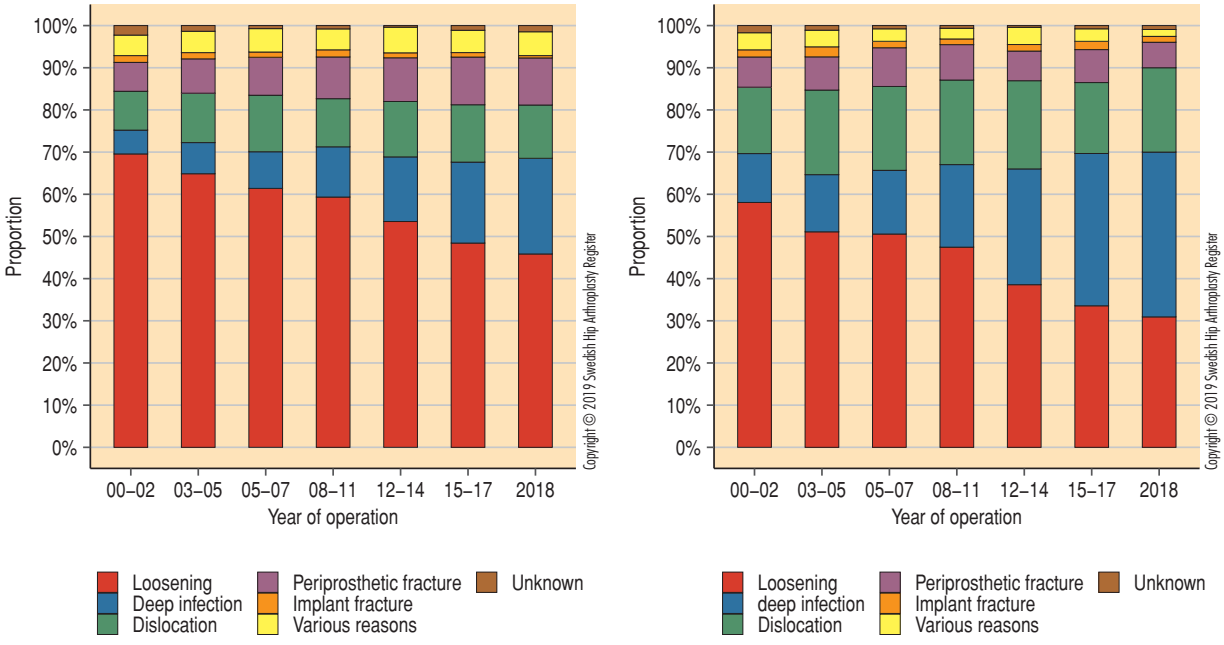


Figure 8.3.2. Relative distribution of reasons for revision during the period between 2000 and 2018 after first revision (to the left), and after multiple revisions (to the right). Both men and women.

Volume of primary and revisional surgery during 2017 and 2018 per operating unit

	Number of operating units per cathegory			
	Primary arthroplasty	First revision	≥ 1 earlier revision(s)	Regardless of earlier revisions
Number per unit and year				
1–9	3/2	16/22	28/25	15/19
10–24	1/2	19/14	14/16	13/10
25–49	9/7	13/15	2/3	18/17
50–99	7/6	7/8	–	8/11
100–149	11/13	–	–	3/2
150–199	13/15	–	–	–
200–299	20/18	–	–	–
300–499	8/10	–	–	–
500–999	9/8	–	–	–
	Total number of operating units in the country			
	81/81	55/59	44/44	57/59

Table 8.3.2. The number of units carrying out first and multiple revisions presented grouped after the years 2017 and 2018. Two session procedures are counted as one operation.

If patients with primary osteoarthritis are separated from the rest, a group that often is less complex and therefore suitable in the specialist training (and often for studies), a more diversified picture emerges. Some units treat a relatively large number of patients, while others only operate a few (table 8.3.3).

Reasons for revision

Between 2000 and 2018, aseptic loosening (63.2%), infection (11.8%), dislocation (10.1%), and periprosthetic fracture (7.5%) were the most common reasons for a revision, regardless if an earlier revision had taken place or not. Over time, the distribution of causes has however changed (figure 8.3.2). At first time revision, 69.9% of the operations carried out 2000-2002 were caused by loosening (or osteolysis, which also is part of this group). Dislocation came second (9.2%), followed by periprosthetic fracture (6.8%), and infection (5.6%). For multiple revision, places were reversed for infection and periprosthetic fracture (loosening: 58.1%, dislocation: 15.7%, infection: 11.6%, periprosthetic fracture: 7.2%). Continuing up to 2018, this distribution has successively changed so that loosening still dominates this year, but has been reduced to 45.8%, followed by infection (22.7%), dislocation (12.6%), and last periprosthetic fracture (11.2%). Deep infection was the most common cause for multiple revision during 2018 (39.1%), followed by loosening (30.9%), dislocation (20.0%), and periprosthetic fracture (6.0%). The total number of revisions due to loosening has regardless if it is a first or multiple revision, decreased from just over 1,000 per year during the beginning of the 2000s to 790 during 2018. The corresponding increase of the number of revisions due to infection has grown in numbers from 106 in 2000, to 493 in 2018.

In general, the distribution of the four most common causes of revision loosening/osteolysis/wear, infection, dislocation, and periprosthetic fracture thus differs between first and multiple revisions. There is also a gender-related difference (figure 8.3.3). In men (figure 8.3.3A), infection is the dominating cause of revision up to 60 years of age at first time revision, and is the most common cause of multiple revision regardless of age. For first-time revision after 60 years of age, loosening is the most common cause. The proportion of periprosthetic fractures increases after 70 years of age regardless if it is a first time revision or a multiple revision. In women, loosening is the most common reason for first time revision regardless of age (figure 8.3.3B). The same trend can be seen for multiple revisions but here the proportion of revisions due to infection is about the same up to 70 years of age. In the age group 71-80 years of age, loosening is the most common cause of revision, and for higher ages, the number of dislocations rises and takes the second place. As in men, the proportion of periprosthetic fractures increases with age, but in women this does not happen before 80 years of age.

Distribution between revisions and primary arthroplasties 2017–2018 for units that have carried out at least 50 revisions during the period

Hospital unit	Revisions number	Primary arthroplasties number	Primary arthroplasties/all prosthesis operations[1], %	
			Primary arthroplasty all diagnosis	Primary arthroplasty due to osteoarthritis *number/2 year*
SU/Mölndal	264	1 200	82.0	53.8 *787*
Danderyd	209	568	73.1	49.5 *385*
Uppsala	208	484	69.9	26.7 *185*
SUS/Lund	185	254	57.9	12.5 *55*
Hässleholm	183	1551	89.4	79.8 *1 383*
Umeå	158	157	49.8	12.7 *40*
Karolinska/Huddinge	153	377	71.1	39.4 *209*
Västerås	133	1 013	88.4	52.0 *596*
Gävle	123	389	76.0	30.1 *154*
Södersjukhuset	106	633	85.7	52.0 *384*
Piteå	100	845	89.4	81.4 *769*
Uddevalla	97	749	88.5	78.5 *664*
Capio S:t Göran	95	1 155	92.4	83.4 *1 042*
Karlstad	93	371	80.0	40.3 *187*
Östersund	89	593	87.0	60.6 *413*
Eskilstuna	87	264	75.2	38.5 *135*
Skövde	86	251	74.5	45.7 *154*
Karolinska/Solna	77	227	74.7	19.7 *60*
Lindesberg	77	1 302	94.4	81.3 *1 121*
Linköping	74	121	62.1	33.3 *65*
Halmstad	68	404	85.6	65.3 *308*
Borås	67	282	80.8	49.3 *172*
Helsingborg	65	138	68.0	25.1 *51*
Jönköping	64	469	88.0	65.7 *350*
Falun	63	425	87.1	71.1 *347*
Växjö	61	247	80.2	57.5 *177*
Aleris, Motala	52	1 244	96.0	90.7 *1 175*

Table 8.3.3. The number of reported revisions, primary arthroplasties, and the proportion of primary operations regardless of diagnosis, and for the group primary osteoarthritis related to the sum of revisions and primary operations during a two-year period for units that have carried out 50 or more revisions 2017-2018. The number of primary arthroplasties due to primary osteoarthritis during a two-year period are shown in the column at the far right.

[1] Primary arthroplasties + revisions.

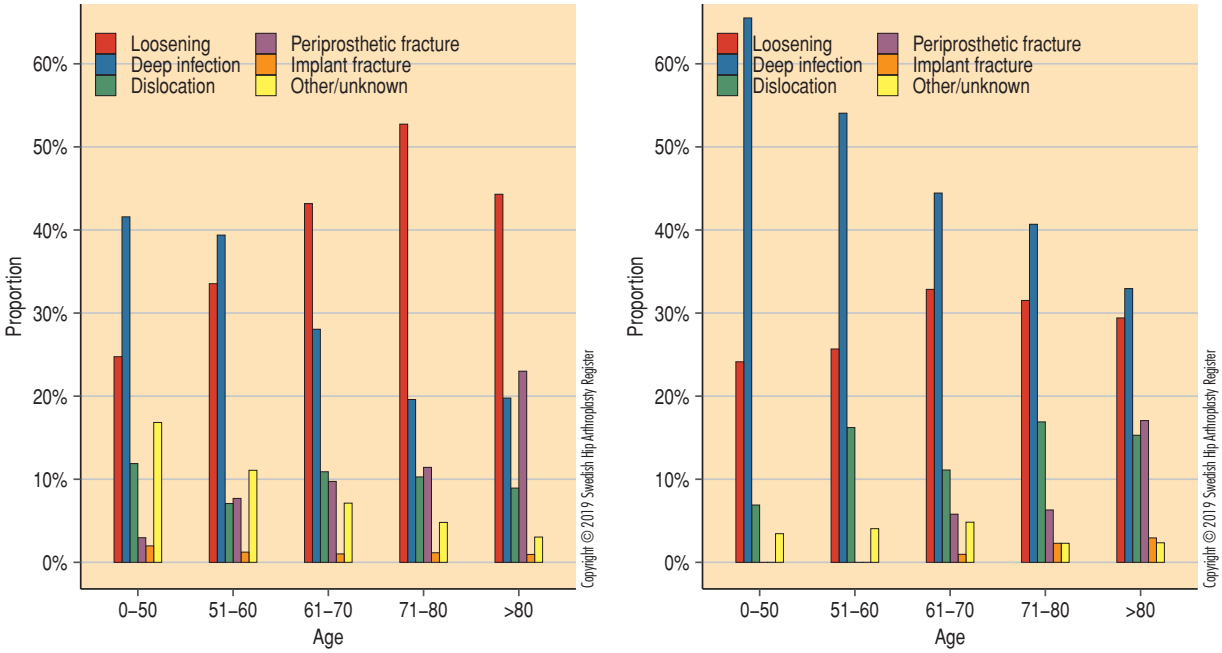


Figure 8.3.3a. Relative distribution of reasons for revision in men during the period between 2000 and 2018 after first revision (to the left), and after multiple revisions (to the right).

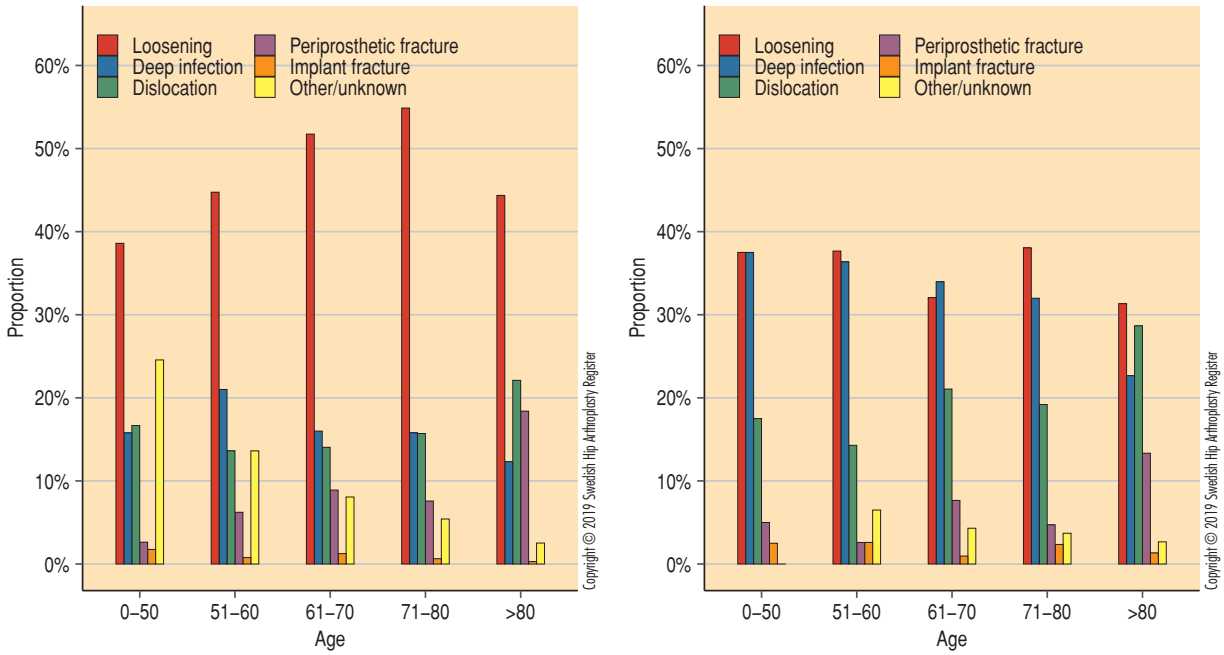


Figure 8.3.3b. Relative distribution of reasons for revision in women during the period between 2000 and 2018 after first revision (to the left), and after multiple revision (to the right).

Stems revised due to implant failure

	Stems inserted 1999–2018			
	number of inserted 1999–2018	first revision/at least one earlier revision	proportion of stem failures, %	number with smallest size[1)]
CLS	13 364	5/0	0.04	0 (5)
Revitan cylinder	1 029	0/7	0.68	1 (14)
MS-30 polished	14 925	6/2	0.05	3 (6)
Wagner Cone	2 159	2/0	0.09	0 (11)
Müller straight	985	2/0	0.20	1 (10)
CPT	3 859	2/5	0.18	0 (S2/0)
Charnley	6 112	3/1	0.07	–
Elite plus	1 723	3/0	0.17	2 (1)
Wagner SL Revision	801	0/1	0.12	–
ZMR Taper	10	0/1	10.00	0 (16)
CFP	463	1/0	0.22	1 (1)
SPII standard	125 470	94/17	0.09	90 (01)
SPII Dysplasia	65	2/1	4.62	0 (1)
MP custom Link	3	0/1	33.33	–
MP proximal standard	3 178	0/3	0.09	1 (1)
Corail standard	17 807	4/1	0.03	0 (8)
Corail high offset	5 262	1/0	0.02	1 (130)
Corail revision	165	0/1	0.61	0 (10)
Reef	24	0/1	4.17	1 (10)
Exeter standard	65 622	38/11	0.07	16 (0)
Exeter short revision stem	808	0/8	0.99	8 (44 offset)
Exeter long	1 428	1/2	0.21	0 (200)
Durom	381	1/0	0.26	–
Cenator	275	1/0	0.36	0 (narrow)
Spectron EF Primary	10 166	10/1	0.11	8 (1)
Bi-Metric X por HA NC	9 378	4/0	0.04	0 (7)
No data	15 696	0/26	0.17	–
All[2)]	301 158	180/90	0.09	132

Table 8.3.4. Stems that have been revised due to an implant failure after primary operation or revision (regardless of the number of earlier revisions) during 2000-2018.

[1)] The value in parenthesis displays the smallest size as it has been reported by the manufacturer and has been registered in the SHAR database. The presented numbers should be viewed as a minimum since detailed data on stem size sometimes is missing.

[2)] Pertains only to the models given in the table (including 15 696 classified as "not available").

Stem fracture

Fracture of the stem is an unusual complication. The registry captures revision due to implant failure. Exact information on which components that are affected is however missing. In this analysis of primary arthroplasties and revisions carried out from 1999 to 2018, we have assumed that if the stem of the prosthesis has been revised due to implant failure, the probability is high that it is a stem fracture even if this could mean a small overestimation. Despite this, we report data for individual stems since we think this information is of value for the profession (table 8.3.4).

This year's analysis differs from that of the previous year in that we also have included stem fracture after revisions, the intention being to include more stem types. For some of these, the relation between the number of stem fractures and the total number of inserted stems is remarkably large (table 8.3.4). This is the case for ZMR Taper, MP custom link, and Reef, all of them used in small numbers, which makes data difficult to interpret. One of the Reef stems, but none of the two former stem types, have been inserted during the last two years. SP II dysplasia also displays an unexpectedly high proportion of stem fractures. Here, the number of inserted prostheses is also very limited. In three of the cases, this stem has been used in revision, of which one has fractured. The short Exeter stem has mainly been used in revisions (81.2% of cases), and all registered stem fractures have occurred during a first revision. The smallest Exeter stem of ordinary length has a considerably lower prevalence of stem fracture (0.11%, Exeter short revision stem: 0.99%), and should if possible be considered an option during these operations. Regarding the SP II-stem, the proportion of stem fractures is relatively low (0.09%) for the whole group including all sizes. Stem fracture almost only affects size 01 (90 out of 94 reported cases, 84 primaries, 6 revisions). The proportion of SP II size 01 affected by stem fracture is almost ten times as large as the proportion of the whole group (0.8%), a problem we have observed repeatedly.

In general, thin stems of some models should be avoided for younger active patients with a narrow medullary cavity. We hope that this review can be of some help, at least regarding designs that should be avoided. Regarding the best choice, specific recommendations are not possible to give, except that well-documented stems of size and model that have the lowest frequency in table 8.3.4, or are not part of the list, should be used. It should however be pointed out that a stem fracture is not always an avoidable complication, and the more often a stem is used the greater the probability that at least a few stem fractures will occur. When assessing stems, which are not part of the list, the number of stems in use and the observation time thus must be considered.

The group other causes of revision consists of several different diagnoses and measures. This year, we will not treat these in the revision chapter. Since several of them also are treated surgically without implant change or extraction, we have instead chosen to more thoroughly account for unusual reasons for revision in a separate chapter.

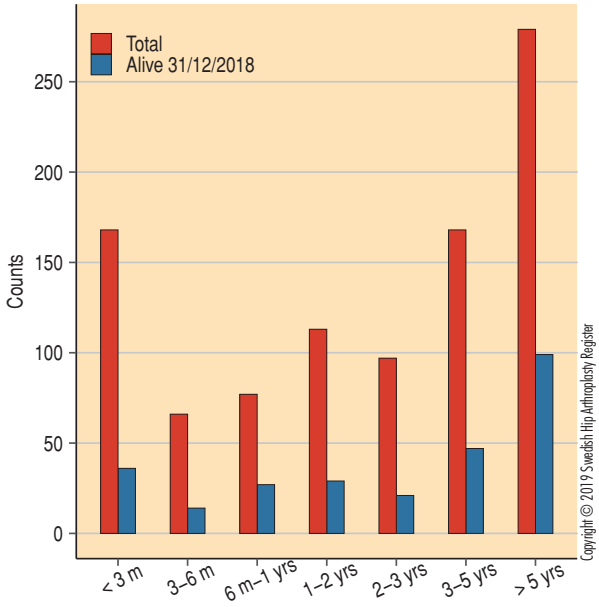


Figure 8.3.4. The number of patients where a prosthesis extraction without subsequent insertion of a new prosthesis or new prosthesis components has been carried out divided into different time periods after the primary operation. The lower bar represents the number of patients who were alive the last day of observation (31.12.2018). For patients who have undergone a bilateral extraction without a subsequent insertion, only the last hip operated on is included.

Reasons for re-revision related to previous reason for revision

The reason for a first time revision will influence the profile of causes at an eventual second time revision (table 8.3.5). A patient who undergoes a first revision due to loosening/osteolysis, infection or dislocation has, at an eventual second revision, a high probability of having a revision for the same reason. The same could be said of patients who have undergone a second revision. An exception is patients who are operated due to periprosthetic fracture in the first revision. In these cases, the most common cause of an eventual later revision is dislocation followed by loosening and infection, both after first and second time revisions. In order to keep data reasonably up-to-date, primary operations and revisions carried out between 2000 and 2018, are shown. A difference from earlier annual reports is that complete and partial prosthesis extractions where a second procedure (session 2) has not been registered, are shown. In these cases, the case may be that a later insertion has not been planned or it may have been planned but due to high comorbidity or other conditions, it has not taken place. In many cases, especially regarding those having an extraction in the later part of 2018, it probably is a two session procedure where stage two will take place in the early part of 2019, thereby exceeding the observational limit of this year's report.

The proportion of patients who have undergone complete or partial extraction of the prosthesis without any registered later insertion varies between 0.5 and 13.2% for first time revisions and between 0.9 and 21.2% for second time revisions "depending on cause of revision group (see table 8.3.5)". As expected the most common cause is infection followed by dislocation and periprosthetic fracture, regardless if it is a first or second revision.

During the period 2000-2018, 968 partial or total prosthesis extractions were carried out where no insertion is registered. The mortality rate among these patients is high. 689 patients (696 hips, 71.9%) were dead as of 31/12 2018. The majority of operations where a future prosthesis insertion is planned ought to be found among the 50 patients who have undergone extraction less than six months before and who were still alive the last day of observation (figure 8.3.4).

Revision procedures

In general, the changes over time regarding the choice of procedure are relatively similar for first time revisions and multiple revisions. A change of both cup and stem has been the most common type of operation during both first time revisions and multiple revisions since 2001 (figure 8.3.5). This procedure has however tended to decrease slightly while isolated changes of the cup has been relatively more constant, albeit with some fluctuations, especially when it comes to absolute numbers (figure 8.3.6, figure 8.3.7). The proportion of changes only of the stem has decreased (figure 8.3.5) as a consequence of an increase of the number of isolated caput and caput + liner changes during the period, which can be related to the increased frequency of revisions due to infection of the DAIR-type (debridement, antibiotics, irrigation and retention). As expected, the proportion of some of these procedures that can be related

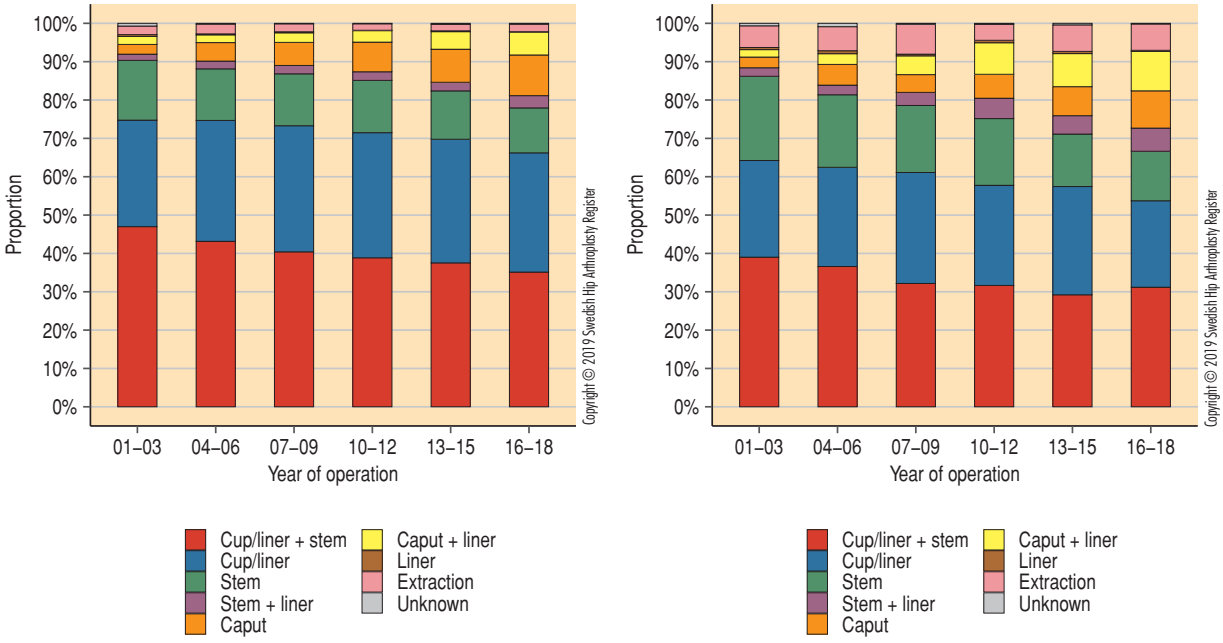


Figure 8.3.5. The distribution of reasons for revision in three-year periods from 2001 to 2018 during first revision (to the left), and during multiple revision (to the right).

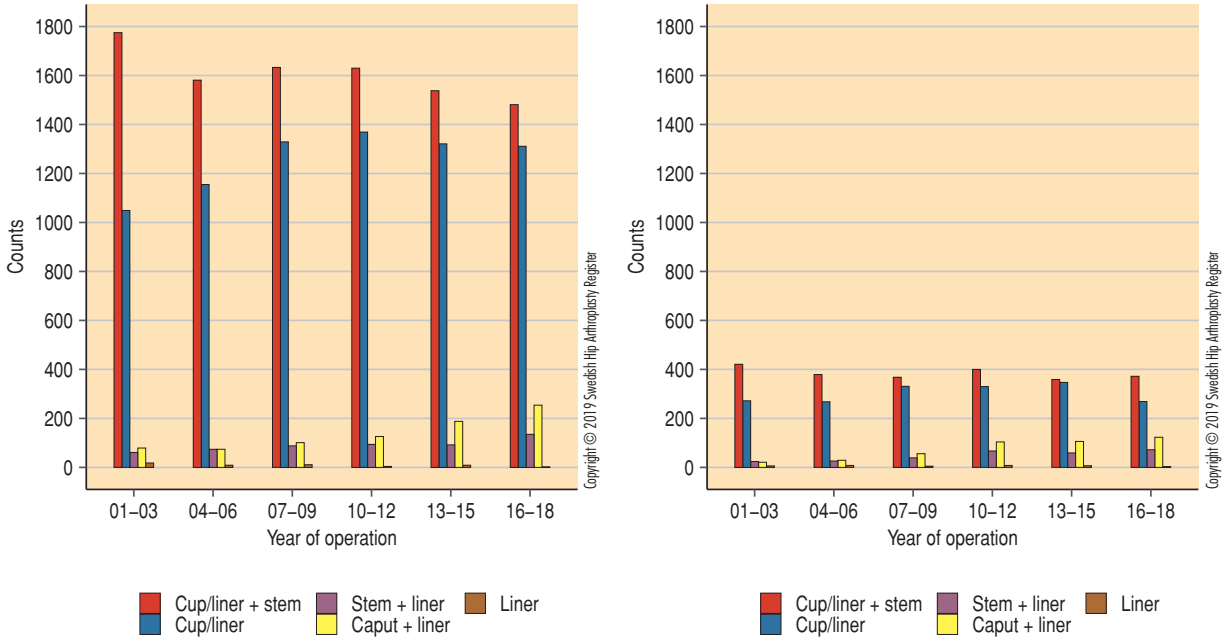


Figure 8.3.6. The number of revisions in three-year periods from 2001 to 2018 where cup and/or liner have been changed or inserted after a preceding extraction. First revisions to the left and multiple revisions to the right.

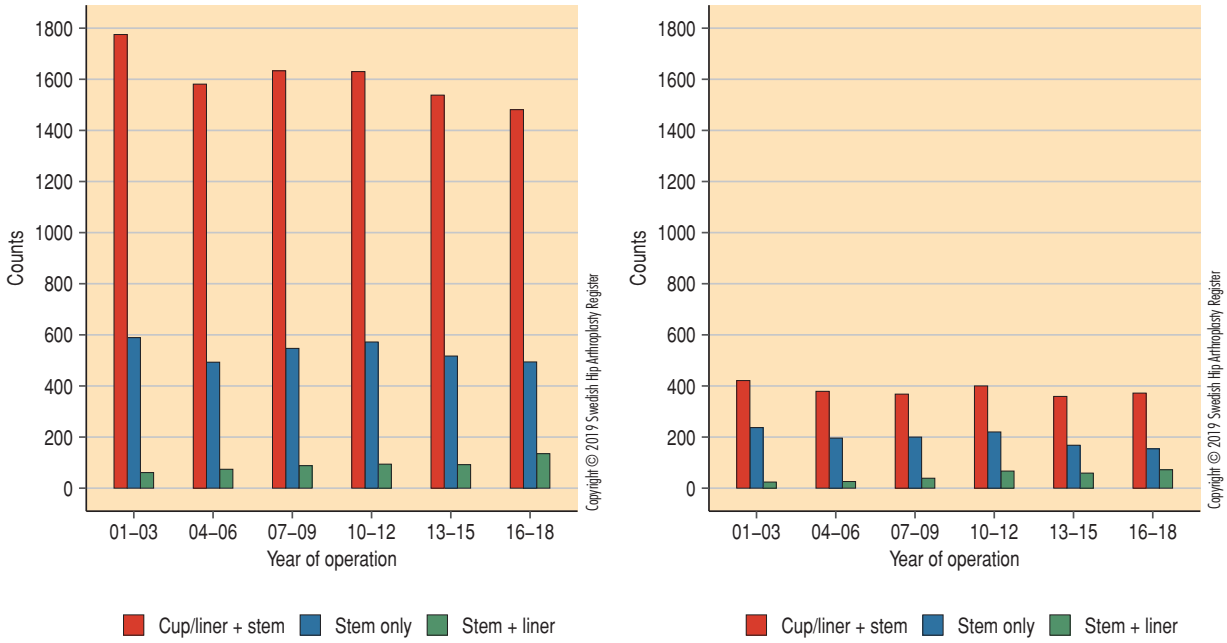


Figure 8.3.7. The number of revisions in three-year periods from 2001 to 2018 where the stem has been changed or inserted after an earlier extraction. First revisions to the left and multiple revisions to the right.

Reason for second and third revision respectively grouped after preceding cause

	Primary operation 2000–2018 number = 286 340				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other/no data**
First revision, %	**1.6**	0.9	0.5	0.8	0.3
No revision	95.9				
	First revision 2000–2018 number = 24 087				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other/no data**
Number re-revised per reason for revision group, %	11.9	18.6	11.7	16.6	15.9
Cause/event, %					
New revision					
Loosening	**6.0**	1.4	3.1	2.1	**6.2**
Infection	1.9	**15.0**	2.7	5.0	2.8
Periprosthetic fracture	1.1	0.4	1.0	0.9	1.5
Dislocation	2.3	1.4	**3.8**	**8.2**	3.5
Other/no data	0.6	0.4	1.0	0.4	1.9
Extraction without (as of yet) any registrated insertion	0.5	13.2	1.8	4.0	0.5
No re-revision, entire prosthesis remains	87.6	68.2	86.5	79.4	83.6
	Second revision 2000–2018 number = 5 351				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other/no data**
Proportion of re-revised per reason for revision group, %	15.7	22.9	17.7	21.2	18.7
Cause/event, %					
New revision					
Loosening	**7.8**	1.0	5.6	3.0	**8.2**
Infection	2.5	**18.7**	2.9	5.7	3.6
Periprosthetic fracture	1.2	0.3	1.3	1.3	0.6
Dislocation	3.3	2.4	**6.3**	**10.2**	3.9
Other/no data	0.9	0.5	1.6	1.1	1.3
Extraction without (as of yet) any registrated insertion	0.9	21.2	1.8	6.3	0.9
No re-revision, entire prosthesis remains	83.4	55.9	80.5	72.5	80.4

Table 8.3.5. The distribution of reasons for second and third revision in percentages grouped after reason for the last preceding revision. Patients who have undergone a primary arthroplasty or have been revised during 2000-2018 have been analysed. The group loosening includes the reasons osteolysis and wear. During two session procedures the reason for the first session (extraction) is given. Prosthesis extraction not followed by any registered insertion are presented as a separate group. The percentage that denotes the most common reason for re-revision within each group of reason for revision respectively is given in bold face.

to infection is relatively higher during multiple revision compared to during first time revision. This is most pronounced for change of head and liner, and permanent extraction of the prosthesis, but is not the case for change of head only that makes up 10.6% of all first time revisions and 9.6% of all multiple revisions during the period 2016 to 2018.

DAIR-procedures were highlighted in in-depth analyses presented in the two latest annual reports. With the help of the units involved we are at present trying to extend the data capture regarding these procedures and are conducting a review of medical records, where we also register results of bacterial culture tests.

Choice of measure related to cause of revision

The chosen type of procedure varies depending on the cause of revision (table 8.3.6). During loosening/osteolysis the most common procedure is to change both components, the second most common procedure being change of cup, while isolated stem revision is carried out in approximately one out of ten cases during first time revision and in one out of five cases during multiple revision. For infection, change of head and/or liner is the most common procedure during first time revision (42.3%), followed by two session procedure (35.2%), and extraction without any registered later prosthesis insertion (9.9%). A change of both cup and stem (one session procedure), was carried out in only 8.2% of the infected cases. During multiple revision, a two session procedure is the most common procedure (39.3%) followed by head and/or liner change (31.9%). Combined cup/liner and stem change (one session procedure) is slightly more common than during first time revision (9.0%). In presence of infection, insertion of only one component is reported in relatively few cases. These cases mean that only a partial extraction has been carried out during step one in a two-stage procedure, or it is a one session procedure where all components are not changed, something that can occur during a DAIR-operation where it is accidently noted that one of the components is loose. In some cases, an incorrect registration could also be the case.

In cases with periprosthetic fracture, a stem change with or without change of cup or liner at the same time, dominates. The group contains a number of isolated cup changes. In isolated cases, there is an acetabular fracture, in the other cases some kind of internal fixation ought to have taken place even if this is not always registered in the registry. During dislocation, an isolated cup change is the most common procedure followed by head and/or liner change, and total change during both first revision and second time revision.

Choice of fixation

The choice of uncemented fixation has a longer tradition in conjunction with a revision than with a primary operation. Until the period 2013-2015, more than half of all cups were

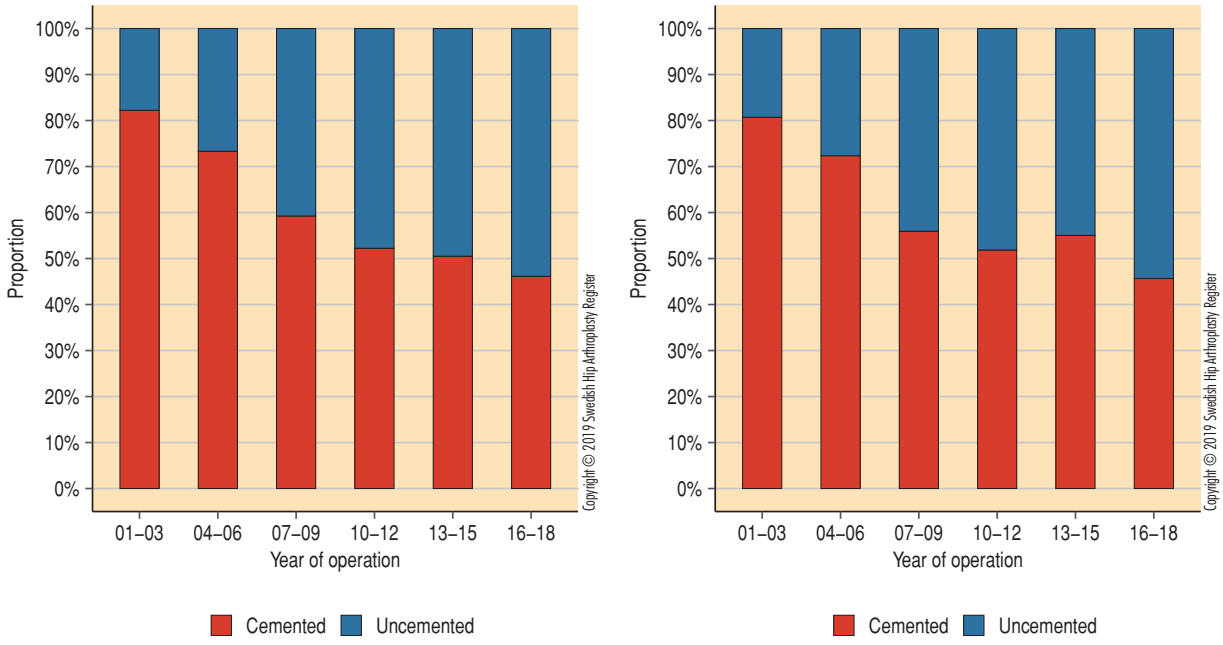


Figure 8.3.8. The distribution of cemented and uncemented cup fixation during first revision (to the left) and multiple revision (to the right) for three-year periods 2001 to 2018.

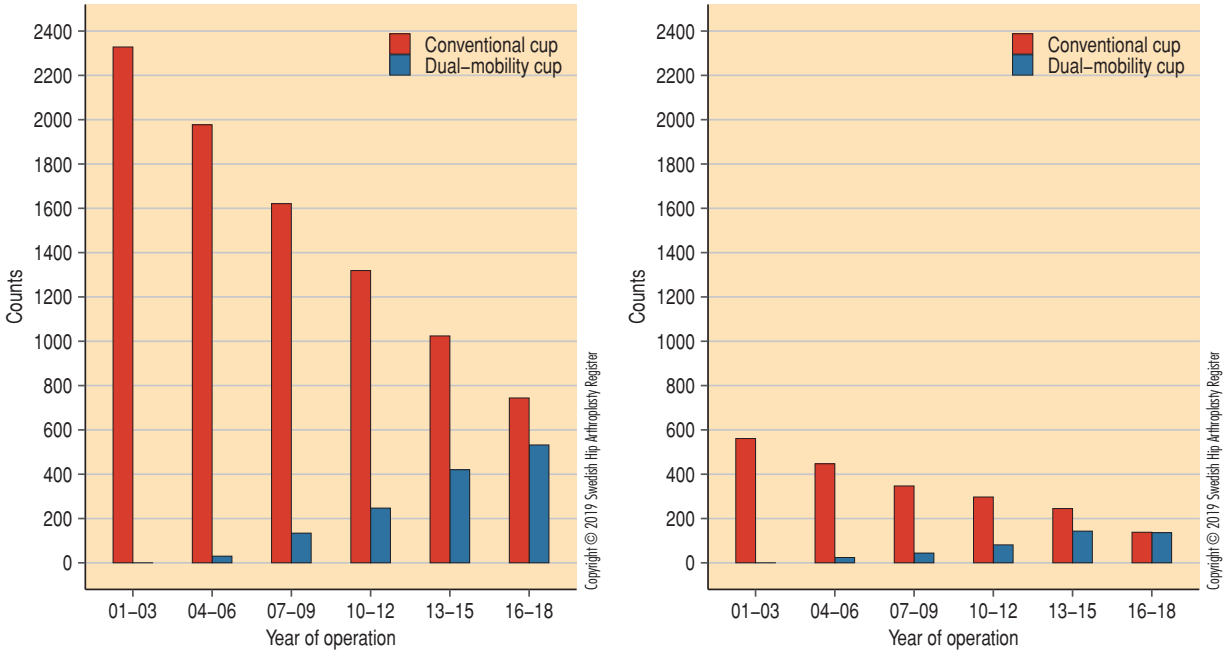


Figure 8.3.9. The number of inserted cemented dual mobility cups, and cups of standard type during first revision (to the left) and multiple revision (to the right) for three-year periods 2001 to 2018.

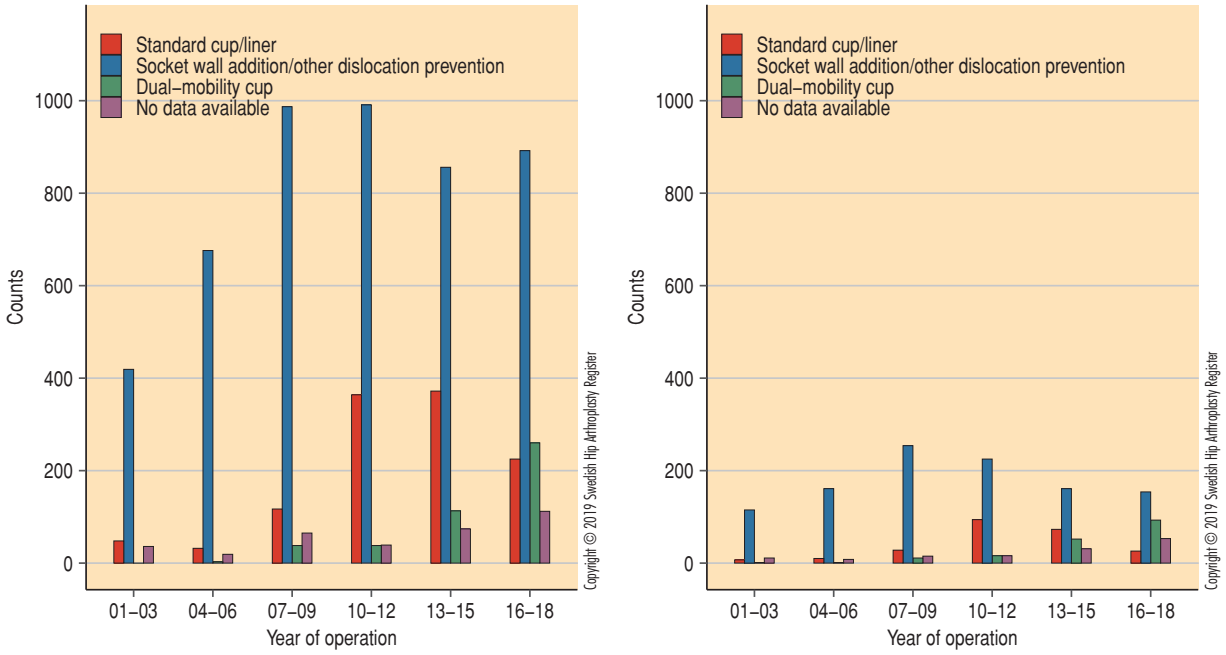


Figure 8.3.10. The number of inserted uncemented dual mobility cups, cups with other sorts of protection from dislocation (acetabular wedge augment, different angles of inclination, increased offset, constrained liner, etc.), and cups with a standard liner during first revision (to the left) and multiple revision (to the right) for three-year periods 2001 to 2018.

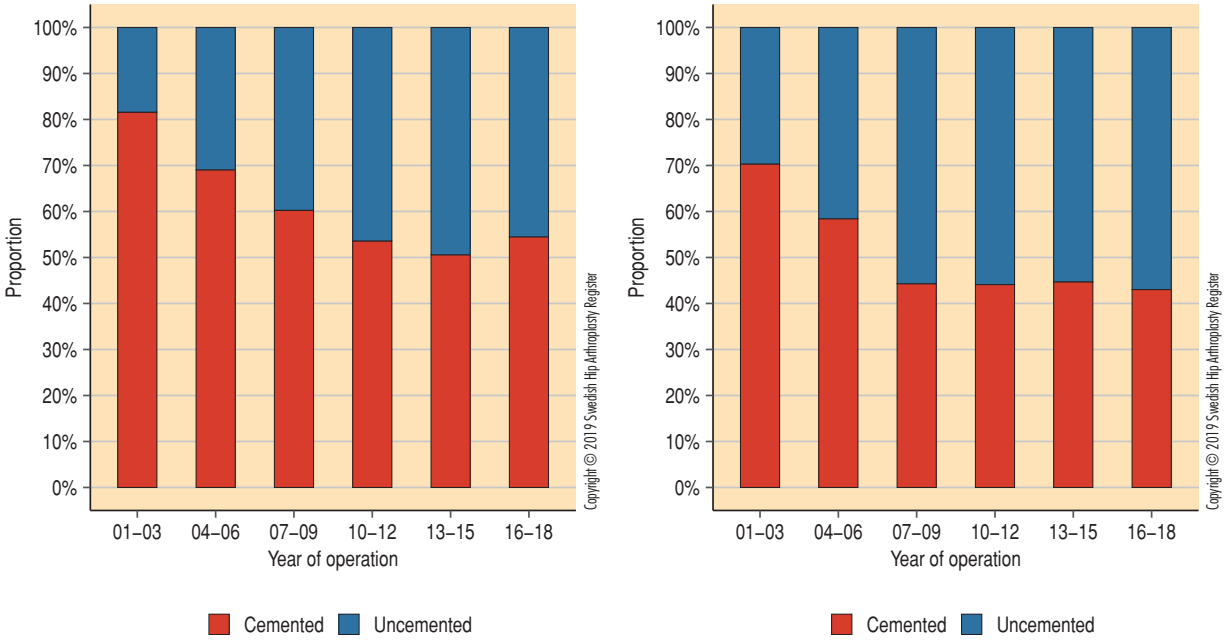


Figure 8.3.11. The distribution of cemented and uncemented fixation during first revision (to the left) and multiple revision (to the right) for three-year periods 2001 to 2018.

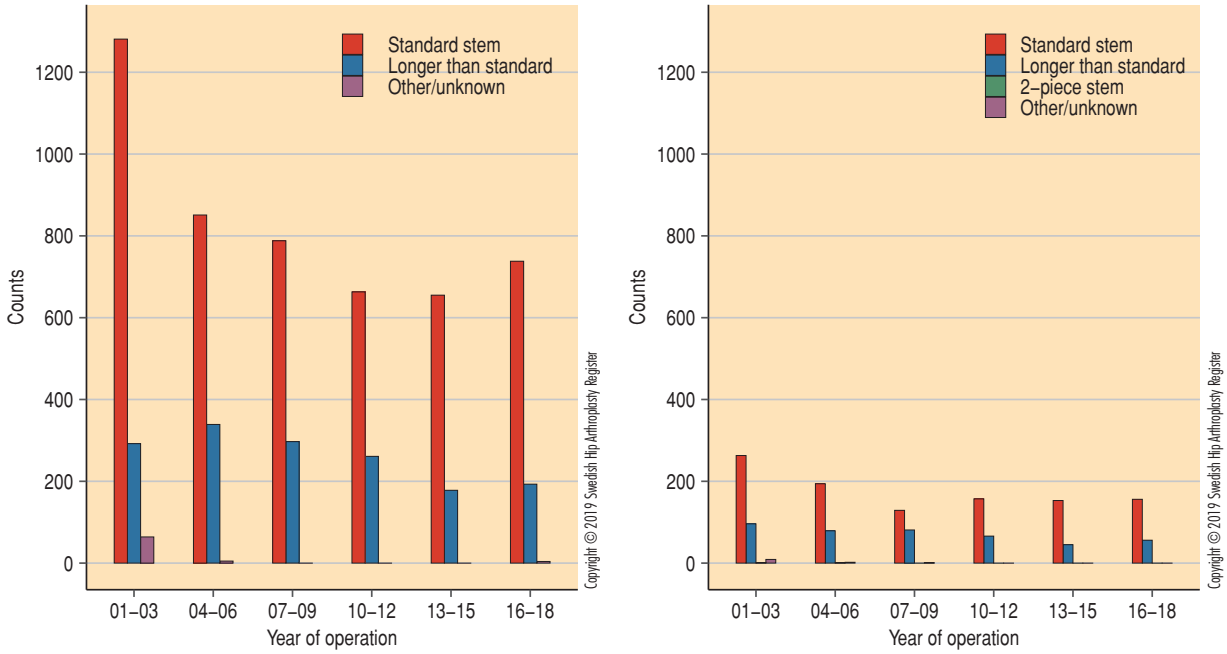


Figure 8.3.12. The number of cemented stems inserted during first revision (to the left), and multiple revision (to the right) related to registered stem length.

cemented during both first revisions and multiple revisions (figure 8.3.8). A dual mobility cup has become increasingly more common during cemented fixation (figure 8.3.9). During the latest period 2016-2018, a dual mobility cup was inserted in around 42% of the cases. The corresponding proportion during multiple revision was around 50%. The use of dual mobility cups also increases during uncemented fixation but here the picture is dominated by other sorts of plastic inserts with different variants of in-built protection against dislocation (figure 8.3.10).

Since the beginning of the 2000s, the trend on the femur side has been to use uncemented fixation more often. During first time revision the proportion of cemented stems was however still over 50%. During multiple revision, this proportion decreased however from 70.3% to 43.0% between the periods 2001-2003 and 2016-2018 (figure 8.3.11). Even if this decrease has affected both cemented standard stems as well as long cemented stems (longer than 15 cm), the relative proportion of standard stems seems to have increased somewhat during the last two three-year periods (figure 8.3.12). These data should however be viewed against the background that some manufacturers have not provided exact data on stem length, which could mean that the group cemented standard stems is hiding a number of observations where a stem longer than 15 cm has been used, something that should be possible to clear up before the next annual report on the basis of article numbers.

Two-part uncemented stems are the main replacement for uncemented fixation on the stem side (figure 8.3.13). The number has increased successively until the period 2010-2012, to decrease a little during the following two three-year periods. Regarding their relative share, the reduction is just short of 5 percentage points, from 83.2% 2010-2012, to 78.6% during the period 2016-2018, regardless if it is a first revision or a multiple revision.

Choice of implant

Table 8.3.7 displays the most used cemented and uncemented cups and stems during 2018, and for 10 to 11 years ago in a moving schedule that is updated on an annual basis. This year's table is not as fine-grained as before in order to give a better overview. Exeter short revision stem is shown separately however, since its result regarding risk of stem fracture is different from the other stems in the same family.

Since 2007, Avantage has been the most commonly used cemented revision cup. Another dual mobility cup, ADES, has become one of the five most used, and in sixth place is the Polar cup (4.0%). Together with Saturne (0.8%) and Bi-Mobile (1.3%), both dual mobility cups, these five cups account for more than half of all inserted cemented revision cups during 2018. Three other cups, Exeter Rim-fit, Lubinus x-link, and Marathon account for the remaining around 44% of the other half.

Regarding uncemented fixation, the Trilogy cup, which during many years dominated the Swedish market for revision surgery, has disappeared from the top in its original make. This goes for Mallory Head, Tritanium AD, and TMT modular as well. During the last two years, TMT revision has dominated followed by Tritanium revision, Continuum, and Pinnacle Gription.

Cups, whose design is based on a three-dimensional reconstruction of the acetabulum, have so far only been registered in conjunction with revision. Although several manufacturers make these implants on demand, only implants from one manufacturer, Materialise, have been reported. In total, 64 such cups are reported, of which the first two were inserted in 2013. The highest number of these implants were inserted during 2017 (n = 24). In total, five re-revisions have been reported, four due to infection and one due to loosening.

The Exeter stem has been the most used revision stem during the whole period and furthermore exhibits an increasing market share for all variants except for the short revision stem, which has decreased from 8.6% during 2008 to 5.9% during 2018. In more than one out of five cases (22.8%) some form of bone transplant has been used during insertion of a cemented revision stem. If these are regular bone impaction procedures or not, cannot be decided since the journals reviewed in each case often do not contain this particular information.

Among uncemented revision stems, modular two-part variants dominate where MP, Restoration, and Revitan hold the first three positions during 2017 and 2018. Together they account for approximately 78% of cases during 2017, and just under 70% during 2018. As shown in figure 8.3.13, there is a trend of decreased use of two-part uncemented stems, and a weak tendency to use uncemented stems more often where only the head is modular. The advantage of this is that one of the couplings with a potential risk of unintended loosening between the proximal and distal parts goes away, and the risk of corrosion problems is decreased. Where the optimal balance between this type of stem and two-part stems lies remains to be seen.

Just as in primary surgery, the conformity in Sweden regarding the choice of implant is the greatest when a cemented fixation is used. The size of the group "others" for each fixation group respectively, gives a certain albeit broad view of how diversified the choice of implant is, since the way implants are classified to a certain extent influences how large the group "others" will be. During 2018, the proportion of others in cemented revision cups was 11.8%, and for uncemented cups, it was 28.3%. On the stem side, the corresponding proportion was 3.4% and 17.6% respectively. During the same year, the group "others" contained 13 different designs of cemented cups, 21 different uncemented cups, 2 different cemented stems, and 10 different uncemented stems.

Measure during first and second revision as it relates to reason for revision

	First revision 2000–2018 number = *25 218*				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other**
Number of operations	14 774	3 075	2 378[2)]	3 064	1 957
Number of measures, %					
Change[1)] cup/liner + stem	7 608 *51.6*	1 246 *40.5*	817 *34.4*	537 *17.5*	544 *27.8*
Change[1)] cup	5 308 *36.0*	100 *3.3*	71 *3.0*	1 660 *54.2*	709 *36.2*
Change[1)] stem (not liner)	16 000 *10.9*	62 *2.0*	1 412 *59.4*	166 *5.4*	221 *11.3*
Change[1)] liner and/or head	148 *1.0*	1 377 *44.8*	28 *1.2*	557 *18.2*	454 *23.2*
Extraction, without (as of yet) any registrated insertion	66 *0.4*	271 *8.8*	43 *1.8*	122 *4.0*	9 *0.5*
No data	13 *0.1*	19 *0.6*	7 *0.3*	22 *0.7*	20 *1.0*
	Second revision *number = 5 351*				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other**
Number of operations	2 583	1 043	453[3)]	941	331
Number of measures, %					
Change[1)] cup/liner + stem	1 165 *45.1*	501 *48.0*	147 *32.5*	176 *18.7*	93 *28.1*
Change[1)] cup	879 *34.0*	31 *3.0*	31 *6.8*	396 *42.1*	94 *28.4*
Change[1)] stem (not liner)	498 *19.3*	26 *2.5*	258 *57.0*	91 *9.7*	82 *24.8*
Change[1)] liner and/or head	12 *0.5*	347 *33.3*	7 *1.5*	212 *22.5*	52 *15.7*
Extraction, without (as of yet) any registrated insertion	24 *0.9*	134 *12.8*	8 *1.8*	59 *6.3*	3 *0.9*
No data	5 *0.2*	4 *0.4*	2 *0.4*	7 *0.7*	7 *2.1*

Table 8.3.6. Type of measure as it relates to reason for revision during first revision and second revision for the period 2000 to 2018.

[1)]Or insertion (during a two session procedure).
[2)]A concurrent fracture reconstruction is registered in 1 136 cases (47.8%).
[3)]A concurrent fracture reconstruction is registered in 203 cases (44.8%).

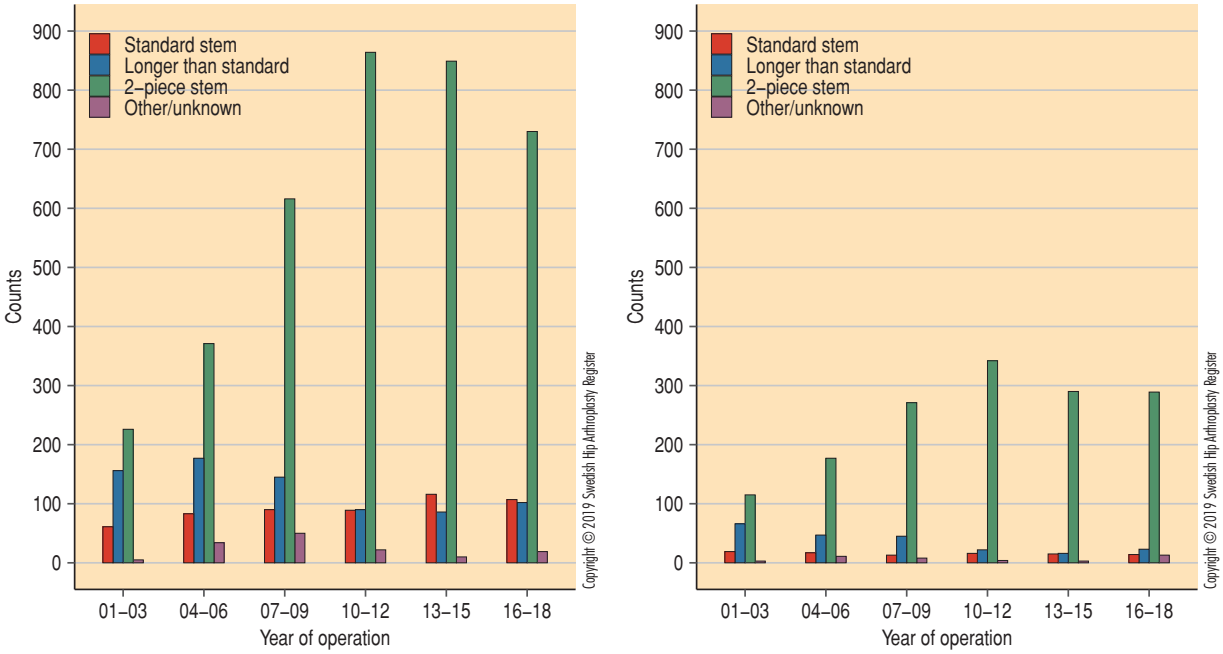


Figure 8.3.13. The number of inserted uncemented stems during first revision (to the left) and multiple revision (to the right) divided into the groups "standard stem", "long revision stem", and two-part stem, where the name revision stem refers to the definition of the manufacturer.

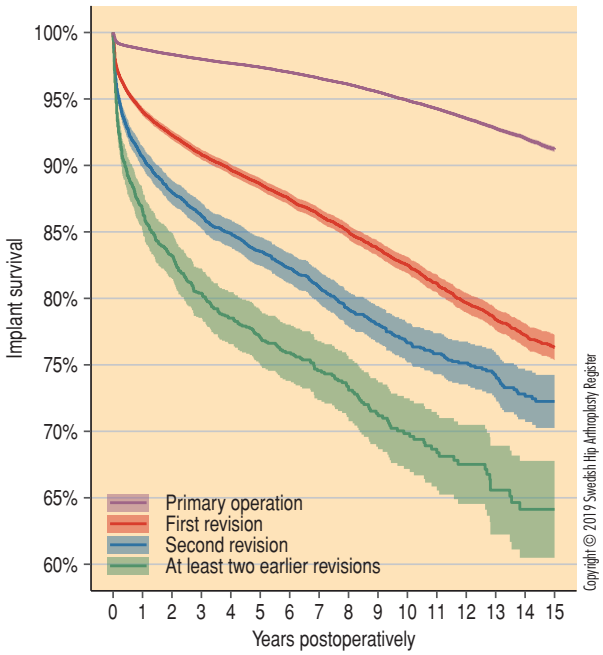


Figure 8.3.14. Implant survival up to 15 years for primary arthroplasties, first, and second revision, and for revisions preceded by at least two earlier revisions. All operations carried out 2000 to 2018 are included. For more details see the text under "Result".

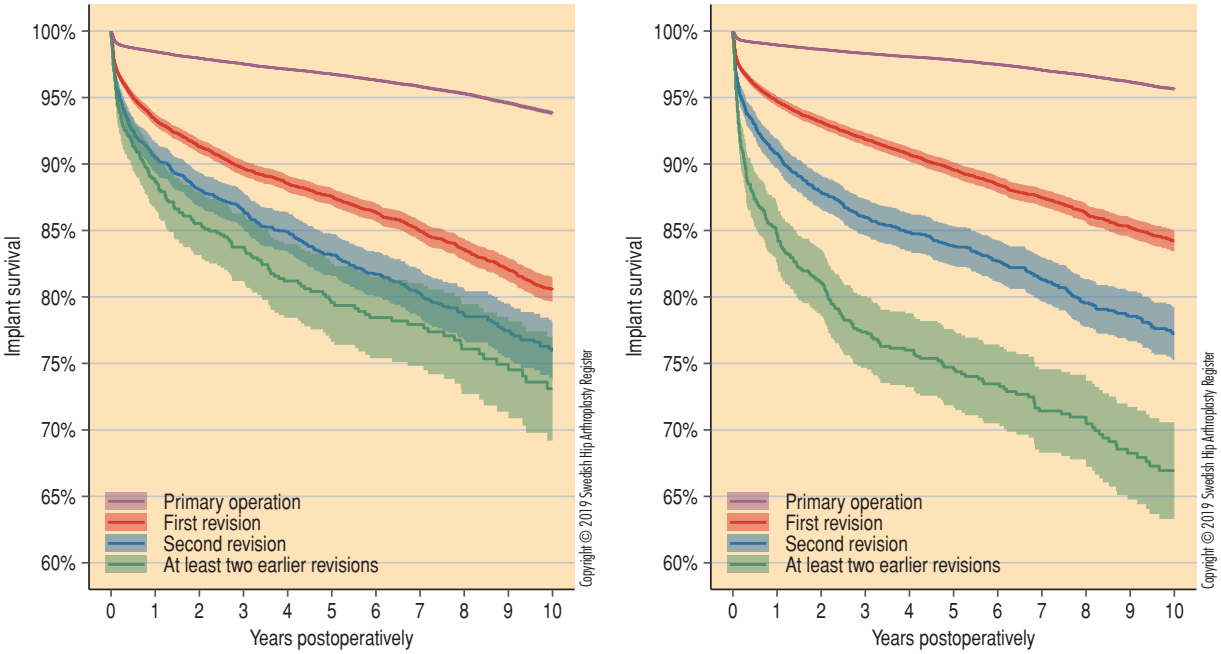


Figure 8.3.15. Implant survival up to 11 years for primary arthroplasties, first, and second revision, and for revisions preceded by at least two earlier revisions divided into men (to the left) and women (to the right). All operations carried out 2000 to 2018 are included.

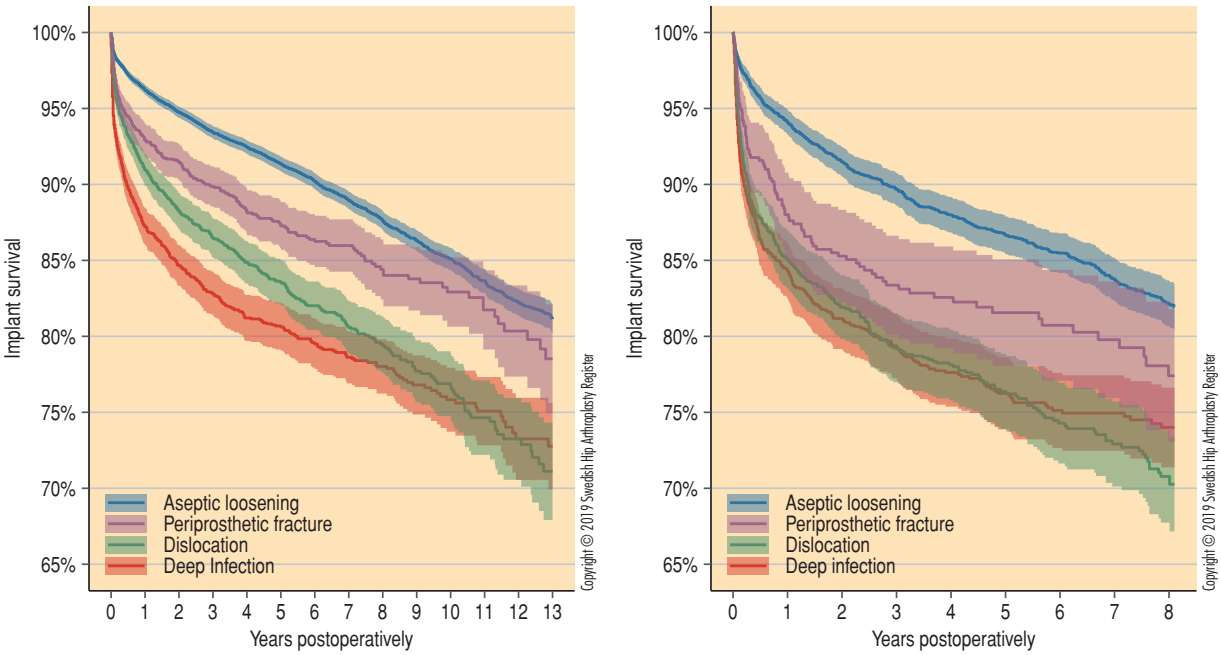


Figure 8.3.16. First revisions due to loosening, infection, periprosthetic fracture, and dislocation for operations carried out 2000 to 2018. Implant survival up to 13 years when more than 100 observations are left in the smallest group.

Figure 8.3.17. Multiple revisions due to loosening, infection, periprosthetic fracture, and dislocation for operations carried out 2000 to 2018. Implant survival up to 8 years when more than 100 observations are left in the smallest group.

Most used cups and stems during revisional surgery

2008		2017		2018	
Cup during revision %					
Cemented number	694		482		474
Lubinus (older plastic)	23.6	Avantage Cemented	33.6	Avantage Cemented	39.7
Contemporary Hooded Duration	15.7	Exeter X3 RimFit	22.2	Exeter X3 RimFit	19.4
ZCA XLPE	12.8	Lubinus X-linked	18.5	Lubinus X-linked	15.0
Elite Ogee	11.0	Marathon XLPE	13.3	Marathon XLPE	9.5
Contemporary	8.6	ADES Dual mobility	3.7	ADES Dual mobility	4.6
Other (n = 15)	28.3	Other (n = 10)	8.7	Other (n = 13)	11.8
Uncemented number	478		623		625
Trilogy±HA	37.4	TMT revision	37.6	TMT revision	30.9
TMT revision	17.2	Continuum	13.4	Tritanium Revision	13.5
TMT modular	14.0	Tritanium Revision	8.0	Continuum	11.8
Trident AD (LW + WHA)	10.7	Pinnacle W/Gription (100 + Sector)	7.7	Pinnacle W/Gription (100+Sector)	9.8
Mallory Head	7.1	Trilogy IT	4.7	Delta-One-TT	6.1
Other (n = 19)	13.6	Other (n = 20)	29.1	Other (n = 21)	27.9
Stem during revision, %					
Cemented number	535		476		478
Exeter ≥ 15 cm	36.8	Exeter ≥ 15 cm	47.7	Exeter ≥ 15 cm	48.8
Lubinus SP II, all lengths	28.7	Lubinus SP II, all lengths	31.7	Lubinus SP II, alla lengths	33.4
CPT, all lengths	11.7	Exeter short rev-stem	9.9	CPT, all lengths	6.2
Exeter short rev. stem	8.6	CPT, all lengths	6.1	Exeter short rev-stem	5.9
MS-30, all lengths	6.0	MS-30, all lengths	2.1	MS-30, all lengths	2.3
Other (n = 3)	8.2	Other (n = 1)	2.5	Other (n = 2)	3.4
Uncemented number	417		426		421
MP	44.8	MP	41.8	MP	38.0
Restoration	15.1	Restoration	20.7	Restoration	20.7
Revitan	14.3	Revitan	15.5	Revitan	10.9
Wagner SL Revision	12.5	Corail revision	7.0	Corail Revision	8.3
CLS	3.4	Arcos	4.0	Arcos	4.5
Other (n = 9)	9.9	Other (n = 10)	11.0	Other (n = 10)	17.6

Table 8.3.7. The five cemented and uncemented cups and stems most used during revision surgery given as percentages of the total number of cases reported during 2008, 2017, and 2018. Both first revisions and multiple revisions are included. The number displayed for the group "others" refers to the number of prosthesis designs that are part of the group.

Results

Of the primary operations carried out between 2000 and 2018, 4.0% had been revised after 15 years as of the 31st December 2018. The corresponding number for first time revisions during the same period is 13.5%, for second time revisions 18.1%, and for the hips that have been revised at least two times before 23.9%. The implant survival after 15 years, when 90 observations remained in the last group and 21,569, 1,518, and 291 respectively remained in the three other groups, was 91.2 ± 0.2% in the primary arthroplasty group and 76.3 ± 1.0%, 72.3 ± 2.0%, and 64.1 ± 3.7 respectively in the revision groups (figure 8.3.14). Figure 8.3.15 displays implant survival for men and women respectively up to 11 years as long as at least 100 observations remain in the group with the least number of observations. Otherwise, the grouping coincides with the grouping in figure 8.3.14. In general, the implant survival is poorer for men in three of the groups (primary, first and second revision).

In general, the risk of revision and re-revision respectively is higher for men than for women and the prognosis is getting worse for each completed revision. Evaluation after 15 years using Cox regression analysis and adjusting for age during index operation, gender, and primary diagnosis shows that the risk of (re)revision is 3.8 times higher (95% confidence interval: 3.7-4.0) after first time revision compared to primary operation, 5.4 (5.0-5.8) times higher if the patient is revised a second time, and 7.6 (6.9-8.3) times higher if the hip has been revised at least two times before.

In general, men have an increased risk of revision or re-revision of approximately 30% (1.33, 1.28-1.37). If operations that have been preceded by at least two earlier revisions are excluded and only first revisions and second revisions are analysed, this risk is affected very slightly (HR 1.35, 1.30-1.39), probably due to the small size of the group that is excluded. A separate analysis of those who have been revised at least two times (1,941 operations) however, shows that the risk for men is reduced in this group (HR 0.7, 0.6-0.7). These data should however be evaluated more thoroughly and to what extent these patients are reoperated without affecting the implant must be taken into consideration as these cases often are infections.

The analysis of implant survival related to cause of revision shows that the risk of re-revision is the largest if the cause is infection or dislocation, and that those re-revisions that take place do so relatively early (figure 8.3.16, figure 8.3.17). The time of follow-up is 13 years here when 113 observations remain in the smallest group (periprosthetic fracture). In the group for multiple revision the follow-up time is 8 years where 119 observations remain in the smallest group which is periprosthetic fracture where the mortality also is high (see annual report of 2016). As can be seen in the diagrams, the curves are not proportional. Moreover, there is a difference between the groups when it comes to demography and comorbidity, why these data should be analysed in more detail, something that is outside the scope of this year's report.

Since 2000, loosening has been the dominating cause of first and second revision but its relative proportion has gradually decreased, while above all the proportion of revisions due to infection has increased. In 2018, infection was the most common revision cause in those cases where at least one revision had taken place earlier.

If a hip prosthesis is re-revised after an earlier revision due to infection, loosening, or dislocation, the most common cause for the re-revision is the same as during the previous operation.

An extraction of the prosthesis without a subsequent insertion is carried out in an estimated 40 to 45 patients each year. Just under 60% are carried out due to infection, around 23% due to dislocation, and 11% due to loosening. The mortality rate among these patients is high. During the beginning of the 2000s the proportion of uncemented implants during revision surgery increased, an increase that now is fading. One reason for this is that cemented dual mobility cups are becoming increasingly popular. Furthermore, the use of uncemented two-part stems has levelled out.

Revision due to infection and for multiple revision also revision due to dislocation, has a poorer result in general if the risk of having an additional revision is considered. The majority of these re-revisions take place within 1-2 years after the previous revision.

The risk of having additional revisions increased successively for each completed revision. The importance of optimising the result of the primary operation therefore cannot be overstated.

8.4 Five and ten-year implant survival rate after total hip arthroplasty

The implant survival within five and ten years after a total arthroplasty is shown per unit, using so-called forest plots. All operations at one unit, regardless of diagnosis during primary operation, and all revisions, regardless of cause, are included in the analysis. Implant survival at five and ten years is presented by Kaplan–Meier estimates. The grey line represents the national average. Green indicates a statistically significantly better implant survival, and red a statistically significantly worse implant survival. It is important to bear in mind that very wide confidence intervals means few patients, which means that few events may result in large changes for these groups. In the five-year survival, we have chosen to exclude units that have operated fewer than 30 patients, and in the ten-year survival we have excluded units which have operated fewer than 60 patients in total during the time period. Those units which did not have any operations during 2008, or that have not registered any operations during 2017 and 2018 also have been excluded. The implant survival is based on revisions carried out on hip arthroplasties during the last five and last ten years. This means that the observation time reaches the nine to ten year interval only for those patients who underwent an operation the first observation year. Since the number of hip arthroplasties has increased during the later part of the time interval 2008-2018, the mean observational time becomes shorter than five years.

The national average for implant survival at five and ten years is over 97 and 95% respectively. There is a considerable variation between units. The five-year survival varies between 93 and 100% at five years, and between 89 and 99% at ten years.

The outcome measure is a valuable quality indicator, especially for those units whose organisation has remained relatively intact, and which have not changed the operation process in any major way, including the choice of standard prosthesis during the last ten years. The outcomes dislocation and infection reflect both the process surrounding primary arthroplasty and the case-mix of the unit. The frequency of revision due to loosening offers a relatively good view of how choice of prosthesis and surgical technique affect the outcome. For those units, which have carried out changes of the organisation during the last ten years, or have changed standard prosthesis, the implant survival within ten years could become harder to interpret since it reflects the current organisation and choice of prosthesis. Therefore, we also include the five-year survival, which to some extent reflects the current organisation. In this way, any sign of problems can be picked up on slightly earlier.

Implant survival for the most common combinations of stem and cup is presented in the swedish online version of the annual report. The online version of the annual report is available at www.shpr.se.

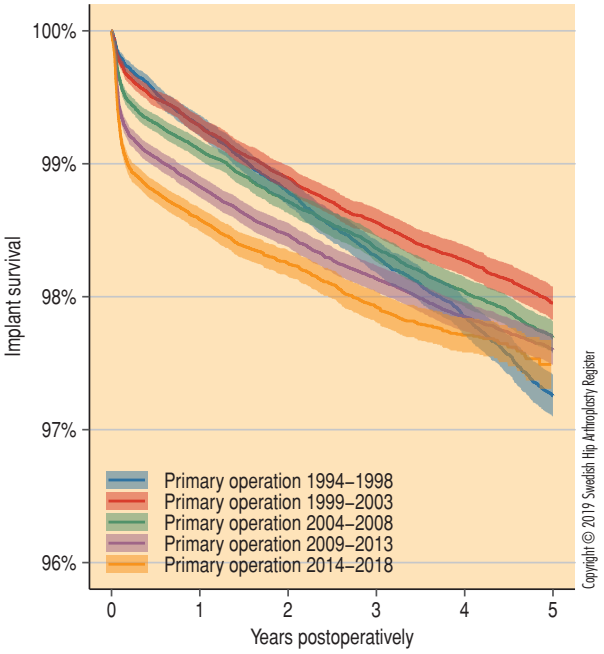


Figure 8.4.1. Implant survival for different periods up to 5 years.

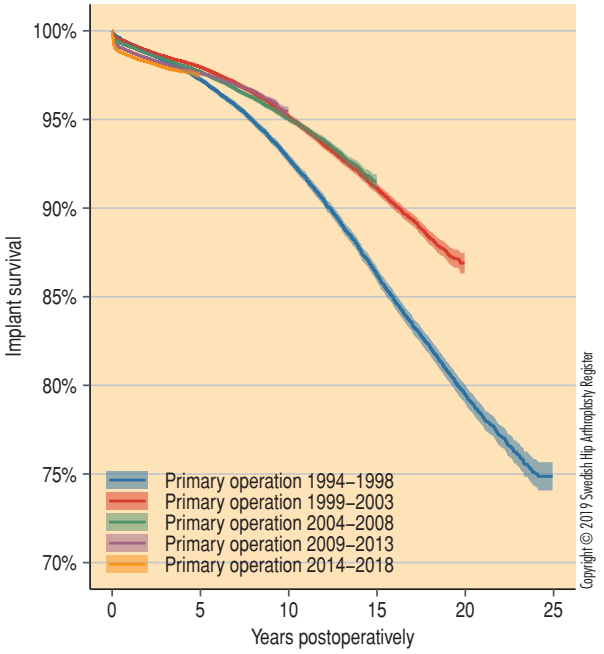
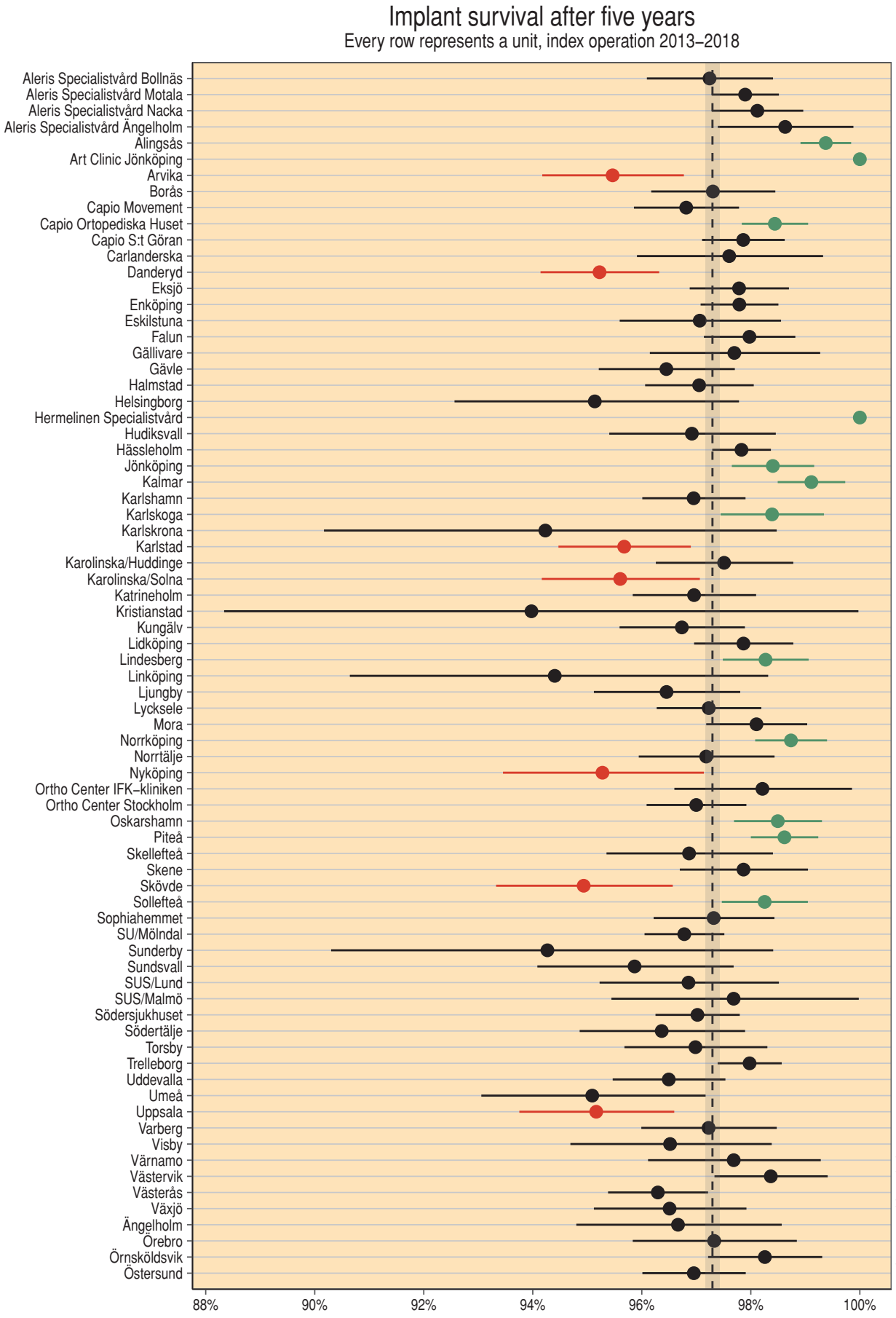


Figure 8.4.2. Implant survival for different periods up to 25 years.



8.4.18. 5-year implant survival with confidence interval per unit.

Units with fewer than 20 registrations have been excluded.

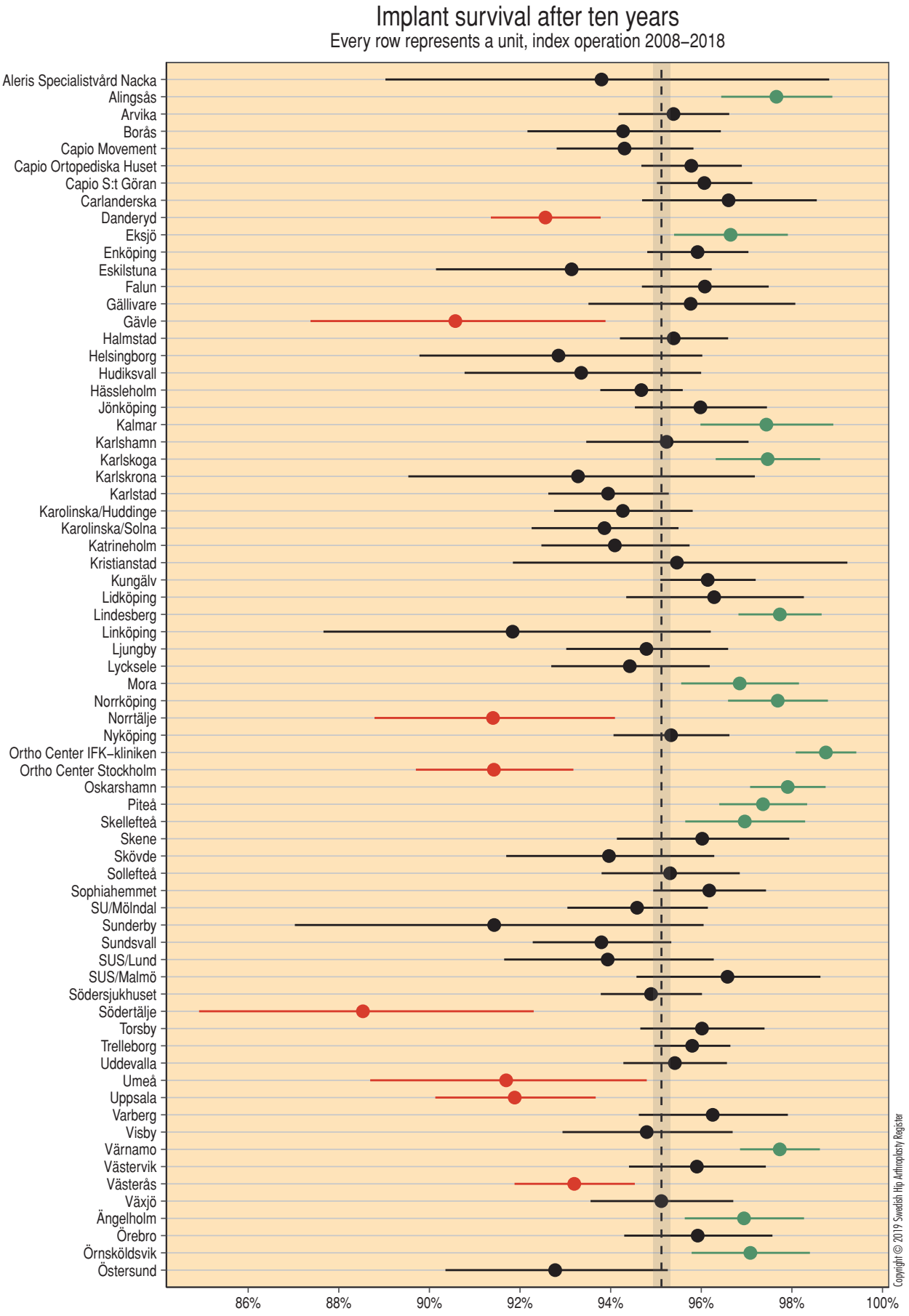


Figure 8.4.19. 10-year implant survival per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

8.5 Unusual reasons for revision

In earlier annual reports, we have regularly accounted for incidence and result after reoperation or revision, and analysed the four most common causes loosening, infection, dislocation, and periprosthetic fracture, in more detail. The annual report of 2017 also treated implant failure, especially as it relates to the choice of stem of the prosthesis.

In this year's report more unusual reasons for reoperation that have been reported during the period from 2000 to 2018, are accounted for. The 10 causes of reoperation that have been selected, together account for 3.0% of all reoperations during the period. The knowledge of the incidence, patient demography, and outcome after these operations is limited. Often case series where the outcome many times is informed by local conditions and local competence are presented. The reasons that have been chosen are displayed in table 8.5.1. The selection is based on causes that have been reported in more than 20 cases and in as many as 403 cases during the period. Different types of wound-related causes (for example reoperation due to hematoma) have been excluded, as they often are infection-based. Four of the chosen groups (uncertain pain, rupture/insufficiency of gluteus medius, material left behind, heterotopic bone formation) have been treated by reoperation without affecting the implant in more than 50 cases. For these, the type of measure that has been taken is accounted for, to the extent this is known. Against the background that the groups are small, we only account for the number of cases where an additional and subsequent reoperation takes place (re-reoperations) as a proportion per group. A survival diagram based on an additional reoperation of the same hip, regardless if it is a revision or other type of reoperation, is presented for the combined group that includes the four most common causes with the worst outcome (792 observations at start). Furthermore, we present survival using the same outcome for the whole group.

Demography

Compared to the whole group of reoperations carried out from 2000 and onwards, the average age is slightly lower among the chosen causes. In most cases, the proportion of women is higher except for the cause "pseudotumour", where the proportion is just as large as it is in the merged group, and in the cause group "heterotopic bone formation", where the reoperation in 81 cases out of a hundred has been carried out on men. There is also a tendency that the chosen reoperations to a slightly higher degree are carried out as first time measures with the exception "material left behind", which is expected since the material left behind most often is material for internal fixation that subsequently is removed (table 8.5.2).

Measure

For "uncertain pain" the most common measure is a soft tissue procedure if no revision is made, followed by exploration and extraction of cement, internal fixation material, or acetabular wedge augment. Only in one case, revision with extraction of prosthesis has been carried out. In significantly many cases (n = 72) information on specific measure taken is missing or it has not been possible to classify it.

Patients with trochanteric pain, limp, or confirmed insufficiency/rupture of the gluteus medius, have mainly been reoperated with muscle or fascia procedures (n = 133), and during an additional six operations this measure has been combined with a revision of the implant.

Results

Using the risk of an additional reoperation as starting point, the result for the whole group of 10 different causes is poor. is poor. After 13 years, the probability that the hip will not be reoperated at least one more time is 60.8 ± 3.8%. (104 observations remain). The proportion suffering at least one additional reoperation is the greatest in the reason for revision groups "material left behind", "uncertain pain", "insufficiency/rupture of gluteus medius", "cement-related problems", and "heterotopic bone formation", where at least 30% of the operations result in an additional reoperation. For this group, that includes four reasons for reoperation, the survival rate is 56.2 ± 4.4% after ten years (110 observations remain), using re-reoperation as outcome (figure 8.5.1). Unfortunately, PROM-data is missing for the majority of these patients, which would have given a more complete picture. It would also be desirable with a deeper analysis of these cases based on both information in medical records and reviewing of X-rays, to deepen our knowledge and if possible improve the assessment of indication for operation and outcome. Against the background of the poor results shown here, it could be questioned if it is meaningful to treat these patients operatively. This applies to several of the reasons for reoperation studied above, given that the indication is not completely evident.

Reoperation in the form of extraction of material for internal fixation or due to "uncertain pain", "gluteus medius insufficiency", "loose or protruding bits of cement", and "heterotopic bone formation", runs a great risk of resulting in residual or new problems and often ends in a new surgical intervention. Primarily, alternative treatments should therefore be considered for these afflictions.

Demography and prevalence of earlier reoperation in the group "unusual reasons for reoperation" reported during the period 2000–2018

	Number	Age *average, min-max* %	Proportion of women, %	Proportion with primary osteo-arthritis, %	Proportion with no earlier reoperation, %
Reason for reoperation					
Unclear pain	403	66 *24–90*	59	78	67
Rupture of gluteus medius[1)]	180	69 *35–89*	71	82	77
Pseudotumour (ALVAL)	125	60 *24–86*	53	73	82
Material left behind	109	68 *39–90*	65	62	36
Implant inserted incorrectly	109	68 *30–92*	55	71	73
Heterotopic bone formation	100	65 *25–84*	19	79	72
Elevated level of metal ion concentration	81	59 *27–84*	58	80	90
Loose implant component	67	65 *34–91*	64	60	63
Cement problems[2)]	62	68 *38–87*	71	66	77
Bone length difference	45	64 *18–84*	60	80	76
All reasons	42 572	72 *13–104*	53	71	66

Table 8.5.1. Demographics and incidence of earlier reoperation in the group "unusual reasons for reoperation", reported during 2000-2018.

[1)] Limp, trochanteric pain.
[2)] Loose part, penetrating cement.

Reported measures for the four most prevalent and selected reasons for reoperation without the implant being affected within the group "unusual reasons for reoperation"

	Reason, number			
	Unclear pain	Rupture of gluteus medius[1)]	Material left behind	Heterotopic bone formation
Measure				
Wound revision	1	–	6	–
Synovectomy, irrigation	6	1	1	–
Open reposition	1	–	–	–
Fracture reconstruction	–	2	–	–
Soft tissue surgery	62	133	–	1
Exstirpation of ectopic bone	8	–	–	59
Exploration	41	2	1	–
Extraction (not of prosthesis/ prosthesis components)	41	–	93	–
Unclear or not possible to classify	72	23	3	2

Table 8.5.2. Reported measures during the four most common reasons and selected reasons for reoperation without the implant being affected within the group "unusual reasons for reoperation".

[1)] Limp, trochanteric pain.

Measure, proportion of operations that are followed by a new reoperation and follow-up for 10 different reasons for reoperation that are less common in Sweden.

	Type of measure, number		Subsequent reoperation number, *% of total*		Total follow-up
	Revision	Other reoperation	Total number, %	Within 2 years	Average, *SD*
Reason for reoperation					
Unclear pain	171	232	146 *36.2*	101 *25.0*	4.6 *4.2*
Rupture of gluteus medius[1)]	18	162	57 *31.7*	34 *18.9*	4.3 *3.8*
Pseudotumour (ALVAL)	123	2	26 *20.8*	22 *17.6*	3.4 *2.5*
Material left behind	5	104	53 *48.6*	38 *34.9*	5.2 *5.0*
Implant inserted incorrectly	99	10	20 *18.3*	16 *14.7*	6.8 *5.6*
Heterotopic bone formation	38	62	30 *30*	23 *23.0*	5.1 *4.6*
Elevated level of metal ion concentration	81	0	8 *9.9*	6 *7.4*	4.5 *2.8*
Loose implant component	58	9	16 *23.9*	8 *11.9*	8.6 *5.7*
Cement problems[2)]	18	44	19 *30.6*	14 *22.5*	4.8 *4.2*
Bone length difference	41	4	8 *17.8*	3 *6.7*	8.3 *5.2*

Table 8.5.3. Measure and the proportion of operations that are followed by a new reoperation, and follow-up for ten less usual reasons for reoperation in Sweden.

[1)]Limp, trochanteric pain.
[2)]Loose part, penetrating cement.

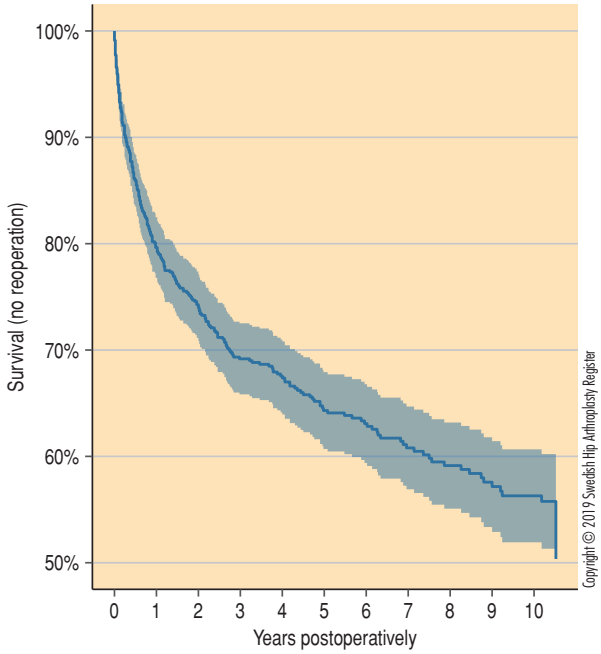


Figure 8.5.1. Survival diagram based on new reoperation regardless of cause and measure after reoperation due to "unclear pain", "gluteus medius rupture/insufficiency/trochanteric pain", "material left behind", and "heterotopic bone formation" merged into one group (792 observations at start, and 110 observations after 10 years).

9 Patient-reported outcome

The PROM-programme of the Swedish Hip Arthroplasty Register

Patient-reported outcome measures, abbreviated PROMs, are tools to measure health or health-related aspects through the patients" own experience. The tools or instruments that are used to measure patient reported outcome are standardised questionnaires answered by patients without any interpretation of someone else. The main goal with most hip arthroplasties is to reduce pain and restore function, thereby improving the health related quality of life of the individual.

The PROM-routine of the registry started as a pilot project in Norrland and in the Västra Götaland region in 2002. Successively, more units joined the programme and since 2008, all units are part of the follow-up routine. That we now have a 100% coverage of units is the result of the well-established structure for the reporting of data. The program was launched under the name "Höftdispensären" but now we call it the PROM-programme.

The logistics of the PROM-programme

All patients operated electively with a total arthroplasty are asked to answer a questionnaire, which contains twelve questions, prior to the operation. The questionnaire comprises questions on comorbidity and walking ability in order to determine Charnley class, questions on hip pain divided into right and left hip (on a 5 level Likert scale), and the EQ-5D-instrument that measures the health related quality of life. Starting in 2017, we use the new version of the EQ-5D-instrument, which consists of two parts; the first part consists of five general questions with five response options each, which gives a health profile that can be translated into an index. The other part of the EQ-5D form consists of a thermometer, EQ VAS (analogue visual scale), where the patient marks his/her present health condition on a scale from 0 to 100. Since 2012, a question if the patient has met a physiotherapist and has participated in an osteoarthritis self management exercise program preoperatively is included, and in 2013, a question on smoking was added. The same PROM questionnaire with the addition of one question on how satisfied the patient is with the result of the operation (on a five level Likert scale) is sent to the patient one, six, and ten years after the operation. The follow-up routine is handled by local contact secretaries, who sends out the questionnaire, enters the questionnaire answers into the PROM database, and sends a reminder after about two months if a person fails to respond. Those patients who preoperatively have entered an e-mail address get the follow-up questionnaires by e-mail.

In 2017, the PROM-programme was extended to include also patients undergoing reoperations. The same questionnaire is used prior to both primary operations and reoperations. This means that there is no need of pondering which type of operation it is.

Two different follow-up questionnaires are used; one for those who only have a prosthesis in one hip (unilateral), and one form for those who have prostheses in both hips (bilateral) hip arthroplasty. The same follow-up questionnaire is used after both primary operations and reoperations. Earlier annual reports (2016 and 2017) contain a more thorough description of the PROM-programme and its change over time.

PROM-values 2017

Table 9.1.1 shows PROM-values for patients who have answered the new questionnaire during 2017 and 2018, divided according to primary operation (prior to and one, six, and, ten years after primary operation) and revision (prior to and one year after revision). The values are given as absolute numbers and proportions for categorical variables and as average with standard deviation for EQ VAS, which is a continuous variable. The tables thus show a cross section of the different prosthesis populations that responded during these two years in order to give a general indication of how the patients respond on the PROM questions. As an example, it can be noted that among those who underwent a primary operation for six and ten years ago, 74 and 71% respectively report "no" or "very mild" hip pain, and around 85% of them are "satisfied or very satisfied" with the result of the operation at both time intervals of follow-up. That the general health-related quality of life is slightly lower for those who responded to the questionnaire at six and ten years compared to those who responded at one year, is natural; they are older in general and some have been affected by other conditions that affect the health condition.

Prior to revision, a larger proportion, as expected, report "none" or "mild" hip pain compared with before they underwent a primary operation. A lower proportion however reports that they are free of pain after one year. One year after revision, 67% report that they are "satisfied" or "very satisfied" with the result of the operation, and 17% are "dissatisfied" or "very dissatisfied". At one year after the operation, the difference is considerable for all EQ-5D dimensions between those who underwent a primary operation and those who underwent a revision. Those who underwent a revision report more problems with mobility, hygiene, normal day-to-day activities, pain/discomfort, and anxiety/depression.

Table 9.1.2 displays data for those who underwent a primary total arthroplasty during 2017 and who have complete preoperative and postoperative PROM-answers. Here, it can be noted that the average change in EQ VAS is 20 units on the scale of 100 degrees. When it comes to the EQ-5D dimensions it is above all pain, mobility, and normal day-to-day activities that have improved. Response distribution between the different response options differs between hospital types both preoperatively and one year postoperatively (figure 9.1.1 and 9.1.2). The so-called Pareto classification describes the change in the EQ-5D dimensions. If the patient is improved in one or more dimensions without getting worse in any other, the patient is classified as "better". If the patient gets worse in one or more dimensions without getting better in any other, the

patient is classified as "worse". No change is classified as "same" and change in different directions is classified as "mix". Figure 9.1.3 shows how the EQ-5D dimensions change in different hospitals. On a national level, 83% improve their results and only 3% have poorer results. The result however differ a lot depending on geographical location within the country. The largest proportion of patients who improve their results can be found at Sophiahemmet (92%), while only 53% improve their results at Karolinska/Huddinge. At several hospitals, none or only 1% deteriorate, while 10% of the patients in Karlstad worse health status at the follow-up. There is also a large variation in the proportion of patients, who have the same or mixed change (6-42%).

The proportion satisfied with the result of the operation

Since the new PROM questionnaire has a different formulation of the question on how satisfied the patient is with the result of the operation, only results for those who underwent an operation in 2017 and who answered the new version of the question during 2018 are presented. The formulation of the question means that a slightly lower proportion report that they are satisfied (those who have answered "satisfied" or "very satisfied") with the result compared with the classification that was made using the previous VAS values (VAS 0-40 was counted as satisfied). With the new way of measuring satisfaction, 86.3% reported that they were "satisfied" or "very satisfied". This should not be compared with the results from earlier annual reports, since the method differs; in the annual report of 2016, which considered operations 2014-2015, the number was 88.7%. For the trend graphs, we have considered this difference by transferring the VAS values to the Likert scale with a distribution-based method, which was presented in the annual report of 2017.

Large differences between units

Table 9.1.3 shows values for units with at least 20 registrations. It can be noted that the differences between the units are large; the proportion of 'satisfied" goes from 69 to 95%. Nineteen units have a lower proportion of satisfied patients than 80% and in 19 units the same number is 90% or higher. Among the major producers, it can be noted that Hässleholm, Ortho Center Stockholm, and Trelleborg have a high proportion of satisfied patients.

Trends, expected and observed PROM-results on a unit level

The trend graphs are only presented in the swedish online version of the annual report (available at www.shpr.se). They illustrate the development of the PROM-results one year postoperatively per operating unit. The values are presented as averages. The values shown correspond to four two-year periods from 2010/2011 to 2016/2017. We only show values for those units that have at least 20 registrations during at least two two-year periods. The PROM variables included are:

1) EQ VAS, which indicates self-reported health condition on a scale of 0-100,
2) Pain (in the operated hip), which is indicated on a scale of 1-5 and
3) How satisfied the patient is with the result of the operation on a scale of 1-5.

In the case of EQ VAS the higher the value, the better self-assessed health. For pain, the relation is reversed: low values indicate a low level of pain. For satisfaction, a high value indicates a positive outcome. Black dots/lines represent the national average and thus are identical in all graphs showing the same outcome. Red dots/lines show observed values for each unit respectively, and the blue dots/lines show the expected result of the units when adjusting for age, gender, diagnosis, Charnley class, and preoperative PROM values. If the black and blue lines are close to each other, the demography of the unit could be viewed as representative of the nation as a whole, but if they are apart there are difference in age, gender, diagnosis, Charnley class, and/or preoperative PROM-values. As an example the values for university and regional hospitals are shown (figure 9.1.4), where it is evident that the observed vales (red lines) are worse than the expected (blue lines), which in turn are lower than the national average (black line).

Positive trend with major differences between units

For PROM variables, there is a trend on a national level towards an improved state of health over time, which we have reported on in earlier annual reports. This positive trend is of course encouraging. Since 2015, we also report trends in the PROM results on the unit level. The idea is to illustrate the trends so that each unit can see how the trend appears in relation to the rest of the country, and compared to the expected result of the unit.

Physiotherapy, osteoarthritis self-management exercise progam, and smoking

Table 9.1.4 shows what proportion of those who responded to the preoperative PROM questionnaire that reported that they have been to a physiotherapist, participated in an osteoarthritis self-management exercise program, and that they are smokers. The proportions are presented on the unit level and refer to those who underwent surgery for osteoarthritis during 2017-2018 and where the response rate is also shown.

What proportion take part of the osteoarthritis exercise program?

In 2012, a question on contact with physiotherapist and participation in an osteoarthritis self-management exercise program was introduced to the preoperative PROM questionnaire. The questions were: "During the time you have had problems with your hip have you been to a physiotherapist to address your hip problems?" and "During the time you have had problems with your hip have you taken part in the supported osteoarthritis self-management programme (could have been many years prior to the operation for some and a little shorter period for others)?". This year's analysis, which comprises 2017-2018, clearly shows the differences between the units. The proportion of patients who have undergone an operation due to osteoarthritis (ICD codes M16.0-M16.9), who have been in contact with a physiotherapist varies from 56% (Visby) to 93% (Art Clinic Jönköping). For the osteo-

PROM responses 2017–2018

	Primary operation				Revision	
	Pre-operatively	Postoperatively			Pre-operatively	Post-operatively
		1 year	6 year	10 year		1 year
Number	24 572	28 031	19 613	13 433	825	2 043
Hip pain in the operated hip, number (%)						
None	206 (0.8)	14 333 (51.3)	10 707 (54.8)	7 064 (52.8)	38 (4.6)	664 (32.6)
Very mild	213 (0.9)	6 785 (24.3)	3 657 (18.7)	2 459 (18.4)	47 (5.7)	448 (22.0)
Mild	828 (3.4)	3 359 (12.0)	2 334 (11.9)	1 688 (12.6)	75 (9.1)	360 (17.7)
Moderate	8 724 (35.6)	2 784 (10.0)	2 214 (11.3)	1 687 (12.6)	340 (41.3)	411 (20.2)
Severe	14 536 (59.3)	698 (2.5)	636 (3.3)	481 (3.6)	324 (39.3)	151 (7.4)
Mobility, number (%)						
I have no problems in walking about	620 (2.5)	1 3776 (49.1)	9 143 (46.6)	5 693 (42.4)	65 (7.9)	571 (27.9)
I have slight problems in walking about	2 740 (11.2)	7 032 (25.1)	4 436 (22.6)	3 008 (22.4)	134 (16.2)	519 (25.4)
I have moderate problems in walking about	8 752 (35.6)	4 856 (17.3)	3 727 (19.0)	2 755 (20.5)	289 (35.0)	524 (25.6)
I have severe problems in walking about	11 743 (47.8)	2 143 (7.6)	1 986 (10.1)	1 659 (12.4)	281 (34.1)	338 (16.5)
I am unable to walk about	717 (2.9)	224 (0.8)	321 (1.6)	318 (2.4)	56 (6.8)	91 (4.5)
Self-care, number (%)						
I have no problems washing or clothing myself	3 319 (30.0)	9 867 (73.1)	6 869 (72.2)	4 169 (66.2)	162 (42.3)	508 (56.3)
I have slight problems washing or clothing myself	3 479 (31.4)	2 501 (18.5)	1 647 (17.3)	1 186 (18.8)	106 (27.7)	227 (25.1)
I have moderate problems washing or clothing myself	3 256 (29.4)	878 (6.5)	723 (7.6)	630 (10.0)	83 (21.7)	123 (13.6)
I have severe problems washing or clothing myself	968 (8.7)	196 (1.5)	209 (2.2)	214 (3.4)	30 (7.8)	31 (3.4)
I am unable to wash or clothing myself	43 (0.4)	48 (0.4)	69 (0.7)	101 (1.6)	2 (0.5)	14 (1.6)
Usual activities, number (%)						
I have no problems doing my ususal activities	1 239 (5.0)	13 479 (48.1)	9 306 (47.4)	5 951 (44.3)	96 (11.6)	579 (28.4)
I have slight problems doing my usual activities	4 102 (16.7)	8 282 (29.5)	5 159 (26.3)	3 373 (25.1)	167 (20.2)	583 (28.6)
I have moderate problems doing my usual activities	8 290 (33.7)	4 127 (14.7)	3 155 (16.1)	2 435 (18.1)	240 (29.1)	489 (24.0)
I have severe problems doing my usual activities	8 642 (35.2)	1 633 (5.8)	1 484 (7.6)	1 207 (9.0)	219 (26.5)	264 (12.9)
I am unable to do my usual activities	2 299 (9.4)	510 (1.8)	509 (2.6)	467 (3.5)	103 (12.5)	125 (6.1)

(the table continues on the next page)

PROM responses 2017–2018, continued

	Primary operation				Revision	
	Pre-operatively	Postoperatively			Pre-operatively	Post-operatively
		1 year	6 year	10 year		1 year
Pain/discomfort, number (%)						
I have no pain or discomfort	45 (0.2)	10 249 (36.6)	7 026 (35.8)	4 421 (32.9)	35 (4.2)	429 (21.0)
I have slight pain or discomfort	732 3.0)	9 759 (34.8)	5 956 (30.4)	3 969 (29.5)	102 (12.4)	672 (32.9)
I have moderate pain or discomfort	9 374 (38.1)	6 137 (21.9)	4 876 (24.9)	3 668 (27.3)	351 (42.5)	630 (30.9)
I have severe pain or discomfort	12 972 (52.8)	1 731 (6.2)	1 582 (8.1)	1 250 (9.3)	295 (35.8)	273 (13.4)
I have extreme pain or discomfort	1 449 (5.9)	155 (0.6)	173 (0.9)	125 (0.9)	42 (5.1)	36 (1.8)
Anxiety/depression, number (%)						
I am not anxious or depressed	9 332 (38.0)	19 607 (69.9)	13 098 (66.8)	8 602 (64.0)	336 (40.8)	1 047 (51.3)
I am slightly anxious or depressed	9 454 (38.5)	6 105 (21.8)	4 544 (23.2)	3 307 (24.6)	322 (39.1)	610 (29.9)
I am moderately anxious or depressed	4 193 (17.1)	1 622 (5.8)	1 400 (7.1)	1 109 (8.3)	104 (12.6)	278 (13.6)
I am severely anxious or depressed	1 378 (5.6)	584 (2.1)	484 (2.5)	349 (2.6)	54 (6.6)	93 (4.6)
I am extremely anxious or depressed	215 (0.9)	113 (0.4)	87 (0.4)	66 (0.5)	8 (1.0)	14 (0.7)
EQ VAS						
Average (standard deviation)	56.27 (22.19)	75.70 (19.32)	72.30 (21.10)	69.91 (21.94)	56.59 (23.11)	65.74 (22.83)
Satisfaction with the result of the operation, number (%)						
Very dissatisfied		614 (2.2)	531 (2.7)	331 (2.5)		145 (7.1)
Dissatisfied		1 069 (3.8)	849 (4.4)	565 (4.2)		199 (9.8)
Neither dissatisfied nor satisfied		2 274 (8.1)	1 666 (8.6)	1 109 (8.3)		317 (15.6)
Satisfied		6 544 (23.5)	4 840 (24.8)	3 447 (25.9)		635 (31.3)
Very satisfied		17 405 (62.4)	11 598 (59.5)	7 878 (59.1)		732 (36.1)

Table 9.1.1

arthritis self-management exercise program, the proportions differ between 16% (Karolinska Huddinge) and 75% (Lycksele). On a national level, 45% of all osteoarthritis patients who had responded to the questionnaire responded that they had participated in an osteoarthritis self-management exercise program. The proportion that responded that they have been to a therapist and that they have participated in an osteoarthritis self-management exercise program steadily increases over time. To some extent, differences between units could reflect the availability of physiotherapy and the osteoarthritis exercise program in different county council areas and regions.

Smoking

Smoking is a well-established risk factor for complications following the majority of surgical interventions. Stopping smoking 6-8 weeks before and after the operation has proven effective in reducing the risk for complications. In 2013, the Swedish Hip Arthroplasty Register introduced a question on smoking in the preoperative routine questionnaire. The question was formulated very simply: "Do you smoke?" with the response options "Never been a smoker", "Ex-smoker", "Smoker, but not daily", and "Daily smoker".

During 2017 and 2018, 31,090 patients underwent a hip arthroplasty due to osteoarthritis. 25,179 (81%) had answered the preoperative form. Of these, 5.1% responded that they were smokers. There were large differences in the number of smokers between units (0 to 12%). The number of smokers has decreased compared to earlier years and the variation between units has decreased.

Patients that have both a preoperative and one-year postoperative EQ-5D-5L

	Primary operation	
	Preoperatively	Postoperatively 1 year
Number	9 178	9 178
Hip pain in the operated hip, number (%)		
None	74 (0.8)	4 850 (53.0)
Very mild	70 (0.8)	2 258 (24.7)
Mild	331 (3.6)	1 005 (11.0)
Moderate	3 440 (37.6)	838 (9.2)
Severe	5 245 (57.3)	196 (2.1)
Mobility, number (%)		
I have no problems in walking about	238 (2.6)	4 742 (51.7)
I have slight problems in walking about	1 075 (11.7)	2 268 (24.7)
I have moderate problems in walking about	3 440 (37.5)	1 490 (16.2)
I have severe problems in walking about	4 197 (45.7)	634 (6.9)
I am unable to walk about	228 (2.5)	44 (0.5)
Self-care, number (%)		
I have no problems washing or clothing myself	2 843 (31.0)	6 872 (74.9)
I have slight problems washing or clothing myself	2 872 (31.3)	1 656 (18.0)
I have moderate problems washing or clothing myself	2 697 (29.4)	539 (5.9)
I have severe problems washing or clothing myself	737 (8.0)	98 (1.1)
I am unable to wash or clothing myself	29 (0.3)	13 (0.1)
Usual activities, number (%)		
I have no problems doing my ususal activities	524 (5.7)	4 669 (50.9)
I have slight problems doing my usual activities	1 609 (17.5)	2 712 (29.5)
I have moderate problems doing my usual activities	3 146 (34.3)	1 206 (13.1)
I have severe problems doing my usual activities	3 119 (34.0)	470 (5.1)
I am unable to do my usual activities	780 (8.5)	121 (1.3)
Pain/discomfort, number (%)		
I have no pain or discomfort	24 (0.3)	3 532 (38.5)
I have slight pain or discomfort	282 (3.1)	3 221 (35.1)
I have moderate pain or discomfort	3 682 (40.1)	1 880 (20.5)
I have severe pain or discomfort	4 701 (51.2)	503 (5.5)
I have extreme pain or discomfort	489 (5.3)	42 (0.5)
Anxiety/depression, number (%)		
I am not anxious or depressed	3 648 (39.7)	6 573 (71.6)
I am slightly anxious or depressed	3 500 (38.1)	1 957 (21.3)
I am moderately anxious or depressed	1 491 (16.2)	467 (5.1)
I am severely anxious or depressed	472 (5.1)	153 (1.7)
I am extremely anxious or depressed	67 (0.7)	28 (0.3)
EQ VAS		
Average (standard deviation)	56.95 (22.29)	76.96 (18.47)
Satisfaction with the result of the operation, number (%)		
Very dissatisfied	0	183 (2.0)
Dissatisfied	0	322 (3.5)
Neither satisfied nor dissatisfied	0	673 (7.4)
Satisfied	0	1 957 (21.4)
Very satisfied	0	5 998 (65.7)

Table 9.1.2

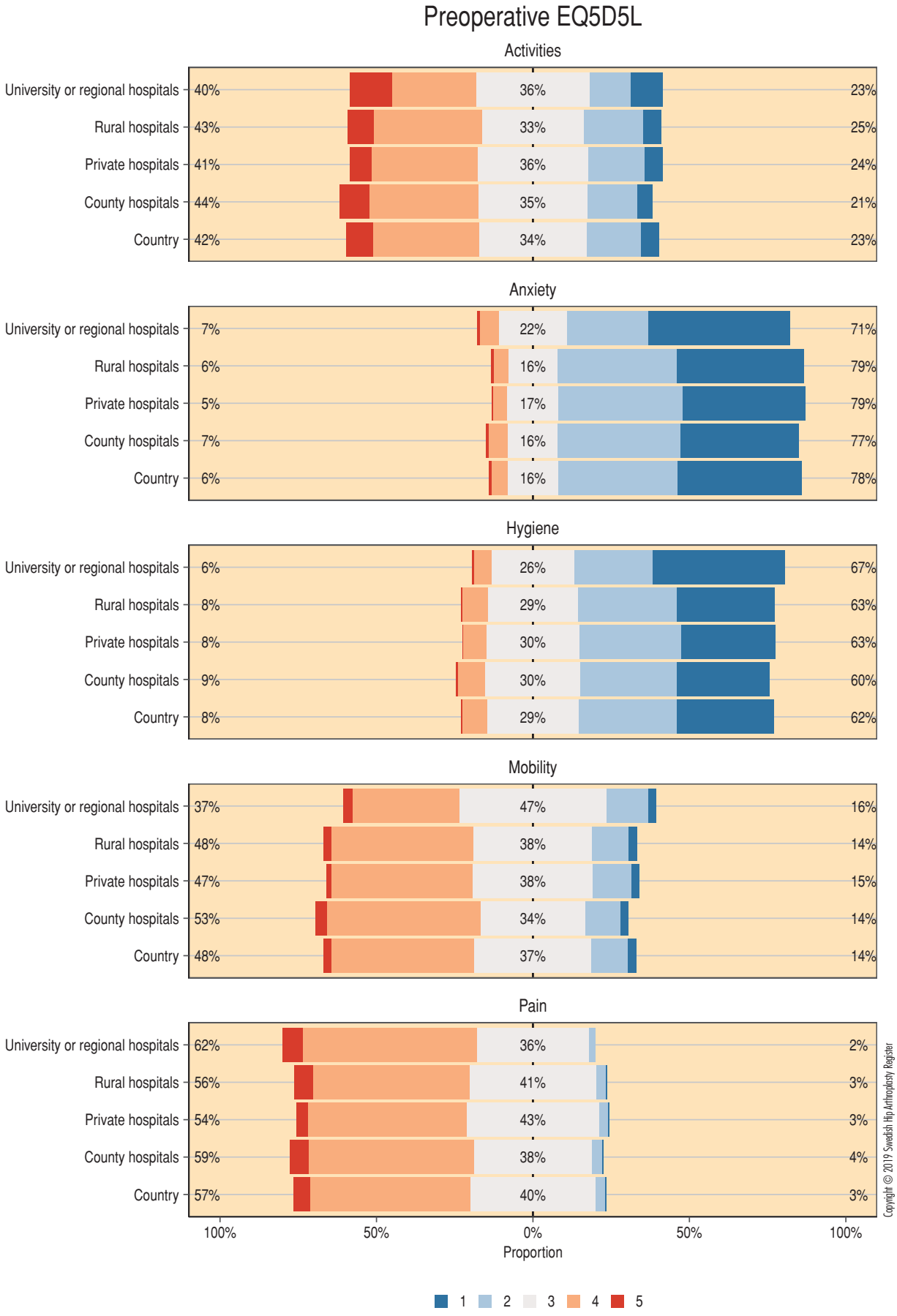


Figure 9.1.1. Preoperative EQ-5D-5L per hospital type. Patients with a primary arthroplasty in 2017 who have both a preoperative and 1-year postoperative response. The five level scale measures different health statuses, starts with no problems (1), and ends with not being able to /extreme problems (5).

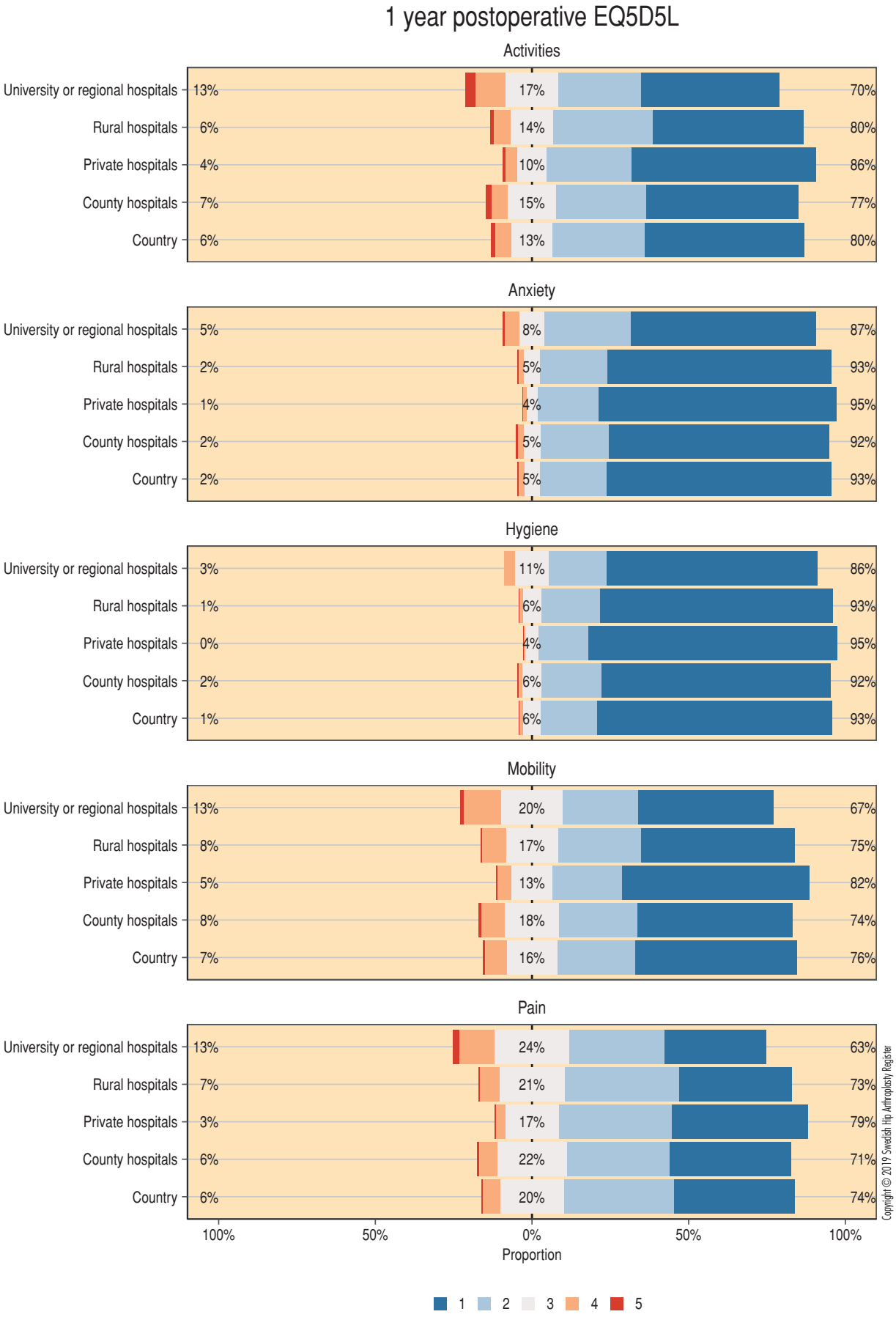


Figure 9.1.2. 1-year postoperative EQ-5D-5L. Patients with a primary arthroplasty in 2017 who have both a preoperative and 1-year postoperative response. The five level scale measures different health statuses, starts with no problems (1), and ends with not being able to /extreme problems (5).

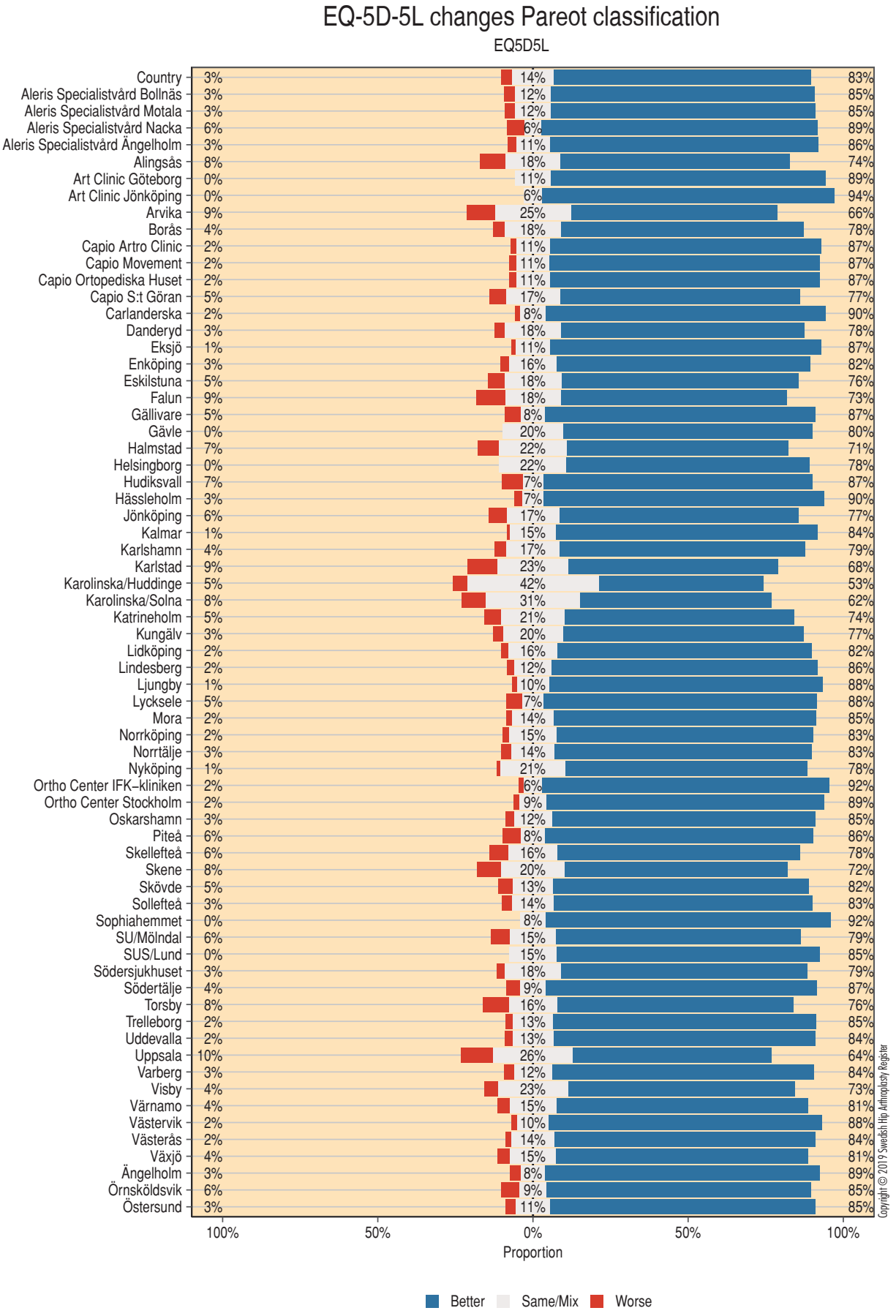


Figure 9.1.3. Pareto classification for EQ-5D for elective patients per unit. Patients with a primary arthroplasty in 2017 who have both a pre-operative and 1-year postoperative response. The EQ-5D health status is better if at least one dimension is better and no others are worse, and the EQ-5D health status is worse if at least one health status is worse and no others are better.

Patient satisfaction

Primary operation 2017

Unit	Number	Proportion, %
Aleris Specialistvård Bollnäs	247	85
Aleris Specialistvård Motala	555	89.5
Aleris Specialistvård Nacka	207	88.4
Aleris Specialistvård Ängelholm	56	91.1
Alingsås	143	69.2
Art Clinic Göteborg	66	84.8
Art Clinic Jönköping	54	92.6
Arvika	173	75.7
Borås	98	78.6
Capio Artro Clinic	202	94.6
Capio Movement	289	94.5
Capio Ortopediska Huset	510	86.7
Capio S:t Göran	393	80.2
Carlanderska	160	95
Danderyd	230	86.5
Eksjö	180	84.4
Enköping	308	79.2
Eskilstuna	106	79.2
Falun	198	78.8
Gällivare	77	94.8
Gävle	174	87.4
Halmstad	168	79.2
Helsingborg	68	76.5
Hudiksvall	74	89.2
Hässleholm	705	91.5
Jönköping	178	82
Kalmar	141	90.1
Karlshamn	194	88.7
Karlskoga	37	83.8
Karlskrona	33	84.8
Karlstad	153	78.4
Karolinska/Huddinge	145	82.1
Karolinska/Solna	87	74.7
Katrineholm	213	75.1
Kristianstad	42	76.2
Kungälv	158	79.7
Lidköping	242	88.8
Lindesberg	502	90.2
Linköping	28	92.9
Ljungby	162	90.1
Lycksele	262	92
Mora	229	86.9
Norrköping	192	77.1
Norrtälje	117	82.9
Nyköping	148	77
NÄL	33	78.8
Ortho Center IFK-kliniken	156	94.2
Ortho Center Stockholm	481	91.9
Oskarshamn	261	92
Piteå	354	88.4
Skellefteå	125	82.4
Skene	132	84.8
Skövde	123	87
Sollefteå	163	89.6
Sophiahemmet	176	92
SU/Mölndal	384	85.2
SUS/Lund	101	78.2
SUS/Malmö	28	82.1
Södersjukhuset	276	80.8
Södertälje	124	87.1
Torsby	117	83.8
Trelleborg	587	92.3
Uddevalla	317	83.6
Umeå	64	79.7
Uppsala	214	78.5
Varberg	196	93.4
Visby	113	83.2
Värnamo	102	82.4
Västervik	118	89
Västerås	169	85.8
Växjö	84	84.5
Ängelholm	129	87.6
Örebro	33	84.8
Örnsköldsvik	138	84.1
Östersund	234	90.2
Country	**14 259**	**86.3**

Table 9.1.3.

Units with fewer than 20 registrations during 2017 have been excluded.

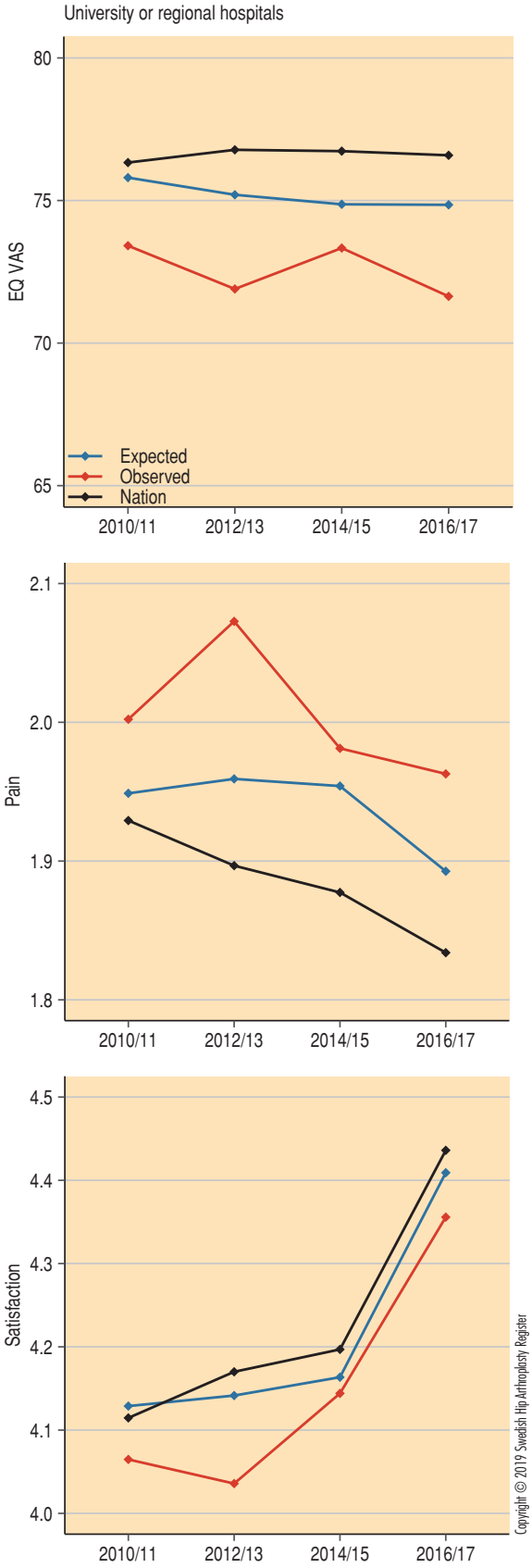


Figure 9.1.4. Presentation of PROMs, university and regional hospital as example.

Smoking, physiotherapy, and osteoarthritis exercise program prior to hip arthroplasty

Unit	Number (diagnosis M16.0-M16.9)	Number responses	Number smoker, %	Proportion physiotherapy, %	Proportion osteo-arthritis exercise program, %	Response frequency, %
Aleris Specialistvård Bollnäs	606	570	3.9	74	44	94
Aleris Specialistvård Motala	1 196	986	4.5	74	58	82
Aleris Specialistvård Nacka	478	292	5.1	86	30	61
Aleris Specialistvård Ängelholm	124	97	5.2	71	35	78
Alingsås	371	344	6.6	85	69	93
Art Clinic Göteborg	184	109	0.9	87	49	59
Art Clinic Jönköping	207	201	1	93	51	97
Arvika	418	268	8.2	80	68	64
Borås	187	126	8.9	71	33	67
Capio Artro Clinic	611	518	5.8	80	36	85
Capio Movement	688	599	3.4	78	35	87
Capio Ortopediska Huset	1 229	1 122	7	76	39	91
Capio S:t Göran	1 052	729	4.1	73	41	69
Carlanderska	471	326	5.9	83	34	69
Danderyd	428	241	8.1	70	33	56
Eksjö	392	346	2	68	35	88
Enköping	843	646	5.4	80	44	77
Eskilstuna	149	88	7	70	30	59
Falun	367	321	6.6	68	58	87
Gällivare	171	112	4.5	69	42	65
Gävle	167	152	10.6	67	46	91
Halmstad	328	249	5.6	75	24	76
Helsingborg	55	37	5.4	65	24	67
Hudiksvall	132	105	3.9	72	42	80
Hässleholm	1 426	1 371	4.1	70	27	96
Jönköping	368	333	1.8	76	29	90
Kalmar	275	263	0.8	74	50	96
Karlshamn	483	453	4.4	71	52	94
Karlstad	197	178	7.9	73	59	90
Karolinska/Huddinge	239	145	9	74	16	61
Karolinska/Solna	90	60	10	83	37	67
Katrineholm	497	484	7.6	71	36	97
Kungälv	330	262	7.8	77	49	79
Lidköping	440	390	5.5	81	50	89
Lindesberg	1 197	722	5.7	80	47	60
Ljungby	333	323	4.6	67	34	97

(the table continues on the next page)

Smoking, physiotherapy, and osteoarthritis exercise program prior to hip arthroplasty, continued

Unit	Number (diagnosis M16.0-M16.9)	Number responses	Number smoker, %	Proportion physiotherapy, %	Proportion osteo-arthritis exercise program, %	Response frequency, %
Lycksele	623	450	0.7	82	75	72
Mora	464	297	8.1	78	51	64
Norrköping	372	299	2.3	78	73	80
Norrtälje	275	185	7.9	69	44	67
Nyköping	249	211	5.2	81	52	85
Ortho Center IFK-kliniken	398	288	4.2	88	47	72
Ortho Center Stockholm	1 337	1 243	5.3	82	46	93
Oskarshamn	575	523	4.5	75	49	91
Piteå	822	560	2.7	82	43	68
Skellefteå	245	205	0.5	74	63	84
Skene	324	270	6.2	82	45	83
Skövde	155	146	8.6	68	35	94
Sollefteå	615	562	2.7	77	58	91
Sophiahemmet	531	463	6	82	26	87
SU/Mölndal	855	595	1.5	75	44	70
SUS/Lund	78	25	11.5	72	27	32
Södersjukhuset	411	234	10.4	74	38	57
Södertälje	277	242	7.3	79	46	87
Torsby	232	225	7.1	74	58	97
Trelleborg	1 274	1157	7.2	72	40	91
Uddevalla	701	563	6	79	60	80
Umeå	60	47	6.4	79	49	78
Uppsala	219	185	4.9	74	30	84
Varberg	472	395	2.5	75	32	84
Visby	215	172	3.5	56	40	80
Värnamo	251	231	1.7	67	24	92
Västervik	260	188	3.8	68	46	72
Västerås	647	526	4.8	75	63	81
Växjö	182	142	1.5	67	29	78
Ängelholm	307	275	7.3	72	38	90
Örebro	38	25	0	60	40	66
Örnsköldsvik	252	196	2	73	50	78
Östersund	447	417	3.9	76	66	93
Country	31 090	25 179	5	76	45	81

Table 9.1.4.

Units with fewer than 20 responses during 2017-2018 have been excluded.

10 90-day mortality after hip arthroplasty

In today's healthcare, hip arthroplasty is often seen as a routine procedure, and the focus may shift towards demands on high production and short hospital stays. Therefore, it is always important to bear in mind that each operative procedure entails risks for the patient. A hip arthroplasty has an increased risk of infections and tromoembolic events. These are potentially life-threatening complications. Prior to the decision to carry out a planned operation the patient must be thoroughly informed, among other things of the fact that a patient who undergoes an elective total arthroplasty has an increased risk of mortality during the first month compared to a non-operated individual of the same age.

90-days mortality is an open reported variable on unit level. The registry's database is updated each night regarding the patients" potential date of death from the Swedish Tax Agency.

The indications for arthroplasty are successively becoming wider. Both younger and older patients undergo an operation more often compared to before. The older patients have a natural higher risk of serious complications, while the younger patients that are operated seem to have a higher degree of comorbidity. More risk patients are operated today compared to before, especially at the larger units. An important group of such risk patients are those patients who undergo an arthroplasty in conjunction with an acute hip fracture. These individuals have not at all the same possibility of stabilisation of possible health problems before the operation, since fracture surgery must take place within a day or two. This is in contrast with those who have a planned, osteoarthritis-related hip arthroplasty, where the date of surgery can be postponed until the health status has improved.

10.1 Total arthroplasty

90-day mortality is often used to evaluate the risks of different treatments. There are many reasons for the death of a patient either during the operation itself or within 90 days (and related to the procedure), but the dominating causes ought to be cardiovascular, cerebrovascular, or tromboembolic diseases.

The mortality rates are low – observe that the results are given as per mille. This is why the last four years are analysed together in order to compensate for the risk of random variation.

The 90-day mortality is higher after an operation at a university/regional hospital and county hospital compared to local hospitals, and above all compared to private care units. The differences reflect the different patient groups operated at each hospital respectively. Units that operate fewer than 70% osteoarthritis patients have a considerably higher mortality rate, which is explained by many fracture patients and in some cases also tumour cases.

The 90-day mortality differ between the Swedish hospitals during the years 2015-2018, from 0 to 58‰. The national average is 6.6‰.

Regardless of whether the unit considers the observed mortality "expected" or not, the mortality rates and their causes should be analysed on a regular basis as a natural part of the patient safety work. It is also of outmost importance that other units and hospitals that take care of newly operated patients with complications, inform the operating unit of these cases. If the orthopaedic surgeon does not see these serious events, it is easy to believe that they do not exist.

10.2 Fracture patients

The hip fracture patient has a considerably higher mortality risk than those undergoing an elective procedure. The fracture patient need acute surgery regardless of health status. In addition, they are older and have more comobidities than osteoarthritis patients. The national average 90-day mortality was slightly less than 13% in 2018 and it has been on the same level during the 2010s. Depending on which patients who are operated, the mortality rate will vary. If the frailest patients instead are treated with internal fixation – in most cases an inferior alternative – the mortality rate decreases. The mortality varies between the hospitals, from 8 to 18% at the units which primarily treat acute fractures. In table 10.2.1 a number of factors that can increase the risk of early death are shown; older patients, male gender, comorbidity, and the proportion of acute fracture operations (as opposed to elective secondary procedures). If the mortality of the unit is higher than what is to be expected considering the current "risk profile" the clinical pathway ought to be analysed in detail.

Mortality within 90 days

Primary total arthroplasties 2015–2018

Unit	Number[1]	Primary osteo-arthritis, %[2]	> 60, %[3]	Women, %[4]	Mortality, ‰[5]
University hospital or regional hospital					
Karolinska/Huddinge	807	56	78	61	12.8
Karolinska/Solna	536	33	65	55	13.1
Linköping	254	49	52	50	3.9
SU/Mölndal	2 402	66	80	60	8.7
SUS/Lund	641	28	84	61	31.9
SUS/Malmö	138	4	98	69	15.2
Umeå	357	23	81	60	14.2
Uppsala	979	44	73	59	22.8
Örebro	237	38	77	55	12.7
County hospital					
Borås	574	62	88	59	12.7
Danderyd	1 224	68	88	59	10.8
Eksjö	932	88	80	55	1.1
Eskilstuna	481	47	88	60	21.1
Falun	933	85	81	57	6.7
Gävle	893	46	86	60	16
Halmstad	846	76	85	56	9.7
Helsingborg	444	58	90	56	18.2
Hässleholm	3 116	90	85	55	2.6
Jönköping	758	73	91	63	8.1
Kalmar	699	75	86	59	4.4
Karlskrona	140	17	95	67	57.7
Karlstad	789	55	86	61	11.8
Kristianstad	169	1	95	65	24.2
Norrköping	1 031	67	85	58	7.9
NÄL	124	5	97	67	8.3
Skövde	620	68	84	59	8.2
Sunderby	137	2	96	58	22.9
Sundsvall	215	26	85	57	4.7
Södersjukhuset	1 436	64	87	62	9.9
Uddevalla	1 525	87	83	58	7.4
Varberg	994	86	87	62	3.1
Västerås	1 812	57	88	61	37.5

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Mortality within 90 days, continued

Primary total arthroplasties 2015–2018

Unit	Number[1]	Primary osteo-arthritis, %[2]	> 60, %[3]	Women, %[4]	Mortality, ‰[5]
Växjö	528	73	82	62	7.9
Östersund	1 147	71	88	60	3.5
Local hospital					
Alingsås	790	91	86	58	1.3
Arvika	815	97	87	59	0
Enköping	1 556	97	89	62	0.6
Frölunda Specialistsjukhus	83	99	88	67	0
Gällivare	395	79	86	53	10.4
Hudiksvall	470	64	87	61	10.8
Karlshamn	1 019	91	85	57	1.1
Karlskoga	401	78	90	61	15
Katrineholm	922	97	82	59	1.1
Kungälv	759	87	84	61	4
Lidköping	1 079	90	86	56	1.9
Lindesberg	1 942	87	83	57	1.6
Ljungby	710	81	87	56	10.2
Lycksele	1 299	95	82	56	2.3
Mora	1 041	90	86	56	1.9
Norrtälje	609	82	86	62	1.7
Nyköping	670	63	89	62	48.4
Oskarshamn	1 180	97	82	55	1.7
Piteå	1 548	92	82	58	2.1
Skellefteå	550	77	85	60	16.8
Skene	571	91	79	60	0
Sollefteå	975	90	87	61	5.3
Södertälje	605	75	84	58	13.7
Torsby	505	88	87	57	10.2
Trelleborg	2 763	88	77	59	0.7
Visby	539	78	85	60	1.9
Värnamo	594	84	83	60	1.7
Västervik	503	89	83	59	4
Ängelholm	394	90	77	60	0
Örnsköldsvik	686	88	87	61	4.5

(the table continues on the next page)

Mortality within 90 days, continued

Primary total arthroplasties 2015–2018

Unit	Number[1)]	Primary osteo-arthritis, %[2)]	> 60, %[3)]	Women, %[4)]	Mortality, ‰[5)]
Private hospital					
Aleris Specialistvård Bollnäs	1 201	96	82	56	0.8
Aleris Specialistvård Motala	2 409	95	85	55	3
Aleris Specialistvård Nacka	940	100	77	65	0
Aleris Specialistvård Sabbatsberg	24	100	96	46	0
Aleris Specialistvård Ängelholm	349	96	81	60	6
Art Clinic Göteborg	254	100	76	57	0
Art Clinic Jönköping	264	100	75	50	0
Capio Artro Clinic	617	95	69	62	5.3
Capio Movement	1 338	98	76	53	1.6
Capio Ortopediska Huset	2 189	97	71	59	0.5
Capio S:t Göran	2 241	90	85	66	3.2
Carlanderska	790	97	65	46	0
Frölundaortopeden	25	100	48	36	0
Hermelinen Specialistvård	66	91	52	30	0
Ortho Center IFK-kliniken	704	94	57	41	1.5
Ortho Center Stockholm	2 385	97	74	57	0
Sophiahemmet	973	99	51	39	2.1
Country	70 676	81	82	58	6.6

Table 10.1.1.

[1)] Refers to the number of primary arthroplasties during the time period considered. Units with fewer than 20 primary arthroplasties during the period at hand are excluded.

[2)] The proportion of patients operated due to primary osteoarthritis.

[3)] The proportion of operations on patients in the age group 60 years of age and older.

[4)] Pertains to the number of women during the period considered.

[5)] 90-day mortality in per mille (the proportion of patients who have died 90 days after the primary operation).

Mortality within 90 days

Fracture patients primary operation 2015–2018

Unit	Number[1)]	> 80, %[2)]	Men, %[3)]	ASA=III, %[4)]	ASA=IV, %[5)]	Acute fracture, %	Mortality, %
University hospital or regional hospital							
Karolinska/Huddinge	486	57	35	61	9	90	13.2
Karolinska/Solna	266	51	37	68	9	84	12.8
Linköping	374	62	38	52	11	92	10.7
SU/Mölndal	1 617	60	36	50	6	94	14
SUS/Lund	882	55	35	58	3	90	10.2
SUS/Malmö	846	63	33	74	7	97	13.2
Umeå	419	58	33	58	8	95	12.8
Uppsala	843	57	36	62	8	93	13.8
Örebro	296	59	32	47	6	89	9.6
County hospital							
Borås	511	65	33	45	5	94	11.6
Danderyd	962	60	31	64	6	89	11.1
Eksjö	254	61	28	47	4	96	10.9
Eskilstuna	469	59	34	47	6	91	15.7
Falun	638	64	36	54	7	94	13.5
Gävle	628	57	34	42	6	95	14.4
Halmstad	395	62	33	44	4	91	9.6
Helsingborg	778	62	31	47	6	93	13.5
Hässleholm	85	28	35	35	1	7	5.9
Jönköping	339	64	31	60	6	95	11.2
Kalmar	354	57	29	41	3	96	11.2
Karlskrona	490	65	32	41	3	97	13.3
Karlstad	690	60	37	59	6	94	13.8
Kristianstad	642	62	37	58	6	97	16.3
Norrköping	474	61	34	48	6	90	13.4
NÄL	730	62	35	63	9	98	16.3
Skövde	457	58	34	46	4	92	11.9
Sunderby	475	59	38	61	10	99	13.3
Sundsvall	498	58	36	47	4	95	14.1
Södersjukhuset	1 320	61	32	64	7	89	11.9
Uddevalla	243	60	36	56	3	83	14.9
Varberg	400	62	34	45	5	93	12
Västerås	673	57	34	64	6	93	10.8
Växjö	296	62	31	56	7	93	9.3
Ystad	174	71	30	59	10	99	12.7
Östersund	470	58	30	43	9	95	10.2

(the table continues on the next page)

Mortality within 90 days

Fracture patients primary operation 2015–2018

Unit	Number[1)]	> 80, %[2)]	Men, %[3)]	ASA=III, %[4)]	ASA=IV, %[5)]	Acute fracture, %	Mortality, %
Local hospital							
Alingsås	188	57	40	58	9	95	11.8
Arvika	23	65	48	30	9	83	13
Gällivare	175	53	37	43	12	95	15.1
Hudiksvall	298	58	35	49	6	91	17.2
Karlskoga	295	55	36	42	8	98	17.4
Kungälv	319	57	36	47	5	96	13.1
Lidköping	222	65	29	42	2	90	10.6
Lindesberg	125	50	35	37	3	76	8.5
Ljungby	201	66	30	50	2	90	10.2
Lycksele	101	53	28	61	3	93	14
Mora	290	58	33	41	6	90	11
Norrtälje	197	54	34	65	6	92	14.1
Nyköping	213	60	34	48	1	93	13.3
Piteå	35	14	49	34	0	14	2.9
Skellefteå	224	44	31	43	6	88	11.8
Sollefteå	56	55	32	52	4	89	10.7
Södertälje	205	49	33	69	3	96	9.5
Torsby	150	61	43	54	6	96	12.7
Trelleborg	51	14	31	16	0	0	2
Visby	143	50	31	37	4	92	9.5
Värnamo	170	61	31	45	2	96	7.9
Västervik	211	65	34	34	2	95	9.7
Örnsköldsvik	295	64	33	56	9	95	12.4
Private hospital							
Aleris Specialistvård Motala	190	66	37	62	6	82	18.6
Capio S:t Göran	785	67	34	62	7	93	15.1
Country	24 706	59	34	54	6	92	12.7

Table 10.2.1.

[1)] Refers to the number of primary arthroplasties during the period considered. Units with fewer than 20 primary arthroplasties are excluded.
[2)] Refers to the proportion of operations on patients in the age group 80 years of age or older.
[3)] Refers to the number of men during the period considered.
[4)] The proportion of patients with ASA class III.
[5)] The proportion of patients with ASA class IV.
[6)] 90-day mortality in percentages (the proportion of patients who have died 90 days after the primary operation).

11 Adverse events within 30 and 90 days

The registry began reporting adverse events in 2007. Apart from a reformulation of the Swedish term, a more significant change is that we have changed the definition of adverse event. We have chosen to use the definition that the Swedish Knee Arthroplasty Register has developed together with the National Board of Health and Welfare modified for hip arthroplasty. The quality indicator is based on linking the Register's data with the Patient Register of the National Board of Health and Welfare, where a list of diagnosis and intervention codes used in conjunction with primary care admission or later admission are sought. Since the completion of the Patient Register's data for the previous operating year often is delayed until the later part of the year, we have chosen to include data until the 1st of October 2017, in order to get a complete 90-day follow-up. Due to the change of the definition of adverse events, we have conducted a national analysis of the most recent 10-year period. We also present adverse events after the first reoperation.

11.1 About the method

The Swedish Hip Arthroplasty Register's data on hip arthroplasties (and reoperations) was used together with care events with complication codes in Patient Register (PAR) of the National Board of Health and Welfare to analyse readmissions after hip arthroplasty.

Only one operation (the latest) is considered if both hips were operated on within 90 days. All care events that matched a hip arthroplasty regarding personal identity number and where the date of surgery in the Swedish Hip Arthroplasty Register fell between the admission date and the date of discharge in inpatient care in PAR, or where the admission date in PAR fell within 90 days after the date of surgery (or date of reoperation for reoperations) in the Swedish Hip Arthroplasty Register, were investigated. In order to be able to include the whole 90-day follow-up period, hip arthroplasties carried out after the 1st of October 2017 were excluded.

An adverse event is matched with a hip arthroplasty through the selections described in the code list.

The indicator is calculated as the proportion of hip arthroplasties that are followed by an adverse event out of all hip arthroplasties in each group of analysis respectively (primary elective total arthroplasty, the standard patient, fracture patients, and first reoperation respectively).

Definition of adverse events

An adverse event is defined as all forms of readmission that can be associated to the completed procedure. This applies not only to local complications but also to general complications and death. The complications are divided into surgical, cardiovascular, and medical complications and are based on diagnosis and intervention codes, which are used in conjunction with inpatient care reported to the PAR. The surgical complications are also divided into intervention and diagnosis codes indicating complication, and diagnosis codes for hip conditions that probably are a complication after the operation. The codes are collected in table 11.1.1, and are described in detail in the box "About the method".

We present results on hospital level for

1) Elective total arthroplasties where acute fracture patients and sequelae after hip fracture, and tumour patients are excluded,
2) Fracture patients that comprise total arthroplasty and hemiarthroplasty due to hip fracture or sequelae after hip fracture,
3) The standard patient, and
4) Patients undergoing a first reoperation.

Trends

During the 10-year period 2008-2017, the number of adverse events decreased for elective patients, standard patients, and fracture patients (figure 11.1.1). For elective patients the 90-day incidence decreased from 8 to 5%, for the standard patient from 6 to 4%, and for fracture patients from 34 to 31%. On the other hand, the complication frequency increases for first time reoperations from 25 to 32% (figure 11.1.2). The results should be interpreted with caution. In the group patients who have undergone a reoperation for the first time, all patients are included regardless of diagnosis during primary operation or if the primary operation was a total arthroplasty or a hemiarthroplasty. Since the registration of hemiarthroplasties (and reoperation after hemiarthroplasty) started in 2005, the proportion of hemiarthroplasties among those who have undergone a reoperation has increased successively. These patients have a higher risk for complications also after reoperation due to natural causes. Furthermore, the diagnosis registration of both local and general complications has improved over time. Nonetheless, an area where there is scope for improvement has been identified.

Strengths, error sources, and weaknesses

The possibility of linking register data with the Patient Register enables the addition of an important quality indicator that provides guidance regarding early adverse events, a variable that apart from reoperations and mortality is not captured by the registry. We regard the new set of codes that define an adverse event as being better at capturing events that probably are linked to the operation and which potentially could be avoided or prevented. The strengths of the analysis are underpinned by the fact that we are using a set of codes that were originally produced by the Knee Arthroplasty Register through in-depth work carried out together with the National Board of Health and Welfare.

There of course weaknesses and sources of error in the analysis. For example, only adverse events occurring during primary care or in conjunction with readmission are included. Outpatient visits are not included, which for example means that a dislocation that is repositioned at an emergency unit, and where the patient then returns home, is not picked up on. This also applies, for example, to venous thromboses, which in the majority of cases do not lead to inpatient care. Furthermore, the coding routines differ between regions and hospitals. In certain cases, there could exist financial incentives to register a large number of codes in order to raise the DRG (diagnosis

related groups) score, where the threshold for including certain complication codes differ between units.

To compare results between units is not the primary purpose with the quality indicator. The most important thing is to be able to follow a unit's result over time and stimulate local analyses in order to better understand the panorama of adverse events and thus identify areas for improvement.

- **The definition of adverse event has changed and is similar to the definition used by the Knee Arthroplasty Register.**
- **Both for the standard patient, as well as for elective and fracture patients, the incidence of adverse events has decreased during the last ten-year period.**
- **Adverse events following first time reoperations has however increased.**
- **There are large variations between hospitals in the incidence of adverse events for all categories.**
- **There is plenty of room for improvement of the care system in order to avoid adverse events, especially for fracture patients and in conjunction with reoperations.**

11.2 Results on unit level 2015-2017

The incidence of adverse events within 30 and 90 days after operation for elective patients, the standard patient, fracture patients, first reoperation, and second or later reoperation (table 11.2.1-11.2.7) are presented on unit level. The variation between units is large for all categories and some units have results far above the national average. For elective patients, the variation of adverse events within 90 days is between 0 and 14% (one diverging unit not counted) with a national average of just above 5%. The incidence for fracture patients varies between 22 and 45%, with the national average at 31%. The greatest variation is seen for reoperations where the incidence varies from 10 to 60% with an average of 29%.

Adverse events in fracture patients

A person who fractures the hip, and subsequently undergoes an arthroplasty, is most often an individual with one or several diseases. Only 4% belong to ASA class I, that is are completely healthy. Furthermore, it is important to perform hip fracture surgery within one or two days, why there is little room for optimisation of the health condition before the procedure. This is in contrast to the situation with the individual with osteoarthritis, who undergoes an operation after a thorough review of the general health. A patient that is far too ill, is often dissuaded from such a procedure, in contrast to the fracture patient who always has to be operated. Consequently, adverse events are more common after a fracture arthroplasty procedure, and the panorama is different. For fracture patients, the registry has chosen to add codes also for urinary tract infection since it is both a known avoidable complication (related to the use of a urinary catheter), and a disease that may have more severe consequences for an elderly patient.

The proportion of cardiovascular events after hip fracture continues to decrease, while the other adverse events remain at a steady level. Unfortunately, the previous decrease in hip related events ("surgical events") has levelled off. This is the part were orthopaedics alone can work for an improvement. Avoidance of other adverse events demands a multi-disciplinary care where orthopaedics, geriatrics, internal medicine, primary care, and rehabilitation cooperate. The focus of today's healthcare often lies on shortening the hospital stays and streamlin-

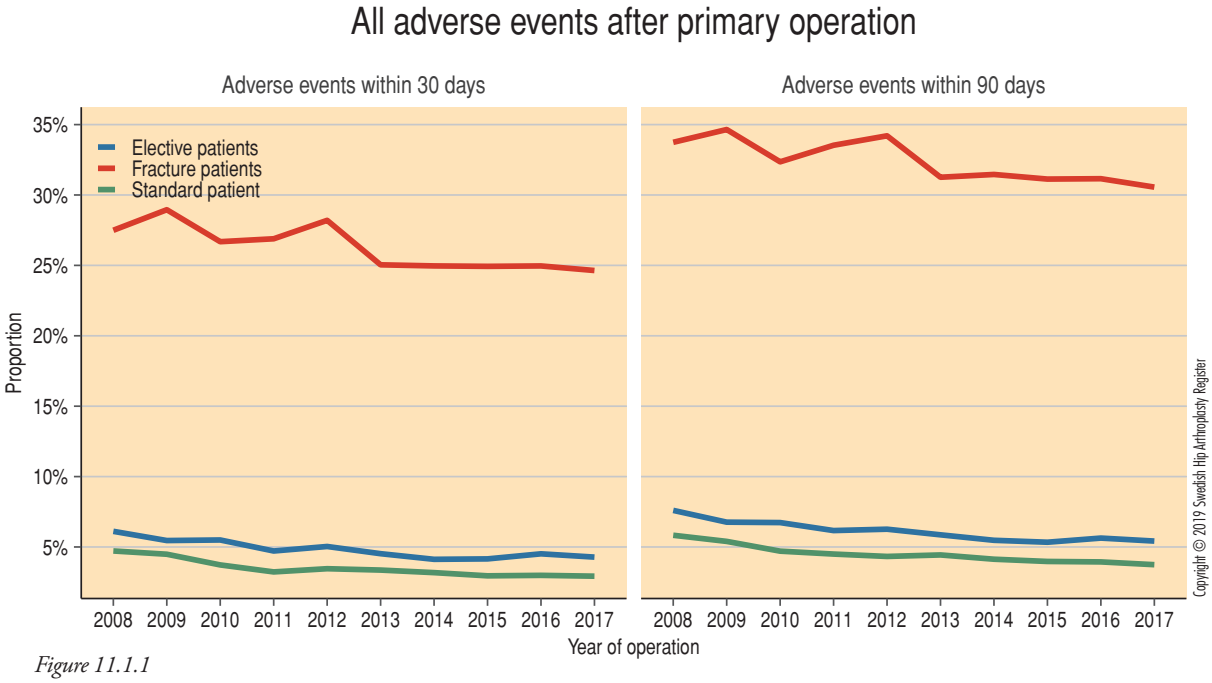


Figure 11.1.1

ing the care. It is likely that a better care process pre-, peri- and postoperatively, could reduce the risk.

Women are affected by adverse events within 90 days in 20-25% of cases, compared to men who are affected in 30-35% of cases. Men suffer from complications to a greater degree than women do. The gender difference is greater after fracture than after osteoarthritis-related procedures. Scientific studies consistently show that the prognosis after hip fracture is worse in men. A contributing factor is that men have more comorbidities at the time of their fracture.

The mortality rate during the first half year is high. It should be borne in mind that some deaths have other causes, it is however estimated that one in four deaths is directly related to the fracture.

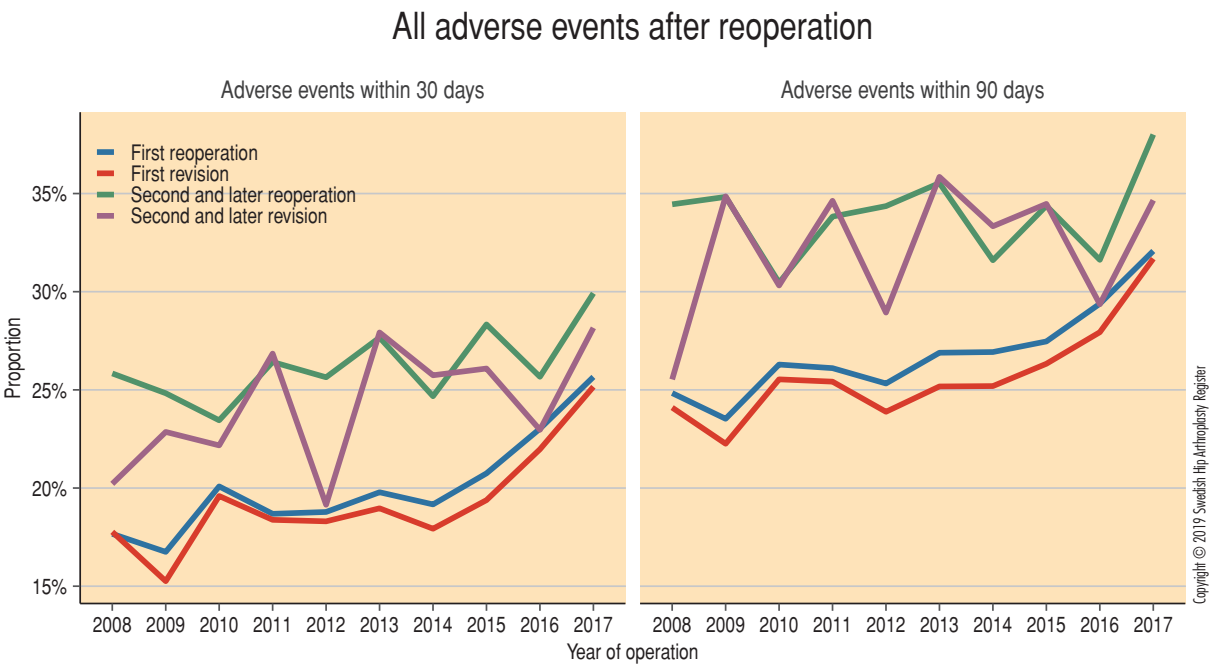


Figure 11.1.2

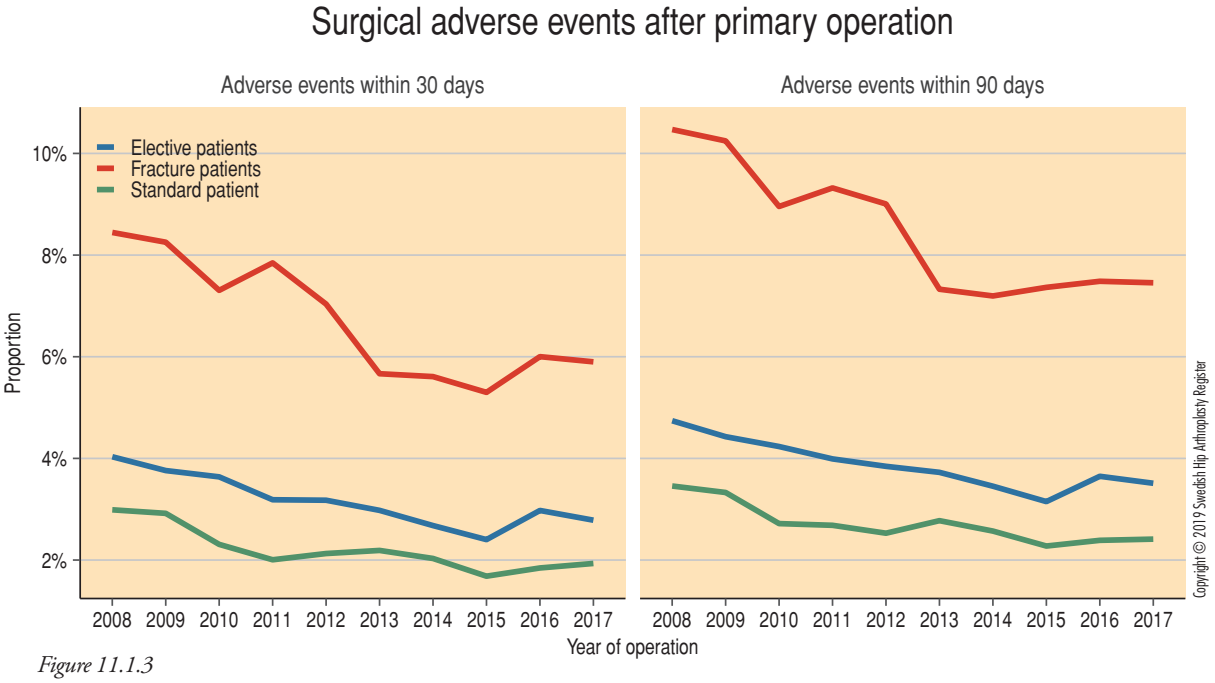


Figure 11.1.3

Codes for adverse events

	Used for primary operations	Used for reoperations and revisions	ICD-10 and KVÅ codes	Additional codes for fractures
Surgical				
A Measure codes for hip arthroplasties. Complications or suspected complications.	If the measure is reported after the surgery date OR for a care event that takes place after the surgery date	If the measure is reported for a care event that takes place after the surgery date	NFA02, NFA11, NFA12, NFA20, NFA21, NFA22, NFC*, NFF*, NFG*, NFH*, NFJ*, NFK*, NFL*, NFM*, NFQ09, NFS*, NFT*, NFU09, NFU19, NFU39, NFU89, NFU99, NFW*, QDA10, QDB00, QDB05, QDB99, QDE35, QDG30, TNF05, TNF10	
	If the measure is reported for a care event that takes place after the surgery date	If the measure is reported for a care event that takes place after the surgery date	NFU49	
DA Diagnoses for complication codes that should have been used during complication.	If they are the main or secondary diagnosis during surgery or the main diagnosis during readmission.	If they are the main diagnosis during readmission.	G978, G979, M966F, M968, M969, T810, T812, T813, T814, T815, T816, T817, T818, T818W, T819, T840, T840F, T843, T843F, T844, T845, T845F, T847, T847F, T848, T848F, T849, T888, T889	
DB Diagnoses for hip related diseases. Probably a complication shortly after the operation.	If they are the main diagnosis or the secondary diangosis during surgery or the main diagnosis during readmission.	If they are the main diagnosis during readmission.	G570, G571, G572, M000, M000F, M002F, M008F, M009F, M243, M244, M244F, S730, S74*, S75*, S76*	
	If they are the main diagnosis during readmission.	If they are the main diagnosis during readmission.	M240F, M245F, M246F, M610F, M621F, M662F, M663F, M843F, M860F , M861F , M866, M866F , M895E	
Cardiovascular				
DC Diagnoses for severe cardio-vascular diseases. Probably a complication shortly after the operation.	If they are the main diagnosis or the secondary diagnosis during surgery or the main diagnosis during readmission.	If they occur as main or secondary diagnosis during the date of operation or as main diagnosis during readmission.	I21*, I24*, I260, I269, I460, I461, I469, I490, I60*, I61*, I62*, I63*, I649, I65*, I66*, I72*, I74*, I770, I771, I772, I819, I82*, I978, I979, J809, J819, T811	
Medical				
DM Diagnoses for medical diseases. May be related to the operation if they occur shortly thereafter.	If they are the main diagnosis or the secondary diagnosis during surgery or the main diagnosis during readmission.	If they occur as main or secondary diagnosis during the date of operation or as main diagnosis during readmission.	I80*, J13*-J18*, J952, J953, J955, J958, J959, J96*, J981, K25*, K26*, K27*, L89*, N17*, N990, N998, N999, R339	N300, N308, N309, N390
	If they are the main diagnosis during readmission.	If they are the main diagnosis during readmission.	J20*-J22*, K29*, K590, N991	

Table 11.1.1

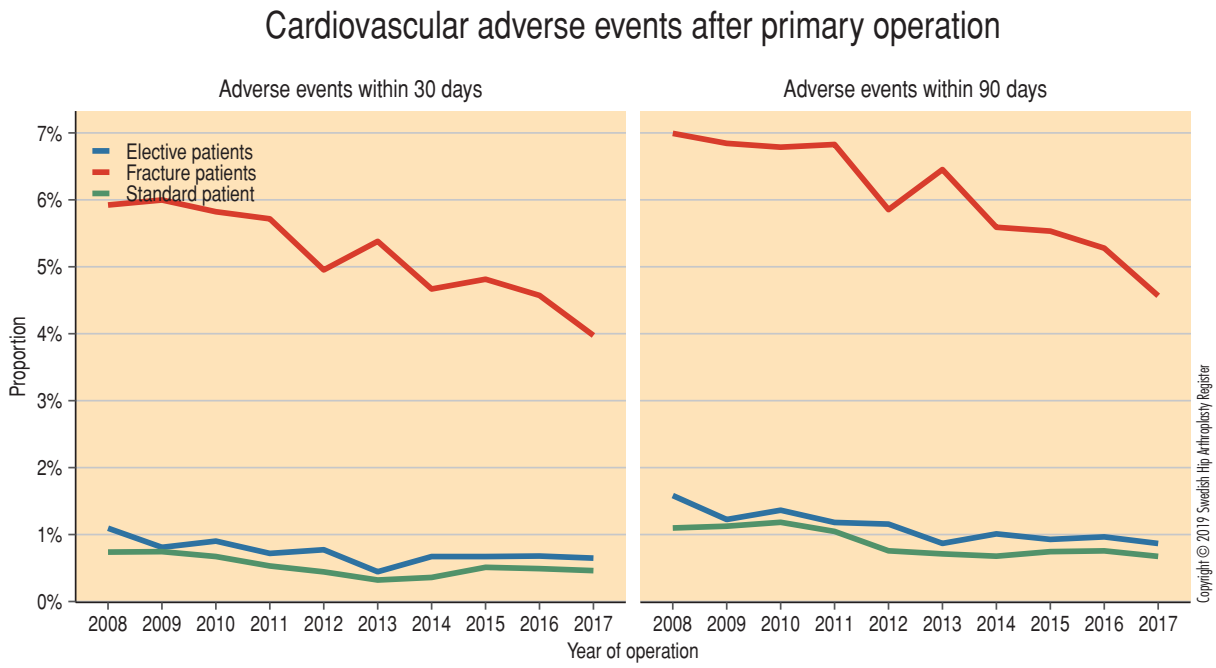


Figure 11.1.4

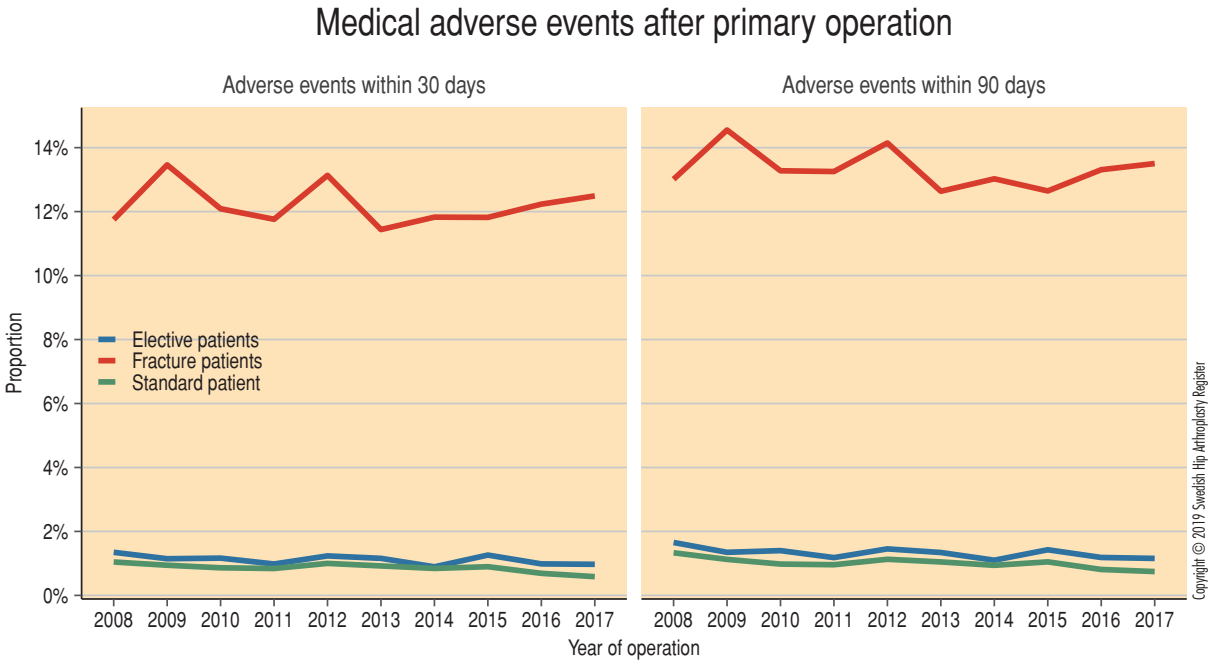


Figure 11.1.5

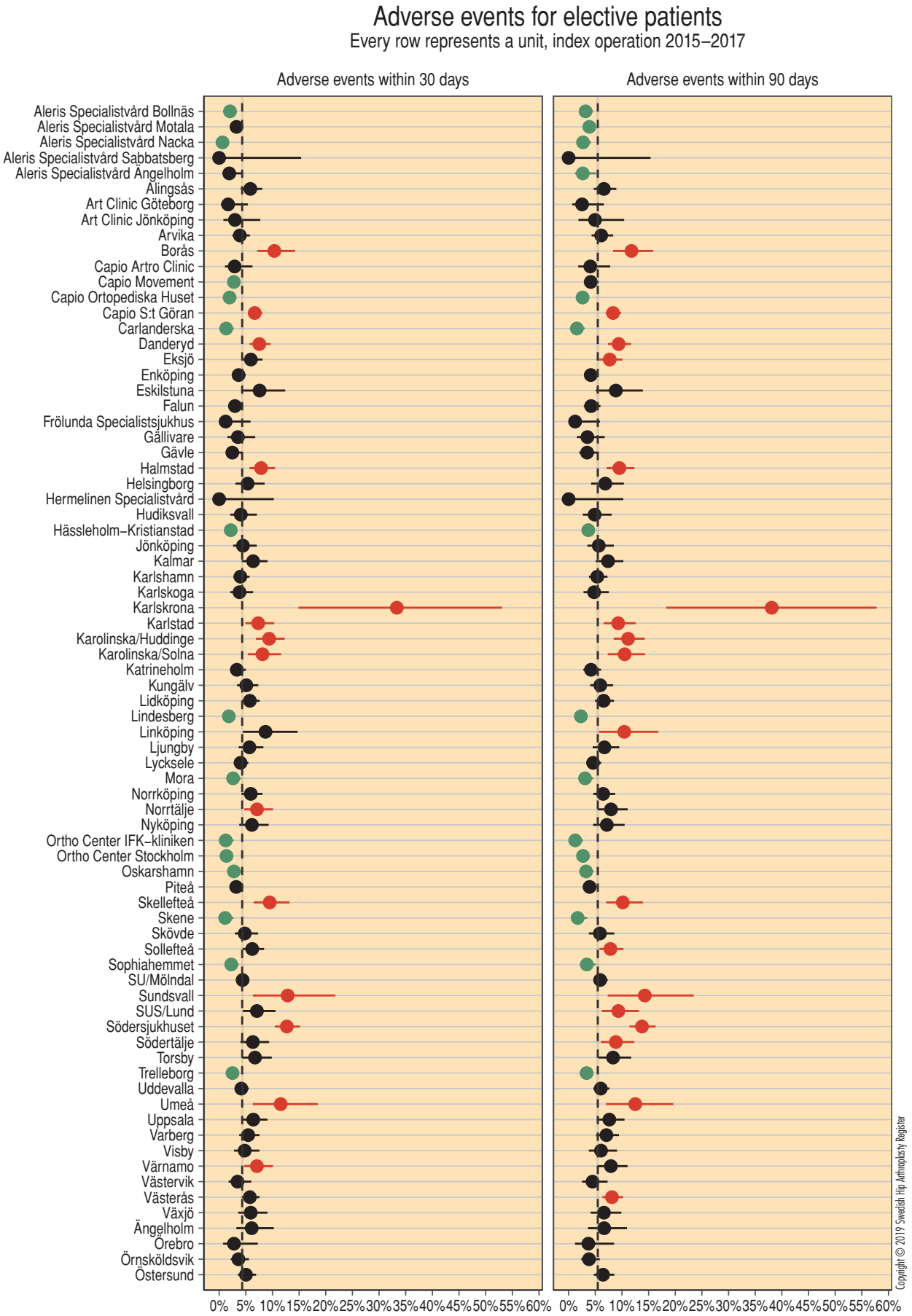


Figure 11.2.1. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

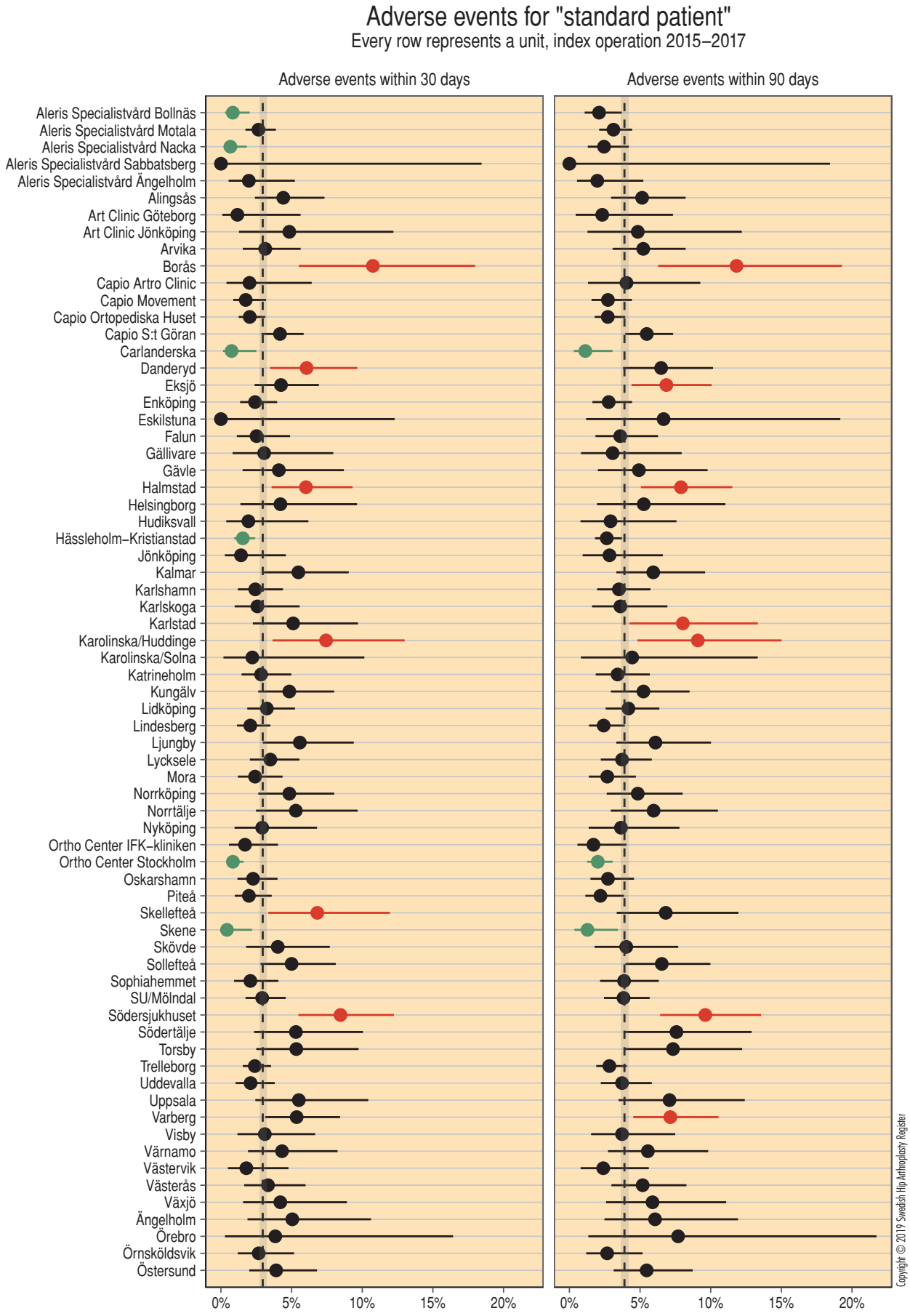


Figure 11.2.2. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

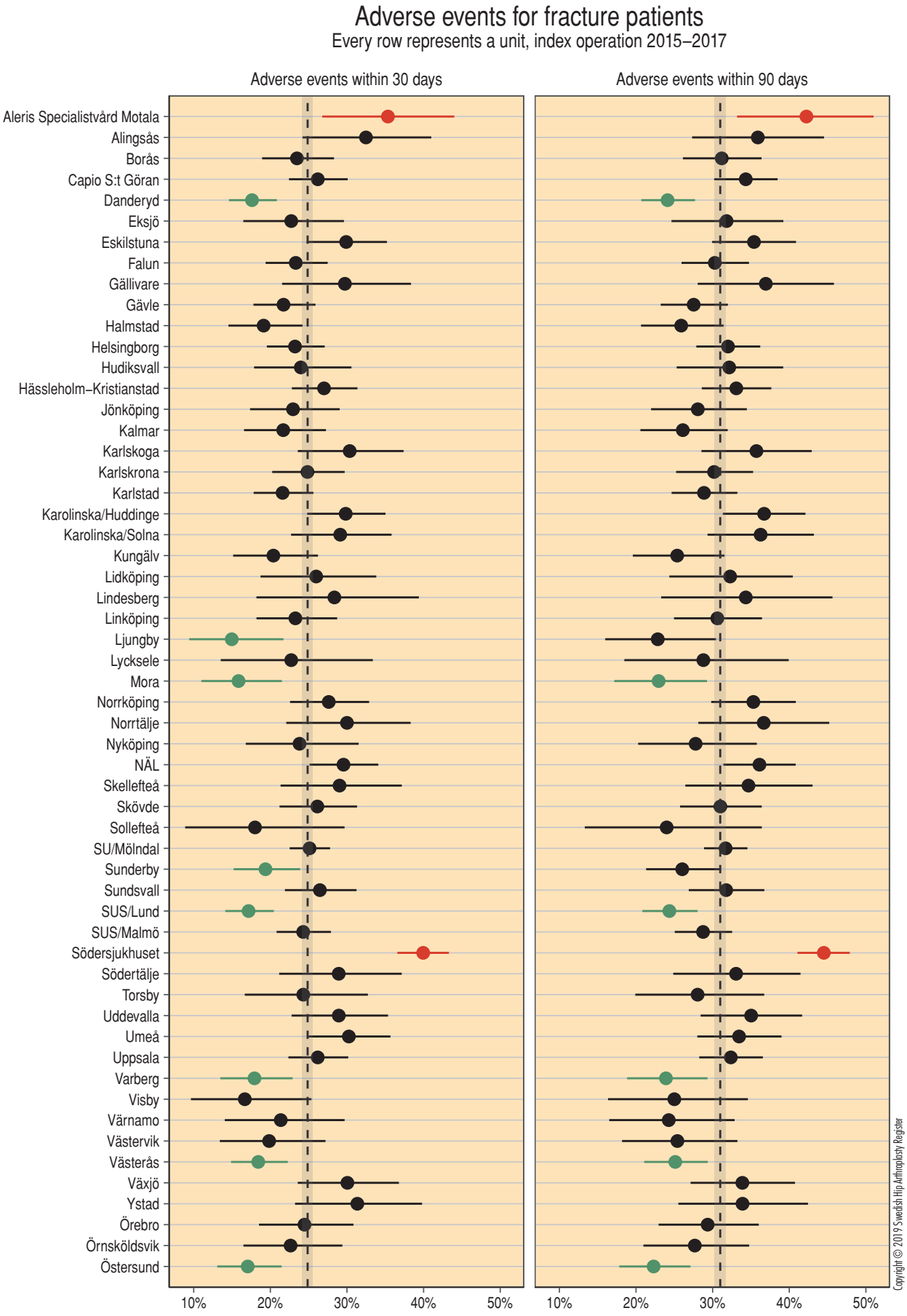


Figure 11.2.3. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

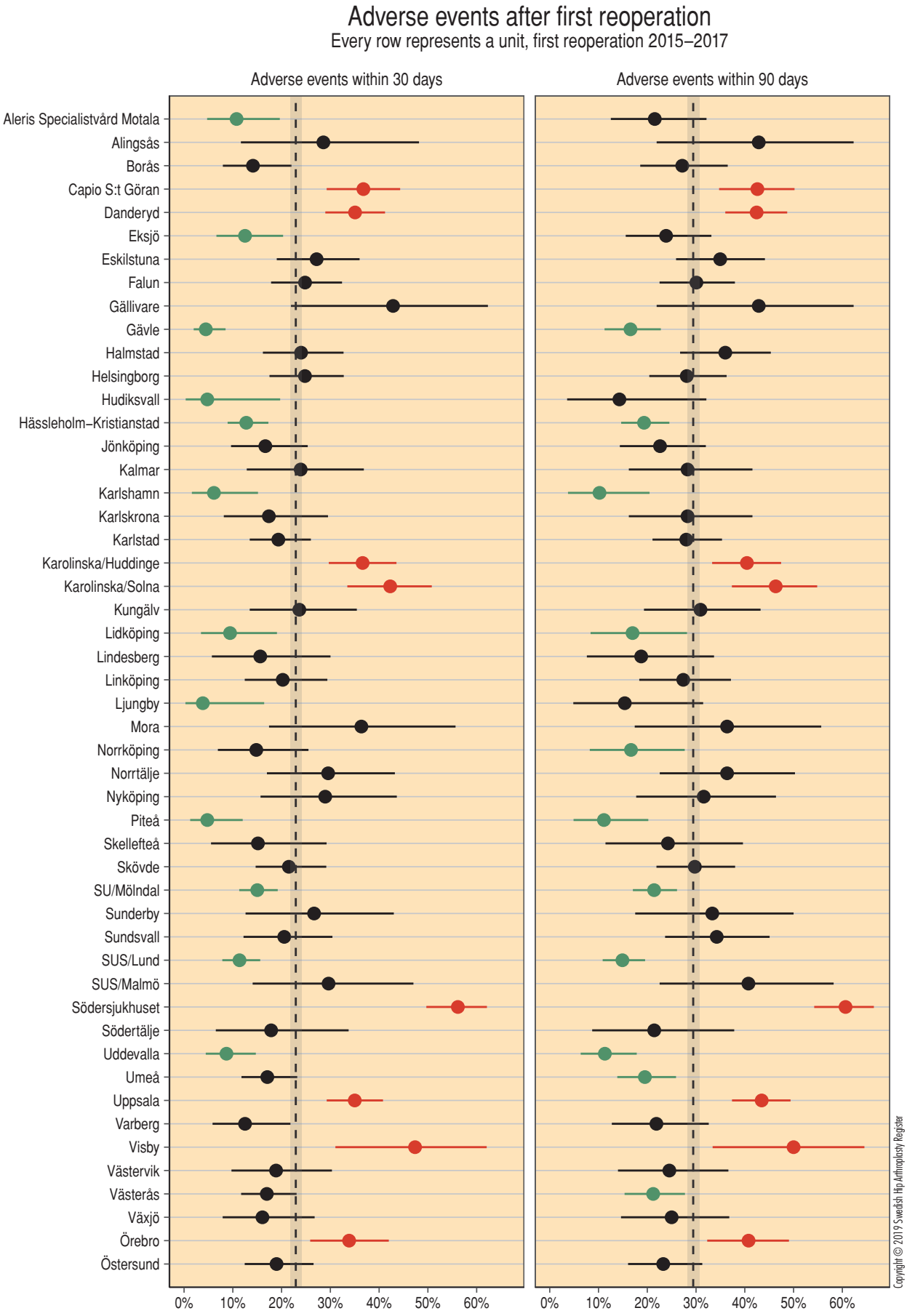


Figure 11.2.4. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

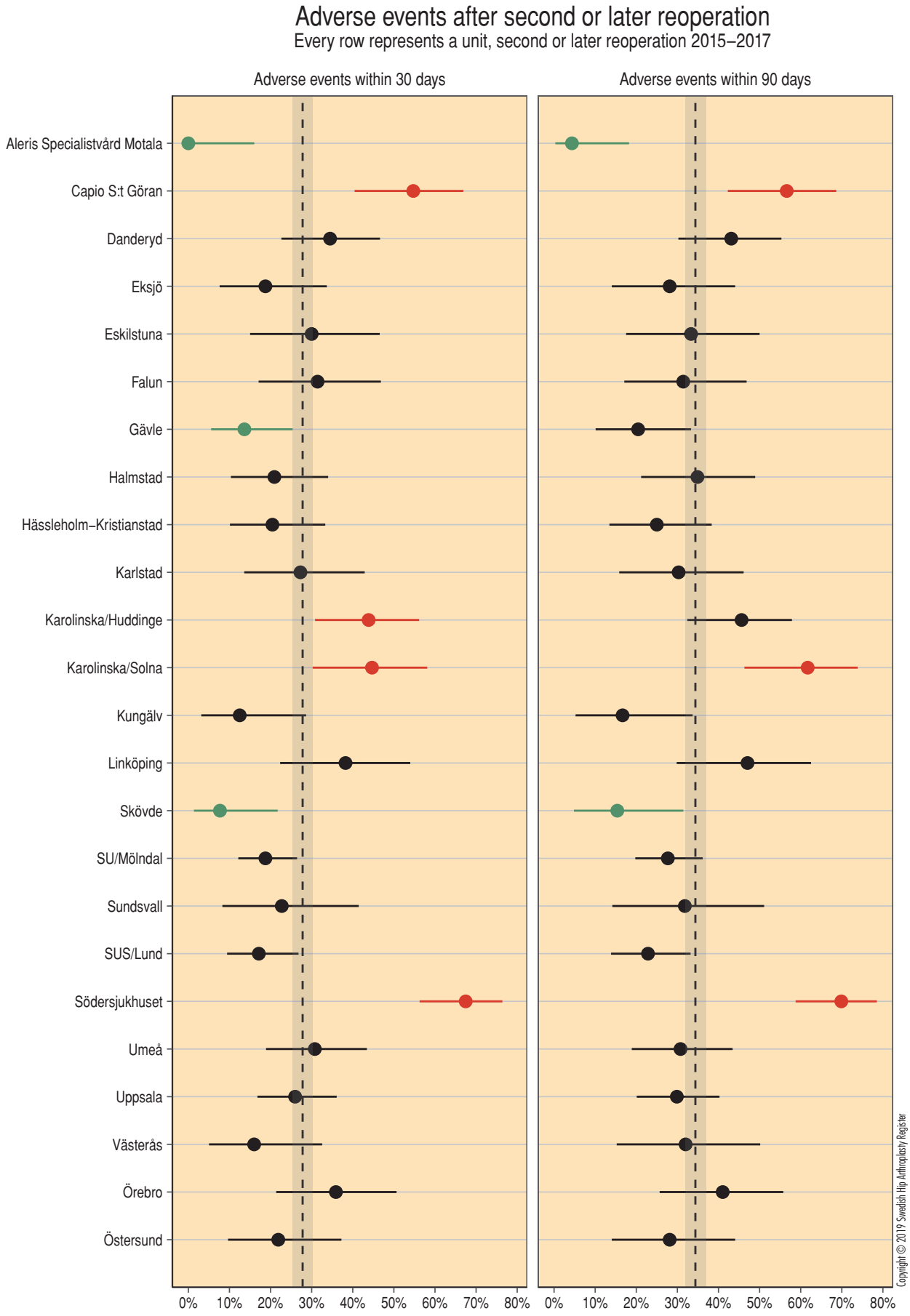


Figure 11.2.5. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

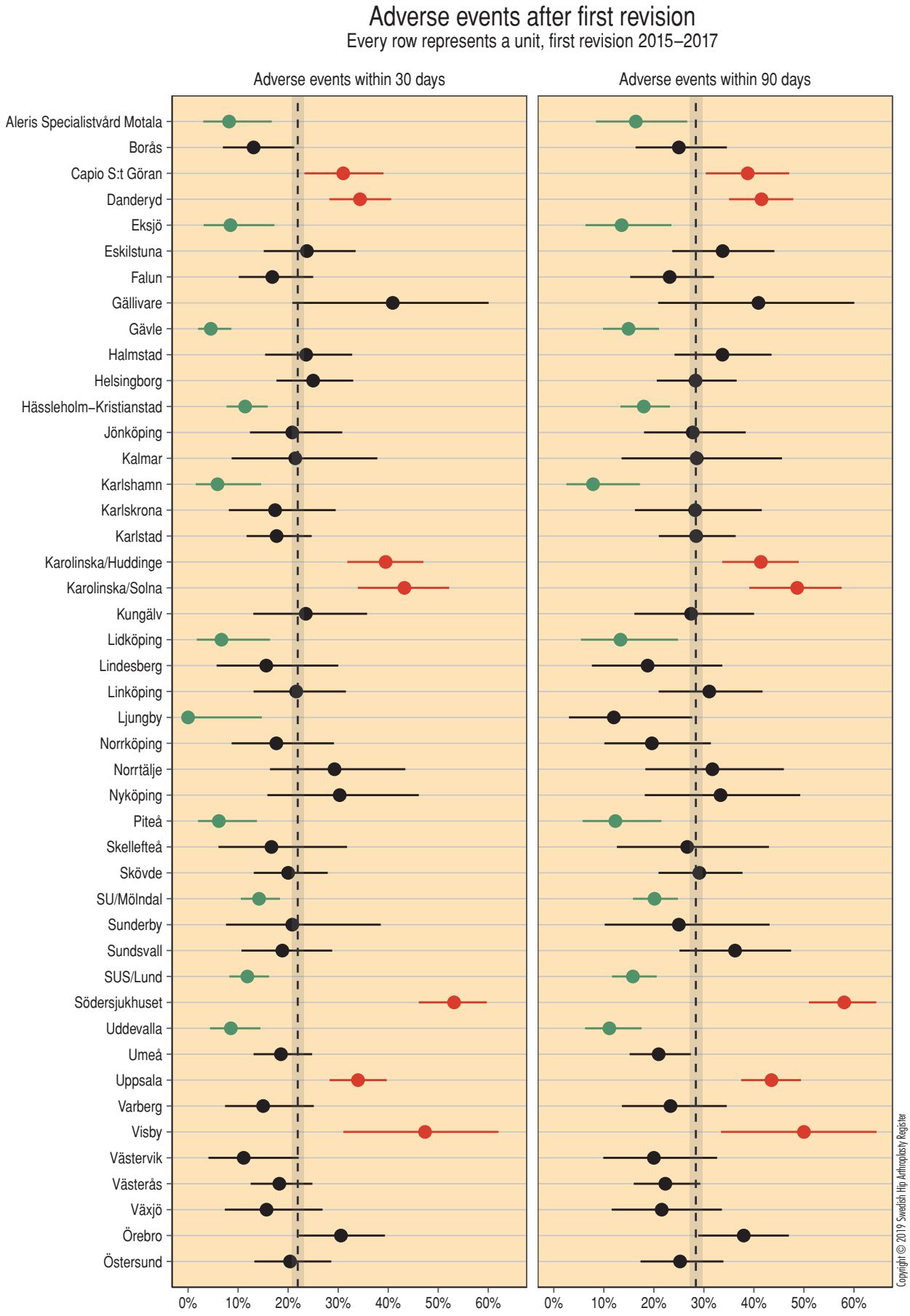


Figure 11.2.6. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

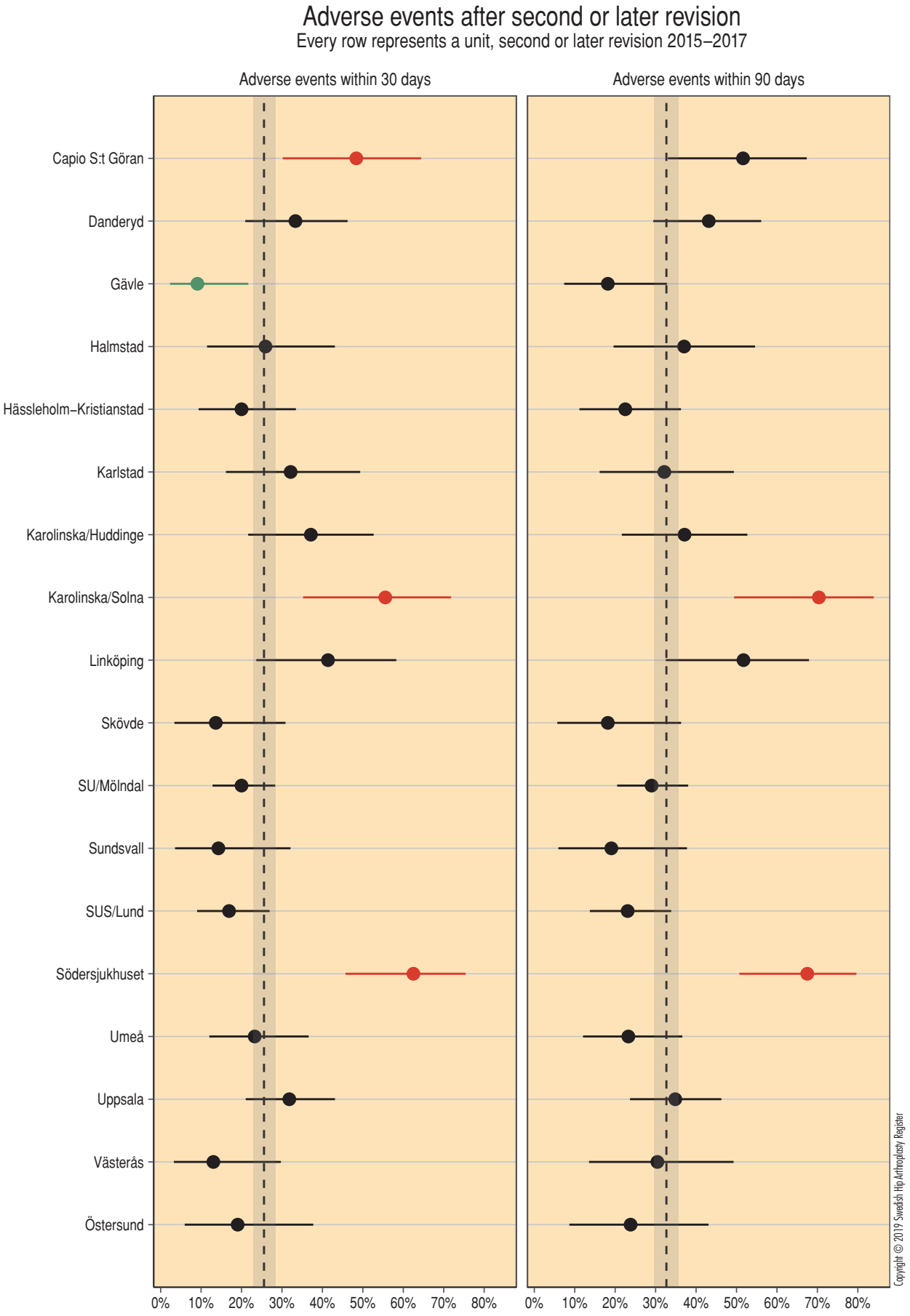


Figure 11.2.7. The proportion of adverse events per unit with confidence interval.

Units with fewer than 20 registrations have been excluded.

12 Fracture treatment with total arthroplasty or hemiarthroplasty

To treat a displaced femoral neck fracture with an arthroplasty has become an established practice in Sweden. Some 20 years ago a relatively sudden shift occurred from internal fixation to arthroplasty as primary treatment. The discussion today is instead focused on where the lower, and possibly upper, age limit should be drawn, and which prosthesis that is the most suitable for different patient groups. In practice, it is a balance of the patient's biological age, activity degree, and comorbidity that should determine the choice of treatment. We will return to these questions in this chapter. First, a survey of 2018.

6,387 primary operations were registered in 2018, a slight increase from a level around 6,000 procedures yearly during the last decade (figure 12.1.1). Above all, the increase takes place in the oldest age group (patients over 85 years of age); from 1,659 in 2005, to 2,448 in 2018. Also among those under 75 years of age, the number who undergo hip arthroplasty increases, from 985 to 1423 during the same period. The increase for the younger group could be explained by the fact that the nativity was considerably higher during the latter part of the 1940s compared to the 1930s, that is more individuals are now at risk of having a fracture. The use of internal fixation has also decreased in this age group. The oldest are also becoming more numerous, and in this age group, we seem to to choose a prosthesis instead of internal fixation more often. Thus, both demography and clinical practice affects age distribution of the patients.

The incidence of dementia is registered for those undergoing a hemiarthroplasty. This proportion increases steadily, and in 2018, 39% of those who underwent a hemiarthroplasty either had a diagnosis dementia or were suspected to have a cognitive dysfunction. In 2005, the corresponding share was 28%. It could be interpreted as arthroplasty is no longer seen as unsuitable in patients with cognitive disorders, where more of these patients got internal fixation 10-20 years ago. It has been shown, in a randomized trial, that hip arthroplasty is beneficial also in those with dementia (Hedbeck et al. J Orthop Trauma 2013; 27:690-695).

The analyses in this chapter are based on 81,266 operations of the 83,535 operations that were carried out during 2005 to 2018. Operations with monoblock prostheses and less common approaches have been excluded.

12.1 Implant choice and technique

The number of bipolar (1,066) and unipolar (3,149) hemiarthroplasties are relatively stable going back 6-8 years. Total arthroplasty as fracture treatment increases steadily, 2,164 fracture patients underwent such a procedure last year (figure 12.1.2). The Swedish Fracture Register, which now reports data from the majority of Swedish hospitals, shows that around 25% of the dislocated femoral neck hip fractures were treated with a total arthroplasty. Not many other national registries to compare with exist. In Norway, the UK, Australia, and New Zeeland the share varies between slightly more than 10% to just under 20%.

The two most common surgical approaches also show stability during the 2010s: two thirds are operated via a direct lateral approach, and a third via a posterior approach (4,455 and 1,794 cases respectively) (figure 12.1.3).

On the stem side the dominance of the two most common prostheses continues to increase; the Lubinus SP II and Exeter stems accounted for more than 90% of Swedish orthopaedic surgeons implant choices in 2018. The uncemented stems continue to decrease and made up only 1% during 2018, an extremely low proportion compared to other countries (table 12.1.1). The variation in choice of head and acetabular cup is greater; the nine most common make up 86%. The number of dual mobility cups have increased by 50% since 2014. Then 430 of these were inserted, compared to 630 in 2018 (table 12.1.2).

Is the limited choice of stem models relevant? Implant survival based on revisions reported to the registry is reported in figures 12.1.4-12.1.8 for the most common stem types. The four most common cemented stems have approximately the same seven year-survival, around 95-96%. "The challengers" MS30 and Covision do at least as well as Exeter and Lubinus in this regard. The uncemented Corail stem has a inferior implant survival than the cemented stems, with reservation for wide confidence intervals at the end of the follow-up period. The curve of Corail is also different, with both more early and late revisions. Of course, the results of all stems are should be interpreted with caution as a varying degree of revision reporting, different treatment strategies during complication, etcetera, may give a skewed picture of the actual clinical result. Fracture patients may also suffer from complications that are more serious, but which do not lead to revision. This could for example depend on that old and frail patients are advised against revision surgery due to medical risks.

Swedish orthopaedic surgeons use virtually no uncemented stems in fracture patients nowadays. This seems wise when considering the increased risk of reoperation for these stems.

12.2 Reoperation and revision

4,051 reoperations have been reported to the registry since 2005, which gives a reoperation rate of 4.8%. 2,801 of these secondary procedures are revisions, during which the prosthesis is completely or partly changed, or extracted. The reasons for reoperation are shown in table 12.2.1 and discussed later in this chapter.

[1]This chapter includes total and hemiarthroplasty performed due to acute fractures as well as sequelae after previous hip fractures.

	2005–2017		2018	
	Number	Proportion, %	Number	Proportion, %
Aseptic loosening	230	0.3	1	0
Deep infection	1 285	1.7	100	1.6
Fracture	883	1.1	14	0.2
Implant failure	3	0	0	0
Dislocation	1127	1.5	64	1
Technical reason	41	0.1	1	0
Only pain	53	0.1	0	0
Other	85	0.1	5	0.1
2-session procedure	1	0	0	0
Acetabular erosion	56	0.1	0	0
No reoperation/ no data	73 384	95.1	6 202	97.1
Total	77 148	100.0	6 387	100.0

Table 12.2.1

The number of reoperations (secondary open surgery) and reasons for reoperation reported to the registry until 2018-12-31.

A Kaplain-Meier-analysis shows that younger patients undergo revision surgery to a larger extent than do older (figure 12.2.1). Those who undergo an arthroplasty after internal fixation of the fracture has failed (secondary arthroplasty) also have an increased risk (figure 12.2.2). If the different surgical approaches are compared, the lateral approach is associated to a lower risk for revision regardless of cause (figure 12.2.3). The prosthesis types have the same risk for revision during the greater part of the follow-up period. Bipolar (and to a certain extent also unipolar) hemiarthroplasty however, shows a higher risk of revision than total arthroplasty do during the first two years (figure 12.2.4).

The difference between total arthroplasty, bipolar hemiarthroplasty, and unipolar hemiarthroplasty respectively is hard to assess. The age of the patient should be considered. The analyses later in this chapter show no notable difference between bipolar hemiarthroplasty and total arthroplasty in the group under 75 years of age. For the oldest group, over 85 years of age, unipolar hemiarthroplasty seems to be a good option, compared to bipolar hemiarthroplasty. One can speculate if the decision to carry out a revision (to change or add a prosthesis component) is influenced by the prosthesis type already inserted. See the discussion under "In-depth analysis – dual mobility cups".

It would be desirable if all complications were surveyed, so that prosthesis models are compared on fair grounds. Susanne Hansson did this in her dissertation from 2018, which is presented in 4.6. The main finding was that total arthroplasties are associated to more hip complications but to fewer reoperations, compared with hemiarthroplasties. The message from the registry is thus that the differences should not be exaggerated. Each unit should set up local guidelines where access to qualified joint arthroplasty surgeons and audit of the local results should be taken into account.

Table 12.2.2 shows reoperations within six months on participating units. The national average is 3% and the units have a proportion that varies between 0 to 8%. A majority of reoperations are thus carried out early. This is an important quality indicator, but the numbers should be interpreted with caution. There can be unrecorded cases for different reasons: apart from underreporting and a special case-mix for the unit, the units can be more or less willing treat complications surgically. Perhaps the patient declines operation or the decision is made to not expose an elderly fracture patient to secondary surgery due to medical reasons. Local treatment traditions may also have an influence. In case of any suspected infection, the aim is to preserve the primary prosthesis by means of early debridement, synovectomy and biopsies for culture followed by tailored antibiotics. How offensive this evaluation and treatment of infection is, varies between the units in the country, which to a certain extent could explain the variation in reoperation frequency.

Units with an elective focus mainly carry out secondary prosthesis surgery, which could explain a higher incidence of reoperations (figure 12.2.2). The use of either an uncemented stem or a posterior approach, which could mean an increased risk for periprosthetic fracture or dislocation, may be another reason for a higher reoperation frequency. If your unit has many reoperations, the registry proposes a local improvement work with in-depth analysis. This could take place as part of a resident's project, and the registry management is happy to pass on the experience that already exists of previous quality assurance initiatives.

As always, the reoperations are attributed to the hospital where the primary operation took place, regardless of where the reoperation subsequently was carried out.

12.3 Risk factors for reoperation

Many factors affect both if a patient will suffer from complications, and if the patient will undergo a subsequent reoperation. Register data only encompasses a small part of these factors, which may be more or less hard to capture. With Cox regression analysis, we assess how the available variables influence the risk of complications leading to reoperation. Men have a higher risk for reoperation than women, and younger patients higher than older. Reoperation as an outcome is a relatively blunt measure. Some patients afflicted by complications are either advised not to undergo a new operation or choose to do so, among other things due to health reasons. The registry is also aware of a certain underreporting of reoperations, where we urge participating units to maintain effective routines. All

open procedures in and around the hip are to be reported. Especially soft tissue procedures due to infection and fracture surgery with internal fixation only tend to be forgotten!

Furthermore, we choose implant based on the general health status and function level of the patient. Healthy, active patients often undergo a total arthroplasty. They live comparatively long after their hip fracture and have time to develop complications and – since they are healthy – are then reoperated to a large extent. The opposite can be said of those who have undergone a unipolar hemiarthroplasty – these patients survive a short time and may be far too ill to have secondary surgery. Consequently, unipolar hemiarthroplasties seem to have fewer reoperations compared to total arthroplasties. Table 12.3.1 shows the unadjusted number of reoperations for different age groups and types of prostheses. In summary, balancing other factors in regression analyses is of the greatest importance when we compare different types of prostheses.

Patients under 75 years of age

The unadjusted reoperation frequency is almost 7%. When the whole cohort has been analysed, male gender and secondary procedure (hip arthroplasty after failed internal fixation) are associated with an increased risk of reoperation in general. A posterior approach and an uncemented stem also increase the risk of reoperation, regardless of cause. A total arthroplasty is associated with a lower risk of reoperation than both bipolar hemiarthroplasties and unipolar hemiarthroplasties. For 60% of the patients, information on ASA class and BMI has been reported, which enables a more in-depth analysis. When adjusting also for these important patient factors, gender is no longer a decisive factor. There is no longer any difference between a total arthroplasty and a bipolar hemiarthroplasty. A unipolar hemiarthroplasty, however still entails an increased reoperation risk in this younger group, compared to a total arthroplasty. More healthy patients (ASA I-II) have a lower reoperation risk than those with ASA III-V. Overweight entails an increased risk, compared to normal weight, while underweight has no influence.

Patients between 75 and 85 years of age

The frequency of reoperation is slightly lower (5%) but the risk factors follow the same patterns as in those under 75 years of age. A total arthroplasty is associated with a lower risk of reoperation compared to the hemiarthroplasties. When only analysing hemiarthroplasties and adjust for ASA class, a unipolar hemiarthroplasty is associated with a lower risk for reoperation than a bipolar hemiarthroplasty. Dementia does not affect the risk.

Patients over 85 years of age

The oldest group has the highest early mortality rate, which could explain the somewhat lower reoperation frequency, 4%. The risk factors are mainly the same as in the younger groups. BMI does not seem to have an effect. Also for this group, the oldest, a unipolar hemiarthroplasty is associated with a lower risk compared to a bipolar hemiarthroplasty.

12.4 Risk factors for specific reasons for reoperation

In Cox regression analyses, we have studied how patient and operation factors affect the outcome. For all complications except erosion, male gender and secondary prosthesis are constantly recurring risk factors, and are not mentioned specifically below.

Infection

Infection is the most common reason why the patient is forced to undergo a new operation. It normally occurs early after the fracture-related arthroplasty. The prevalence of deep infection was 1.6% in those operated in 2018, and 1.7% in those operated 2005-2017. A longer period of follow-up thus does not increase the proportion of infection cases.

A high BMI and serious comorbidity are associated with an increased infection risk. Compared to a total arthroplasty, both bipolar hemiarthroplasties and unipolar hemiarthroplasties entail a somewhat higher risk for infection, here patient factors probably affect more than the implants themselves. Older and sicker patients, who are more infection-prone, undergo hemiarthroplasties to a greater extent.

Dislocation

Among those operated in 2017, 1.0% suffered from such severe dislocation problems that they underwent new, open surgery. Since closed reduction of dislocation is not registered, there is a great underreporting of the "true" number of dislocations. An ongoing scientific study that combines data from the Swedish Hip Arthroplasty Register with data from the Patient Register, finds that 13% of those who underwent a total arthroplasty with a posterior approach have a dislocation, compared to 7% of those who underwent a hemiarthroplasty. If the prosthesis is inserted via a lateral approach the proportion of dislocations decreases – 4% after a total arthroplasty, and 3% after a hemiarthroplasty. The result is as close to the "true" dislocation rate that it is possible to reach through registry studies (Jobory, Kärrholm, Rogmark – manuscript 2019).

In a Cox regression analysis, a posterior approach entails an almost doubled risk for a dislocation-related reoperation (confidence interval 1.6-2.0). Comorbidity is also a risk factor. The result remains after adjusting for BMI, which in itself does not influence the risk.

Periprosthetic fracture

According to the data in the registry, 0.2% of the fracture patients in 2018 suffered a periprosthetic fracture, and 1% of all patients who underwent a primary operation 2005-2018. This is a complication that can arise both early and late after surgery. An uncemented stem increase the risk 2.5 times compared with a cemented stem. Underweight and comorbidity are also associated with an increased risk for periprosthetic fracture. Overweight "protects" against periprosthetic fracture.

For the fracture patients, both osteoporosis and risk of falling leads to an increased risk for periprosthetic fracture, compared to osteoarthritis patients. Choosing a cemented prosthesis stem is therefore especially important for this patient group.

We reiterate that also fracture surgery with screw and plate fixation should be reported to the registry, so that correct and fair analyses can be undertaken.

Loosening

The prevalence of aseptic loosening increases with a longer follow-up period, as it is a distinctively long-term complication. 0.3% of all patients with a primary operation 2005-2018 have undergone a reoperation due to loosening. The number is low compared to the osteoarthritis group. One can assume that patients who have survived after their fracture, and who have had the time to develop loosening, not always choose to or are recommended to undergo a new operation. The proportion of X-ray confirmed aseptic loosenings therefore may be considerably higher.

The age of the patient is the most decisive risk factor for a reoperation due to aseptic loosening, the younger the higher risk. A posterior approach is associated with a lower risk for loosening, compared to a direct lateral approach. However, after adjusting for ASA class and BMI the influence of the approach disappears, possibly due to a decrease in statistical power in the material.

Erosion

A hemiarthroplasty articulates against the native cartilage, which may lead to its erosion. Acetabular erosion causes reoperation in 0.1% of the patients. It is a condition that is hard to capture. The "true" incidence of erosion is not known. Erosion usually causes pain when walking. Probably some adapt to this slowly progressing complication by being less active, and never seek care. Erosion may be hard to separate from pain of more unclear origin, which is why we have merged both these causes of reoperation in the analyses. When analysing hemiarthroplasties with Cox regression, we find a more than four times increased risk for reoperation due to erosion or pain after a unipolar hemiarthroplasty compared to after a bipolar hemiarthroplasty (confidence interval 2.3-7.9). A lower age, and to some extent a posterior approach, are also risk factors.

12.5 Clinical significance

The use of total arthroplasty continues to increase in Sweden. The trade-off, in terms of age and functional demands, towards hemiarthroplasty remains unclear. Although a relation between total arthroplasties and fewer reoperations can be seen in registry data, other studies suggests that total arthroplasties may in fact lead to more hip complications. Especially when a posterior approach is used, dislocation seems to be a major problem. A unipolar hemiarthroplasty seems to work well in the oldest age group, but shows a clear association with acetabular erosion, and should be avoided in those with an estimated long survival and a high activity level. If an unit chooses to not use total arthroplasty in fracture patients, bipolar hemiarthroplasty seems to be a good option for those under 75 years of age. In the way dual mobility cups are used in Sweden, that is with an equal distribution between lateral and posterior approach, no difference can be seen in the risk for reoperation compared to a conventional total arthroplasty.

A pragmatic way is to decide upon a treatment rationale where the combinations of implants and techniques consider the local conditions. A unit with many experienced joint arthroplasty surgeons and a preference for the posterior approach, probably can keep the dislocation frequency for hemiarthroplasties down with a muscle sparing technique, and with dual mobility cups reduce it for total arthroplasties as well. A unit that has to rely on on-call surgeons with a varying degree of experience, should use hemiarthroplasties to a large extent, and a lateral approach. A lateral approach remains a reliable method for keeping the dislocation frequency at a low level. A few clinical studies suggest that a posterior approach may have advantages in the form of a better function, likewise we see a certain protection against loosening in the registry's own analyses. Still these advantages are subtle compared to the high risk for dislocation. Regardless of the choice the individual unit makes, the results must be checked on a regular basis. Resident's projects provide a good opportunity for such quality control – see good examples in this and in earlier annual reports! The registry staff is happy to share experiences of earlier projects.

The result for the different prosthesis types; total prosthesis, unipolar hemiprosthesis, and bipolar hemiprosthesis respectively, is the same, measured as implant survival. The result may be interpreted as the Swedish orthopaedic surgeons choose the most appropriate implant for each patient group respectively, an implant that meets the functional needs of the patient in the best way.

Remember that all open procedures in and around the hip should be reported. Do not forget to report soft tissue procedures during infection and fracture surgery!

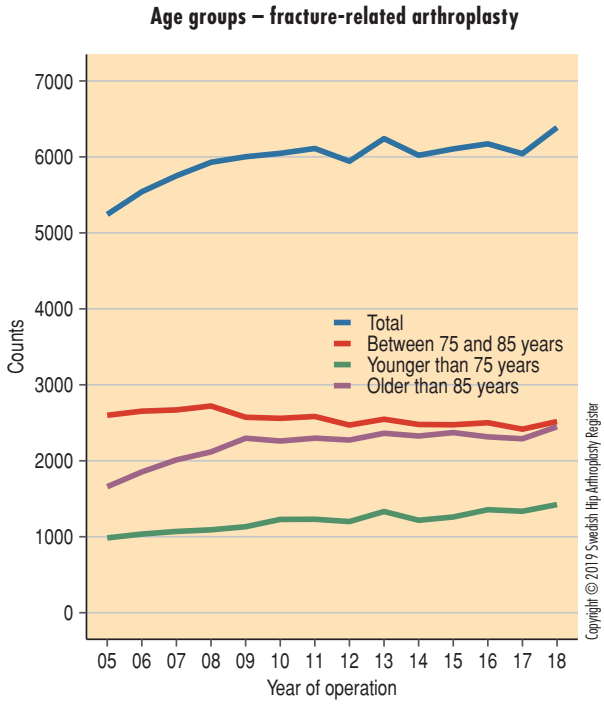


Figure 12.1.1

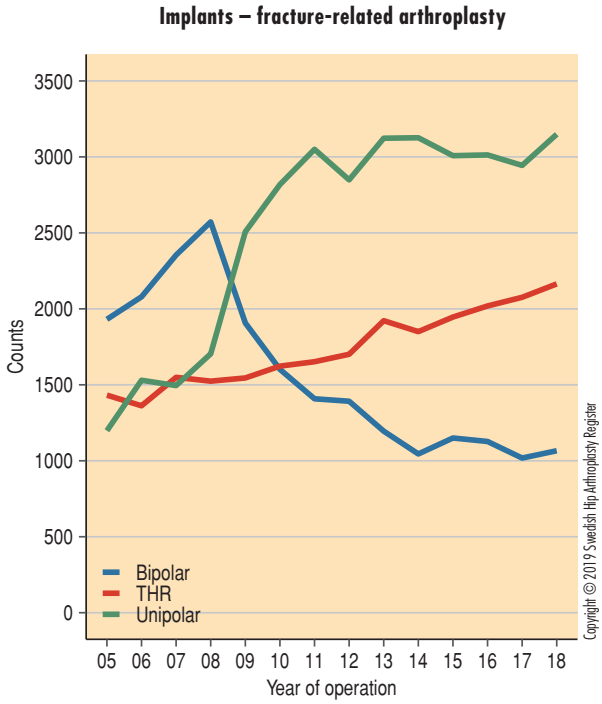


Figure 12.1.2

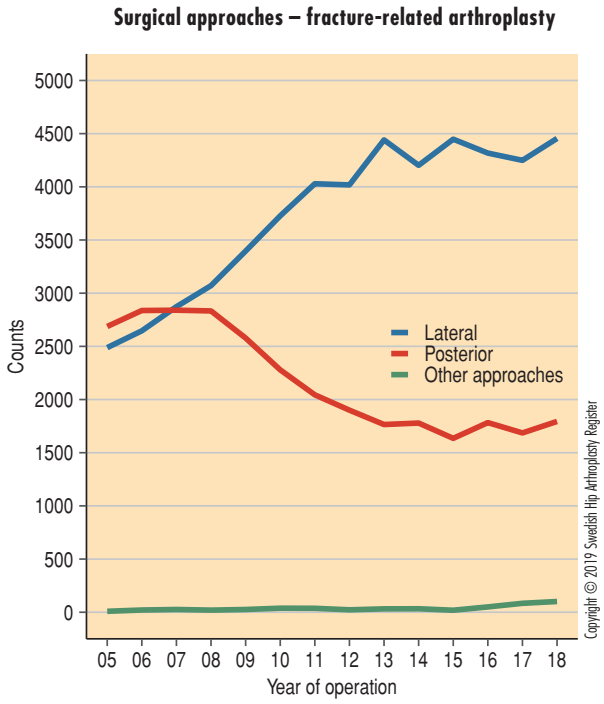


Figure 12.1.3

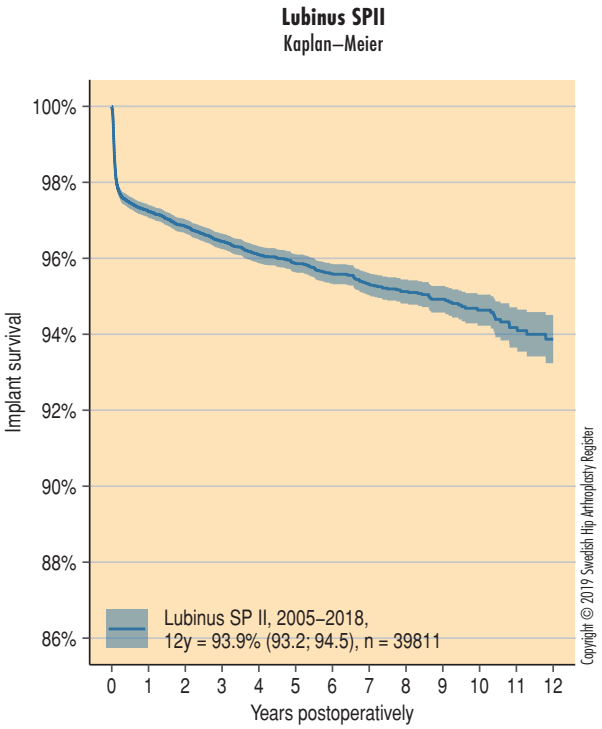


Figure 12.1.4

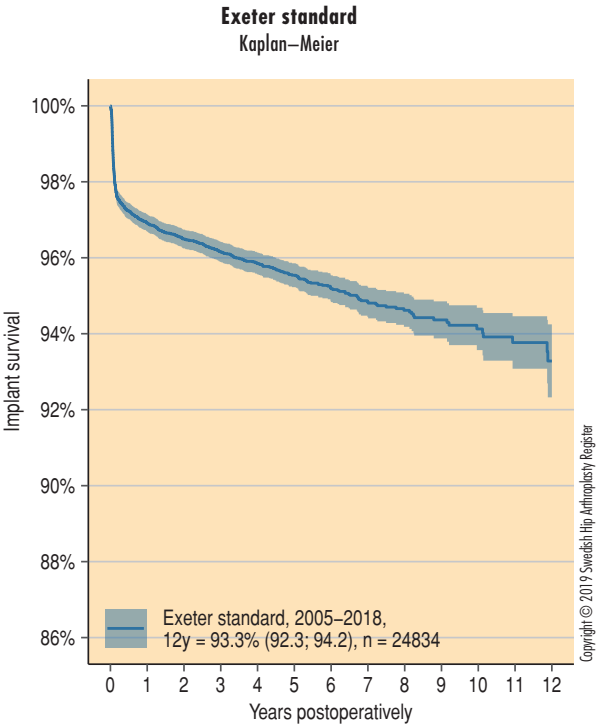


Figure 12.1.5

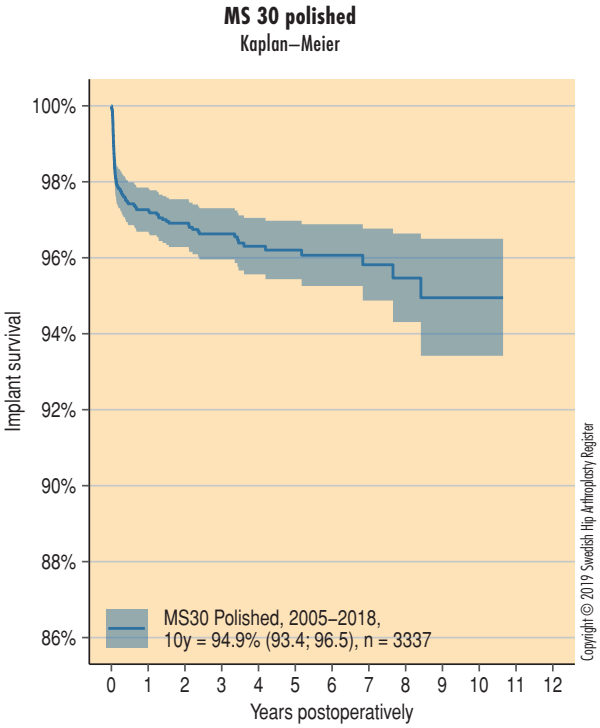


Figure 12.1.6

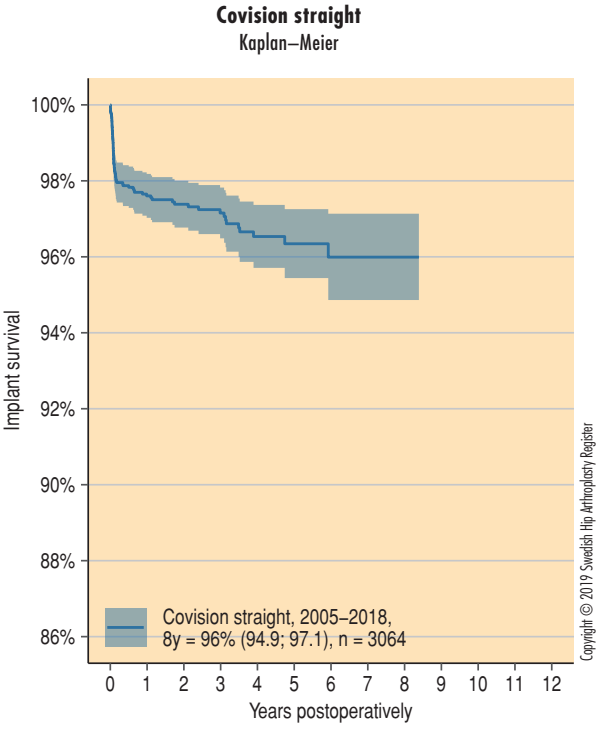


Figure 12.1.7

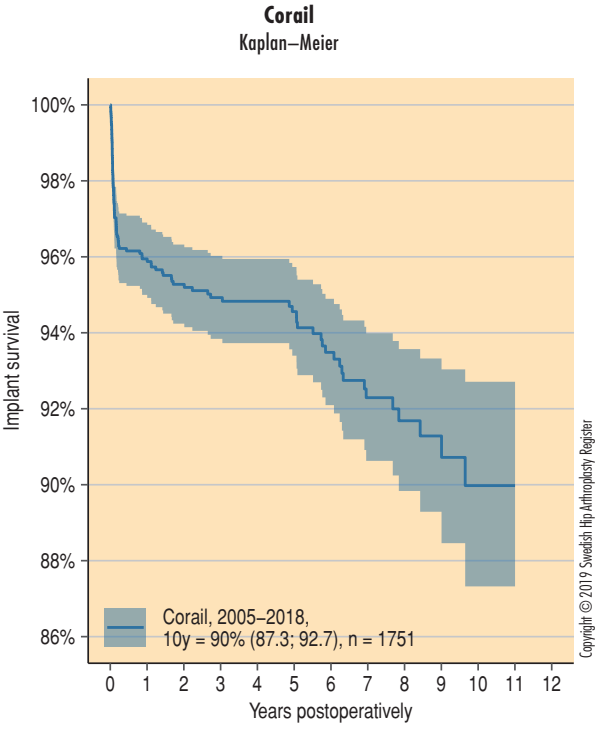


Figure 12.1.8

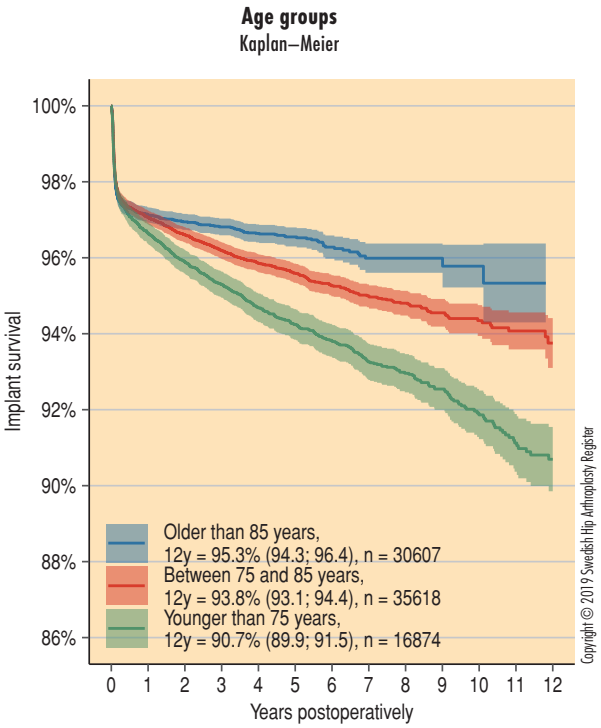


Figure 12.2.1

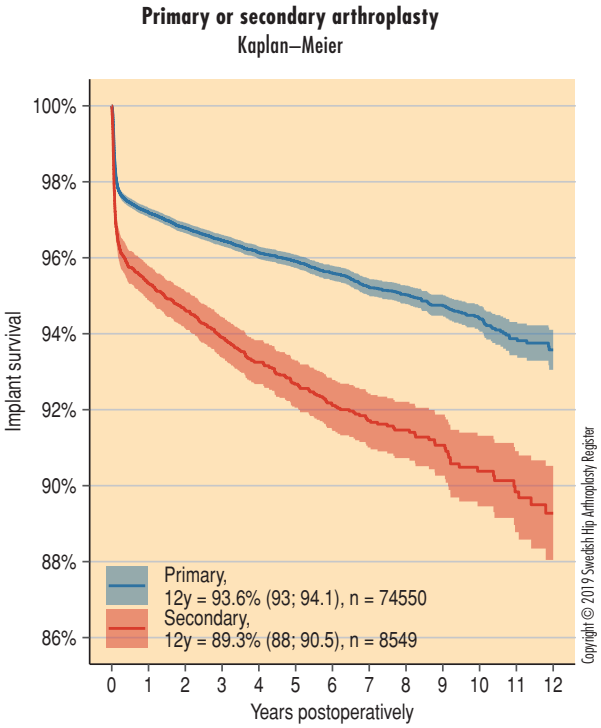


Figure 12.2.2

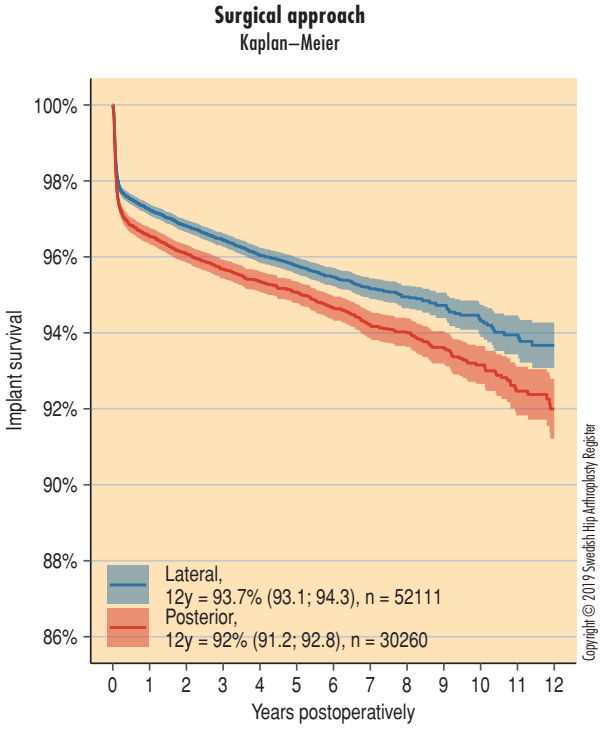


Figure 12.2.3

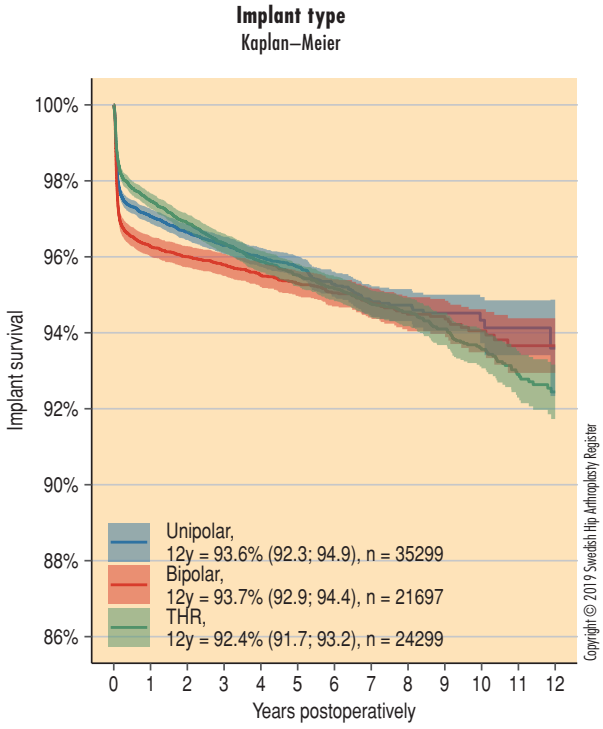


Figure 12.2.4

15 most common stem components for frakture patients

Stem	2005–2013	2014	2015	2016	2017	2018	Total[1)]	Share, %[2)]
SPII standard	23 540	2 976	3 082	3 390	3 321	3 774	16 543	53.8
Exeter standard	14 814	2 077	2 118	1 995	1 957	1 973	10 120	32.9
MS-30 polerad	1 772	323	321	318	304	312	1 578	5.1
Covision straight	1 726	385	345	251	232	142	1 355	4.4
Corail standard	1 146	83	89	55	49	45	321	1
Exeter long	250	38	29	23	34	21	145	0.5
Corail coxa vara	123	18	14	11	18	10	71	0.2
Wagner Cone	105	21	17	12	12	5	67	0.2
Restoration	70	7	12	19	12	13	63	0.2
MP proximal standard	112	18	10	4	13	12	57	0.2
Bi-Metric X por HA NC	273	17	14	11	7	5	54	0.2
Corail high offset	50	9	5	13	5	9	41	0.1
CLS	210	5	12	4	11	3	35	0.1
Exeter short rev stem	16	3	2	4	6	14	29	0.1
Unclear	0	0	1	0	14	13	28	0.1
Other	8 576	41	28	45	45	27	186	0.5
Total	52 783	6 021	6 099	6 155	6 040	6 378	30 693	

Table 12.1.1.

[1)] Refers to the number of cases over the last five years.
[2)] Refers to the proportion of the total number of primary arthroplasties for fracture patients during the last five years.

15 most common cup/head components

Cup/hemiprosthesis head	2005–2013	2014	2015	2016	2017	2018	Total[1)]	Share, %[2)]
Unipolar prosthesis head	9 525	1 758	1 755	1 971	1 943	2 063	9 490	30.9
UHR Universal Head	5 792	743	835	832	777	817	4 004	13
Unitrax modular endohead	1 562	524	468	534	658	677	2 861	9.3
Lubinus x-link	454	338	467	611	547	678	2 641	8.6
Avantage	585	235	232	321	402	417	1 607	5.2
Marathon	1 557	324	302	269	274	203	1 372	4.5
Covision unipolar	1 743	397	348	253	228	143	1 369	4.5
Exeter Rim-fit	309	184	224	275	307	367	1 357	4.4
Lubinus	5 448	373	297	152	146	155	1 123	3.7
V40 unipolar	4 038	348	336	158	8	0	850	2.8
MultiPolar Bipolar Cup	580	137	145	135	131	132	680	2.2
Vario cup	6 862	128	131	159	108	113	639	2.1
Unipolar	803	96	100	97	90	105	488	1.6
Polarcup cemented	197	60	83	90	95	81	409	1.3
IP Link	85	64	71	83	92	66	376	1.2
Other	11 483	312	309	214	231	360	1 426	4.5
Total	51 023	6 021	6 103	6 154	6 037	6 377	30 692	

Table 12.1.2.

[1)] Refers to the number of cases over the last five years.
[2)] Refers to the proportion of the total number of primary arthroplasties for fracture patients during the last five years.

Reoperations within six months per unit

Fracture patients 2016–2018

Unit	Number of primary operations[1)]	Number of reoperations[2)]	Proportion, %[3)]
University hospital or regional hospital			
Karolinska/Huddinge	373	14	3.9
Karolinska/Solna	182	14	7.7
Linköping	268	7	2.7
SU/Mölndal	1 224	18	1.5
SUS/Lund	647	16	2.5
SUS/Malmö	621	27	4.5
Umeå	317	7	2.2
Uppsala	657	24	3.8
Örebro	228	11	4.9
County hospital			
Borås	378	7	1.9
Danderyd	740	17	2.3
Eksjö	185	15	8.4
Eskilstuna	353	15	4.4
Falun	472	22	4.7
Gävle	474	5	1.1
Halmstad	286	11	3.9
Helsingborg	584	26	4.6
Hässleholm	66	1	1.5
Jönköping	264	10	3.9
Kalmar	286	3	1.1
Karlskrona	373	9	2.5
Karlstad	535	13	2.5
Kristianstad	498	18	3.7
Norrköping	352	2	0.6
NÄL	710	11	1.6
Skövde	343	21	6.4
Sunderby	320	5	1.6
Sundsvall	367	7	1.9
Södersjukhuset	992	30	3.1
Uddevalla	29	0	0
Varberg	298	4	1.5
Västerås	519	13	2.6
Växjö	228	3	1.3
Ystad	147	4	2.7
Östersund	355	17	4.9

Unit	Number of primary operations[1)]	Number of reoperations[2)]	Proportion, %[3)]
Local hospital			
Alingsås	142	12	8.5
Gällivare	123	7	5.8
Hudiksvall	210	4	2
Karlskoga	249	18	7.5
Kungälv	243	4	1.7
Lidköping	169	9	5.4
Lindesberg	95	3	3.4
Ljungby	147	7	4.8
Lycksele	80	1	1.2
Mora	204	4	2
Norrtälje	146	5	3.5
Nyköping	160	5	3.2
Piteå	31	0	0
Skellefteå	181	8	4.5
Sollefteå	23	0	0
Södertälje	158	6	3.9
Torsby	104	0	0
Trelleborg	39	0	0
Visby	106	2	2
Värnamo	139	6	4.6
Västervik	167	7	4.2
Örnsköldsvik	251	4	1.6
Private hospital			
Aleris Specialistvård Motala	126	2	1.6
Capio S:t Göran	574	14	2.6
Country	18 601	555	3.1

Table 12.2.2.

[1)] Refers to the number of primary arthroplasties for fracture patients 2016-2018. Units with fewer than 20 operations during the time period considered are excluded.

[2)] Refers to the number that have undergone a reoperation within 6 months.

[3)] The proportion of reoperations calculated using a competing risk analysis at six months follow-up.

Number of reoperations

	Number of operations	Unipolar prosthesis		Bipolar prosthesis		Total prosthesis		All prosthesis	
		Number	Proportion, %	Number	Proportion, %	Number	Proportion, %	Number	Proportion, %
< 75 years	16 895	168	6.1	168	8.1	785	6.6	1 121	6.7
75–85 years	35 759	699	4.6	547	5.4	468	4.8	1 714	4.9
> 85 years	30 881	605	3.4	416	4.3	107	4.1	1 128	3.8

Table 12.3.1. The number of reoperations (secondary open surgery) divided into age groups and prosthesis types that have been reported to the registry up to 2018-12-31.

13 Register development – value compasses

The Swedish Hip Arthroplasty Register began reporting hospital results openly in 1999. The number of variables reported in this way have increased over the years, and they are presented in tabular form at different places in this report. These tables are by necessity extensive, and at times difficult to interpret. Furthermore, it is difficult using tables to acquire a quick overview of the results of the units in multiple dimensions. In order to facilitate interpretation and to quickly gain an overview of the results of the units, we make use of what is termed the value compass, which includes seven or eight outcome variables (compass points). The compasses are produced purely with the aim of acquiring a quick and pedagogical overview. A deviating result in a value compass is an indication that there is scope for improvement. The compass ought to be viewed as a simple signalling system. We have produced value com-passes for all total arthroplasty patients, the standard patient, and patients who have undergone an arthroplasty procedure as a result of a fracture.

Each variable has been re-scaled to values from 0 to 1. The lowest value (0.0) for the variables is the origin and the highest value (1.0) is on the periphery. The limits are determined by taking the highest and lowest mean value (on the unit level) +/- one standard deviation. The national mean value is stated for each compass point through the outer edge of the red area. Each unit's mean value for the variable in question is given for each compass point through the outer edge of the green area. The values within the red area are lower than the national mean value, and values outside the red area are higher. The more of the red field that can be seen, the poorer the results. It should be noted that the observation period for the variables differs.

13.1 Register follow-up after total hip arthroplasty

Result variables in value compasses:

- Patient satisfaction at one-year follow-up.
- Pain relief. The value is calculated by subtracting the pain value reported one year after the operation from the preoperative pain value.
- Improvement in health-related quality of life (gain in the EQ-5D index). The value is calculated by subtracting the EQ-5D index one year after the operation from the preoperative EQ-5D index.
- "Adverse events" within 90 days. For definitions, see the "Adverse event" section in Chapter 13. The indicator also includes mortality. Reporting 'adverse events" using a higher number and variability creates a dimension in the compasses that offers greater scope for improvement.
- Completeness. Completeness on the individual level according to the most recent linkage with the Patient Register at the National Board of Health and Welfare.
- Reoperation within two years. Reports all forms of reoperation within two years following a primary operation and during the most recent four-year period.
- Five-year implant survival. Implant survival after five years using Kaplan–Meier statistics.
- Ten-year implant survival. The same variable as above but with a longer follow-up period.

Linked to the value compass for each unit is a graphic representation of the unit's case mix. This part is designed in the same way as the value compass, and it includes some of the patient-related variables which when analysing the Register's database were shown to be linked to patient-reported outcome and long-term results with regard to revision requirements. The larger the green area in this figure, the better the patient profile for the unit in question. For a standard patient, there are no case mix compasses as an adjustment has already been made for this via the selection process.

- Charnley classification. Patients who are classified as Charnley class A or B (without other diseases and/or problems in joints other than the hips that affect the patient's ability to walk) run a low risk of complications and have a better patient-reported outcome.
- Number of primary osteoarthritis patients. Compared with other underlying joint diseases, primary osteoarthritis is associated with a lower risk of complications and a better patient-reported outcome.
- Number of patients aged 60 or older. Individuals over the age of 60 run a lower risk of a reoperation.
- Number of women. Women run a lower risk of a reoperation.

13.2 Register follow-up after hip arthroplasty as treatment for a hip fracture

The value compasses, a reflection of the units´ results, include total arthroplasties and hemiarthroplasties due to hip fractures. The value compasses include five variables (compass points), including adverse events. The fracture compasses are limited by the fact that many of the fracture patients are not covered by the Register's PROM programme.

The purpose of the presentation is that each hospital should be able to compare itself with the national mean value and identify any problem areas that may initiate local improvement work. The results must be viewed in context, where many factors come into play. The value compass can be regarded as a balanced scorecard. The larger the area, the better the total multidimensional result for each unit.

We have chosen slightly different result variables for fracture-related arthroplasties compared to those for elective total arthroplasties. The follow-up time for reoperation and revision is set shorter. Individuals with a hip fracture have a shorter remaining life expectancy due to their high age and diseases. The majority of reoperations take place within a few months, and long-term complications are uncommon.

- Completeness on an individual level for hemiarthroplasty according to the latest linkage with the Patient Register (2017).

- Adverse events within 90 days according to the latest linkage with the Patient Register. These are defined as cardiovascular and cerebrovascular conditions, thromboembolic disease, pneumonia, gastric ulcers and urinary tract infection if these have resulted in readmission or death. All types of reoperation of the hip are also included.
- 90-day mortality. In the international literature, this variable is used to monitor mortality following hip arthroplasty.
- Reoperation within six months. All open, subsequent procedures on the hip in question.
- Implant survival after one year using Kaplan–Meier statistics.

The selection of fracture patients who receive hip arthroplasty (instead of internal fixation) varies between hospitals, and each unit's value compass must be interpreted alongside its case mix. The case mix framework is designed in the same way as the value compass and includes the variables that prove to be crucial demographic parameters for the risk of reoperation and, to a certain extent, mortality. The larger the surface in this figure, the more advantageous the patient profile for the unit in question.

- Proportion of patients aged 85 years or older. A high age protects against reoperation and revision. There could be many reasons for this: reduced activity reduces the risk, for example, of erosion and dislocation. Short remaining life expectancy means that loosening does not have time to develop. On the other hand, the 'risk reduction" that can be observed may be caused by the fact that an older individual, despite suffering a complication, is advised not to undergo secondary surgery for medical reasons. Units that operate on a large number of patients over the age of 85 achieve better results with regard to reoperation/revision but will have higher mortality rate.
- The proportion of acute fractures (diagnosis S72.0). The more patients treated due to an acute fracture, the better the long-term results according to the regression analysis of the register database.
- Proportion of non-dementia patients. The figure show the unit's proportion of patients assessed to be cognitively intact. Dementia is associated with a higher mortality rate following hip fracture. A unit that has a large proportion of non-dementia patients, will have lower mortality rate.
- Proportion of women. Women generally have better results than men in terms of the need for reoperation/revision, particularly due to the lower risk of periprosthetic fracture.

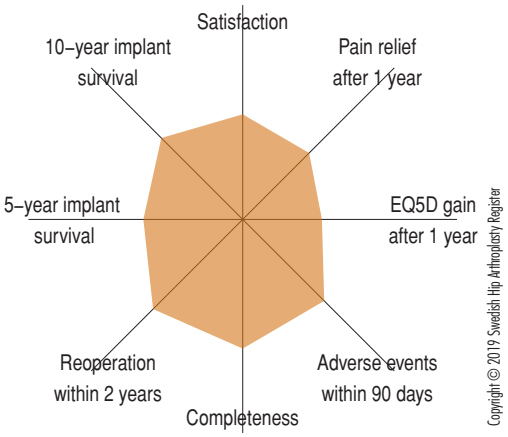
Discussion

By comparing value compasses in previous years, the development can be followed over time. Compared with 2017, Gävle, Södertälje, Uppsala, Visby, and Värnamo, for example, have clearly improved their value compasses. Some hospitals, however, still report inferior or deteriorating results. This ought to initial a local analysis of the different factors that affect the clinical results and measures for improvement. The Register willingly mediates the experience from similar analyses at other hospitals, and can also provide practical assistance. The decrease in completeness, as is the case in Sunderbyn and Borås, ought to be relatively easy to rectify by reviewing the unit's routines. In this respect, we would like to point out that some units have 'zero" on the completeness axis as the completeness analysis is based on hemiarthroplasty registration. These units (marked with an asterisk) perform total arthroplasties only and completeness should thus not be deemed to be a problem.

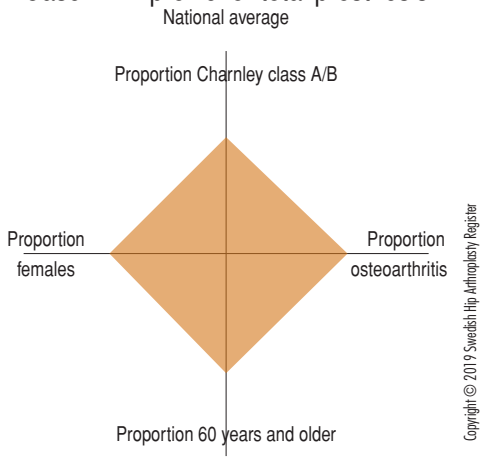
In aged hip fracture patients who are also ill, non-surgical treatment of complications is a more common problem than in osteoarthritis patients. For both infections and dislocations, the treatment could in certain circumstances be aimed at the symptoms, thus avoiding surgery, e.g. if a new operation were to be associated with substantial medical risks. Non-surgical treatment may therefore be appropriate, and when making an assessment of the value compasses, this relationship ought to be taken into account. On the other hand, a higher incidence of reoperations and revisions could to a certain extent be an indication that an active approach to complications has been adopted.

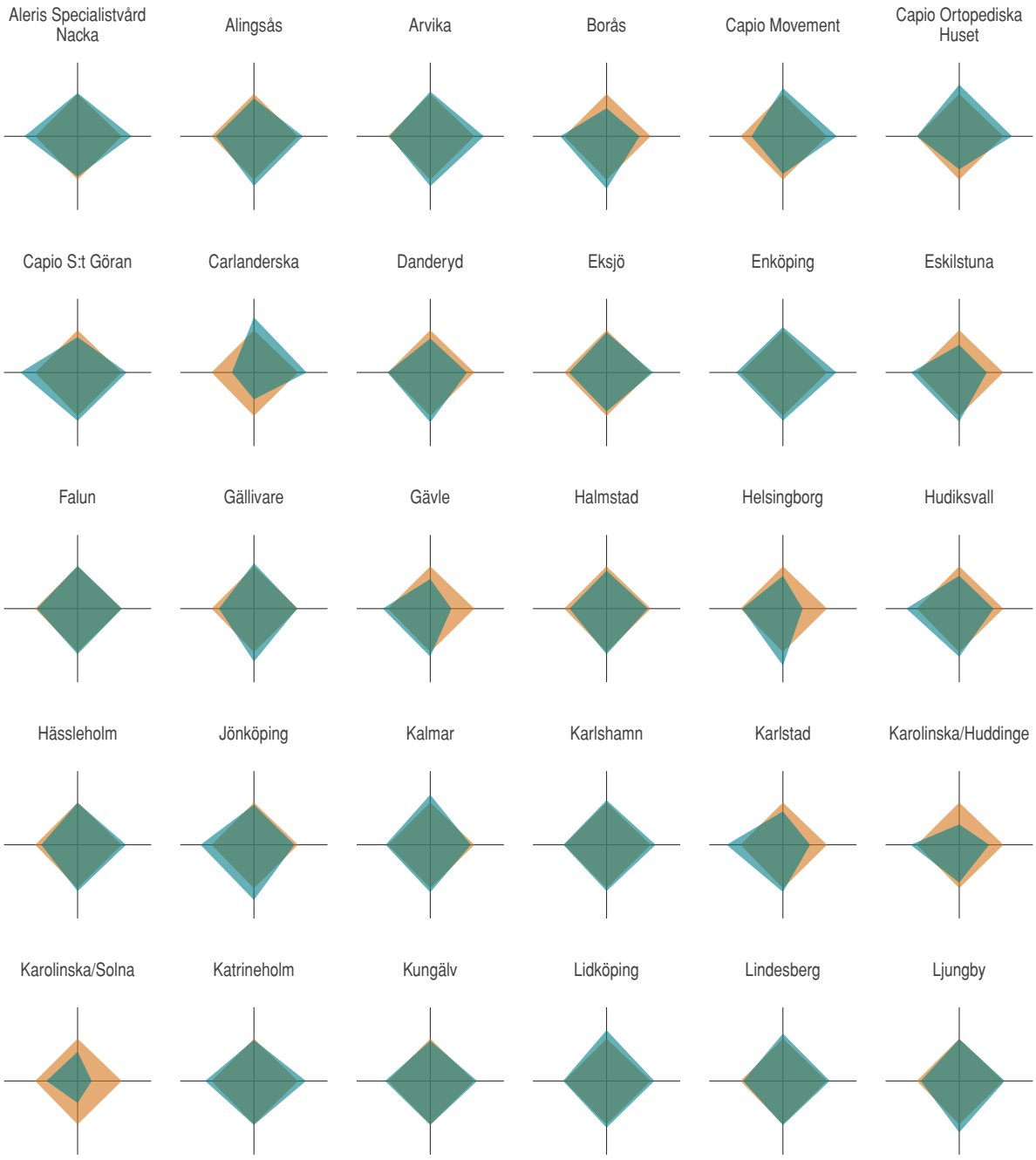
Quality indicator for total prosthesis

Value compass – national average



Case–mix–profile for total prosthesis

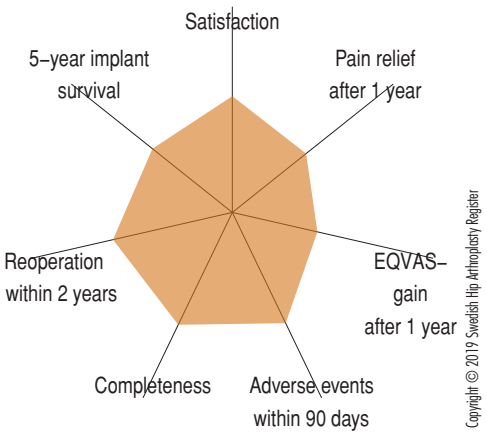




*Completeness cannot be calculated since the units have not reported operations to the National Patient Register at the National Board of Health and Welfare.

Quality indicator for the "standard patient"

Value compass – national average



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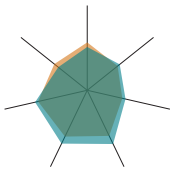

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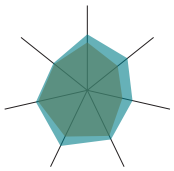

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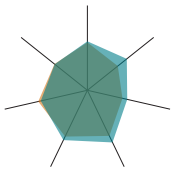

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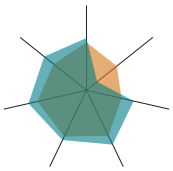

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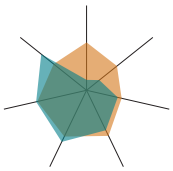
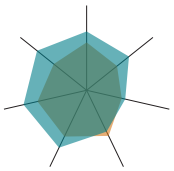


Art Clinic Jönköping



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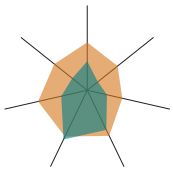

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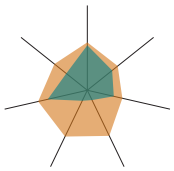

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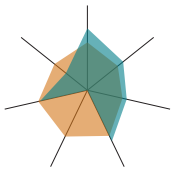
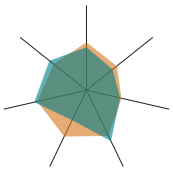
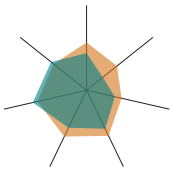


Capio Ortopediska Huset



Capio S:t Göran



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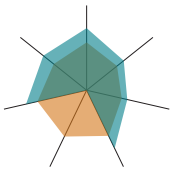
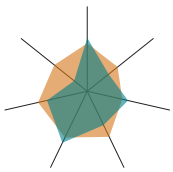
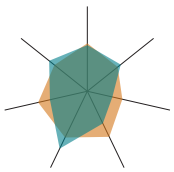


Danderyd



Eksjö



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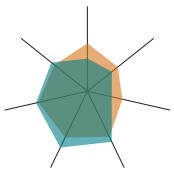

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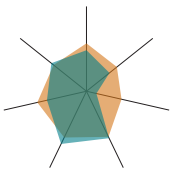

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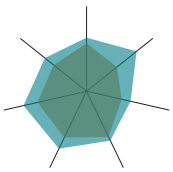

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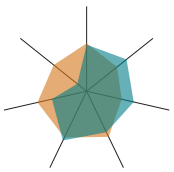

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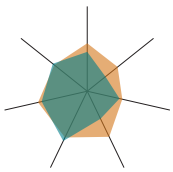

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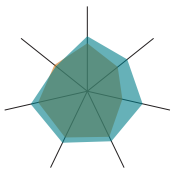

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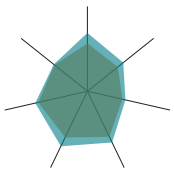
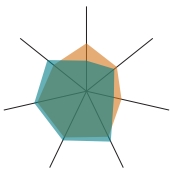


Jönköping



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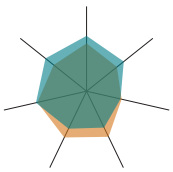

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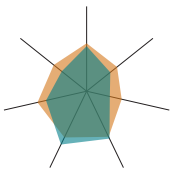

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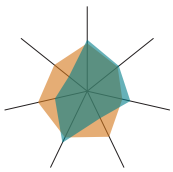

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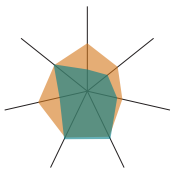

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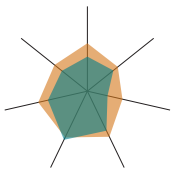

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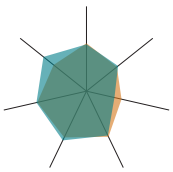
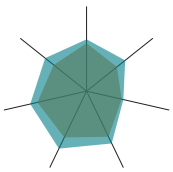


Lindesberg



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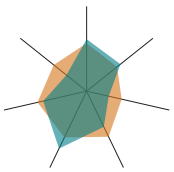
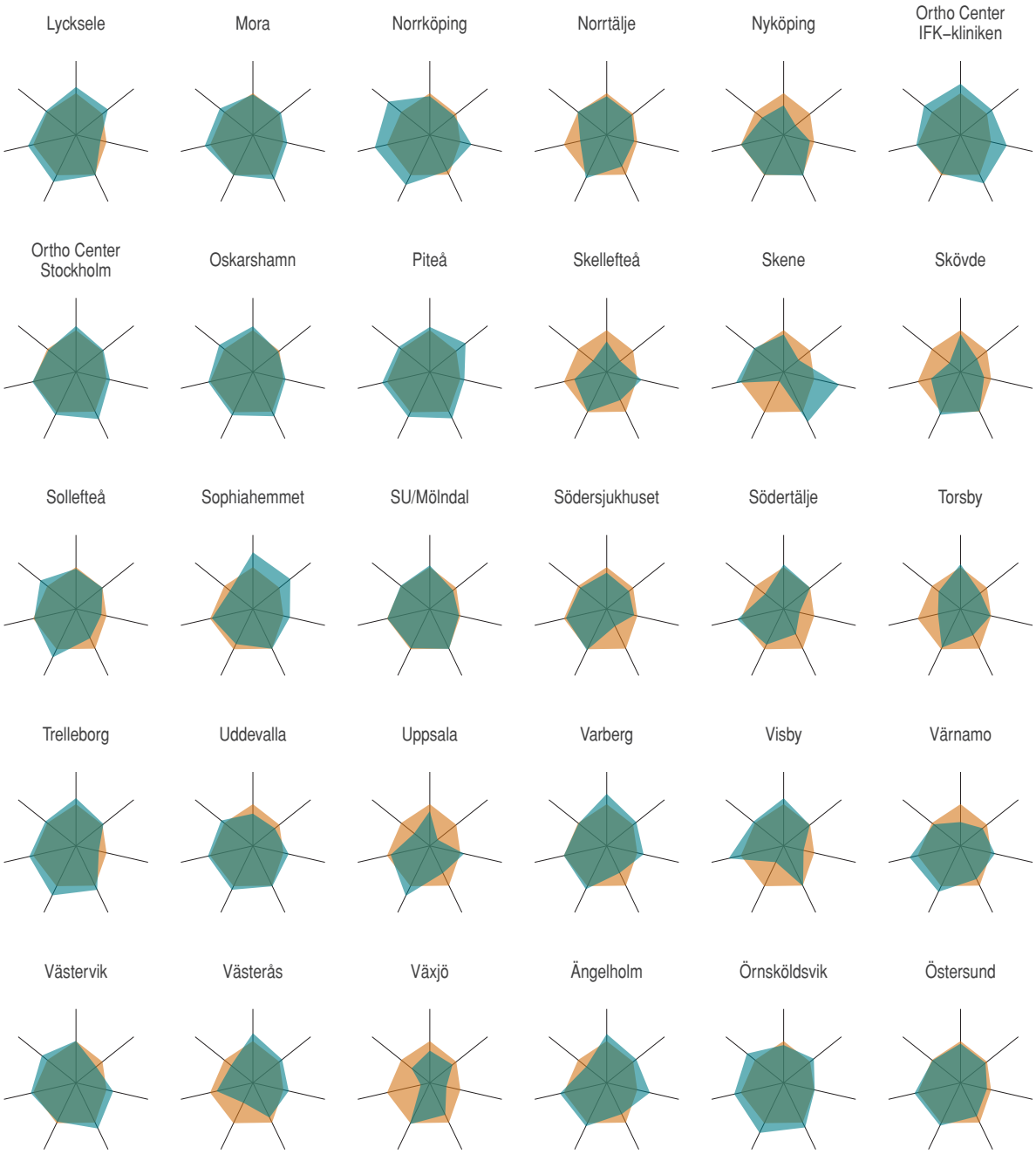
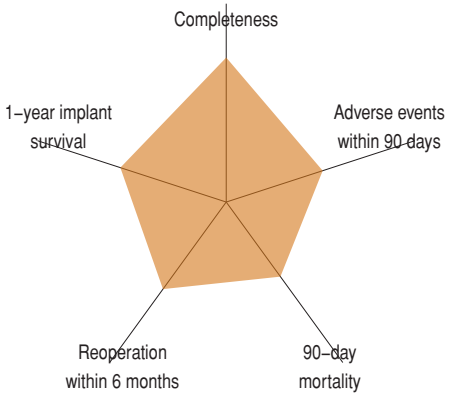


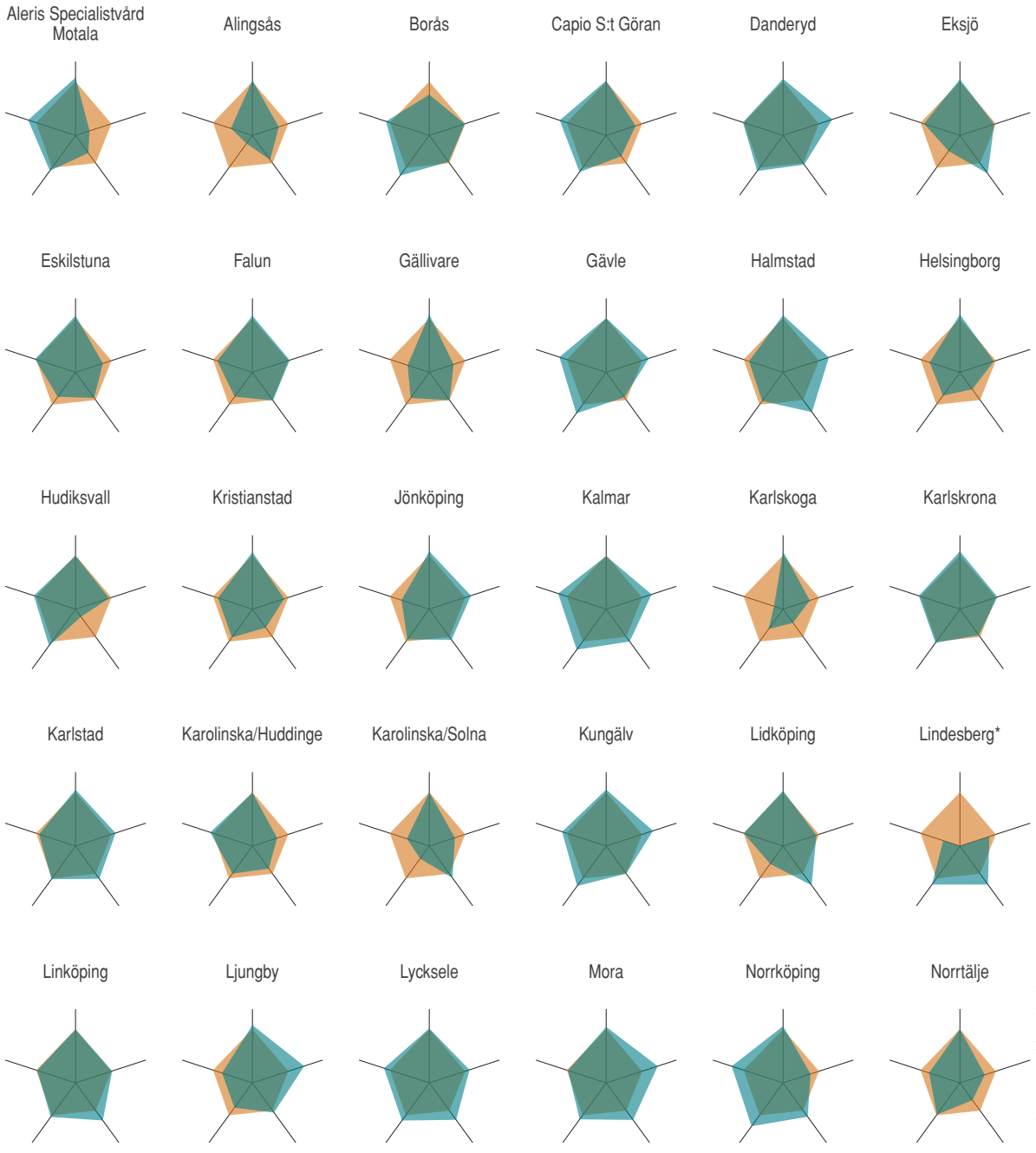


*Completeness cannot be calculated since the units have not reported operations to the National Patient Register at the National Board of Health and Welfare.

Quality indicator for hip fracture patients

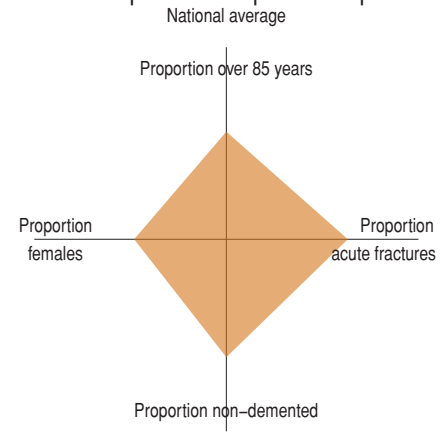
Value compass – national average

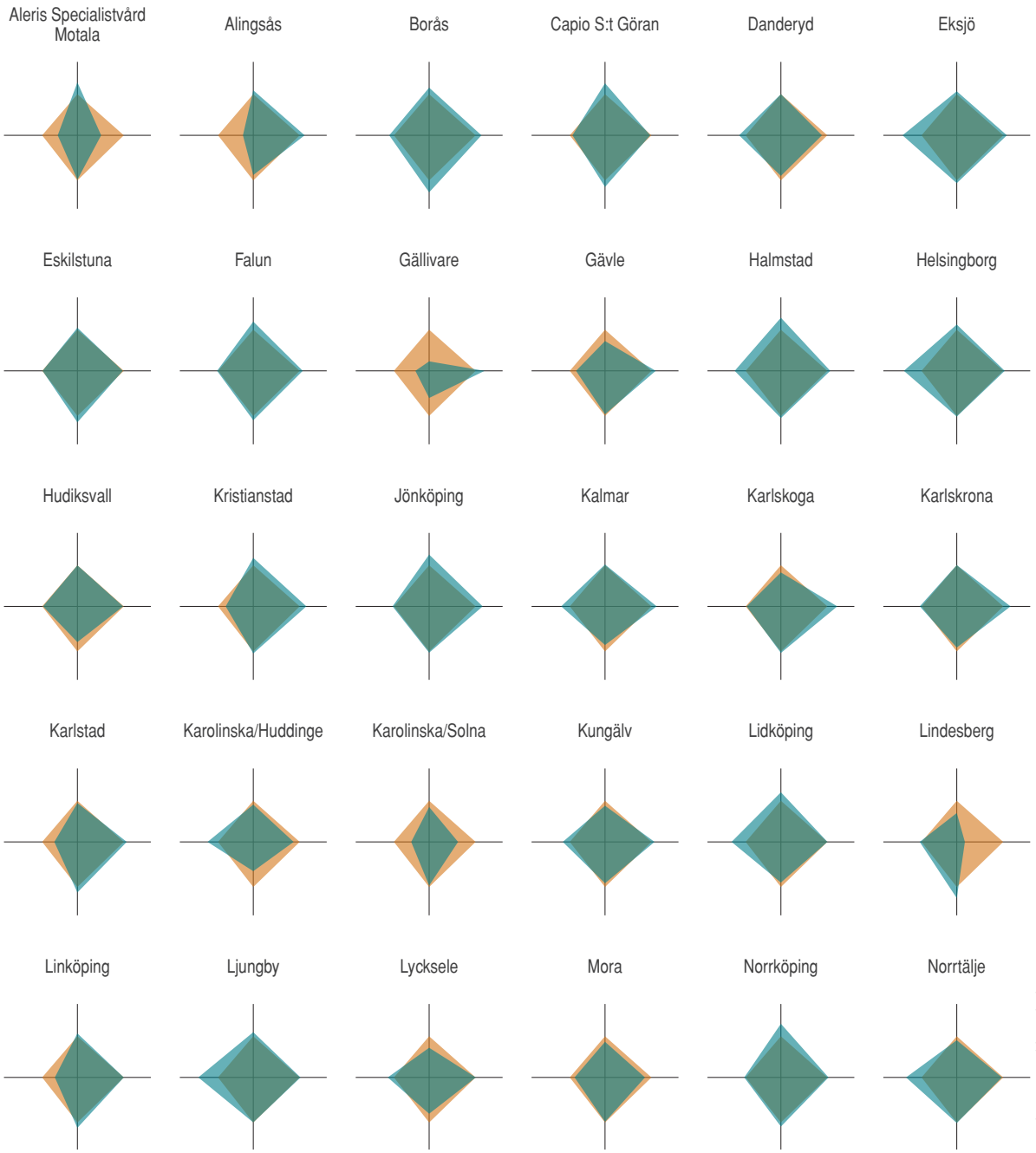


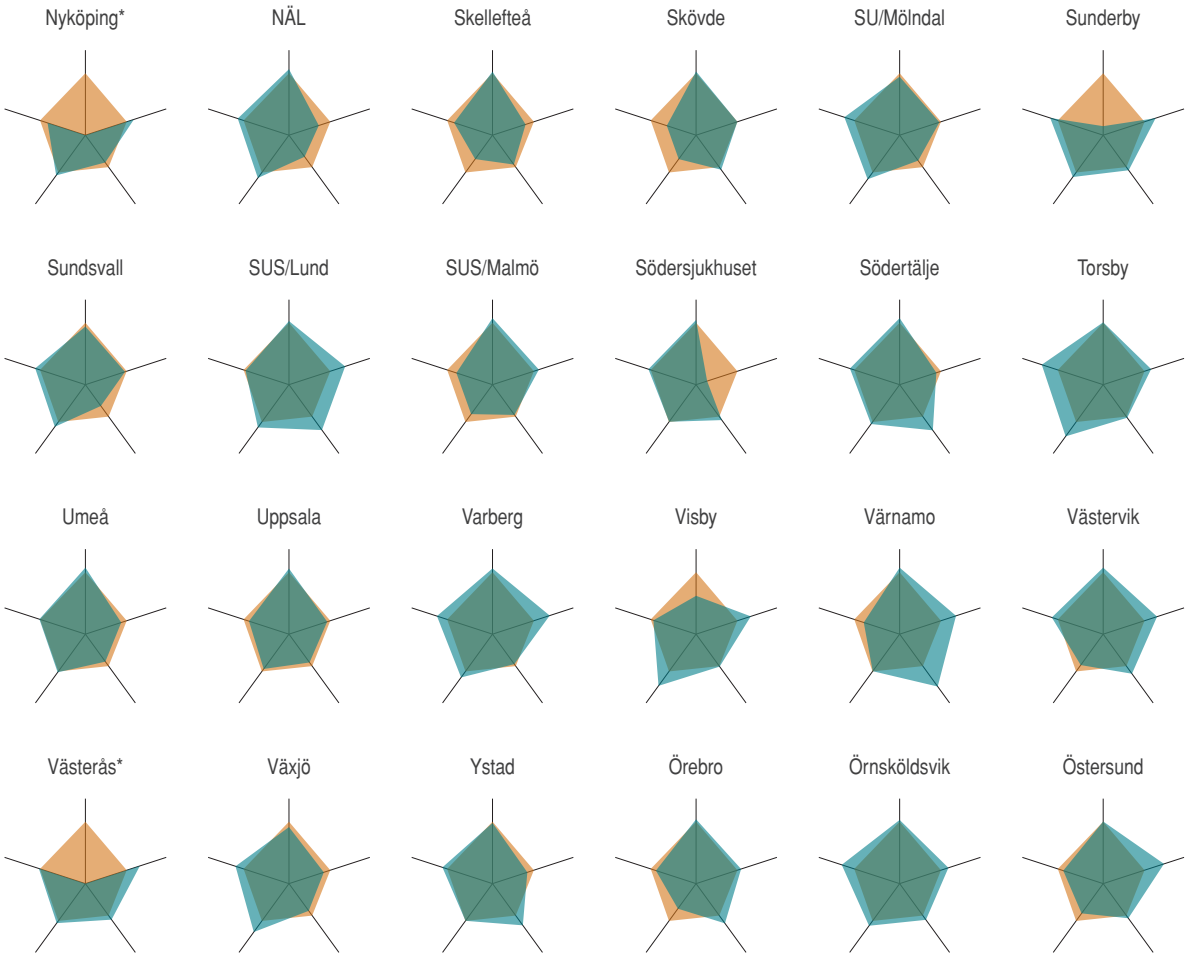


*Units with few hemiarthroplasties used (the axis is based on completeness for hemis).

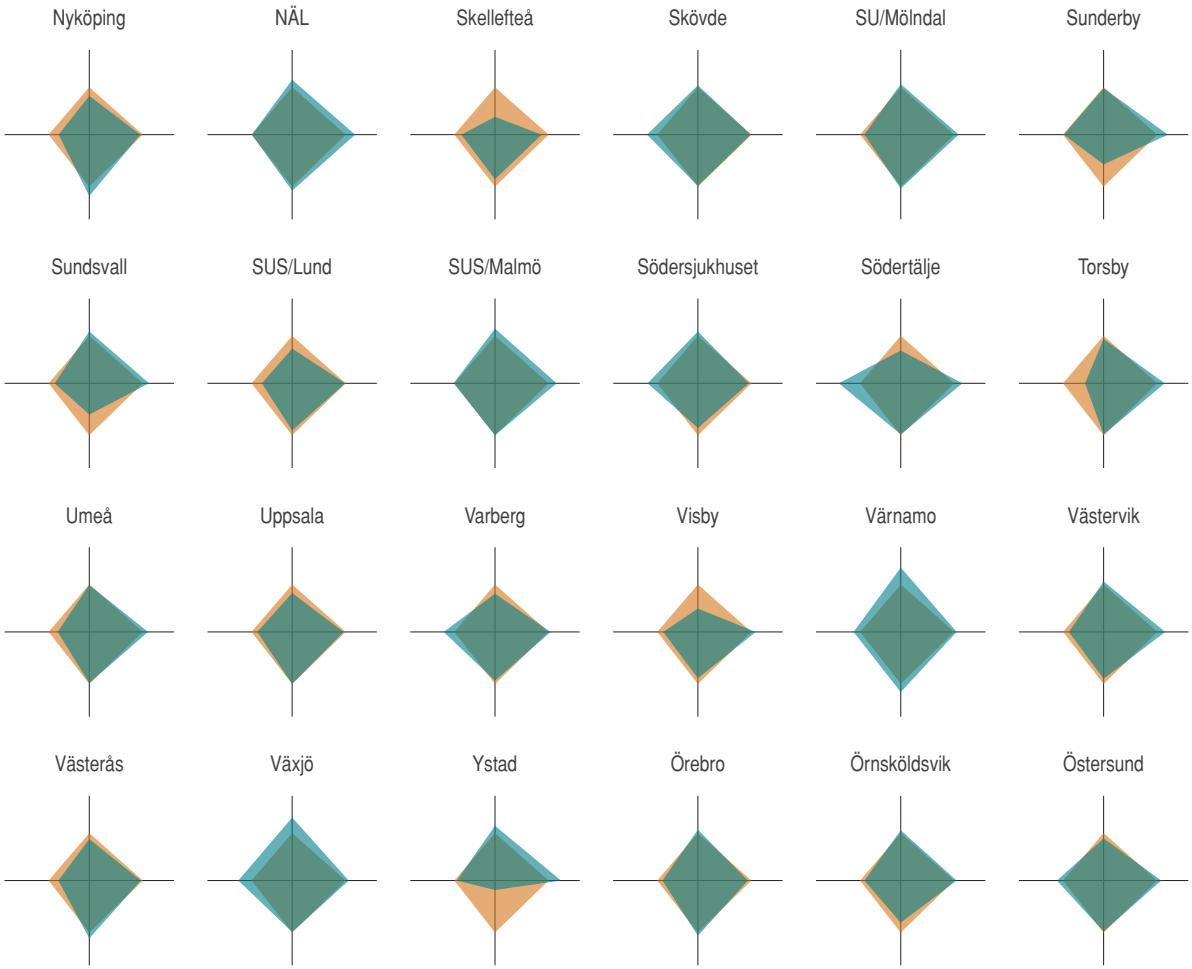
Case–mix–profile for hip fracture patients







*Units with few hemiarthroplasties used (the axis is based on completeness for hemis).



14 The Hip Arthroplasty Register and clinical research

According to an agreement between the state and the Swedish Association of Local Authorities and Regions (SALAR) regarding funding of the quality registers, the vision is that the Swedish National Quality Register should contribute to saving lives and achieve equal health, and be used actively for follow-up, learning, quality development, improvement, research, and guidance. The aim is that quality registers should be an integral part of a national system for collective knowledge control and follow-up of Swedish healthcare, and an important source of support to achieve knowledge-based, equal health and resource-effective care and welfare. National quality registers should be used as part of an improvement programme within care and welfare and as a source of know-how for clinical research, including collaboration with the life science sector. Apart from covering operational costs, grants from SALAR and the state should be channelled into the first two remits. The idea is that register-based research should be funded from other sources.

What is research and what are register operations?

The limit for what can be deemed to be clinical research and evaluation of the work that is being carried out and improvement work is, however, unclear. All registered analysis aimed at feedback of results and operational improvements is founded on scientific methods. In the Annual Report, we publish focused in-depth analyses, validation studies and the linking of data with other health data registers that is carried out according to established register research methods. Within the Register, ongoing work takes place according to scientific principles aimed at improving and developing the methods used in register work. Despite the fact that central grants are not intended for research, SALAR and the Agency for Health and Care Services evaluate the research activities of the Register on a regular basis. A high degree of research activity is a criterion for granting a register the highest certification level.

26 dissertations from the Hip Arthroplasty Register

We have carried out strategic work within the Register to improve the infrastructure with the purpose of increasing and reinforcing research activities. This has produced good results, which can be noted in, among other things, the fact that we have 19 PhD students linked to the Register. These PhD students base the whole or part of their dissertation work on data from the Swedish Hip Arthroplasty Register and represent seven Swedish universities (Uppsala University, Lund University, Gothenburg University, Umeå University, Linköping University, the Karolinska Institute, and Örebro University). In 2018, 20 scientific articles from the Register were published, and we had more than 80 presentations at national and international meetings. Since 1986, when Lennart Ahnfelt defended the first Hip Register-based dissertation, a further 25 PhD students have produced dissertations based on data from the Register and under the supervision of Register staff. A strong contributing factor behind the steady increase in research activity is that the Register now has several biostatisticians who work full-time for the Register.

Linkage studies

A further explanation for the increase in research activity is that we are utilising other health data registers to a greater extent as part of research. As everything is based on personal identity numbers, linking the Register data with other data sources, such as Statistics Sweden, regional patient registers and the health data register kept by the National Board of Health and Welfare, offers unique research opportunities. In 2016, we published a description of the process of linking data from the National Board of Health and Welfare, Statistics Sweden, and the Hip Arthroplasty Register (Cnudde et al, BMC Musculoskelet Disord. 2016 Oct 4;17(1):414). An updated research database includes all patients who underwent surgery up to 2016.

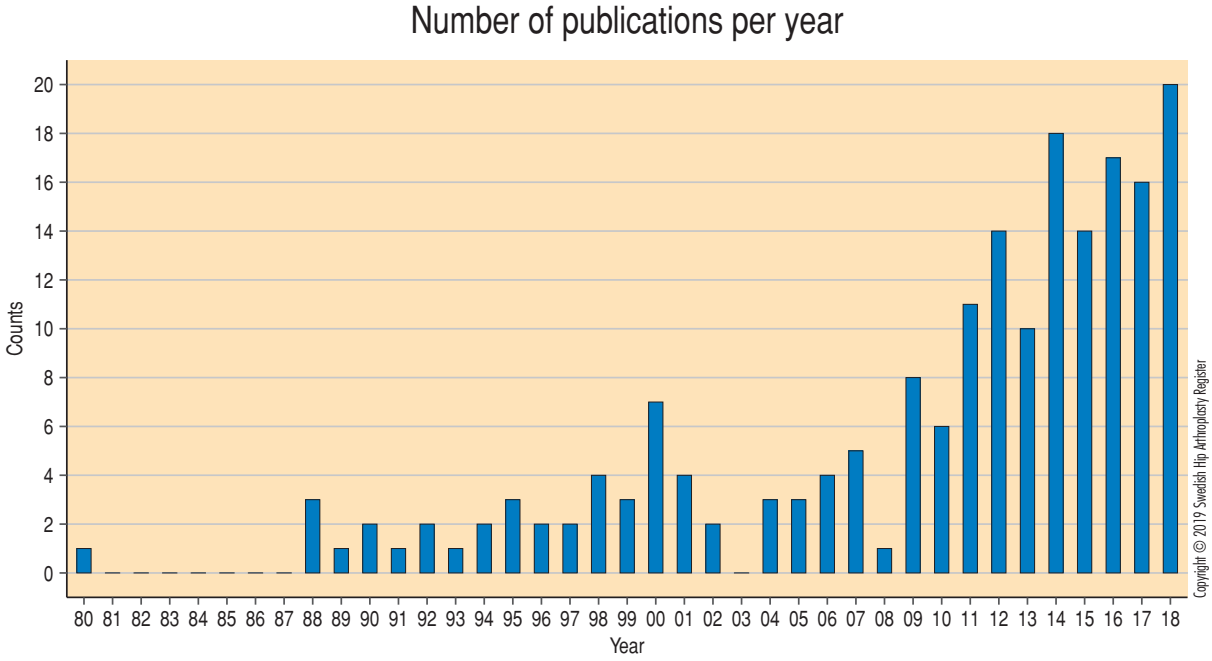
Why is observational research needed?

Register studies and randomised clinical trials (RCT) complement each other. Research within the field of joint arthroplasty requires a long follow-up period and a large number of patients. A number of important outcome parameters (reoperations, implant survival and mortality) represent relatively few incidents. This means that register studies are particularly good in conjunction with research within joint arthroplasty. Register studies have particular advantages that can be highlighted in this context:

- Register studies represent results in practice. This means that the results have a high degree of generalisation. A register study provides a fair picture of how a certain form of treatment functions within routine healthcare in the standard population.
- Regardless of whether one is studying exposure or outcome, a register study, due to its size and long follow-up period, means that it is possible to study events that seldom occur.
- Registration of an individual in a quality register does not require written informed consent. This means that it is easier to compile complete data and that data collection can take place at a low cost.
- The continuous longitudinal collection of data means that it is possible to analyse changes in patient demography, treatment, and results over time.

What is required in order to use register data for research purposes?

All register-based research requires approval from the Ethics Review Committee. All information in the Register is deemed to be in the public domain although it is protected by the Public Access to Information and Secrecy Act. The Register Manager has been delegated by the Västra Götaland Region Central Data Controller to assume responsibility for reviewing confidentiality in conjunction with a data request. We use a special form for data requests which is available for download at the website of Registercentrum. https://registercentrum.se/forskning/



All research projects are documented in the project database and are published on the registry's website. If one wants to discuss research projects, we recommend that the Register Manager be contacted.

The Register Management Team is open for ideas, proposals and discussions about collaboration in new register studies.

All the necessary tools are available on SODA

In order to ensure maximum data security, all data used in research is accessed via a server (a SODA server = Secure On-line Data Access). Using this server, the user has access to a virtual computer by two factor authentication. The virtual computer contains project specific databases, every conceivable statistical software, the Office Suite, and other software.

Research meeting

Since 2012, the registry hosts a two-day residential research programme in January each year. All PhD students, supervisors and other researchers contributing to the registry's work are invited. Both general and specific research questions are discussed in a workshop setting. This year's meeting had around 50 participants and was arranged together with the Swedish Knee Arthroplasty Register, the Swedish Fracture Register and the BOA Register. Invited were also other researchers and PhD students active in the field of the musculoskeletal diseases. All PhD students held short presentations of their projects and received feedback. We also had a mini defence of a thesis where Sebastian Mukka opposed on Martin Magnéli's dissertation.

PhD Defences 2018

2018–11–23 Clinical results after hip fracture – with special focus on hip arthroplasty
Susanne Hansson

2018–05–15 The clinical utility of patient-reported outcome measures in total hip replacement and lumbar spine surgery
Ted Eneqvist

2018–02–23 Longitudinal outcome following total hip replacement. Time trends, sequence of events and study of factors influencing implant survival and mortality
Peter Cnudde

PhD Defences 2019 (up to June)

2019–06–13 International Outcomes of Total Hip Arthroplasty
Elizabeth Walton Paxton

2019–05–16 Adverse events following surgery of the hip
Martin Magnéli

2019–04–12 The Uncemented Cup in Total Hip Arthroplasty: stability, Wear and Osteolysis
Volker Otten

The databases of the registry are also well suited for scientific work during specialist training, degree projects run within the medical programme and other masters" theses. During the past five years, a number of such projects have been conducted and many of them are summarised in the yearly reports.

Many researchers contribute to the registry's work

In the Register Management Team and in the Steering Committee there are senior researchers who are supervisors or co-supervisors for the PhD students linked to the registry. This group conduct a wide range of research in the field. There are current studies dealing with different implants and types of fixation, epidemiology, health economics, equal care, hip fractures and arthroplasty, periprosthetic fractures, revision surgery, statistical methodology and patient reported outcome following an arthroplasty. This group includes:

Johan Kärrholm, Göteborg
Cecilia Rogmark, Malmö
Ola Rolfson, Göteborg
Henrik Malchau, Göteborg
Maziar Mohaddes, Göteborg
Hans Lindahl, Lidköping
Leif Dahlberg, Lund
André Stark, Stockholm
Per Wretenberg, Örebro
Nils Hailer, Uppsala
Rüdiger Weiss, Stockholm
Olof Sköldenberg, Stockholm
Max Gordon, Stockholm
Kjell G Nilsson, Umeå
Arkan Sayed Noor, Umeå
Sebastian Mukka, Umeå
Annette W-Dahl, Lund
Martin Sundberg, Lund
Otto Robertsson, Lund
Harald Brismar, Stockholm
Clas Rehnberg, Stockholm
Viktor Lindgren, Stockholm
Anne Garland, Visby
John Timperley, Exeter, England
Ashley Blom, Bristol, England
Stephen Graves, Adelaide, Australien
Liz Paxton, San Diego, USA
Peter Cnudde, Llanelli, Wales
Anne Lübekke, Geneve, Schweiz
Li Felländer-Tsai, Stockholm
Håkan Hedlund, Visby
Kristina Burström, Stockholm
Volker Otten, Umeå
Susanne Hansson, Malmö
Szilard Nemes, Göteborg

The NARA-group with representatives from the Hip and Knee Arthroplasty Registers in Finland, Norway and Denmark.

PhD students

On the back cover of the annual report, there is a list of the PhD students who, either wholly or in part, base their dissertation work on data from the registry.

International research collaboration

The registry has an intensive research collaboration within NARA (Nordic Arthroplasty Register Association), which is a collaborative register initiative between Finland, Norway, Denmark and Sweden since 2007, where a common database is created every year. The group has now published more than 30 scientific articles and further manuscripts are in progress. The NARA database is also available to Swedish PhD students.

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