LROI Report 2013

Insight into Quality & Safety

Annual Report of the Dutch Arthroplasty Register (Landelijke Registratie Orthopedische Implantaten) 2013

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's-Hertogenbosch, the Netherlands

Netherlands Orthopaedic Association (NOV)
Dutch Arthroplasty Register (LROI)
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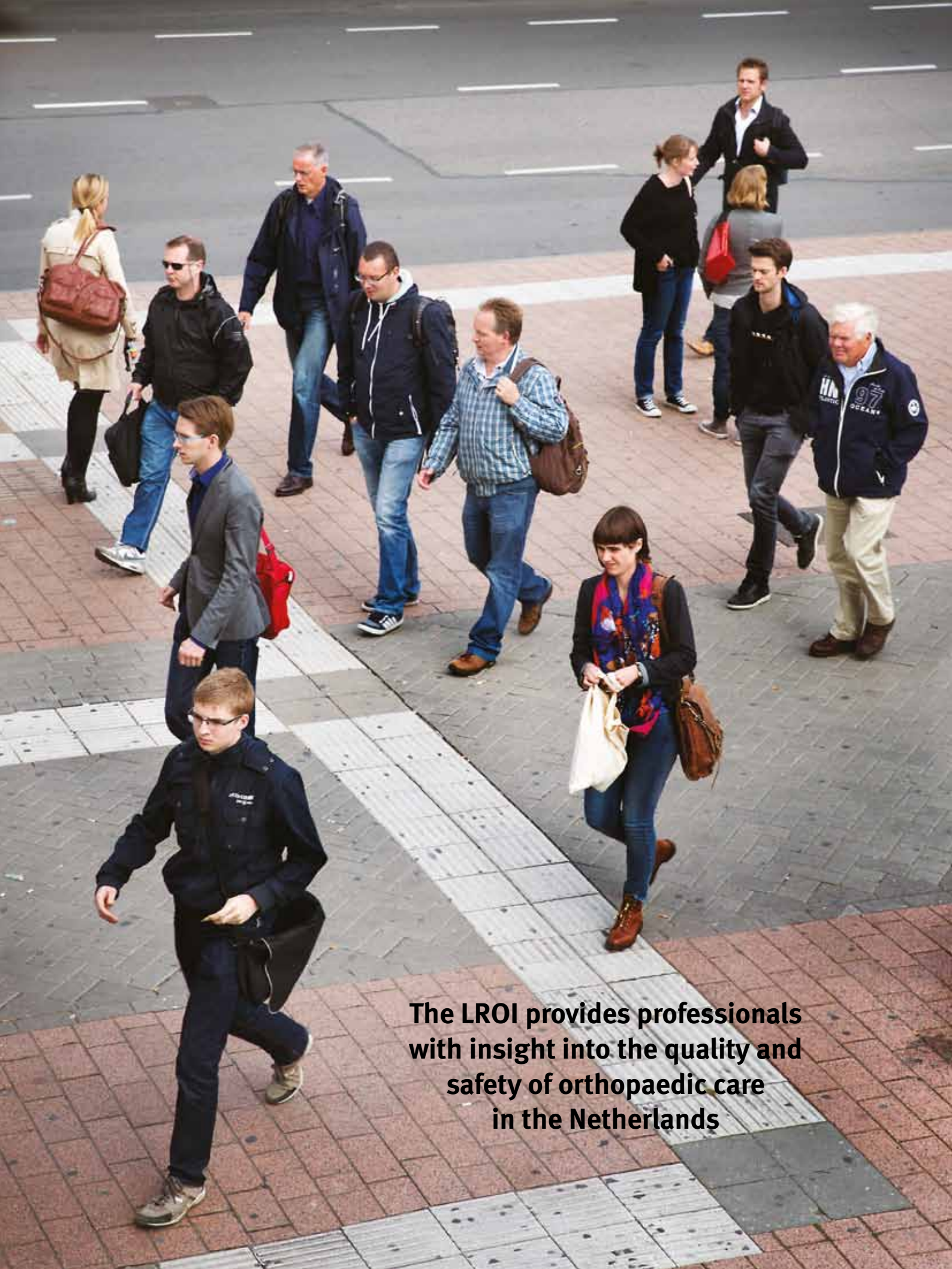

The LROI provides professionals with insight into the quality and safety of orthopaedic care in the Netherlands

Preface

We are proud to present the third annual report of the Dutch Arthroplasty Register (LROI). First and foremost, we would like to thank all Dutch orthopaedic departments for their relentless commitment to register all cases into the dataset. Through their efforts, completeness has increased again when compared to 2012; in 2013 it proves to be nearly 100%, which is of course a great result. The LROI head office, the LROI board, and the scientific advisory board have processed these data into this third annual report.

To optimize the data in the LROI, all prosthetic components were classified according to several characteristics. As a result, you will find a lot of new information in this report, compared to the previous edition. For example, lists of the most frequently implanted hip and knee components are included. Descriptions of the various prosthetic components are also presented, such as the materials and types of components used. This report contains a description of the variation between hospitals with regard to orthopaedic care and patient characteristics that affect the outcomes of this care (case mix factors). All this information provides you with even more insight into the quality of orthopaedic care provided in the Netherlands in respect of hip and knee arthroplasty.

Purpose

The LROI is a digital quality register of joint replacement surgery (arthroplasty) in the Netherlands. The quality register was initiated by the Netherlands Orthopaedic Association (Nederlandse Orthopaedische Vereniging; NOV) and it is a product of the LROI organization. In health care, a continuous process of measuring, registration and feedback is necessary to monitor and improve quality. The registration of orthopaedic prostheses is such a continuous process of insight into and feedback on the results of arthroplasties in the Netherlands and the related orthopaedic care. This contains feedback on both prosthesis level ('what is the survival of one prosthesis, compared to another?'), as on department level ('what are the results of one hospital, compared to another?'). In addition, the LROI contributes strongly to patient safety, in respect of arthroplasty surgery. In the event of a recall of a particular type of prosthesis, an overview of the patients who have had that type of prosthesis implanted can be created instantly. The LROI organization can provide this information to the relevant hospitals.

Rapid succession of developments

As you may have noticed, developments in respect of the LROI follow each other in rapid succession. To make sure that these developments will head in the right direction, the LROI organization published its Strategic Plan. It describes the vision and mission of the LROI with activities that will be given priority in the period 2014 to 2016. One of the goals described in the Strategic Plan is to inform the Dutch general public and society. Therefore, this annual report is published in combination with a Z-card. This is a user-friendly, foldable card that displays the key results of this report in an organized manner. The Z-card can be given to patients to provide them with more information on the data in the LROI.

In addition, the LROI was extended in 2014 with registration of ankle, shoulder and elbow arthroplasties. Although these arthroplasties are performed less frequently than hip and knee arthroplasties, their registration is of great importance, to understand orthopaedic care with regard to these joints for the traceability of these implants. The LROI was also extended with Patient Reported Outcome Measures (PROMs), which are important to determine the effect of arthroplasty on the perceived health of the patient. After years of effort, the dates of death were included in the LROI recently, so the survival rate of a prosthesis (the expected time to revision) can be determined correctly. This is truly a milestone for our register. In the last chapter of this report, you will find more information about the developments that the LROI experienced in the past year.

Traceability of implants

In addition to insight into the quality of orthopaedic care in the Netherlands, patient safety is paramount for the LROI organization. Therefore, the traceability of prostheses is of great importance. The Dutch Minister of Health, Welfare and Sports decided that there should be a national register for implants. The main function of this register is traceability of all medical devices implanted in the Netherlands: tracing back an implant to a person. The LROI

organization proposed to the minister to use the LROI as a source for the traceability of joint implants. After all, every orthopaedic department registers the implanted hip, knee, shoulder, elbow and ankle implants in the LROI and the completeness of the LROI is close to 100 percent. Via the hospitals, all prostheses can be traced back to the patient, which guarantees patient safety.

In conclusion

Without the continuous commitment of all orthopaedic departments it would not have been possible to create this annual report. Therefore, we would like to thank everyone who entered data in the LROI in the last seven years. We also hope for an excellent cooperation in the years to come. The commitment of all stakeholders is needed to achieve valid results. Feedback on this report is always welcome and may only serve to improve this report. We hope you enjoy reading this report as much as we did!

Drs Henk Koot, *chairman of the LROI board*
Dr Wim Schreurs, *chairman of the scientific advisory board LROI*

Definitions

Acetabular component
The part of a hip prosthesis that is implanted into the acetabulum – the socket part of a ball and socket joint

Arthrodesis
A procedure in which a natural joint is fused together (stiffened)

Articulation
The two surfaces that move together (articulate) in a joint replacement

ASA score
The American Society of Anaesthesiologists (ASA) score is a scoring system for grading the overall physical condition of the patient, as follows: P1 – fit and healthy; P2 – mild disease, not incapacitating; P3 – incapacitating systemic disease; P4 – life threatening disease; P5 – expected to die within 24 hrs with or without an operation

Case mix
Term used to describe variation in the population, relating to factors such as diagnosis (indication for surgery), patient age at surgery, gender and health condition at surgery

Cement
Material (polymethyl methacrylate) used to fixate joint replacements to bone

Completeness
The completeness of the number of registered procedures in the LROI, based on a comparison with the hospital information system of every hospital that performs hip and/or knee arthroplasty in the Netherlands

Femoral component (hip)
Part of a hip prosthesis that is implanted into the femur (thigh bone) of the patient

Femoral component (knee)
Part of a knee prosthesis that is implanted into the femur (thigh bone) of the patient

Femoral head component
Part of a hip prosthesis that is implanted on top of the femoral component of a hip prosthesis and moves inside the acetabular component or the cup of the hip joint

Girdlestone
Revision procedure to a hip in which no new prosthesis is implanted after removal of the hip prosthesis (often because of a bacterial infection)

Hip revision arthroplasty
Any change (insertion, replacement and/or removal) of one or more components of the hip prosthesis

Hybrid fixation hip prosthesis
Fixation of a hip prosthesis in which the acetabular component is implanted uncemented and the femoral component is implanted cemented

Hybrid fixation knee prosthesis
Fixation of a knee prosthesis in which the femoral component is implanted uncemented and the tibial component is implanted cemented

Insert hip
Intermediate part (inner layer) of a hip prosthesis which is implanted between the acetabular component and the femoral head component of a hip prosthesis

Insert knee
Intermediate part of a knee prosthesis, made of polyethylene, which is implanted between the femoral component and the tibial component of a knee prosthesis, ensuring the smooth movement of the knee prosthesis

Knee revision arthroplasty
Any change (insertion, replacement and/or removal) of one or more components of the knee prosthesis

LROI
Dutch Arthroplasty Register (Landelijke Registratie Orthopedische Implantaten)

Meniscectomy
Meniscus removal

Osteosynthesis
Securing bone parts together with plates, pins and/or screws

Osteotomy
Splitting bones (with saw or chisels) in order to correct the position, to shorten or lengthen the bone

Patellar component
Part of a knee prosthesis that is implanted on the knee cap

Patellofemoral prosthesis
Two-piece knee prosthesis that provides a prosthetic (knee) articulation surface between the patella and trochlear groove

Primary hip arthroplasty
The first time one primary total, hemi or resurfacing prosthesis is implanted, to replace the hip joint

Primary knee arthroplasty
The first time one primary unicondylar, patella-femoral or total prosthesis is implanted, to replace the knee joint

Resurfacing hip prosthesis
Hip prosthesis in which the cup (acetabulum) is replaced and a metal cap is implanted on top of the femoral head

Reversed hybrid fixation hip prosthesis
Fixation of a hip prosthesis in which the acetabular component is implanted cemented and the femoral component is implanted uncemented

Reversed hybrid fixation knee prosthesis
Fixation of a knee prosthesis in which the femoral component is implanted cemented and the tibial component is implanted uncemented

Synovectomy
The removal of inflamed mucosa in a joint

Tibial component
Portion of a knee prosthesis that is used to replace the articulating surface of the tibia (shin bone) at the knee joint

Total hip arthroplasty
Hip arthroplasty in which the entire hip joint (both head and cup) of a patient is replaced

Total knee arthroplasty
Knee arthroplasty in which the entire knee joint (with or without patella) of a patient is replaced

Unicondylar knee arthroplasty
Knee arthroplasty in which one tibial condyle and one femoral condyle in the knee (either inner or outer side) are replaced

Abbreviations

ASA	American Society of Anaesthesiologists
BMI	Body Mass Index
HIS	Hospital Information System
LROI	Dutch Arthroplasty Register
NOV	Netherlands Orthopaedic Association
PE	Polyethylene
PROMs	Patient Reported Outcome Measures
SD	Standard Deviation
THA	Total Hip Arthroplasty
THP	Total Hip Prosthesis
TKA	Total Knee Arthroplasty
TKP	Total Knee Prosthesis
UMC	University Medical Centre

Summary

Introduction
The Dutch Arthroplasty Register (LROI) is a digital quality register of orthopaedic joint replacement surgery in the Netherlands, established in 2007. Through a continuous process of insight into and feedback on the results of joint implants, the LROI contributes to the improvement of orthopaedic care in the Netherlands. Orthopaedic departments are able to compare the results of the hip and knee arthroplasties performed in their hospital to the national data through the LROI dashboard. In addition, the LROI is important for the traceability of joint implants with regard to patient safety. In case of a calamity with a prosthesis, data from the LROI can be used to trace all implanted prostheses of this type.

Data quality
A complete register is important for the reliability of the results. To determine the completeness of the LROI, the numbers of primary and revision hip and knee arthroplasties registered in the LROI were compared to data from the hospital information system of each hospital. In addition, the quality of the registered data was assessed by determining the amount of missing or incorrect values for several important variables in the entire LROI database. Since 2012, every hospital registers in the LROI. For 2013, the completeness was 96% for primary total hip arthroplasties (THAs) and primary knee arthroplasties. For hip revision arthroplasties, the completeness was 88%, for knee revision arthroplasties this was 90%. The proportion of missing or incorrect values was less than 0.5% for most variables. The proportion of missing values for the encrypted personal identification number decreased from 33% in 2007 to 9% in 2013.

Primary hip arthroplasty
In 2010-2013, 96,973 primary THAs were registered. In 2013, 25,642 primary THAs were registered in 95 hospitals with a median of 251 THAs (range 19-703) per hospital. Two-thirds of the patients who underwent a THA in 2013 were female and the mean age was 68.7 years. Over 65% of these patients had an ASA score of II and 87% underwent a THA after the diagnosis osteoarthritis. Over 90% was treated in a general hospital. The most frequently used surgical approach for a primary THA in 2010-2013 was posterolateral (61%), followed by straight lateral (24%). Over 60% was implanted fully uncemented and 28% was implanted fully cemented in 2013. In 2010-2013, 67% of the implanted cemented acetabular components consisted of standard polyethylene (PE) and 29% consisted of cross-linked PE with an increase of cross-linked PE over time. Of the uncemented acetabular components, 93% consisted of titanium. Over 80% of the implanted inserts consisted of PE with an increased use of cross-linked PE from 45% in 2010 to 72% in 2013. In 2010-2013, a decreasing amount of femoral heads with a diameter of 22-28 mm was implanted (from 45% in 2010 to 31% in 2013), while the amount of femoral heads with a diameter of 32 and 36 mm increased. Sixty percent of the femoral head components were ceramic and 34% consisted of cobalt chrome. Femoral components often consisted of titanium (66%) or cobalt chrome (27%) in 2010-2013. Ceramic-on-PE articulation is the most common articulation for primary total hip prostheses (THPs) in 2010-2013 (48%) with an increased use from 44% in 2010 to 55% in 2013. The proportion metal-on-metal THPs decreased from 6% in 2010 to less than 1% in 2013. The metal-on-PE THPs were implanted more often in younger patients. In 2010-2013, when bone cement was used during implantation, it was most often cement with gentamicin (94%).

Patient characteristics varied considerably among hospitals. The median age varied between 55 and 73 years and the proportion of patients with an ASA score of I-II varied between 67% and 100%. The variations in fixation, diameter of the femoral head and articulation of THPs in 2013 were considerable. For example, in some hospitals all THPs were implanted cemented, while in other hospitals all prostheses were implanted uncemented.

Hip revision arthroplasty
Hip revision arthroplasty is defined as any change (insertion, replacement and/or removal) of one or more components of the hip prosthesis. This includes revision procedures to any prostheses ever implanted (including those before the start of the LROI). In 2013, 3,454 hip revision arthroplasties were registered in 93 hospitals with a median number of 28 (range

1-196) per hospital. In 69% of the hip revision arthroplasties, a partial revision was performed and in 27% of the procedures a total system revision. In 91% of the partial revision arthroplasties the femoral head was replaced, and in 57% of the arthroplasties the acetabulum and/or insert were replaced. The most common reasons for hip revision arthroplasty were loosening of the acetabular component (33%) or the femoral component (27%). Liner wear (27%) and dislocation (22%) were also mentioned as reasons for revision.

Primary knee arthroplasty

In 2010-2013, 89,536 primary knee arthroplasties were registered. In 2013, 23,738 primary knee arthroplasties were registered in 100 hospitals, with a median number of 216 (range 14-677) per hospital. Almost 90% of the patients were treated in a general hospital. Unicondylar knee arthroplasties were relatively often performed in private hospitals (18%) and relatively often in patients younger than 50 years. Two-thirds of the patients who underwent a total knee arthroplasty (TKA) in 2013 were female and the mean age was 68.2 years. Seventy percent of the patients who underwent a TKA in 2013 had an ASA score of II and 95% underwent a TKA after the diagnosis osteoarthritis. In 2010-2013, 51% of the implanted femoral components were cruciate retaining and 41% were posterior stabilized. Eight percent of the femoral components were unicondylar. In 2013, almost 90% of the primary knee prostheses were implanted cemented and in 20% of the arthroplasties, a patellar component was implanted. In 2010-2013, 97% of the implanted femoral components consisted of cobalt chrome; the tibial component consisted of either cobalt chrome (53%) or titanium (47%). The inserts and patellar components were usually made of standard PE. In 2010-2013, cement with gentamicin was used in 89% of all primary knee arthroplasties in which bone cement was used.

Patient characteristics varied considerably among hospitals. The median age varied between 58 and 73 years and the proportion of patients with an ASA score of I-II varied between 64% and 100%. The variations in type of knee prosthesis, fixation and use of a patellar component in 2013 were considerable. In 2013, more than 20% of the total number of primary knee arthroplasties was unicondylar in 11 hospitals. Twelve hospitals used uncemented or hybrid fixation in more than half of the primary knee arthroplasties and 13 hospitals implanted a patella during more than half of the primary knee arthroplasties in 2013.

Knee revision arthroplasty

In 2013, 2,215 knee revision arthroplasties were registered in 95 hospitals with a median number of 16 (range 1-242) per hospital. In 52% of the revision arthroplasties, a total system revision was performed and in 40% it was a partial revision arthroplasty. The insert was replaced in 75% of all knee revision arthroplasties and the patella was replaced in 36% of all revision arthroplasties. In 32% of the partial knee revision arthroplasties, only an insert was implanted and in 19% only a patella was implanted. The most common reasons for revising a knee prosthesis were instability (23%), loosening of the tibial component (27%), and patellar pain (25%).

New developments in the LROI

In August 2014, the Strategic Plan was presented, which described the vision, mission and main goals of the LROI organization. Since the summer of 2013, a range of variables was added to the database. These include smoking, body mass index (BMI), Charnley score, primary bone tumour and bone metastasis and several surgeries that may precede a knee arthroplasty. In September 2014, the LROI was extended with the date of death of people with a joint prosthesis. This date is necessary to determine the correct survival rate of a prosthesis (expected time to revision). Scientific regulations were developed which describe the criteria a study needs to fulfil and under what conditions data will be provided to an applicant. Furthermore, the LROI has been extended with the registrations of Patient Reported Outcome Measures (PROMs) as well as the registration of ankle, shoulder and elbow arthroplasties. Finally, this LROI report will be followed by a patient edition, so that information from the LROI can also be provided to the patient.

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Content

LROI data can inform patients about the prosthesis and the surgery

1 Introduction

The Dutch Arthroplasty Register (LROI) is a digital quality register of orthopaedic arthroplasties, performed in the Netherlands. By means of a continuous process of insight into and feedback on the results of joint implants, it contributes to the improvement of orthopaedic care in the Netherlands. The quality register was initiated in 2007 by the Netherlands Orthopaedic Association (NOV) and is a product of the LROI organization.

This third annual report of the LROI organization mainly focuses on patients who underwent hip or knee arthroplasty in 2013. The report consists of descriptive results: patient characteristics (e.g. age, ASA score [general health aspects] and diagnosis), but also hospital characteristics, including type and amount of hip and knee arthroplasties and surgical techniques including fixation method and surgical approach. In addition, descriptive results of the revision arthroplasties are presented, including the reasons for revision. New to this edition, is a description of the characteristics of the implanted hip and knee prostheses in the Netherlands. The type of prosthesis, the characteristics of the cement, the material and the name of the implanted prosthesis components are presented. Variations among hospitals are also shown in this report. Variations in patient characteristics (case mix), surgical techniques and implant characteristics will be considered. Data of hip and knee arthroplasties performed between 2010 and 2013 that were registered before September 1st 2014 were included in the analyses.

In 2014, the LROI organization has visited eleven hospitals to validate their data. During these hospital visits, an overview was created of the procedures that were not registered in the LROI. In addition, the data of a random selection of procedures were compared to data retrieved from the hospital information system. Discrepancies discovered during these visits were linked back to the relevant hospitals. Furthermore, an overview of the missing values in the entire LROI database was created and provided to the hospitals as feedback, which improved the data quality of the LROI database considerably. The findings are described in Chapter 2. The hospital visits will be continued over the next year and hospitals will again be supported in optimizing the quality of their data in the LROI.

Orthopaedic departments can compare the results of their hip and knee arthroplasties to national data through the online LROI dashboard (Figure 1.1) and prepare a plan for improvement of data collection, if necessary. In addition, the LROI is of importance to monitor the safety of joint implants for the benefit of the patients. In case of a problem with a prosthesis, it is known what hospitals have implanted this type of prosthesis. The LROI organization will inform the orthopaedic departments immediately and they can trace their patients subsequently.

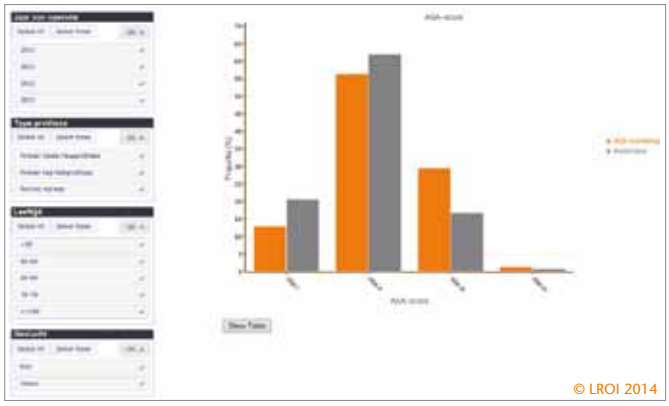


Figure 1.1 Example of the online LROI Dashboard with benchmarking information.

To guarantee traceability, it is important to know what implant was implanted in what patient in what hospital and at what time. All these factors are registered in the LROI by using the batch number (LOT number), the implant code (REF number), and patient identification through the encrypted personal identification number and the hospital patient number. Furthermore, surgical characteristics are registered, including the hospital and the date of surgery. This results in an optimum traceability of the implant (Figure 1.2).

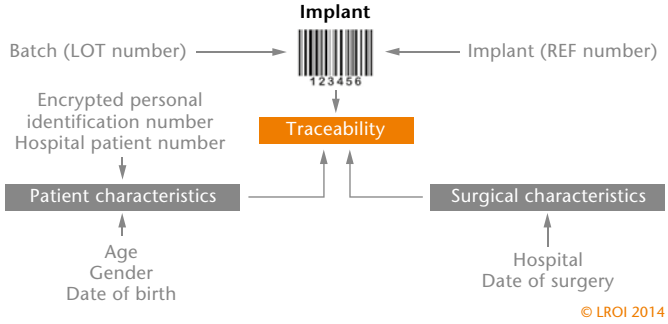


Figure 1.2 Traceability of joint implants in the LROI.

The LROI dataset is very well suited to conduct scientific research. The LROI provides a good source of data for research on hip and knee arthroplasties in the Netherlands with seven years of registration and national coverage. Furthermore, the LROI aims to educate and inform the Dutch general public and society on joint implant surgery.

Data are registered in the LROI about the patient (coded), the surgery and the joint prosthesis

2 LROI data quality

2.1 Number of registrations and number of registering hospitals

186,315 hip arthroplasties performed between January 1st 2007 and December 31st 2013 are registered in the LROI. Of all hip arthroplasties, 77% (n=141,075) was a primary total hip arthroplasty (THA) and 10% (n=19,049) was a hip revision arthroplasty. The number of resurfacing hip arthroplasties decreased to 1 in 2013 (Table 2.1). 137,026 knee arthroplasties are registered in the LROI, performed between January 1st 2007 and December 31st 2013. Of all knee arthroplasties, 83% (n=113,092) was a primary total knee arthroplasty (TKA), 7% (n=10,002) was a primary unicondylar knee arthroplasty, and 8% (n=10,448) was a knee revision arthroplasty (Table 2.2). Since 2010 the LROI is almost complete; therefore, a dotted line was drawn between 2009 and 2010. The number of arthroplasties registered in the LROI for the period 2007-2012 is somewhat higher than described in previous annual reports, since hospitals are still working on increasing the completeness of the register. As a result, some hospitals are supplementing the database in retrospect for the years 2007-2012.

Table 2.1 Number of registered hip arthroplasties per year of surgery.

		Type of hip arthroplasty			
Year of surgery	Total hip arthroplasty (n)	Hemiarthroplasty (n)	Resurfacing arthroplasty (n)	Other primary hip arthroplasty (n)	Revision arthroplasty (n)
2007	8,579	921	457	432	1,267
2008	14,516	1,379	717	452	1,813
2009	21,007	2,056	845	710	2,675
2010	22,932	2,328	599	698	2,940
2011	23,510	2,376	225	699	3,192
2012	24,889	2,748	11	640	3,708
2013	25,642	2,932	1	207	3,454
Total	141,075	14,740	2,855	3,838	19,049

Please note: In 5.1% (n=8,596) of primary hip arthroplasties, the type of hip arthroplasty is missing.

Table 2.2 Number of registered knee arthroplasties per year of surgery.

		Type of knee arthroplasty			
Year of surgery	Total knee arthroplasty (n)	Unicondylar knee arthroplasty (n)	Patellofemoral knee arthroplasty (n)	Other primary knee arthroplasty (n)	Revision arthroplasty (n)
2007	6,688	678	49	308	594
2008	10,942	1,115	93	314	878
2009	16,020	1,524	143	371	1,296
2010	17,872	1,697	162	389	1,617
2011	18,907	1,598	150	317	1,790
2012	21,009	1,586	189	290	2,058
2013	21,654	1,804	156	135	2,215
Total	113,092	10,002	942	2,124	10,448

Please note: In 3.2% (n=4,009) of primary knee arthroplasties, the type of knee arthroplasty is missing.

Table 2.3 Number of participating hospitals per year of surgery.

	Hip arthroplasty		Knee arthroplasty	
Year of surgery	Number (n)	Proportion[1] (%)	Number (n)	Proportion[2] (%)
2007	59	64	63	68
2008	87	96	88	96
2009	90	98	91	98
2010	91	99	92	99
2011	93	99	95	99
2012	95	100	100	100
2013	95	100	100	100

[1] Proportion of the total number of hospitals performing hip arthroplasties in the Netherlands (based on Vektis data (see box)).
[2] Proportion of the total number of hospitals performing knee arthroplasties in the Netherlands (based on Vektis data (see box)).

Since 2009, almost all hospitals register in the LROI (98%) and since 2012 all hospitals who performed hip (n=95) and/or knee arthroplasties (n=100) registered in the LROI (see Appendix I). These hospitals can be divided into general hospitals (n=81), university medical centres (UMCs) (n=8) and private hospitals (n=11).

2.2 Completeness

With an aim to determine whether the LROI is a correct and complete representation of the total number of implanted hip and knee replacements in the Netherlands, it is important to compare the registered arthroplasties to the total number of implanted hip and knee replacements in the Netherlands. This was done by comparing the number of hip and knee arthroplasties registered in the LROI with the number of arthroplasties performed according to the hospital information system of each hospital. Data collected by Vektis was used (see box) to determine the coverage (participation) of hospitals registering in the LROI. Vektis holds reimbursement data of hospitals who declared costs for hip and/or knee arthroplasties. Having a health insurance is mandatory in the Netherlands. With these data, Vektis is able to state with certainty which hospitals have performed hip and knee arthroplasties in 2013. This information was used to conclude that all Dutch hospitals that performed hip and/or knee arthroplasties in 2013 registered in the LROI.

The definitions used make it difficult to compare LROI data with data from the hospital information system (HIS). Despite establishing and communicating clear definitions, the definitions of the four categories of surgical procedures may be interpreted differently in various hospitals. This may have led to a discrepancy between the number of surgical procedures in the LROI and the HIS of a hospital. This is a problem for revision arthroplasties in particular (for both hips and knees), because it is a varied group of procedures in which one patient may have undergone multiple arthroplasties for the revision of one primary prosthesis.

Vektis is an organisation of health insurance companies. Vektis collects and analyses data on the costs and quality of health care in the Netherlands. Vektis data mainly originates from reimbursement files from health care insurers. Therefore, Vektis has national data on medication use and use of aiding devices, data on primary health care and data on Diagnosis Treatment Combinations in hospitals and any other types of insured care in the Netherlands. In addition, Vektis collects demographic data, based on surveys among insurers and results of quality studies.[1]

[1] www.vektis.nl

Of all hospitals who registered arthroplasties in the LROI in 2013 (n=100), 95 hospitals registered primary THAs and 94 hospitals registered hip revision arthroplasties in 2013. In total, 96% of the primary THAs and 88% of the hip revision arthroplasties were registered. All hospitals together (n=100) registered 96% of all primary knee arthroplasties and 95 hospitals registered knee revision arthroplasties. They registered 90% of all knee revision arthroplasties (Table 2.4). A completeness of over 90% was obtained in 93% of the participating hospitals in 2013 for primary THAs and in 94% of the participating hospitals for primary knee arthroplasties. In respect of hip revision arthroplasties, 88% of the hospitals had a completeness over 75%. In respect of knee revision arthroplasties, 85% of all hospitals had a completeness over 75%.

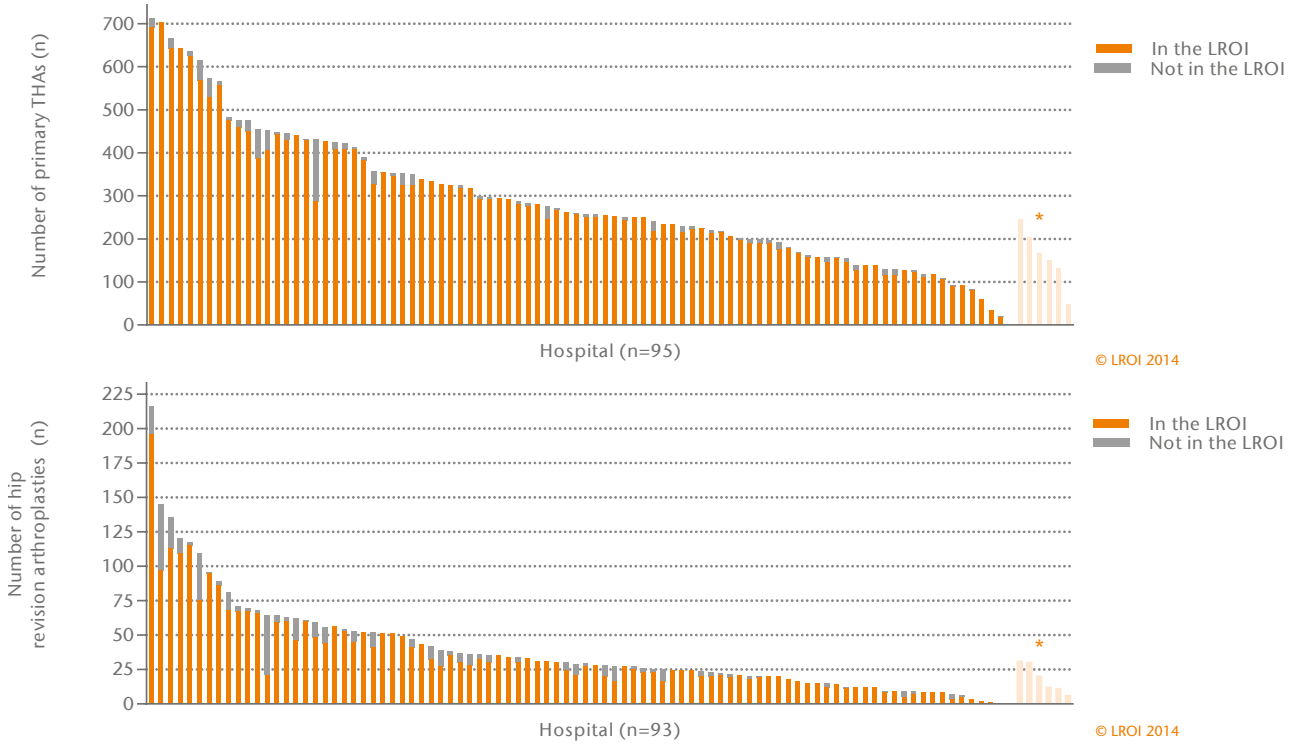


Figure 2.1 Number of procedures performed (based on the hospital information system) and the number of registered procedures in the LROI per hospital for primary total hip arthroplasties (THAs) and hip revision arthroplasties in 2013. * No data provided for comparison by the hospital.

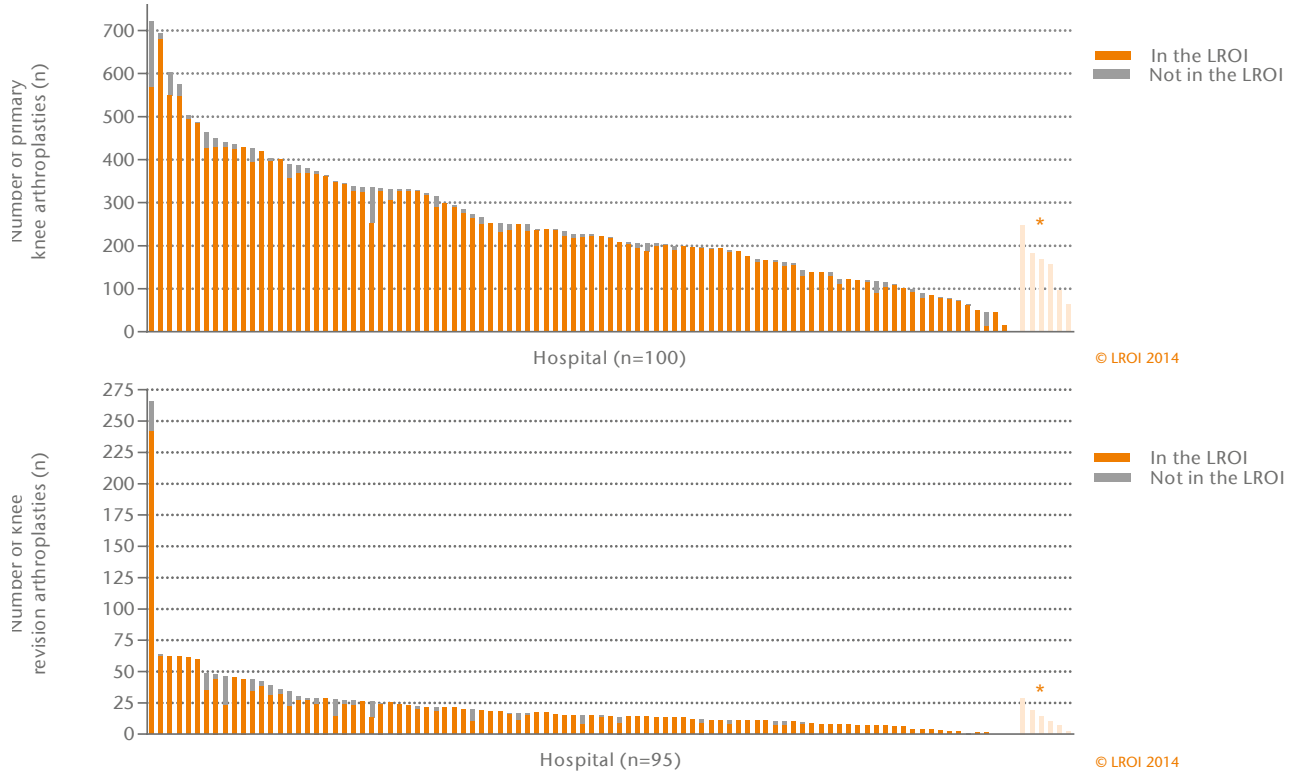


Figure 2.2 Number of procedures performed (based on the hospital information system) and the number of registered procedures in the LROI per hospital for primary knee arthroplasties and knee revision arthroplasties in 2013. * No data provided for comparison by the hospital.

Table 2.4 Completeness of the LROI in 2013, based on the hospital information system

	Hip		Knee	
	Primary total hip arthroplasty	Hip revision arthroplasty	Primary knee arthroplasty	Knee revision arthroplasty
Number of hospitals[1]	95	93	100	95
Completeness of participating hospitals	96%	88%	96%	90%

[1] Number of hospitals that implanted primary and/or revision knee arthroplasties in 2013.
Not all hospitals perform both hip and knee arthroplasties. This results in a discrepancy in number of hospitals.

Six hospitals performed hip and/or knee arthroplasties in 2013, but did not provide data from the hospital information system. Based on a comparison with Vektis data, the completeness for these hospitals was comparable to the average for 2012.

2.3 Validity

In order to obtain high quality registered data, it is important to identify and correct systematic registration errors and missing values. Therefore, we determined the proportions of missing and incorrect values for a number of important variables in the entire LROI database. These variables are date of birth, gender, encrypted personal identification number, hospital patient number, ASA score, diagnosis, reason for revision, type of prosthesis, conversion, fixation, and the product numbers of the prosthetic components used. Date of surgery, side of surgery, and type of surgery (primary or revision) are essential variables and therefore mandatory in the LROI. In addition, a random selection of procedures (n=355) was checked to examine whether the data entered into the database corresponded with the data on the registration form. In eleven hospitals with suboptimal completeness for 2012, reasons for the suboptimal completeness were determined and the quality of the registered data was examined.

The proportion of missing and incorrect values was less than 0.5% for most variables in the period 2007-2013. However, for the encrypted personal identification number the proportion of missing values was 17% and for the ASA score it was 10%. Diagnosis and fixation were missing in about 3% of the registered procedures, for both hip and knee arthroplasties. A clear improvement was visible over time. The proportion of missing values for the encrypted personal identification number decreased from 33% in 2007 to 9% in 2013 (Figure 2.3). Results of the random selection show that the data entry of the paper registration form into the database was generally very good, with only minor discrepancies.

2.4 In practice

Hospital visits showed that consistent and regular data entry of the LROI registration forms by one person or a small team leads to optimum registration in respect of completeness and validity. Incorporation of monitoring or self-monitoring moments is a useful aid. This can be done by e.g. counting the number of procedures per week or month on the operating schedule and comparing them to the number of procedures registered in the LROI. In addition, a structured manner of collecting and storing the LROI registration forms contributes to a complete and valid

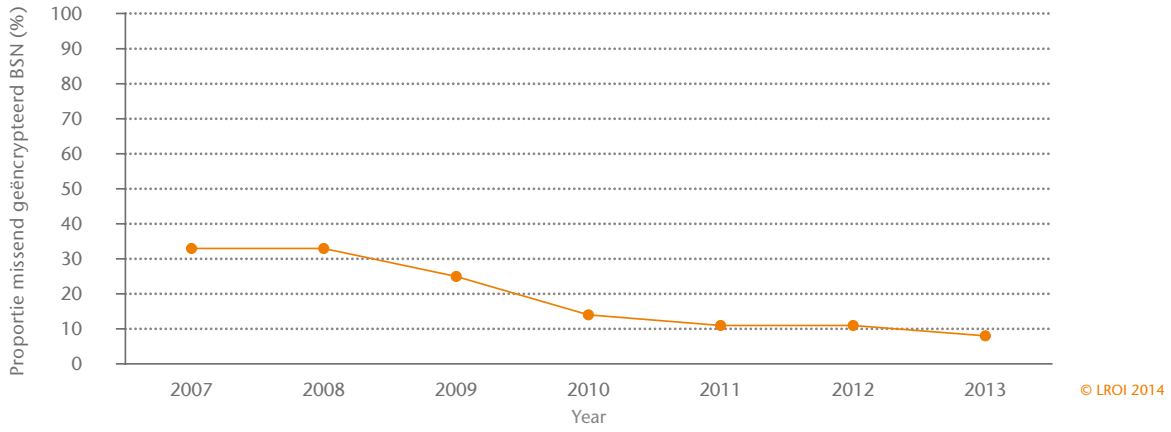


Figure 2.3 Proportion of missing values for encrypted personal identification numbers in the LROI in the period 2007-2013.

LROI database. As such, an overview can be retained and any ambiguities can be retrieved.

Primary arthroplasty: primary surgery performed to implant a prosthesis, replacing the natural joint.

Revision arthroplasty: any change (insertion, replacement and/or removal) of one or more components of the prosthesis.

For a valid database, it is of great importance to use the correct and complete definitions, so that all procedures will be registered or registered correctly. This applies primarily to the definitions of primary and revision procedures (see box). These were regularly misinterpreted.
Furthermore, procedures that were not registered in the LROI were often emergency surgeries, surgeries performed in holiday periods, or at the end of the day. In 2013, the encrypted personal identification number was not registered in the LROI for 9% of all procedures. The registration of the personal identification number, which is directly stored encrypted, is of great importance, because the encrypted personal identification number is used to link the primary and revision arthroplasties to a patient. This can only be done correctly when the encrypted personal identification number is known for all patients who underwent an arthroplasty. By using the encrypted personal identification numbers, arthroplasties performed in various hospitals can be linked to each other and survival of a prosthesis can be determined correctly. By emphasizing these focal points, all hospitals may further improve their registration. A summary of the general focal points, was published earlier this year in the NTvO[2] (Dutch only).

[2] Nederlands Tijdschrift voor Orthopaedie. September 2014, Volume 21, no. 3, p. 92-93.

In the operating room registration in the LROI begins with collecting data on the surgery, the prosthesis and the patient

3 Hip arthroplasty

3.1 Trends and associations of primary hip and hip revision arthroplasties

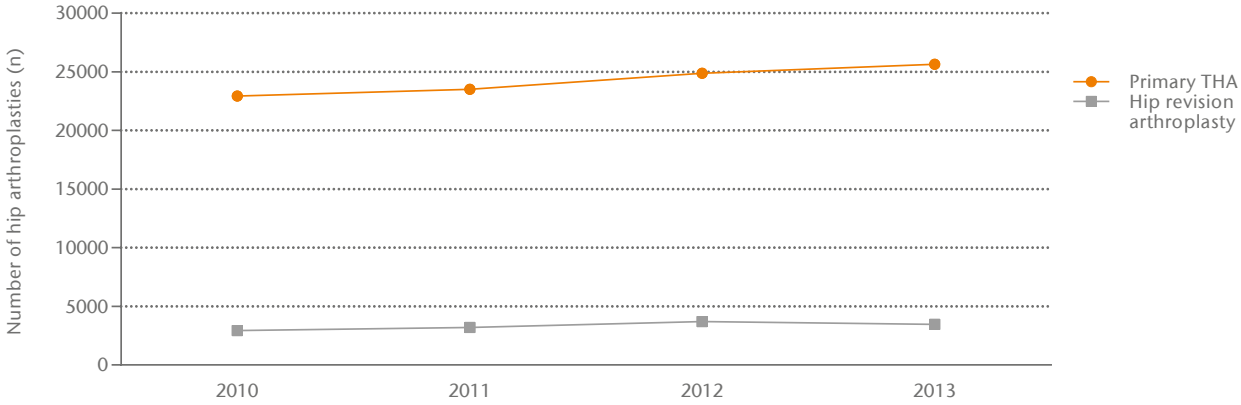
In 2010-2013, 96,973 primary THAs and 13,294 hip revision arthroplasties were registered in the LROI. The number of registered THAs slightly increased from 22,932 in 2010 to 25,642 in 2013 and the number of hip revision arthroplasties also increased from 2,940 in 2010 to 3,454 in 2013 (Figure 3.1). Of the 25,642 patients who underwent a primary THA in 2013, 13% (n=3,340) underwent a bilateral primary THA in 2013.

A distinction was made between general hospitals, university medical centres (UMCs) and private hospitals. In 2010-2013, 8 UMCs and 82 general hospitals performed THAs, of which one general hospital no longer performed primary THAs as of 2012. The number of private hospitals that performed primary THAs increased from 2 in 2010 to 6 in 2013. In general hospitals, 11% of all 25,960 hip arthroplasties were revision procedures, while 26% of the 1,308 hip arthroplasties in UMCs were revision procedures in 2013. In private hospitals, 5% of the hip arthroplasties were revision procedures (Figure 3.2).

3.2 Primary total hip arthroplasty

3.2.1 Demographics

The mean age of patients who underwent a primary THA in 2013 was 68.7 (standard deviation [SD] 10.7) years and approximately two thirds were female. Almost 70% of the patients were between 60 and 79 years old. Over 65% of patients who underwent a THA had an ASA score of II (moderately ill, not disabling) and the vast majority (87%) underwent a THA after an osteoarthritis diagnosis. Over 90% of the patients were treated in a general hospital (Table 3.2). Patients who underwent a THA as a result of a childhood condition – such as hip dysplasia or Perthes' disease – were

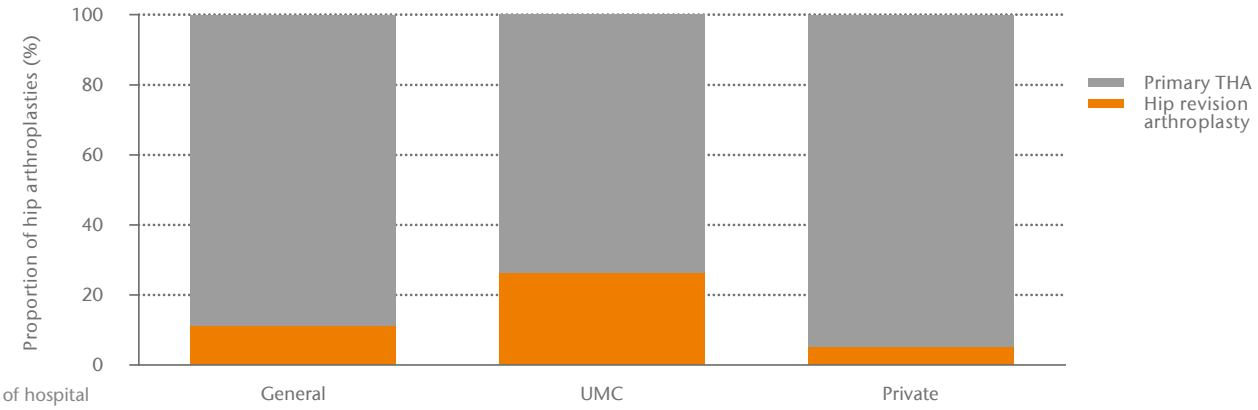


Type of procedure	2010	2011	2012	2013	Total
Primary THA (n)	22,932	23,510	24,889	25,642	96,973
Hip revision arthroplasty (n)	2,940	3,192	3,708	3,454	13,294

THA: total hip arthroplasty

Figure 3.1 Number of primary total hip arthroplasties (THAs) and hip revision arthroplasties, registered in the LROI in the Netherlands in 2010-2013.

the youngest patients of which 60% and 83% respectively were under 60 years of age (Table 3.1). In total, 58 patients (0.2%) underwent a primary THA as a result of a tumour. In 15 patients this was a primary tumour and in 33 patients it was a metastasis. For 10 procedures, it remained unspecified whether it was a primary tumour or a metastasis, because they



Type of procedure				Total
Primary THA (%)	88.7	73.6	95.0	88.2
Hip revision arthroplasty (%)	11.3	26.4	5.0	11.8
Total (n)	25,960	1,308	1,019	28,287

Please note: 208 primary hip arthroplasties (excluding hemiarthroplasties) were of a different type than THA.
General: general hospital; UMC: university medical centre; Private: private hospital; THA: total hip arthroplasty

Figure 3.2 Proportion of primary total hip arthroplasties (THAs) and hip revision arthroplasties by type of hospital in the Netherlands in 2013.

Table 3.1 Patient characteristics of all patients who underwent a total hip arthroplasty (THA) by diagnosis in the Netherlands in 2013.

	Osteoarthritis	**Dysplasia**	**Rheumatoid arthritis**	**Fracture**	**Osteonecrosis**	**Post-Perthes**	**Tumour**	**Late posttraumatic**	**Total**
N	19,131 (86.5%)	448 (2.0%)	194 (0.9%)	882 (4.0%)	648 (2.9%)	63 (0.3%)	58 (0.2%)	564 (2.6%)	22,110
Mean age (years) (SD)	69.4 (9.8)	56.2 (14.1)	64.0 (13.2)	70.4 (10.7)	61.8 (15.7)	48.7 (13.2)	62.9 (12.0)	66.6 (13.7)	68.7 (10.7)
Age (years) (%)									
<50	4	34	15	3	22	49	12	14	6
50-59	14	27	17	12	22	34	23	14	14
60-69	34	22	33	35	25	14	40	30	34
70-79	36	14	30	35	19	3	21	26	34
≥80	12	3	5	15	12	0	4	16	12
Gender (%)									
Men	34	34	19	34	47	62	42	41	34
Women	66	66	81	66	53	38	58	59	66
ASA-score (%)									
I	20	45	7	18	19	39	5	19	21
II	68	49	70	58	57	53	42	61	66
III-IV	12	6	23	24	24	8	53	20	13
Type of hospital (%)									
General	93	80	87	93	88	87	72	88	92
UMC	3	8	10	7	9	10	28	10	4
Private	4	12	3	0	3	3	0	2	4

In 2013, 125 (0.6%) patients received a primary THA after a diagnosis that is not described in the table.

THA: total hip arthroplasty; General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation

Table 3.2 Patient characteristics of all patients who underwent a primary total hip arthroplasty (THA) in the Netherlands in 2013.

	THA (n=22,302)
Completeness (%)	96%
Mean age (years) (SD)	68.7 (10.7)
Age (years) (%)	
<50	6
50-59	14
60-69	34
70-79	34
≥80	12
Gender (%)	
Men	34
Women	66
ASA-score (%)	
I	21
II	66
III-IV	13
Type of hospital[1] (%)	
General	92
UMC	4
Private	4
Diagnosis (%)	
Osteoarthritis	87
Dysplasia	2
Rheumatoid arthritis	1
Fracture (acute)	4
Osteonecrosis	3
Post-Perthes	0
Tumour	0
Late posttraumatic	2
Other	1

[1] In 2013, there were 8 UMCs; 81 general hospitals and 6 private hospitals performing primary THAs.
THA: total hip arthroplasty;
General: general hospital; UMC: university medical centre;
Private: private hospital; SD: standard deviation

were registered before mid-2013, when this specification was not yet registered in the LROI.

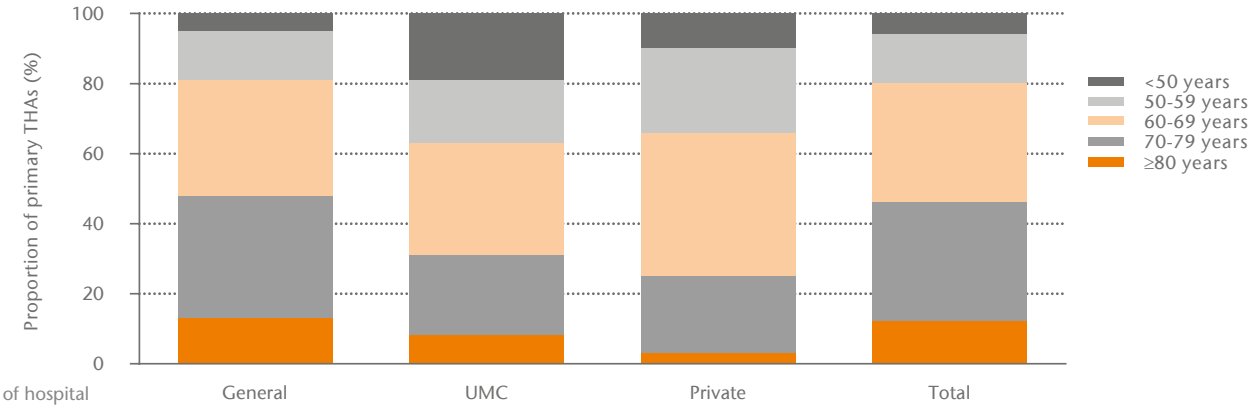
Women generally underwent a THA for the first time at an older age when compared to men (69.8 years [SD 10.4] in women versus 66.9 [SD 10.8] years in men) (Figure 3.3). In a UMC, 19% of the patients who underwent a THA were under 50 years of age. Almost 90% of the patients who were treated in a private hospital were aged between 50 and 79 years (Figure 3.4). In UMCs, patients who underwent a THA more frequently had a higher ASA score; 21% had an ASA score of III-IV (incapacitating systemic disease – life threatening illness). On the other hand, patients in private hospitals more often had a lower ASA score (Figure 3.5). Of all patients who underwent a THA in 2013, 5% had undergone a previous surgery to the same hip. In most cases, this was an osteosynthesis (Table 3.3).

Table 3.3 Previous surgeries to the same joint in patients who underwent a primary total hip arthroplasty (THA) in the Netherlands in 2013 (n=22,302).

	Proportion[1] (%)
Previous surgery to the same hip (total)	5.4
Osteosynthesis	4.0
Osteotomy	1.2
Arthrodesis	0.1
Girdlestone situation	0.1
Other	1.1

Please note: For 114 patients, it was unknown whether previous surgery had been performed to the same hip.
[1] A patient may have had multiple previous surgeries. Therefore, the total proportion adds up to more than 5.4% (proportion of patients with one or more previous surgeries to the same joint).

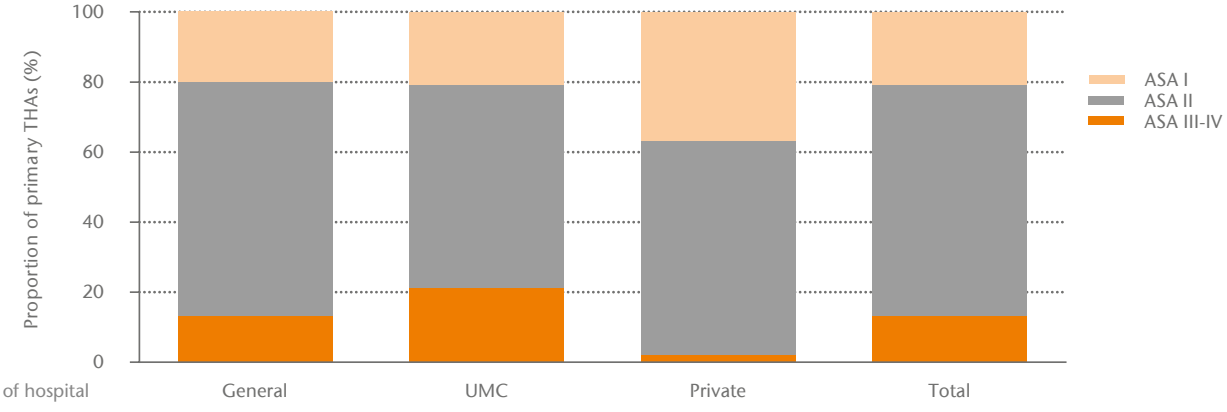
Figure 3.3 Age distribution of patients who underwent a primary total hip arthroplasty (THA) for the first time by gender in the Netherlands in 2013 (n=22,183).



Type of hospital	General	UMC	Private	Total
Age (years)				
<50 (%)	4.9	19.4	9.7	5.7
50-59 (%)	13.6	17.4	24.0	14.1
60-69 (%)	33.5	32.1	40.8	33.8
70-79 (%)	35.1	23.0	22.4	34.1
≥80 (%)	12.9	8.2	3.2	12.3
Total (n)	19,902	845	888	21,635

General: general hospital; UMC: university medical centre; Private: private hospital

Figure 3.4 Age distribution (proportion [%] per category) of patients who underwent a primary total hip arthroplasty (THA) for the first time by type of hospital in the Netherlands in 2013.



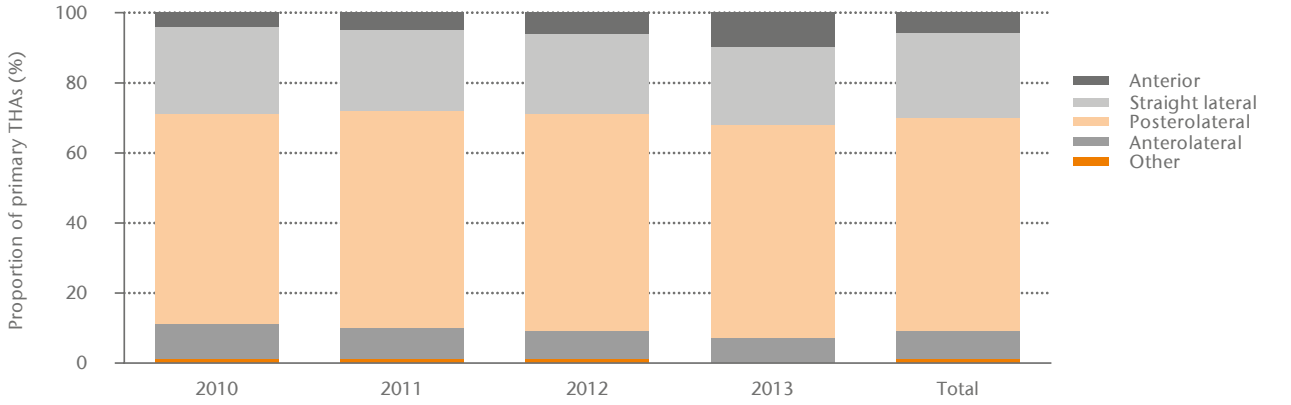
Type of hospital	General	UMC	Private	Total
ASA-score				
ASA I (%)	19.6	20.8	37.2	20.4
ASA II (%)	66.8	58.0	61.3	66.2
ASA III-IV (%)	13.6	21.2	1.5	13.4
Total (n)	19,707	834	883	21,424

General: general hospital; UMC: university medical centre; Private: private hospital

Figure 3.5 ASA score (proportion [%] per category) of patients who underwent a primary total hip arthroplasty (THA) for the first time by type of hospital in the Netherlands in 2013.

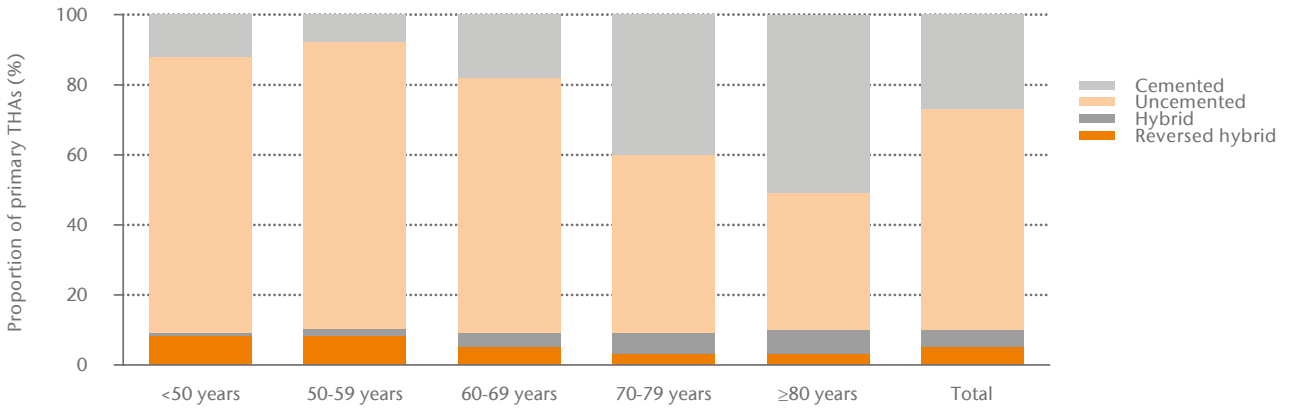
3.2.2 Prosthesis characteristics and surgical techniques

The most frequently used surgical approach during primary THAs was posterolateral (61%), followed by the straight lateral approach (24%). The use of the anterior approach increased from 4% in 2010 to 10% in 2013 (Figure 3.6). In 2013, most (63%) primary total hip prostheses (THPs) were uncemented, and almost 30% were cemented. In younger patients, a THP was implanted more frequently uncemented compared to THPs in older patients, in both men and women. In younger patients (<50 years), reversed hybrid fixation was used in 8% of the primary THAs, while reversed hybrid fixation was used in 3% of the primary THAs performed on patients aged ≥80 years. This



Year	2010	2011	2012	2013	Total
Surgical approach					
Anterior (%)	4.2	4.9	6.0	9.9	6.3
Straight lateral (%)	25.6	23.3	23.1	21.9	23.5
Posterolateral (%)	59.9	62.2	62.0	61.3	61.4
Anterolateral (%)	9.7	8.7	7.9	6.6	8.2
Other (%)	0.7	0.9	0.9	0.3	0.7
Total (n)	22,788	23,351	24,764	25,538	96,441

Figure 3.6 Trend (proportion [%] per year) in surgical approach for performing a primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.

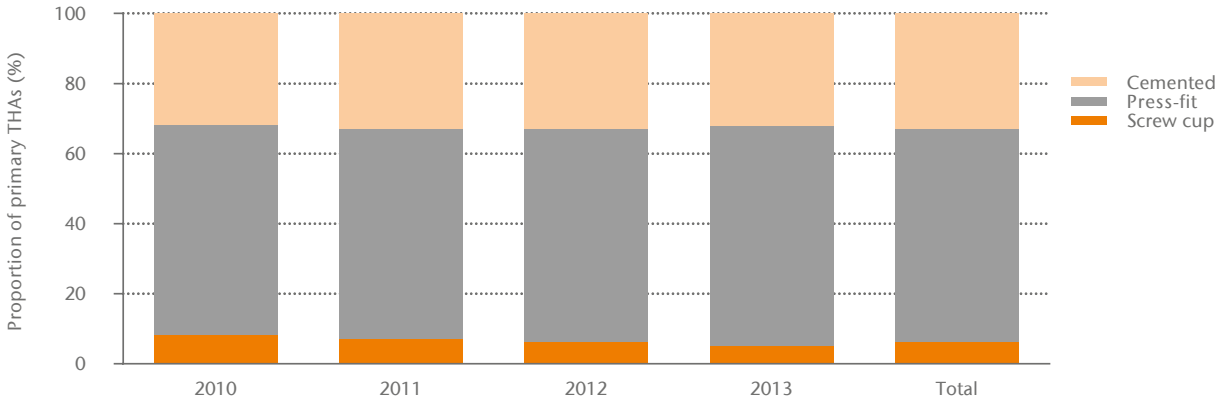


Age	<50 years	50-59 years	60-69 years	70-79 years	≥80 years	Total
Fixation						
Cemented (%)	11.5	8.2	18.1	39.6	50.9	27.7
Uncemented (%)	78.8	82.2	72.6	51.1	38.8	62.8
Hybrid (%)	1.4	2.2	3.8	6.2	7.2	4.7
Reversed hybrid (%)	8.3	7.5	5.5	3.1	3.1	4.8
Total (n)	1,421	3,586	8,620	8,741	3,104	25,472

Figure 3.7 Type of fixation (proportion [%] per category) used during primary total hip arthroplasties (THAs) by age category in the Netherlands in 2013.

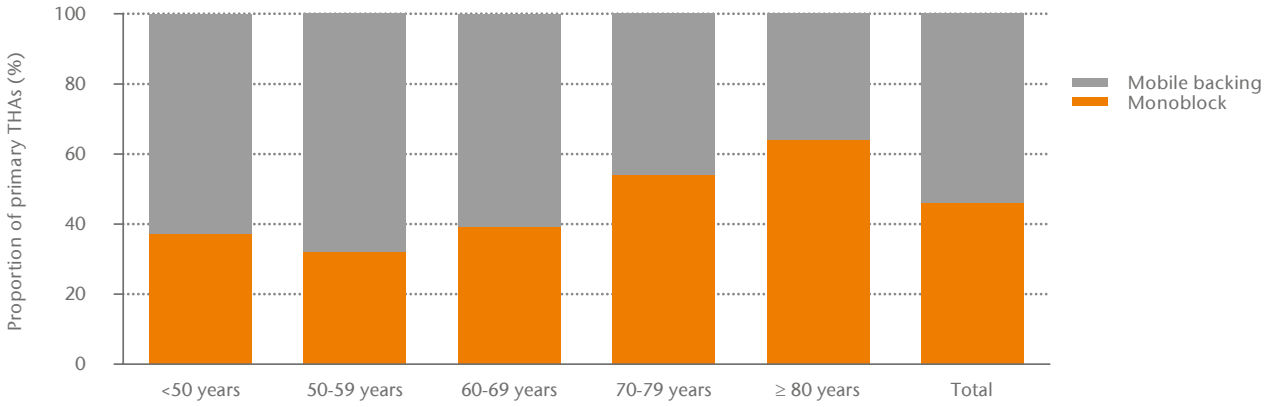
latter group more frequently received a hybrid implanted THP in comparison with younger patients (7% versus 1%) (Figure 3.7). In men, an uncemented THP was implanted slightly more often than in women (69% versus 60%).

Approximately one third of the acetabular components were intended for cemented fixation. The vast majority of the acetabular components were clamped into the acetabulum (press-fit) and a small part of the acetabular components were screw cups. The proportion of press-fit cups increased slightly, while the proportion of screw cups decreased over the period 2010-2013 (Figure 3.8). In 46% of the acetabular components, a monoblock component was used, and no insert was used. In the other 54%, the acetabular component had a separate insert, functioning as a bearing (articulation). In older patients, a monoblock component was used more frequently compared to procedures in younger patients (36% versus 63%) (Figure 3.9). The vast majority (96%) consisted of polyethylene (PE)



Year	2010	2011	2012	2013	Total
Type of acetabulum					
Cemented (%)	32.2	32.7	33.3	32.0	32.5
Press-fit (%)	59.8	60.3	60.5	62.9	60.9
Screw cup (%)	7.9	7.1	6.3	5.1	6.5
Total (n)	22,340	22,676	24,057	25,077	94,150

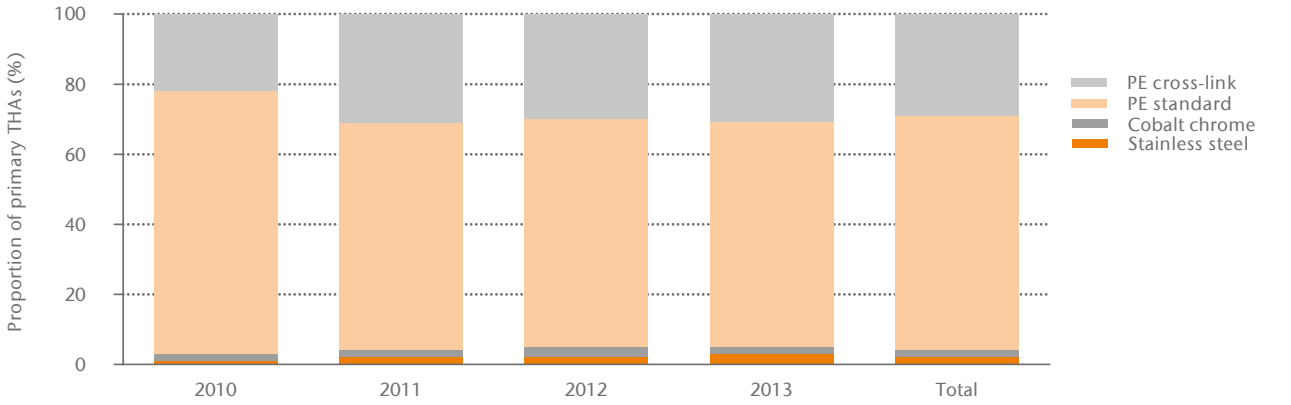
Figure 3.8 Trend (proportion [%] per year) in type of acetabular components implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.



Age	<50 years	50-59 years	60-69 years	70-79 years	≥ 80 years	Total
Type of acetabulum						
Mobile backing (%)	63.1	68.0	60.9	45.9	36.1	53.9
Monoblock (%)	36.9	32.0	39.1	54.1	63.9	46.1
Total (n)	1,402	3,522	8,481	8,586	3,016	25,007

Figure 3.9 Type of acetabular component (proportion [%] per category) implanted during primary total hip arthroplasty (THA) by age category in the Netherlands in 2013.

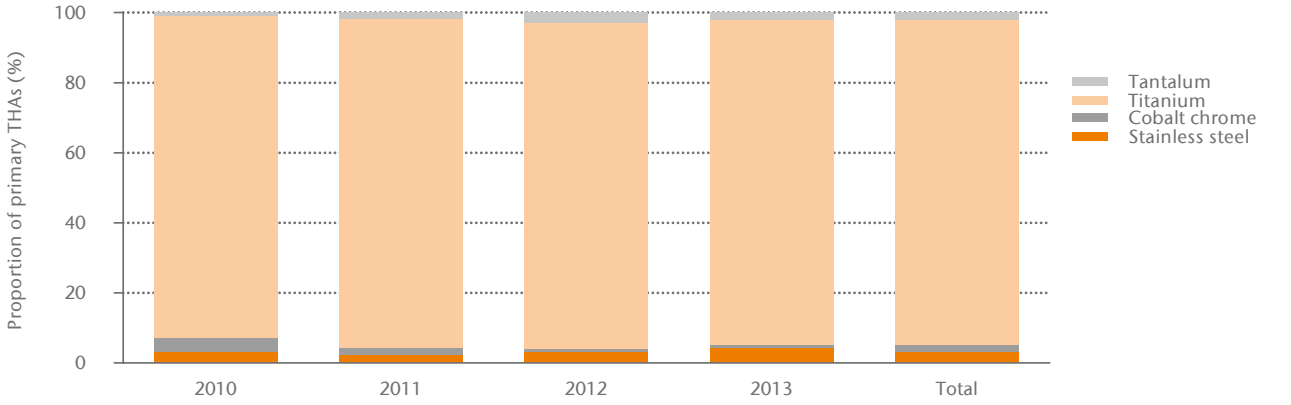
of the acetabular components intended for cemented fixation with an increase of the proportion cross-linked PE from 23% in 2010 to 31% in 2013 (Figure 3.10a). The vast majority of acetabular components intended for uncemented fixation, consisted of titanium (93%) (Figure 3.10b). Over 80% of the implanted inserts consisted of PE. In 2010, 45% of the used inserts consisted of cross-linked PE, which increased to 72% in 2013. The proportion of standard PE inserts decreased from



Year	2010	2011	2012	2013	Total
Material cemented acetabulum					
PE cross-link (%)	22.5	31.1	30.4	31.0	28.9
PE standard (%)	74.6	65.2	64.9	63.9	67.0
Cobalt chrome (%)	1.6	2.3	2.5	1.8	2.0
Stainless steel (%)	1.3	1.4	2.3	3.2	2.1
Total (n)	7,207	7,403	8,006	8,058	30,674

PE: polyethylene

Figure 3.10a Trend (proportion [%] per year) in material for cemented acetabular components implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.

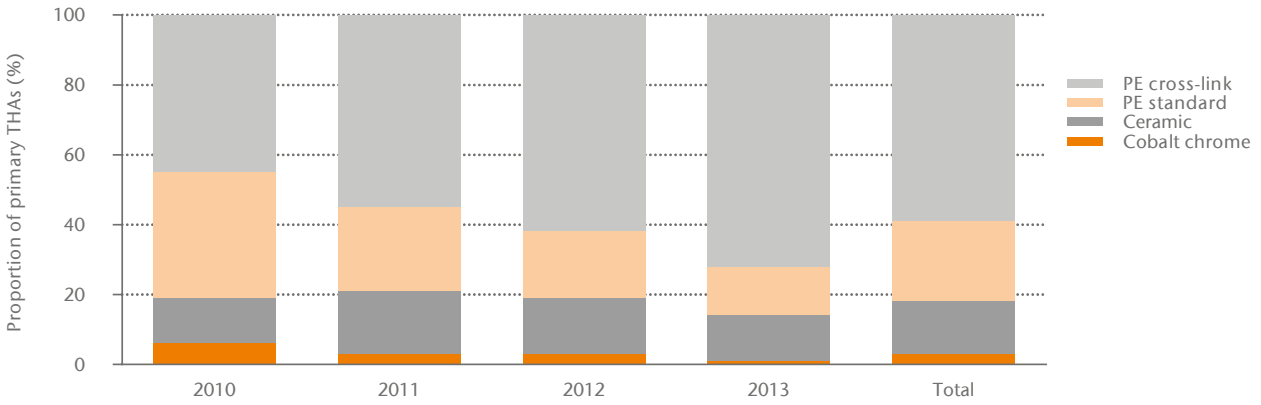


Year	2010	2011	2012	2013	Total
Material uncemented acetabulum					
Tantalum (%)	1.3	2.0	2.7	1.9	2.0
Titanium (%)	92.4	93.9	93.3	93.6	93.3
Cobalt chrome (%)	3.7	1.9	0.7	0.8	1.7
Stainless steel (%)	2.5	2.3	3.2	3.8	3.0
Total (n)	15,012	15,028	15,840	16,911	62,791

Figure 3.10b Trend (proportion [%] per year) in material for uncemented acetabular components implanted during total hip arthroplasty (THA) in the Netherlands in 2010-2013.

36% in 2010 to 14% in 2013. Inserts that consisted of cobalt chrome were also implanted less frequently since 2010 (Figure 3.11).

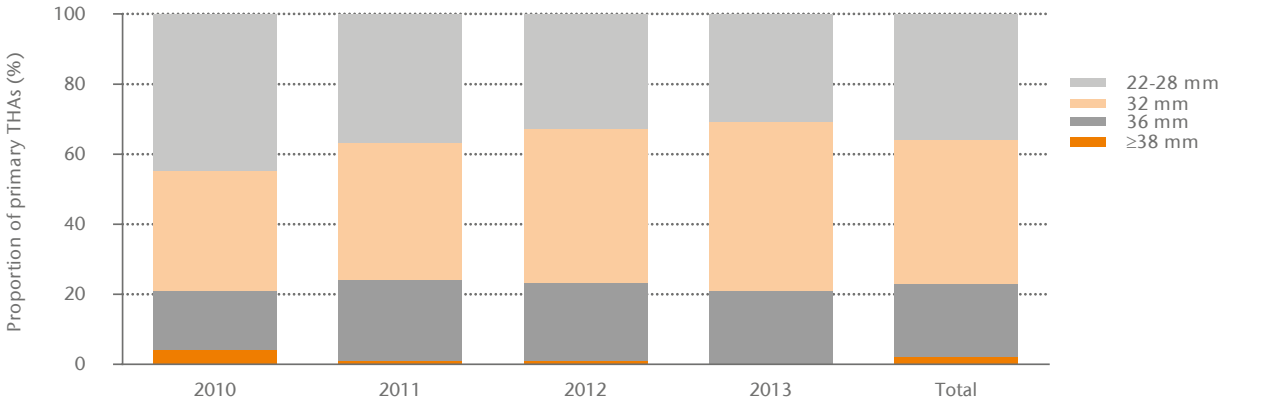
In the period 2010-2013, a trend emerged over time in which the number of implanted femoral heads with a diameter of 22-28 mm decreased (from 45% in 2010 to 31% in 2013) and more



Year	2010	2011	2012	2013	Total
Material insert					
PE cross-link (%)	45.0	55.0	62.3	71.8	59.3
PE standard (%)	36.1	23.9	19.2	14.3	22.7
Ceramic (%)	13.3	17.7	15.9	12.7	14.9
Cobalt chrome (%)	5.5	3.3	2.6	1.2	3.0
Total (n)	12,477	13,988	14,935	15,572	56,972

PE: polyethylene

Figure 3.11 Trend (proportion [%] per year) in material for inserts implanted during total hip arthroplasty (THA) in the Netherlands in 2010-2013.

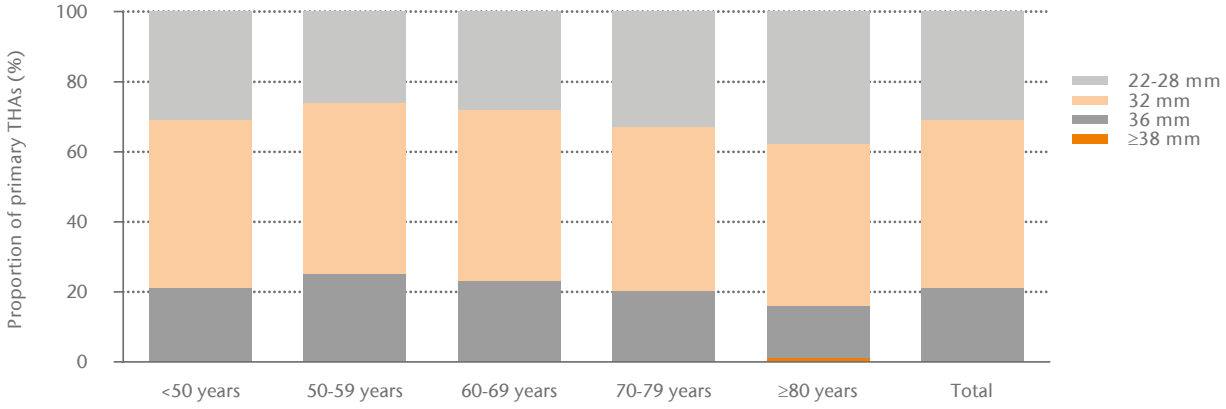


Year	2010	2011	2012	2013	Total
Diameter femoral head					
22-28 mm (%)	45.4	36.5	33.3	30.8	36.2
32 mm (%)	33.5	38.7	43.7	47.6	41.1
36 mm (%)	17.5	23.5	22.3	21.2	21.2
≥38 mm (%)	3.6	1.4	0.8	0.4	1.5
Totaal (n)	22,263	22,660	24,202	25,259	94,384

Figure 3.12 Trend (proportion [%] per year) in the diameter of femoral heads implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.

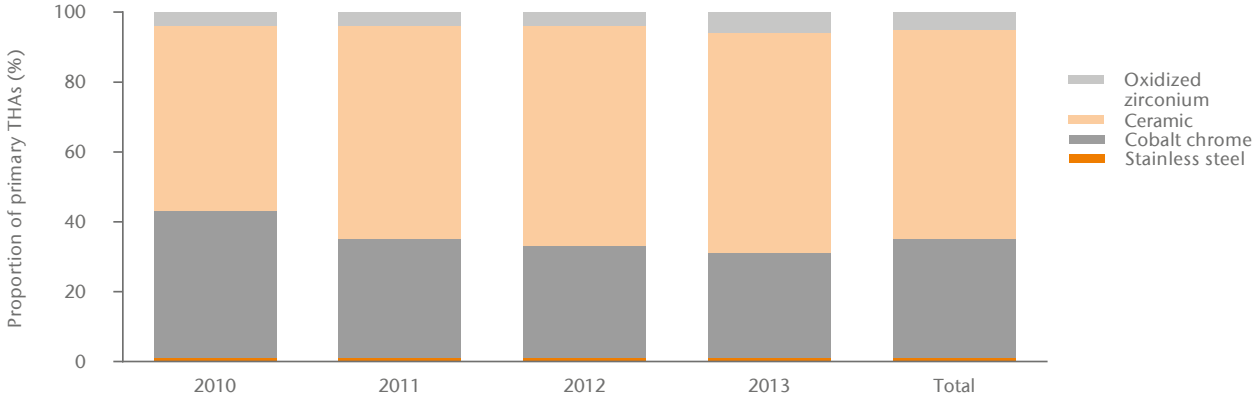
femoral heads with a diameter of 32 or 36 mm were implanted (Figure 3.12). Older patients more often received a femoral head with a smaller diameter than younger patients during primary THA (Figure 3.13).

The proportion of femoral heads that consist of ceramic increased from 53% in 2010 to 63% in 2013, while the proportion of femoral heads that consist of cobalt chrome, decreased from 42% in 2010 to 30% in 2013 (Figure 3.14). The femoral



Age	<50 years	50-59 years	60-69 years	70-79 years	≥80 years	Total
Diameter femoral head						
22-28 mm (%)	31.0	26.4	27.7	33.0	38.0	30.8
32 mm (%)	48.2	48.9	48.6	46.9	45.6	47.7
36 mm (%)	20.5	24.5	23.5	19.8	15.4	21.2
≥38 mm (%)	0.3	0.3	0.3	0.3	0.9	0.4
Total (n)	1,402	3,544	8,524	8,653	3,069	25,192

Figure 3.13 Diameter of femoral heads (proportion [%] per category) implanted during primary total hip arthroplasty (THA) per age category in the Netherlands in 2013.



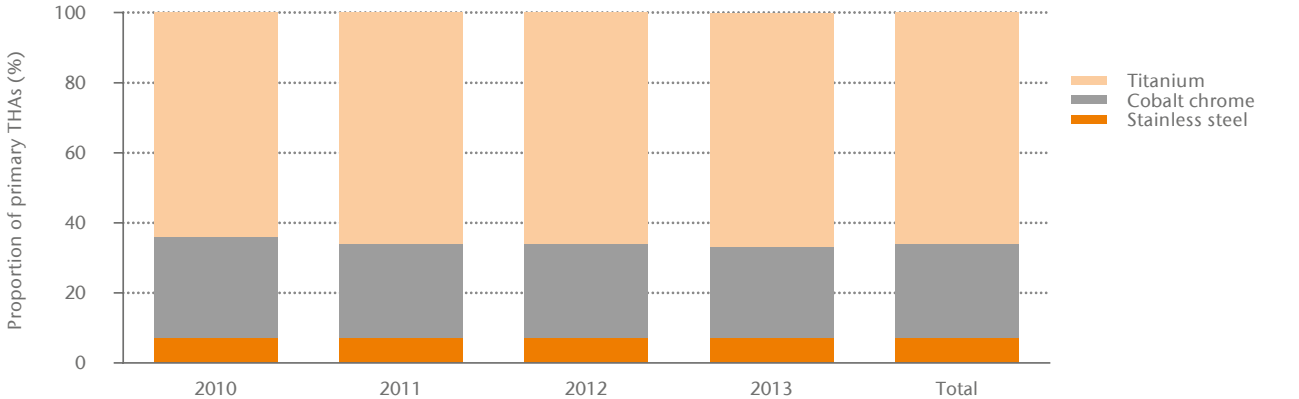
Year	2010	2011	2012	2013	Total
Material femoral head					
Oxidized zirconium (%)	4.7	4.7	4.8	5.7	5.0
Ceramic (%)	52.8	60.7	62.6	63.0	60.0
Cobalt chrome (%)	41.5	33.9	31.8	30.4	34.2
Stainless steel (%)	1.1	0.6	0.8	0.8	0.8
Total (n)	22,262	22,661	24,218	25,320	94,461

Please note: During 17 primary THAs a femoral head component consisting of titanium was implanted, of which one with a hardened layer.

Figure 3.14 Trend (proportion [%] per year) in material for femoral head components implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.

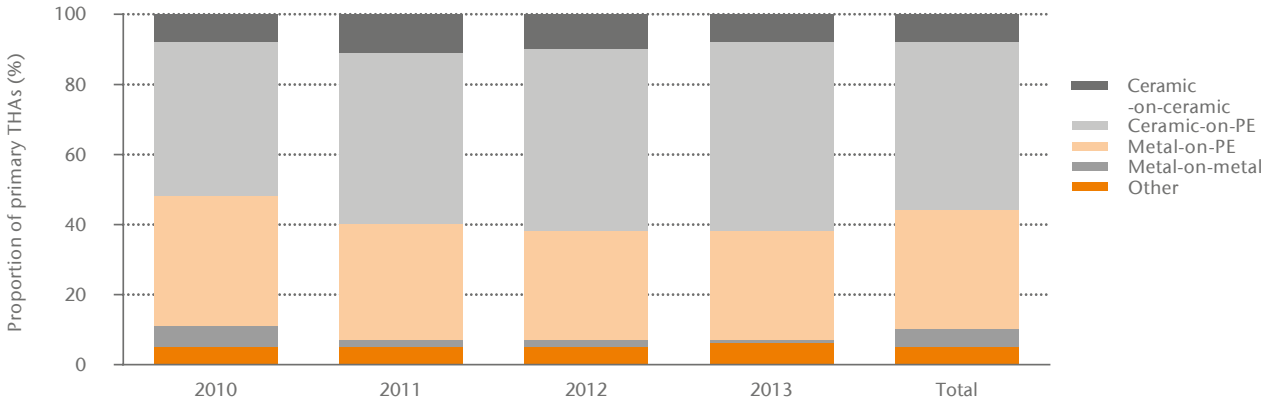
components implanted during primary THA often consisted of titanium (66%) or cobalt chrome (27%) in the period 2010-2013, which is fairly stable over time (Figure 3.15).

Ceramic-on-PE was the most frequently used articulation for primary THAs in the Netherlands in 2010-2013. In this period, an articulation consisting of a ceramic femoral head and a PE insert or PE acetabular component was used in 48% of the THAs. This increased from 44% in 2010 to 55% in 2013. The proportion of metal-on-metal articulations decreased from 6% in 2010 to less than 1% in 2013 (Figure 3.16). For THAs, the metal-on-PE articulations were used more often in older patients in 2013, while ceramic-on-PE and ceramic-on-ceramic articulations were used more often in younger patients (Figure 3.17).



Year	2010	2011	2012	2013	Total
Material femur					
Titanium (%)	64.0	65.9	66.1	67.0	65.8
Cobalt chrome (%)	28.5	27.2	26.8	26.0	27.1
Stainless steel (%)	7.4	6.8	7.1	7.0	7.1
Total (n)	22,382	23,095	24,362	25,270	95,109

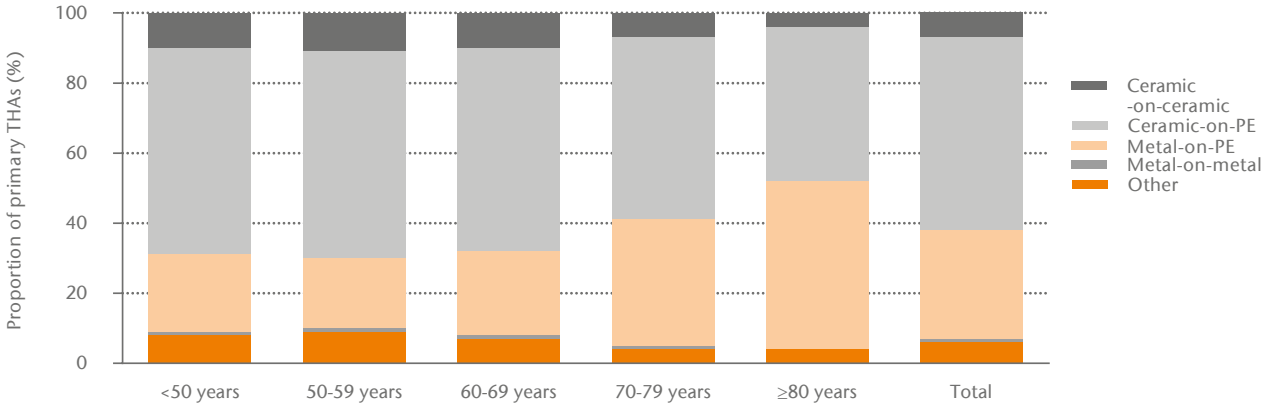
Figure 3.15 Trend (proportion [%] per year) in material for femoral components implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.



Articulation					
Ceramic-on-ceramic (%)	8.0	11.1	10.0	8.1	7.8
Ceramic-on-PE (%)	44.0	49.1	52.4	54.6	47.7
Metal-on-PE (%)	37.2	32.4	30.9	30.6	34.5
Metal-on-metal (%)	5.8	2.5	1.7	0.8	4.9
Other (%)	5.0	4.9	5.0	5.9	5.1
Total (n)	21,472	21,921	23,515	24,634	91,542

Please note: Of 8,404 primary THAs no articulation could be determined, because not all components were implanted and/or registered.
PE: polyethylene; THA: total hip arthroplasty

Figure 3.16 Trend (proportion [%] per year) in articulation of components implanted during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.

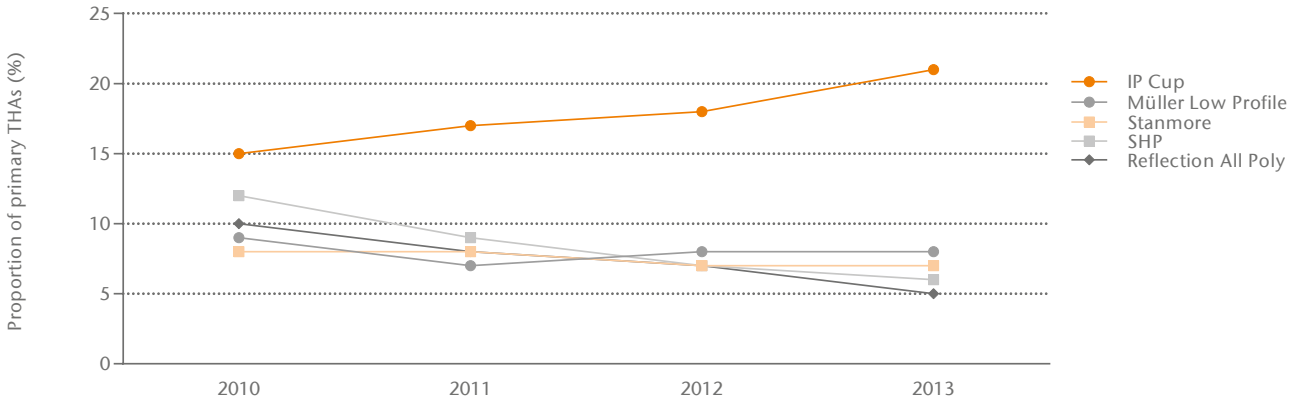


Articulation						
Ceramic-on-ceramic (%)	10.4	10.9	9.5	6.5	4.1	8.1
Ceramic-on-PE (%)	58.4	59.0	58.2	52.3	43.9	54.6
Metal-on-PE (%)	22.1	20.3	24.5	36.4	47.5	30.7
Metal-on-metal (%)	0.9	1.0	1.1	0.6	0.4	0.8
Other (%)	8.2	8.7	6.7	4.2	4.1	5.9
Total (n)	1,350	3,435	8,337	8,463	2,983	24,568

Please note: Of 1,069 primary THAs no articulation could be determined, because not all components were implanted and/or registered.
PE: polyethylene; THA: total hip arthroplasty

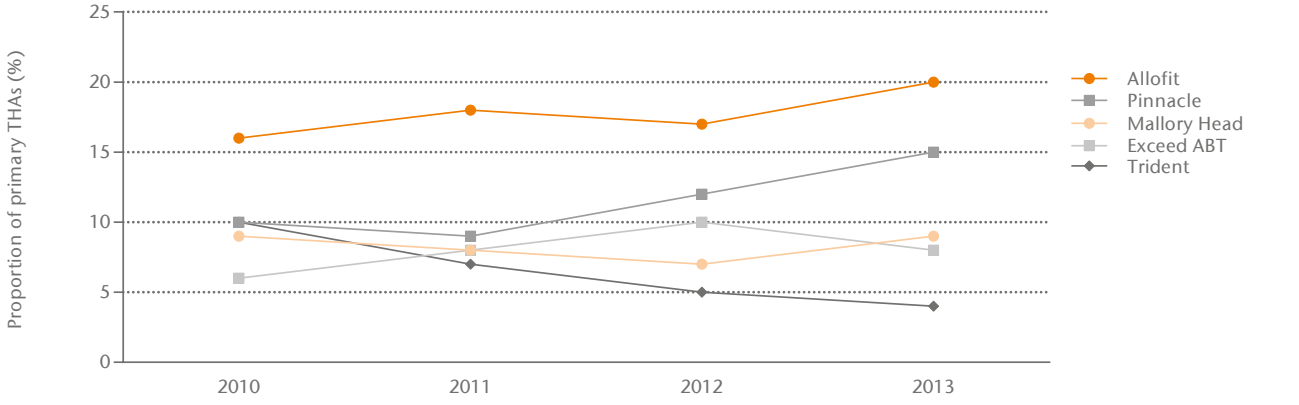
Figure 3.17 Articulation (proportion [%] per category) of components implanted during primary total hip arthroplasty (THA) by age category in the Netherlands in 2013.

Trends in the implanted cemented and uncemented acetabular and femoral components implanted during primaire THAs in the period 2010-2013 show that each year one type was clearly used most frequently for each category, with exception of the uncemented femoral components. The four most frequently registered types of femoral components were each used in 11-15% of all components used (Figures 3.18a and b and 3.19a and b).



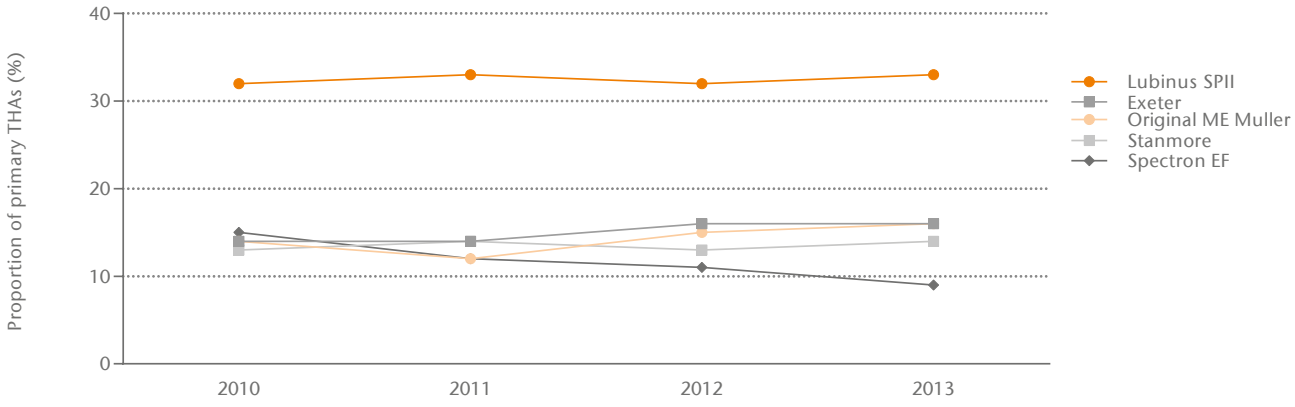
Year	2010	2011	2012	2013
Cemented acetabulum				
IP Cup (%)	15.8	17.7	18.4	21.0
Müller Low Profile (%)	9.1	7.0	8.4	8.3
Stanmore (%)	8.0	8.6	7.5	7.4
SHP (%)	12.6	9.8	7.9	6.0
Reflection All Poly (%)	10.0	8.6	7.8	5.0
Total (n)	6,120	6,357	6,810	6,754

Figure 3.18a Trend (proportion [%] per year) in the five most frequently used cemented acetabular components implanted during primary total hip arthroplasty (THA) for patients with osteoarthritis in the Netherlands in 2010-2013 (n=26,041).



Year	2010	2011	2012	2013
Uncemented acetabulum				
Allofit (%)	16.1	18.1	18.0	20.3
Pinnacle (%)	10.7	9.9	12.4	15.8
Mallory Head (%)	9.4	8.4	8.0	9.3
Exceed ABT (%)	6.1	8.7	10.5	8.8
Trident (%)	10.4	7.8	5.8	4.5
Total (n)	12,994	13,318	14,202	14,935

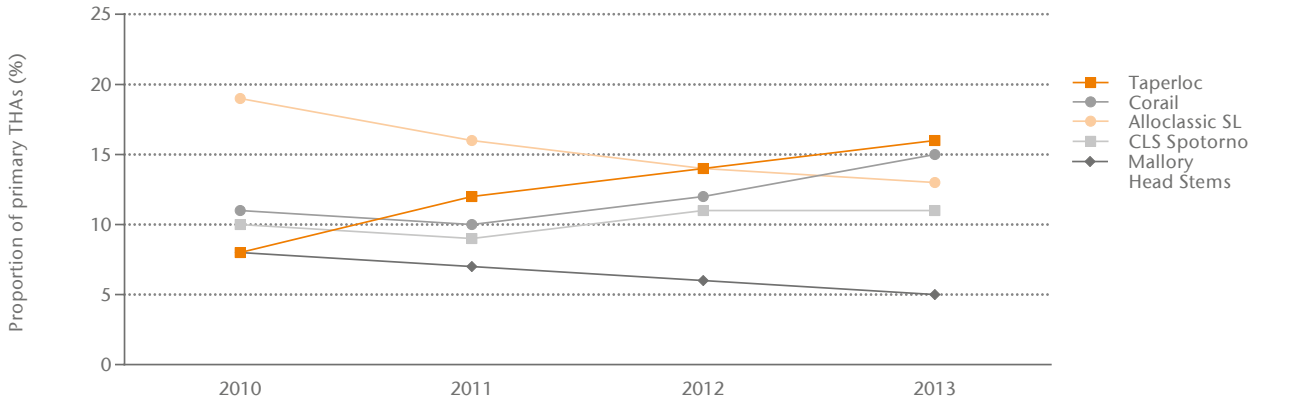
Figure 3.18b Trend (proportion [%] per year) in the five most frequently registered uncemented acetabular components implanted during primary total hip arthroplasty (THA) in patients with osteoarthritis in the Netherlands in 2010-2013 (n=55,459).



Cemented femur

	2010	2011	2012	2013
Lubinus SPII (%)	32.8	33.9	32.7	33.6
Exeter (%)	14.6	14.2	16.4	16.9
Original ME Muller (%)	14.1	12.6	15.5	16.4
Stanmore (%)	13.2	14.3	13.6	14.5
Spectron EF (%)	15.0	12.9	11.4	9.7
Total (n)	6,509	6,594	6,877	6,906

Figure 3.19a Trend (proportion [%] per year) in the five most frequently registered cemented femoral components implanted during primary total hip arthroplasty (THA) in patients with osteoarthritis in the Netherlands in 2010-2013 (n=26,886).



Uncemented femur

	2010	2011	2012	2013
Taperloc (%)	8.2	13.0	14.6	16.0
Corail (%)	11.0	10.6	12.8	15.6
Alloclassic SL (%)	19.0	16.6	14.7	13.0
CLS Spotorno (%)	10.0	9.9	11.5	11.1
Mallory Head Stems (%)	8.8	7.5	7.0	5.8
Total (n)	12,589	13,409	14,300	14,842

Figure 3.19b Trend (proportion [%] per year) in the five most frequently registered uncemented femoral components implanted during primary total hip arthroplasty (THA) in patients with osteoarthritis in the Netherlands in 2010-2013 (n=55,140).

In 2013, 8,053 cemented (52 different components) and 16,941 uncemented (55 different components) acetabular components and 8,192 cemented (43 different components) and 16,928 uncemented (59 different components) femoral components were implanted during primary THAs. Table 3.4 summarizes the ten most frequently registered acetabular and femoral components. A distinction is made between components that are implanted with cement and components that are implanted uncemented (as indicated by the orthopaedic department).

During the vast majority of the THAs performed in 2010-2013, bone cement with gentamicin was used (Figure 3.20) and in 2013, the vast majority of the bone cement had a high viscosity (87%) (Figure 3.21). In 2013, 14 types of bone cement were used to fixate primary THPs in the Netherlands. Table 3.5 shows the five types of bone cement that were registered most frequently in 2013.

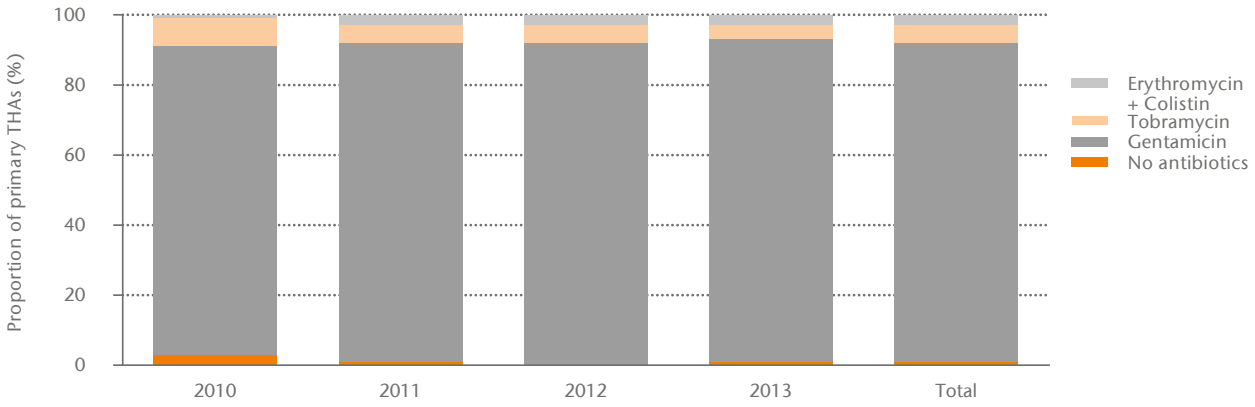
Table 3.4 The ten most frequently registered acetabular components (cemented and uncemented) and femoral components (cemented and uncemented) implanted during primary total hip arthroplasty (THA) for all diagnoses in the Netherlands in 2013.

Acetabular component (n=25,077)

Cemented (n=8,053)		Uncemented (n=16,941)	
Name	Proportion (%)	Name	Proportion (%)
IP Cup	20.8	Allofit	20.6
Müller Low Profile	8.4	Pinnacle	15.2
Durasul	8.4	Mallory Head	9.3
Stanmore	6.8	Exceed ABT	8.7
SHP	5.6	Trident Tritanium	7.1
Exeter Rimfit	5.3	RM Pressfit Cup	7.1
Reflection All Poly	5.0	R3	5.1
FAL Cup	4.8	Trident	4.7
Contemporary Hooded	4.6	Reflection	4.4
Exeter Contemporary Flanged	4.0	Bicon Plus	3.3

Femoral component (n=25,213)

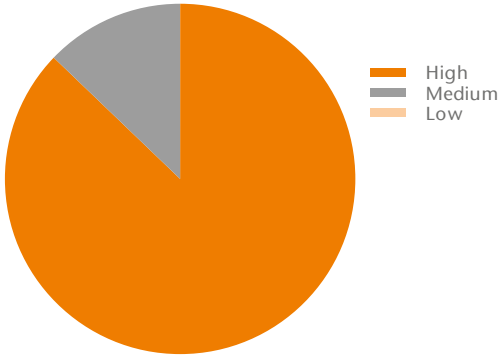
Cemented (n=8,192)		Uncemented (n=16,928)	
Name	Proportion (%)	Name	Proportion (%)
Lubinus SPII	33.2	Taperloc	15.8
Exeter	17.6	Corail	15.1
Original ME Muller	16.4	Alloclassic SL	13.4
Stanmore	14.3	CLS Spotorno	11.0
Spectron EF	9.4	Accolade	8.3
CCA Stem	2.2	SL Plus	6.8
Charnley Mod	2.1	Mallory Head Stems	6.1
Taperloc	1.0	Twinsys Stem	4.1
Twinsys Stem	0.6	Synergy	3.9
OHST Müller	0.5	CBH Stem	2.4



Antibiotics bone cement					
Erythromycin + Colistin (%)	1.0	2.7	2.9	3.1	2.5
Tobramycin (%)	7.5	5.0	4.6	4.1	5.2
Gentamicin (%)	87.8	90.6	91.9	92.1	90.7
No antibiotics (%)	3.4	1.5	0.4	0.3	1.3
Total (n)	7,802	8,277	8,895	9,183	34,157

Please note: During 2 (<0.01%) primary THAs, bone cement with gentamicin and vancomycin was used. During 86 (0.3%) primary THAs, bone cement with gentamicin and clindamycin was used.

Figure 3.20 Trend (proportion [%] per year) in antibiotics in bone cement used during primary total hip arthroplasty (THA) in the Netherlands in 2010-2013.



Viscosity	Number (n)	Proportion (%)
High	7,931	87.2
Medium	1,166	12.8
Low	1	0.0

Figure 3.21 Viscosity of bone cement used during primary total hip arthroplasty (THA) in the Netherlands in 2013 (n=9,098).

Table 3.5 The five most frequently registered types of bone cement used during primary total hip arthroplasty (THA) in the Netherlands in 2013 (n=9,183).

Name	Proportion (%)
Palacos R+G	67.5
Refobacin Bone Cement R	14.2
Palacos MV+G	5.5
Refobacin Plus Bone Cement	4.2
Simplex ABC EC	3.1

3.2.3 Practice variation among hospitals

In total, 95 hospitals performed primary THAs in the Netherlands in 2013. One of these hospitals was not able to register data into the LROI database in time due to uploading difficulties. The total number of primary THAs performed per hospital varied significantly in 2013. The median number of primary THAs performed per hospital was 251 in 2013 (range 19-703) (Figure 3.22).

The characteristics of the patient population (also known as case mix) of a hospital, largely determine the outcomes of the hospitals as presented in the annual report. The case mix of the patient population varied considerably per hospital. For example, the age distribution varied with a median age at surgery between 55 and 73 years among hospitals (Figure 3.23). Furthermore, the proportion of men per hospital varied between 25% and 51% (Figure 3.24) and the proportion of patients with an ASA score of I-II varied between 67% and 100% among hospitals (Figure 3.25). The proportion of patients with the diagnosis osteoarthritis varied between 44% and 98% among hospitals.

The variation in surgical techniques and prostheses characteristics was significant for primary THAs. Fixation for primary THAs varied enormously among hospitals, with many hospitals fixating the majority of the prostheses uncemented. However, 14 hospitals implanted less than a quarter of the prostheses uncemented (Figure 3.26). A similar large variation was observed in the diameter of the femoral heads for primary THAs. A total of 54 hospitals used a femoral head of 22-32 mm in more than 90%

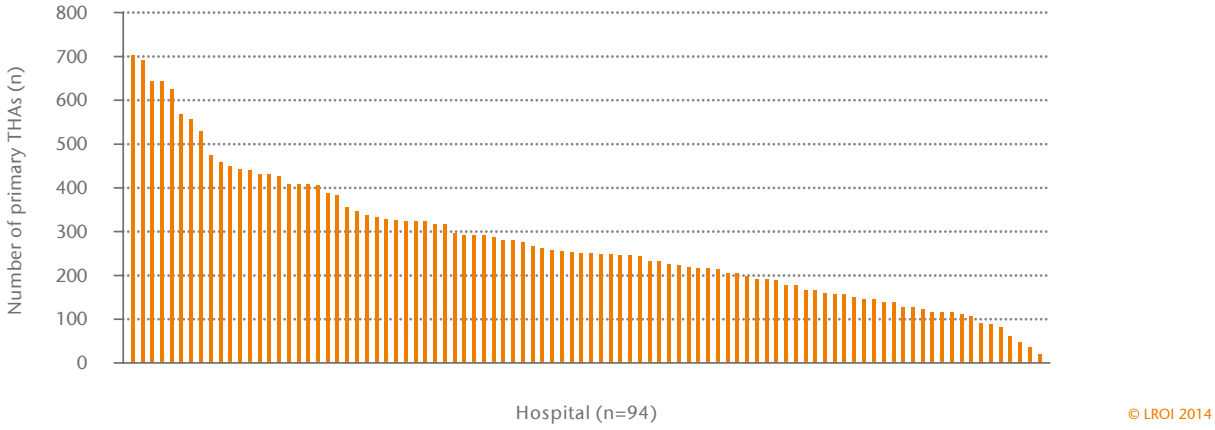


Figure 3.22 Number of primary total hip arthroplasties (THAs) per hospital in the Netherlands in 2013 (n=26,042).
Please note: This includes the other and unknown types of primary hip arthroplasties (THAs).

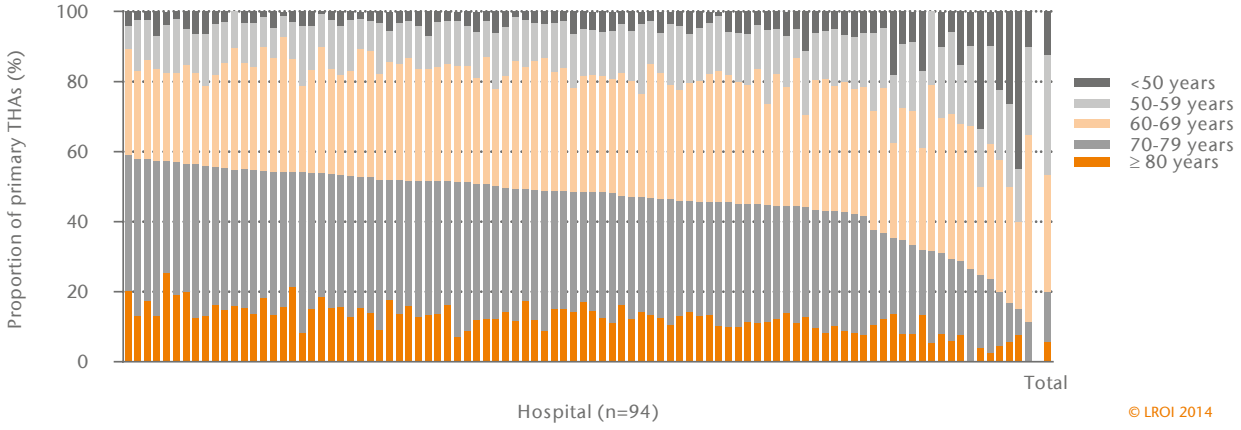


Figure 3.23 Age distribution of patients who underwent a primary total hip arthroplasty (THA) for the first time per hospital in the Netherlands in 2013 (n=22,236).

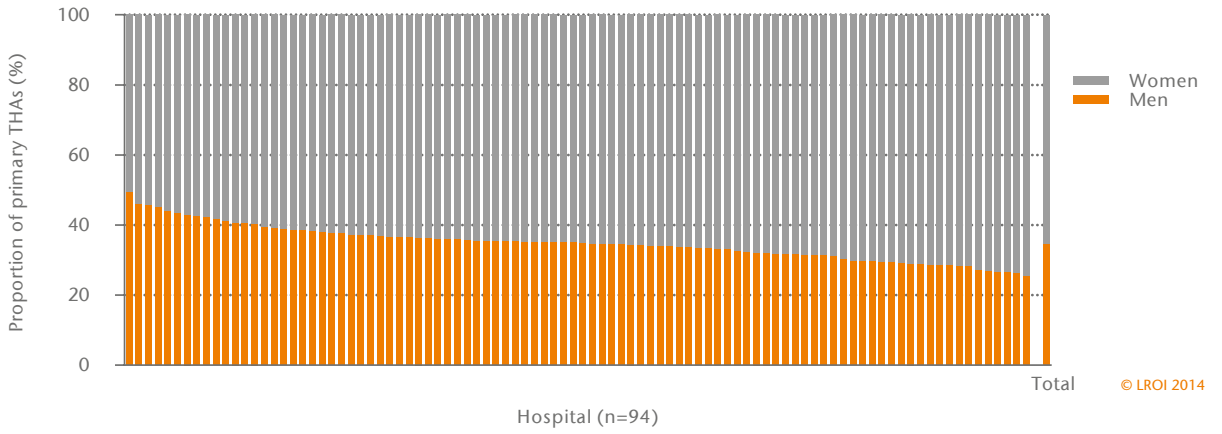


Figure 3.24 Gender distribution of patients who underwent a primary total hip arthroplasty (THA) for the first time per hospital in the Netherlands in 2013 (n=22,203).

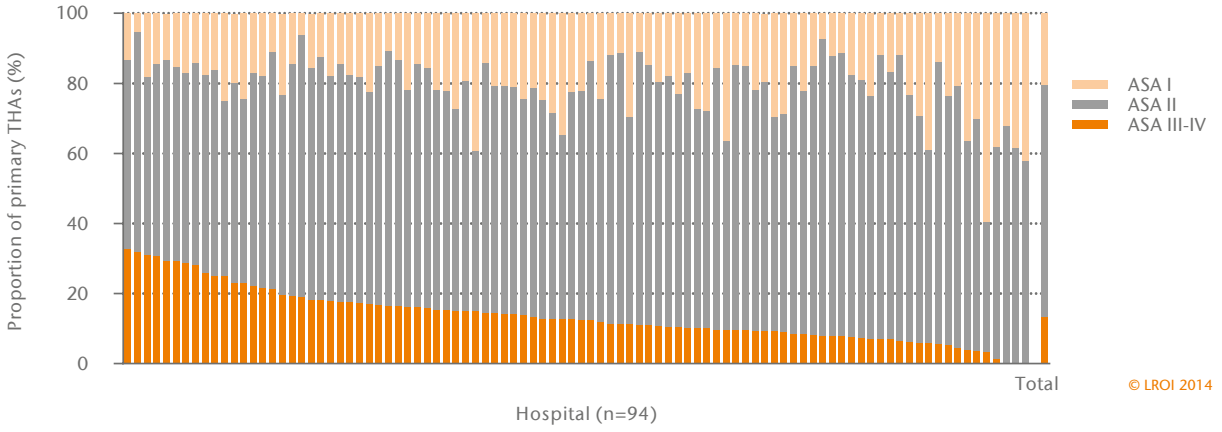


Figure 3.25 Distribution of ASA score of patients who underwent a primary total hip arthroplasty (THA) for the first time per hospital in the Netherlands in 2013 (n=22,014).

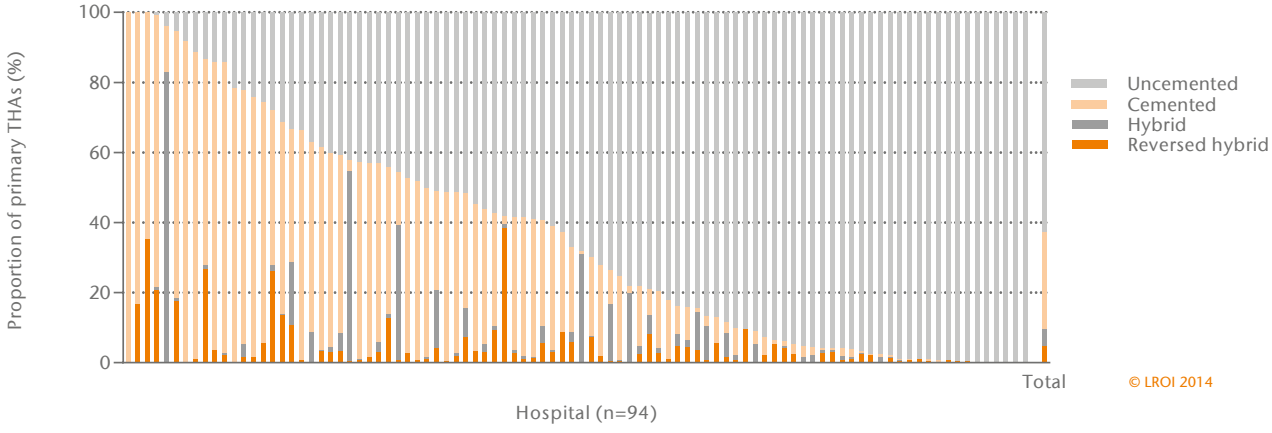


Figure 3.26 Type of fixation used during primary total hip arthroplasties (THAs) per hospital in the Netherlands in 2013 (n=25,552).

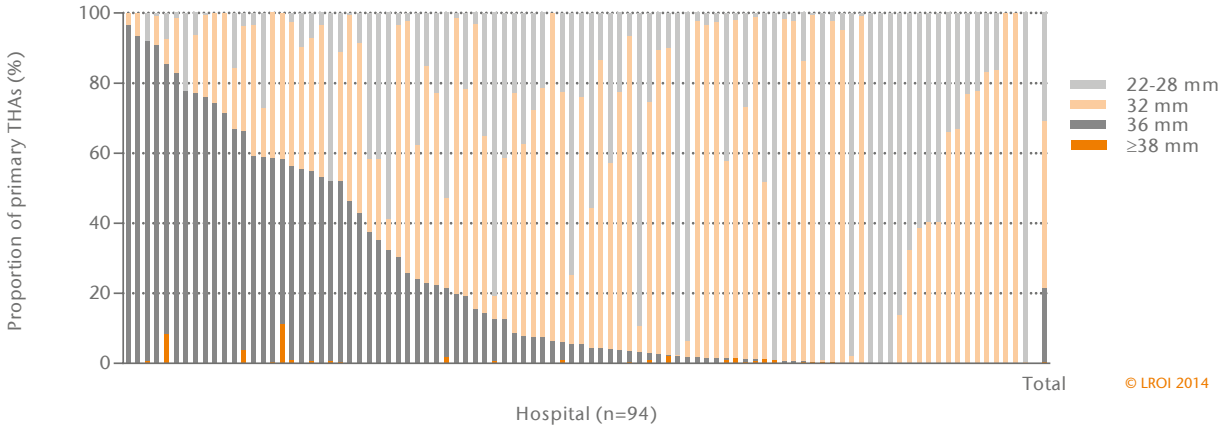


Figure 3.27 Diameter of femoral heads implanted during primary total hip arthroplasties (THAs) per hospital in the Netherlands in 2013 (n=25,259).

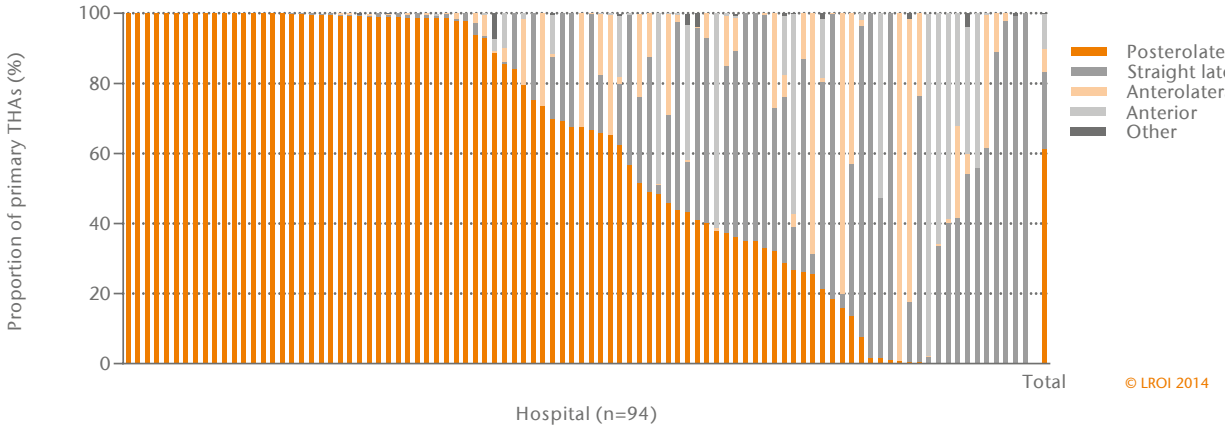


Figure 3.28 Surgical approach used during primary total hip arthroplasties (THAs) per hospital in the Netherlands in 2013 (n=25,538).

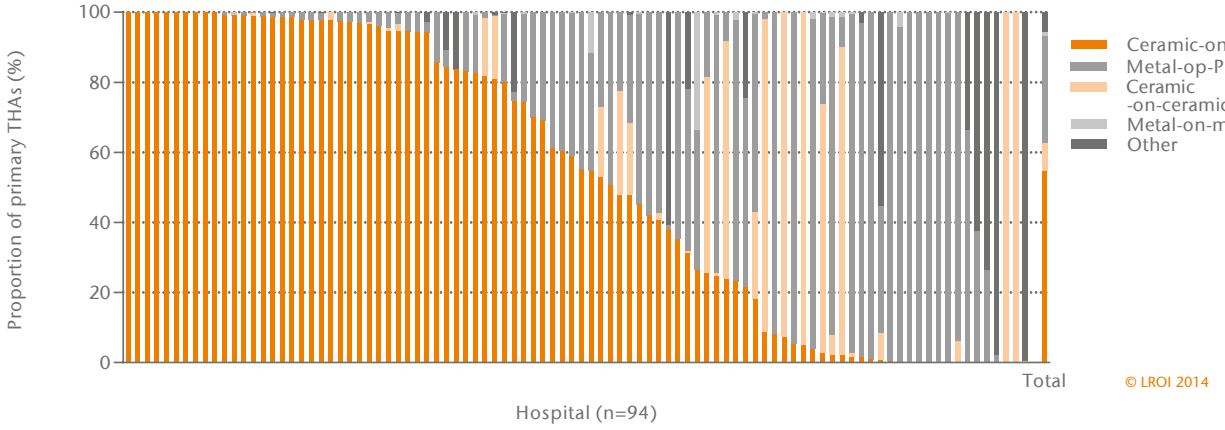


Figure 3.29 Articulation used during primary total hip arthroplasties (THAs) per hospital in the Netherlands in 2013 (n=24,634).

of the THAs. Also, 10 hospitals used a femoral head of 36 mm in 75% of their THAs (Figure 3.27). In 42 hospitals, more than 90% of the primary THAs were performed with a posterolateral approach. However, more than half of the primary THAs were performed with an anterior approach in 6 hospitals (Figure 3.28). More than 75% of the implanted THPs had a ceramic-on-PE articulation in 40 hospitals. More than 75% of the implanted THPs had a metal-on-PE articulation in 17 hospitals (Figure 3.29).

3.3 Hemiarthroplasty

The number of registered hemiarthroplasties in the LROI increased from 2,328 in 2010 to 2,932 in 2013. However, the number of registered hemiarthroplasties in the LROI is not complete, since these procedures are also performed by trauma surgeons. In the fall of 2013, an agreement was reached with the trauma surgeons, requesting them to register hemiarthroplasties in the LROI.

The completeness of hemiarthroplasties performed by orthopaedic surgeons is 70%. The mean age of patients who underwent a hemiarthroplasty in 2013 was 81.6 years (SD 9.3), which is more than ten years older than a patient who received a THA in the same year. Furthermore, the proportion of patients with an ASA score of III-IV was almost 60%, while this was 13% in patients with a THA. The vast majority of hemiarthroplasties (91%) were performed as the result of a fracture (including posttraumatic cause) (Table 3.6).

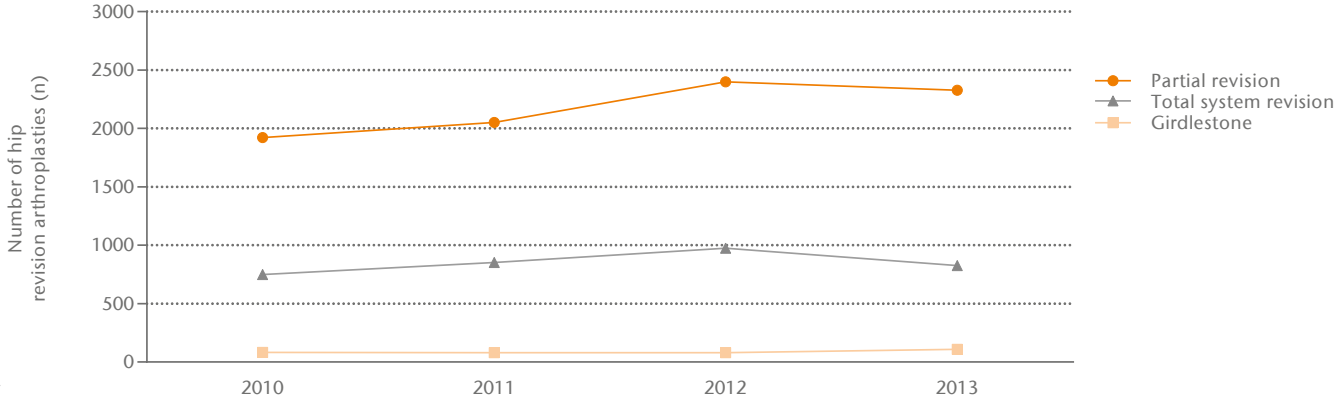
Table 3.6 Patient characteristics of all unique patients with a registered hemiarthroplasties in the Netherlands in 2013.

	Hemiarthroplasties (n=2,932)
Completeness	70%
Mean age (years) (standard deviation)	81.6 (9.3)
Age (years) (%)	
<50	1
50-59	2
60-69	7
70-79	27
≥80	63
Gender (%)	
Men	30
Women	70
ASA-score (%)	
I	3
II	39
III-IV	58
Type of hospital[1] (%)	
General	95
UMC	5
Private	0
Diagnose (%)	
Osteoarthritis	6
Dysplasia	0
Rheumatoid arthritis	0
Fracture (acute)	88
Osteonecrosis	1
Post-Perthes	0
Tumour	1
Late posttraumatic	3
Other	1

[1] In 2013, 8 UMCs; 76 general hospitals and 4 private hospitals performed hemiarthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital

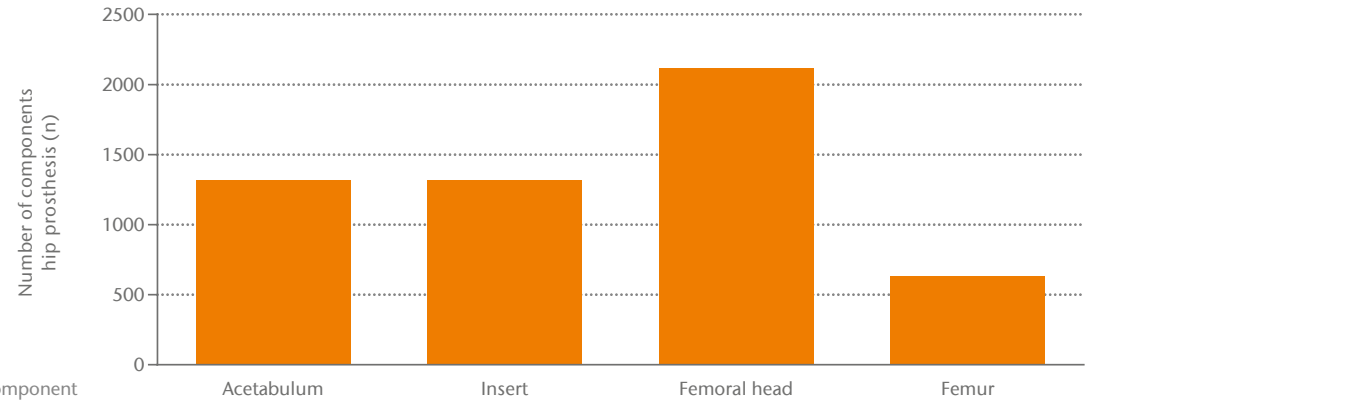
3.4 Hip revision arthroplasty

Hip revision arthroplasty is defined as any change (insertion, replacement and/or removal) of one or more components of a hip prosthesis. Patients may undergo multiple procedures for one revision. This may be the case when an implant is removed during one surgery due to an infection, and a new prosthesis is implanted during a next surgery. This results in multiple hip revision arthroplasties, but it still relates to the revision of a single primary prosthesis. In addition, the majority of hip revision arthroplasties in the LROI are revisions of primary hip prostheses implanted before the start of the LROI in 2007. Therefore, no patient characteristics are shown in this chapter.



Year	2010	2011	2012	2013	Total
Type of revision					
Partial revision (n)	1,921	2,052	2,399	2,327	8,699
Total revision (n)	750	852	975	827	3,404
Girdlestone (n)	83	80	81	109	353
Other (n)	49	46	61	50	206
Unknown (n)	137	162	192	141	632
Total (n)	2,940	3,192	3,708	3,454	13,294

Figure 3.30 Number of hip revision arthroplasties by type of revision procedure in the Netherlands in 2010-2013.



Component	Acetabulum	Insert	Femoral head	Femur
Revised component				
Number (n)	1,319	1,313	2,119	635
Proportion (%)[1]	56.8	56.6	91.2	27.3

[1] Multiple components may be revised in one procedure. Therefore, the total proportion adds up to more than 100%.

Figure 3.31 Number of components revised during partial hip revision arthroplasty in the Netherlands in 2013 (n=2,327).

The increase in the number of revision arthroplasties in 2010-2012 indicates that registration has become more complete (Figure 3.30). In 2013, completeness was 88%, as described in Chapter 2. However, the number of hip revision arthroplasties was lower in 2013 than it was in 2012, while a study examining the completeness of the LROI showed that the completeness of hip revision arthroplasties registered in the LROI increased from 83% in 2012 to 88% in 2013. In 2013, 2,327 (69%) partial hip revision arthroplasties and 827 (27%) total system hip revision arthroplasties were performed. A girdlestone procedure was performed in 109 (3%) revision arthroplasties and in 50 (2%) hip revision arthroplasties another type of revision arthroplasty was performed (Figure 3.30). The femoral head was revised in 91% of all partial revision arthroplasties performed in 2013, while in 57% of all cases the acetabulum was revised. In over 50% of all partial revisions the insert was replaced (Figure 3.31). In 45% of the arthroplasties two components were replaced and in 44% of the arthroplasties three components were replaced (mainly the combination of the acetabulum, the insert, and the femoral head). During 11% of the revision arthroplasties, a single component was replaced, mainly the femoral head. In 13% of all hip revision arthroplasties performed in 2013, a conversion from a hemi-prosthesis or resurfacing hip prosthesis to a THP was performed. In UMCs, a total system revision was performed more often (32%) than in general hospitals (24%) in 2013. Girdlestone procedures were also performed more often in UMCs (7% versus 3%).

The number of hip revision arthroplasties per hospital varied strongly in 2013, from less than 10 revision arthroplasties in nine hospitals to 117 revision arthroplasties in one hospital (with an outlier of 196 revision arthroplasties in one hospital). The median number of hip revision arthroplasties per hospital was 28 in 2013 (range 1-196; Figure 3.32). The number of patients with two or more hip revision arthroplasties was 161 in 2013 (4.7% of all patients who underwent hip revision arthroplasty in 2013). The most common reasons for revision of a primary or revised hip prosthesis were loosening of the acetabular component (33%) or femoral component (27%). Also, liner wear (27%) and dislocation (22%) were reported as reasons for revision (Table 3.7).

Almost half of the revised hip prostheses were implanted cemented (Figure 3.33). The diameter of the femoral head was 22-28 mm in more than half of the cases in 2013 (Figure 3.34).

Table 3.7 Reasons for revision or re-surgery in patients who underwent hip revision arthroplasty in the Netherlands in 2013 (n=3,454).

	Proportion (%)
Loosening acetabular component	32.9
Liner wear	26.8
Loosening femoral component	26.6
Dislocation	22.0
Periprosthetic fracture	13.6
Infection	10.7
Girdlestone	6.7
Peri-articular ossification	3.3

Please note: One patient could have multiple reasons for revision or re-surgery. Therefore, the total proportion is more than 100%.

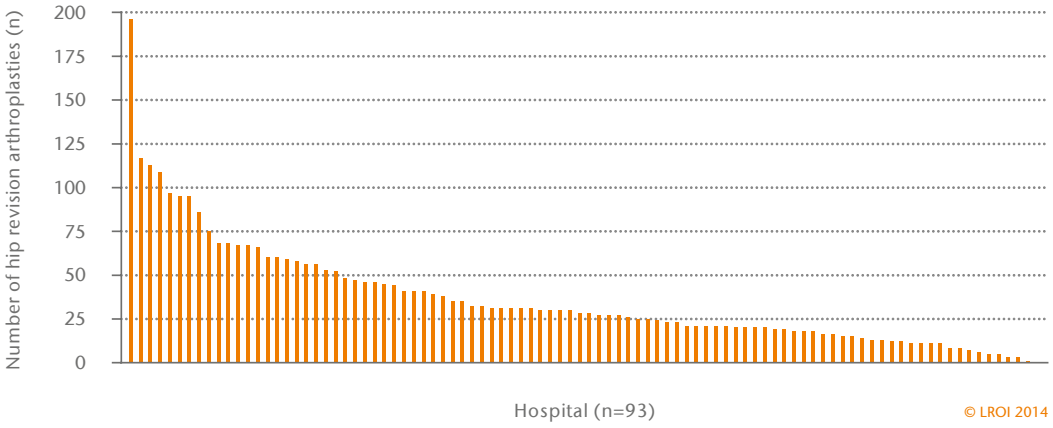
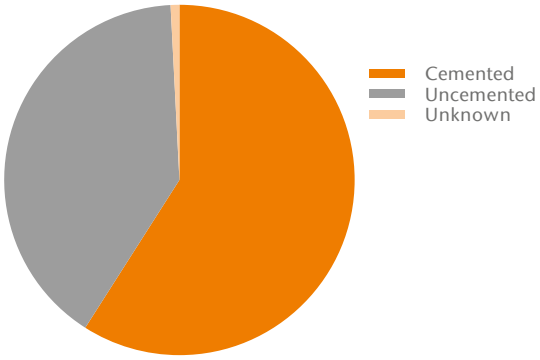
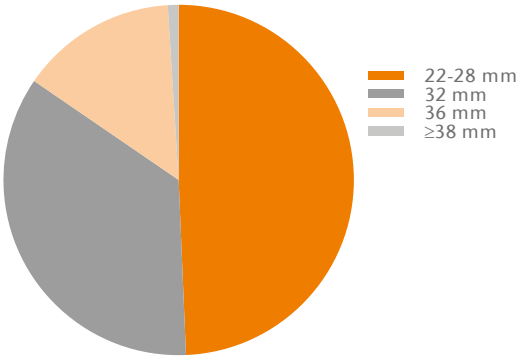


Figure 3.32 Number of hip revision arthroplasties per hospital in the Netherlands in 2013 (n=3,454).



Fixation	Number (n)	Proportion (%)
Cemented	1,899	59.0
Uncemented	1,292	40.2
Unknown	26	0.8

Figure 3.33 Type of fixation used during hip revision arthroplasties in the Netherlands in 2013 (n=3,217). © LROI 2014



Diameter femoral head	Number (n)	Proportion (%)
22-28 mm	1,444	49.3
32 mm	1,031	35.2
36 mm	423	14.5
≥ 38 mm	29	1.0

Figure 3.34 Diameter femoral head implanted during hip revision arthroplasties in the Netherlands in 2013 (n=2,927). © LROI 2014

Table 3.8 The ten most registered acetabular (cemented and uncemented) and femoral (cemented and uncemented) components implanted during hip revision arthroplasty in the Netherlands in 2013.

Acetabular component (n=2,067)

Cemented (n=1,475)		Uncemented (n=574)	
Name	Proportion (%)	Name	Proportion (%)
Avantage	39.6	Allofit	15.2
Exeter Rimfit	7.7	Continuum	11.1
IP Cup	6.3	Pinnacle	8.0
Müller Low Profile	6.2	Mallory Head	7.3
Reflection All Poly	4.8	Trident	7.3
FAL Cup	4.5	Reflection	6.1
Durasol	3.8	R3	5.2
Exeter Contemporary Flanged	2.8	Lto Delta-TT	5.1
Stanmore	2.4	RM Pressfit Cup	4.7
Polarcup	2.4	Trident Tritanium	4.7

Femoral component (n=1,395)

Cemented (n=625)		Uncemented (n=758)	
Name	Proportion (%)	Name	Proportion (%)
Exeter	28.0	Restoration Modular	16.1
Lubinus SPII	25.8	MP Reconstruction Prosthesis	7.8
Stanmore	11.0	Arcos	6.1
Spectron EF	9.8	Corail	6.1
Original ME Muller	4.8	Revitan	6.1
MP Reconstruction Prosthesis	2.2	Mallory Head Stems	5.1
Restoration Modular	2.2	SLR Plus	4.7
Taperloc	1.9	CLS Spotorno	4.6
CS Plus	1.8	Lto Revision Stem	3.8
Corail	1.1	MRS Stem	3.8

Please note: The number of components may vary because not all hip components are replaced in most procedures
Please note: Cemented and uncemented components do not sum up to 100% of all implanted components, because the fixation method is not always known.
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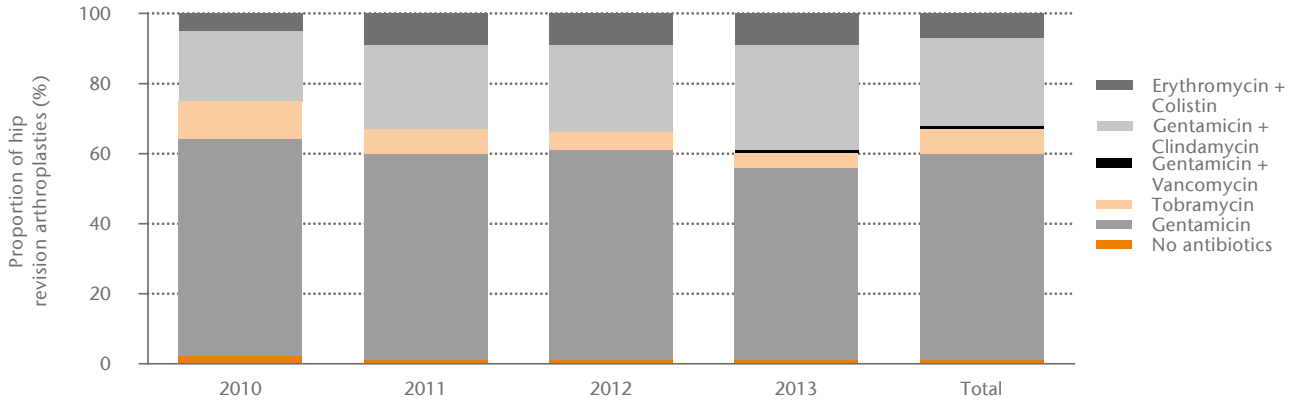
Although a total of 3,454 hip revision arthroplasties were registered in 2013, not all components (acetabular, insert, femoral and femoral head component) were revised in each procedure. Therefore, these numbers do not add up to a total of 3,454. In 2013, 1,475 cemented acetabular components (49 different types) and 574 uncemented acetabular components (45 different types) were registered. Additionally, 625 cemented femoral components (39 different types) and 758 uncemented femoral components (50 different types) were registered. Table 3.8 summarizes the ten most registered acetabular and femoral components implanted during hip revision arthroplasties in the Netherlands in 2013. Many different hip components were registered, of which the vast majority was implanted in less than 3% of all hip revision arthroplasties. This means that many implanted hip components for revision arthroplasty were used 1 to 50 times per year throughout the Netherlands. The component may however also be implanted as a component for primary hip arthroplasties.

Bone cement with gentamicin was used during more than half of the cemented hip revision arthroplasties and bone cement with gentamicin and clindamycin was used in 25% of the procedures in 2010-2013 (Figure 3.35). In 2013, 16 different types of bone cement were used to fixate revised hip prostheses in the Netherlands. Table 3.9 shows the five most registered types of bone cement.



Year	2010	2011	2012	2013	Total
Antibiotics bone cement					
Erythromycin + Colistin (%)	4.6	8.9	9.0	8.7	8.1
Gentamycin + Clindamycin (%)	20.5	23.5	24.5	30.2	25.1
Gentamycin + Vancomycin (%)	0.1	0.0	0.3	1.5	0.5
Tobramycin (%)	10.7	7.4	5.3	4.1	6.5
Gentamicin (%)	62.4	58.8	59.6	54.6	58.6
No antibiotics (%)	1.7	1.3	1.3	0.9	1.3
Total (n)	1,215	1,457	1,861	1,776	6,309

Figure 3.35 Trend (proportion [%] per year) in antibiotics in bone cement used during hip revision arthroplasty in the Netherlands in 2010-2013.

Table 3.9. The five most registered types of bone cement used in hip revision arthroplasties in the Netherlands in 2013 (n=1,776).

Name	Proportion (%)
Palacos R+G	39.2
Copal G+C	18.9
Refobacin Revision	11.3
Simplex ABC EC	8.7
Refobacin Bone Cement R	7.4

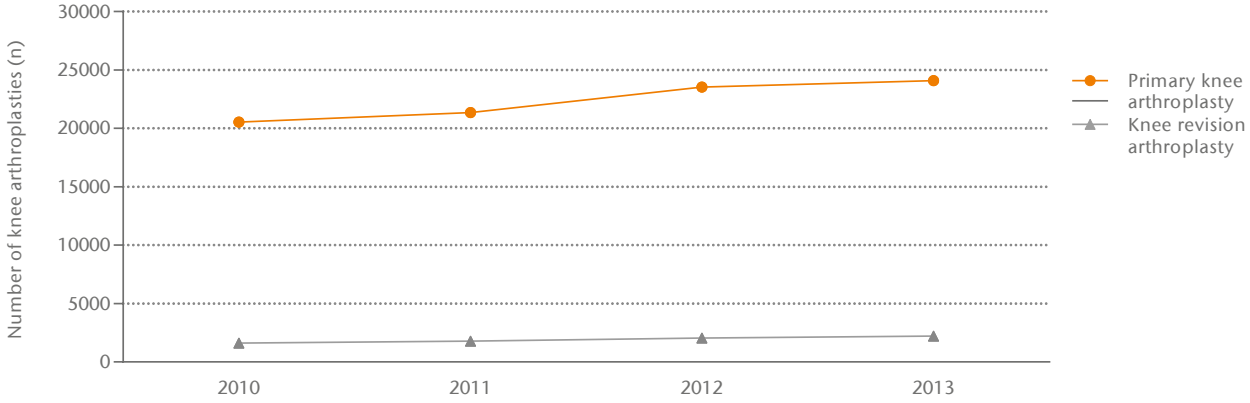
Stickers with product numbers of the prosthesis components are pasted on the LROI form

4 Knee arthroplasty

4.1 Trends and associations of primary knee and knee revision arthroplasties

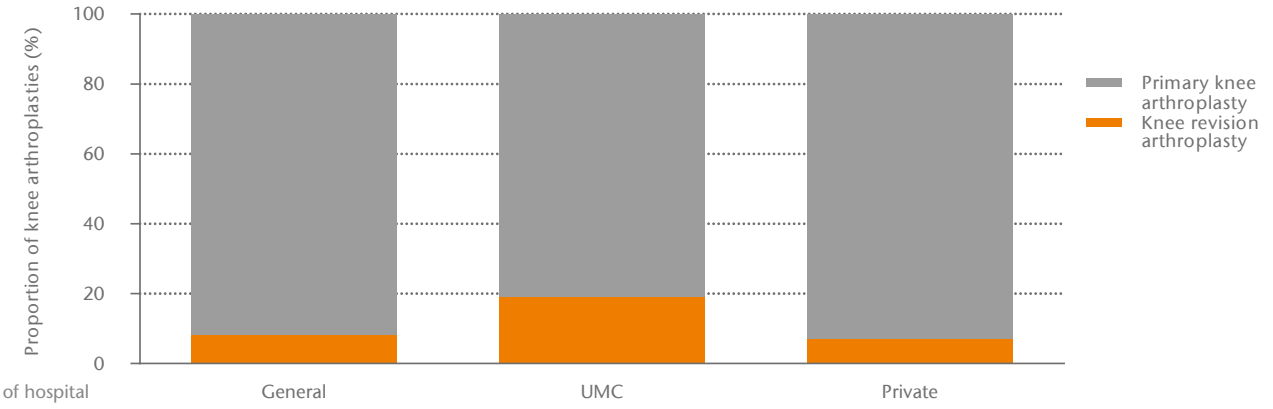
In 2010-2013, 89,536 primary knee arthroplasties and 7,680 knee revision arthroplasties were registered in the LROI. The number of registered knee arthroplasties slightly increased from 20,539 in 2010 to 24,091 in 2013. The number of registered knee revision arthroplasties increased from 1,617 in 2010 to 2,215 in 2013 (Figure 4.1). Among the 24,091 primary knee arthroplasties performed in 2013, 15% (n=3,658) was a bilateral primary knee arthroplasty.

A distinction was made between general hospitals, university medical centres (UMCs) and private hospitals. In 2010-2013, 8 UMCs and 81 general hospitals performed primary knee arthroplasties. The number of private hospitals performing primary knee arthroplasties increased from 2 in 2010 to 11 in 2013. Among the 22,530 knee arthroplasties performed in general hospitals in 2013, 8% was a revision procedure, while in UMCs 19% of the 910 performed knee arthroplasties were revision procedures in the same year. In private hospitals, 7% of the 2,335 knee arthroplasties in 2013 were revision procedures (Figure 4.2).



Type of knee arthroplasty					Total
Primary knee arthroplasty (n)	20,539	21,366	23,540	24,091	89,536
Knee revision arthroplasty (n)	1,617	1,790	2,058	2,215	7,680
Total (n)	22,156	23,156	25,598	26,306	97,216

Figure 4.1 Number of primary knee arthroplasties and knee revision arthroplasties, registered in the LROI in the Netherlands in 2010-2013.



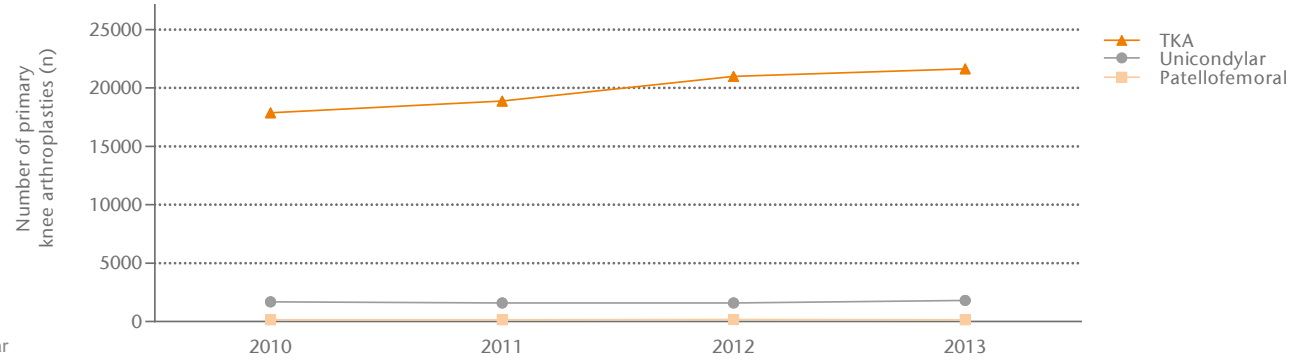
Type of knee arthroplasty	General	UMC	Private	Total
Primary knee arthroplasty (%)	91.8	81.0	93.4	91.6
Knee revision arthroplasty (%)	8.2	19.0	6.6	8.4
Total (n)	22,530	910	2,335	25,775

Please note: In 531 procedures the type of hospital was unknown.
General: general hospital; UMC: university medical centre; Private: private hospital

Figure 4.2 Proportion of primary knee arthroplasties and knee revision arthroplasties by type of hospital in the Netherlands in 2013.

4.2 Primary knee arthroplasty

Among primary knee arthroplasties, a distinction was made between the TKAs, the unicondylar knee arthroplasties and the patellofemoral knee arthroplasties. The number of registered TKAs increased from 17,872 in 2010 to 21,654 in 2013 and the number of registered unicondylar knee arthroplasties slightly increased from 1,697 to 1,804 in the same period (Figure 4.3). The vast majority was performed with a medial approach (94%). And the vast majority of primary knee arthroplasties performed in 2013, was performed in general hospitals. Of the unicondylar knee prostheses, over 18% was implanted in private hospitals

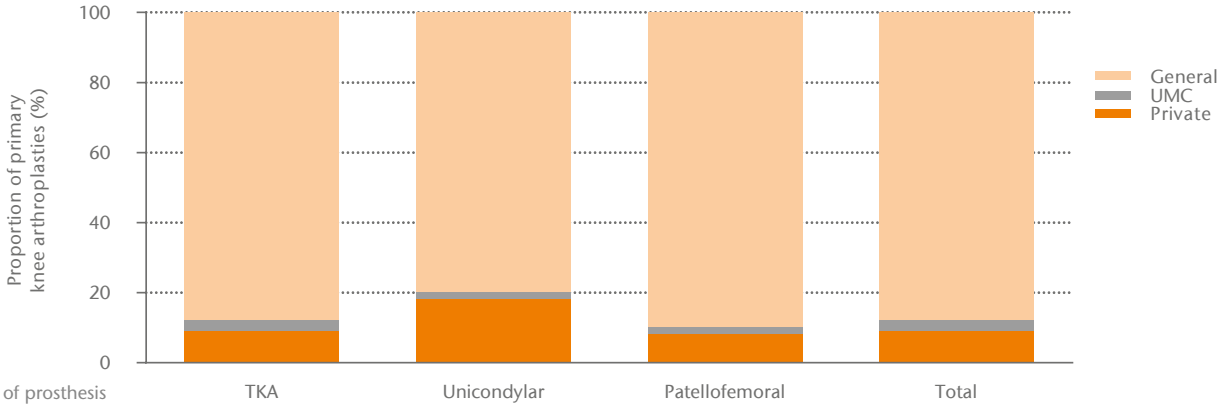


Type of primary knee arthroplasty	2010	2011	2012	2013	Total
Total knee arthroplasty (n)	17,868	18,888	20,987	21,649	79,392
Unicondylar knee arthroplasty (n)	1,697	1,597	1,583	1,804	6,681
Patellofemoral knee arthroplasty (n)	160	149	188	156	653
Other (n)	383	317	288	129	1,117
Unknown / missing (n)	431	415	494	353	1,693
Total (n)	20,539	21,366	23,540	24,091	89,536

TKA: total knee arthroplasty

Figure 4.3 Number of primary knee arthroplasties by type of arthroplasty in the Netherlands in 2010-2013.

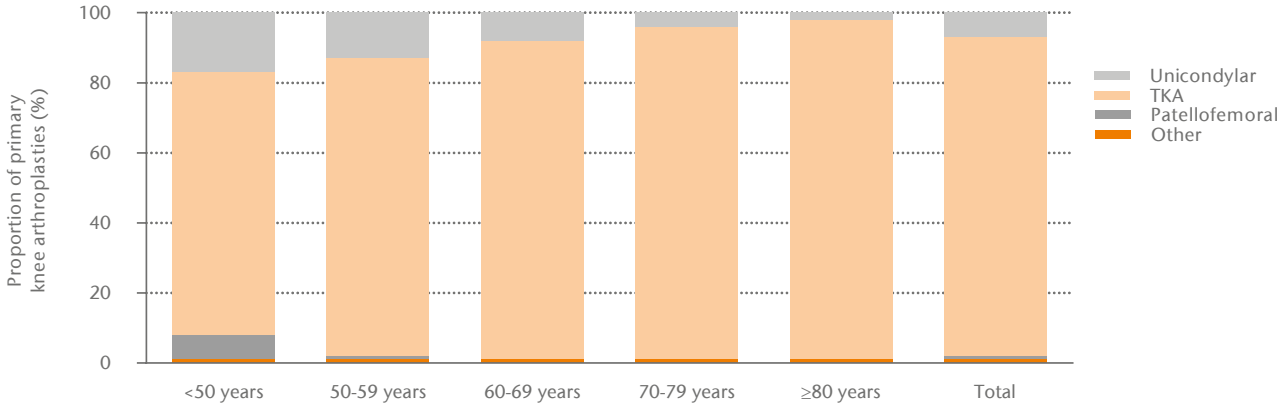
(Figure 4.4). In most of the primary knee arthroplasties, a TKA was performed (91%). The proportion of unicondylar knee arthroplasties strongly decreased with the age of the patient from 17% in patients younger than 50 years to 2% in patients older than 80 years. The patellofemoral knee arthroplasty was performed almost exclusively on patients younger than 50 years (Figure 4.5).



Type of prosthesis	TKA	Unicondylar	Patellofemoral	Total
Type of hospital				
General (%)	88.2	79.5	89.7	87,6
UMC (%)	3.2	2.2	1.9	3,1
Private (%)	8.6	18.3	8.3	9,3
Total (n)	21,180	1,792	156	23,265

General: general hospital; UMC: university medical centre; Private: private hospital
TKA: total knee arthroplasty

Figure 4.4 Type of primary knee arthroplasty (proportion [%] per category) of patients who underwent a primary knee arthroplasty for the first time by type of hospital in the Netherlands in 2013.



Age	<50 years	50-59 years	60-69 years	70-79 years	≥80 years	Total
Type of primary knee arthroplasty						
Unicondylar knee arthroplasty (%)	17.2	13.2	8.2	3.9	2.1	7.6
Total knee arthroplasty (%)	75.2	85.4	90.9	95.3	97.3	91.2
Patellofemoral knee arthroplasty (%)	6.5	0.9	0.3	0.3	0.1	0.6
Other knee arthroplasty (%)	1.2	0.5	0.6	0.6	0.5	0.6
Total (n)	944	4,217	8,708	7,173	2,049	23,091

TKA: total knee arthroplasty

Figure 4.5 Type of primary knee arthroplasty (proportion [%] per category) of patients who underwent a primary knee arthroplasty for the first time by age category in the Netherlands in 2013.

4.2.1 Demographics

The mean age of patients who underwent a primary TKA in 2013 was 68.1 (standard deviation [SD] 9.4) years and approximately two thirds were female. Seventy percent of these patients were aged 60-79 years and a similar percentage of these patients had an ASA score of II (mild disease, not incapacitating). The vast majority (96%) underwent a TKA after the diagnosis osteoarthritis. Almost 90% was treated in a general hospital. Patients who underwent a unicondylar knee arthroplasty in 2013 were on average younger (62.3 years [SD 9.0]) and had a better health condition (93% ASA I-II) than patients who underwent a TKA. Patients who received patellofemoral knee prostheses in 2013 had a mean age of 54.8 years (SD 12.3) and were therefore clearly aged younger than patients undergoing a TKA or unicondylar knee arthroplasty (Table 4.1). The age at which a patient underwent a primary knee arthroplasty and the type of hospital that treated a patient strongly depended on the diagnosis (Table 4.2).

Considerably more women than men underwent primary knee arthroplasty in 2013. The mean age at which women received a unicondylar knee prosthesis for the first time, was higher than in men (62.4 years [SD 9.3] in women versus 62.2 [SD 8.3] in men) (Figure 4.6a). Also, the mean age at which women underwent a TKA for the first time (68.8 years [SD 9.5]) was higher than in men (66.9 years [SD 9.1]) (Figure 4.6b).

Figure 4.6a Age distribution of patients who underwent a primary unicondylar knee arthroplasty for the first time by gender in the Netherlands in 2013 (n=1,582).

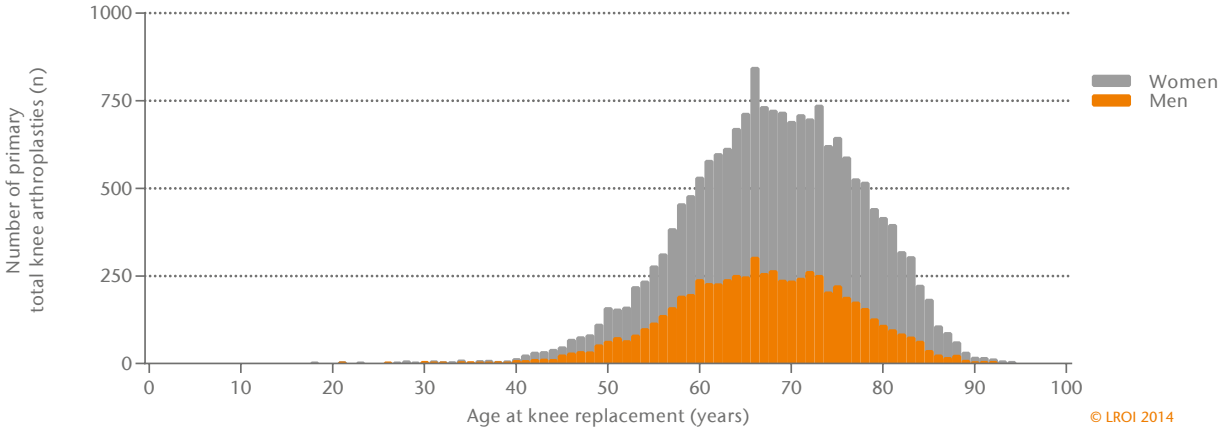


Figure 4.6b Age distribution of patients who underwent a primary total knee arthroplasty (TKA) for the first time by gender in the Netherlands in 2013 (n=18,355).

Table 4.1 Patient characteristics of all patients who underwent a primary knee arthroplasty by type of primary knee arthroplasty in the Netherlands in 2013.

	Total knee arthroplasty (n=18,305)	Unicondylar knee arthroplasty (n=1,593)	Patellofemoral knee arthroplasty (n=137)	Total (n=20,158)[1]
Completeness (%)				96%
Mean age (years) (standard deviation)	68.1 (9.4)	62.3 (9.0)	54.8 (12.1)	67.6 (9.6)
Age (years) (%)				
<50	3	10	43	4
50-59	17	32	28	18
60-69	38	41	16	38
70-79	32	15	12	31
≥80	10	2	1	9
Gender (%)				
Men	35	42	27	35
Women	65	58	73	65
ASA-score (%)				
I	16	30	47	18
II	70	63	46	69
III-IV	14	7	7	13
Type of hospital[2] (%)				
General	88	80	89	87
UMC	3	2	2	3
Private	9	18	9	10
Diagnosis (%)				
Osteoarthritis	96	98	94	96
Post-traumatic	2	1	4	2
Rheumatoid arthritis	1	0	0	1
Osteonecrosis	1	1	0	1
Other	0	0	2	0

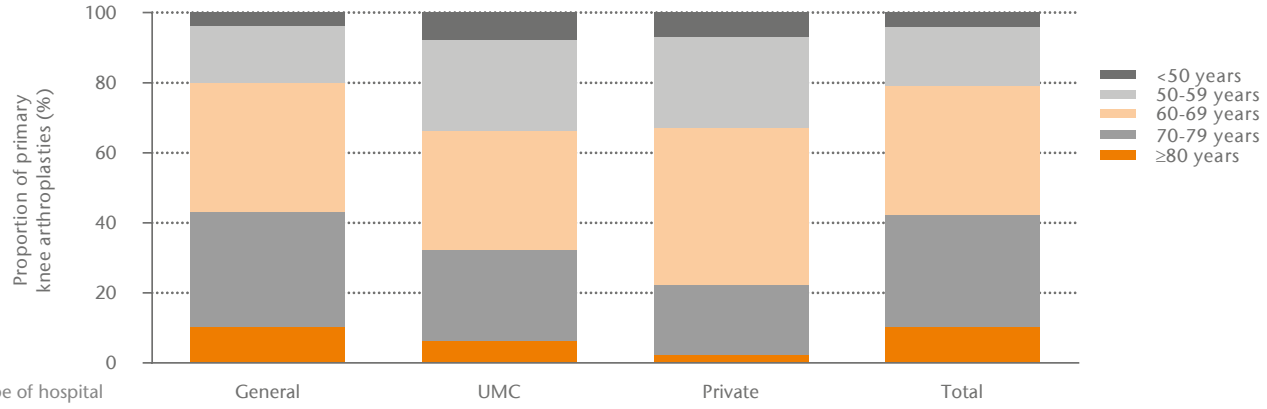
[1] This included 114 patients with a primary knee arthroplasty classified as 'other' and 9 unknown primary knee arthroplasties.
[2] In 2013, there were 8 UMCs; 81 general hospitals and 11 private hospitals where primary knee arthroplasties were performed.
General: general hospital; UMC: university medical centre; Private: private hospital

Table 4.2 Patient characteristics of all patients who underwent a primary knee arthroplasty by diagnosis in the Netherlands in 2013.

	N	Osteoarthritis 19,263 (94.3%)	Post-traumatic 308 (1.5%)	Rheumatoid arthritis 305 (1.3%)	Osteonecrosis 107 (0.5%)	Total 20,048
Mean age (years) (standard deviation)		67.9 (9.3)	62.0 (12.4)	66.8 (10.5)	66.8 (14.9)	67.6 (9.6)
Age (years) (%)						
<50		4	17	7	13	4
50-59		18	30	20	15	18
60-69		38	29	33	24	38
70-79		31	19	30	31	31
≥80		9	5	10	17	9
Gender (%)						
Men		35	42	25	31	35
Women		65	58	75	69	65
ASA-score (%)						
I		18	25	2	10	18
II		69	62	71	66	69
III-IV		13	13	27	24	13
Type of hospital (%)						
General		87	84	88	81	87
UMC		3	7	10	14	3
Private		10	9	2	5	10

In 2013, 111 (0.5%) patients underwent a primary knee arthroplasty after a diagnosis not described in the table.
General: general hospital; UMC: university medical centre; Private: private hospital

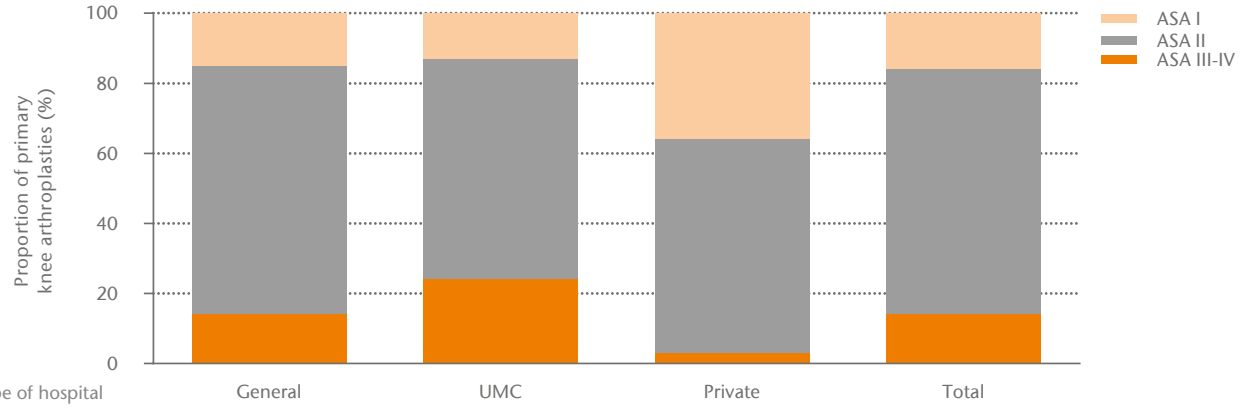
In UMCs, the proportion of treated patients aged younger than 50 years of age was relatively high. More than 90% of the patients who underwent a primary knee arthroplasty in a private hospital were aged 50 to 79 years. In UMCs, patients who underwent a primary knee arthroplasty more often had a higher ASA score: 24% had an ASA score III-IV (incapacitating systemic disease – life threatening disease), while in a private hospital, patients more often had a lower ASA score (Figure



Type of hospital	General	UMC	Private	Total
Age				
< 50 years (%)	3.4	8.3	7.0	3.9
50-59 years (%)	16.2	25.6	26.2	17.4
60-69 years (%)	36.7	33.8	44.9	37.4
70-79 years (%)	33.4	26.1	20.2	31.9
≥ 80 years (%)	10.4	6.2	1.6	9.4
Total (n)	15,780	551	1,655	17,986

General: general hospital; UMC: university medical centre; Private: private hospital

Figure 4.7 Age distribution (proportion [%] per category) of patients who underwent a primary knee arthroplasty for the first time by type of hospital in the Netherlands in 2013.



Type of hospital	General	UMC	Private	Total
ASA score				
ASA I (%)	14.7	12.8	36.0	16.6
ASA II (%)	70.8	63.5	61.4	69.7
ASA III-IV (%)	14.5	23.7	2.6	13.6
Total (n)	15,623	548	1,642	17,813

General: general hospital; UMC: university medical centre; Private: private hospital

Figure 4.8 ASA score (proportion [%] per cateogry) for patients who underwent a primary knee arthroplasty for the first time by type of hospital in the Netherlands in 2013.

4.8). Of all the patients who underwent a primary knee arthroplasty in 2013, 35% had undergone a previous operation to the same knee. This mainly was a meniscectomie (Table 4.3).

4.2.2 Prosthesis characteristics and surgical techniques

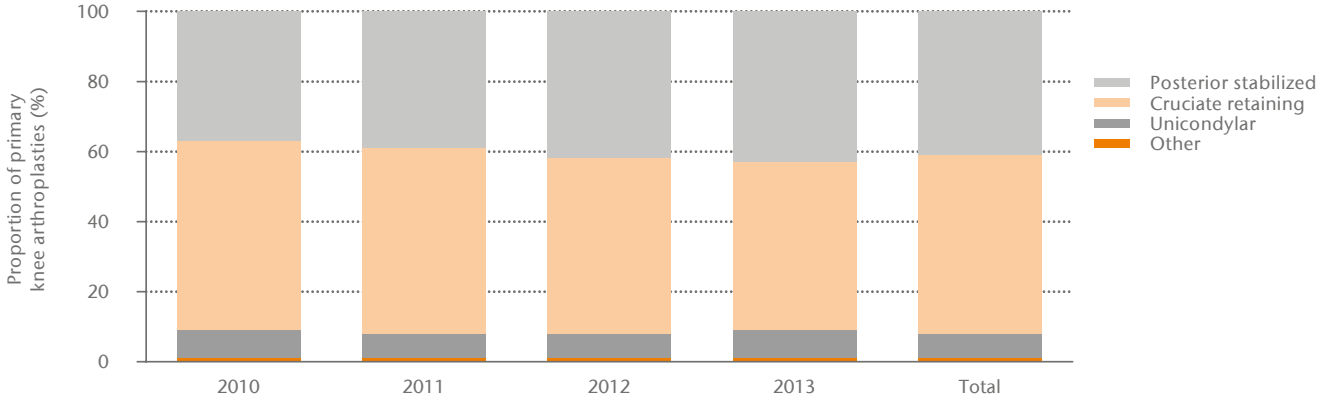
In 2010-2013, 51% of the femoral components were implanted while retaining the posterior cruciate ligament (cruciate retaining) and 41% while sacrificing the posterior cruciate ligament (posterior stabilized). Therefore, the proportion of cruciate retaining knee arthroplasties decreased from 54% to 48% and the proportion of posterior stabilized knee arthroplasties increased from 37% in 2010 to 43% in 2013 (Figure 4.9). The vast majority (95%) of the primary knee arthroplasties were performed through a medial parapatellar arthrotomy (after a median incision). Almost 90% of the primary knee arthroplasties were implanted with cement in 2013. In 4% of the primary knee arthroplasties, hybrid fixation was used where the tibial component was in most cases cemented (Figure 4.10). In 20% of the primary knee arthroplasties, the patellar component was replaced in 2013. In arthroplasties performed in patients younger than 50 years, the patellar component was replaced more frequently than in patients aged 60 years and older (29% versus 18%) (Figure 4.11).

Table 4.3 Previous surgeries to the same joint in patients who underwent a primary knee arthroplasty in the Netherlands in 2013 (n=19,442).

	Proportion[1] (%)
Previous surgery to the same knee	36.5
Meniscectomy	29.5
Osteotomy	3.2
Osteosynthesis	1.5
ACL-reconstruction	1.3
Synovectomy	1.2
Other	3.5

Please note: For 187 patients it was unknown whether a previous surgery to the same knee had been performed.

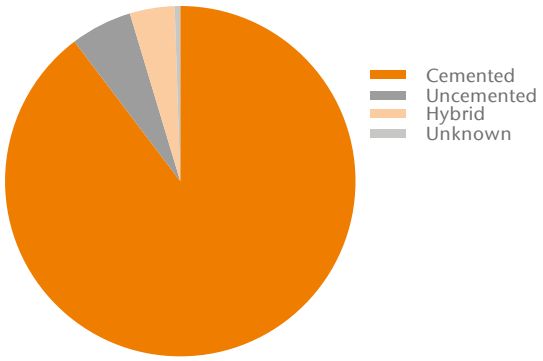
[1] A patient may have had multiple previous surgeries. Therefore, the total proportion adds up to more than 36,5% (proportion of patients with one or more previous surgeries to the same knee).



Year	2010	2011	2012	2013	Total
Type of femoral component					
Posterior stabilized (%)	37.0	38.9	42.0	43.4	40.5
Cruciate retaining (%)	53.7	52.6	50.2	48.1	51.0
Unicondylar (%)	8.3	7.6	6.7	7.5	7.5
Other (including patellofemoral) (%)	1.0	0.9	1.1	1.0	1.0
Total (n)	19,891	20,678	22,659	22,865	86,093

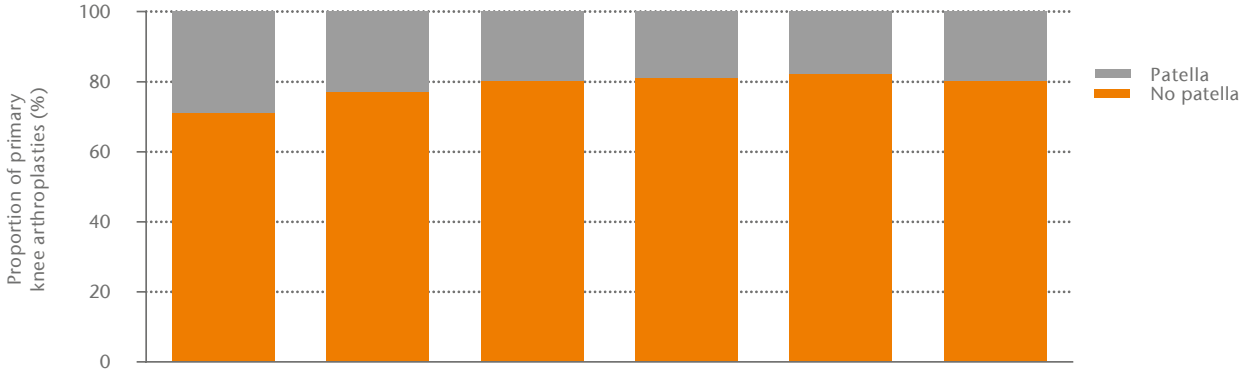
Figure 4.9 Trend (proportion [%] per year) in type of femoral component implanted during primary knee arthroplasty in the Netherlands in 2010-2013.

Approximately 97% of the femoral components implanted during primary knee arthroplasty consisted of cobalt chrome in 2010-2013 (Figure 4.12). The inserts usually consisted of standard polyethylene (PE) (94%), with a small shift from standard to cross-linked PE since 2010 (Figure 4.13).



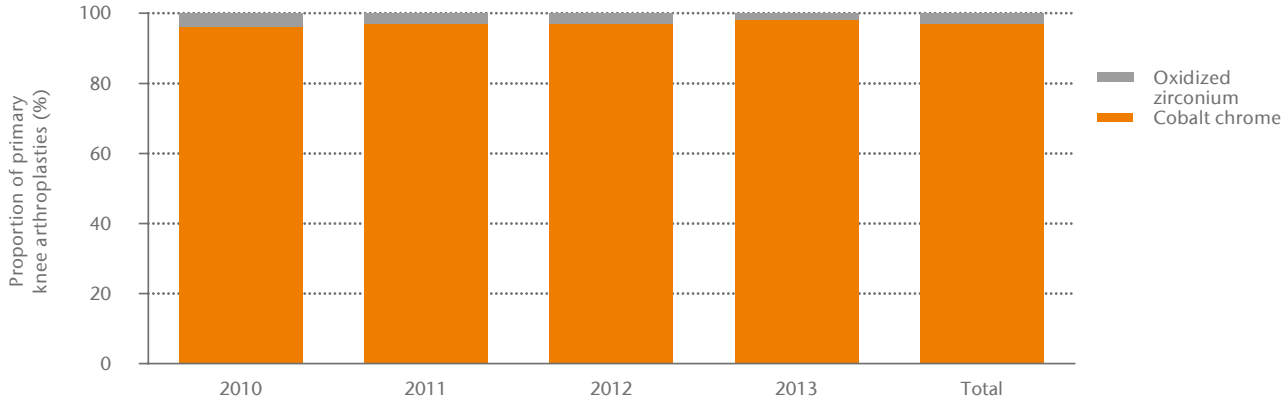
Fixation	Number (n)	Proportion (%)
Cemented	21,366	89.7
Uncemented	1,352	5.7
Hybrid	986	4.1
Unknown	122	0.5

Figure 4.10 Type of fixation used during primary knee arthroplasty in the Netherlands in 2013 (n=23,826).



Age	<50 years	50-59 years	60-69 years	70-79 years	≥80 years	Total
Patella						
Patella (%)	29.3	23.3	19.7	18.7	18.3	20.2
No patella (%)	70.7	76.7	80.3	81.3	81.7	79.8
Total (n)	769	3,635	7,976	6,897	2,001	21,278

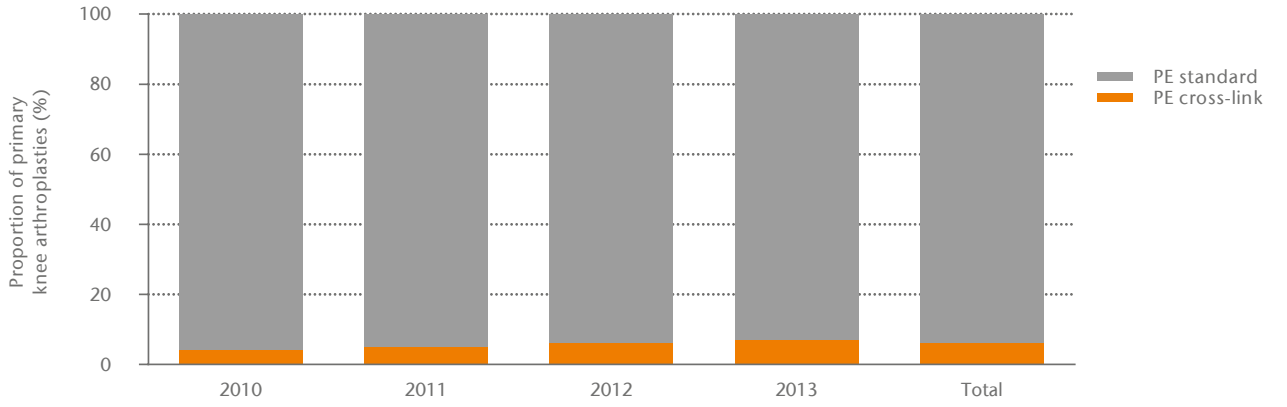
Figure 4.11 Patellar component (proportion [%] per category) implanted during primary total knee artrhoplasty (TKA) by age category in the Netherlands in 2013.



Material femur					
Oxidized zirconium (%)	3.5	3.1	2.7	2.2	2.9
Cobalt chrome (%)	96.5	96.9	97.3	97.8	97.1
Total (n)	19,861	20,653	22,689	22,889	86,092

Please note: The material of the femoral components consisted of ceramic in 40 (<0.1%) cases and of titanium in 80 (0.1%) cases.

Figure 4.12 Trend (proportion [%] per year) in material for femoral components implanted during primary knee arthroplasty in the Netherlands in 2010-2013.



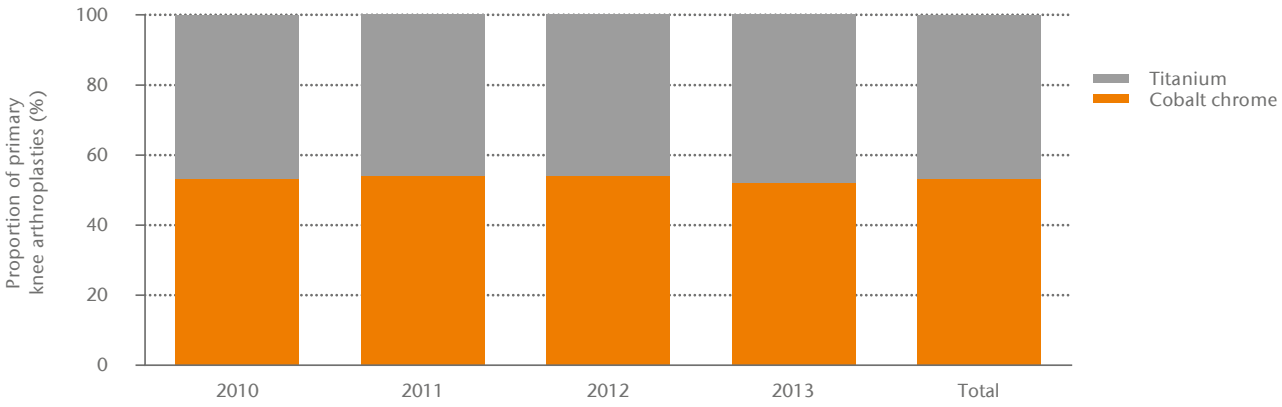
Material insert					
PE standard (%)	95.7	94.6	93.6	92.6	94.0
PE cross-link (%)	4.3	5.4	6.4	7.4	6.0
Total (n)	18,893	19,811	21,923	22,683	83,310

PE: polyethylene

Figure 4.13 Trend (proportion [%] per year) in material for inserts implanted during primary knee arthroplasty in the Netherlands in 2010-2013.

The patellar components implanted during primary knee arthroplasty in 2010-2013 usually consisted of standard PE (97%). The tibial components consisted of cobalt chrome in 53% of the cases and of titanium in 47% (Figure 4.14).

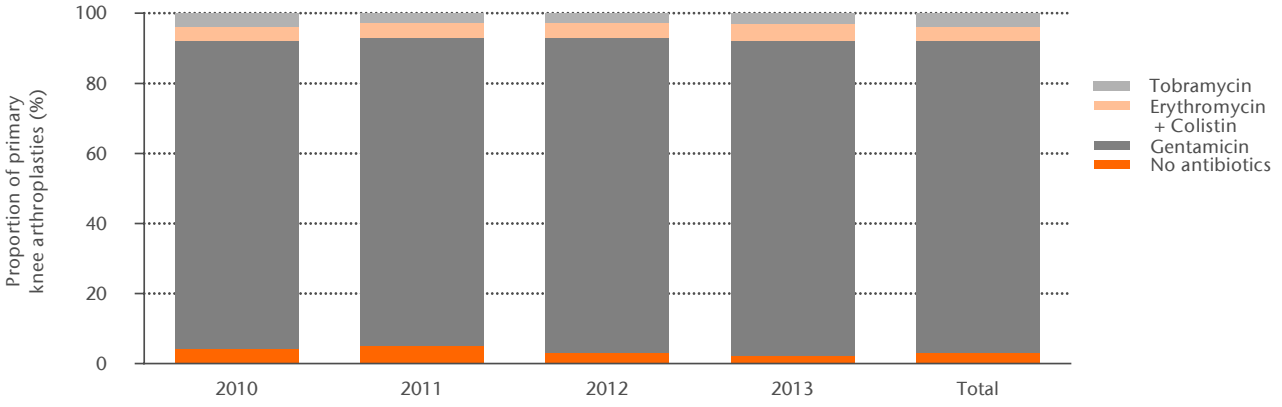
In 2013, 40 different primary TKAs were registered. In the vast majority of the primary knee arthroplasties performed, the same types of femoral, tibial and insert components were used for one knee prosthesis. Table 4.4 shows the ten most registered TKPs in the Netherlands in 2013.



Material tibia					
Titanium (%)	47.2	45.8	46.0	47.5	46.6
Cobalt chrome (%)	52.5	53.9	53.8	52.5	53.2
Total (n)	19,000	19,950	22,172	22,974	84,096

Please note: The material of the tibial component consisted of PE (polyethylene) standard in 166 (0.2%) cases.

Figure 4.14 Trend (proportion [%] per year) in material for tibial components implanted during primary knee arthroplasty in the Netherlands in 2010-2013.

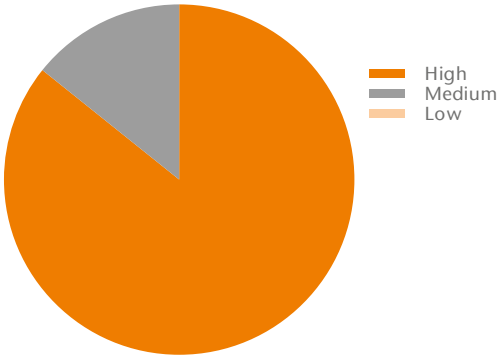


Antibiotics bone cement					
Tobramycin (%)	4.2	3.3	3.3	3.3	3.5
Erythromycin + Colistin (%)	3.8	4.4	4.2	4.6	4.3
Gentamicin (%)	87.9	87.6	89.7	89.7	88.8
No antibiotics (%)	4.1	4.6	2.6	2.2	3.3
Total (n)	16,581	18,193	20,196	21,070	76,040

Please note: In 106 (0.1%) primary knee arthroplasties, bone cement with gentamicin and clindamycin was used.

Figure 4.15 Trend (proportion [%] per year) in antibiotics in bone cement used during primary knee arthroplasty in the Netherlands in 2010-2013.

In 2013, 17 types of bone cement were used to fixate primary TKPs in the Netherlands. During the vast majority of the cemented primary knee arthroplasties in 2010-2013, bone cement with gentamicin was used (Figure 4.15) and the bone cement had a high viscosity (86%; Figure 4.16). Table 4.5 shows the five most frequently registered types of bone cement in 2013.



Viscosity	Number (n)	Proportion (%)
High (%)	17,895	85.7
Medium (%)	2,974	14.3
Low (%)	1	0.0

Figure 4.16 Viscosity of bone cement used during primary knee arthroplasty in the Netherlands in 2013 (n=20,870).

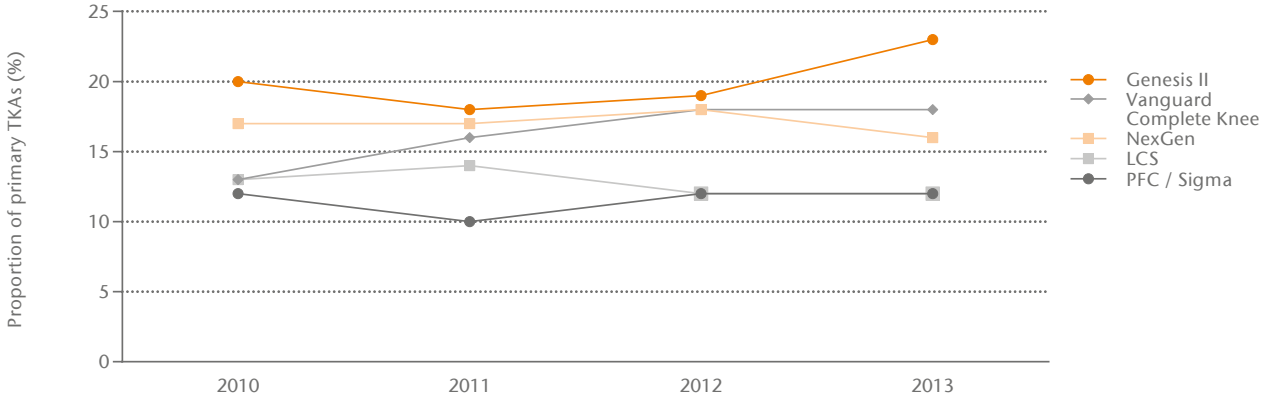
Table 4.4 The ten most frequently registered total knee prostheses implanted during primary total knee arthroplasty for all diagnoses in the Netherlands in 2013 (n=22,159).

Total knee prostheses	
Name	Proportion (%)
Genesis II	22.7
Vanguard Complete Knee	18.6
NexGen	16.8
PFC / Sigma	12.5
LCS	12.3
Triathlon	2.6
ACS	2.4
Scorpio NRG	1.7
Optetrak	1.7
AGC V2	1.6

Table 4.5 The five most frequently registered types of bone cement used during primary knee arthroplasty in the Netherlands in 2013 (n=19,994).

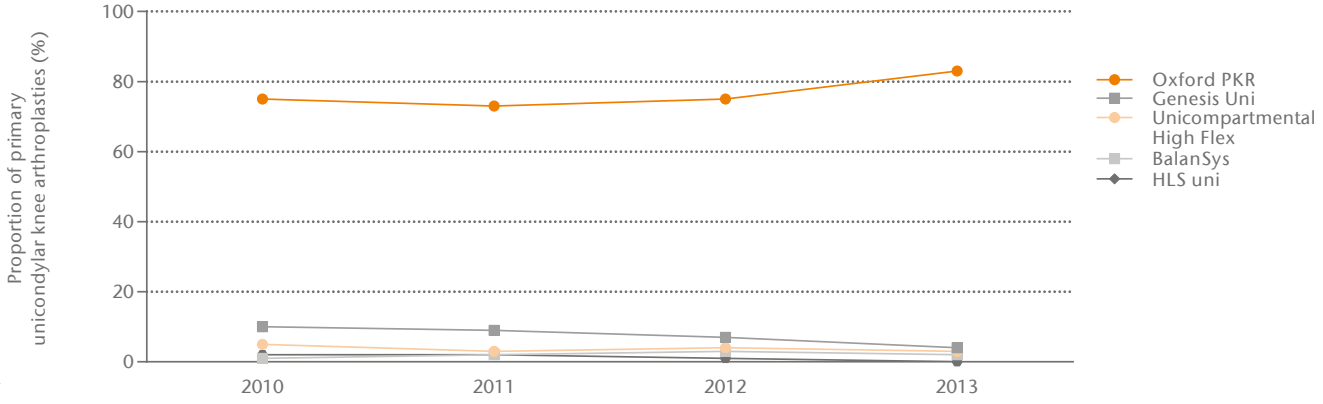
Name	Proportion (%)
Palacos R+G	59.4
Refobacin Bone Cement R	12.3
Refobacin Plus Bone Cement	9.6
Palacos MV+G	5.6
Simplex ABC EC	4.4

Genesis II, Vanguard Complete Knee, NexGen, LCS and PFC / Sigma are the TKPs that were registered most frequently. Together they were used in 75-85% of the primary TKAs in the Netherlands in 2010-2013 (Figure 4.17). The Oxford PKR was by far the most often used unicondylar knee prosthesis (83% in 2013). The proportion of other types of unicondylar knee prostheses decreased to less than 5% per type in 2013 (Figure 4.18). For patellofemoral knee prostheses, the five most registered prostheses were all used in approximately 11-20% of all patellofemoral knee arthroplasties performed in 2013. A



Total knee prostheses				
Genesis II (%)	20.3	18.3	19.8	23.2
Vanguard Complete Knee (%)	13.2	16.1	18.8	19.0
NexGen (%)	17.1	17.8	18.5	17.0
LCS (%)	13.6	14.2	12.2	12.6
PFC / Sigma (%)	12.4	10.9	12.6	12.7
Total (n)	16,757	17,654	19,631	19,761

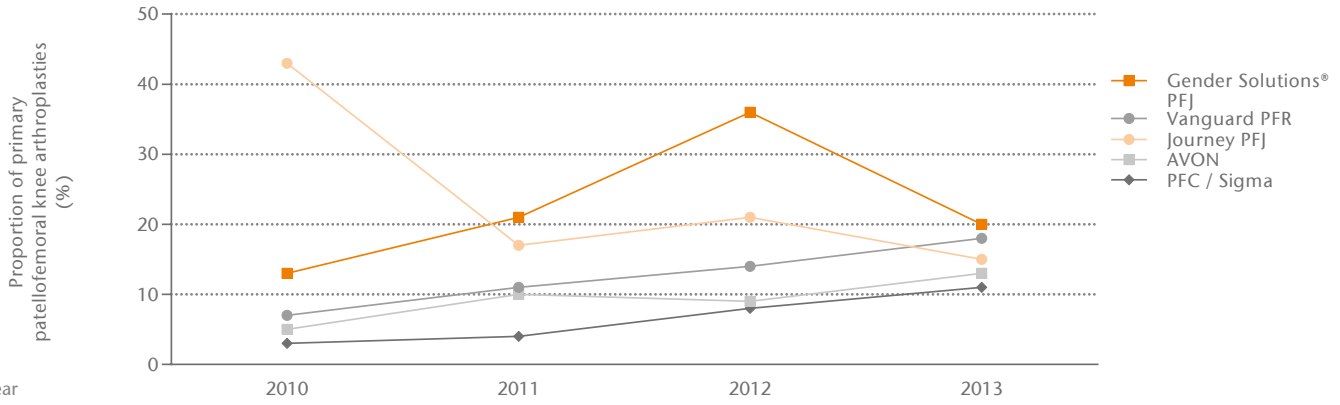
Figure 4.17 Trend (proportion [%] per year) in the five most frequently registered total knee prostheses implanted during primary total knee arthroscopy (TKA) in patients with osteoarthritis in the Netherlands in 2010-2013 (n= 73,803).



Unicondylar knee prostheses				
Oxford PKR (%)	75.8	73.4	75.7	83.0
Genesis Uni (%)	10.6	9.8	7.3	4.3
Unicompartmental High Flex (%)	5.2	3.9	4.4	3.5
BalanSys (%)	1.4	2.5	3.2	2.5
HLS uni (%)	2.6	2.7	1.8	0.0
Total (n)	1,600	1,548	1,488	1,714

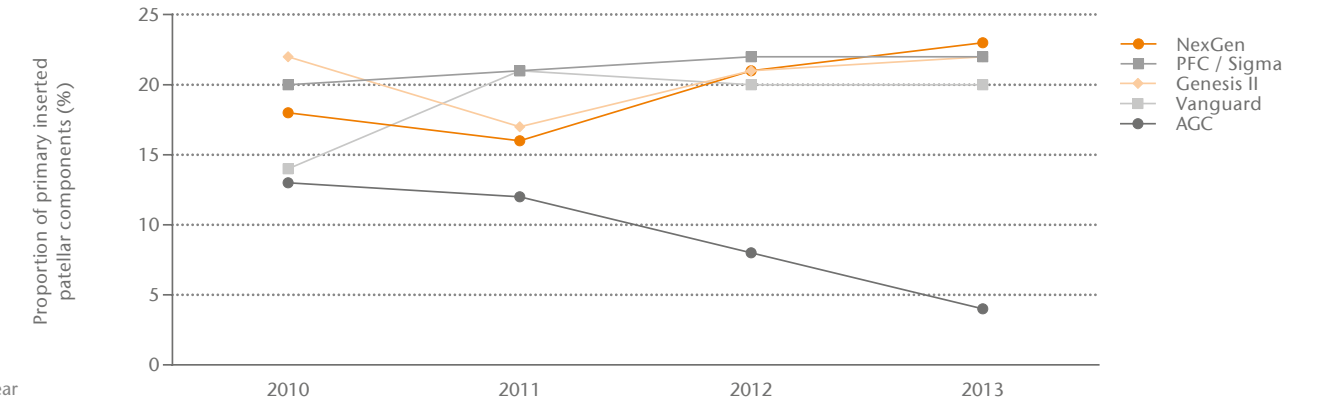
Figure 4.18 Trend (proportion [%] per year) in the five most frequently registered unicondylar knee prostheses implanted during primary unicondylar knee arthroplasty in patients with osteoarthritis in the Netherlands in 2010-2013 (n=6,350).

decrease was observed in the use of the Journey PFJ prosthesis since 2010, which is compensated by an increase of the four other most frequently registered patellofemoral knee prostheses (Figure 4.19). The four most frequently registered patellar components were each implanted during approximately 20-24% of all primary knee arthroplasties. The AGC patella was clearly implanted less frequently, with a decrease in 2010-2013 (Figure 4.20).



Patellofemoral knee prostheses				
Gender Solutions® PFJ (%)	13.7	21.8	36.6	20.0
Vanguard PFR (%)	7.7	11.9	14.5	18.9
Journey PFJ (%)	43.6	17.8	21.4	15.6
AVON (%)	6.0	10.9	9.9	13.3
PFC / Sigma (%)	3.4	5.0	8.4	11.1
Total (n)	117	101	131	90

Figure 4.19 Trend (proportion [%] per year) in the five most often frequently registered patellofemoral knee prostheses implanted during primary patellofemoral knee arthroplasty in patients with osteoarthritis in the Netherlands in 2010-2013 (n=439).



Patellar component				
NexGen (%)	18.8	16.8	21.2	23.7
PFC / Sigma (%)	20.0	21.4	22.0	22.7
Genesis II (%)	22.3	17.8	21.7	22.4
Vanguard (%)	14.2	21.2	20.3	20.3
AGC (%)	13.4	12.5	8.4	4.2
Total (n)	3,335	3,630	4,606	4,443

Figure 4.20 Trend (proportion [%] per year) in the five most frequently registered patellar components implanted during primary knee arthroplasty in the Netherlands in 2010-2013 (n=16,014).

4.2.3 Practice variation among hospitals

In total, 100 hospitals performed primary knee arthroplasties in the Netherlands in 2013. One of these hospitals was not able to register the data into the LROI database in time due to uploading difficulties. The total number of primary knee arthroplasties performed per hospital varied significantly in 2013. The median number of primary knee arthroplasties per hospital was 216 in 2013 (range 14-677) (Figure 4.21).

The characteristics of the patient population (also known as case mix) of a hospital largely determine the outcomes of the hospitals as presented in this annual report. The case mix of the patient population varied considerably per hospital. For example, the age distribution varied with a median age at surgery between 58 and 73 years among hospitals (Figure 4.22). Furthermore, the proportion of men per hospital varied between 8% and 57% (Figure 4.23) and the proportion of patients with an ASA score of I-II; varied between 65% and 100% among hospitals (Figure 4.24). The proportion of patients with the diagnosis osteoarthritis varied between 54% and 100% among hospitals.

There was considerable variation in the proportions of unicondylar knee arthroplasties and TKAs among hospitals in 2013. In 11 hospitals, a unicondylar knee arthroplasty was performed in more than 20% of all primary knee arthroplasties (Figure 4.25).

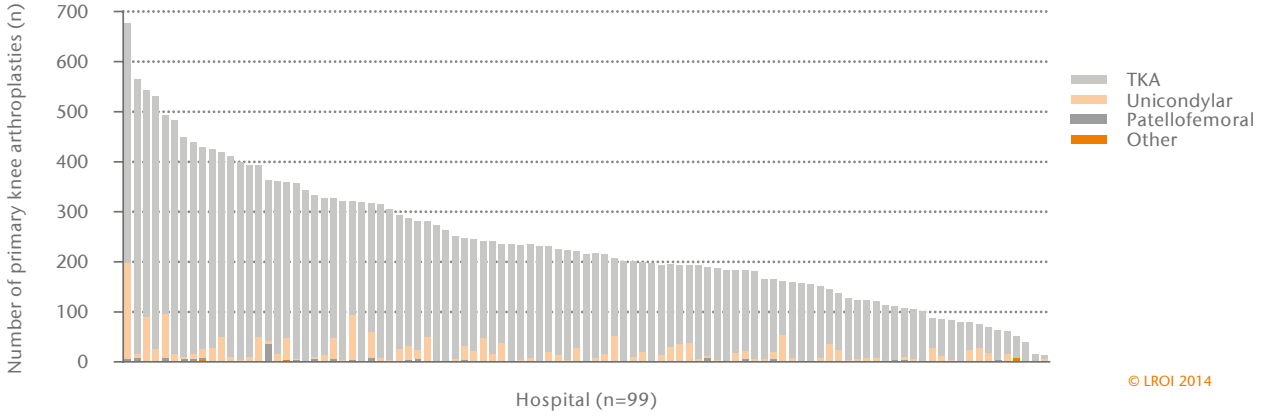


Figure 4.21 Number of primary knee arthroplasties per hospital in the Netherlands in 2013 (n=23,738).

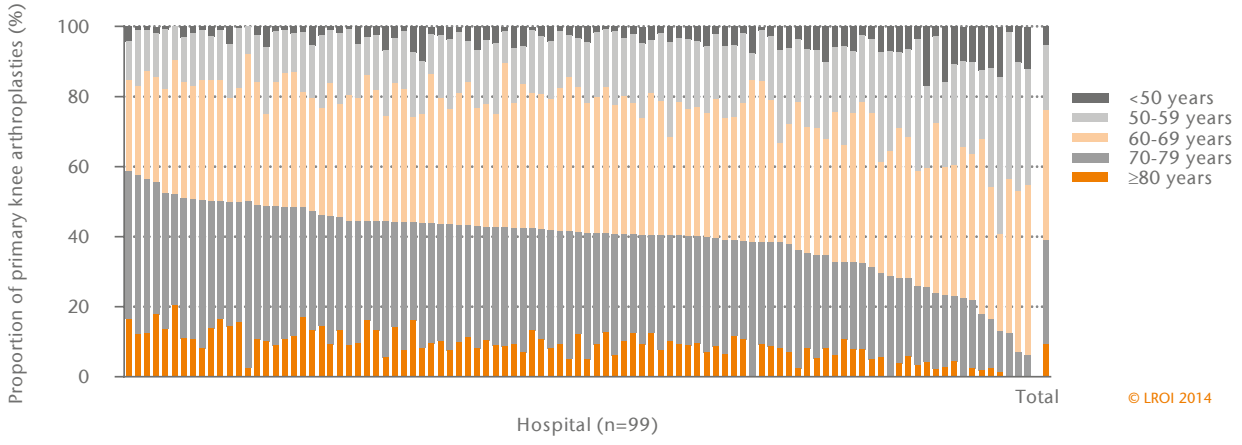


Figure 4.22 Age distribution of patients who underwent a primary total knee arthroplasty (TKA) for the first time per hospital in the Netherlands in 2013 (n=20,380).

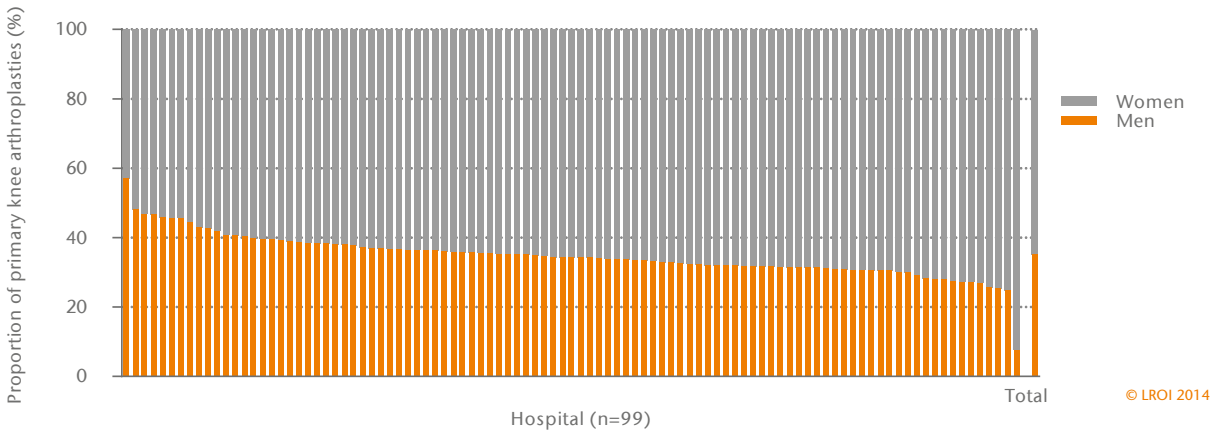


Figure 4.23 Gender distribution of patients who underwent a primary total knee arthroplasty (TKA) for the first time per hospital in the Netherlands in 2013 (n=20,350).

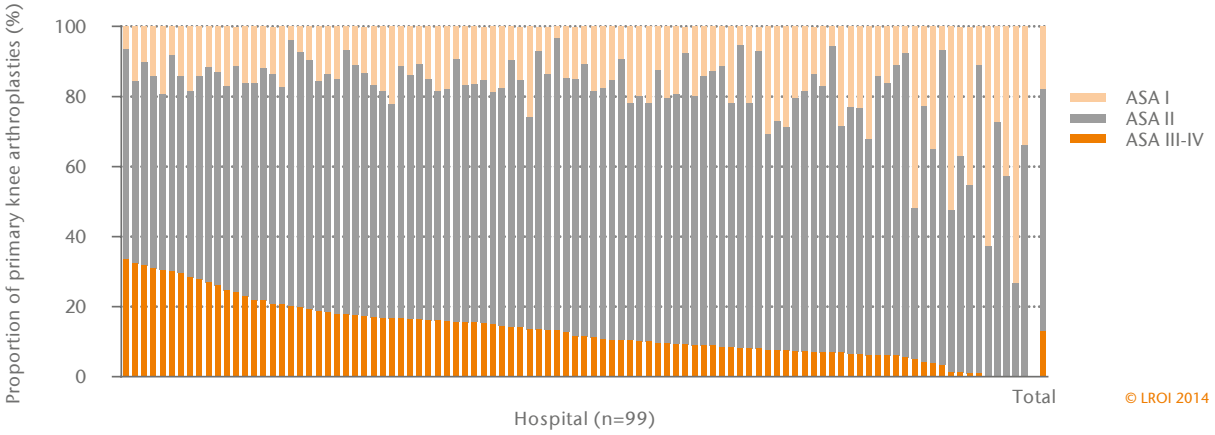


Figure 4.24 Distribution of ASA score of patients who underwent a primary total knee arthroplasty (TKA) for the first time per hospital in the Netherlands in 2013 (n=19,934).

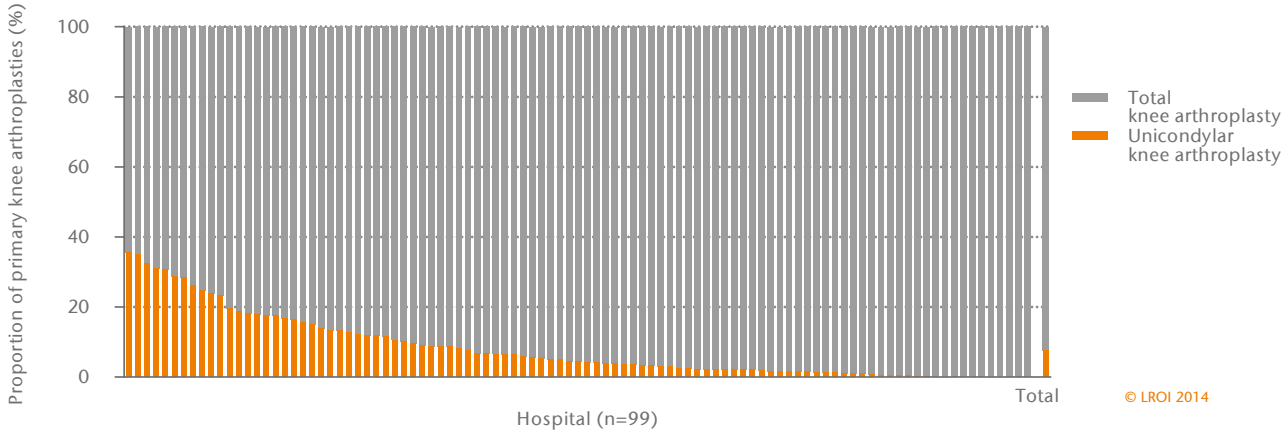


Figure 4.25 Distribution of unicondylar knee arthroplasties and total knee arthroplasties per hospital in the Netherlands in 2013 (n=23,748).

In most hospitals, primary knee prostheses were implanted cemented in 2013. However, in 12 hospitals more than half of the primary knee prostheses were implanted uncemented or hybrid (Figure 4.26). In 13 hospitals the patella was replaced in over 50% of all primary TKAs and patellofemoral knee arthroplasties (Figure 4.27).

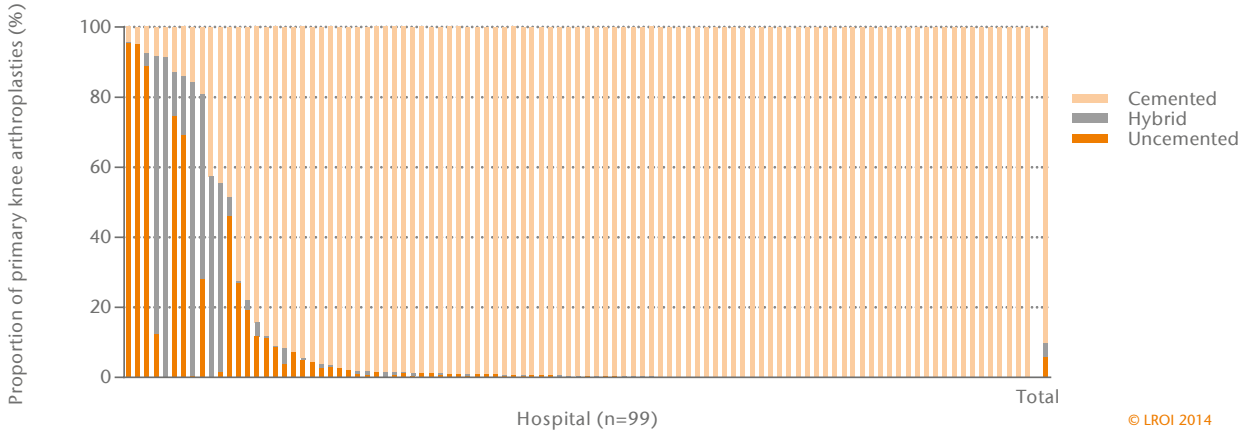


Figure 4.26 Type of fixation used during primary knee arthroplasties per hospital in the Netherlands in 2013 (n=23,704).

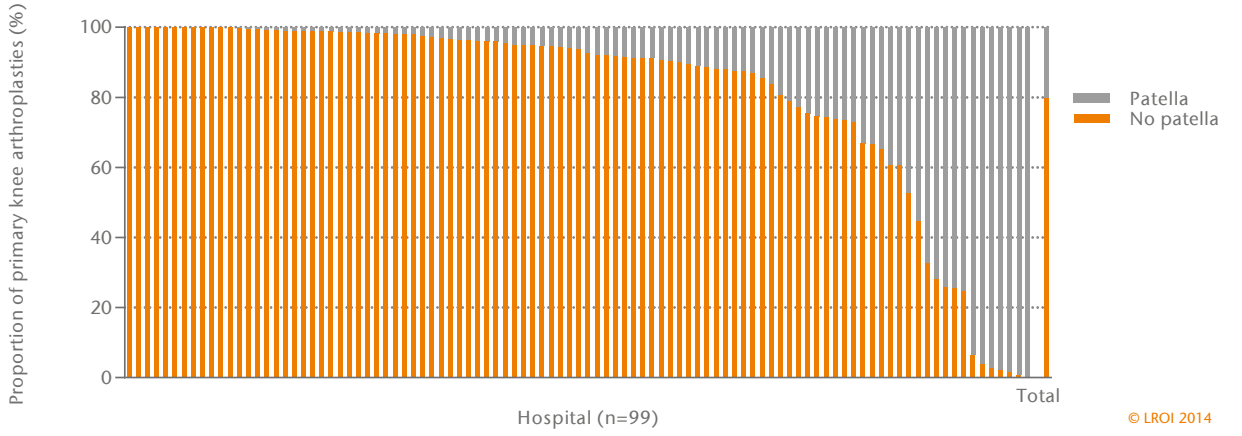
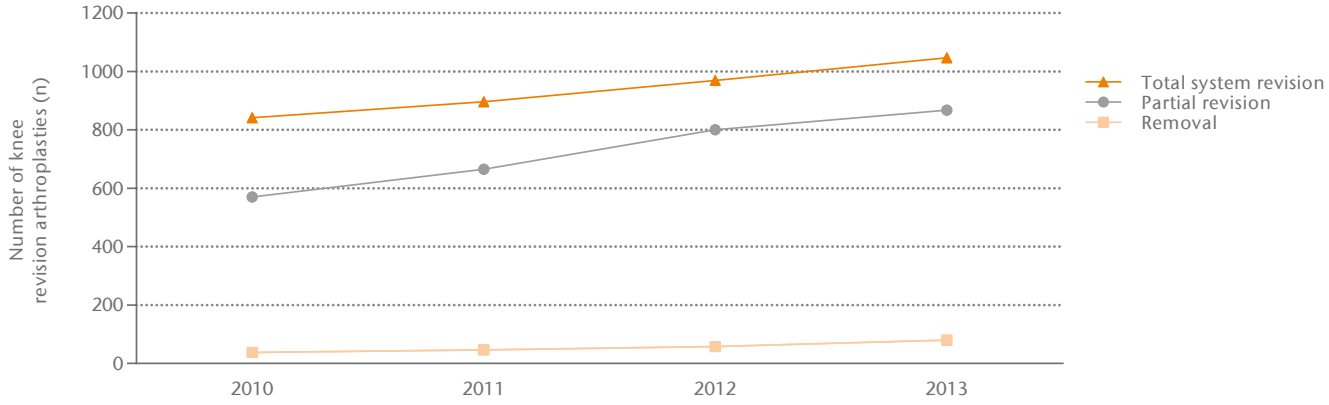


Figure 4.27 Patellar component implanted during primary knee arthroplasty (total and patellofemoral knee arthroplasties) per hospital in the Netherlands in 2013 (n=23,376).

The LROI measures patient experiences by means of PROMs

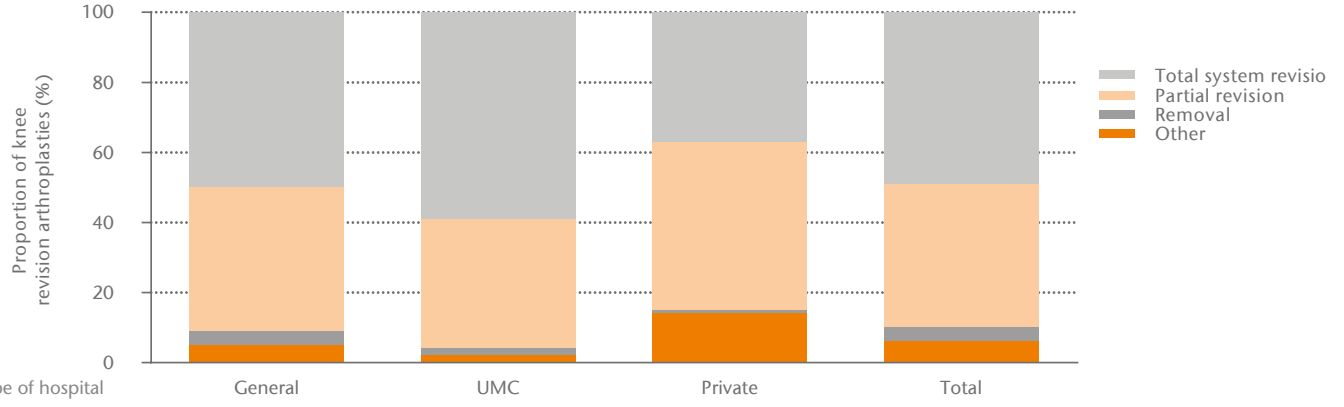
4.3 Knee revision arthroplasty

Knee revision arthroplasty is defined as any change (insertion, replacement and/or removal) to one or more components of the knee prosthesis. It is possible that a patient underwent multiple arthroplasties for one revision. This may be the case when an implant is removed during one surgery due to an infection, and a new prosthesis is implanted during a next surgery. This results in multiple knee revision arthroplasties, but it still relates to the revision of a single primary prosthesis. In



Type of knee revision					Total
Total system revision (n)	842	896	969	1,047	3,754
Partial revision (n)	570	665	800	868	2,903
Removal (n)	38	47	58	80	223
Other type of revision (n)	67	86	110	118	381
Unknown / missing (n)	100	96	121	102	419
Total (n)	1,617	1,790	2,058	2,215	7,680

Figure 4.28 Number of knee revision arthroplasties by type of revision procedure in the Netherlands in 2010-2013.



Type of knee revision				
Total system revision (%)	49.5	58.9	37.1	49.4
Partial revision (%)	41.2	36.9	48.3	41.4
Removal (%)	4.2	2.4	0.7	3.8
Other type of revision (%)	5.1	1.8	14.0	5.5
Total (n)	1,761	168	143	2,072

General: general hospital; UMC: university medical centre; Private: private hospital

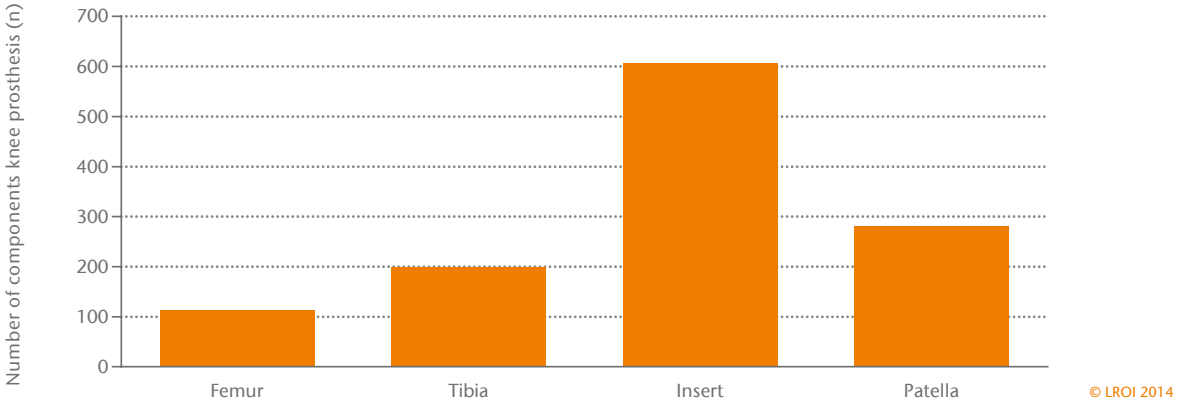
Figure 4.29 Type of knee revision arthroplasty (proportion [%] per category) by type of hospital in the Netherlands in 2013.

addition, the majority of knee revision arthroplasties in the LROI are revisions of primary knee prostheses implanted before the start of the LROI in 2007. Therefore, no patient characteristics are shown in this chapter.

The increase in the number of knee revision arthroplasties indicates that the register has become more complete. In 2013, completeness was 90%, as described in Chapter 2. In 1,047 (47%) of all knee revision arthroplasties a total system revision was performed and in 868 (39%) of the cases a partial knee revision was performed (Figure 4.28). In general hospitals, half of the revision procedures to a knee were a total system revision and 41% a partial revision. In UMCs, relatively more total system revisions were performed, while in private hospitals almost half of the revision procedures were a partial revision (Figure 4.29).

The insert was revised in 75% of partial revision arthroplasties and the patella was replaced or added in 36% of all partial revision arthroplasties (Figure 4.30). In 32% of the partial revision arthroplasties, only the insert was revised and in 19% of the procedures, only the patella was replaced or added. A conversion from a unicondylar or patellofemoral knee prosthesis to a total knee prosthesis was performed in 26% of all knee revision arthroplasties performed in 2013.

The number of knee revision arthroplasties per hospital varied strongly in 2013 from less than ten procedures in 24 hospitals to 78 procedures in one hospital. In one hospital 242 knee revision arthroplasties were registered in 2013. The median number of revision arthroplasties per hospital was 16 (range 1-242) (Figure 4.31).



Revised component	Femur	Tibia	Insert	Patella
Number (n)	113	199	606	282
Proportion (%)[1]	14.6	25.5	75.2	36.0

[1] Multiple components may be replaced in one procedure. Therefore, the total proportion adds up to more than 100%.

Figure 4.30 Number of components revised during partial knee revision arthroplasty in the Netherlands in 2013 (n=868).

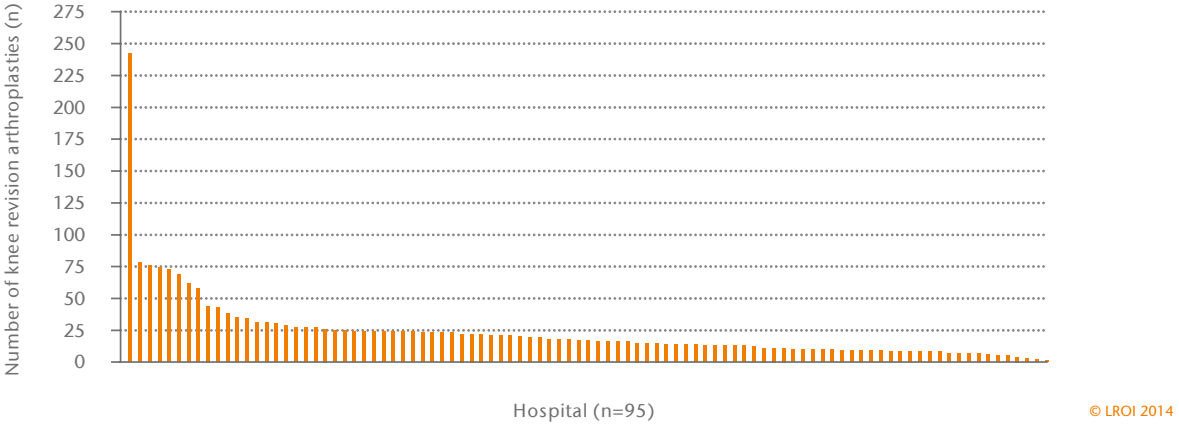


Figure 4.31 Number of knee revision arthroplasties per hospital in the Netherlands in 2013 (n=2,215).

Table 4.6 Reasons for revision or re-surgery in patients who underwent knee revision arthroplasty in the Netherlands in 2013 (n=2,215).

	Proportion (%)
Instability	29.2
Loosening tibial component	27.0
Patellar pain	25.7
Other reasons for revision	20.7
Malalignment	18.0
Infection	16.9
Loosening femoral component	13.2
Liner wear	12.3
Progression of osteoarthritis	11.3
Revision after knee removal	8.1
Patella dislocation	3.4
Loosening patellar component	2.9
Periprosthetic fracture	2.5

Please note: A patient could have multiple reasons for revision or re-surgery. Therefore, the total proportion adds up to more than 100%.

The most common reasons for the revision of a primary or revised knee prosthesis were instability (29%), loosening of the tibial component (27%) and patellar pain (26%). Also, malalignment and infection were named for 17-18% of the revision arthroplasties as a reason for the revision or re-surgery (Table 4.6). The number of patients that underwent two or more revision arthroplasties in 2013 was 98 (4.4%).

During knee revision arthroplasty a prosthesis is not always replaced or replaced immediately in a knee revision arhroplasty, for example after an infection or in case of a partial revision. Therefore, femoral, tibial, insert and/or patellar components were not implanted in all knee revision arthroplasties and thus not registered. In 2013, 2,215 knee revision arthroplasties were registered. 1,113 femoral components (40 different types), 1,161 tibial components (32 different types), 1,593 insert components (38 different types) and 791 patellar components (18 different types) were registered. Table 4.7 shows the ten most frequently

Table 4.7 The ten most registered femoral and tibial components implanted during knee revision arthroplasty in the Netherlands in 2013.

Femoral component (n=1,113)		Tibial component (n=1,161)	
Name	Proportion (%)	Name	Proportion (%)
Legion	18.3	Legion	18.4
NexGen	14.7	NexGen	14.6
Genesis II	9.9	Vanguard Complete Knee	12.2
Vanguard Complete Knee	8.8	S-Rom	10.1
RT Plus	8.4	RT Plus	8.2
LCS	8.4	Genesis II	7.8
PFC / Sigma	7.7	PFC / Sigma	4.6
Triathlon 360	4.0	Vanguard 360	3.8
Vanguard SSK	3.6	LCS	2.8
Triathlon	2.8	Triathlon	2.7

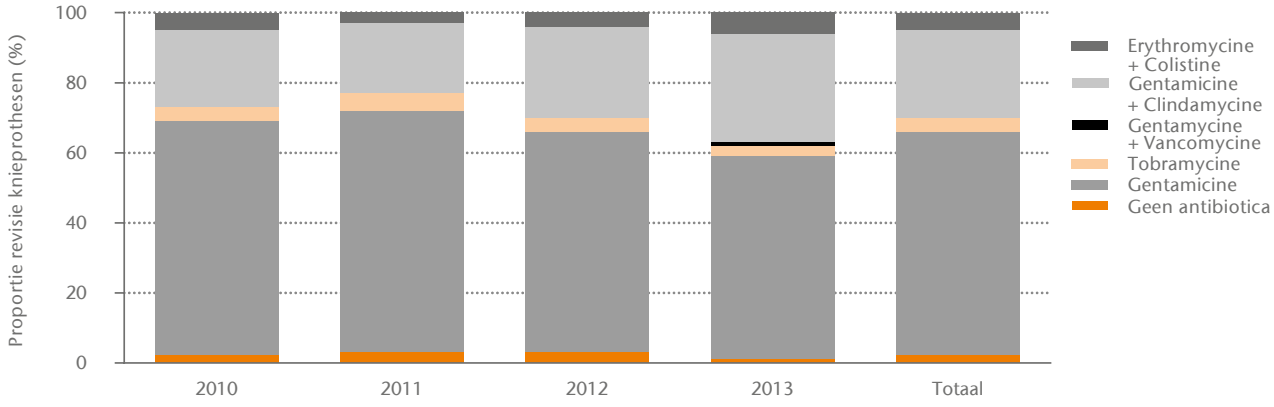
Insert (n=1,593)		Patellar component (n=791)	
Name	Proportion (%)	Name	Proportion (%)
Genesis II	25.4	Genesis II	35.5
NexGen	14.5	Vanguard	16.4
LCS	10.1	NexGen	15.2
Vanguard Complete Knee	10.0	PFC / Sigma	10.1
PFC / Sigma	7.0	LCS	4.9
RT Plus	6.3	Optetrak	3.7
Vanguard SSK	5.2	AGC	3.2
ACS	3.5	Scorpio	2.8
Oxford PKR	2.3	Triathlon	2.8
Triathlon	2.3	ACS	1.4

registered femoral, tibial, insert and patellar components implanted during knee revision arthroplasty in the Netherlands in 2013. Many different types of revision components are used to revise a knee component, in which the vast majority was used in less than 3% of all knee revision arthroplasties. This means that many knee prostheses used for revision arthroplasties were used 1 to 35 times per year in the Netherlands.

In more than 60% of the 1,693 knee revision arthroplasties with bone cement, cement with gentamicin was used, with a decrease from 67% in 2010 to 58% in 2013. In one quarter of knee revision arthroplasties, bone cement with gentamicin and clindamycin was used in 2010-2013 (Figure 4.32). In 2013, 16 different types of bone cement were used for knee revision arthroplasties in the Netherlands. Table 4.8 shows the six types of bone cement that were registered most often (each with a proportion of >5%).

Table 4.8 The six most registered types of bone cement used in knee revision arthroplasties in the Netherlands in 2013 (n=1,628).

Name	Proportion (%)
Palacos R+G	38.0
Copal G+C	21.7
Refobacin Revision	9.0
Refobacin Bone Cement R	8.1
Refobacin Plus Bone Cement	7.4
Simplex ABC EC	5.8



Antibiotics bone cement					
Erythromycin + Colistin (%)	4.5	3.9	4.3	5.8	4.7
Gentamicin + Clindamycin (%)	21.8	19.6	25.8	30.8	24.9
Gentamycin + Vancomycin (%)	0.0	0.0	0.1	1.0	0.3
Tobramycin (%)	4.3	4.5	3.5	2.8	3.7
Gentamicin (%)	67.4	68.9	63.2	58.4	64.0
No antibiotics (%)	2.0	3.2	3.0	1.2	2.3
Total (n)	1,157	1,324	1,556	1,628	5,665

Figure 4.32 Trend (proportion [%] per year) in antibiotics in bone cement used during knee revision arthroplasty in the Netherlands in 2010-2013.

The scientific advisory board advises the LROI board

5 New developments in the LROI

The LROI database is developing continuously and significant changes have taken place since the previous LROI report (LROI report 2012 Insight into Quality of Orthopaedic Care in the Netherlands). This chapter describes major changes the LROI organization and the LROI database have experienced and will experience.

5.1 Strategic plan

In August 2014, the Strategic Plan 2014-2016 'Insight into Quality and Safety' of the LROI organisation was presented. This title reflects the vision and mission of the LROI organization to contribute directly to the improvement of quality of care and to enhance patient safety, through a continuous process of measuring, registration and feedback.
In the Strategic Plan, the five main objectives of the LROI are described:

1 To improve the quality of orthopaedic surgery;
2 To educate and inform the general public and society;
3 To identify calamities and trace implants;
4 To support scientific research; and
5 To optimize and monitor the (quality of the) LROI database.

With an aim to achieve the objectives of the Strategic Plan, activities have been planned that will be on the agenda of the LROI organization during the next three years. One of the focal points is to expand scientific research with data from the LROI database and make LROI data available to external researchers. To achieve this, scientific regulations were drawn up. These regulations describe the conditions under which LROI data may be provided. In addition, the LROI organization started to develop a communication policy in 2014, since communication with stakeholders such as patients is an important focal point of the LROI. Later on in this chapter, you will read more on this subject. Finally, guaranteeing patient safety is an important aspect. Underperforming prostheses can be identified earlier through research into the quality of prostheses and continuous monitoring. In case of a recall, patients can be traced and informed (via the hospital).

5.2 New variables added for hip and knee arthroplasties

By mid-2013 the registration form for hip and knee arthroplasties was renewed. From scientific literature and foreign implant

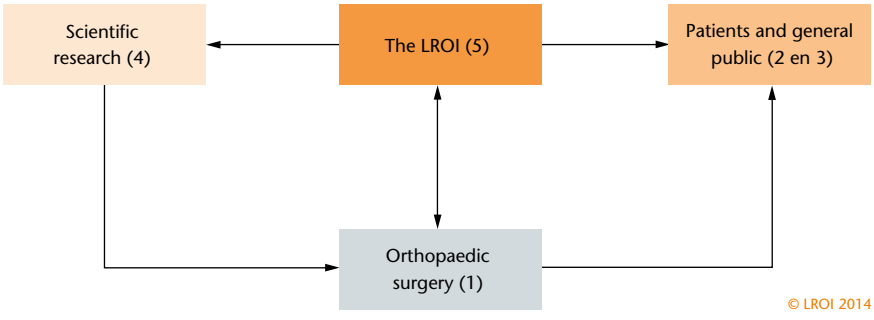


Figure 5.1 Overview of the five main objectives of the LROI organization.

registers it appears that smoking, body mass index (BMI), and Charnley score are import factors to adjust for in the survival analyses of hip and knee prostheses. Therefore, these variables were added to the registration form. Furthermore, no distinction could be made between a primary bone tumour and a metastasis; therefore, a distinction was made on the new form. Also, several surgeries that may have been performed to the same knee before the knee arthroplasty were added ('arthroscopy' and 'patella realignment procedure') to obtain a better image of the surgical history of the patient.

In this report, results on these new variables are not yet included, since they were not registered for the entire year 2013. In Table 5.1 and Table 5.2, you will find preliminary results of these new case mix variables.

5.3 New registrations

As of January 1st 2014, three new registrations were added to the LROI: the registration of ankle, shoulder and elbow arthroplasties. Although the frequency of these arthroplasties is much smaller than the frequency of hip or knee arthroplasties, it is important to gain more insight into these arthroplasties. Through these registers, traceability is achieved and the quality of the implanted prostheses will be monitored.
In Table 5.3, you will find a preliminary summary of the number of hospitals that registered these prostheses and the number of arthroplasties that were registered in the period January 1st 2014 to September 1st 2014.

Table 5.1 Preliminary results of new case mix variables for patients who underwent a primary hip arthroplasty (n=12,941) for the first time in the period July 2013 to December 2013.

	Missing values (%)	Valid proportion (%)
Body Mass Index (BMI, kg/m²)	27.0	
Underweight (≤18.5)		0.7
Normal (>18.5-25)		33.1
Overweight (>25-30)		43.0
Obesity (>30-40)		22.2
Morbid obesity (>40)		1.0
Smoking	40.0	
Yes		13.2
No	86.8	
Charnley score	19.1	
A One hip joint affected		49.9
B1 Both hip joints affected		27.8
B2 Contralateral hip joint with a total hip prosthesis		19.4
C Multiple joints affected or a chronic disease that affects the quality of life (mostly walking)		2.9

Table 5.2 Preliminary results of new case mix variables for patients who underwent a primary knee arthroplasty (n=11,351) for the first time in the period July 2013 to December 2013.

	Missing values (%)	Valid proportion (%)
Body Mass Index (BMI, kg/m²)	26.9	
Underweight (≤18.5)		0.2
Normal (>18.5-25)		17.7
Overweight (>25-30)		42.3
Obesity (>30-40)		36.6
Morbid obesity (>40)		3.3
Smoking	38.9	
Yes		11.1
No	88.9	
Charnley score	20.7	
A One knee joint affected		51.0
B1 Both knee joints affected		31.3
B2 Contralateral knee joint with a total knee prosthesis		14.5
C Multiple joints affected or a chronic disease that affects the quality of life (mostly walking)		3.2

Table 5.3 Number of registering hospitals and number of registered primary and revision procedures for ankle, shoulder and elbow arthroplasties in the LROI in the period January 2014 to August 2014.

	Number of hospitals in the LROI	Number of hospitals according to Vektis[1]	Participating hospitals	Number of procedures in the LROI	Estimated annual number[2]
Ankle arthroplasty	10	33	-	31	192
Shoulder arthroplasty	73	95	77%	848	2,012
Elbow arthroplasty	15	23	-	51	154

[1] Based on hospitals with a health product code for ankle, shoulder or elbow arthroplasty from Vektis (health insurance organisation) in 2013. The volume of elbow and ankle arthroplasties is very low, therefore it is possible that hospitals that performed these arthroplasties in 2013, no longer performed these arthroplasties in 2014. Since only data on 2014 are available in the LROI, participation of the hospitals has yet to be determined.
[2] Based on data from Vektis in 2012.

5.4 Dates of death in the LROI

This report does not contain survival analyses of prostheses, since the LROI did not yet have access to the patients' date of death - if applicable - at the time of the analyses for this report. These dates are necessary to calculate the correct survival rate of a prosthesis, like the expected time to a revision.
In September 2014, the LROI was expanded with the date of death. The link that was needed to include the dates of death into the database was realized in a way that guarantees the privacy of the patient and which is legally permitted. The LROI is the first quality register in the Netherlands to realize such a link. The exchange of information took place by means of the encryption service of TRES, a product of ZorgTTP. The personal identification numbers of deceased patients registered in a database of Vektis (Dutch health care insurance organisation) who underwent an arthroplasty and are therefore also registered in the LROI, were encrypted using TRES. The encrypted personal identification numbers, together with the dates of death were added to the LROI in a safe manner for research purposes. Over the next years, it will be possible to calculate the survival of a prosthesis.

5.5 Scientific regulations

For 2010, the LROI register was over 90% complete and for 2012 this percentage increased to 95%. As of then, valid analyses could be performed on the data. The scientific advisory board of the LROI developed scientific regulations to make it possible to provide applicants with data for scientific research in an orderly manner.

The scientific regulations state the criteria a research proposal to be met by and the conditions for providing information to the applicant. As such, data security and privacy are guaranteed. Over the next years, more and more scientific research may be performed using the research data in the LROI. These studies will render the quality of orthopaedic care more transparent and comprehensible. Ultimately, this will result in an enhanced quality of orthopaedic care.

5.6 Implementation of PROMs and striving for a national benchmark

On October 4th 2012, during the General Assembly Meeting, the members of the Netherlands Orthopaedic Association (NOV) established their recommendation in respect of the Patient Reported Outcome Measures (PROMs). In 2013, the recommendation was followed by a PROM implementation plan. This implementation plan described how PROMs can be measured in orthopaedic practice. In addition, the implementation plan described that a national benchmark is desired and that, consequently, it should be possible to link the PROMs data to the implant data in the LROI.

Currently, many orthopaedic departments have started working with the NOV's PROMs recommendation. The methods for measuring the PROMs differ, since there are several ways to collect PROMs: through the hospitals' own software, through paper forms or through digital LROI web forms.

The majority of the orthopaedic departments collect PROMs data through a private software provider. The measurement of PROMs therefore operates in a slightly different manner in each system. To get the best and most uniform PROMs possible, the NOV and the LROI organization have described several conditions for measuring PROMs. The software providers who meet these three 'required' LROI conditions, as described by the NOV, will receive an LROI certificate.
These three required conditions are:
— Security of personal data is governed by the applicable ISO and/or NEN standards;
— Software allows uploading of data to the LROI;
— Validated PROM questionnaires are used.

In September 2014, 15 hospitals used the LROI web forms to provide the LROI with their PROMs data. Two hospitals provided the LROI with their data through data upload.

5.7 Patient edition of LROI annual report

After the 2012 LROI report, the LROI organization published two patient infographics on hip and knee arthroplasties. These infographics were spread among the orthopaedic departments as a poster. This 2013 LROI report will be followed by a more extended patient edition, in the form of a Z-card. This Z-card has a manageable size and provides the patient with information on hip and knee arthroplasties. Furthermore, the most important results from the 2013 LROI report are described on the card. With this card, patients will become increasingly involved in the register. The card was designed with assistance from the NOV Communications Commission.

Appendix Participating hospitals LROI

Table 1 General hospitals that registered in the LROI in 2013.

Admiraal de Ruyter Ziekenhuis
Albert Schweitzer Ziekenhuis
Algemeen Ziekenhuis de Tjongerschans
Algemeen Ziekenhuis Westfries Gasthuis
Amphia Ziekenhuis
Antonius Ziekenhuis
Atrium Medisch Centrum
Beatrix ziekenhuis, Rivas Zorggroep
BovenIJ Ziekenhuis
Bronovo Ziekenhuis
Canisius-Wilhelmina Ziekenhuis
Deventer Ziekenhuis
Diaconessenhuis, Leiden
Diaconessenhuis, Meppel
Diakonessenhuis, Utrecht
Elkerliek Ziekenhuis
Flevoziekenhuis
Gelre Ziekenhuizen
Gemini Ziekenhuis
Groene Hart Ziekenhuis
HagaZiekenhuis
Havenziekenhuis
Het Van Weel-Bethesda Ziekenhuis
IJsselland Ziekenhuis
IJsselmeerziekenhuizen
Ikazia Ziekenhuis
Isala Klinieken
Jeroen Bosch Ziekenhuis
Kennemer Gasthuis
LangeLand Ziekenhuis
Lievensberg Ziekenhuis
Maasstad Ziekenhuis
Martini Ziekenhuis
Meander Medisch Centrum
Medisch Centrum Alkmaar
Medisch Centrum Haaglanden
Medisch Centrum Leeuwarden
Medisch Spectrum Twente
Ommelander Ziekenhuisgroep
Onze Lieve Vrouwe Gasthuis
Orbis Medisch Centrum
Orthopedie Groot Eindhoven
Orthopedisch Centrum Oost Nederland
Refaja Ziekenhuis
Reinier de Graaf Gasthuis
Rijnland Ziekenhuis
Rode Kruis Ziekenhuis
Röpcke Zweers Ziekenhuis
Scheper Ziekenhuis
Sint Anna Ziekenhuis
Sint Antonius Ziekenhuis
Sint Elisabeth Ziekenhuis
Sint Franciscus Gasthuis
Sint Franciscus Ziekenhuis
Sint Jans Gasthuis
Sint Laurentius Ziekenhuis
Sint Lucas-Andreas Ziekenhuis
Sint Maartenskliniek, locatie Nijmegen
Sint Maartenskliniek, locatie Boxmeer
Sint Maartenskliniek, locatie Woerden
Slingeland Ziekenhuis
Slotervaart Ziekenhuis
Spaarne Ziekenhuis
Spijkenisse Medisch Centrum
Streekziekenhuis Koningin Beatrix
Tergooiziekenhuizen
TweeSteden Ziekenhuis
Viecuri Medisch Centrum voor Noord-Limburg
Vlietland Ziekenhuis
Waterlandziekenhuis
Wilhelmina Ziekenhuis
Zaans Medisch Centrum
Ziekenhuis Amstelland
Ziekenhuis Bernhoven
Ziekenhuis Bethesda
Ziekenhuis Gelderse Vallei
Ziekenhuis Nij Smellinghe
Ziekenhuis Rijnstate
Ziekenhuis Rivierenland
Ziekenhuis St. Jansdal
ZorgSaam Zeeuws-Vlaanderen

Table 2 University Medical Centres that registered in the LROI in 2013.

Academisch Medisch Centrum
Erasmus Medisch Centrum
Leids Universitair Medisch Centrum
Universitair Medisch Centrum Groningen
Maastricht UMC+
Radboudumc
Universitair Medisch Centrum Utrecht
VU Medisch Centrum

Table 3 Private hospitals that registered in the LROI in 2013.

Annatommie
AVE Orthopedische Klinieken
Bergman Clinics
Knee Clinic*
Medinovakliniek, locatie Breda
Medinovakliniek, locatie Klein Rosendael*
Medinovakliniek, locatie Zestienhoven*
Orthopedie Kliniek*
Orthopedium
Reinaert Kliniek*
Kliniek ViaSana

* No hip arthroplasties performed.

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