The Swedish Hip Arthroplasty Register

Annual Report 2015

FOR YEAR 2015

The Swedish Hip Arthroplasty Register

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Footnote. A number of descriptive tables have been removed from our printed annual report and are published only on our website. Refer to "Tables" at www.shpr.se/sv/Publications/DocumentsReports.aspx

Introduction

The Swedish Hip Arthroplasty Register is a national quality register with the highest level of certification. The Register includes hip replacement surgeries performed in Sweden, either at a public or private unit, and regardless of the condition that led to the surgery. This is the 37th year of operation for the Swedish Hip Arthroplasty Register. This year's cover art illustrates the importance of equality and gender equality during treatment. Regardless of who or where one is, everyone must have the possibility to receive high-quality hip replacement surgery. We have emphasised this meaningful question in this year's report and presented all aspects on pages 13–22.

Another new feature in this year's report is that the clinics' results for patient-reported outcomes are presented graphically on pages 117–135. This way, it is possible to compare the achieved results with the expected result, which is based on the composition of specific patient groups. The national results are also presented graphically. The Register hopes that this may help produce input for better quality in this important issue.

This year's in-depth analyses concern, among others, new prostheses, highly cross-linked polyethylene and dislocation risk in relation to head size. In-depth analyses aim at supporting clinical improvement work, initiation and subsequent publication of scientific reports. The road to scientific publication takes usually many years and may not reach everyone. We hope to make a well-balanced compromise between both reporting systems in order to disseminate the Register's results.

This year's production

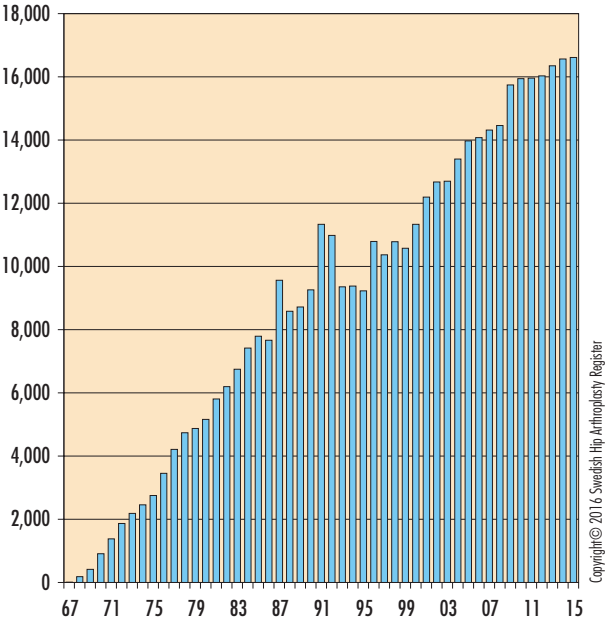
During 2015, the annual production of total hip replacements was identical to 2014. 16,531 operations were carried out, which is 168 per 100,000 inhabitants. The production of hemiarthroplasties remained unchanged as well with approximately 4,200 operations. The number of reported reoperations in 2015, which were carried out after total replacement surgeries, was 2,339.

Elective prosthetic surgery is going through a period of change in Sweden. The annual production of total arthroplasties was carried out at about 80 clinics. Almost a quarter of them are private establishments. A number of larger elective clinics have been created. Now, more than 1/3 of the annual production is carried out at 10 hospitals. The Register follows this structural change in regards to country results and patient-reported outcomes, which is going to be a process lasting several years.

Validation process and publishing

Every year, the Register carries out a comprehensive external and internal validation of data with the aim of continuously improve the data quality of the Register, which takes about four months. Additionally, an annual completeness analysis is conducted via linkage to the Patient Register at the National Board of Health and Welfare (PAR). The data for the year 2015

Primary total hip replacement in Sweden



Number of primary total hip replacement operations, which have been carried out in Sweden from 1967 (6 operations) till 2015 (16 609 operations).

from the National Board of Health and Welfare is delivered to the Register in November 2016, which explains the delay of the definitive annual report. In turn, the delayed delivery is dependent upon some counties/regions failing to report to the PAR on time. This is the second time it has happened during the last 5 years. A significant part of our report is based on the annual linkage with the PAR, namely the completeness analysis and the mapping of adverse events. Due to technical issues, the value compasses are not included in this year's report.

The Register's analyses of its own database for 2015 were finished in June 2016, after the annual validation, and the first version of the annual report was published on our website.

Coverage

All units, public and private, that carry out hip replacements, are included in the Register. The Swedish Hip Arthroplasty Register, thus, has a 100% degree of coverage for hospitals. Coverage for primary hip replacement on an individual basis (completeness), which has been controlled by linking our data with the National Patient Register, was 98.3% for total hip replacement and 97.5% for hemiarthroplasty in 2015. Details regarding coverage are elaborated in a separate chapter.

Patient-reported outcome measures were reported from all Swedish hospitals during 2015. The Register now has a nationwide system to prospectively and longitudinally capture patient-reported outcomes for all patients with total hip replacement. The response

frequency for one-year follow-ups is slightly higher than 90%. In 2015, a total of 40,324 PROM surveys were registered as a part of the on-going follow-up routine.

Reporting and feedback data

Most of the clinics report via a web application. Medical record copies from reoperations are sent to the Register's systematic central data collection, which allows an improved analysis in regards to reoperations and revisions.

All publications, annual reports and scientific reports are presented on our website. The Swedish Hip Arthroplasty Register calls, in cooperation with the Swedish Knee Arthroplasty Register all clinics to an annual user meeting in Arlanda.

Mission of the Swedish Hip Arthroplasty Register

The Swedish Hip Arthroplasty Register is a fusion of two registers: one for surgery with total hip replace-ment with osteoarthritis as the primary indication, and one for surgery with so-called hemi-arthroplasty with hip fracture as the main indication. Patient groups vary considerably: a relatively healthy population with an average age of just under 70, and a group of patients with a mean age of approximately 80, with severe medical comorbidity and short expected survival. However, more and more fracture patients now receive a total hip replacement as the first treatment, therefore fracture patients group is presented in a separate chapter.

National Quality Registers have three main tasks: analyses of institutions and their activities, continuous improvement projects and clinical research. The arthroplasty-related registers have a fourth assignment: implant surveillance ("post market surveillance"). This fourth task is not described as a task of the Swedish Association of Local Authorities and Regions, but paradoxically, it is the task that gains most international recognition. In Sweden, mostly only well-documented prostheses are used. Only a limited number of different types of prosthetics are used for about 95% of all operations. This reflects the Register's ongoing feedback to the profession and provides a continuously improved prosthesis survival rate. In many other countries, about 100–200 different types of prosthetics are used, many of which have been introduced without an extended clinical documentation. In addition to analysing the relationship between reoperation risk and types of implants, the Register's main task, however, is to analyse the entire process surrounding hip replacement surgery – that is, to identify predictors of both, good and poor outcomes in a multidimensional and individual-based manner. The 10-year survival of our most common and well-documented implants is currently over 95%. Today, the potential for improvement exists chiefly within certain patient groups. There is a greater possibility for outcome improvement from a patient perspective through optimizing indications, care processes, pre- and postoperative information, rehabilitation and implementation of non-surgical, early management of patients with osteoarthritis of the hip – in other words, surgery for the right patient at the right time with the right technique!

International cooperation

The Register is a member of two international associations, which concurrently run their databases with the goal of creating common research databases. International cooperation is elaborated in the report.

The Swedish Hip Arthroplasty Register and clinical research

The Register's research activity is more extensive than ever before with 21 (four more are being worked on) doctoral students from 5 universities during 2015. During 2015, the Register has published 22 articles in "peer-reviewed journals". In order to broaden research fields and operational analyses, we have, throughout the year, implemented a number of projects linking hip replacement data with other health data registers at the National Board of Health and Welfare and Statistics Sweden and Statistics Sweden.

Ongoing development projects

We continue our work with multiple-year projects which are all dependent on the future funding:

- Transition to a new portal/system: Stratum. In use by 2017.
- Popular scientific summary of the annual report with patients and decision-makers as a target group.
- Interactive statistics application for participating units. Dependent on the new portal.
- Aggregated decision support for patients and surgeons. Prepared in 2016 and is based on 300,000 operations with long-term follow-up and coordination with the health data register and Statistics Sweden (socio-economic variables).
- Registration of results for individual surgeons.

The future

The investment in the National Quality Register has lasted from 2012 to 2016. The investment was financed by the state (Ministry of Health and Social Affairs) and the county councils/regions. The total amount of investment is 1,540 million kronor. The amount constitutes for 0.7‰ of the estimated total cost for the Swedish health care during the given period. For the Swedish Hip Arthroplasty Register and many other established registers, the investment meant that for the first time they were largely fully financed. The multiple-year contracts have also led to an improved planning work and a peace of mind in regards to the development of the Register.

At present, the future is unclear, but the funding for 2017 has

been reduced by 15%. What happens afterwards depends on a project group whose proposal will be presented March 2017. The Quality Register is proposed to be a part of the future so-called knowledge governance of the Swedish health care. There are also proposals for increasing control and management of the Register via authorities, through county councils and regions. The unique circumstances which stood for the success of the Swedish Register, have been that the initiative and development of the Register work have been carried out by professionals in the field who have also analysed and interpreted the Register results. The profession representatives have openly examined their own and authorities' activity in health care. The Register management emphasises the importance of having this support in the profession also in the future.

Our thanks to all contributors

The Swedish Hip Arthroplasty Register is based on decentralized data capture, which is why the clinics' contact secretary and physician contributions are highly necessary to the Register's function. Many thanks for all contributions during the past year!

The Register management also wants to send a sincere thank you to Göran Garellick who, after serving many years as a register administrator, is now succeeded by Ola Rolfson. With knowledge, enthusiasm and energy, Göran has worked for the Swedish Quality Register in general and the Swedish Hip Arthroplasty Register, in particular, and thus contributed to the fact that the good register work has been recognized both within and outside the country's borders.

Gothenburg in December 2016
The Register's management

PROM programme's data quality

From 2008, the clinics which carry out hip replacement surgeries in Sweden take part in the Register's follow-up routine for patient-reported outcomes. The response rate for the preoperative form, which is naturally meant for elective patients, has been very high. Among osteoarthritis patients, the preoperative response rate has varied between 87 and 89% since 2011. At one-year follow-up, the response frequency for the past years has been between 89 and 92% among osteoarthritis patients. The total loss, if both the preoperative and postoperative responses are included, is around 20%. While the preoperative response rate is fairly stable over time, there has been a slight deterioration of the response rate at one-year follow-up in recent years. It is worrying that the response rate at one year for those who underwent surgery due to osteoarthritis in 2014 is only 83.6%, which, of course, is substantially lower than before. Admittedly, only those are included who registered in the Swedish Hip Arthroplasty Register (SHPR) by 14 April 2016, and from experience, we know that there is some delay with the registration and reminders..

Since the input mode of the PROM database requires that all the questions have answers, all the registered questionnaires are fully completed. Contact Secretaries can supplement incomplete surveys by contacting the patient via telephone or letter. If a response is missing in the incomplete survey, the response may not be registered in the database.

PROM programme's missing responses – number and proportion which are missing from preoperative and one-year postoperative forms 2011–2014

	2011	2012	2013	2014
All operations with a total hip replacement				
Total number of operations	15,954	16,028	16,348	16,564
Deceased within one year	301	344	331	329
Reoperated within one year	222	218	244	245
Included in the routine follow-up within one year	15,431	15,466	15,773	15,990
No preop response	3,374	3,338	3,507	3,669
Proportion of all (%)	21.1	20.8	21.5	22.2
No preop response within one year	1,719	1,886	2,121	3,123
Proportion of those who are included in the follow-up routine (%)	11.1	12.2	13.4	19.5
No preop or postop response within one year	4,397	4,511	4,807	5,672
Proportion of those who are included in the follow-up routine (%)	28.5	29.2	30.5	35.5
All operations with total hip replacement due to primary osteoarthritis				
Total number of operations	13,256	13,336	13,397	13,683
Deceased within one year	112	134	106	96
Reoperated within one year	148	158	171	167
Included in the routine follow-up within one year	12,996	13,044	13,120	13,420
No preop response	1,665	1,624	1,542	1,710
Proportion of all (%)	12.6	12.2	11.5	12.5
No preop response within one year	1,110	1,218	1,408	2,195
Proportion of those who are included in the follow-up routine (%)	8.5	9.3	10.7	16.4
No preop or postop response within one year	2,549	2,644	2,693	3,501
Proportion of those who are included in the follow-up routine (%)	19.6	20.3	20.5	26.1

Degree of coverage

A high degree of coverage is one of the most important factors for a register's data quality and the possibility to carry out operational analyses and clinical research. Coverage should be indicated on an individual level (*completeness*). Coverage concerning participating units is an important variable, but if each participating unit underreports on an individual basis, analyses and feedback will be misleading. All hip arthroplasty-producing units in Sweden have participated for many years by reporting to the Register, so that the primary goal of current analyses is to illuminate completeness.

Method

For many years now, the Register has, every year reported on completeness regarding primary total and hemiarthroplasties at hospital level. The analysis is based on coordination with the National Patient Register at the National Board of Health and Welfare. The method is presented in several consecutive annual reports; for details, refer to the previous reports.

Weaknesses in the analyses:

1. *Laterality*. In most cases, the patient register lacks laterality, i.e. right or left is not indicated as a unique variable. Patients operated with one-stage or two-stage bilateral total hip replacement "are considered" as operations in PAR. In 2015, 475 patients were operated bilaterally (75 in one session), which is why a number of procedures are not covered by the analysis.
   Sweden's PAS-systems lack the laterality variable (right/left), which leads to suboptimal statistical utility of these databases for illnesses involving pared organs.
2. *Lag in registration*. Certain units have a certain amount of lag – not so seldom after New Year, which is a great disadvantage with this type of necessary quality control. Experience has shown that another 0.5% to 1.0% are reported to the Register during the subsequent year.
3. *Administrative fusions of hospitals*. Differences in completeness may consequently have non-medical logistical causes; e.g. that hospitals report to the PAR via 'the principal hospital' and to the Register via the unit where the operation was performed or vice versa. The Swedish Hip Arthroplasty Register has always and will always state hospital affiliation to the hospital/operational environment where the actual intervention is performed.

Results

Total hip replacements. Completeness for the country at large for 2015 was 98.3%. Should the analysis be repeated, the regular lag of 0.5–1.0% would probably mean that over 98–99% of all primary total hip replacements are registered in Sweden. Departments with values less than one standard deviation below the national mean are marked with red in the table. 20 units received this marking regarding the completeness in the register during 2015. The deviations for most of the hospitals are small, but despite the high national average, there is always room for improvement.

Hemiarthroplasties. Hemiarthroplasty registration has been going on for more than 10 years and completeness on a national level is relatively unchanged at (marginal increase) at 97.5%. 12 units were marked red.

Reporting

The completeness analysis does not include secondary interventions. Unfortunately, the reason lies with flaws in recording accurate diagnosis code (ICD-10) and intervention code (KVÅ) at secondary interventions. We have made several attempts, but have found up to 30 different (and often inadequate) intervention codes, which are used for different types of reoperations. Since the Patient Register also lacks laterality in their database, a comprehensive system development is required before a similar coverage analysis of secondary interventions.

The Register works with the following strategy in order to improve the analysis of secondary interventions.

- Monitoring of the hospitals. Refer to the respective chapter.
- A continuous appeal to all operational managers to work locally towards a better code-setting culture in their units.
- Each and every unit should review its routines for reporting reoperations, which is a ***broader concept than revision*** – "any kind of further surgery".
- Actively work towards an obligatory addition to the country's local, regional and national patient administrative systems (PAS).

The Swedish Hip Arthroplasty Register has always and will always state hospital affiliation to the hospital body/operational environment where the intervention in question has been carried out.

Completeness for THRs 2015

Hospital	Number[1)]	SHAR[2)]	PAR[3)]
University/Regional hospitals			
Karolinska/Huddinge	241	98.8	94.7
Karolinska/Solna	191	**97.4**	99.0
Linköping	70	**94.6**	97.3
SU/Mölndal	593	**97.2**	97.4
SUS/Lund	177	**97.3**	97.3
SUS/Malmö	22	100.0	95.5
Umeå	103	**97.2**	97.2
Uppsala	233	98.7	98.3
Örebro	74	98.7	100.0
Central hospitals			
Borås-Skene	283	97.9	96.2
Danderyd	329	**96.5**	98.8
Eksjö	244	98.0	98.4
Eskilstuna	109	99.1	98.2
Falun	254	**97.3**	99.2
Gävle	248	**95.4**	92.7
Halmstad	236	99.2	97.9
Helsingborg	181	**95.3**	97.9
Hässleholm-Kristianstad	804	99.6	99.4
Jönköping	160	98.2	98.8
Kalmar	174	**97.8**	99.4
Karlskrona-Karlshamn	289	98.6	97.6
Karlstad	195	**91.1**	91.6
Lidköping-Skövde	441	98.7	96.2
Norrköping	250	98.8	96.8
Sunderbyn	40	**93.0**	93.0
Sundsvall	84	98.8	98.8
Södersjukhuset	390	98.7	99.2
Uddevalla	373	98.7	98.7
Varberg	187	99.5	98.9
Västerås	375	**97.4**	97.7
Växjö	148	**97.4**	99.3
Östersund	257	**93.8**	**79.2**
Rural hospitals			
Alingsås	197	98.5	96.5
Arvika	192	**96.0**	97.5
Enköping	346	99.7	99.4
Frölunda Specialistsjukhus	83	**97.6**	96.5
Gällivare	93	100.0	98.9
Hudiksvall	137	100.0	99.3
Karlskoga	186	98.4	97.9
Katrineholm	219	98.6	99.1
Kungälv	185	100.0	98.4
Lindesberg	214	100.0	99.5
Ljungby	152	98.1	97.4
Lycksele	334	99.4	99.4
Mora	241	**97.6**	99.6
Norrtälje	128	100.0	100.0
Nyköping	147	99.3	98.6
Oskarshamn	289	99.7	100.0
Piteå	329	99.4	99.7
Skellefteå	126	100.0	100.0
Sollefteå	139	100.0	99.3
Södertälje	119	98.3	97.5
Torsby	118	100.0	95.8
Trelleborg	657	99.8	98.6
Visby	135	99.3	96.3
Värnamo	133	**97.8**	97.8
Västervik	97	99.0	100.0
Ängelholm	130	99.2	**0.8**
Örnsköldsvik	203	99.0	100.0
Private hospitals			
Aleris Specialistvård Bollnäs	306	99.4	96.4
Aleris Specialistvård Motala	579	99.7	99.8
Aleris Specialistvård Nacka	218	98.2	98.2
Aleris Specialistvård Sabbatsberg	24	100.0	**75.0**
Art Clinic Göteborg	25	100.0	**0**
Art clinic Jönköping	20	100.0	**0**
Capio Movement Halmstad	304	100.0	**0**
Capio Ortopediska Huset	472	98.3	**66.7**
Capio S:t Göran	506	**94.1**	97.4
Carlanderska	140	100.0	**0**
Hermelinen Spec.vård	11	100.0	**0**
Ortho Center IFK-klinike	127	100.0	**0**
Ortho Center Stockholm	495	99.6	**57.9**
Sophiahemmet	220	100.0	**0**
Country	16,531	98.3	90.0

Red marking indicates values one standard deviation below national average.

[1)] Refers to the number of registrations in the Swedish Hip Arthroplasty Register.
[2)] Refers to the proportion of registrations in both registers or only in the Swedish Hip Ar-throplasty Register.
[3)] Refers to propotion of registrations in both registers or only in the National Patient Register.

Completeness for hemi-arthroplasties 2015

Hospital	Number[1)]	SHAR[2)]	PAR[3)]
University/Regional hospitals			
Karolinska/Huddinge	71	**92.2**	**92.2**
Karolinska/Solna	66	100	**90.9**
Linköping	92	98.9	96.8
SU/Mölndal	275	97.8	**91.4**
SUS/Lund	184	98.9	94.1
SUS/Malmö	208	99.5	96.7
Umeå	50	100	100
Uppsala	110	99.1	96.4
Örebro	48	100	**91.7**
Central hospitals			
Borås-Skene	86	96.6	93.3
Danderyd	162	96.4	**91.1**
Eksjö	53	96.4	92.7
Eskilstuna	63	100	**90.5**
Falun	147	98.7	92.6
Gävle	64	98.4	**90.7**
Halmstad	66	98.5	95.5
Helsingborg	171	98.9	97.2
Hässleholm-Kristianstad	118	99.2	92.4
Jönköping	44	97.7	95.5
Kalmar	49	100	**89.8**
Karlskrona-Karlshamn	98	**96.1**	**89.2**
Karlstad	87	**93.5**	**87.1**
Lidköping-Skövde	121	**96.1**	96.1
Norrköping	64	100	96.9
Sunderbyn	119	96.8	96
Sundsvall	97	100	**91.8**
Södersjukhuset	237	99.5	97
Uddevalla	201	99.5	95.5
Västerås	21	100	95.2
Växjö	39	**86.6**	97.7
Ystad	27	100	92.6
Östersund	85	98.8	**77.9**

Hospital	Number[1)]	SHAR[2)]	PAR[3)]
Rural hospitals			
Alingsås	41	97.6	**88.1**
Gällivare	33	100	100
Hudiksvall	42	100	97.6
Karlskoga	34	97.1	94.3
Kungälv	57	98.3	**91.4**
Lindesberg	11	100	100
Ljungby	29	96.6	96.6
Lycksele	20	**95.3**	**85.8**
Mora	67	100	98.5
Norrtälje	36	**94.7**	**92.1**
Skellefteå	21	**91.3**	**91.3**
Sollefteå	16	100	**81.3**
Södertälje	35	97.2	97.2
Torsby	34	100	97.1
Visby	14	**93.3**	**86.7**
Värnamo	25	**89.3**	100
Västervik	36	**90**	97.5
Örnsköldsvik	32	100	93.8
Private hospitals			
Aleris Specialistvård Motala	46	100	93.5
Capio S:t Göran	167	**93.8**	97.2
Country	4,200	97.4	93.9

Red marking indicates values one standard deviation below national average.

[1)] Refers to the number of registrations in the Swedish Hip Arthroplasty Register.
[2)] Refers to the proportion of registrations in both registers or only in the Swedish Hip Ar-throplasty Register.
[3)] Refers to the propotion of registrations in both registers or only in the National Patient Register.

Notes

Monitoring –validation process

For a number of years, the Register has annually published the level of completeness, which does not include secondary interventions. Analysing the completeness of primary hip replacements with the aid of the Patient Register (PAR) is relatively easy whereby all primary interventions are encompassed within five intervention codes.

The Register has continued the plan of action intended to capture hidden statistics and validate clinics' registration, and monitoring individual clinics is a part of this plan of action. Such measure is resource-intensive, both economically and in terms of staff, but necessary.

How is monitoring carried out?

The previous annual reports have described the process of monitoring, however, we chose to describe it once again:

The Swedish Hip Arthroplasty Register (SHPR) sends a letter for signature to the director of operations concerning monitoring and a request for access to the clinic's diverse computer systems used by the Register's coordinators when visiting the clinic. This modus operandi has been approved by the Data Inspection Board – in other words, the clinic requests monitoring by the SHPR and not vice versa. "Monitors" from the Register then gains temporary authorization for the local patient administrative and medical records system without violating the Patient Data Act.

- Selection: only the previous year's "settled" productions (the procedures which are included in an Annual Report).
- Aim: to check that all primary operations and reoperations are registered, to ensure correct registration, and to document clinical logistics concerning reporting to the Register.

Upon the return of the signed letter, a requirement specification is sent to the clinic enabling SHPR to acquire a database prior to monitoring. All this is to facilitate our coordinator's visit to the clinic and save the clinic time as well. The database is requested in Excel, must be password-protected, and sent as a special delivery on a CD or memory stick to the Register.

The database should include the following data for patients operated during the year when monitoring was called for (from the operation planning system) for primary total hip arthroplasty and primary partial hip replacement and reoperation following total and hemiarthroplasty and should be sorted according to operation date:

- Personal identification number (preferably 12 digits with a hyphen)
- Operation date
- Diagnosis and the respective ICD-10-code
- Side (if available)
- Operations are to be presented with intervention codes (KVÅ-codes NF* and QD* = searches should be per-formed for all NF* and QD*) (when these codes are used for both classifying of operations on the hip joint, both primary and secondary interventions, refer also to Coding, page 175 in Annual Report 2015).

The following is checked at the visit: A production year is scrutinized in both, the medical journals and local PAS-system or other administrative system checking the following:

- Operation date
- Side
- Diagnosis in the operation report and discharge report with codes according to ICD-10
- Intervention (KVÅ) codes in the operation report
- Eventual reoperations after unreported primary operations
- PROM registration

It is desirable during monitoring that a contact person is available during the visit as well as a contact person capable of performing searches/statistics. During the visit, the Register's staff requires two workplaces with computers, preferably in the same room. Monitoring takes 1–3 days depending on the clinic's annual production. The idea is that the units' staff will not be burdened during monitoring visit, but they are only available for questions and help in the beginning with a short introduction to the computer system.

The Register plans to carry out 6–8 local monitorings annually.

Performed monitorings to date

May 2012	Kungälv's Hospital
June 2012	OrthoCenter IFK clinic in Gothenburg.
November 2012	Central Hospital Växjö
September 2013	Sahlgrenska University Hospital/Mölndal and Sahlgrenska
December 2013	Falun Hospital
January 2014	Lycksele Hospital
January 2014	Norrland's University Hospital in Umeå
April 2014	Södra Älvsborg's Hospital in Borås
April 2014	Södra Älvsborg's Hospital in Skåne
June 2014	Mora Hospital
December 2014	Lidköping's hospital
June 2015	Capio Movement, Halmstad
September 2015	University Hospital in Linköping
October 2015	Nyköping Hospital
November 2015	Visby Hospital
November 2015	Regional Hospital in Sundsvall
December 2015	South Hospital, Stockholm
January 2016	Aleris Specialistvård Nacka
Mars 2016	University Hospital in Örebro
April 2016	Skaraborg Hospital Skövde
May 2016	Skåne University Hospital in Malmö
June 2016	Aleris Orthopaedic Clinic Ängelholm
August 2016	Alingsås Hospital
September 2016	Karolinska University Hospital in Huddinge
September 2016	Central Hospital Karlstad

The results from monitorings to date

Primary total hip replacement and primary hemiarthroplasty: Operations were not reported to SHPR, probably because the patients were relocated to a department outside the unit.

Reoperation after total hip replacement and hemiarthroplasty: A number of reoperations were found, which were not reported to SHPR, partly because the patients were relocated to a unit outside the clinic, but also because it was not known that certain types of reoperations should be registered (for example, wound revision/washing, secondary suture, fracture reconstruction without replacement of prosthesis components, open reposition among others).

Incorrect registration of side: Incorrect registrations were found.

Incorrect registration of operation date: Incorrect registrations were found.

Also, during monitoring incorrect ICD10- and KVÅ-codes were found in medical records system, which had not influenced reporting to SHPR but this may cause trouble during possible cross-referencing between SHPR and the National Board of Health and the Welfare's PAR-register.

In addition, from the review of clinics' reporting procedures it has emerged that some of the contact secretaries have not had access to the clinic's operation planning program, which is necessary to carry out regular checks.

Discussion

The above errors may be considered small but can, in a national aggregation, affect statistical results. It is very surprising to the Register that local, regional and national patient administration systems (PAS) lack laterality. It is, of course, important to know which of the paired organs are operated on or successively reoperated. It is also surprising that a hospital has different PAS-systems that do not communicate with each other; thus, there is a tremendous potential for administrative improvement!

In conclusion, we ask that, with these forthcoming monitorings, contact secretaries and physicians take up the issue of registration logistics at their "clinic meetings".

Validation of data in the local operation programme through interlinking with the Swedish Hip Arthroplasty Register's primary database

Within the framework of a validation project, we have chosen to try and control the data entered in different surgery planning programmes in the Västra Götaland region with the data reported to the Swedish Hip Arthroplasty Register. During the period under comparison (2007–2012), primary total Hip replacements were carried out at ten different public hospitals in the Västra Götaland region, divided between one university hospital, three country hospitals and six rural hospitals. One of the first mappings was carried out on which surgery planning programs are used in respective hospitals and what data could be extracted. This mapping showed that there are five different planning programmes (four computer-based, but also one paper-based system) in the Västra Götaland region. The next step was the collection of operational data from the local surgery planning programs at each hospital, as well as from the Register. The following inclusion criteria were used:

- Operated at one of the public hospitals in the Västra Götaland region
- Operation date between 2007-01-01–2012-12-31
- Diagnosis code (for the underlying joint condition): ICD-10 code M16.0–16.7 and M16.9
- Intervention code for the operation: KVÅ code NFB29, NFB39 and NFB49

The following data was extracted from the surgery planning programs:

- Personal identity number
- Operation date
- Surgeon
- Assistant or assistant surgeon (if the data is registered)
- Operating time (skin-to-skin)
- Time spent in the operating room
- ASA classification[1]
- Diagnosis code (ICD)
- Intervention code (KVÅ)
- Laterality[2]
- At which hospital was the operation carried out (the data is extracted from each hospital)

The following data was extracted from the Register:

- Personal identification number
- Operation date
- ASA classification
- Diagnosis code (ICD)
- Intervention code (KVÅ)
- Laterality
- Which hospital carried out the operation

All surgeries, which are collected from the surgery planning programs, were merged with data taken from the Register. In total, we found 8301 operations. In the collected material, 219 surgeries were missing from the Register. In order to verify and ensure that these 219 operations met our inclusion criteria in respect to the diagnosis code, operation intervention code and the surgery date, letters were sent to every hospital's Contact Secretary, where the primary operation was performed. When these 219 surgeries were compared to the data in the medical journals at each hospital, it showed that 143 of the surgeries were incorrectly registered in the local surgery program. The most common incorrect registration was that the patient had a different diagnosis (ICD-10 code), as opposed to what had been reported in the operation planning program. The remaining 76 operations, which were not found in the Register when the database was created, could be identified manually. This means that all operations (n = 8301) from the local operation programs were reported to the Register, however, the ICD-10 code was incorrectly registered in 1.7% of the cases in the local operation program.

Regarding the remaining 8,158 surgeries, which met our inclusion criteria, a comparison of two different data sources was carried out in regards to the ASA classification, reason code and intervention code (KVÅ). Generally, the data in the Register and the local operation program matched adequately (Table 1).

	Proportion of similar registrations	ICC[3]
ASA	89%	0.90
ICD-10	91%	0.73
KVÅ	95%	0.95

This analysis shows that there is a relatively strong coherence between registrations in the local operation planning programs and the data supplied to the Register. It would be desirable to have a greater accuracy in the registration in the local program, particularly in terms of registering the code of diagnosis. An improved diagnostic composition of local operation programs could pave the way for an automated extraction of data into the Register in the future.

[1] Borås and Skene did not specify the ASA classification in the operation planning program until 2011 when the registration was tightened according to Orbit-manager at Southern Älvsborg Hospital

[2] Laterality is missing in 67.5% of operations in the operation planning program

[3] Intraclass correlation coefficient

Total hip replacement in Sweden

Incidence

Since the Register began its work, the incidences for total hip replacement operations have steadily increased in Sweden. During 2015, 16,609 total hip replacement operations were carried out in Sweden, which corresponds to 329 procedures per 100,000 inhabitants aged 40 and older. In an international comparison of the countries reporting procedure frequency in national quality registers, Sweden has one of the highest incidences. A natural explanation for the increasing incidence is that life expectancy is increasing and that the proportion of older people among the population increases.

Number of people in Sweden with at least one hip prosthesis*

Number per age group	2000	2005	2010	2015
<40	582	766	862	849
40–49	1,459	2,223	3,040	3,427
50–59	6,372	8,499	9,854	11,896
60–69	14,570	22,944	31,559	34,414
70–79	25,564	34,539	44,600	58,618
80–89	18,100	29,292	36,976	43,754
90 +	2,093	4,325	7,350	10,383
Total	68,740	102,588	134,241	163,341
Prevalence per 100,000 >=40	1,571	2,245	2,795	3,238
Women				
<40	359	442	465	443
40–49	762	1,112	1,417	1,602
50–59	3,355	4,373	4,818	5,618
60–69	8,103	12,580	17,040	18,246
70–79	15,514	20,672	26,396	34,059
80–89	12,437	19,884	24,614	28,443
90 +	1,680	3,363	5,569	7,814
Total	42,210	62,426	80,319	96,225
Prevalence per 100,000 >=40	1,844	2,632	3,244	3,724
Men				
<40	223	324	397	406
40–49	697	1,111	1,623	1,825
50–59	3,017	4,126	5,036	6,278
60–69	6,467	10,364	14,519	16,168
70–79	10,050	13,867	18,204	24,559
80–89	5,663	9,408	12,362	15,311
90 +	413	962	1,781	2,569
Total	26,530	40,162	53,922	67,116
Prevalence per 100,000 >=40	1,272	1,828	2,317	2,727

** those operated on after 1991*

Prevalence

We have also studied how prevalence has changed over the years. Since calculation requires information on the possible death date, we have not been able to include those who had surgery before 1992 when registration was not on an individual level. In the analysis, we have therefore included all patients with total hip replacement since 1992. We present partly the prevalence of prosthesis bearers either unilaterally or bilaterally and partly the prevalence of bilateral prosthesis bearers. Prevalence is expressed as the number of prosthesis bearers per 100,000, aged 40 years or older at the end of each year.

At the end of 2015, 163,341 people had had at least one total hip replacement performed after 1991. This implies that 3.2% of the population aged 40 years or older had a total hip replacement, which is an increase of 0.1% compared to the previous year. 41,827 (26%) of these had bilateral prostheses. In 2015, 1.7% of the Swedish population had undergone at least one total hip replacement after 1991. Prevalence was lower for men (2.7%) compared to women (3.7%).

Of those who had undergone surgery on one hip in 1992, 17% were alive at the end of 2015. The later it is studied, the more accurately the figures reflect the "true" prevalence. The number of people who had surgery before 1992 and were still alive in the late 2014 was, if not negligible, relatively low. Since the incidence has steadily increased, prevalence has also increased. As an example, the prevalence per 100,000, aged 40 years or older has increased by 17% between 2010 and 2015.

Number of people in Sweden with bilateral hip prosthesis*

Number per age group	2000	2005	2010	2015
<40	130	169	203	185
40–49	218	388	595	694
50–59	1,038	1,656	1,973	2,725
60–69	2,342	4,823	7,534	8,575
70–79	3,436	6,679	11,049	16,046
80–89	1,804	4,603	7,744	11,411
90 +	133	442	1,205	2,191
Total	9,101	18,760	30,303	41,827
Prevalens per 100,000 >=40	208	411	631	829

** those operated on after 1991*

Country production and geographic inequality

Equality in health care in Sweden is regulated by law (section 2 of the Health Care Act), and the new regime at the Ministry of Health and Social Affairs has emphasized equality in health care as a focus area for the National Quality Registers. Equality is primarily based on the demographic and socio-economic variables. Swedish Hip Arthroplasty Register currently has a strong focus on gender analysis - both in business analysis and clinical research. Main tool for such an analysis is linking different health data sources (the Register, the Patient Register and Statistics Sweden). Such processes are slow because they require an ethics review and are burdened by the extensive resources for the Register. Because of this, there is always a delay regarding such analyses - usually at least two to three years, if the analysis should also include the short-term outcomes after elective and emergency surgery with total hip arthroplasty. The first analysis is planned to be publishe-d in 2017.

Equality, in a broad sense, can also be related to where the patient is living in the country. The 21 county councils/regions have autonomy over their medical care but must follow the act mentioned above. For several years now, we have published the following "Sweden Maps" showing a surprisingly large variation between counties, and the Register management is surprised by the lack of a change.

Procedure frequency and incidence in the country

The total output of total hip arthroplasties in 2015 in Sweden increased marginally in comparison to previous years (16,609, 2015 in comparison to 16,565, 2014 and 16,330, 2013). The incidence remained also unchanged: 169/100,000 inhabitants, 326/100,000 >40 years.

These figures are based on SCB's population statistics from December 31, 2015 (9,851,017 inhabitants). Note that many national and international comparative reports are based on statistics from the National Patient Board (PAR), which since 2000, has had a coverage of 3–6% less than the Register, and it does not register laterality (right and left, respectively!).

Production versus consumption per 100,000 inhabitants per county

Decision-makers are primarily interested in the so-called consumption figures per county - while the professional and the quality registers (particularly the registers that control a surgical intervention) have focused on production figures.

Consumption means the residents of county councils/regions have access to hip arthroplasty regardless of the fact if the procedure is performed in the county council or elsewhere. These figures are important for the management and control but cannot be used for business analysis and clinical improvement, which is the quality registries' mission.

The proliferation of both production and consumption figures per 100 000 inhabitants shows a great variation between principal actors (the private contractors are geographically included); production: 143,247 and consumption 122–245/100,000 inhabitants. The consumption is thus almost doubled between counties with the lowest to the counties/regions with the highest production and consumption.

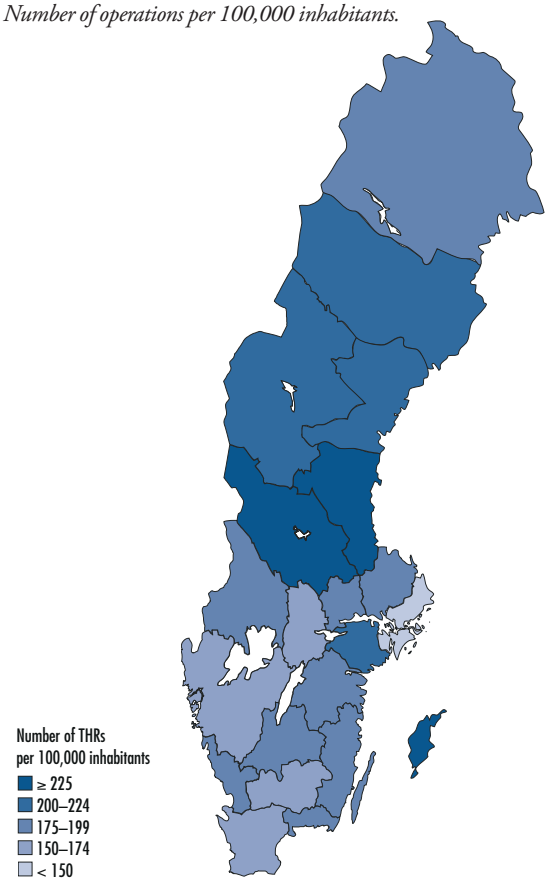
It is more sensible to compare the incidence per 100 000 inhabitants over 40 years of age, but in this analy-sis, the variation is equal: production: 254–438 and consumption 259–434/100,000 inhabitants >40 years.

The reason for this large variation cannot only depend on demographic and/or socio-economic differences. The present situation indicates that we have a geographically expressed unequal health care regarding treatment of the last stage of hip osteoarthritis in Sweden. Unfortunately, the register's management believes that non-medical and local "political" management decisions are one of the many causes to the large variation.

Production

County	Operations	Population	Number[1)]
01 Stockholm	3,343	2,231,439	150
03 Uppsala	585	354,164	165
04 Södermanland	478	283,712	168
05 Östergötland	902	445,661	202
06 Jönköping	557	347,837	160
07 Kronoberg	300	191,369	157
08 Kalmar	560	237,679	236
09 Gotland	136	57,391	237
10 Blekinge	289	156,253	185
12 Region Skåne	1985	1,303,627	152
13 Halland	727	314,784	231
14 Västra Götaland	2467	1,648,682	150
17 Värmland	514	275,904	186
18 Örebro	474	291,012	163
19 Västmanland	377	264,276	143
20 Dalarna	495	281,028	176
21 Gävleborg	696	281,815	247
22 Västernorrland	426	243,897	175
23 Jämtland	261	127,376	205
24 Västerbotten	563	263,378	214
25 Norrbotten	474	249,733	190
Country		9,851,017	169

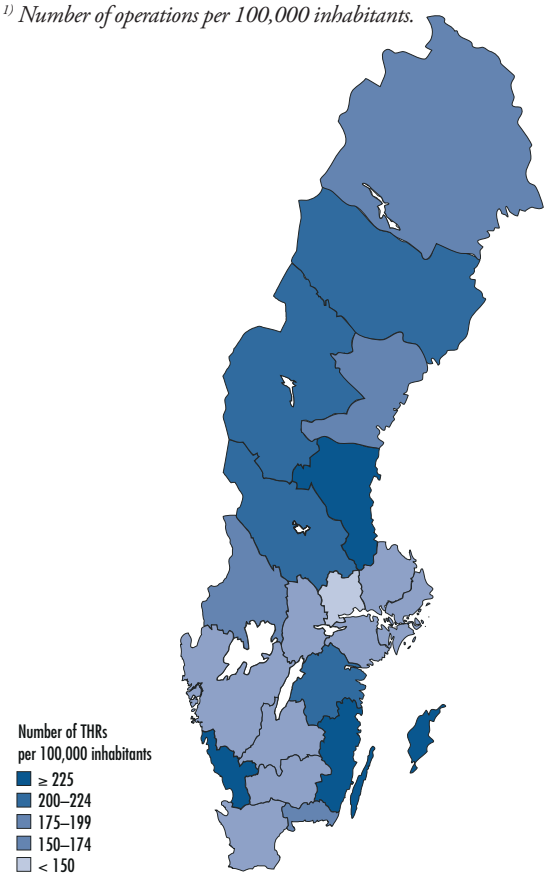
1) Number of operations per 100,000 inhabitants.



Consumption

County	Operations	Population	Number[1)]
01 Stockholm	2,719	2,231,439	122
03 Uppsala	640	354,164	181
04 Södermanland	606	283,712	214
05 Östergötland	792	445,661	178
06 Jönköping	610	347,837	175
07 Kronoberg	321	191,369	168
08 Kalmar	465	237,679	196
09 Gotland	136	5,7391	237
10 Blekinge	288	156,253	184
12 Region Skåne	2,001	1,303,627	153
13 Halland	555	314,784	176
14 Västra Götaland	2,518	1,648,682	153
17 Värmland	539	275,904	195
18 Örebro	453	291,012	156
19 Västmanland	488	264,276	185
20 Dalarna	635	281,028	226
21 Gävleborg	690	281,815	245
22 Västernorrland	533	243,897	219
23 Jämtland	282	127,376	221
24 Västerbotten	555	263,378	211
25 Norrbotten	486	249,733	195
Country		9,851,017	169

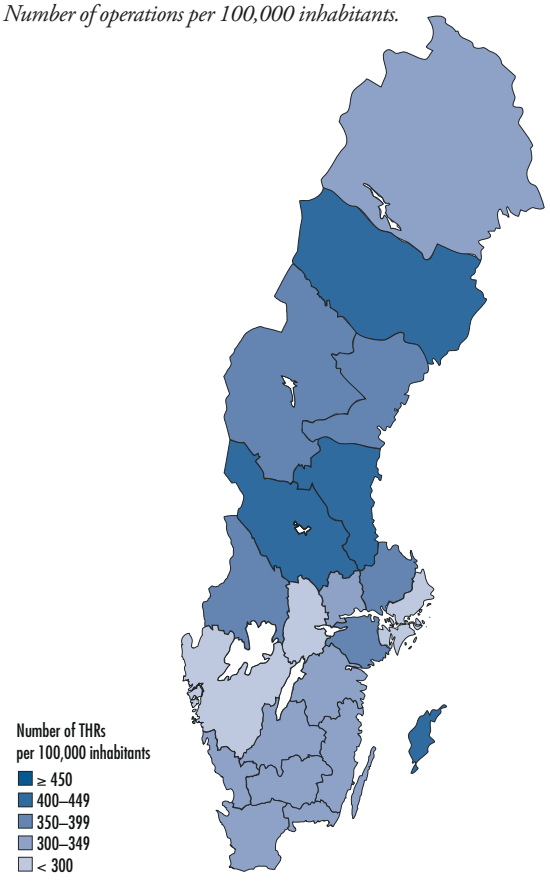
1) Number of operations per 100,000 inhabitants.



Production 40 years and older

County	Operations	Population, 40 years and older	Number[1)]
01 Stockholm	3,293	1,056,938	312
03 Uppsala	573	173,059	331
04 Södermanland	477	152,984	312
05 Östergötland	894	227,928	392
06 Jönköping	553	180,306	307
07 Kronoberg	297	99,076	300
08 Kalmar	557	134,090	415
09 Gotland	135	33,361	405
10 Blekinge	288	85,701	336
12 Region Skåne	1,966	657,620	299
13 Halland	720	168,551	427
14 Västra Götaland	2,438	834,250	292
17 Värmland	514	153,781	334
18 Örebro	473	151,790	312
19 Västmanland	375	140,789	266
20 Dalarna	493	156,716	315
21 Gävleborg	695	156,976	443
22 Västernorrland	425	136,253	312
23 Jämtland	259	70,227	369
24 Västerbotten	553	134,845	410
25 Norrbotten	472	139,659	338
Country		5,044,900	326

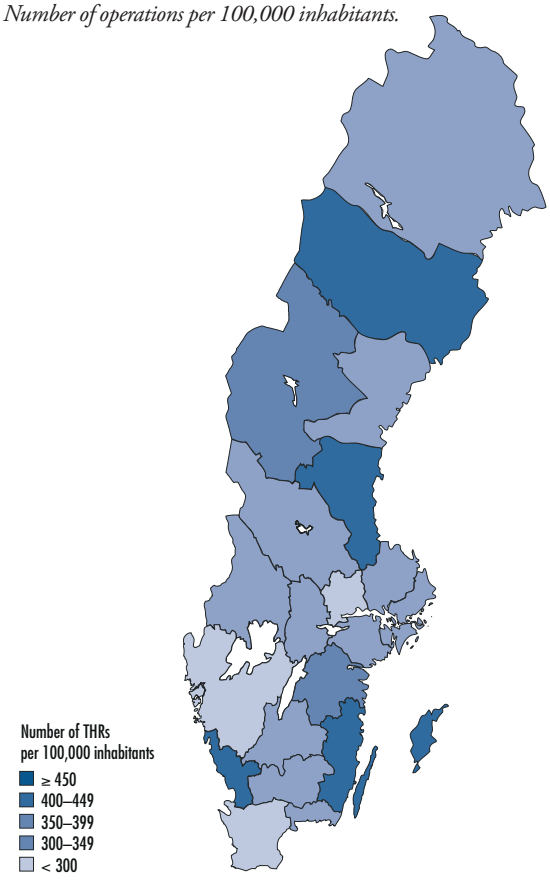
1) Number of operations per 100,000 inhabitants.



Consumption 40 years and older

County	Operations	Population, 40 years and older	Number[1)]
01 Stockholm	2,681	1,056,938	254
03 Uppsala	631	173,059	365
04 Södermanland	600	152,984	392
05 Östergötland	786	227,928	345
06 Jönköping	606	180,306	336
07 Kronoberg	316	99,076	319
08 Kalmar	463	134,090	345
09 Gotland	135	33,361	405
10 Blekinge	287	85,701	335
12 Region Skåne	1,984	657,620	302
13 Halland	550	168,551	326
14 Västra Götaland	2,490	834,250	298
17 Värmland	538	153,781	350
18 Örebro	449	151,790	296
19 Västmanland	486	140,789	345
20 Dalarna	632	156,716	403
21 Gävleborg	687	156,976	438
22 Västernorrland	529	136,253	388
23 Jämtland	277	70,227	394
24 Västerbotten	547	134,845	406
25 Norrbotten	482	139,659	345
Country		5,044,900	326

1) Number of operations per 100,000 inhabitants.



Gender – osteoarthritis patients

In this report, we have chosen to continue graphically describing the difference in the number of operations between men and women, in total and in different age groups. Figures describe the percentage of women who had received a hip replacement compared to men. The figures are adjusted for the difference according to the gender in terms of population. On the one hand, the figures describe the total number of people who had surgery for hip replacement, and the division into different age categories. Overall, the proportion of women is relatively stable at around 60%. In the group, where patients are younger than 50, one can see a tendency towards equalization of the genders over time. In other age groups, the division between the genders is relatively stable over time. With increasing age, the percentage of women rises.

The mean age of men and women at primary operation is described in Figure 7. For men, the mean age from the first three-year period 1995–1997 to 2007–2009 is from 68.1 to 66.9 years. Then it turns and increases to 67.3 years. For women, the turnaround arrives in the last three-year period 2013–2015. The mean age firstly decreases from 70.6 to 69.5 years so as to increase during the last period to 70.0 years. There are small variations but one could speculate that Artrosskola shifts the surgery date. Future annual reports will show whether the trend continues.

If one divides men and women into different age groups (Figure 8), you can see some differences. Relatively speaking, more men are operated in the groups aged <55 years and 55–64 years compared with women. In the group of women, more are operated in the group aged > 75 years, compared with the same group of men. However, the proportion of women in this group has diminished from the first three-year period compared to last (41.2% to 37.2%). In the group aged <55 years, there has been an increase among men from 11.5% to 12.7%, while the proportion of women fell slightly from 8.6% to 8.2%. Overall, the largest percentage increase in both men and women has taken place in the age group of 55–64 years, although there has been a slight decrease in the annual period 2013 to 2015 compared with the previous three-year period. In men, the increase is from 21.1% to 23.7% and for women from 16.6% to 19.8%.

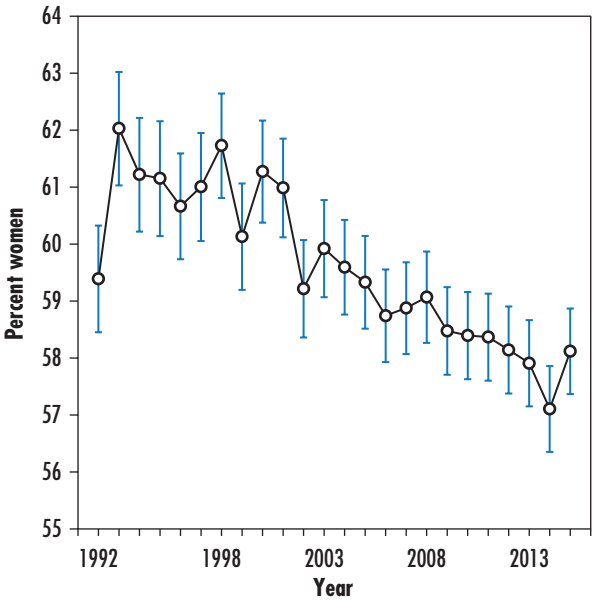


Figure 1. Total number

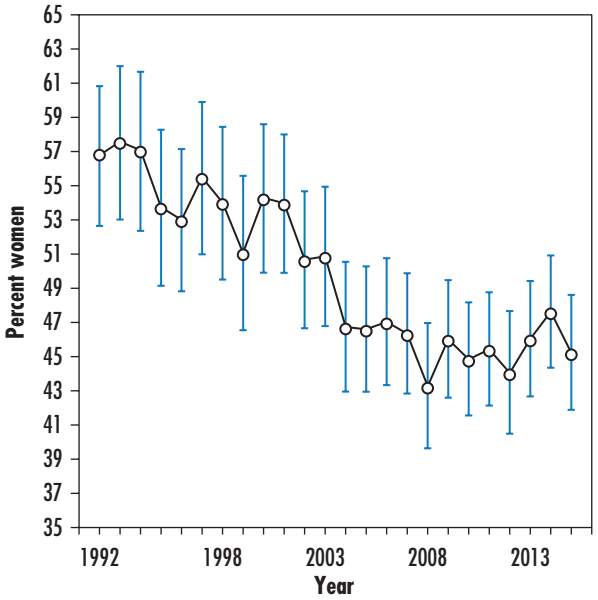


Figure 2. The age group 0–49

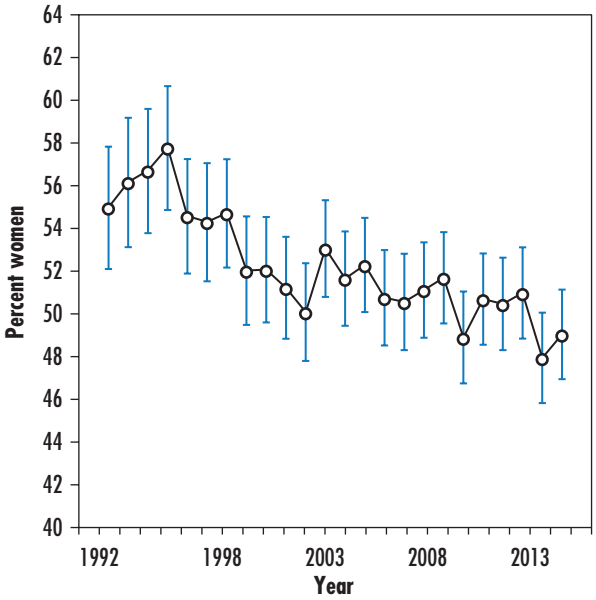


Figure 3. The age group 50–59

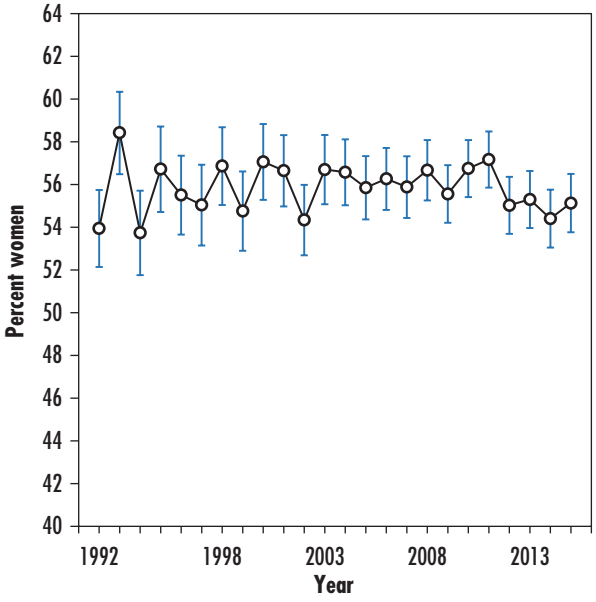


Figure 4. The age group 60–69

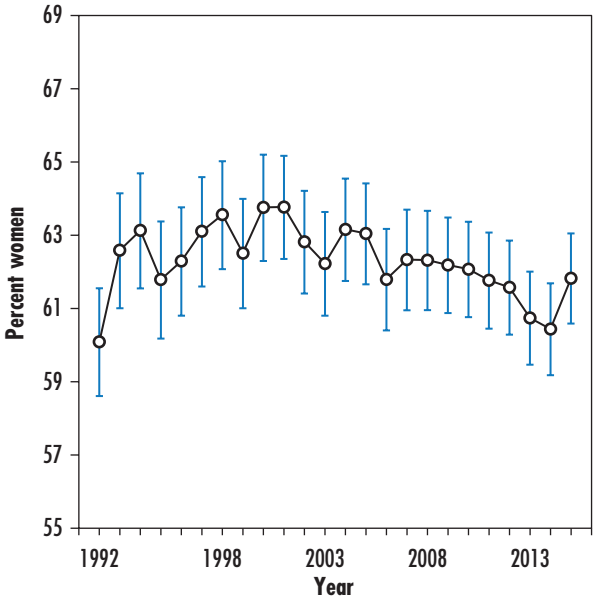


Figure 5. The age group 70–79

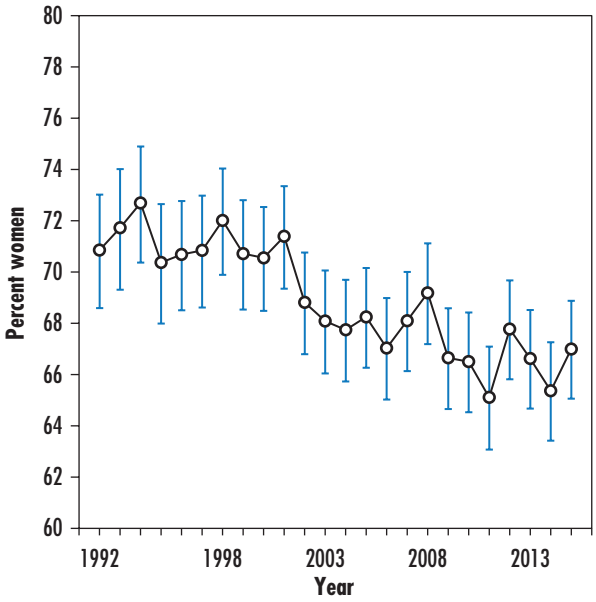


Figure 6. The age group 80–89

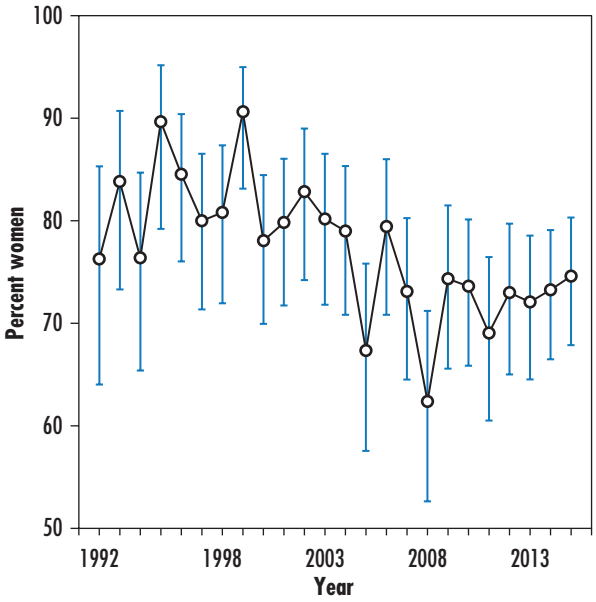


Figure 7. The age group >90

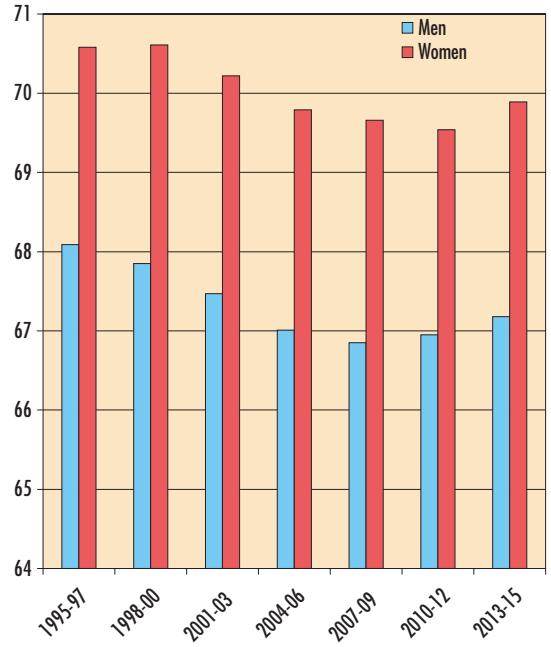


Figure 7. Mean age among men and women during primary operation during 3-year periods 1995–2015. Y-axis starts at 64 years.

The diagnosis distribution differs between men and women (Figure 9). In men, the osteoarthritis disease proportion has increased slightly in the last period, from around 2.5% in first periods to 3.0% in the last period. In women, it has declined continuously, so that in the last three years, it constitutes 1.3%. The explanation lies in the improved treatment methods for these diseases. The proportion of patients with osteoarthritis has, among men, remained relatively stable at around 85% and since, 2004, about 80% among women. The fracture and sequelae trauma group among women has decreased from 15.2% to 12.3%, while that of men rose from 7.4% to 8.5%. Possibly, the increase is due to the use of more total prostheses.

As previously, the most common incisions are posterior in the side position and lateral incision. In recent years, direct lateral incision in the supine or side position are slightly more used among women, while the posterior incision is more often used among men. The difference is that, 3.2% men have surgery with a posterior incision and 2.3% of women undergo surgery with a direct lateral incision. In the subgroup of primary osteoarthritis, the distribution is similar. Probably, the increased risk for dislocation among women plays a certain role in choosing the incision, since the lateral incisions involve a smaller risk for this complication. However, it must be emphasised that the difference is small.

More often, women receive a cemented prosthesis and men an uncemented prosthesis (Figure 11). The fact that women receive a cemented prosthesis more often than men may depend on the fact that the mean age during the operation is higher and that it is assumed that women's bone quality is somewhat worse. It is noteworthy that there is a slight shift in the proportion of cemented and uncemented prosthesis

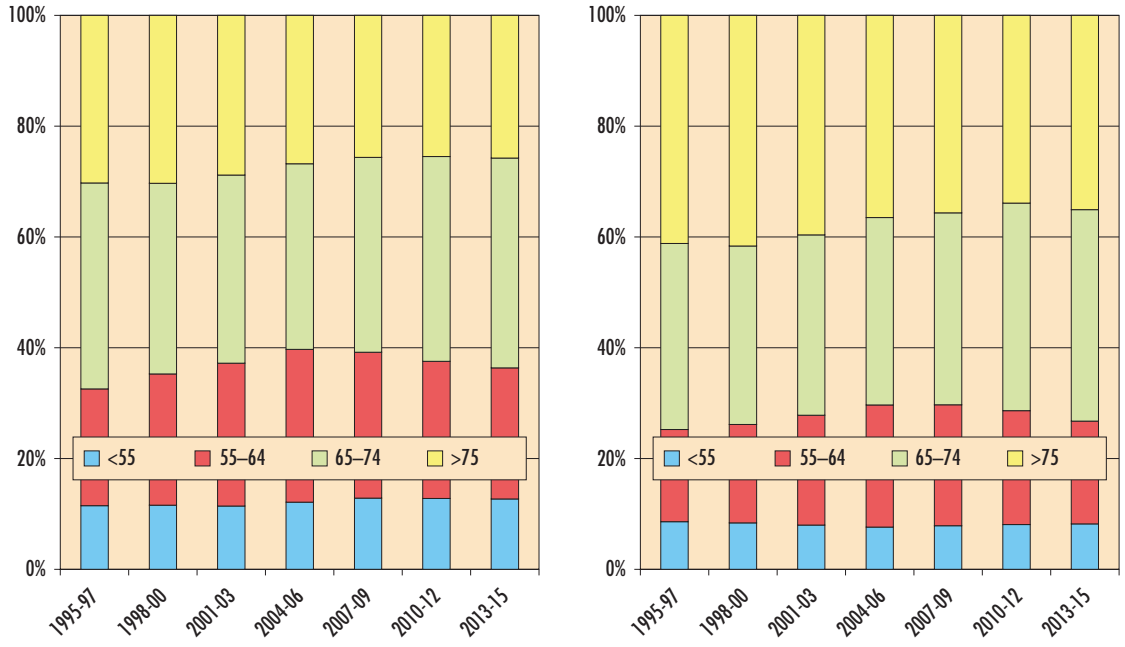


Figure 8. Distribution of male (left) and female (right) into four groups according to age for 3-year periods from 1995 to 2015.

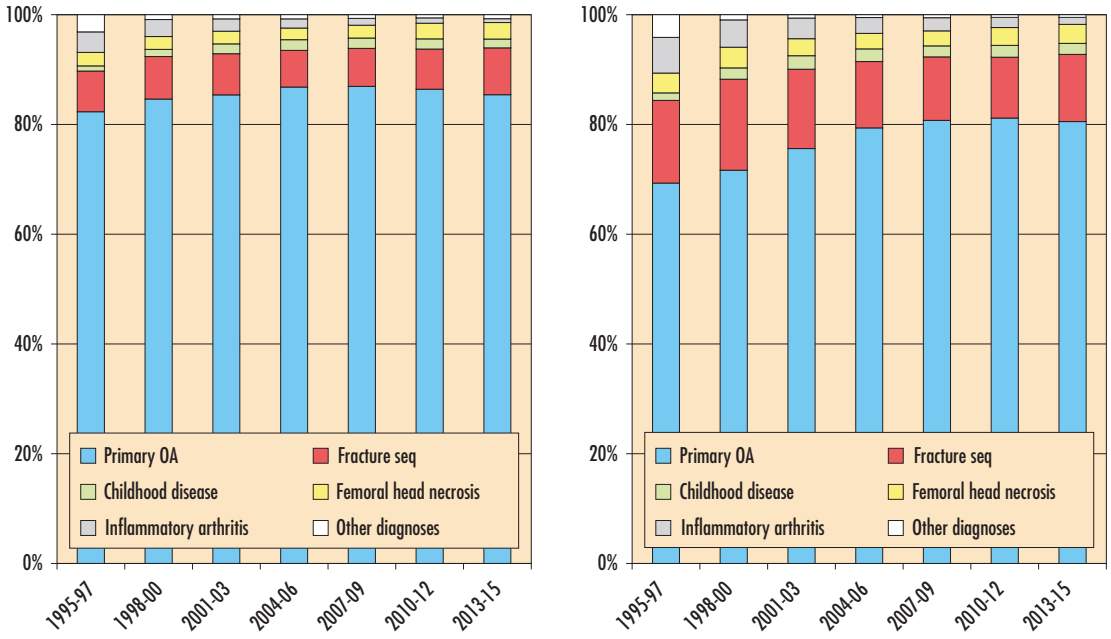


Figure 9. Distribution of diagnoses in men (left) and female (right).

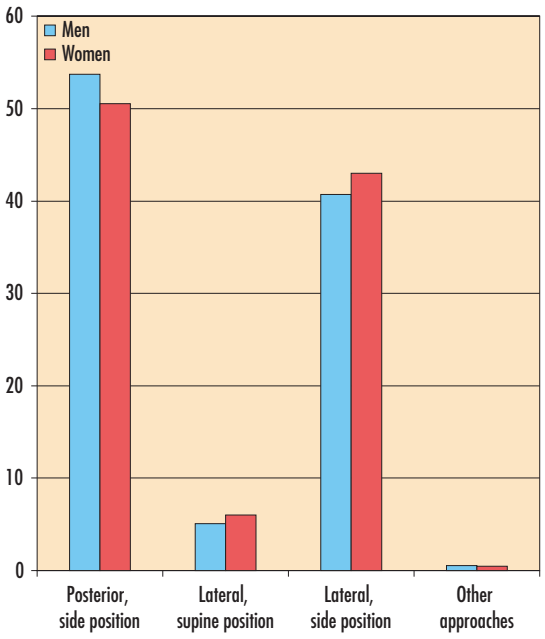


Figure 10. The percentage distribution of incision, men compared to women 2013–2015.

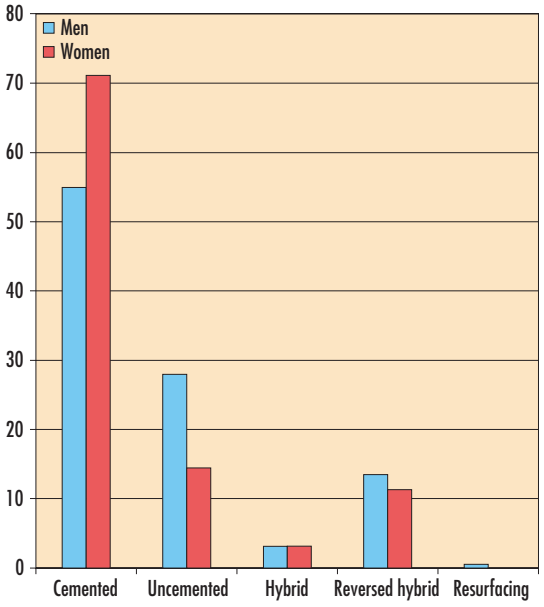


Figure 11. The percentage distribution of types of prostheses, men compared to women 2013–2015.

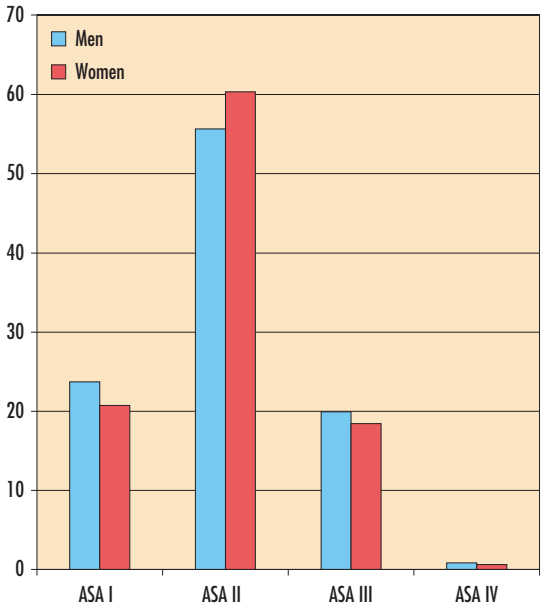


Figure 12. The percentage distribution of the ASA-class men compared with women 2013–2015.

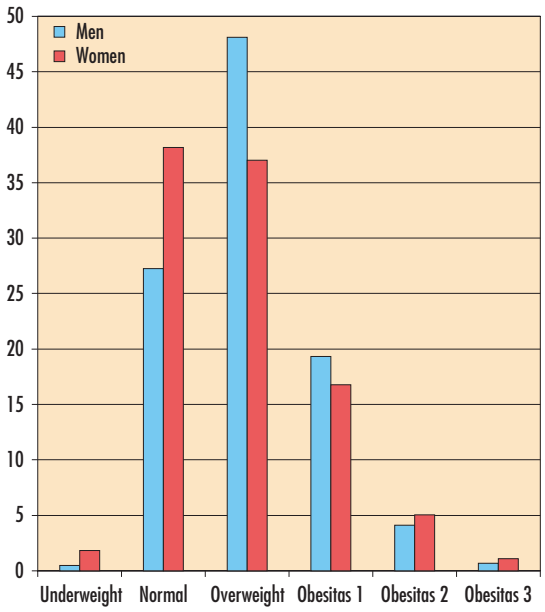


Figure 13. The percentage distribution of BMI, men compared to women 2013–2015. (Under-weight is defined as BMI <18.5, normal weight 18.5–24.9, overweight 25.0–29.9, obesity.1 30.0–34.9, obesity 2 35.0–39.9, obesity 3 >40.)

among both men and women. In comparison to the previous three-year period, the proportion of cemented prosthesis has decreased by 1.7% for men and 1.2% for women. The increase of uncemented prosthesis is 2.9% for men and 1.0% for women. Resurfacing prostheses continue to decline. In 2013–2015, 0.5% (110) were inserted among men, but none among women.

Risk factors are registered in ASA classes (Figure 12). Similarly to the previous period, there are slightly more men than women in ASA class I and slightly more women than men in ASA class II. Generally, the changes are very small in comparison to the previous period. Possibly, the differences may depend on the fact that women have, on average, a higher mean age during operation and therefore, possibly a higher ASA class.

Compared to 2012–2014 there has been a slight change in BMI. Among women, there has been no significant shift. However, among men, there has been a shift so that the proportion of normal weight men has increased by 2.6% and obese by 4.4%. However, the proportion of obesity 1 decreased by 6.9%.

Gender – fracture patients

The mean age for men with hip fracture rises faster than among women; according to our data, from 80 in 2005 to 81 in 2015, while the mean age for women is around 82 years. Since 2005, 116 women over 100 years have been operated on with fracture hip prostheses in comparison to 38 men, which is a small over-representation for men in comparison to the gender distribution among non-fractured peers.

Men have poorer prognosis after a hip fracture than women. The Register shows that 17% of men who had surgery for hip replacement because of hip fracture died within 90 days of the injury. The corresponding figure for women is 10% and applies to 2015. Similarly, to previous years, these numbers stay constant. In the population, an 85-year-old has an average of 5.5 and 6.5 years to live (men and women), respectively, as a hip fracture is both a sign of poor health and a real threat to life.

Men have a higher risk factor for reoperation according to the analyses in chapter "Hip replacement as fracture treatment". The registry includes no data on functional recovery, but the literature shows that men find it more difficult to resume "activities of daily living" (ADL), but achieve the same walking ability and return home just as women. The gender differences may be due to men have a more serious comorbidity at the time of fracture, than women.

Notes

Register development 2015–2016

Background

In the annual report regarding the business year 2013 (published in September, 2014), it was described in the chapter *Vision for the future* a development project for the Hip Arthroplasty Register. All of these development projects are still ongoing, but are now closer to the final implementation. The most imminent are:

- Transition to a new IT platform
- Interactive statistical module for clinic-specific results
- Decision support
- Popular scientific report

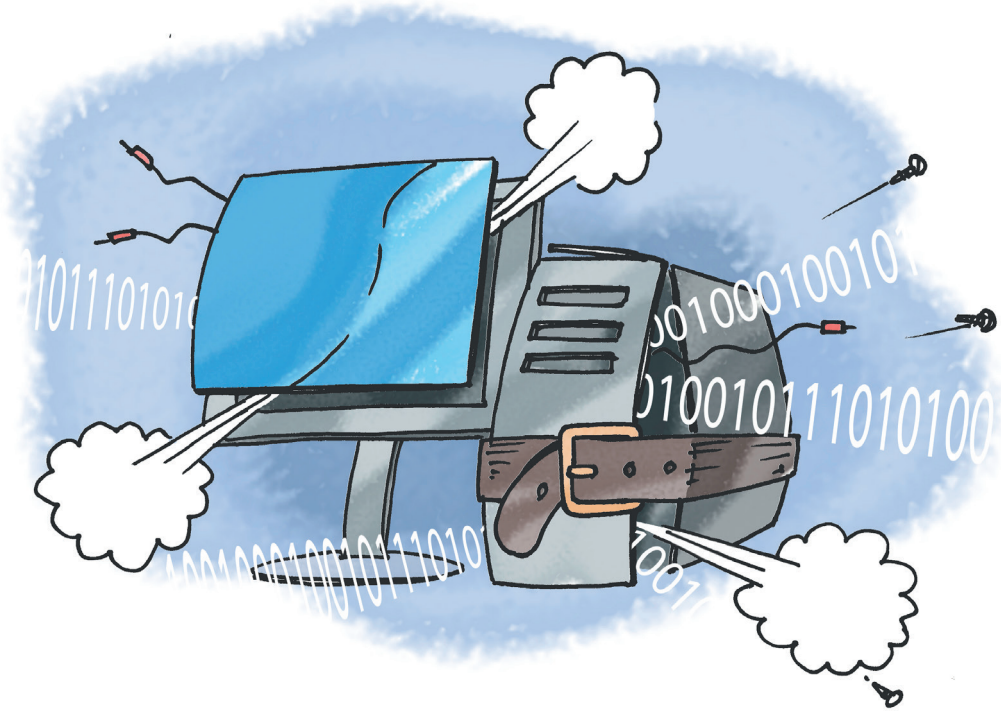
Transition to a new IT platform

The Register Centre in Västra Götaland has a new generic platform (Stratum) for the Quality Register and the Hip Arthroplasty Register has prepared itself to be transferred to this platform during the past three years. The reason it has taken longer than expected lies mainly with the age of the Register! The Register's databases go back to the 1970's and have been handled by a number of database coordinator generations. In order to avoid the loss of older data and to make this available and analysis-friendly, it has taken longer than expected. The process is now close to completion and we introduced a new online-registration system in regards to the decentralised data capture, which is based on the new platform, in the beginning of 2017. The implementation has been prepared by, among other thing, educating the country's contact secretaries. When the register goes over to the Stratum, the website is also going to be redone.

Interactive statistical module for clinic-specific results

Since January 1, 1999, all clinics have, via website and with two-factor authentication, been able to download their own raw data for local analysis. This function has not been used very frequently during the years, which is why the Register is has during the 2015 business year and all through 2016 worked with an interactive statistical module. Through this module, it is possible for clinics to easily analyse their results in detail – both historically and in real-time. The interactivity means that it is possible to choose subgroups, like age categories, diagnoses, sex, ASA class, BMI, type of fixation and selection of prosthesis, to name a few. Outcome parameters that can be observed are patient-reported outcomes, frequency of reoperation, implant survival, 'adverse events', mortality and so on.

The results can be seen as time-lines, but also the current business year as a separate function – it will be called "track mode" ("Koll på läget"). Note that the latter results are invalidated until April of the following fiscal year. One should therefore assess the real-time results with caution. All results of the statistics module will be compared with the national results for the same patient cohort chosen.



Decision support

The Register began with the development of decision support two years ago. According to the Patient Data Act, the Register may not develop an individual-based decision support, which could legally be perceived as a patient record. The Register is therefore developing an aggregate support which will be published openly on our website. The data set to be used is based on matching of approximately 300,000 hip replacement surgeries by Statistics Sweden, and a variety of health data on the National Board of Health (Patient, Pharmaceutical, Cancer and Cause of Death Registry). In addition to traditional variables such as demographics, surgical techniques and selection of implant, the database also contains co-morbidity and socio-economic variables at the individual level. The outcomes will be patient-reported outcomes, risk of complication and revision surgery. Through mathematical algorithms, an interactive module is created, where both, the patient and the attending doctor can fill in the data and then jointly assess expected results and risks associated with any surgical procedure.

At the moment, the Register is waiting for an update of interlinking database and the aim is to publish the decision support in the beginning of 2017.

”Popular scientific” annual report/website for patients and decision-makers

Patients are using Internet more and more. The government and the Swedish Association of Local Authorities and Regions support developing E-health (E-hälsa). The aim of E-health:

… E-health is a common term for efforts, tools and processes aimed at the right people having the right information at the right time and to create benefits for residents, patients, personnel and decision-makers. The initiative is a part of the government's efforts to achieve the objective of the digital agenda – an agenda that aims at Sweden becoming the best in the world at using digitization opportunities… .

Because of this, many registers are planning to publish “popular scientific” texts as summaries on their websites and annual reports. Register's reports have traditionally been written for professionals but the pressure to make the reports more available to the public is increasing rapidly.

During the year, the Hip Arthroplasty Register has started a cooperation with a medical journalist and the development of the report is on-going. The plan is that the report should partly inform about the hip arthroplasty surgery, the Register's analyses and reporting results, and partly about the actual results. As previously mentioned, this year's Register report is significantly delayed due to a problem with the Patient Register at the National Board of Health and Welfare. Since we are planning to also include the actual results in the popular scientific report, this report will also be delayed and hopefully, we can publish it during the end of the year 2016/2017.

The aim of the development projects

The Register management is confident that the previously mentioned projects will increase the daily use of the Register's feedback to the participating clinics, decision-makers and our patients. The projects have taken a long time to develop for several reasons – among others, that they have been very resource intensive in terms of skills of the software developer, statisticians and interlinking logistics and also in regards to finances. Even only the interlinking system with the Statistics Sweden and the National Board of Health has so far cost more than 200 000 kronor. If the system development and journalist's work is included, the total amount is over 1 million kronor. This investment is now being made while the Register's future and the future financing are discussed, and the only thing we know for sure is, that in 2017, we will have a reduction in funds allocated 15–20%. We hope, however, that the bulk of the financing is settled.

Individual surgery results

During the recent years, a discussion has been going on about what should be the optimal or possibly lowest annual operation volume to retain a good quality within operating specialities, both on the hospital and surgeon level. Within hip replacement surgery, there are several studies which show a connection between annual operation volume and outcomes in the form of complications and reoperations. Glassou et al (*Osteoarthritis Cartilage 2016;24(3):419–426*) describe that hospitals which carry out <50 total hip replacements per year have an increased risk for revision within two, five, ten and 15 years after the operation and Singh et al (*Arthritis Rheum 2011;63(8):2531–2539*) report that hospitals which have an annual volume >25 have an increased 30-day frequency of thromboembolic events, and higher one-year mortality compared with hospitals that have an annual volume of > 200 per year.

In 2004, Losina et al (*Arthritis Rheum 2004;50(4):1338–1343*) reported that surgeons who carried out less than 25 or less primary arthroplasties per year, had an increased revision frequency 18 months after the operation in comparison to those who carry out more than a 100 per year, regardless of the hospital volume. In a study by Katz et al (*J Bone Joint Surg (Am) 2001;83(11):1622–1629*), it is possible to see the difference between surgeons who carry out less than 50 primary total arthroplasties per year and those who carry out more than five per year in regards to the dislocation frequency.

For several years, the Swedish Hip Arthroplasty Register has been working on a project, which aims at creating a methodology, which allows individual surgeon to follow his results in a systematic way, and the continuous feedback provides an opportunity to improve the quality of work. Before a feedback system of individual surgery results on the national level will be initiated, a local pilot project in the Västra Götaland region will be carried out.

International feedback models

Systems with feedback about surgeon-specific results are already used in the national registers in England/Wales/North-Ireland, Scotland and Australia, to name a few. In the feedback models used by the English/Welsh/North-Irish arthroplasty register National Joint Registry (NJR), it is possible for the patients to see online, in which hospital is "their" orthopaedic surgeon active and how many primary total hip replacement surgeries and hip revisions this specific surgeon has carried out in the last 12 to 36 months, respectively. It is also possible to see the 90-day mortality rate and which type of patient characteristics "their" orthopaedic surgeon has. Moreover, there is a possibility to compare with the national mean value.

In NJR's feedback model, Consultant Level Report, there are additional facts that the individual surgeon has access to. In this part, the individual surgeon can see a summary of their operations in the last 12 and 36 months, both for primary and revision arthroplasties, in both the hip and knee, and at which hospitals they have performed operations on. In the "hip replacement part" of the individual surgeon, there is a more specific part about the volume, type of operation and type of articulation during the last 36 months. Each surgeon can see their patient profile for a period of 12 months, and this profile contains ASA class, BMI, age and how to relate to a national average.

The follow-up of primary hip replacements includes mortality (for all causes) within 90 days after the operation, and a "case mix" adjustment for age, sex and ASA class. This is shown in a graphic that describes the relation between the expected number based on surgical volume and the national average (Figure 1).

The feedback also presents a list of all the revisions which are listed according to their actual names, showing the date of the revision, the cause of the revision, type of implant for primary surgery, patient age and ASA class at primary operation. The time lapse between the primary operation and the revision, and the revision frequency after one, three and five years, is shown for the individual surgeon compared to a national average (the data is not "case-mix" adjusted).

There is also an alternative presentation of the individual surgeon's performance in relation to other operators. Funnel plots are used to illustrate this (Figure 2).

In the Scottish feedback system makes use of a different statistical model called CUSUM, where the individual surgeon will be notified when he / she breaks through a predetermined statistical tolerance limit of acceptable complication rates (Figure 3).

Easily identifiable results, like death, dislocation, wound infection and revision, but also medical complications, such as heart attack, kidney failure and stroke, are followed. The

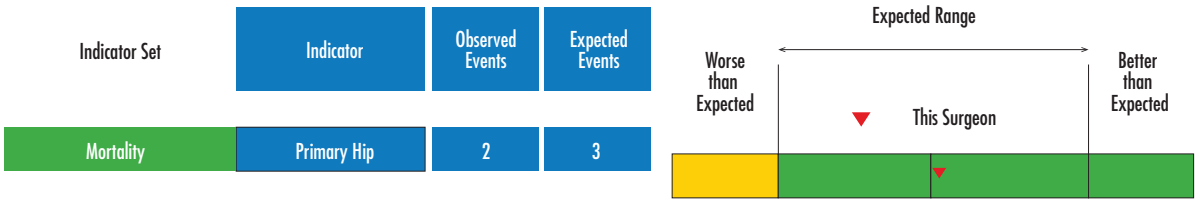


Figure 1. Example of feedback of mortality from Consultant Level Report. Published with permission of the surgeon.

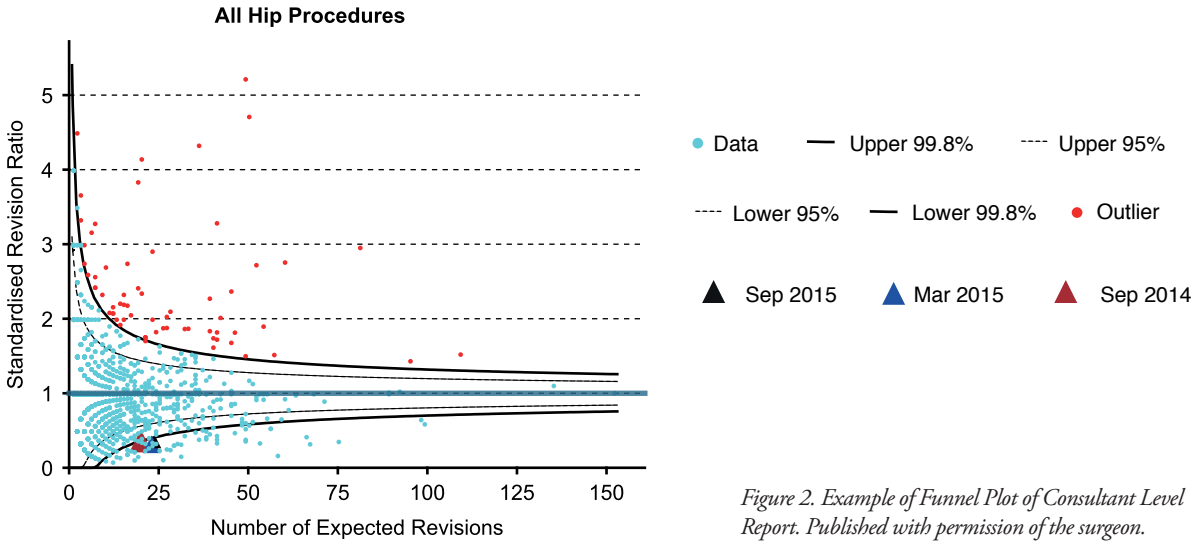


Figure 2. Example of Funnel Plot of Consultant Level Report. Published with permission of the surgeon.

Scottish arthroplasty register, Scottish Arthroplasty Project, has access to only routine data, so the "case mix" adjustment takes into account sex, age, osteoarthritis and rheumatoid arthritis (*J Bone Joint Surg (Am) 2011; 93 Suppl 3 : 81–88*). If the individual surgeon passes the predetermined statistical tolerance limit, he/she is notified by a steering committee and will review their own operations to return an "Action Plan". Once this review is completed and the answer is approved, the individual surgeon CUSUM data is reset.

The future Swedish feedback model

Before the pilot project in the Västra Götaland region is carried out, the "normal complication rates" and the factors which may affect the result on the surgery level, are mapped out. In order to examine what "normal complication levels" are, a retrospective register study for the period 2007–2012 is carried out to map out the complications 90 days after the surgery and reoperations within two years after the patients have been operated on for primary total arthroplasty (KVÅ code NFB29, 39 and 49) and with operation indication ICD-10 codes M16.0–M16.7 ad M16.9 at one of Västra Götaland region's hospitals.

In the same patient cohort, we will analyse whether there is any difference in patient-reported outcomes one year after surgery, between the surgery volumes per operator, but also if surgeon's experience based on years of specialist evidence in orthopaedics is associated with better patient-reported outcomes one year after surgery.

How the future of the feedback for the individual surgery results for the individual surgeon will look like and what statistical methods Swedish Hip Arthroplasty Register will use, will become clear after we carry out a more detailed study in which we intend to use the results from the two studies mentioned above.

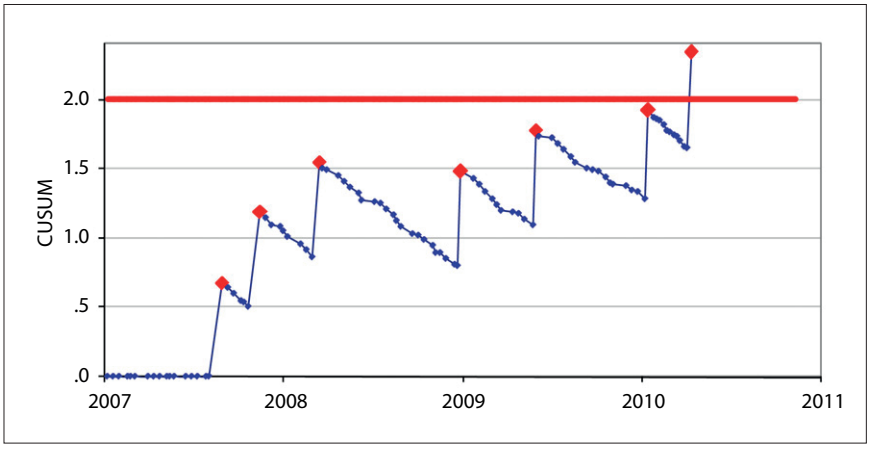


Figure 3. Example of CUSUM-charts from the "Outlier Analysis in Orthopaedics: Use of CUSUM: the Scottish Arthroplasty Project: shouldering the burden of improvement".

Structured care process for elective hip replacement surgery – what is it like in Sweden?

In recent years, in many hospitals in Sweden, changes have been introduced in the care processes for scheduled joint prostheses surgeries in the hip and knee. One area of focus has been to improve the parts of the process which contribute to early mobilization and fast recovery, which is rooted in the concept of "fast-track surgery". The idea behind Fast-track is that the care process and the surgery should be as gentle as possible for the patient both psychologically and physiologically, so that mobilization can begin as soon as possible after surgery. Thus, the hospital stay is shortened without compromising on quality and patient safety. How do these changes affect the outcome in the form of reoperations, other complications, and patient satisfaction is not known in the Swedish experience. Nor do we know which factors matter most.

In an ongoing research cooperation between the Hip and Knee Arthroplasty Registries, a mapping survey has been made about the care processes during scheduled joint prosthesis surgeries in Swedish orthopaedic clinics. In the end of 2014, a questionnaire was sent out with a reminder in the beginning of 2015, and the responses describe the historical design of care processes from 2011 until the time the responses were sent in, several times during the first half of 2015. The questionnaire contained questions about procedures pre-, peri- and postoperatively, and when these procedures had been carried out. The focus has been directed towards the introduction of, which in a few simple criteria can be described as, Fast-track.

Of the Swedish units, which carry out planned hip replacement surgeries, 64 have answered. These represent 91% of the 2014 production. All clinics have used structured information, both in writing and orally, usually in conjunction with a preoperative admission visit. However, there were fewer than 10% who had information in several languages, or used informative film at the time of the questionnaire responses.

During the past five years, the concept of Fast-track has been introduced in more and more clinics.

Number of clinics reporting that they implemented programs with Fast-track

Year	Yes	No
2010	15	49
2011	19	45
2012	27	37
2013	35	29
2014	45	19

Although Fast-Track is an established concept, the definition is not clear. Short hospital stay is included in the concept but a clear limit has not been specified. Some responses of the questionnaire may illustrate that the application of the concept can vary in Swedish hospitals.

Question	Yes	No
Has Fast-track concept been introduced in the clinic?	45	19
The patient is admitted in the morning of the surgery?	53	11
Mobility begins within 6 hours of the surgery?	35	29
There are functional release criteria?	51	13

The survey will be used for studies in regards to the impact of the care process on the complications in the form of adverse events within 90 days, reoperations within two years and patient satisfaction in the form of PROM data after one year.

International perspective on the Register's work

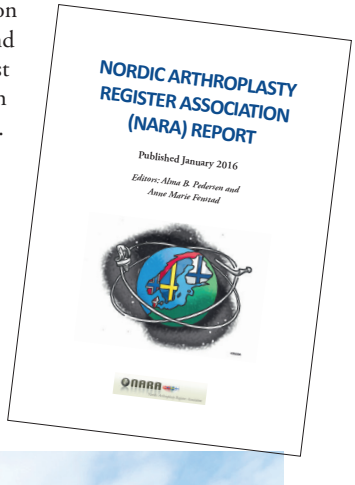
The Swedish Hip Arthroplasty Register has continued its close cooperation with International Society of Arthroplasty Registries (ISAR) for another year. The annual meeting in 2016 was held in Wrightington and Manchester, a country with a history of orthopaedics and considering the ground-breaking work by Sir John Chanely in regards to the concept of "Low Friction Arthroplasty". The meeting was led by Martin Porter with support from both local contributors and also, as previously, from our eminent register coordinators Kajsa Erikson, Karin Lindborg, Karin Davidsson and Karin Pettersson.

All meeting details can be found on ISAR's website (www.isarhome.org). The next meeting will take place in San Francisco 20–22 May 2017 under the leadership of Liz Paxton. Liz is the manager and responsible for all implant registers in the health care organization Kaiser Permanente. She has also recently been admitted as a graduate student at the University of Gothenburg. ISAR's work continues to focus on global harmonization of data and implementation of a global implant database. The first project of ISAR, using data from several registers (Australia, Denmark, England-Wales, Finland, New Zealand, Norway and Sweden), proceeds with planned publications in autumn 2016.

NARA cooperation yields have continued to be a great success under Keijo Mäkelä's fine leadership. 19 publications have been published and there are many interesting projects. More information is available at www.nordicarthroplasty.org.

With the support of EFORT, in 2015, NORE, "Network of Orthopaedic Registries of Europe", was established. NORE has the goal of creating a registry network that is wider than ISAR as it includes all European records with orthopaedic connection. Since NORE, with a so-called "standing committee", is integrated in EFORT, it can use EFORT platform for training, quality assurance and research using register data. NORE has thus great potential but it also faces major challenges. It will be exciting to follow the development of this initiative.

In 2015, through a focused effort with Ola Rolfson in a pivotal role, ICHOM (International Consortium of Health Outcome Measurement) presented a "Standard Set for Hip & Knee Osteoarthritis". This is a recommendation on which outcome measures and background variables are most important for patients with hip and knee osteoarthritis. For further information see http://www.ichom.org/medical-conditions/hip-knee-osteoarthritis.



Participants in front of the main building in Wrightington

Difference in cup/liner and head size

The individual prosthetic component, which are implanted during hip arthroplasty, are identified by a specific number. From the beginning cup, any liner, femoral head and stem (or its proximal and distal parts if modular), are assigned unique numbers. These unique numbers can be linked to a component database with two variables, the product name and number. In recent years, the Swedish Hip Arthroplasty Register has developed component databases, so that specific properties, such as material quality and size can identified for each specific operation and the components used. This work has made it possible that we can now present the plastic quality, choice of articulation and analysis about how, for example, the stem size affects the outcome of specific prosthetic's design. There is an ongoing international cooperation within the International Society of Arthroplasty Registries to create a similar database covering the majority of the implants which are used worldwide. Once the database is complete, we will evaluate whether it can be applied to our records, and if it adds any additional value.

Specific registration of individual components began in 1999 and has become increasingly better, after initial shortcomings were faced in regards to the cup or liner's internal diameter. Specific registration of implant size brings new opportunities for quality improvement. Insertion of a femoral head, while its diameter does not conform to the cup or liner internal diameter, is described (*Barrack and co-author, J Bone Joint Surg (Br) 1993; 75 (5): 688–692*), and has also been discussed in the context registers.

In 2015, we decided to analyse this complication, with the intention to chart its prevalence, alert processing clinic and to get an idea of the frequency of misreporting.

From 1999 to 2014, the proportion of operations increased, with reported detailed data including both, the cup / liner's internal diameter and femoral head's outer diameter from 72 to over 99%. Since the majority of producers could not deliver information about the inner diameter of resurfacing cups, these implants were excluded; in 2010's, they accounted for slightly more than 1% of total production.

For 544 of the 209,275 operations (0.26%) with complete data, the internal diameter of the cup or the liner was not the same as recorded for the outer diameter of the femoral head. Details of these operations were sent to the 73 affected units. Replies were received from all but three cases from one clinic.

The most common reason for the femoral head size not matching the liner or cup's inner diameter in the database, was incorrect registration at each clinic (0.19% of all operations), followed by errors in the code lists from supplier (0.06%). In 11 cases, each clinic could verify that faulty components were inserted (0.005%). In two of these cases, the patient had been revised for this reason. In some cases, too small femoral heads had been used, because the correct size was not available. In 14 cases, it was not possible to find labels from the operation, nor determine the sizes from surgery report. If these 14 cases are added to the three, for which we have not received a response, and to the 11 with verified faulty components, and suppose that all 28 received the faulty components, the proportion of operations with faulty components is 0.013%. We have thus found that the insertion of the cup / liner and femoral head with different diameters occurred safely at one per 20,000 completed primary hip arthroplasties during the period 1999 to 2014, and at worst, at just over one per 10,000 cases.

A different inner and outer diameter of the cup and femoral head is a rare combination. It occurs in fewer than one case among 10,000 hip replacements in Sweden. Are we aware of the problem and have good enough practices so this does not happen? Entering the bar codes in the operating room could probably bring about safer registration of implants. In two cases per 1000, the entry was incorrect and has now corrected.

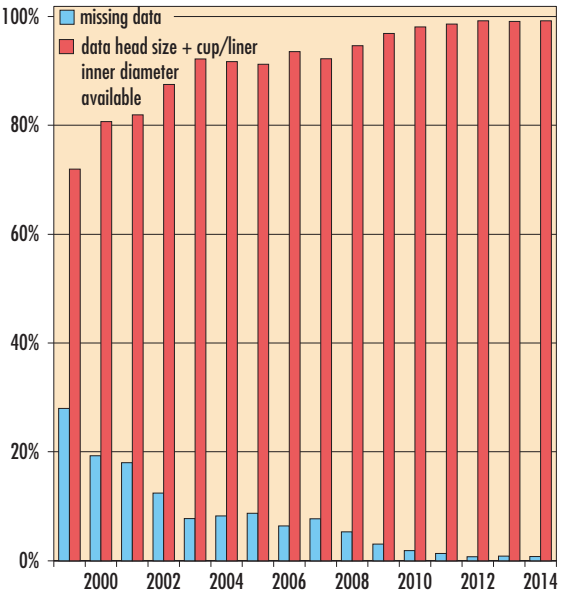


Figure 1. The proportion of hip replacements where complete cup or liner inner diameter and femoral head outer diameter data was reported to the Swedish Hip Arthroplasty Register. Data from 2015 is missing because the survey began this year.

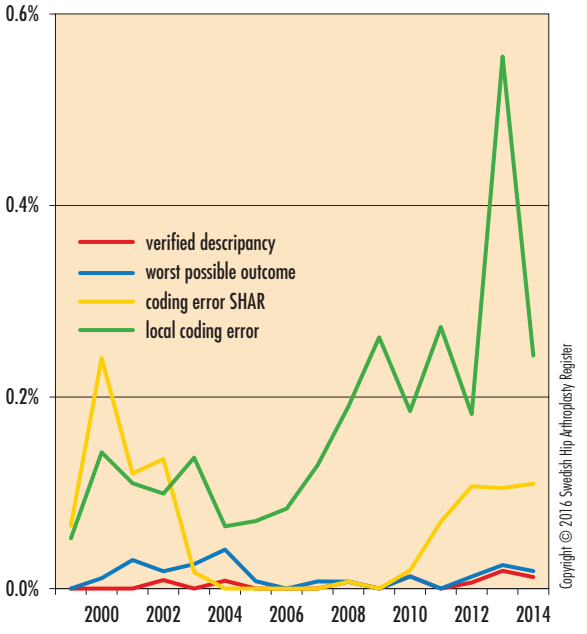


Figure 2. The distribution of verified discrepancy between the inner diameter of the inserted cup/liner and the outer diameter of the femoral head, the worst possible outcome (all missing observations have been accounted as verified mistakes) and the various causes of faulty component registration.

Primary total hip replacement

The Hip Arthroplasty Register continues to develop a new database structure. The reporting of the data will be changed while the new database simplifies data processing. Furthermore, real-time reports can be generated at each clinic. Our plan is that the new database will be implemented in early 2017. 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. Kaplan-Meier statistic, which is used in the annual report, describes the proportion of patients, which after a certain number of years, has not been affected by reoperation. Data is presented in proportions, including a 95% confidence interval (C.I.). Regression data is presented as risk ratio (relative risk). Risk ratio describes the degree of increased or decreased risk 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 risk is doubled for the group in question. An increased or decreased risk should be related with the outcome in the reference group. The clinical meaning of a doubled risk has an entirely different significance, if in one case, the reference group is revised by one of 1000 patients after 10 years whiles in another case 100 of a 1000 patients in the reference group have been revised after 10 years. A doubling in the first case indicates that two hips are expected to suffer a revision in the study group. In the second case, revision in the study group occurs in 200 patients. Risk ratio is shortened to RR and indicated in this report with one decimal and 95% confidence interval (C.I.). The further away the confidence intervals upper and lower limits are from 1.0, the safer it is to say, that it differs from the comparison group.

Demographics

Since 1993, the number of registered primary prostheses has, more or less, continuously increased from 8,989 to 16,609 in 2015. Last year, there has been only a modest increase. The number for men has since 1995 more or less continuously increased until 2014. In 2015, the number of men decreased to 41.9%, which constitutes a decrease of 1.0% in comparison to the previous year (Figure 1).

In 2015, the average age for men was 67.1 and 70.0 for women. From 2000 until 2010–2011, average age decreased for both sex. Afterwards the mean age has stayed relatively unchanged among men, while there has been a smaller rise in the mean age among women. Between 2014 and 2015, the mean age fell slightly for men (from 67.2 to 67.1) and increased somewhat for women (from 69.9 to 70.0). The same trend is noticeable even if fracture diagnosis is excluded (Figure 2). By creating age groups where fracture diagnosis is excluded (Figure 3), it is evident that the three younger age groups' relative proportion increased during 2000 to 2010. Since 2011, the number of patients who are 70 or older has increased slightly.

The mean age during hip replacement surgery continuous to fall slowly for men. Furthermore, the number of patients who are older than 70 has increased slightly over the last 10 years.

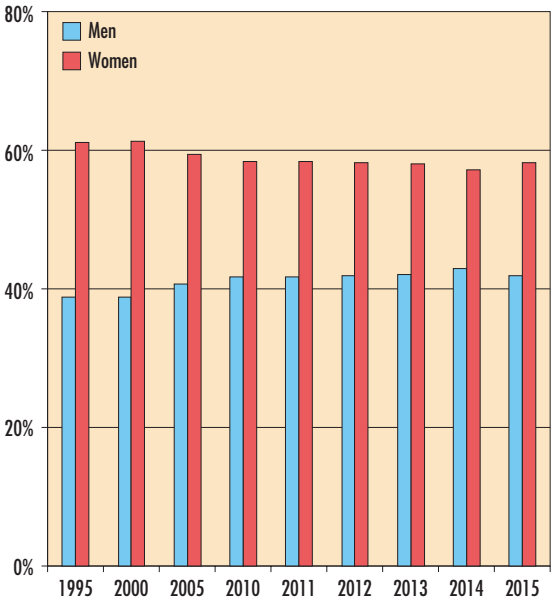


Figure 1. Proportion of men and women among patients who were operated for a total hip arthroplasty.

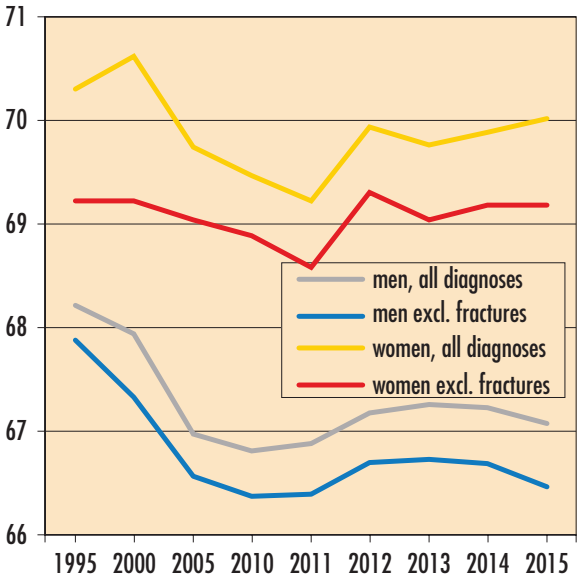


Figure 2. Mean age for men and women at primary hip surgery. The mean age has continued to decline between 2014 and 2015 when patients who underwent operation due to fracture are excluded.

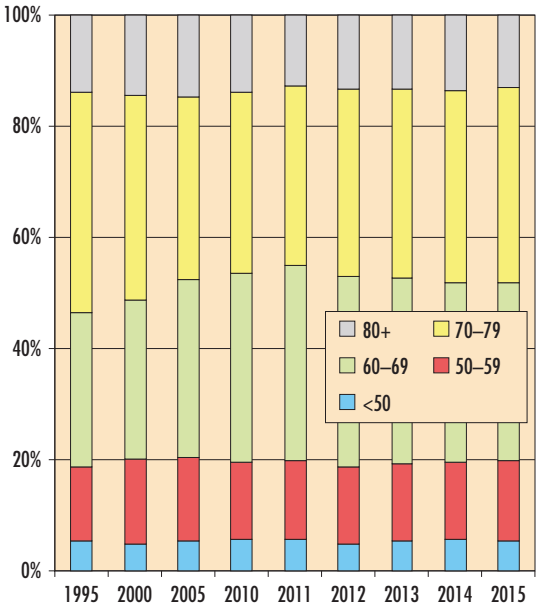


Figure 3. Grouped age distribution. Since 1995, the proportion in the age group of 60–69 years increases while the relative proportion of those over 70 decreases.

Diagnosis

The most common reason for total hip replacement is primary osteoarthritis (Figure 4). Between 1995 and 2010, the proportion of patients operated due to primary osteoarthritis increased from 83 to 87% among men and from 68 to 82% among women (Figure 4). Subsequently, the proportion of primary osteoarthritis has been relatively constant. 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 substantially reduced since 1995 and in 2015, 1% was operated due to this diagnosis. Figure 5 illustrates the age distribution for the most common diagnosis groups. In general, the mean age at surgery is higher among women than in men. The only exception is the group with osteoarthritis due to congentinal hip disease (childhood sequelae), where the mean age for both men and women is relatively similar.

The proportion of patients, who undergo surgery due to primary osteoarthritis, continues to increase. This increase is most likely realistic, but may, to a small extent, also display the declining resources and interest for recording the most accurate diagnosis.

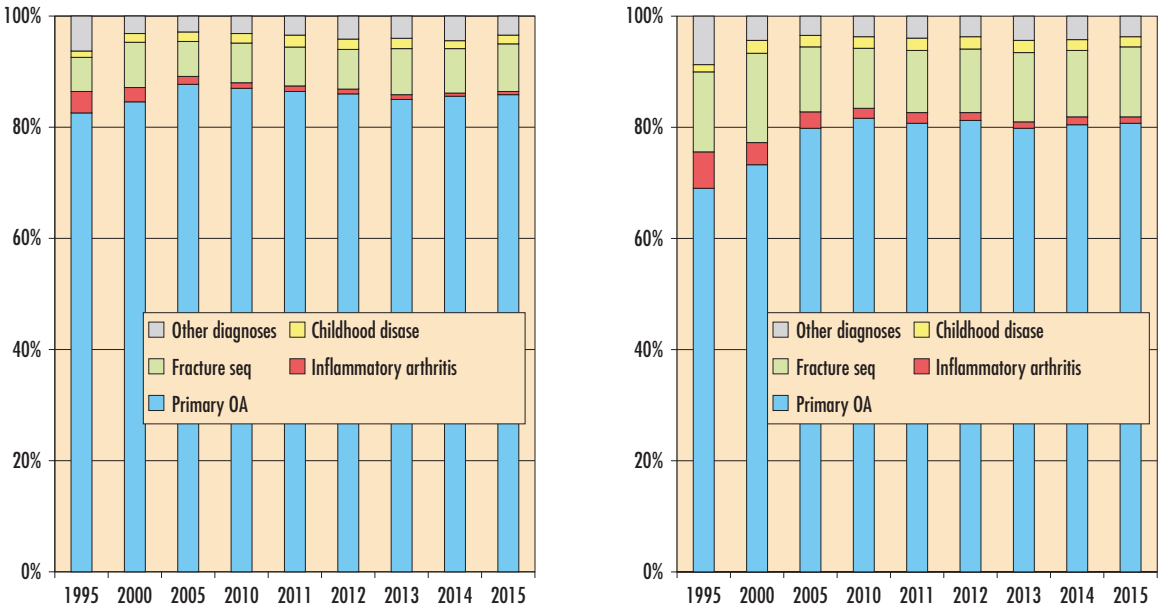


Figure 4. Grouped age distribution for men (on the left) and women (on the right), respectively. Since 1995, the proportion of patients with primary osteoarthritis has increased. The proportion of patients with inflammatory joint diseases, who have been operated with a hip replacement, has decreased.

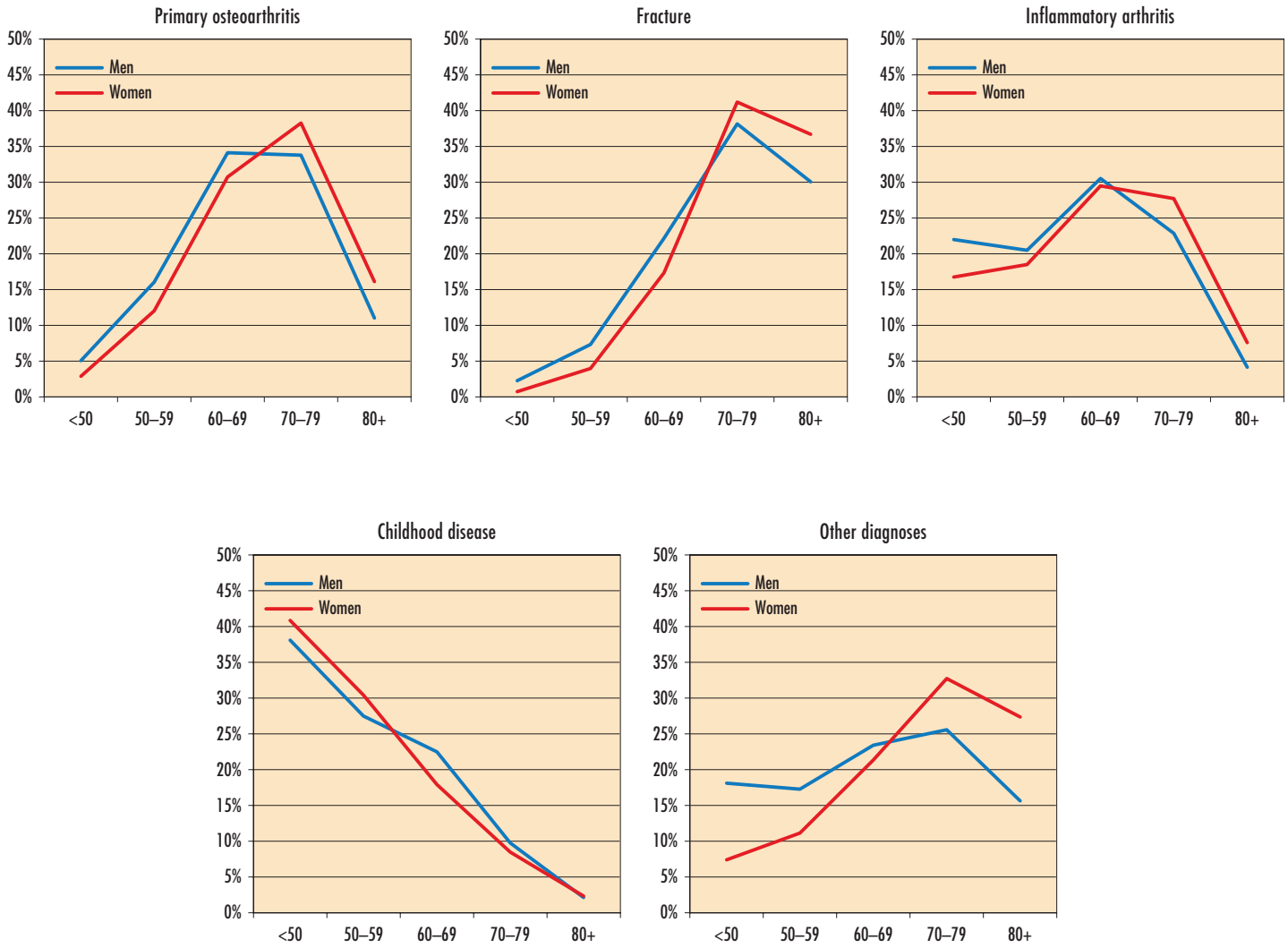


Figure 5. Relative age distribution for the five most typical diagnosis groups. Patients were operated on between 1992 and 2015.

BMI and ASA classification

Reporting of BMI (Body Mass Index) and ASA class (American Society of Anaesthesiology Physical Status Classification System) to the Swedish Hip Arthroplasty Register began in 2008. For the first year, there was data for 82.3% and 89.9% of the cases regarding BMI and ASA, respectively and reporting has continued to improve. In 2015, BMI was reported in 96.4% and ASA class in 98.6% of the cases. Between 2008 and 2015, the mean value for BMI was relatively constant (Table 1). Possibly, there is a slight tendency towards increasing proportion of patients with different degrees of obesity (BMI ≥30). Regarding ASA class, the proportion which are considered to be healthy (class I) has continuously fallen during the period. Corresponding increase is mainly in classes III-V (dangerous or life-threatening illness) (Table 1).

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 2). According to ASA, the healthiest patients can be found in the group with sequelae after hip disease during childhood and the sickest can be found in the group, which undergo operation due to fracture. The trend towards an increasing ASA class over time (Table 1) 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.

There are differences in demographics for various diagnostic groups, for example with respect to age, 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 can be found in the fracture group, and the lowest proportion in the group with sequelae after hip disease during childhood.

BMI and ASA class

2008–2015

	2008	2010	2012	2014	2015
BMI					
Valid obs./missing obs.	*11,896/2,559*	*14,644/1,302*	*15,152/874*	*15,746/819*	*16,012/597*
Mean value *median*					
Men	27.3 *26.8*	27.3 *26.8*	27.6 *27.1*	27.5 *26.9*	27.6 *27.1*
Women	26.6 *26.0*	26.8 *26.1*	26.8 *26.2*	26.7 *26.1*	26.7 *26.1*
Percentage distribution					
Underweight <18.5					
Men	0.4	0.5	0.5	0.4	0.5
Women	1.9	1.8	1.6	1.8	2.0
Normal weight 18.5–24.9					
Men	28.9	28.5	26.3	28.0	26.5
Women	39.9	38.3	38.2	38.7	38.6
Overweight 25–29.9					
Men	49.0	49.2	49.0	47.9	48.8
Women	36.3	36.9	37.1	36.6	36.3
Obesity grade I 30–34.9					
Men	17.0	17.2	18.9	18.9	19.3
Women	16.3	16.9	16.8	16.8	17.0
Obesity grade II–III 35–					
Men	4.7	4.5	5.3	4.7	4.9
Women	5.6	6.1	6.2	6.2	6.2
ASA class					
Valid obs./missing obs.	*12,977/1,479*	*15,341/605*	*15,618/408*	*16,212/353*	*16,378/231*
Percentage distribution					
Healthy (I)					
Men	27.8	27.2	24.3	23.0	23.4
Women	22.7	22.8	21.4	20.8	20.0
Mild systemic disease (II)					
Men	54.8	54.3	54.6	56.4	55.1
Women	60.2	60.0	60.4	60.2	60.3
Serious/life threatening systemic conditions (III–V)					
Men	17.3	18.5	21.0	20.6	21.5
Women	17.1	17.2	18.3	18.9	19.8

Table 1.

BMI and ASA class proportional distribution

selected diagnoses

		Primary osteoarthritis	Inflammatory arthritis	Fracture	Seq childhood disease	Other diagnoses
BMI						
Underweight	<18.5	0.7	2.9	5.9	1.3	4.0
Normal weight	18.5–24.9	31.5	41.0	54.5	35.8	44.6
Overweight	25–29.9	43.3	36.8	30.1	39.7	33.6
Obesity grade I	30–34.9	18.7	13.5	7.7	16.5	13.0
Obesity grade II-III	35+	5.8	5.9	1.8	6.7	4.7
ASA class						
Healthy (I)		25.0	5.3	10.2	44.2	14.0
Mild systemic disease (II)		59.5	64.3	51.2	46.0	49.7
Serious/life threatening systemic condition (III-V)		15.2	29.8	36.5	9.6	33.3

Table 2.

Prosthesis selection

Cemented fixation continues to be more common in Sweden compared to other Scandinavian countries. Poor results with uncemented fixation during the 1990s resulted in cemented fixation reaching a peak of 92–93% during 1998–2000 (Figure 6). Hereafter, cemented fixation has declined every year. During 2015, the proportion of cemented prostheses was 62.5%. Completely uncemented fixation has instead become ever more common. In 2000, the uncemented prosthesis constituted for 2.4% and afterwards the percentage has risen about 1.2% per year. In 2015, more than every fifth hip prosthesis (21.2%) was completely uncemented. The increase of uncemented fixation has mainly occurred in under 60 age groups, but also in patients who are 60 and older (Figure 7). Since 2012, the proportion of reversed hybrid prostheses (cemented cup, uncemented stem) decreased from 13.7 to 12.3% in 2015. The proportion of hybrid prosthesis (uncemented cup, cemented stem) has during a 10-year period been small and increased during 2007–2010 to about 1.5%. Subsequently, a slow increase has occurred, up to 4.0% during 2015. The increased use of uncemented implants in Sweden, especially among patients older than 70 years, is partly remarkable since the existing data from several international registers does not support using uncemented fixation in this patient group.

Resurfacing prostheses were used during surgery in 2015 for three men, aged 50–56 years, while all of them had primary osteoarthritis (In 2014, 37 operations were reported).

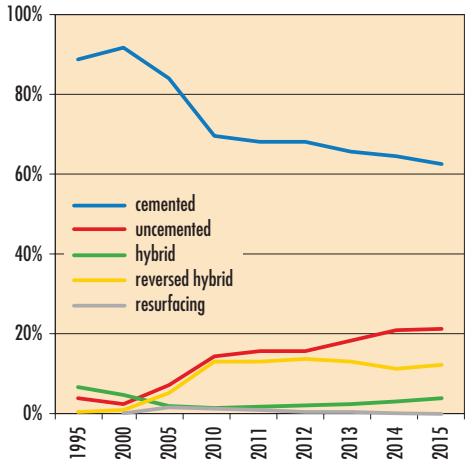


Figure 6. Distribution of primary prosthesis based on the selection of fixation.

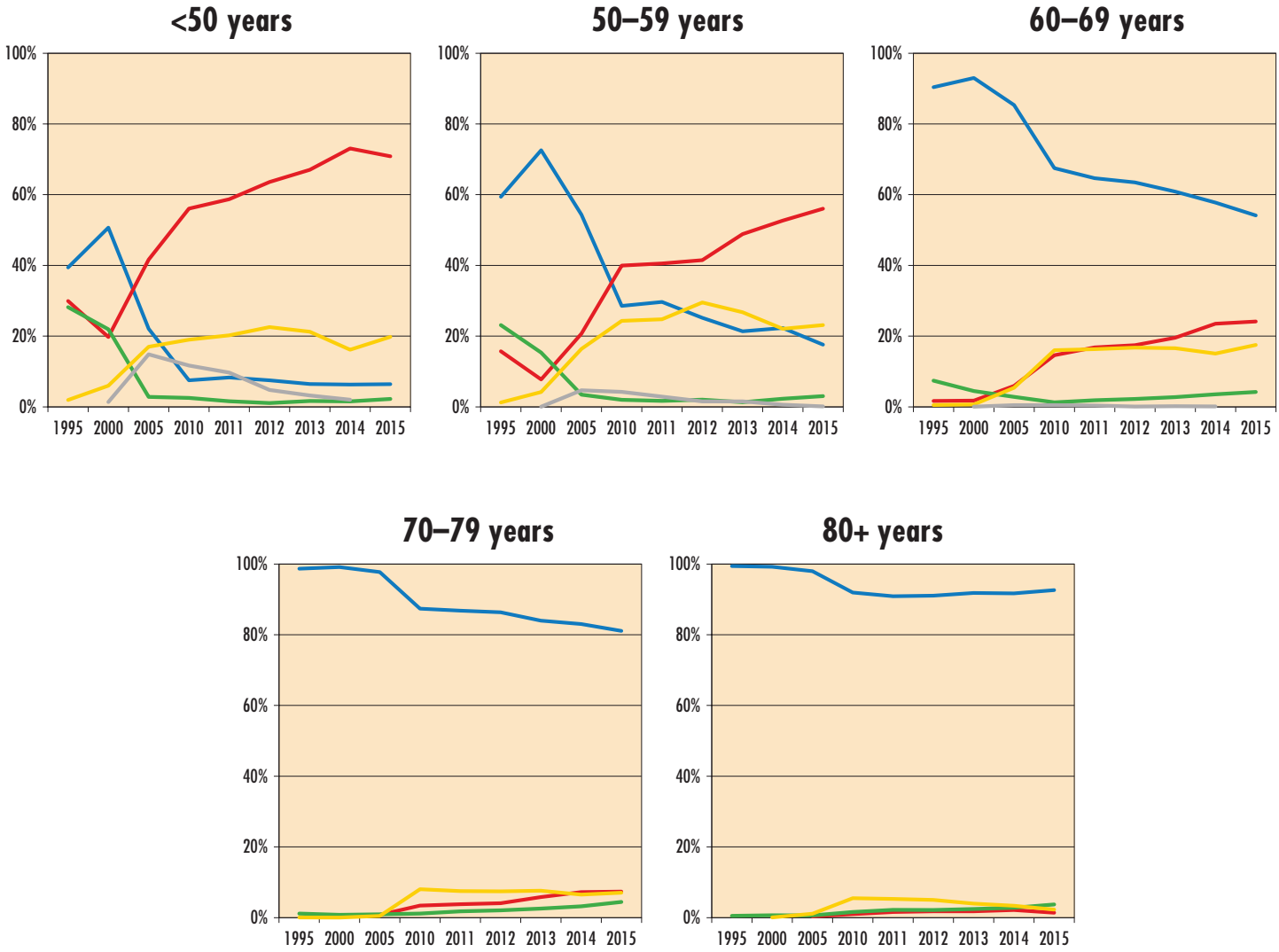


Figure 7. Distribution of primary prosthesis based on the selection of fixation among different age groups during 1995–2015.

Typical prostheses

In 2015, five of the most popular cemented cups account for 93% of the total number of cemented cups being reported. Standard poly is still used in almost 20% of cases of the cemented fixations (Figure 8). Seven clinics still use standard poly in the majority (over 90%) of surgeries during which a cemented cup is used.

Regarding stems, Lubinus SP II, Exeter and MS 30 dominate. Together, they constitute more than 99% of all cemented stems reported to the Register. Use of both CPT and Sirius stems has decreased somewhat and these stems constitute 0.3% of all stems used in Sweden.

Selection of uncemented cup shows a greater variation, five typical uncemented cups accounted for 69% of the total. The proportion of cups with trabecular coatings continues to increase. Three of the five most used uncemented cups, which were reported to the Register during 2015, have a trabecular coating. Given the uncertainty, with individual studies reporting development of radiological zones around certain cups with trabecular titanium coating and lack of long-term follow-up for trabecular cups, raises a concern regarding increased use of such cups in primary hip replacement.

Change to highly cross-linked polyethylene has gone considerably faster for uncemented cups. In 2010, the proportion for highly cross-linked polyethylene was 95% and in 2015, almost all cups had this type of polyethylene (99.9%).

Concerning uncemented stems, the diversification is less pronounced here than among cups. Since 2009, the Corail stem has been the most common uncemented stem. Use of Corail stem has increased in comparison to 2014 and this stem is used in more than half (54.4%) of all uncemented stem designs, which were reported to the Register during 2015.

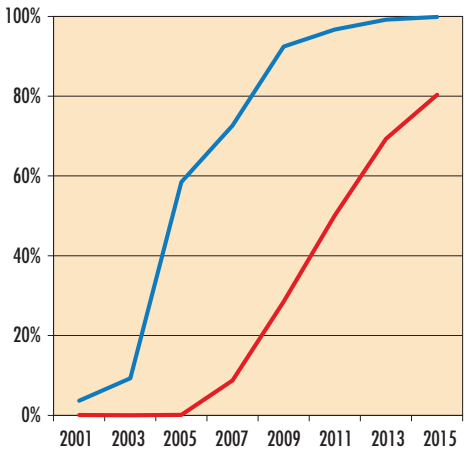


Figure 8. Proportion of cemented and uncemented cups with highly cross-linked polyethylene. There is a delay for changing from older standard polyethylene to highly cross-linked polyethylene for cemented cups.

Articulation

The proportion of cups with highly cross-linked polyethylene continues to increase (Figure 9). During 2015, highly cross-linked polyethylene was used at 84.2% of all hip replacement procedures. The combination of ceramic femoral head-ceramic insert shows also a small increase, from 15.2 to 17.4%. Most often, femoral head with a diameter of 32 mm is used. The proportion of femoral head with 36 mm diameter continues to be at around 10%. The trends regarding the choice of the femoral head and its size during the last decade are visualized in Figure 9 and 10.

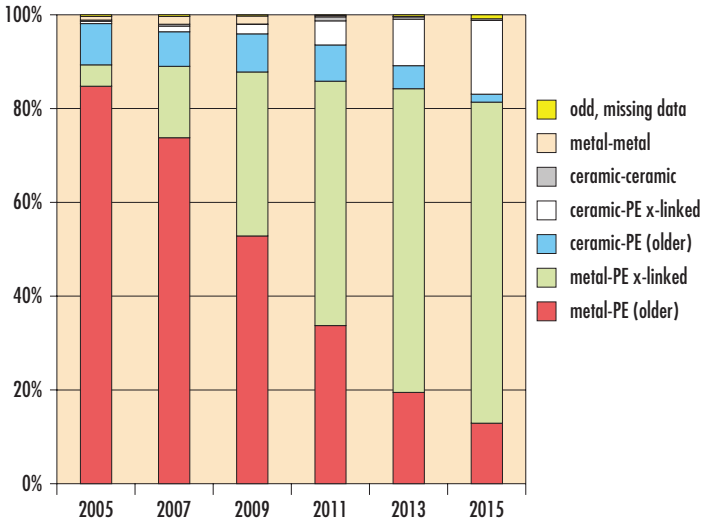


Figure 9. Type of inserted articulation since 2005–2015.

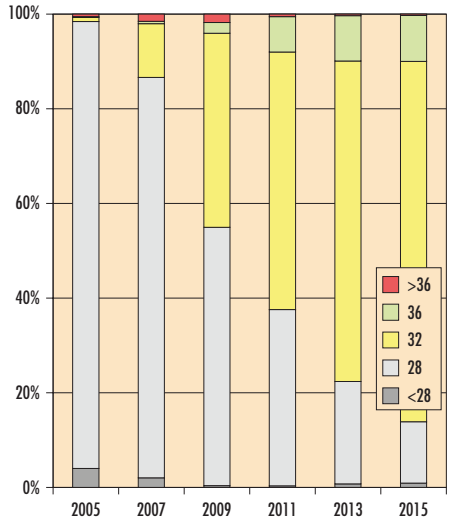


Figure 10. Distribution of femoral head sizes being inserted between 2005 and 2015. The trend to select a larger femoral head diameter is probably rationalised with an increasing percentage of highly cross-linked polyethylene being used and possibility to reduce the risk of dislocation.

Implant combinations

The most common implant combinations are presented in table 4. Regarding cemented prostheses, use of Lubinus SP-II stem - Lubinus cup is increasing. In the group of uncemented prostheses, use of Corail stem - Pinnacle W/Griptionn 100 cup is increasing. In comparison to 2014, the biggest change can be found in the group for hybrid prostheses. The combination of Lubinus SP II stem - Pinnacle cup has replaced MS30 stem – Continuum cup. With several of these combinations, implants from different manufacturers are used. This practise has developed over a long period of time, although it is not recommended by most of the manufacturers. There is also long-term data for several of the implant combinations which have proven to function well. On the Swedish market, there are many manufacturers/importers who provide cups only from a specific manufacturer, but do not provide a stem from the same producer.

Proportion of uncemented hip arthroplasties is increasing and, on a small scale the proportion of hybrid prostheses and hybrids is also increasing. Use of cemented prostheses is decreasing. Upon insertion of uncemented cup, almost exclusively polyethylene inserts of high-molecular highly cross-linked polyethy-lene are used. Upon insertion of cemented cup, this type of polyethylene is used in just over 80% of cases. In the absence of long term data regarding uncemented cups with trabecular coating, some caution should be taken when inserting these cups into patients where well-documented uncemented cups could be used.

Incision

Since 2005, posterior inscision and direct lateral incision have been the most frequently used incision in Sweden. During 2015, either a posterior or a direct lateral incision was used in 99% reported cases. The posterior incision is still the most common (52.2%). Direct lateral incision with the patients on the latera position was used in 40.8% of all surgeries and the proportion for direct lateral incision with patients on the supine position was 6.5% (a marginal increase in comparison to the last two years (5.2%)). Mini-incision, Watson-Jones incision and direct lateral/posterior incision in combination with trochanteric osteotomy is only used sporadically. The distribution between the three most used incisions shows no significant variation during the last five years (Figure 11).

Table 5 shows the number of reoperations within three years. Here, instead of revision, reoperation has been used to include open surgical interventions, where the hip implant is not being exchanged (for example open reduction or internal fixation being performed due to dislocation or fracture). The highest frequency for reoperations is found in the two groups operated with a mini-incision. In both groups, the proportion of uncemented implants is high, which is likely to affect the results (Table 6). Also the slightly lower risk of reoperation within three years in the group for posterior incision may be explained by the fact that more patients with secondary osteoarthritis and especially with hip fracture undergo operation with a lateral incision. The relationship between patient demographics, comorbidity, implant selection and choice of incision is complex. Therefore, the data presented should primarily be seen as descriptive.

About 93% of all total hip arthroplasties are performed through a posterior or a direct lateral incision. The risk for reoperation does not appear to be affectedbased on any of these two incisions being used, when all operations are included. However, the choice of incision may play a role for different subgroups and exhibit different risk profile, something we have described earlier in patients with fracture diagnosis.

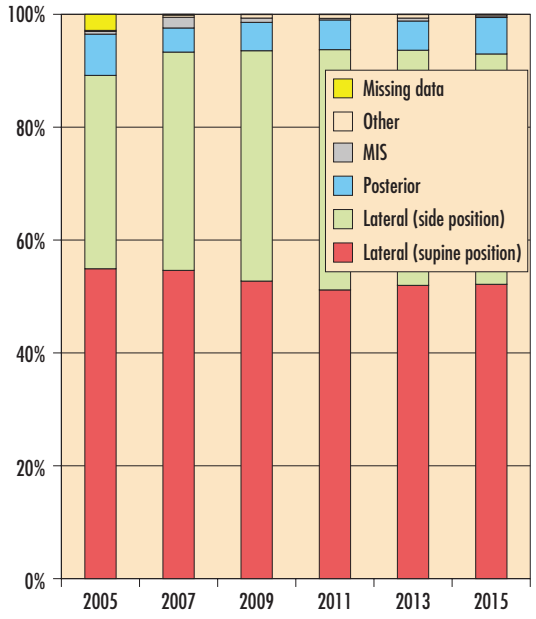


Figure 11. Relative distribution of incision in 2005–2015. The left column illustrates the distribution of three different age groups. The right column shows diagnoses of primary osteoarthritis and hip fracture, respectively.

Reoperation within two years in relation to surgical approach

2005–2015

Surgical approach	Number	Proportion reoperated
Posterior	89,369	2.0%
Direct lateral		
Side position (Gammer)	68,886	2.2%
Supine position (Hardinge)	9,146	1.9%
Mini incicsion		
Anterior	775	3.5%
Posterior	329	2.1%
Others*	85	2.4%
Watson-Jones	317	1.6%
Trochanteric osteotomy		
Direct lateral	313	2.6%
Posterior	172	0.6%
Missing data	607	2.3%

** OCM, 2-incision technique (Berger)*

Table 5.

Demography and fixation in relation to surgical approach

2005–2015

Surgical approach	Number	Proportion reoperated	Proportion women	Proportion primary OA	Proportion uncemented cup fixation	Proportion uncemented stem fixation
Posterior	89,369	2.0	57.0	85.5	17.4	24.2
Direct lateral						
Side position (Gammer)	68,886	2.2	64	80	6	32
Supine position (Hardinge)	9,146	1.9	60	80	20	27
Mini incision		0.0				
Anterior	775	3.5	63.2	89.4	70.2	66.7
Posterior	329	2.1	52.9	82.1	45.9	48.9
Others*	85	2.4	42.4	89.4	70.6	76.5
Watson-Jones	317	1.6	53.6	85.5	47	57.3
Trochanteric osteotomy		0.0				
Direct lateral	313	2.6	61.7	72.5	27.5	35
Posterior	172	0.6	55.8	79.7	20.9	30.8
Missing data	607	2.3	49.6	74.1	47.4	29.6

Table 6.

15 most common components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Lubinus all-poly (Lubinus SP II)	82,412	4,347	3,611	2,627	2,319	1,457	96,773	25.8%
Lubinus X-linked (Lubinus SP II)	23	687	1,462	2,571	3,245	4,246	12,234	7.8%
ZCA XLPE (MS30 Polished)	3,646	1,150	1,225	1,008	524	738	8,291	5.3%
Contemporary Hooded Duration (Exeter Polished)	7,994	632	565	414	200	149	9,954	5.1%
Marathon XLPE (Exeter Polished)	1,842	1,260	1,401	1,301	1,109	1,010	7,923	5.1%
Exeter X3 RimFit (Exeter Polished)	106	1,021	1,070	1,200	1,603	1,661	6,661	4.3%
Charnley Elite (Exeter Polished)	9,455	49	6	0	4	0	9,514	2.6%
Trilogy HA (CLS Spotorno)	2,082	372	255	183	220	223	3,335	1.9%
FAL (Lubinus SP II)	5,770	266	163	109	43	3	6,354	1.8%
Exeter Duration (Exeter Polished)	11,714	72	0	0	0	0	11,786	1.7%
ZCA XLPE (Lubinus SP II)	1,327	334	352	355	64	15	2,447	1.6%
Lubinus all-poly (Corail collarless)	1,067	356	317	195	143	123	2,201	1.4%
Marathon XLPE (Corail collarless)	583	387	422	303	265	241	2,201	1.4%
Reflection XLPE (Spectron EF Primary)	1,436	97	0	0	0	0	1,533	1.0%
Trident HA (Accolade)	983	201	178	120	44	73	1,599	1.0%
Others (1,615)	200,893	4,723	5,001	5,962	6,781	6,670	230,030	
Total	331,333	15,954	16,028	16,348	16,564	16,609	412,836	

1) *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common cemented components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Lubinus all-poly (Lubinus SP II)	82,412	4,347	3,611	2,627	2,319	1,457	96,773	37.1%
Lubinus X-linked (Lubinus SP II)	23	687	1,462	2,571	3,245	4,246	12,234	11.3%
ZCA XLPE (MS 30 Polished)	3,646	1,150	1,225	1,008	524	738	8,291	7.6%
Contemporary Hooded Duration (Exeter Polished)	7,994	632	565	414	200	149	9,954	7.4%
Marathon XLPE (Exeter Polished)	1,842	1,260	1,401	1,301	1,109	1,010	7,923	7.3%
Exeter X3 RimFit (Exeter Polished)	106	1,021	1,070	1,200	1,603	1,661	6,661	6.1%
Charnley Elite (Exeter Polished)	9,455	49	6	0	4	0	9,514	3.8%
FAL (Lubinus SP II)	5,770	266	163	109	43	3	6,354	2.6%
Exeter Duration (Exeter Polished)	11,714	72	0	0	0	0	11,786	2.4%
ZCA XLPE (Lubinus SP II)	1,327	334	352	355	64	15	2,447	2.3%
Reflection XLPE (Spectron EF Primary)	1,436	97	0	0	0	0	1,533	1.4%
Reflection (Spectron EF Primary)	7,524	4	3	7	3	0	7,541	1.2%
ZCA XLPE (Exeter Polished)	320	237	225	209	101	50	1,142	1.1%
Avantage Cemented (Lubinus SP II)	155	74	113	203	277	298	1,120	1.0%
Exeter X3 RimFit (MS 30 Polished)	20	129	200	169	119	55	692	0.6%
Others (360)	156,058	502	507	565	1,082	691	159,405	
Total	289,802	10,861	10,903	10,738	10,693	10,373	343,370	

1) *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common uncemented components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Trilogy HA (CLS Spotorno)	2,082	372	255	183	220	223	3,335	13.9%
Trident HA (Accolade)	983	201	178	120	44	73	1,599	6.9%
Allofit (CLS Spotorno)	1,349	80	43	52	61	80	1,665	5.7%
Pinnacle HA (Corail collarless)	347	123	189	221	131	125	1,136	5.2%
Pinnacle Gription (Corail collarless)	0	10	66	98	369	461	1,004	4.6%
Trilogy HA (Corail collarless)	496	160	83	47	104	40	930	4.3%
Continuum (CLS Spotorno)	37	94	156	206	212	196	901	4.1%
Trident HA (Accolade II)	0	0	44	160	302	252	758	3.5%
Exceed ABT (Bi-Metric HA std)	2	85	140	163	178	185	753	3.5%
Trident HA (ABG II HA)	418	83	49	40	43	27	660	2.9%
Pinnacle (Corail collarless)	134	79	90	89	83	120	595	2.7%
CLS Spotorno (CLS Spotorno)	1,249	38	27	9	0	0	1,323	2.7%
Trilogy HA (Bi-Metric HA std)	324	53	50	38	40	9	514	2.3%
Continuum (Corail with collar)	0	13	38	94	159	161	465	2.1%
Ranawat/Burstein (Bi-Metric HA std)	375	44	32	11	0	0	462	2.1%
Others (435)	10,830	1,075	1,076	1,461	1,516	1,571	17,529	
Total	18,626	2,510	2,516	2,992	3,462	3,523	33,629	

[1)] *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common hybrid components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Trident HA (Exeter Polished)	80	82	92	115	171	294	834	24.9%
Trilogy HA (Lubinus SP II)	1,197	70	68	50	108	65	1,558	19.1%
Trilogy HA (Spectron EF Primary)	1,246	2	0	0	0	0	1,248	4.7%
Continuum (MS 30 Polished)	0	5	17	32	36	22	112	3.4%
Tritanium (Exeter Polished)	0	9	13	30	28	31	111	3.3%
Trilogy HA (MS 30 Polished)	84	15	4	3	1	3	110	3.3%
Trilogy HA (Exeter Polished)	122	7	1	1	6	3	140	3.3%
Ranawat/Burstein (Lubinus SP II)	74	18	15	1	0	0	108	3.2%
Trident HA (Lubinus SP II)	49	5	3	10	16	7	90	2.6%
Trilogy HA (CPT (CoCr))	31	15	17	0	0	0	63	1.8%
TM revision (Lubinus SP II)	10	2	10	10	14	13	59	1.8%
Pinnacle (Lubinus SP II)	0	0	0	1	1	55	57	1.7%
Trilogy IT (Lubinus SP II)	0	0	0	0	20	36	56	1.7%
Continuum (Lubinus SP II)	0	4	7	22	14	8	55	1.7%
Trident HA (ABG II Cemented)	63	0	0	0	0	0	63	1.5%
Others (291)	6,860	62	87	119	89	122	7,339	
Total	9,816	296	334	394	504	659	12,003	

[1)] *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common reversed hybrid components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Marathon XLPE (Corail collarless)	583	387	422	303	265	241	2,201	12.5%
Lubinus all-poly (Corail collarless)	1,067	356	317	195	143	123	2,201	12.4%
Marathon XLPE (ABG II HA)	95	85	115	124	116	141	676	3.8%
Marathon XLPE (Corail with collar)	43	104	117	147	128	133	672	3.8%
ZCA XLPE (Corail collarless)	214	51	84	114	59	97	619	3.5%
Contemporary Hooded Duration (ABG II HA)	615	25	6	0	0	0	646	3.3%
Exeter X3 RimFit (Corail collarless)	8	54	59	51	166	244	582	3.3%
Lubinus helplast (Corail with collar)	41	104	79	110	126	100	560	3.2%
Contemporary Hooded Duration (Corail collarless)	60	105	146	183	22	23	539	3.1%
Lubinus helplast (CLS Spotorno)	398	34	47	36	18	27	560	3.0%
Marathon XLPE (Bi-Metric HA std)	134	102	101	72	51	52	512	2.9%
Lubinus X-linked (Corail collarless)	1	20	67	121	124	154	487	2.8%
ZCA XLPE (CLS Spotorno)	286	66	60	14	8	4	438	2.5%
Charnley Elite (Corail collarless)	416	20	5	1	0	0	442	2.4%
Lubinus helplast (Bi-Metric HA lat)	323	81	22	1	3	2	432	2.1%
Others (325)	5,454	504	549	674	631	702	8,514	
Total	9,738	2,098	2,196	2,146	1,860	2,043	20,081	

1) *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common resurfacing components

Cup (Stem)	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
BHR Acetabular Cup (BHR Femoral Head)	921	125	60	61	33	3	1,203	54.7%
ASR Cup (ASR Head)	396	0	0	0	0	0	396	22.8%
Durom (Durom)	362	0	0	0	0	0	362	12.4%
Adept (Adept Resurfacing Head)	49	25	1	0	0	0	75	4.6%
BHR Acetabular Cup (BMHR VS)	8	11	9	9	4	0	41	2.5%
Durom study cup (Durom)	15	0	0	0	0	0	15	0.9%
BHR Dysplasia Cup (BHR Femoral Head)	12	3	1	0	0	0	16	0.8%
ReCap Cup (ReCap Head)	9	0	0	0	0	0	9	0.5%
BHR Acetabular Cup (BMHR)	5	0	0	0	0	0	5	0.3%
Zimmer MMC Cup (Durom)	0	3	1	0	0	0	4	0.2%
ReCap HA Cup (ReCap Head)	3	0	0	0	0	0	3	0.2%
ASR Cup (BHR Femoral Head)	1	0	0	0	0	0	1	0.1%
BHR Dysplasia Cup (BMHR VS)	1	0	0	0	0	0	1	0.1%
Unknown resurfacing cup (Unknown resurfacing head)	1	0	0	0	0	0	1	0.1%
Cormet 2000 resurf (Cormet 2000 HA resurf)	2	0	0	0	0	0	2	0%
Others (2)	11	0	0	0	0	0	11	
Total	1,796	167	72	70	37	3	2,145	

1) *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common cup components

Cup	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Lubinus all poly	106,895	5,006	4,147	3,016	2,657	1,734	123,455	28.5%
ZCA XLPE	6,865	1,912	2,012	1,786	787	947	14,309	9.2%
Lubinus X-linked	24	735	1,639	2,969	3,651	4,807	13,825	8.9%
Marathon XLPE	3,109	2,295	2,497	2,250	1,882	1,762	13,795	8.8%
Contemporary Hooded Duration	9,311	802	752	618	229	174	11,886	6.3%
Exeter X3 RimFit	138	1,258	1,400	1,504	1,969	2,056	8,325	5.3%
Trilogy HA	7,067	933	710	444	570	382	10,106	4.3%
Charnley Elite	15,601	172	82	42	21	3	15,921	3.9%
Trident HA	2,016	407	386	484	690	811	4,794	2.9%
FAL	5,995	290	170	117	52	3	6,627	1.9%
Exeter Duration	12,700	79	0	0	0	0	12,779	1.9%
Continuum	68	229	403	700	766	650	2,816	1.8%
Reflection XLPE	1,597	123	1	2	1	1	1,725	1.1%
Pinnacle HA	421	211	275	321	229	162	1,619	1.0%
Avantage Cemented	279	115	171	305	351	363	1,584	1.0%
Others (206)	159,247	1,387	1,383	1,790	2,709	2,754	169,270	
Totalt	331,333	15,954	16,028	16,348	16,564	16,609	412,836	

[1)] *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

15 most common stem components

Stem	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Lubinus SP II	98,449	6,147	6,174	6,287	6,518	6,553	130,128	40.2%
Exeter Polished	51,611	3,415	3,459	3,435	3,420	3,336	68,676	21%
Corail Collarless	3,732	1,527	1,672	1,562	1,734	1,955	12,182	7.8%
MS30 Polished	4,841	1,324	1,470	1,252	1,178	1,091	11,156	6.6%
CLS Spotorno	7,816	861	735	645	630	648	11,335	5.7%
Bi-Metric HA std	2,063	424	429	452	432	455	4,255	2.6%
Corail with collar	188	500	603	824	826	855	3,796	2.4%
Spectron EF Primary	11,548	132	8	9	3	7	11,707	2.2%
Bi-Metric HA lat	1,814	309	338	381	429	384	3,655	2.1%
ABG II HA	2,008	277	201	186	193	188	3,053	1.6%
Accolade	1,094	252	224	170	72	89	1,901	1.1%
Wagner Cone Prosthesis	872	135	128	156	203	169	1,663	0.8%
CPT (CoCr)	1,340	130	121	130	30	26	1,777	0.8%
Accolade II	0	0	47	211	363	349	970	0.6%
BHR Femoral Head	934	128	61	61	33	3	1,220	0.6%
Others (211)	143,023	393	358	587	500	501	145,362	
Totalt	331,333	15,954	16,028	16,348	16,564	16,609	412,836	

[1)] *Refers to the proportion of the total number primary total hip replacements performed during the last 10 years.*

Number of primary THRs per hospital and year

Hospital	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Aleris Specialistvård Bollnäs	0	0	241	268	312	306	1,127	0.3%
Aleris Specialistvård Motala	437	429	438	491	520	580	2,895	0.7%
Aleris Specialistvård Nacka	341	133	134	112	119	218	1,057	0.3%
Aleris Specialistvård Sabbatsberg	1,798	145	160	175	141	24	2,443	0.6%
Aleris Specialistvård Ängelholm	0	2	5	9	83	130	229	0.1%
Alingsås	2,720	210	209	252	178	197	3,766	0.9%
Art Clinic Göteborg	0	0	0	0	0	25	25	0%
Art Clinic Jönköping	0	0	10	6	14	20	50	0%
Arvika	1,858	184	190	140	217	193	2,782	0.7%
Borås	5,879	188	180	167	170	158	6,742	1.6%
Capio Movement	953	253	176	127	229	304	2,042	0.5%
Capio Ortopediska Huset	3,406	316	332	370	375	473	5,272	1.3%
Capio S:t Göran	10,635	454	405	472	423	508	12,897	3.1%
Carlanderska	1,491	158	120	113	157	145	2,184	0.5%
Danderyd	8,256	338	306	327	343	331	9,901	2.4%
Eksjö	4,991	183	216	191	207	244	6,032	1.5%
Enköping	2,486	295	327	320	342	347	4,117	1.0%
Eskilstuna	4,342	128	129	136	97	109	4,941	1.2%
Falun	6,697	367	397	353	325	254	8,393	2.0%
Frölunda Specialistsjukhus	509	82	85	80	97	83	936	0.2%
Gällivare	2,623	86	111	92	96	93	3,101	0.8%
Gävle	5,687	204	198	257	223	252	6,821	1.7%
Halmstad	4,696	227	238	243	241	236	5,881	1.4%
Helsingborg	3,980	59	69	76	109	182	4,475	1.1%
Hermelinen Spec.vård	0	0	2	6	7	12	27	0%
Hudiksvall	3,243	129	100	148	146	138	3,904	0.9%
Hässleholm-Kristianstad	11,015	775	675	777	847	807	14,896	3.6%
Jönköping	4,799	211	194	167	210	160	5,741	1.4%
Kalmar	4,858	184	122	146	160	174	5,644	1.4%
Karlshamn	2,745	235	217	230	240	259	3,926	1.0%
Karlskoga	2,792	120	166	173	162	186	3,599	0.9%
Karlskrona	2,437	36	36	32	28	30	2,599	0.6%
Karlstad	5,423	260	238	265	248	203	6,637	1.6%
Karolinska/Huddinge	6,219	283	241	251	265	241	7,500	1.8%
Karolinska/Solna	4,889	206	198	182	184	195	5,854	1.4%
Katrineholm	2,935	239	208	242	260	221	4,105	1.0%
Kungälv	3,096	171	135	165	205	185	3,957	1.0%
Lidköping	2,486	186	196	238	281	280	3,667	0.9%
Lindesberg	2,728	234	211	230	202	214	3,819	0.9%
Linköping	5,445	68	58	66	67	70	5,774	1.4%
Ljungby	2,672	165	175	151	172	152	3,487	0.8%

(Continued on next page.)

Number of primary THRs per hospital and year (cont.)

Hospital	1979–2010	2011	2012	2013	2014	2015	Total	Proportion[1)]
Lycksele	3,601	308	276	290	302	334	5,111	1.2%
Mora	3,503	222	203	219	207	241	4,595	1.1%
Norrköping	5,684	245	230	253	258	252	6,922	1.7%
Norrtälje	1,816	101	106	129	115	128	2,395	0.6%
Nyköping	3,220	171	167	143	159	148	4,008	1.0%
NÄL	2,982	0	0	0	0	2	2,984	0.7%
Ortho Center IFK-kliniken	332	150	131	128	133	127	1,001	0.2%
Ortho Center Stockholm	2,485	400	435	396	442	495	4,653	1.1%
Oskarshamn	2,843	210	204	286	233	289	4,065	1%%
Piteå	2,891	373	389	367	337	329	4,686	1.1%
SU/Mölndal	2,460	406	416	469	594	600	4,945	1.2%
SU/Sahlgrenska	4,974	4	3	6	6	5	4,998	1.2%
SUS/Lund	4,730	100	140	195	203	180	5,548	1.3%
SUS/Malmö	6,243	83	74	27	34	22	6,483	1.6%
Skellefteå	2,688	79	98	133	122	126	3,246	0.8%
Skene	1,371	106	113	126	152	125	1,993	0.5%
Skövde	5,758	198	243	162	136	161	6,658	1.6%
Sollefteå	2,219	125	123	126	109	139	2,841	0.7%
Sophiahemmet	5,583	166	193	211	213	220	6,586	1.6%
Sunderby (Boden included)	4,863	30	36	32	34	40	5,035	1.2%
Sundsvall	5,927	229	184	208	158	84	6,790	1.6%
Södersjukhuset	8,360	337	416	430	419	391	10,353	2.5%
Södertälje	1,616	119	109	92	97	119	2,152	0.5%
Torsby	1,732	106	122	107	97	118	2,282	0.6%
Trelleborg	6,112	598	643	594	627	664	9,238	2.2%
Uddevalla	6,352	337	342	389	390	374	8,184	2.0%
Umeå	4,453	63	64	64	98	103	4,845	1.2%
Uppsala	7,155	257	230	271	284	238	8,435	2.0%
Varberg	4,800	241	242	239	213	187	5,922	1.4%
Visby	2,545	118	121	125	121	136	3,166	0.8%
Värnamo	2,901	146	148	148	122	133	3,598	0.9%
Västervik	2,976	120	109	121	109	97	3,532	0.9%
Västerås	4,631	461	513	476	436	377	6,894	1.7%
Växjö	3,690	146	154	125	151	148	4,414	1.1%
Örebro	5,607	177	116	107	151	74	6,232	1.5%
Örnsköldsvik	3,150	140	140	133	144	203	3,910	0.9%
Östersund	4,856	278	301	314	261	261	6,271	1.5%
Others	42,657	661	646	461	195	0	44,620	10.8%
Total	331,333	15,954	16,028	16,348	16,564	16,609	412,836	

[1)] *Refers to the proportion of the total number of total hip replacements performed 1979–2013.*

Number of primary THRs per diagnosis and year
1992–2015

Diagnosis	1992–2010	2011	2012	2013	2014	2015	Total	Proportion
Primary osteoarthritis	181,986	13,256	13,336	13,397	13,683	13,758	249,416	79.9%
Fracture	24,800	1,509	1,542	1,743	1,699	1,804	33,097	10.6%
Inflammatory arthritis	8,256	243	194	173	175	154	9,195	2.9%
Femoral head necrosis	6,517	508	528	553	584	492	9,182	2.9%
Childhood disease	4,296	339	324	339	283	281	5,862	1.9%
Tumour	1,232	76	79	103	108	85	1,683	0.5%
Other secondary osteoarthritis	1,300	2	1	1	0	0	1,304	0.4%
Posttraumatic osteoarthritis	501	21	24	39	32	35	652	0.2%
(missing)	1,837	0	0	0	0	0	1,837	0.6%
Total	230,725	15,954	16,028	16,348	16,564	16,609	312,228	100%

Number of primary THRs per diagnosis and age group
1992–2015

Diagnosis	<50 years		50–59 years		60–75 years		>75 years		Total	Proportion
Primary osteoarthritis	9,540	61.7%	34,298	83.2%	137,907	84.5%	67,671	73.3%	249,416	79.9%
Fracture	385	2.5%	1,619	3.9%	13,479	8.3%	17,614	19.1%	33,097	10.6%
Inflammatory arthritis	1,655	10.7%	1,734	4.2%	4,373	2.7%	1,433	1.6%	9,195	2.9%
Femoral head necrosis	1,085	7.0%	1,204	2.9%	3,578	2.2%	3,315	3.6%	9,182	2.9%
Childhood disease	2,338	15.1%	1,723	4.2%	1,502	0.9%	299	0.3%	5,862	1.9%
Tumour	176	1.1%	314	0.8%	785	0.5%	408	0.4%	1,683	0.5%
Other secondary osteoarthritis	99	0.6%	112	0.3%	474	0.3%	619	0.7%	1,304	0.4%
Posttraumatic osteoarthritis	78	0.5%	75	0.2%	231	0.1%	268	0.3%	652	0.2%
(missing)	98	0.6%	163	0.4%	875	0.5%	701	0.8%	1,837	0.6%
Total	15,454	100%	41,242	100%	163,204	100%	92,328	100%	312,228	100%

Number of primary uncemented THRs per diagnosis and age group
1992–2015

Diagnosis	<50 years		50–59 years		60–75 years		>75 years		Total	Proportion
Primary osteoarthritis	4,405	65.2	10,008	88.4	10,488	92.3	707	82	25,608	84.5%
Childhood disease	1,209	17.9	655	5.8	254	2.2	21	2.4	2,139	7.1%
Femoral head necrosis	513	7.6	300	2.7	212	1.9	25	2.9	1,050	3.5%
Inflammatory arthritis	443	6.6	167	1.5	158	1.4	16	1.9	784	2.6%
Fracture	89	1.3	144	1.3	223	2	87	10.1	543	1.8%
Posttraumatic osteoarthritis	30	0.4	8	0.1	6	0.1	4	0.5	48	0.2%
Other secondary osteoarthritis	32	0.5	7	0.1	4	0	1	0.1	44	0.1%
Tumour	7	0.1	8	0.1	4	0	1	0.1	20	0.1%
(missing)	26	0.4	20	0.2	11	0.1	0	0	57	0.2%
Total	6,754	100	11,317	100	11,360	100	862	100	30,293	100%

Number of primary THRs per type of fixation and age group
1992–2015

Type of fixation	<50 years		50–59 years		60–75 years		>75 years		Total	Proportion
Cemented	3,856	25.0%	19,518	47.3%	136,505	83.6%	88,263	95.6%	248,142	79.5%
Uncemented	6,754	43.7%	11,317	27.4%	11,360	7.0%	862	0.9%	30,293	9.7%
Reversed hybrid	1,977	12.8%	5,808	14.1%	10,309	6.3%	1,942	2.1%	20,036	6.4%
Hybrid	1,512	9.8%	3,398	8.2%	4,534	2.8%	1,147	1.2%	10,591	3.4%
Resurfacing implants	1,003	6.5%	880	2.1%	260	0.2%	2	0%	2,145	0.7%
(missing)	352	2.3%	321	0.8%	236	0.1%	112	0.1%	1,021	0.3%
Total	15,454	100%	41,242	100%	163,204	100%	92,328	100%	312,228	100%

Number of primary THRs per type of surgical approach and year
1992–2015

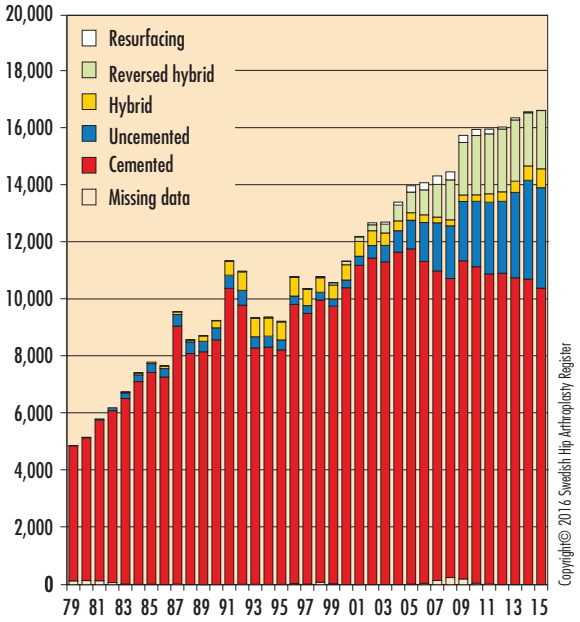
Typ av snitt	1992–2010	2011	2012	2013	2014	2015	Total	Proportion
Posterior approach (Moore)	82,231	8,161	8,285	8,494	8,453	8,662	124,286	39.8%
Direct lateral approach, lateral position (Gammer)	54,414	6,795	6,777	6,815	7,083	6,784	88,668	28.4%
Direct lateral approach, supine position (Hardinge)	10,707	839	860	851	846	1,072	15,175	4.9%
Others	1,545	155	101	183	180	89	2,253	0.7%
(missing)	81,828	4	5	5	2	2	81,846	26.2%
Total	230,725	15,954	16,028	16,348	16,564	16,609	312,228	100%

Number of primary THRs per type of cement and year
1992–2015

Type of cement	1992–2010	2011	2012	2013	2014	2015	Total	Proportion
Palacos cum Gentamycin	101,814	0	0	0	0	0	101,814	32.6%
Palacos R+G	25,896	5,378	5,261	3,994	3,506	2,714	46,749	15.0%
Refobacin Palacos R	19,615	0	0	0	0	0	19,615	6.3%
Refobacin Bone Cement	25,838	5,056	5,258	6,015	5,873	5,910	53,950	17.3%
Cemex Genta System Fast	1,988	247	225	3	0	0	2,463	0.8%
Cemex Genta System	236	1	0	0	0	0	237	0.1%
Others	13,757	21	36	600	1,193	1,607	17,214	5.5%
(all or partly uncemented)	38,632	5,251	5,248	5,735	5,992	6,378	67,236	21.5%
(missing)	2,949	0	0	1	0	0	2,950	0.9%
Total	230,725	15,954	16,028	16,348	16,564	16,609	312,228	100%

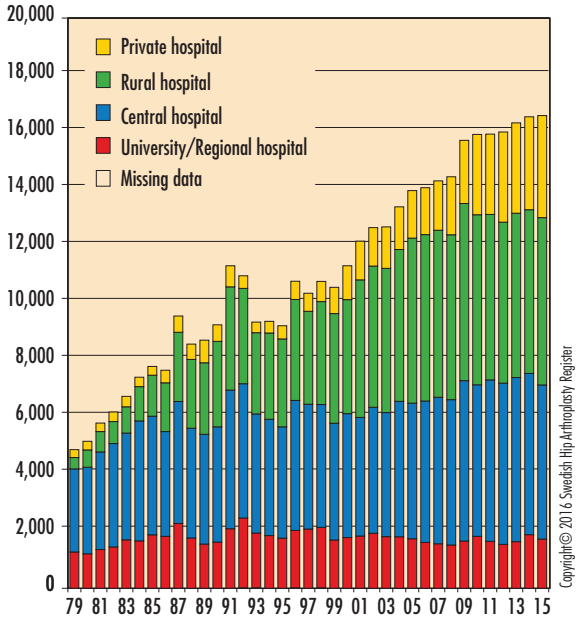
Number of primary THRs

per type of fixation, 1979–2015



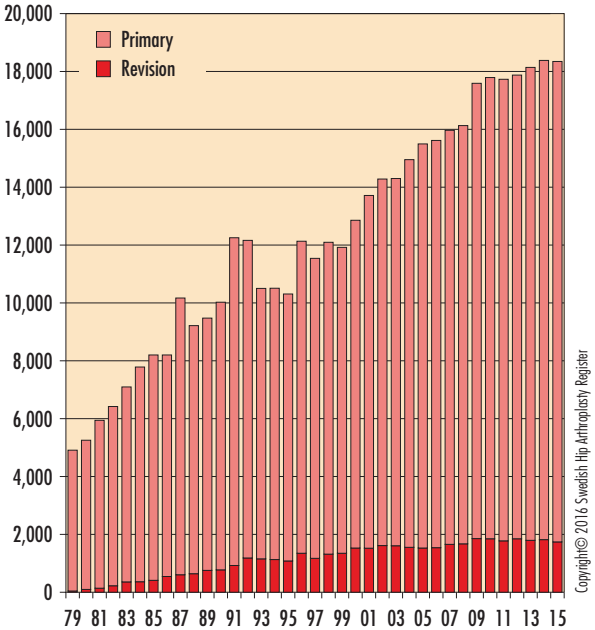
Number of primary THRs

per type of hospital, 1979–2015



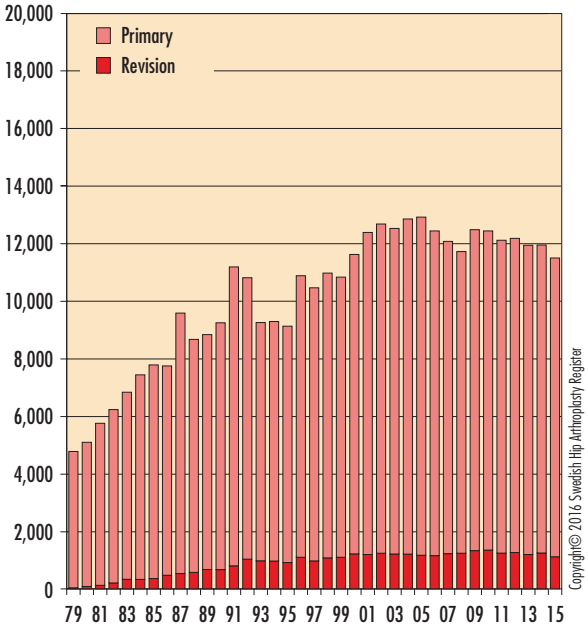
All THRs

412 836 primary THRs, 42 360 revisions, 1979–2015



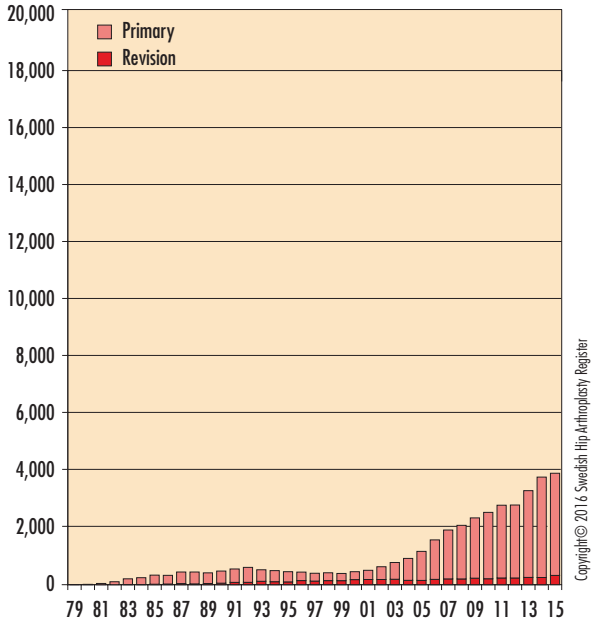
THRs with cemented implants

343 370 primary THRs, 32 827 revisions, 1979–2015



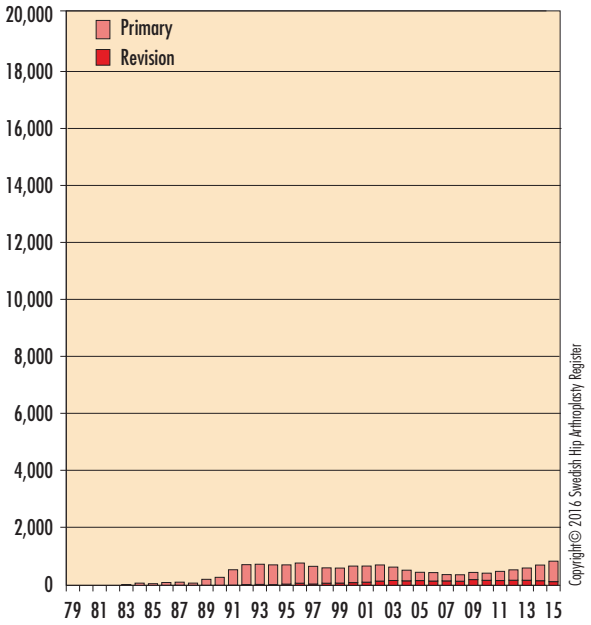
THRs with uncemented implants

33 629 primary THRs, 4 553 revisions, 1979–2015



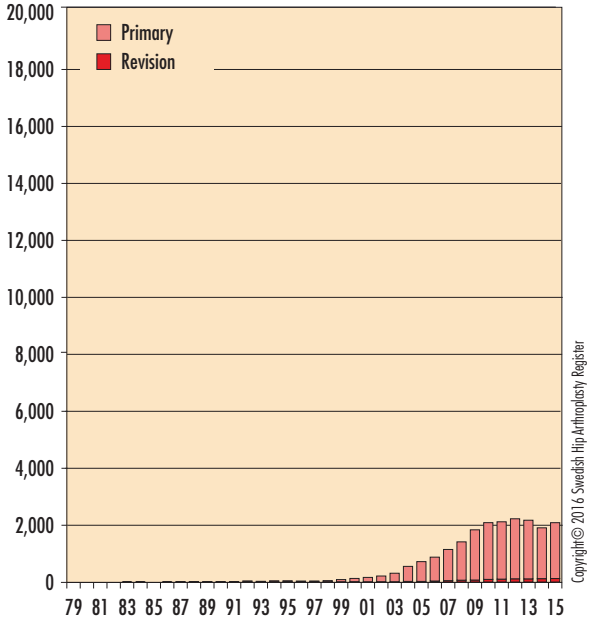
THRs with hybrid implants

12 003 primary THRs, 2 679 revisions, 1979–2015



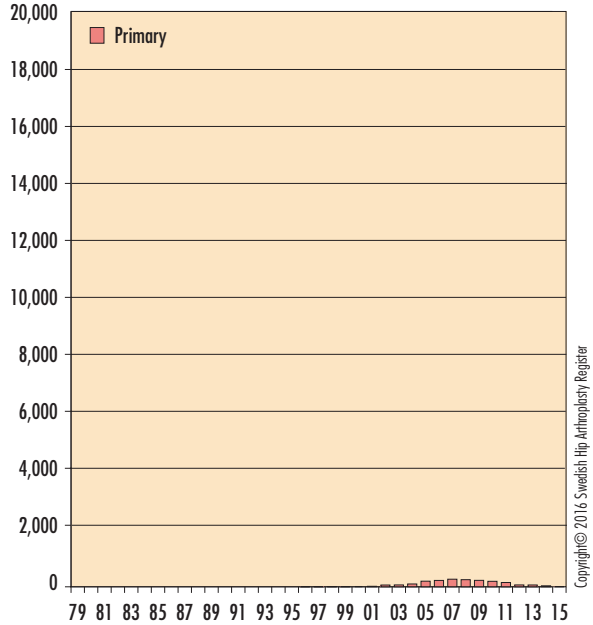
THRs with reversed hybrid implants

20 081 primary THRs, 1 066 revisions, 1979–2015

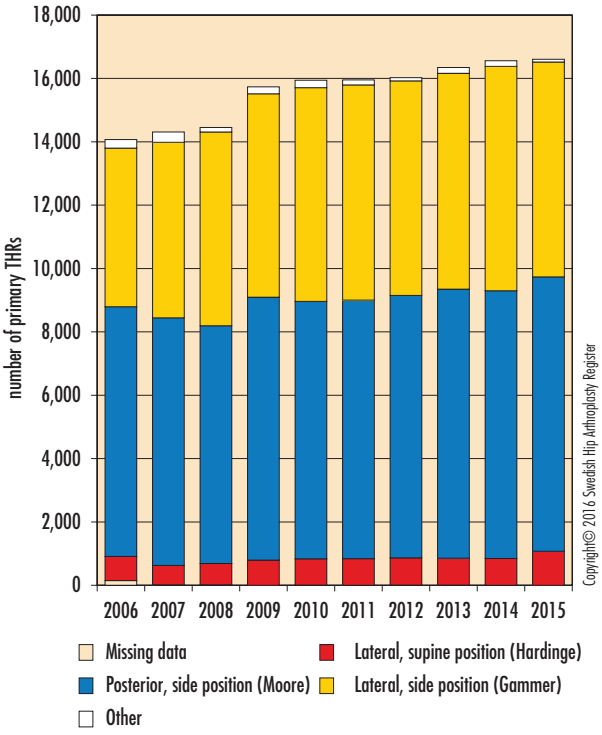


THRs with resurfacing implants

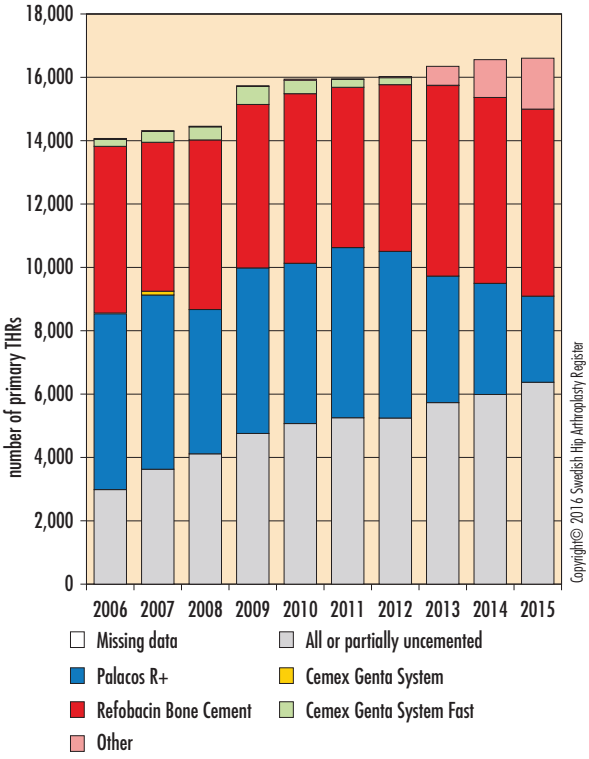
2 145 primary THRs, 1979–2015



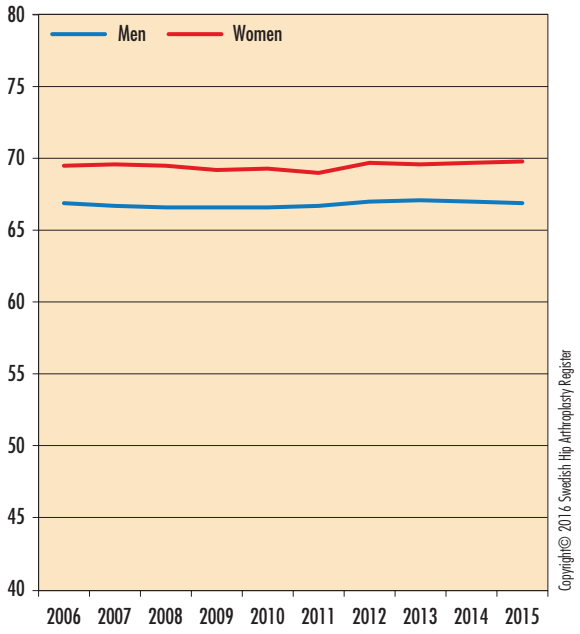
Surgical approach
2006–2015



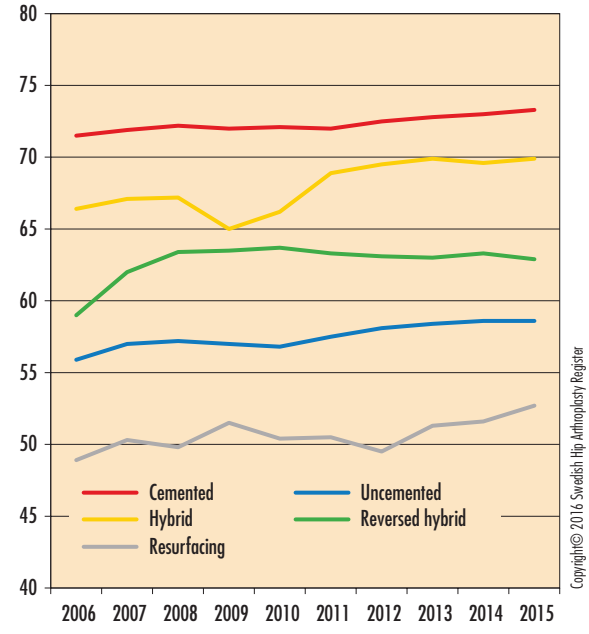
Type of cement
2006–2015



Mean age per gender
the past 10 years, 156 030 primary THRs

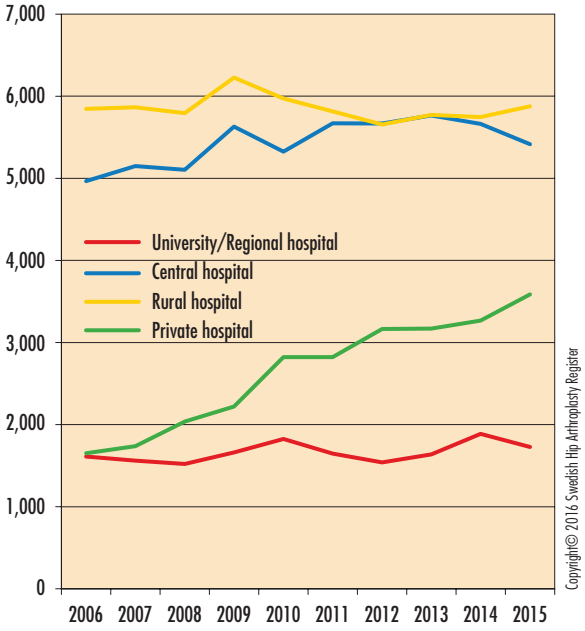


Mean age per type of fixation
the past 10 years, 156 030 primary THRs



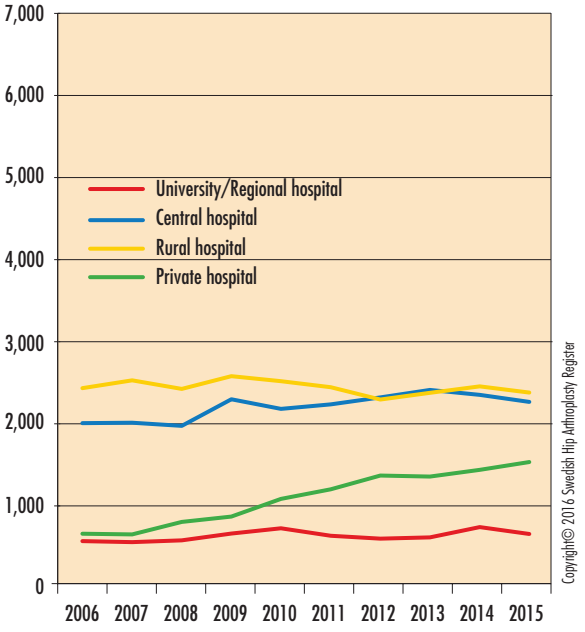
Trend in number of primary THRs

the past 10 years, per type of hospital



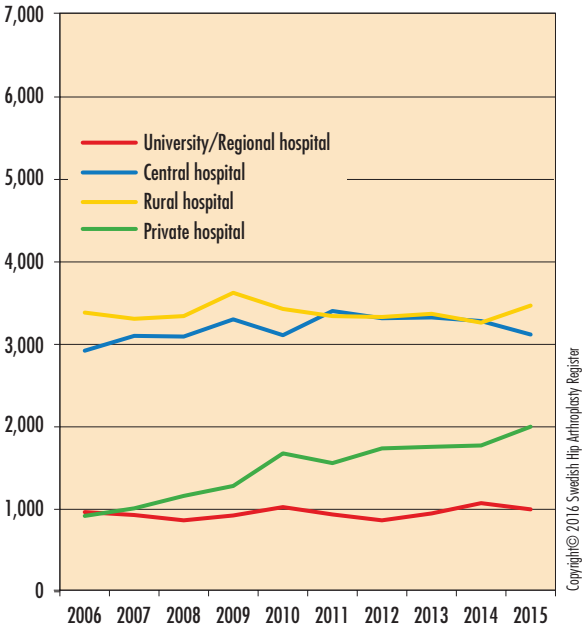
Trend in number of primary THRs

the past 10 years, men only



Trend in number of primary THRs

the past 10 years – women only



"New" primary prosthesis

In the 1980s, the Swedish Hip Arthroplasty Register won international recognition due to the possibility to track deviations on both the level of clinics and implants. In the end, this means a development of a more streamlined process concerning operations and a more rigorous selection of implants. The possibilities to identify deviations with a well-functioning register have been developed by many other registers. In Britain, an expert group called The Orthopaedic Data Evaluation Panel (ODEP) was formed to formulate new guide-lines for assessment of new implants. The developed criteria have received international acclaim. A similar organization can also be found in the Australian Arthroplasty Register. In ODEP, the degree of evidence is divided into several classes. The highest level (10A*) in this rating means that at least 500 hip replacement surgeries were performed in more than three centres, or by more than three different surgeons ~~and those~~, who had not been involved in prosthetic development and follow-up should should exceed 10 years. The proportion of revisions must be less than 5% or the implant survival must be 90% or higher according to Kaplan-Meier. Indication for revision and number of deaths should be known. Up to 20% missing observations ("lost to follow-up") are accepted. After at least 10 years of follow-up, the proportion of revisions must be less than 5%. A similar system exists in the Australian Arthroplasty Register where you divide the evaluation in three stages. The first stage consists of an automated screening, where the prostheses, which are compared with all others in the same group, and present a double risk of revision, are identified. In the second stage, those prostheses are examined, which have been discarded as deviant regarding possible causes for worse outcomes, for example abnormal patient selection. Detailed statistical analyses are also carried out. If necessary, an expert panel can carry out further analysis before the presentation in the register's annual report (for details, refer to www.odep.org.uk and *Acta Orthop 2013;84(4):348–352*).

In Sweden, we have had a restrictive approach towards replacement of standard implants for more than 20 years. This has been a very successful approach even if, in isolated cases, the introduction of new, and in some cases, better materials or implants have been delayed. Today, there are no preclinical tests that can safely determine, whether a new prosthesis functions better or worse that the existing one. The prostheses currently used in Sweden are of a very high standard, and in only selected patient groups could further implant development make a difference. Change of a standard implant also means taking a certain risk, because new procedures need to be learned. Against this background, it seems obvious that the replacement of implants should only be done in cases where there is a clinical need and the replacement implant has documented benefits. Service and price also play a role, though usually the price represents a small part of the total cost.

The procedure surrounding the implant evaluation is not simple and obvious. Most registers use revision for any reason and regardless of which component should be revised as an outcome. Some registers multiply the number of observed components with the number of observation years, which means that no attention is paid to the fact that causes for revision vary over time. Considering the way comparison with other prostheses is made, the comparison group can be comprised of all other implants, all other implants in the same product category or a selected reference group. So far, there has been no established standard. Such a standard is also not easy to achieve because the circumstances vary greatly between different registers with respect to the total number of observations, the number of implants used in the register's coverage area, the monitoring of the follow-up duration, and the extent of the individual register's data capture.

This year's follow-up of "new" implants, we have used same selection principles for the reference group as last year. Similarly, to previous analysis, the outcome is not all types of revision. Upon evaluation of the cup, the change of cup and/or liner and a definitive extraction are seen as outcomes, regardless if the stem is changed or not. The same principle applies to evaluation of the stems. Revisions due to infection have been excluded, as this outcome mainly reflects the care process and patient composition. The control group consists of prosthetic components, where at least 50 cases have been followed for at least ten years. To be included in the control group, the implant survival at ten years should exceed 95%. Furthermore, at least

Composition of control groups

Type of component *period for analysis*	**Number**	**Prosthesis survival after 10 year, 2 SEM***
Cemented cup *2005–2015*		
Contemporary Hooded Duration	7,064	96.1 *1.4*
FAL	3,648	96.3 *1.0*
Lubinus	50,342	97.6 *0.3*
ZCA	1,747	96.5 *1.4*
All	**62,801**	**97.4** ***0.3***
Uncemented cup *2004–2015*		
Allofit	1,503	98.4 *1.0*
Trident AD WHA	1,277	96.9 *1.4*
Trilogy±HA	7,796	98.3 *0.5*
All	**11,983**	**98.1** ***0.5***
Uncemented stem *2003–2015*		
ABG II HA	2,928	97.1 *0.7*
Accolade Straight	1,901	96.7 *1.8*
Bi-Metric X Por HA	7,605	98.0 *0.4*
CLS	10,339	98.0 *0.4*
Wagner Cone	1,398	98.5 *1.0*
All	**24,171**	**97.8** ***0.3***

** and stem survival, respectively, excluding the revisions due to infection*

Table 1. Implant in the control groups in the analysis of "new" implants in Table s 2 and 4. For cups, only the cup revisions are included, and for stems, only the stem revisions are included.

50 implants must have been inserted in conjunction with hip replacement surgery during the past two years.

The implants which are included in each control group are presented in Table 1. An implant is defined as new if less than 50 implants are reported in a 10-year follow-up period. Additionally, the number of prostheses, which were reported to the register in 2014–2015, must exceed 50 . Several of these implants have a longer documentation abroad, but because the coverage and the risk of revisions can vary between countries,

Follow-up, number of revisions and implant survival for "new" cups

	Stating year*	Number		Follow-up in number of years	Cup revisions#, number %		Prosthesis survival# cup/liner, *2 SEM.*	
		Total	*After 2 years*	**mean,** *max*	*Total*	*≤ 2 years*	*2 years*	*5 years*
Cup cemented								
Avantage Cemented	**2006**	**1,578**	**412**	**2.0** ***10***	**25** ***1.6***	**20** ***1.3***	**98.4** ***0.7***	**97.6** ***1.2***
Exceed ABT E1 no flange	2011	351	206	2.4 4.7	2 0.6	0 0.0	100 0.0	–
Exeter X3 RimFit	2010	8,324	4,073	2.2 5.3	15 0.2	12 0.1	99, 8 0.1	99.7 0.2
FAL X-linked	2011	265	166	2.7 4.8	0 0	0 0	100 0.0	–
Lubinus X-linked	2010	13,218	4,944	1.4 5.0	34 0.3	28 0.2	99.6 0.2	–
Concentric X-linked IP¤	**2011**	**582**	**130**	**1.4** ***4.8***	**5** ***0.9***	**5** ***0.9***	**98.9** ***1.0***	–
Marathon XLPE	2008	13,793	9,495	2.6 *6.2*	50 *0.4*	30 *0.2*	99.7 *0.1*	99.5 *0.2*
Polarcup	2010	437	120	1.92 *5.9*	2 *0.5*	1 *0.5*	99.5 *0.7*	–
ZCA XLPE	**2006**	**14,295**	**10,127**	**4.3** ***10.0***	**174** ***1.2***	**103** ***0.7***	**99.2** ***0.2***	**98.6** ***0.2***
Low Profile Cup (Müller)	2008	160	26	5.2 *7.6*	1 *0.6*	0 *0*	–	–
Control group	2006	55,617	47,254	4.8 *10.0*	647 *1.2*	232 *0.4*	99.6 *0.1*	99.0 *0.1*
Cup uncemented								
Continuum	**2010**	**2,796**	**1,322**	**2.1** ***5.8***	**34** ***1.2***	**30** ***1.1***	**98.7** ***0.5***	**97.9** ***1.0***
Delta Motion	2011	188	118	2.7 *4.9*	0 *0*	0 *0*	100 *0.0*	–
Delta TT	2012	267	79	1.5 *4.1*	2 *0.7*	2 *0.7*	98.9 *1.5*	–
Exceed ABT Ringloc	2011	1,136	576	2.1 *4.8*	4 *0.4*	4 *0.4*	99.6 *0.4*	–
Pinnacle 100	2007	1,729	1,120	3.1 *8.9*	20 *1.2*	9 *0.5*	99.2 *0.5*	98.3 *1.1*
Pinnacle sector	2006	639	351	3.9 *10.0*	9 *1.4*	3 *0.5*	99.5 *0.6*	98.6 *1.2*
Pinnacle W/Gription 100	2011	1,255	235	1.3 *4.3*	9 *0.7*	8 *0.6*	99.2 *0.6*	–
Pinnacle W/Gription sector	2014	160	–	0.7 *2.0*	0 *0*	0 *0*	–	–
R3	2014	59	–	0.8 *1.9*	0 *0*	0 *0*	–	–
Regenerex	2008	675	393	2.6 *6.6*	4 *0.6*	1 *0.1*	99.3 *0.8*	99.0 *1.0*
TM revision	**2008**	**397**	**259**	**2.9** ***8.0***	**9** ***2.2***	**8** ***2.0***	**97.8** ***1.5***	**96.4** ***3.1***
Trident AD LW	2004	784	608	5.0 *11.8*	12 *1.5*	7 *0.9*	99, 0 *0.8*	98.2 *1.1*
Trident hemi	2005	2,684	1,480	3.2 *10.6*	20 *0.7*	6 *0.2*	99.6 *0.3*	99.0 *0.6*
Trilogy IT	**2012**	**854**	**245**	**1.4** ***3.2***	**18** ***2.1***	**17** ***2.0***	**97.3** ***1.4***	–
Tritanium	2010	549	360	2.9 *6.0*	5 *0.9*	2 *0.4*	99.3 *0.8*	–
Control group	2004	11,353	9,685	6.0 *12.0*	146 *1.3*	77 *0.7*	99.3 *0.2*	98.9 *0.2*

** The first year when more than 10 implants were used*
 # all causes apart from infection; data is presented only for at least 50 observations
¤ Also called Lubinus IP

Table 2. Cups which were introduced on the Swedish market from 2004 and onwards and which have been used for more than 50 hip arthroplasties during the past two years as well as they have been in use in 2014–2015. Bold text indicates that the outcome differs from the worse outcome in the group "other" (log rank test).

Follow-up, number of revisions and prosthesis survival for "new" stems

	Starting year*	Number		Follow-up mean	Stem revisions#, number %		Prosthesis survival¤ stem, 95% KI	
		Total	After 2 years	Max years	Total	≤ 2 years	2 years	5 years
Stem uncemented								
Accolade II	2012	970	249	1.4 *3.9*	1 *0.1*	1 *0.1*	99.9 *0.2*	–
CFP**	**2000**	**455**	**372**	**5.3 *15.8***	**17 *3.7***	**10 *2.2***	**97.6 *1.5***	**96.7 *1.8***
Corail *all*	2005	15,913	7,850	3.2 *11.0*	147 *0.9*	114 *0.7*	99.2 *0.1*	98.8 *0.2*
Standard	2006	10,353	10,134	3.2 *10.0*	98 *0.9*	84 *0.8*	99.1 *0.1*	98.8 *0.3*
Coxa vara	2006	2,339	1,451	3.1 *9.9*	17 *0.7*	11 *0.5*	99.4 *0.3*	99.1 *0.5*
High offset	2006	3,108	2,028	3.2 *10.0*	32 *1.0*	19 *0.6*	99.3 *0.3*	98.5 *0.5*
Echo Bi-Metric	2013	78	13	1.0 *3.0*	1 *1.3*	1 *1.3*	–	–
Fitmore	2009	305	223	3.2 *6.8*	6 *2.0*	5 *1.6*	98.3 *1.4*	–
M/L Taper	2012	775	270	1.6 *3.8*	1 *0.1*	1 *0.1*	99.8 *0.4*	–
Control	2003	24,171	19,615	5.4 *13.0*	367 *1.4*	257 *1.1*	98.8 *0.1*	98.5 *0.2*

** The first year when more than 10 implants were reported, control groups starting year is arbitrarily set at 2003*
 # all causes excluding infection
¤ data is presented only for at least 50 observations
*** 16 cases in 2000, 2–10 cases during 2001–2006, >10 cases/years 2007–2015*

Table 3. Stems, which were introduced on the Swedish, market from 2000 and which have been used for more than 50 hip arthroplasties during the past two years as well as they have been in use in 2015. The implant survival has been calculated if the number of observations exceeds 50. No stems differ significantly for the worse in comparison with the group "other" (log rank test).

we believe that a domestic analysis is interesting and of value. Regarding cemented stems, there is no design that meets the criteria for the "new" prosthesis. The starting year, as indicated in Table 2 and 3, corresponds to the first year when more than 10 prostheses of the relevant type were inserted. All data is applicable from this year. Single prostheses inserted before "starting year" have thus been excluded. In the control group, the starting year has been set according to the first year of the observation group under the heading "new" implant. In the control group for "cemented cup", all implants are manufactured of older polyethylene. In the group for "uncemented cup", the corresponding proportion of older standard polyethylene is significantly lower (6.8%). Table 5 indicates the number of units that use a specific implant in the observation group at more than 10 and 50 hip replacement surgeries, respectively, to get an idea of the implant distribution in the country.

Most of the cemented cups in the observation group show an early implant survival with respect to the cup revision, which is comparable to the control group and in some cases, slightly higher (Exeter X3 RimFit, Marathon XLPE). Three of the implants (Avantage, Concentric X-linked IP, ZCA XLPE) differ significantly for the worse. In Avantage group, the cause for revision is dislocation in half of the cases, which may seem surprising. The proportion of revision due to periprosthetic fracture is also relatively high. This complication pattern fits well with a large proportion of patients with hip fracture in this group (61.7%, Table 4). The slightly worse result for Avantage could thus be explained by the fact that a large proportion of these patients has received dual articular cup because preoperative assessment concluded that the risk of dislocation is increased (refer also to Annual Report 2014).

The concentric IP cup has the same structure on the convex surface as the Lubinus cup and, after two years, it has worse performance than the control group. There are only five cup revisions, all of which were revised due to dislocation or a "technical" cause, where one can suppose that surgical technique or patient selection may have had an influence. The proportion of patients with hip fracture in this group is also significantly larger than in the control group.

Similarly to the last years' analysis, the ZCA XLPE cup shows a higher risk for revision. Compared with the control group, the implant survival is only 0.4% lower, resulting in a statistical significance due to the large number of observations. Table 4 shows that this implant has a relatively high proportion of revision for dislocation. In the control group, 43.7% of cup revisions with non-infectious genesis were performed due to dislocation, equivalent to 0.7% of all inserted cups from 2006. The corresponding proportion for ZCA XLPE is 60.3% (0.9% of total). If the apparently increased risk of revision

for dislocation in the ZCA XLPE group has something to do with its design, then assessment cannot be made on the basis of register data, but the occurrence of a greater proportion of revisions for dislocation may be of value to know for those who use this cup.

Among the uncemented cups, Allofit Alloclastic has disappeared from the analysis, because the use of those cups had decreased to below 50 cups during the past two years. Trident AD WHA belongs to a control group, where more than 50 cups are followed for more than ten years, while the prostheses survival is over 95%. As in previous years' analysis, Continuum and TM modular differ significantly from the control group. The same goes for Trilogy IT. All of these cups have a surface area of trabecular metal. Table 4 shows that the most common reason for revision in all three cases is dislocation (82–100% of all revisions in each group). The reason for this observation is unknown. Possibly may these implants, because of their high friction, be more difficult to position.

Internationally, separate studies have expressed some concern about the occurrence of radiolucent lines around cups of trabecular metal. This has mainly concerned design with trabecular titanium surface, like Pinnacle/Gription, Regenerex and Tritanium. However, in our analysis, the implant survival is within expected levels, although the follow-up time is still very short.

In this year's analysis of "new" stems, there are mainly uncemented versions. However, there is one new cemented stem. Since 2013, in Sweden, 56 operations with the Sirius stem were reported, all were inserted in one and the same hospital. The average follow-up time is short, 1.3 years (maximum value = 2.0 years). So far, none of these stems have been revised.

The control group to the new uncemented stems has been expanded with the Accolade Straight that shows a ten-year survival of 95%. Echo Bi-Metric is a new addition, which including all its variations comprises more than 50 implants for the period 2014–2015. Many of the uncemented stem types (Corail standard, Corail coxa vara, Accolade II and M/L Taper have a slightly higher implant survival based the stem revision where all causes, apart from infection, were compared to the control group (log-rank test: p=0.07–0.03). M/L Taper and Accolade II have only been on the Swedish market since 2012. It should be noted that any effects, deriving from the fact that patient groups are not strictly comparable, have not been considered in this evaluation.

One of the stems, CFP, has a poorer implant survival compared with the control group. This stem is revised more due to loosening. Table 4 shows the most obvious causes in the group "others", where loosening within two years has been included. Seven of the ten in the group "others" have been revised due to early loosening, which means that in total 12 of 17 revisions were caused by this complication. These 12 represent less than 3% of all inserted stems, but since loosening is a relatively rare complication after the insertion of an uncemented stem, the difference is significant (log-rank: p<0.0005). Patients who had surgery with CFP-stem are slightly younger than in the control group, are more often male and have more often osteoarthritis. Adjusting for these variables, we find that the risk of stem revision due to non-infectious causes is almost three times greater in the selection of the CFP, compared with the control group (RR=2.8 *1.7–4.6, p<0.0005*).

In a review of the spread of the implants that are considered new and are not yet sufficiently documented in the Swedish market, we find that a surprising number of clinics are using

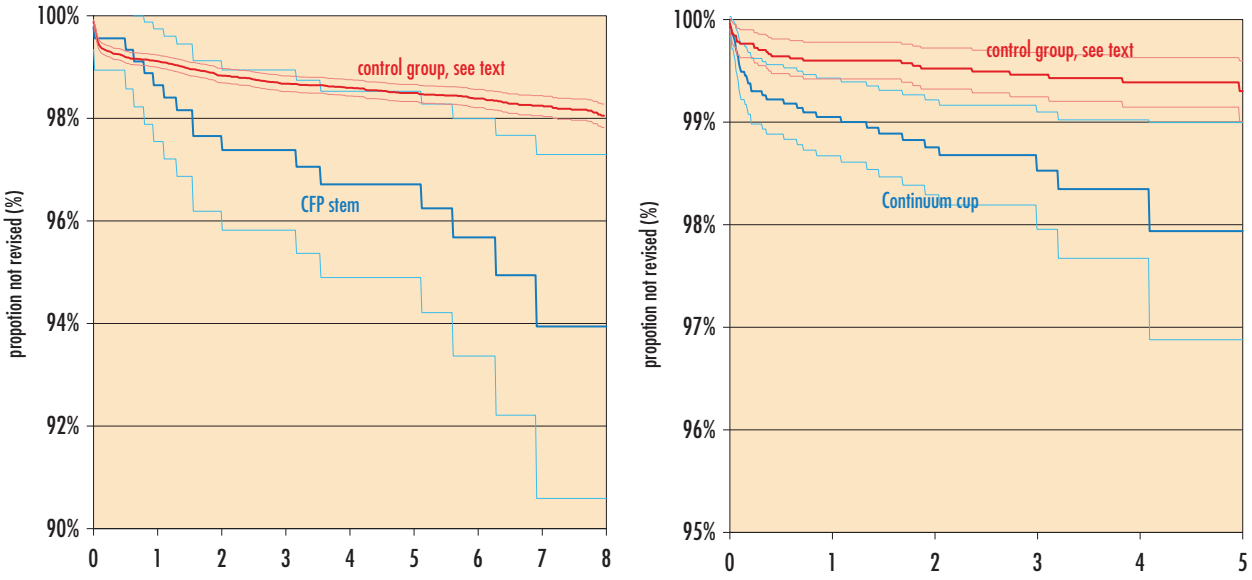


Figure 1. Survival chart for two "new" or so far badly documented implants in Sweden (CFP stem on the left, Continuum cup on the right). Both show an increased revision risk in comparison to a control group.

these implants, even in very small quantities. In Table 5, there are examples of new implants that are only used at a few clinics (for example R3 Cup), while some others are used in a few patients at many clinics (for example TM revision). However, it may be that an implant that is often used in the revision context, in individual cases and under special indication, is used in a primary operation. It should also be noted that some implants have solid documentation based on data from foreign registries and studies. One such example is the Corail stem which has been used for a long time in Norway. An interesting observation regarding the choice between Corail-stem's three main variants (standard, coxa vara, high offset) is the large spread between different clinics. Prosthesis CCD angle and offset are generally determined by the preoperative planning and the choice is based primarily on the hip joint anatomy. The proportion for coxa vara and the high offset prostheses varies between 0 and 54 and 0 and 66% respectively of the total number of used Corail stems in the Swedish hospitals, which performed at least 100 surgeries. This would mean that some hospitals do not consider all variants necessary.

During the past decade, mostly new uncemented cups and stems have been introduced in Sweden. Regarding the cemented cups, there has mainly been a transition to modern high-molecular polyethylene, which in single cases, also involved changes in the cup design. The majority of the new implants have a short survival in line with the control group. Two cemented (Avantage, ZCA XLPE) and three uncemented cups (Continuum, TM revision, Trilogy IT) have a significantly lower survival rate, where increased risk for revision due to dislocation seems to be main reason at least in four cases. One uncemented stem (CFP) has an increased risk for revision due to loosening and/or osteolysis. If the worse outcome for these four implants is determined by patients' composition, inadequate surgical technique or implant design and inherent properties cannot be assessed in this analysis.

Demographics and cause for revision for "new" cups and their control groups

Type of implant	Age	Sex	Diagnosis %	Cause for revision number % #			
	Mean SD	*Women %*	*Primary osteoarthritis/ fracture/Other secondary osteoarthritis*	*Loosening/ osteolysis*	*Dislocation*	*Periprosthetic fracture*	*Other**
Cemented cup							
Avantage Cemented	75.4 *11.4*	63.1	21.6/61.7/16.7	2 *(7.7)*	13 *(50.0)*	7 *(26.9)*	4 *(15.4)*
Konc. X-linked IP	74.7 *9.0*	67.9	54.8/36.1/9.1	–	3 *(60.0)*	–	2 *(40.0)*
ZCA XLPE	71.0 *9.1*	62.7	85.3/9.7/4.9	36 *20.7*	105 *60.3*	11 *6.3*	22 *12.6*
Control group	71.1 *8.8*	61.0	84.6/10.5/4.9	285 *44.0*	283 *43.7*	22 *3.4*	57 *8.8*
Uncemented cup							
Continuum	61.0 *10.7*	48.0	87.1/2.3/10.6	1 *(2.9)*	28 *(82.4)*	0 *(0)*	5 *(14.7)*
TM revision	58.9 *13.4*	44.7	67.5/4.4/28.2	0 *(0)*	9 *(100)*	0 *(0)*	0 *(0)*
Trilogy IT	63.6 *11.5*	45.7	85.9/2.8/11.3	0 *(0)*	16 *(88.9)*	2 *(11.2)*	0 *(0)*
Control group	58.7 *11.1*	48.9	81.8/4.3/13.9	36 *24.7*	73 *50.0*	14 *9.6*	23 *15.8*
Uncemented stem							
CFP	55.6 *9.2*	45.9	89.0/10.5/0.4	5 *29.4*	1 *5.9*	1 *5.9*	10 *58.8*
Control group	58.0 *10.3*	47.8	85.9/12.1/2.0	95 *24.7*	42 *10.9*	176 *45.8*	71 *18.5*

 # percentage in parenthesis when the number is <100
** excluding infection*

Table 4. Demographic data and the cause for the revision of the implants were analysed in Table 1 and have a significantly different or inferior implant survival or they are distinguished by a high number of the cup/liner revisions.

Number of hospitals which reported < 10, ≥ 10 and ≥ 50 inserted prosthetic components

2014–2015

Cemented cup	Number/hospital *<10/ ≥10/≥50*
ADES	9/4/0
Avantage Cemented	14/19/2
Exceed ABT E1 utan fläns	4/2/1
Exeter X3 RimFit	2/2/12
FAL X-linked	3/0/1
Lubinus X-linked	7/7/29
Koncentrisk X-linked IP	4/0/2
Marathon	5/6/12
Polarcup	1/4/1
ZCA XLPE	1/7/9
Low Profile Cup (Müller)	1/0/2
Control group	**6/12/26**

Uncemented cup	Number/hospital *<10/ ≥10/≥50*
Continuum	13/5/7
Delta Motion	3/2/0
Delta TT	1/4/1
Exceed ABT Ringloc	0/1/2
Pinnacle 100	4/6/2
Pinnacle sector	3/3/1
Pinnacle W/Gription 100	7/9/5
Pinnacle W/Gription sector	4/2/1
R3	0/0/1
Regenerex	2/2/2
TM revision	9/1/1
Trident AD LW	0/3/1
Trident hemi	1/1/3
Trilogy IT	3/0/3
Tritanium	2/3/2
Control group	**4/2/7**

Uncemented stem	Number/hospital *<10/ ≥10/≥50*
Accolade II	0/3/2
CFP	1/2/0
Corail *all*	5/11/27
Standard	3/17/20
Coxa vara	9/15/4
High offset	8/20/4
Echo Bi-Metric	3/2/0
Fitmore	2/2/0
M/L Taper	6/2/3
Control group	**15/13/24**

Table 5. Number of hospitals which reported less than 10, 10–49 and more than 50 inserted implants during the period of 2014–2015.

Highly cross-linked polyethylene

Polyethylene which is radiated with a high dosage in order to induce additional cross-linkages between molecular chains, and is subsequently heat-treated in order to reduce the amount of free radicals, is called a highly cross-linked polyethylene in analogy with the English term ”highly cross-linked”. The term ”high-molecular-weight polyethylene” has also been used, but was actually introduced during the 1970s, when the molecular weight of polyethylene was gradually increased in order to improve its wear resistance. In Sweden, the first operation with highly cross-linked polyethylene cup was carried out in 1998. This was a cemented cup entirely made of polyethylene on a study patient, and until 2005, this type of polyethylene was used in cemented cups or liners in less than 25 cases per year. In 2006, 277 operations were registered and thereafter, there has been a continuous increase until 2015, when 77.7% of the cemented cups were produced of different versions of highly cross-linked polyethylene (Figure 1). During 2000, the use of polyethylene implants (liner) of high-molecular-weight polyethylene was first registered. During the following three years, the number of registered liners made of highly cross-linked polyethylene was under 100 per year, but began to rise in the following years. In 2015, there were only 34 operations registered, where older or unknown quality polyethylene was used in the liner. Of the cemented cups inserted with the newer type of plastic in 2015, 78.5% were of highly cross-linked polyethylene. Most used was X-linked, Link (38.8%), X3, Stryker (16.6%), Marathon, DePuy (14.2%) and Longevity, Zimmer Biomet (7.6%). Almost all plastic inserts were made of high cross-linked polyethylene. In percentages, the most used polyethylene in all uncemented cups, were Longevity, Zimmer Biomet (32.8%), X3, Stryker (21.6%), Marathon, DePuy (19.9%) and E-poly, Zimmer Biomet (11.7%).

Today, there is an excellent documentation, which shows that the new polyethylene really does reduce wear in a 10-year perspective for many of the different types of polyethylene, which can be found on the Swedish market. Regarding clinical studies, it has also been possible to document that in some cases, there is a reduced incidence of osteolysis, while the register studies, which research the revision risk, show a reduced risk in some cases, and in other cases, no difference in comparison to older polyethylene types. The follow-up period in these studies varies between five and just over ten years. In cases, where different cup designs are studied separately, there is a variation, so that the newer polyethylene type reduces the revision risk for certain designs, but not for others. It is not clear why this variation occurs, but different follow-up periods and differing quality of the polyethylene, mainly in the control group where the older type of polyethylene is used, plays a role. Certain polyethylenes, for example where the vitamin E is included to neutralize free radicals, lack documentation up to ten years. Today, there is nothing to suggest that this type of plastic would have any advantages or disadvantages compared to previous generations of highly cross-linked polyethylenes. Given that there is such a good documentation in regards to the first generation of highly cross-linked polyethylene, there may be a reason to postpone switching to even newer polyethylenes before there is reliable scientific evidence supporting the latest generation of polyethylenes. In total, for example, the liner produced of E-poly or Vivacit E was used during 670 operations during 2015 in Sweden. Although some of these were included in different studies, the numbers are still surprisingly high.

Data from the Australian and the English hip arthroplasty registers indicate that the new polyethylene reduces the risk for revision, although this has not been demonstrated for all implants studied. Generally, all types of revisions are presented, regardless of cause and which prosthesis part was revised. Since the new polyethylene is introduced with the hope of reducing the risk of wear and impact, we have, in our analysis, focused on the cup revision irrespective of cause and cup revision due to loosening, where even osteolysis and wear are included.

This year’s analysis starts the observation period with the first year, when the respective types of cups, produced of highly cross-linked polyethylene, were taken into use. The comparison

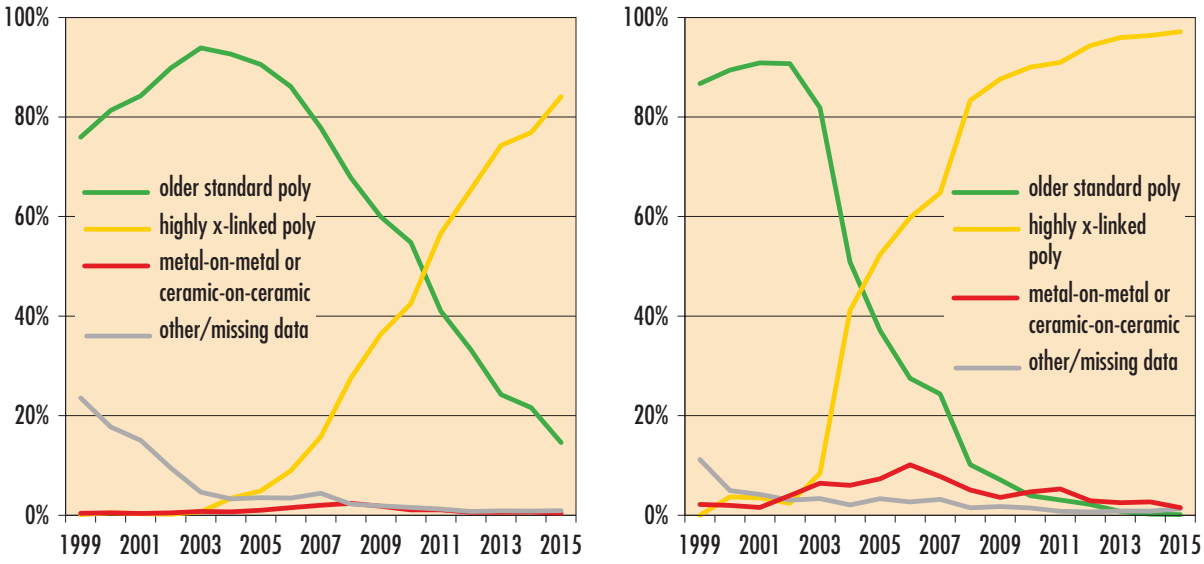


Figure 1. Number of operations where the cup or liner was made from older standard polyethylene or with additional cross-links, with or without cement.

between Exeter (older standard polyethylene) and Exeter X3 RimFit (highly cross-linked polyethylene) is, however, and exception. The reason is that the change between Exeter and Exeter X3 RimFit was conducted over a short period of time (2010–2011) when only 268 cups of the old version were used. In order to have enough representatives in the control group, the starting year has arbitrarily been set for 2005, the first year when any of the cemented sockets was taken into use. Regarding the combined groups of cemented and uncemented cups which include all five group comparisons of cemented and four of the uncemented cups, the comparison starts on the first year when any of the cups were used with the new polyethylene. The three uncemented cups, which are included in the same group analysis, have more than 150 observations in the smallest group, which was always the group for older standard polyethylene. In the other cases, the number of observations in the smallest subgroup is too small for a meaningful evaluation.

In the first comparison of separate cemented cups, we find that three of the five designs (Reflection all-poly, Elite Ogee/ Marathon XLPE, Exeter/Exeter X3 RimFit) constitute a reduced risk for cup revision, regardless of the cause. In the comparison between different polyethylenes in Reflection all-poly, Lubinus and the combined group, there is a reduced risk for cup revision due to loosening. The cause for these varied results cannot be determined. Further in-depth analysis of separate design levels is hampered by the fact that the use of femoral head's size and material, and the stem fixation, are unevenly distributed and also, have varied over time. To the extent that it is possible to implement a statistical adjustment, the differences disappear.

In order to get a rough understanding, we have in this year's report based our analysis on the combined group where there is a good proportionality over time. In a Cox regression analysis, we have adjusted for age, sex, diagnosis, year of operation, caput material and diameter with stem fixation. Only cases with 28 and 32 mm caput diameter are included. After the selection procedure, 65,209 cemented cups made of the older polyethylene and 48,113 cemented cups produced of highly cross-linked polyethylene remain. The analysis indicates no significant difference between the two groups whether using revision regardless of cause and type of procedure, cup revision regardless of cause or cup revision due to loosening/osteolysis as outcomes (RR value in the use of cup revision due to loosening or osteolysis as outcome: older/newer polyethylene = 1.1, *95% CI 0.9 1.5, p = 0.3*). If the two first years, where revisions due to infection and dislocation dominate, the risk for cup revision due to loosening and/or osteolysis when using older polyethylene, increases (RR=1.6, *1.1–2.2, p=0,01*), while the risk for cup revision regardless of cause and the risk for revision regardless of measure and cause don't show a significant difference (cup revision all causes: RR=1.2, *0.98–1.6, p=0,07*; all types of revision, all causes: 1.1, *0.9–1.3, p=0,3*).

In comparisons between uncemented cups, we find, that the choice of highly cross-linked polyethylene appears to reduce the risk for cup/liner revision regardless, if the Trilogy cup is analysed separately or if the other three implants are also added. In Figure 2 (on the right), it is shown that during the first years, there is no difference between older and newer polyethylene in regards to cup revisions due to loosening, osteolysis and wear (routinely combined to a cause group in the Hip Arthroplasty Register). After about four years, the new polyethylene seems to take advantage. Due to this, we have stratified the analysis so, that it starts at four years when early revisions due to loosening are a question of technology rather than an effect of the polyethylene quality. After a selection of prostheses which have been inserted with 28 or 32 mm femoral head, and hip prostheses which are followed during at least four years, 2,719 cups with an older type liner and 6,560 cups with a newer type liner remain. As in the previous analysis, we adjusted for age, sex, diagnosis, year of operation, caput material and diameter and stem fixation. The risk of revision regardless of cause and measure, as well as cup revision regardless of the measure do not differ in terms of safety. The corresponding analysis based on cup revision due to loosening, osteolysis and/or wear, show an increased risk of older standard polyethylene (RR = 2.8, *1.2–6.7, p = 0.02*).

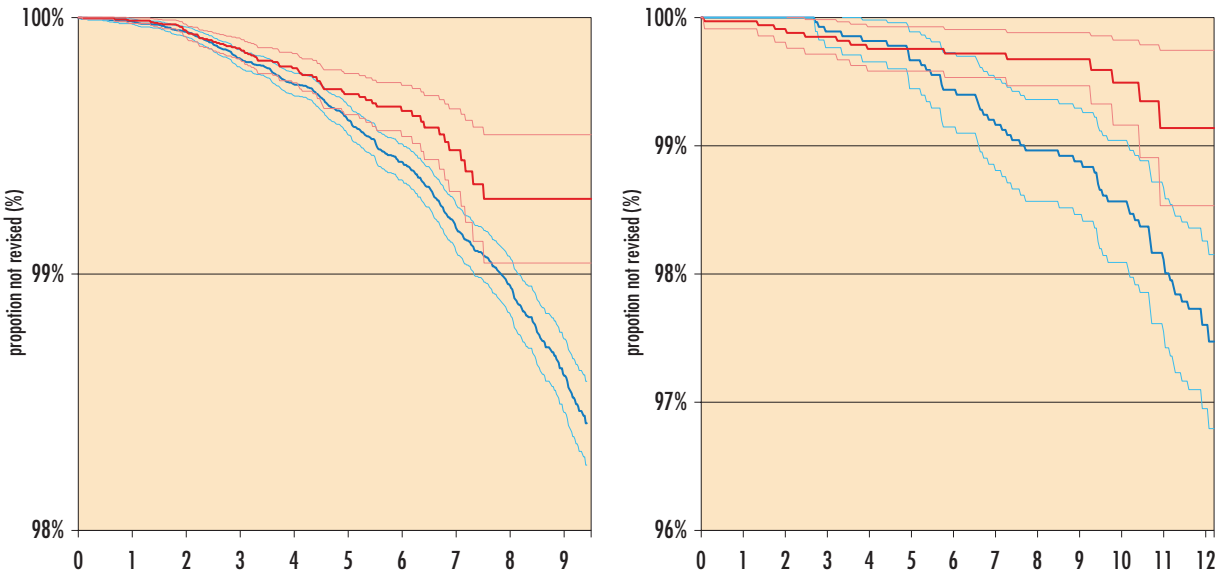


Figure 2. Implant survival based on cup revision due to loosening or osteolysis for the five types of cemented (on the left) and four types of uncemented cups (on the right). The cups included are reported in Table 1. Control group is illustrated by blue lines and the study group (highly cross-linked polyethylene) with the red line.

Cup survival with older or newer highly cross-linked polyethylene

	Starting years	Number		Survival with cup/liner revision		Log rank test
	Actual analysis	*At start*	*During the end/ length of the observation period**	*All causes % ± 2SEM*	*loosening-osteolysis % ± 2SEM*	*All causes/ loosening-osteolysis, p-value*
Cemented cup						
ZCA						
older plastic	2005	1,747	447/9.4 år	96.9±1.4	98.5±1.0	0.96/0.06
highly cross-linked polyethylene	2005	14,306	110/9.4 år	97.5±0.4	99.4±0.3	
Reflection all-poly						
older plastic	2006	1,448	537/8.5 år	91.2±1.8	93.2±1.8	<0.0005/<0.0005
highly cross-linked polyethylene	2006	1,720	114/8.5 år	97.3±1.0	98.3±0.8	
Elite Ogee/Marathon XLPE						
older plastic	2008	2,447	1,113/6.9 år	98.4±0.6	99.5±0.3	0.03/0.6
highly cross-linked polyethylene	2008	13,793	128/6.9 år	99.1±0.2	99.7±0.2	
Lubinus¤						
older plastic	2010	22,400	6,112/4.8 år	98.8±0.2	99.7±0.1	0.08/0.03
highly cross-linked polyethylene	2010	13,242	105/4.8 år	99.1±0.7	99.9±0.1	
Exeter/Exeter X3 RimFit						
older plastic	2005	4,203	3,597/5 år	98.6±0.4	99.7±0.2	<0.0005/0.16
highly cross-linked polyethylene	2005	8,324	124/5 år	99.5±0.2	99.9±0.1	
All cemented above						
older plastic	2005	65,297	9,992/9.5 år	97.0±0.2	98.3±0.2	0.17/0.002
highly cross-linked polyethylene	2005	51,391	101/9.5 år	98.1±0.4	99.3±0.2	
Uncemented cup						
Trilogy±HA#						
older plastic	2000	2,146	1,198/12.2 år	94.5±1.0	97.5±0.7	0.17/<0.0005
highly cross-linked polyethylene	2000	8,147	105/12.2 år	96.2±0.8	99.2±0.6	
Trilogy, Allofit, Trident hemi, Ranawat Burstein						
older plastic	2000	2,937	1,466/12.2 år	94.7±0.9	97.5±0.7	0.14/<0.0005
highly cross-linked polyethylene	2000	12,394	106/12.2 år	96.4±0.8	99.2±0.6	

** by the end of the observation time, at least 100 remaining hips are necessary in the smallest group # excluding IT option ¤excluding IP*

Table 1. The outcome is cup revision with or without stem revision regardless of the cause, and due to loosening or osteolysis. Allofit, Trident hemi and Ranawat Burstein are not reported separately due to few observations in each subgroup (refer also to the introductory text).

After a follow-up period of almost ten years for cemented and 12 years for uncemented cups, we can with relative certainty say, that the quality of polyethylenes, which mainly consist of first generation polyethylenes with additional cross-links, do not show any negative effects which result in the form of revision. Analysis of the observation period in the latter part, from two and four years cemented and uncemented cups, respectively, suggests that the first generation of new polyethylenes really addresses the problems they were supposed to solve. Against this background, it may seem remarkable that the polyethylenes developed further, in order to further improve the durability of the material, are used extensively, although the clinical documentation is still lacking.

Femoral head size and risk of dislocation

Charnley prosthesis' small (femoral head) with a diameter of 22 mm was designed so that femoral friction and contact surface against the polyethylene is reduced, which constitutes less friction and reduced amount of wear particles. However, the use of small femoral heads was not a common practice among other prostheses producers due to higher risk of dislocation. During the 1970's, it was uncommon in Sweden to use prostheses where the femoral head exceeded 32 mm. In the 1980's, femoral heads with 22 and 32 mm diameter dominated in Sweden. During the early 1990's, an increasing number of clinics changed to 28 mm femoral heads, probably because a study by Livermore and colleagues got a great response from the Swedish surgeons (*J Bone Joint Surg (Am) 1990;72(4):518–528*). The authors observed more wear during the use of 22 mm in comparison to the 28 mm caput and more osteolysis during the use of 32 mm in comparison to 28 mm caput.

Introduction of new, more wear-resistant polyethylene in the 2000s, enabled to start using larger femoral heads since the problem of osteolysis was reduced. The theoretical advantage of a large femoral head is the reduced risk of dislocation, as long as the cup and stem are positioned correctly. The importance of the size of the femoral head is the smaller, the steeper the cup opening is positioned in relation to the body's longitudinal axis.

From year 2005, we see an increased use of mainly 32 mm, but also, albeit to a lesser degree, of 36 mm femoral head (Figure 1). Regarding 36 mm caput, the increase is much greater when using uncemented (from 2.1% in 2005 to 23.6% in 2015) compared to cemented cups (0.0% to 5.0% during the same period, Figure 2).

The purpose of this in-depth analysis is to get an idea whether there is any difference between the different choices of femoral head sizes and the risk of revision for dislocation. Revision due to dislocation is an early complication. Between 1992 and 2015, 0.9% (2666 revisions) of primary prostheses were revised for this reason. 42.1% of these revisions were carried out in the first and 9.8% in the second year after the primary operation. The two following years reduced the proportions to 5.9 and 5.6%, respectively, and the decrease continued for the next 20 years to 0.1% during the last observation year, 24 years after the primary operation. Given that 32 and 36 mm femoral heads have a maximum observation period of about ten years and that the revision due to dislocation is a complication that often occurs early, we have, in this analysis, maximized the observation period to four years. Only conventional articulations with metal or ceramic femoral head as articulates with a polyethylene liner or polyethylene cup, have been included. Dual articular cups have therefore been excluded. The first inclusion year is 2005. To reduce selection bias, the analysis includes only two diagnostic groups, patients with primary osteoarthritis (135,235 primary arthroplasties) or hip fracture. In the hip fracture group, both acute fractures (n=11,696) and surgeries due to hip fracture complication (n=3,190) are included in order to increase the number of observations. In the assessment of the evaluation results, one must be aware that the differences between the groups caused by, for example, the fact that the 36 mm femoral head might preferably be used in patients with increased susceptibility for dislocations, have not taken into account because this information was missing.

Demographics – analysis of femoral head size

	Primary osteoarthritis	Hip fracture*
Mean age *SD*	68.9 *9.8*	75.0 *9.1*
Women %	57.3	69.7
Caput diameter n/%		
28 mm	66,237/*49.0*	7,393/*49.7*
32 mm	62,096/*45.9*	6,906/*46.4*
36 mm	6,866/*5.1*	587/*3.9*
Cup *cemented* %	83.0	95.2
Stem *cemented* %	73.3	91.2

** acute hip fracture and complication after hip fracture*

Table 1. Patients (hips) with osteoarthritis or acute hip fracture/ complication following hip fracture included in the analysis of femoral head size and revision due to dislocation.

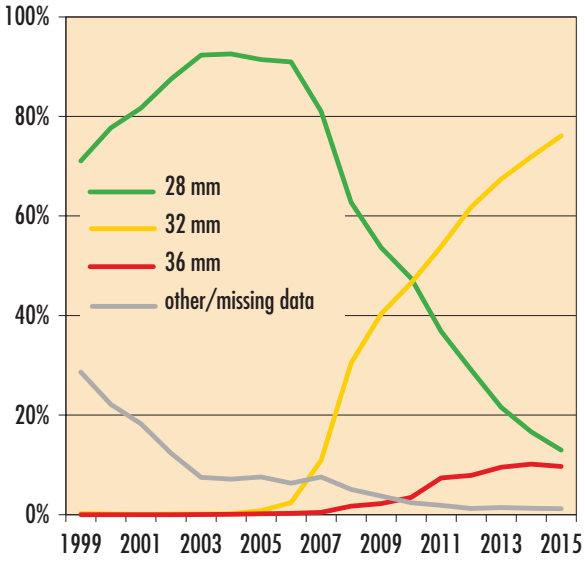


Figure 1. Caput diameter during insertion of hip prosthesis 1999–2015. Since 2005, the proportion of caput with primarily 32 diameters and, to a lesser extent, 36 mm, increased.

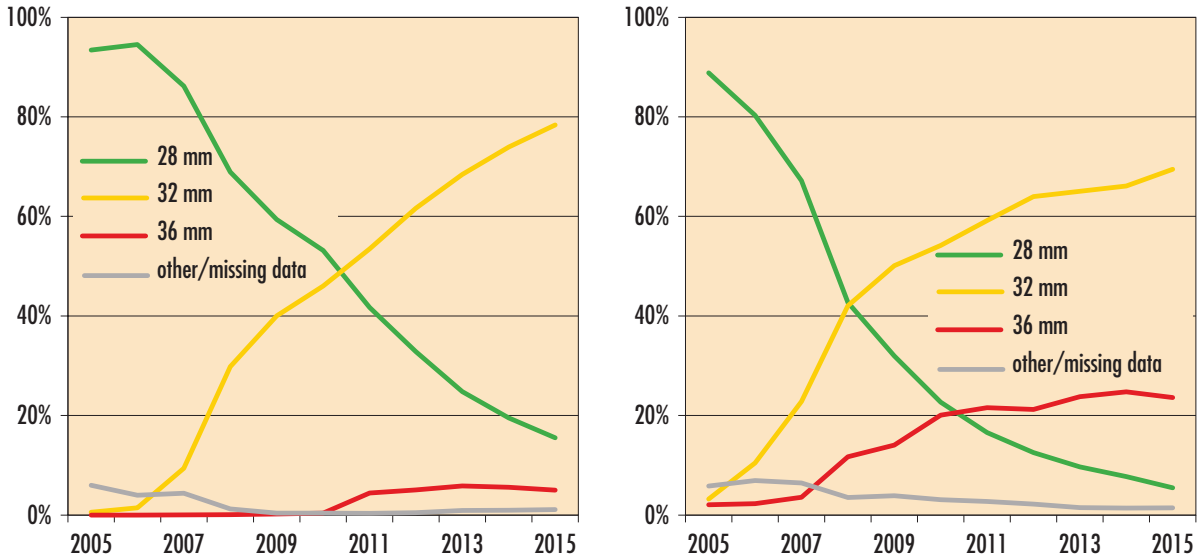


Figure 2. Caput diameter during insertion of hip prosthesis 2005–2015 in relation to the selection of cup fixation (cemented cups on the left, uncemented cups on the right). The femoral head with a diameter of 36 mm has primarily been used during insertion of an uncemented cup. (Resurfacing prostheses have been excluded.)

After four years of observation in the osteoarthritis group, 0.5% have been revised due to dislocation in the group with 28 mm caput and 0.3% have been revised in the groups with 32 and 36 mm caputs, respectively. Prosthesis survival rate is also slightly higher in the group with 32 versus 28 mm femoral head. If the Cox regression is adjusted for age, sex, cup and stem fixation, the increased risk, during the use of 28 mm femoral head, remains (RR = 1.4 *1.1–1.7*, p = 0.001). The corresponding comparison between groups with 28 and 36 mm caputs shows also an increased risk during the use of 28 mm (RR = 1.8, *1.1–2.9*, p = 0.016). If the respective analysis excludes the most recently operated hip for the patients who were operated on both sides, the differences remain and even increase slightly (data not shown). After four years, the implant survival is roughly the same in the group with 32 and in the group with 36 mm femoral head (log rank test: p = 0.83). Comparison based on Cox regression has not been carried out in this case, because of methodological reasons.

In the group of hip fracture, the risk of revision due to dislocation is significantly higher than in the osteoarthritis group, where four-year survival rate exceeds 99% regardless of the diameter of the femoral head which was used. After adjusting for age, sex and the cup/stem fixation, the degree of increased risk of revision due to dislocation, in the use of 28 mm compared with 32 mm joint head, is about the same as in the primary osteoarthritis group (1.5 *1.1–2.0*; p = 0.007; only the first hip surgery included: 1.6 *1.1–2.2*, p = 0.005). Additional statistical comparisons between 28 and 32 mm against 36 mm femoral head is hampered by the small number of observations in the group with 36 mm femoral head. Of the 587 operations performed, only 72 were revised after four years, and seven were revised due to dislocation, all within five months after the primary operation. A simple statistical evaluation using the log rank test shows no differences in outcomes, either between 28 and 32 mm, or 32 mm and 36 caputs (p = 0.9 and 0.5). Because it is necessary to get an idea about possible protective effects of 36 and 32 mm caputs in relation to the risk of revision due to dislocation, we have pooled diagnosis groups of osteoarthritis and fracture, as one last analysis. After adjusting for factors, which were used in the previous regression analysis, and diagnosis, we find that there is no significant difference (RR, 32/36 mm: 1.2 *0.8–1.8*, p=0.4).

Inserting a 32 mm femoral head instead of a 28 mm femoral head, decreases the risk of revision due to dislocation during primary osteoarthritis and during hip fracture operation. 36 mm femoral head has the same effect for primary osteoarthritis. There are too few observations to draw any safe conclusions for hip fracture in regards to the use of 28 or 36 mm femoral head. Based on the existing observations, it is not possible to demonstrate a secure gain when choosing a 36 mm femoral head instead of a 32 mm femoral head.

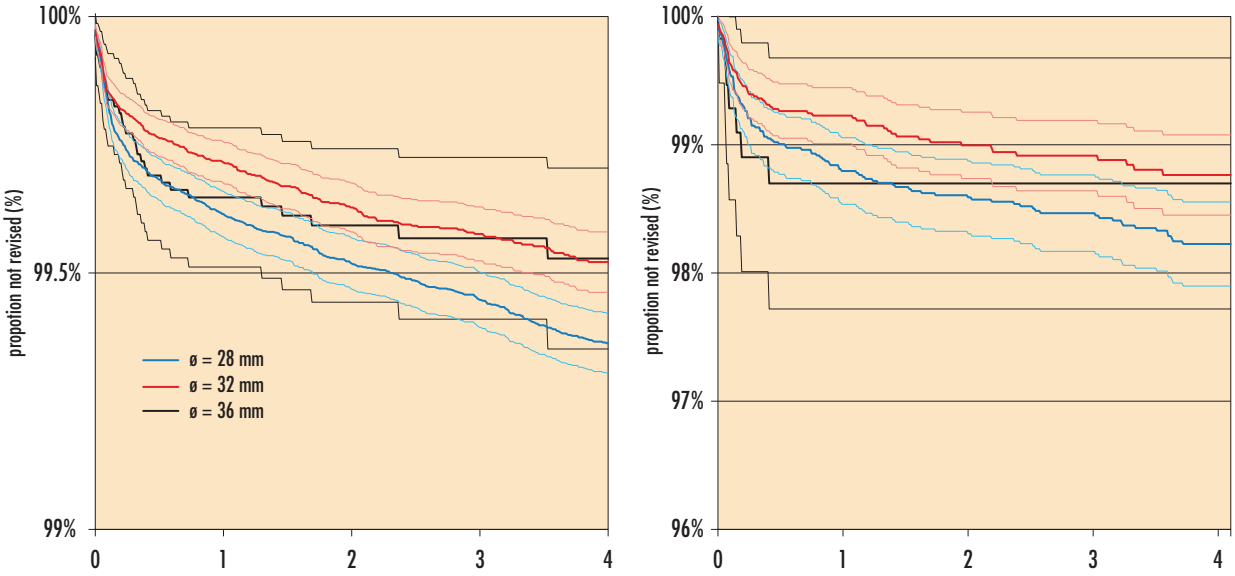


Figure 3. Implant survival based on revision due to dislocation as outcome after hip arthroplasty due to primary osteoarthritis (on the left) and acute hip fracture after hip fracture (on the right).

Dual mobility cups

Within the framework of Nordic cooperation registers, NARA has analysed dual mobility-cups (DMC) in patients with osteoarthritis. These cups have another joint surface consisting of one mobile polyethylene component between the prosthetic head and one outer metal shell (which is attached to the pelvis with or without cement). Over a 12-year follow-up, the DMC showed the same revision risk as conventional cups. However, there were differences in terms of the specific causes for revision. DMC reduced risk of revision due to dislocation, but had increased risk of revision due to infection. The latter has been shown in other studies too, but has primarily been interpreted as caused by patient selection, because DMC is used, in larger extent, in patients prone to dislocate their hip. These patients should also have a greater risk of developing infection. This reasoning leads to the conclusion that DMC implant itself would not cause a risk of infection. Further studies, preferably randomized comparisons, are needed to examine, whether more polyethylene in Dual Mobility Cup and its slightly better grip during surgery, can increase the risk of infection.

Reoperation

Reoperation includes all kinds of surgical intervention that can be directly related to an inserted hip arthroplasty irrespective of whether the prosthesis or one of its parts has been exchanged, extracted or left untouched. The proportion of reoperations in relation to the total number of primary total hip replacements performed and the number of reoperations has since 1992 stayed relatively stable and constituted about 12–13% (Figure 1). The number of performed operations has thus followed the increase of primary hip arthroplasty (Figure 2). The relation between reoperations and primary operations gives some idea of the extent of the burden reoperations put on health care resources for hip arthroplasty in one country or in one area, but it is not suitable to use for other purposes due to its sensitivity to fluctuations in the number of performed primary operations. The quota is also affected by many other factors such as patient flow between healthcare departments, the medical professionals' attitude to performing revision surgery as well as the period of time that total hip replacement has been practiced in a certain healthcare department. The reporting of reoperations is probably inferior to that of primary operations. This particularly applies to the operations where the implant is left untouched, such as the irrigation and debridement of infection or osteosynthesis due to periprosthetic fracture, where prosthesis is left untouched. "Other surgeries", similar to those which do not relate inserted implants, increased after the turn of the millennium, probably as a result of the fact that the diagnosis for periprosthetic fracture was from the year 2001 checked against the data in the Patient Register as part of a validation project.

Restructuring of healthcare has led to the situation where the quota for reoperations/primary operations at mainly university and to some extent at regional hospitals has increased (refer to Annual Report 2013). The breakdown of reoperations between the four different types of hospitals has been more constant. Since 2012, there has been a weak trend that the university hospitals performing more reoperations (Figure 3).

The demographics for patients who undergo reoperation has changed over time. Proportion for women has increased marginally. Compared with the period 1981–1995, the mean age in 2011–2015 has increased by about three years. Above all, the proportion of patients over 85 years has become larger, from the first period when their proportion was 3.1%, has this proportion risen till 11.4% during the last five years. The proportion of primary osteoarthritis has varied but increased during the recent period. Patients who were operated primarily due to fracture or fracture sequelae have declined in proportion, perhaps because the number of hemiarthroplasties has increased and we are operating more and more elderly and frail patients with high mortality.

The patient group who underwent reoperation during 2011–2015, differs from those who underwent primary surgery during the same period, in several ways. They are about three years older, more often male and more often have various types of secondary osteoarthritis, excluding primary diagnosis of hip fracture. BMI differs slightly between the patients undergoing primary surgery and the patients undergoing reoperation. However, a greater proportion of patients in the reoperation group is classified as ASA class III or higher.

Since the period 1981–1995, the mean age for the patients undergoing reoperation has increased. Compared with patients undergoing primary surgery, these patients are older, sicker and more often male.

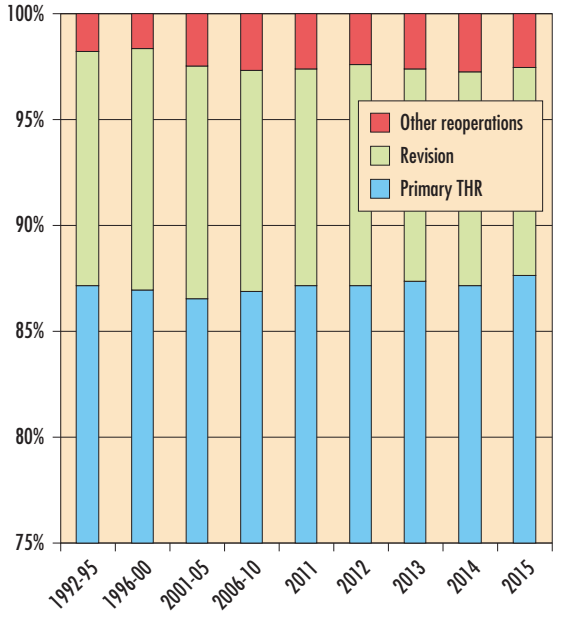


Figure 1. Proportion of the re-reoperated (revision + other reoperation) relative to the total hip arthroplasty-related operations during selected years 1992–2015. Note that the y-axis scale is adjusted and starts at 75%.

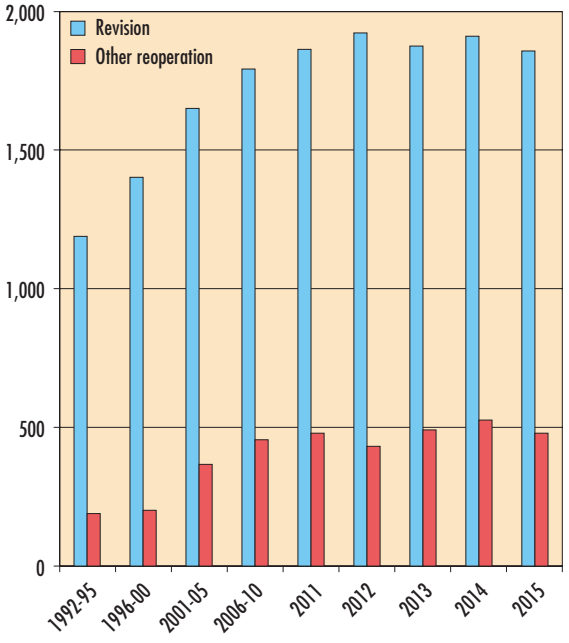


Figure 2. The total number of reoperations in the period 1992–2015. For intervals spanning several years, an average is presented.

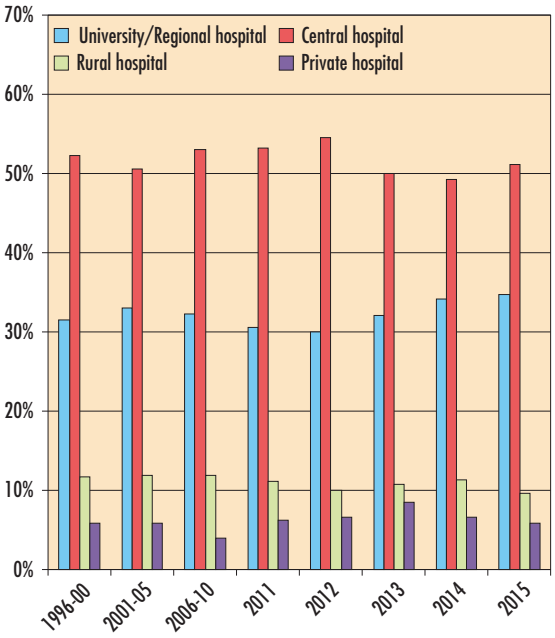


Figure 3. Distribution of reoperations between different types of hospitals between 1992 and 2014.

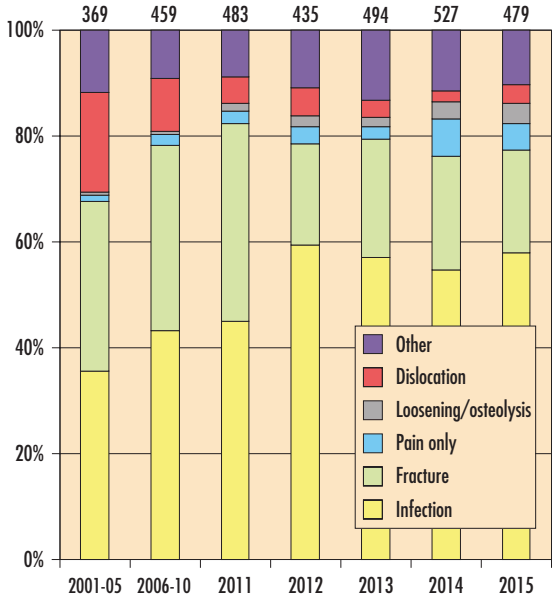


Figure 4. The most common reasons for reoperation in which the implant is left untouched during the period 2011–2015. The relative frequency is presented from 2001. The reported number of reoperations without implant exchange or removal is provided at the top as the average figures for the first two periods and subsequently annually.

Reoperation without changing the implant/extraction

In many cases, there are several reasons for a reoperation, which may affect the reporting of data. Regardless of whether infection has been the only or one of several causes, infection has still been dominant in recent years, followed by fracture. During 2015, 278 reoperations (58.0% of the total) were reported due to infection and 92 (19.2%) due to the fracture (Figure 4). After 2011, which was the last year in the period 2001 and 2011, when the diagnosis data for the periprosthetic fracture was checked against the Patient Register, the number of reported periprosthetic fractures treated without prosthetic replacement has fallen by an average of 27 cases per year, which probably is an indication of under-reporting. We hope that this problem can be partially solved by a link between the Fracture Register and the Swedish Hip Arthroplasty Register, and by an increased awareness within the profession. Cause groups "only pain" and loosening take third and fourth place. In these cases, they have often taken biopsy due to a suspected infection that later could not be verified.

The usual approach in surgery, where the implant is left untouched, were different types of wound revision, which without wound revision, incision and drainage, include synovectomy, secondary suture and excision of the fistula. In 94.2% of all cases operated from 2001 to 2015, the cause is infection (Figure 5). The second most common measure is fracture reconstruction, where the number decreased between 2011 and 2012 with the decrease in reported fractures, both in absolute and relative number, as shown above. During the

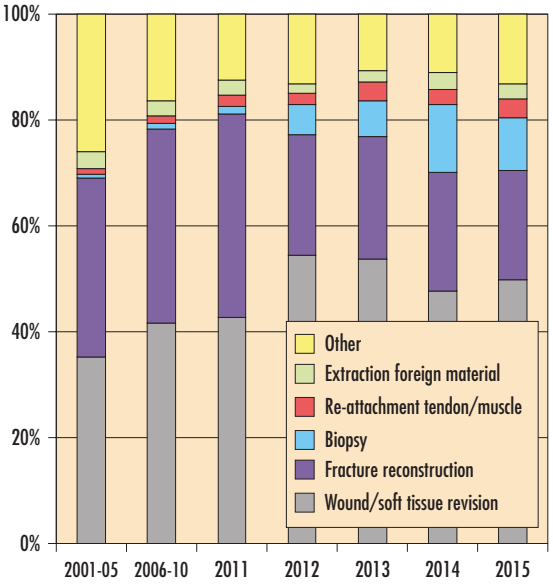


Figure 5. The most common measures at reoperation where the implant is left untouched during the period 2011–2015. The relative frequency of these measures is presented from 2001.

Demographics – reoperation during different periods and primary operation

2011–2015

	Reopereration			Primary operation
	1981–1995	*1996–2010*	*2011–2015*	*2011–2015*
Number	12,765	29,397	11,864	81,503
Age				
Mean value *SD*	68.2 *11.1*	71.1 *11.6*	71.6 *11.4*	68.7 *10.7*
<55 years *%*	11.4	8.9	8.0	10.0
55–69 years *%*	36.1	30.1	30.6	40.4
70–84 years *%*	49.5	51.3	49.9	44.5
>=85 years *%*	3.1	9.6	11.4	5.1
Sex				
Proportion of women %	51.1	53.2	50.9	57.9
BMI	–	–		
Number, *% of all in the interval*		5,173 *17.8*	10,229 *86.2*	77,271 *94.8*
Mean value *SD*		27.0 *5.7*	27.2 *5.5*	27.1* *5.1*
<18.5 *%*	–	2.0	1.7	1.3
18.5–24.9 *%*	–	34.9	33.4	33.7
25–29.9 *%*	–	39.2	40.6	41.6
>=30 *%*	–	23.9	24.3	23.4
ASA class				
Number, *% of all in the interval*		6,238 *21.2*	11,119 *93.7*	79,751 *97.9*
I *%*	–	13.0	11.0	22.3
II *%*	–	52.5	50.8	58.3
III– *%*	–	34.5	38.2	18.7
Diagnosis during primary operation*				
Primary osteoarthritis	72.6	71.5	75.3	82.7
Fracture including sequelae	11.4	10.3	9.1	10.2
Inflammatory joint disease	8.1	8.1	5.6	1.2
Sequelae after childhood disease	4.6	5.3	4.5	1.9
Femoral head necrosis	1.5	3.1	3.9	3.3
Other secondary osteoarthritis	1.5	1.8	1.6	0.7

**up to 263 observations regarding reoperations are missing for this period*

Table 1. Sex and age distribution at all types of reoperation for three periods and BMI and ASA class for the last two periods. During the period of 1996–2010, registration was carried out only between 2008 and 2010. Data for patients who underwent primary operation, is shown for comparison.

period 2001–2011, when we were able to verify the number of completed operations via the Patient Register, we find that it mainly concerns cemented prostheses treated without revision. During initial surgery (initial reoperation which was registered after primary surgery), 92.6% were cemented stems (n=1,104). Among these, the most common was Exeter stem (31.1%), followed by Lubinus SP II (29.6%), Charnley (16.8%), Spectron EF Primary (4.4%) and CPT (3.4%). These rates will be related to the exposed population size, which is hampered by the fact that we lack precise data on the prostheses used in the primary operation before 1992.

Number of reoperations per procedure and year

primary THRs performed 1979–2015

Procedure at reoperation	1979–2010	2011	2012	2013	2014	2015	Total	Proportion
Revision	35,133	1,868	1,926	1,876	1,916	1,860	44,579	82.2%
Major surgical intervention	4,879	281	188	210	217	208	5,983	11.0%
Minor surgical intervention	2,368	202	247	284	310	271	3,682	6.8%
Missing	3	0	0	3	0	0	6	0%
Total	42,383	2,351	2,361	2,373	2,443	2,339	54,250	100%

Number of reoperations per reason and year

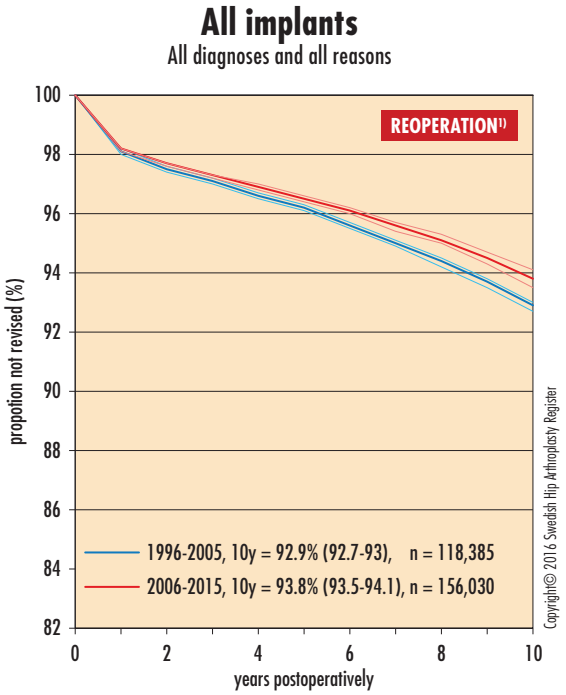
primary THRs performed 1979–2015

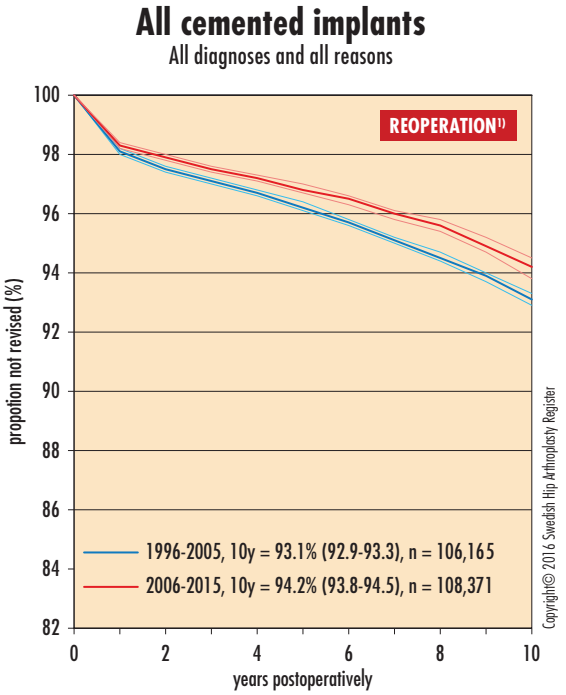
Reason for reoperation	1979–2010	2011	2012	2013	2014	2015	Total	Proportion
Aseptic loosening	23,315	989	977	918	871	841	27,911	51.4%
Deep infection	4,952	487	554	593	655	628	7,869	14.5%
Dislocation	4,942	255	282	288	297	266	6,330	11.7%
Fracture	4,223	361	289	296	311	293	5,773	10.6%
2-stage procedure	1,756	97	83	85	103	126	2,250	4.1%
Technical error	1,126	71	65	51	61	46	1,420	2.6%
Others	1,049	38	52	94	68	69	1,370	2.5%
Implant fracture	570	32	27	20	22	26	697	1.3%
Pain only	408	19	30	21	49	39	566	1.0%
Secondary infection	5	1	0	0	1	0	7	0%
Missing	37	1	2	7	5	5	57	0.1%
Total	42,383	2,351	2,361	2,373	2,443	2,339	54,250	100%

Number of reoperations per reason and year

primary THRs performed 2006–2015

Reason for reoperation	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Aseptic loosening	1,030	1,008	1,006	1,118	1,070	989	977	918	871	841	9,828
Deep infection	297	330	409	431	429	487	554	593	655	628	4,813
Dislocation	267	308	303	290	299	255	282	288	297	266	2,855
Fracture	263	321	309	357	391	361	289	296	311	293	3,191
2-stage procedure	80	83	74	97	103	97	83	85	103	126	931
Technical error	19	41	45	58	61	71	65	51	61	46	518
Others	17	36	23	36	33	38	52	94	68	69	466
Implant fracture	25	25	21	39	23	32	27	20	22	26	260
Pain only	18	16	22	15	19	19	30	21	49	39	248
Secondary infection	0	3	0	0	0	1	0	0	1	0	5
Missing	0	0	1	0	0	1	2	7	5	5	21
Total	2,016	2,171	2,213	2,441	2,428	2,351	2,361	2,373	2,443	2,339	23,136

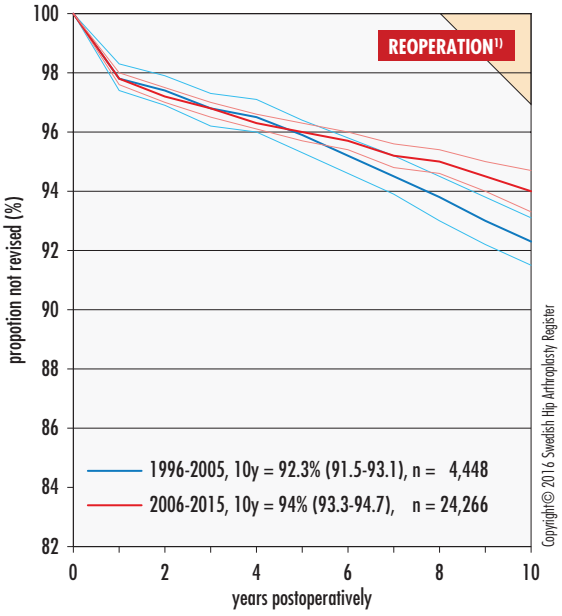




1) Kaplan Meier survival statistics defined by reoperation (all further surgery, revision included)

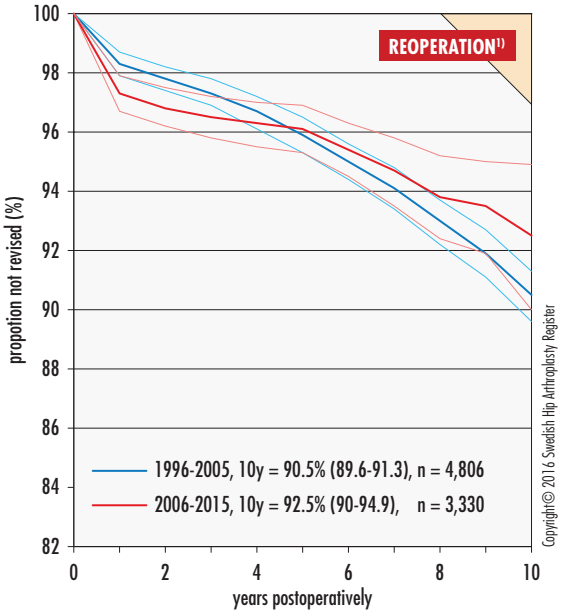
All uncemented implants

All diagnoses and all reasons



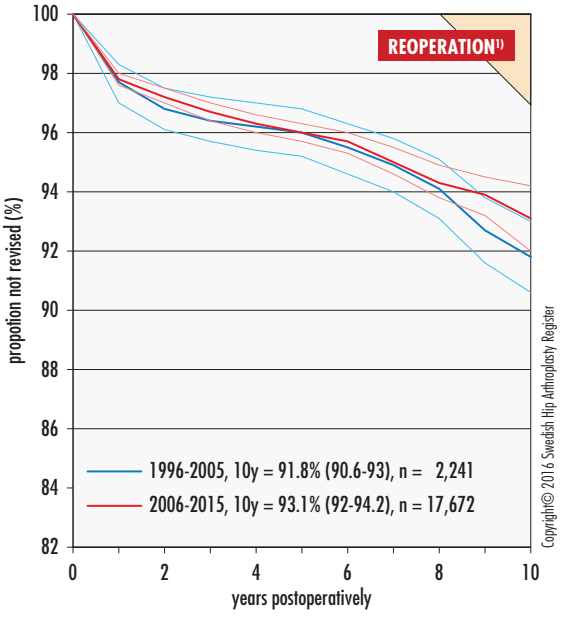
All hybrid implants

All diagnoses and all reasons



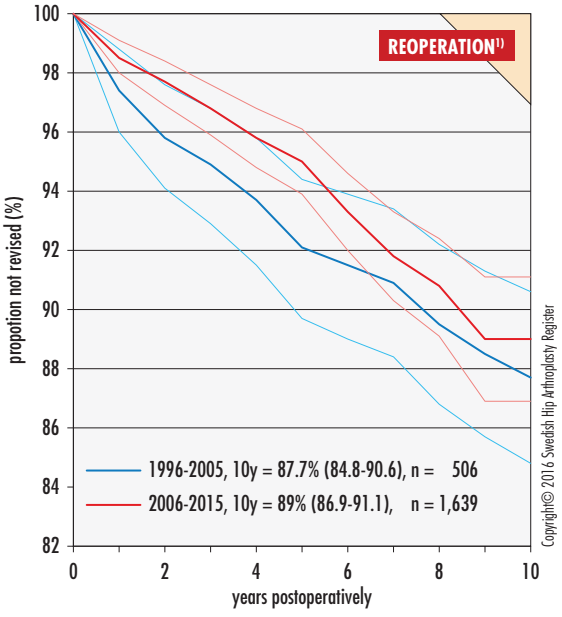
All reversed hybrid implants

All diagnoses and all reasons



All resurfacing implants

All diagnoses and all reasons



[1)] Survival statistics according to Kaplan-Meier with reoperation (all form of further surgery, including revision) as end-point definition.

Infection

Several studies have shown an increased incidence of deep infection after hip replacement surgery. Increased use of antibiotics, further indications, increased number of patients who undergo hip replacement, and the global spread of multi-resistant bacteria have been cited as possible reasons for this observation. The statistics are generally based on the number of completed operations and it can be difficult to determine whether this increase is real, and if so, how big it is. It is difficult to obtain reliable incidence data because such an analysis requires prospective studies of well-defined patient groups for a long time, where the diagnosis is defined according to established criteria. The situation is hampered by the fact that all infected patients with hip prosthesis are not treated operatively and, thus are often not recorded. Virtually all prosthetic registers only capture revision operations, despite the fact, that many patients undergo reoperation without replacing or extracting a part or the whole prosthesis, and some are treated only with antibiotics. The Swedish Hip Arthroplasty Register is probably unique because, not only revisions, but also all reoperations are recorded, providing unique opportunities for extended studies. One problem that affects all registrations is under-reporting, a problem that might be especially important during reoperation due to infection. Hopefully, the work which Viktor Lindgren and his colleagues have carried out, results in some improvement of reporting to the Swedish Hip Arthroplasty Register (*BMC Musculoskelet Disord 2014;15(1):384, Infect Control Hosp Epidemiol 2014;35(12):1491–1496*).

In this in-depth analysis, we intend to provide an overview of the incidence of reoperations in Sweden and the outcome for specific types of interventions with respect to the risk of renewed reoperation and revision due to infection, regardless of whether the patient undergoes reoperation for the same or a new infection.

During the period 1979–2015, 8,231 reoperations were reported, where infection was reported as the single (n=8,088, 98.3%) or one of many causes for the surgery. In 73 cases (0.9%) the cause was reported as dislocation, in 62 cases (0.8%) it was fracture and in eight cases (0.1%) the cause was implant damage. In 296 cases (3.6%), the infection was classified as superficial. Also, these cases have been included, because the distinction between superficial and deep infection is difficult. In this group, 3.4% underwent surgery with prosthetic replacement or extraction, although infection was classified as superficial.

Since 1992, when the identification code based database for primary arthroplasties was started, the proportion of patients who are reported due to infection, increased, at least up to 2012 (Figure 1). The same applies for the initial revisions due to loosening/osteolysis/wear until 2011. The decline in recent years could be real but can most likely be, partially or entirely, explained by the fact that the observation period is short. For the same reason, years 2014 and 2015 have been excluded. Regarding the total number of reoperations due to infection, the increase is partly more pronounced, because the number of patients with implanted hip prosthesis has gradually risen, more patients with a high degree of comorbidity are undergoing surgery, and there is a more active attitude towards early surgical intervention in order to avoid prosthesis extraction (Figure 2). Hopefully, reporting of surgical procedures due to infection is improved. An interesting observation is that reoperation without affecting the implant, is more common than revision in cases, where the hip prosthesis has previously undergone reoperation (Figure 2, on the right). Figure 3 shows how the proportion of patients who undergo reoperation within two years after primary surgery or previous reoperation, has gradually increased since the turn of the millennium.

During the 1990's, prosthesis extraction was common, but it was not always followed by another session of insertion of new prosthesis, the dominating procedure during infection, and especially during initial revision (refer also to the chapter Revision). After the turn of the millennium, the proportion of wound revisions, and especially in the cases where the patient has undergone a previous reoperation, increased. The proportion of operations with replacement of liner and/or femoral head in combination with lavage and synovectomy step during initial measure, increased from 4.8% during the period 2001–2005 to 41.6% during the period 2011–2015. It is likely that this procedure is increasingly replacing wound revision with washing and synovectomy without replacing modular parts during the past decade (Figure 4, on the left). This trend is not as clear for those patients who have undergone reoperation at least once before. Most likely, it is not the same type of procedure distribution (the group classified as "wound revision/synovectomy" is a synthesis of 17 or more similar procedures), but this explanation is not sufficient, because about 80% of procedures in both groups have exactly the same procedure designation ("wound revision-incision-drainage").

In the previous annual report, a simple analysis was carried out about revision due to infection, where the femoral head and/or liner were replaced by using rerevision due to infection as an outcome. Given that this procedure often seems to replace a reoperation where the implant is left intact (here classified as wound revision/synovectomy) and that this phenomenon is mainly observed during initial surgery, a combined analysis of these procedures may be of interest. However, it should be noted that the register data cannot safely determine the extent to which interventions are interchangeable. This hypothesis requires more detailed studies. Nonetheless, it is in the interest of the clinical community to get an idea about how interventions can lead to a situation, where a new surgical procedure due to the same cause, does not need to be repeated.

The analysis includes replacement of the femoral head/liner and reoperation where the wound revision was implemented without affecting the implant. 13 cases of wound revisions, where patients have a resurfacing cup (including six with femoral part of the same type), and all cases, where a spacer has been inserted or extracted, have been excluded. In the evaluation, the reoperations performed for the first time and those which were carried out after at least one prior reoperation, were studied separately. In this year's analysis, the

outcome is reoperation due to infection, and not the revision, which in regards to the comparison with liner and/or caput replacement interventions from the previous annual report, implies expectedly a worse result because even recurring reoperation where the prosthesis is left untouched, has been included. The survival graphs extend to the year where the number of remaining observations is less than 100.

No matter which of the two selected interventions are undertaken and regardless of whether it concerns the initial reoperation or whether the patient has been reoperated previously, a possible new reoperation due to infection usually takes place within the first year. Therefore, it is possible to assess relatively early, whether the intervention has been successful or not, with regard to recurrence. On the other hand, the risk of failure is high, especially in the case of wound revision. After three years, the survival rate is 46.4 ± 3.2% for initial wound revision, and 37.2 ± 3.4% if the same hip has been reoperated before. The corresponding survival rate for replacement of liner and/or the femoral head is much better, 75.0 ± 3.4 and 68.2 ± 4.9%. Comparing the risk ratio between the two interventions, we find that wound revision is associated with a nearly three-fold increased risk for another reoperation, if performed for the first time, regardless of whether it is adjusted for age, sex, diagnosis and fixation of an existing implant (unadjusted RR = 2.9 2.4–3.4, p <0.0005; adjusted: 2.8 2.4–3.4, p <0.0005). For patients, who have undergone at least one previous reoperation, the ratio is roughly the same. As a linear variable, the number of previous reoperations has also been included (RR unadjusted=2.7 2.2–3.2, p<0.0005; adjusted RR=2.5 2.1–3.1, p<0.0005). In the last analysis, we also find that the risk of further reoperation performed because of the same reason, increases with the increasing number of reoperations for which the same hip has been exposed to (data not shown). In summary, one obtains a better result with femoral head/ liner replacement. It may also be that this measure indicates that, in general, better surgical techniques are being used.

Of the patients undergoing revisions by replacing the liner and/or femoral head due to infection, about one-fifth to one-quarter will undergo surgery for the same reason again. On this occasion, revision was carried out in 72.7% of cases where the procedure corresponded to a secondary revision. 64.3% of the patients who had previously been revised, had been rerevised several times, and the remaining (35.7%) underwent a reoperation where implants were neither replaced nor extracted. The most common type of revision in these cases was partial or total extraction (49.4% at secondary revision, 64.8% if the patient has been revised more than once before). Complete or incomplete implant replacement was performed in about one in ten cases. It is remarkable, that a high number of patients undergo the same operation again. In 49.4 and 64.5% of those who were rerevised due to persistent infection, a rerevision with liner and/or caput replacement was carried out during secondary revision.

During revision with replacement of femoral head and/or liner (and soft tissue revision and washing), it is possible to prevent further surgical intervention due to the same reason, within a three to five-year period in seven to eight out of ten cases, depending on whether the case concerns initial intervention or not. Although it is not possible to determine whether the infection is resolved or not, the risk that reoperation will be carried out at a later stage, is believed to be relatively small, in light of previous studies in this area, not least from previous analyses of register data. The probability that an infection will heal after a wound revision, is small, more than half of the patients who had undergone this procedure, had undergone reoperation in three years because of the same reason. It should be pointed out, that comparisons between treatment groups, based on register data, are difficult to interpret, because there may be differences in patient selection and indications, which are not known. Wound revisions may be performed more frequently as a palliative measure, that is, healing is not expected, but the patient, for as long as possible, should avoid being bothered by a runny wound or a fistula in cases, where serious comorbidity or other circumstances result in avoiding a more extensive surgery.

Notes

Short-term complications – reoperations within 2 years

In Sweden reoperation within two years is used as a quality indicator for primary hip arthroplasty comparing different care givers. The background to this is that the most common causes for early reoperation are mainly infection and dislocation. The distribution of the cause for early reoperation, and especially during the first year after primary surgery, has varied (Figure 1). In the 1990s, the most common causes for reoperation during the first year were dislocation and early loosening. Recently, early loosenings have been classified as "technical" errors. These these two groups have been merged in the figure in order to allow comparioson over time. There is a trend toward increasing number of infections being reported to the Registry. Most probably, the increased proportion of reoperations due to infection reflects a more active attitude towards surgical treatment. Moreover, if there is an increased incidence, it is not safe to make any assumptions but it cannot be excluded either.

The proportion reoperated within two years, during the periods studied here varied between 2.0 and 3.5%. It should be noted that all the patients who operated between 2014 and 2015 have not passed the two-year limit and the proportion of patients, who were operated within two or three years, will increase. Until the period 2004–2007, the proportion of early reoperations decreased, from 3.5% in two years during the first period 1992–1995 down to 2.0%. Hereafter, the number rises, but appears to stay on a constant level just over 2%.

Reoperation within 2 years refers to all forms of subsequent open surgical intervention after a primary total hip replacement. This variable reflects mainly early and serious complications such as deep infection and dislocation. This variable is therefore a faster indicator and easier to use monitoring clinical improvements compared with 10-year survival, which is important, but a slow and, to some extent, historical indicator. Reoperation within 2 years has been selected by SALAR and the Swedish National Board of Health and Welfare as a national quality indicator for this type of surgery and it has been included in Regional comparisons (open comparisons). This indicator should be seen as one of the most important and most responsive endpoints reported by the Swedish Hip Arthroplasty Register.

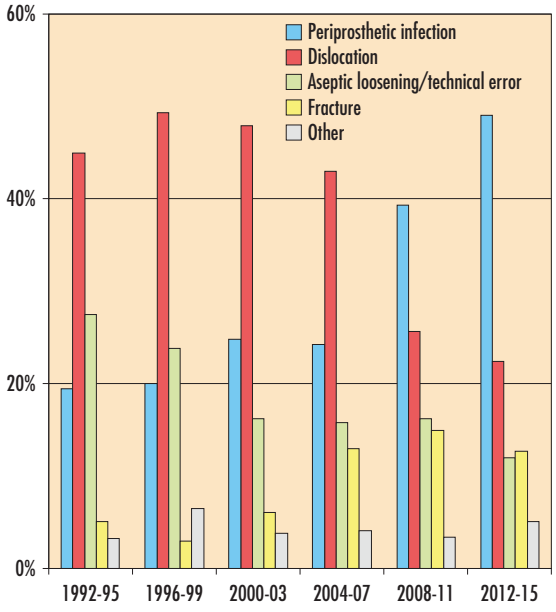


Figure 1. Distribution of the causes of reoperation within two years after the primary operation, divided into six time intervals between 1992 and 2014.

Definition

Short-term complications include all forms of open surgery within two years after the primary operation. The latest 4-year period has been studied. Please note that the report only includes complications that have been surgically treated. Infections treated with antibiotics and non-surgically treated dislocations (closed reductions) are not reported to the Register. Patients who have been repeatedly operated on because of the same complication are presented as one complication. Patients who undergo reoperation at a clinic that is not the primary clinic are counted as belonging to the primary clinic. When interpreting results one should only compare units from the same hospital category. This due to differences in patient demographics between hospital categories. Clinics that operate the more difficult cases with the greatest risk for complications may, of course, have a higher frequency.

Apart from the hospitals' different risk profiles, the following factors must also be weighed into the interpretation of these results:

- Underreporting.
- With the number of complications being generally low a random variability might be presented. Therefor we suggest looking in to distinct time trends (if present) rather than actual numbers - see separate trend table.
- Clinics that take a cautious stance (non-surgical treatment of for example infection and dislocation), which is to say that they avoid operation for these complications, are not registered in the database.
- Conversely, clinics that are surgically "aggressive" in treating patients with early infection and dislocation, might have a high frequencies of early complications. The treatment algorithm in case of early infection has changed during recent years, for both knee and hip arthroplasty. It is more and more common to intervene surgically.

The Register's management has completely avoided ranking and will never rank the various hospitals with consideration to this important result indicator. Since the number of complications in general is so low, a in registration can substantially affect a unit's ranking position. Irrespective of hospital category and result, clinics should analyse their own complications and investigate whether or not systematic short-comings exist – all to avoid serious complications for the individual patients.

All units are advised to carry out in-depth analyses on all cases of reoperation within two years. We encourage you to contact the Register when perfoming such analyses.

Reoperations in different time intervals

Figure 6 shows the cause of reoperation in the first, second and third year after primary surgery between 2001 and 2014. During the period 2001 to 2005, dislocation is the most common cause of reoperation during the first postoperative year. During the following period, infection is the most common cause, and dominated even more so from 2011. In the second year following primary surgery, we see a similar trend with the difference, that infection replaces loosening as a cause. A similar trend, albeit less pronounced, seems to be emerging regarding the cause distribution during the third year after surgery.

The absolute number reoperated during the first three years after primary hip replacement, should be related to the total number of patients who had primary surgery during each year (Figure 7). The relative proportion of those operated during the first three postoperative years, is highest during first year after surgery. It is also evident that this proportion has increased from below 1% until 2005–2006 to just over 1.5% in 2013 and 2014. This might reflect the growing number of patients who undergo reoperation due to infection. However, in light of these data, it is not possible to safely assess whether this increase is determined by a real increase in the incidence of infection, a more active approach to surgical intervention for suspected infection or a combination of these, and other unknown reasons.

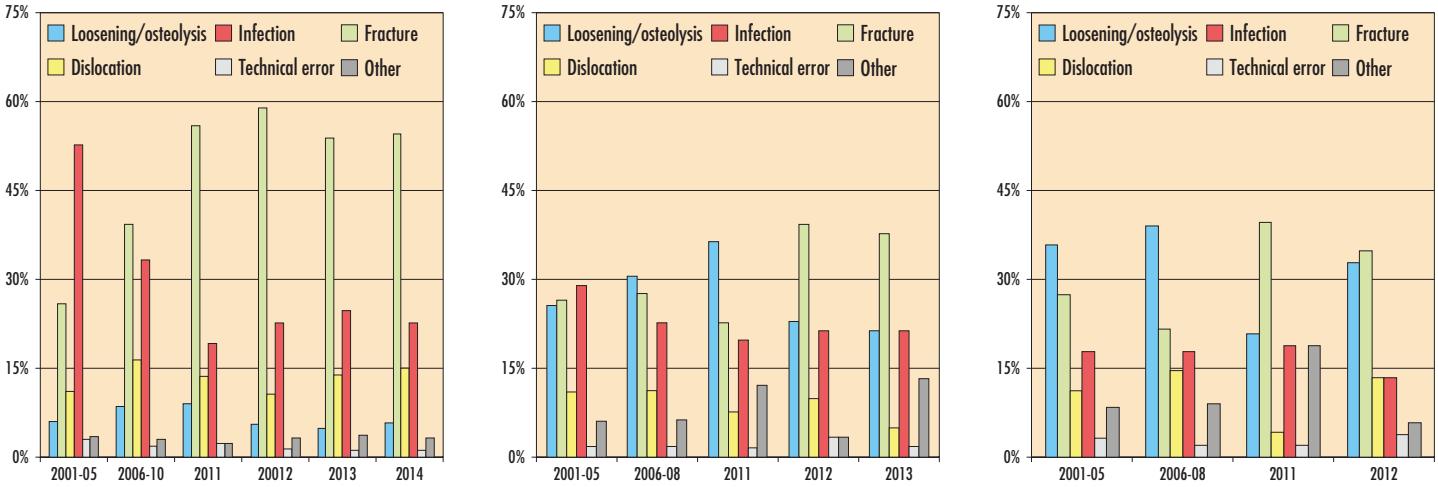


Figure 6. Distribution of the most common causes for reoperation during the first, second and third year after the primary hip replacement, divided into different time periods between 2001 and 2014. Year 2015 has been excluded, since all patients reported having a primary hip replacement in 2015 had not been observed for at least one year.

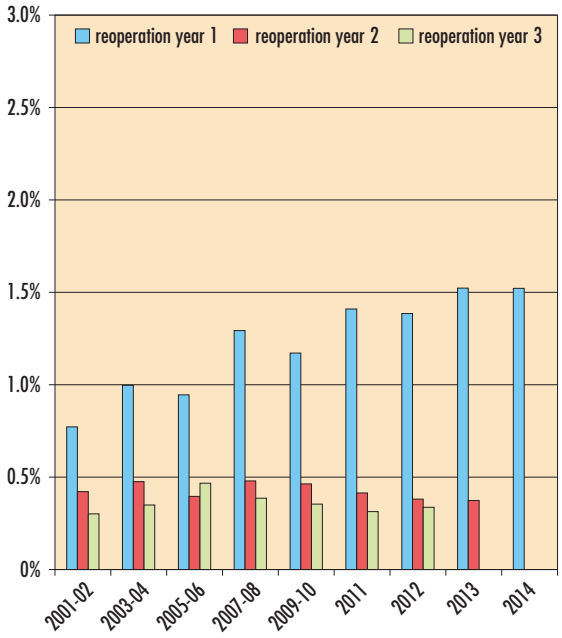


Figure 7. Proportion of reoperation during the first three years after primary surgery related to year of primary hip replacement.

Reoperations within 2 years per hospital[1)]
2012–2015

Hospital	Prim THRs	Patientes [2)]		Infection		Dislocation		Loosening		Others		Proportion with data on ASA&BMI
	Number	Number	%	Number	%	Number	%	Number	%	Number	%	
University/Regional hospitals												
Karolinska/Huddinge	998	14	1.4%	6	0.6%	0	0%	0	0%	9	0.9%	98.9%
Karolinska/Solna	759	30	4.0%	19	2.5%	7	0.9%	1	0.1%	7	0.9%	98.0%
Linköping	261	7	2.7%	6	2.3%	4	1.5%	0	0%	3	1.1%	83.1%
SU/Mölndal	2,079	40	1.9%	28	1.3%	6	0.3%	1	0%	19	0.9%	94.8%
SUS/Lund	718	18	2.5%	8	1.1%	6	0.8%	2	0.3%	7	1.0%	91.2%
SUS/Malmö	157	2	1.3%	1	0.6%	0	0%	0	0%	1	0.6%	59.2%
Umeå	329	14	4.3%	7	2.1%	1	0.3%	0	0%	6	1.8%	68.7%
Uppsala	1,023	36	3.5%	19	1.9%	7	0.7%	1	0.1%	14	1.4%	97.0%
Örebro	448	12	2.7%	9	2%	0	0%	0	0%	6	1.3%	98.2%
Central hospitals												
Borås	675	18	2.7%	10	1.5%	1	0.1%	0	0%	7	1.0%	98.8%
Danderyd	1,307	46	3.5%	21	1.6%	14	1.1%	0	0%	17	1.3%	99.2%
Eksjö	858	18	2.1%	15	1.7%	0	0%	0	0%	5	0.6%	94.5%
Eskilstuna	471	13	2.8%	7	1.5%	3	0.6%	0	0%	4	0.8%	99.8%
Falun	1,329	25	1.9%	15	1.1%	2	0.2%	0	0%	11	0.8%	98.9%
Gävle	930	23	2.5%	13	1.4%	3	0.3%	2	0.2%	10	1.1%	92.6%
Halmstad	958	18	1.9%	13	1.4%	4	0.4%	0	0%	5	0.5%	92.7%
Helsingborg	436	9	2.1%	3	0.7%	5	1.1%	1	0.2%	1	0.2%	95.4%
Hässleholm-Kristianstad	3,106	48	1.5%	37	1.2%	3	0.1%	2	0.1%	16	0.5%	91.9%
Jönköping	731	10	1.4%	7	1%	1	0.1%	0	0%	4	0.5%	100%
Kalmar	602	8	1.3%	3	0.5%	1	0.2%	1	0.2%	3	0.5%	97.8%
Karlskrona	126	4	3.2%	0	0%	4	3.2%	0	0%	0	0%	98.4%
Karlstad	954	38	4.0%	29	3.0%	3	0.3%	2	0.2%	8	0.8%	87.5%
Norrköping	993	10	1.0%	6	0.6%	1	0.1%	0	0%	6	0.6%	87.9%
Skövde	702	16	2.3%	13	1.9%	1	0.1%	0	0%	5	0.7%	90.6%
Sunderby (inklusive Boden)	142	4	2.8%	2	1.4%	1	0.7%	1	0.7%	0	0%	30.3%
Sundsvall	634	18	2.8%	12	1.9%	6	0.9%	0	0%	4	0.6%	89.0%
Södersjukhuset	1,656	47	2.8%	25	1.5%	5	0.3%	2	0.1%	22	1.3%	99.6%
Uddevalla	1,495	24	1.6%	11	0.7%	6	0.4%	0	0%	8	0.5%	85.3%
Varberg	881	12	1.4%	6	0.7%	3	0.3%	0	0%	6	0.7%	89.7%
Västerås	1,802	53	2.9%	29	1.6%	13	0.7%	1	0.1%	15	0.8%	86.8%
Växjö	578	7	1.2%	4	0.7%	2	0.3%	0	0%	1	0.2%	96.7%
Östersund	1,137	25	2.2%	17	1.5%	1	0.1%	1	0.1%	7	0.6%	93.9%

(Continued on next page.)

Reoperations within 2 years per hospital[1)] (cont.)
2012–2015

Hospital	Prim THRs	Patientes [2)]		Infection		Dislocation		Loosening		Others		Proportion with data on ASA&BMI
	Number	Number	%	Number	%	Number	%	Number	%	Number	%	
Rural hospitals												
Alingsås	836	11	1.3%	9	1.1%	1	0.1%	0	0%	3	0.4%	100%
Arvika	740	13	1.8%	13	1.8%	0	0%	0	0%	2	0.3%	96.1%
Bollnäs	90	2	2.2%	2	2.2%	0	0%	0	0%	0	0%	100%
Enköping	1,336	27	2.0%	12	0.9%	9	0.7%	1	0.1%	14	1.0%	99.8%
Frölunda Specialistsjukhus	345	2	0.6%	1	0.3%	1	0.3%	0	0%	0	0%	0%
Gällivare	392	3	0.8%	3	0.8%	1	0.3%	0	0%	0	0%	94.1%
Hudiksvall	532	11	2.1%	5	0.9%	0	0%	0	0%	8	1.5%	94.7%
Karlshamn	946	19	2.0%	7	0.7%	9	1.0%	1	0.1%	5	0.5%	100%
Karlskoga	687	10	1.5%	6	0.9%	2	0.3%	0	0%	4	0.6%	95.3%
Katrineholm	931	16	1.7%	12	1.3%	0	0%	0	0%	4	0.4%	100%
Kungälv	690	18	2.6%	13	1.9%	1	0.1%	0	0%	7	1.0%	99.7%
Lidköping	995	11	1.1%	7	0.7%	0	0%	0	0%	6	0.6%	99.0%
Lindesberg	857	7	0.8%	2	0.2%	1	0.1%	0	0%	5	0.6%	97.3%
Ljungby	650	14	2.2%	5	0.8%	4	0.6%	0	0%	7	1.1%	99.8%
Lycksele	1,202	20	1.7%	8	0.7%	5	0.4%	0	0%	7	0.6%	92.9%
Mora	870	11	1.3%	7	0.8%	5	0.6%	0	0%	4	0.5%	92.9%
Norrtälje	478	8	1.7%	5	1.0%	2	0.4%	0	0%	2	0.4%	99.6%
Nyköping	617	26	4.2%	24	3.9%	5	0.8%	0	0%	6	1.0%	95.3%
Oskarshamn	1,012	9	0.9%	8	0.8%	0	0%	0	0%	1	0.1%	99.8%
Piteå	1,422	13	0.9%	10	0.7%	2	0.1%	0	0%	2	0.1%	100%
Skellefteå	479	7	1.5%	3	0.6%	1	0.2%	0	0%	4	0.8%	98.7%
Skene	516	8	1.6%	3	0.6%	2	0.4%	0	0%	4	0.8%	99.4%
Sollefteå	497	4	0.8%	0	0%	3	0.6%	0	0%	1	0.2%	99.0%
Södertälje	417	24	5.8%	15	3.6%	4	1.0%	1	0.2%	6	1.4%	97.8%
Torsby	444	11	2.5%	9	2%	1	0.2%	0	0%	4	0.9%	98.4%
Trelleborg	2,528	29	1.1%	11	0.4%	6	0.2%	2	0.1%	12	0.5%	95.5%
Visby	503	13	2.6%	3	0.6%	4	0.8%	0	0%	8	1.6%	92.6%
Värnamo	551	8	1.5%	3	0.5%	4	0.7%	0	0%	2	0.4%	80.4%
Västervik	436	3	0.7%	3	0.7%	0	0%	0	0%	0	0%	90.6%
Ängelholm	436	7	1.6%	2	0.5%	2	0.5%	0	0%	3	0.7%	99.1%
Örnsköldsvik	620	5	0.8%	2	0.3%	1	0.2%	0	0%	2	0.3%	95.2%

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Reoperations within 2 years per hospital[1)] (cont.)

2012–2015

Hospital	Prim THRs	Patientes [2)]		Infection		Dislocation		Loosening		Others		Proportion with data on ASA&BMI
	Number	Number	%	Number	%	Number	%	Number	%	Number	%	
Private hospitals												
Aleris Specialistvård Bollnäs	1,127	18	1.6%	11	1.0%	2	0.2%	0	0%	7	0.6%	99.9%
Aleris Specialistvård Elisabethsjukhuset	113	2	1.8%	1	0.9%	1	0.9%	0	0%	0	0%	99.1%
Aleris Specialistvård Motala	2,029	33	1.6%	19	0.9%	3	0.1%	0	0%	12	0.6%	85.5%
Aleris Specialistvård Nacka	583	12	2.1%	8	1.4%	1	0.2%	0	0%	4	0.7%	99.8%
Aleris Specialistvård Sabbatsberg	500	4	0.8%	4	0.8%	1	0.2%	0	0%	1	0.2%	99.4%
Aleris Specialistvård Ängelholm	227	2	0.9%	2	0.9%	0	0%	0	0%	0	0%	99.6%
Art Clinic Jönköping	50	0	0%	0	0%	0	0%	0	0%	0	0%	90.0%
Capio Movement	836	29	**3.5%**	12	1.4%	12	1.4%	0	0%	9	1.1%	98.8%
Capio Ortopediska Huset	1,550	12	0.8%	4	0.3%	1	0.1%	2	0.1%	6	0.4%	99.5%
Capio S:t Göran	1,808	46	2.5%	30	1.7%	5	0.3%	1	0.1%	17	0.9%	98.3%
Carlanderska	535	6	1.1%	4	0.7%	1	0.2%	0	0%	1	0.2%	97.0%
Ortho Center IFK-kliniken	519	2	0.4%	2	0.4%	0	0%	0	0%	0	0%	100%
Ortho Center Stockholm	1,768	39	2.2%	23	1.3%	6	0.3%	2	0.1%	15	0.8%	99.9%
Sophiahemmet	837	14	1.7%	5	0.6%	2	0.2%	0	0%	8	1.0%	99.4%
Spenshult	654	24	**3.7%**	6	0.9%	15	2.3%	0	0%	5	0.8%	98.3%
Others	83	1	1.2%	0	0%	1	1.2%	0	0%	0	0%	75.5%
Country	65,549	1,281	2.0%	745	1.1%	241	0.4%	28	0%	455	0.7%	94.6%

Red marking denotes values one standard deviation above the national average.

[1)] Art Clinic Göteborg, Hermelinen Spec.vård, NÄL, SU/Sahlgrenska and Ystad have been excluded due to too few operations performed or discontinued activity.

[2)] Refers to number of patients with short-term complications which may differ from the sum of complications since each patient may have more than one type of complication.

Reoperations within 2 years per hospital[1] – trend

primary operation 2008–2015

Hospital	2008–2011	2009–2012	2010–2013	2011–2014	2012–2015[2]
University/Regional hospitals					
Karolinska/Huddinge	2.4%	2.2%	2.2%	1.8%	1.4%
Karolinska/Solna	3.0%	2.6%	3.1%	3.2%	4.0%
Linköping	1.6%	2.0%	3.2%	2.7%	2.7%
SU/Mölndal	3.6%	2.7%	2.5%	2.3%	1.9%
SUS/Lund	3.5%	3.2%	3.1%	2.8%	2.5%
SUS/Malmö	1.8%	1.7%	2.0%	1.4%	1.3%
Umeå	3.4%	3.6%	4.5%	5.9%	4.3%
Uppsala	3.2%	3.2%	2.7%	3.8%	3.5%
Örebro	1.9%	2.4%	2.4%	2.2%	2.7%
Central hospitals					
Borås	3.0%	3.1%	2.8%	3.1%	2.7%
Danderyd	4.5%	3.7%	3.9%	4.0%	3.5%
Eksjö	2.3%	2.5%	2.0%	2.0%	2.1%
Eskilstuna	2.0%	2.5%	3.4%	3.3%	2.8%
Falun	2.1%	2.1%	2.2%	1.9%	1.9%
Gävle	6.0%	5.5%	4.7%	4.4%	2.5%
Halmstad	3.3%	3.1%	2.7%	2.1%	1.9%
Helsingborg	1.6%	1.8%	2.9%	2.6%	2.1%
Hässleholm-Kristianstad	2.0%	2.0%	1.8%	1.9%	1.5%
Jönköping	1.7%	1.6%	1.4%	1.4%	1.4%
Kalmar	1.8%	1.7%	1.3%	1.5%	1.3%
Karlskrona	0.9%	2.2%	2.7%	3.8%	3.2%
Karlstad	4.9%	5.3%	5.6%	4.9%	4.0%
Norrköping	1.3%	1.1%	1.0%	1.2%	1.0%
Skövde	0.9%	1.3%	1.4%	1.8%	2.3%
Sunderby (inklusive Boden)	3.9%	4.1%	2.2%	3.0%	2.8%
Sundsvall	4.7%	3.4%	3.4%	3.7%	2.8%
Södersjukhuset	2.7%	3.0%	3.0%	2.9%	2.8%
Uddevalla	1.8%	1.7%	1.5%	1.4%	1.6%
Varberg	1.6%	1.5%	1.4%	1.4%	1.4%
Västerås	4.1%	3.9%	3.8%	3.6%	2.9%
Växjö	2.1%	2.3%	2.4%	1.9%	1.2%
Östersund	2.8%	3.0%	2.8%	2.5%	2.2%

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Reoperations within 2 years per hospital[1)] – trend (cont.)

primary operation 2008–2015

Hospital	2008–2011	2009–2012	2010–2013	2011–2014	2012–2015[2)]
Rural hospitals					
Alingsås	2.5%	2.1%	2.2%	1.9%	1.3%
Arvika	2.9%	2.2%	2.3%	1.6%	1.8%
Bollnäs	1.3%	1.4%	1.7%	2.4%	2.2%
Enköping	2.7%	2.0%	2.2%	2.2%	2.0%
Frölunda Specialistsjukhus	2.2%	1.8%	1.5%	0.6%	0.6%
Gällivare	1.3%	1.3%	1.5%	1.0%	0.8%
Hudiksvall	2.5%	2.6%	2.7%	2.5%	2.1%
Karlshamn	1.1%	1.3%	1.6%	1.7%	2.0%
Karlskoga	1.0%	0.9%	1.0%	1.1%	1.5%
Katrineholm	1.8%	2.0%	1.9%	1.8%	1.7%
Kungälv	1.8%	2.2%	2.4%	2.7%	2.6%
Lidköping	0.7%	1.0%	0.8%	1.0%	1.1%
Lindesberg	1.0%	1.0%	0.8%	0.8%	0.8%
Ljungby	1.1%	1.0%	1.2%	1.7%	2.2%
Lycksele	1.7%	1.8%	1.9%	1.8%	1.7%
Mora	1.1%	0.8%	0.9%	1.2%	1.3%
Norrtälje	3.4%	3.5%	3.1%	2.7%	1.7%
Nyköping	5.1%	6.3%	6.9%	6.1%	4.2%
Oskarshamn	1.7%	1.4%	1.1%	0.9%	0.9%
Piteå	1.2%	1.3%	0.9%	1.0%	0.9%
Skellefteå	1.1%	1.1%	1.2%	1.4%	1.5%
Skene	1.6%	1.9%	2.4%	1.6%	1.6%
Sollefteå	1.0%	0.6%	0.6%	0.8%	0.8%
Södertälje	1.0%	1.5%	3.9%	5.3%	5.8%
Torsby	1.3%	1.8%	1.8%	1.9%	2.5%
Trelleborg	1.7%	1.6%	1.5%	1.4%	1.1%
Visby	2.2%	1.9%	3.0%	3.5%	2.6%
Värnamo	1.1%	1.6%	1.4%	1.2%	1.5%
Västervik	4.4%	3.5%	2.6%	2.2%	0.7%
Ängelholm	0.9%	0.8%	0.6%	1.4%	1.6%
Örnsköldsvik	0.7%	0.6%	1.0%	1.1%	0.8%

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Reoperations within 2 years per hospital[1)] – trend (cont.)

primary operation 2008–2015

Hospital	2008–2011	2009–2012	2010–2013	2011–2014	2012–2015[2)]
Private hospitals					
Aleris Specialistvård Bollnäs	0%	2.5%	2.2%	1.9%	1.6%
Aleris Specialistvård Elisabethsjukhuset	0.8%	1.4%	1.7%	1.2%	1.8%
Aleris Specialistvård Motala	2.7%	2.4%	2.3%	2.1%	1.6%
Aleris Specialistvård Nacka	0.8%	1.0%	1.8%	2.4%	2.1%
Aleris Specialistvård Sabbatsberg	1.4%	1.4%	1.4%	0.8%	0.8%
Aleris Specialistvård Ängelholm	0%	0%	0%	1.0%	0.9%
Capio Movement	2.9%	3.5%	3.7%	3.9%	3.5%
Capio Ortopediska Huset	2.1%	1.6%	1.1%	1.0%	0.8%
Capio S:t Göran	2.4%	3.2%	3.3%	3.4%	2.5%
Carlanderska	1.9%	1.6%	1.8%	2.0%	1.1%
Ortho Center IFK-kliniken	0.6%	0.8%	0.4%	0.2%	0.4%
Ortho Center Stockholm	2.4%	2.7%	2.9%	2.7%	2.2%
Sophiahemmet	1.9%	1.7%	1.7%	1.7%	1.7%
Spenshult	2.8%	3.4%	3.6%	3.5%	3.7%
Others	1.9%	2.0%	1.5%	3.9%	1.2%
Country	2.3%	2.3%	2.3%	2.2%	2.0%

[1)] *Falköping, Köping, Motala (to 2009), NÄL, Ystad, Art Clinic Göteborg, Hermelinen Spec.vård, SU/Sahlgrenska and SU/Östra have been excluded due to too few operations performed during 2012–2015 or discontinued activity.*

[2)] *N.B. Shorter than 2 years follow up!*

Reoperations, "standard patient", within 2 years per hospital[1)]

2012–2015

	Prim THRs	Patients[2)]		Infection		Dislocation		Loosening		Others	
Hospital	**Number**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
University/Regional hospitals											
Karolinska/Huddinge	253	3	1.2%	1	0.4%	0	0%	0	0%	2	0.8%
Karolinska/Solna	142	0	0%	0	0%	0	0%	0	0%	0	0%
SU/Mölndal	706	10	1.4%	5	0.7%	1	0.1%	0	0%	4	0.6%
Uppsala	239	1	0.4%	0	0%	0	0%	0	0%	1	0.4%
Örebro	131	3	2.3%	3	2.3%	0	0%	0	0%	0	0%
Central hospitals											
Borås	208	5	2.4%	1	0.5%	1	0.5%	0	0%	3	1.4%
Danderyd	415	12	2.9%	4	1.0%	4	1.0%	0	0%	4	1.0%
Eksjö	434	1	0.2%	1	0.2%	0	0%	0	0%	0	0%
Eskilstuna	70	0	0%	0	0%	0	0%	0	0%	0	0%
Falun	655	5	0.8%	2	0.3%	0	0%	0	0%	3	0.5%
Gävle	253	5	2.0%	3	1.2%	1	0.4%	0	0%	1	0.4%
Halmstad	457	5	1.1%	4	0.9%	1	0.2%	0	0%	0	0%
Helsingborg	113	1	0.9%	1	0.9%	0	0%	0	0%	0	0%
Hässleholm-Kristianstad	1,437	10	0.7%	9	0.6%	0	0%	0	0%	1	0.1%
Jönköping	297	5	1.7%	4	1.3%	0	0%	0	0%	1	0.3%
Kalmar	306	2	0.7%	1	0.3%	0	0%	1	0.3%	0	0%
Karlstad	280	7	2.5%	7	2.5%	0	0%	0	0%	0	0%
Norrköping	377	1	0.3%	1	0.3%	0	0%	0	0%	0	0%
Skövde	291	3	1.0%	2	0.7%	1	0.3%	0	0%	0	0%
Sundsvall	255	4	1.6%	2	0.8%	2	0.8%	0	0%	0	0%
Södersjukhuset	460	12	2.6%	7	1.5%	0	0%	0	0%	5	1.1%
Uddevalla	613	2	0.3%	1	0.2%	0	0%	0	0%	1	0.2%
Varberg	463	3	0.6%	1	0.2%	1	0.2%	0	0%	1	0.2%
Västerås	477	9	1.9%	4	0.8%	1	0.2%	0	0%	4	0.8%
Växjö	229	0	0%	0	0%	0	0%	0	0%	0	0%
Östersund	459	6	1.3%	3	0.7%	0	0%	0	0%	3	0.7%
Rural hospitals											
Alingsås	504	3	0.6%	3	0.6%	0	0%	0	0%	0	0%
Arvika	372	5	1.3%	5	1.3%	0	0%	0	0%	0	0%
Bollnäs	52	0	0%	0	0%	0	0%	0	0%	0	0%
Enköping	720	8	1.1%	3	0.4%	2	0.3%	0	0%	3	0.4%
Gällivare	169	0	0%	0	0%	0	0%	0	0%	0	0%
Hudiksvall	198	3	1.5%	1	0.5%	0	0%	0	0%	2	1.0%
Karlshamn	529	8	1.5%	3	0.6%	5	0.9%	0	0%	0	0%
Karlskoga	345	1	0.3%	1	0.3%	0	0%	0	0%	0	0%
Katrineholm	636	6	0.9%	4	0.6%	0	0%	0	0%	2	0.3%
Kungälv	348	6	1.7%	4	1.1%	1	0.3%	0	0%	1	0.3%
Lidköping	586	1	0.2%	0	0%	0	0%	0	0%	1	0.2%

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Reoperations, "standard patient", within 2 years per hospital[1] (cont.)

2012–2015

	Prim THRs	Patients[2]		Infection		Dislocation		Loosening		Others	
Hospital	**Number**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Lindesberg	475	2	0.4%	1	0.2%	0	0%	0	0%	1	0.2%
Ljungby	307	6	2.0%	4	1.3%	0	0%	0	0%	2	0.7%
Lycksele	662	8	1.2%	2	0.3%	4	0.6%	0	0%	2	0.3%
Mora	465	3	0.6%	2	0.4%	1	0.2%	0	0%	0	0%
Norrtälje	170	4	2.4%	2	1.2%	1	0.6%	0	0%	1	0.6%
Nyköping	222	4	1.8%	4	1.8%	0	0%	0	0%	0	0%
Oskarshamn	564	3	0.5%	2	0.4%	0	0%	0	0%	1	0.2%
Piteå	727	4	0.6%	3	0.4%	1	0.1%	0	0%	0	0%
Skellefteå	178	3	1.7%	2	1.1%	0	0%	0	0%	1	0.6%
Skene	341	1	0.3%	0	0%	0	0%	0	0%	1	0.3%
Sollefteå	261	0	0%	0	0%	0	0%	0	0%	0	0%
Södertälje	165	4	2.4%	2	1.2%	1	0.6%	0	0%	1	0.6%
Torsby	168	3	1.8%	3	1.8%	0	0%	0	0%	0	0%
Trelleborg	1,356	9	0.7%	4	0.3%	1	0.1%	0	0%	4	0.3%
Visby	258	2	0.8%	0	0%	0	0%	0	0%	2	0.8%
Värnamo	245	3	1.2%	2	0.8%	0	0%	0	0%	1	0.4%
Västervik	219	0	0%	0	0%	0	0%	0	0%	0	0%
Ängelholm	280	5	1.8%	1	0.4%	2	0.7%	0	0%	2	0.7%
Örnsköldsvik	299	0	0%	0	0%	0	0%	0	0%	0	0%
Private hospitals											
Aleris Specialistvård Bollnäs	687	5	0.7%	2	0.3%	1	0.1%	0	0%	2	0.3%
Aleris Specialistvård Elisabethsjukhuset	84	0	0%	0	0%	0	0%	0	0%	0	0%
Aleris Specialistvård Motala	1,016	9	0.9%	6	0.6%	1	0.1%	0	0%	2	0.2%
Aleris Specialistvård Nacka	435	9	2.1%	6	1.4%	1	0.2%	0	0%	2	0.5%
Aleris Specialistvård Sabbatsberg	360	1	0.3%	1	0.3%	0	0%	0	0%	0	0%
Aleris Specialistvård Ängelholm	126	1	0.8%	1	0.8%	0	0%	0	0%	0	0%
Capio Movement	496	10	2.0%	2	0.4%	8	1.6%	0	0%	0	0%
Capio Ortopediska Huset	1,008	8	0.8%	2	0.2%	0	0%	1	0.1%	5	0.5%
Capio S:t Göran	760	9	1.2%	5	0.7%	1	0.1%	0	0%	3	0.4%
Carlanderska	328	2	0.6%	1	0.3%	0	0%	0	0%	1	0.3%
Ortho Center IFK-kliniken	294	2	0.7%	2	0.7%	0	0%	0	0%	0	0%
Ortho Center Stockholm	1,216	17	1.4%	9	0.7%	2	0.2%	1	0.1%	5	0.4%
Sophiahemmet	492	8	1.6%	2	0.4%	0	0%	0	0%	6	1.2%
Spenshult	378	13	3.4%	3	0.8%	8	2.1%	0	0%	2	0.5%
Others	195	2	1.0%	0	0%	0	0%	0	0%	2	1.0%
Country	29,716	316	1.1%	167	0.6%	54	0.2%	3	0%	92	0.3%

1) Karlskrona, Sunderby (incl. Boden), Art Clinic Göteborg, Art Clinic Jönköping, Hermelinen Spec.vård, Linköping, S US/Lund, SUS/Malmö and Umeå have been included in the group "Others" due to too few operations performed.

2) Refers to number of patients with short-term complications, which may differ from the sum of complications since each patient may have more than one type of complication.

Red marking denotes values one standard deviation above the national average.

”Adverse events” within 30 days and 90 days

The term “adverse events” refers to all forms of readmission that may be associated with hip replacement procedure - not just local complications, but also general medical complications (including death).

The Register’s and the Swedish National Board of Health and Welfare’s definition of “adverse events” after hip arthroplasty surgery: all forms of reoperation of the hip in question as well as cardiovascular, cerebrovascular and thromboembolic complications, pneumonia, ulcers if these complications have resulted in hospitalization, plus death. From the patient’s standpoint, this type of analyses is more relevant compared to analyses of only prosthesis-related events/complications.

To partially adjust for different case-mix distribution at hospitals, we report in this year’s adverse events three different groups: all patients, standard patient and patients who underwent operation due to hip fracture (acute and sequelae after fracture)

Result

All patients. The analysis took as its point of departure the register’s database for primary total hip replacements during 2013 up to and including September 2015 (44,749 operations) and this database was coordinated with the National Patient Register. The national average is 3.15%, after 30 days and 5.16% after 90 days. These national averages are marginally lower in comparison to previous year’s analysis. The frequency of adverse events varies considerably between hospitals. 30 days: 0.0–10.20%. 90 days: 0.0–18.75%. Hospitals differing from the average with a standard deviation or more are marked in red in the table.

The ”standard” patient. Analysis similar to the above, only with a smaller number of patients: 20,273 operations. The definition for the ”standard patient” can be found on page 142. The national average is 1.66%, after 30 days and 2.83% after 90 days. This “newer” patient group had thus, as expected, less adverse events compared to the whole national total hip arthroplasty population. However, the frequency varies between different hospitals concerning this more homogeneous patient group, and there is room for improvement. 30 days: 0.0–6.62%. 90 days: 0.0–8.82%.

Fracture patients. Analysis similar to the above, only now with 16,236 operations. The national average is 14.22%, after 30 days and 22.33% after 90 days. This group (higher mean age and more expressed comorbity) has, as expected, the frequency of adverse events is remarkably higher than in the groups above. There are very large differences between the clinics. There is a slight increase since last year, but local analyses and improvement are necessary.30 days: 0.0–35.48%. 90 days: 0.0–42.86%.

Problems and discussion

This type of analysis from the Patient Register (PAR) may in the future be of great significance for continued development of quality for Swedish hip arthroplasty. We can capture variables in PAR that our ordinary routines do not register. At present, there are however, a number of sources of error described in the section entitled “Coverage”. A number of hospital amalgamations have been carried out with shared reporting to the Patient Register despite the surgery being performed at different hospitals. The greatest source of error, however, is probably sub-optimal code setting, and that many patients have a large number of side diagnoses when discharged, where the most relevant diagnosis for that particular care occurrence is not always the first diagnosis in the report. These factors give rise to the probability that the analysis will present values that are too low.

The great variation in the frequency of adverse events between hospitals suggests an improvement potential within this area. Of course, various case-mixes can explain some of the differences, but differences in preoperative medical assessment/optimization, etc. should also be discussed at clinics when these figures are interpreted locally.

Adverse events, all patients

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
University/Regional hospitals							
Karolinska/Huddinge	694	19	2.74	1.24	43	6.20	1.83
Karolinska/Solna	506	29	5.73	2.07	50	9.88	2.65
Linköping	186	13	6.99	3.74	24	12.9	4.92
SU/Mölndal	1,460	44	3.01	0.89	70	4.79	1.12
SU/Sahlgrenska	16	1	6.25	12.1	3	18.75	19.52
SUS/Lund	523	25	4.78	1.87	51	9.75	2.59
SUS/Malmö	78	4	5.13	4.99	5	6.41	5.55
Umeå	231	14	6.06	3.14	26	11.26	4.16
Uppsala	713	32	4.49	1.55	61	8.56	2.10
Örebro	313	7	2.24	1.67	13	4.15	2.26
Central hospitals							
Borås	456	27	5.92	2.21	39	8.55	2.62
Danderyd	902	53	5.88	1.57	70	7.76	1.78
Eksjö	571	17	2.98	1.42	29	5.08	1.84
Eskilstuna	307	31	10.10	3.44	43	14.01	3.96
Falun	864	16	1.85	0.92	24	2.78	1.12
Gävle	659	25	3.79	1.49	35	5.31	1.75
Halmstad	665	23	3.46	1.42	37	5.56	1.78
Helsingborg	319	17	5.33	2.52	29	9.09	3.22
Hässleholm-Kristianstad	2,222	51	2.30	0.64	93	4.19	0.85
Jönköping	484	12	2.48	1.41	22	4.55	1.89
Kalmar	431	12	2.78	1.58	19	4.41	1.98
Karlskrona	75	7	9.33	6.72	11	14.67	8.17
Karlstad	640	31	4.84	1.70	52	8.13	2.16
Norrköping	688	21	3.05	1.31	40	5.81	1.78
Skövde	405	13	3.21	1.75	22	5.43	2.25
Sunderbyn	98	10	10.20	6.12	16	16.33	7.47
Sundsvall	429	34	7.93	2.61	46	10.72	2.99
Södersjukhuset	1,147	45	3.92	1.15	64	5.58	1.36
Uddevalla	1,038	27	2.60	0.99	51	4.91	1.34
Varberg	584	15	2.57	1.31	30	5.14	1.83
Västerås	1,183	71	6.00	1.38	123	10.40	1.77
Växjö	387	17	4.39	2.08	28	7.24	2.63
Ystad	1	0	0	0	0	0	0
Östersund	752	15	1.99	1.02	24	3.19	1.28

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Adverse events, all patients (cont.)

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
Rural hospitals							
Alingsås	579	24	4.15	1.66	33	5.70	1.93
Arvika	501	18	3.59	1.66	32	6.39	2.18
Enköping	920	28	3.04	1.13	44	4.78	1.41
Frölunda Specialistsjukhus	249	2	0.80	1.13	5	2.01	1.78
Gällivare	251	9	3.59	2.35	12	4.78	2.69
Hudiksvall	378	13	3.44	1.87	25	6.61	2.56
Karlshamn	659	21	3.19	1.37	36	5.46	1.77
Karlskoga	470	14	2.98	1.57	22	4.68	1.95
Katrineholm	648	13	2.01	1.10	23	3.55	1.45
Kungälv	510	16	3.14	1.54	25	4.90	1.91
Lidköping	720	13	1.81	0.99	26	3.61	1.39
Lindesberg	585	12	2.05	1.17	14	2.39	1.26
Ljungby	434	13	3.00	1.64	25	5.76	2.24
Lycksele	837	17	2.03	0.98	28	3.35	1.24
Mora	584	9	1.54	1.02	23	3.94	1.61
Norrtälje	343	11	3.21	1.90	17	4.96	2.34
Nyköping	408	29	7.11	2.54	40	9.80	2.94
Oskarshamn	728	11	1.51	0.90	20	2.75	1.21
Piteå	929	14	1.51	0.80	28	3.01	1.12
Skellefteå	348	13	3.74	2.03	19	5.46	2.44
Skene	366	4	1.09	1.09	9	2.46	1.62
Sollefteå	325	12	3.69	2.09	19	5.85	2.60
Södertälje	272	17	6.25	2.94	27	9.93	3.63
Torsby	281	9	3.20	2.10	12	4.27	2.41
Trelleborg	1,696	28	1.65	0.62	44	2.59	0.77
Visby	344	13	3.78	2.06	21	6.10	2.58
Värnamo	367	18	4.90	2.25	24	6.54	2.58
Västervik	295	6	2.03	1.64	9	3.05	2.00
Ängelholm	270	7	2.59	1.93	11	4.07	2.41
Örnsköldsvik	411	8	1.95	1.36	18	4.38	2.02

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Adverse events, all patients (cont.)

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
Private hospitals							
Aleris Specialistvård Bollnäs	796	8	1.01	0.71	20	2.51	1.11
Aleris Specialistvård Elisabethsjukhuset	48	0	0	0	1	2.08	4.12
Aleris Specialistvård Motala	1,433	37	2.58	0.84	53	3.70	1.00
Aleris Specialistvård Nacka	397	10	2.52	1.57	12	3.02	1.72
Aleris Specialistvård Sabbatsberg	340	0	0	0	0	0	0
Aleris Specialistvård Ängelholm	204	5	2.45	2.17	7	3.43	2.55
Art Clinic Göteborg	7	0	0	0	0	0	0
Art clinic Jönköping	32	1	3.13	6.15	1	3.13	6.15
Capio Movement	568	25	4.40	1.72	39	6.87	2.12
Capio Ortopediska Huset	1,084	19	1.75	0.80	31	2.86	1.01
Capio S:t Göran	1,242	64	5.15	1.25	88	7.09	1.46
Carlanderska	371	7	1.89	1.41	11	2.96	1.76
Hermelinen Spec.vård	22	0	0	0	0	0	0
Ortho Center IFK-kliniken	349	1	0.29	0.57	2	0.57	0.81
Ortho Center Stockholm	1,202	14	1.16	0.62	28	2.33	0.87
Sophiahemmet	582	5	0.86	0.77	13	2.23	1.23
Spenshult	337	14	4.15	2.17	18	5.34	2.45
Country	44,749	1,410	3.15	0.17	2,308	5.16	0.21

Adverse events, "standard patient"

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
University/Regional hospitals							
Karolinska/Huddinge	179	3	1.68	1.92	8	4.47	3.09
Karolinska/Solna	95	2	2.11	2.95	2	2.11	2.95
Linköping	34	0	0	0	3	8.82	9.73
SU/Mölndal	506	7	1.38	1.04	13	2.57	1.41
SUS/Lund	34	0	0	0	0	0	0
Umeå	27	1	3.70	7.27	1	3.70	7.27
Uppsala	168	1	0.60	1.19	4	2.38	2.35
Örebro	90	1	1.11	2.21	2	2.22	3.11
Central hospitals							
Borås	136	9	6.62	4.26	10	7.35	4.48
Danderyd	292	9	3.08	2.02	12	4.11	2.32
Eksjö	290	4	1.38	1.37	12	4.14	2.34
Eskilstuna	37	0	0	0	1	2.70	5.33
Falun	425	5	1.18	1.05	7	1.65	1.23
Gävle	173	1	0.58	1.15	4	2.31	2.29
Halmstad	319	8	2.51	1.75	11	3.45	2.04
Helsingborg	82	2	2.44	3.41	3	3.66	4.15
Hässleholm-Kristianstad	1,020	12	1.18	0.68	26	2.55	0.99
Jönköping	191	2	1.05	1.47	5	2.62	2.31
Kalmar	218	1	0.46	0.92	2	0.92	1.29
Karlskrona	4	0	0	0	0	0	0
Karlstad	182	3	1.65	1.89	5	2.75	2.42
Norrköping	266	4	1.50	1.49	8	3.01	2.09
Skövde	167	3	1.80	2.06	5	2.99	2.64
Sundsvall	174	7	4.02	2.98	8	4.60	3.18
Södersjukhuset	316	10	3.16	1.97	10	3.16	1.97
Uddevalla	426	7	1.64	1.23	10	2.35	1.47
Varberg	294	5	1.70	1.51	10	3.40	2.11
Västerås	313	8	2.56	1.78	15	4.79	2.41
Växjö	156	4	2.56	2.53	7	4.49	3.32
Östersund	307	4	1.30	1.29	6	1.95	1.58

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Adverse events, "standard patient" (cont.)

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
Rural hospitals							
Alingsås	355	12	3.38	1.92	14	3.94	2.07
Arvika	265	5	1.89	1.67	9	3.40	2.23
Enköping	501	8	1.60	1.12	16	3.19	1.57
Gällivare	106	1	0.94	1.88	2	1.89	2.64
Hudiksvall	148	2	1.35	1.90	3	2.03	2.32
Karlshamn	368	7	1.90	1.42	16	4.35	2.13
Karlskoga	240	1	0.42	0.83	6	2.50	2.02
Katrineholm	448	6	1.34	1.09	13	2.90	1.59
Kungälv	260	4	1.54	1.53	5	1.92	1.70
Lidköping	439	6	1.37	1.11	11	2.51	1.49
Lindesberg	328	3	0.91	1.05	4	1.22	1.21
Ljungby	192	6	3.13	2.51	7	3.65	2.71
Lycksele	463	7	1.51	1.13	12	2.59	1.48
Mora	309	5	1.62	1.44	8	2.59	1.81
Norrtälje	125	2	1.60	2.24	3	2.40	2.74
Nyköping	150	5	3.33	2.93	6	4.00	3.20
Oskarshamn	405	4	0.99	0.98	11	2.72	1.62
Piteå	482	3	0.62	0.72	9	1.87	1.23
Skellefteå	127	3	2.36	2.70	5	3.94	3.45
Skene	242	1	0.41	0.82	4	1.65	1.64
Sollefteå	170	4	2.35	2.33	4	2.35	2.33
Södertälje	103	3	2.91	3.31	8	7.77	5.27
Torsby	104	3	2.88	3.28	4	3.85	3.77
Trelleborg	929	9	0.97	0.64	15	1.61	0.83
Visby	178	3	1.69	1.93	4	2.25	2.22
Värnamo	174	7	4.02	2.98	10	5.75	3.53
Västervik	141	2	1.42	1.99	2	1.42	1.99
Ängelholm	169	4	2.37	2.34	5	2.96	2.61
Örnsköldsvik	201	4	1.99	1.97	6	2.99	2.40

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Adverse events, "standard patient" (cont.)

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
Private hospitals							
Aleris Specialistvård Bollnäs	489	4	0.82	0.81	10	2.04	1.28
Aleris Specialistvård Elisabethsjukhuset	35	0	0	0	1	2.86	5.63
Aleris Specialistvård Motala	728	11	1.51	0.90	14	1.92	1.02
Aleris Specialistvård Nacka	292	10	3.42	2.13	11	3.77	2.23
Aleris Specialistvård Sabbatsberg	244	0	0	0	0	0	0
Aleris Specialistvård Ängelholm	111	2	1.80	2.53	4	3.60	3.54
Art Clinic Göteborg	6	0	0	0	0	0	0
Art clinic Jönköping	17	0	0	0	0	0	0
Capio Movement	331	11	3.32	1.97	17	5.14	2.43
Capio Ortopediska Huset	696	11	1.58	0.95	22	3.16	1.33
Capio S:t Göran	500	15	3.00	1.53	25	5.00	1.95
Carlanderska	219	3	1.37	1.57	5	2.28	2.02
Hermelinen Spec.vård	5	0	0	0	0	0	0
Ortho Center IFK-kliniken	195	0	0	0	1	0.51	1.02
Ortho Center Stockholm	826	6	0.73	0.59	14	1.69	0.90
Sophiahemmet	341	3	0.88	1.01	7	2.05	1.54
Spenshult	195	8	4.10	2.84	10	5.13	3.16
Country	20,273	337	1.66	0.18	573	2.83	0.23

Adverse events, fracture patients

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
University/Regional hospitals							
Karolinska/Huddinge	348	44	12.64	3.56	79	22.70	4.49
Karolinska/Solna	197	34	17.26	5.38	55	27.92	6.39
Linköping	275	45	16.36	4.46	64	23.27	5.10
SU/Mölndal	1,134	131	11.55	1.90	229	20.19	2.38
SU/Sahlgrenska	14	4	28.57	24.15	6	42.86	26.45
SUS/Lund	577	50	8.67	2.34	96	16.64	3.10
SUS/Malmö	616	98	15.91	2.95	142	23.05	3.39
Umeå	255	44	17.25	4.73	66	25.88	5.49
Uppsala	529	71	13.42	2.96	107	20.23	3.49
Örebro	226	28	12.39	4.38	50	22.12	5.52
Central hospitals							
Borås	369	44	11.92	3.37	81	21.95	4.31
Danderyd	568	77	13.56	2.87	122	21.48	3.45
Eksjö	175	32	18.29	5.84	45	25.71	6.61
Eskilstuna	301	56	18.60	4.49	82	27.24	5.13
Falun	376	43	11.44	3.28	74	19.68	4.10
Gävle	421	59	14.01	3.38	75	17.81	3.73
Halmstad	267	38	14.23	4.28	65	24.34	5.25
Helsingborg	520	74	14.23	3.06	121	23.27	3.71
Hässleholm-Kristianstad	497	103	20.72	3.64	142	28.57	4.05
Jönköping	209	24	11.48	4.41	40	19.14	5.44
Kalmar	215	22	10.23	4.13	47	21.86	5.64
Karlskrona	306	45	14.71	4.05	77	25.16	4.96
Karlstad	391	75	19.18	3.98	105	26.85	4.48
Norrköping	285	28	9.82	3.53	56	19.65	4.71
Skövde	299	44	14.72	4.10	60	20.07	4.63
Sunderbyn	455	72	15.82	3.42	114	25.05	4.06
Sundsvall	302	47	15.56	4.17	69	22.85	4.83
Södersjukhuset	952	126	13.24	2.20	193	20.27	2.61
Uddevalla	597	71	11.89	2.65	129	21.61	3.37
Varberg	268	33	12.31	4.01	56	20.90	4.97
Västerås	435	56	12.87	3.21	97	22.30	3.99
Växjö	196	19	9.69	4.23	34	17.35	5.41
Ystad	31	11	35.48	17.19	12	38.71	17.50
Östersund	280	23	8.21	3.28	45	16.07	4.39

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Adverse events, fracturepatients (cont.)

2013–2015

	Patients	Adverse events within 30 days			Adverse events within 90 days		
Hospital	Number	Number	%	±	Number	%	±
Rural hospitals							
Alingsås	116	19	16.38	6.87	29	25.00	8.04
Arvika	14	4	28.57	24.15	6	42.86	26.45
Frölunda Specialistsjukhus	2	0	0	0	0	0	0
Gällivare	145	26	17.93	6.37	36	24.83	7.18
Hudiksvall	220	39	17.73	5.15	52	23.64	5.73
Karlshamn	6	0	0	0	0	0	0
Karlskoga	125	24	19.20	7.05	35	28.00	8.03
Katrineholm	1	0	0	0	0	0	0
Kungälv	238	30	12.61	4.30	50	21.01	5.28
Lidköping	146	17	11.64	5.31	32	21.92	6.85
Lindesberg	90	16	17.78	8.06	22	24.44	9.06
Ljungby	122	17	13.93	6.27	26	21.31	7.42
Lycksele	55	7	12.73	8.99	13	23.64	11.46
Mora	192	30	15.63	5.24	56	29.17	6.56
Norrtälje	106	22	20.75	7.88	28	26.42	8.56
Nyköping	121	13	10.74	5.63	21	17.36	6.89
Piteå	3	0	0	0	0	0	0
Skellefteå	126	16	12.70	5.93	20	15.87	6.51
Sollefteå	102	17	16.67	7.38	25	24.51	8.52
Södertälje	116	34	29.31	8.45	43	37.07	8.97
Torsby	113	27	23.89	8.02	32	28.32	8.48
Trelleborg	6	0	0	0	0	0	0
Visby	97	13	13.40	6.92	22	22.68	8.50
Värnamo	97	5	5.15	4.49	9	9.28	5.89
Västervik	137	22	16.06	6.27	29	21.17	6.98
Örnsköldsvik	122	16	13.11	6.11	26	21.31	7.42
Private hospitals							
Aleris Specialistvård Motala	123	15	12.20	5.90	27	21.95	7.46
Aleris Specialistvård Ängelholm	1	0	0	0	0	0	0
Capio S:t Göran	602	106	17.61	3.10	149	24.75	3.52
Carlanderska	2	0	0	0	0	0	0
Ortho Center Stockholm	3	1	33.33	54.43	1	33.33	54.43
Spenshult	1	1	100	0	1	100	0
Country	16,236	2,308	14.22	0.55	3,625	22.33	0.65

Revision

Revision means that a hip arthroplasty-operated patient undergoes a further operation in which a section or the whole prosthesis is replaced or extracted. Since 1979, revisions (and other reoperations) were reported on the individual level, which gives the possibility to extract more complete data from that year as opposed to getting the data from the primary database that has registered personal identification codes since 1992. Until 1991, only aggregated data per clinic for primary operations was registered. Since 1979, the number of revisions, with an exception for periods with a short-term, fall in the number until 2009. Subsequently, a small reduction can be seen (Figure 1). Registration of revision or other type of reoperation requires that the primary prosthesis is also registered, which are important to know when interpreting the chart's left side. Since 1992, when detailed records on the primary operations began, the proportion of revisions represented approximately 10–11%. This proportion has declined in recent periods (Figure 2).

From the Register's starting year 1979, the number of multiple-time revisions increased until the early 2000s (refer to Annual Report 2013). Over the past 20 years, the division between first-time revision (no previous revision = 0 in Figure 3) and multiple-time revisions have not showed any dramatic changes. However, there is a slight trend for the proportion of first-time revisions to decline as an effect of the increase of multiple-time revisions (Figure 3). Between the first and the last period, the increase is about 4%. Hypothetically, if the division between first-time and multiple-time revisions were unchanged between the first (1995–1997) and the last period (2013–2015), this would mean that 215 of multiple-time revisions that were performed between 2013 and 2015, should instead be first-time revisions. Given that the population is aging and more and more people have one or two implanted hip prostheses, there is an expected shift that we are operating more and more multiple-time revised patients. The number of patients undergoing revision for the fourth time is still relatively small. In 1995, 12 cases (1.1% of the entire year's production) underwent operation, in 2005, 37 (2.4%) and in 2015, 62 cases underwent a fourth-time revision (3.5%).

Patients undergoing revision differs (as well as those undergoing reoperation) demographically from the patients who undergo surgery with primary prosthesis. Generally, they

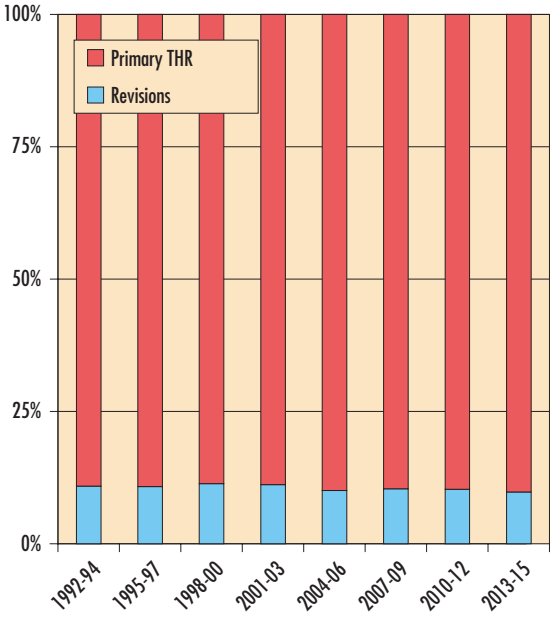


Figure 2. Proportion of revisions related to the total number of primary arthroplasties in three-year periods from 1992.

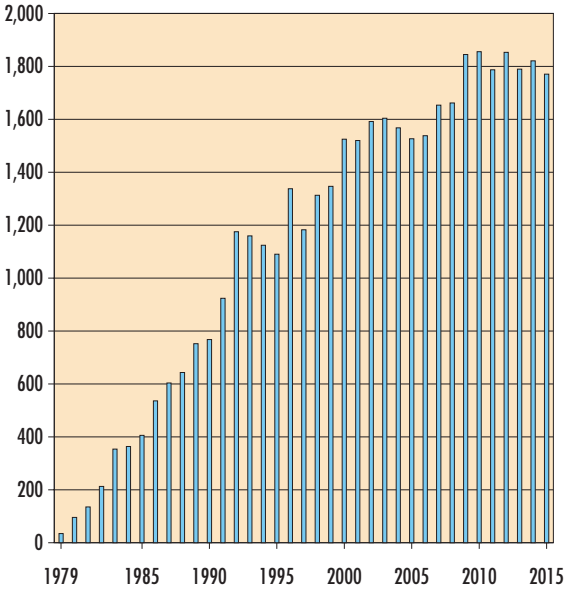


Figure 1. Number of revisions 1979–2015.

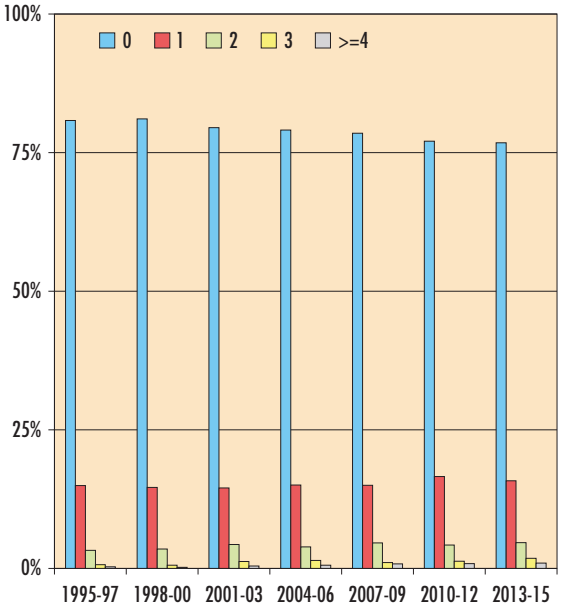


Figure 3. Distribution of initial and multiple-time revisions between 1995 and 2015 based on three-year periods.

are the older, more often male, have more often secondary osteoarthritis (excluding hip fracture group) and a higher degree of comorbidity (Table 1). Some of these tendencies are exacerbated in patients undergoing multiple revisions. Among patients who have had at least one revision and are forced to undergo another revision, the degree of comorbidity is further increa¬sed, and an even greater proportion of them had initially undergone surgery due to secondary osteoarthritis.

Almost 72% of all revisions carried out during the period 2013–2015, were performed at hospitals that performed at least 100 revisions during the same period. Compared with the period

Demographics – initial, secondary and multiple-time revisions and during primary arthroplasty

2008–2015

	Number of previous revisions			Primary arthro-plasties
	None	*1*	*>1*	*2008–2015*
Number	11,112	2,289	984	127,642
Age				
Mean Value *SD*	71.6 *11.2*	71.8 *11.3*	70.6 *11.2*	68.6 *10.8*
<55 years *%*	7.4	8.1	10.5	10.0
55–69 years *%*	31.1	29.4	31.9	40.7
70–84 years *%*	51.1	50.8	48.7	44.2
>=85 years *%*	10.4	11.7	8.9	5.1
Sex				
Proportion of women %	52.2	49.7	52.7	58.2
BMI				
Number, *% of all in the interval*	9,667 *87.0*	1,943 *84.9*	829 *84.2*	117822 *83.1*
Mean Value *SD*	27.2 *5.6*	27.0 *5.7*	27.1 *5.1*	27.1 *5.2*
<18.5 *%*	1.3	1.6	2.2	1.2
18.5–24.9 *%*	34.0	35.3	33.2	33.9
25–29.9 *%*	41.0	41.0	38.7	41.7
>=30 *%*	23.7	22.1	25.5	23.1
ASA class				
Number, *% of all in the interval*	10,505 *94.5*	2,163 *94.5*	909 *92.4*	122,991 *96.4*
I *%*	13.1	11.4	8.0	23.3
II *%*	53.6	49.6	44.8	58.1
III– *%*	33.3	39.0	47.2	18.6
Diagnosis during primary arthroplasty*				
Primary osteoarthritis	76.9	70.9	64.0	83.1
Fracture. including sequelae	7.4	6.9	8.3	9.9
Inflammatory joint disease	5.3	7.9	11.3	1.4
Sequelae after childhood disease	4.5	7.2	8.1	1.9
Femoral head necrosis	3.8	4.5	4.7	3.1
Other secondary osteoarthritis	1.2	2.1	3.6	0.6

**51,263 and 90 observations are missing for respective intervals among revisions*

Table 1. Sex and age distribution during initial, secondary and multiple-time revisions from 2008, when registration of ASA class, length and weight began. Data for primary operations are presented for comparison.

2012–2014, when the figure was about 80%, these data suggest a tendency for decentralization. 541 revisions (10.1%, the previous period 9.1%) were performed in hospitals that performed fewer than 50 revision operations between 2013 and 2015, which corresponds to less than 17 revisions per year per clinic. Among the units that performed between 25 and 40 revisions during the last three years, the most common procedure was replacing both cup/ liner and stem (34.7% of cases), followed by the cup/liner replacement (28.4%). The most common surgery performed at hospitals that performed less than 25 revisions during the same three-year period, was the replacement of cup and/or liner (34.3%), followed by replacement of the femoral head (34.3%). Just under half of the operations (48.9%) in the first group consisted of stem revision with or without replacement of cup or liner. The corresponding proportion among the hospitals with the absolute lowest volume was 25.3%.

Low volume per operation unit does not necessarily mean poorer quality of health care, because some clinics may have sold their business and moved during the period. In other cases, good skills can be available despite the fact, that only a few revisions were carried out and some of them did not require high competence and experience. However, it can be regarded as remarkable that as many as 24 units carried out less than 9 revisions over a three-year period.

The restructuring of health care has meant that some units and above all university/regional hospitals do fewer and fewer primary operations and in particular fewer standard operations. This has implications for education and opportunities to pursue studies. Although research and training can be outsourced, there are many advantages to the cohesion of this activity for better resource utilization, optimal infrastructure and to create effective teamwork. Table 2 shows the number of primary arthroplasties for units which conducted more than 100 revisions between 2013 and 2015. For some units, the number of performed primary arthroplasties is small, especially due to a large proportion of patients who receive primary prosthesis due to hip fracture, anatomical abnormalities and/or have a high degree of comorbidity. During the period 2012–2014, 25 clinics performed more than 100 revisions per clinic, corresponding to a total number of 4,523. During the period 2013–2015, the corresponding number of clinic dropped to 20, who together performed 3855 revisions, which represent a decrease of 668 revisions. Table 2 also shows that the number of clinics, which performed only a few revisions during the most recent period, increases slightly.

The number of revisions over the past three years has been relatively constant and has been just below 2000 per year. There are not many patients who are revised more than two times in Sweden, but they constitute a group with high comorbidity, which puts high demands on medical resources and surgical expertise. There is no tendency towards centralizing hip prosthesis revisions in Sweden, rather the opposite.

Number of clinics with different volumes of primary and revision arthroplasty 2013–2015

	Number of clinics			
	Primary prosthesis	Initial revision	≥ 1 previous revision(s)	Regardless of previous number of revisions
Volume per clinic				
1–24	3 *3*	23 *24*	35 *30*	24 *23*
25–49	4 *1*	11 *11*	12 *11*	9 *10*
50–99	2 *3*	15 *17*	5 *10*	13 *7*
100–149	1 *1*	8 *6*	1 *1*	8 *12*
150–199	3 *4*	5 *6*	–	6 *5*
200–299	6 *4*	2 *2*	–	4 *6*
300–499	26 *21*	–	–	2 *2*
500–999	27 *32*	–	–	–
1000–1499	9 *8*	–	–	–
1500–2499	4 *3*	–	–	–

Table 2. Number of clinics, which carry out initial and multiple-time revisions, is presented in groups for the period 2013–2015. Numbers for previous periods (2012–2014) are presented in italic. Note that volumes are attributed to three years.

Revisions and primary prosthesis

Clinic	Revisions	Primary prosthesis
Borås	107	495
Capio S:t Göran	177	1,403
Danderyd	252	1,001
Gävle	236	732
Halmstad	102	720
Helsingborg	130	367
Hässleholm-Kristianstad	247	2,431
Karlstad	166	716
Karolinska/Huddinge	197	757
Karolinska/Solna	188	561
Linköping	119	203
Skövde	120	459
SU/Mölndal	428	1,663
SUS/Lund	344	578
Södersjukhuset	199	1,240
Uddevalla	130	1,153
Umeå	164	265
Uppsala	291	793
Västerås	144	1,289
Örebro	114	332

Table 3. Number of reported revisions and primary hip replacement operations during a three-year period for the clinics which performed 100 revisions or more during 2013–2015.

Cause for revision

Through the review of surgery report, carried out by the register coordinators, the cause for reoperation is determined. Over the years, a large number of causes and causal combinations have been defined, as quite often, several causes are listed. Before this year's report and the transition to a new database structure, we have seen how different causes are grouped. This has caused small adjustments with marginal effects. The reason given is regarded as the most relevant. For example, during a revision of a dislocated prosthesis, which is also found to be infected, the main cause will be infection. Osteolysis, like polyethylene wear, is relatively common and was cited as a reason, or in combination with other causes, of at least 12.7 and 2.6% of all cases, and in 20.8% and 4.1% of cases classified as loosening, during the period of 2001–2015 (Figure 4). We believe it is less appropriate to build more extensive analyses of these data, because it cannot be assumed, that case records is always complete and the clinical assessment can often also be difficult.

The distribution of the cause of revision has changed over time (Figure 5). Relatively speaking, primarily has the cause group for infection, but also dislocation and periprosthetic fracture, increased, both in terms of initial and multiple-time revisions. Meanwhile, since 2001 the proportion of patients revised for loosening/ osteolysis/wear has gradually decreased from 77.5%, in the first three-year period, to 55.7% in the last period, in the group which was revised for the first time. In the group that has undergone at least one prior revision, the relative decline is about the same (64.2 to 41.1%), albeit from a lower starting level. The more revisions a patient has undergone, the more likely it is that it will be done due to infection or dislocation (Figure 6). 2.0 to 3.7% of the revisions have been caused by implant fracture, or so-called "technical reasons". In this presentation, loosening within two years has been classified as loosening, because it is probably more instructive to describe the time of the revision due to loosening than to introduce a specific time limit. In the grouping, over a third of cases is made up of hip replacements, which have been revised due to incorrectly inserted parts of prosthesis, followed by different leg lengths and dislocated polyethylene liner. In the group for revisions due to implant fracture, where the femoral part of the prosthesis is replaced or extracted, includes mainly cemented components (87.8%). Of the 327 stems, which were revised 2001–2015 due to implant fracture, 146 were different Lubinus versions (130 SP II), 65 Exeter (59 with polished and 6 with matte surface), 27 Charnley (2 Charnley Elite), 14 Spectron (10 Spectron EF Primary) and 13 Scan Hip. Among the uncemented stems were 5 Revitan Proximal Cylindrical, 5 Astra Tech and 3 MP and 2 Corail stems revised due to implant fracture. In other uncemented fixation cases, there was only one case per design. In the group for other causes, there was 146 surgeries which had been revised due to established or suspicion of pseudotumour with labels ALVAL (n = 81), elevated levels of metal ions (n=57) or corrosion (n=8). These data cannot be used for any kind of clinical or scientific judgments, but can be a starting point for more in-depth studies from the journal studies and comparative analyses based on all of the exposed population.

The cause of revision varies depending on age. At the primary revision, the proportion of revision due to loosening/osteolysis/wear is relatively constant and constitutes two-thirds (about 68%) of cases up to 84 years of age. Thereafter, this proportion drops to about half of the cases (49.4%). At multiple-time revisions, the proportion (and number) or revisions due to loosening/osteolysis reduces relatively linearly with age. In both groups, revision due to dislocation and periprosthetic fracture increases with age. The increase is particularly evident for the group 85 years and older. Infections are more evenly distributed, regardless of whether it regards initial revisions or patients who have undergone previous revisions.

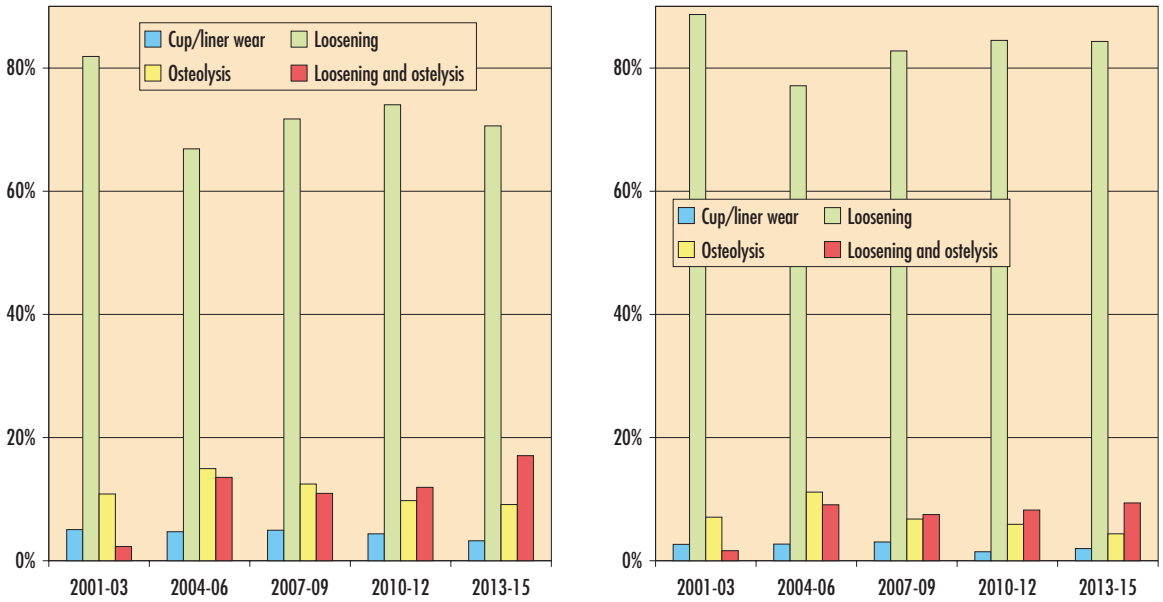


Figure 4. Distribution of causes for revision at initial (left) and multiple-time revisions (right) which are classified as loosening, osteolysis and/or wear in Figure 5. In cases where wear has been named without further specification, this cause has been excluded.

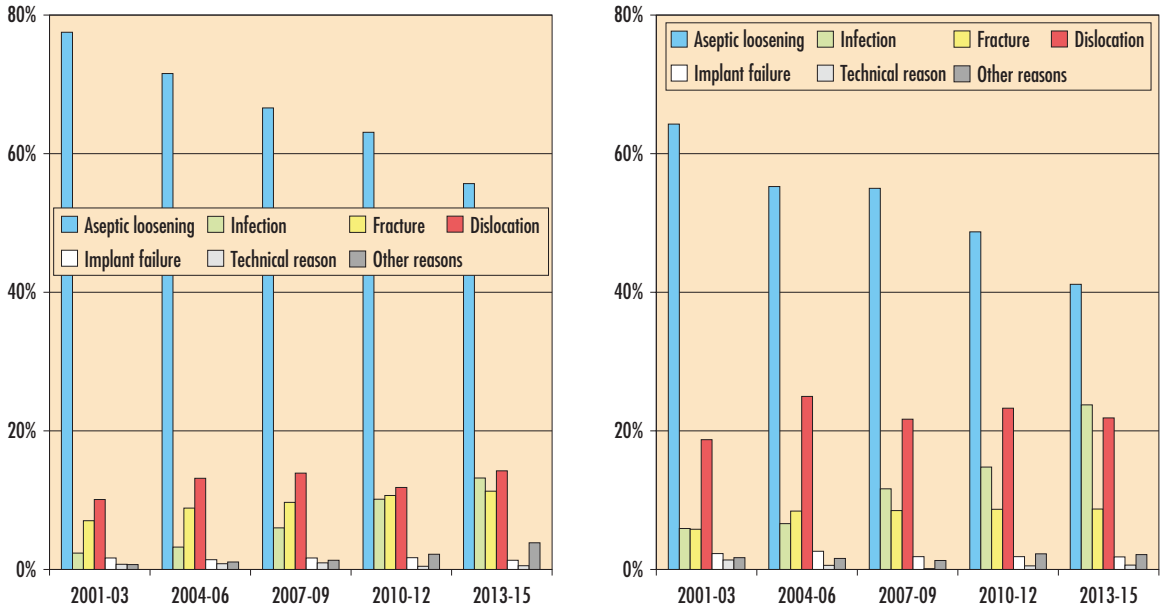


Figure 5. Distribution of causes for revision at initial (left) and multiple-time revisions (right) between 2001 and 2015. During multiple-time revision, "insertion of prosthesis after previous extraction" has been excluded.

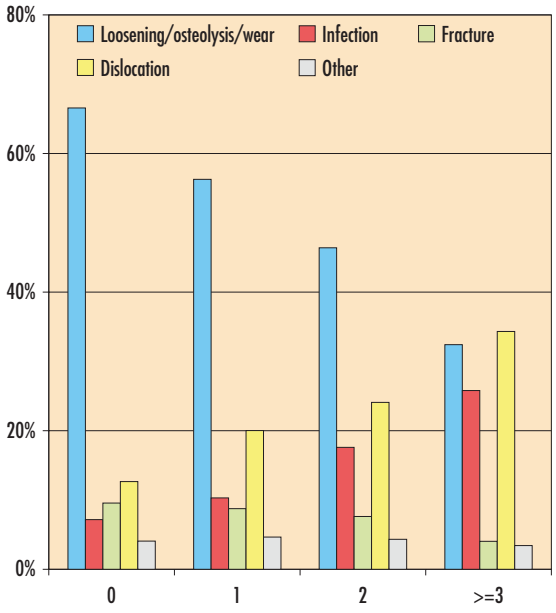


Figure 6. Distribution of causes for revision at initial (left) and multiple-time revisions (right) presented in three-year periods between 2001 and 2015. The proportion who had been revised due to loosening/osteolysis/wear decreases as more revisions are performed. Instead, the proportion for dislocation and infection.

The cause for revision has varied over time, which likely reflects several factors, such as changes in indication setting, changes in the distribution of cemented/uncemented fixation, implant selection, surgical technique and other less known factors. The cause of the revision varies depending on demographic factors, as has been illustrated with age. Presence of previously completed revision also plays a role. Dislocation and infection are most common during multiple-time revisions.

Multiple-time revisions

Of primary operations performed between 1992 and 2015, 5.6% has been revised on the 31 December, 2015. The corresponding figure for first-time revisions performed during the same period, is 16.0% and for multiple revisions, 21.9%. The corresponding implant survival after 19 years, when at least 100 observations remained in each group, was 82.7 ± 0.4 in the primary implant group, 64.7 ± 1.4 in the group for initially revised, and 59.0 ± 2.6 for patients, who have previously undergone at least one revision. As shown in Figure 6, rerevision occurs in the groups, who have been previously revised close to the revision performed last and depending on the number of previous revisions. Of the patients, who were revised once before and then once again, around 30% were rerevised within the first postoperative year. Among patients who were rerevised three times, or earlier, this percentage has risen to almost 60%.

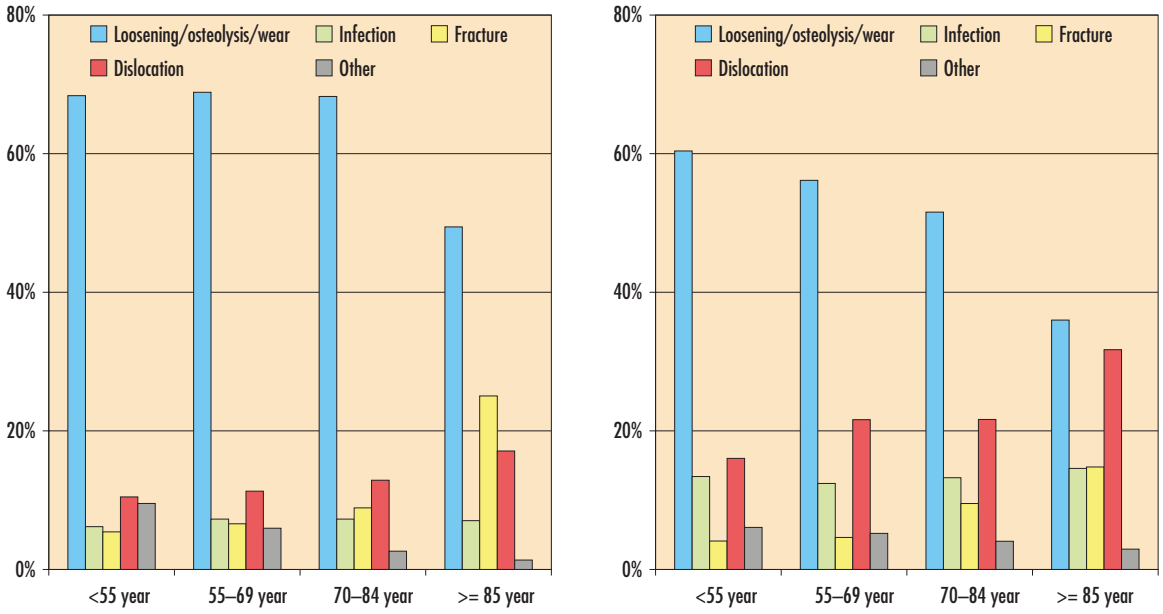


Figure 7. Distribution of causes for revision relative to four age groups at primary (left) and multiple-time revisions (right). The entire period 2001–2015 is included in order to have a sufficiently large baseline.

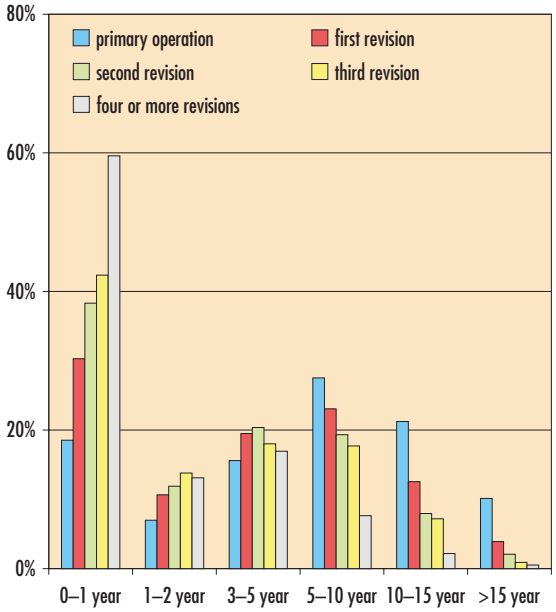


Figure 8. Time until the initial, secondary, third and fourth to ninth revision from the primary arthroplasty after the previous revision. Primary arthroplasties and revisions performed in 1992 or later, have been included. Upon insertion of the prosthesis after previous extraction, the time interval is calculated from the second session corresponding to the day when the patient has a complete prosthesis.

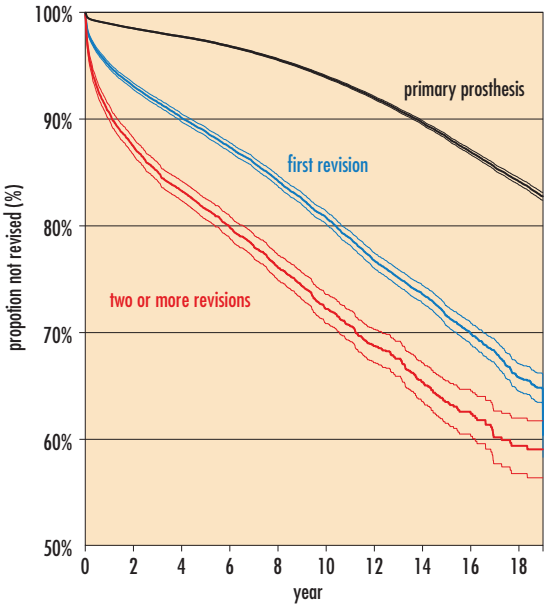


Figure 9. Prosthesis survival for all 311 730 primary arthroplasties, 29 067 initial revisions and 7 576 multiple-time revisions carried out during 1992–2015 and including all measures and all causes for revision/multiple-time revisions as results.

The reason for patient's initial revision affects the cause profile for a possible secondary revision (Table 4). A patient who undergoes a primary revision due to loosening/osteolysis, infection and dislocation, has a high probability that if he must undergo another revision, he will be revised because of the same reason. The same applies to patients who suffer a secondary revision. If a patient is operated due to periprosthetic fracture at initial revision, then this is the most common cause for a possible rerevision due to dislocation. If rectification of a periprosthetic fracture is performed as a secondary revision and eventually this results in a new revision, there is a great possibility that this is carried out due to loosening of one or both components, followed by dislocation. As opposed to previous annual reports, we now present the relative proportion of patients in distinctive revision and cause groups, which are rerevised in relation to the total number in the group. Patients, who are revised due to infection where almost 20% are rerevised after an initial and almost 25% after a secondary revision, have the worst prognosis. Second worst prognosis derives from the surgeries which are performed due to dislocation. Distribution of causes of revision at primary operation is shown at the top of Table 4 for comparison.

The more revisions a patient has undergone, the worse is the prognosis for the risk of further revisions. The likelihood that any subsequent revision will occur early, increases with the number of previously completed procedures. If an initial or secondary revision is performed due to loosening/osteolysis/wear, infection or dislocation, the cause for the next revision is often the same as in the previous revision. If a patient is revised due to periprosthetic fracture, it is likely that the next revision is performed due to dislocation or loosening. This suggests, that in addition to the stem, also the cup should be replaced in these patients.

Cause for secondary and third revision grouped according to prior cause

	Primary arthroplasty *n = 311 730*				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other**
Initial revision %	**3.2**	1.0	0.9	1.0	0.4
No revision	96.8				
	Initial revision *n = 27 811*				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other**
Second revision n	19,771	1,576	2,304	3,075	1,085
Cause %					
Loosening	**9.9**	1.8	**3.5**	2.9	**6.1**
Infection	1.6	**12.1**	2.1	4.0	2.8
Periprosthetic fracture	1.4	0.7	0.9	0.8	1.5
Dislocation	2.3	1.8	**3.6**	**9.4**	2.8
Other	0.7	3.0	1.6	0.6	2.2
No rerevision	84.1	80.6	88.4	82.3	84.7
	Secondary revision *n = 5 072*				
	Loosening	**Infection**	**Periprosthetic fracture**	**Dislocation**	**Other**
Third revision n	3,080	430	427	905	230
Cause %					
Loosening	**12.3**	1.2	**6.8**	4.8	**33.9**
Infection	2.2	**17.7**	1.9	5.1	17.7
Periprosthetic fracture	1.8	0.0	0.7	1.4	3.2
Dislocation	2.9	1.9	**6.1**	**9.6**	27.4
Other	0.9	3.5	1.9	1.0	17.7
No rerevision	79.9	75.8	82.7	78.1	74.8

Table 4. Distribution of causes for second and third time revision in percentages according to cause closest to the previous revision. Patient who were primarily operated on or revised during 1992–2015, have been analysed. Two-stage revisions have been classified as one procedure. The group for loosening includes osteolysis and wear (refer to the previous text).

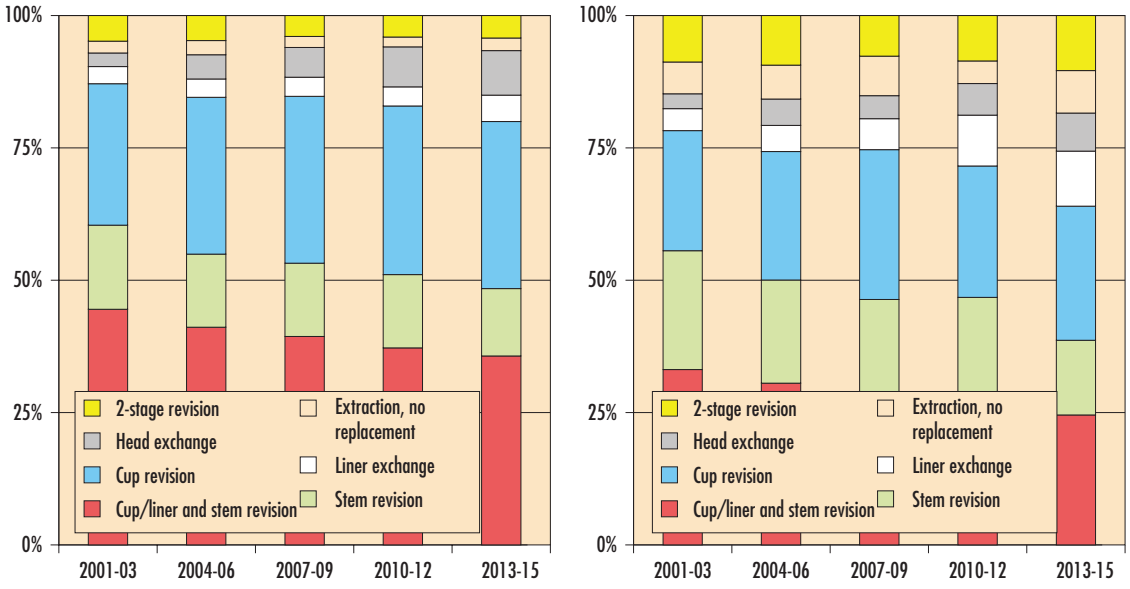


Figure 10. Distribution of measures for revision at initial (left) and multiple-time revisions (right). During a two-session operation, total or partial prosthesis extraction and the following insertion of new components been counted as on reoperation.

Measures at revision

Until the last period 2013–2015, the most common measure during revision, regardless of whether the prosthesis had been revised before or not, was replacement of cup/liner and stem. However, since 2001, the proportion of isolated cup revisions has increased and during the last period, was more common during multiple-time revisions (Figure 10). If isolated liner/caput replacements are added to the cup revisions, cup/liner revisions during initial revision are also the most common measure during 2013–2015, and during multiple-time revisions already during 2007–2009. During multiple-time revisions, measures like replacement of liner and caput, extraction without following insertion of prosthesis and two-session surgery, are more common in comparison to initial revisions. This corresponds to the reasoning that the more revisions are carried out, the more likely it is, that the cause is infection. It is not possible to determine, based on the register data, that a prosthesis extraction is definitive, which is illustrated by the fact that the number of "definitive" extractions (no insertion registered in Figure 10) increases during 2013–2015 in comparison to the previous period (26% higher during initial revision, 88% higher during multiple-time revision). This is an effect of a number of patients who, mainly during 2015, underwent stage one while they had planned to undergo stage two in 2016, had not yet managed to report their second session to the register. Between 2001 and 2014, the number of partial or total prosthesis extractions, without subsequent prosthesis insertion, has been relatively constant and varied between 39 and 61 per year (Figure 11). In 2015, the number was higher (n = 92), partly due to the cause mentioned above.

The type of measure varies depending on reasons for revision (Figure 12). It is most common, that at loosening/osteolysis both components are replaced, the second most common is the replacement of cup/liner while isolated stem revision is carried out only at every tenth case during initial revision and at every fifth case at multiple-time revisions. During infection, replacement of femoral head and/or liner is most common during initial revision, followed by a two-stage revision

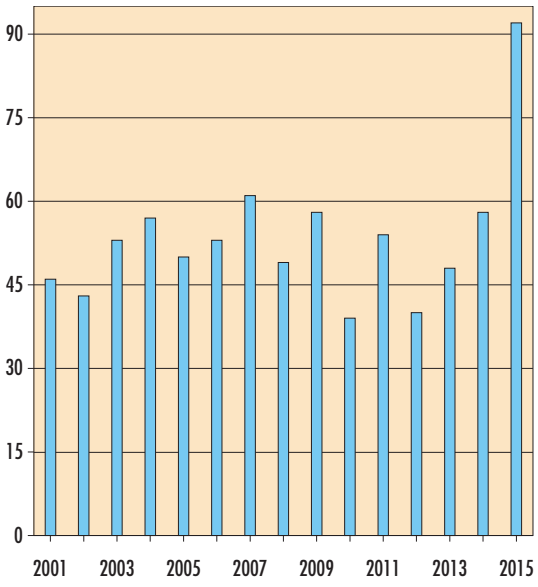


Figure 11. Number of partial or total prosthesis extractions during initial or multiple-time revisions, carried out between 2001 and 2015, where no following insertion of new prosthesis is registered. In 280 cases (35%), the extracted prostheses had been inserted before 2001.

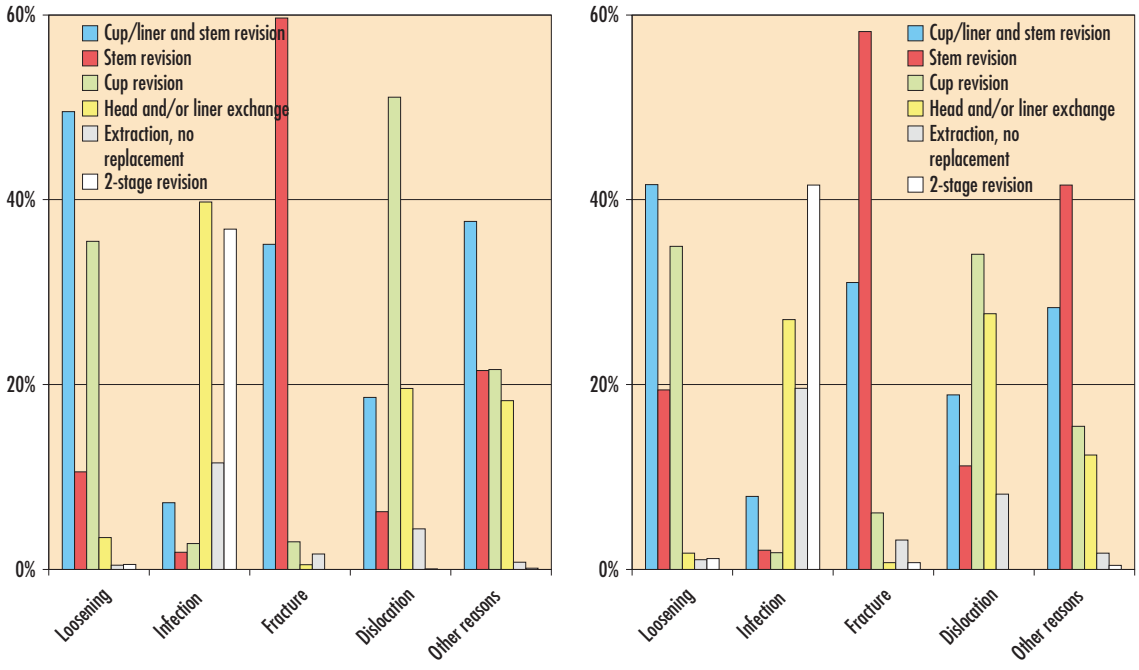


Figure 12. Measure during revision in relation to revision cause during initial revision (left) and multiple-time revision (right) during 2001–2014. Insertion of prosthesis after previous extraction has been excluded.

(36.8%) and extraction, without a registered following insertion of prosthesis (11.5%). Replacement of both cup/liner and stem is performed in only 7.2% of infec¬tious cases. During multiple-time revision, two-stage operation is most common (41.6%), followed by femoral head and/or liner replacement. Combined cup/liner and stem replacement (equivalent to a one-stage revision) is almost as common as during first-time revision (7.9%). During operation due to periprosthetic fracture, it is more common that only stem is replaced, rather than cup and stem, regardless of whether it is an initial revision or not. A small number of acetabular fractures are presented in the group, which can probably be explained by the existence of isolated cup replacement. During operations due to dislocation, isolated replacement of the cup is most common in both groups following cup and/or liner replacement, which in just over a quarter of cases is combined with insertion of a socket wall addition, a measure which today is used only in isolated cases (refer to the previous annual report). Insertion of socket wall addition, without replacing any of the parts of the prosthesis, is not classified as a revision.

Selection of implant

Selection of uncemented fixation has a longer tradition in revision than in operations with primary prostheses. However, between 2001 and 2003, about 80% of all revision cups were fixated with cement regardless of whether it concerned first-time or multiple-time revision (Figure 13). In regards to stems, the proportion with cemented fixation was the same size during first-time revisions (79.9% cemented stems, regardless of length) and somewhat lower during multiple-time revisions (77%). Hereafter, the proportion of cemented fixation of cups had decreased to 50.7% during first-time, and 56.7% during multiple-time revision (Figure 14). The corresponding decline in relation to stems had resulted in the fact that 53.3% of first-time revisions and 43.2% of multiple-time revisions were fixed with cement during the period of 2013–2015. Two-piece cemented stems have successively increased in popularity during the period and are used during first-time and multiple-time revisions, in 37.9% and 49.7% of cases, respectively, between 2013 and 2015. This year's report does not present cemented monoblock stems separately, since there are only a few cases (n=79) and they have not been used since 2004.

From the period 2004–2006, the use of mainly cemented dual articular cups has increased (refer to the previous annual report). Since the mid of 2000s first decade, the proportion of uncemented dual articular cups and insertion of constrained liner increased. In total, there have been about 373 operations (both initial and multiple-time revisions). In these cases, cups designed for dual articular cups were only used in about a third of cases (33.5%). In just over a quarter of the operations, a constrained liner (28.7%) has been used. In remaining cases, either a cemented dual articular cup in a metal shell or a specially designed metal prosthesis was used, which attached on the inside of the metal shell. In the first case, most commonly a TM or Trilogy cup (n=160, 65.2%) has been used and in the other case, one of the versions of the Delta cup (n=56, 22.9%).

Concerning the stem, we see a similar trend towards the use of increasingly uncemented fixation during the first decade of the 2000s, followed by a more stable situation in which cemented

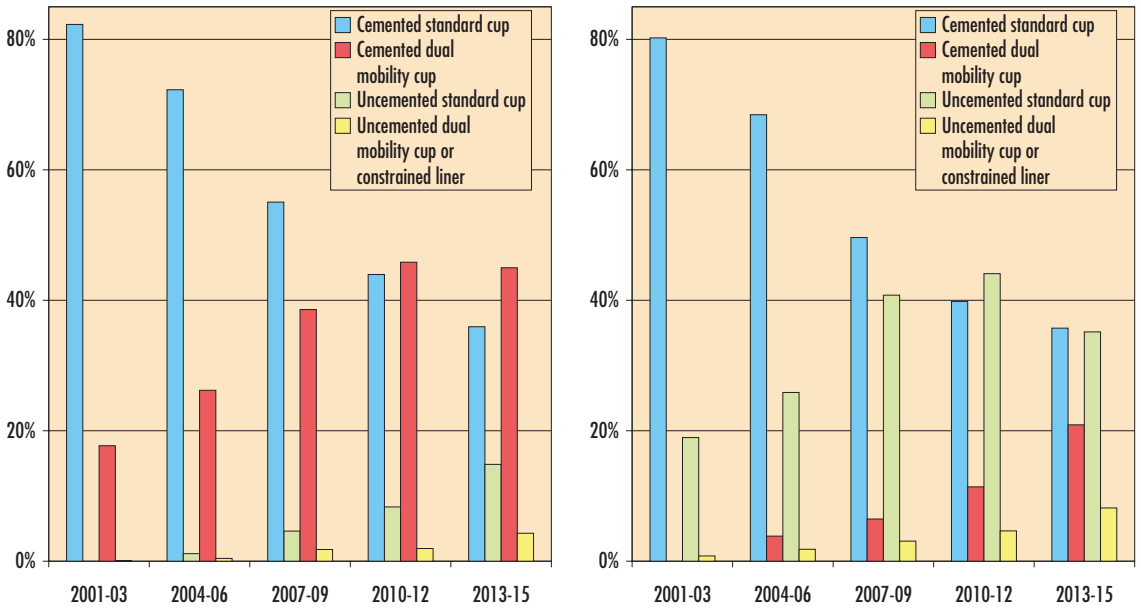


Figure 13. Use of cemented and uncemented cup 2001–2015 divided into three-year periods. Uncemented fixation is used ever more as cups which aim to minimize the risk for dislocation. Initial revisions on the left and multiple-time revisions on the right.

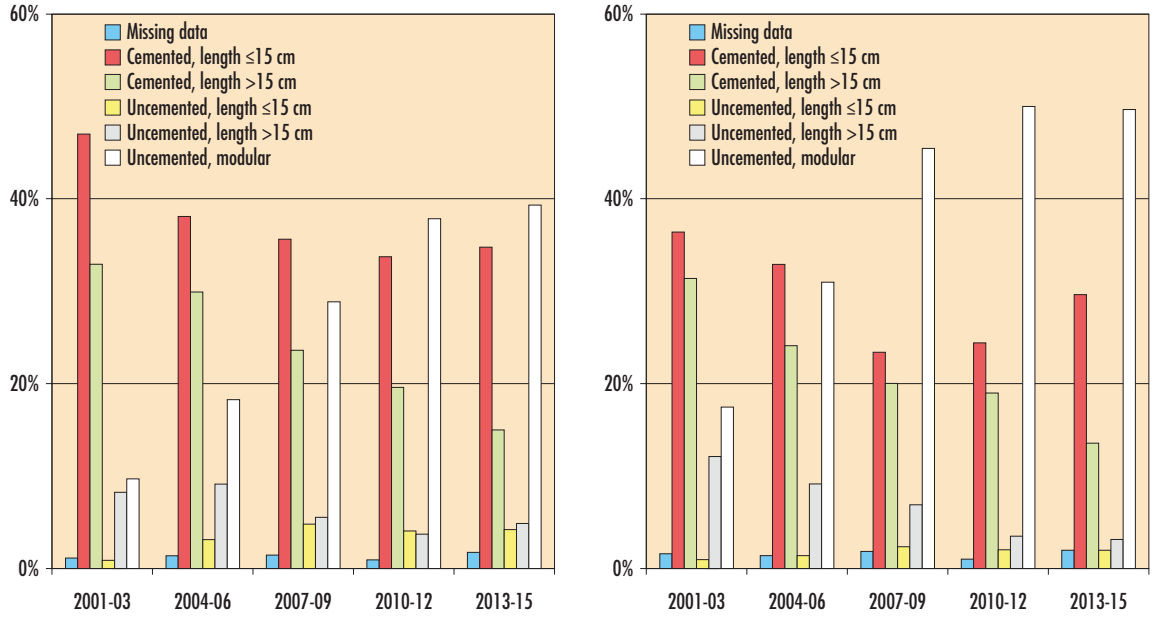


Figure 14. Distribution of the selection of fixation at the initial revision (left) and multiple-time revision (right) during 2001–2015. Selection of uncemented fixation has increased, especially the use of bifurcated stems. The increase is most pronounced in multiple-time revision.

and uncemented fixations account for about half the cases, each with a trend to prefer uncemented fixation at multiple-time revisions (Figure 14). In case of uncemented fixation, preferably a modular stem is chosen, probably because these provide greater flexibility in the attempt to correct leg length in combination with a relatively good documentation regarding its fixation. In recent years, this type of implant was used in more than 90% of all cases in the uncemented group.

During revision surgery, in most cases, smaller or larger bone defects have become apparent, which can be handled in different ways. One possibility might be the use of larger and/or specially designed implants, porous metal inserts (augment), bone substitutes and transplanting of autologous or homologous bones. Because of local problems after graft harvesting and the limited availability of autologous bone, transplanting homologous bone is completely dominant,

when it comes to major defects. Often, several approaches for replacing bone defects are combined. In Sweden, bone transplant to the cavity, which is caused when the prosthesis and soft tissue are removed from the acetabulum and the femoral medullary canal, is a standard measure that is based on a good documentation in most studies with long follow-up. Commonly, the donor bone is used in the form of the femoral head, which is removed during primary arthroplasty and which, after rigorous handling according to legislation, is stored in cold storage. In some cases, the whole implant bed is packed as a transplant, in other cases, one or more cavities are filled with the transplant.

The occurrence of bone graft associated with revision surgery is recorded in the Hip Arthroplasty Register. The registration is based on medical record data and its quality can vary. It has proven difficult to deduce from the surgery report which bone graft method was used. It is not possible to completely exclude the possibility that some kind of bone graft was performed, even though it is not mentioned in the surgery report. Registration has therefore been reduced to the fact whether bone graft was performed in the pelvis and femur or not. Figure 15 shows the proportion of operations where any kind of bone graft used. It is common for bone graft to be used in cemented fixation and on the acetabular side. Comparing the distribution over the entire period (as shown in Figure 15) with the last period 2013–2015 (not shown), the proportions

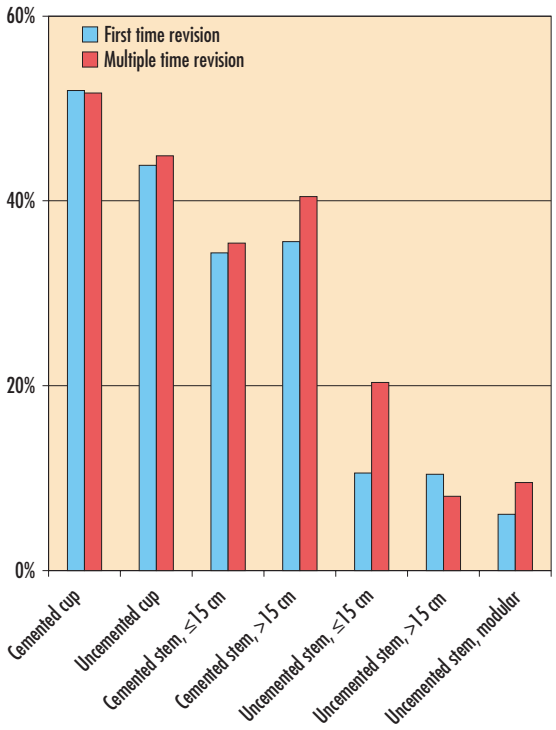


Figure 15. Proportion of operations where the surgery report indicated that some form of bone graft was used during initial and multiple-time revisions in 2001–2015.

are largely unchanged. Upon insertion of cemented stem, the use of bone graft decreased from 34.4% during the entire interval 2001–2015, to 24.9% in 2013–2015. When using long cemented stems, the reduction was slightly smaller (35.6 to 29.6%). When using uncemented stems, the proportion of operations using bone graft halved from about 10 to about 5%, while the transplant during the insertion of the two-piece stem, rose from 6.1 to 10.4%. In summary, the use of bone grafting in most types of revision procedures, where the stem is changed, has decreased, while the situation during the last three years has been more stationary during replacement of the cup.

Selection of implant

Table 5 shows the most used cemented and uncemented cups and stems in 2014 and 2015. Corresponding most used implants for the last ten years are presented for comparison. The changes reflect the trend towards using more often uncemented fixation. Between 2014 and 2015, there have only occurred marginal changes in relation to changed ordering of single implants. Among the uncemented cups, three designs have been replaced with new ones, and one of the uncemented stems (Arcos) has changed places with the Corail stem in the standard length. The proportion of others indicates, to some extent, diversification within each group. As for the primary prosthesis, the rectification is highest when choosing the cemented stem, where the group for others constituted only 6–7% during 2014 and 2015. The greatest variation between different prosthetic designs lies among the uncemented cups, where the proportion of others is largest. If one were to merge the implants in the groups with the same brand, one would reduce the degree of diversification, apparently. However, we will avoid this, because one and the same brand name does not mean that the products have the same level of performance. On such historical example is Spectron EF and Spectron EF Rimary stem, where the first, older version had a significantly lower revision rate (refer to pervious annual reports).

It has become more common during revision surgery to use uncemented fixation, two-part uncemented stems and dual articular cups. The frequency of cup revisions with some form of bone graft has during the past three years stayed on the same level as during 2001–2015 on average. During stem revision, bone graft is used less frequently and the tendency is decreasing, except for the insertion of uncemented two-part stems.

Most used cups and stems during revision surgery

	2005		2014		2015
Cup during revision %					
Cemented *antal*	**846**		**621**		**576**
Lubinus	24.3	Avantage Cemented	26.1	Avantage Cemented	26.2
Elite OGEE	17.3	Exeter X3 RimFit	24.8	Exeter X3 RimFit	23.8
Exeter	17.0	Marathon	11.8	Lubinus X-linked	15.3
Contemporary Hooded Duration	6.7	Lubinus x-linked	10.4	Marathon	13.5
FAL	5.3	Contemporary Hooded Duration	3.3	Contemporary Hooded Duration	5.0
Other	29.1	Other	23.6	Other	16.1
Uncemented *number*	**264**		**566**		**580**
Trilogy±HA	74.2	TM revision	35.0	TM revision	37.4
Mallory Head	8.7	Continuum	16.4	Continuum	12.8
Trident AD LW	5.7	Trilogy±HA	5.8	Mallory Head	4.7
LOR	3.0	Regenerex	5.1	Trident Tritanium Revision	4.3
Reflection SP3 HA	1.5	Delta-ONE-TT	5.1	Tritanium	4.3
Other	10.3	Other	32.6	Other	32.8
Stem during revision %					
Cemented *number*	**610**		**471**		**432**
Lubinus SP II standard	30.2	Exeter standard	35.7	Exeter standard	37.3
Exeter standard	29.3	Lubinus SP II standard	25.5	Lubinus SP II standard	30.3
Exeter long	12.6	Exeter short rev-stem	15.3	Exeter short rev-stem	9.0
CPT	11.5	CPT	7.4	Exeter long	7.4
Spectron EF Primary	3.3	Exeter long	7.3	CPT	6.3
Other	11.8	Other	6.5	Other	6.7
Unemented *number*	**307**		**441**		**449**
MP	32.2	MP	41.8	MP	38.8
Wagner SL Revision	23.1	Restoration	21.7	Restoration	19.6
Revitan cylinder	19.2	Revitan cylinder	16.0	Revitan cylinder	17.1
Revitan spout	3.9	Corail Revision	5.3	Corail Revision	3.8
Epoch	3.9	Arcos	3.1	Corail standard±collar	2.8
Other	12.2	Other	9.1	Other	10.3

Table 5. The five most used cemented and uncemented cups and stems at revision surgery have been presented in percentages of the total number, which was reported during 2005, 2014 and 2015. Both initial and multiple-time revisions are included.

Measures not presented above

When revising acetabular components, reinforcement ring, which is fixed with screws in the pelvis, can be used, in order to achieve better stability. This measure is most often used at major bone defects and at a so-called pelvic dissociation, but indications for the use of a pelvic ring vary surprisingly lot. This can partly be explained by these implants having different designs and are applied in different ways depending on the designer's understanding of its function and use. Insertion of the reinforcement ring was registered for the first time in Sweden in 1985, and got a boost in the early 2000s (Figure 16). Hereafter, the number of reported operations using this implant has varied between 61 and 102 per year. During 1985–2015, in total, 39 clinics have inserted less than 25 implants, nine clinics of between 25 and 90, three clinics 118–166 and one clinic had inserted 299 implants. In total, all four units spent more than 100 reinforcement rings from 1985 to 2015 and reported that they inserted this type of implant in 2015 during least three and no more than 14 revision operations, and therefore, still has users. A total of 1475 operations with reinforcement rings have been reported.

Porous augment is used to replace bone defects and improve the stability of the cup. This type of implant was used for the first time in Sweden in 2006, and has since 2009 reached a stable level of about 80 inserted and reported implants per year. Even here, the use is very diversified. 37 clinics have reported that they have inserted at least one augment during less than 25 operations (13 of which only one), five clinics between 25 and 80, and two clinics have reported 137 and 150 implants during surgeries. Currently, neither size or the manufacturer is reported. On the other hand, the operations can be identified in any future evaluation projects.

Reinforcement rings or acetabular augment has been used regularly during revision surgery without a clear tendency towards increasing or decreasing.

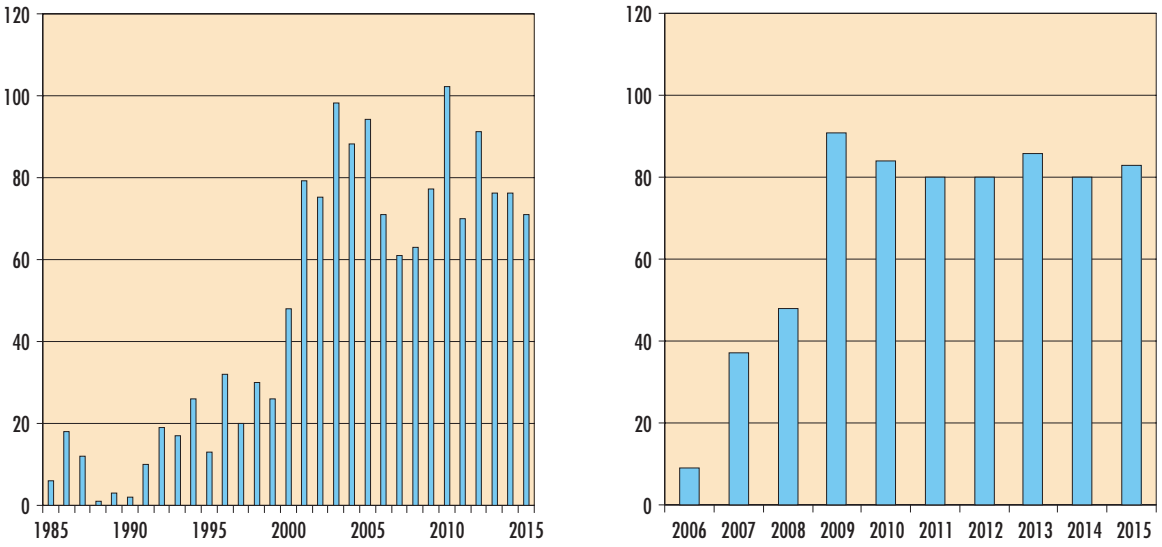


Figure 16. Number of operations where reinforcement ring (left) and at lease an acetabular augment is used to replace bone defect during revision (right) in relation to operation wound.

Number of revisions per diagnosis and number of previous revisions

primary THR 1979–2015

Diagnosis at primary THR	0		1		2		>2		Total	Proportion
Primary osteoarthritis	25,556	74.6%	4,396	70.4%	886	65.5%	287	61.1%	31,125	73.5%
Fracture	2,943	8.6%	503	8.1%	101	7.5%	29	6.2%	3,576	8.4%
Inflammatory arthritis	2,456	7.2%	562	9.0%	165	12.2%	69	14.7%	3,252	7.7%
Childhood disease	1,675	4.9%	444	7.1%	104	7.7%	43	9.1%	2,266	5.4%
Femoral head necrosis	880	2.6%	181	2.9%	50	3.7%	15	3.2%	1,126	2.7%
Posttraumatic osteoarthritis	255	0.7%	81	1.3%	30	2.2%	24	5.1%	390	0.9%
Other secondary osteoarthritis	119	0.3%	23	0.4%	4	0.3%	2	0.4%	148	0.3%
Tumour	77	0.2%	19	0.3%	6	0.4%	1	0.2%	103	0.2%
(missing)	292	0.9%	37	0.6%	6	0.4%	0	0%	335	0.8%
Total	34,253	100%	6,246	100%	1,352	100%	470	100%	42,321	100%

Number of revisions per reason and number of previous revisions

primaryt opererade 1979–2015

Reason for revision	0		1		2		>2		Total	Proportion
Aseptic loosening	23,554	68.8%	3,455	55.3%	607	44.9%	154	32.8%	27,770	65.6%
Dislocation	3,252	9.5%	987	15.8%	273	20.2%	131	27.9%	4,643	11.0%
Deep infection	3,184	9.3%	961	15.4%	289	21.4%	140	29.8%	4,574	10.8%
Fracture	2,621	7.7%	525	8.4%	109	8.1%	22	4.7%	3,277	7.7%
Technical error	772	2.3%	148	2.4%	36	2.7%	11	2.3%	967	2.3%
Implant fracture	487	1.4%	105	1.7%	24	1.8%	10	2.1%	626	1.5%
Others	230	0.7%	31	0.5%	8	0.6%	1	0.2%	270	0.6%
Pain only	153	0.4%	31	0.5%	6	0.4%	1	0.2%	191	0.5%
Secondary infection	0	0%	3	0%	0	0%	0	0%	3	0%
Total	34,253	100%	6,246	100%	1,352	100%	470	100%	42,321	100%

Number of revisions per revision year and number of previous revisions

primary THR 1979–2015

Year of revison	0		1		2		>2		Total	Proportion
1979–2010	27,337	79.8%	4,744	76%	981	72.6%	301	64%	33,363	78.8%
2011	1,370	4.0%	310	5.0%	64	4.7%	28	6.0%	1,772	4.2%
2012	1,434	4.2%	317	5.1%	68	5.0%	26	5.5%	1,845	4.4%
2013	1,402	4.1%	297	4.8%	69	5.1%	22	4.7%	1,790	4.2%
2014	1,388	4.1%	302	4.8%	81	6.0%	45	9.6%	1,816	4.3%
2015	1,322	3.9%	276	4.4%	89	6.6%	48	10.2%	1,735	4.1%
Total	34,253	100%	6,246	100%	1,352	100%	470	100%	42,321	100%

Number of revisions per reason and revision year

first revision only, primary THR 1979–2015

Reason for revision	1979–2010	2011	2012	2013	2014	2015	Total	Proportion
Aseptic loosening	19,798	794	811	759	710	682	23,554	68.8%
Dislocation	2,372	153	166	193	198	170	3,252	9.5%
Deep infection	2,127	194	199	209	233	222	3,184	9.3%
Fracture	1,862	145	153	146	162	153	2,621	7.7%
Technical error	591	47	44	27	30	33	772	2.3%
Implant fracture	399	23	19	17	13	16	487	1.4%
Others	84	9	28	44	32	33	230	0.7%
Pain only	104	5	14	7	10	13	153	0.4%
Total	27,337	1,370	1,434	1,402	1,388	1,322	34,253	100%

Number of revisions per type of fixation at primary THR and revision year

first revision only, primary THR 1979–2015

Type of fixation at primary THR	1979–2010	2011	2012	2013	2014	2015	Total	Proportion
Cemented	22,188	979	999	955	965	889	26,975	78.8%
Uncemented	2,524	162	173	181	185	212	3,437	10.0%
Hybrid	1,542	108	108	117	104	79	2,058	6.0%
Reversed hybrid	392	90	94	99	95	99	869	2.5%
Resurfacing implants	84	14	24	29	17	26	194	0.6%
(missing)	607	17	36	21	22	17	720	2.1%
Total	27,337	1,370	1,434	1,402	1,388	1,322	34,253	100%

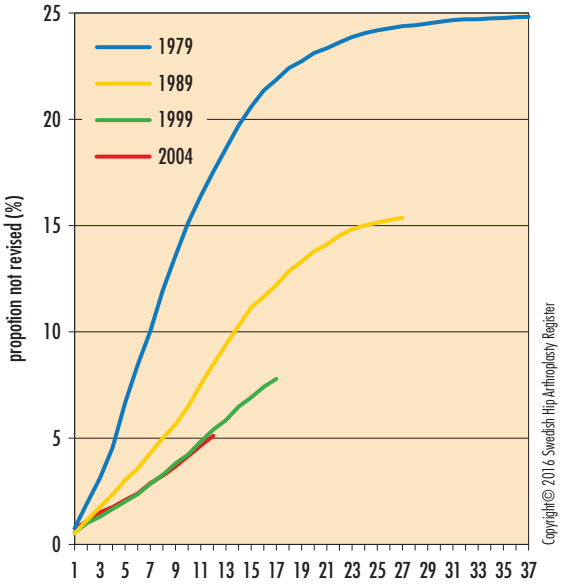
Number of revisions per reason and time to revision

first revision only, primary THR 1979–2015

Reason for revision	0–3 years		4–6 years		7–10 years		>10 years		Total	Proportion
Aseptic loosening	3,163	34.3%	4,172	75.8%	6,325	82.3%	9,894	83.5%	23,554	68.8%
Dislocation	1,885	20.5%	407	7.4%	388	5.0%	572	4.8%	3,252	9.5%
Deep infection	2,427	26.3%	297	5.4%	225	2.9%	235	2.0%	3,184	9.3%
Fracture	766	8.3%	374	6.8%	539	7.0%	942	8.0%	2,621	7.7%
Technical error	703	7.6%	30	0.5%	23	0.3%	16	0.1%	772	2.3%
Implant fracture	74	0.8%	122	2.2%	140	1.8%	151	1.3%	487	1.4%
Others	90	1.0%	75	1.4%	41	0.5%	24	0.2%	230	0.7%
Pain only	108	1.2%	27	0.5%	5	0.1%	13	0.1%	153	0.4%
Total	9,216	100%	5,504	100%	7,686	100%	11,847	100%	34,253	100%

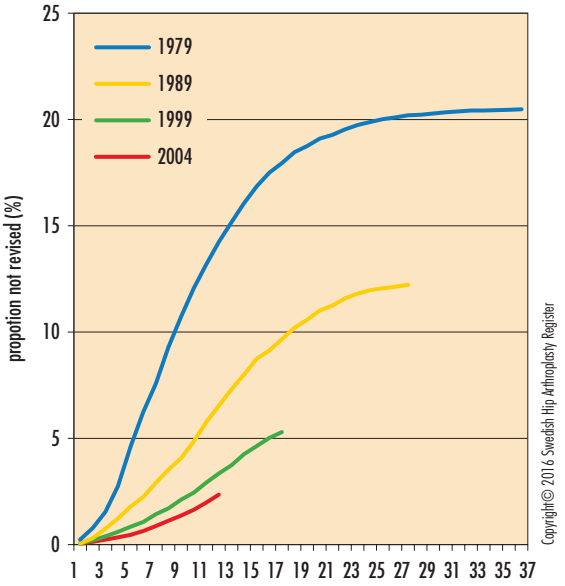
All diagnoses and all reasons

cumulative revision frequency



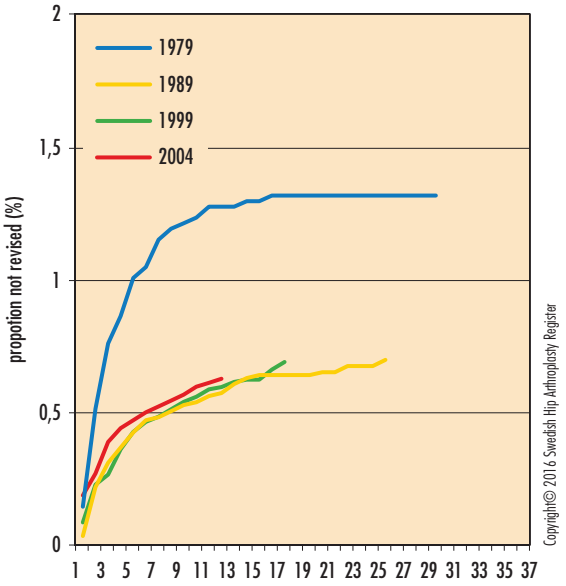
Aseptic loosening

cumulative revision frequency



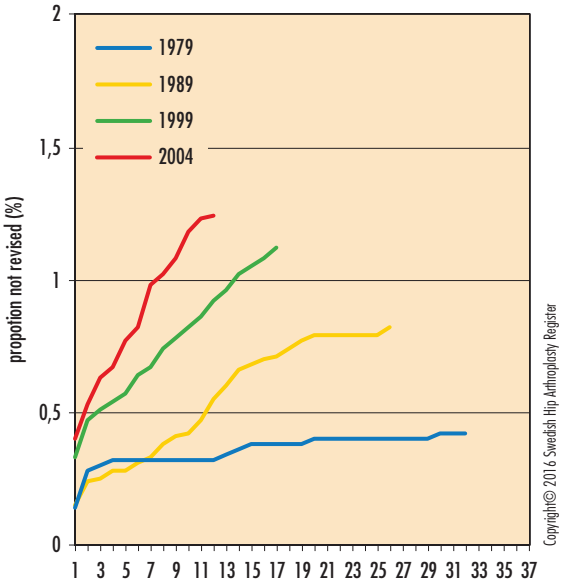
Deep infection

cumulativ revision frequency



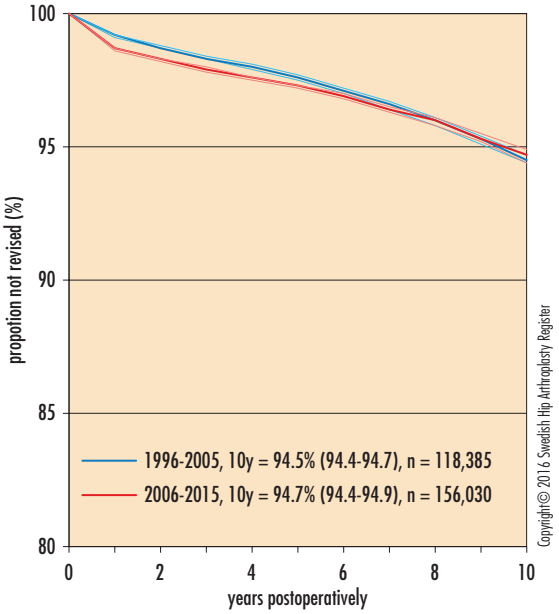
Dislocation

cumulativ revision frequency



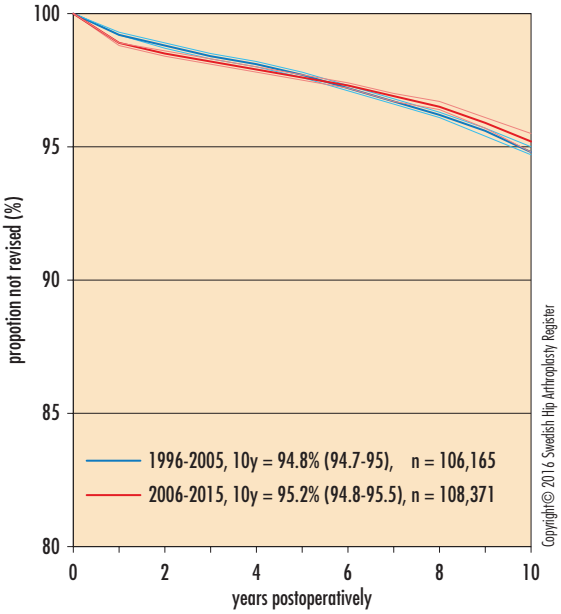
All implants

All diagnoses and all reasons



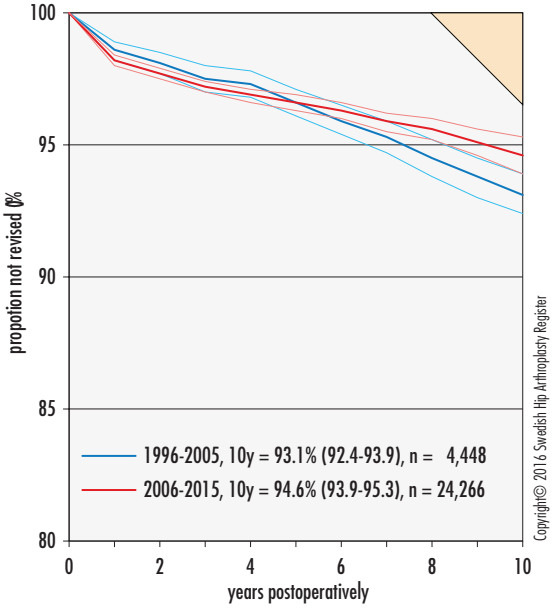
All cemented implants

All diagnoses and all reasons



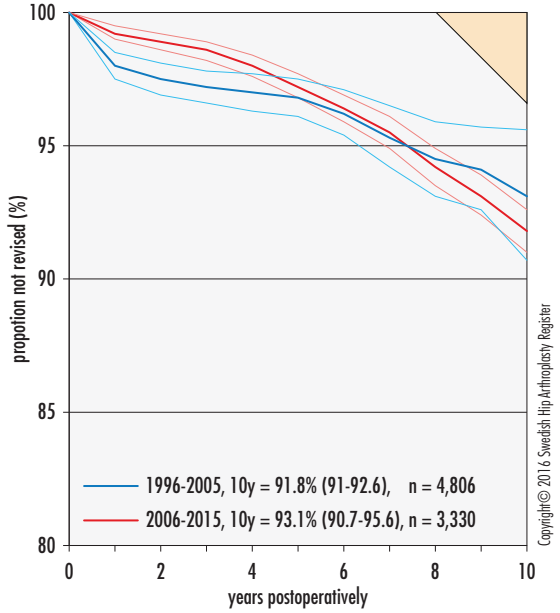
All uncemented implants

All diagnoses and all reasons



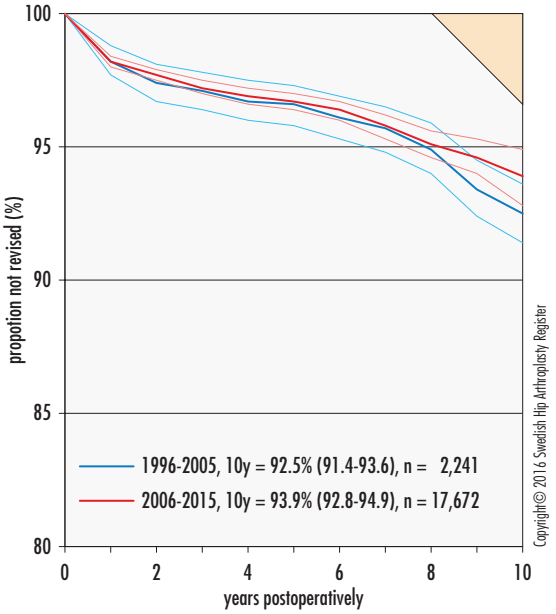
All hybrid implants

All diagnoses and all reasons



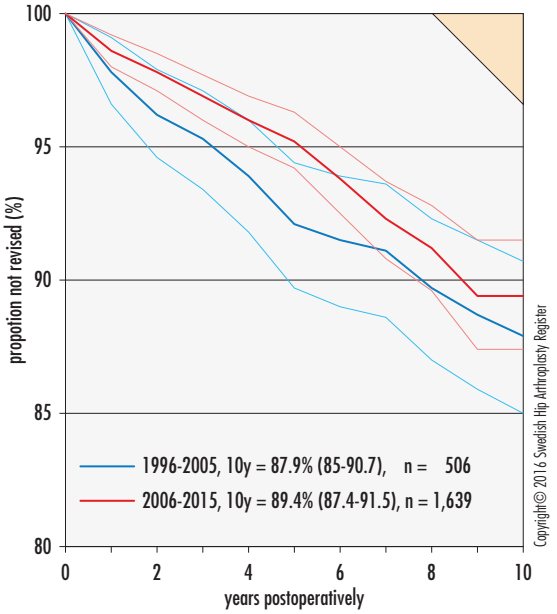
All reversed hybrid implants

All diagnoses and all reasons



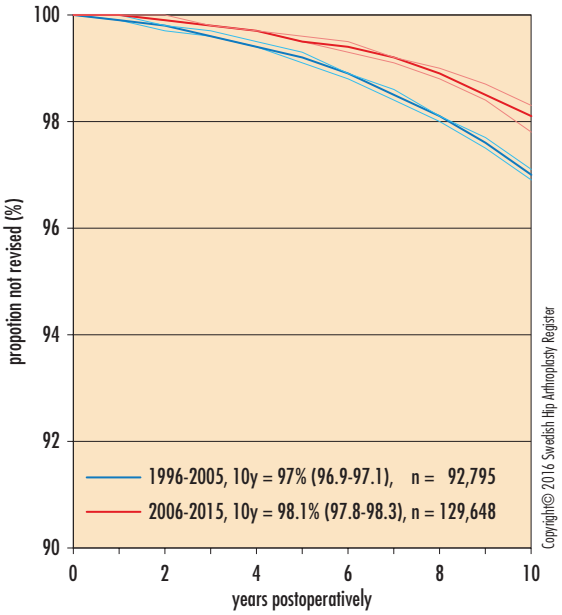
All resurfacing implants

All diagnoses and all reasons



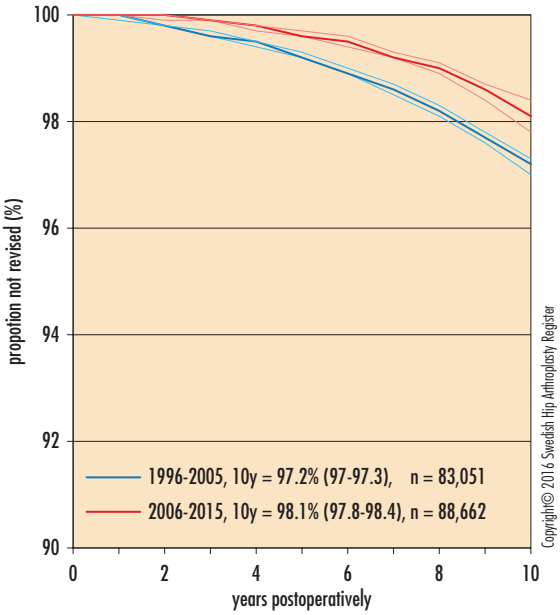
All implants

Primary osteoarthritis and aseptic loosening



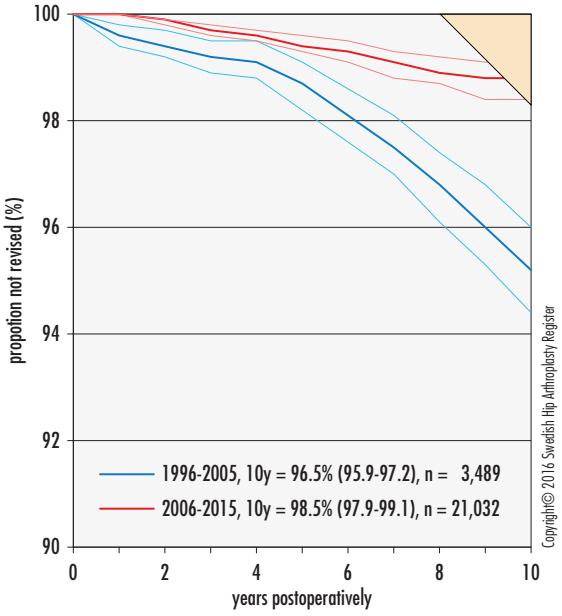
All cemented implants

Primary osteoarthritis and aseptic loosening



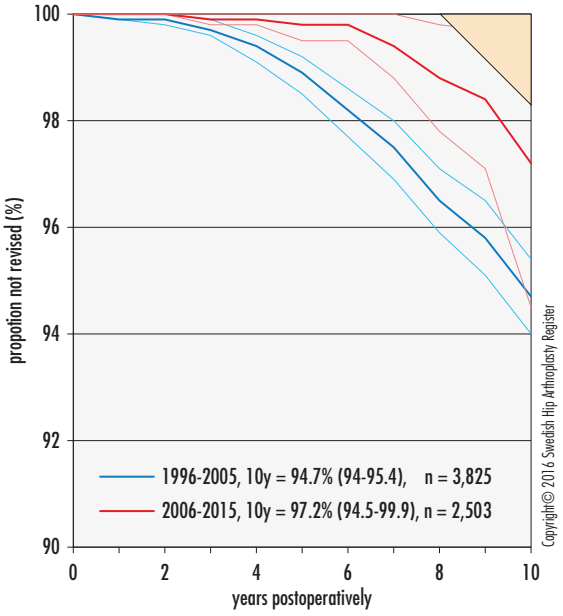
All uncemented implants

Primary osteoarthritis and aseptic loosening



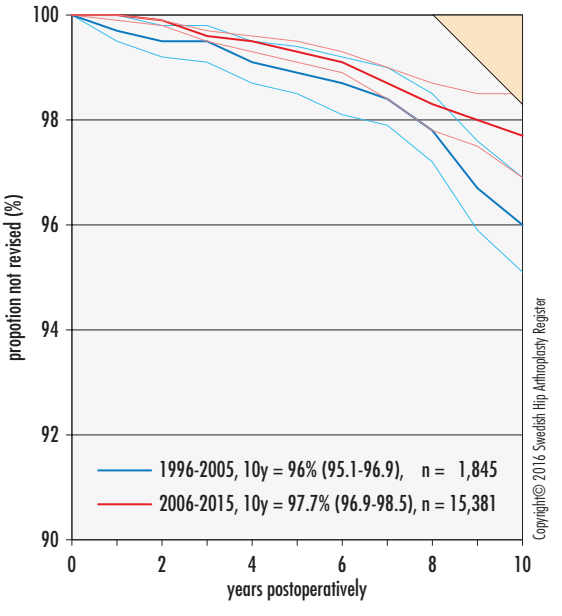
All hybrid implants

Primary osteoarthritis and aseptic loosening



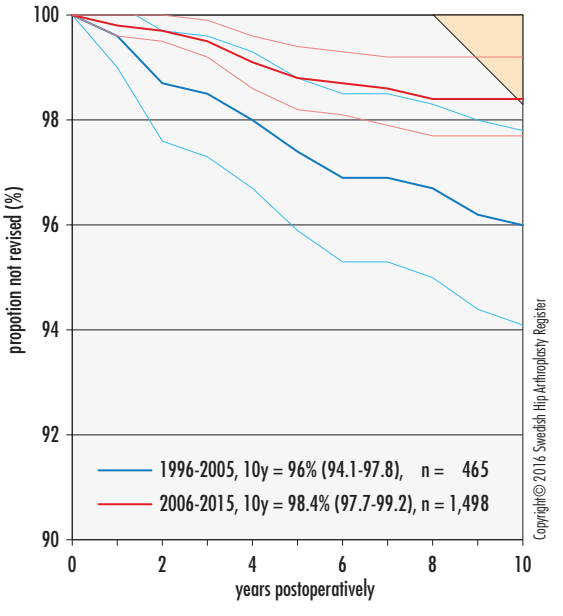
All reversed hybrid implants

Primary osteoarthritis and aseptic loosening



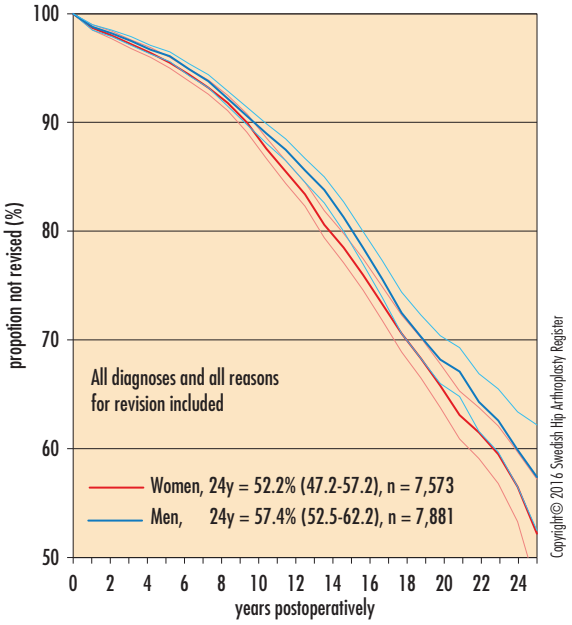
All resurfacing implants

Primary osteoarthritis and aseptic loosening



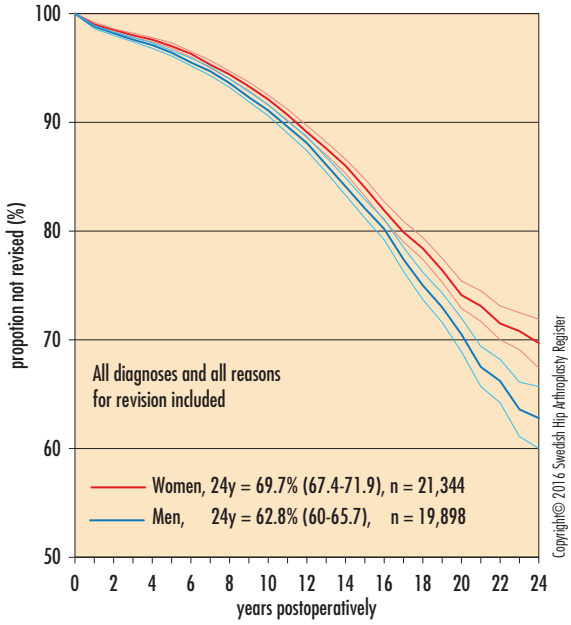
Younger than 50 years

all observations, 1992–2015



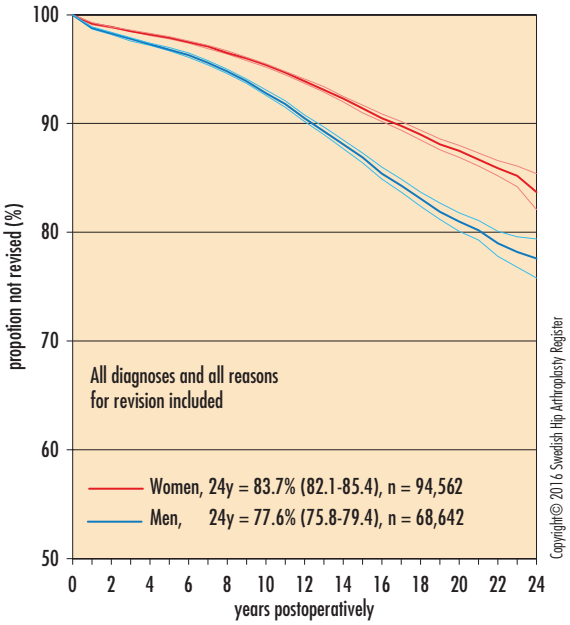
Between 50 and 59 years

all observations, 1992–2015



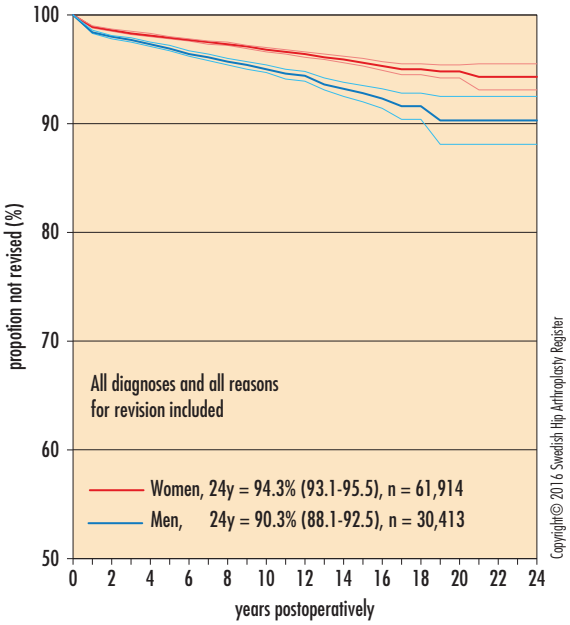
Between 60 and 75 years

all observations, 1992–2015



Older than 75 years

all observations, 1992–2015



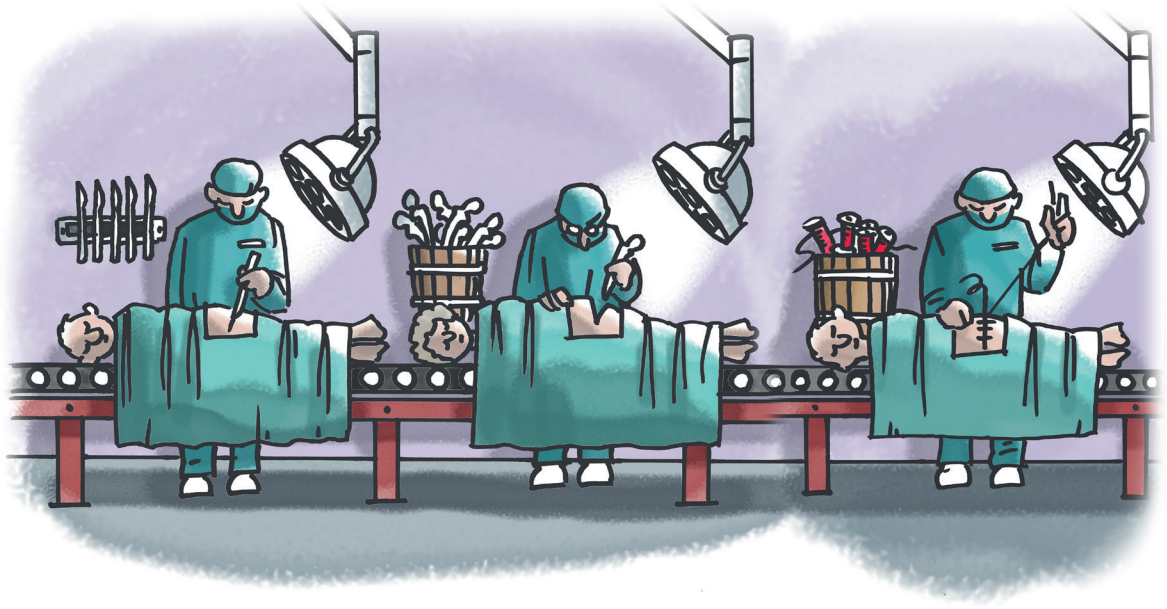
Implant survival within ten years

Implant survival within ten years is based on total hip replacements performed during the past ten years. This means that the observation period attains a nine- to ten-year interval only for patients operated in the first year of observation. Since more and more total hip replacements were performed during the latter part of 2006–2015, the average observation period is shorter than five years. During the period, 155,994 operations were registered. Most common cause for reoperation is aseptic loosening, followed by infection, fracture and dislocation.

This variable is of great value especially for those clinics with a relatively intact organization without extensive changes in the operation process including selection of standard prosthesis during the past ten years. The outcomes dislocation and infection reflect both the process surrounding primary total hip replacement and the clinic's case-mix. The frequency of revision due to loosening provides relatively good information about how prosthesis selection and surgical technology/technique influence outcome. For clinics that have undergone organizational transformations during the past ten years or that have changed their standard prosthesis, implant survival within ten years becomes more difficult to interpret since it reflects to a lesser extent the current organization and current prosthesis selection.

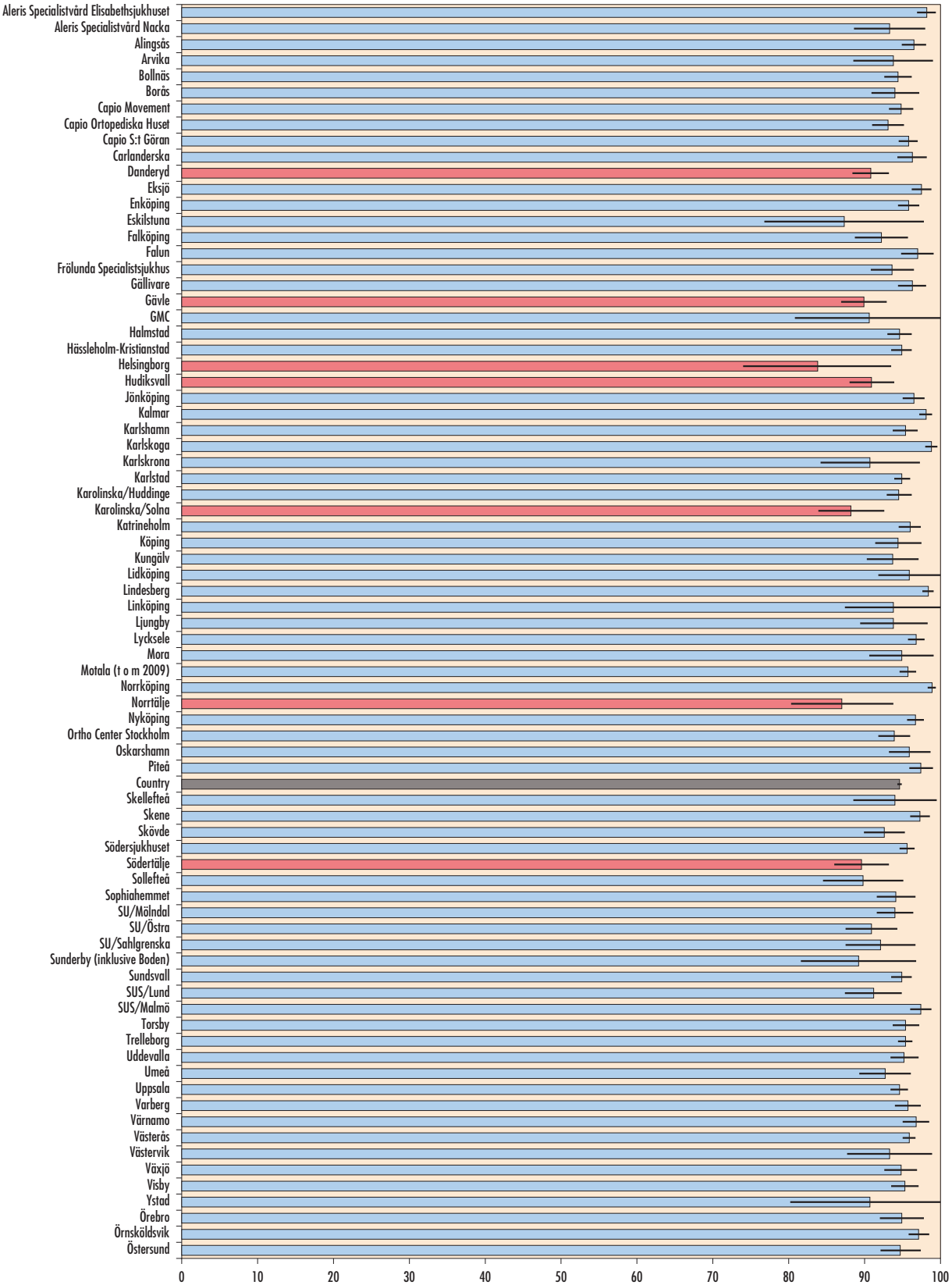
In this year's analysis, six hospitals (SU/Mölndal, Södertälje, KS/Solna, Helsingborg, Danderyd and Gävle) show significantly lower implant survival rate compared to the national average. As mentioned in earlier annual reports, there is an overrepresentation of patients with secondary osteoarthritis (36–74% as opposed to the national average of 17%). Other risk factors, such as high ASA Grade and high or low BMI have not been registered for the entire period and thus cannot be correctly assessed. Some hospitals have used prosthetic systems with expected inferior outcomes (Spectron EF Primary, Durom, ASR), which may have influenced the results. Nonetheless, this data should give rise to an in-depth study of the outcome and its possible causes.

Units with high frequency of revisions, even if not differing significantly from the national average, should also take the opportunity of carrying out an operative analysis. The first step is to based on data published here perform a case by case analysis and thereafter decide whether further improvement measures are motivated.



Implant survival after 10 years

Each bar represents one unit, primary THR 2006–2015



Implant survival after 10 years shown according to clinics. The gray bar represents the national average. Red bars represent clinics, whose upper confidence interval is below the national lower confidence interval, i.e. clinics with 95% certainty to have poorer implant survival after 10 years than the national average. Primary operations were conducted during the past 10 years.

Clinics with less than 10 operations are not included.

Patient-reported outcomes

The Swedish Hip Arthroplasty Register's PROM programme

The well-established structure that exists for reporting to the Swedish Hip Arthroplasty Register has made it possible for the Register to be able to introduce a unique nationwide follow-up programme for patient-reported outcomes. The programme was launched under the name Höftdispensären (The Hip Dispensary) but we have now come to calling it the *PROM programme*. Since 2008, all clinics report patient-reported variables where the response frequency is almost 90% both preoperatively and at one-year follow-up.

PROM programme's logistics

All patients who shall undergo elective surgery, are encouraged to voluntarily answer a 12-item questionnaire. The survey includes questions about comorbidity and walking capacity in order to define musculoskeletal comorbidity according to the Charnley classification, a Visual Analogue Scale (VAS) for pain estimation and the EQ-5D instrument that measures health-related quality of life. The EQ-5D consists of two parts. The first of five general questions each with three alternatives providing a health profile that can be translated into an index. The other part consists of a thermometer, the EQ VAS, where the patient marks her/his current health status on a 100-degree scale. Since 2012, a question has been included asking whether or not the patient has participated in physiotherapy or osteoarthritis training preoperatively, and in 2013, a question was included about smoking. The same PROM form with a complementary estimation of satisfaction with the result of the surgery (VAS 0–100) VAS is sent to patients after one, six and ten years. The Register's coordinators send out a list every month to all clinics for the patients who are to be followed up. Thereafter the follow-up routine is managed by local administrators who send out the forms, enter survey responses to the PROM database and send out reminders about missing responses within about two months.

This is how patient-reported outcomes are presented

The graphs illustrate the development of the PROM results one year postoperatively per clinic. The values are presented as mean values. The presented values refer to the four-year period from 2007/2008 to the 2013/2014. We just show values for those clinics that have at least 40 registrations for at least two periods. The PROM variables included, are: 1) EQ VAS indicating self-reported health status on a scale of 0–100, 2) Pain VAS indicating hip pain on a scale of 0–100, and 3) satisfaction with the outcome of the surgery on a scale of 0–100. For EQ VAS, the higher the value, the better the self-rated health status. For pain and satisfaction, the opposite applies: low scores indicate little pain and good satisfaction. Black dots/lines are the national average results, and are thus identical in all the graphs which show the same outcome measurements. Red dots/lines show the observed values for each clinic and the blue points/lines show the expected results of the clinic when adjusting for age, sex, diagnosis, Charnley class and preoperative PROM values. If the black and blue lines are close together (e.g. Falun), this clinic's demographics are assumed to be representative of the country, but if they fall apart (e.g. Eskilstuna), there are differences in age, sex, diagnosis, Charnley class and/or preoperative PROM values.

The tables with the mean values for all PROM variables, deviation from the expected and the improvement index are published on the Register's website in the preliminary annual report (tables).

Positive trend but great differences between clinics

For all PROM variables, at national level, there is a positive trend over time, which we reported on in the last two annual reports. This positive trend is of course encouraging. In this year's report, we also show trends in the PROM results at the clinic level. The idea is to illustrate trends, so that each clinic can see how the development looks like in relation to the rest of the country and the clinic's expected results.

There are some clinics with results that are particularly illustrative or which for some other reason, are worth commenting on. The development in Kalmar is interesting. During the entire period, the expected values are close to the national average. During 2007–2008, the observed values are almost as expected, but thereafter, there is a very positive improvement trend. However, In Västervik, the results are remarkably unstable, with a negative development during the last two periods.

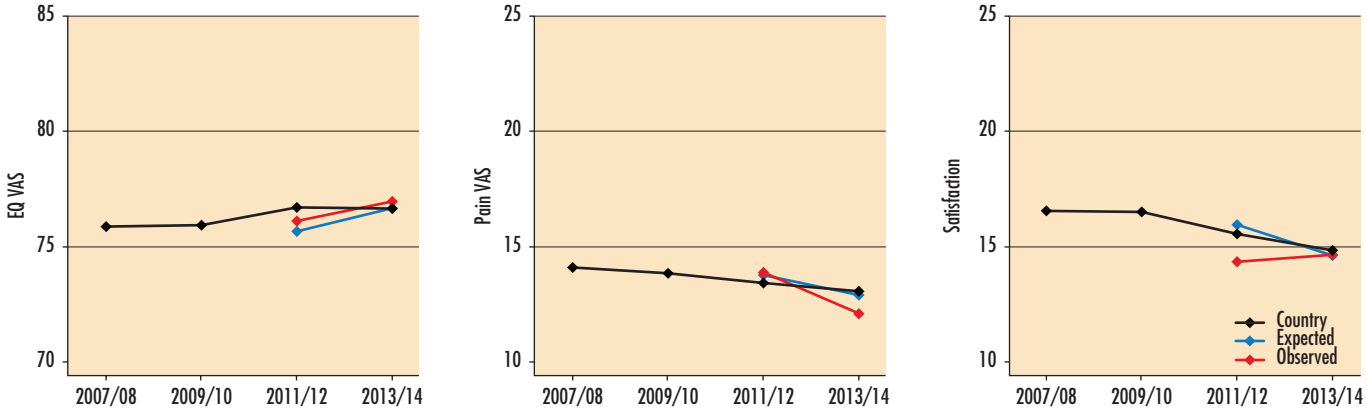
In Växjö, the results go completely against the general improvement trend in Sweden. Without any signs that the patient demographics have changed, the results have gradually deteriorated and were, in the last period, clearly worse than the national average. In Kungälv, there is also a negative trend, which led to an extensive local in-depth analysis which is presented in this year's report.

Enköping is a good example of a clinic which had worse outcomes than expected, but during the past two years, has improved and is now on par with the national average and the expected value. Hässleholm performs most elective hip prostheses in Sweden. Here, the patients report, on average, better health, less pain and more satisfaction than expected, with a significant improvement trend.

How can the PROM results be improved?

How can patient-reported outcomes be improved? Inherently, register data cannot give answers to causal relationships in order to give concrete advice concerning a question. With the help of the Register's data, we have been able to show the relationship between features of surgical technique, like incision and fixation, and the patient-reported outcome. The effects are not so obvious that it would lead us to recommend changing the routine incision or fixation because such a change could have unintended consequences on other levels. Experiences from those who developed different programs for "*enhanced recovery*" or "*fast-track*" speak for the fact that meticulousness in decisions concerning surgery, sound preoperative information, optimization of patients, continuity in contact with physicians and other caregiver categories, a well-planned care process, ultra-early mobilization, a short length of stay and optimized pain treatment lead to better patient-reported outcomes.

Aleris Specialistvård Bollnäs



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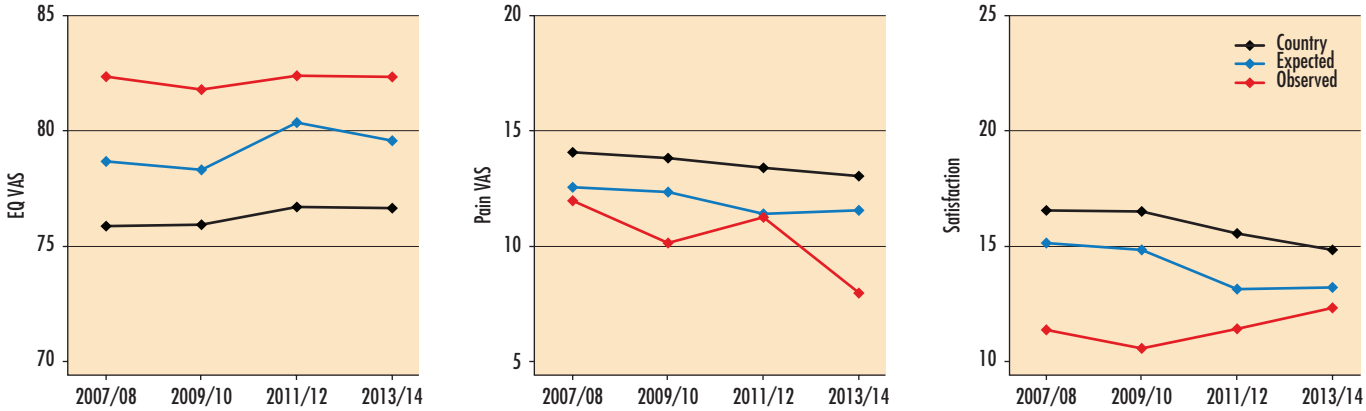

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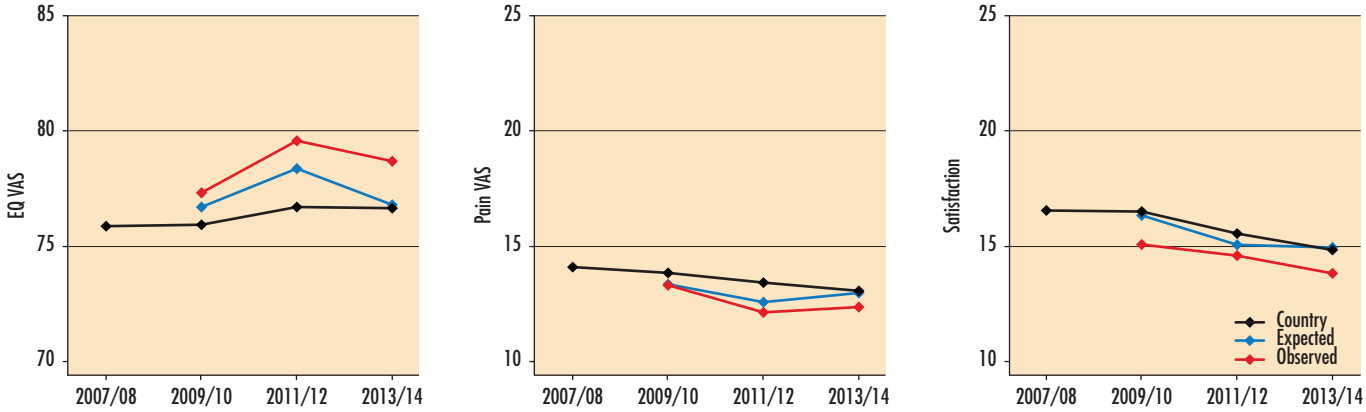

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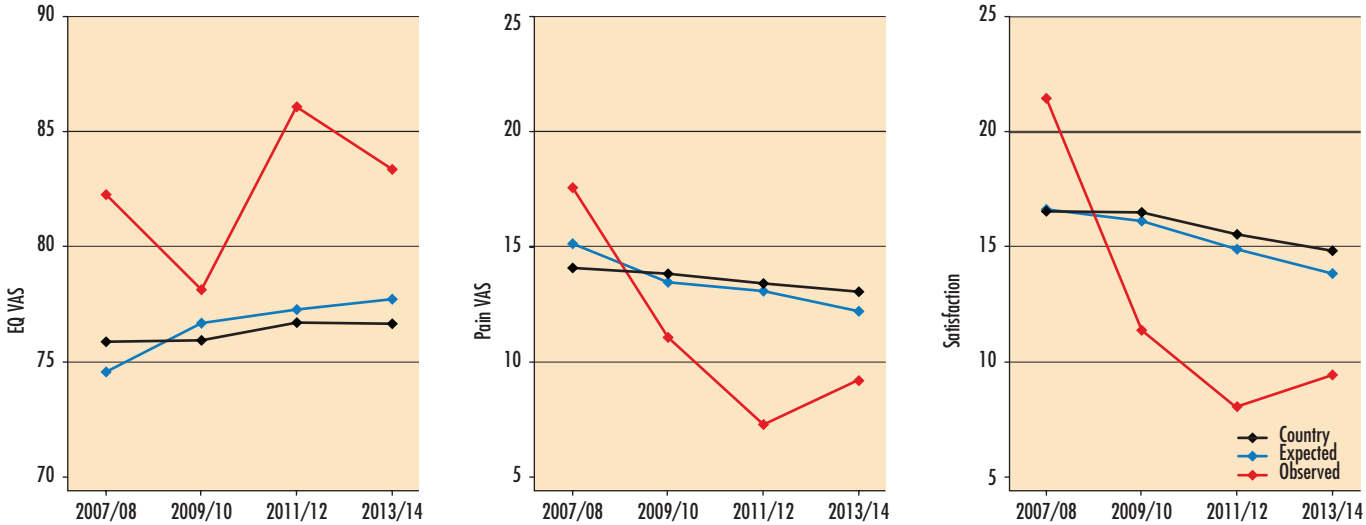

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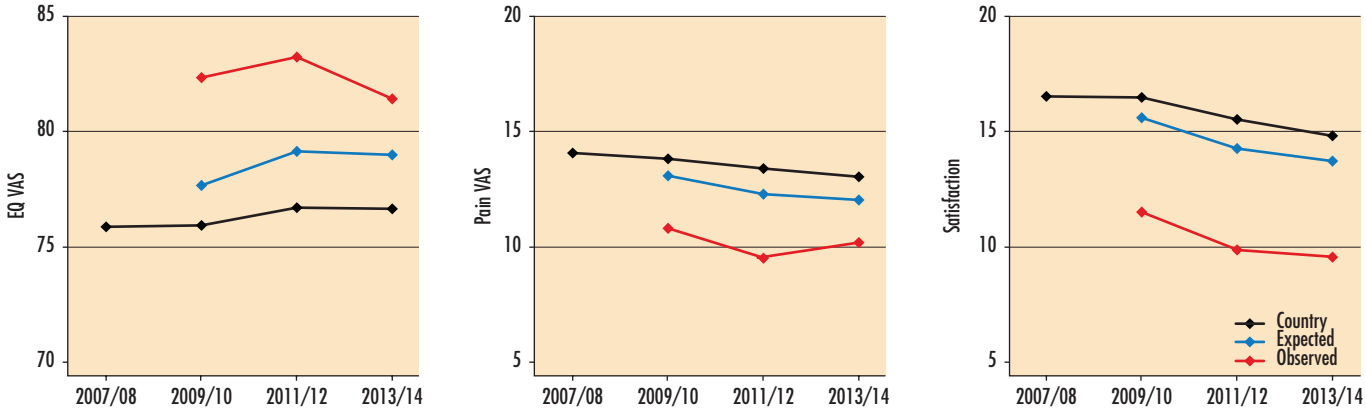

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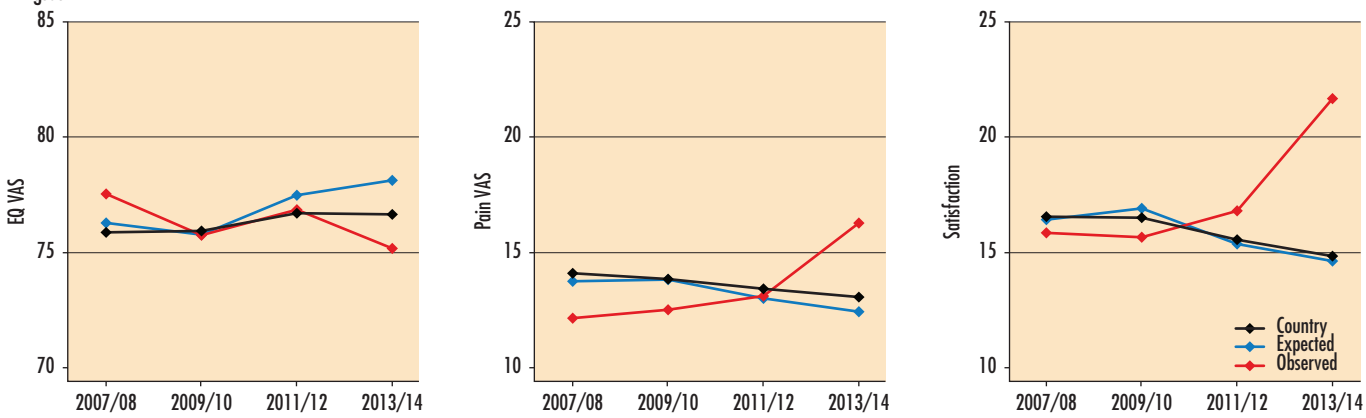

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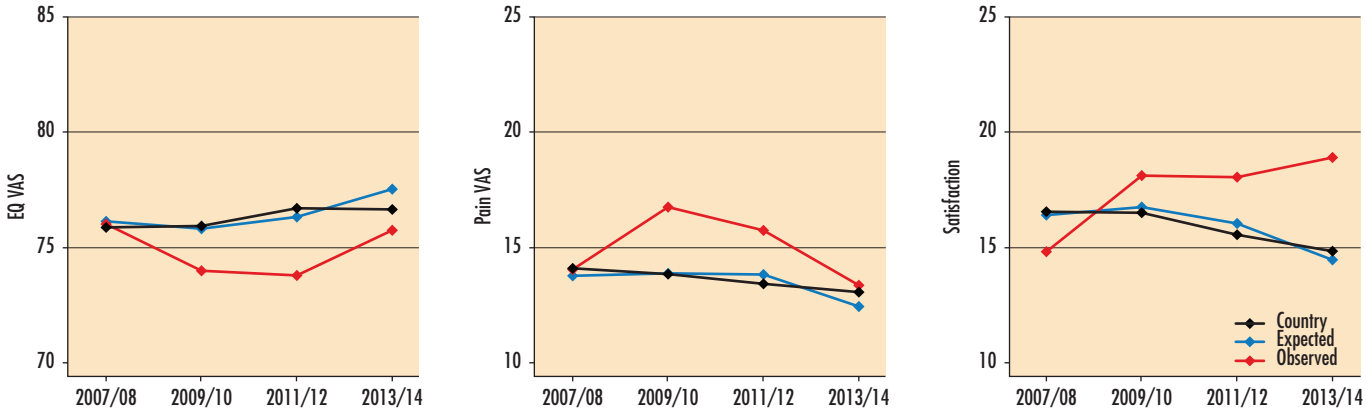

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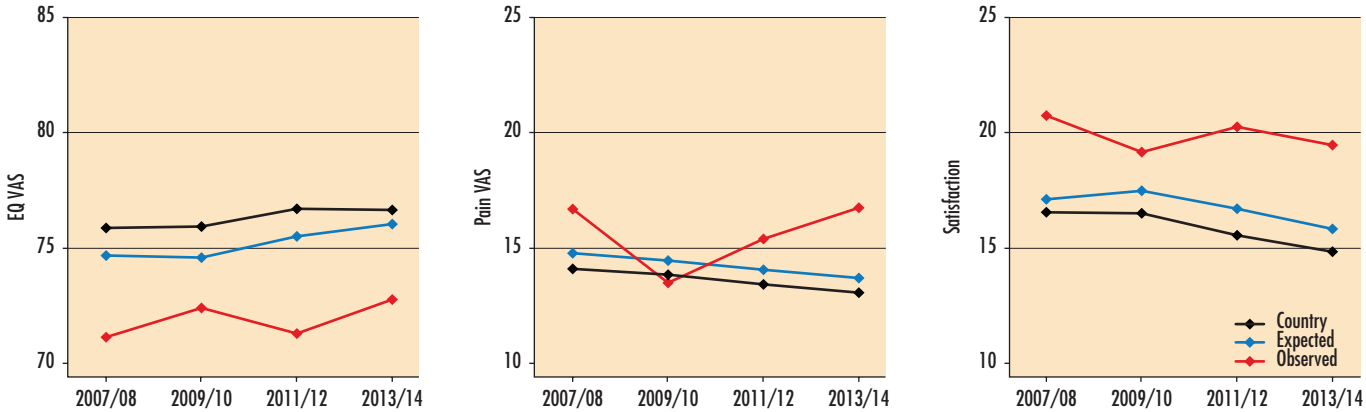

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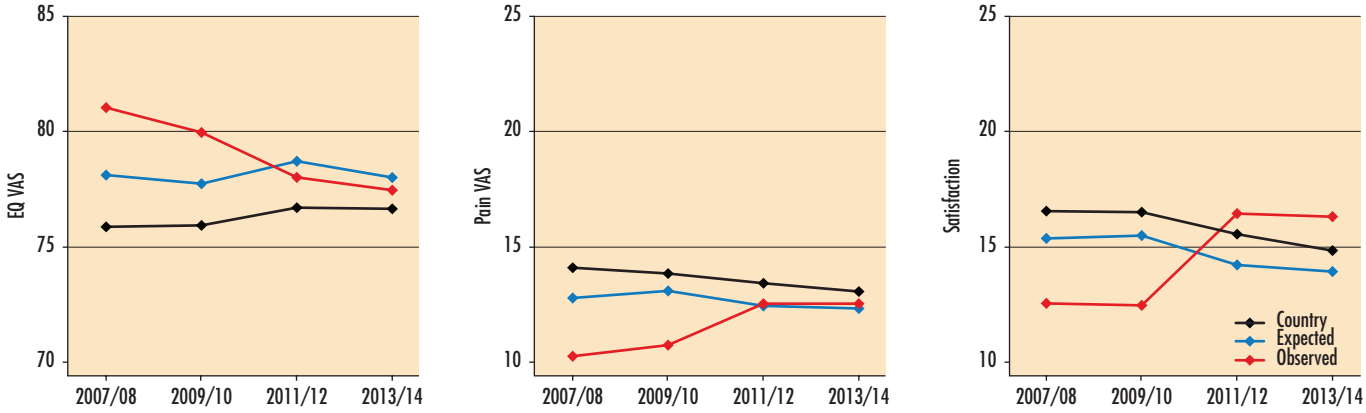

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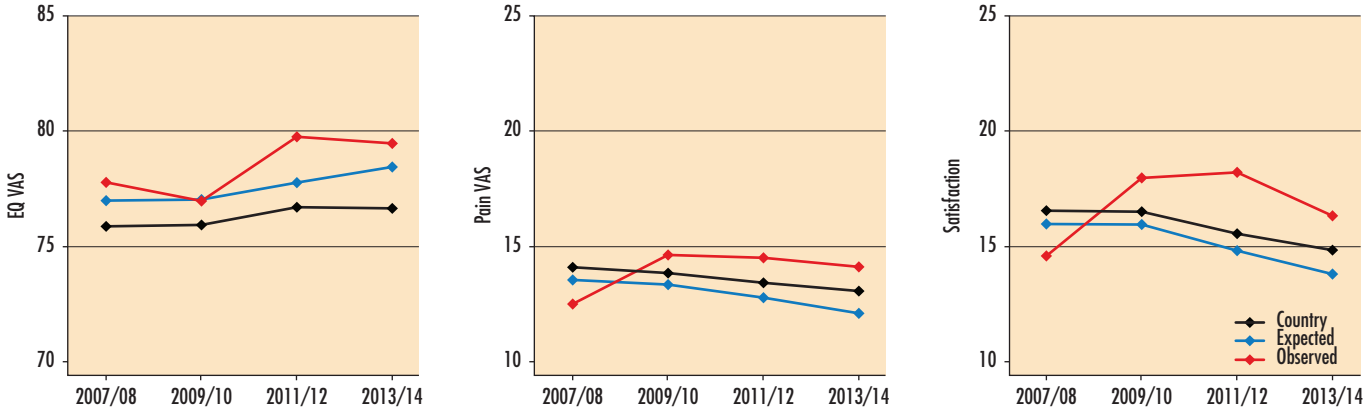

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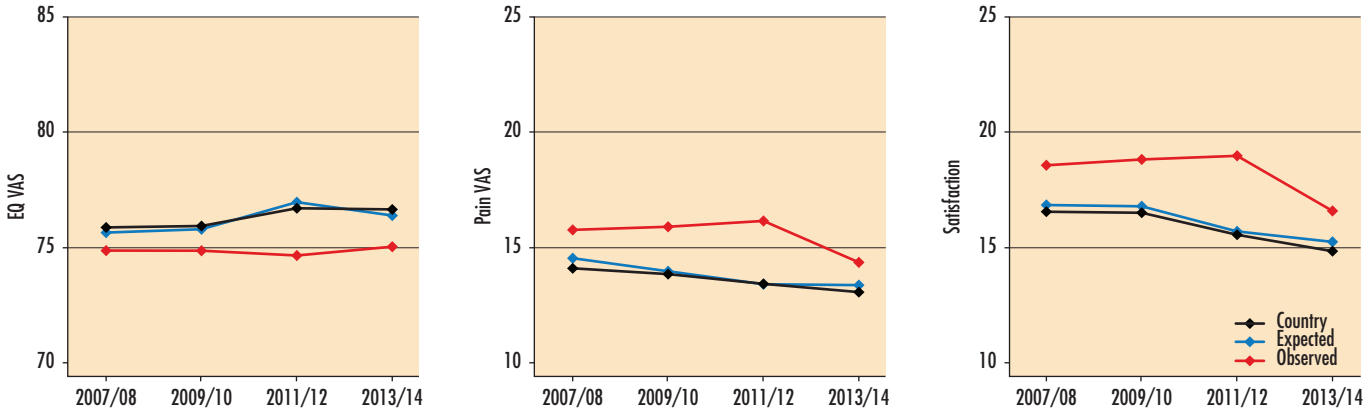

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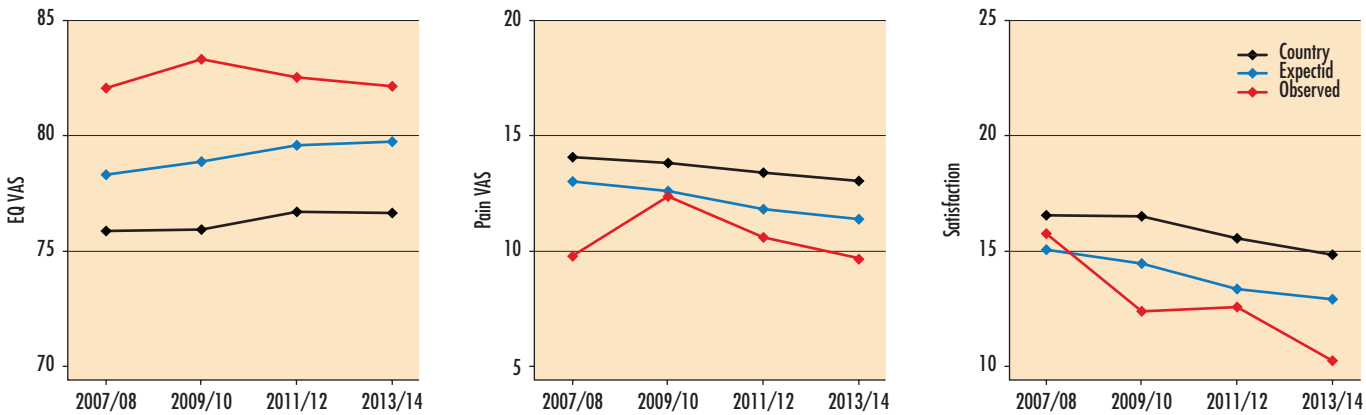

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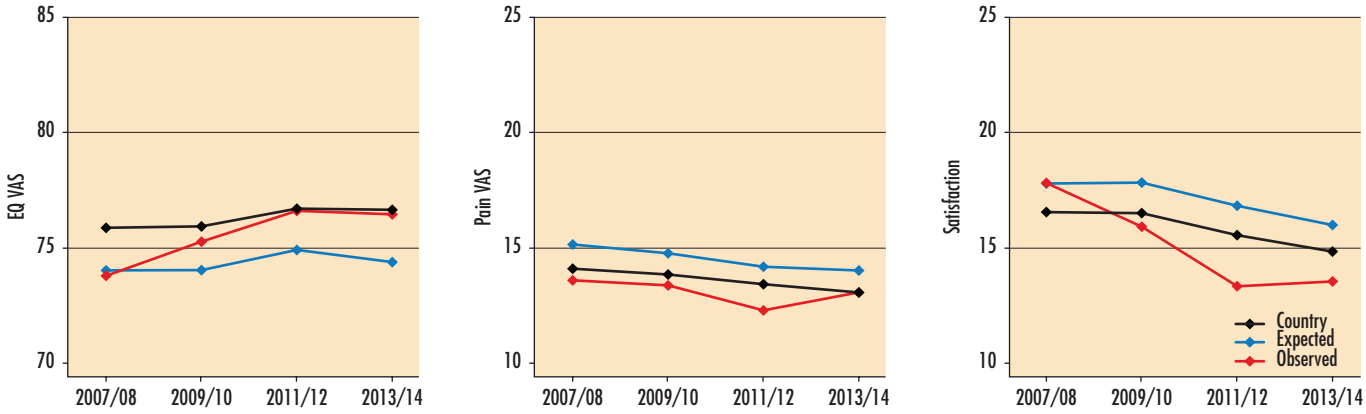

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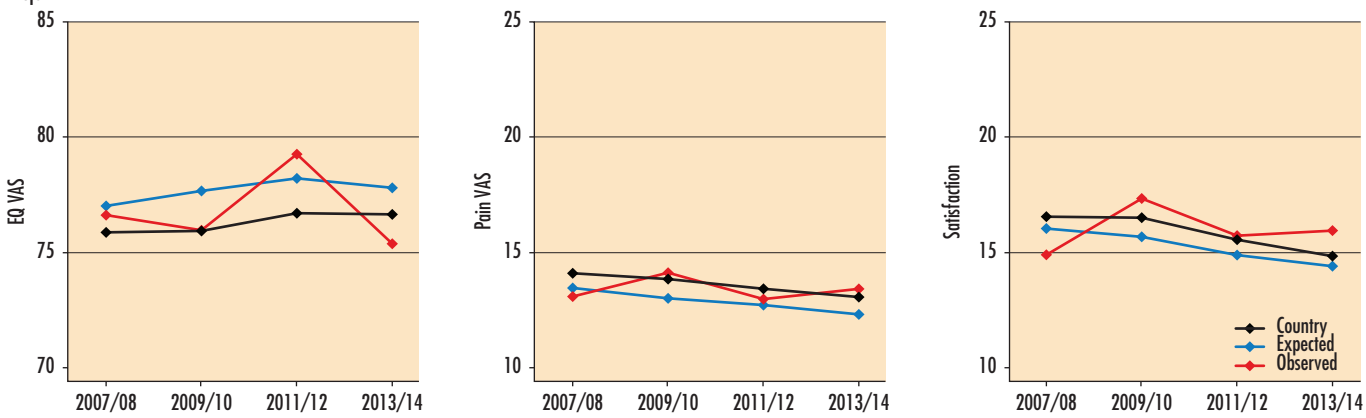

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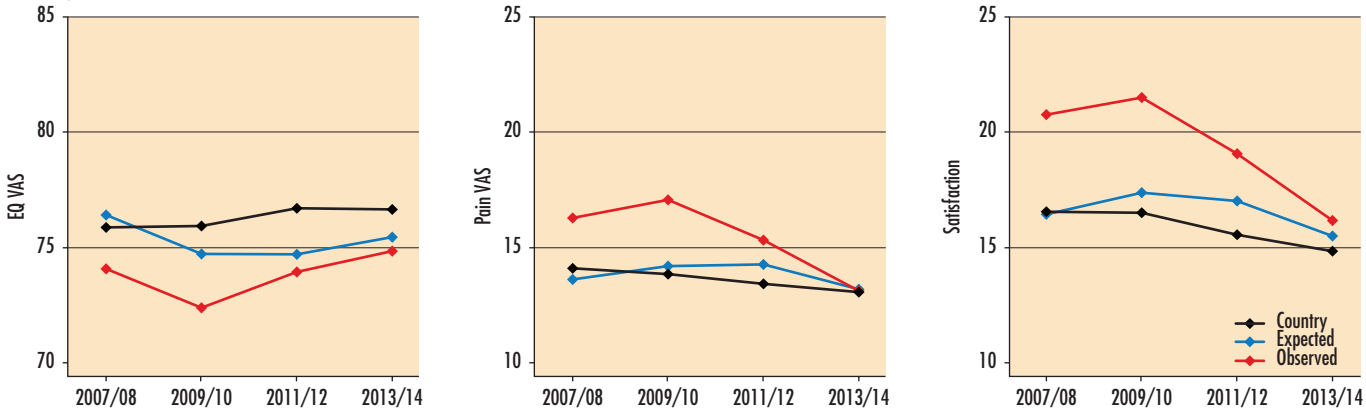

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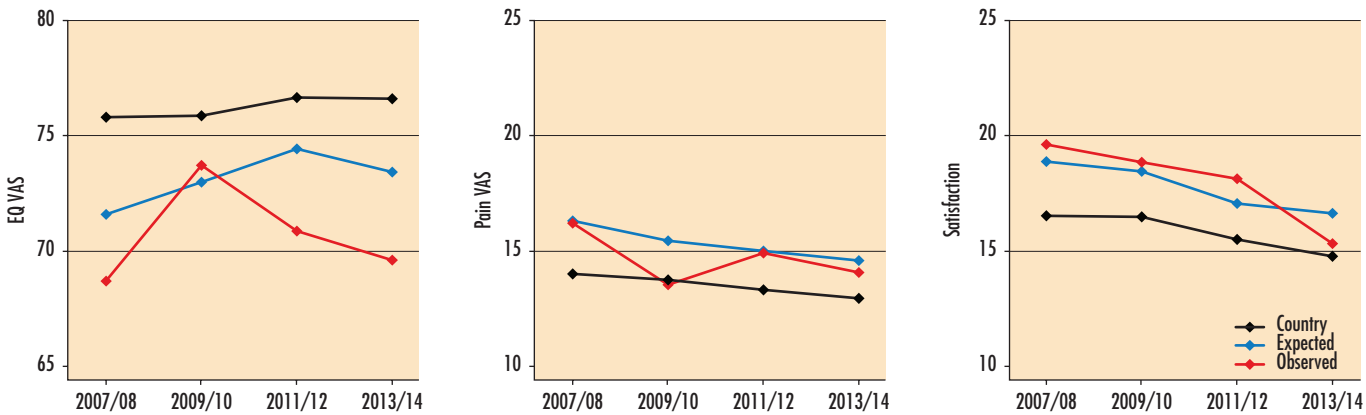

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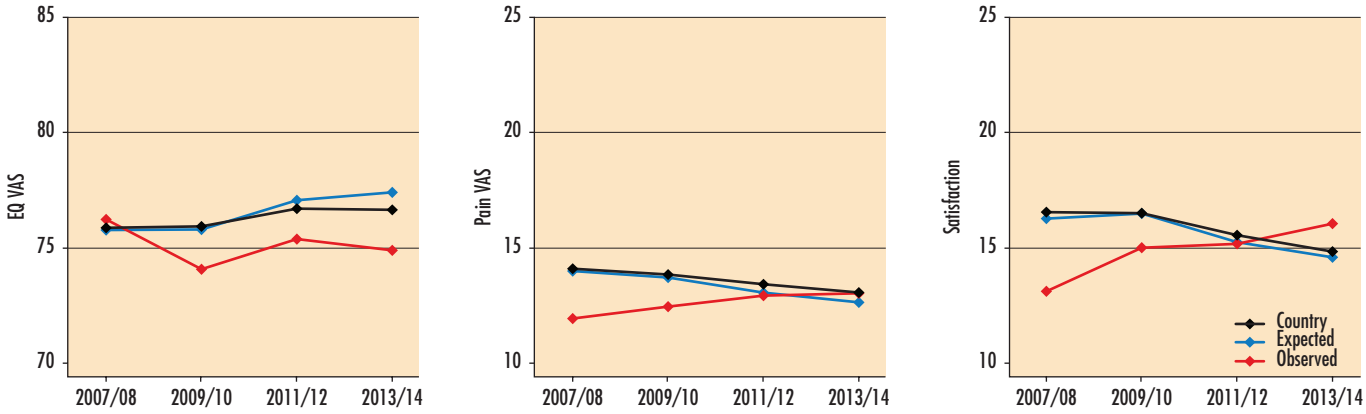

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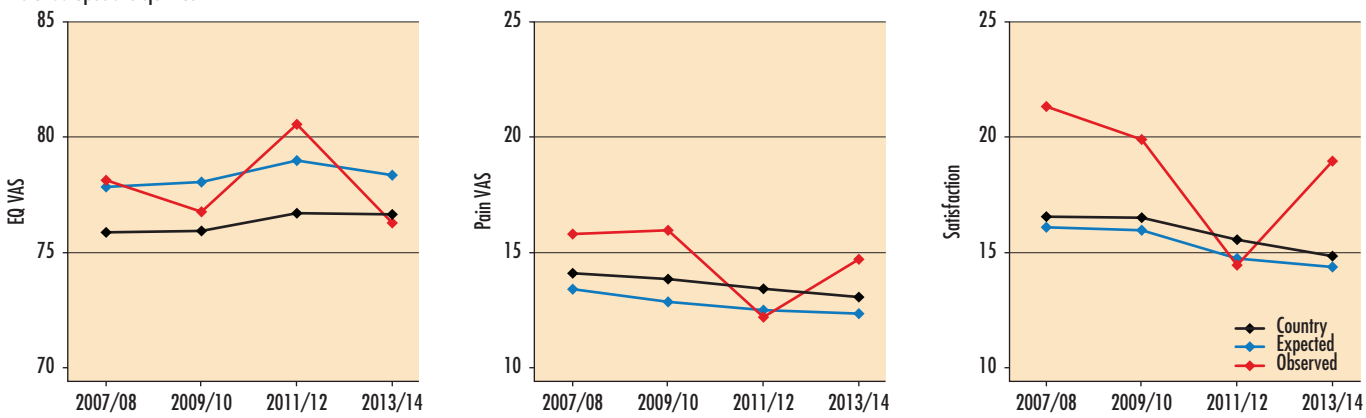

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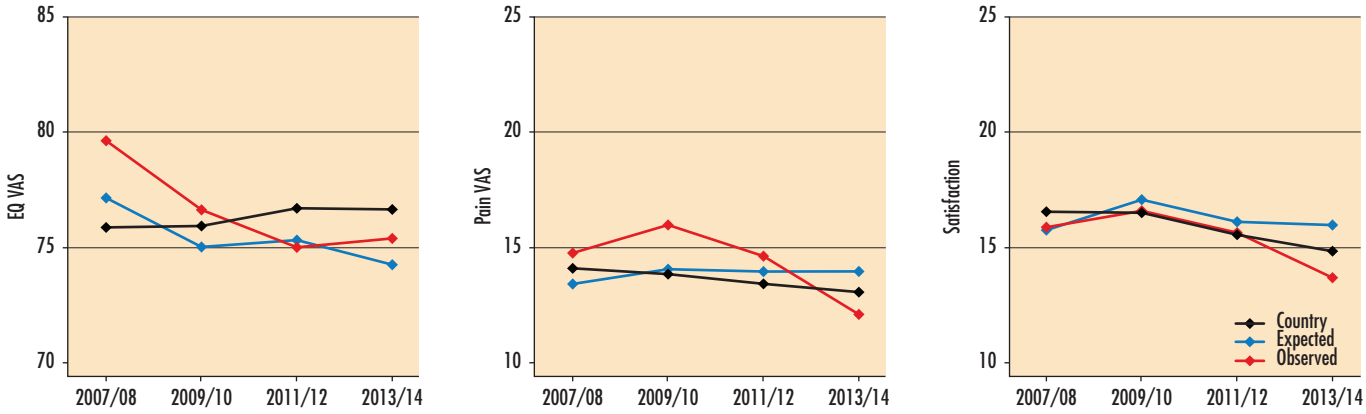

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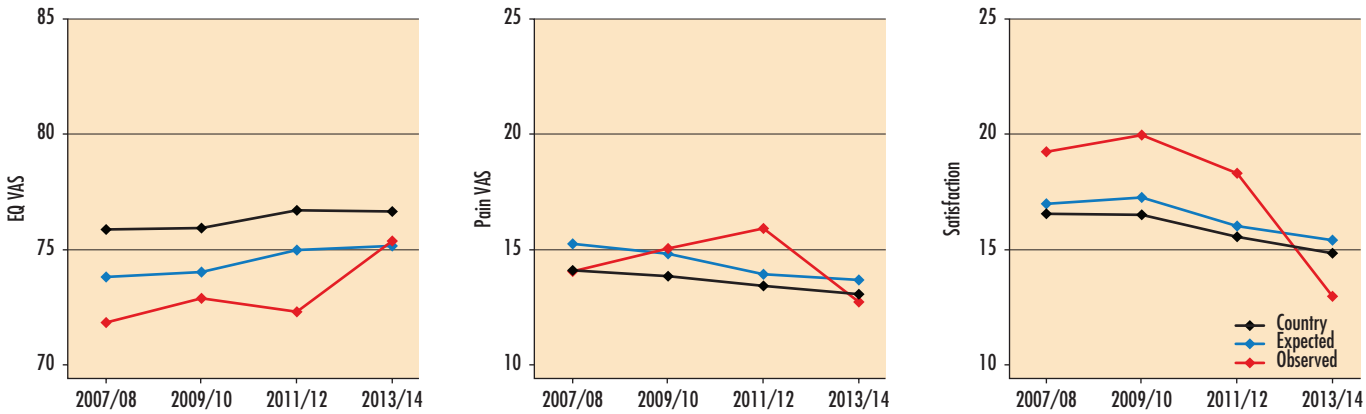

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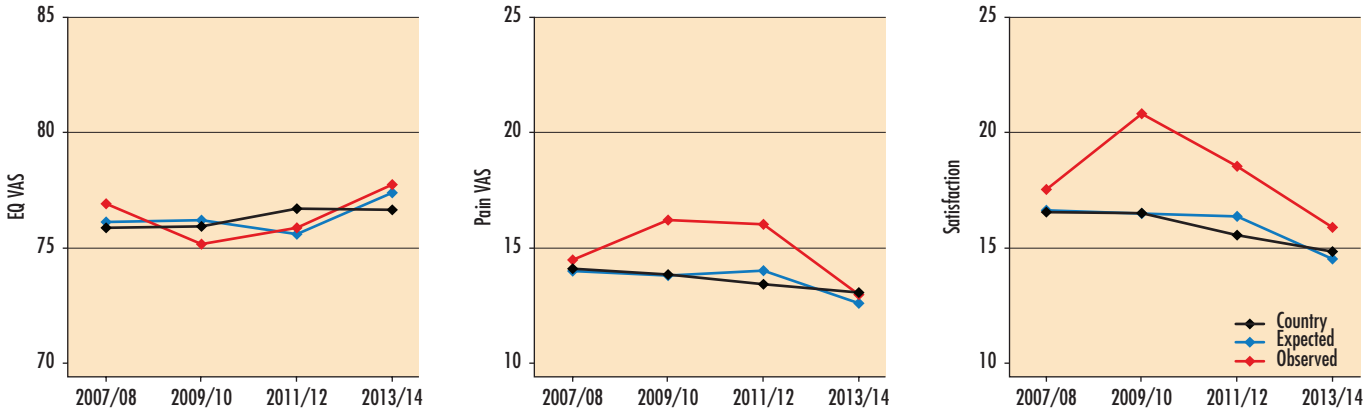

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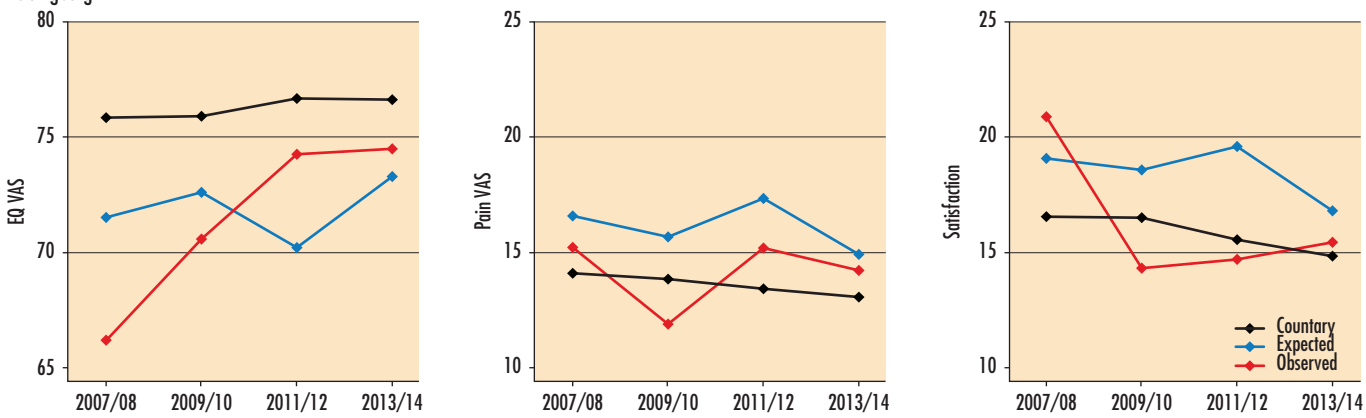

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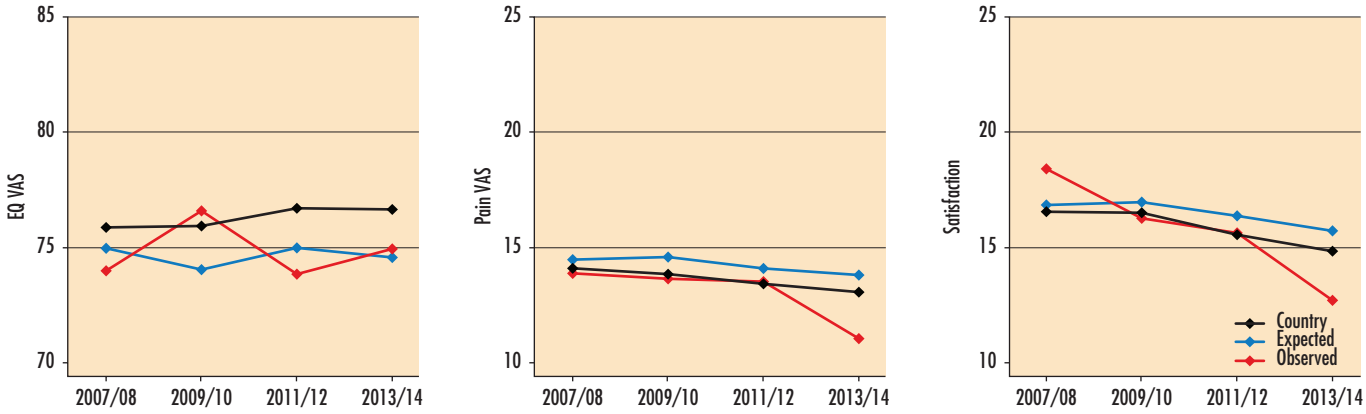

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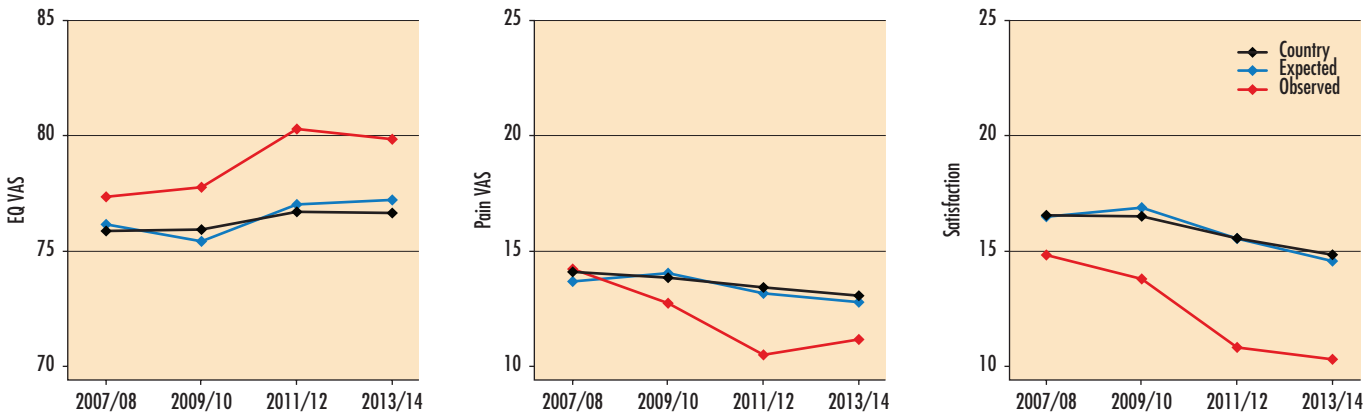

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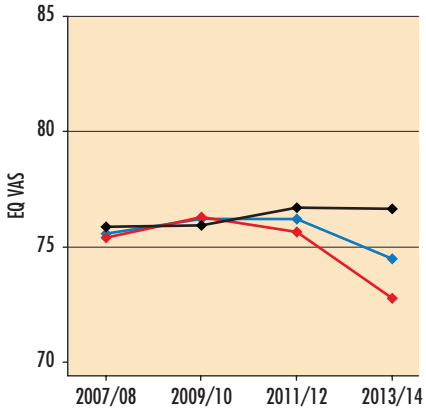

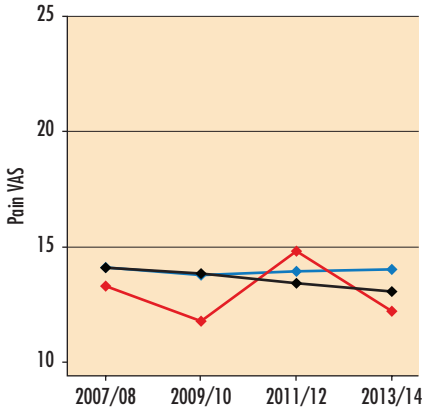

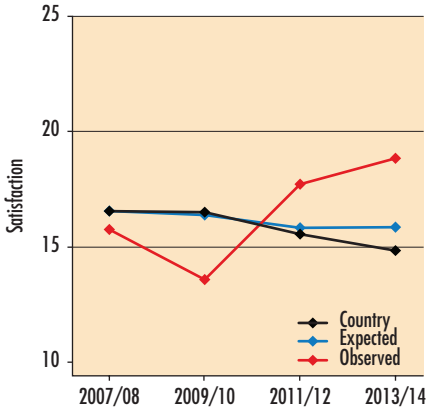

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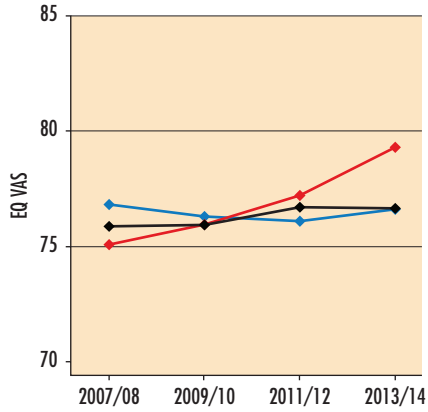

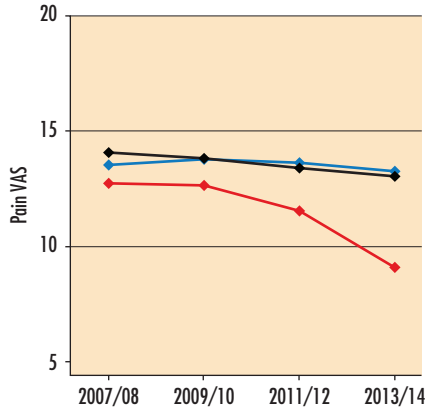

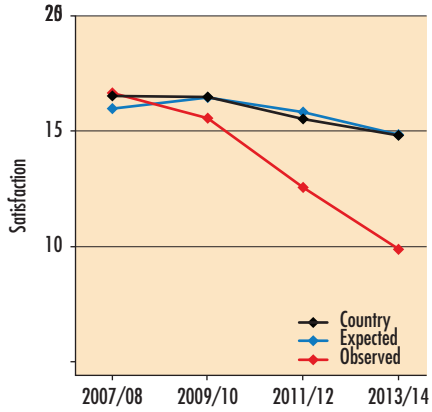

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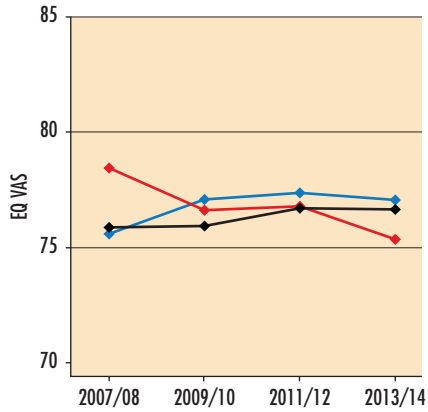

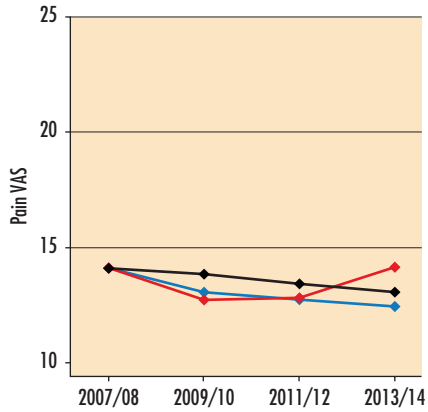

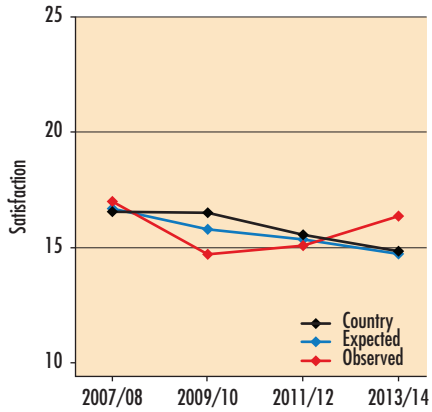

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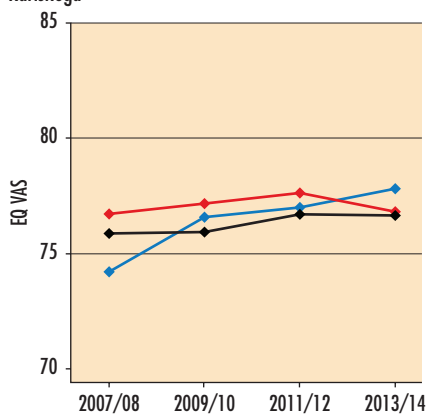

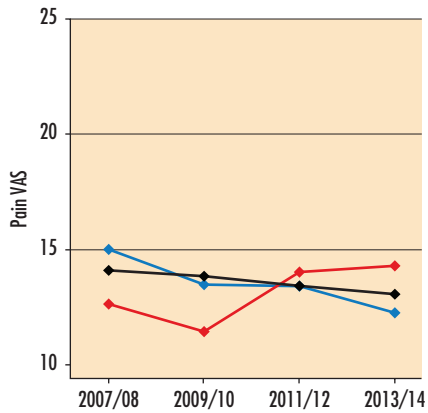

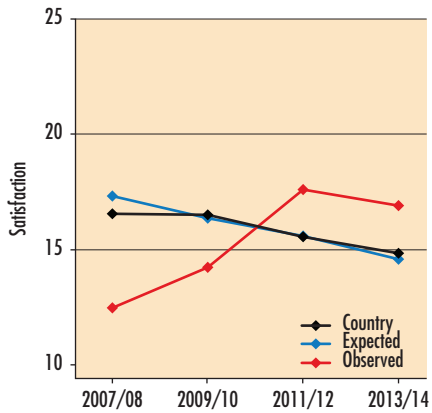

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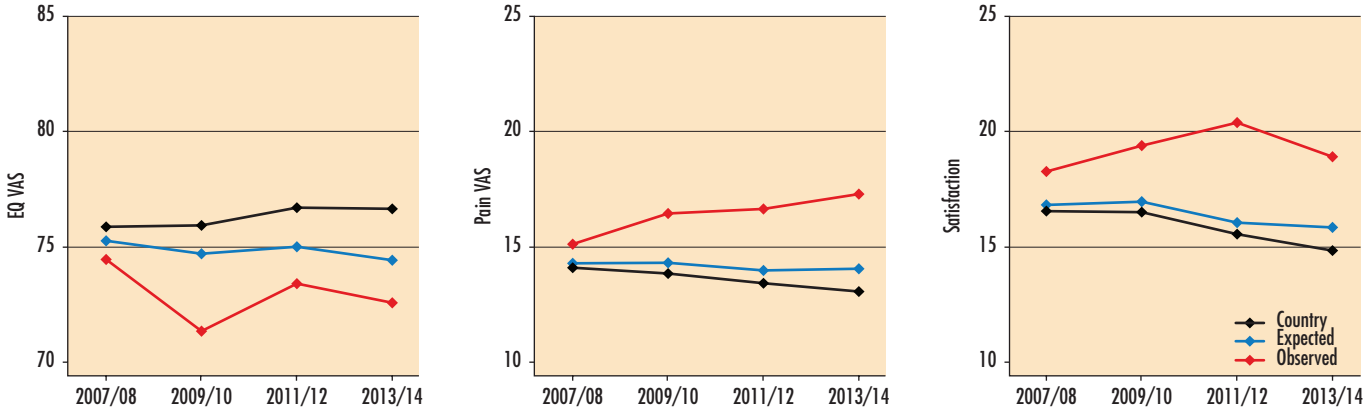
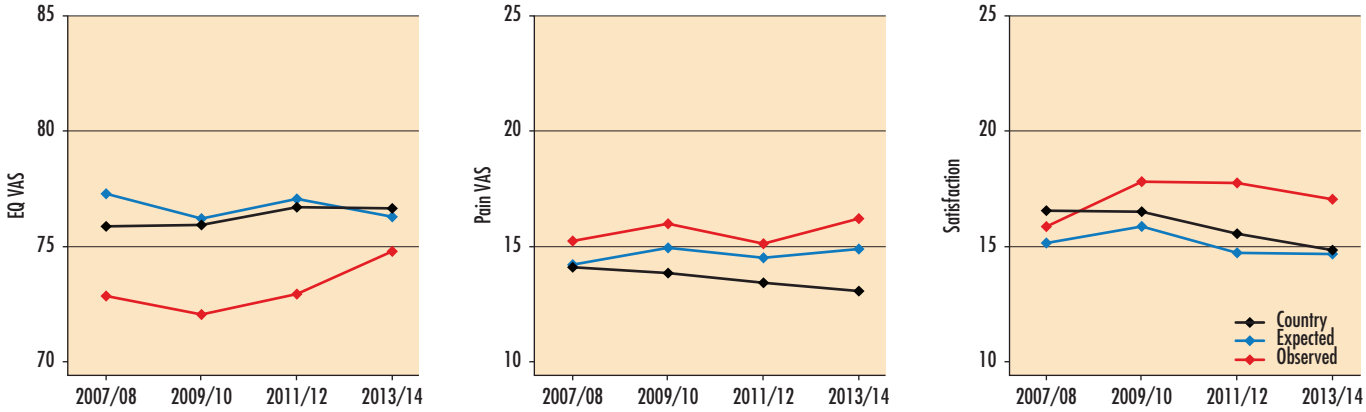


Karolinska/Huddinge



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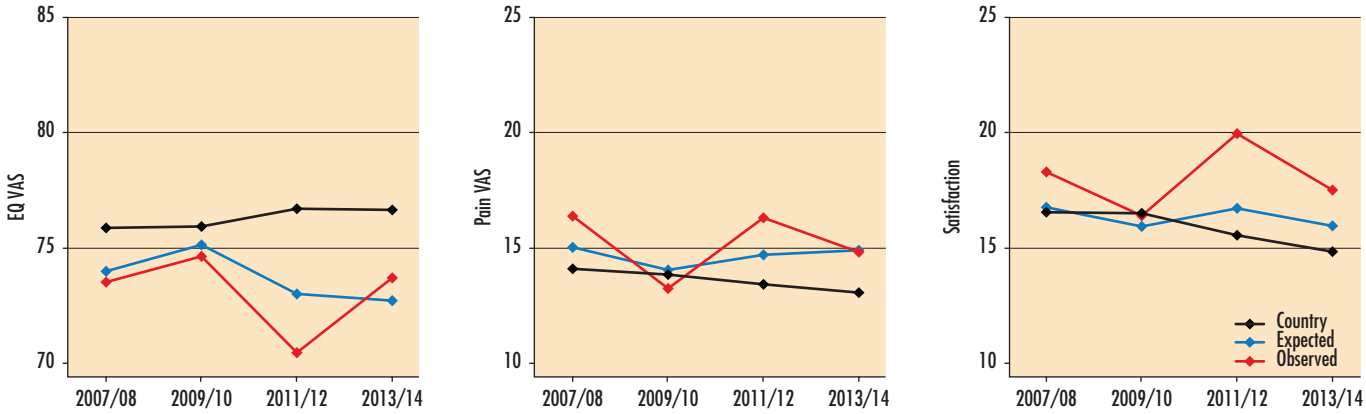

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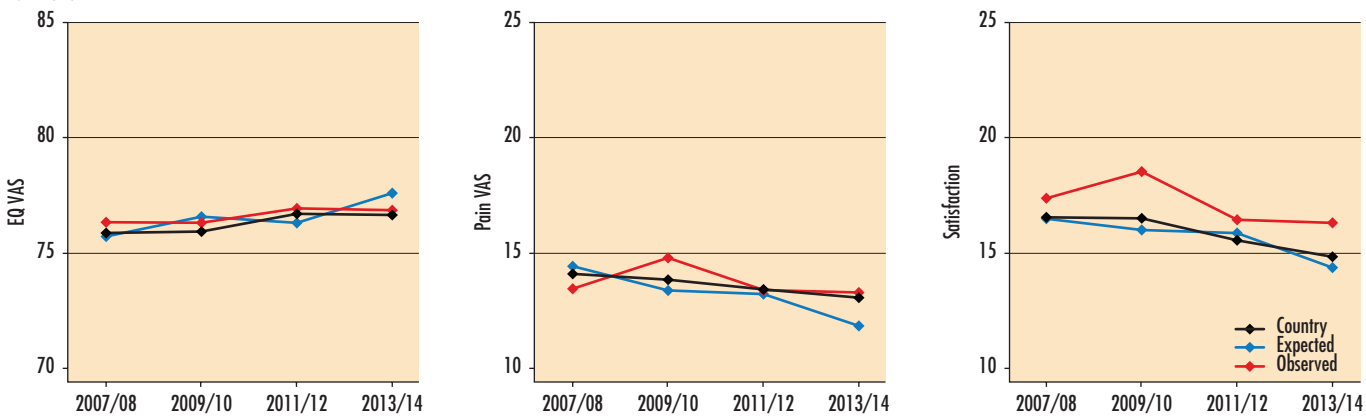

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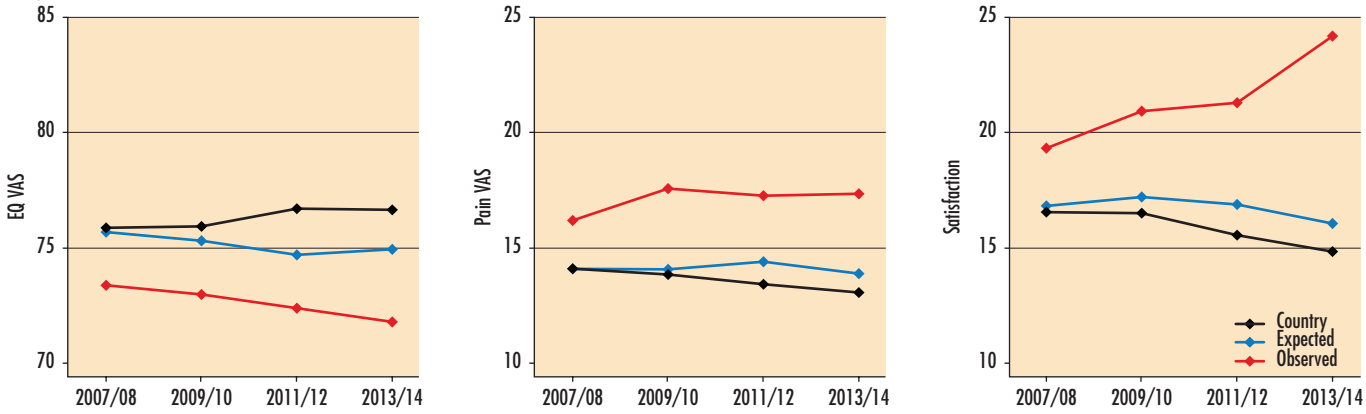

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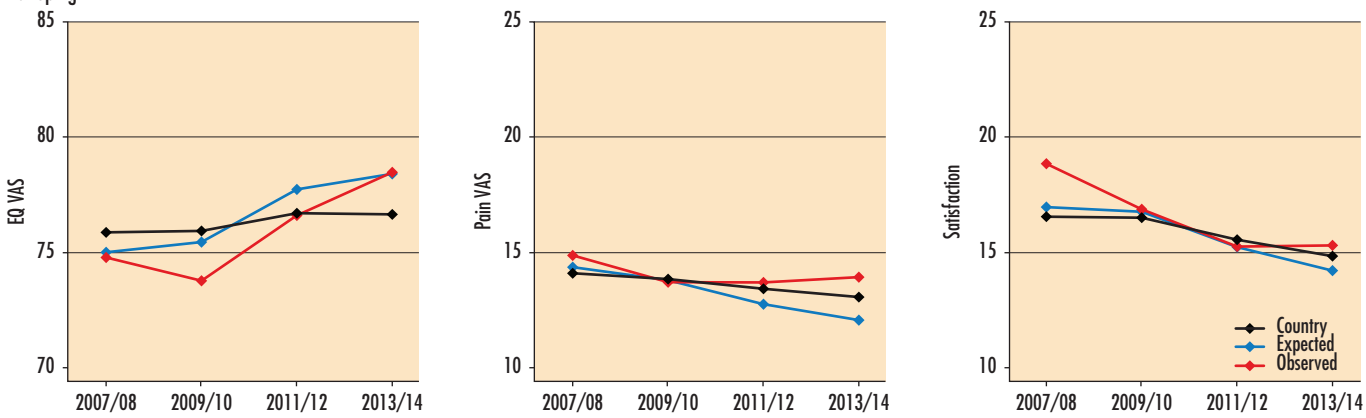

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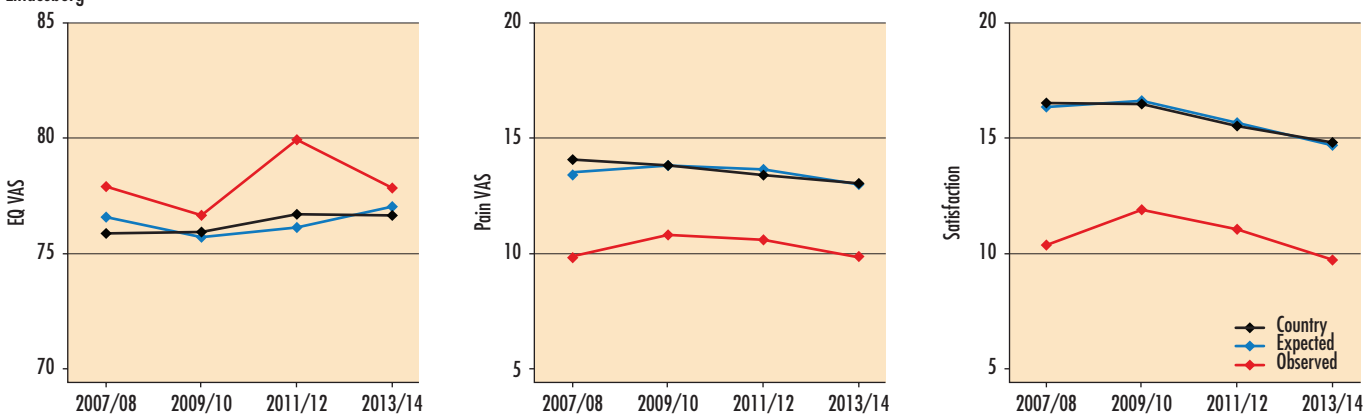
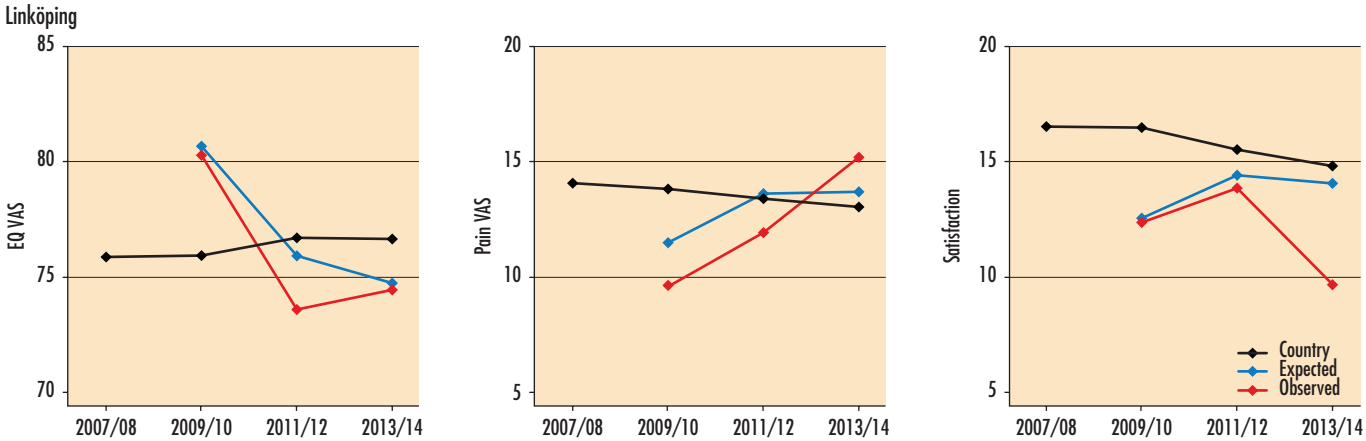


Linköping



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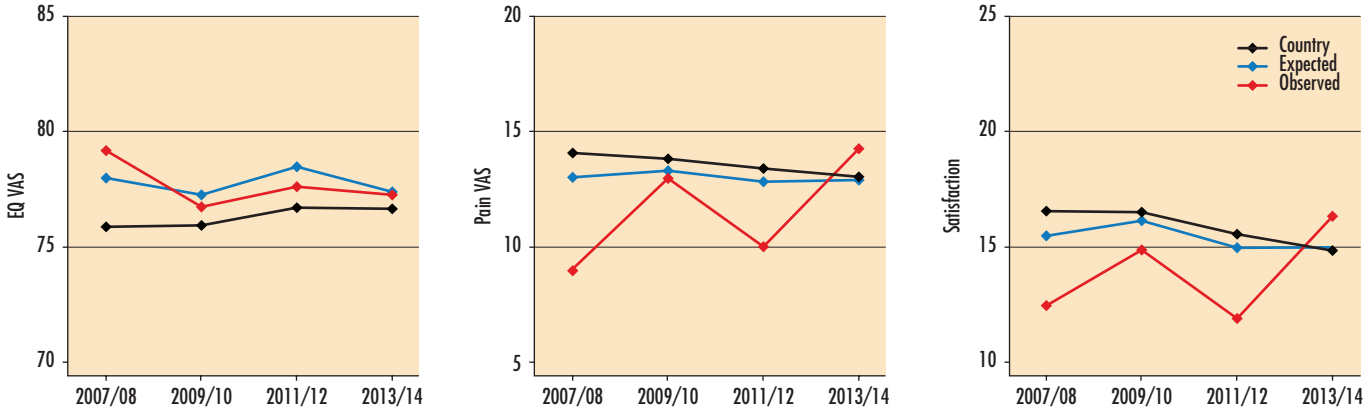

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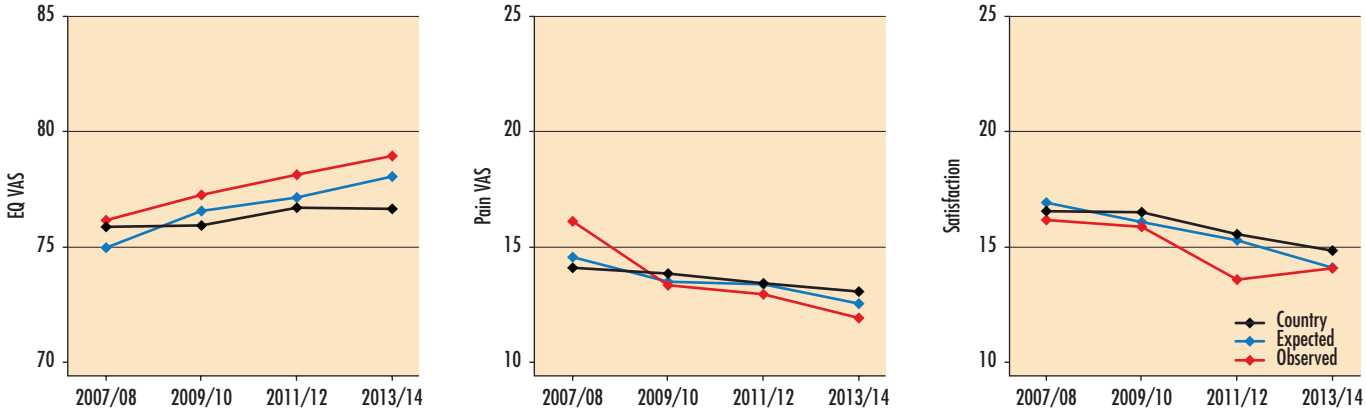

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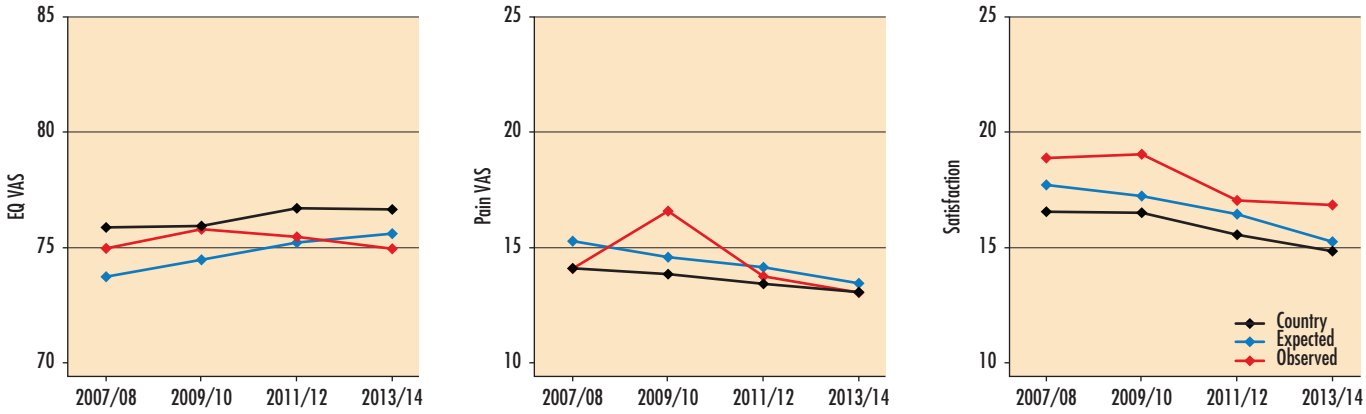

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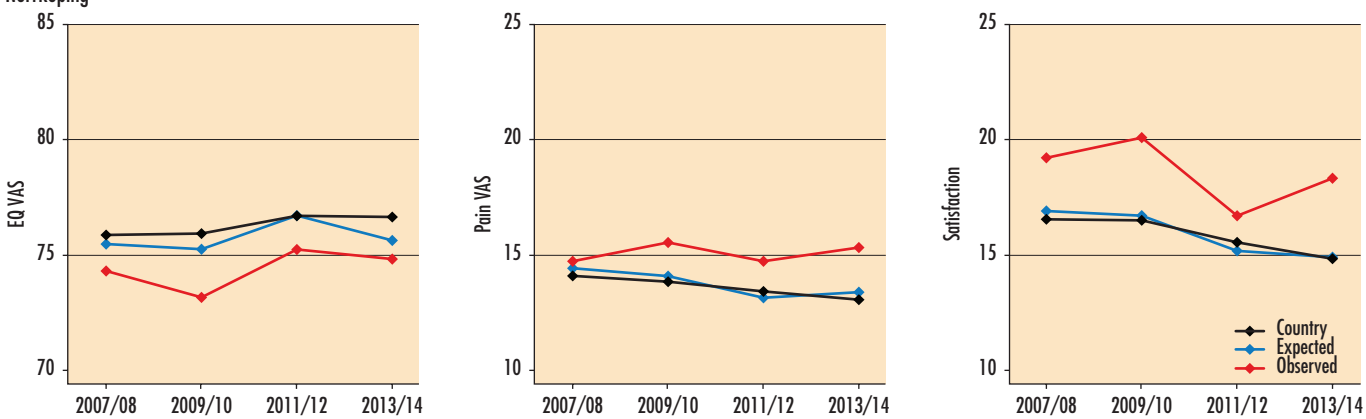

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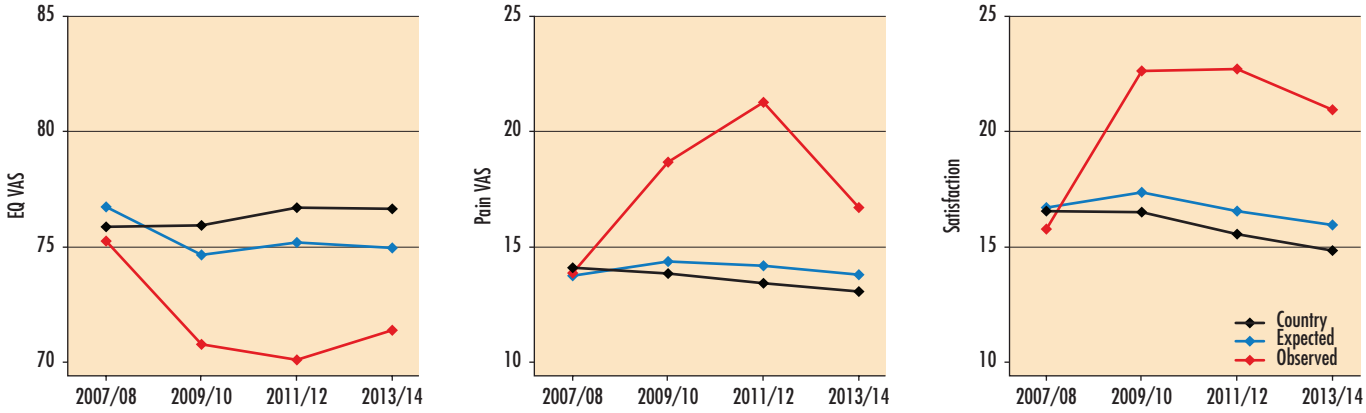

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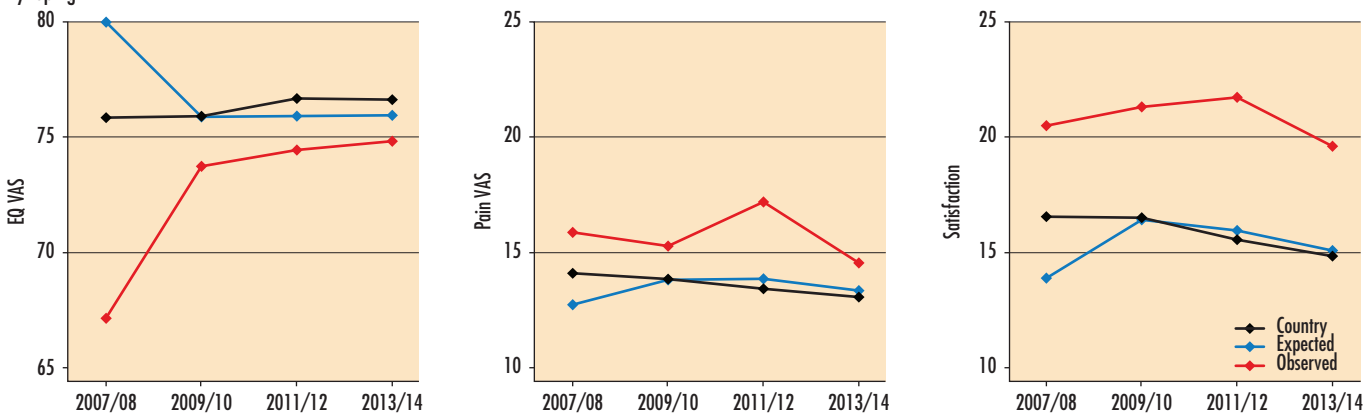

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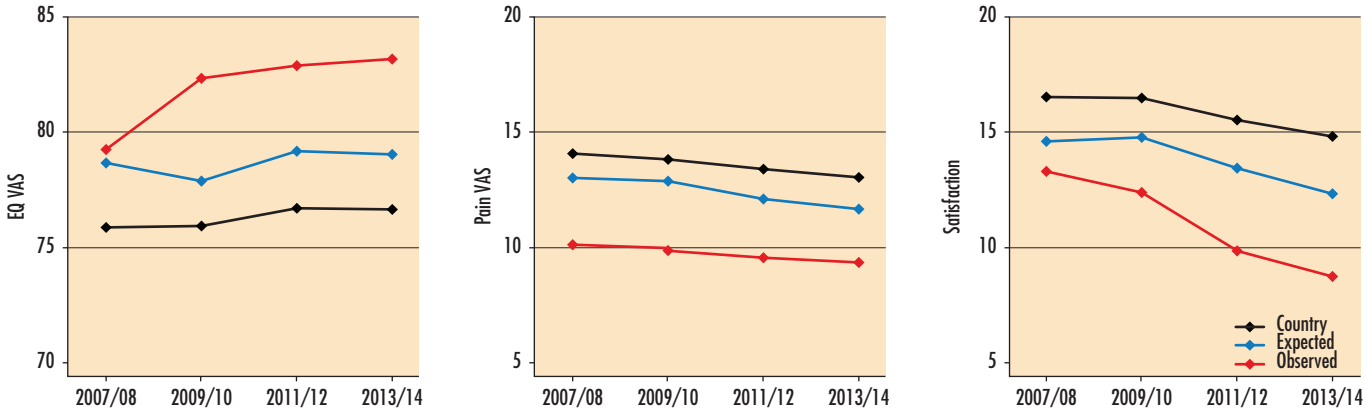

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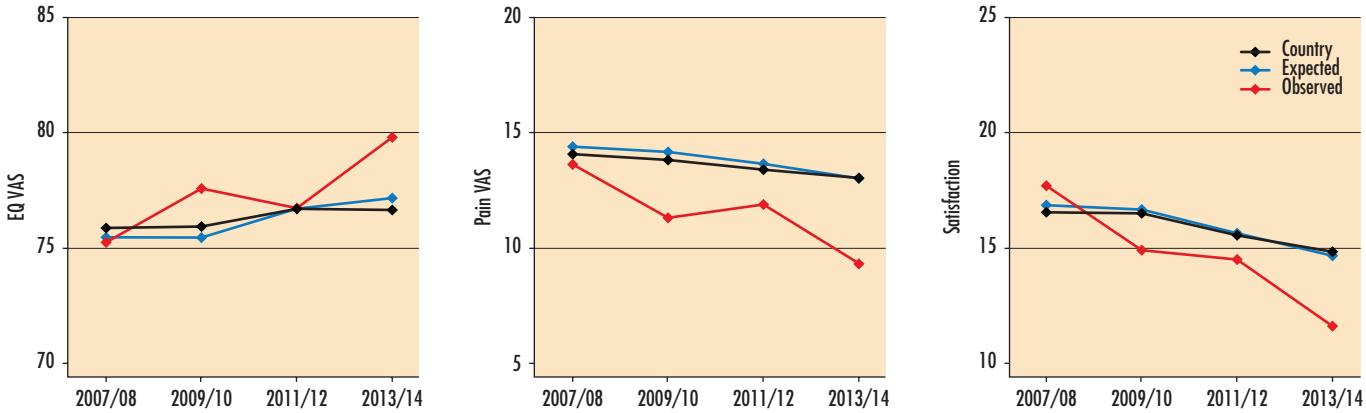

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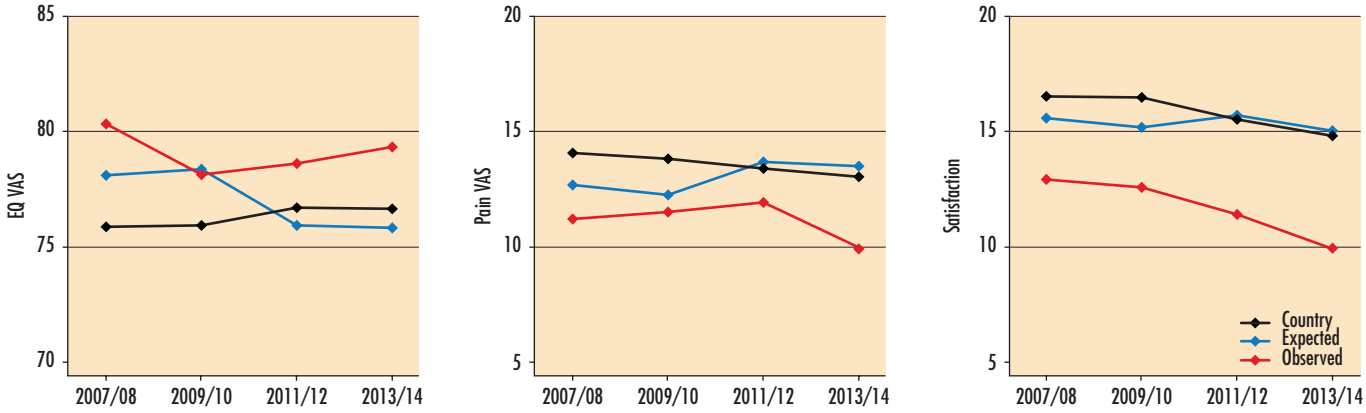

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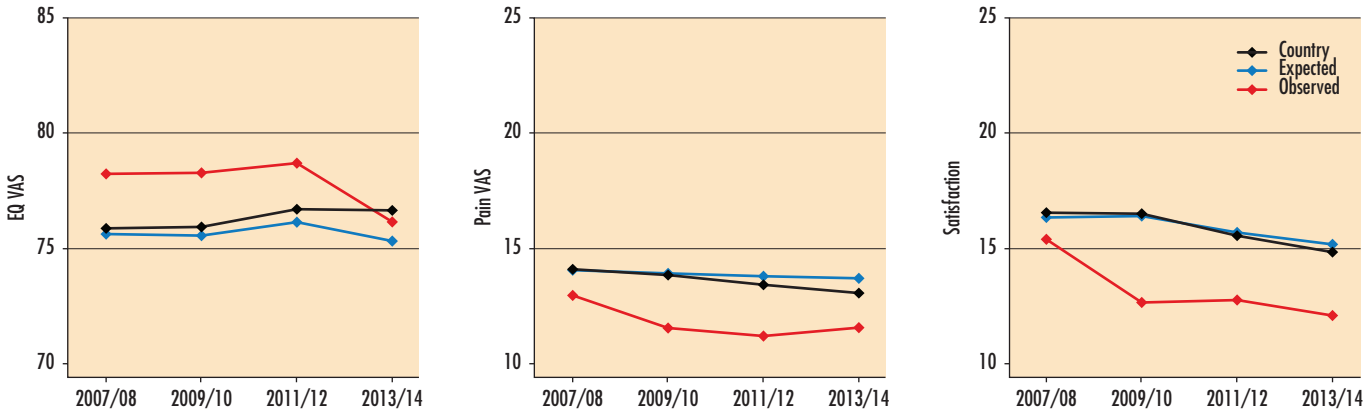

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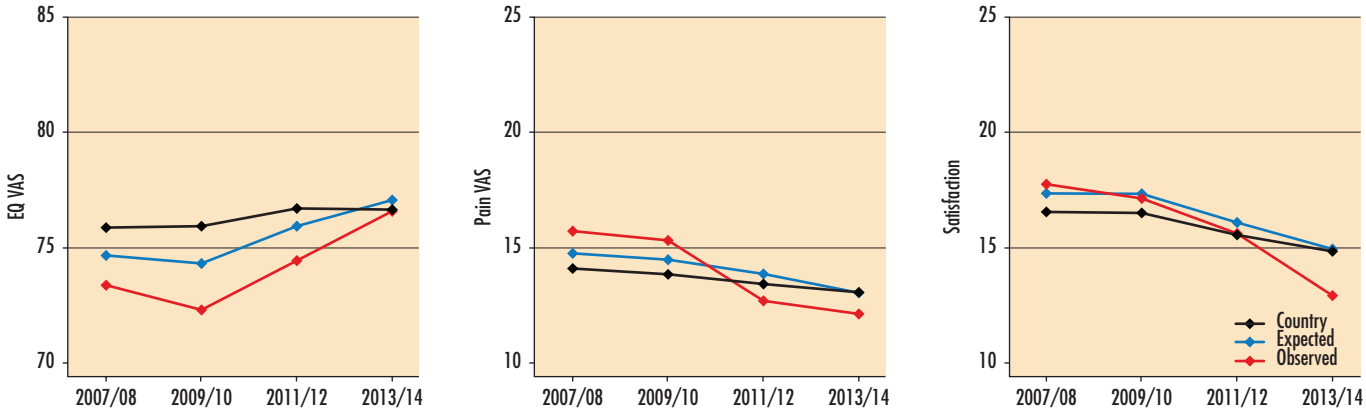

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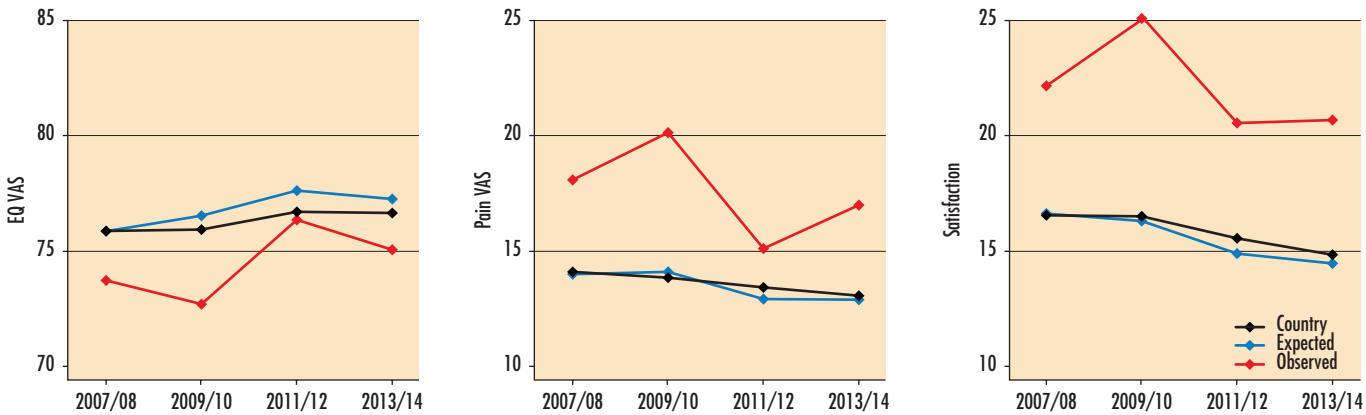

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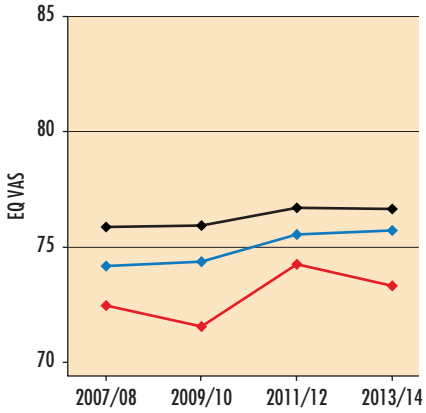

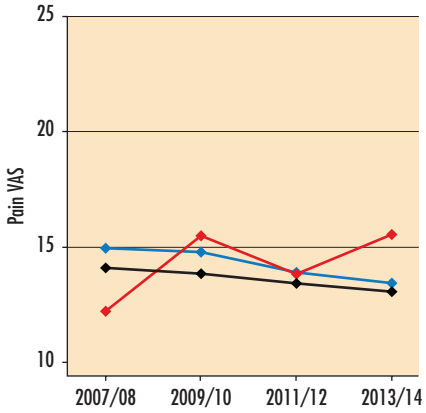

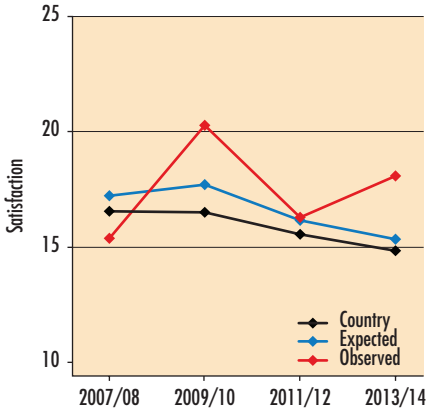

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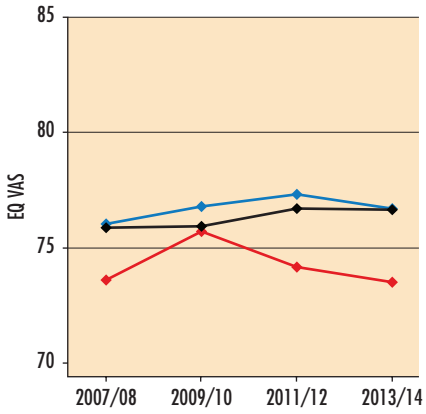

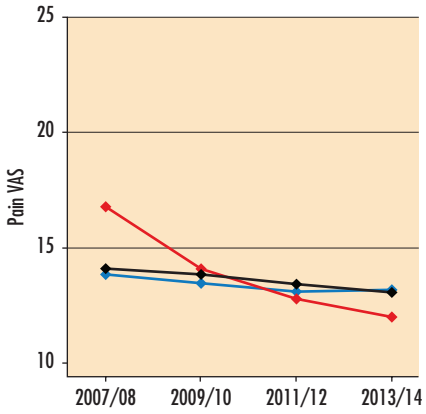

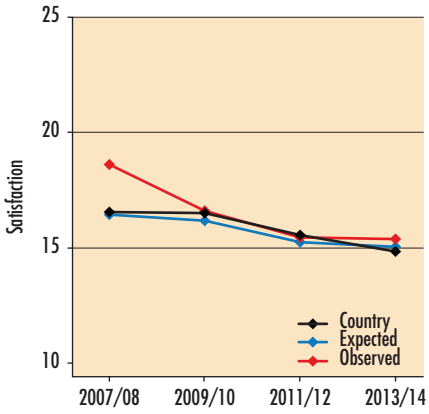

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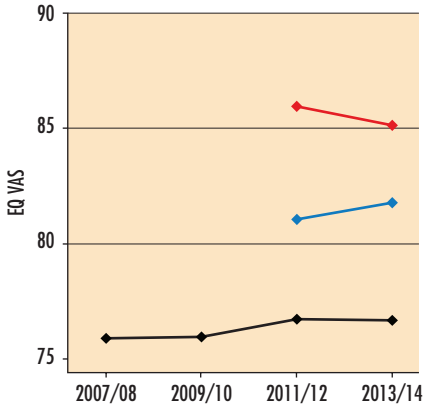

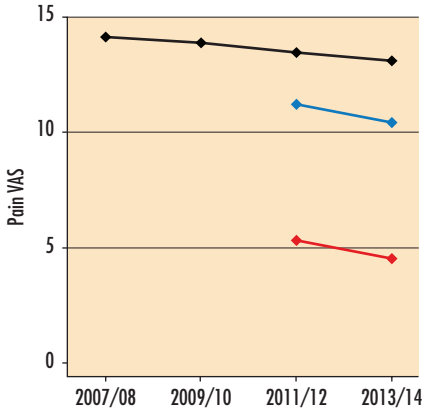

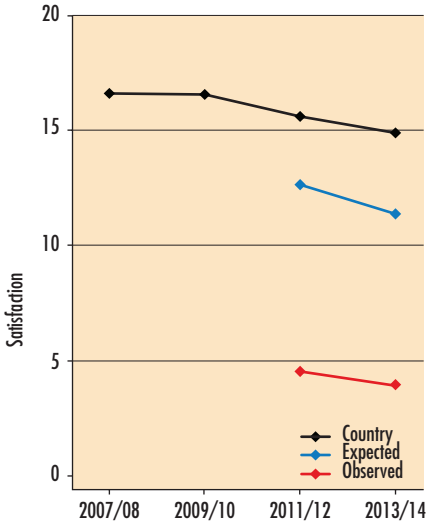

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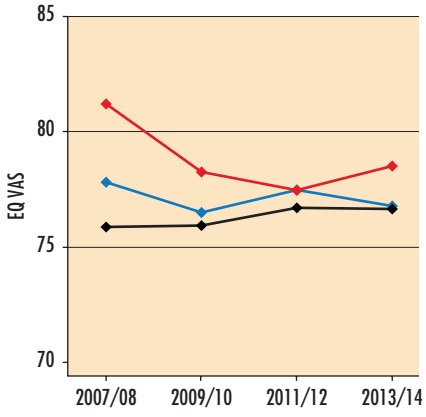

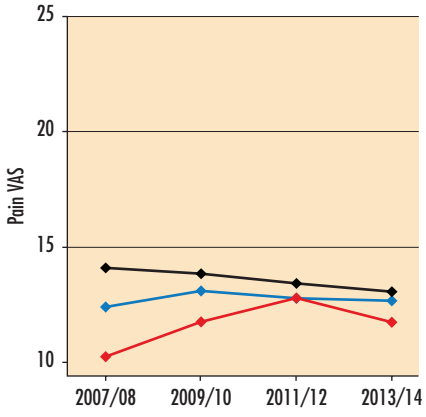

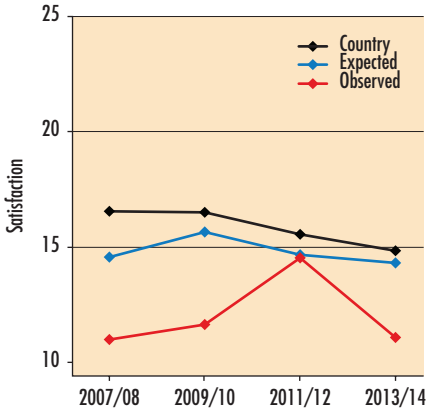

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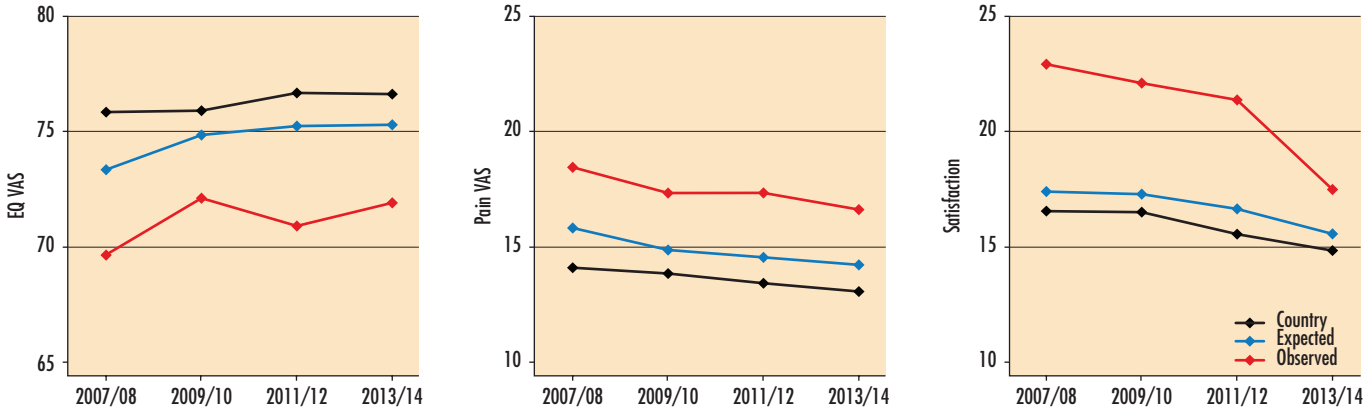

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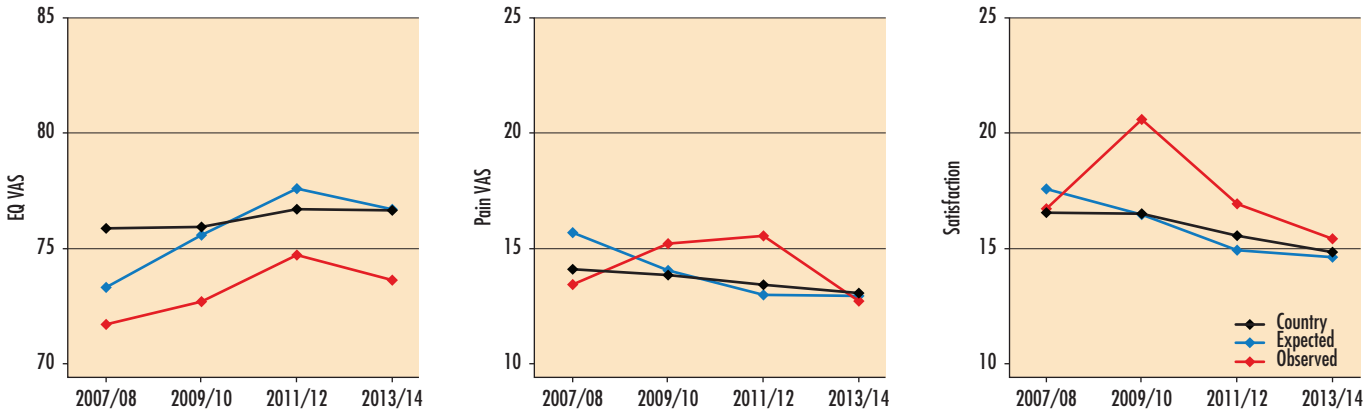

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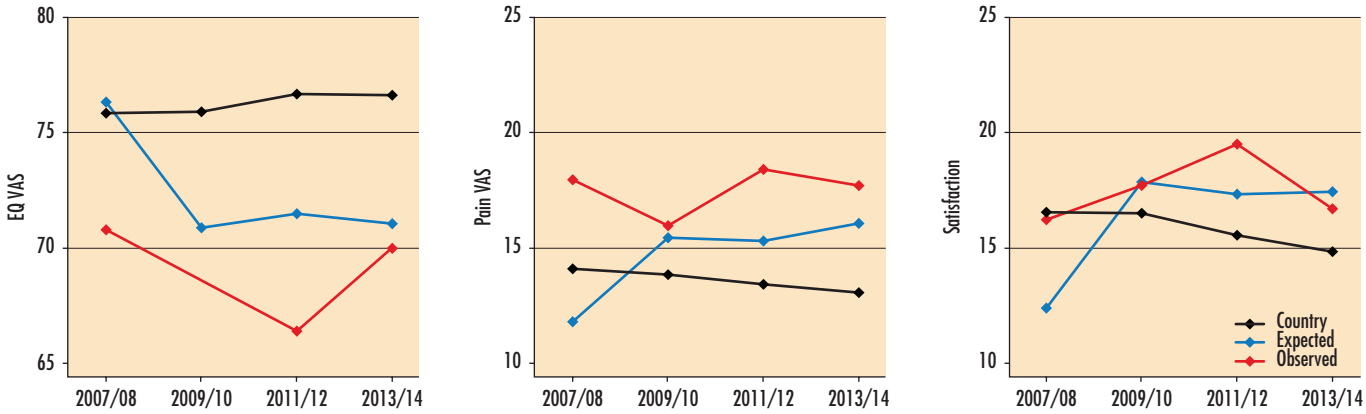

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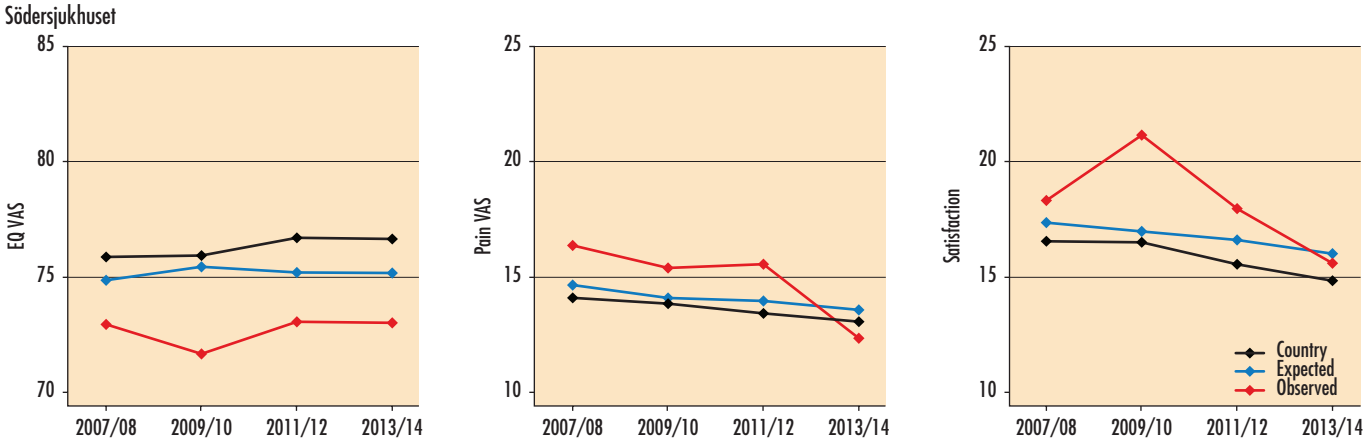

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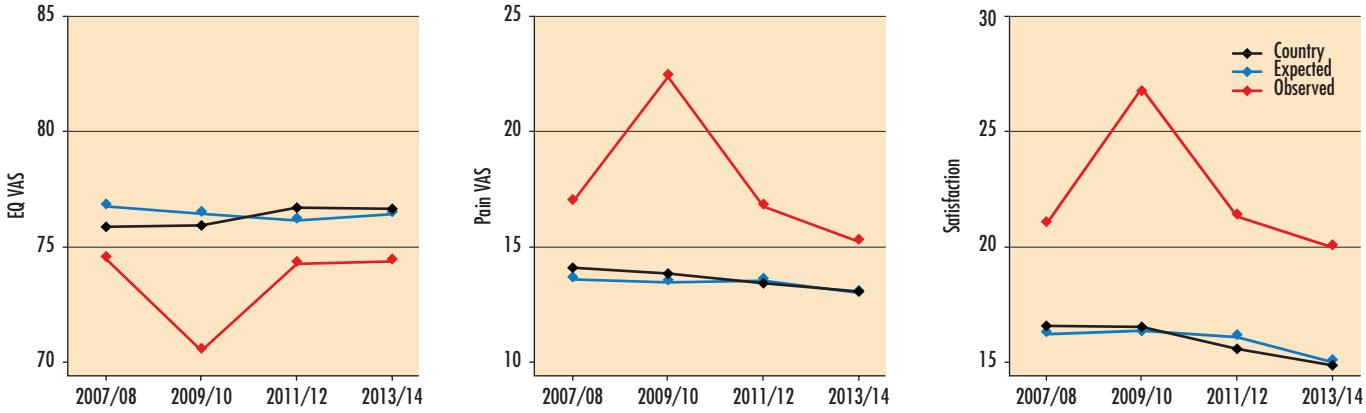

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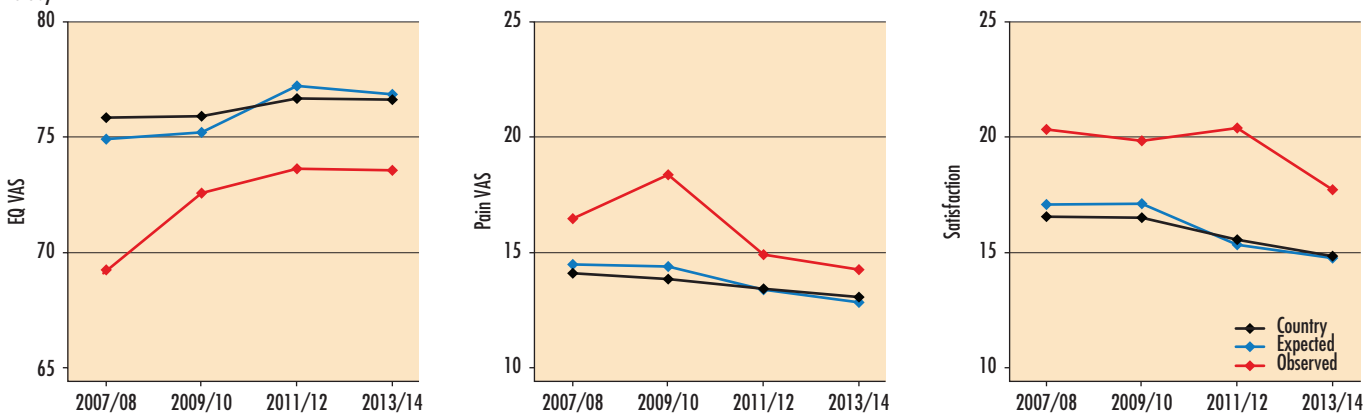

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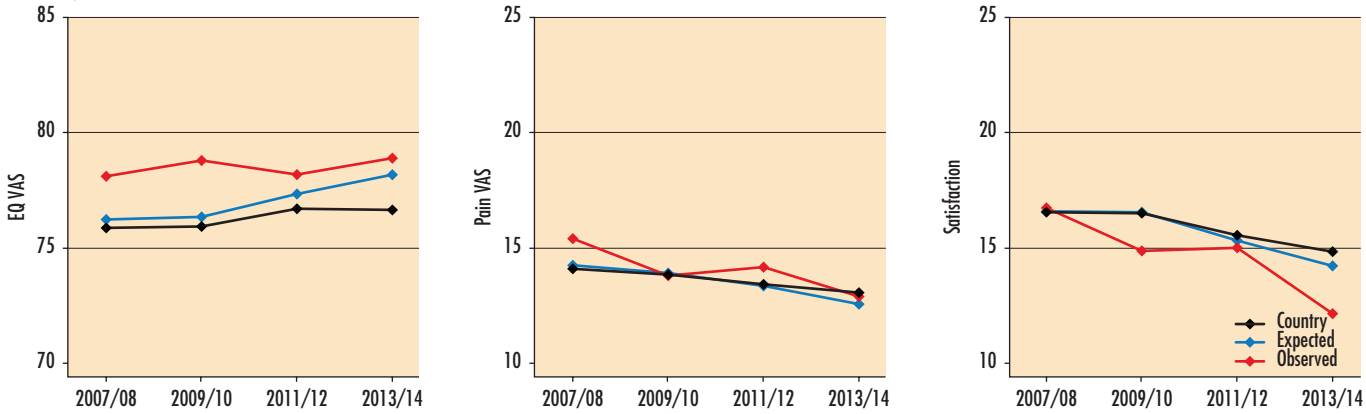

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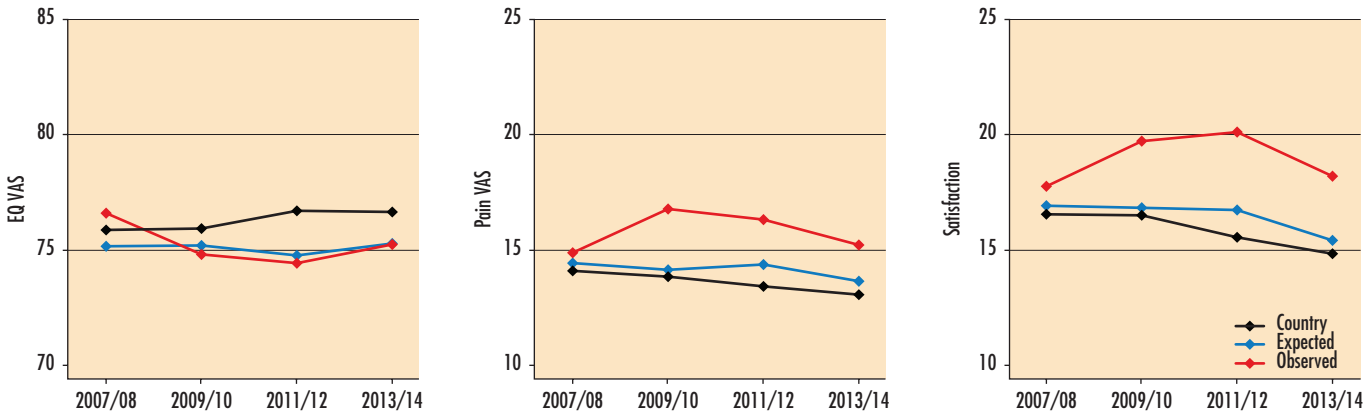

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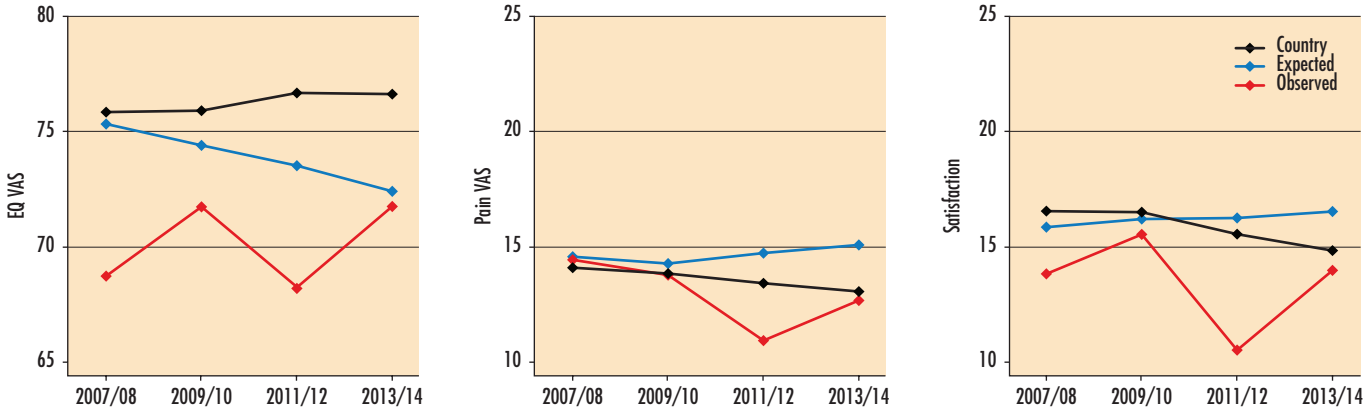

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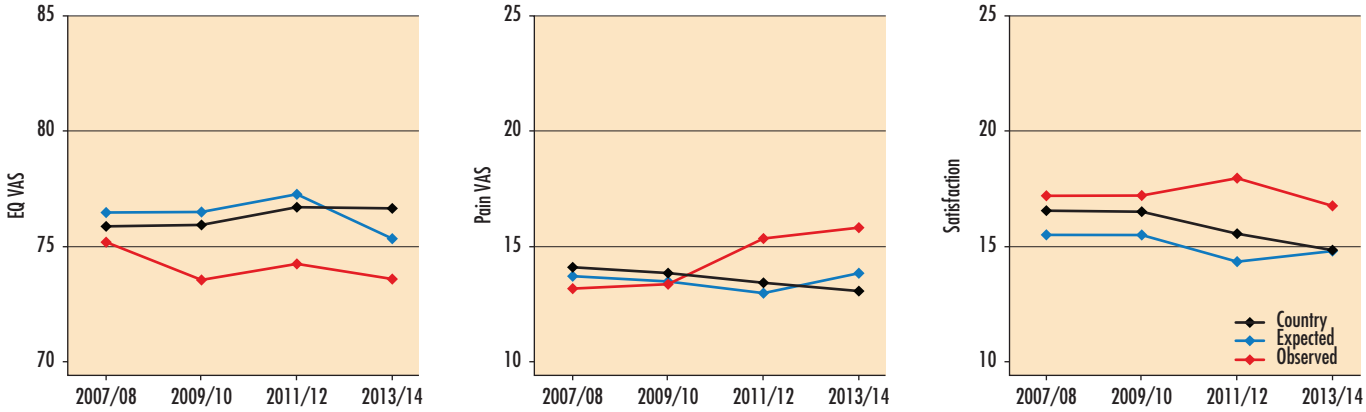

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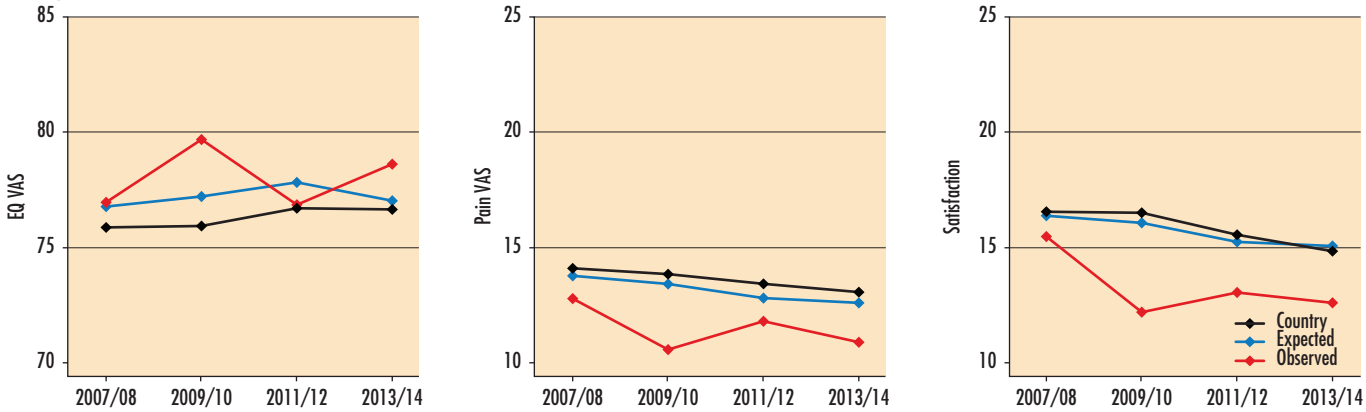

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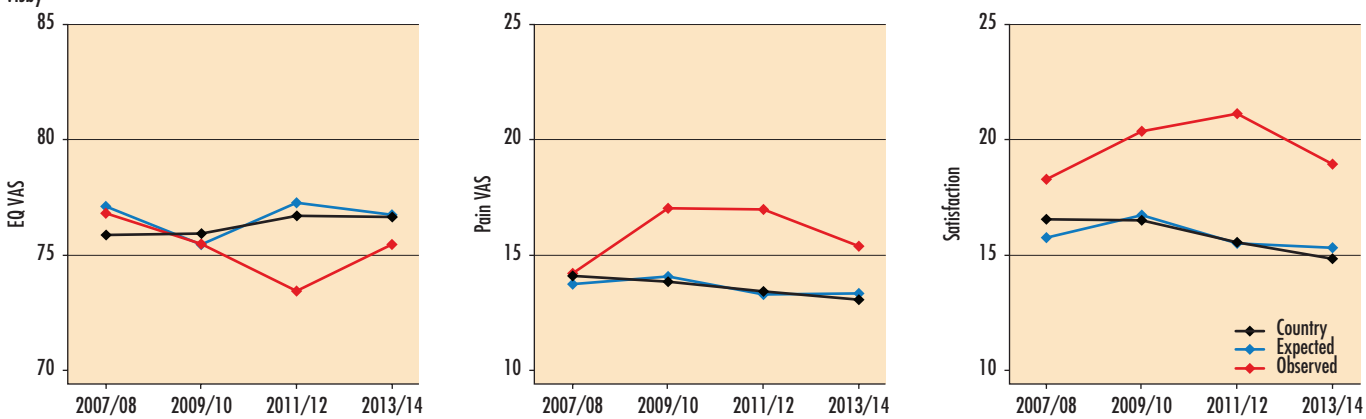

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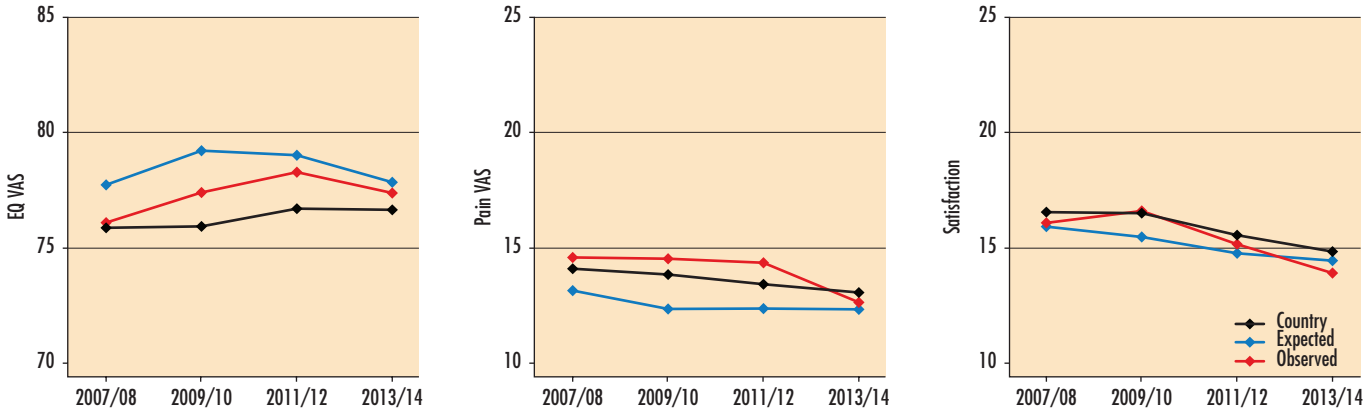

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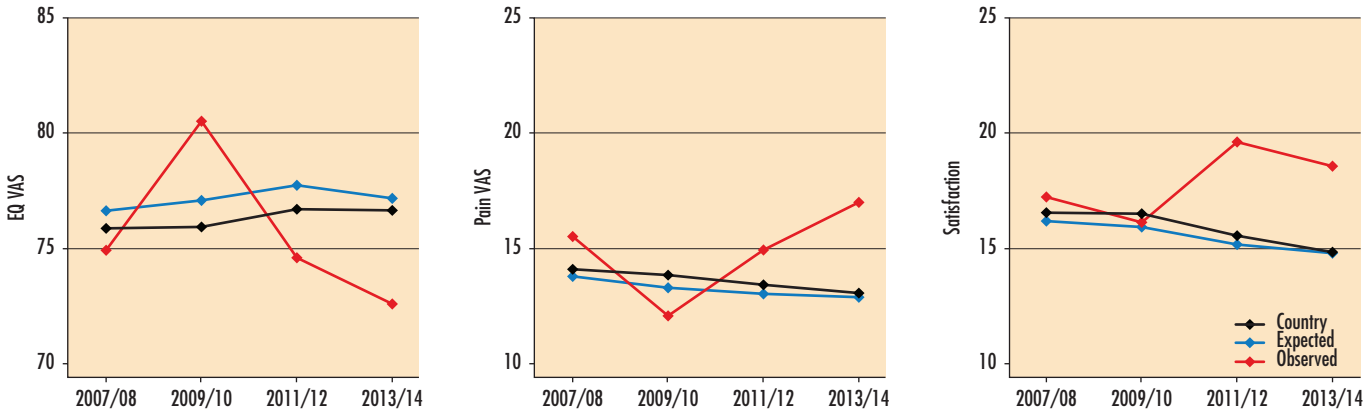

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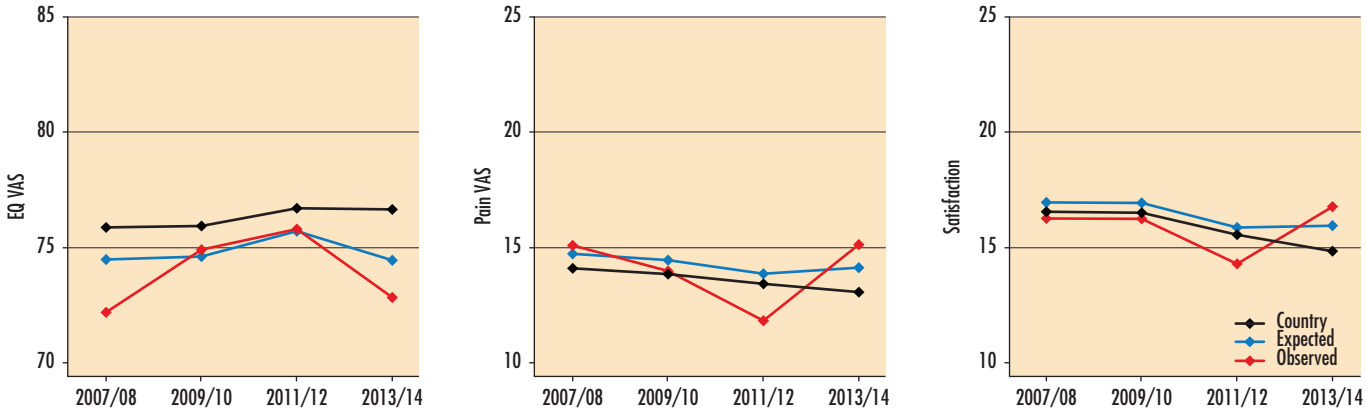

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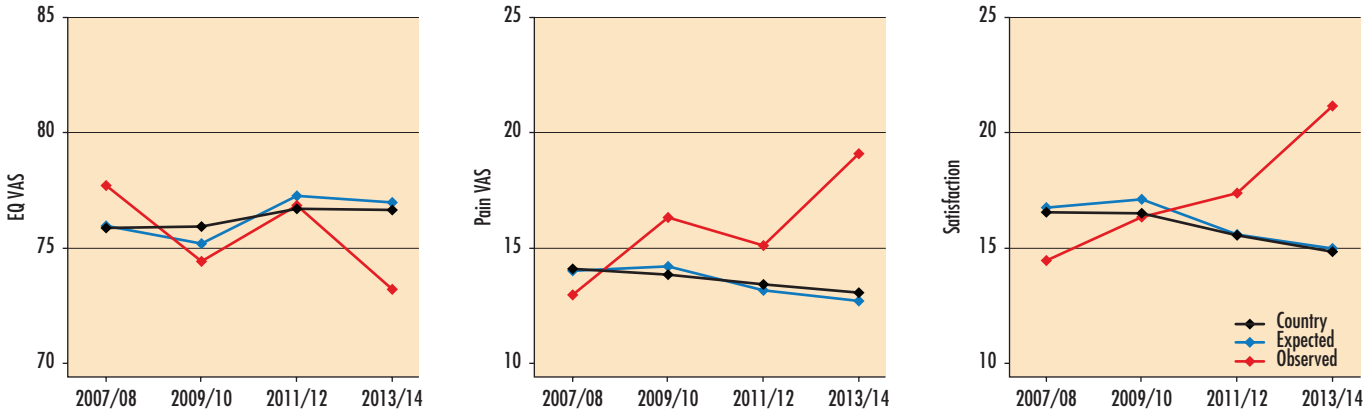

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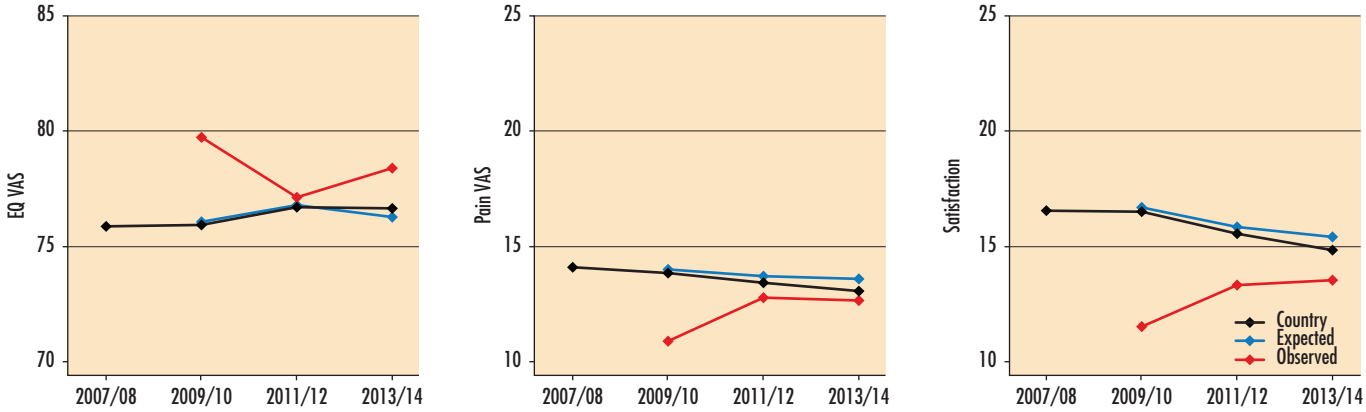

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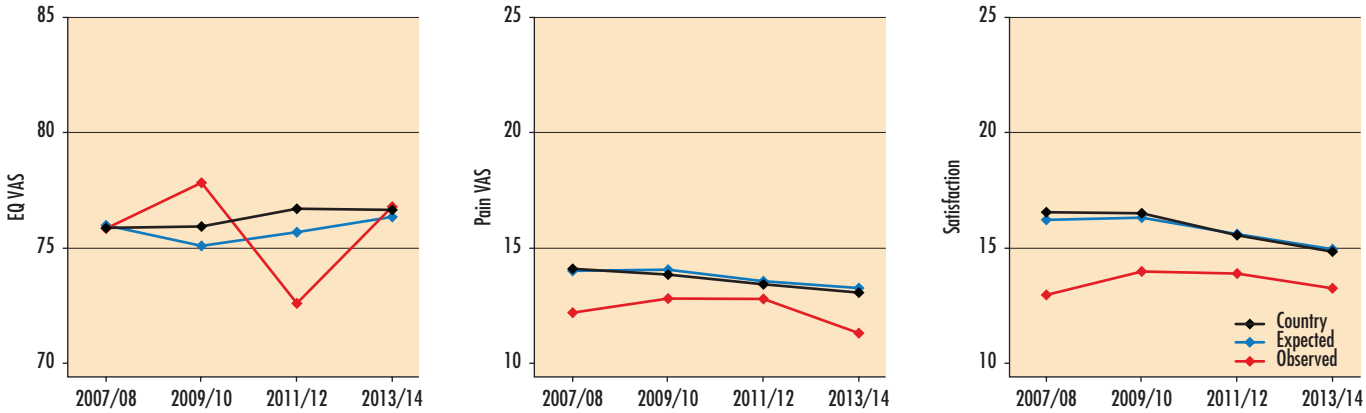

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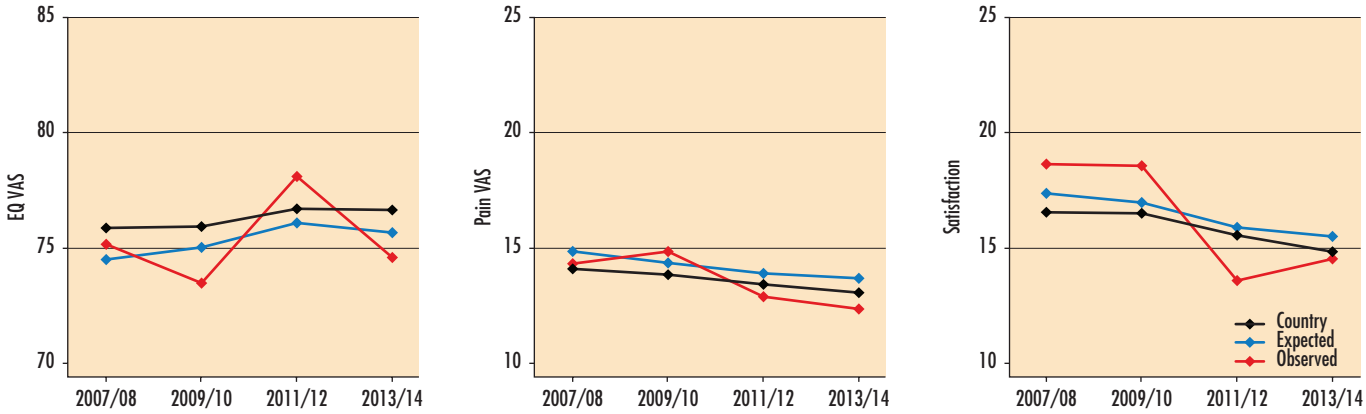

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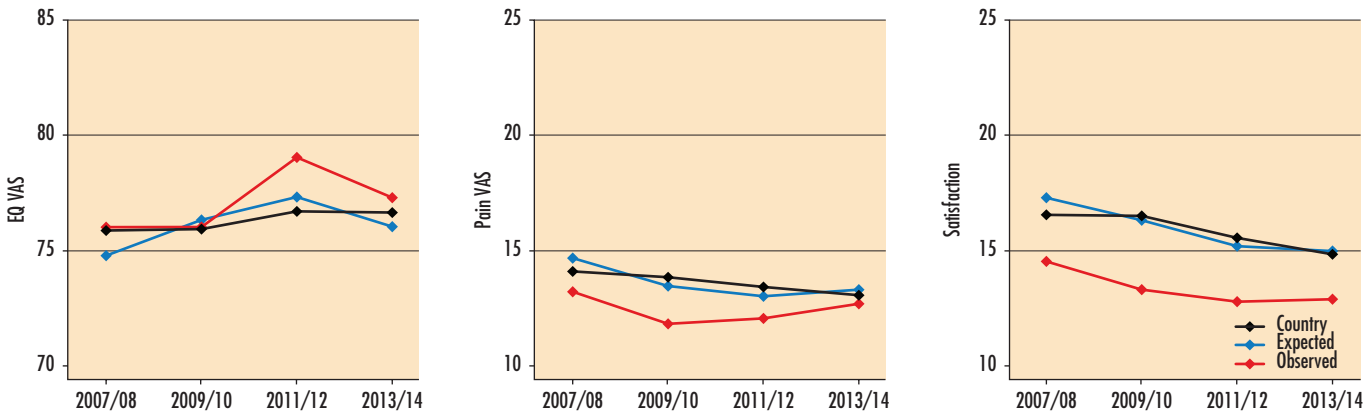


Patient satisfaction 1 year after total hip replacement operation

Primary operation patients 2013–2014

Clinic	Number	Proportion
Aleris Specialistvård Bollnäs	537	89.6%
Aleris Specialistvård Elisabethsjukhuset	46	93.5%
Aleris Specialistvård Motala	901	92.0%
Aleris Specialistvård Nacka	211	91.9%
Aleris Specialistvård Sabbatsberg	153	92.8%
Aleris Specialistvård Ängelholm	83	98.8%
Alingsås	372	80.4%
Arvika	228	82.0%
Borås	211	83.9%
Capio Movement	280	85.7%
Capio Ortopediska Huset	681	86.6%
Capio S:t Göran	650	86.5%
Carlanderska	233	94.8%
Danderyd	452	89.4%
Eksjö	369	89.7%
Enköping	567	86.9%
Eskilstuna	107	85.0%
Falun	617	86.7%
Frölunda Specialistsjukhus	158	84.2%
Gällivare	140	92.9%
Gävle	295	88.5%
Halmstad	375	90.1%
Helsingborg	107	94.4%
Hudiksvall	195	90.3%
Hässleholm-Kristianstad	1,379	93.3%
Jönköping	297	85.2%
Kalmar	240	96.7%
Karlshamn	423	88.9%
Karlskoga	261	89.3%
Karlstad	321	84.4%
Karolinska/Huddinge	408	84.3%
Karolinska/Solna	251	83.3%
Katrineholm	464	87.5%
Kungälv	285	77.9%
Lidköping	440	88.9%
Lindesberg	328	94.5%
Linköping	67	88.1%
Ljungby	251	86.9%
Lycksele	492	91.7%
Mora	320	86.9%
Norrköping	382	86.4%
Norrtälje	198	82.8%
Nyköping	199	84.4%
Ortho Center IFK-kliniken	239	95.4%
Ortho Center Stockholm	764	91.6%
Oskarshamn	480	94.4%
Piteå	676	92.2%
SU/Mölndal	740	86.6%
SUS/Lund	201	90.5%
Skellefteå	195	92.3%
Skene	258	85.3%
Skövde	218	85.3%
Sollefteå	75	86.7%
Sophiahemmet	348	98.9%
Spenshult	85	92.9%
Sundsvall	265	88.3%
Södersjukhuset	368	85.1%
Södertälje	144	82.6%
Torsby	143	87.4%
Trelleborg	1,127	93.8%
Uddevalla	585	85.8%
Umeå	91	90.1%
Uppsala	279	84.9%
Varberg	383	91.4%
Visby	184	84.8%
Värnamo	219	92.2%
Västervik	199	83.9%
Västerås	471	88.7%
Växjö	200	80.5%
Ängelholm	239	90.8%
Örebro	187	92.0%
Örnsköldsvik	227	90.7%
Östersund	467	91.9%
Country	25,066	89.1%

Only clinics with >=40 primary operations are presented, (Art Clinic Jönköping, Karlskrona, SU/Sahlgrenska, SUS/Malmö and Sunderby (including Boden) are excluded).

Physiotherapy, Artrosskola and smoking

In 2012, a question was added to the preoperative PROM questionnaire concerning the contact with a physiotherapist and participation in Artrosskola. The questions sounded as follows: "Have you been to see a physiotherapist for your hip during the period of hip problems?" and "Have you taken part in a so-called Artrosskola (may have been many years before the operation for a shorter period of time) during the period of hip problems?" This year's analysis, including the year 2015, shows striking differences. The proportion of patients who underwent surgery due to osteoarthritis (ICD codes M16.0–M16.9) who had contact with a physiotherapist ranges from 47% (Karolinska/Huddinge) to 89% (Art Clinic Jönköping). The numbers for Artrosskola differ from 10% (SUS/Lund and Eskilstuna) to 63% (Torsby). On the national level, 34% of all osteoarthritis patients stated that they had participated at the Artrosskola. This is an increase of six whole percent in comparison to 2014. 70% indicated that they had contact with a physiotherapist, which is an increase of four percent. From 2012 to 2015, there has been a steady increase in the use of physiotherapy and Artrosskola. Given that the National Board of Health and Welfare's guidelines for treatment of hip and knee osteoarthritis advocates for a prolonged supervised training, information and pain relief as primary treatment strategy (34%) considers it quite bad. However, the institution is young and in many aspects, has not had the time to establish itself to such an extent that all patients can be offered this help.

A preliminary analysis on those who underwent surgery due to osteoarthritis during 2012–2014, shows a weak relationsship between contact with a physiotherapist and Artrosskola and how the patients report pain and quality of life one year after surgery. However, there does not seem to be a relationship between the degree of discomfort before the surgery and the patient-reported outcomes one year after physiotherapy/attending Artrosskola or not.

Smoking and patient-reported outcomes

Smoking is an established risk factor for complications after most surgical interventions. Smoking cessation during six to eight weeks before and after the operation has proved effective in reducing the risk of complications. Effect of smoking on pain, function and patient-reported outcome measures after hip replacement surgery, is not investigated. In 2013, the Swedish Hip Arthroplasty Register introduced a question about smoking into the preoperative routine questionnaire. The question is presented simply and says, "Do you smoke?" with the response options yes and no.

During 2013 and 2014, 22,520 of patients underwent hip arthroplasty due to osteoarthritis. 19,651 (87%) had answered the preoperative questionnaire. Of these, 6.1% stated that they were smokers. There were large differences in the proportion of smokers between clinics (0.5 to 24%).

Regression analyses, which were adjusted for age, sex, Charnley class and preoperative PROM values, showed that smoking was clearly associated with poorer health-related quality of life, measured by the EQ-5D index and EQ VAS, and more pain and lower degree of satisfaction one year after surgery. The risk of reoperation due to infection within three years was significantly higher for smokers (risk ratio = 1.83 with a 95 % confidence interval 1.1–3.0).

The table refers to those who had surgery in 2015. For the whole country, the proportion of smokers among osteoarthritis patients has increased to 5%. At a number of clinics, there were no patients who had stated that they were smoking, but it is noteworthy, that six hospitals had more than 10–20% of patients, who said they smoke.

Therefore, smoking is not only a risk factor for reoperation due to infection, but also a risk factor for poorer patient-reported outcomes. The results suggest that smoking should be one of the many factors considered when assessing a patient's individual capacity to take advantage of a possible hip replacement surgery. However, it remains to be seen whether the pre- and postoperative smoking cessation may improve patient-reported outcomes.

Questionnaire in regards to smoking, physiotherapy and Artrosskola before hip arthroplasty

Clinic	Number (diagnosis M16.0–M16.9)	Number of respondents	Proportion of smokers (%)	Proportion of physiotherapy (%)	Proportion of Artrosskola (%)	Response frequency (%)
Aleris Specialistvård Bollnäs	301	264	3	66	31	88
Aleris Specialistvård Motala	559	486	4	67	47	87
Aleris Specialistvård Nacka	218	183	3	83	23	84
Aleris Specialistvård Sabbatsberg	24	23	4	61	30	96
Aleris Specialistvård Ängelholm	129	102	4	75	35	79
Alingsås	184	152	3	70	43	83
Art Clinic Jönköping	20	19	5	89	16	95
Arvika	186	166	6	75	57	89
Borås	104	91	10	68	21	88
Capio Movement	299	269	10	77	37	90
Capio Ortopediska Huset	469	447	8	72	30	95
Capio S:t Göran	455	329	9	61	22	72
Carlanderska	145	141	6	73	23	97
Danderyd	257	220	5	71	31	86
Eksjö	216	202	2	64	25	94
Enköping	340	189	5	68	31	56
Eskilstuna	47	42	7	57	10	89
Falun	226	188	7	54	31	83
Frölunda Specialistsjukhus	82	81	9	78	23	99
Gällivare	73	48	0	73	42	66
Gävle	136	112	4	71	36	82
Halmstad	188	154	6	61	21	82
Helsingborg	143	130	3	58	20	91
Hermelinen Spec.vård	10	7	0	71	14	70
Hudiksvall	90	82	2	71	27	91
Hässleholm-Kristianstad	720	711	6	68	24	99
Jönköping	130	123	0	66	31	95
Kalmar	142	139	1	72	51	98
Karlshamn	247	235	6	69	47	95
Karlskoga	171	141	3	79	39	82
Karlstad	145	129	5	81	56	89
Karolinska/Huddinge	163	133	8	47	13	82
Karolinska/Solna	109	89	8	70	17	82
Katrineholm	219	218	3	66	19	100
Kungälv	165	158	5	78	41	96
Lidköping	261	223	5	70	37	85

(Continued on next page.)

Questionnaire in regards to smoking, physiotherapy and Artrosskola before hip arthroplasty (cont.)

Clinic	Number (diagnosis M16.0–M16.9)	Number of respondents	Proportion of smokers (%)	Proportion of physiotherapy (%)	Proportion of Artrosskola (%)	Response frequency (%)
Lindesberg	191	189	8	77	35	99
Linköping	48	8	0	75	50	17
Ljungby	126	125	5	59	16	99
Lycksele	330	264	0	77	57	80
Mora	220	176	5	66	30	80
Norrköping	175	161	8	66	53	92
Norrtälje	109	104	4	67	34	95
Nyköping	89	59	10	68	41	66
Ortho Center IFK-kliniken	126	125	4	86	22	99
Ortho Center Stockholm	488	463	5	78	36	95
Oskarshamn	282	264	3	74	45	94
Piteå	322	175	6	70	21	54
Skellefteå	100	96	2	63	49	96
Skene	125	94	2	66	29	75
Skövde	129	37	3	57	27	29
Sophiahemmet	220	190	5	73	16	86
SU/Mölndal	431	298	2	68	30	69
Sundsvall	46	31	0	71	32	67
SUS/Lund	76	49	8	53	10	64
Södersjukhuset	273	234	8	68	23	86
Södertälje	107	97	16	78	52	91
Torsby	103	99	13	77	63	96
Trelleborg	611	580	9	68	29	95
Uddevalla	322	241	5	78	56	75
Umeå	42	30	0	73	27	71
Uppsala	136	117	9	76	21	86
Varberg	161	148	1	78	30	92
Visby	106	88	1	59	31	83
Värnamo	126	122	3	51	12	97
Västervik	88	73	5	64	37	83
Västerås	229	192	7	76	55	84
Växjö	116	107	4	68	25	92
Örebro	42	41	20	76	17	98
Örnsköldsvik	189	173	0	74	34	92
Östersund	213	200	1	75	63	94
Country total	14,022	11,878	5	70	34	85

The standard patient

Reoperation within 2 years is one of the quality indicators of the Swedish Hip Arthroplasty Register that is used for continual work towards improvement. The risk of suffering from an early reoperation is influenced by several factors. For example, sex, age, diagnosis, comorbidity and social situation interact in more or less complex ways that are difficult to predict. The situation is complicated by the fact that only certain factors are included in the register's data capture. In order to implement a periodic risk analysis, at least on an annual basis, it is required that the analysis of the variables also recorded continuously over time. Extended collection of variables such as comorbidity and medication intake from other registries would improve risk analysis, but at the same time, would also cause a delay in the current situation, since it is not compatible with an update on an annual basis.

A risk analysis has often a high degree of complexity and may methodologically need to be varied depending on the issue, the variables' content and diversity and data's composition. For the layman, and not least for the majority of our patients, interpretation of data could easily be problem. The same applies when comparing results between different surgical units. For the professionals, it is obvious that the probability of failure is higher for units that operate on the sickest patients, which can be easily overlooked if the results are presented without relevant background data.

To facilitate comparisons and reduce the need for interpretation for the public, four years ago, we created the so-called "standard patient". The idea was that in light of the variables that affect the outcome "Reoperation within 2 years" to define thresholds, such as the age groups that represent a low risk. Such a definition involves compromises, because the line between "safe" and "unsafe" interval always becomes unclear. For the individual patient, it is important to know that even if you belong to a low-risk group, complications can occur. When this happens, it is a small consolation to know, that the risk of what actually occurred, was low.

The construction of "the standard patient" is based on the emergence of BMI and ASA class variables, which were first recorded in 2008. Already in our first analysis, we left open the possibility that the definition of the "standard patient" may need to be adjusted in the future, as the patient population, which constituted the basis of assessment, may have increased. The upper age limit was changed from 80 to 85 years at an early stage. Subsequently, no changes have been made.

In this year's report, we have updated the analysis of standard patient. One difference from previous analyses is that each patient is only included with the hip joint which was operated first during the period 2008 to 2015. The hip surgeries where the patient undergoes surgery for the second time in the given period are therefore excluded. The background for the choice of time period is mentioned above explaining that the information on weight, height and ASA class was first recorded in 2008. In this year's report, for the period 2013 onwards, we have also made a preliminary assessment of the significance of smoking in relation to reoperation within two years after primary surgery.

During the period from 2008 to 2015, 127,642 hip arthroplasties were carried out. 14,850 have been excluded because they constituted the other hip joint which underwent surgery on the same patient during the same period (Table 1). In the unadjusted analysis, we find that in addition to a 40% increase in risk for men, there is also an increased risk during all types of secondary osteoarthritis in addition to the group with sequelae after a hip disease during childhood. However, we have chosen to exclude this group because the risk of reoperation in these patients tends to increase after two years (Figure 1). Additionally, this group differs from patients with primary osteoarthritis because of a different demography and degree of surgical complexity. Therefore, in the first step, all patients with secondary osteoarthritis are excluded from the concept of "the average patient".

Further studies of patients with primary osteoarthritis indicate that males now have a risk increase of about 50%. Age over 74 years, is also a risk factor. The age group 75–84 years is, however, the second largest group, which together with a low level of significance for this group, led to including these patients in the group "the average patient." Patients under age 55 do not differ during the first years, but after two years, they differ clearly, and therefore, are not seen as part of the group (refer to Annual Report 2014). ASA class II and III, and higher carries an increased risk. The compromise has meant including the ASA class II, with the lowest risk increase, so that the group of standard patients will not become too small and thus lose its representativeness. The same applies to patients classified as overweight (BMI 25–29.9), and they have a small increase in risk compared with normal weight patients. To illustrate how severely obesity affects the outcome, in this year's report, we have divided the group with BMI 30 or higher into two groups (30 to 34.9; 35 and over, Table 2 and 3, Figure 2). Underweight patients (BMI <18.5) have seemingly no increased risk of reoperation within two years. However, we have decided to indefinitely exclude these patients from "the average patient" group until there is a greater number of observations.

In the unadjusted analysis (Table 2), the risk is slightly higher for patients with multiple disabilities (Charnley class C), but the significance for this increased risk disappears when considering the correlation between the variables. "The standard patient" can thus belong to whichever Charnley class.

Since 2013, the preoperative PROM questionnaire has included questions about Artrosskola and smoking. Separate analysis of this patient group shows, that smoking increases the risk of reoperation in all analyses. The risk factor for smoking seems to have an even greater impact in the analysis of "the standard patient". This may partly depend on the fact, that the number of patients included in this analysis, is relatively small, which means increased uncertainty regarding the outcome, and that a number of risk groups have been excluded from this analysis.

Patients who fall within the category of "the average patient", are most commonly treated in private hospitals, followed by county hospitals. University/regional hospitals have the lowest proportion (Figure 3).

"The standard patient" is defined as a woman or man aged 55–84.9 years with an ASA class I or II and with a BMI between 18.5 and 29.9. During 2015, this patient group was most common in private hospitals (58.2%) and most uncommon in university/regional hospitals (22.0%).

Scope of bilaterality, sex and diagnosis for reoperation risk within two years

Variable, *reoperation outcome in 2 years*	*n*	RR	95% KI	*p-value*
All operations 2008–2015	**127,642**			
Bilaterality *in the period*				
First side	112,792	1	1	
Other side	14,850	**0.9**	0.8–1.03	*0.91*
Only initially operated side				
Sex				
Women	65,294	1	1	
Men	47,498	**1.4**	1.3–1.5	*<0.0005*
Diagnosis				
Primary osteoarthritis	92,533	1	1	
Hip fracture, acute, sequelae	12,161	**2.4**	2.2–2.7	*<0.0005*
Inflammatory joint disease	1,488	1.5	1.1–2.1	*0.005*
Sequelae after childhood disease	2,158	1.05	0.8–1.4	*0.77*
Femoral head nectosis	3,571	**2.1**	1.8–2.5	*<0.005*
Other	881	**3.8**	2.9–5.1	*<0.0005*
Diagnosis, *simplified compromise*				
Primary osteoarthritis	92,553	1	1	
Secundary arthritis	20,259	**2.2**	2.02–2.4	*<0.0005*

Table 1. Scope of bilaterality, sex and diagnosis for suffering a from reoperation within two years based on unadjusted risk ratio (Cox regression). In the analysis of sex and diagnosis, only the first operated side is included.

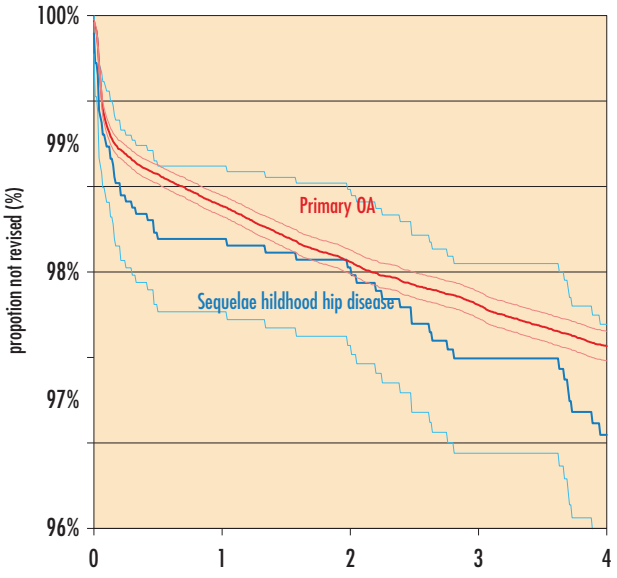


Figure 1. Survival chart based on the risk for reoperation within four years for patients with sequelae after childhood disease and patients with primary arthrosis 2008–2015 (first operated hip).

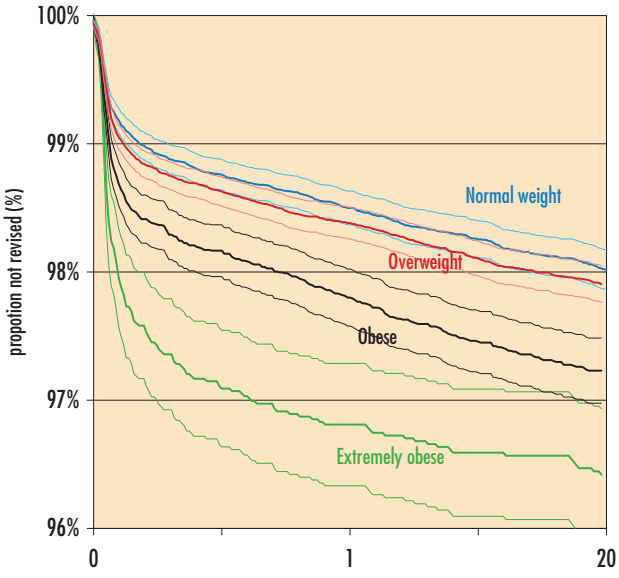


Figure 2. Survival chart based on the risk for reoperation in relation to BMI. Underweight patients (BMI <18,5) have been excluded because of few observations. (BMI 18,5–24,9=normal weight, 25–29,9=overweight, 30–34,9=obese, 35 and over=extremely obese).

Factors which influence the risk for reoperation within two years

Primary osteoarthritis – unadjusted data

Variable, *reoperation outcome in 2 years*	*n*	RR	95% KI	*p-value*
Primary osteoarthritis, *first side*	**92,553**			
Sex				
Women	51,989	1		
Men	40,544	**1.5**	1.3–1.6	*<0.0005*
Age				
<55 years	8,558	1.2	0.99–1.4	*0.06*
55–64 years	21,393	1.1	0.9–1.2	*0.40*
65–74 years	35,102	1	1	
75–84 years	23,531	**1.2**	1.08–1.4	*0.001*
85– years	3,949	**1.6**	1.3–2.0	*<0.0005*
ASA class				
I	22,316	1	1	
II	52,906	**1.4**	1.3–1.7	*<0.0005*
III–V	14,077	**2.3**	1.9–2.6	*<0.0005*
Missing	3,234			
BMI				
<18.5	648	0.9	0.5–1.9	*0.9*
18.5–24.9	27,773	1	1	
25–29.9	37,994	**1.2**	1.1–1.4	*0.001*
30–34.9	16,288	**1.8**	1.6–2.1	*<0.0005*
≥35	4,997	**2.4**	2.0–2.8	*<0.0005*
Missing	4,833			
Charnley class				
Hip disease, one side (A)	38,189	1	1	
Hip disease, both sides (B)	10,190	1.0	0.9–1.2	*0.8*
Multiple disabilities (C)	32,243	1.1	1.03–1.3	*0.02*
Missing	11,911			
Smoking (data from 2012)				
Does not smoke	27,533	1	1	
Smokes	1,729	1.6	1.1–2.2	*0.006*
Missing	4,525			

Table 2. Evaluation of the unadjusted risk ratio (RR) as basis for the definition of "the standard patient". Data is based on the first hip surgery during the period 2008–2015.

Factors which influence the risk for reoperation within two years

Primary osteoarthritis – adjusted data

Variable, *reoperation outcome in 2 year*	*n*	RR	95% KI	*p-value*
Primary osteoarthritis, *first side*	**76,638**			
Sex				
Women	42,868	1		
Men	33,770	**1.5**	1.4–1.7	
Age				
<55 years	7,099	1.1	0.9–1.4	*0.18*
55–64 years	17,963	1.1	1.0–1.3	*0.20*
65–74 years	29,498	1	1	
75–84 years	19,089	**1.2**	1.03–1.4	*0.02*
85– years	2,989	**2.0**	1.3–2.1	*<0.0005*
ASA class				
I	19,186	1	1	
II	45,264	**1.4**	1.2–1.6	*<0.0005*
III–V	12,188	**2.0**	1.6–2.4	*<0.0005*
BMI				
<18.5	516	1.1	0.5–2.2	*0.9*
18.5–24.9	24,078	1	1	
25–29.9	33,373	**1.2**	0.99–1.3	*0.05*
30–34.9	14,328	**1.7**	1.5–2.0	*<0.0005*
≥35	4,343	**2.0**	1.6–2.5	*<0.0005*
Charnley class				
Hip disease, one side (A)	36,337	1	1	
Hip disease, both sides (B)	9,707	1.1	0.9–1.3	*0.4*
Multiple disabilities (C)	30,594	1.1	0.96–1.2	*0.17*
Smoking*				
Does not smoke	26,815	1	1	
Smokes	1,672	**1.7**	1.2–2.4	*0.02*

** less detailed data, which to some extent, affect the risk ratio for each variable. This data is not shown.*

Table 3. Evaluation of the unadjusted risk ratio (RR) as basis for the definition of "the standard patient". Data is based on the first hip surgery during the period 2008–2015. The number of observations will be smaller than in Table 2 because of lack of data for some variables. In the analysis of smoking, the number of observations is limited even further. This correlation and the effect of covariance, affect the result of the analysis where smoking is included, so that the risk ratio for the ASA class II and the age of 85 will be lower and no longer significant (data not shown).

Risk factors which are included in the definition of the standard patient and the scope of smoking

Variable, *reoperation outcome in 2 years*	*n*	RR	95% KI	*p-value*
"The standard patient"	**49,073**			
Sex				
Women	28,050	1	1	
Men	21,023	**1.5**	1.3–1.7	*<0.0005*
Age				
55–64 years	13,559	1.0	**0.8–1.2**	*0.9*
65–74 years	21,813	1	1	
75–84 years	13,701	1.2	1.0–1.4	*0.05*
ASA class				
I	14,663	1	1	
II	34,410	**1.3**	1.1–1.6	*0.002*
BMI				
18.5–24.9	20,670	1	1	
25–29.9	28,403	1.2	1.04–1.4	*0.02*
The standard patient	49,073	1	1	
Other patients	63,719	**2.1**	1.9–2.3	*<0.0005*
Smoking*				
Does not smoke	15,444	1	1	
Smokes	938	**1.9**	1.2–3.0	*0.01*

** less detailed data, which to some extent, affect the risk ratio for each variable (sex, age, ASA class, BMI). This data is not shown.*

Table 4. Evaluation of the unadjusted risk ratio (RR) based only on surgeries on "the standard patient". Data is based on first operated hip during 2008–2015. In the analysis of smoking, the number of observations is limited because this information was first registered in 2013. This correlation and the effect of covariance, affect the result of the analysis in the same manner as in Table 3, so that the risk ration for ASA class II no longer has a significance (data not shown).

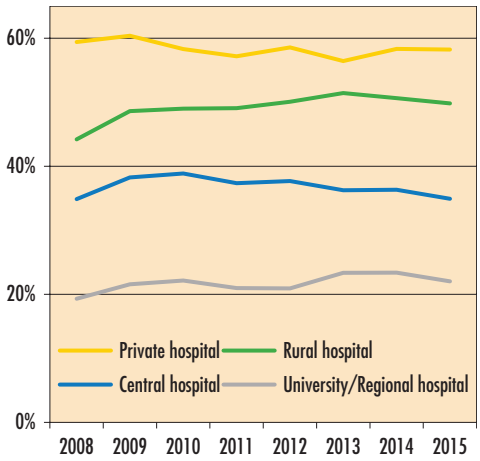


Figure 3. Proportion of patients defined as "standard" before hip arthroplasty for different types of hospitals.

Mortality after total hip replacement

Hip arthroplasty is a major surgery that can pose risks to the patient. The procedure is also seen as routine surgery and sometimes, the focus is placed on high production and short length of stay. Keeping in mind that those who are undergoing elective total hip replacement surgery, have an increased risk of death during the first month compared to non-operated peers, is very important.

90-day mortality is an open variable on a unit level. The Swedish Hip Arthroplasty Register updates its database several times a year with respect to the input of dates of death via the Swedish tax authorities.

The indications for arthroplasty have been expanded even further. Both young and old, are operated now earlier than before. The latter group runs a particularly greater natural risk of serious complications while the younger group tends to have a higher comorbidity. Nowadays, and mainly at larger units, more high-risk patients undergo operation than previously.

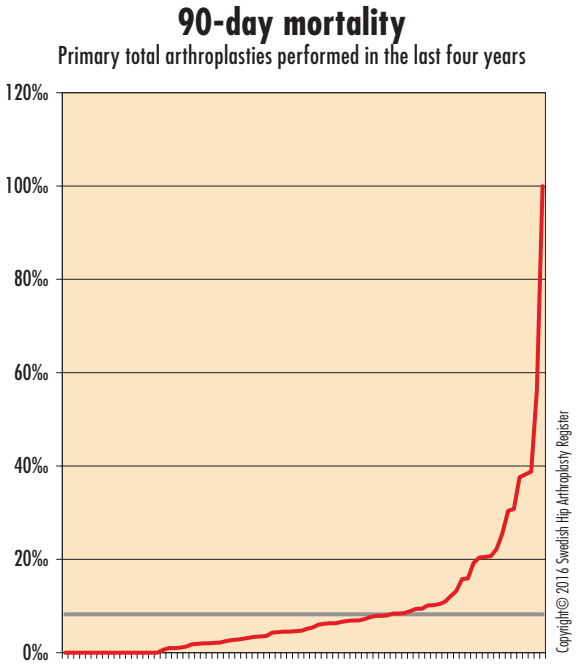
Short-term mortality (90-day mortality)

90-day mortality is an indicator, which is often used in the literature of many medical fields. The causes for a patient's death in connection with or within 90 days from a hip arthroplasty (and related to the intervention) can be many, but the dominant causes seem to be cardiac, cerebrovascular or thromboembolic illnesses.

The mortality is low – note that the results given in thousandths. Therefore, the last four years' production will be analysed to partially compensate for the risk of chance variability.

90-day mortality is higher after surgery at a university/regional hospital and county hospitals compared to sub-county hospitals and especially compared to private care units. The differences reflect the different compositions of groups of patients who undergo surgery at each hospital. 90-day mortality varies between Swedish hospitals during the years of observation 2012–2015 from 0 to 100‰. Average value for the country is 7.6‰.

An analysis of mortality and its causes is included in the patient safety work. Inherent problem may be that there is no feedback from other clinics and hospitals about newly operated patients dying there.



The grey line shows the national average value of 7.6‰.

Each line in the baseline corresponds to a unit.

From in-depth analyses, which are based on register data and concern mortality after total arthroplasty, we see that both preoperative comorbidity and socio-economic background influence mortality. It does not have a clinical relevance, if the prosthesis is cemented or not. Those with an entirely cemented arthroplasty have a slightly increased mortality during the first two weeks, but thereafter, they have lower mortality than the non-operated control group (also referred to as relative survival). Today's patient selection for simultaneous bilateral hip arthroplasty, there is no relevant difference in 90-day mortality.

The figures for mortality are generally low and must be assessed with the same exactitude as the variable "reoperation within 2 years" – is a trend evident over time?

90-day mortality

proportion of deceased within three months after primary surgery (per thousand)**, 2012–2015**

Clinic	Number[1)]	OA[2)]	≥60[3)]	Women[)]	Mortality[5)]
University/Regional hospitals					
Karolinska/Huddinge	998	66	69	51	8.0‰
Karolinska/Solna	759	54	68	61	13.2‰
Linköping	261	62	62	52	19.2‰
SU/Mölndal	2,079	67	78	62	6.3‰
SU/Sahlgrenska	20	5	80	53	100‰
SUS/Lund	718	35	80	62	37.6‰
SUS/Malmö	157	10	94	67	25.5‰
Umeå	329	48	80	58	30.4‰
Uppsala	1,023	52	69	58	20.5‰
Örebro	448	64	74	60	8.9‰
Central hospitals					
Borås	675	63	90	60	20.7‰
Danderyd	1,307	71	86	61	6.9‰
Eksjö	858	91	84	54	4.7‰
Eskilstuna	471	47	87	61	38.2‰
Falun	1,329	89	82	57	3.0‰
Gävle	930	58	84	59	20.4‰
Halmstad	958	80	84	58	10.4‰
Helsingborg	436	64	90	58	4.6‰
Hässleholm-Kristianstad	3,106	87	85	54	4.5‰
Jönköping	731	79	83	61	6.8‰
Kalmar	602	79	84	53	6.6‰
Karlskrona	126	12	99	64	15.9‰
Karlstad	954	62	82	60	8.4‰
Norrköping	993	71	80	54	22.2‰
NÄL	2	50	100	100	0‰
Skövde	702	80	82	58	8.5‰
Sunderby (inklusive Boden)	142	11	89	55	56.3‰
Sundsvall	634	78	84	57	7.9‰
Södersjukhuset	1,656	68	84	60	10.9‰
Uddevalla	1,495	81	84	59	9.4‰
Varberg	881	86	89	60	4.5‰
Västerås	1,802	63	88	61	38.8‰
Växjö	578	77	84	58	12.1‰
Ystad	9	0	89	100	0‰
Östersund	1,137	77	84	57	7.9‰

(Continued on next page.)

90-day mortality (cont.)

proportion of deceased within three months after primary surgery (per thousand)**, 2012–2015**

Clinic	Number[1)]	OA[2)]	≥60[3)]	Women[)]	Mortality[5)]
Rural hospitals					
Alingsås	836	94	85	58	3.6‰
Arvika	740	96	87	58	5.4‰
Bollnäs	90	97	79	58	0‰
Enköping	1,336	98	91	57	2.2‰
Frölunda Specialistsjukhus	345	99	83	64	0‰
Gällivare	392	76	83	51	5.1‰
Hudiksvall	532	68	88	59	9.4‰
Karlshamn	946	93	85	57	3.2‰
Karlskoga	687	91	87	58	10.2‰
Katrineholm	931	99	85	58	1.1‰
Kungälv	690	88	87	61	4.3‰
Lidköping	995	92	88	53	1.0‰
Lindesberg	857	91	86	57	3.5‰
Ljungby	650	84	85	56	6.2‰
Lycksele	1,202	97	82	60	2.5‰
Mora	870	90	86	56	3.4‰
Norrtälje	478	79	90	62	8.4‰
Nyköping	617	66	89	62	30.8‰
Oskarshamn	1,012	96	82	59	1.0‰
Piteå	1,422	97	81	57	2.1‰
Skellefteå	479	78	82	62	6.3‰
Skene	516	93	80	56	0‰
Sollefteå	497	88	89	59	10.1‰
Södertälje	417	86	87	61	7.2‰
Torsby	444	86	88	55	15.8‰
Trelleborg	2,528	91	78	59	2.0‰
Visby	503	83	86	61	6.0‰
Värnamo	551	91	86	57	1.8‰
Västervik	436	89	87	54	6.9‰
Ängelholm	436	98	86	64	0‰
Örnsköldsvik	620	91	85	63	0‰

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90-day mortality (cont.)

proportion of deceased within three months after primary surgery (per thousand)**, 2012–2015**

Clinic	Number[1)]	OA[2)]	≥60[3)]	Women[4)]	Mortality[5)]
Private hospitals					
Aleris Specialistvård Bollnäs	1,127	96	80	54	2.7‰
Aleris Specialistvård Elisabethsjukhuset	113	92	81	52	0‰
Aleris Specialistvård Motala	2,029	96	86	55	2.0‰
Aleris Specialistvård Nacka	583	99	77	60	0‰
Aleris Specialistvård Sabbatsberg	500	94	79	63	0‰
Aleris Specialistvård Ängelholm	227	98	84	55	4.4‰
Art Clinic Göteborg	25	100	84	57	0‰
Art Clinic Jönköping	50	98	66	52	0‰
Capio Movement	836	98	76	54	0‰
Capio Ortopediska Huset	1,550	98	73	58	1.3‰
Capio S:t Göran	1,808	88	83	64	2.8‰
Carlanderska	535	97	65	43	1.9‰
Hermelinen Spec.vård	27	81	33	28	0‰
Ortho Center IFK-kliniken	519	96	54	40	0‰
Ortho Center Stockholm	1,768	97	80	61	0.6‰
Sophiahemmet	837	100	56	39	0‰
Spenshult	654	90	78	58	0‰
Country	65,549	83	82	58	7.6‰

1) *Refers to the number of primary operations during the period.*
2) *Refers to proportion of primary operations carried out for primary osteoarthritis.*
3) *Refers to proportion of primary operations in age group 60 years or older (age during primary operation).*
4) *Refers to proportion of women receiving primary surgery during the period.*
5) *90-day mortality (number of patients dying within three months of primary operation / number of primary operations during period).*

For variables 2) 3) and 4) higher values indicate a low risk of serious complication (death).

Red marking indicates values, which lie by one standard deviation above the national average.

Notes

Fracture treatment with total or hemiarthroplasty

This chapter includes total and hemi-arthroplasties performed due to acute fractures, and sequelae after previous hip fracture. 5,930 operations were registered in 2015. Since 2008, the annual number has stayed around this level. Even in terms of age groups, we see a fixed image; those between ages 75 and 85 and over 85, constitute two equal groups (2426 and 2332), while 1172 are younger than 75 years (Figure page 153). In the last two years, 37% of patients have had some degree of dementia, compared with 28% in 2005, the year when hemiarthroplasties were also included in the Register, and a special focus on fracture patients was initiated.

Implant selection and technique

Among both total arthroplasties, 1,800 during the last year, and bipolar hemiarthroplasties, 1,150 during the same period, there is a slight increase. Unipolar hemiarthroplasties, 2,980, have decreased somewhat (Figure page 153). The distribution of the surgical incision seems to have stabilized at three-quarters for direct lateral incision and a quarter for posterior incision (4338 and 1580) (Figure page 153).

The Swedish orthopaedic surgeons are considered to be conservative in their choice of implants, which, in this context, is often beneficial. There have not been any dramatic changes; cemented Lubinus and Exeter stems are clearly the most common, followed by Covision and MS30. Further, we see that uncemented stems are used sparingly, around 3%, with the Corail being the most common cementless stem (table on page 154). This year, for the first time, we present prosthesis survival data for the most common stem types among fracture patients. This data has been presented for the elective hip replacement operations for a long time. The most popular cemented stems all have approximately the same five-year survival rate, around 94 95% (Figure page 161). Among the uncemented stems, collared Corail is on the same level, while collarless Corail has poorer results, 91%. The most common complication for the uncemented stem is periprosthetic fracture, which can be treated with another operation, rather than replacing the prosthesis, and one should take this into account when interpreting the graphs. Of course, all the stems' results should be interpreted with caution, because of varying levels of revision reporting, different treatment strategies in case of complications, and other factors can produce a distorted picture of the actual clinical outcome.

With the stem, a cup is used during total arthroplasties, or a larger head during hemiarthroplasties. This distribution is also substantially unchanged. Unipolar prosthesis heads, UHR Universal Head and Unitrax, are most commonly used hemiarthroplasties. As acetabulum cup during total arthroplasty, both of the Lubinus cups are most commonly used (table page 154). A cup type, which has seen a slight increase in usage, are the so-called dual mobility cups (DMC), where a total of 309 were used in 2015, compared with 294 and 271 during previous years. The most common model is Avantage cup (214 in 2015) followed by Polarcup (82), both are cemented. There are now 1352 DMC in the Register. DMC is widely used among fracture patients in some countries, with preference for the posterior incision, after the scientific studies showed that DMC can reduce the higher dislocation rate associated with the posterior incision. However, the Swedish DMCs are inserted with direct lateral incision as often as with posterior incision.

The most commonly used stem types give a relatively accurate and equivalent result, as measured by the implant survival rate. We should be aware that the reality for the patient may be different - all complications will not result in revision surgery.

Reoperation and revision

3,010 reoperations have been reported to the Register since 2005, corresponding to reoperation frequency of 4.8%. 2,266 of these hips underwent a revision (replacement of at least one prosthesis part). Table on page 155 lists the proportion of reoperations in six months at a participating unit as a quality indicator. For the country, the proportion is 3.0%. A majority of reoperations occur in an early stage. Since 2005, the figures have varied between 2.7 and 3.9%. This is an important quality indicator, but the report must be read with reservation. Due to different reasons, there may also be unreported cases: The clinics can be more or less offensive in terms of secondary surgery. Due to medical reasons or because of patient's refusal, the surgeon may hesitate to suggest reoperation. Local treatment traditions also have an effect, in case of suspected infection, for example, operation is carried out acutely and infected tissue is cleaned, so that in combination with the right antibiotics, one tries to heal the infection and preserve the primary prosthesis. How aggressive this infection examination and treatment is, varies between the clinics in the country, and may partially explain the variation in the reoperation rate.

However, a high frequency of reoperation should always prompt a local analysis and improvement work.

As usual, any reoperation is imputed to the hospital that performed the primary procedure, regardless where the reoperation was actually carried out.

A survival analysis shows that younger age groups have increased risk for reoperation of hip replacement compared to those over 85 years (Figure, page 160). Even those who receive a prosthesis after failure of internal fixation (secondary prosthesis), have an increased risk (Figure, page 160). The same type of analysis for the incision is more difficult to

interpret. The first five years show the posterior incision increased reoperation risk, but then the difference is no longer significant (Figure, page 160). A comparison between the prosthesis types becomes even more complicated (Figure page 160). During the first two years, bipolar hemi-arthroplasty has presented a higher revision risk, while after that, there is no difference when compared to unipolar hemi-arthroplasty or total hip arthroplasty. The patient's general condition during the primary operation affects the choice of implant. A healthier, younger individual often receives a total prosthesis; with a longer period of continued active life, the risk of certain complications increases, and the physician is more likely to propose revision operation in case of any complications for a healthy individual. Conversely, the oldest and sickest usually receive a hemiarthroplasty; they move little, "spare" their prosthesis and can be dissuaded from further surgery due to health reasons in case of complications. This selection bias affects the results and may explain the tendency of increasing the number of revisions which are performed for total hip arthroplasty after eight years. The difference between the patient groups is also described in the table on page 159. By the end of the follow-up period, 60–70% of those with a hemi prosthesis, has been deceased, compared with about 30% among the group for total hip arthroplasty.

The Register has previously highlighted the increased reoperation risk for the bipolar heads. This seems to apply only the first two years. If it takes into account the protective effect regarding acetabulum erosion (see below), the bipolar prosthesis seems as a good option for individuals who are expected to live many years after their fracture. In some analyses (see below), total arthroplasty provides a reduced risk for reoperation. If the clinical studies are taken into account, the total arthroplasty is a better alternative for the younger, healthier and more active fracture patients. However, the intervention is technically more demanding than the hemiarthroplasty, and the availability of skilled arthroplasty surgeons on the trauma call list may be decisive when selecting a prosthesis type.

Risk factors for reoperation and specific complications

The Register data is often analysed with Cox regression, where potential risk factors, which include gender, age, diagnosis, type of prosthesis, incision and stem, are weighed against each other. We can also adjust for the ASA class, BMI and dementia. Since this latter data is not available for all patients, the number of observations decreases. To gain a more accurate picture, it is essential to include more patient-specific factors. Nevertheless, there are unknown factors that affect the results, and the analysis therefore has its limitations. Generally, in the total patient population, male gender, young age, secondary prosthesis, uncemented stem and posterior incision increase the risk of reoperation. Total arthroplasty is associated with lower reoperation risk than hemiarthroplasty types. The age groups are analysed separately with adjustment for ASA class and the result for the two younger groups are changed. For individuals under 75 years of age, uncemented stem is generally no longer associated with reoperation. For those between 75 and 85 years, the incision loses its importance in this regard.

Infection

Infection is the main cause of secondary open surgery again and constitutes 33% of reoperations (table, page 159). Infection is more common in fracture patients than in those who undergo surgery for osteoarthritis, among others, due to worse nutritional status and more severe comorbidity in the fracture group.

In a Cox regression analysis, secondary prosthesis, male gender, younger age and morbidity (high ASA class) increase the risk for infection-related reoperation. Even patients undergoing hemi-arthroplasty have a slightly higher risk of infection, probably the patient factors play a more important role here than the prosthesis itself. Aged and sicker individuals are more prone to infection and usually receive a hemiarthroplasty. When BMI is applied to the analysis, age loses its significance and we see that being overweight increases the risk.

Dislocation

The analyses include open surgery only because closed repositioning of dislocation is not registered, the dislocations constitute 32% of reoperations. We suspect a relatively large number of unrecorded procedures regarding the "true" number of dislocation in the fracture group. First and secondary dislocations are usually treated without surgery, and therefore, remain unknown to the register. If dislocation occurs again, a reoperation in regard to healthy individuals may be considered, but even here, it may be assumed that sick individuals are offered a reoperation less often. Individuals with hip fracture run the increased risk of dislocating their hip prostheses in comparison with the osteoarthritis group. It is believed that it depends on a free range of motion before the fracture (in contrast to osteoarthritis patients who become stiffer during the development of osteoarthritis) and that many patients with fracture cannot remain cautious during rehabilitation, due to dementia or abuse. It is important to reduce the risk of dislocation. One method, which is based on both clinical studies and register data, is to use a direct lateral incision instead of a posterior incision, which the Swedish orthopaedic surgeons have embraced (Figure page 142).

In a Cox regression analysis, regarding dislocation-related reoperation, the posterior incision increases the risk for reoperation 1.7 times (confidence interval 1.4–2.0). Also, secondary prosthesis and high ASA class are risk factors. Adding BMI does not affect this result.

Dual mobility cups, which are mentioned above, have increased somewhat in numbers. However, there are so few of them in use that it is too early to comment about their pros and cons in the Swedish Register's materials. In our traditional regression analyses, we see no difference between DMC and

other total arthroplasties, whether in case of reoperations in general or due to dislocation. Without evaluating the clinical and statistical significance, it was noted that the incidence of reoperation due to dislocation with a posterior incision is 1.0% for DMC, and other total prostheses 1.5%. Via direct lateral incision, the proportion is the same for DMC and other total prostheses (0.6%). The analysis covers operations from 2012 to 2015. These completely "raw" numbers are affected by a variety of factors. The Register invites the clinics which use dual-mobility cups to make a clinical evaluation, where it is possible to adjust for patient selection and other confounders. Especially interesting is the question of whether DMC provides added value by inserting it via lateral incision.

Periprosthetic fracture

Periprosthetic fracture has increased in proportion and constitutes 23% of reoperations in 2015, in comparison with 17% in 2013. The increase can be explained by a validation work which has recorded non-reported reoperations for this reason. It is important that periprosthetic fractures treated with internal fixation only (without implant revision) are reported as well, so we could carry out accurate analyses.

Fracture patients have two main causes for increased risk of periprosthetic fracture, in comparison to osteoarthritis patients, namely, osteoporosis and increased risk of falling. The choice of prosthesis stem becomes especially important in this group. Sweden has a uniquely low proportion of uncemented stems, which seems wise, since this stem type causes increased fracture risk. On the other hand, the cementing procedure presents a risk for circulatory disorder and death on the operating table, something that the orthopaedic surgeon and anaesthetists can largely prevent in cooperation.

An increased risk of fracture-related reoperation derives from uncemented stem, male gender and secondary prosthesis. Uncemented stem constitutes a 2.8 higher risk in comparison to a cemented stem (confidence interval 2.0–3.8).

Loosening

With longer follow-up, the incidence of aseptic loosening, as a typical long-term complication, increases. After adjusting for ASA class, only young age is seen as a risk factor. Most hip fracture patients live so few years after their injury, that they do not have time to develop loosening, thus the risk is reflected in age rather than in surgical techniques.

Erosion

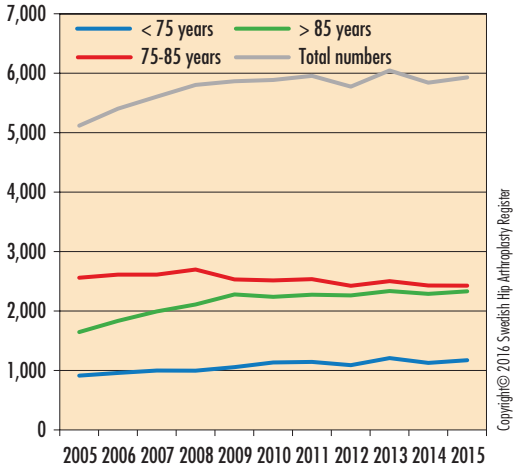
A number of unreported cases should also apply for acetabulum erosion, which is wearing of the cartilage after insertion of hemi-arthroplasty, representing 5% of the reoperations. The "true" incidence of erosion is unknown. There are reasons to believe that some do not seek medical advice, but adapt to the slowly progressive complication by being less active. Erosion tends to be primarily associated with movement-related pain. Since it is difficult to distinguish manifested erosion from more obscure pain, both of these causes for reoperation have been grouped together in our analyses. In the analysis of hemiarthroplasty with Cox regression, we find 4.6 times greater risk of reoperation due to erosion or pain after surgery with unipolar head, when compared with bipolar head (confidence interval 3.0–6.9). Even uncemented stem is a risk factor.

90-day mortality after fracture-related prosthesis

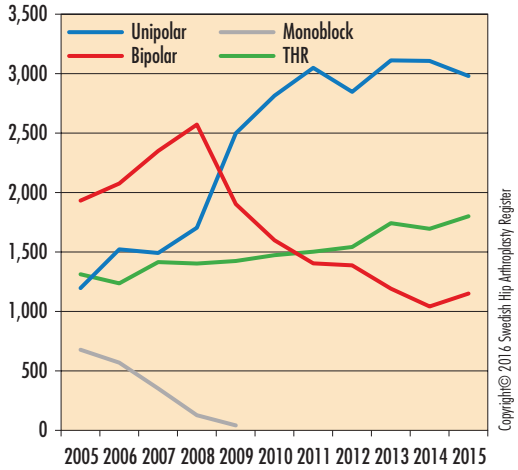
Mortality after a hip arthroplasty surgery due to hip fracture is considerably higher than after a planned operation due to, for example, osteoarthritis. Fracture patients must be dealt with urgently, regardless of their health condition, and they are generally both more ill and older than osteoarthritis patients are. This year's national average for 90-day mortality was 13% 2015, on the same level as last year. Mortality is influenced by the type of patients that are selected for prosthetic surgery. If the sickest of patients receive osteosynthesis – in most cases, the worse alternative from a hip perspective – mortality reduces. Mortality varies significantly between hospitals, 6 to 22% among the larger clinics. A number of factors that can increase the risk for early mortality are shown in the table on page 157: aged patients, male gender, comorbidities and acute fracture operations (as compared to planned secondary prostheses). If the mortality rate at one's own clinic exceeds the expected rate for the risk profile in question, then the clinical pathway should be analysed in detail.

Uncemented stems and posterior incision increase the risk for reoperation, in general, and for periprosthetic fracture and dislocation, in particular. Total arthroplasty and the two hemiarthroplasty types, bipolar and unipolar, produce a rather similar result for the first two to eight years after surgery, in regards to reoperation. Unipolar hemiarthroplasty is a worse choice for active patients, who are expected to live for many years with their prosthesis, because it increases the risk of acetabular erosion.

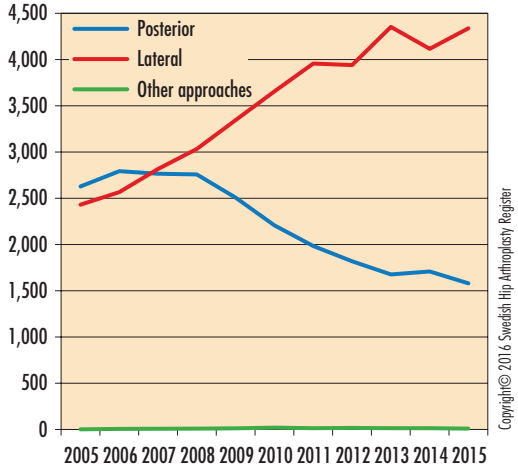
Age groups treated with hip prosthesis in case of hip fracture



Choice of prosthesis in case of fracture-related hip prosthesis



Incision in case of fracture-related hip prosthesis



15 most common stem components – fracture patients

2005–2015

Stem	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Proportion
Lubinus SP II	2,152	2,247	2,657	2,796	2,674	2,598	2,653	2,609	2,694	2,893	3,031	29,004	45.9%
Exeter Polished	1,185	1,247	1,374	1,532	1,713	1,823	1,840	1,883	2,025	2,047	2,069	18,738	29.6%
CPT (CoCr)	244	252	270	317	390	374	424	409	383	10	6	3,079	4.9%
Covision straight	0	0	24	152	239	273	336	334	373	383	345	2,459	3.9%
MS30 Polished	3	8	163	244	219	228	236	293	315	320	316	2,345	3.7%
Spectron EF Primary	467	505	240	145	234	206	173	20	5	0	1	1,996	3.2%
Thompson	354	360	243	167	44	2	0	0	0	0	0	1,170	1.9%
Corail collarless	29	116	125	166	164	200	87	50	23	23	26	1,009	1.6%
Austin Moore (Anatomica)	316	214	77	22	27	2	0	0	1	0	0	659	1.0%
Corail Collared	0	0	0	0	0	45	93	62	92	77	72	441	0.7%
ETS Endo	97	101	127	47	0	0	0	0	0	0	0	372	0.6%
Müller Straight	114	99	71	33	0	0	1	0	0	0	0	318	0.5%
Basis	0	35	46	51	55	18	0	0	0	0	0	205	0.3%
Bi-Metric Fracture Stem	46	64	43	23	3	0	0	0	0	0	0	179	0.3%
CLS Spotorno	13	23	43	24	12	6	8	10	8	3	6	156	0.2%
Others	97	132	102	85	92	111	104	105	126	86	58	1,098	1.7%
Totalt	5,117	5,403	5,605	5,804	5,866	5,886	5,955	5,775	6,045	5,842	5,930	63,228	100%

15 most common cup or head components – fracture patients

2005–2015

Cup/hemiarthroplasty head	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Proportion
Unipolar head	457	644	667	701	1,168	1,382	1,534	1,405	1,552	1,748	1,753	13,011	20.6%
UHR Universal Head	592	575	624	696	670	671	625	641	666	740	835	7,335	11.6%
Vario Cup	991	1,034	1,294	1,348	777	530	363	356	185	128	131	7,137	11.3%
Lubinus all poly	614	554	639	630	594	585	561	508	432	350	289	5,756	9.1%
V40 Uni polar	272	322	374	491	715	766	431	282	366	344	314	4,677	7.4%
Ultima Monk	311	432	381	422	319	276	268	254	213	27	0	2,903	4.6%
Unitrax	0	0	0	0	2	0	416	573	561	520	465	2,537	4.0%
Covision unipolar head for sleeves	0	0	7	33	152	161	232	285	370	394	348	1,982	3.1%
Marathon XLPE	0	0	0	9	123	279	307	321	356	289	277	1,961	3.1%
Tandem Unipolar	334	438	221	142	161	130	91	2	5	0	0	1,524	2.4%
Lubinus X-linked	0	0	0	0	0	2	66	161	272	377	514	1,392	2.2%
ZCA XLPE	0	9	131	190	225	219	183	163	161	61	48	1,390	2.2%
Charnley Elite	197	223	227	231	118	47	20	6	1	1	0	1,071	1.7%
Unipolar head	94	56	119	104	92	93	68	86	90	96	100	998	1.6%
Monoblock	677	568	351	127	41	2	0	0	1	0	0	1,767	2.8%
Others	578	548	570	680	709	743	790	732	814	767	856	7,787	12.3%
Total	5,117	5,403	5,605	5,804	5,866	5,886	5,955	5,775	6,045	5,842	5,930	63,228	100%

Reoperation within six months per clinic – fracture patients

2014–2015

Clinic	Number of primary arthroplasties[1)]	Number of reoperations (within six months)[2)]	Proportion in percentages[3)]
University/Regional hospitals			
Karolinska/Huddinge	229	2	0.9%
Karolinska/Solna	149	9	6.0%
Linköping	206	4	1.9%
SU/Mölndal	807	14	1.7%
SU/Sahlgrenska*	10	0	–
SUS/Lund	431	11	2.6%
SUS/Malmö	427	12	2.8%
Umeå	193	9	4.7%
Uppsala	385	14	3.6%
Örebro	152	5	3.3%
Central hospitals			
Borås	261	7	2.7%
Danderyd	403	12	3.0%
Eksjö	138	4	2.9%
Eskilstuna	212	5	2.4%
Falun	280	14	5.0%
Gävle	306	10	3.3%
Halmstad	194	8	4.1%
Helsingborg	389	15	3.9%
Hässleholm-Kristianstad	355	7	2.0%
Jönköping	156	2	1.3%
Kalmar	141	6	4.3%
Karlskrona	239	2	0.8%
Karlstad	259	6	2.3%
Norrköping	208	2	1.0%
NÄL	20	0	0%
Skövde	226	8	3.5%
Sunderby (Boden inclusive)	334	7	2.1%
Sundsvall	231	11	4.8%
Södersjukhuset	663	33	5.0%
Uddevalla	411	10	2.4%
Varberg	200	8	4.0%
Västerås	314	11	3.5%
Växjö	129	5	3.9%
Ystad	27	0	0%
Östersund	208	10	4.8%

(Continued on next page.)

Reoperation within six months per clinic – fracture patients (cont.)

2014–2015

Clinic	Number of primary arthroplasties[1)]	Number of reoperations (within six months)[2)]	Proportion in percentages[3)]
Rural hospitals			
Alingsås	88	4	4.5%
Arvika	3	0	–
Frölunda Specialistsjukhus	1	0	–
Gällivare	115	2	1.7%
Hudiksvall	183	4	2.2%
Karlshamn	3	0	–
Karlskoga	94	3	3.2%
Kungälv	169	10	5.9%
Lidköping	109	2	1.8%
Lindesberg	62	1	1.6%
Ljungby	102	3	2.9%
Lycksele	48	1	2.1%
Mora	145	5	3.4%
Norrtälje	84	2	2.4%
Nyköping	88	3	3.4%
Piteå	4	0	–
Skellefteå	86	2	2.3%
Sollefteå	73	2	2.7%
Södertälje	90	10	11.1%
Torsby	69	0	0%
Trelleborg	6	0	–
Visby	79	2	2.5%
Värnamo	72	0	0%
Västervik	97	5	5.2%
Örnsköldsvik	87	1	1.1%
Private hospitals			
Aleris Specialistvård Motala	95	1	1.1%
Aleris Specialistvård Ängelholm	1	0	–
Capio S:t Göran	422	7	1.7%
Carlanderska	1	0	–
Ortho Center Stockholm	2	0	–
Spenshult	1	1	–
Country	11,772	354	3

Red marking indicates values, which lie one standard deviation above the national average.

[1)] *Refers to the number of primary operations during the period.*
[2)] *Refers to the number of those who were reoperated within six months.*
[3)] *Refers to the quota between 1) and 2) in percentages.*
* *Only tumour cases*

90-day mortality per clinic – fracture patients

proportion of deaths within 90 days after primary surgery (percent)**, 2014–2015**

Clinic	Number[1)]	>80[2)]	Men[3)]	ASA=III[4)]	ASA=IV[5)]	Acute fracture	Patients operated within 24 h[6)]	Mortality[7)]
University/Regional hospitals								
Karolinska/Huddinge	229	60%	40%	61%	11%	93%	87%	12%
Karolinska/Solna	149	63%	32%	67%	15%	92%	–	19%
Linköping	206	67%	37%	48%	9%	95%	69%	12%
SU/Mölndal	807	61%	33%	50%	5%	96%	62%	13%
SU/Sahlgrenska*	10	30%	50%	56%	11%	90%	–	40%
SUS/Lund	431	55%	30%	65%	5%	91%	73%	8%
SUS/Malmö	427	66%	30%	81%	7%	99%	59%	13%
Umeå	193	53%	36%	52%	3%	94%	–	12%
Uppsala	385	57%	31%	62%	6%	95%	35%	9%
Örebro	152	60%	28%	39%	3%	88%	51%	10%
Central hospitals								
Borås	261	70%	34%	44%	3%	95%	81%	13%
Danderyd	403	61%	28%	64%	8%	91%	63%	9%
Eksjö	138	70%	36%	50%	4%	96%	69%	17%
Eskilstuna	212	65%	36%	49%	6%	92%	52%	17%
Falun	280	60%	34%	44%	6%	93%	68%	12%
Gävle	306	66%	30%	43%	8%	97%	55%	13%
Halmstad	194	65%	36%	39%	3%	95%	72%	12%
Helsingborg	389	62%	35%	47%	3%	96%	60%	13%
Hässleholm-Kristianstad	355	62%	35%	49%	6%	94%	83%	16%
Jönköping	156	63%	24%	53%	6%	96%	65%	11%
Kalmar	141	55%	30%	35%	2%	94%	73%	11%
Karlskrona	239	69%	29%	43%	4%	95%	55%	15%
Karlstad	259	65%	30%	57%	6%	97%	62%	18%
Norrköping	208	59%	34%	47%	5%	89%	53%	15%
NÄL	20	70%	10%	55%	5%	100%	–	0%
Skövde	226	62%	33%	40%	4%	95%	51%	12%
Sunderby (inklusive Boden)	334	61%	34%	63%	9%	98%	70%	16%
Sundsvall	231	58%	32%	49%	4%	93%	–	13%
Södersjukhuset	663	65%	33%	64%	9%	90%	62%	13%
Uddevalla	411	64%	36%	56%	5%	96%	71%	13%
Varberg	200	62%	36%	34%	5%	94%	58%	12%
Västerås	314	57%	28%	66%	6%	93%	77%	10%
Växjö	129	60%	33%	53%	3%	93%	48%	6%
Ystad	27	70%	22%	52%	15%	96%	76%	15%
Östersund	208	64%	33%	47%	7%	94%	62%	13%

(Continued on next page.)

90-day mortality per clinic – fracture patients (cont.)

proportion of deaths within 90 days after primary surgery (percent)**, 2014–2015**

Clinic	Number[1]	>80[2]	Men[3]	ASA=III[4]	ASA=IV[5]	Acute fracture	Patients operated within 24 h[6]	Mortality[7]
Rural hospitals								
Alingsås	88	58%	44%	53%	8%	95%	66%	11%
Arvika	3	0%	67%	67%	0%	67%	40%	0%
Frölunda Specialistsjukhus	1	0%	0%	0%	0%	100%	–	0%
Gällivare	115	46%	33%	46%	12%	93%	72%	12%
Hudiksvall	183	55%	37%	39%	7%	92%	72%	15%
Karlshamn	3	0%	67%	67%	0%	0%	–	0%
Karlskoga	94	61%	32%	46%	3%	91%	68%	15%
Kungälv	169	58%	40%	50%	5%	95%	60%	13%
Lidköping	109	67%	29%	42%	0%	94%	59%	12%
Lindesberg	62	61%	32%	46%	7%	95%	69%	6%
Ljungby	102	68%	35%	59%	0%	84%	70%	10%
Lycksele	48	60%	25%	51%	2%	96%	–	15%
Mora	145	59%	30%	42%	5%	90%	91%	14%
Norrtälje	84	52%	35%	64%	7%	90%	78%	10%
Nyköping	88	61%	25%	56%	2%	95%	46%	11%
Piteå	4	50%	25%	75%	0%	25%	–	0%
Skellefteå	86	53%	19%	41%	5%	92%	74%	7%
Sollefteå	73	53%	36%	39%	3%	93%	–	14%
Södertälje	90	51%	39%	69%	8%	93%	64%	10%
Torsby	69	59%	36%	62%	4%	94%	85%	**22%**
Trelleborg	6	17%	33%	17%	0%	0%	–	0%
Visby	79	63%	23%	38%	2%	87%	81%	15%
Värnamo	72	72%	28%	30%	6%	99%	72%	8%
Västervik	97	65%	26%	36%	1%	95%	81%	12%
Örnsköldsvik	87	63%	28%	52%	5%	95%	–	14%
Private hospitals								
Aleris Specialistvård Motala	95	72%	33%	69%	6%	92%	54%	18%
Aleris Specialistvård Ängelholm	1	0%	0%	0%	0%	0%	–	0%
Capio S:t Göran	422	68%	30%	64%	5%	95%	81%	13%
Carlanderska	1	0%	0%	0%	0%	0%	–	0%
Ortho Center Stockholm	2	0%	50%	0%	0%	0%	–	0%
Spenshult	1	0%	0%	0%	0%	0%	–	0%
Country	11,772	62%	32%	53%	6%	94%	66%	13%

[1] *Refers to the number of primary operations during the period.*
[2] *Refers to the proportion of operations on patients who belong to the age group of over 80 years of age.*
[3] *Refers to the number of during the period.*
[4] *Proportion of patients with ASA class III.*
[5] *Proportion of patients with ASA class IV.*
[6] *Refers to the proportion who were operated within 24 hours (from Rikshöft).*
[7] *90-day mortality (100× (number of patients who died within three months of the primary operation/number of operations during the period)).*
* *EOnly tumour cases*

Red marking indicates values, which lie one standard deviation above the national average.

Cause for reoperation

2005–2015

	Number	Proportion of all operations	Proportion of all reoperations
Dislocation	948	1.5	31.5
Infection	994	1.6	33.0
Periprosthetic fracture	681	1.1	22.6
Erosion and pain	157	0.2	5.2
Aseptic loosening	109	0.2	3.6
Other causes	118	0.2	3.9
Missing data	3	0	0.1
Total number of reoperations	3,010	4.8	100

Number of reoperations and number of deaths during the follow-up period for different types of prosthesis

2005–2015

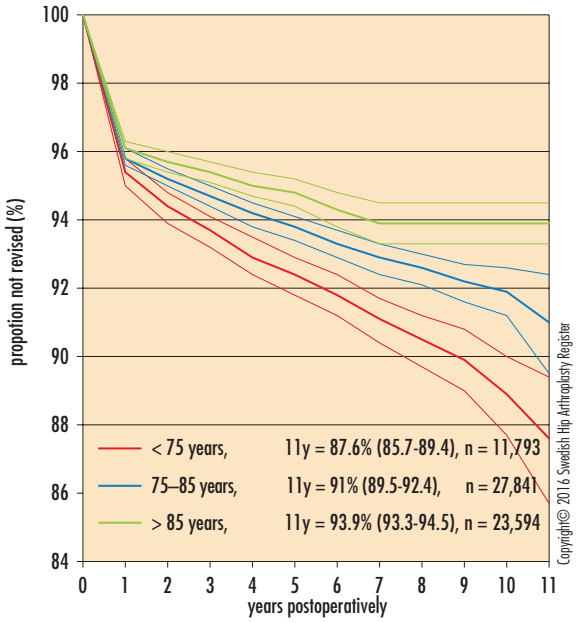
Type of prosthesis	Total	Number of reoperations	Proportion of reoperations (%)	Number of deaths	Proportion of deaths (%)
Unipolar hemi-athroplasty	26,317	1,074	4.1	16,100	61.2
Bipolar hemi-athroplasty	18,601	932	5.0	12,961	69.7
Monoblock hemi-athroplasty	1,767	84	4.8	1,660	93.9
Total arthroplasty	16,539	920	5.6	5,413	32.7
Missing data	4	0	0	3	75.0
Total	63,228	3,010	4.8	36,137	57.2

Type of reoperation

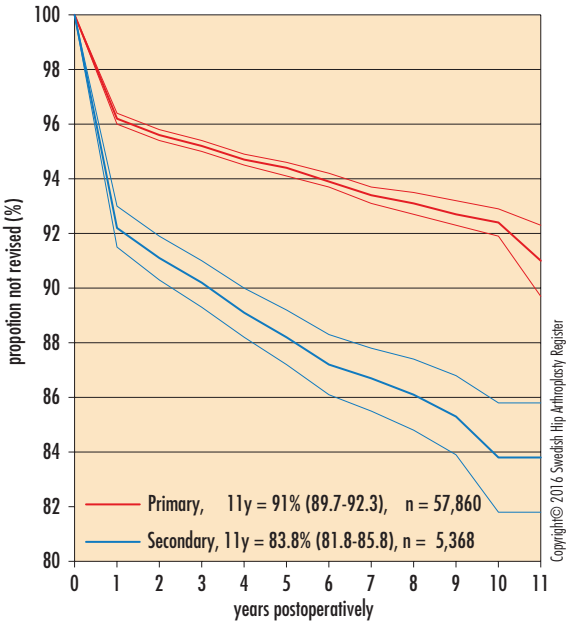
2005–2015

Type of reoperation	Number	Proportion of all operations	Proportion of all reoperations
Total arthroplasty; replacement with total arthroplasty	562	0.9	18.7
Hemiarthroplasty; replacement with total arthroplasty	653	1.0	21.7
Hemiarthroplasty; replacement with hemiarthroplasty	537	0.8	17.8
Extraction of prosthesis	300	0.5	10.0
Other reoperations	687	1.1	22.8
Missing data	271	0.4	9.0
Total number of reoperations	3,010	4.8	100

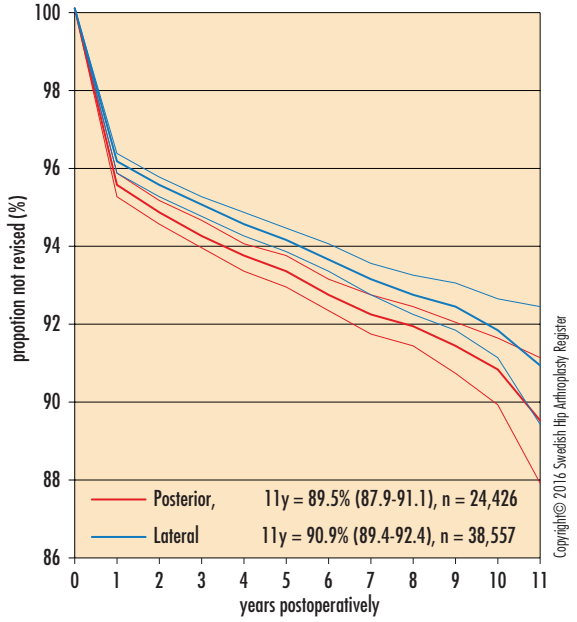
Age groups
2005–2015



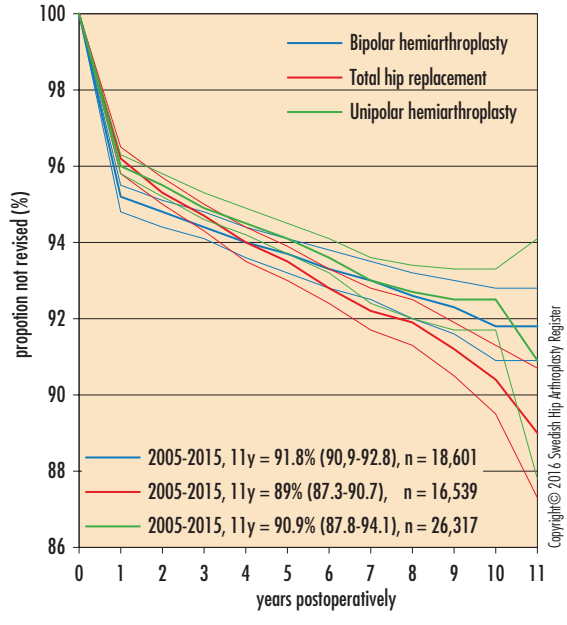
Primary and secondary prosthesis
2005–2015



Surgical approach
2005–2015

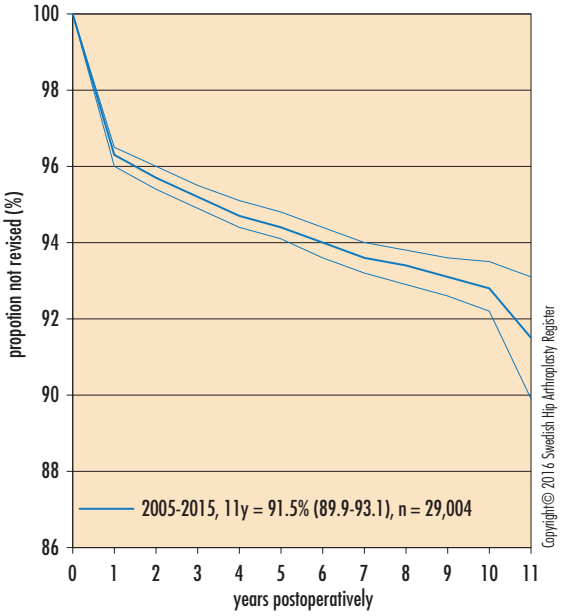


Protestyp
2005–2015



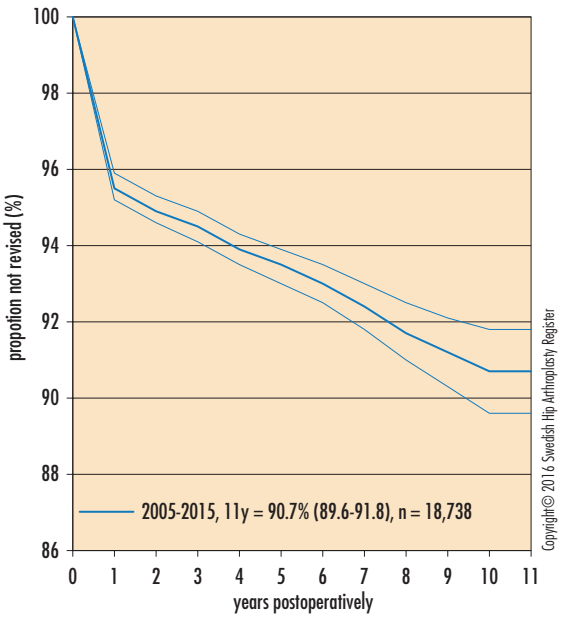
Lubinus SP II

fracture diagnosis and all causes (2005–2015)



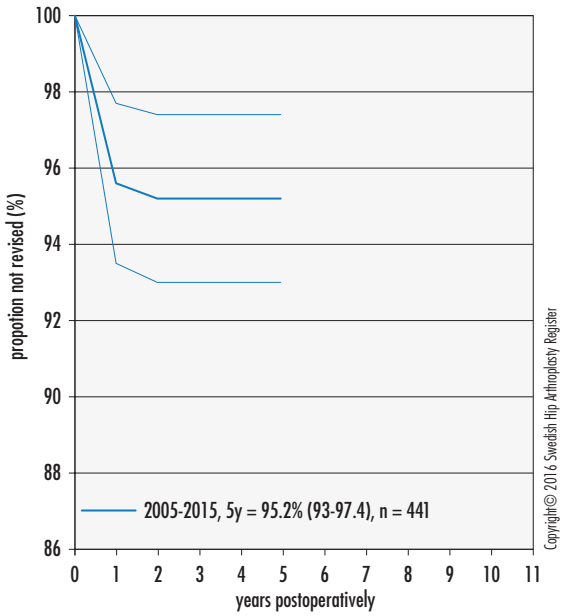
Exeter Polished

fracture diagnosis and all causes (2005–2015)



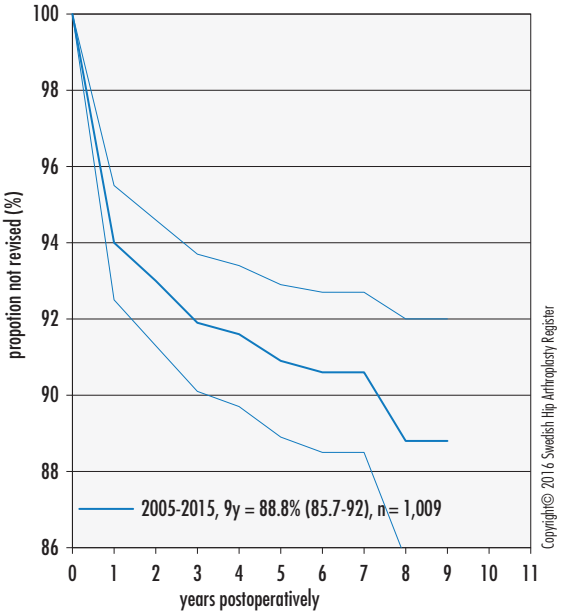
Corail Collared

fracture diagnosis and all causes (2005–2015)



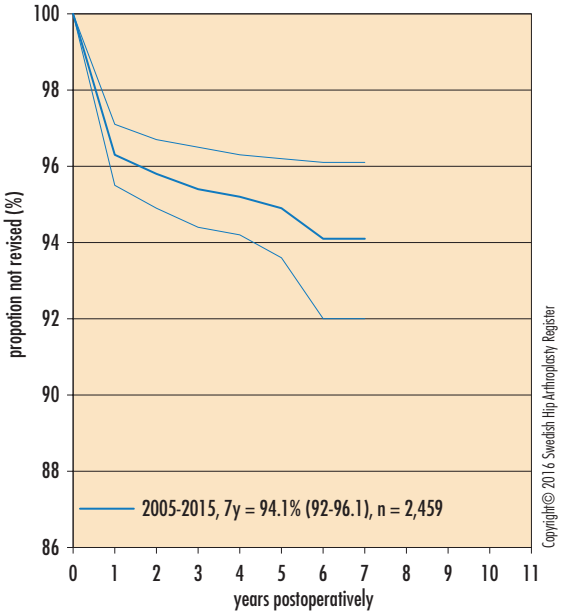
Corail Collarless

fracture diagnosis and all causes (2005–2015)



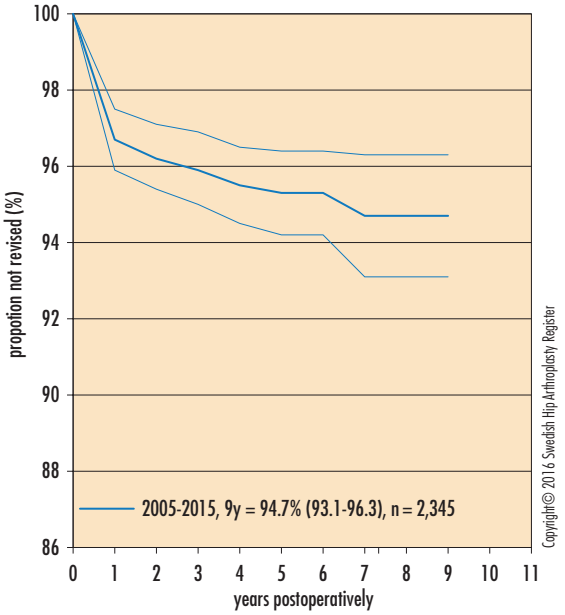
Covision straight

fracture diagnosis and all causes (2005–2015)



MS30 Polished

fracture diagnosis and all causes (2005–2015)



Notes

Swedish Hip Arthroplasty Register and clinical research

Background

The main tasks of a National Quality Register are analyses of institutions and their activities, improvement projects and clinical research. The operational resources the SKL and the Ministry of Health and Social Affairs provide every year shall, apart from the operation of the Register, go towards supporting the first two tasks and are ***not*** "earmarked" to fund the register-based research.

Paradoxically, SKL and the Swedish Agency for Health and Care Services Analysis control the research activities of the registers in their evaluation matrix – this condition is at least somewhat contradictory but means that our research activity and infrastructure must be financed by external funds. In turn, this entails applications in a highly competitive world of research, where observational studies of musculoskeletal diseases still has a rather low status compared to randomised studies in the field or basic research in other medical field.

Despite this, our research activity and infrastructure has increased substantially during the past years. There are several explanations to this gratifying development. Many years ago, the register's management contac¬ted all universities and we now have 20 doctoral students (who have completely or partially based their thesis on the Register) in four Swedish universities, and more are on their way in. A major contributor to the escalating development is also the fact that the register has now, after almost two years, two biostaticians. In order to maintain this good research infrastructure, external funding must continually be looked for.

The highly versatile databases still have a large research potential. A database merging official databases such as the Swedish National Board of Health and the Welfare's Health Data register, the National Insurance Office, Statistics Sweden and regional patient-administrative systems has resulted and can result in databases that are unique with respect to observational studies. Interconnecting of the health data register and SCB takes 8–12 months and costs about 150,000 kronor, but so far has been "cost-effective" and resulted in extensive research and high publishing rate.

In research and evidence-based medicine, the randomized controlled study (RCT) is considered the research gold standard with the highest "level of evidence". However, we have no possibilities of running this type of study in all areas – perhaps least of all within surgical disciplines. The randomization process does not include the role of the surgeon, her or his experience and competence. What is termed 'single-surgeon' material seldom manages to attain statistical power. A national prospective observational study (register study) has characteristics unreachable with an RCT. Large materials afford above all possibilities to analyse unusual complications with great statistical power. Another great advantage is that generalizable results can be achieved – a result measured within the entire profession. Other tangible benefits include longer follow-up times and lower cost for the observational studies. However, the two study designs are not mutually antagonistic. An RCT is primarily designed to study the effect of a treatment while an observational study is particularly effective in analysing the "adverse effects" of a treatment.

A new Swedish-launched research method, which has received international attention, is the so-called rRCT (register randomized controlled trial). This type of study is well suited for the evaluation of pharmacological treatment of internal medicine conditions, for example heart attack, stroke, diabetes, etc. However, the method may be more difficult to apply in the evaluation of a surgical treatment. Within the register, it has been discussed, however, to design a so-called cluster randomization for the analysis of, for example antithrombotic treatments. The advantage of a cluster randomization, where hospitals are randomly allocated to different treatment strategies, may be to avoid the written consent of each participating patient. An individual-based rRCT is regarded in the same way as a conventional RCT, meaning that each participant must consent. One of the strengths of the research of register's large databases (without randomization) is that it does not require such consent.

How does this work?

All registry-based research requires ethical approval, privacy assessment, research contracts and special research form - it sounds complicated and bureaucratic, but is necessary for the registry to be able to follow the PUL and the Patient Data Act. Full regulations concerning records research are available at http://kvalitetsregister.se/registerarbete/forskning. The Register has a tested ethics guideline in regards to Register-based research.

The Swedish Hip Arthroplasty Register's website has published a so-called project database, where you can find an overview of ongoing projects. If you want to discuss research projects, contact the register administrator. A special research coordinator (Karin Davidsson) works full-time at register. Phone numbers and email addresses are available on the report's cover (back cover).

To ensure maximum data security, the Register does not release data, but all current data sets relating to research projects are stored in a research server (SODA-severn = Secure Online Data Access). On this server, a "virtual desktop" is created and it is available to the current research groups via two-factor

authentication. The desktop includes the project-specific databases, statistical software (four different ones) and the Office package. We must not store data sets with sensitive personal data on our own computers!

For four years, the Register organises a two-day research convention every January. All active doctoral students and supervisors are invited to take part and general as well as specific research issues are discussed in a workshop format.

Guidelines for Register-based research

Anyone who conducts observational research should study in detail the guidelines for STROBE and RECORD:

STROBE –
http://strobe-statement.org/index.php?id=strobe-home

RECORD –
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0125620

These fairly comprehensive guidelines can be summarized as follows:

- address all types of potential bias
- clearly define all types of outcomes and potential ”confounders”
- always report unadjusted results and, if possible, also the ”confounder” adjusted results
- describe the data quality and how ”missing-data” is handled during analysis

The Swedish Hip Arthroplasty Register has created its own recommendations (guideline) for the research and publication of data from the Register:

- at the start of the project, gather the research group for a “brain storm” and create and discuss the DAG (directed acyclic graph)
- always describe the final study group with a clear ”flow chart”
- follow STROBE
- always discuss the data quality and the risk for ”residual confounders” in the manuscript

Register's research

17 doctoral theses and about 150 scientific articles have been published, wholly or partly based on analyses from the Swedish Hip Arthroplasty Register. In 2015 and up until October 10, 2016, 35 register-based scientific articles had been published in ”peer reviewed” magazines and additional 6 have been submitted. In 2015, three dissertations with register results were carried out and two are planned for 2017.

Dissertations 2015:

Meridith Greene, Gothenburg and Boston, USA: *Who should have total hip replacement? Use of patient-reported outcome measures in identifying the indications for and assessment of total hip replacement.*

Maziar Mohaddes, Gothenburg: *Acetabular Revisions. Risk Factors and Prediction of Re-revision.*

Buster Sandgren, Stockholm: *Assessment with computed tomography of wear and osteolysis in uncemented acetabular cups*.

The register's database is well suited to ST and medical student projects and a number of these have been carried out in the past four years.

The Register's directorship and governing group include many Swedish postgraduate researchers who are supervisors and assistant supervisors for a number of postgraduate students. Currently, within this group, research is being carried out concerning prosthesis fixation, health economy, hip fracture and prosthetic surgery, fractures close to the prosthesis, revision surgery and patient-reported outcomes after prosthetic surgery. Members of the group are:

- Johan Kärrholm, Gothenburg
- Göran Garellick, Gothenburg
- Henrik Malchau, Gothenburg
- Ola Rolfson, Gothenburg
- Szilárd Nemes, Gothenburg
- Cecilia Rogmark, Malmö
- Leif Dahlberg, Lund
- André Stark, Stockholm
- Per Wretenberg, Örebro
- Nils Hailer, Uppsala
- Hans Lindahl, Lidköping
- Rüdiger Weiss, Stockholm
- Lars Weidenhielm, Stockholm
- Olof Sköldenberg, Stockholm
- Max Gordon, Stockholm
- Clas Rehnberg, Stockholm
- Viktor Lindgren, Stockholm
- John Timperley, Exeter, England
- Ashley Blom, Bristol, England
- Stephen Graves, Adelaide, Australia
- Li Felländer-Tsai, Stockholm
- Håkan Hedlund, Visby
- Kristina Burström, Stockholm
- The NARA group with representatives from Knee and Hip Arthroplasty Registers in Finland, Norway and Denmark

Postgraduate students with all or part of their dissertation material from the Register – refer to the reports back cover.

The register has also intensive research cooperation with the NARA (Nordic Arthroplasty Register Association), which is a register-based cooperation between Finland, Norway, Denmark and Sweden established in 2007 and where a common database is created annually). The group has published 22 scientific articles and further more manuscripts are being prepared. NARA database is also available to Swedish postgraduates.

If you are considering an interesting study within the field of hip arthroplasty, contact the Register's management!

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Book chapters

The Well Cemented Total Hip Arthroplasty in Theory and Practice. Editors Steffen Breusch & Henrik Malchau. Springer Verlag, Berlin, 2005.

2.1 Operative Steps: Acetabulum, sidor 16–27.
Steffen J. Breusch, Henrik Malchau, John Older

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Swedish Hip Arthroplasty Register

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