
# Online LROI annual report 2017

## 10 years of registration, a wealth of information



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# Introduction

This online annual report 2017 of the Dutch Arthroplasty Register (LROI) contains information on orthopaedic prosthesis procedures in the Netherlands in 2016. This concerns primary hip, knee, ankle, shoulder and elbow arthroplasties and revision procedures.

You will find data on:

- Prosthesis characteristics
- Surgical techniques
- Survival of prostheses
- Patient characteristics of patients who underwent an arthroplasty procedure
- Patients' experiences in the form of PROMs (Patient Reported Outcome Measures)
- Information on the data quality, like completeness and validity of the register

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Dutch Knee Society
Dutch Shoulder and Elbow Society
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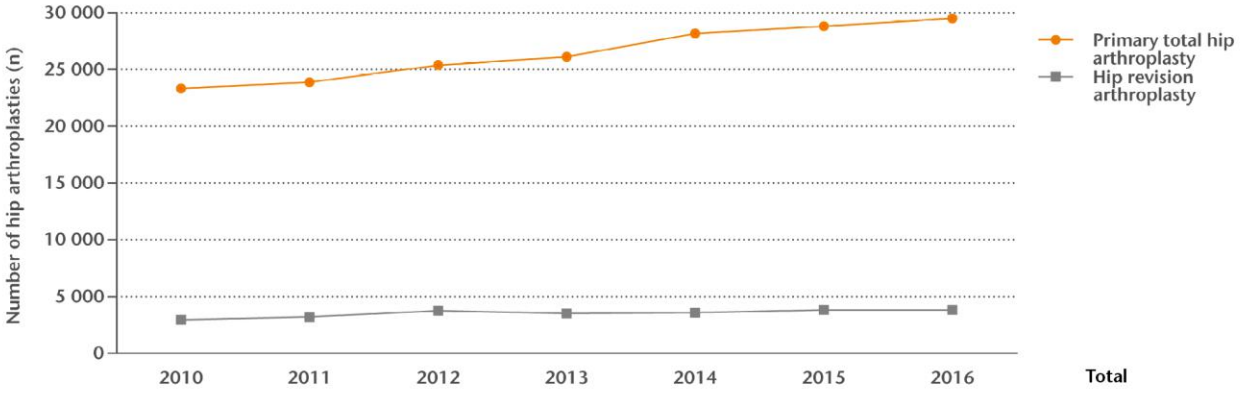
# Hip arthroplasty

## Numbers

### Procedures 2010-2016

**FIGURE NUMBER OF PRIMARY TOTAL HIP ARTHROPLASTIES AND HIP REVISION ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2010-2016.**




| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| **Type of procedure** | | | | | | | | |
| Primary total hip arthroplasty (n) | 23,330 | 23,872 | 25,388 | 26,114 | 28,174 | 28,811 | 29,520 | 185,209 |
| Hip revision arthroplasty (n) | 2,949 | 3,198 | 3,764 | 3,513 | 3,581 | 3,833 | 3,836 | 24,674 |
| Total (n) | 26,279 | 27,070 | 29,152 | 29,627 | 31,755 | 32,644 | 33,356 | 209,883 |

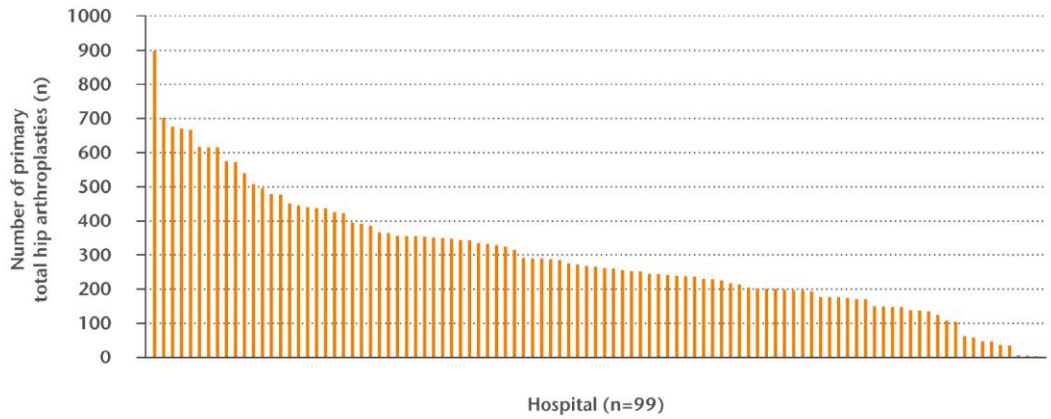
Please note: Data before 2015 were frozen for hip arthroplasties in this annual report.



**Out of 29,520 primary total hip arthroplasties that were performed in 2016, 2.8% (n=834) was performed bilaterally.**

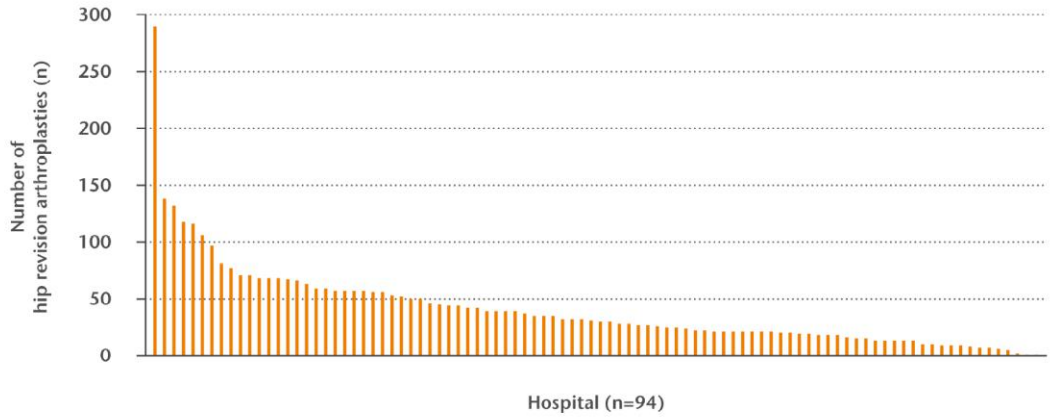
### THA per hospital

**FIGURE NUMBER OF PRIMARY TOTAL HIP ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=29,520).**



## Revisions per hospital

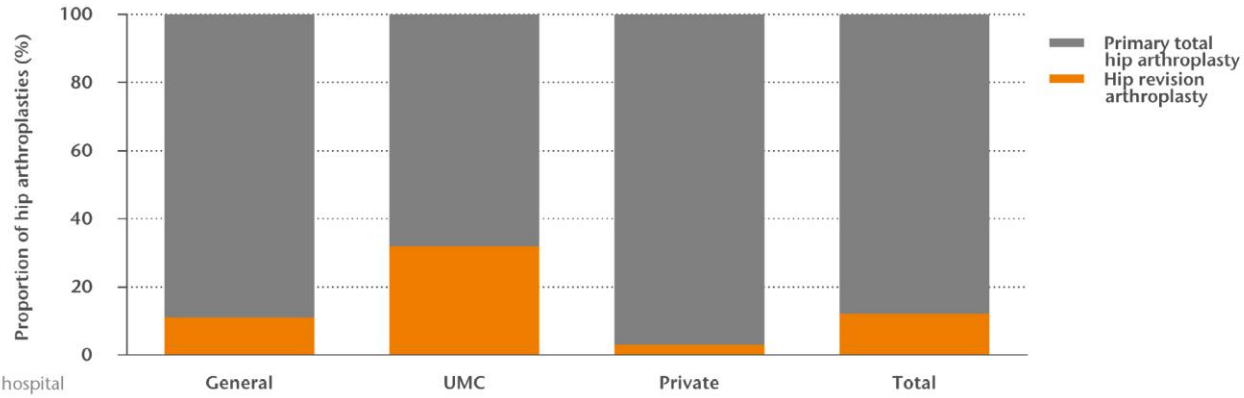
**FIGURE NUMBER OF HIP REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=3,836).**






## Type of procedure by type of hospital

**FIGURE PRIMARY TOTAL HIP ARTHROPLASTIES AND HIP REVISION ARTHROPLASTIES (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**




| Type of procedure | General | UMC | Private | Total |
|---|---|---|---|---|
| Primary total hip arthroplasty (%) | 89.0 | 68.0 | 97.4 | 88.5 |
| Hip revision arthroplasty (%) | 11.0 | 32.0 | 2.6 | 11.5 |
| Total (n) | 30,261 | 1,434 | 1,661 | 33,356 |

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

# Total hip arthroplasty

## Demographics

### Patient characteristics by diagnosis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY TOTAL HIP ARTHROPLASTY BY DIAGNOSIS IN THE NETHERLANDS IN 2016.**

| N | Osteoarthritis 24,654 (85.9%) | Fracture 1,380 (4.8%) | Osteonecrosis 807 (2.8%) | Late post-traumatic 691 (2.4%) | Dysplasia 599 (2.1%) | Reumatoid arthritis 203 (0.7%) | Post-Perthes' disease 85 (0.3%) | Tumour 74 (0.3%) | Total 28,686 |
|---|---|---|---|---|---|---|---|---|---|
| Completeness (%) | | | | | | | | | 99 |
| Mean age (years) (SD) | 69.6 (9.7) | 69.7 (9.1) | 62.7 (15.4) | 66.9 (11.8) | 54.7 (13.8) | 64.6 (12.6) | 46.3 (15.1) | 61.0 (11.0) | 68.8 (10.5) |
| Age (years) (%) | | | | | | | | | |
| <50 | 3 | 2 | 19 | 8 | 32 | 14 | 51 | 16 | 4 |
| 50-59 | 12 | 11 | 20 | 16 | 31 | 14 | 27 | 27 | 13 |
| 60-69 | 33 | 37 | 26 | 35 | 21 | 30 | 16 | 35 | 33 |
| 70-79 | 37 | 37 | 22 | 26 | 13 | 35 | 6 | 19 | 35 |
| ≥80 | 15 | 13 | 13 | 15 | 3 | 7 | 0 | 3 | 15 |
| Gender (%) | | | | | | | | | |
| Men | 34 | 31 | 46 | 42 | 29 | 27 | 71 | 42 | 35 |
| Women | 66 | 69 | 54 | 58 | 71 | 73 | 29 | 58 | 65 |
| ASA score (%) | | | | | | | | | |
| I | 18 | 14 | 14 | 18 | 40 | 8 | 48 | 8 | 18 |
| II | 66 | 60 | 53 | 55 | 54 | 71 | 47 | 38 | 65 |
| III-IV | 16 | 26 | 33 | 27 | 6 | 21 | 5 | 54 | 17 |
| Type of hospital (%) | | | | | | | | | |
| General | 92 | 95 | 85 | 89 | 82 | 90 | 89 | 72 | 91 |
| UMC | 2 | 5 | 12 | 8 | 8 | 9 | 5 | 28 | 3 |
| Private | 6 | 0 | 3 | 3 | 10 | 1 | 6 | 0 | 6 |
| Charnley-score (%) | | | | | | | | | |
| A One hip joint affected | 46 | 81 | 65 | 87 | 54 | 36 | 74 | 77 | 48 |
| B1 Both hip joints affected | 31 | 8 | 18 | 4 | 28 | 29 | 20 | 6 | 29 |
| B2 Contralateral hip joint with a total hip prosthesis | 21 | 7 | 4 | 6 | 16 | 15 | 6 | 11 | 20 |
| C Multiple joints affected or chronic disease that affects quality of life | 2 | 4 | 3 | 3 | 2 | 20 | 0 | 6 | 3 |
| Body Mass Index (kg/m²) (%) | | | | | | | | | |
| Underweight (≤18,5) | 1 | 3 | 2 | 5 | 1 | 1 | 0 | 2 | 1 |
| Normal weight (>18,5-25) | 31 | 50 | 42 | 45 | 40 | 36 | 32 | 47 | 33 |
| Overweight (>25-30) | 43 | 36 | 36 | 36 | 37 | 35 | 36 | 27 | 42 |
| Obesity (>30-40) | 24 | 10 | 18 | 14 | 21 | 27 | 32 | 23 | 23 |
| Morbid obesity (>40) | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 1 | 1 |
| Smoking (%) | | | | | | | | | |
| No | 89 | 85 | 80 | 81 | 85 | 91 | 73 | 75 | 88 |
| Yes | 11 | 15 | 20 | 19 | 15 | 9 | 27 | 25 | 12 |

Please note: In 2016, 34 (0.1%) patients received a primary total hip arthroplasty after a diagnosis that is not listed in the table. The diagnosis of 159 (0.6%) patients was not registered.
Please note: In 2016, 80 general hospitals, 8 UMCs and 11 private hospitals performed primary total hip arthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.



**Patient characteristics of patients who underwent a primary THA in 2016 strongly depend on the primary diagnosis.**

## Previous surgery

**TABLE PREVIOUS SURGERIES TO THE SAME JOINT IN PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=28,594).**

| | Proportion[1] (%) |
|---|---|
| Previous surgery to the relevant hip (total) | 5.0 |
| Osteosynthesis | 3.7 |
| Osteotomy | 0.9 |
| Arthrodesis | 0.1 |
| Girdlestone situation | 0.1 |
| Other | 1.3 |

[1] A patient may have undergone multiple previous surgeries to the same joint. As such, the total proportion is more than the total proportion of patients with one or more previous surgeries to the same joint.

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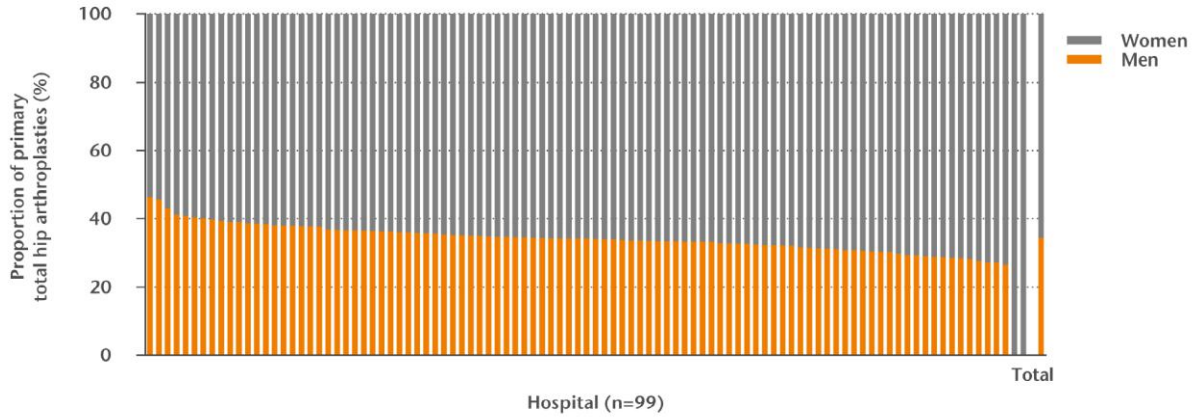
## Practice variation

### Gender

**FIGURE DISTRIBUTION OF GENDER OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=28,662).**

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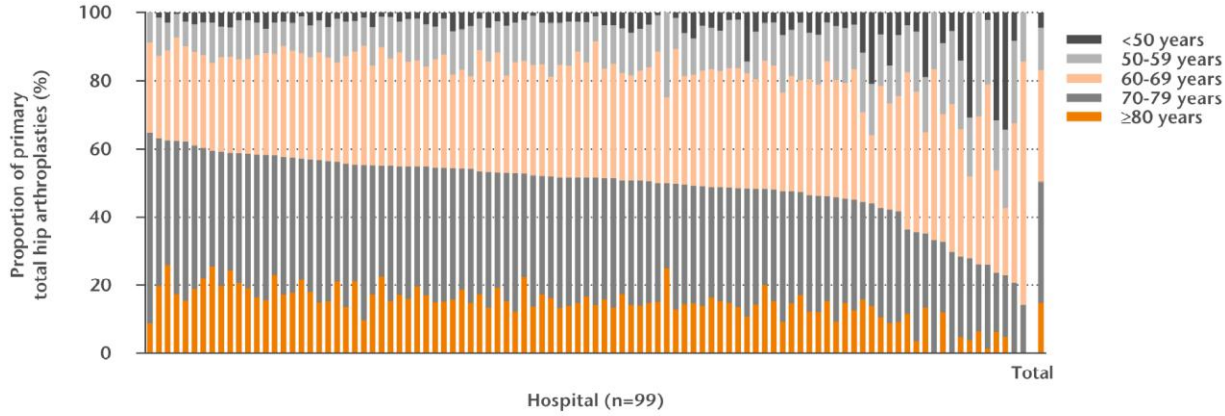
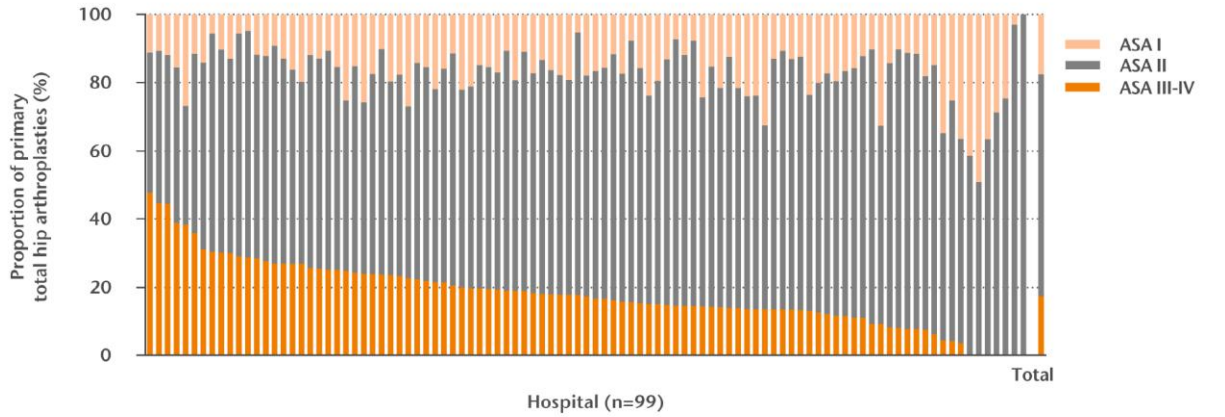
## Age

**FIGURE DISTRIBUTION OF AGE OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=28,658).**



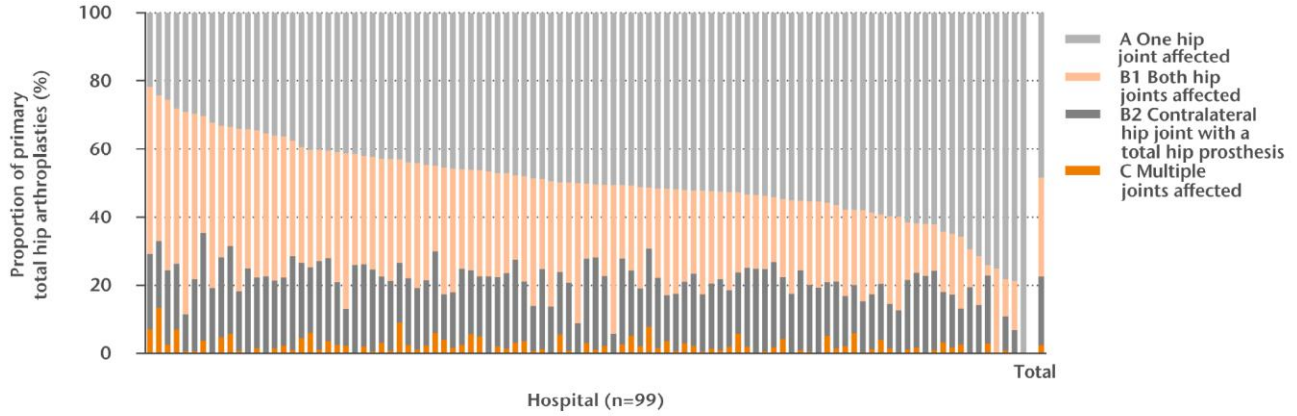

## ASA score

**FIGURE DISTRIBUTION OF ASA SCORE OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=28,668).**



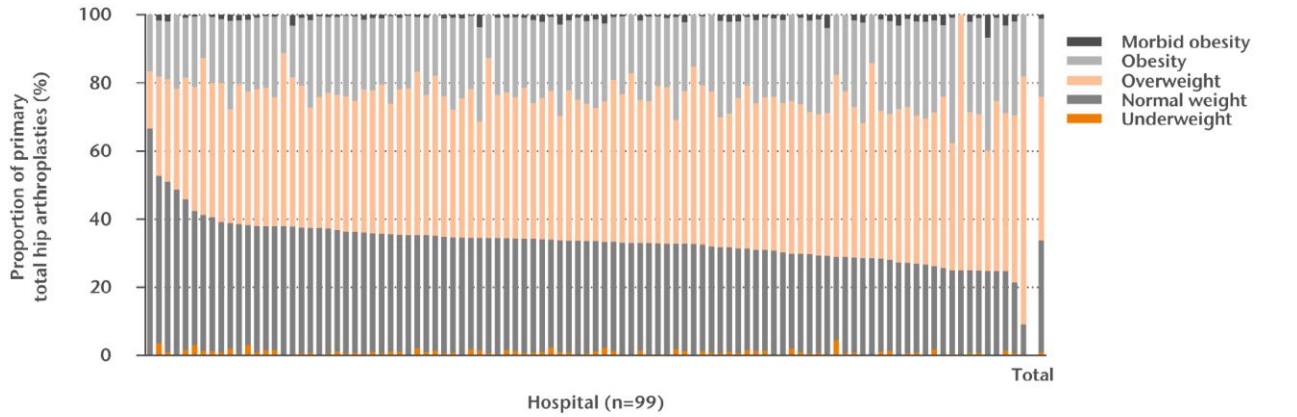
## Charnley score

**FIGURE DISTRIBUTION OF CHARNLEY SCORE OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=26,839).**



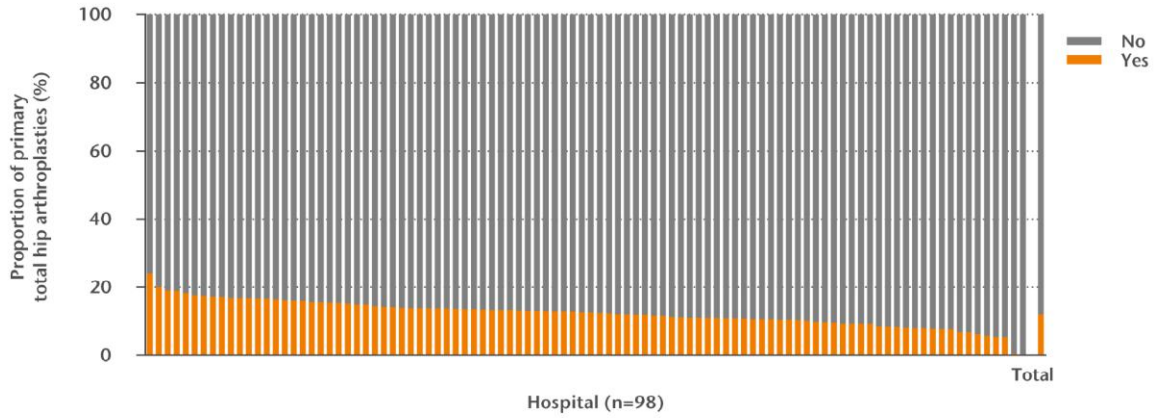

## Body Mass Index

**FIGURE DISTRIBUTION OF BODY MASS INDEX (KG/M²) OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=28,521).**



## Smoking

**FIGURE DISTRIBUTION OF SMOKING BY PATIENTS WHO UNDERWENT A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,992).**

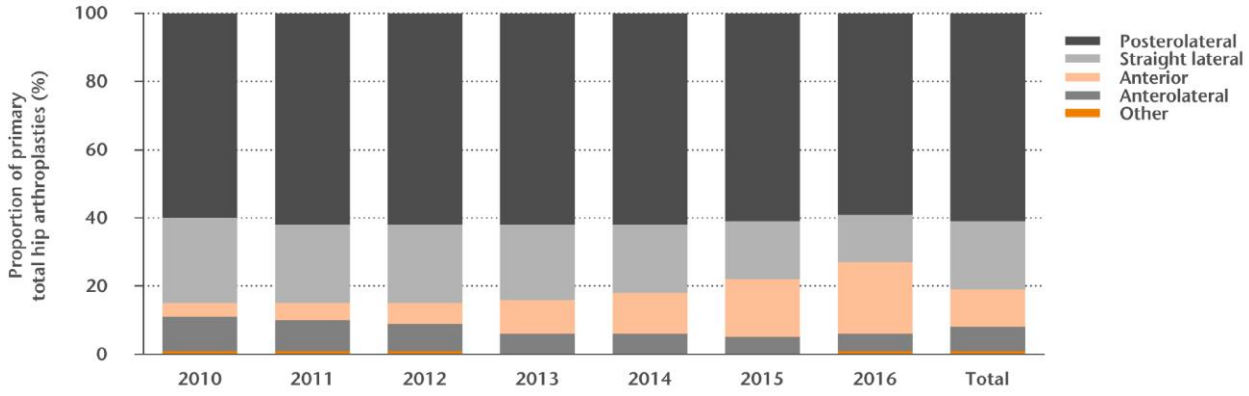



# Surgery

## Surgical techniques

## Surgical approach 2010-2016

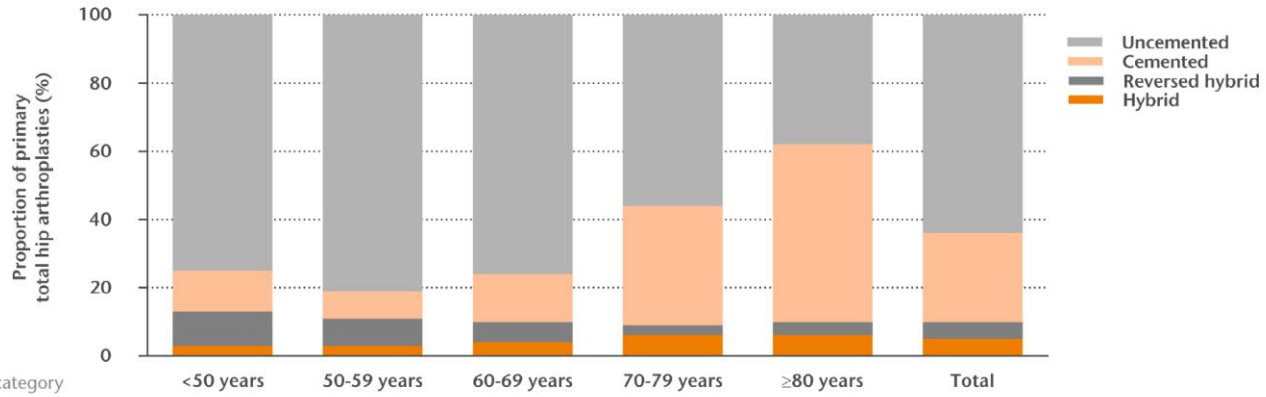
**FIGURE TREND (PROPORTION [%] PER YEAR) IN SURGICAL APPROACH FOR PERFORMING A PRIMARY TOTAL HIP ARTHROPLASTY IN THE NETHERLANDS IN 2010-2016.**




| Surgical approach | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Posterolateral (%) | 59.9 | 62.2 | 62.1 | 61.6 | 62.0 | 60.7 | 59.5 | 61.1 |
| Straight lateral (%) | 25.5 | 23.3 | 23.1 | 21.7 | 20.2 | 17.0 | 13.5 | 20.3 |
| Anterior (%) | 4.2 | 5.0 | 6.3 | 9.8 | 12.3 | 16.7 | 20.6 | 11.2 |
| Anterolateral (%) | 9.7 | 8.6 | 7.9 | 6.6 | 5.3 | 5.1 | 5.5 | 6.8 |
| Other (%) | 0.7 | 0.9 | 0.6 | 0.3 | 0.2 | 0.5 | 0.9 | 0.6 |
| Total (n) | 22,822 | 23,380 | 24,843 | 25,805 | 27,978 | 28,751 | 29,503 | 183,082 |

## Fixation by age category

**FIGURE TYPE OF FIXATION (PROPORTION [%] PER CATEGORY) IN PRIMARY TOTAL HIP ARTHROPLASTIES BY AGE CATEGORY IN THE NETHERLANDS IN 2016.**



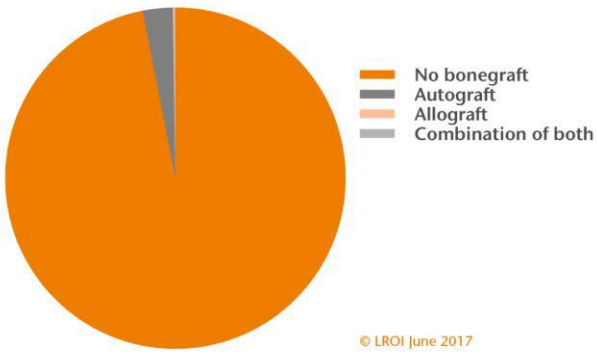

| Fixation | | | | | | |
|---|---|---|---|---|---|---|
| Uncemented (%) | 74.7 | 80.8 | 76.2 | 55.5 | 38.5 | 63.8 |
| Cemented (%) | 12.3 | 8.4 | 14.5 | 34.6 | 51.5 | 26.2 |
| Reversed hybrid (%) | 10.2 | 8.0 | 5.7 | 3.5 | 3.5 | 5.1 |
| Hybrid (%) | 2.8 | 2.8 | 3.6 | 6.4 | 6.5 | 4.9 |
| Total (n) | 1,301 | 3,694 | 9,624 | 10,386 | 4,330 | 29,335 |



## Prosthesis characteristics

## Type of bonegraft

**FIGURE TYPE OF BONEGRAFT IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=29,423).**

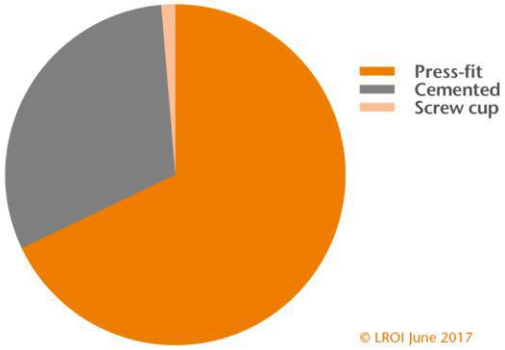





| Type of bonegraft | Number (n) | Proportion (%) |
|---|---|---|
| No bonegraft | 28,511 | 96.9 |
| Autograft | 841 | 2.9 |
| Allograft | 40 | 0.1 |
| Combination of both | 31 | 0.1 |

## Type of acetabular component

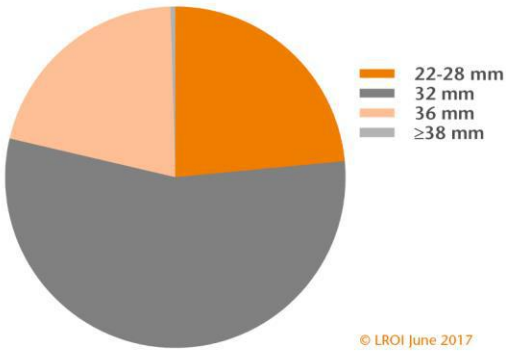
**FIGURE TYPE OF ACETABULAR COMPONENT IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=28,717).**




| Type of acetabular component | Number (n) | Proportion (%) |
|---|---|---|
| Press-fit | 19,503 | 67.9 |
| Cemented | 8,831 | 30.8 |
| Screw cup | 383 | 1.3 |

## Femoral head diameter

**FIGURE FEMORAL HEAD COMPONENT DIAMETER IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=29,073).**

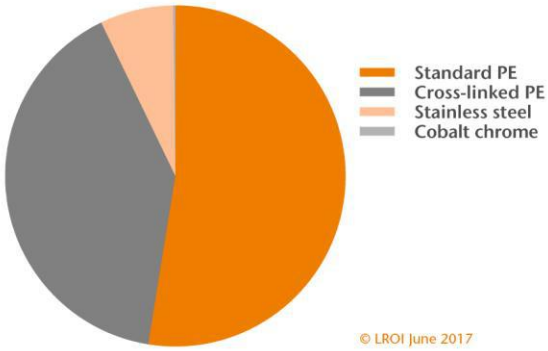



| Femoral head diameter | Number (n) | Proportion (%) |
|---|---|---|
| 22-28 mm | 6,831 | 23.5 |
| 32 mm | 16,034 | 55.1 |
| 36 mm | 6,076 | 20.9 |
| ≥38 mm | 132 | 0.5 |

## Materials

### Cemented acetabular component

**FIGURE CEMENTED ACETABULUM MATERIAL IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=8,831).**

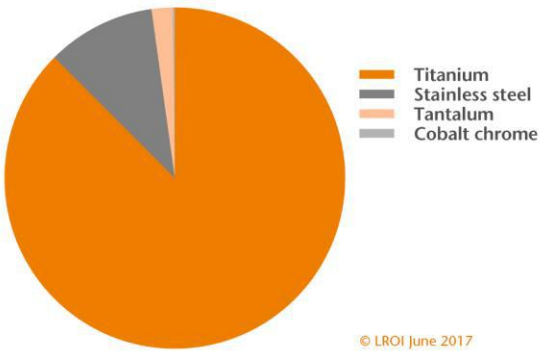



| Cemented acetabulum | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 4,641 | 52.6 |
| Cross-linked PE | 3,556 | 40.3 |
| Stainless steel | 614 | 6.9 |
| Cobalt chrome | 20 | 0.2 |

PE: polyethylene.

### Uncemented acetabular component

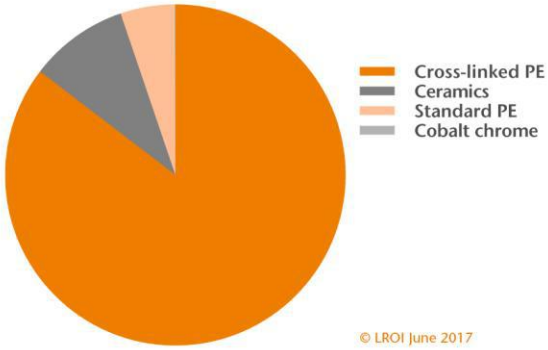
**FIGURE UNCEMENTED ACETABULUM MATERIAL IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=19,886).**




| Uncemented acetabulum | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 17,400 | 87.5 |
| Stainless steel | 2,048 | 10.3 |
| Tantalum | 395 | 2.0 |
| Cobalt chrome | 43 | 0.2 |

## Inlay

**FIGURE INLAY MATERIAL IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=18,569).**

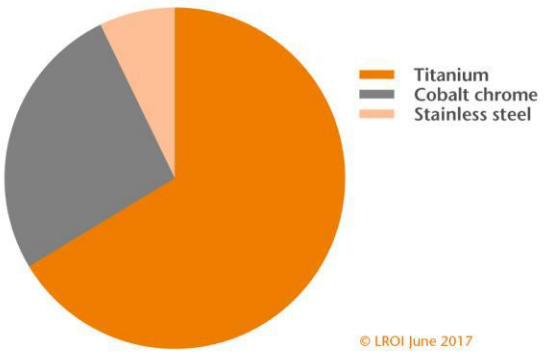



| Inlay material | Number (n) | Proportion (%) |
|---|---|---|
| Cross-linked PE | 15,853 | 85.4 |
| Ceramics | 1,747 | 9.4 |
| Standard PE | 956 | 5.1 |
| Cobalt chrome | 13 | 0.1 |

PE: polyethylene.

## Femur component

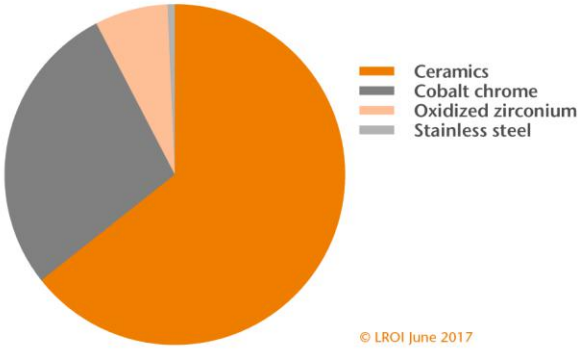
**FIGURE FEMUR COMPONENT MATERIAL IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=28,415).**




| Femur material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 18,854 | 66.4 |
| Cobalt chrome | 7,515 | 26.4 |
| Stainless steel | 2,046 | 7.2 |

## Femoral head component

**FIGURE FEMORAL HEAD MATERIAL IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=28,103).**

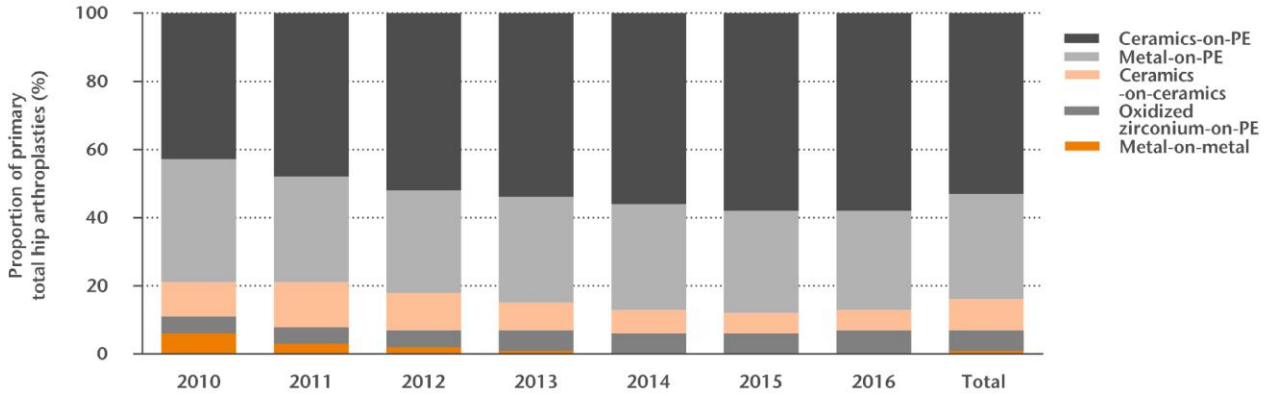



| Femoral head material | Number (n) | Proportion (%) |
|---|---|---|
| Ceramics | 18,081 | 64.4 |
| Cobalt chrome | 7,875 | 28.0 |
| Oxidized zirconium | 1,948 | 6.9 |
| Stainless steel | 197 | 0.7 |

Please note: In 2 (0.01%) primary total hip arthroplasties a titanium femoral head component was implanted.

## Articulation 2010-2016

**FIGURE TREND (PROPORTION [%] PER YEAR) IN ARTICULATION IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2010-2016.**

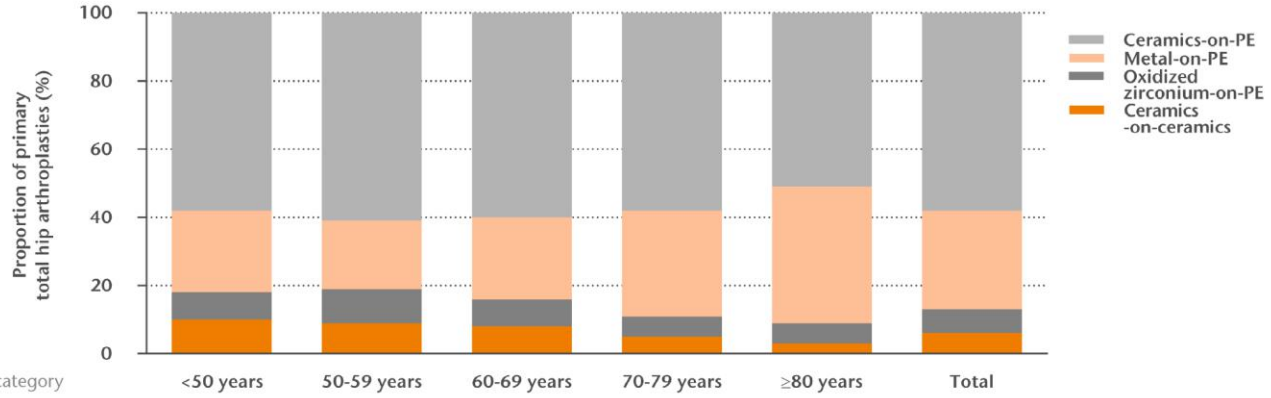



| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Articulation | | | | | | | | |
| Ceramics-on-PE (%) | 43.3 | 47.8 | 51.7 | 54.6 | 55.9 | 57.6 | 58.1 | 53.2 |
| Metal-on-PE (%) | 36.5 | 31.6 | 30.3 | 30.6 | 31.2 | 29.7 | 28.6 | 31.1 |
| Ceramics-on-ceramics (%) | 9.8 | 13.2 | 11.5 | 8.4 | 6.7 | 6.5 | 6.3 | 8.7 |
| Oxidized Zirconium-on-PE (%) | 4.5 | 4.6 | 4.8 | 5.8 | 6.1 | 6.1 | 7.0 | 5.6 |
| Metal-on-Metal (%) | 5.8 | 2.6 | 1.7 | 0.6 | 0.1 | 0.1 | 0.0 | 1.4 |
| Other (%) | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total (n) | 21,750 | 22,532 | 24,003 | 25,044 | 27,175 | 27,973 | 27,528 | 176,005 |

Please note: The proportion of other articulation was too small to show in the figure.
PE: polyethylene.

## Articulation by age category

**FIGURE ARTICULATION (PROPORTION [%] PER YEAR) IN PRIMARY TOTAL HIP ARTHROPLASTIES BY AGE CATEGORY IN THE NETHERLANDS IN 2016.**



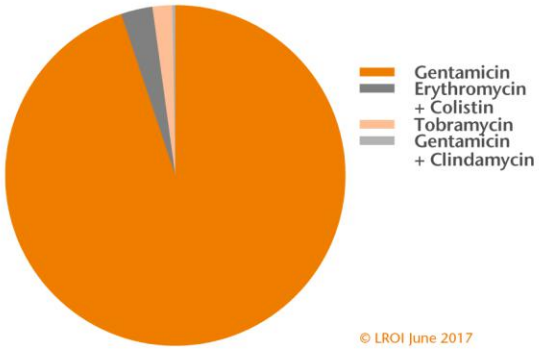

| Age category | <50 years | 50-59 years | 60-69 years | 70-79 years | ≥80 years | Total |
|---|---|---|---|---|---|---|
| Articulation | | | | | | |
| Ceramics-on-PE (%) | 57.5 | 61.0 | 60.7 | 57.5 | 51.4 | 58.1 |
| Metal-on-PE (%) | 24.1 | 20.5 | 23.9 | 31.4 | 40.2 | 28.6 |
| Oxidized Zirconium-on-PE (%) | 8.2 | 9.8 | 7.5 | 5.9 | 5.6 | 7.0 |
| Ceramics-on-ceramics (%) | 9.9 | 8.6 | 7.9 | 5.2 | 2.8 | 6.3 |
| Metal-on-Metal (%) | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total (n) | 1,167 | 3,406 | 8,986 | 9,829 | 4,110 | 27,498 |

Please note: In 2 (<0.01%) primary total hip arthroplasties, another type of articulation was registered. The proportion metal-on-metal primary total hip arthroplasties was too small to show in this figure.
PE: polyethylene.

## Bone cement

### Antibiotics

**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=9,357).**

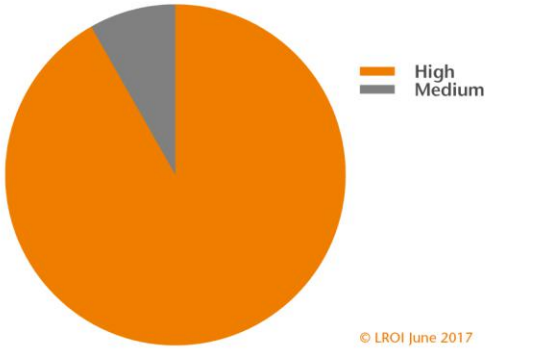



| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 8,871 | 94.8 |
| Erythromycin + Colistin | 280 | 3.0 |
| Tobramycin | 174 | 1.9 |
| Gentamicin + Clindamycin | 28 | 0.3 |

Please note: Bone cement with gentamicin and vancomycin was used in 3 (0.03%) primary total hip arthroplasties. Bone cement without antibiotics was used in 1 (0.01%) primary total hip arthroplasty.

### Viscosity

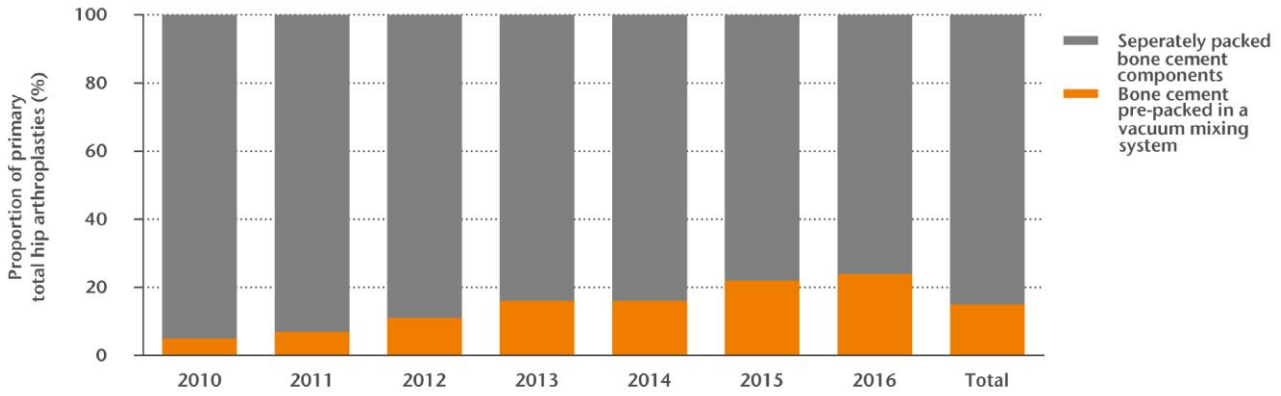
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=9,357).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 8,586 | 91.8 |
| Medium | 771 | 8.2 |

## Vacuum mixing system 2010-2016

**FIGURE TREND (PROPORTION [%] PER YEAR) IN USE OF BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2010-2016.**




| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Vacuum mixing system | | | | | | | | |
| Separately packed bone cement components (%) | 94.6 | 92.7 | 88.7 | 83.6 | 82.0 | 75.6 | 72.8 | 83.8 |
| Bone cement pre-packed in a vacuum mixing system (%) | 5.4 | 7.3 | 11.3 | 16.4 | 18.0 | 24.4 | 27.2 | 16.2 |
| Total (n) | 7,809 | 8,292 | 8,906 | 9,247 | 9,977 | 9,545 | 9,357 | 63,133 |

## Most frequently registered components

**TABLE THE TEN MOST FREQUENTLY REGISTERED ACETABULUM (BOTH CEMENTED AND UNCEMENTED) AND FEMUR (BOTH CEMENTED AND UNCEMENTED) COMPONENTS IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

**Acetabulum**

| Cemented (n=9,005) | | Uncemented (n=20,018) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Müller low profile | 23.2 | Pinnacle | 22.5 |
| IP Cup | 16.3 | Allofit | 22.0 |
| Reflection All Poly XLPE | 9.1 | Mallory Head | 10.9 |
| FAL Cup | 8.7 | Exceed ABT | 8.8 |
| Exeter Rimfit | 7.6 | R3 | 5.3 |
| Avantage | 5.3 | Trident | 4.9 |
| Stanmore | 4.5 | Reflection | 4.1 |
| Contemporary Hooded | 3.2 | Trident Tritinium | 3.9 |
| CCB cup Low Profile | 3.1 | RM Pressfit Vitamys cup | 3.7 |
| Exeter Contemporary Flanged | 2.8 | RM Pressfit cup | 2.5 |

**Femur**

| Cemented (n=9,039) | | Uncemented (n=19,854) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Lubinus SPII | 30.8 | Corail | 22.2 |
| Original ME Muller | 19.8 | Taperloc Complete | 20.9 |
| Exeter | 18.2 | CLS Spotorno | 8.9 |
| Spectron EF | 10.7 | Alloclassic Zweymuller SL | 8.5 |
| Stanmore | 10.0 | Accolade | 8.4 |
| CCA stem | 2.1 | SL Plus | 4.7 |
| C-Stem AMT | 1.6 | Twinsys stem Cementless | 4.5 |
| Taperloc Complete | 1.4 | Mallory Head | 3.5 |
| MS30 | 0.8 | M/L Taper | 3.0 |
| Twinsys stem Cementless | 0.7 | Synergy | 2.9 |



## Most frequently registered types of bone cement

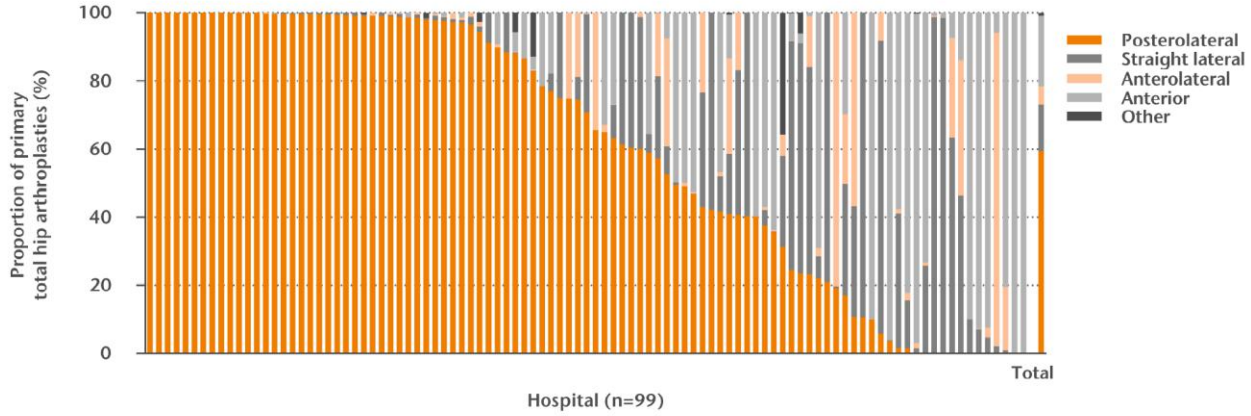
**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Separately packed bone cement components (n=6,816) | | Bone cement pre-packed in a vacuum mixing system (n=2,541) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Palacos R+G | 79.6 | Refobacin Bone Cement R | 30.5 |
| Refobacin Bone Cement R | 5.0 | Palacos Pro | 29.0 |
| Palacos MV+G | 4.6 | Optipac | 24.5 |
| Simplex ABC EC | 4.1 | Refobacin Plus Bone Cement | 11.7 |
| Simplex HV | 2.7 | Cemex | 3.9 |

## Practice variation

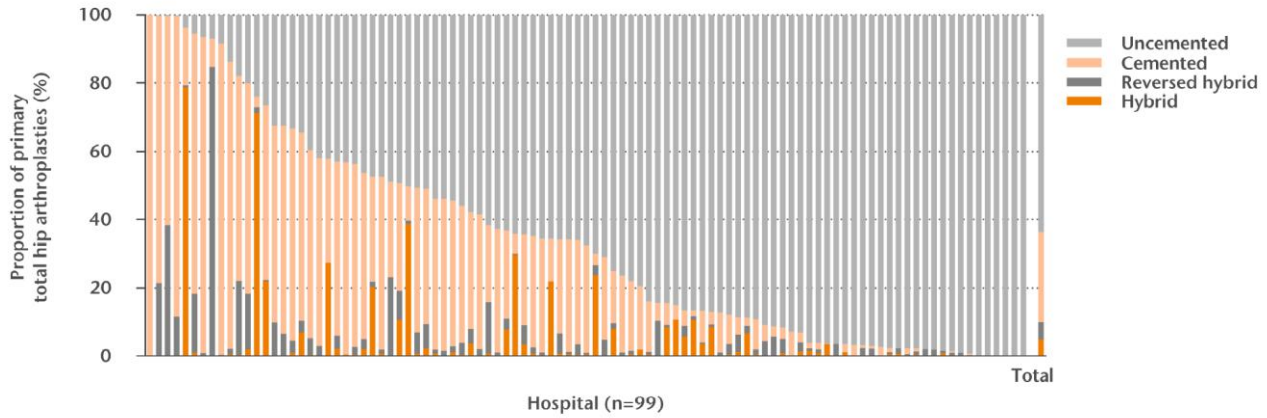
## Surgical approach

**FIGURE DISTRIBUTION OF SURGICAL APPROACH USED DURING PRIMARY TOTAL HIP ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=29,503).**



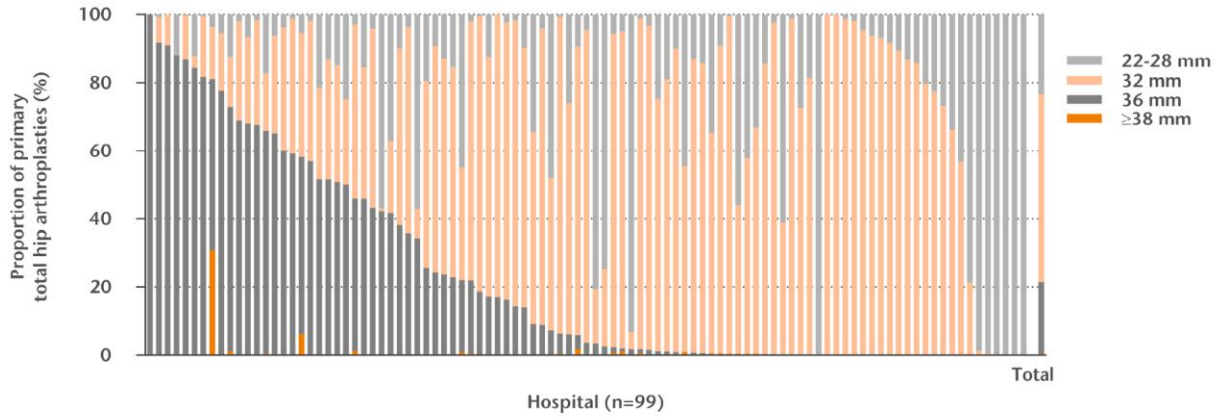

## Fixation

**FIGURE DISTRIBUTION OF TYPE OF FIXATION USED DURING PRIMARY TOTAL HIP ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=29,363).**



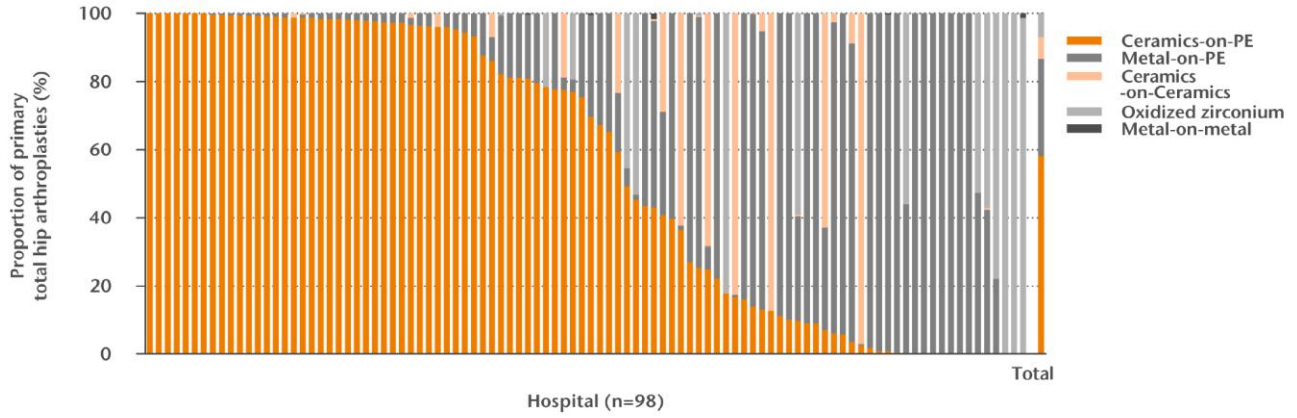
## Femoral head diameter

**FIGURE DISTRIBUTION OF DIAMETER FEMORAL HEAD USED DURING PRIMARY TOTAL HIP ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=29,073).**




## Articulation

**FIGURE DISTRIBUTION OF ARTICULATION USED DURING PRIMARY TOTAL HIP ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,526).**



# Hip hemiarthroplasty

## Demographics

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY HIP HEMIARTHROPLASTY BY SPECIALISM IN THE NETHERLANDS IN 2016.**

| | Orthopaedic surgeon | Trauma surgeon | Total |
|---|---|---|---|
| N | 4,103 (78.2%) | 1,146 (21.8%) | 5,249 |
| Completeness (%) | 95 | 50 | 78 |
| Mean age (years) (SD) | 82.3 (8.6) | 82.0 (8.1) | 82.2 (8.5) |
| Age (years) (%) | | | |
| <50 | 1 | 0 | 0 |
| 50-59 | 1 | 1 | 1 |
| 60-69 | 5 | 7 | 6 |
| 70-79 | 23 | 27 | 24 |
| ≥80 | 70 | 65 | 69 |
| Gender (%) | | | |
| Men | 33 | 33 | 33 |
| Women | 67 | 67 | 67 |
| ASA score (%) | | | |
| I | 2 | 3 | 2 |
| II | 33 | 34 | 33 |
| III-IV | 65 | 63 | 65 |
| Type of hospital (%) | | | |
| General | 97 | 92 | 96 |
| UMC | 3 | 8 | 4 |
| Private | 0 | 0 | 0 |
| Diagnosis (%) | | | |
| Fracture (acute) | 95 | 98 | 96 |
| Osteoarthritis | 3 | 1 | 2 |
| Late post-traumatic | 1 | 1 | 1 |
| Tumour | 1 | 0 | 1 |
| Osteonecrosis | 0 | 0 | 0 |
| Dysplasia | 0 | 0 | 0 |
| Rheumatoid arthritis | 0 | 0 | 0 |
| Post-Perthes' disease | 0 | 0 | 0 |
| Inflammatory arthritis | 0 | 0 | 0 |
| Charnley-score (%) | | | |
| A One hip joint affected | 78 | 80 | 79 |
| B1 Both hip joints affected | 7 | 9 | 7 |
| B2 Contralateral hip joint with a total hip prosthesis | 10 | 5 | 9 |
| C Multiple joints affected or chronic disease that affects quality of life | 5 | 6 | 5 |
| Body Mass Index (kg/m²) (%) | | | |
| Underweight (≤18,5) | 6 | 6 | 6 |
| Normal weight (>18,5-25) | 55 | 56 | 55 |
| Overweight (>25-30) | 31 | 31 | 31 |
| Obesity (>30-40) | 8 | 7 | 8 |
| Morbid obesity (>40) | 0 | 0 | 0 |
| Smoking (%) | | | |
| No | 91 | 91 | 91 |
| Yes | 9 | 9 | 9 |

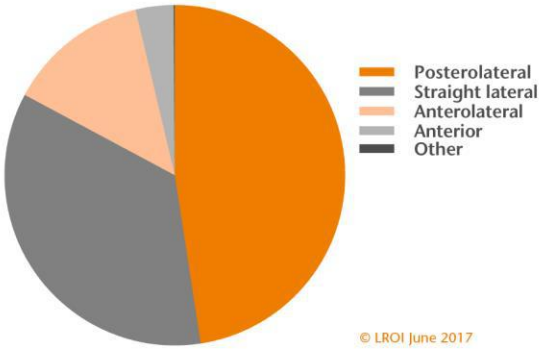
Please note: In 2016, 77 general hospitals and 8 UMCs performed primary hip hemiarthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.

# Surgery

## Surgical techniques

## Surgical approach

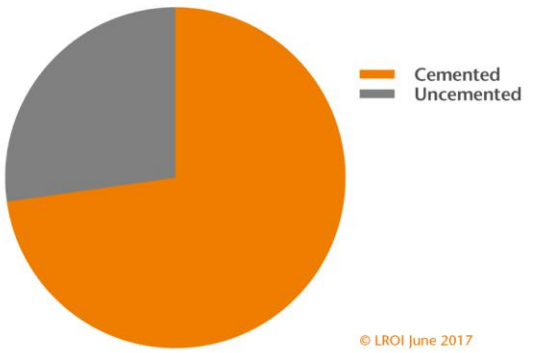
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY HIP HEMIARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=5,228).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Posterolateral | 2,487 | 47.6 |
| Straight lateral | 1,843 | 35.2 |
| Anterolateral | 704 | 13.5 |
| Anterior | 188 | 3.6 |
| Other | 6 | 0.1 |

## Fixation

**FIGURE TYPE OF FIXATION IN PRIMARY HIP HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=5,210).**

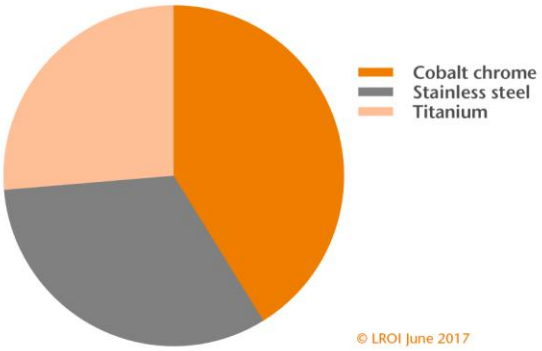



| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 3,790 | 72.7 |
| Uncemented | 1,420 | 27.3 |

## Materials

### Femur component

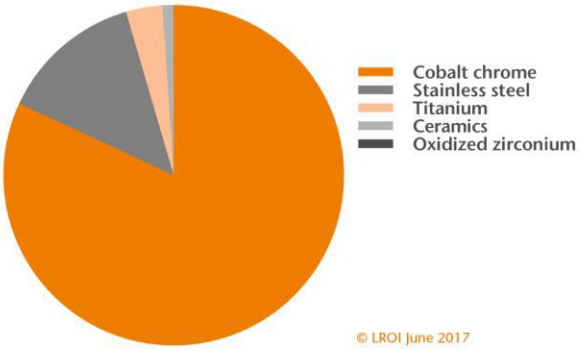
**FIGURE FEMUR MATERIAL IN PRIMARY HIP HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=4,957).**




| Femur material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 2,041 | 41.2 |
| Stainless steel | 1,611 | 32.5 |
| Titanium | 1,305 | 26.3 |

### Femoral head component

**FIGURE FEMORAL HEAD MATERIAL IN PRIMARY HIP HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=4,891).**




| Femoral head material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 4,007 | 81.9 |
| Stainless steel | 663 | 13.6 |
| Titanium | 169 | 3.5 |
| Ceramics | 51 | 1.0 |
| Oxidized Zirconium | 1 | 0.0 |

## Most frequently registered components

**TABLE THE TEN MOST FREQUENTLY REGISTERED FEMORAL AND FEMORAL HEAD COMPONENTS IN PRIMARY HIP HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Femur component (n=5,061) | | Femoral head component (n=4,996) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Original ME Muller | 22.1 | Unipolar Head | 26.2 |
| Lubinus SPII | 10.0 | Stainless Steel head | 11.6 |
| CCA stem | 9.8 | CoCr head | 10.8 |
| Spectron EF | 7.8 | UHR Unitrax | 10.6 |
| Taperloc Complete | 6.0 | Hemi Heads | 10.6 |
| Exeter | 5.6 | Uni-polar | 9.9 |
| Stanmore | 5.5 | Modular Cathcard Unipolar head | 5.1 |
| DB10 | 4.5 | COCR Modular Heads | 4.4 |
| Accolade | 4.4 | V40 Exeter Heads | 2.4 |
| Corail | 2.6 | Bipolar Hip | 1.3 |



## Most frequently registered types of bone cement

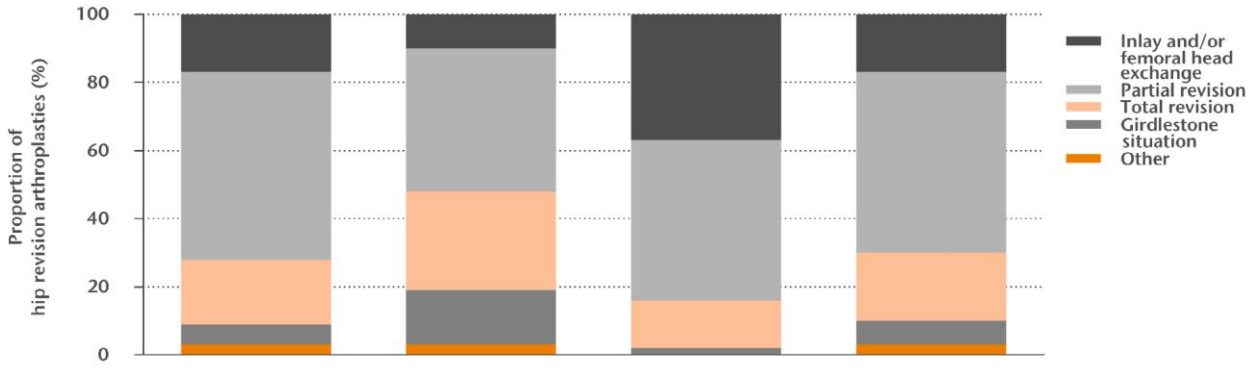
**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING PRIMARY HIP HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Separately packed bone cement components (n=2,065) | | Bone cement pre-packed in a vacuum mixing system (n=1,326) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Palacos R+G | 73.6 | Palacos Pro | 38.5 |
| Refobacin Bone Cement R | 8.2 | Optipac | 28.8 |
| Simplex HV | 5.1 | Refobacin Plus Bone Cement | 14.9 |
| Palacos MV+G | 4.3 | Refobacin Bone Cement R | 10.3 |
| Simplex ABC EC | 3.7 | Cemex | 7.0 |

# Hip revision arthroplasty

## Type of revision

**FIGURE TYPE OF REVISION (PROPORTION [%] PER CATEGORY) IN HIP REVISION ARTHROPLASTIES BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**




| Type of hospital | General | UMC | Private | Total |
|---|---|---|---|---|
| **Type of revision** | | | | |
| Inlay and/or femoral head exchange (%) | 17.2 | 10.3 | 37.2 | 16.6 |
| Partial revision (%) | 54.8 | 42.3 | 46.5 | 53.3 |
| Total revision (%) | 19.5 | 28.9 | 14.0 | 20.5 |
| Girdlestone situation (%) | 5.6 | 15.6 | 2.3 | 6.7 |
| Other (%) | 2.9 | 2.9 | 0.0 | 2.9 |
| Total (n) | 3,306 | 454 | 43 | 3,803 |

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



**In 1,321 (65.2%) partial hip revision arthroplasties the acetabulum component was revised and in 657 (32.4%) partial hip revision arthroplasties the femur component was revised in 2016.**

## Reasons for revision

**TABLE REASONS FOR REVISION OR RE-SURGERY IN PATIENTS WHO UNDERWENT A HIP REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=3,836).**

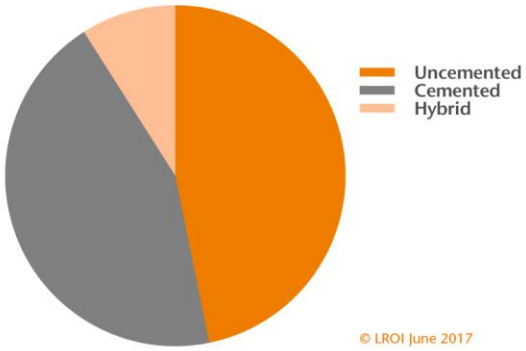
| Reasons for revision | Proportion[1] (%) |
|---|---|
| Loosening of acetabulum component | 22.4 |
| Dislocation | 19.3 |
| Infection | 19.3 |
| Loosening of femur component | 18.7 |
| Inlay wear | 18.5 |
| Peri-prosthetic fracture | 12.3 |
| Girdlestone situation | 6.1 |
| Symptomatic MoM inlay | 4.0 |
| Peri-articular ossification | 2.3 |
| Other | 10.6 |

[1] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

# Surgery

## Fixation

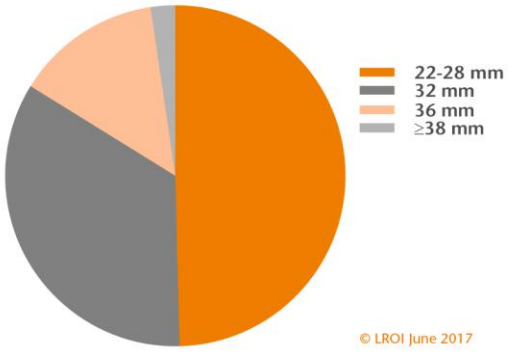
**FIGURE TYPE OF FIXATION IN HIP REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=3,479).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Uncemented | 1,628 | 46.8 |
| Cemented | 1,537 | 44.2 |
| Hybrid | 314 | 9.0 |

## Femoral head diameter

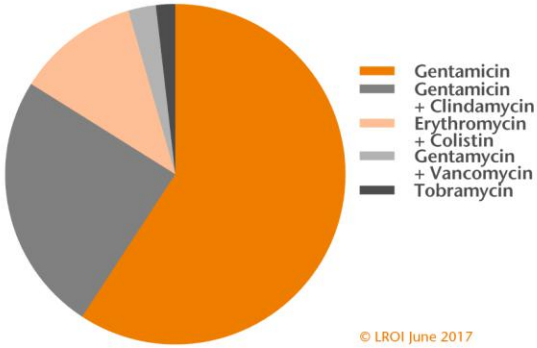
**FIGURE FEMORAL HEAD DIAMETER IN HIP REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=3,304).**




| Femoral head diameter | Number (n) | Proportion (%) |
|---|---|---|
| 22-28 mm | 1,639 | 49.6 |
| 32 mm | 1,130 | 34.2 |
| 36 mm | 458 | 13.9 |
| ≥38 mm | 77 | 2.3 |

## Bone cement antibiotics

**FIGURE BONE CEMENT ANTIBIOTICS IN HIP REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,528).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 905 | 59.2 |
| Gentamicin + Clindamycin | 377 | 24.7 |
| Erythromycin + Colistin | 178 | 11.7 |
| Gentamycin + Vancomycin | 40 | 2.6 |
| Tobramycin | 28 | 1.8 |

## Most frequently registered components

**TABLE THE TEN MOST FREQUENTLY REGISTERED ACETABULUM (BOTH CEMENTED AND UNCEMENTED) AND FEMUR COMPONENTS (BOTH CEMENTED AND UNCEMENTED) IN HIP REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

**Acetabulum**

| Cemented (n=1,481) | | Uncemented (n=617) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Avantage | 43.8 | Continuum | 20.9 |
| Saturne Dual Mobility | 9.2 | Pinnacle | 10.2 |
| Müller low profile | 7.6 | Trident | 8.8 |
| Polarcup | 7.6 | Allofit | 7.0 |
| Reflection All Poly XLPE | 5.1 | Delta-One TT | 6.8 |
| FAL Cup | 4.9 | Delta-TT | 4.9 |
| Exeter Contemporary Flanged | 4.4 | Saturne Dual Mobility | 4.9 |
| Exeter Rimfit | 4.1 | Reflection | 4.5 |
| Contemporary Hooded | 1.8 | Avantage Reload | 3.4 |
| IP Cup | 1.6 | Mallory Head | 2.8 |

**Femur**

| Cemented (n=583) | | Uncemented (n=847) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Exeter | 32.1 | Restoration Modular | 13.9 |
| Lubinus SPII | 21.6 | MP Reconstruction Prosthesis | 10.7 |
| Spectron EF | 10.6 | Revitan | 9.8 |
| Original ME Muller | 7.7 | Arcos | 7.0 |
| Stanmore | 6.5 | SLR Plus | 5.7 |
| C-Stem AMT | 3.9 | Corail | 4.8 |
| MP Reconstruction Prosthesis | 2.2 | MRS stem | 4.5 |
| Taperloc Complete | 1.7 | Corail Revision | 4.3 |
| Synergy | 1.5 | Alloclassic SLL | 3.0 |
| CCA stem | 1.0 | Alloclassic Zweymuller SL | 2.5 |



## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING HIP REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Separately packed bone cement components (n=1,142) | | Bone cement pre-packed in a vacuum mixing system (n=386) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Palacos R+G | 43.9 | Refobacin Bone Cement R | 23.6 |
| Copal G+C | 20.8 | Optipac | 23.1 |
| Simplex ABC EC | 15.6 | Refobacin Revision | 21.8 |
| Palacos MV+G | 5.3 | Palacos Pro | 19.7 |
| Refobacin Revision | 4.7 | Refobacin Plus Bone Cement | 6.2 |

# Survival

## Revision within 1 year

### By type of revision

**TABLE CUMULATIVE 1-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL HIP ARTHROPLASTIES BY TYPE OF REVISION IN THE NETHERLANDS IN 2011-2015 (N=131,066).**

| | Cumulative 1-year revision percentage | |
|---|---|---|
| | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Any type of revision | 1.5 (1.4-1.5) | 1.5 (1.4-1.6) |
| Small revision[1] | 0.4 (0.4-0.4) | 0.4 (0.4-0.4) |
| Substantial revision[2] | 1.0 (1.0-1.1) | 1.1 (1.0-1.1) |

[1] Only inlay and/or femoral head exchange.
[2] Including acetabulum or femur.
THA: total hip arthroplasty; CI: confidence interval.

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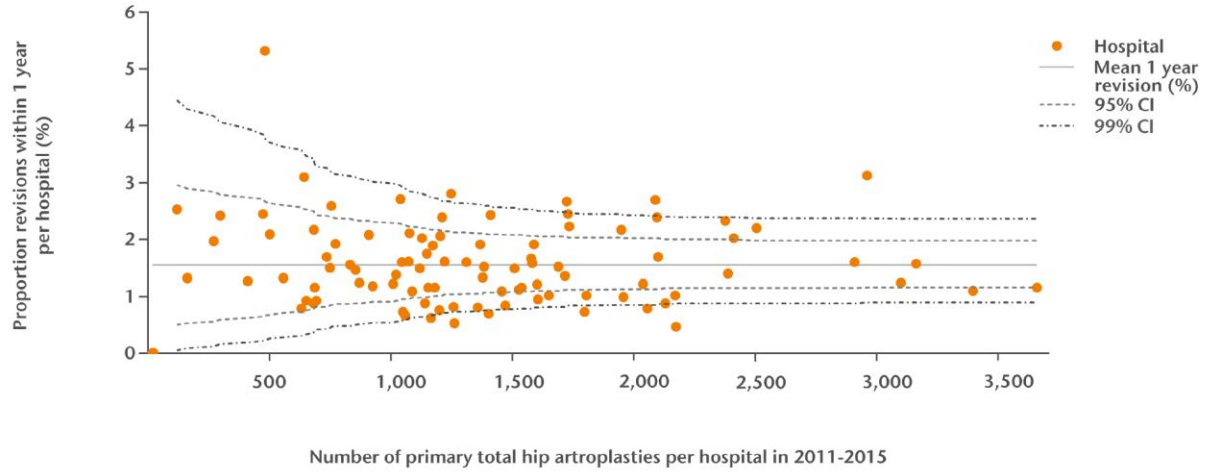
**In 2011-2015, 1,728 (1.3%) primary total hip arthroplasties were implanted in patients who died within one year after the primary procedure.**

### Per hospital

**FIGURE FUNNEL PLOT OF PROPORTION OF HIP REVISION ARTHROPLASTIES WITHIN ONE YEAR AFTER A PRIMARY TOTAL HIP ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2011-2015 (N=131,066).**

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**The mean 1-year revision percentage is 1.5 (95% CI: 1.4-1.5) in the Netherlands in 2011-2015. Confidence intervals are the boundaries within one would expect the outcome if only chance is of influence.**

## Reasons for revision by type of revision

**TABLE REASONS FOR REVISION WITHIN ONE YEAR IN PATIENTS THAT UNDERWENT A HIP REVISION ARTHROPLASTY BY TYPE OF REVISION IN THE NETHERLANDS IN 2011-2015.**

| Reason for revision | Small revision[1] (n=592) Proportion[3] (%) | Substantial revision[2] (n=1,443) Proportion[3] (%) | Any type of revision (n=2,035) Proportion[3] (%) |
|---|---|---|---|
| Dislocation | 30.1 | 36.3 | 34.5 |
| Infection | 41.0 | 11.2 | 19.9 |
| Peri-prosthetic fracture | 1.7 | 24.4 | 17.8 |
| Loosening of femur component | 1.2 | 22.2 | 16.1 |
| Loosening of acetabulum component | 0.3 | 13.1 | 9.4 |
| Girdlestone situation | 0.8 | 3.3 | 2.6 |
| Inlay wear | 1.4 | 1.2 | 1.2 |
| Peri-articular ossification | 0.8 | 1.0 | 1.0 |
| Symptomatic MoM inlay | 0.0 | 0.1 | 0.0 |
| Other | 16.2 | 15.1 | 15.4 |

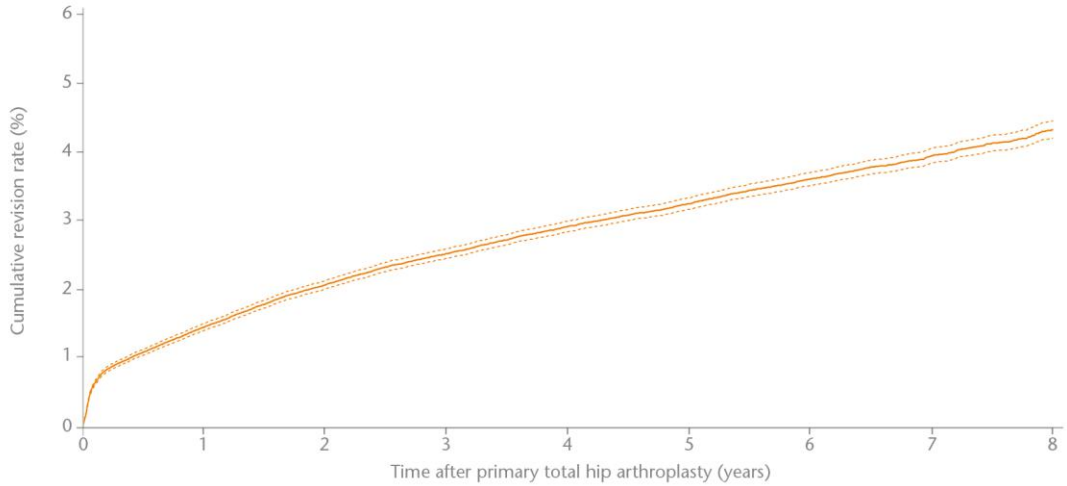
[1] Only inlay and/or femoral head exchange.
[2] Including acetabulum or femur.
[3] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.



## Revision within 8 years

### Overall

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=227,301).**




Please note: Dotted lines represent the upper and lower limits of the 95% confidence interval.

## By type of revision

**TABLE CUMULATIVE 8-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL HIP ARTHROPLASTIES BY TYPE OF REVISION IN THE NETHERLANDS IN 2007-2016 (N=227,301).**

| | Cumulative 8-year revision percentage | |
|---|---|---|
| | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Any type of revision | 4.3 (4.2-4.5) | 4.6 (4.4-4.7) |
| Small revision[1] | 0.9 (0.9-1.0) | 1.0 (0.9-1.0) |
| Substantial revision[2] | 3.4 (3.3-3.6) | 3.6 (3.4-3.7) |

[1] Only inlay and/or femoral head exchange.
[2] Including acetabulum or femur.
THA: total hip arthroplasty; CI: confidence interval.



**In 2007-2016, 13,809 (6.1%) primary total hip arthroplasties were implanted in patients who died within eight years after the primary procedure.**

## By demographics

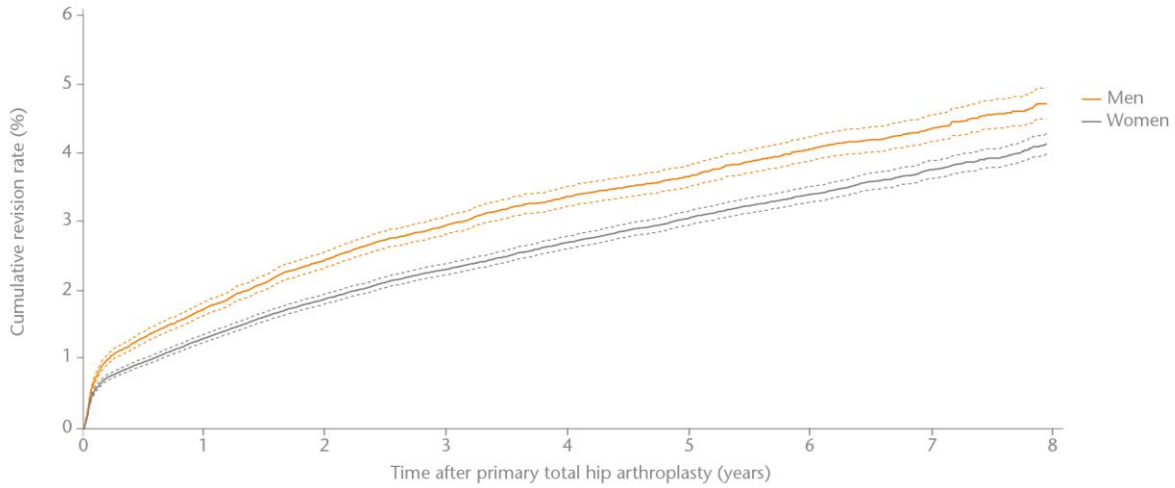
**TABLE CUMULATIVE 8-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL HIP ARTHROPLASTIES BY DEMOGRAPHICS IN THE NETHERLANDS IN 2007-2016.**

| | | Cumulative 8-year revision percentage | |
|---|---|---|---|
| | Number (n) | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Total | 227,301 | 4.3 (4.2-4.5) | 4.6 (4.4-4.7) |
| Gender | | | |
| Men | 75,135 | 4.7 (4.5-5.0) | 5.0 (4.8-5.3) |
| Women | 151,590 | 4.1 (4.0-4.3) | 4.4 (4.2-4.5) |
| Age (years) | | | |
| <50 | 10,165 | 7.0 (6.2-7.8) | 7.1 (6.3-7.9) |
| 50-59 | 27,931 | 6.0 (5.6-6.5) | 6.1 (5.7-6.6) |
| 60-69 | 72,516 | 4.7 (4.5-5.0) | 5.0 (4.6-5.2) |
| 70-79 | 82,027 | 3.8 (3.6-4.0) | 4.1 (3.8-4.3) |
| ≥80 | 34,265 | 2.7 (2.5-2.9) | 2.9 (2.7-3.2) |
| Diagnosis | | | |
| Osteoarthritis | 196,057 | 4.2 (4.1-4.4) | 4.4 (4.3-4.6) |
| Other | 29,111 | 5.1 (4.7-5.4) | 5.5 (5.1-5.9) |
| ASA score | | | |
| I | 50,658 | 4.7 (4.4-4.9) | 4.8 (4.5-5.1) |
| II | 137,191 | 4.3 (4.1-4.4) | 4.5 (4.3-4.7) |
| III-IV | 30,071 | 4.2 (3.9-4.5) | 4.6 (4.2-5.0) |

CI: confidence interval.

## By gender

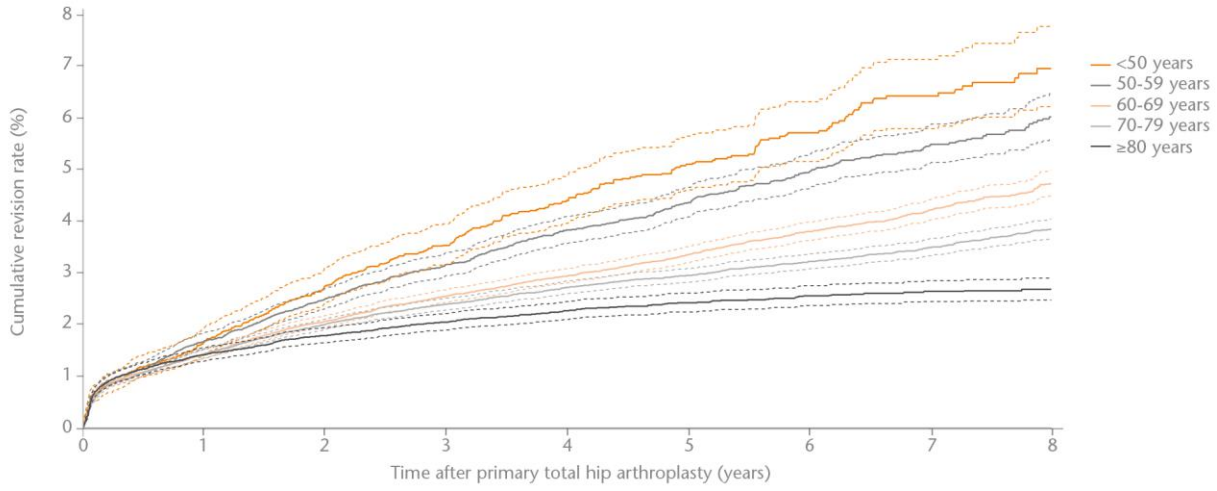
**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL HIP ARTHROPLASTIES BY GENDER IN THE NETHERLANDS IN 2007-2016 (N=226,725).**





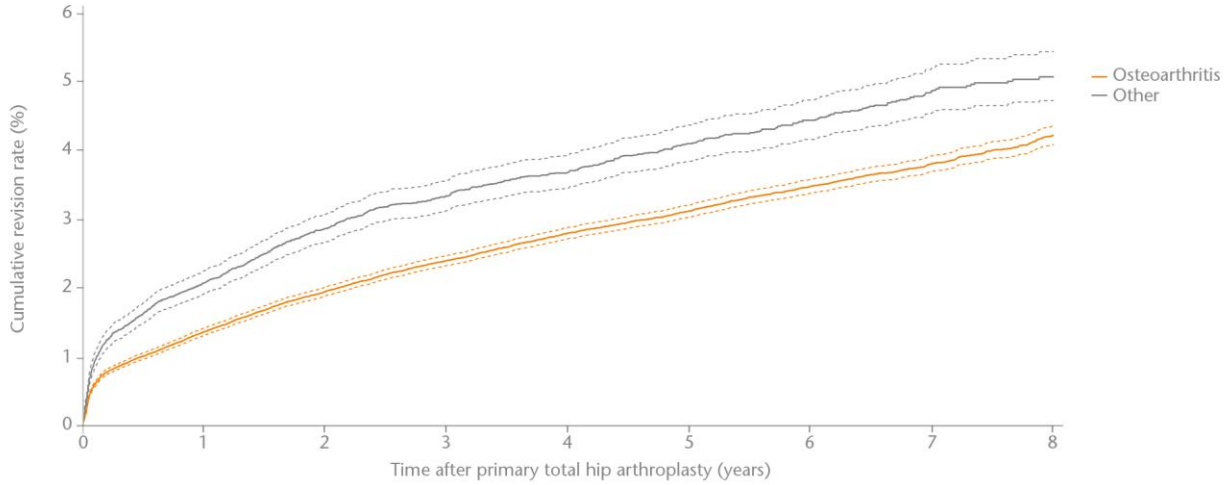

## By age category

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL HIP ARTHROPLASTIES BY AGE CATEGORY IN THE NETHERLANDS IN 2007-2016 (N=226,904).**



## By diagnosis

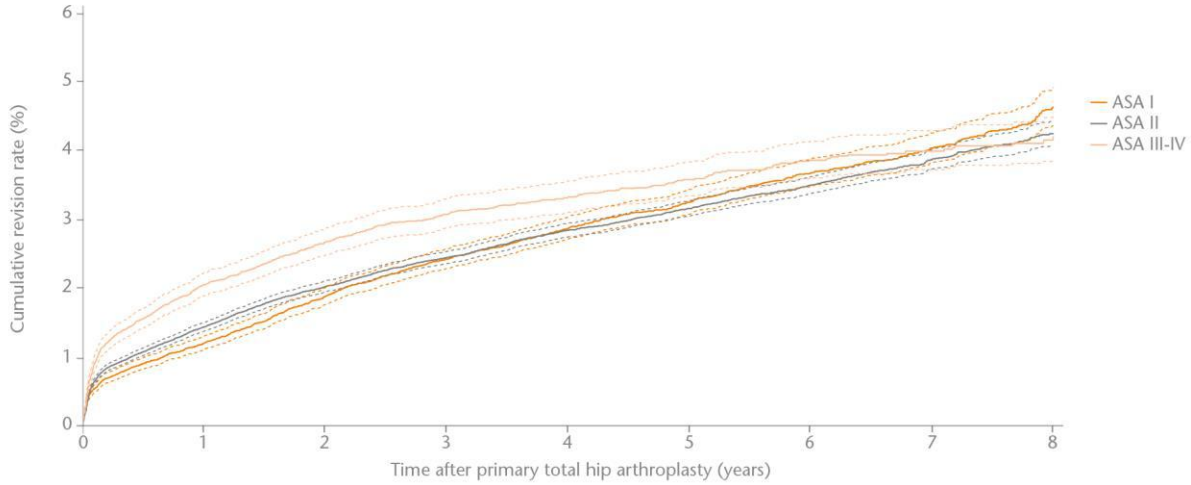
**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL HIP ARTHROPLASTIES BY DIAGNOSIS IN THE NETHERLANDS IN 2007-2016 (N=225,168).**






## By ASA score

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL HIP ARTHROPLASTIES BY ASA SCORE IN THE NETHERLANDS IN 2007-2016 (N=217,920).**



# Revision within 1, 3 and 5 years per THA component

## Cemented acetabular component

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE TEN MOST FREQUENTLY REGISTERED CEMENTED ACETABULAR COMPONENTS IN 2016, IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=74,357).**

| Cemented acetabular component | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| IP Cup | 12,354 | 1.1 (0.9-1.3) | 2.0 (1.7-2.2) | 2.5 (2.2-2.8) |
| Müller low profile | 12,055 | 1.2 (1.0-1.4) | 1.9 (1.7-2.2) | 2.3 (2.0-2.6) |
| Reflection All Poly XLPE | 5,942 | 0.9 (0.7-1.2) | 1.6 (1.3-2.0) | 1.9 (1.6-2.4) |
| Stanmore | 4,444 | 0.7 (0.5-1.0) | 1.5 (1.2-2.0) | 1.9 (1.5-2.4) |
| FAL Cup | 4,038 | 1.5 (1.1-1.9) | 2.8 (2.2-3.4) | 3.3 (2.7-4.1) |
| Contemporary Hooded | 3,581 | 1.2 (0.9-1.6) | 2.2 (1.7-2.7) | 3.1 (2.6-3.8) |
| Exeter Rimfit | 3,479 | 1.5 (1.1-1.9) | 2.3 (1.7-2.9) | 3.2 (2.3-4.3) |
| Exeter Contemporary Flanged | 2,844 | 0.9 (0.6-1.4) | 1.9 (1.4-2.5) | 2.5 (1.9-3.2) |
| CCB cup Low Profile | 2,182 | 1.3 (0.9-1.9) | 2.2 (1.6-2.9) | 2.7 (2.0-3.6) |
| Avantage | 1,835 | 2.7 (2.0-3.6) | 3.4 (2.6-4.5) | 4.0 (3.0-5.3) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.



**Of the registered cemented acetabular components, 96 components were not part of this top ten. These components represented 27% of all registered cemented acetabular components in 2007-2016.**

## Uncemented acetabular component

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE TEN MOST FREQUENTLY REGISTERED UNCEMENTED ACETABULAR COMPONENTS IN 2016, IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=150,300).**

| Uncemented acetabular component | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Allofit | 28,373 | 1.7 (1.5-1.8) | 2.4 (2.3-2.6) | 3.0 (2.8-3.2) |
| Pinnacle | 21,953 | 1.4 (1.3-1.6) | 2.4 (2.2-2.7) | 3.1 (2.8-3.4) |
| Mallory Head | 15,327 | 1.6 (1.4-1.8) | 2.7 (2.4-3.0) | 3.2 (2.9-3.5) |
| Exceed ABT | 11,508 | 1.2 (1.0-1.4) | 2.1 (1.8-2.4) | 2.4 (2.1-2.8) |
| Trident | 10,247 | 1.7 (1.5-2.0) | 3.1 (2.8-3.5) | 4.1 (3.7-4.6) |
| Reflection | 6,705 | 1.6 (1.3-2.0) | 2.4 (2.1-2.9) | 2.9 (2.4-3.3) |
| Trident Tritanium | 5,992 | 1.7 (1.4-2.0) | 2.9 (2.5-3.4) | 3.3 (2.8-3.9) |
| R3 | 5,094 | 1.7 (1.4-2.1) | 2.4 (2.0-2.9) | 3.4 (2.7-4.2) |
| RM Pressfit cup | 3,750 | 2.5 (2.0-3.0) | 3.4 (2.9-4.1) | 4.0 (3.4-4.8) |
| RM Pressfit Vitamys cup | 3,622 | 1.7 (1.3-2.2) | 2.6 (2.1-3.3) | 3.3 (2.6-4.2) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.



**Of the registered cemented acetabular components, 105 components were not part of this top ten. These components represented 23% of all registered cemented acetabular components in 2007-2016.**

## Cemented femur component

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE TEN MOST FREQUENTLY REGISTERED CEMENTED FEMUR COMPONENTS IN 2016, IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=74,937).**

| Cemented femur component | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Lubinus SPII | 22,880 | 1.1 (1.0-1.2) | 1.9 (1.8-2.1) | 2.5 (2.3-2.7) |
| Exeter | 13,229 | 1.5 (1.3-1.7) | 2.3 (2.1-2.6) | 2.9 (2.6-3.2) |
| Original ME Muller | 11,560 | 1.3 (1.1-1.5) | 1.9 (1.6-2.1) | 2.2 (1.9-2.5) |
| Spectron EF | 9,125 | 0.8 (0.6-1.0) | 1.5 (1.3-1.8) | 1.9 (1.6-2.3) |
| Stanmore | 8,803 | 0.8 (0.6-1.0) | 1.5 (1.3-1.8) | 1.9 (1.6-2.3) |
| CCA stem | 1,673 | 1.9 (1.3-2.6) | 2.4 (1.8-3.3) | 2.8 (2.1-3.9) |
| Taperloc Complete | 605 | 1.1 (0.5-2.5) | 2.0 (1.0-4.0) | 2.5 (1.3-4.8) |
| MS30 | 507 | 1.0 (0.4-2.4) | 1.7 (0.9-3.5) | 2.4 (1.3-4.4) |
| C-Stem AMT[1] | 187 | n.a. | n.a. | n.a. |
| Twinsys stem Cementless[1] | 83 | n.a. | n.a. | n.a. |

[1] Only registered in recent years. As such, no revision percentage could be determined.
Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.



**Of the registered cemented femur components, 76 components were not part of this top ten. These components represented 7% of all registered cemented femur components in 2007-2016.**

## Uncemented femur component

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE TEN MOST FREQUENTLY REGISTERED UNCEMENTED FEMUR COMPONENTS IN 2016, IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=149,720).**

| Uncemented femur component | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Alloclassic Zweymuller SL | 22,082 | 1.3 (1.1-1.4) | 2.1 (2.0-2.4) | 2.8 (2.6-3.1) |
| Corail | 21,868 | 1.5 (1.3-1.7) | 2.5 (2.3-2.8) | 3.3 (3.0-3.6) |
| Taperloc Complete | 20,601 | 1.4 (1.2-1.6) | 2.7 (2.4-2.9) | 3.4 (3.1-3.8) |
| CLS Spotorno | 15,542 | 2.1 (1.9-2.4) | 3.2 (2.9-3.5) | 4.1 (3.7-4.4) |
| SL Plus | 9,622 | 1.6 (1.4-1.9) | 3.3 (3.0-3.7) | 4.3 (3.9-4.8) |
| Mallory Head | 9,283 | 1.3 (1.1-1.6) | 2.2 (1.9-2.5) | 2.6 (2.3-3.0) |
| Accolade | 8,739 | 1.4 (1.2-1.7) | 3.0 (2.6-3.5) | 4.1 (3.5-4.7) |
| Synergy | 5,346 | 1.9 (1.6-2.4) | 2.8 (2.4-3.3) | 3.3 (2.8-3.9) |
| Twinsys stem Cementless | 4,524 | 1.8 (1.4-2.2) | 2.4 (1.9-2.9) | 2.7 (2.2-3.4) |
| M/L Taper | 2,314 | 2.2 (1.7-2.9) | 3.2 (2.5-4.2) | 4.3 (3.2-5.7) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.



**Of the registered uncemented femur components, 107 components were not part of this top ten. These components represented 18% of all registered uncemented femur components in 2007-2016.**

## Bone cement

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM IN 2016, IN PRIMARY TOTAL HIP ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016.**

| Bone cement | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Separately packed bone cement components (n=64,081) | | | | |
| Palacos R+G | 47,739 | 1.3 (1.2-1.4) | 2.2 (2.0-2.3) | 2.7 (2.5-2.8) |
| Refobacin Bone Cement R | 4,666 | 0.6 (0.4-0.9) | 1.4 (1.1-1.8) | 1.7 (1.4-2.2) |
| Palacos MV+G | 2,729 | 0.6 (0.4-1.0) | 1.3 (0.9-1.8) | 1.9 (1.4-2.7) |
| Simplex ABC EC | 2,061 | 2.2 (1.6-2.9) | 3.4 (2.6-4.3) | 4.6 (3.6-5.8) |
| Simplex HV | 426 | 0.5 (0.1-2.0) | 0.5 (0.1-2.0) | n.a. |
| Bone cement pre-packed in a vacuum mixing system (n=10,563) | | | | |
| Refobacin Bone Cement R | 5,234 | 1.1 (0.9-1.5) | 2.0 (1.6-2.5) | 2.7 (2.2-3.5) |
| Refobacin Plus Bone Cement | 2,811 | 0.9 (0.6-1.3) | 1.5 (1.1-2.1) | 1.9 (1.4-2.7) |
| Palacos Pro | 1,075 | 1.3 (0.7-2.5) | n.a. | n.a. |
| Optipac | 908 | 3.1 (2.0-4.9) | 3.1 (2.0-4.9) | n.a. |
| Cemex | 437 | 1.5 (0.7-3.3) | 2.2 (1.1-4.3) | 3.0 (1.4-6.2) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.

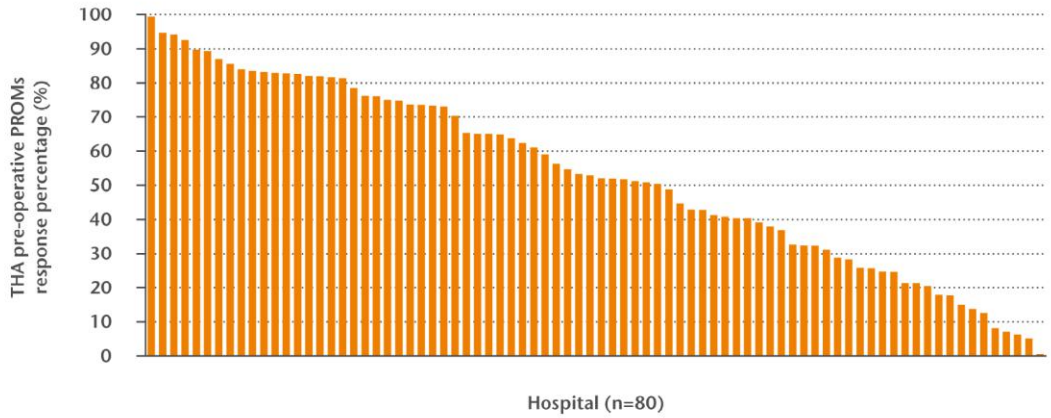


**Of the registered types of bone cement, 19 types were not part of these top fives. These types represented 7% of all registered types of bone cement in 2007-2016.**

# PROMs

## Response

**FIGURE PRE-OPERATIVE PROMS RESPONSE PERCENTAGE OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER PROMS REGISTERING HOSPITAL IN THE NETHERLANDS IN 2016 (N=21,610).**




THA: total hip arthroplasty; PROM: patient reported outcome measure.

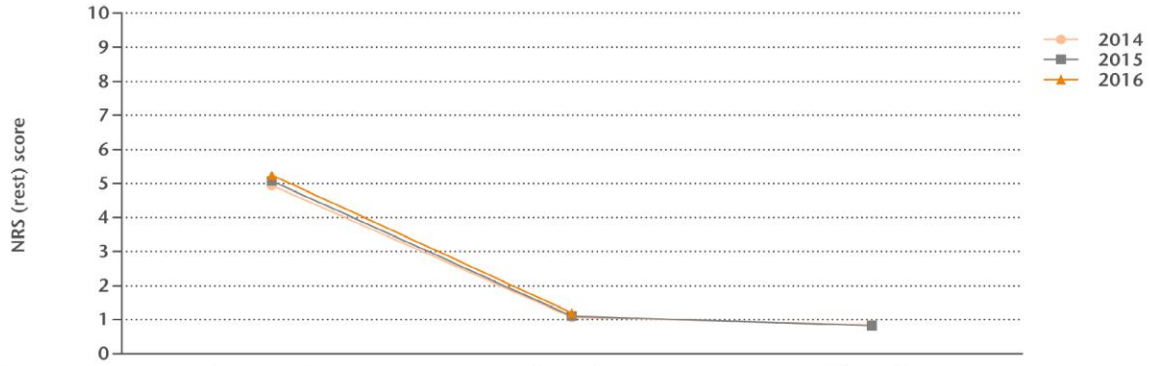


**Of all 21,610 patients who underwent a THA for osteoarthritis in a PROMs registering hospital, the mean pre-operative response score was 54.1% (n=11,695).**

## Mean scores (preoperative, 3 months and 12 months)

### NRS (rest)

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS NRS (REST) SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| NRS (rest) score | Pre-operative (n=24,608) | 3 months (n=16,865) | 12 months (n=9,207) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 4.9 (4.9-5.0) | 1.1 (1.0-1.1) | 0.8 (0.8-0.9) |
| 2015 (95% CI) | 5.1 (5.0-5.1) | 1.1 (1.1-1.1) | 0.8 (0.8-0.9) |
| 2016 (95% CI) | 5.3 (5.2-5.3) | 1.2 (1.2-1.2) | n.a. |
| Total (95% CI) | 5.1 (5.1-5.2) | 1.1 (1.1-1.2) | 0.8 (0.8-0.9) |

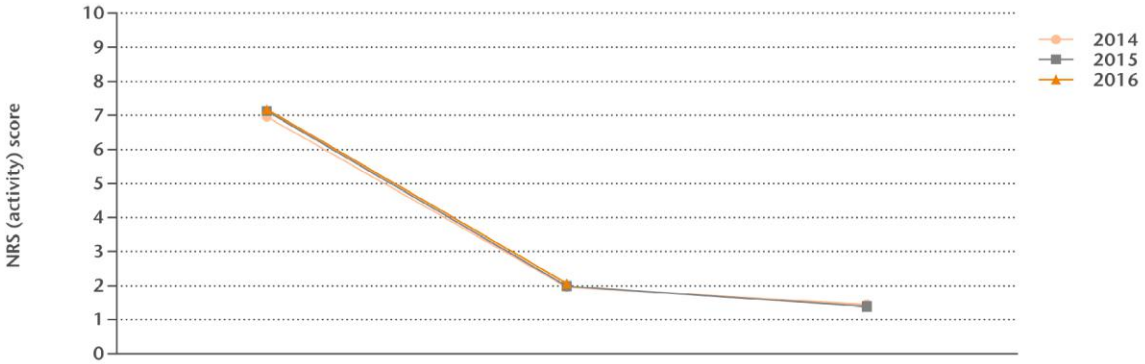
Please note: The 12 months NRS (rest) score was not available for 2016.
THA: total hip arthroplasty.



**The NRS (rest) score measures pain during rest. The score has a range of 0.0 to 10.0, with 0.0 representing no pain and 10.0 representing the most possible pain.**

## NRS (activity)

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS NRS (ACTIVITY) SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| NRS (activity) score | Pre-operative (n=24,659) | 3 months (n=16,876) | 12 months (n=9,217) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 7.0 (6.9-7.0) | 2.0 (1.9-2.0) | 1.4 (1.4-1.5) |
| 2015 (95% CI) | 7.1 (7.1-7.2) | 2.0 (1.9-2.0) | 1.4 (1.3-1.4) |
| 2016 (95% CI) | 7.2 (7.1-7.2) | 2.1 (2.0-2.1) | n.a. |
| Total (95% CI) | 7.1 (7.1-7.2) | 2.0 (2.0-2.1) | 1.4 (1.4-1.5) |

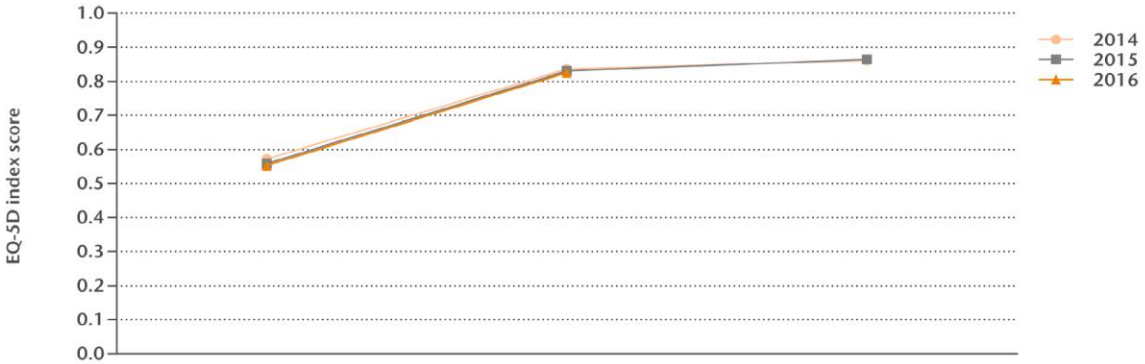
Please note: The 12 months NRS (activity) score was not available for 2016.
THA: total hip arthroplasty.



**The NRS (activity) score measures pain during activity. The score has a range of 0.0 to 10.0, with 0.0 representing no pain and 10.0 representing the most possible pain.**

## EQ-5D index score

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS EQ-5D INDEX SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| EQ-5D index score | Pre-operative (n=25,191) | 3 months (n=16,743) | 12 months (n=9,759) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 0.57 (0.56-0.58) | 0.84 (0.83-0.84) | 0.86 (0.86-0.87) |
| 2015 (95% CI) | 0.56 (0.55-0.56) | 0.83 (0.83-0.83) | 0.86 (0.86-0.87) |
| 2016 (95% CI) | 0.55 (0.55-0.56) | 0.83 (0.82-0.83) | n.a. |
| Total (95% CI) | 0.56 (0.55-0.56) | 0.83 (0.83-0.83) | 0,86 (0.86-0.87) |

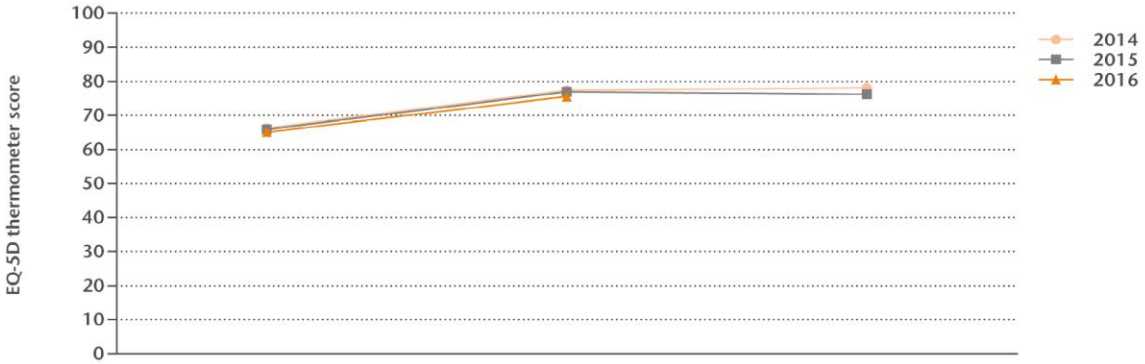
Please note: The 12 months EQ-5D index score was not available for 2016.
THA: total hip arthroplasty.



**The EQ-5D index score measures quality of life.**
**The score has a range of -0.329 to 1.0, with 1.0 representing the best possible quality of life.**

## EQ-5D thermometer

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS EQ-5D THERMOMETER SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| EQ-5D thermometer | Pre-operative (n=24,920) | 3 months (n=16,782) | 12 months (n=9,823) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 66.3 (65.7-66.9) | 77.3 (76.7-77.9) | 78.1 (77.5-78.7) |
| 2015 (95% CI) | 65.9 (65.5-66.3) | 76.8 (76.4-77.3) | 76.1 (75.6-76.6) |
| 2016 (95% CI) | 65.1 (64.7-65.5) | 75.5 (75.0-75.9) | n.a. |
| Total (95% CI) | 65.6 (65.4-65.9) | 76.2 (76.0-76.6) | 76.8 (76.4-77.2) |

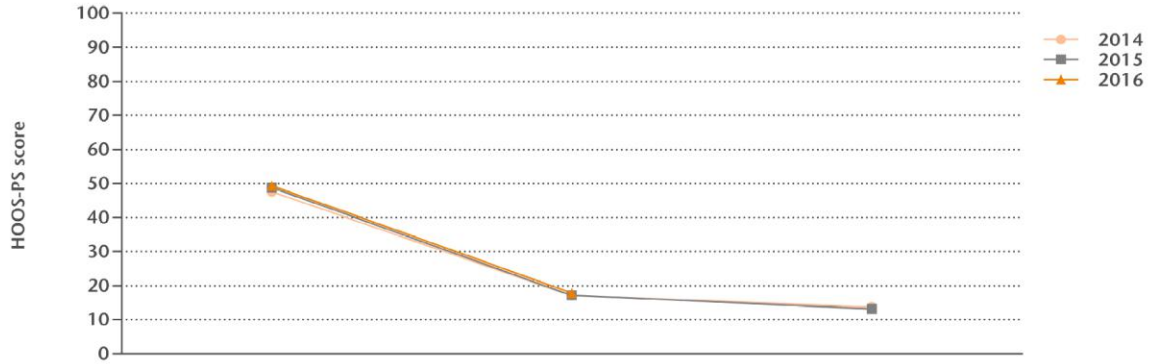
Please note: The 12 months EQ-5D thermometer score was not available for 2016.
THA: total hip arthroplasty.



**The EQ-5D thermometer score measures the health situation. The score has a range of 0.0 to 100.0, with 0.0 representing the worst possible health situation and 100.0 the best possible health situation.**

## HOOS-PS score

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS HOOS-PS SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| HOOS-PS score | Pre-operative (n=23,413) | 3 months (n=15,230) | 12 months (n=8,953) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 47.6 (47.1-48.2) | 17.1 (16.5-17.6) | 13.7 (13.1-14.2) |
| 2015 (95% CI) | 48.8 (48.4-49.2) | 17.2 (16.8-17.5) | 13.2 (12.8-13.5) |
| 2016 (95% CI) | 49.3 (49.0-49.7) | 17.8 (17.5-18.2) | n.a. |
| Total (95% CI) | 48.9 (48.6-49.1) | 17.5 (17.2-17.7) | 13.3 (13.0-13.6) |

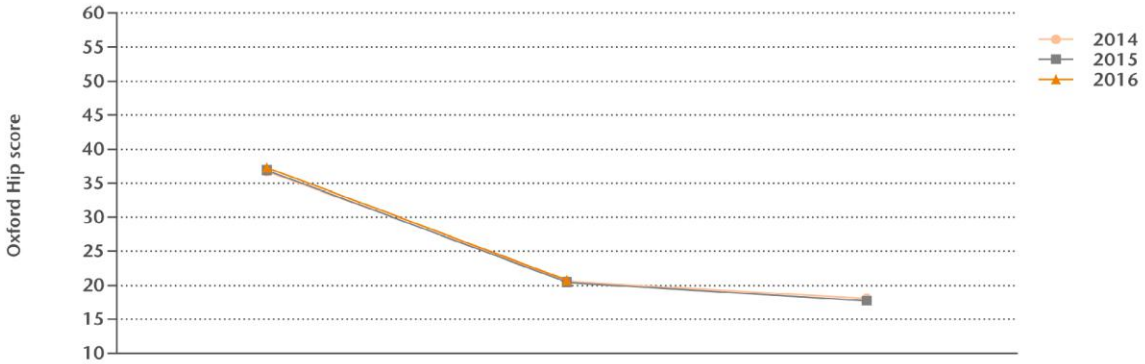
Please note: The 12 months HOOS-PS score was not available for 2016.
THA: total hip arthroplasty.



**The HOOS-PS score measures the physical functioning of patients with osteoarthritis to the hip. The score has a range of 0.0 to 100.0, with 0.0 representing no effort and 100.0 the most possible effort.**

## Oxford Hip score

**FIGURE MEAN PRE-OPERATIVE, 3 MONTHS AND 12 MONTHS OXFORD HIP SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2014-2016.**




| Oxford Hip score | Pre-operative (n=22,023) | 3 months (n=14,450) | 12 months (n=8,454) |
|---|---|---|---|
| **Year of THA** | | | |
| 2014 (95% CI) | 36.8 (36.5-37.1) | 20.6 (20.3-20.9) | 18.1 (17.8-18.3) |
| 2015 (95% CI) | 36.9 (36.7-37.1) | 20.5 (20.3-20.6) | 17.7 (17.5-17.9) |
| 2016 (95% CI) | 37.3 (37.1-37.5) | 20.8 (20.6-21.0) | n.a. |
| Total (95% CI) | 37.1 (37.0-37.2) | 20.6 (20.3-20.9) | 17.8 (17.7-18.0) |

Please note: The 12 months Oxford Hip score was not available for 2016.
THA: total hip arthroplasty.

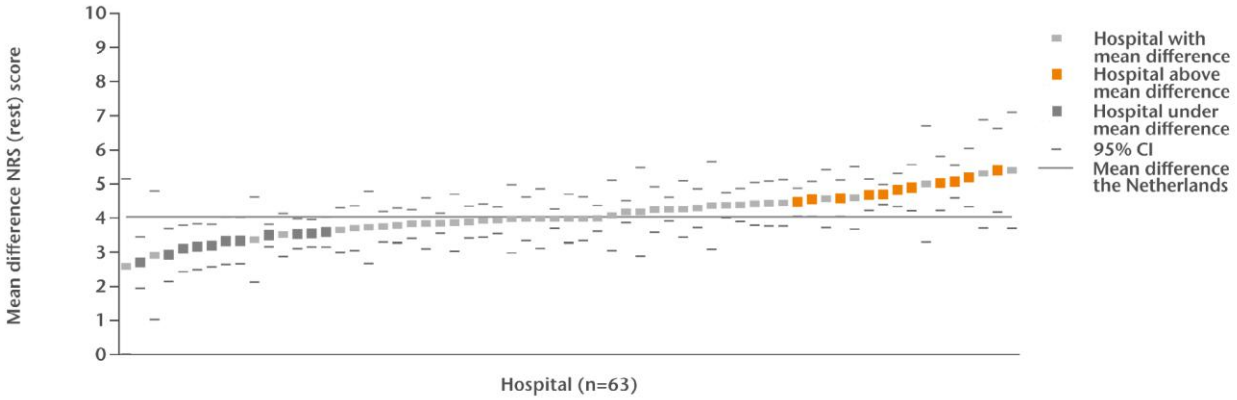


**The Oxford Hip score measures the physical functioning and pain of patients with osteoarthritis to the hip. The score has a range of 12.0 to 60.0, with 12.0 representing no functional disability and 60.0 the most possible functional disability.**

# Mean differences (preoperative and 3 months) per hospital

## NRS (rest)

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE NRS (REST) SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=6,631).**



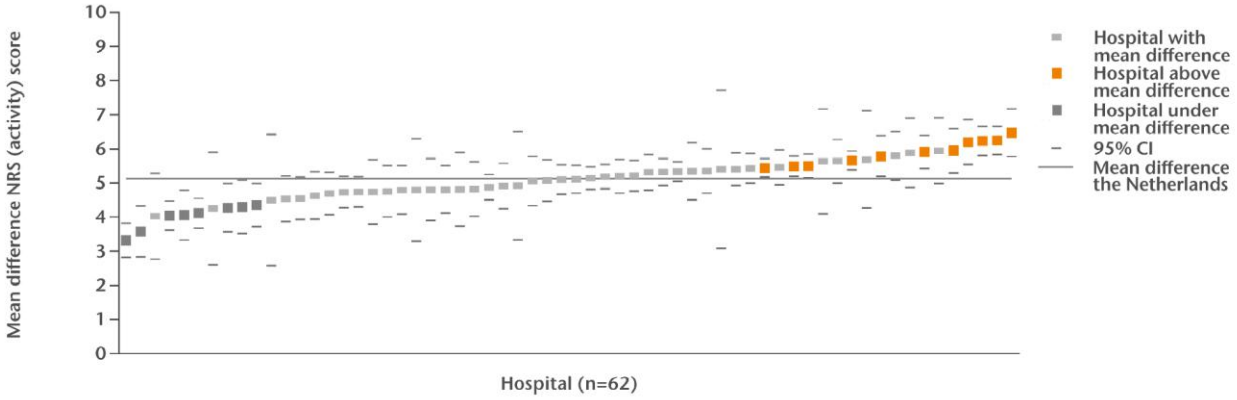

Please note: The 63 hospitals with a minimum of 10 PROMs (mean differences in NRS (rest) score) were included in this figure.
THA: total hip arthroplasty.



**The mean difference between pre-operative and 3 months postoperative NRS (rest) scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 4.0 (95% CI: 4.0-4.1).**

## NRS (activity)

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE NRS (ACTIVITY) SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=6,625).**



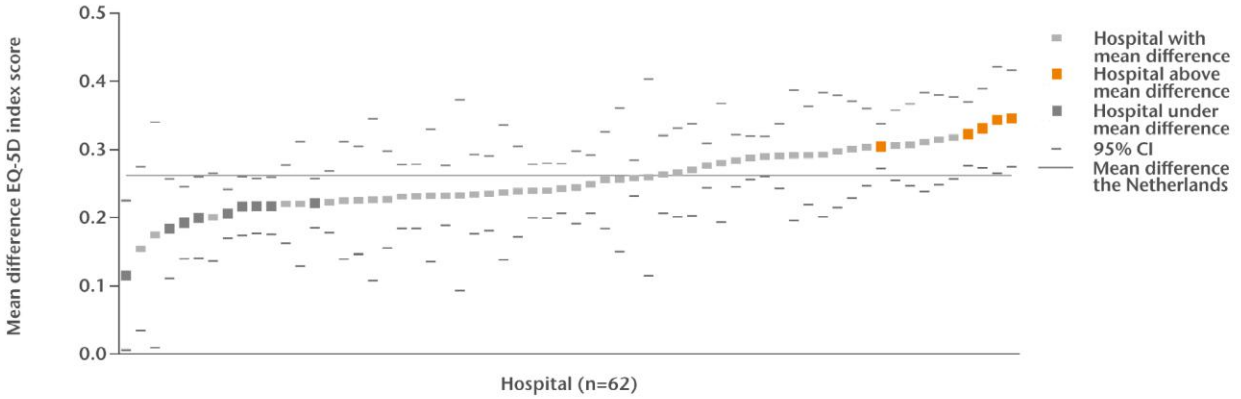

Please note: The 62 hospitals with a minimum of 10 PROMs (mean differences in NRS (activity) score) were included in this figure.
THA: total hip arthroplasty.



**The mean difference between pre-operative and 3 months postoperative NRS (activity) scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 5.1 (95% CI: 5.1-5.2).**

## EQ-5D index score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE EQ-5D INDEX SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=6,747).**



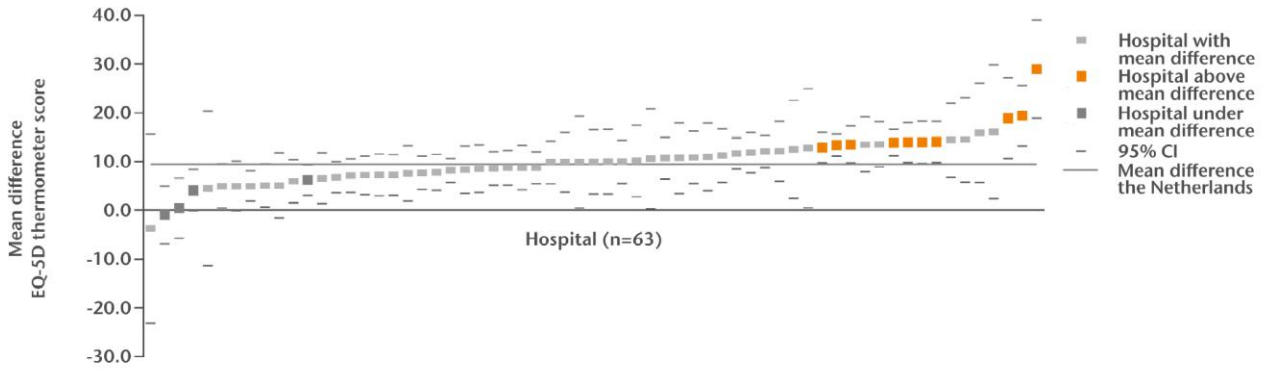

Please note: The 62 hospitals with a minimum of 10 PROMs (mean differences in EQ-5D index score) were included in this figure.
THA: total hip arthroplasty.



**The mean difference between pre-operative and 3 months postoperative EQ-5D index scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 0.26 (95% CI: 0.26-0.27).**

## EQ-5D thermometer

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE EQ-5D THERMOMETER SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=6,832).**



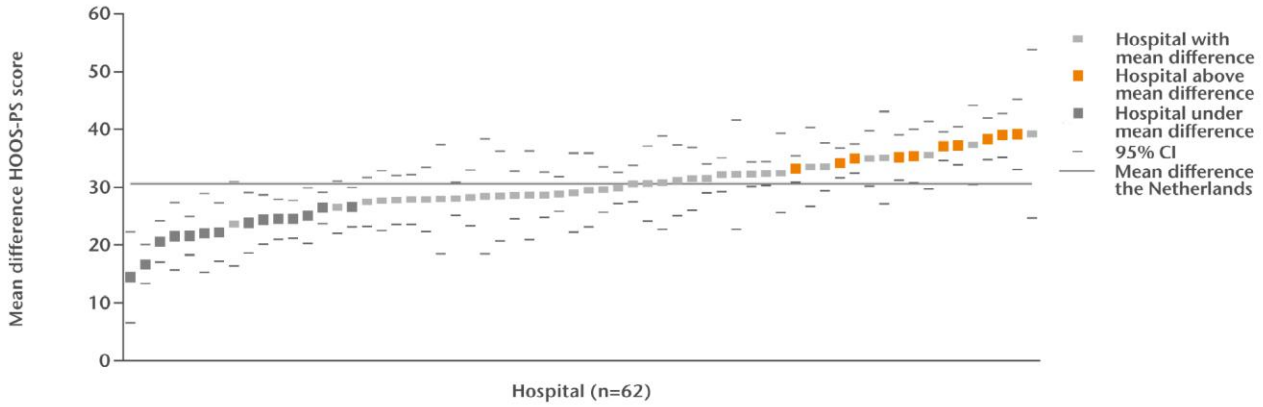

The 63 hospitals with a minimum of 10 PROMs (mean differences in EQ-5D thermometer score) were included in this figure.
THA: total hip arthroplasty.



**The mean difference between pre-operative and 3 months postoperative EQ-5D thermometer scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 9.5 (95% CI: 8.9-10.1).**

## HOOS-PS score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE HOOS-PS SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=6,010).**



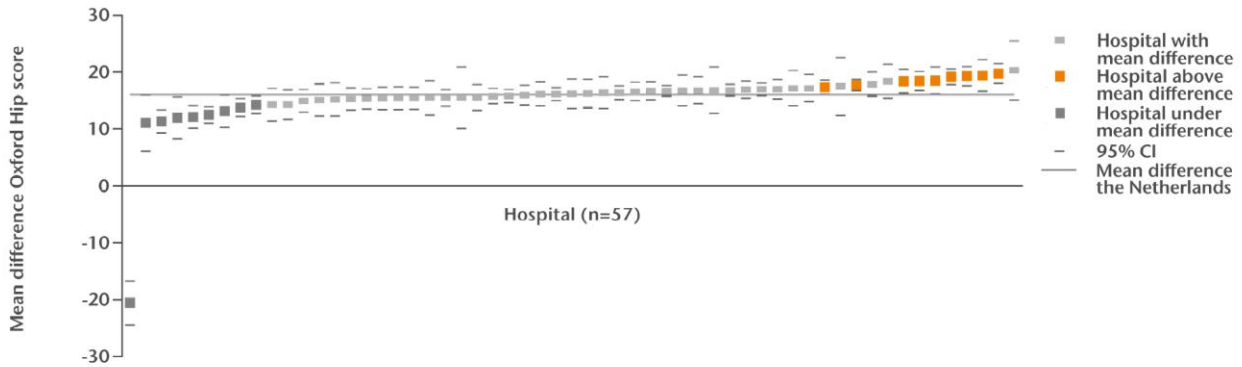

The 62 hospitals with a minimum of 10 PROMs (mean differences in HOOS-PS score) were included in this figure.
THA: total hip arthroplasty.



**The mean difference between pre-operative and 3 months postoperative HOOS-PS scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 30.6 (95% CI: 30.1-31.1).**

## Oxford Hip score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 3 MONTHS POSTOPERATIVE OXFORD HIP SCORES OF PATIENTS WHO UNDERWENT A THA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=5,981).**




Please note: The 57 hospitals with a minimum of 10 PROMs (mean differences in Oxford Hip score) were included in this figure.
THA: total hip arthroplasty.



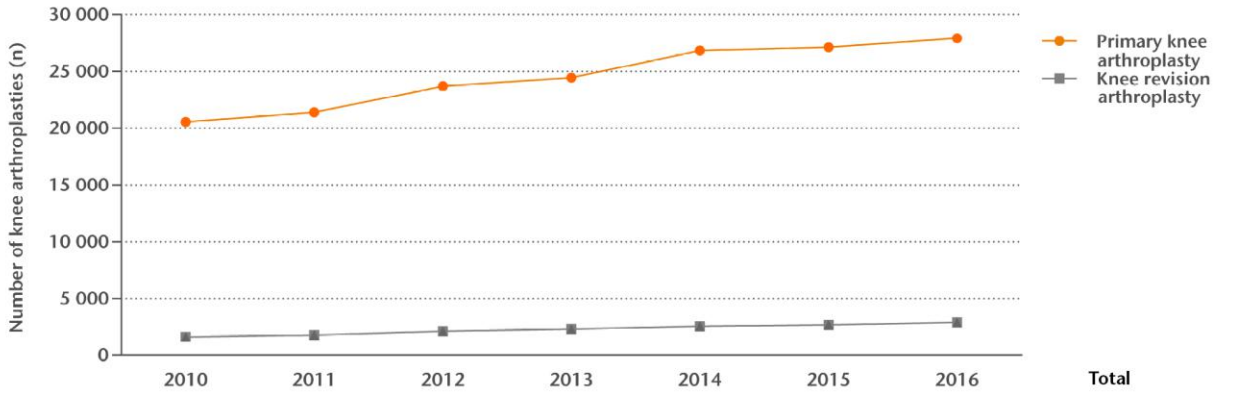
**The mean difference between pre-operative and 3 months postoperative Oxford Hip scores of patients who underwent a THA for osteoarthritis in the Netherlands in 2016 was 16.1 (95% CI: 15.8-16.3).**

# Knee arthroplasty

## Numbers

### Procedures 2010-2016

**FIGURE NUMBER OF PRIMARY KNEE ARTHROPLASTIES AND KNEE REVISION ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2010-2016.**



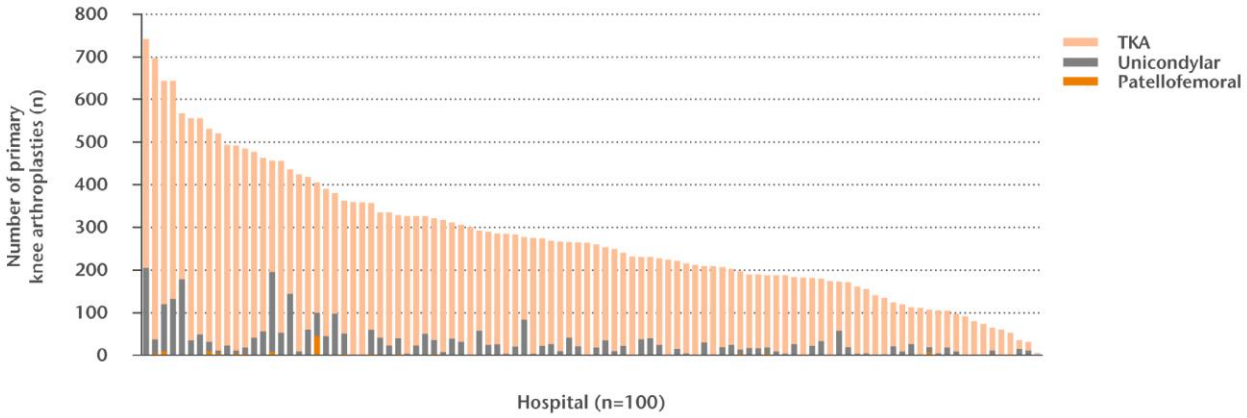

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| **Type of procedure** | | | | | | | | |
| Primary knee arthroplasty (n) | 20,573 | 21,412 | 23,711 | 24,454 | 26,837 | 27,134 | 27,918 | 172,039 |
| Knee revision arthroplasty (n) | 1,622 | 1,794 | 2,115 | 2,306 | 2,557 | 2,683 | 2,886 | 15,963 |
| Total (n) | 22,195 | 23,206 | 25,826 | 26,760 | 29,394 | 29,817 | 30,804 | 188,002 |



**Out of 27,918 primary knee arthroplasties that were performed in 2016, 3% (n=811) was performed bilaterally.**

## Type of primary knee prosthesis per hospital

**FIGURE NUMBER OF PRIMARY KNEE ARTHROPLASTIES BY TYPE OF ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,772).**

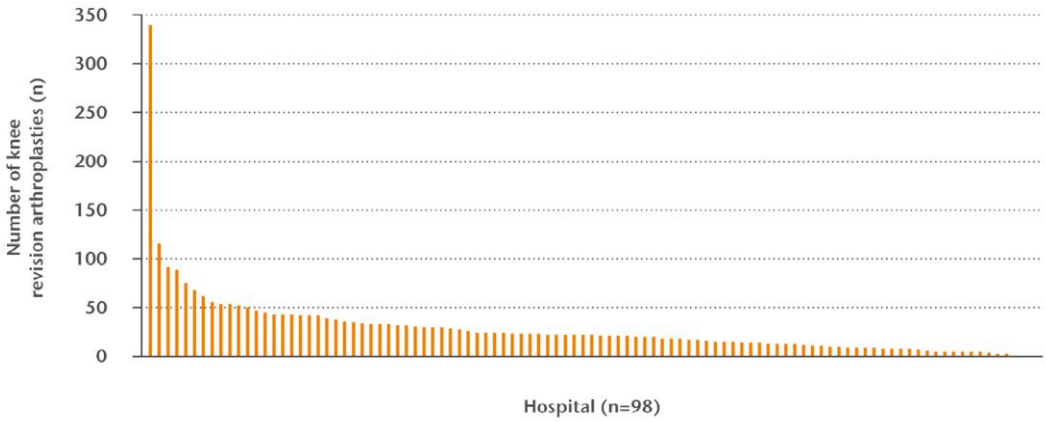



Please note: In 2016, 35 (0.1%) primary knee arthroplasties were registered in the LROI as other type of primary knee arthroplasty. Of 111 (0.4%) primary knee arthroplasties, the type of prosthesis was not registered.
TKA: total knee arthroplasty.



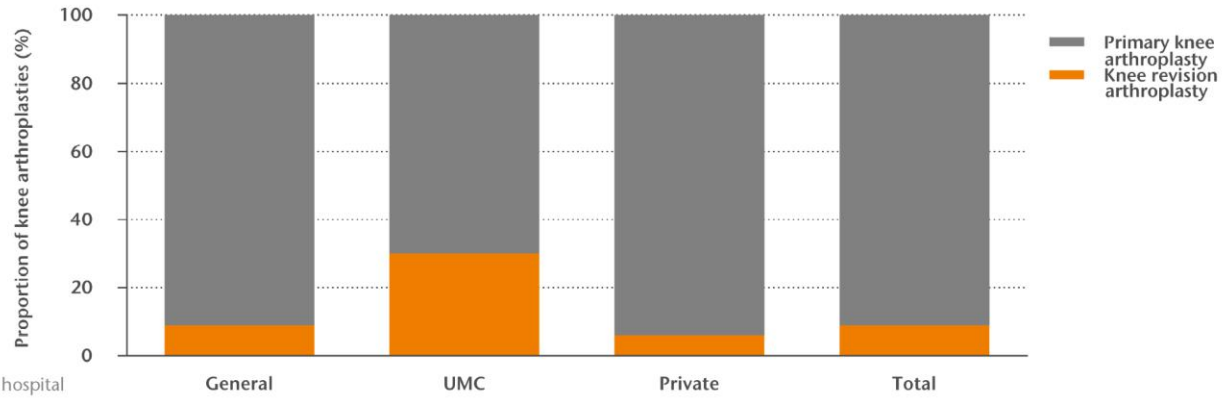
## Revisions per hospital

**FIGURE NUMBER OF KNEE REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,886).**



## Type of procedure by type of hospital

**FIGURE PRIMARY KNEE ARTHROPLASTIES AND KNEE REVISION ARTHROPLASTIES (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**

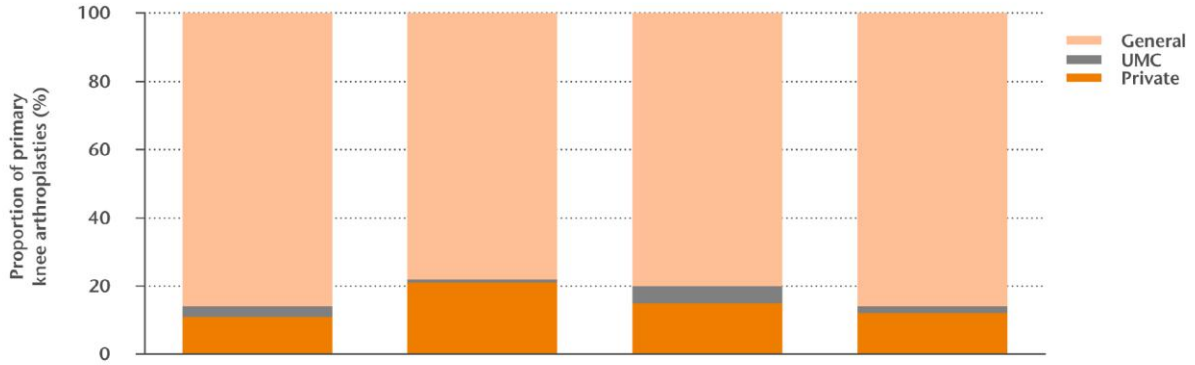



| Type of hospital | General | UMC | Private | Total |
|---|---|---|---|---|
| **Type of procedure** | | | | |
| Primary knee arthroplasty (%) | 91.0 | 69.8 | 93.9 | 90.6 |
| Knee revision arthroplasty (%) | 9.0 | 30.2 | 6.1 | 9.4 |
| Total (n) | 26,265 | 1,008 | 3,531 | 30,804 |

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

## Type of primary knee prosthesis by type of hospital

**FIGURE TYPE OF HOSPITAL (PROPORTION [%] PER CATEGORY) BY TYPE OF PRIMARY KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016.**

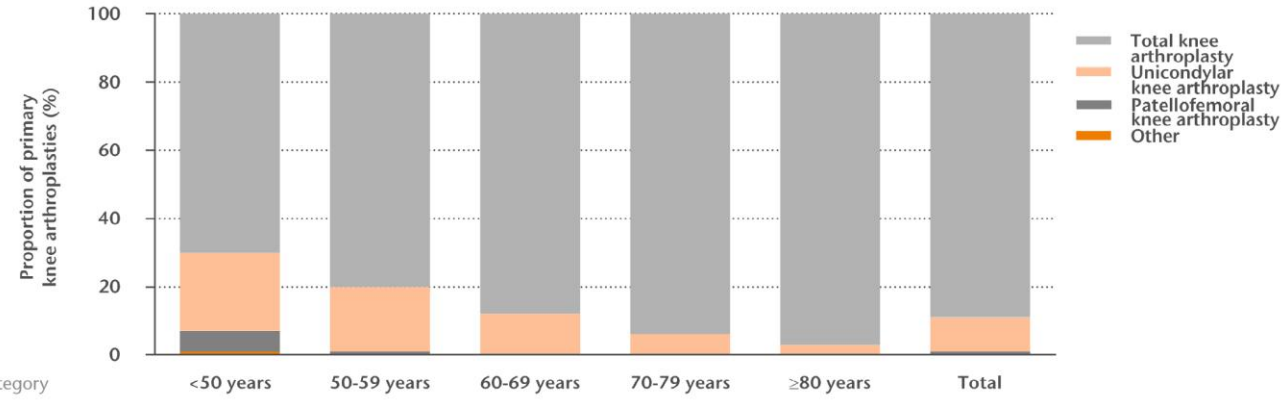



| Type of primary knee arthroplasty | Total knee arthroplasty | Unicondylar knee arthroplasty | Patellofemoral knee arthroplasty | Total |
|---|---|---|---|---|
| Type of hospital | | | | |
| General (%) | 86.5 | 78.1 | 79.7 | 85.6 |
| UMC (%) | 2.6 | 1.4 | 5.4 | 2.5 |
| Private (%) | 10.9 | 20.5 | 14.9 | 11.9 |
| Total (n) | 24,709 | 2,915 | 148 | 27,772 |

Please note: In 2016, 35 (0.1%) primary knee arthroplasties were registered in the LROI as other type of primary knee arthroplasty. Of 111 (0.4%) primary knee arthroplasties, the type of prosthesis was not registered.
General: general hospital; UMC: university medical centre; Private: private hospital.

## Type of primary knee prosthesis by age category

**FIGURE TYPE OF PRIMARY KNEE ARTHROPLASTY (PROPORTION [%] PER CATEGORY) OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY BY AGE CATEGORY IN THE NETHERLANDS IN 2016.**




| Age category | <50 years | 50-59 years | 60-69 years | 70-79 years | ≥80 years | Total |
|---|---|---|---|---|---|---|
| Type of primary knee arthroplasty | | | | | | |
| Total knee arthroplasty (%) | 70.4 | 79.6 | 87.6 | 93.7 | 96.6 | 88.9 |
| Unicondylar knee arthroplasty (%) | 22.8 | 18.8 | 12.0 | 6.1 | 3.3 | 10.5 |
| Patellofemoral knee arthroplasty (%) | 5.9 | 1.4 | 0.3 | 0.1 | 0.1 | 0.5 |
| Other (%) | 0.9 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 |
| Total (n) | 689 | 4,328 | 10,008 | 9,149 | 2,809 | 26,983 |

# Primary knee arthroplasty

## Demographics

### Patient characteristics

### By type of knee prosthesis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY KNEE ARTHROPLASTY BY TYPE OF PRIMARY KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016.**

| | Total knee arthroplasty (n=24,014) | Unicondylar knee arthroplasty (n=2,822) | Patellofemoral knee arthroplasty (n=139) | Total[1] (n=27,107) |
|---|---|---|---|---|
| Completeness (%) | | | | 99 |
| Mean age (years) (SD) | 68.6 (9.1) | 63.2 (8.8) | 54.5 (10.1) | 68.0 (9.3) |
| Age (years) (%) | | | | |
| <50 | 2 | 5 | 29 | 3 |
| 50-59 | 14 | 29 | 42 | 16 |
| 60-69 | 37 | 43 | 22 | 37 |
| 70-79 | 36 | 20 | 8 | 34 |
| ≥80 | 11 | 3 | 2 | 10 |
| Gender (%) | | | | |
| Men | 36 | 43 | 20 | 37 |
| Women | 64 | 57 | 80 | 63 |
| ASA score (%) | | | | |
| I | 13 | 26 | 34 | 15 |
| II | 69 | 64 | 60 | 68 |
| III-IV | 18 | 10 | 6 | 17 |
| Type of hospital[2] (%) | | | | |
| General | 87 | 78 | 80 | 86 |
| UMC | 2 | 2 | 6 | 2 |
| Private | 11 | 20 | 14 | 12 |
| Diagnosis (%) | | | | |
| Osteoarthrosis | 96 | 99 | 98 | 97 |
| Post-traumatic | 2 | 0 | 1 | 1 |
| Rheumatoid arthritis | 1 | 0 | 1 | 1 |
| Osteonecrosis | 1 | 1 | 0 | 1 |
| Other | 0 | 0 | 0 | 0 |
| Charnley score (%) | | | | |
| A One knee joint affected | 44 | 60 | 52 | 45 |
| B1 Both knee joints affected | 34 | 26 | 36 | 34 |
| B2 Contralateral knee joint with a total knee prosthesis | 19 | 13 | 8 | 18 |
| C Multiple joints affected or chronic disease that affects quality of life | 3 | 1 | 4 | 3 |
| Body Mass Index (kg/m²) (%) | | | | |
| Underweight (≤18.5) | 0 | 0 | 1 | 0 |
| Normal weight (>18,5-25) | 17 | 17 | 29 | 17 |
| Overweight (>25-30) | 41 | 44 | 39 | 42 |
| Obesity (>30-40) | 38 | 37 | 30 | 38 |
| Morbid obesity (>40) | 4 | 2 | 1 | 3 |
| Smoking (%) | | | | |
| No | 90 | 88 | 81 | 90 |
| Yes | 10 | 12 | 19 | 10 |

[1] Also contains 32 (0.1%) primary knee arthroplasties that were registered as other and 100 primary knee arthroplasties of which the type of prosthesis had not been registered.
[2] In 2016, 80 general hospitals, 8 UMCs and 12 private hospitals performed knee arthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.

## By diagnosis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY KNEE ARTHROPLASTY BY DIAGNOSIS IN THE NETHERLANDS IN 2016.**

| | Osteoarthritis (n=26,028) | Post-traumatic (n=367) | Rheumatoid arthritis (n=352) | Osteonecrosis (n=153) | Total (n=27,107) |
|---|---|---|---|---|---|
| Mean age (years) (SD) | 68.1 (9.2) | 62.3 (10.6) | 65.6 (10.1) | 69.1 (10.9) | 68.0 (9.3) |
| Age (years) (%) | | | | | |
| <50 | 2 | 11 | 7 | 4 | 3 |
| 50-59 | 16 | 31 | 19 | 15 | 16 |
| 60-69 | 37 | 34 | 39 | 33 | 37 |
| 70-79 | 34 | 19 | 28 | 29 | 34 |
| ≥80 | 11 | 5 | 7 | 19 | 10 |
| Gender (%) | | | | | |
| Men | 37 | 43 | 22 | 29 | 37 |
| Women | 63 | 57 | 78 | 71 | 63 |
| ASA score (%) | | | | | |
| I | 15 | 22 | 5 | 12 | 15 |
| II | 68 | 64 | 68 | 59 | 68 |
| III-IV | 17 | 14 | 27 | 29 | 17 |
| Type of hospital (%) | | | | | |
| General | 86 | 73 | 88 | 86 | 86 |
| UMC | 2 | 7 | 8 | 7 | 2 |
| Private | 12 | 20 | 4 | 7 | 12 |
| Charnley score (%) | | | | | |
| A One knee joint affected | 45 | 76 | 26 | 73 | 45 |
| B1 Both knee joints affected | 34 | 16 | 33 | 15 | 34 |
| B2 Contralateral knee joint with a total knee prosthesis | 18 | 5 | 22 | 8 | 18 |
| C Multiple joints affected or chronic disease that affects quality of life | 3 | 3 | 19 | 4 | 3 |
| Body Mass Index (kg/m²) (%) | | | | | |
| Underweight (≤18.5) | 0 | 1 | 0 | 0 | 0 |
| Normal weight (>18,5-25) | 17 | 25 | 27 | 25 | 17 |
| Overweight (>25-30) | 41 | 44 | 41 | 37 | 42 |
| Obesity (>30-40) | 38 | 28 | 28 | 37 | 38 |
| Morbid obesity (>40) | 4 | 2 | 4 | 1 | 3 |
| Smoking (%) | | | | | |
| No | 90 | 79 | 89 | 89 | 90 |
| Yes | 10 | 21 | 11 | 11 | 10 |

Please note: In 2016, 92 (0.3%) patients had a primary knee arthroplasty after a diagnosis that is not listed in the table. Of 115 primary knee arthroplasties the diagnosis was not registered.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.

## Previous surgery

**TABLE PREVIOUS SURGERIES TO THE SAME JOINT IN PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=26,847).**

| | Proportion[1] (%) |
|---|---|
| Previous surgery to the relevant knee (total) | 33.6 |
| Meniscectomy | 27.0 |
| Arthroscopy | 19.7 |
| Osteotomy | 2.8 |
| Osteosynthesis | 1.5 |
| ACL reconstruction | 1.4 |
| Synovectomy | 1.1 |
| Other | 3.2 |

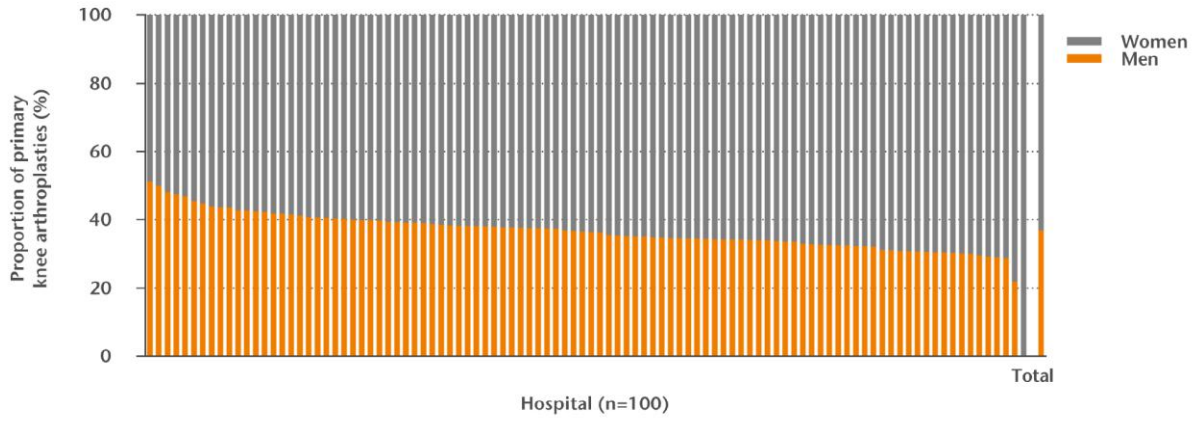
[1] A patient may have undergone multiple previous surgeries to the same joint. As such, the total proportion is more than the total proportion of patients with one or more previous surgeries to the same joint.



## Practice variation

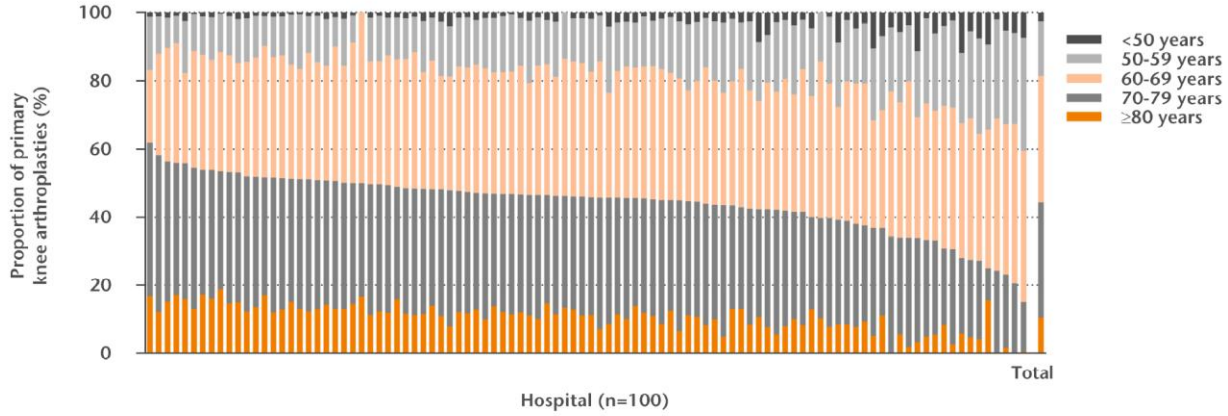
### Gender

**FIGURE DISTRIBUTION OF GENDER OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,081).**



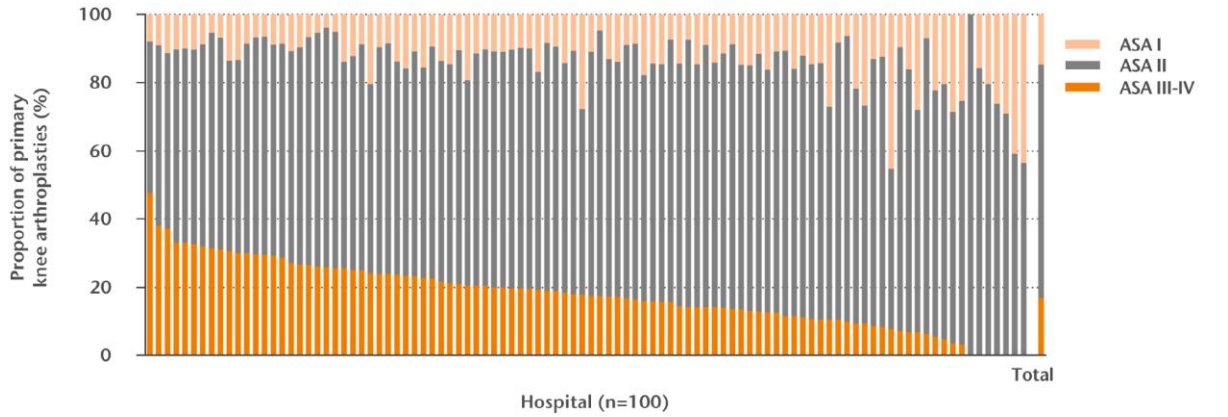
## Age

**FIGURE DISTRIBUTION OF AGE OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,083).**



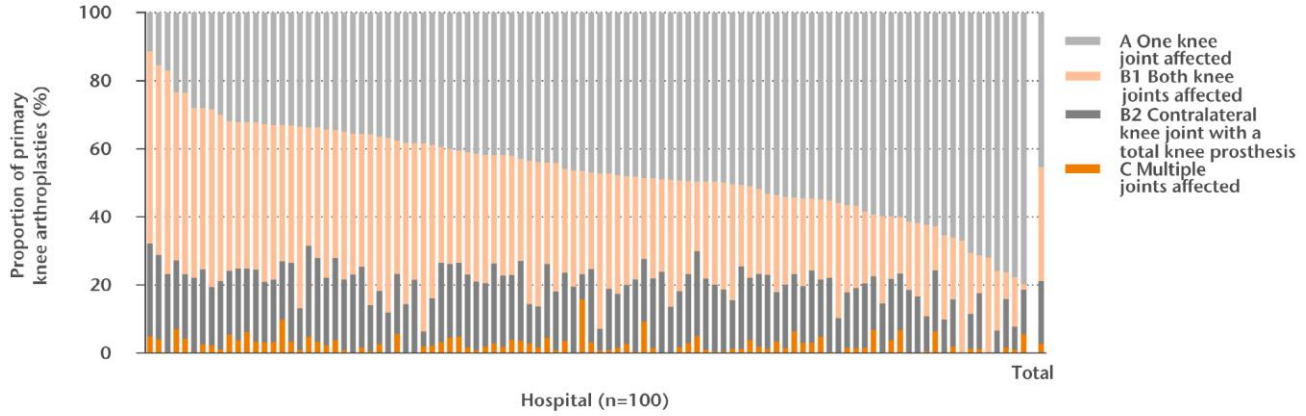

## ASA score

**FIGURE DISTRIBUTION OF ASA SCORE OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=27,007).**



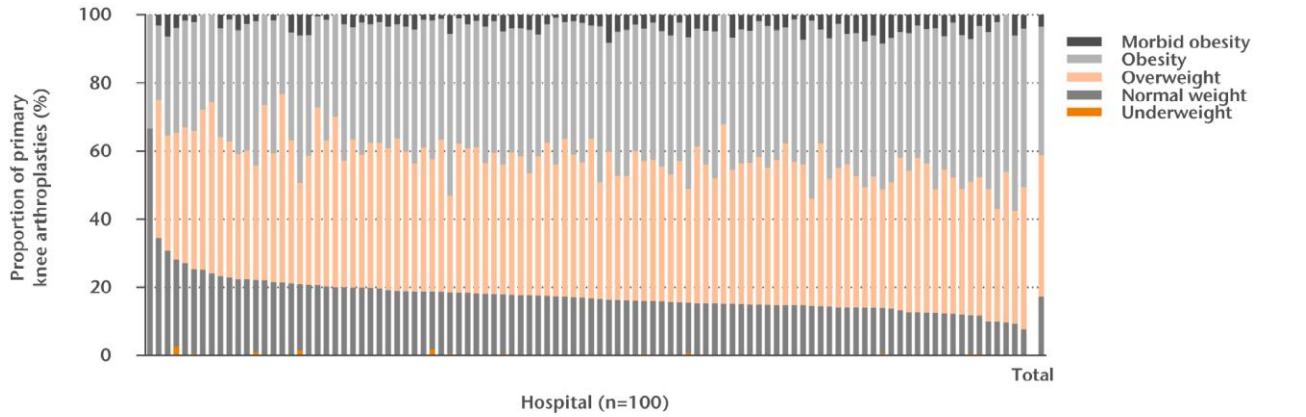
## Charnley score

**FIGURE DISTRIBUTION OF CHARNLEY SCORE OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=26,512).**



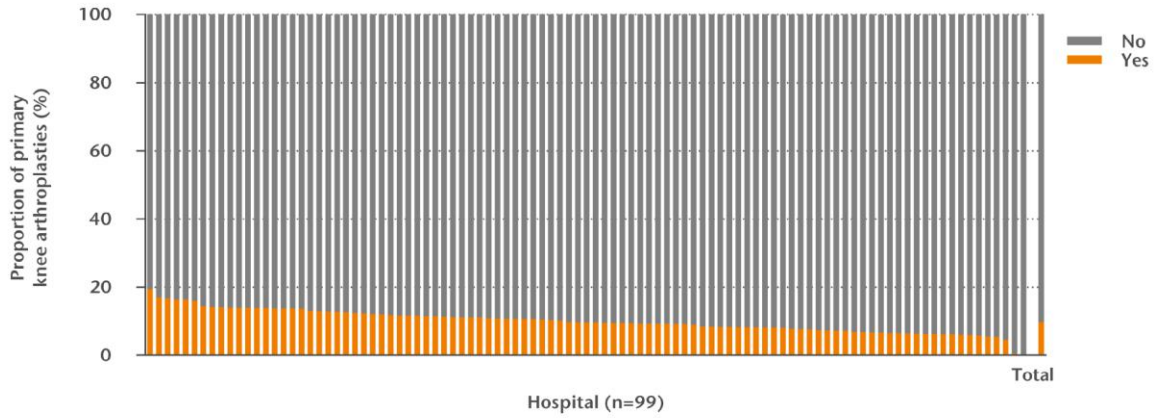

## Body Mass Index

**FIGURE DISTRIBUTION OF BODY MASS INDEX (KG/M²) OF PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=26,911).**



## Smoking

**FIGURE DISTRIBUTION OF SMOKING BY PATIENTS WHO UNDERWENT A PRIMARY KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=26,280).**

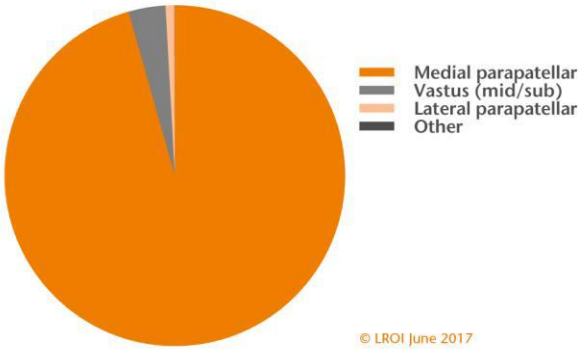



# Total knee arthroplasty

## Surgical techniques

## Surgical approach

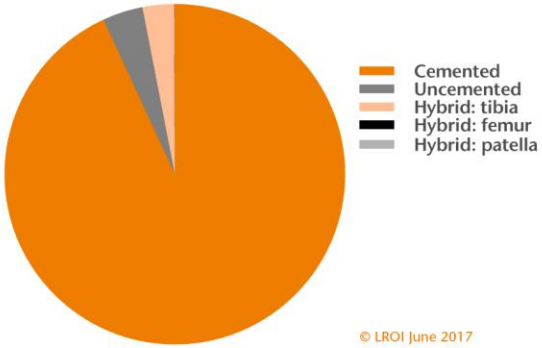
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY TOTAL KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=24,694).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Medial parapatellar | 23,610 | 95.6 |
| Vastus (mid/sub) | 867 | 3.5 |
| Lateral parapatellar | 208 | 0.9 |
| Other | 9 | 0.0 |

## Fixation

**FIGURE TYPE OF FIXATION IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=24,599).**

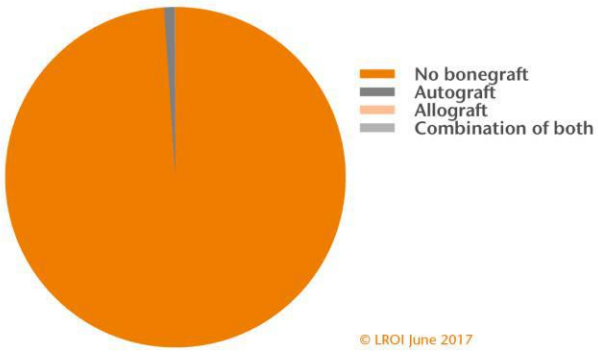



| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 22,906 | 93.1 |
| Uncemented | 942 | 3.9 |
| Hybrid: tibia | 741 | 3.0 |
| Hybrid: femur | 6 | 0.0 |
| Hybrid: patella | 4 | 0.0 |

## Prosthesis characteristics

### Type of bonegraft

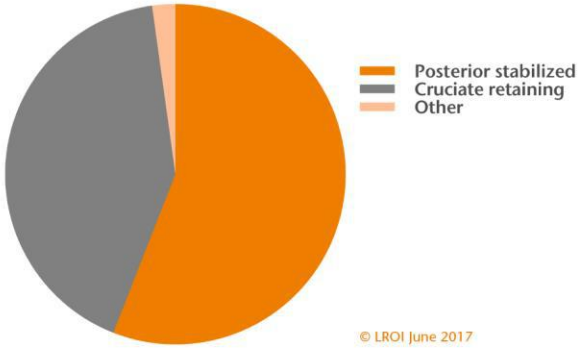
**FIGURE TYPE OF BONEGRAFT IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=24,680).**




| Type of bonegraft | Number (n) | Proportion (%) |
|---|---|---|
| No bonegraft | 24,416 | 98.9 |
| Autograft | 252 | 1.0 |
| Allograft | 7 | 0.1 |
| Combination of both | 5 | 0.0 |

## Type of femur component

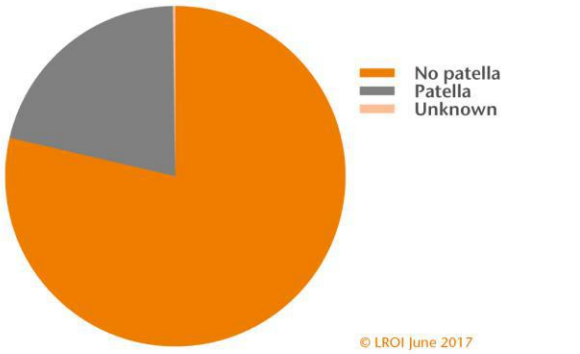
**FIGURE TYPE OF FEMUR COMPONENT IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=23,047).**




| Type of femur component | Number (n) | Proportion (%) |
|---|---|---|
| Posterior stabilized | 12,891 | 55.9 |
| Cruciate retaining | 9,650 | 41.9 |
| Other | 506 | 2.2 |

## Implantation of patella

**FIGURE IMPLANTATION OF PATELLA IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=24,617).**

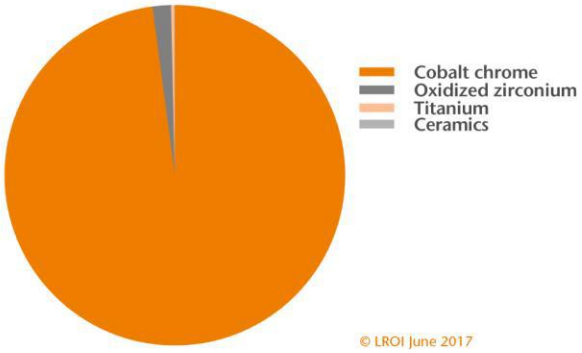



| Implantation of patella | Number (n) | Proportion (%) |
|---|---|---|
| No patella | 19,357 | 78.6 |
| Patella | 5,201 | 21.1 |
| Unknown | 59 | 0.3 |

## Materials

### Femur component

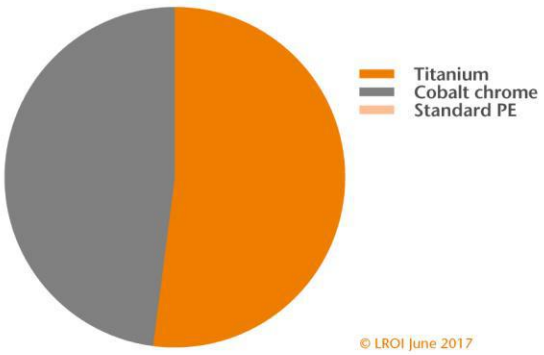
**FIGURE FEMUR MATERIAL IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=23,041).**




| Femur material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 22,556 | 97.9 |
| Oxidized zirconium | 401 | 1.7 |
| Titanium | 67 | 0.3 |
| Ceramics | 17 | 0.1 |

### Tibia component

**FIGURE TIBIA MATERIAL IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=23,322).**

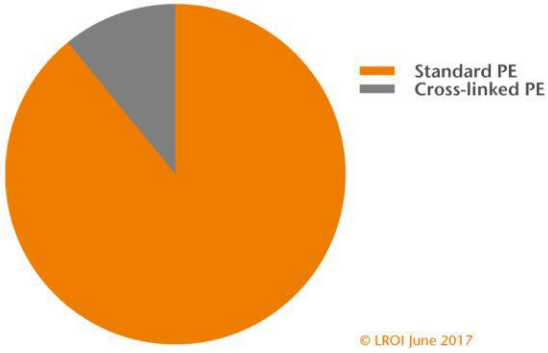



| Tibia material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 12,137 | 52.0 |
| Cobalt chrome | 11,184 | 48.0 |
| Standard PE | 1 | 0.0 |

PE: polyethylene.

## Insert

**FIGURE INSERT MATERIAL IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=23,257).**

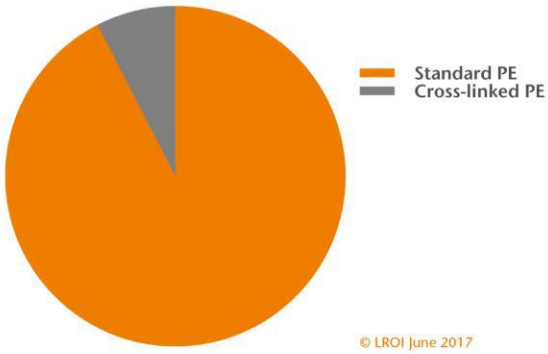



| Insert material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 20,725 | 89.1 |
| Cross-linked PE | 2,532 | 10.9 |

PE: polyethylene.

## Patella component

**FIGURE PATELLA MATERIAL IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=4,773).**



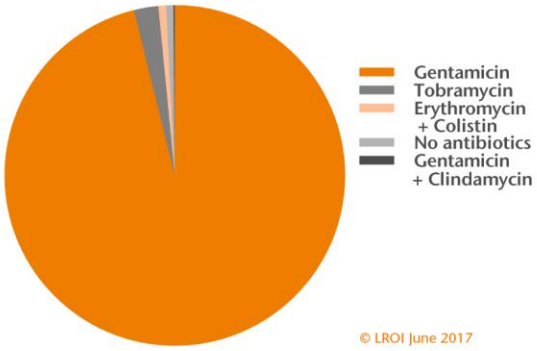

| Patella material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 4,412 | 92.4 |
| Cross-linked PE | 361 | 7.6 |

PE: polyethylene.

## Bone cement

### Antibiotics

**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=21,487).**

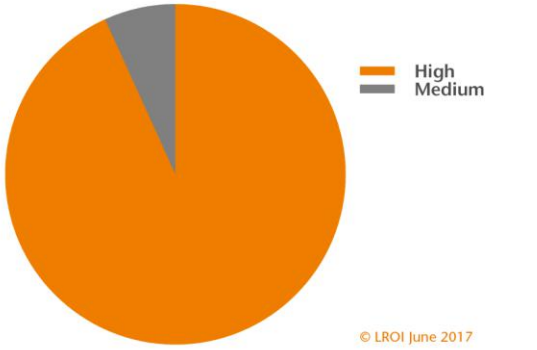



| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 20,656 | 96.2 |
| Tobramycin | 497 | 2.3 |
| Erythromycin + Colistin | 155 | 0.7 |
| No antibiotics | 150 | 0.7 |
| Gentamicin + Clindamycin | 28 | 0.1 |

Please note: In 1 (<0.01%) of primary total knee arthroplasties the antibiotics in bone cement was gentamicin + vancomycin.

### Viscosity

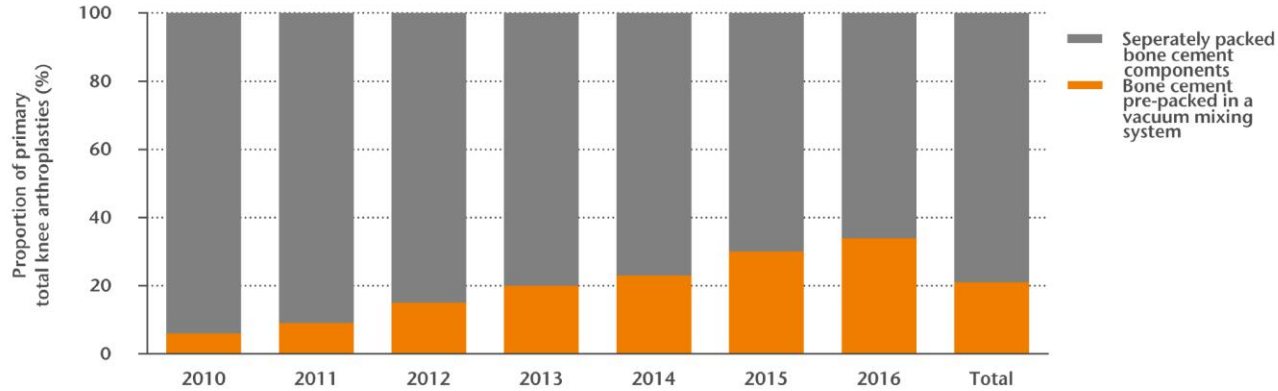
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=21,487).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 20,030 | 93.2 |
| Medium | 1,457 | 6.8 |

## Vacuum mixing system 2010-2016

**FIGURE TREND (PROPORTION [%] BY YEAR) IN USE OF BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2010-2016.**




| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Vacuum mixing system | | | | | | | | |
| Separately packed bone cement components (%) | 93.7 | 91.3 | 85.4 | 79.6 | 76.7 | 69.9 | 66.4 | 79.3 |
| Bone cement pre-packed in a vacuum mixing system (%) | 6.3 | 8.7 | 14.6 | 20.4 | 23.3 | 30.1 | 33.6 | 20.7 |
| Total (n) | 14,765 | 16,437 | 18,597 | 19,728 | 21,412 | 21,564 | 21,487 | 133,990 |



## Most frequently registered total knee prostheses

**TABLE THE FIVE MOST FREQUENTLY REGISTERED PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=24,709).**

| Name | Proportion (%) |
|---|---|
| NexGen | 21.7 |
| Vanguard Complete Knee | 20.0 |
| Genesis II | 18.9 |
| PFC / SIGMA | 11.6 |
| LCS | 8.4 |

## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

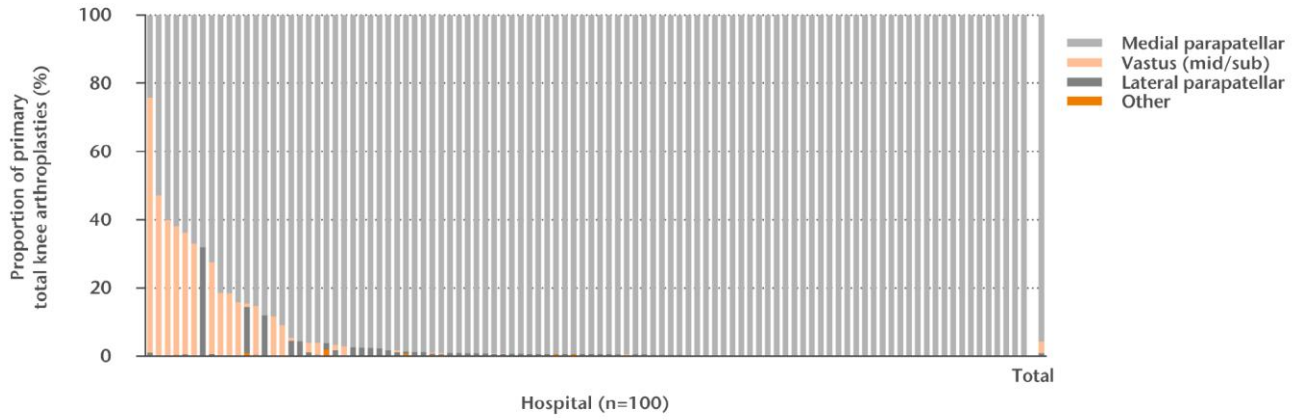
| Separately packed bone cement components (n=16,553) | | Bone cement pre-packed in a vacuum mixing system (n=7,214) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Palacos R+G | 68.8 | Optipac | 32.2 |
| Refobacin Bone Cement R | 5.8 | Palacos Pro | 27.3 |
| Palacos MV+G | 4.8 | Refobacin Bone Cement R | 23.8 |
| Simplex ABC Tobra | 3.0 | Refobacin Plus Bone Cement | 12.3 |
| Refobacin Plus Bone Cement | 1.7 | Cemex | 4.1 |



## Practice variation

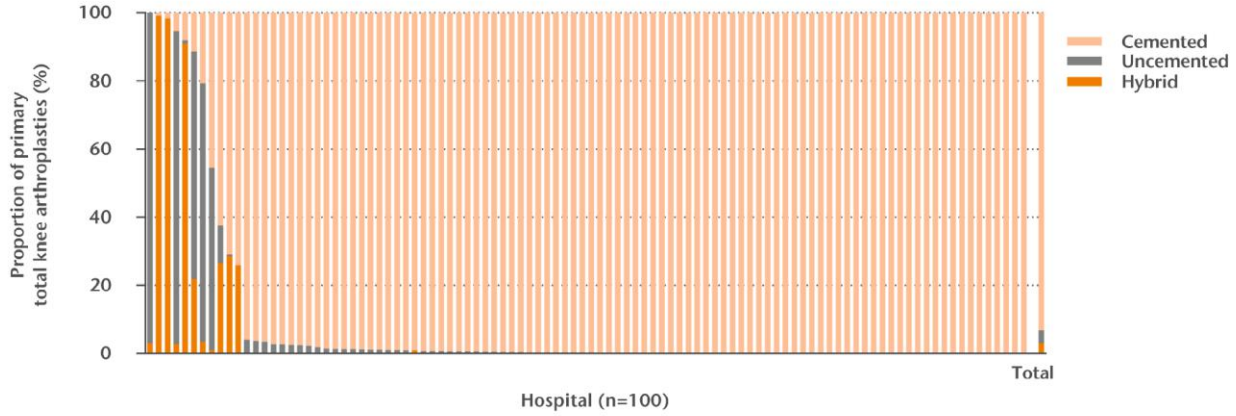
## Surgical approach

**FIGURE DISTRIBUTION OF SURGICAL APPROACH USED DURING PRIMARY TOTAL KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=24,694).**



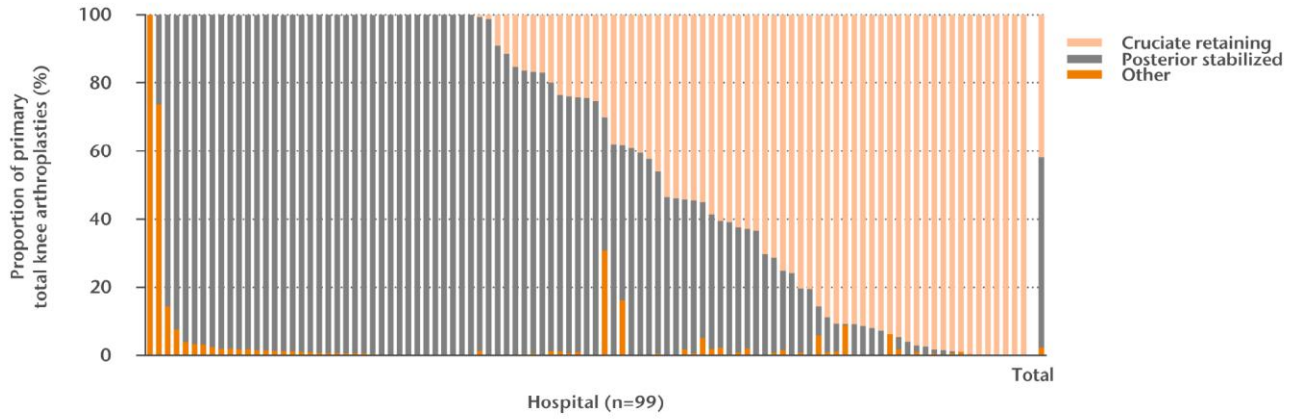
## Fixation

**FIGURE DISTRIBUTION OF TYPE OF FIXATION USED DURING PRIMARY TOTAL KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=24,694).**



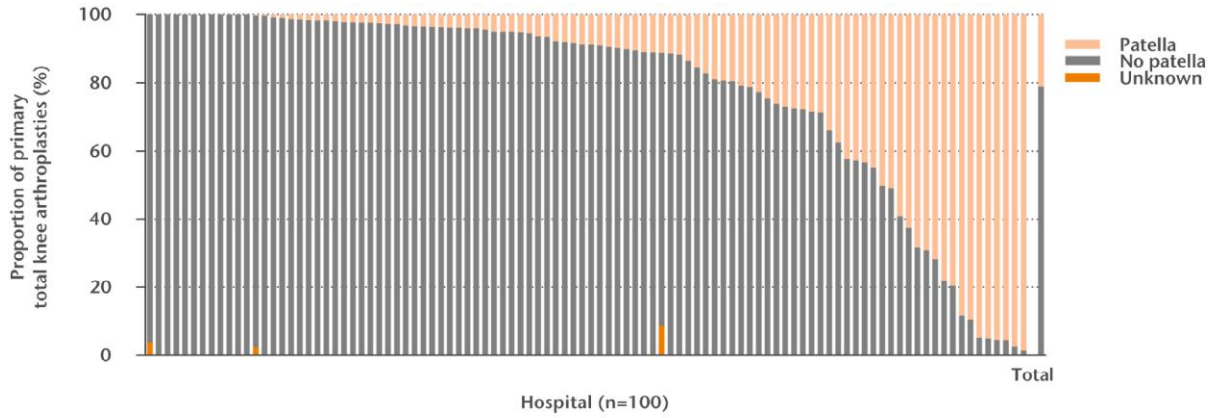

## Type of femur component

**FIGURE DISTRIBUTION OF TYPE OF FEMUR COMPONENT USED DURING PRIMARY TOTAL KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=23,047).**



## Implantation of patella

**FIGURE DISTRIBUTION OF IMPLANTATION OF PATELLA DURING PRIMARY TOTAL KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=24,617).**

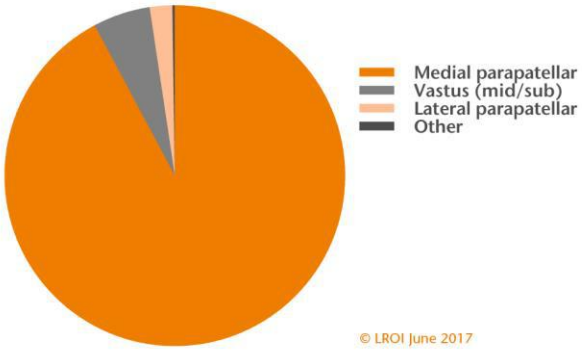



## Unicondylar knee arthroplasty

### Surgical techniques

### Surgical approach

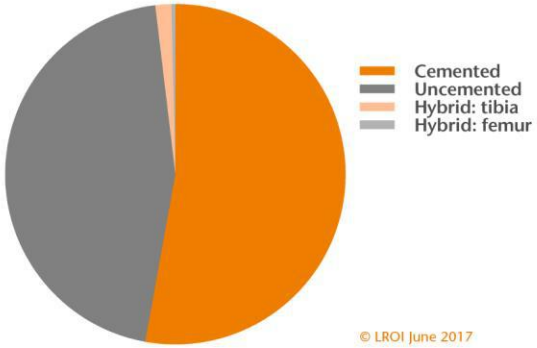
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY UNICONDYLAR KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=2,909).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Medial parapatellar | 2,682 | 92.2 |
| Vastus (mid/sub) | 158 | 5.4 |
| Lateral parapatellar | 62 | 2.1 |
| Other | 7 | 0.3 |

## Fixation

**FIGURE TYPE OF FIXATION IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,911).**

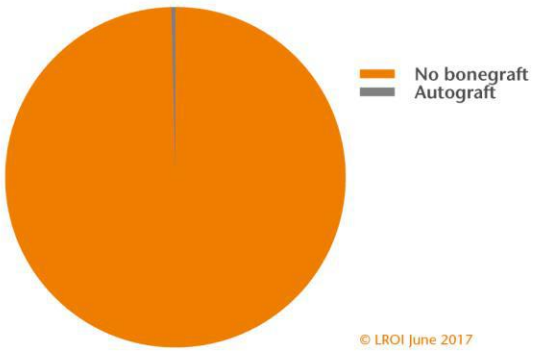



| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 1,538 | 52.8 |
| Uncemented | 1,318 | 45.3 |
| Hybrid: tibia | 44 | 1.5 |
| Hybrid: femur | 11 | 0.4 |

## Prosthesis characteristics

### Type of bonegraft

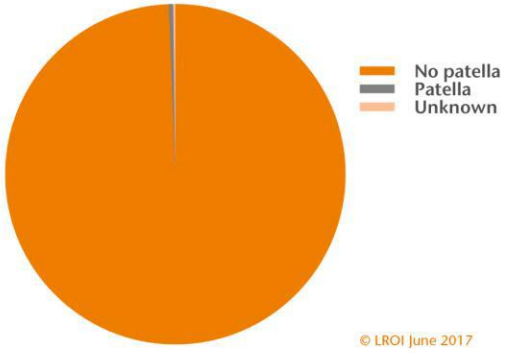
**FIGURE TYPE OF BONEGRAFT IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,912).**




| Type of bonegraft | Number (n) | Proportion (%) |
|---|---|---|
| No bonegraft | 2,901 | 99.6 |
| Autograft | 11 | 0.4 |

## Implantation of patella

**FIGURE IMPLANTATION OF PATELLA IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,910).**

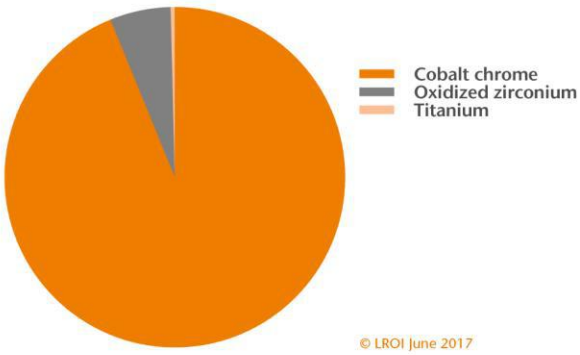



| Implantation of patella | Number (n) | Proportion (%) |
|---|---|---|
| No patella | 2,892 | 99.4 |
| Patella | 12 | 0.4 |
| Unknown | 6 | 0.2 |

## Materials

## Femur component

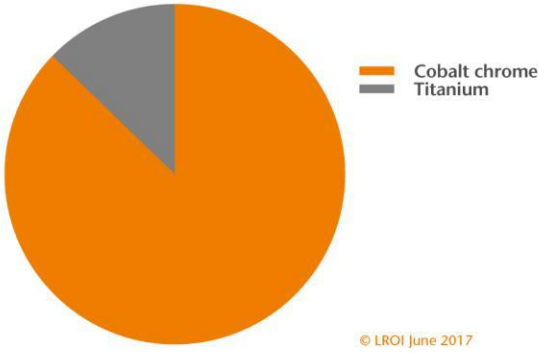
**FIGURE FEMUR MATERIAL IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,739).**




| Femur material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 2,570 | 93.8 |
| Oxidized zirconium | 158 | 5.8 |
| Titanium | 11 | 0.4 |

## Tibia component

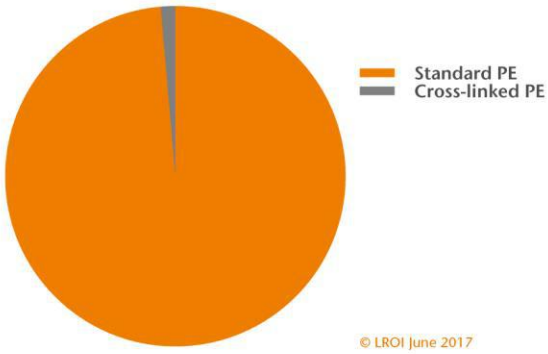
**FIGURE TIBIA MATERIAL IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,749).**




| Tibia material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 2,398 | 87.2 |
| Titanium | 351 | 12.8 |

## Insert

**FIGURE INSERT MATERIAL IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,733).**

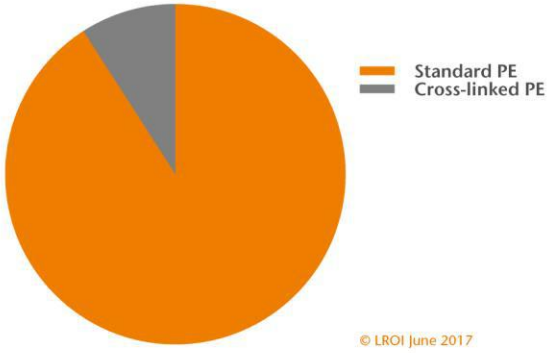



| Insert material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 2,695 | 98.6 |
| Cross-linked PE | 38 | 1.4 |

PE: polyethylene.

## Patella component

**FIGURE PATELLA MATERIAL IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=11).**



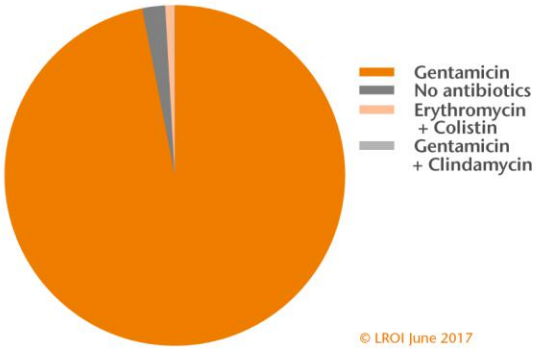

| Patella material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 10 | 90.9 |
| Cross-linked PE | 1 | 9.1 |

PE: polyethylene.

## Bone cement

## Antibiotics

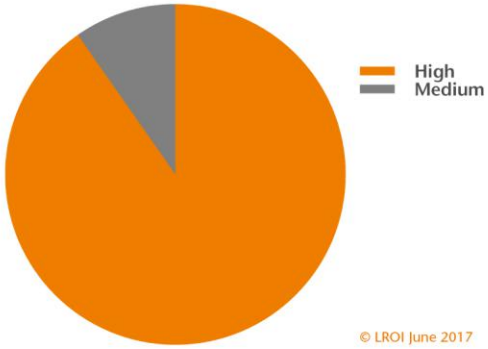
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,429).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 1,385 | 96.9 |
| No antibiotics | 31 | 2.2 |
| Erythromycin + Colistin | 12 | 0.8 |
| Gentamicin + Clindamycin | 1 | 0.1 |

## Viscosity

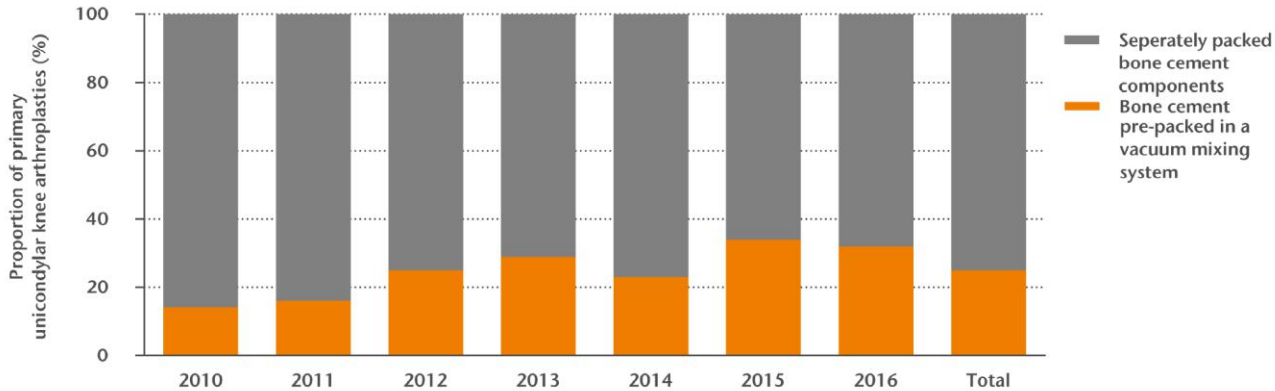
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,429).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 1,290 | 90.3 |
| Medium | 139 | 9.7 |

## Vacuum mixing system 2010-2016

**FIGURE TREND (PROPORTION [%] BY YEAR) IN USE OF BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2010-2016.**




| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Vacuum mixing system | | | | | | | | |
| Separately packed bone cement components (%) | 86.1 | 84.5 | 74.8 | 71.2 | 76.8 | 66.4 | 68.3 | 75.4 |
| Bone cement pre-packed in a vacuum mixing system (%) | 13.9 | 15.5 | 25.2 | 28.8 | 23.2 | 33.6 | 31.7 | 24.6 |
| Total (n) | 1,416 | 1,332 | 1,246 | 1,342 | 1,559 | 1,455 | 1,429 | 9,779 |

## Most frequently registered unicondylar knee prostheses

**TABLE THE FIVE MOST FREQUENTLY REGISTERED UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,915).**

| Name | Proportion (%) |
|---|---|
| Oxford PKR | 80.1 |
| Unicompartmental High Flex Knee | 5.0 |
| Genesis Uni | 3.5 |
| Journey Uni | 1.9 |
| BalanSys | 0.9 |

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## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING UNICONDYLAR KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Separately packed bone cement components (n=976) | | Bone cement pre-packed in a vacuum mixing system (n=453) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Palacos R+G | 75.0 | Refobacin Bone Cement R | 34.4 |
| Palacos MV+G | 13.0 | Optipac | 29.6 |
| Refobacin Bone Cement R | 4.6 | Palacos Pro | 18.5 |
| Biomet Plus Bone Cement | 3.2 | Cemex | 9.5 |
| Simplex HV | 1.4 | Refobacin Plus Bone Cement | 7.9 |

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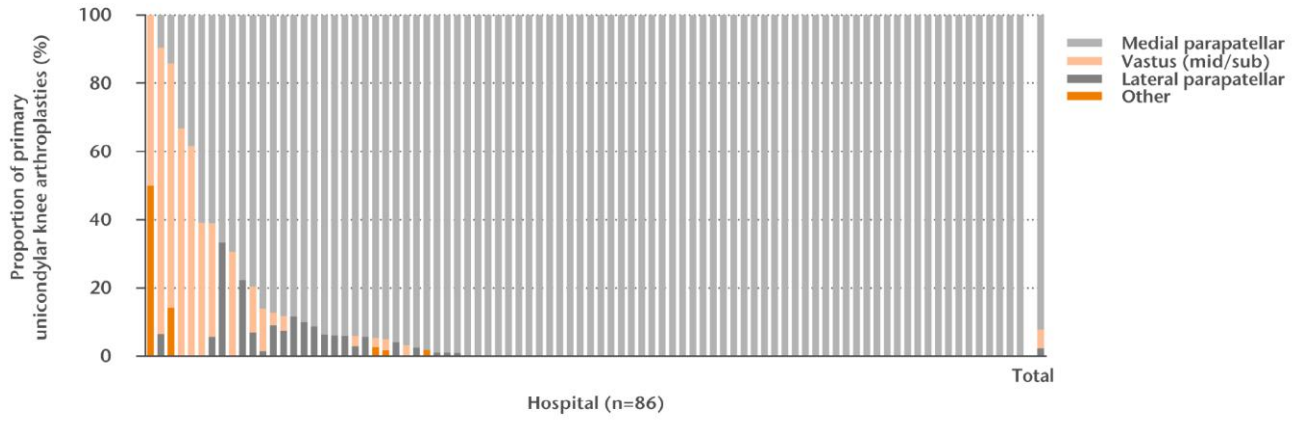
## Practice variation

## Surgical approach

**FIGURE DISTRIBUTION OF SURGICAL APPROACH USED DURING PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,909).**

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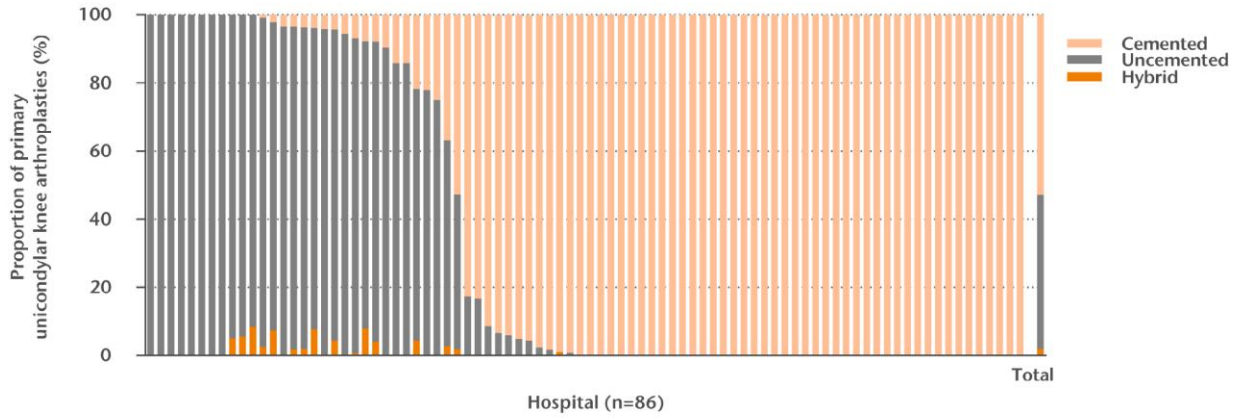
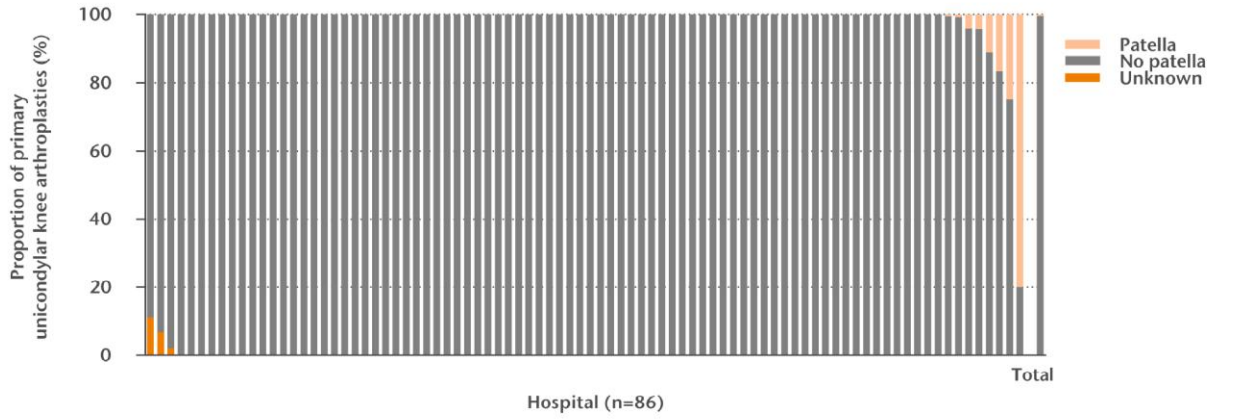
## Fixation

**FIGURE DISTRIBUTION OF TYPE OF FIXATION USED DURING PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,911).**




## Implantation of patella

**FIGURE DISTRIBUTION OF IMPLANTATION OF PATELLA DURING PRIMARY UNICONDYLAR KNEE ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,910).**

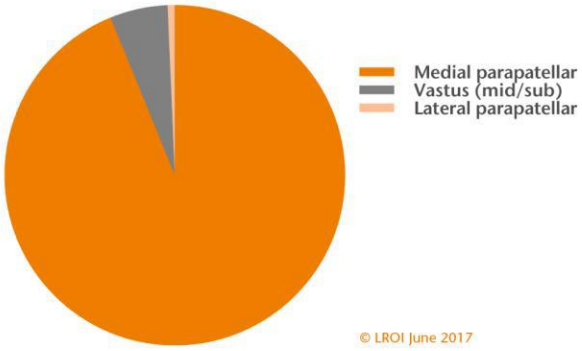


# Patellofemoral knee arthroplasty

## Surgical techniques

### Surgical approach

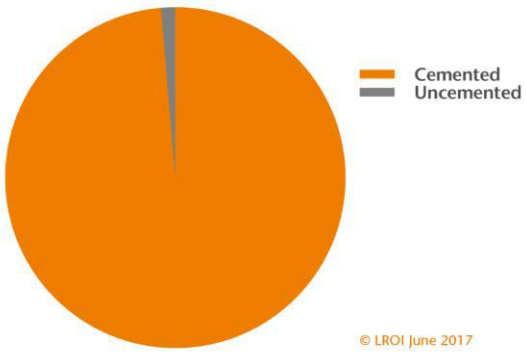
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=146).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Medial parapatellar | 137 | 93.8 |
| Vastus (mid/sub) | 8 | 5.5 |
| Lateral parapatellar | 1 | 0.7 |

### Fixation

**FIGURE TYPE OF FIXATION IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=148).**

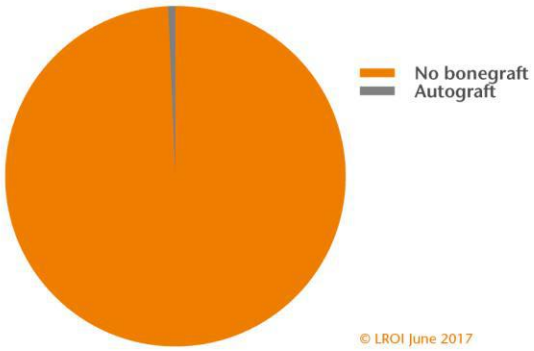



| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 146 | 98.6 |
| Uncemented | 2 | 1.4 |

## Prosthesis characteristics

### Type of bonegraft

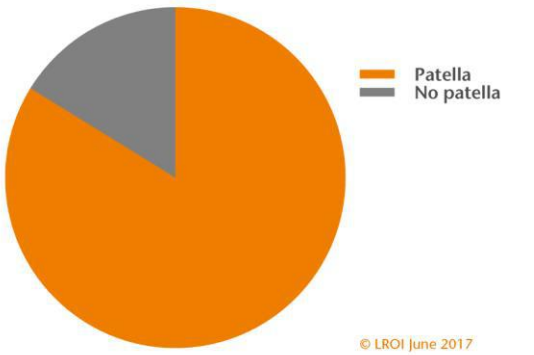
**FIGURE TYPE OF BONEGRAFT IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=147).**




| Type of bonegraft | Number (n) | Proportion (%) |
|---|---|---|
| No bonegraft | 146 | 99.3 |
| Autograft | 1 | 0.7 |

### Implantation of patella

**FIGURE IMPLANTATION OF PATELLA IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=148).**

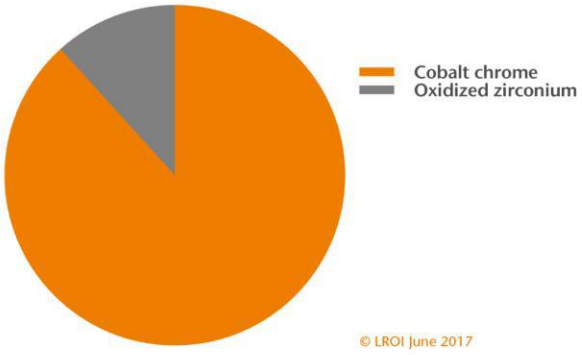



| Implantation of patella | Number (n) | Proportion (%) |
|---|---|---|
| Patella | 124 | 83.8 |
| No patella | 24 | 16.2 |

## Materials

### Femur component

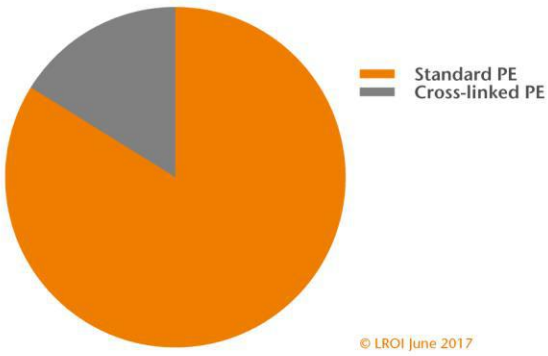
**FIGURE FEMUR MATERIAL IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=128).**




| Femur material | Number (n) | Proportion (%) |
|---|---|---|
| Cobalt chrome | 113 | 88.3 |
| Oxidized zirconium | 15 | 11.7 |

### Patella component

**FIGURE PATELLA MATERIAL IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=130).**



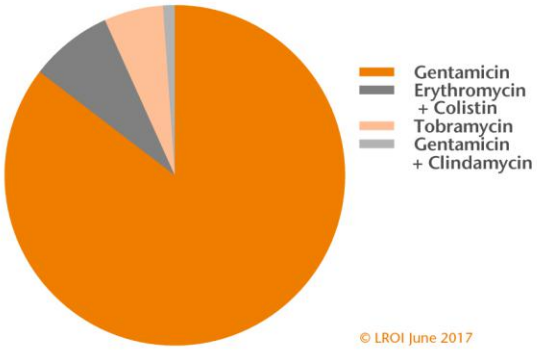

| Patella material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 109 | 90.9 |
| Cross-linked PE | 21 | 9.1 |

PE: polyethylene.

## Bone cement

### Antibiotics

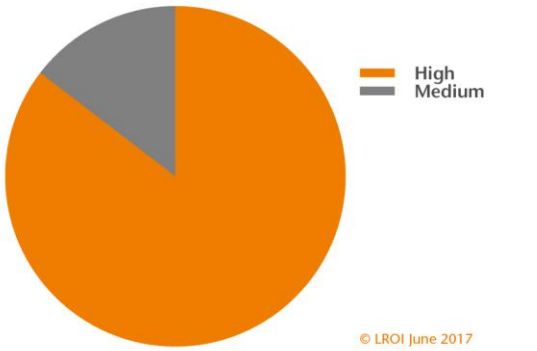
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=146).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 76 | 85.4 |
| Erythromycin + Colistin | 7 | 7.9 |
| Tobramycin | 5 | 5.6 |
| Gentamicin + Clindamycin | 1 | 1.1 |

### Viscosity

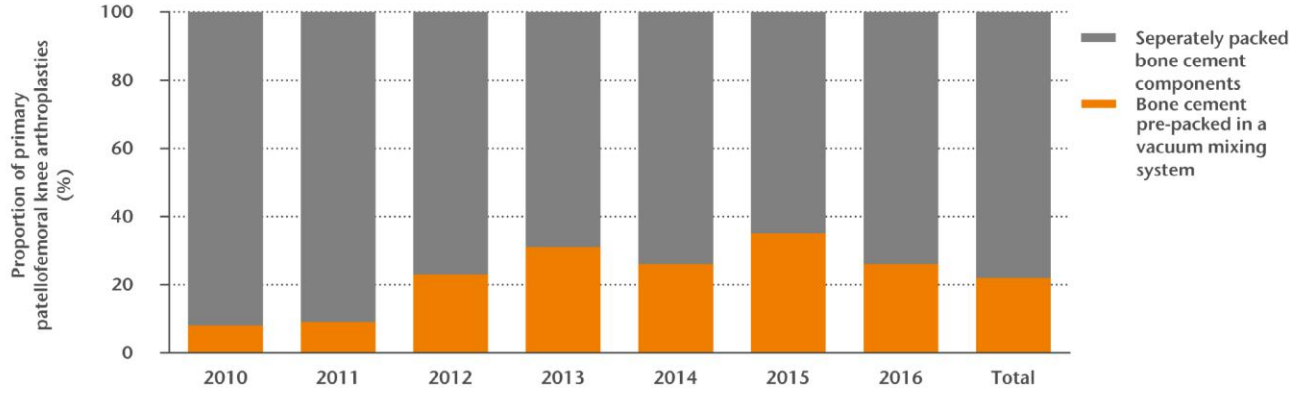
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=146).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 76 | 85.4 |
| Medium | 13 | 14.6 |

## Vacuum mixing system 2010-2016

**FIGURE TREND (PROPORTION [%] BY YEAR) IN USE OF BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2010-2016.**




| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|
| Vacuum mixing system | | | | | | | | |
| Separately packed bone cement components (%) | 92.1 | 91.1 | 76.5 | 68.9 | 74.4 | 65.3 | 74.2 | 78.2 |
| Bone cement pre-packed in a vacuum mixing system (%) | 7.9 | 8.9 | 23.5 | 31.1 | 25.6 | 34.7 | 25.8 | 21.8 |
| Total (n) | 126 | 112 | 132 | 106 | 90 | 101 | 89 | 756 |



## Most frequently registered patellofemoral knee prostheses

**TABLE THE FIVE MOST FREQUENTLY REGISTERED PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=148).**

| Name | Proportion (%) |
|---|---|
| Gender Solutions® Patello-Femoral Joint | 48.0 |
| Avon | 13.5 |
| Journey PFJ | 10.1 |
| PFC / Sigma | 6.8 |
| IBalance PFJ | 4.7 |

## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT USED DURING PATELLOFEMORAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=121).**

| Name | Proportion (%) |
|---|---|
| Palacos R+G | 39.7 |
| Refobacin Bone Cement R | 12.4 |
| Palacos Pro | 5.8 |
| Simplex ABC EC | 5.8 |
| Simplex ABC Tobra | 4.1 |

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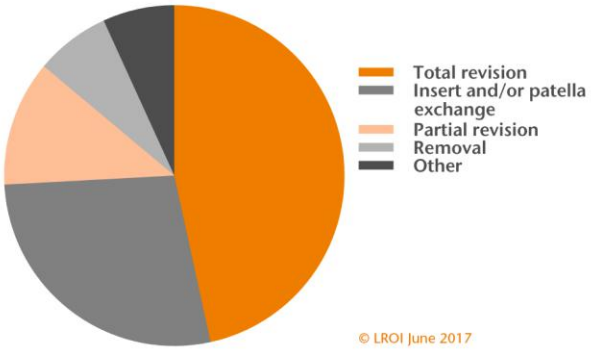
# Knee revision arthroplasty

## Type of revision

**FIGURE TYPE OF REVISION ARTHROPLASTY OF KNEE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,832).**




| Type of knee revision | Number (n) | Proportion (%) |
|---|---|---|
| Total revision | 1,319 | 46.6 |
| Insert and/or patella exchange | 781 | 27.6 |
| Partial revision | 338 | 11.9 |
| Removal | 201 | 7.1 |
| Other | 193 | 6.8 |

**In 130 partial knee revision arthroplasties the femur component was revised and in 196 partial knee revision arthroplasties the tibia component was revised in 2016.**

## Reasons for revision

**TABLE REASONS FOR REVISION OR RE-SURGERY IN PATIENTS WHO UNDERWENT A KNEE REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=2,886).**

| Reasons for revision | Proportion[1] (%) |
|---|---|
| Instability | 25.1 |
| Loosening of tibia component | 22.0 |
| Patellar pain | 21.1 |
| Infection | 19.8 |
| Malalignment | 14.0 |
| Progression of osteoarthritis | 9.4 |
| Loosening of femur component | 9.0 |
| Insert wear | 7.4 |
| Revision after knee removal | 6.3 |
| Arthrofibrosis | 4.3 |
| Patellar dislocation | 2.0 |
| Loosening of patella component | 1.9 |
| Periprosthetic fracture | 1.7 |

[1] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

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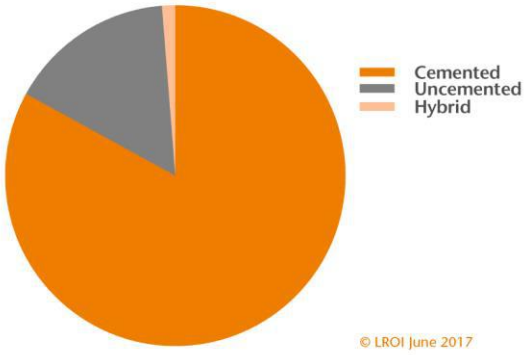
## Surgery

### Fixation

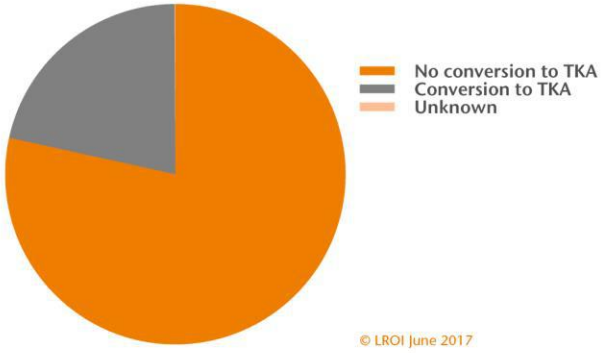
**FIGURE TYPE OF FIXATION IN KNEE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=2,618).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 2,172 | 83.0 |
| Uncemented | 413 | 15.8 |
| Hybrid | 33 | 1.2 |

## Conversion to TKA

**FIGURE CONVERSION OF A UNICONDYLAR OR PATELLOFEMORAL KNEE ARTHROPLASTY TO A TOTAL KNEE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=2,602).**

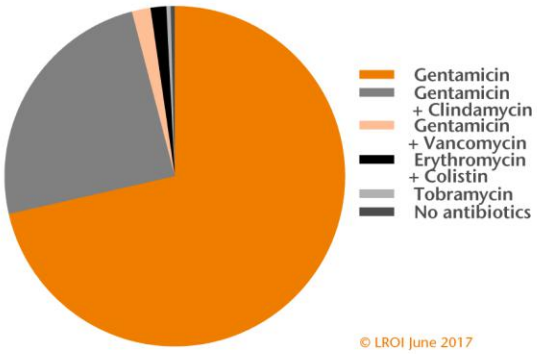



| Conversion to TKA | Number (n) | Proportion (%) |
|---|---|---|
| No conversion to TKA | 2,041 | 78.4 |
| Conversion to TKA | 559 | 21.5 |
| Unknown | 2 | 0.1 |

TKA: total knee arthroplasty.

## Bone cement antibiotics

**FIGURE BONE CEMENT ANTIBIOTICS IN KNEE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,747).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 1,248 | 71.4 |
| Gentamicin + Clindamycin | 428 | 24.5 |
| Gentamycin + Vancomycin | 31 | 1.8 |
| Erythromycin + Colistin | 26 | 1.5 |
| Tobramycin | 7 | 0.4 |
| No antibiotics | 7 | 0.4 |

## Most frequently registered components

**TABLE THE TEN MOST FREQUENTLY REGISTERED FEMUR, TIBIA, INSERT AND PATELLA COMPONENTS IN KNEE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Femur (n=1,461)

| Name | Proportion (%) |
|---|---|
| Legion | 18.3 |
| NexGen | 17.7 |
| PFC / Sigma | 7.5 |
| Genesis II | 6.8 |
| Vanguard Complete Knee | 6.6 |
| LCS | 5.6 |
| Vanguard 360 | 4.0 |
| Legion Hinged | 3.9 |
| Triathlon | 3.1 |
| ACS SC | 1.8 |

Tibia (n=1,562)

| Name | Proportion (%) |
|---|---|
| Legion | 19.3 |
| NexGen | 16.8 |
| S-Rom | 11.3 |
| Vanguard 360 | 5.6 |
| Vanguard Complete Knee | 5.4 |
| Genesis II | 4.5 |
| PFC / Sigma | 4.0 |
| Legion Hinged | 3.6 |
| Triathlon | 2.8 |
| Scorpio | 1.6 |

Insert (n=2,143)

| Name | Proportion (%) |
|---|---|
| Genesis II | 24.6 |
| NexGen | 17.0 |
| Vanguard Complete Knee | 8.9 |
| PFC / Sigma | 8.0 |
| LCS | 6.9 |
| ACS | 3.2 |
| Vanguard SSK | 3.1 |
| Legion Hinged | 3.1 |
| Oxford PKR | 2.9 |
| Triathlon | 2.6 |

Patella (n=1,170)

| Name | Proportion (%) |
|---|---|
| Genesis II | 31.3 |
| NexGen | 13.8 |
| Vanguard | 11.9 |
| PFC / Sigma | 10.9 |
| LCS | 4.1 |
| Triathlon | 4.0 |
| ACS | 2.1 |
| AGC | 1.9 |
| Attune | 1.2 |
| Scorpio | 1.1 |



## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING KNEE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Separately packed bone cement components (n=1,235)

| Name | Proportion (%) |
|---|---|
| Palacos R+G | 56.3 |
| Copal G+C | 24.7 |
| Refobacin Revision | 4.3 |
| Refobacin Bone Cement R | 3.5 |
| Palacos MV+G | 3.5 |

Bone cement pre-packed in a vacuum mixing system (n=504)

| Name | Proportion (%) |
|---|---|
| Optipac | 37.3 |
| Palacos Pro | 19.2 |
| Refobacin Bone Cement R | 14.9 |
| Refobacin Revision | 13.5 |
| Cemex | 7.7 |

# Survival

## Revision within 1 year

### By type of revision

**TABLE CUMULATIVE 1-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL KNEE ARTHROPLASTIES BY TYPE OF REVISION IN THE NETHERLANDS IN 2011-2015 (N=110,033).**

| | Cumulative 1-year revision percentage | |
|---|---|---|
| | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Any type of revision | 1.0 (0.9-1.0) | 1.0 (1.0-1.0) |
| Small revision[1] | 0.5 (0.5-0.6) | 0.6 (0.5-0.6) |
| Substantial revision[2] | 0.4 (0.4-0.5) | 0.4 (0.4-0.5) |

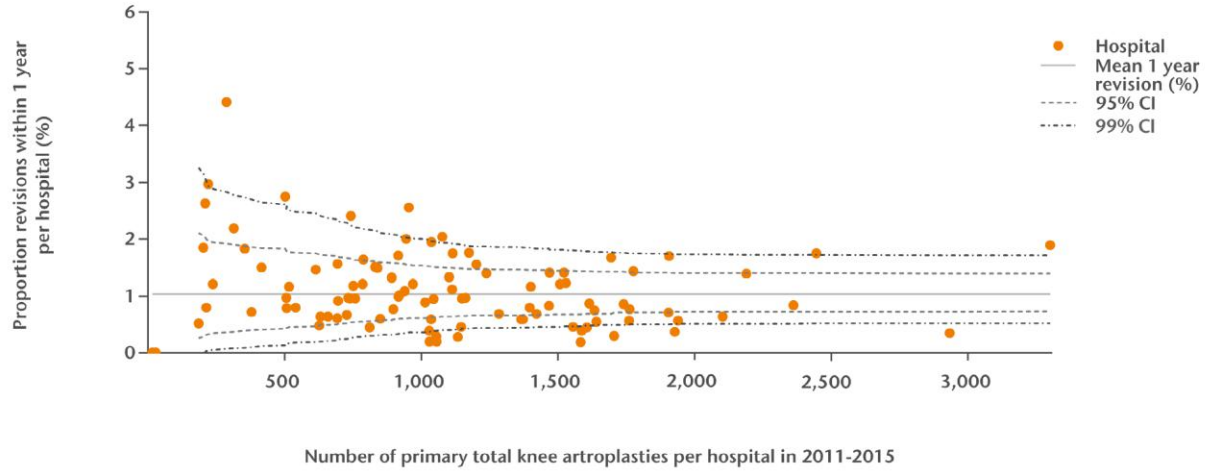
[1] Only insert and/or patella exchange.
[2] Including femur or tibia.
TKA: total knee arthroplasty; CI: confidence interval.



**In 2011-2015, 797 (0.7%) primary total knee arthroplasties were implanted in patients who died within one year after the primary procedure.**

### Per hospital

**FIGURE FUNNEL PLOT OF PROPORTION OF KNEE REVISION ARTHROPLASTIES WITHIN ONE YEAR AFTER A PRIMARY TOTAL KNEE ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2011-2015 (N=110,033).**




Please note: The proportions of revisions within 1 year per hospital were adjusted for casemix factors age, gender, ASA score and diagnosis (osteoarthritis versus other).
CI: confidence interval.



**The mean 1-year revision percentage is 1.0 (95% CI: 0.9-1.0) in the Netherlands in 2011-2015. Confidence intervals are the boundaries within one would expect the outcome if only chance is of influence.**

## Reasons for revision by type of revision

**TABLE REASONS FOR REVISION WITHIN ONE YEAR IN PATIENTS THAT UNDERWENT A KNEE REVISION ARTHROPLASTY BY TYPE OF REVISION IN THE NETHERLANDS IN 2011-2015.**

| Reason for revision | Small revision[1] (n=634) Proportion[3] (%) | Substantial revision[2] (n=510) Proportion[3] (%) | Any type of revision (n=1,147) Proportion[3] (%) |
|---|---|---|---|
| Infection | 28.5 | 22.7 | 26.1 |
| Patellar pain | 29.8 | 8.2 | 20.1 |
| Instability | 16.1 | 23.7 | 19.4 |
| Malalignment | 1.3 | 27.6 | 13.0 |
| Loosening of tibia component | 0.8 | 22.5 | 10.5 |
| Periprosthetic fracture | 0.8 | 10.8 | 5.2 |
| Arthrofibrosis | 4.9 | 5.5 | 5.1 |
| Patellar dislocation | 5.0 | 2.9 | 4.1 |
| Revision after knee removal | 0.5 | 8.0 | 3.8 |
| Loosening of femur component | 0.5 | 6.3 | 3.1 |
| Insert wear | 2.4 | 0.4 | 1.5 |
| Progression of osteoarthritis | 0.3 | 0.8 | 0.5 |
| Loosening of patella component | 0.9 | 0.0 | 0.5 |

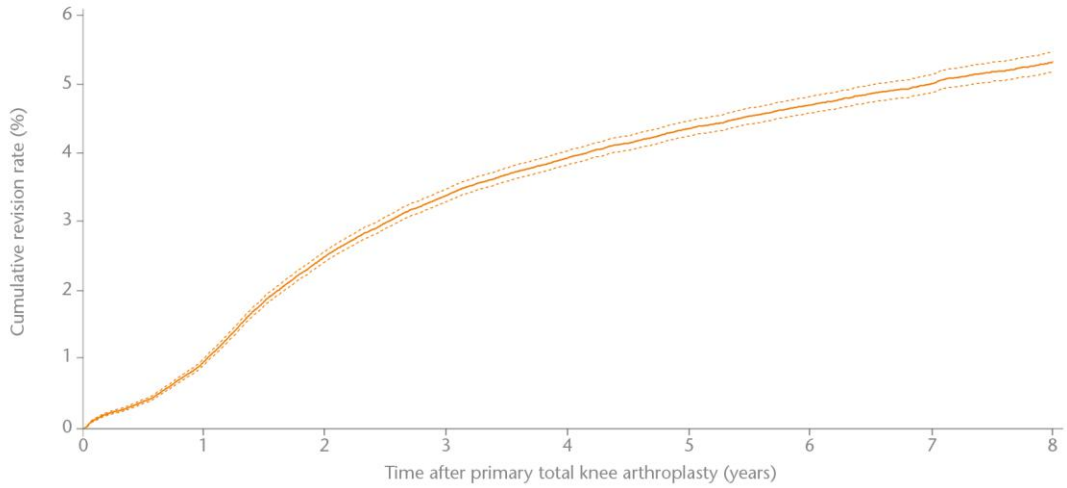
[1] Only insert and/or patella exchange.
[2] Including femur or tibia.
[3] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.



## Revision within 8 years

### Overall

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016 (N=186,270).**




Please note: Dotted lines represent the upper and lower limits of the 95% confidence interval.

## By type of revision

**TABLE CUMULATIVE 8-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL KNEE ARTHROPLASTIES BY TYPE OF REVISION IN THE NETHERLANDS IN 2007-2016 (N=186,270).**

| | Cumulative 8-year revision percentage | |
|---|---|---|
| | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Any type of revision | 5.3 (5.2-5.5) | 5.5 (5.4-5.7) |
| Small revision[1] | 2.6 (2.5-2.7) | 2.7 (2.6-2.8) |
| Substantial revision[2] | 2.8 (2.7-2.9) | 2.9 (2.8-3.0) |

[1] Only insert and/or patella exchange.
[2] Including femur or tibia.
TKA: total knee arthroplasty; CI: confidence interval.



## By demographics

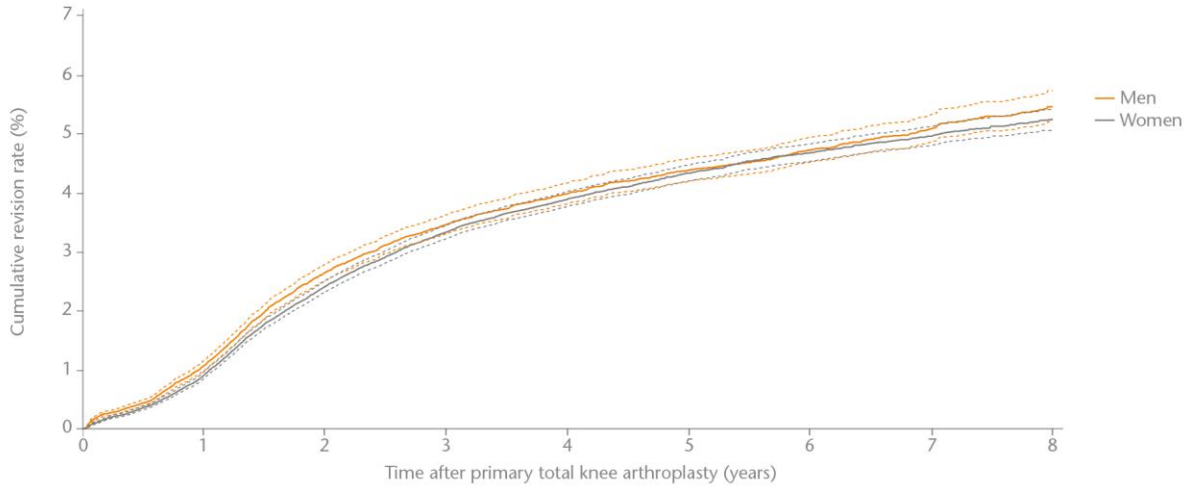
**TABLE CUMULATIVE 8-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL KNEE ARTHROPLASTIES BY DEMOGRAPHICS IN THE NETHERLANDS IN 2007-2016.**

| | | Cumulative 8-year revision percentage | |
|---|---|---|---|
| | Number (n) | Competing Risk (95% CI) | Kaplan Meier (95% CI) |
| Total | 186,270 | 5.3 (5.2-5.5) | 5.5 (5.4-5.7) |
| Gender | | | |
| Men | 63,419 | 5.5 (5.2-5.7) | 5.7 (5.4-6.0) |
| Women | 122,470 | 5.2 (5.1-5.4) | 5.4 (5.2-5.6) |
| Age (years) | | | |
| <50 | 4,762 | 12.9 (11.5-14.4) | 13.0 (12.9-13.1) |
| 50-59 | 27,656 | 8.9 (8.4-9.4) | 9.0 (8.5-9.5) |
| 60-69 | 65,938 | 5.6 (5.4-5.9) | 5.8 (5.5-6.0) |
| 70-79 | 64,442 | 4.1 (3.9-4.3) | 4.3 (4.1-4.5) |
| ≥80 | 23,170 | 2.1 (1.9-2.3) | 2.2 (2.0-2.5) |
| Diagnosis | | | |
| Osteoarthritis | 177,154 | 5.3 (5.2-5.5) | 5.5 (5.4-5.7) |
| Other | 7,126 | 5.9 (5.2-6.7) | 6.2 (5.4-7.1) |
| ASA score | | | |
| I | 33,912 | 5.9 (5.6-6.3) | 6.1 (5.7-6.4) |
| II | 119,939 | 5.2 (5.0-5.4) | 5.4 (5.2-5.6) |
| III-IV | 24,931 | 5.0 (4.6-5.4) | 5.4 (4.9-5.8) |

CI: confidence interval.

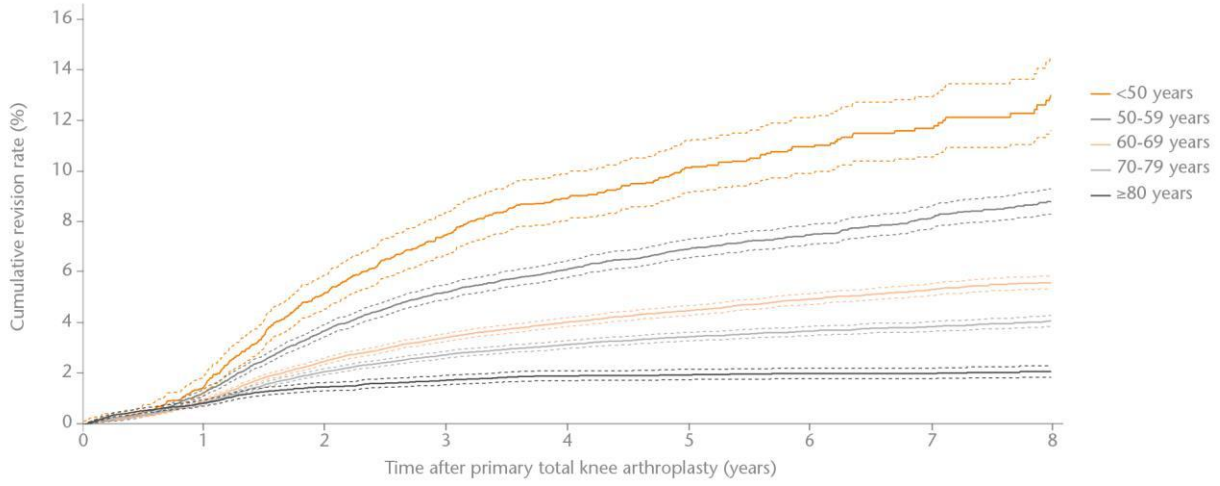
## By gender

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL KNEE ARTHROPLASTIES BY GENDER IN THE NETHERLANDS IN 2007-2016 (N=185,968).**



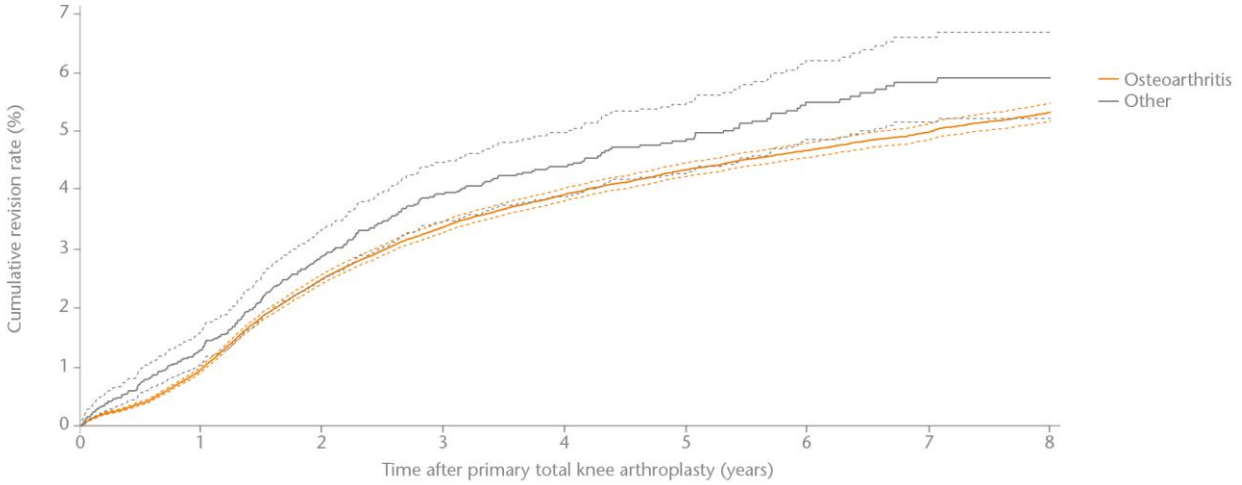

## By age category

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL KNEE ARTHROPLASTIES BY AGE CATEGORY IN THE NETHERLANDS IN 2007-2016 (N=185,889).**



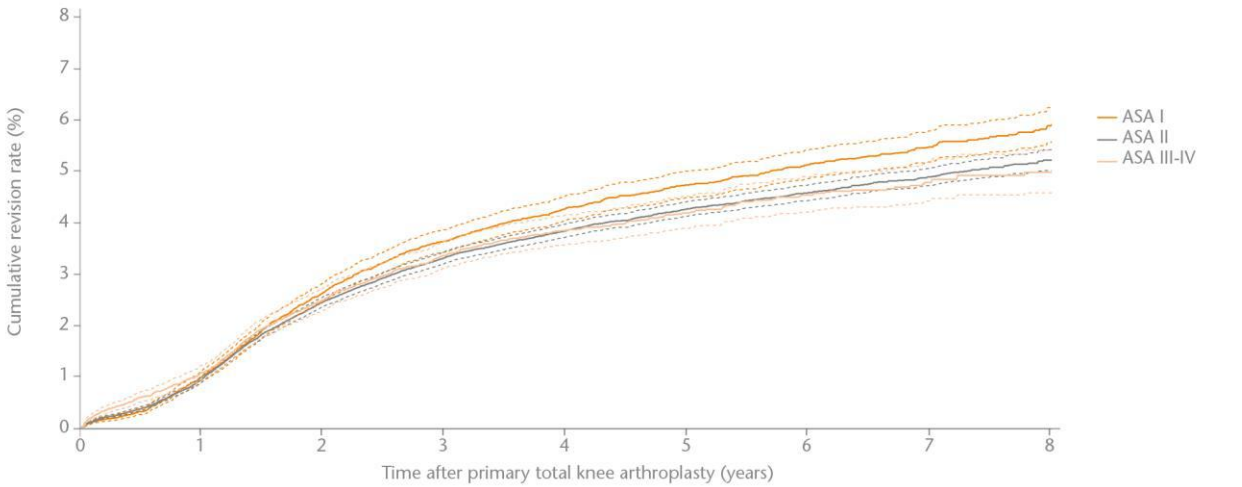
## By diagnosis

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL KNEE ARTHROPLASTIES BY DIAGNOSIS IN THE NETHERLANDS IN 2007-2016 (N=184,280).**




## By ASA score

**FIGURE CUMULATIVE REVISION PERCENTAGE OF TOTAL KNEE ARTHROPLASTIES BY ASA SCORE IN THE NETHERLANDS IN 2007-2016 (N=178,782).**



# Revision within 1, 3 and 5 years per type of knee prosthesis

## Total knee arthroplasty

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE FIVE MOST FREQUENTLY REGISTERED TOTAL KNEE ARTHROPLASTIES IN 2016, IN THE NETHERLANDS IN 2007-2016 (N=186,270).**

| Total knee arthroplasty | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Genesis II | 37,915 | 1.2 (1.1-1.3) | 4.0 (3.8-4.2) | 5.0 (4.8-5.3) |
| NexGen | 36,881 | 0.9 (0.8-1.0) | 2.9 (2.7-3.1) | 4.0 (3.8-4.3) |
| Vanguard Complete Knee | 29,167 | 1.0 (0.9-1.1) | 3.2 (3.0-3.5) | 4.2 (3.9-4.5) |
| PFC / Sigma | 22,712 | 0.8 (0.7-0.9) | 3.0 (2.8-3.3) | 3.8 (3.5-4.1) |
| LCS | 21,586 | 0.9 (0.7-1.0) | 3.3 (3.1-3.6) | 4.2 (3.9-4.5) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.



**Of the registered total knee arthroplasties, 68 femur components were not part of this top five. These components represented 19% of all registered total knee arthroplasties in 2007-2016.**

## Bone cement

**TABLE CUMULATIVE 1-, 3- AND 5-YEAR REVISION PERCENTAGES OF THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM IN 2016, IN PRIMARY TOTAL KNEE ARTHROPLASTIES IN THE NETHERLANDS IN 2007-2016.**

| Bone cement | n | Cumulative 1-year revision percentage (95% CI) | Cumulative 3-year revision percentage (95% CI) | Cumulative 5-year revision percentage (95% CI) |
|---|---|---|---|---|
| Separately packed bone cement components (n=124,244) | | | | |
| Palacos R+G | 90,719 | 0.9 (0.9-1.0) | 3.4 (3.3-3.5) | 4.4 (4.3-4.6) |
| Refobacin Bone Cement R | 7,839 | 0.9 (0.7-1.2) | 3.2 (2.8-3.6) | 4.2 (3.7-4.7) |
| Palacos MV+G | 6,392 | 0.9 (0.7-1.2) | 3.1 (2.7-3.7) | 4.0 (3.4-4.6) |
| Simplex ABC Tobra | 4,916 | 0.8 (0.6-1.2) | 2.5 (2.0-3.0) | 3.2 (2.7-3.8) |
| Refobacin Plus Bone Cement | 2,787 | 1.3 (1.0-1.9) | 4.9 (4.1-5.8) | 5.8 (5.0-6.8) |
| Bone cement pre-packed in a vacuum mixing system (n=28,700) | | | | |
| Refobacin Bone Cement R | 10,945 | 1.2 (1.0-1.4) | 3.5 (3.2-4.0) | 4.5 (4.0-5.1) |
| Refobacin Plus Bone Cement | 9,278 | 0.8 (0.7-1.0) | 3.4 (3.0-3.8) | 4.5 (3.9-5.1) |
| Optipac | 3,476 | 1.2 (0.8-1.8) | 3.5 (1.9-6.4) | n.a. |
| Palacos Pro | 3,381 | 1.3 (0.9-1.9) | 5.2 (3.4-7.8) | n.a. |
| Cemex | 1,434 | 1.3 (0.8-2.1) | 4.9 (3.8-6.4) | 5.2 (4.0-6.8) |

Please note: Revision is defined as any change (insertion, replacement and/or removal) of one or more components of the prosthesis.
CI: confidence interval.

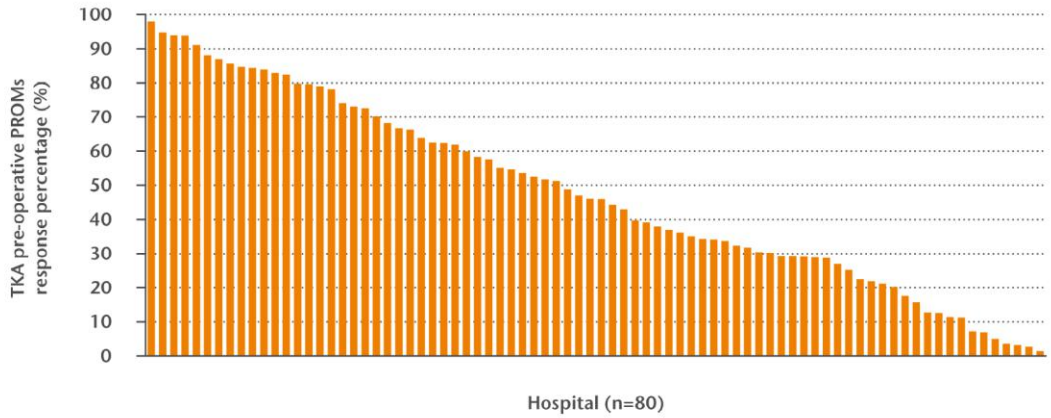


**Of the registered types of bone cement, 24 types were not part of these top fives. These types represented 6% of all registered types of bone cement in 2007-2016.**

# PROMs

## Response

**FIGURE PRE-OPERATIVE PROMS RESPONSE PERCENTAGE OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER PROMS REGISTERING HOSPITAL IN THE NETHERLANDS IN 2016 (N=19,902).**




TKA: total knee arthroplasty; PROM: patient reported outcome measure.

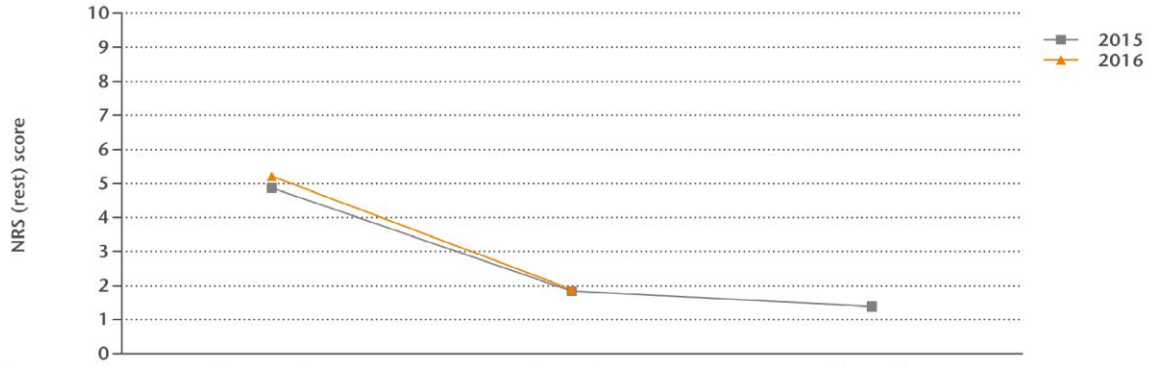


**Of all 19,902 patients who underwent a TKA for osteoarthritis in a PROMs registering hospital, the mean pre-operative response score was 48.2% (n=9,585).**

## Mean scores (preoperative, 6 months and 12 months)

### NRS (rest)

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS NRS (REST) SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| NRS (rest) score | Pre-operative (n=10,327) | 6 months (n=3,293) | 12 months (n=2,555) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 4.9 (4.8-5.0) | 1.8 (1.7-2.0) | 1.4 (1.3-1.5) |
| 2016 (95% CI) | 5.2 (5.2-5.3) | 1.9 (1.8-2.0) | n.a. |
| Total (95% CI) | 5.1 (5.1-5.2) | 1.9 (1.8-1.9) | 1.4 (1.3-1.5) |

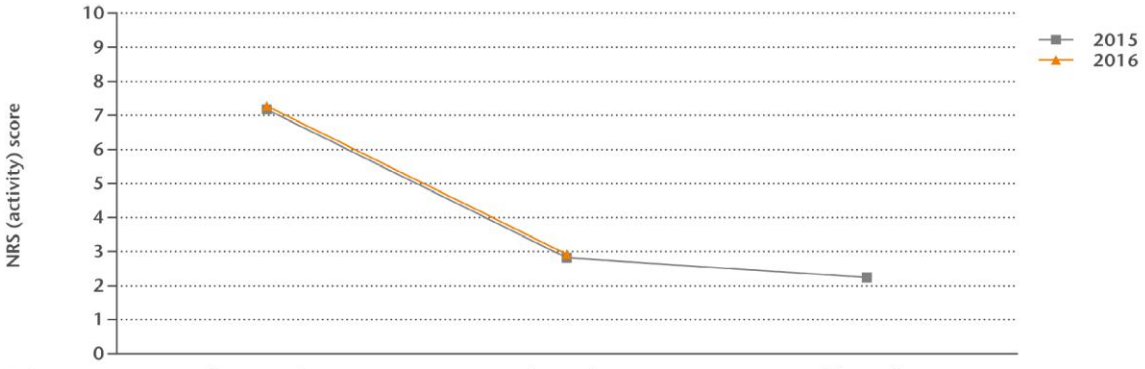
Please note: The 12 months NRS (rest) score was not available for 2016.
TKA: total knee arthroplasty.



**The NRS (rest) score measures pain during rest. The score has a range of 0.0 to 10.0, with 0.0 representing no pain and 10.0 representing the most possible pain.**

## NRS (activity)

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS NRS (ACTIVITY) SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| NRS (activity) score | Pre-operative (n=10,328) | 6 months (n=3,296) | 12 months (n=2,555) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 7.2 (7.1-7.2) | 2.8 (2.7-3.0) | 2.2 (2.1-2.3) |
| 2016 (95% CI) | 7.3 (7.2-7.3) | 2.9 (2.8-3.0) | n.a. |
| Total (95% CI) | 7.3 (7.2-7.3) | 2.9 (2.8-3.0) | 2.2 (2.1-2.3) |

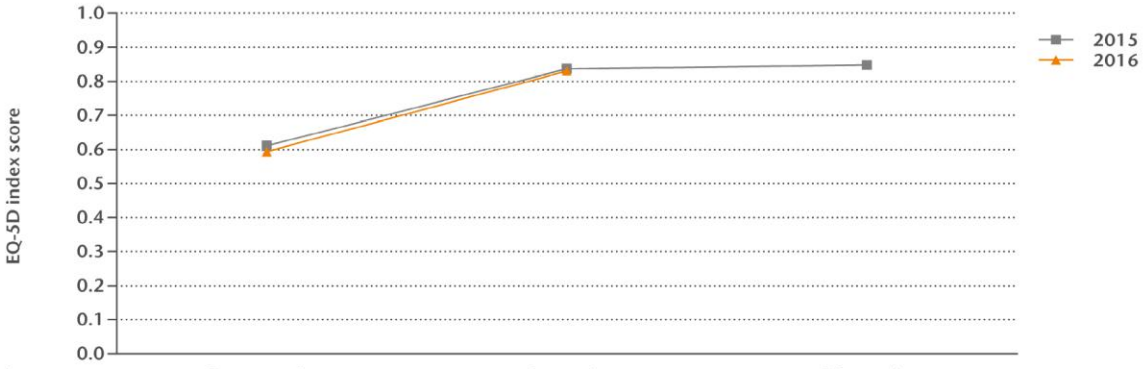
Please note: The 12 months NRS (activity) score was not available for 2016.
TKA: total knee arthroplasty.



**The NRS (activity) score measures pain during activity. The score has a range of 0.0 to 10.0, with 0.0 representing no pain and 10.0 representing the most possible pain.**

## EQ-5D index score

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS EQ-5D INDEX SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| EQ-5D index score | Pre-operative (n=12,363) | 6 months (n=4,226) | 12 months (n=3,852) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 0.61 (0.60-0.62) | 0.84 (0.83-0.85) | 0.85 (0.84-0.85) |
| 2016 (95% CI) | 0.59 (0.59-0.60) | 0.83 (0.82-0.84) | n.a. |
| Total (95% CI) | 0.60 (0.59-0.60) | 0.83 (0.83-0.84) | 0.85 (0.84-0.85) |

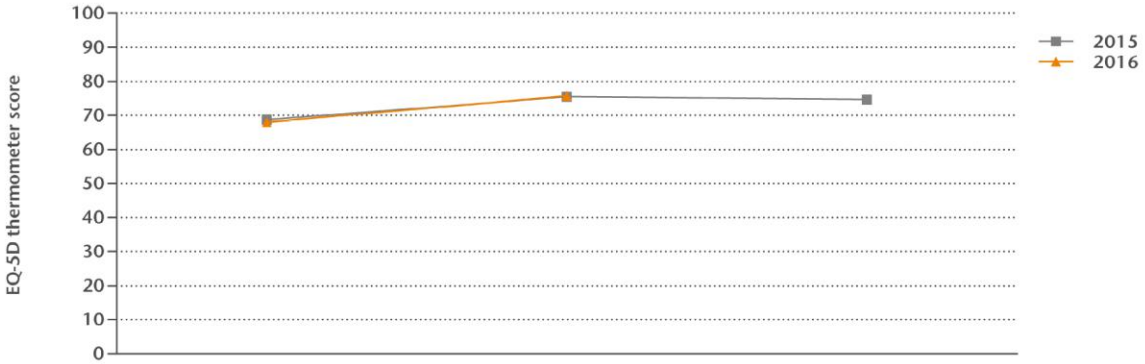
Please note: The 12 months EQ-5D index score was not available for 2016.
TKA: total knee arthroplasty.



**The EQ-5D index score measures quality of life. The score has a range of -0.329 to 1.0, with 1.0 representing the best possible quality of life.**

## EQ-5D thermometer

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS EQ-5D THERMOMETER SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| EQ-5D thermometer | Pre-operative (n=12,239) | 6 months (n=4,236) | 12 months (n=3,894) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 68.7 (68.1-69.3) | 75.4 (74.5-76.3) | 74.6 (74.0-75.3) |
| 2016 (95% CI) | 68.0 (67.6-68.3) | 75.6 (74.9-76.3) | n.a. |
| Total (95% CI) | 68.1 (67.8-68.5) | 75.5 (75.0-76.1) | 74.6 (74.0-75.3) |

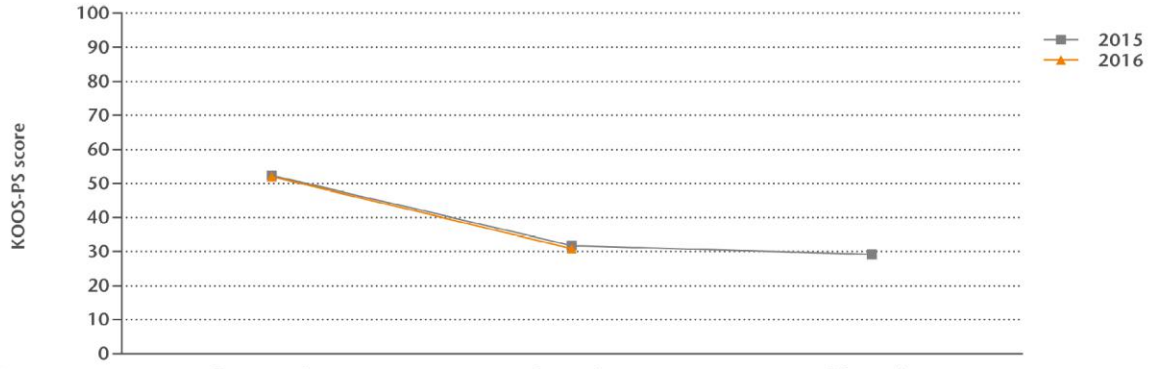
Please note: The 12 months EQ-5D thermometer score was not available for 2016.
TKA: total knee arthroplasty.



**The EQ-5D thermometer score measures the health situation. The score has a range of 0.0 to 100.0, with 0.0 representing the worst possible health situation and 100.0 the best possible health situation.**

## KOOS-PS score

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS KOOS-PS SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| KOOS-PS score | Pre-operative (n=12,067) | 6 months (n=4,162) | 12 months (n=3,702) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 52.4 (51.8-53.0) | 31.8 (31.0-32.6) | 29.2 (28.7-29.7) |
| 2016 (95% CI) | 52.0 (51.7-52.3) | 30.9 (30.4-31.5) | n.a. |
| Total (95% CI) | 52.1 (51.8-52.4) | 31.2 (30.8-31.7) | 29.2 (28.7-29.7) |

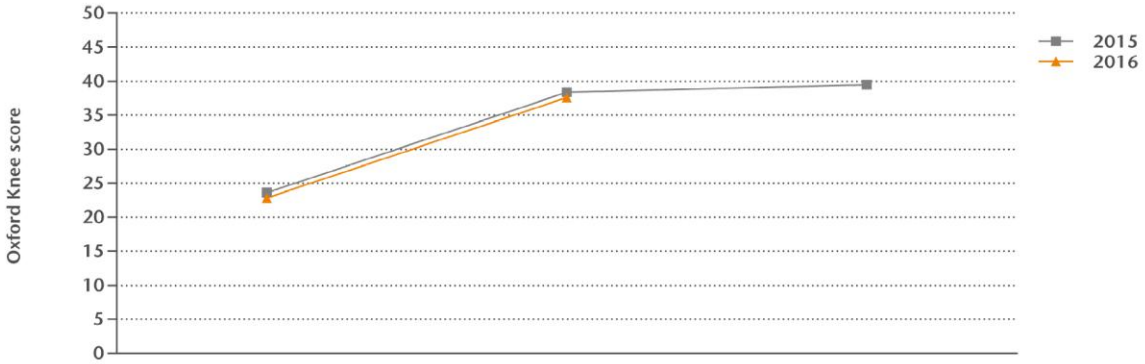
Please note: The 12 months KOOS-PS score was not available for 2016.
TKA: total knee arthroplasty.



**The KOOS-PS score measures the physical functioning of patients with osteoarthritis to the knee. The score has a range of 0.0 to 100.0, with 0.0 representing no effort and 100.0 the most possible effort.**

## Oxford Knee score

**FIGURE MEAN PRE-OPERATIVE, 6 MONTHS AND 12 MONTHS OXFORD KNEE SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS IN THE NETHERLANDS IN 2015-2016.**




| Oxford Knee score | Pre-operative (n=9,359) | 6 months (n=3,722) | 12 months (n=3,272) |
|---|---|---|---|
| **Year of TKA** | | | |
| 2015 (95% CI) | 23.6 (23.1-24.1) | 38.4 (37.9-38.8) | 39.5 (39.2-39.8) |
| 2016 (95% CI) | 22.9 (22.7-23.0) | 37.6 (37.2-37.9) | n.a. |
| Total (95% CI) | 23.0 (22.8-23.2) | 37.9 (37.6-38.1) | 39.5 (39.2-39.8) |

Please note: The 12 months Oxford Knee score was not available for 2016.
TKA: total knee arthroplasty.

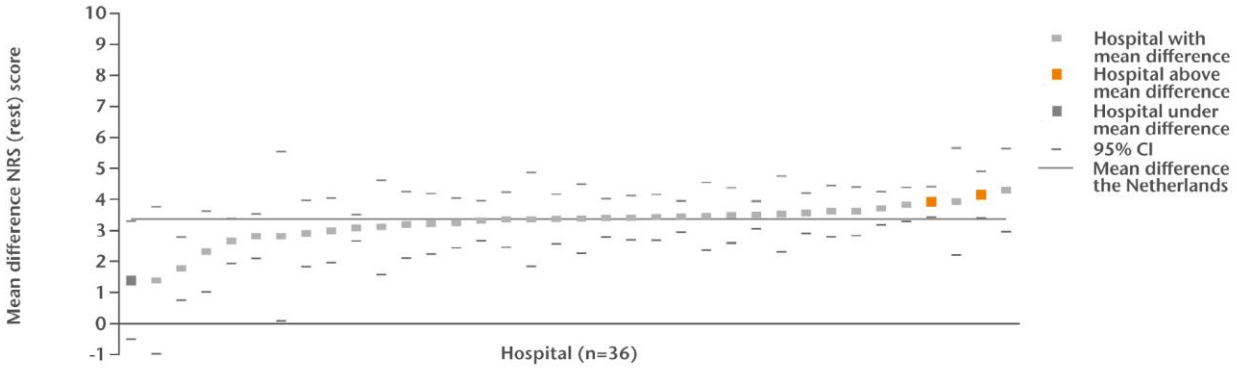


**The Oxford Knee score measures the physical functioning and pain of patients with osteoarthritis to the knee. The score has a range of 0.0 to 48.0, with 0.0 representing the most possible functional disability and 48.0 no functional disability.**

# Mean differences (preoperative and 6 months) per hospital

## NRS (rest)

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE NRS (REST) SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=1,938).**



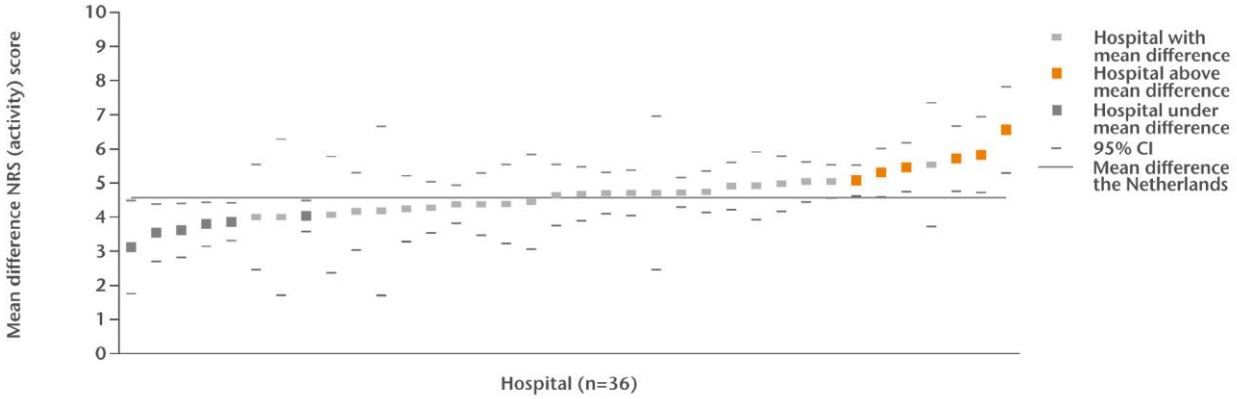

Please note: The 36 hospitals with a minimum of 10 PROMs (mean differences in NRS (rest) score) were included in this figure.
TKA: total knee arthroplasty.



**The mean difference between pre-operative and 6 months postoperative NRS (rest) scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 3.4 (95% CI: 3.2-3.5).**

## NRS (activity)

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE NRS (ACTIVITY) SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=1,940).**



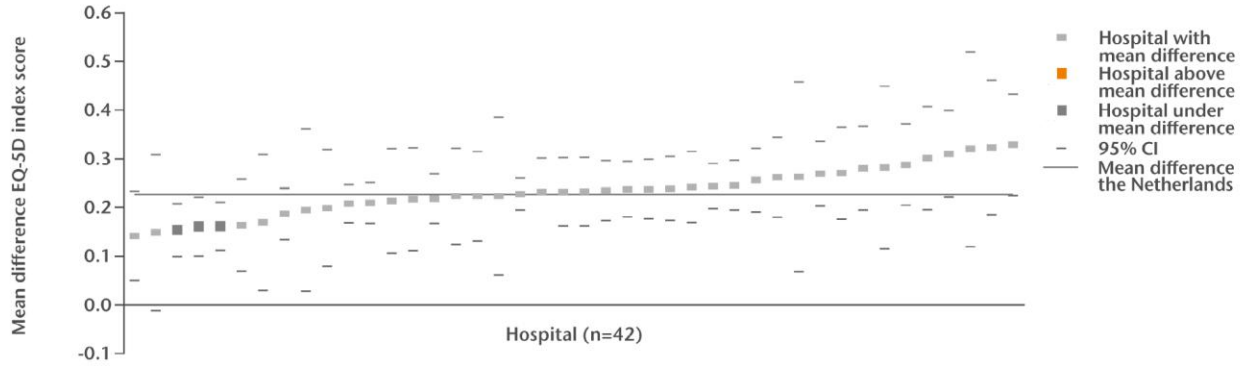

Please note: The 36 hospitals with a minimum of 10 PROMs (mean differences in NRS (activity) score) were included in this figure.
TKA: total knee arthroplasty.



**The mean difference between pre-operative and 6 months postoperative NRS (activity) scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 4.6 (95% CI: 4.4-4.7).**

## EQ-5D index score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE EQ-5D INDEX SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,394).**



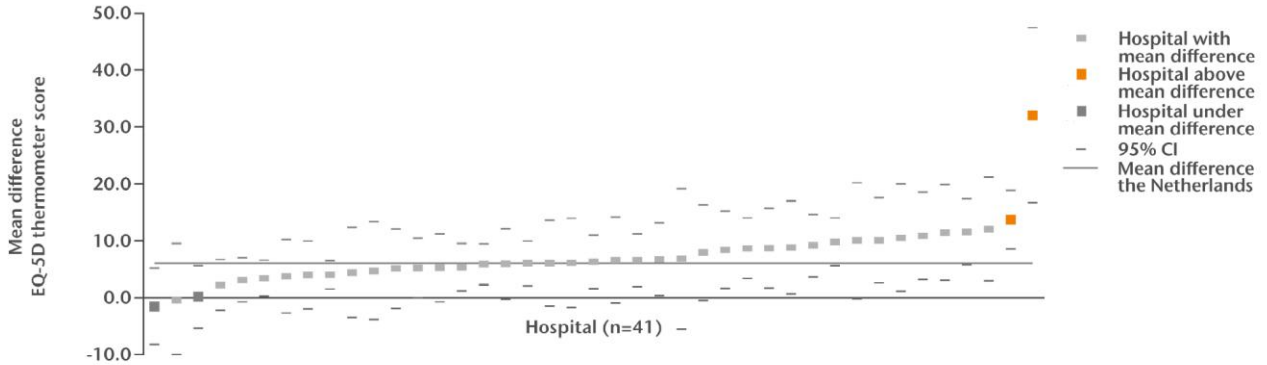

Please note: The 42 hospitals with a minimum of 10 PROMs (mean differences in EQ-5D index score) were included in this figure.
TKA: total knee arthroplasty.



**The mean difference between pre-operative and 6 months postoperative EQ-5D index scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 0.23 (95% CI: 0.22-0.24).**

## EQ-5D thermometer

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE EQ-5D THERMOMETER SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,385).**



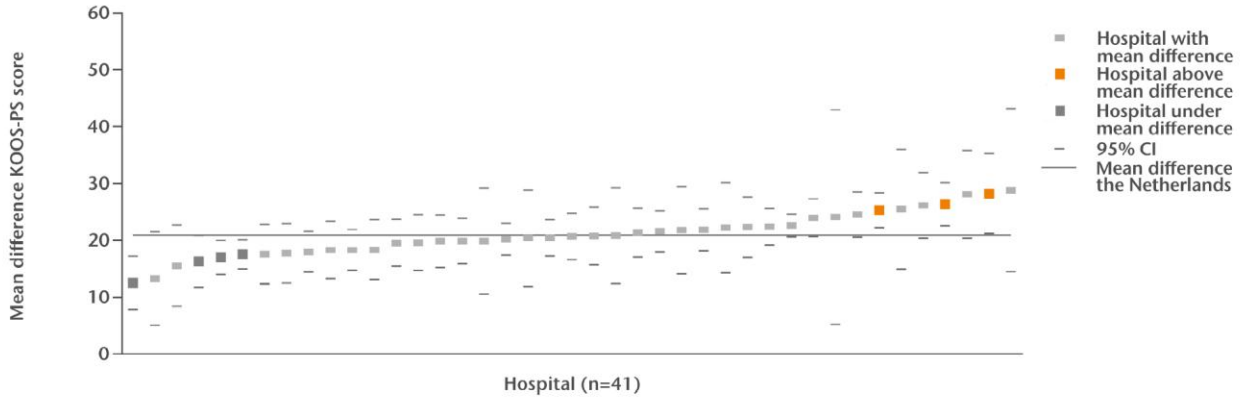

Please note: The 41 hospitals with a minimum of 10 PROMs (mean differences in EQ-5D thermometer score) were included in this figure.
TKA: total knee arthroplasty.



**The mean difference between pre-operative and 6 months postoperative EQ-5D thermometer scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 6.1 (95% CI: 5.2-7.0).**

## KOOS-PS score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE KOOS-PS SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,357).**



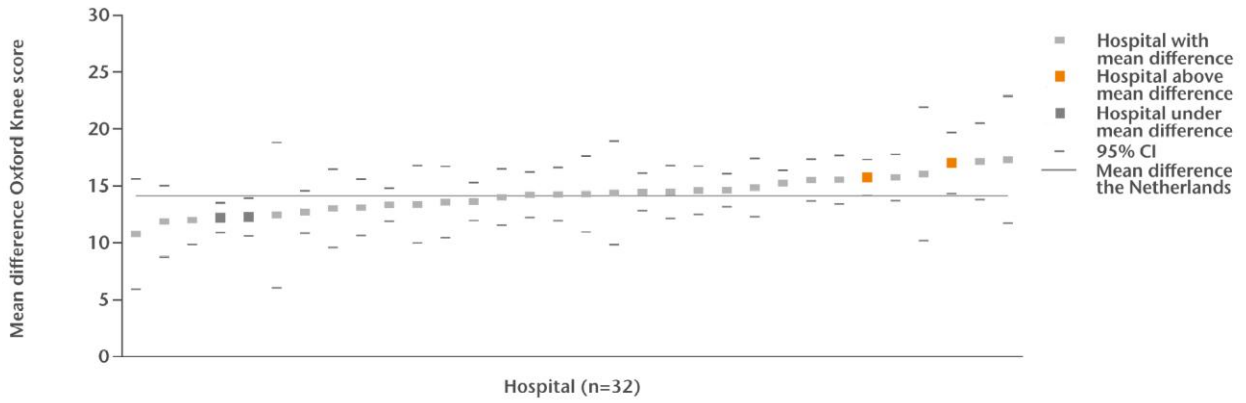

Please note: The 41 hospitals with a minimum of 10 PROMs (mean differences in KOOS-PS score) were included in this figure.
TKA: total knee arthroplasty.



**The mean difference between pre-operative and 6 months postoperative KOOS-PS scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 20.9 (95% CI: 20.2-21.6).**

## Oxford Knee score

**FIGURE MEAN DIFFERENCE BETWEEN PRE-OPERATIVE AND 6 MONTHS POSTOPERATIVE OXFORD KNEE SCORES OF PATIENTS WHO UNDERWENT A TKA FOR OSTEOARTHRITIS PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,072).**




Please note: The 32 hospitals with a minimum of 10 PROMs (mean differences in Oxford Knee score) were included in this figure.
TKA: total knee arthroplasty.



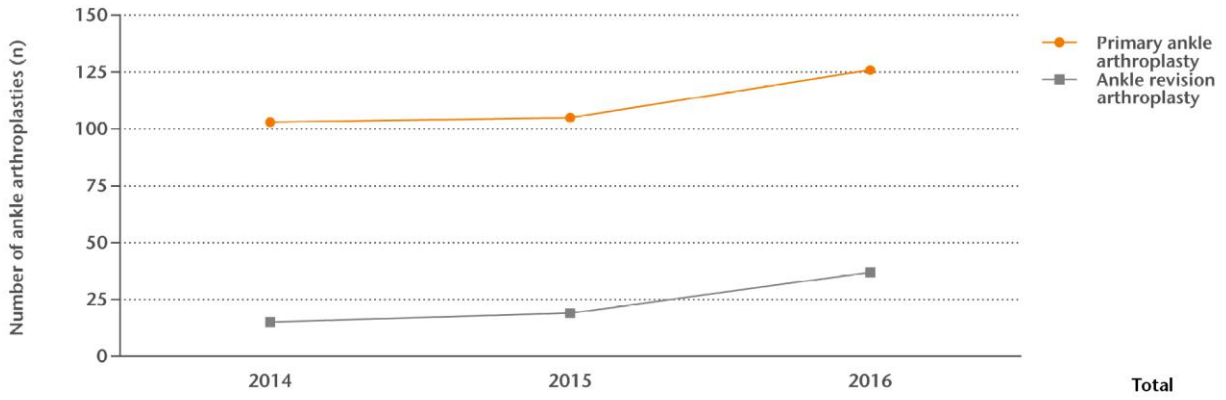
**The mean difference between pre-operative and 6 months postoperative Oxford Knee scores of patients who underwent a TKA for osteoarthritis in the Netherlands in 2016 was 14.1 (95% CI: 13.8-14.5).**

# Ankle arthroplasty

## Numbers

### Procedures 2014-2016

**FIGURE NUMBER OF PRIMARY ANKLE ARTHROPLASTIES AND ANKLE REVISION ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2014-2016.**



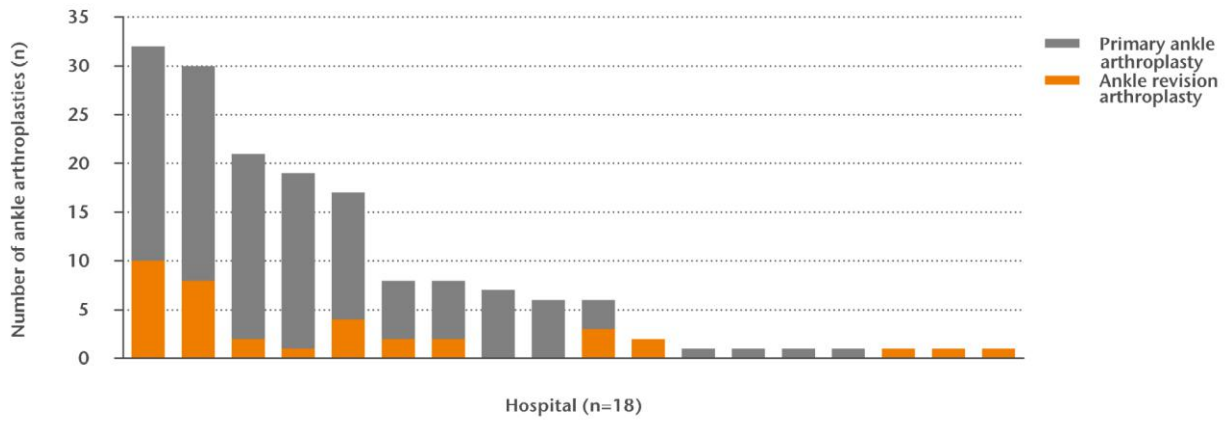

| Year | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|
| **Type of procedure** | | | | |
| Primary ankle arthroplasty (n) | 103 | 105 | 126 | 334 |
| Ankle revision arthroplasty (n) | 15 | 19 | 37 | 71 |
| Total (n) | 118 | 124 | 163 | 405 |



**One (0.8%) of the primary ankle arthroplasties that were performed in 2016 was performed bilaterally.**

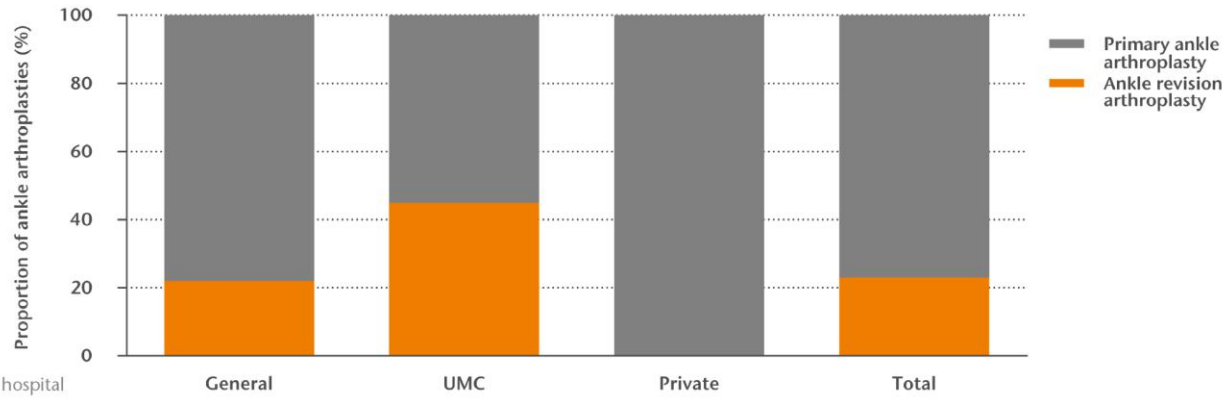
### Type of procedure per hospital

**FIGURE NUMBER OF PRIMARY ANKLE ARTHROPLASTIES AND ANKLE REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=163).**



## Type of procedure by type of hospital

**FIGURE PRIMARY ANKLE ARTHROPLASTIES AND ANKLE REVISION ARTHROPLASTIES (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**




| Type of procedure | General | UMC | Private | Total |
|---|---|---|---|---|
| Primary ankle arthroplasty (%) | 77.8 | 54.5 | 100.0 | 77.3 |
| Ankle revision arthroplasty (%) | 22.2 | 45.5 | 0.0 | 22.7 |
| Total (n) | 144 | 11 | 8 | 163 |

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

# Primary ankle arthroplasty

## Demographics

### Patient characteristics by diagnosis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY ANKLE ARTHROPLASTY BY DIAGNOSIS IN THE NETHERLANDS IN 2016.**

| | Osteoarthritis (n=95) | No osteoarthritis[1] (n=29) | Total[2] (n=125) |
|---|---|---|---|
| Completeness (%) | | | 92 |
| Mean age (years) (SD) | 66.2 (8.2) | 61.0 (8.4) | 65.0 (8.5) |
| Age (years) (%) | | | |
| <50 | 1 | 7 | 3 |
| 50-59 | 23 | 38 | 26 |
| 60-69 | 43 | 38 | 42 |
| 70-79 | 27 | 17 | 24 |
| ≥80 | 6 | 0 | 5 |
| Gender (%) | | | |
| Men | 66 | 24 | 56 |
| Women | 34 | 76 | 44 |
| ASA score (%) | | | |
| I | 24 | 10 | 21 |
| II | 67 | 86 | 72 |
| III-IV | 9 | 4 | 7 |
| Type of hospital[3] (%) | | | |
| General | 93 | 83 | 89 |
| UMC | 5 | 3 | 5 |
| Private | 2 | 14 | 6 |
| Body Mass Index (kg/m²) (%) | | | |
| Underweight (≤18.5) | 0 | 0 | 0 |
| Normal weight (>18.5-25) | 17 | 18 | 17 |
| Overweight (>25-30) | 54 | 39 | 51 |
| Obesity (>30-40) | 29 | 39 | 31 |
| Morbid obesity (>40) | 0 | 4 | 1 |
| Charnley score (%) | | | |
| A One ankle joint affected | 76 | 73 | 75 |
| B1 Both ankle joints affected | 15 | 9 | 14 |
| B2 Contralateral ankle joint with an ankle prosthesis | 4 | 9 | 5 |
| C Multiple joints affected or chronic disease that affects quality of life | 5 | 9 | 6 |
| Smoking (%) | | | |
| No | 91 | 100 | 93 |
| Yes | 9 | 0 | 7 |

[1] Another diagnosis than osteoarthritis registered as primary diagnosis, specifically post-traumatic (13%), rheumatoid arthritis (7%) or other primary diagnosis (3%).
[2] The primary diagnosis of 1 (1%) patient was not registered.
[3] In 2016, 11 general hospitals, 1 UMC and 2 ZBCs performed primary ankle arthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.

## Previous surgery

**TABLE PREVIOUS SURGERIES TO THE SAME JOINT IN PATIENTS WHO UNDERWENT A PRIMARY ANKLE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=125).**

| | Proportion[1] (%) |
|---|---|
| Previous surgery to the relevant ankle (total) | 31.2 |
| Osteosynthesis | 13.6 |
| Arthroscopy | 11.2 |
| Hindfoot surgery | 6.4 |
| Arthrodesis | 4.0 |
| Forefoot surgery | 2.4 |
| Osteotomy | 2.4 |
| Ligament reconstruction | 1.6 |
| Treatment of osteochondral bone defect | 1.6 |
| Synovectomy | 1.6 |
| Other | 4.8 |

[1] A patient may have undergone multiple previous surgeries to the same joint. As such, the total proportion is more than the total proportion of patients with one or more previous surgeries to the same joint.

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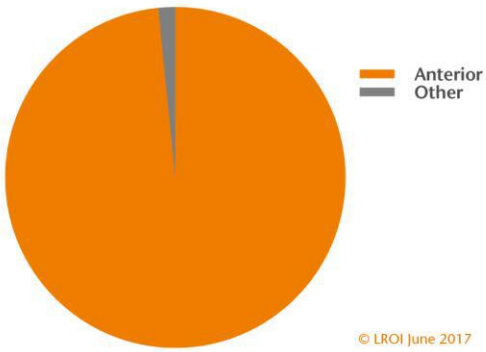
# Surgery

## Surgical approach

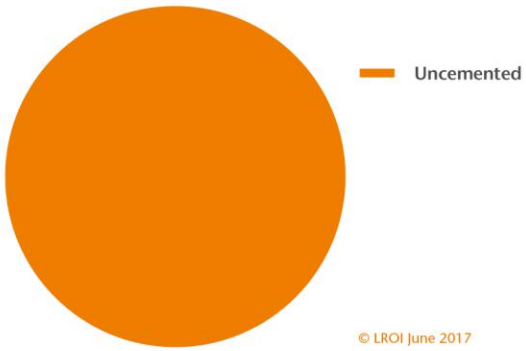
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY ANKLE ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=124).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Anterior | 122 | 98.4 |
| Other | 2 | 1.6 |

## Fixation

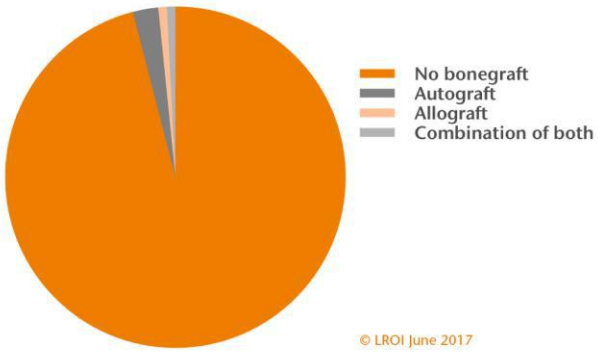
**FIGURE TYPE OF FIXATION IN PRIMARY ANKLE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=124).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Uncemented | 124 | 100.0 |

## Type of bonegraft

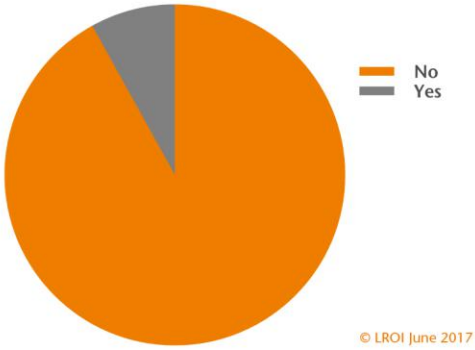
**FIGURE TYPE OF BONEGRAFT IN PRIMARY ANKLE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=124).**




| Type of bonegraft | Number (n) | Proportion (%) |
|---|---|---|
| No bonegraft | 119 | 96.0 |
| Autograft | 3 | 2.4 |
| Allograft | 1 | 0.8 |
| Combination of both | 1 | 0.8 |

## Medial malleolus osteotomy

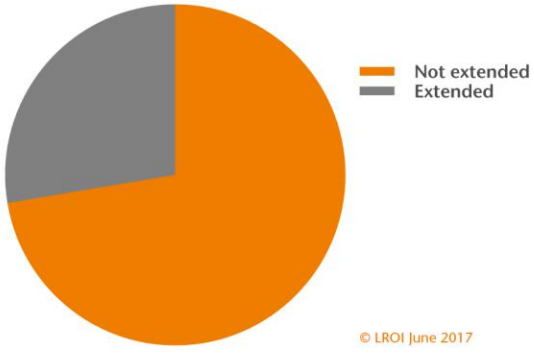
**FIGURE MEDIAL MALLEOLUS OSTEOTOMY IN PRIMARY ANKLE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=124).**




| Medial malleolus osteotomy | Number (n) | Proportion (%) |
|---|---|---|
| No | 114 | 91.9 |
| Yes | 10 | 8.1 |

## Extension heel cord

**FIGURE EXTENSION HEEL CORD IN PRIMARY ANKLE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=123).**




| Extension heel cord | Number (n) | Proportion (%) |
|---|---|---|
| Not extended | 89 | 72.4 |
| Extended | 34 | 27.6 |

## Most frequently registered ankle prostheses

**TABLE THE SIX REGISTERED PRIMARY TOTAL ANKLE ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=124).**

| Name | Proportion (%) |
|---|---|
| Salto | 45.2 |
| AAA OSG | 17.7 |
| CCI | 9.7 |
| Box | 4.8 |
| Mobility | 1.6 |
| Hintegra Regular | 0.8 |

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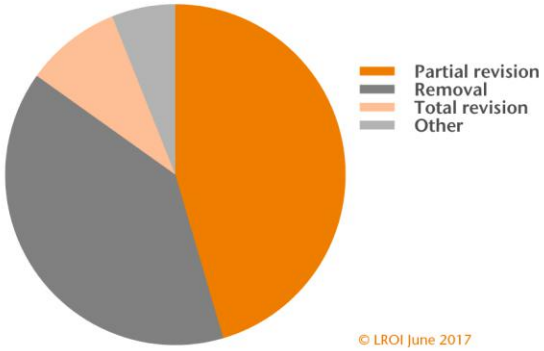
**In one primary ankle arthroplasty, the type of prosthesis was registered as 'other'. The type of prosthesis of one patient was not registered.**

# Ankle revision arthroplasty

## Type of revision

**FIGURE TYPE OF REVISION ARTHROPLASTY OF ANKLE REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=33).**

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| Type of revision | Number (n) | Proportion (%) |
|---|---|---|
| Partial revision | 15 | 45.4 |
| Removal | 13 | 39.4 |
| Total revision | 3 | 9.1 |
| Other | 2 | 6.1 |

**In partial ankle revision arthroplasties, the inlay was always revised. In two (13%) partial ankle revision arthroplasties, the talus component was revised. The tibia component was never revised.**

## Reasons for revision

**TABLE REASONS FOR REVISION OR RE-SURGERY IN PATIENTS WHO UNDERWENT AN ANKLE REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=37).**

| Reasons for revision | Proportion[1] (%) |
|---|---|
| Inlay wear | 35.1 |
| Loosening of talus component | 29.7 |
| Loosening of tibia component | 18.9 |
| Infection | 13.5 |
| Malalignment | 8.1 |
| Instability | 8.1 |
| Arthrofibrosis | 5.4 |
| Dislocation | 5.4 |
| Peri-prosthetic fracture | 0.0 |
| Other | 5.4 |

[1]A patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

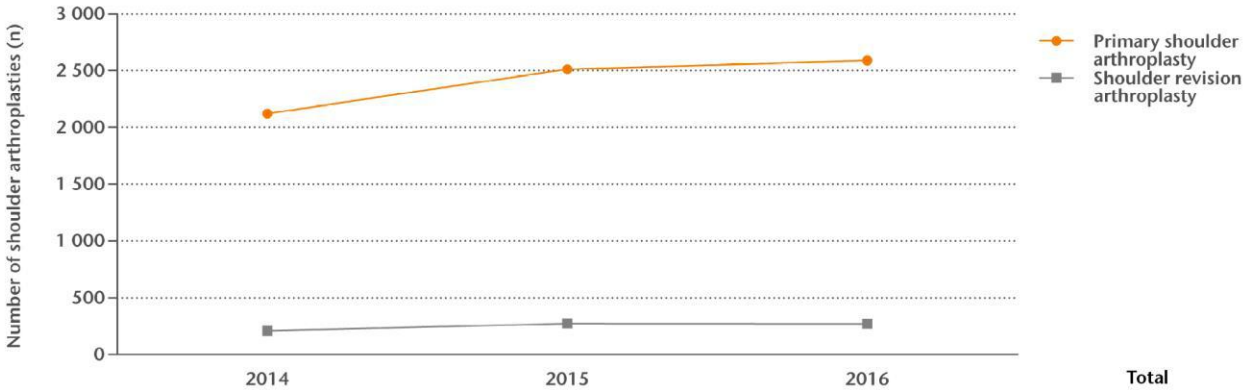


# Shoulder arthroplasty

## Numbers

### Procedures 2014-2016

**FIGURE NUMBER OF PRIMARY SHOULDER ARTHROPLASTIES AND SHOULDER REVISION ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2014-2016.**



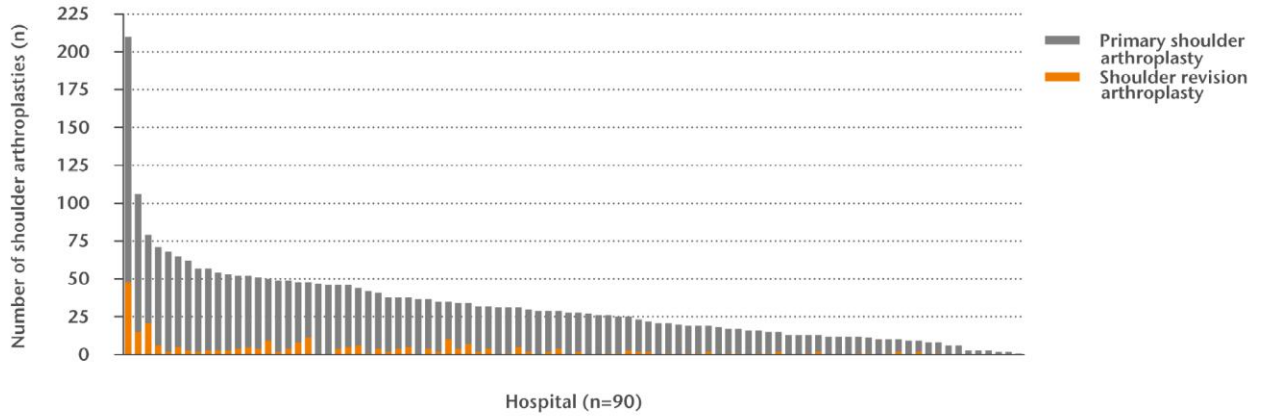

| Year | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|
| **Type of procedure** | | | | |
| Primary shoulder arthroplasty (n) | 2,120 | 2,511 | 2,588 | 7,219 |
| Shoulder revision arthroplasty (n) | 208 | 272 | 269 | 749 |
| Total (n) | 2,328 | 2,783 | 2,857 | 7,968 |



**Out of 2,588 primary shoulder arthroplasties that were performed in 2016, 2% (n=46) was performed bilaterally.**

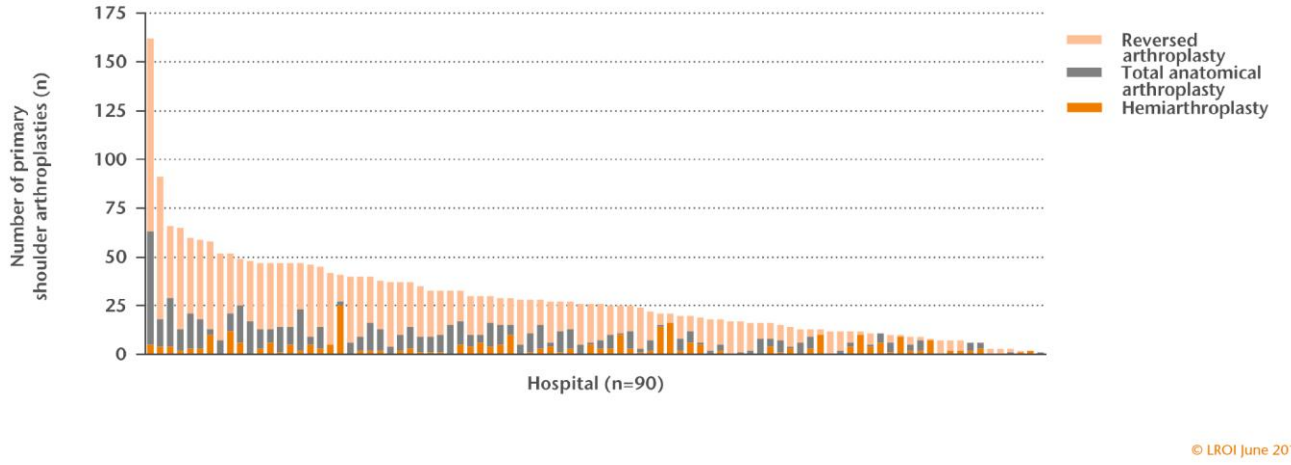
## Type of procedure per hospital

**FIGURE NUMBER OF PRIMARY SHOULDER ARTHROPLASTIES AND SHOULDER REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,857).**



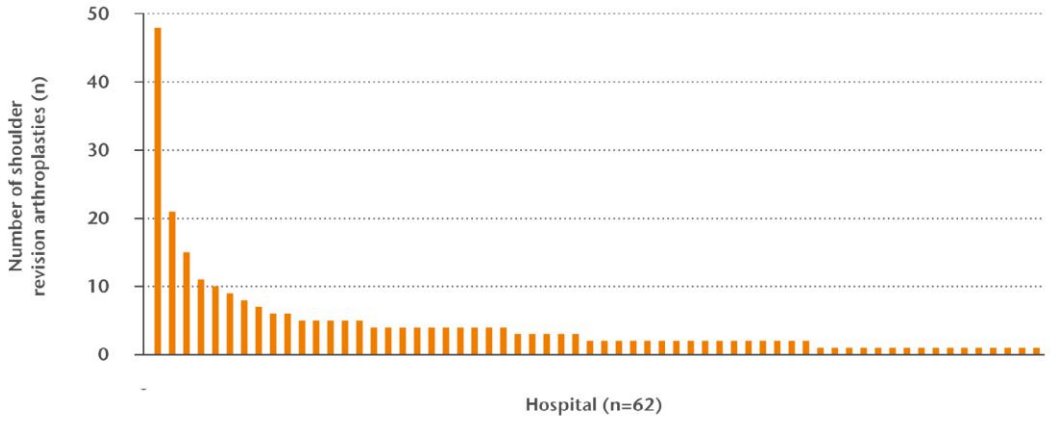

## Type of primary shoulder prosthesis per hospital

**FIGURE NUMBER OF PRIMARY SHOULDER ARTHROPLASTIES BY TYPE OF ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=2,569).**



## Revisions per hospital

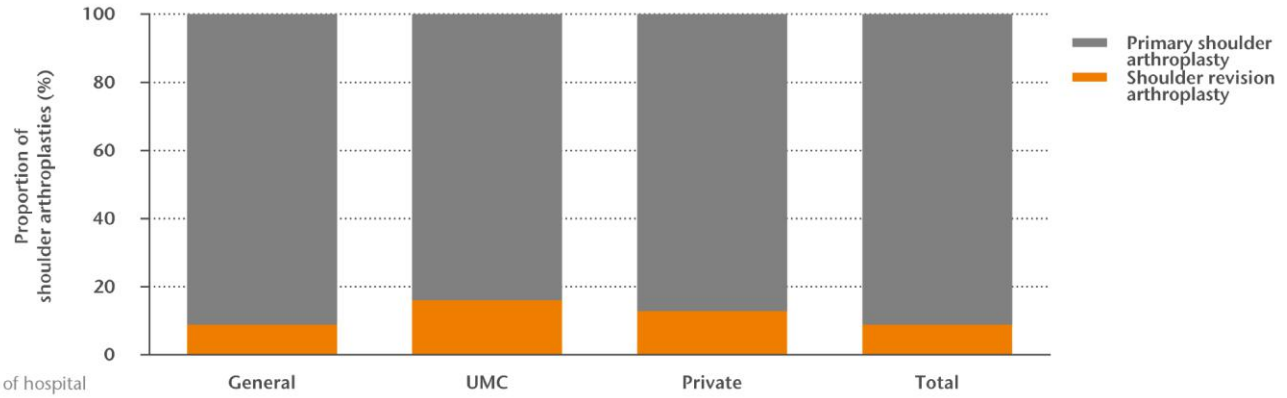
**FIGURE NUMBER OF SHOULDER REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=269).**






## Type of procedure by type of hospital

**FIGURE PRIMARY SHOULDER ARTHROPLASTIES AND SHOULDER REVISION ARTHROPLASTIES (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**

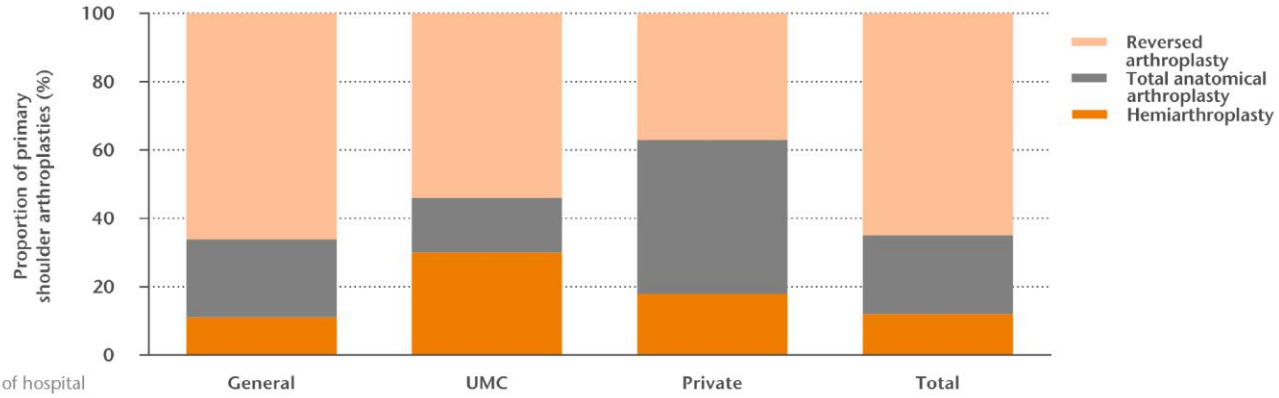



| Type of procedure | General | UMC | Private | Total |
|---|---|---|---|---|
| Primary shoulder arthroplasty (%) | 91.0 | 84.5 | 87.0 | 90.6 |
| Shoulder revision arthroplasty (%) | 9.0 | 15.5 | 13.0 | 9.4 |
| Total (n) | 2,641 | 116 | 100 | 2,857 |

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

## Type of primary shoulder prosthesis by type of hospital

**FIGURE TYPE OF PRIMARY SHOULDER ARTHROPLASTY (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**

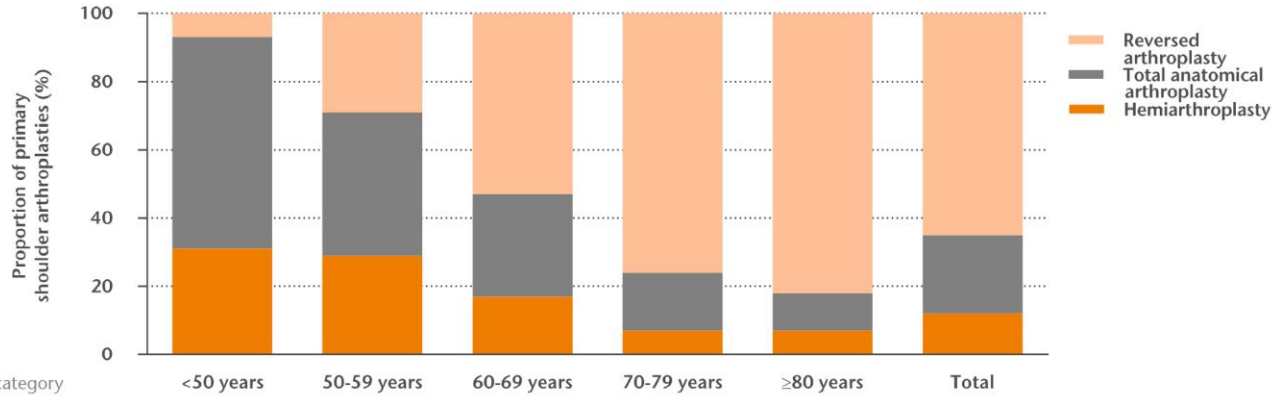



| Type of primary shoulder arthroplasty | General | UMC | Private | Total |
|---|---|---|---|---|
| Reversed shoulder arthroplasty (%) | 66.2 | 54.1 | 36.8 | 64.7 |
| Total anatomical shoulder arthroplasty (%) | 22.5 | 16.3 | 44.8 | 23.1 |
| Shoulder hemiarthroplasty (%) | 11.3 | 29.6 | 18.4 | 12.2 |
| Total (n) | 2,384 | 98 | 87 | 2,569 |

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

## Type of primary shoulder prosthesis by age category

**FIGURE** TYPE OF PRIMARY SHOULDER ARTHROPLASTY (PROPORTION [%] PER CATEGORY) BY AGE CATEGORY IN PATIENTS WITH A PRIMARY SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2016.




| Type of primary shoulder arthroplasty | <50 years | 50-59 years | 60-69 years | 70-79 years | ≥80 years | Total |
|---|---|---|---|---|---|---|
| Reversed arthroplasty (%) | 11.1 | 23.0 | 52.0 | 76.8 | 81.6 | 63.2 |
| Total anatomical arthroplasty (%) | 36.7 | 42.5 | 31.3 | 12.1 | 6.9 | 20.4 |
| Hemiarthroplasty (%) | 52.2 | 34.5 | 16.7 | 11.1 | 11.5 | 16.4 |
| Total (n) | 90 | 235 | 690 | 1,060 | 408 | 2,483 |

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

# Primary shoulder arthroplasty

## Demographics

### Patient characteristics by type of shoulder prosthesis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY SHOULDER ARTHROPLASTY BY TYPE OF PRIMARY SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2016.**

| | Reversed shoulder arthroplasty (n=1,638) | Total anatomical shoulder arthroplasty (n=576) | Shoulder hemiarthroplasty (n=310) | Total[1] (n=2,542) |
|---|---|---|---|---|
| Completeness (%) | | | | 94 |
| Mean age (years) (SD) | 73.8 (7.6) | 66.1 (10.7) | 65.4 (11.1) | 71.0 (9.6) |
| Age (years) (%) | | | | |
| <50 | 0 | 8 | 7 | 3 |
| 50-59 | 4 | 15 | 20 | 8 |
| 60-69 | 23 | 37 | 38 | 28 |
| 70-79 | 50 | 32 | 24 | 43 |
| ≥80 | 23 | 8 | 11 | 18 |
| Gender (%) | | | | |
| Men | 22 | 27 | 32 | 24 |
| Women | 78 | 73 | 68 | 76 |
| ASA score (%) | | | | |
| I | 5 | 14 | 11 | 8 |
| II | 62 | 69 | 62 | 64 |
| III-IV | 33 | 17 | 27 | 28 |
| Type of hospital[2] (%) | | | | |
| General | 95 | 91 | 86 | 93 |
| UMC | 3 | 3 | 9 | 4 |
| Private | 2 | 6 | 5 | 3 |
| Diagnosis (%) | | | | |
| Osteoarthrosis | 28 | 82 | 43 | 42 |
| Cuff arthropathy | 34 | 2 | 1 | 23 |
| Fracture | 15 | 3 | 31 | 14 |
| Post-traumatic | 11 | 4 | 9 | 10 |
| Osteonecrosis | 3 | 4 | 10 | 4 |
| Rheumatoid arthritis | 2 | 4 | 3 | 3 |
| Cuff rupture | 4 | 0 | 0 | 2 |
| Other | 3 | 1 | 4 | 2 |
| Walch score (%) | | | | |
| A1 Humeral head centered, minor erosion glenoid | 57 | 46 | 74 | 56 |
| A2 Humeral head centered, major erosion glenoid | 23 | 27 | 12 | 23 |
| B1 Humeral head subluxed posteriorly, posterior joint space narrow, subchondrial sclerosis and osteophytes | 11 | 18 | 8 | 13 |
| B2 Humeral head subluxed posteriorly retroverted, glenoid with posterior rim erosion | 6 | 7 | 2 | 6 |
| B3 Humeral head subluxed posteriorly more than 70 percent and glenoid retroversion more than 10 degrees | 2 | 1 | 2 | 1 |
| C Glenoid retroversion more than 25 degrees regardless of erosion | 1 | 1 | 2 | 1 |
| Body Mass Index (kg/m²) (%) | | | | |
| Underweight (≤18.5) | 1 | 1 | 0 | 1 |
| Normal weight (>18,5-25) | 29 | 29 | 23 | 27 |
| Overweight (>25-30) | 37 | 39 | 41 | 39 |
| Obesity (>30-40) | 27 | 28 | 33 | 29 |
| Morbid obesity (>40) | 6 | 3 | 3 | 4 |
| Smoking (%) | | | | |
| No | 89 | 87 | 81 | 87 |
| Yes | 11 | 13 | 19 | 13 |

[1] Also contains 18 (0.7%) primary shoulder arthroplasties of which the type of prosthesis had not been registered.
[2] In 2016, 75 general hospitals, 6 UMCs and 9 private hospitals performed shoulder arthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.



**The number of registered shoulder hemiarthroplasties in the LROI is not complete, since these procedures are also performed by trauma surgeons. For 2016, only shoulder hemiarthroplasties that were carried out by orthopaedic surgeons were registered in the LROI.**

## Previous surgery by type of shoulder prosthesis

**TABLE PREVIOUS SURGERIES TO THE SAME JOINT IN PATIENTS WHO UNDERWENT A PRIMARY SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2016.**

| | Reversed shoulder arthroplasty (n=1,638) Proportion[1] (%) | Total anatomical shoulder arthroplasty (n=576) Proportion[1] (%) | Shoulder hemiarthroplasty (n=310) Proportion[1] (%) |
|---|---|---|---|
| Previous surgery to the relevant shoulder (total) | 17.3 | 15.5 | 11.9 |
| Acromioplasty | 7.1 | 5.9 | 3.2 |
| Osteosynthesis | 5.3 | 3.3 | 6.1 |
| Rotator cuff repair | 9.0 | 1.6 | 1.0 |
| Stabilisation procedure | 0.9 | 2.8 | 2.3 |
| Distal clavicle resection | 1.6 | 2.3 | 1.3 |
| Other | 2.9 | 4.3 | 1.6 |

[1] A patient may have undergone multiple previous surgeries to the same joint. As such, the total proportion is more than the total proportion of patients with one or more previous surgeries to the same joint.

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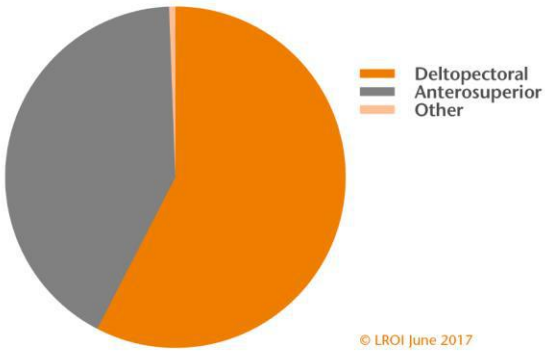
## Reversed shoulder arthroplasty

### Surgical techniques

### Surgical approach

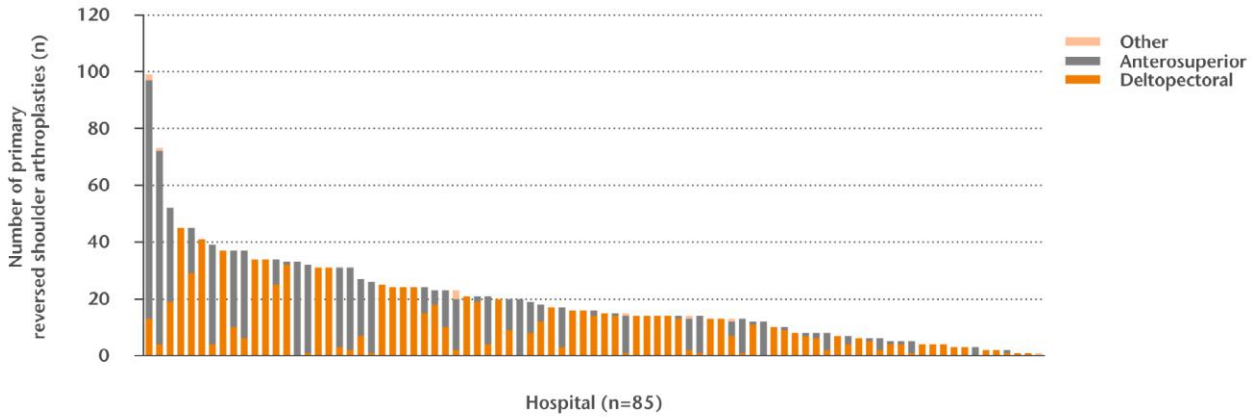
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY REVERSED SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=1,662).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Deltopectoral | 957 | 57.6 |
| Anterosuperior | 695 | 41.8 |
| Other | 10 | 0.6 |

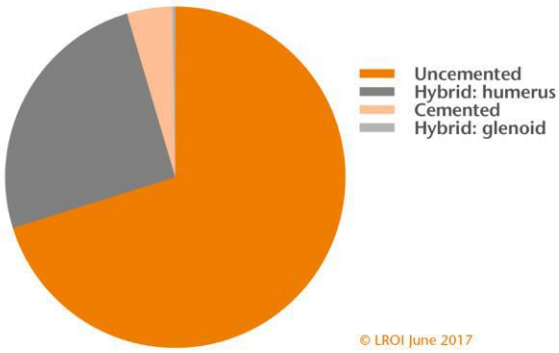
## Surgical approach per hospital

**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY REVERSED SHOULDER ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=1,662).**




## Fixation

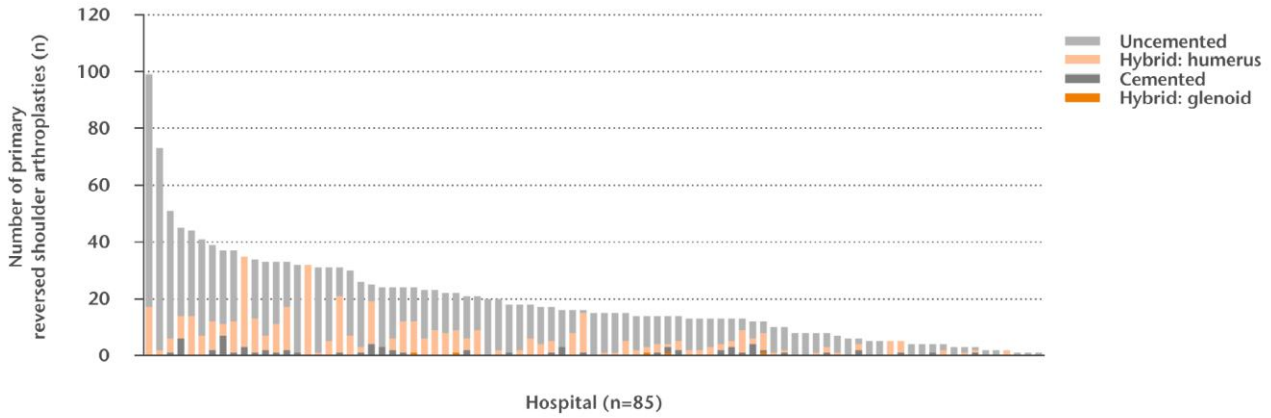
**FIGURE TYPE OF FIXATION IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,633).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Uncemented | 1,146 | 70.2 |
| Hybrid: humerus | 412 | 25.2 |
| Cemented | 70 | 4.3 |
| Hybrid: glenoid | 5 | 0.3 |

## Fixation per hospital

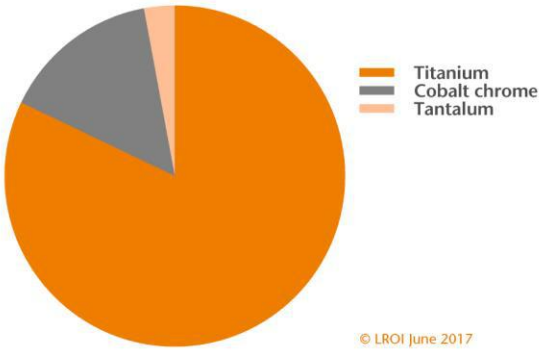
**FIGURE TYPE OF FIXATION IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=1,633).**




## Materials

## Humeral stem component

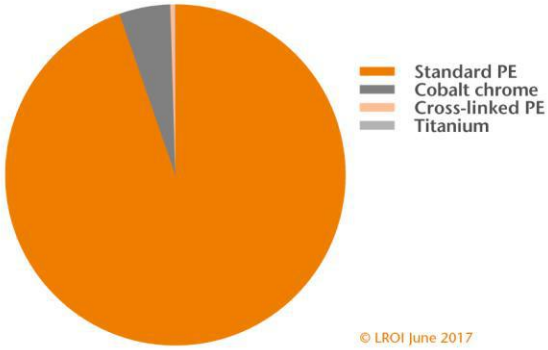
**FIGURE HUMERAL STEM MATERIAL IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,441).**




| Humeral stem material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 1,183 | 82.1 |
| Cobalt chrome | 216 | 15.0 |
| Tantalum | 42 | 2.9 |

## Humeral liner

**FIGURE HUMERAL LINER MATERIAL IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,424).**

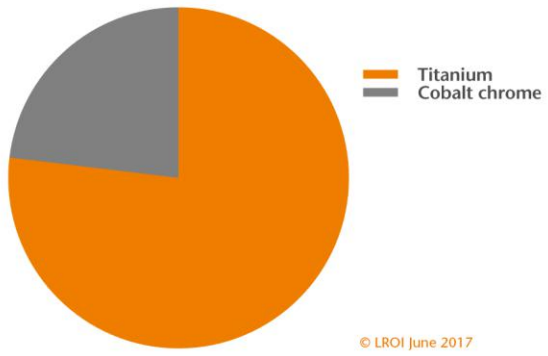



| Humeral liner material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 1,348 | 94.6 |
| Cobalt chrome | 61 | 4.3 |
| Cross-linked PE | 14 | 1.0 |
| Titanium | 1 | 0.1 |

PE: polyethylene.

## Metaphysis component

**FIGURE METAPHYSIS MATERIAL IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=1,078).**

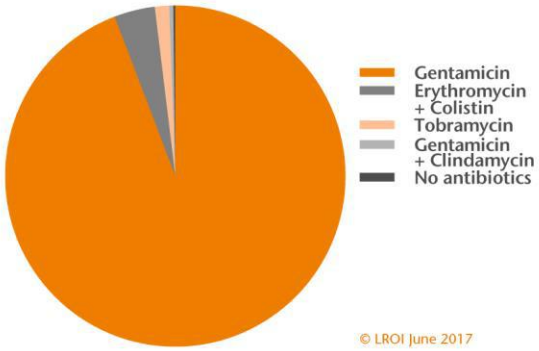



| Metaphysis material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 829 | 76.9 |
| Cobalt chrome | 249 | 23.1 |

## Bone cement

### Antibiotics

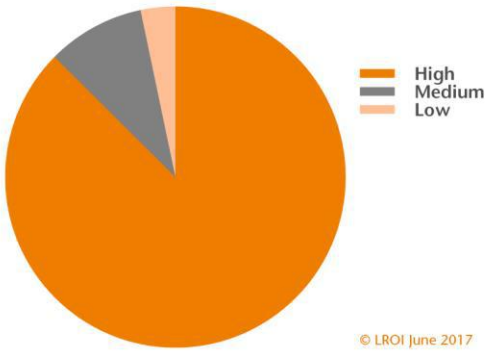
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=429).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 399 | 93.0 |
| Erythromycin + Colistin | 20 | 4.7 |
| Tobramycin | 7 | 1.6 |
| Gentamicin + Clindamycin | 2 | 0.5 |
| No antibiotics | 1 | 0.2 |

### Viscosity

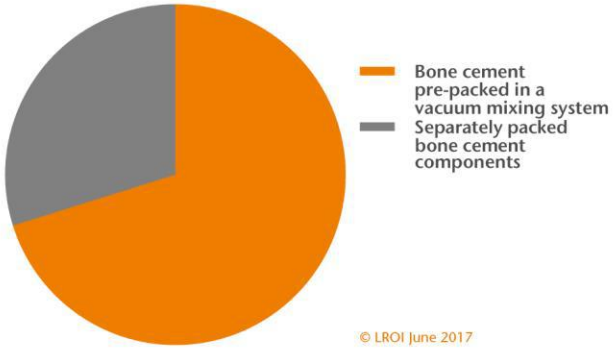
**FIGURE BONE CEMENT VISCOSITY IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=429).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 364 | 84.8 |
| Medium | 48 | 11.2 |
| Low | 17 | 4.0 |

## Vacuum mixing system

**FIGURE BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=429).**




| Vacuum mixing system | Number (n) | Proportion (%) |
|---|---|---|
| Bone cement pre-packed in a vacuum mixing system | 301 | 70.2 |
| Separately packed bone cement components | 128 | 29.8 |

## Most frequently registered components

**TABLE THE FIVE MOST FREQUENTLY REGISTERED HUMERAL STEMS, HUMERAL LINERS, GLENOSPHERES, METAPHYSES AND GLENOID BASEPLATES IN PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Humeral stem (n=1,595)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 32.3 |
| Aequalis Reversed | 15.6 |
| Comprehensive | 9.7 |
| Aequalis Ascend Flex | 8.9 |
| Aequalis Reversed Fracture | 7.3 |

Humeral liner (n=1,553)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 32.1 |
| Aequalis Reversed | 16.1 |
| Comprehensive | 9.2 |
| Aequalis Ascend Flex | 9.1 |
| Aequalis Reversed Fracture | 6.4 |

Glenosphere (n=1,595)

| Name | Proportion (%) |
|---|---|
| Aequalis Reversed | 32.5 |
| Delta X-tend | 31.5 |
| Comprehensive | 9.3 |
| TM Reverse Glenoid Heads | 5.5 |
| Equinoxe | 4.3 |

Metaphysis (n=1,217)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 29.3 |
| Aequalis Reversed | 20.3 |
| Aequalis Ascend Flex | 11.3 |
| Comprehensive | 10.8 |
| Equinoxe | 6.3 |

Glenoid baseplate (n=1,560)

| Name | Proportion (%) |
|---|---|
| Aequalis Reversed | 32.0 |
| Delta X-tend | 30.9 |
| Comprehensive | 9.6 |
| Trabecular Metal Baseplate | 5.3 |
| Equinoxe | 4.4 |



## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING PRIMARY REVERSED SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Separately packed bone cement components (n=128)

| Name | Proportion (%) |
|---|---|
| Palacos MV+G | 16.4 |
| Simplex ABC EC | 15.6 |
| Refobacin Bone Cement R | 14.1 |
| Cemex | 14.1 |
| Palacos LV+G | 13.3 |

Bone cement pre-packed in a vacuum mixing system (n=301)

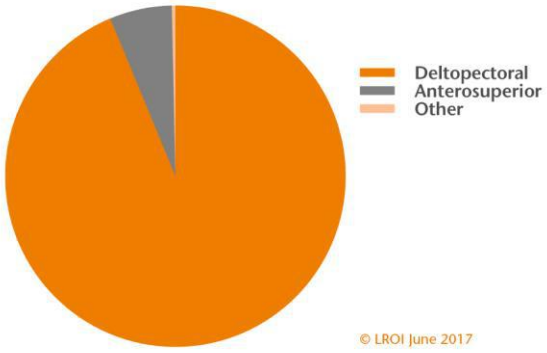
| Name | Proportion (%) |
|---|---|
| Palacos R+G | 58.8 |
| Palacos PRO | 16.3 |
| Refobacin Bone Cement R | 15.6 |
| Optipac | 9.0 |
| Refobacin Revision | 0.3 |

# Total anatomical shoulder arthroplasty

## Surgical techniques

## Surgical approach

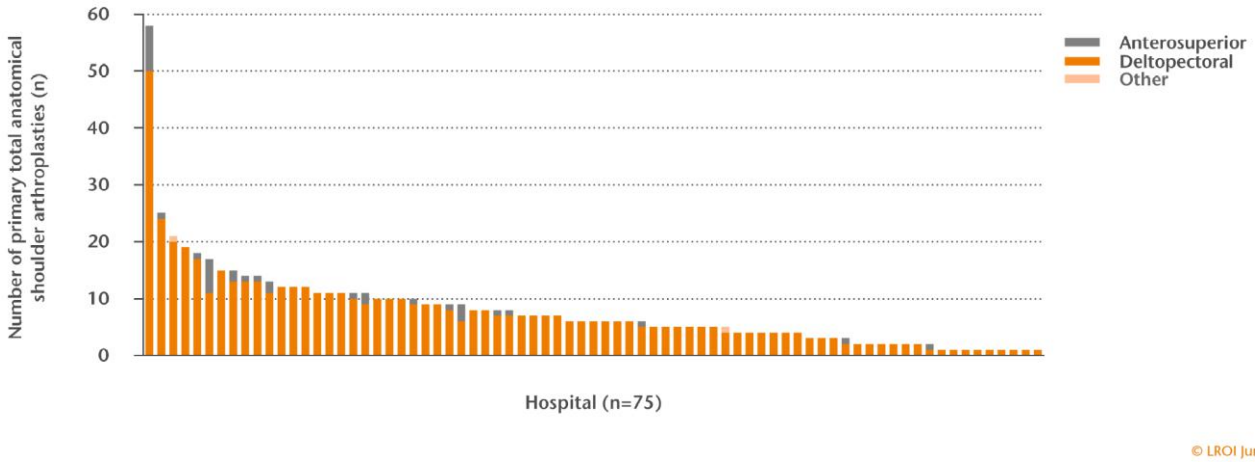
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=592).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Deltopectoral | 555 | 93.8 |
| Anterosuperior | 35 | 5.9 |
| Other | 2 | 0.3 |

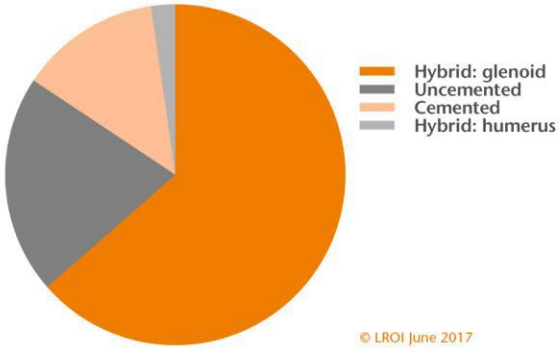
## Surgical approach per hospital

**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=592).**



## Fixation

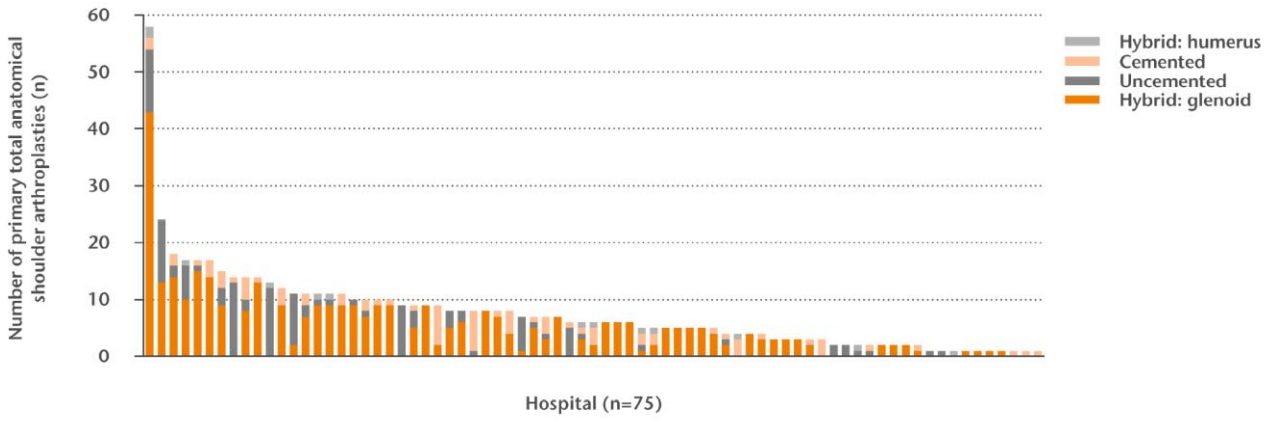
**FIGURE TYPE OF FIXATION IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=568).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Hybrid: glenoid | 361 | 61.0 |
| Uncemented | 118 | 19.9 |
| Cemented | 76 | 12.9 |
| Hybrid: humerus | 13 | 2.2 |

## Fixation per hospital

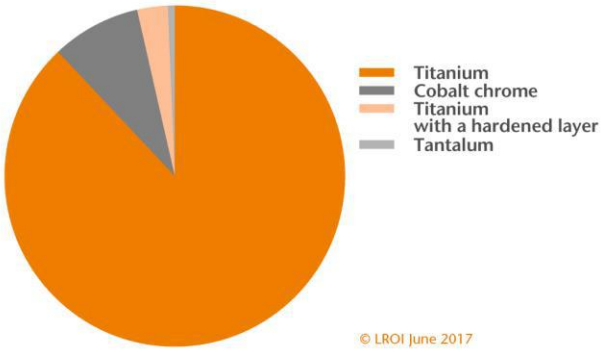
**FIGURE TYPE OF FIXATION IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=568).**



## Materials

### Humeral stem component

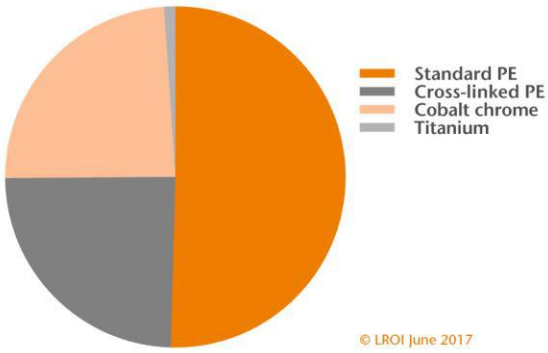
**FIGURE HUMERAL STEM MATERIAL IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=449).**




| Humeral stem material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 395 | 88.0 |
| Cobalt chrome | 38 | 8.4 |
| Titanium with a hardened layer | 13 | 2.9 |
| Tantalum | 3 | 0.7 |

### Glenoid component

**FIGURE GLENOID MATERIAL IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=466).**



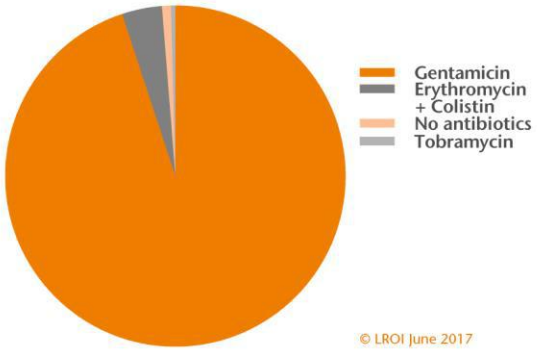

| Glenoid material | Number (n) | Proportion (%) |
|---|---|---|
| Standard PE | 235 | 50.4 |
| Cross-linked PE | 114 | 24.5 |
| Cobalt chrome | 112 | 24.0 |
| Titanium | 5 | 1.1 |

PE: polyethylene.

## Bone cement

### Antibiotics

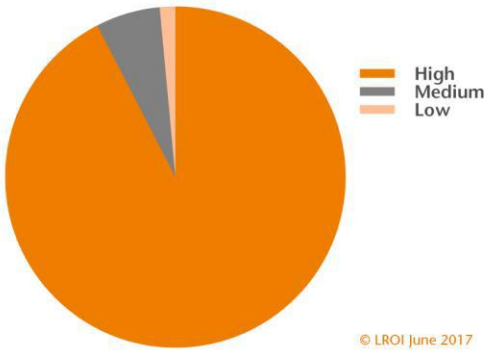
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=369).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 345 | 93.5 |
| Erythromycin + Colistin | 18 | 4.9 |
| No antibiotics | 4 | 1.1 |
| Tobramycin | 2 | 0.5 |

### Viscosity

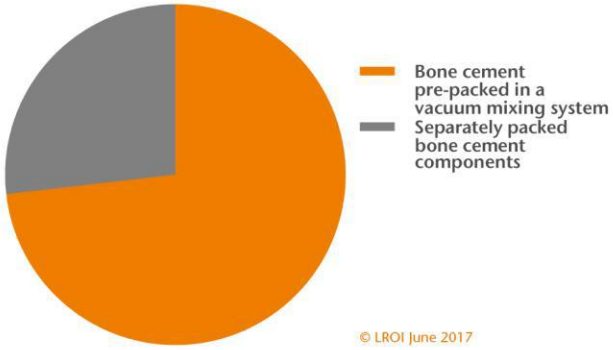
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=369).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 333 | 90.2 |
| Medium | 29 | 7.9 |
| Low | 7 | 1.9 |

## Vacuum mixing system

**FIGURE BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=369).**




| Vacuum mixing system | Number (n) | Proportion (%) |
|---|---|---|
| Bone cement pre-packed in a vacuum mixing system | 270 | 73.2 |
| Separately packed bone cement components | 99 | 26.8 |

## Most frequently registered components

**TABLE THE FIVE MOST FREQUENTLY REGISTERED HUMERAL STEMS, HUMERAL HEADS AND GLENOID COMPONENTS IN PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Humeral stem (n=548)

| Name | Proportion (%) |
|---|---|
| Aequalis Ascend Flex | 21.0 |
| Comprehensive | 13.9 |
| Global Unite | 12.4 |
| Global AP | 9.1 |
| Aequalis Primary | 4.7 |

Humeral head (n=562)

| Name | Proportion (%) |
|---|---|
| Aequalis Ascend Flex | 20.1 |
| Comprehensive | 12.5 |
| Global Unite/ Global AP | 11.9 |
| Global AP | 9.6 |
| Aequalis humeral head | 8.0 |

Glenoid (n=549)

| Name | Proportion (%) |
|---|---|
| Global APG+ | 20.6 |
| Aequalis Sferisch Glenoid | 17.1 |
| Comprehensive | 13.8 |
| Aequalis Perform glenoid | 13.1 |
| Affinis | 4.2 |

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## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT BY TYPE OF MIXING SYSTEM USED DURING PRIMARY TOTAL ANATOMICAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Separately packed bone cement components (n=99) | | Bone cement pre-packed in a vacuum mixing system (n=270) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Cemex | 22.2 | Palacos R+G | 76.7 |
| Simplex ABC EC | 18.2 | Refobacin Bone Cement R | 11.1 |
| Optipac | 15.2 | Optipac | 5.9 |
| Refobacin Plus Bone Cement | 13.1 | Palacos Pro | 5.6 |
| Palacos MV+G | 9.1 | Refobacin Plus Bone Cement | 0.7 |

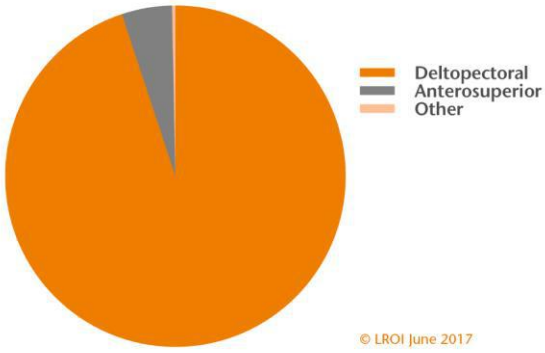


## Shoulder hemiarthroplasty

### Surgical techniques

### Surgical approach

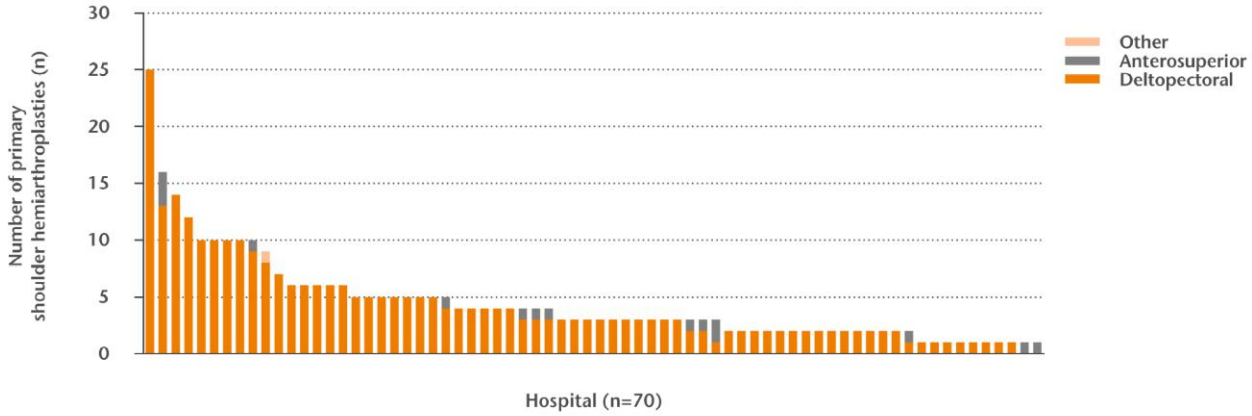
**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY SHOULDER HEMIARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=314).**




| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Deltopectoral | 298 | 94.9 |
| Anterosuperior | 15 | 4.8 |
| Other | 1 | 0.3 |

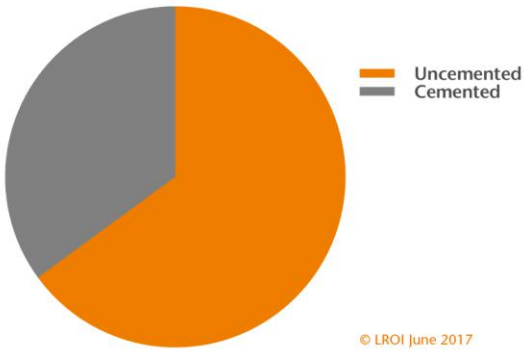
## Surgical approach per hospital

**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY SHOULDER HEMIARTHROPLASTY PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=314).**




## Fixation

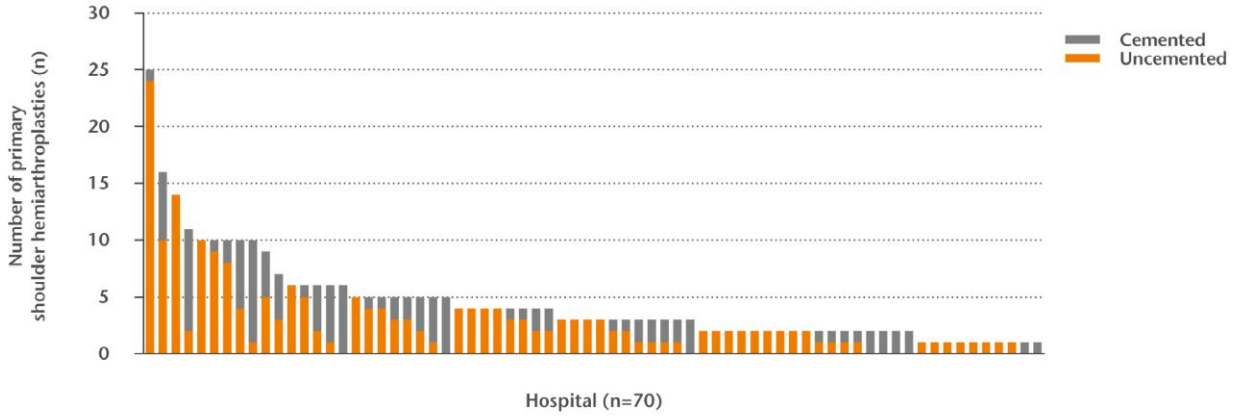
**FIGURE TYPE OF FIXATION IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=311).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Uncemented | 202 | 65.0 |
| Cemented | 109 | 35.0 |

## Fixation per hospital

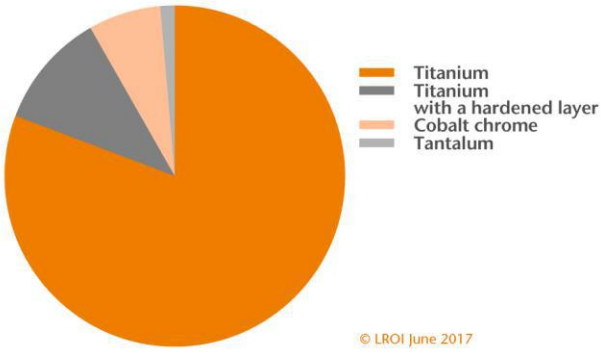
**FIGURE TYPE OF FIXATION IN PRIMARY SHOULDER HEMIARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=311).**




## Materials

## Humeral stem component

**FIGURE HUMERAL STEM MATERIAL IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=218).**

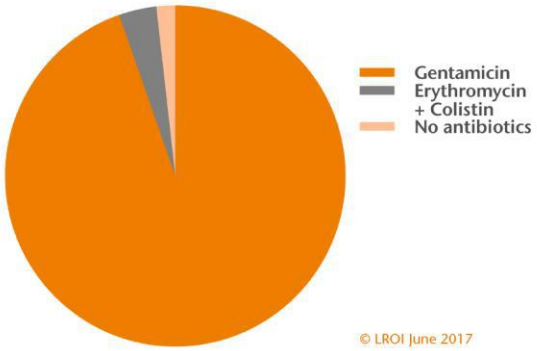



| Humeral stem material | Number (n) | Proportion (%) |
|---|---|---|
| Titanium | 176 | 80.7 |
| Titanium with a hardened layer | 24 | 11.0 |
| Cobalt chrome | 15 | 6.9 |
| Tantalum | 3 | 1.4 |

## Bone cement

### Antibiotics

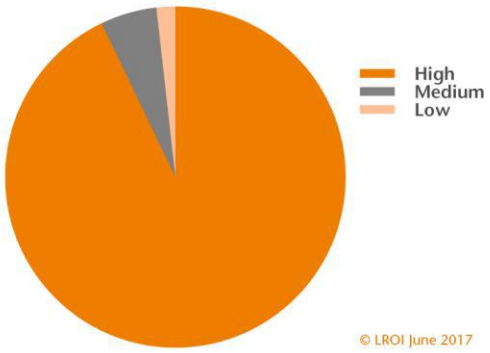
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=90).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 84 | 93.3 |
| Erythromycin + Colistin | 4 | 4.5 |
| No antibiotics | 2 | 2.2 |

### Viscosity

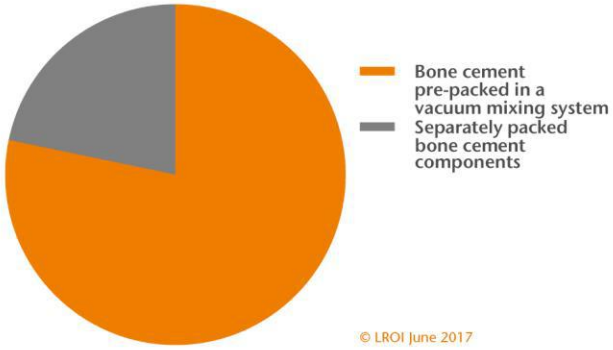
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=90).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 82 | 91.1 |
| Medium | 6 | 6.7 |
| Low | 2 | 2.2 |

## Vacuum mixing system

**FIGURE BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=90).**




| Vacuum mixing system | Number (n) | Proportion (%) |
|---|---|---|
| Bone cement pre-packed in a vacuum mixing system | 70 | 77.8 |
| Separately packed bone cement components | 20 | 22.2 |

## Most frequently registered components

**TABLE THE FIVE MOST FREQUENTLY REGISTERED HUMERAL STEMS AND HUMERAL HEADS IN PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Humeral stem (n=273) | | Humeral head (n=287) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Comprehensive | 16.5 | Aequalis humeral head | 19.5 |
| Aequalis Fracture hemi | 13.9 | Comprehensive | 15.7 |
| Global Unite | 9.2 | Global Unite/ Global AP | 8.4 |
| Sidus Baseplate | 8.8 | Sidus Heads | 7.0 |
| Aequalis Ascend Flex | 8.1 | Aequalis Resurfacing | 5.6 |

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## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT USED DURING PRIMARY SHOULDER HEMIARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=93).**

| Name | Proportion (%) |
|---|---|
| Palacos R+G | 44.1 |
| Refobacin Bone Cement R | 21.5 |
| Optipac | 16.1 |
| Simplex ABC EC | 4.3 |
| Refobacin Plus Bone Cement | 3.2 |

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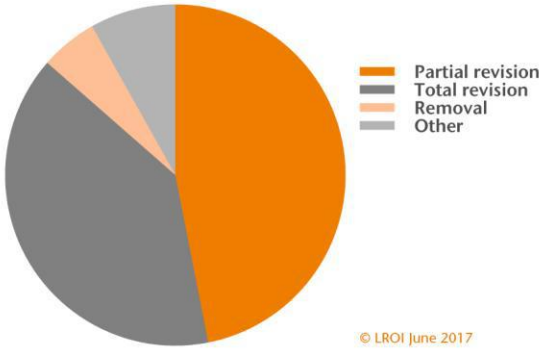
# Shoulder revision arthroplasty

## Type of revision

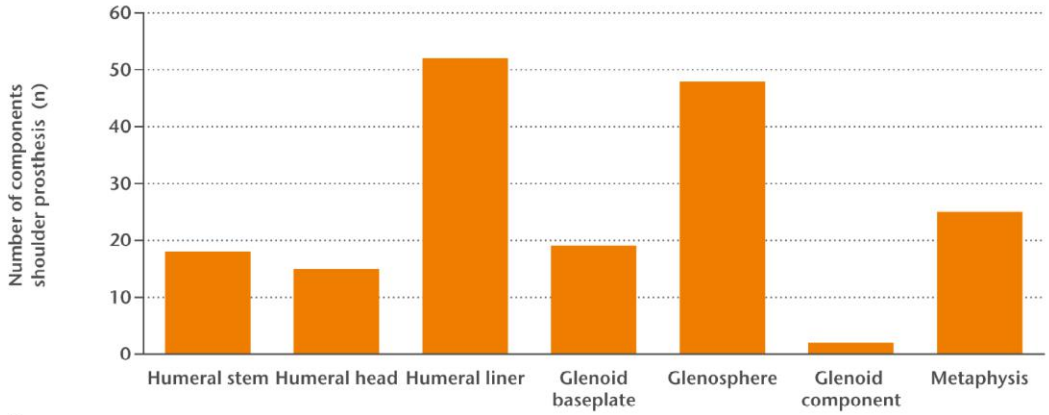
**FIGURE TYPE OF REVISION ARTHROPLASTY OF SHOULDER REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=258).**




| Type of shoulder revision | Number (n) | Proportion (%) |
|---|---|---|
| Partial revision | 121 | 46.9 |
| Total revision | 102 | 39.5 |
| Removal | 14 | 5.4 |
| Other | 21 | 8.2 |

## Revised components in partial revisions

**FIGURE REVISED COMPONENTS IN PARTIAL SHOULDER ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=121).**




| Revised component | Humeral stem | Humeral head | Humeral liner | Glenoid baseplate | Glenosphere | Glenoid component | Metaphysis |
|---|---|---|---|---|---|---|---|
| Number (n) | 18 | 15 | 52 | 19 | 48 | 2 | 25 |
| Proportion[1] (%) | 14.9 | 12.4 | 43.0 | 15.7 | 39.7 | 1.7 | 20.7 |

[1] More than one component can be replaced during a procedure. As such, the total proportion is over 100%.



## Reasons for revision

**TABLE REASONS FOR REVISION OR RE-SURGERY IN PATIENTS WHO UNDERWENT A SHOULDER REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=269).**

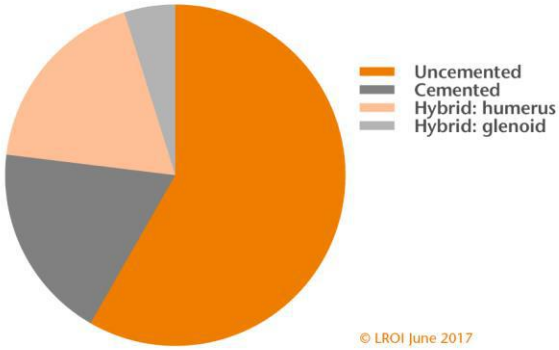
| Reasons for revision | Proportion[1] (%) |
|---|---|
| Instability | 23.8 |
| Infection | 21.2 |
| Progression of osteoarthritis | 17.5 |
| Cuff arthropathy | 13.4 |
| Cuff rupture | 11.5 |
| Loosening of humeral component | 11.2 |
| Loosening of glenoid component | 10.8 |
| Malalignment | 8.6 |
| Peri-prosthetic fracture | 5.2 |
| Other | 11.9 |

[1] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

# Surgery

## Fixation

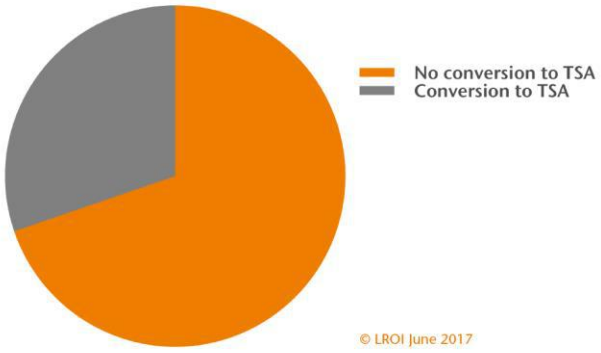
**FIGURE TYPE OF FIXATION IN SHOULDER REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=243).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Uncemented | 141 | 58.0 |
| Cemented | 45 | 18.5 |
| Hybrid: humerus | 45 | 18.5 |
| Hybrid: glenoid | 12 | 5.0 |

## Conversion to TSA

**FIGURE CONVERSION OF A SHOULDER HEMIPROSTHESIS TO A TOTAL (ANATOMICAL OR REVERSED) SHOULDER PROSTHESIS IN THE NETHERLANDS IN 2016 (N=248).**

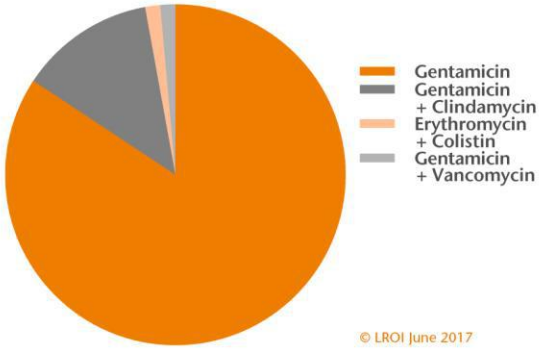



| Conversion to TSA | Number (n) | Proportion (%) |
|---|---|---|
| No conversion to TSA | 173 | 69.8 |
| Conversion to TSA | 75 | 30.2 |

TSA: total shoulder arthroplasty.

## Bone cement antibiotics

**FIGURE BONE CEMENT ANTIBIOTICS IN SHOULDER REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=70).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 59 | 84.3 |
| Gentamicin + Clindamycin | 9 | 12.9 |
| Erythromycin + Colistin | 1 | 1.4 |
| Gentamycin + Vancomycin | 1 | 1.4 |

## Most frequently registered components

**TABLE THE FIVE MOST FREQUENTLY REGISTERED HUMERAL STEMS, HUMERAL HEADS, HUMERAL LINERS, GLENOID BASEPLATES, GLENOSPHERES, GLENOID COMPONENTS AND METAPHYSES IN SHOULDER REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

Humeral stem (n=124)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 21.8 |
| Aequalis Reversed | 9.7 |
| Aequalis Reversed Fracture | 6.5 |
| Comprehensive | 5.6 |
| Aequalis Ascend Flex | 3.2 |

Humeral head (n=36)

| Name | Proportion (%) |
|---|---|
| Aequalis humeral head | 30.6 |
| Global AP | 11.1 |
| Univers II | 8.3 |
| Affinis | 5.6 |
| Anatomical Shoulder Bipolar Heads | 5.6 |

Humeral liner (n=135)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 37.8 |
| Aequalis Reversed | 20.0 |
| Comprehensive | 8.9 |
| Aequalis Reversed Fracture | 8.9 |
| Anatomical Inverse Humeral Poly Inlays | 6.7 |

Glenoid baseplate (n=92)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 39.1 |
| Aequalis Reversed | 31.5 |
| Comprehensive | 10.9 |
| Trabecular Metal Baseplate | 6.5 |
| Equinoxe | 3.3 |

Glenosphere (n=121)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 38.8 |
| Aequalis Reversed | 32.2 |
| Comprehensive | 9.1 |
| SMR reversed head | 6.6 |
| TM Reverse Glenoid Heads | 5.8 |

Glenoid component (n=18)

| Name | Proportion (%) |
|---|---|
| Aequalis Sferisch Glenoid | 33.3 |
| Global APG+ | 22.2 |
| Glenoid | 16.7 |
| Aequalis Perform glenoid | 5.6 |
| Affinis | 5.6 |

Metaphysis (n=85)

| Name | Proportion (%) |
|---|---|
| Delta X-tend | 18.8 |
| Aequalis Reversed | 17.6 |
| Comprehensive | 12.9 |
| SMR reversed body | 9.4 |
| Anatomical inverse Humeral Cups | 8.2 |



## Most frequently registered types of bone cement

**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT USED DURING SHOULDER REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=71).**

| Name | Proportion (%) |
|---|---|
| Palacos R+G | 42.3 |
| Optipac | 14.1 |
| Palacos Pro | 9.9 |
| Refobacin Bone Cement R | 8.5 |
| Refobacin Revision | 7.0 |

# Survival

## Revision within 1 year

### By type of shoulder arthroplasty

**TABLE CUMULATIVE 1-YEAR REVISION PERCENTAGE OF PRIMARY SHOULDER ARTHROPLASTIES BY TYPE OF SHOULDER ARTHROPLASTY IN THE NETHERLANDS IN 2014-2015.**

| Type of primary shoulder arthroplasty | Number of primary shoulder arthroplasties (n) | Cumulative 1-year revision percentage (95% CI) |
|---|---|---|
| Reversed shoulder arthroplasty | 2,642 | 1.9 (1.4-2.5) |
| Total anatomical shoulder arthroplasty | 1,042 | 1.4 (0.9-2.4) |
| Shoulder hemiarthroplasty | 877 | 2.6 (1.7-3.9) |



**In 2014-2015, 79 (1.7%) primary shoulder arthroplasties were implanted in patients who died within one year after the primary procedure.**

### Reasons for revision

**TABLE REASONS FOR REVISION WITHIN ONE YEAR IN PATIENTS THAT UNDERWENT A SHOULDER REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2014-2015.**

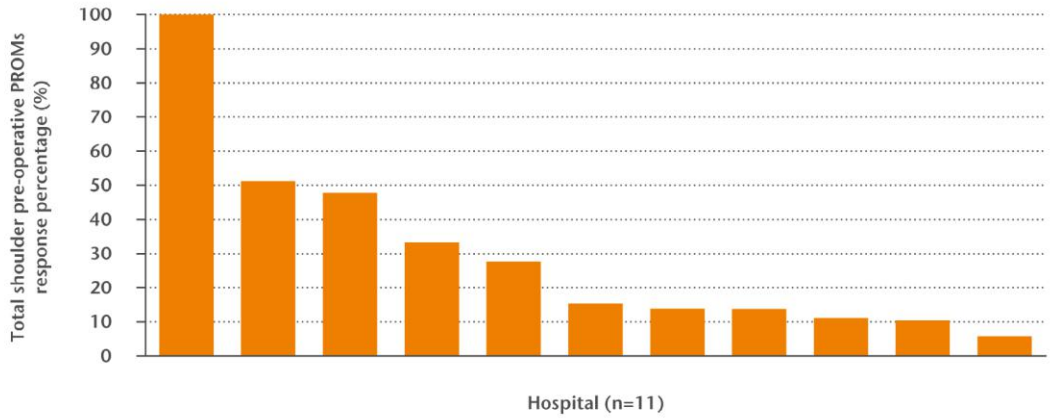
| Reason for revision | Proportion[1] (%) |
|---|---|
| Instability | 27.7 |
| Infection | 20.8 |
| Cuff rupture | 12.9 |
| Malalignment | 11.9 |
| Cuff arthropathy | 8.9 |
| Loosening of glenoid component | 8.9 |
| Loosening of humeral component | 6.9 |
| Peri-prosthetic fracture | 5.0 |
| Progression of osteoarthritis | 4.0 |
| Other | 8.9 |

[1] One patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

# PROMs

## Response

**FIGURE PRE-OPERATIVE PROMS RESPONSE PERCENTAGE OF PATIENTS WHO UNDERWENT A PRIMARY TOTAL (ANATOMICAL OR REVERSED) SHOULDER ARTHROPLASTY PER PROMS REGISTERING HOSPITAL IN THE NETHERLANDS IN 2016 (N=295).**




PROM: patient reported outcome measure.



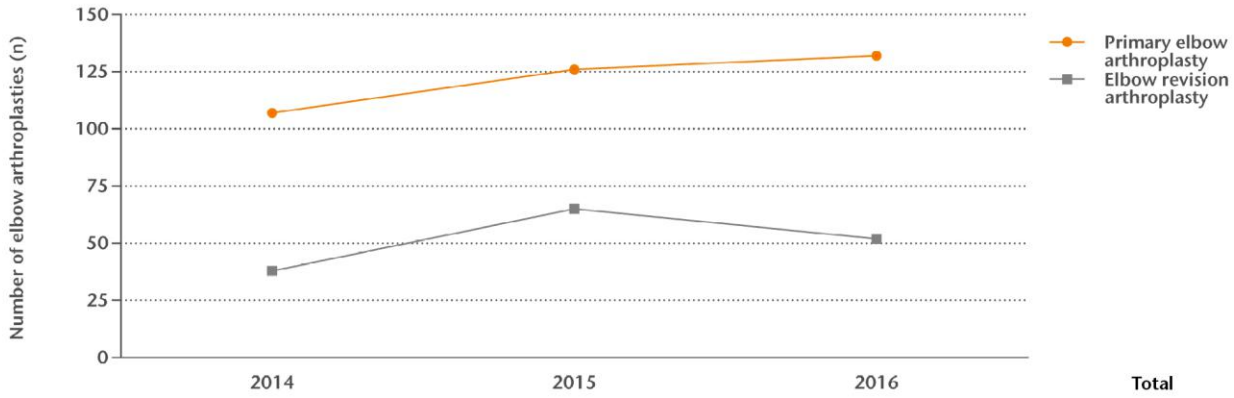
**Of all 295 patients who underwent a primary total shoulder arthroplasty in a PROMs registering hospital, the mean pre-operative response score was 23.1% (n=68).**

# Elbow arthroplasty

## Numbers

### Procedures 2014-2016

**FIGURE NUMBER OF PRIMARY ELBOW ARTHROPLASTIES AND ELBOW REVISION ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2014-2016.**



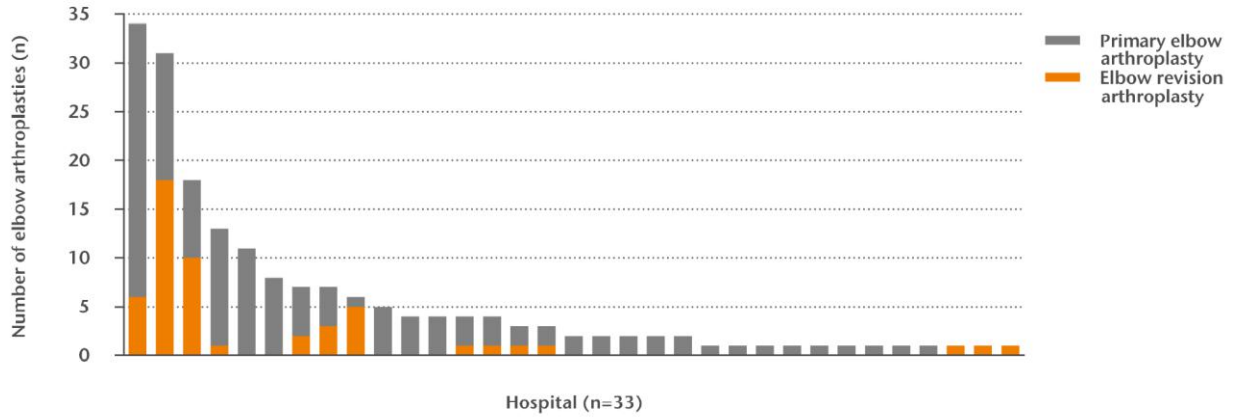

| Year | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|
| **Type of procedure** | | | | |
| Primary elbow arthroplasty (n) | 107 | 126 | 132 | 365 |
| Elbow revision arthroplasty (n) | 38 | 65 | 52 | 155 |
| Total (n) | 145 | 191 | 184 | 520 |



**Out of 132 primary elbow arthroplasties that were performed in 2016, 2% (n=3) was performed bilaterally.**

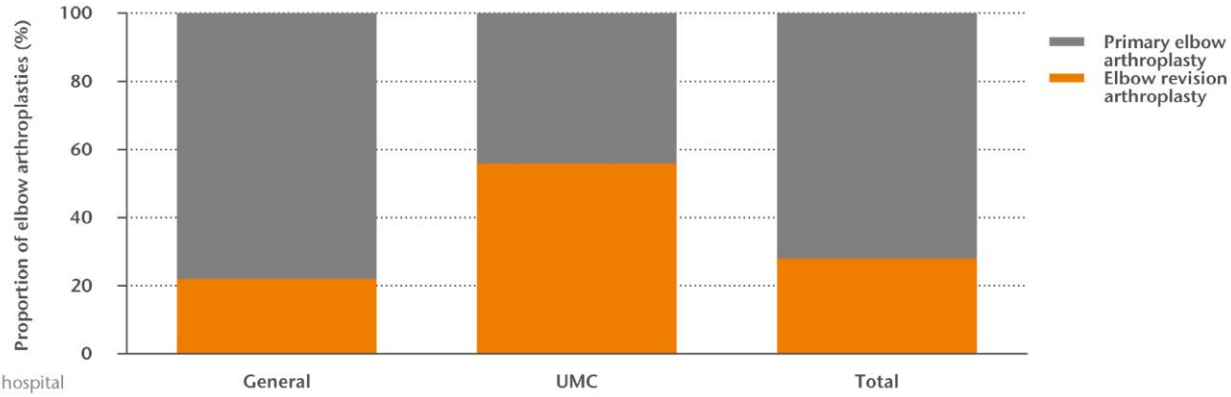
### Type of procedure per hospital

**FIGURE NUMBER OF PRIMARY ELBOW ARTHROPLASTIES AND ELBOW REVISION ARTHROPLASTIES PER HOSPITAL IN THE NETHERLANDS IN 2016 (N=184).**



## Type of procedure by type of hospital

**FIGURE PRIMARY ELBOW ARTHROPLASTIES AND ELBOW REVISION ARTHROPLASTIES (PROPORTION [%] PER CATEGORY) BY TYPE OF HOSPITAL IN THE NETHERLANDS IN 2016.**



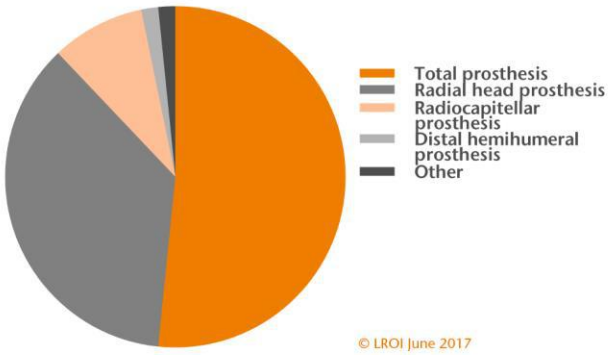

| Type of hospital | General | UMC | Total |
|---|---|---|---|
| **Type of procedure** | | | |
| Primary elbow arthroplasty (%) | 77.6 | 43.8 | 71.7 |
| Elbow revision arthroplasty (%) | 22.4 | 56.2 | 28.3 |
| Total (n) | 152 | 32 | 184 |

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



## Type of primary elbow prosthesis

**FIGURE TYPE OF PRIMARY ELBOW PROSTHESIS IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=124).**






| Type of primary elbow prosthesis | Number (n) | Proportion (%) |
|---|---|---|
| Total prosthesis | 64 | 51.6 |
| Radial head prosthesis | 45 | 36.3 |
| Radiocapitellar prosthesis | 11 | 8.9 |
| Distal hemihumeral prosthesis | 2 | 1.6 |
| Other | 2 | 1.6 |

# Primary elbow arthroplasty

## Demographics

### Patient characteristics by type of elbow prosthesis

**TABLE PATIENT CHARACTERISTICS OF ALL PATIENTS WITH A REGISTERED PRIMARY ELBOW ARTHROPLASTY BY TYPE OF PRIMARY ELBOW ARTHROPLASTY IN THE NETHERLANDS IN 2016.**

| | Total arthroplasty[1] (n=63) | Radial head arthroplasty[2] (n=56) | Total[3] (n=129) |
|---|---|---|---|
| Completeness (%) | | | 88 |
| Mean age (years) (SD) | 68.7 (10.1) | 56.3 (13.7) | 62.6 (13.3) |
| Age (years) (%) | | | |
| <50 | 5 | 30 | 19 |
| 50-59 | 11 | 21 | 16 |
| 60-69 | 40 | 36 | 36 |
| 70-79 | 30 | 13 | 22 |
| ≥80 | 14 | 0 | 7 |
| Gender (%) | | | |
| Men | 29 | 27 | 28 |
| Women | 71 | 73 | 72 |
| ASA score (%) | | | |
| I | 10 | 33 | 21 |
| II | 63 | 53 | 59 |
| III-IV | 27 | 14 | 20 |
| Type of hospital[4] (%) | | | |
| General | 87 | 95 | 91 |
| UMC | 13 | 5 | 9 |
| Diagnosis (%) | | | |
| Late post-traumatic | 18 | 62 | 37 |
| Rheumatoid arthritis | 24 | 30 | 27 |
| Acute fracture | 37 | 2 | 20 |
| Osteoarthritis | 15 | 2 | 11 |
| Other | 6 | 4 | 5 |
| Body Mass Index (kg/m²) (%) | | | |
| Underweight (≤18.5) | 3 | 0 | 2 |
| Normal weight (>18.5-25) | 37 | 34 | 36 |
| Overweight (>25-30) | 38 | 46 | 42 |
| Obesity (>30-40) | 16 | 18 | 16 |
| Morbid obesity (>40) | 6 | 2 | 4 |
| Smoking (%) | | | |
| No | 88 | 89 | 89 |
| Yes | 12 | 11 | 11 |

[1] Including distal hemihumeral prostheses (n=2).
[2] Including radiocapitellar prostheses (n=11).
[3] Also contains 2 (2%) primary elbow arthroplasties that were registered as other and 8 (6.2%) primary elbow arthroplasties of which the type of prosthesis had not been registered.
[4] In 2016, 26 general hospitals and 4 UMCs performed primary elbow arthroplasties.
General: general hospital; UMC: university medical centre; Private: private hospital; SD: standard deviation.

## Previous surgery

**TABLE PREVIOUS SURGERIES TO THE SAME JOINT IN PATIENTS WHO UNDERWENT A PRIMARY ELBOW ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=129).**

| | Proportion[1] (%) |
|---|---|
| Previous surgery to the relevant elbow (total) | 37.2 |
| Lateral arthrotomy | 21.7 |
| Osteosynthesis | 16.3 |
| Posterior arthrotomy | 7.0 |
| Plate or screw removal | 7.8 |
| Arthroscopy | 5.4 |
| Medial arthrotomy | 3.9 |
| Decompression ulnar nerve | 2.3 |
| Other | 10.1 |

[1] A patient may have undergone multiple previous surgeries to the same joint. As such, the total proportion is more than the total proportion of patients with one or more previous surgeries to the same joint.

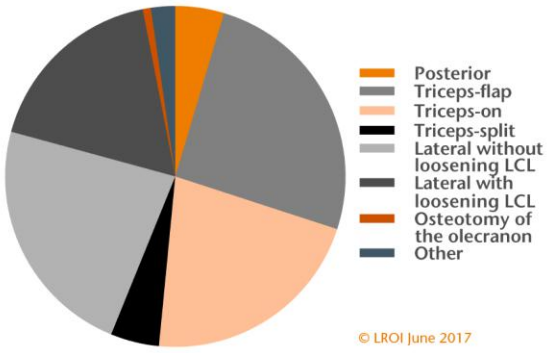


# Surgery

## Surgical techniques

## Surgical approach

**FIGURE SURGICAL APPROACH FOR PERFORMING A PRIMARY ELBOW ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=130).**



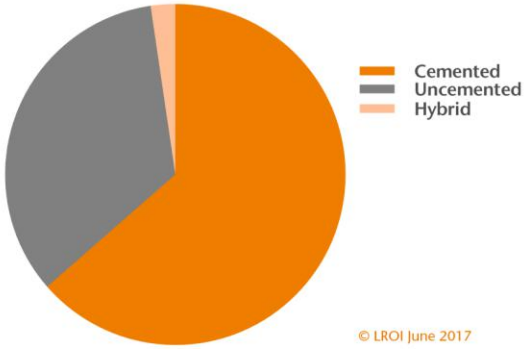



| Surgical approach | Number (n) | Proportion (%) |
|---|---|---|
| Posterior | 6 | 4.6 |
| Triceps-flap | 33 | 25.4 |
| Triceps-on | 28 | 21.5 |
| Triceps-split | 6 | 4.6 |
| Lateral without loosening LCL | 30 | 23.1 |
| Lateral with loosening LCL | 23 | 17.7 |
| Osteotomy of the olecranon | 1 | 0.8 |
| Other | 3 | 2.3 |

**For performing a primary elbow arthroplasty, a posterior approach was used in 56% of all cases and in 41% of all cases a lateral approach was used.**

## Fixation

**FIGURE TYPE OF FIXATION IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=128).**

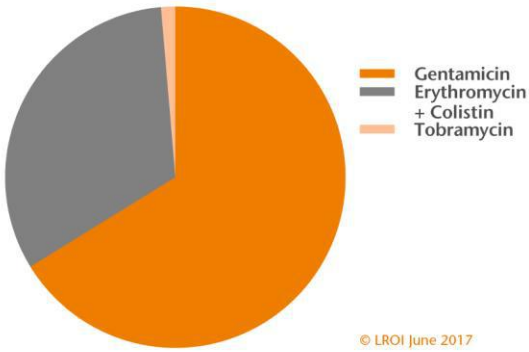



| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 82 | 64.1 |
| Uncemented | 44 | 34.3 |
| Hybrid | 2 | 1.6 |

## Bone cement

## Antibiotics

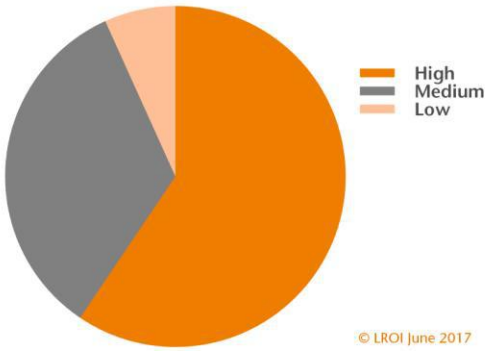
**FIGURE ANTIBIOTICS IN BONE CEMENT IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=74).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 49 | 66.2 |
| Erythromycin + Colistin | 24 | 32.4 |
| Tobramycin | 1 | 1.4 |

## Viscosity

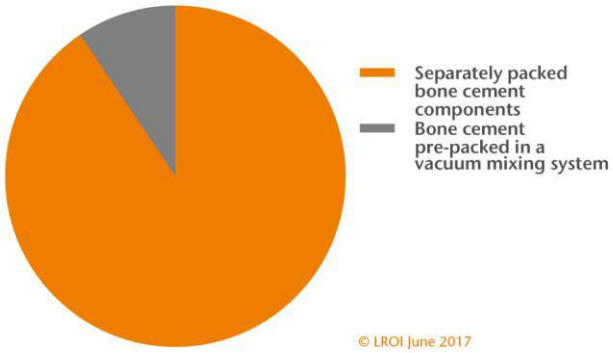
**FIGURE VISCOSITY IN BONE CEMENT IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=74).**




| Bone cement viscosity | Number (n) | Proportion (%) |
|---|---|---|
| High | 44 | 59.5 |
| Medium | 25 | 33.8 |
| Low | 5 | 6.7 |

## Vacuum mixing system

**FIGURE BONE CEMENT PRE-PACKED IN A VACUUM MIXING SYSTEM IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=74).**




| Vacuum mixing system | Number (n) | Proportion (%) |
|---|---|---|
| Separately packed bone cement components | 67 | 90.5 |
| Bone cement pre-packed in a vacuum mixing system | 7 | 9.5 |

## Most frequently registered elbow prostheses

**TABLE THE THREE MOST FREQUENTLY REGISTERED TOTAL ELBOW ARTHROPLASTIES (INCLUDING DISTAL HEMIHUMERAL ARTHROPLASTIES) AND RADIAL HEAD ARTHROPLASTIES (INCLUDING RADIOCAPITELLAR ELBOW ARTHROPLASTIES) IN PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Total elbow arthroplasties[1] (n=65) | | Radial head arthroplasties[2] (n=47) | |
|---|---|---|---|
| Name | Proportion (%) | Name | Proportion (%) |
| Latitude EV | 46.2 | RHS | 66.0 |
| Coonrad/Morrey | 12.3 | Explor | 8.5 |
| NES | 10.8 | CRF | 2.1 |

Please note: A total of 64 total elbow arthroplasties and 2 distal hemihumeral elbow arthroplasties were registered. Only 65 humeral components were registered for these types of elbow arthroplasties.
Please note: A total of 45 radial head arthroplasties and 11 radiocapitellar elbow arthroplasties were registered. Only 47 radial head components were registered for these types of elbow arthroplasties.
[1] Including distal hemihumeral prostheses (n=2).
[2] Including radiocapitellar prostheses (n=11).



## Most frequently registered types of bone cement

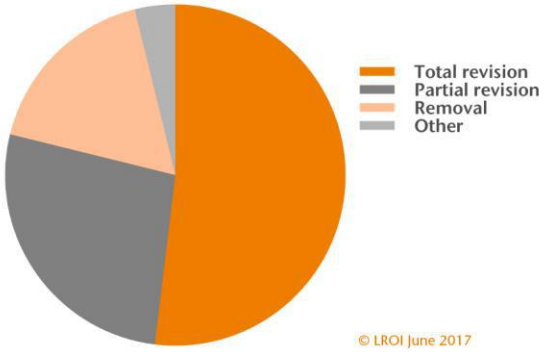
**TABLE THE FIVE MOST FREQUENTLY REGISTERED TYPES OF BONE CEMENT USED DURING PRIMARY ELBOW ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=73).**

| Name | Proportion (%) |
|---|---|
| Palacos R+G | 42.5 |
| Simplex ABC EC | 32.9 |
| Refobacin Bone Cement R | 8.2 |
| Palacos LV+G | 5.5 |
| Refobacin Plus Bone Cement | 5.5 |

# Elbow revision arthroplasty

## Type of revision

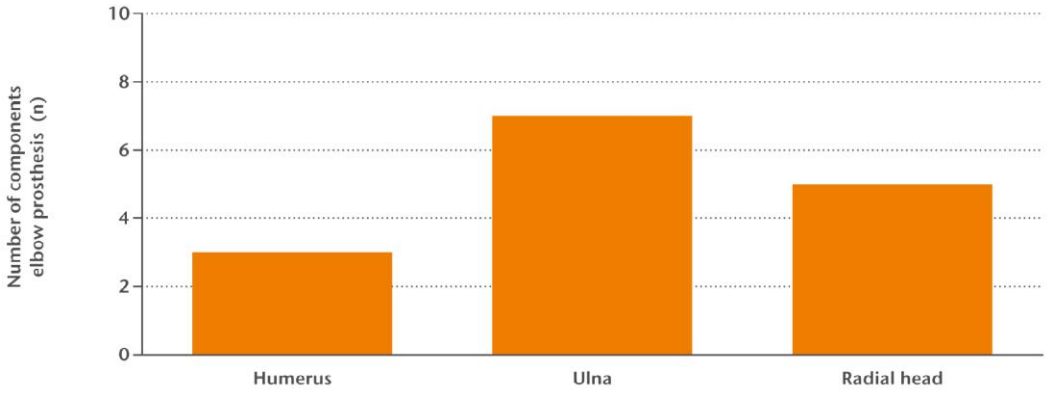
**FIGURE TYPE OF REVISION ARTHROPLASTY OF ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=52).**




| Type of elbow revision | Number (n) | Proportion (%) |
|---|---|---|
| Total revision | 27 | 51.9 |
| Partial revision | 14 | 26.9 |
| Removal | 9 | 17.3 |
| Other | 2 | 3.9 |

## Revised components in partial revisions

**FIGURE REVISED COMPONENTS IN PARTIAL ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=14).**




| Revised component | Humerus | Ulna | Radial head |
|---|---|---|---|
| Number (n) | 3 | 7 | 5 |
| Proportion[1] (%) | 21.4 | 50.0 | 35.7 |

[1]More than one component can be replaced during a procedure. As such, the total proportion is over 100%.

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## Reasons for revision

**TABLE REASONS FOR REVISION OR RE-SURGERY IN PATIENTS WHO UNDERWENT AN ELBOW REVISION ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=52).**

| Reasons for revision | Proportion[1] (%) |
|---|---|
| Polyethylene wear | 30.8 |
| Metallosis | 25.0 |
| Instability | 21.2 |
| Loosening of radial head component | 19.2 |
| Loosening of ulnar component | 17.3 |
| Loosening of humeral component | 17.3 |
| Infection | 15.4 |
| Peri-prosthetic fracture | 3.8 |
| Other | 9.6 |

[1]A patient may have more than one reason for revision or re-surgery. As such, the total proportion is over 100%.

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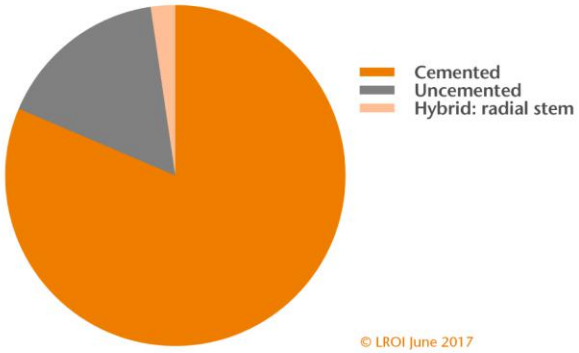
## Surgery

### Fixation

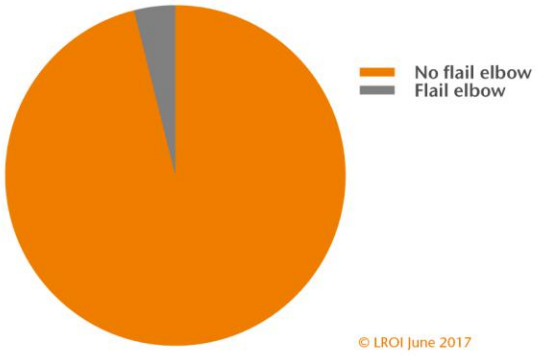
**FIGURE TYPE OF FIXATION IN ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=43).**




| Fixation | Number (n) | Proportion (%) |
|---|---|---|
| Cemented | 35 | 81.4 |
| Uncemented | 7 | 16.3 |
| Hybrid: radial stem | 1 | 2.3 |

## Flail elbow

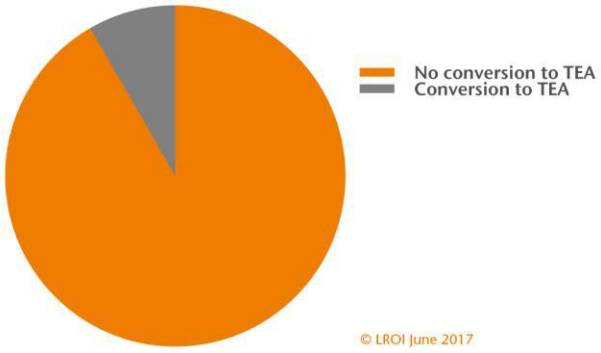
**FIGURE FLAIL ELBOW IN ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=51).**




| Flail elbow | Number (n) | Proportion (%) |
|---|---|---|
| No flail elbow | 49 | 96.1 |
| Flail elbow | 2 | 3.9 |

## Conversion to TEA

**FIGURE CONVERSION OF A RADIAL HEAD ARTHROPLASTY TO A TOTAL ELBOW ARTHROPLASTY IN THE NETHERLANDS IN 2016 (N=48).**

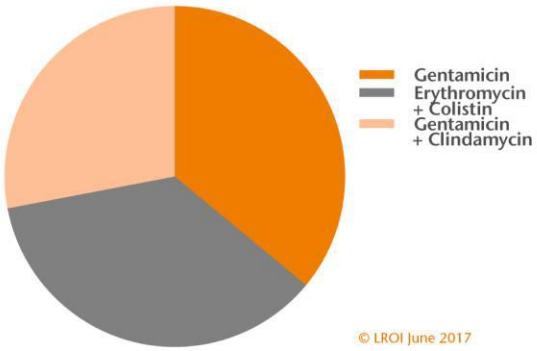



| Conversion to TEA | Number (n) | Proportion (%) |
|---|---|---|
| No conversion to TEA | 44 | 91.7 |
| Conversion to TEA | 4 | 8.3 |

TEA: total elbow arthroplasty.

## Bone cement antibiotics

**FIGURE BONE CEMENT ANTIBIOTICS IN ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=25).**




| Bone cement antibiotics | Number (n) | Proportion (%) |
|---|---|---|
| Gentamicin | 9 | 36.0 |
| Erythromycin + Colistin | 9 | 36.0 |
| Gentamicin + Clindamycin | 7 | 28.0 |

## Most frequently registered components

**TABLE THE REGISTERED HUMERUS, ULNA AND RADIAL HEAD COMPONENTS IN ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016.**

| Humerus (n=15) | |
|---|---|
| Name | Proportion (%) |
| Latitude EV | 28.0 |
| NES | 16.0 |
| Coonrad/Morrey | 12.0 |
| Discovery | 4.0 |

| Ulna (n=12) | |
|---|---|
| Name | Proportion (%) |
| Latitude EV | 58.4 |
| NES | 16.7 |
| Coonrad/Morrey | 8.3 |
| Discovery | 8.3 |
| K Elbow | 8.3 |

| Radial head (n=6) | |
|---|---|
| Name | Proportion (%) |
| RHS | 83.3 |
| Explor | 16.7 |

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## Most frequently registered types of bone cement

**TABLE THE REGISTERED TYPES OF BONE CEMENT USED DURING ELBOW REVISION ARTHROPLASTIES IN THE NETHERLANDS IN 2016 (N=24).**

| Name | Proportion (%) |
|---|---|
| Simplex ABC EC | 37.5 |
| Refobacin Revision | 25.0 |
| Palacos R+G | 16.6 |
| Refobacin Bone Cement R | 12.5 |
| Copal G+C | 4.2 |
| Refobacin Plus Bone Cement | 4.2 |



# Data quality

## Number of registered procedures

### Hip

**TABLE NUMBER OF REGISTERED HIP ARTHROPLASTIES PER YEAR OF SURGERY (2007-2016) IN THE LROI IN JUNE 2017.**

| | Type of hip arthroplasty | | | | | |
|---|---|---|---|---|---|---|
| Year of surgery | Total arthroplasty (n) | Hemiarthroplasty (n) | Resurfacing arthroplasty (n) | Other (n) | Revision arthroplasty (n) | Total[1] (n) |
| 2007 | 8,660 | 937 | 447 | 1,257 | 1,269 | 12,606 |
| 2008 | 15,172 | 1,365 | 727 | 754 | 1,856 | 19,950 |
| 2009 | 21,536 | 2,047 | 846 | 872 | 2,676 | 28,068 |
| 2010 | 23,330 | 2,343 | 601 | 884 | 2,949 | 30,163 |
| 2011 | 23,872 | 2,396 | 225 | 871 | 3,198 | 30,638 |
| 2012 | 25,388 | 2,788 | 10 | 822 | 3,764 | 32,816 |
| 2013 | 26,114 | 3,016 | 1 | 437 | 3,513 | 33,105 |
| 2014 | 28,174 | 3,731 | 0 | 180 | 3,581 | 35,681 |
| 2015 | 28,811 | 4,911 | 15 | 28 | 3,833 | 37,727 |
| 2016 | 29,520 | 5,235 | 16 | 39 | 3,836 | 38,763 |
| Total | 230,577 | 28,769 | 2,888 | 6,144 | 30,475 | 299,517 |

[1] In 0.2% (n=664) primary hip arthroplasties the type of primary hip prosthesis has not been registered.
Please note: Data before 2015 were frozen for hip arthroplasties in this annual report.



**The LROI is nearly complete as of 2010. Therefore, a dotted line was inserted between 2009 and 2010.**

## Knee

**TABLE NUMBER OF REGISTERED KNEE ARTHROPLASTIES PER YEAR OF SURGERY (2007-2016) IN THE LROI IN JUNE 2017.**

| Year of surgery | Type of knee arthroplasty: Total arthroplasty (n) | Unicondylar knee arthroplasty (n) | Patellofemoral knee arthroplasty (n) | Other (n) | Revision arthroplasty (n) | Total[1] (n) |
|---|---|---|---|---|---|---|
| 2007 | 6,688 | 679 | 49 | 306 | 596 | 9,336 |
| 2008 | 11,108 | 1,129 | 94 | 324 | 908 | 14,376 |
| 2009 | 16,050 | 1,531 | 141 | 468 | 1,299 | 19,948 |
| 2010 | 17,899 | 1,700 | 160 | 501 | 1,622 | 22,195 |
| 2011 | 18,930 | 1,600 | 149 | 418 | 1,794 | 23,206 |
| 2012 | 21,146 | 1,596 | 189 | 364 | 2,115 | 25,826 |
| 2013 | 21,985 | 1,831 | 158 | 139 | 2,306 | 26,760 |
| 2014 | 24,130 | 2,362 | 127 | 60 | 2,557 | 29,394 |
| 2015 | 24,161 | 2,688 | 162 | 43 | 2,683 | 29,817 |
| 2016 | 24,709 | 2,915 | 148 | 36 | 2,886 | 30,804 |
| Total | 186,806 | 18,031 | 1,377 | 2,659 | 18,766 | 231,662 |

[1] In 1.7% (n=4,023) primary knee arthroplasties the type of primary knee prosthesis has not been registered.

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**The LROI is nearly complete as of 2010. Therefore, a dotted line was inserted between 2009 and 2010.**

## Ankle

**TABLE NUMBER OF REGISTERED ANKLE ARTHROPLASTIES PER YEAR OF SURGERY (2014-2016) IN THE LROI IN JUNE 2017.**

| Year of surgery | Type of ankle arthroplasty: Total arthroplasty (n) | Other (n) | Revision arthroplasty (n) | Total (n) |
|---|---|---|---|---|
| 2014 | 102 | 0 | 15 | 118 |
| 2015 | 105 | 0 | 19 | 124 |
| 2016 | 124 | 1 | 37 | 163 |
| Total | 331 | 1 | 71 | 405 |

[1] In 0.5% (n=2) primary ankle arthroplasties the type of primary ankle prosthesis has not been registered.

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## Shoulder

**TABLE NUMBER OF REGISTERED SHOULDER ARTHROPLASTIES PER YEAR OF SURGERY (2014-2016) IN THE LROI IN JUNE 2017.**

| Year of surgery | Type of shoulder arthroplasty<br>Reversed arthroplasty (n) | Total anatomical arthroplasty (n) | Hemiarthroplasty (n) | Revision arthroplasty (n) | Total[1] (n) |
|---|---|---|---|---|---|
| 2014 | 1,164 | 465 | 459 | 208 | 2,328 |
| 2015 | 1,492 | 579 | 425 | 272 | 2,783 |
| 2016 | 1,663 | 592 | 314 | 269 | 2,857 |
| Total | 4,319 | 1,636 | 1,198 | 749 | 7,968 |

[1] In 0.8% (n=66) primary shoulder arthroplasties the type of primary shoulder prosthesis has not been registered.



## Elbow

**TABLE NUMBER OF REGISTERED ELBOW ARTHROPLASTIES PER YEAR OF SURGERY (2014-2016) IN THE LROI IN JUNE 2017.**

| Year of surgery | Type of elbow arthroplasty<br>Total arthroplasty (n) | Distal hemihumeral arthroplasty (n) | Radial head arthroplasty (n) | Radiocapitellar arthroplasty (n) | Lateral resurfacing arthroplasty (n) | Other (n) | Revision arthroplasty (n) | Total[1] (n) |
|---|---|---|---|---|---|---|---|---|
| 2014 | 72 | 5 | 22 | 0 | 4 | 0 | 38 | 145 |
| 2015 | 79 | 4 | 41 | 1 | 0 | 0 | 65 | 191 |
| 2016 | 64 | 2 | 45 | 11 | 0 | 2 | 52 | 184 |
| Total | 215 | 11 | 108 | 12 | 4 | 2 | 155 | 520 |

[1] In 2.5% (n=13) primary elbow arthroplasties the type of primary elbow prosthesis has not been registered.

## Coverage and completeness

**TABLE COMPLETENESS OF REGISTERING HOSPITALS AND COMPLETENESS OF REGISTERED ARTHROPLASTIES IN THE LROI BASED ON THE HOSPITAL INFORMATION SYSTEM IN 2016.**

| | Number of hospitals in LROI[1] | Completeness of registering hospitals[2] (%) | Median [range] number of registrations | Completeness of registrations[3] (%) |
|---|---|---|---|---|
| Hip arthroplasties | | 99 | | |
| Primary total hip arthroplasties | 99 | | 266 [4-898] | 99 |
| Primary hip hemiarthroplasties (orthopaedic surgeon) | 82 | | 39 [1-175] | 95 |
| Primary hip hemiarthroplasties (trauma surgeon) | 45 | | 18 [1-103] | 50 |
| Hip revision arthroplasties | 94 | | 31 [1-290] | 97 |
| Knee arthroplasties | | 100 | | |
| Primary knee arthroplasties | 100 | | 262 [6-742] | 99 |
| Knee revision arthroplasties | 98 | | 22 [3-340] | 98 |
| Ankle arthroplasties | | 95 | | |
| Primary ankle arthroplasties | 14 | | 6 [1-22] | 92 |
| Ankle revision arthroplasties | 12 | | 2 [1-10] | 94 |
| Shoulder arthroplasties | | 99 | | |
| Primary shoulder arthroplasties | 90 | | 26 [1-162] | 94 |
| Shoulder revision arthroplasties | 62 | | 2 [1-48] | 92 |
| Elbow arthroplasties | | 97 | | |
| Primary elbow arthroplasties | 30 | | 2 [1-28] | 88 |
| Elbow revision arthroplasties | 14 | | 1 [1-18] | 93 |

[1] Number of hospitals that performed arthroplasties in accordance with their hospital information system in 2016.
[2] Proportion of total number of hospitals that performed arthroplasties in 2016 (bases on Vektis data).
[3] Completeness of number of registered arthroplasties in the LROI in September 2017, compared to the total number of arthroplasties performed (based on the hospital information system) in 2016. This pertains only to hospitals that submitted data for comparison.



**Vektis is a care information centre. Vektis collects and analyses data on the costs and quality of health care in the Netherlands. Vektis data mainly originates from reimbursement files of 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 (DBCs/DOT) 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].**

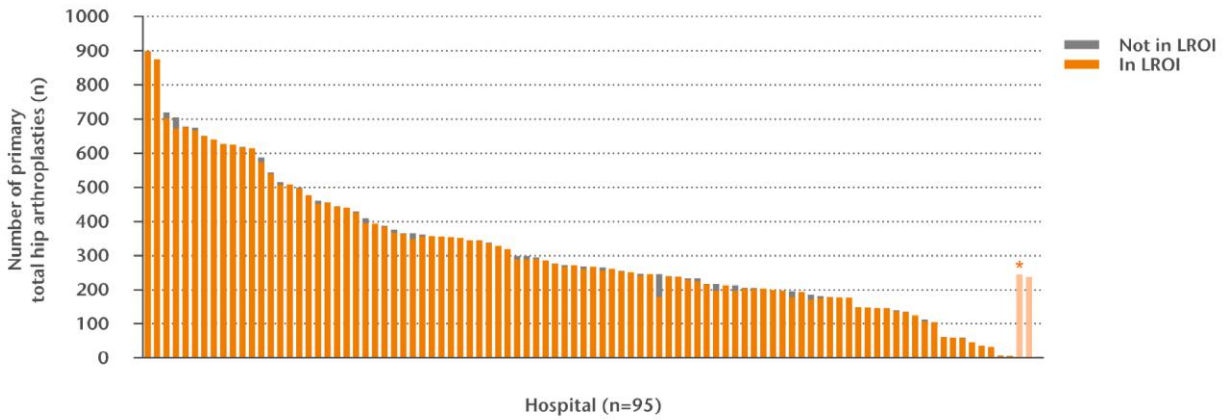
[1] www.vektis.nl

# Completeness per hospital

## Hip

### Primary total hip arthroplasties

**FIGURE 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 IN 2016.**

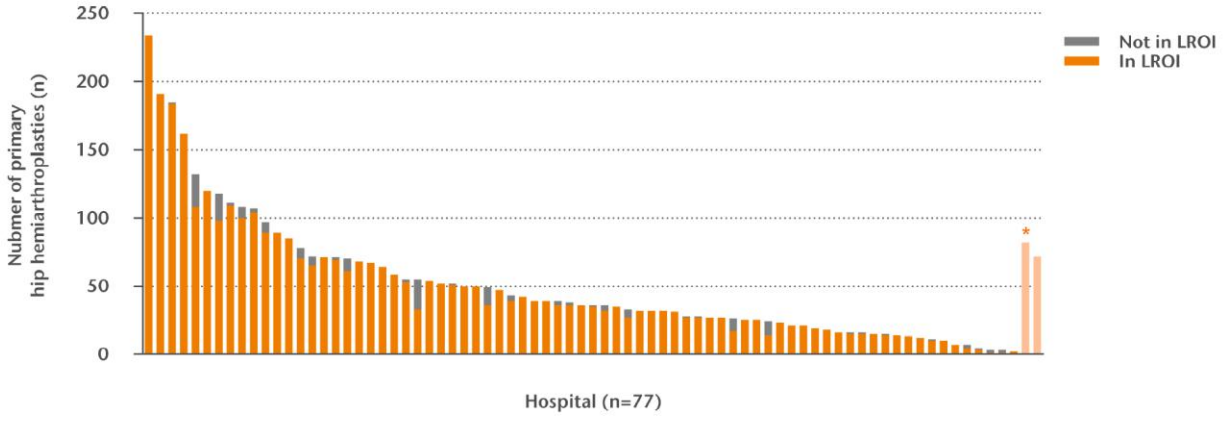



* No data provided for comparison by the hospital.
Please note: In the LROI, four hospitals have two separate locations. Data for comparison for these locations were combined.



### Primary hip hemiarthroplasties (orthopaedic surgeon)

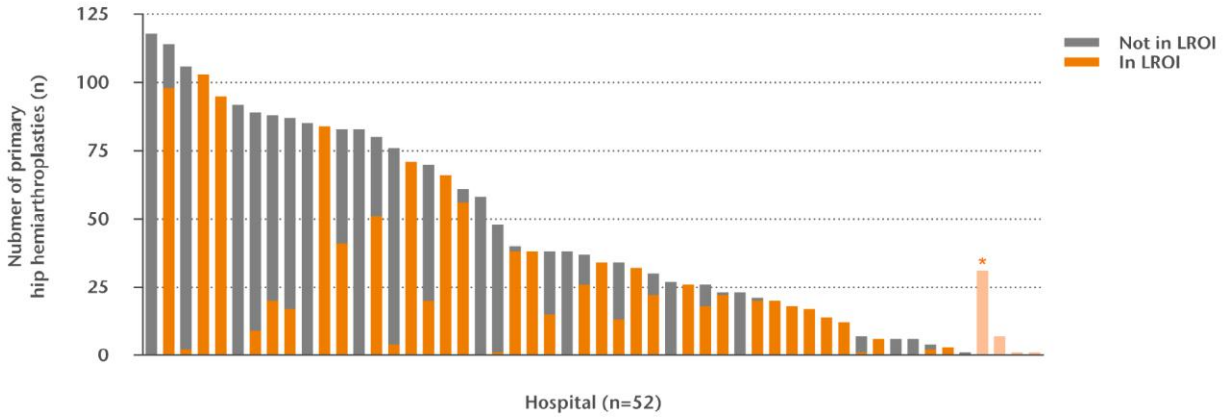
**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR PRIMARY HIP HEMIARTHROPLASTIES (PERFORMED BY AN ORTHOPAEDIC SURGEON) IN 2016.**




* No data provided for comparison by the hospital.
Please note: In the LROI, two hospitals have two separate locations. Data for comparison for these locations were combined.
Please note: 3 hospitals registered a hip hemiarthroplasty in the LROI but not in the hospital information system.

## Primary hip hemiarthroplasties (trauma surgeon)

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR PRIMARY HIP HEMIARTHROPLASTIES (PERFORMED BY A TRAUMA SURGEON) IN 2016.**

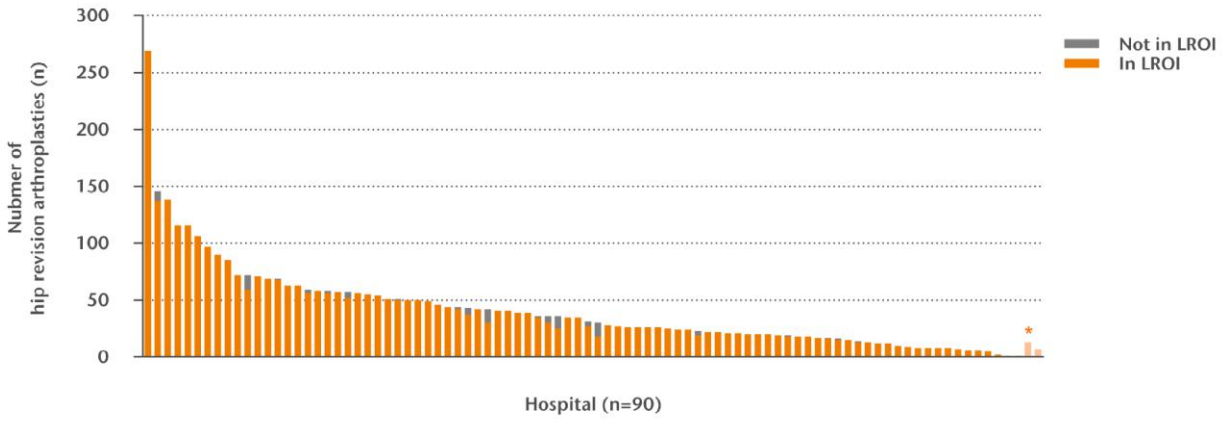



* No data provided for comparison by the hospital.
Please note: In the LROI, one hospital has two separate locations. Data for comparison for these locations were combined.
Please note: 3 hospitals registered a hip hemiarthroplasty in the LROI but not in the hospital information system.



## Hip revision arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR HIP REVISION ARTHROPLASTIES IN 2016.**

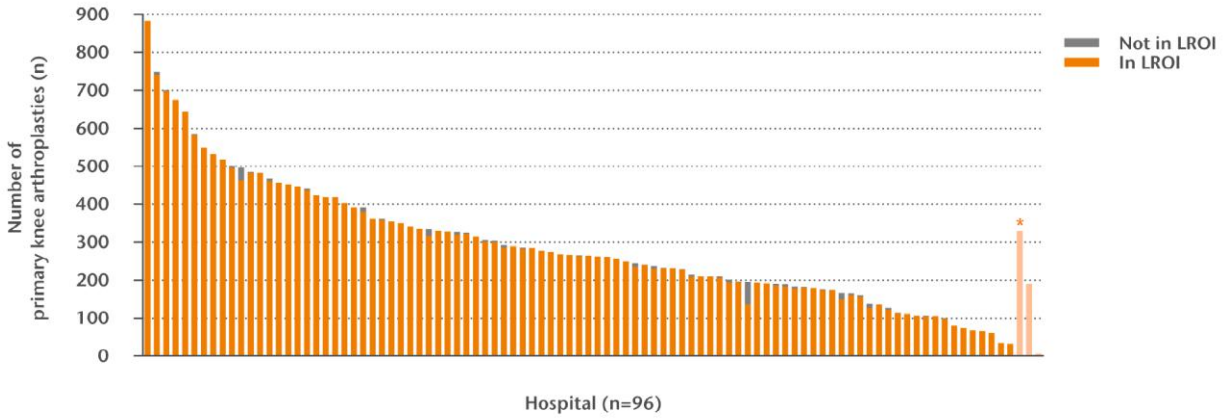



* No data provided for comparison by the hospital.
Please note: In the LROI, four hospitals have two separate locations. Data for comparison for these locations were combined.

# Knee

## Primary knee arthroplasties

**FIGURE 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 IN 2016.**

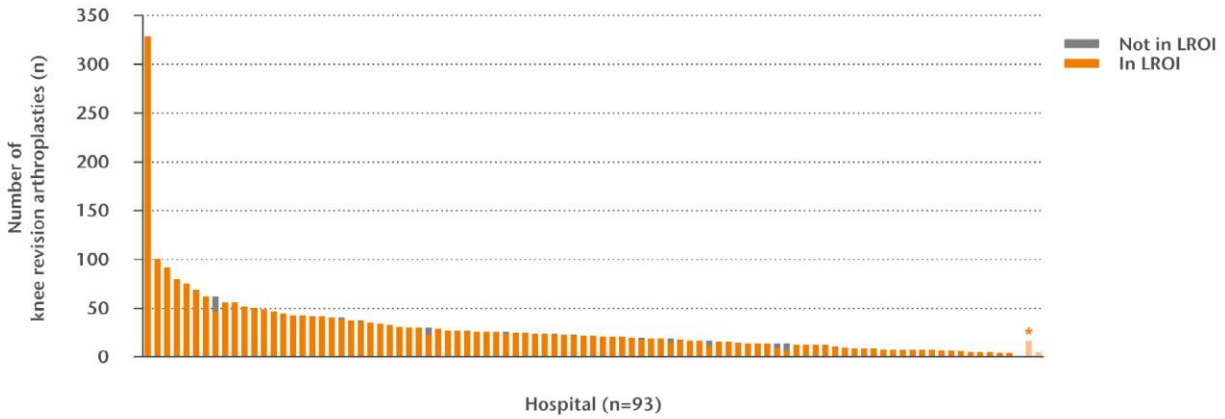



* No data provided for comparison by the hospital.
Please note: In the LROI, four hospitals have two separate locations. Data for comparison for these locations were combined.



## Knee revision arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR KNEE REVISION ARTHROPLASTIES IN 2016.**

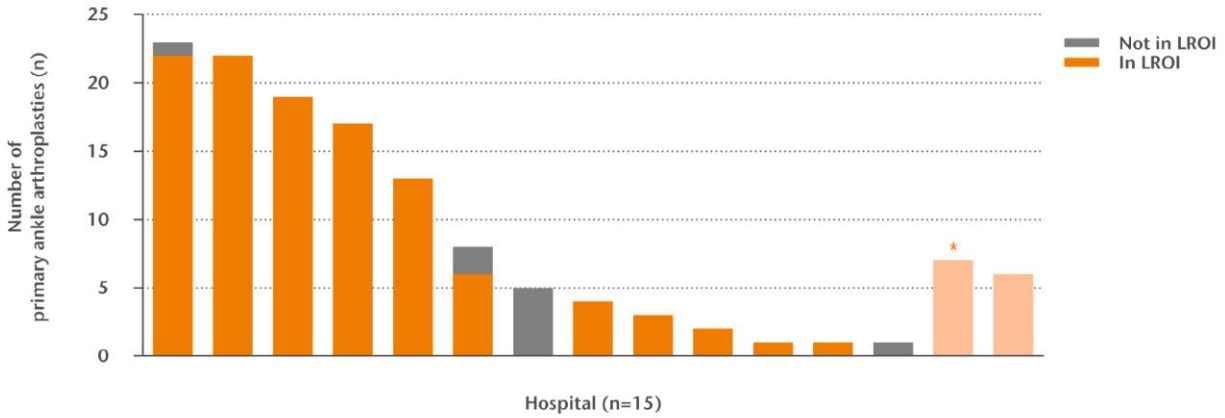



* No data provided for comparison by the hospital.
Please note: In the LROI, four hospitals have two separate locations. Data for comparison for these locations were combined.
Please note: 1 hospital registered a knee revision arthroplasty in the LROI but not in the hospital information system.

# Ankle

## Primary ankle arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR PRIMARY ANKLE ARTHROPLASTIES IN 2016.**

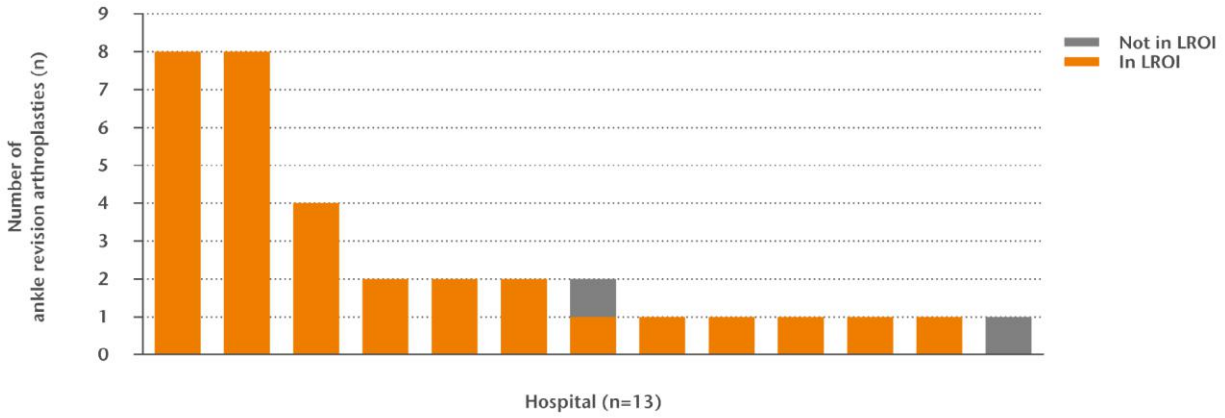



* No data provided for comparison by the hospital.
Please note: In the LROI, two hospitals have two separate locations. Data for comparison for these locations were combined.
Please note: 1 hospital registered a primary ankle arthroplasty in the LROI but not in the hospital information system.



## Ankle revision arthroplasties

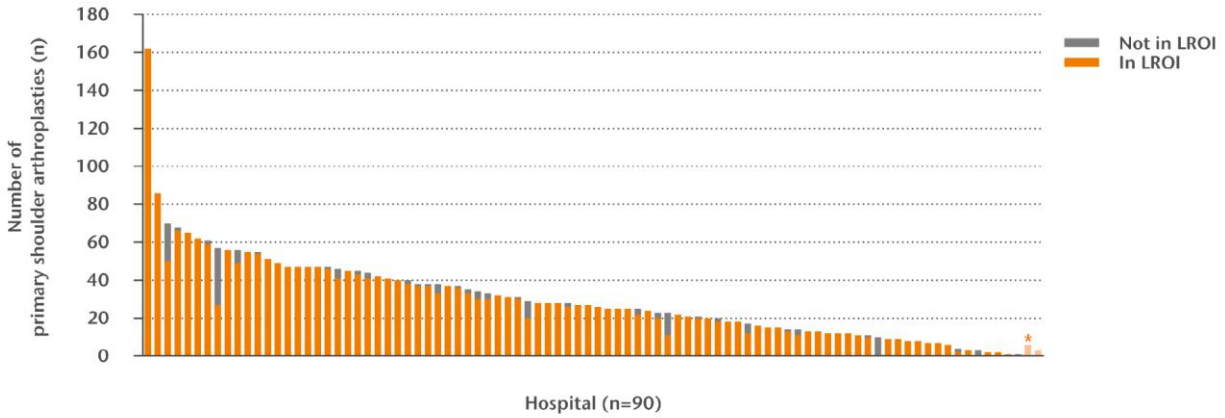
**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR ANKLE REVISION ARTHROPLASTIES IN 2016.**



# Shoulder

## Primary shoulder arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR PRIMARY SHOULDER ARTHROPLASTIES IN 2016.**

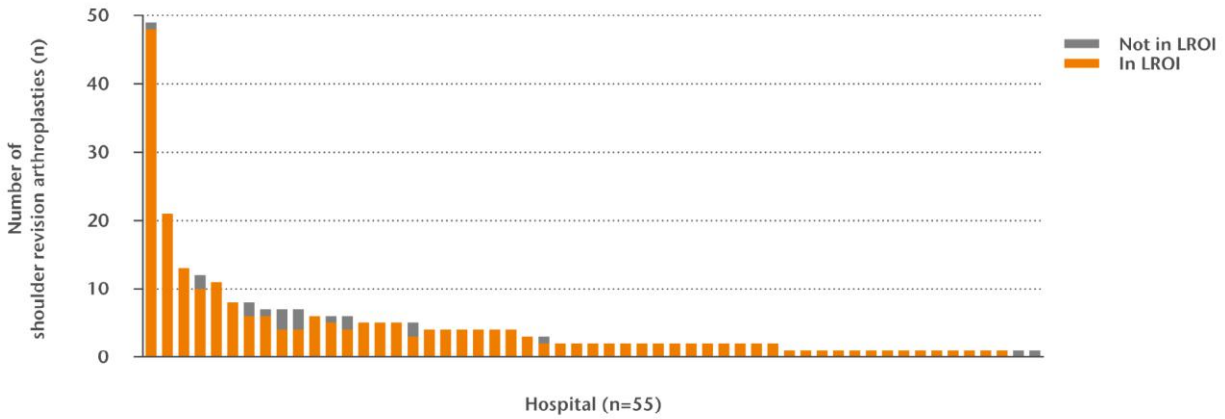



* No data provided for comparison by the hospital.
Please note: In the LROI, three hospitals have two separate locations. Data for comparison for these locations were combined.



## Shoulder revision arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR SHOULDER REVISION ARTHROPLASTIES IN 2016.**

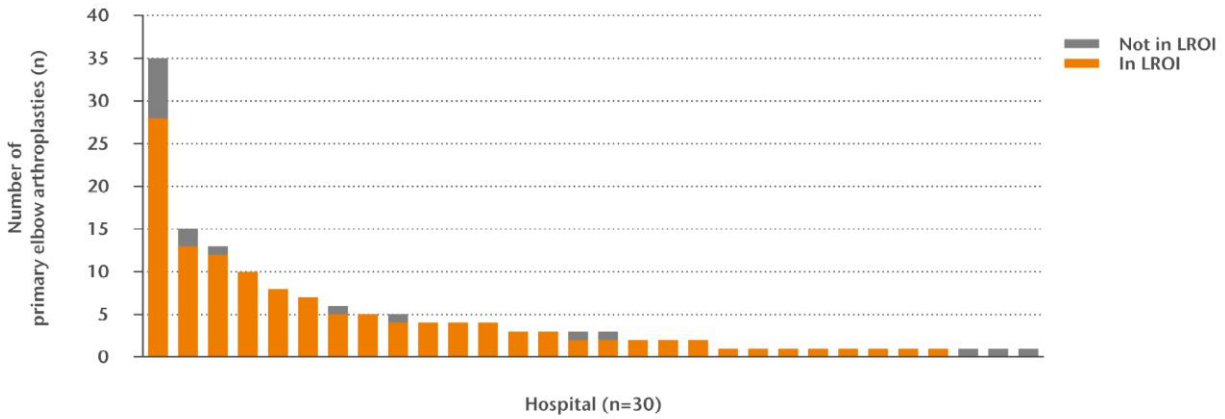



* No data provided for comparison by the hospital.
Please note: In the LROI, one hospital has two separate locations. Data for comparison for these locations were combined.
Please note: 8 hospitals registered a shoulder revision arthroplasty in the LROI but not in the hospital information system.

# Elbow

## Primary elbow arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR PRIMARY ELBOW ARTHROPLASTIES IN 2016.**

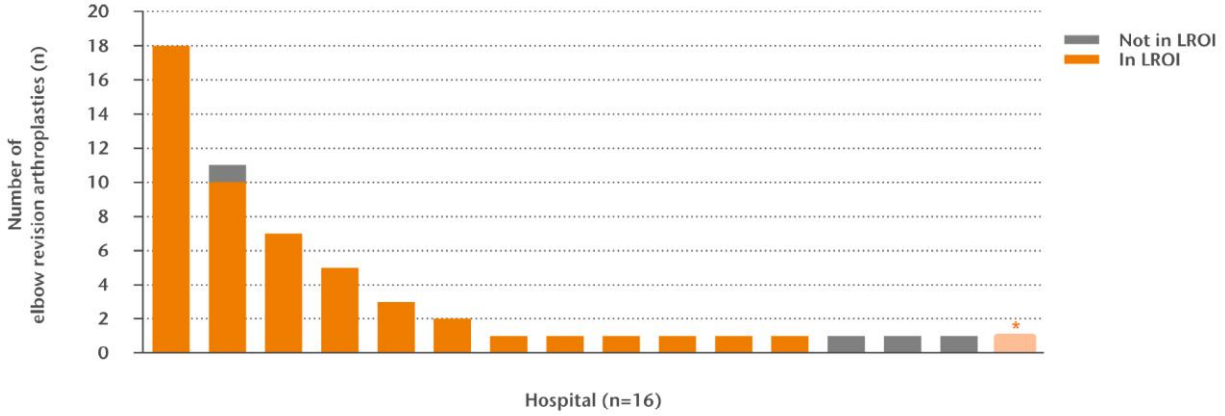



* No data provided for comparison by the hospital.
Please note: In the LROI, one hospital has two separate locations. Data for comparison for these locations were combined.
Please note: 2 hospitals registered a primary elbow arthroplasty in the LROI but not in the hospital information system.



## Elbow revision arthroplasties

**FIGURE NUMBER OF PROCEDURES PERFORMED (BASED ON THE HOSPITAL INFORMATION SYSTEM) AND THE NUMBER OF REGISTERED PROCEDURES IN THE LROI PER HOSPITAL FOR ELBOW REVISION ARTHROPLASTIES IN 2016.**

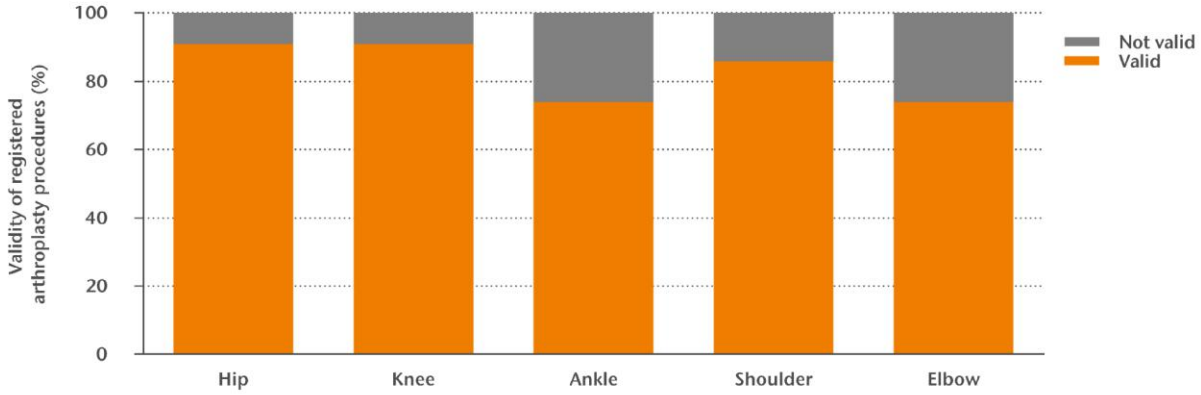



* No data provided for comparison by the hospital.
Please note: In the LROI, one hospital has two separate locations. Data for comparison for these locations were combined.

# Validity

## Overall validity

**FIGURE VALIDITY (PROPORTION [%] PER JOINT) OF THE REGISTRATION OF PROCEDURES IN THE LROI IN 2016.**




| | Hip | Knee | Ankle | Shoulder | Elbow |
|---|---|---|---|---|---|
| Number of procedures (n) | 38,763 | 30,804 | 163 | 2,857 | 184 |
| Validity registered procedures (%) | 91.1 | 90.6 | 74.2 | 86.2 | 73.9 |

## Validity per variable

**TABLE OVERVIEW OF VALIDITY BY VARIABLE FOR EACH JOINT OF HIP, KNEE, ANKLE, SHOULDER AND ELBOW ARTHROPLASTIES REGISTERED IN THE LROI IN THE NETHERLANDS IN 2016.**

| | Hip | Knee | Ankle | Shoulder | Elbow |
|---|---|---|---|---|---|
| Number of arthroplasties[1] (n) | 38,763 | 30,804 | 163 | 2,857 | 184 |
| Number of primary arthroplasties (n) | 34,927 | 27,918 | 126 | 2,588 | 132 |
| Number of revision arthroplasties (n) | 3,836 | 2,886 | 37 | 269 | 52 |
| General characteristics | % | % | % | % | % |
| Gender | 99.9 | 100.0 | 100.0 | 99.9 | 100.0 |
| Encrypted citizen service number | 96.1 | 95.7 | 79.8 | 92.2 | 87.0 |
| HIS patient number | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Date of birth | 99.9 | 99.9 | 100.0 | 100.0 | 100.0 |
| Type of procedure | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Operating side | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Postal code | 99.5 | 99.5 | 98.8 | 98.8 | 81.5 |
| BMI | 98.3 | 99.2 | 95.1 | 98.3 | 82.6 |
| Smoking | 97.0 | 97.0 | 96.9 | 98.4 | 96.2 |
| ASA score | 99.4 | 99.5 | 98.1 | 99.2 | 98.9 |
| Fixation | 99.4 | 99.5 | 96.3 | 99.0 | 98.4 |
| Primary arthroplasty characteristics | % | % | % | % | % |
| Diagnosis | 99.6 | 99.6 | 99.2 | 99.4 | 98.5 |
| Charnley/Walch score | 98.6 | 99.0 | 98.4 | 95.9 | n.a. |
| Prosthesis | 99.7 | 99.6 | 99.2 | 99.3 | 93.9 |
| Surgical approach | 99.6 | 99.6 | 98.4 | 99.3 | 98.5 |
| Revision arthroplasty characteristics | % | % | % | % | % |
| Type of revision | 99.1 | 98.1 | 89.2 | 95.9 | 100.0 |
| Charnley/Walch score | 96.9 | 97.6 | n.a. | n.a. | n.a. |
| Reason for revision | 98.8 | 99.3 | 91.9 | 97.0 | 100.0 |

Please note: Validity by variable as determined in June 2016.
HIS: hospital information system; BMI: body mass index.

# General

## Traceability

Since 2015, the National Cardiovascular Data Registry (NCDR), the Dutch Breast Implant Registry (DBIR), the registration of gynaecologic meshes and the LROI have been connected to the National Implant Registry (LIR) of the Ministry of Health, Welfare and Sport (VWS). Though this, the traceability of implants has been organized out of existing quality registers of cardiology, gynaecology and plastic surgery and orthopaedics.
Besides these implants, there are also implants that are not currently registered in a quality register, for example cochlear implants, lenses of the eye, and neurological implants. The Ministry of VWS has decided that hospitals should provide traceability data directly from their Electronic Patient Record System (EPRs) to the LIR per July 1st 2018. The Ministry has placed the implants concerned on an inclusion list of implants. This list also lists orthopaedic implants that are already registered in the LROI.
Since hospitals will provide implant data directly from the EPRs to the LIR per July 1st 2018, the quality registers of scientific associations (including LROI) will no longer provide data to the LIR from that date. The LIR will receive data from the EPRs. However, quality registers like the LROI remain necessary to provide us with more insight into implant outcomes, since the data for these outcomes are not measured by the LIR.

# Methodology of survival analyses

## Methodology of survival analyses

The life span of a joint prosthesis is the time between implantation of a primary prosthesis and the time of the first revision. However, patients may die before the prosthesis needs to be revised (Figure).

**Link between primary and revision arthroplasties**

In order to assess a prosthesis' life span, follow-up time of all primary prostheses was examined. This was done by linking revision arthroplasties to the primary arthroplasties in the LROI by means of the encrypted Citizen Service Number (BSN). In this way, the correct revision arthroplasty can be linked anonymously to a primary arthroplasty. In about 11% of the arthroplasties, the encrypted BSN was not entered into the system, mainly in the first years of registration. Links between these primary and revision arthroplasties were established based on the LROI hospital number and the LROI patient number. As such, revision arthroplasties have been linked to primary arthroplasties of a patient when the patient underwent primary and revision arthroplasty on the same joint in the same hospital.

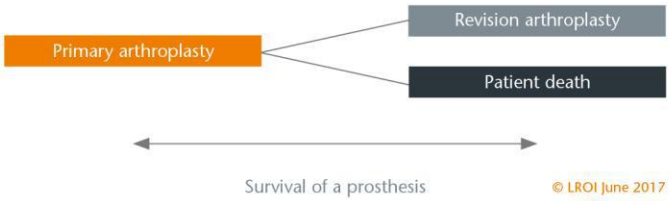
**Kaplan Meier survival analysis**

Survival of a prosthesis may be determined in various ways. Traditionally, the Kaplan Meier method is used. This method was developed for situations with one possible end point (such as death of the patient). However, in order to calculate survival of a prosthesis at least two end points are important: revision of the prosthesis and death of the patient. The Kaplan Meier method estimates the proportion of failed prostheses if patients would live on forever. However, a number of patients dies before the prosthesis requires revision. Consequently, fewer revisions are carried out than could be expected based on the model. That is why this method overrates the chance of revision.

**Competing risk survival analysis**

The competing risk method allows monitoring for several end points. When an end point occurs (such as death), other end points will no longer be available (such as prosthesis revision). The cumulative incidence (summed occurrence of an end point) will be calculated. Death of a patient is a final end point, the prosthesis will no longer be revised and this finalizes the period that a prosthesis lasts. The time at risk will be the period from primary implantation to death.

**FIGURE SURVIVAL OF A PROSTHESIS.**




**Method comparison**

In order to get a clearer picture of the difference in results between the Kaplan Meier method and competing risk method we have calculated the revision percentage within 8 years using both methods. The revision percentage was calculated for patients who underwent a total hip arthroplasty according to age group over the period 2007-2016.

This comparison shows that the revision percentage calculated by means of the Kaplan Meier method results in a higher chance of revision within 8 years. The difference is more pronounced in groups of patients with a higher chance of the competing event (death of the patient), as we can see in the groups of elderly patients (Table). This difference is still relatively minor, but will increase as follow-up extends. Consequently, this Annual Report estimates the chance of revision of a prosthesis by means of the competing risk method. However, for comparability with other arthroplasty registries Kaplan Meier revision rates are also shown.

**TABLE CUMULATIVE 8-YEAR REVISION PERCENTAGE OF PRIMARY TOTAL HIP ARTHROPLASTIES BY AGE IN THE NETHERLANDS IN 2007-2016.**

| | | Cumulative 8-year revision percentage | |
|---|---|---|---|
| | Number (n) | Competing risk (95% CI) | Kaplan Meier (95% CI) |
| Age (years) | | | |
| <50 | 10,165 | 7.0 (6.2-7.8) | 7.1 (6.3-7.9) |
| 50-59 | 27,931 | 6.0 (5.6-6.5) | 6.1 (5.7-6.6) |
| 60-69 | 72,516 | 4.7 (4.5-5.0) | 5.0 (4.6-5.2) |
| 70-79 | 82,027 | 3.8 (3.6-4.0) | 4.1 (3.8-4.3) |
| ≥80 | 34,265 | 2.7 (2.5-2.9) | 2.9 (2.7-3.2) |

Please note: The primary outcome in a Kaplan Meier analysis is prosthesis survival, while this is the revision percentage of prostheses in the competing risk method. In order to compare methods, survival as determined by means of the Kaplan Meier analysis is converted into the revision percentage (100% - survival% = revision%).
CI: confidence interval.

# Developments: LROI in 2016 and 2017

## Anniversary year

2017 marks the 10th anniversary of the LROI. During the annual congress and spring congress of the Netherlands Orthopaedic Association (NOV), we have devoted considerable attention to this fact in the programming. Moreover, we reached the special milestone of 500.000 registered orthopaedic implants, just before the beginning of the anniversary year. The 500.000th prosthesis was registered by Noordwest Ziekenhuisgroep (Alkmaar). During the annual NOV congress, they were celebrated for this. During the same congress, professor Ronald Brand (LUMC) received a reward as gratitude for his long-term commitment to the LROI. Furthermore, we awarded the Van Rens prize to dr. Loes Janssen (VieCuri Medisch Centrum) for her lecture on the effect of femoral design and surgical approach on the survival of an uncemented femur of a hip arthroplasty.

## New environment

For a year, the LROI has been running in a new digital environment (Reports). A lot of attention has been paid to the ease of use of the registration system, for example by the introduction of barcode scanners. Where one previously had to enter the prosthesis code manually, this is now done by scanning a barcode. As a result, typing errors are no longer possible and the registration of a procedure is less time consuming: it saves minutes per procedure. Based on 60,000 newly registered procedures per year, this is a phenomenal gain in time for hospitals!
Through the renewed LROI dashboard, hospitals receive feedback on the outcomes of orthopaedic care. For example, a hospital can (anonymously) compare their 1-year revision rate with other hospitals. Furthermore, it is possible to compare PROMs outcomes in an anonymous benchmark.

## Clinical documentation at the point of care; one-time registration and multiple use

The LROI was one of the implementation pilots of the programme *Clinical documentation at the point of care (In Dutch: Registratie aan de Bron).* In this programme, the information entered into an electronic patient record system (EPRs) is reused for registration in the LROI. This way, the registration burden and the risk of making errors decrease. Chipsoft (EPRs) and Rivas Zorggroep (hospital) have built in the health and care information models (HCIMs), necessary for registration in the LROI, in their EPRs. Rivas Zorggroep is able to automatically deliver the data to the LROI. A lot of knowledge has been gathered about incorporating HCIMs into an EPR, the usefulness of HCIMs for the LROI and how they can eventually fill the registration in the LROI. In April 2017, the pilot was successfully completed. Other hospitals may start using these methods as well.

## LROI data suitable for ODEP application

ODEP (Orthopaedic Data Evaluation Panel) is an international organization that classifies hip, knee and shoulder prostheses based on survival data. A manufacturer who can show that 95% of a certain type of prosthesis has not yet been revised after five years for example, gets rated an ODEP 5A classification for that particular prosthesis.
The LROI has now been collecting data from orthopaedic implants for 10 years. Among other things, we calculate the survival of prostheses with this data. Manufacturers can use these data and calculations for an ODEP application. In the past year, the first manufacturers have applied for an ODEP rating based on LROI data. The contribution of the LROI to ODEP classification provides the manufacturer, the patient and the orthopaedic surgeon with even more insight into the quality of the prosthesis.

## Outliers procedure

The NOV highly values quality of care and has determined an *outliers procedure* in 2017. If a prosthesis or hospital is determined to be an outlier, because of a prominent revision rate for example, the association will initiate this procedure. The NOV will take a closer look at the outlier with the concerned orthopaedic department, to find a possible explanation. If necessary, an improvement plan will be drawn up and improvement will be monitored. This way, the LROI serves as an instrument to regulate internal quality control and to improve quality of orthopaedic care even more.

## Overall picture orthopaedic patient

Since 2007, orthopaedic implants are registered in the LROI. With the registration of patient reported outcome measures (PROMs), she has now further expanded as a quality register. The NOV has also taken steps to register orthopaedic operations. Examples include the registration of surgery for orthopaedic conditions in children (such as lump foot treatment), foot and ankle disorder and surgery in patients with osteoarthritis. The registration system for this is under development, with the LROI serving as a blueprint. This way, a more complete overall picture of the orthopaedic patient will be created.

# Definitions and abbreviations

## Definitions

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

**Allograft**
Transplant of bone tissue from a different body

**Arthrodesis**
A procedure in which a natural joint is fused together

**Arthrofibrosis**
Rigidity of the joint as a consequence of connective tissue adhesion

**Arthroscopy**
Keyhole surgery to examine and treat joint disorders

**Arthrotomy**
Opening a joint during surgery

**Articulation**
The two surfaces that move together (articulate) in a total 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: I – fit and healthy; II – mild disease, not incapacitating; III – incapacitating systemic disease; IV – life threatening disease

**Autograft**
Transplant of bone tissue originating from the patient's own body

**Bilaterality**
Replacing the same joint on both sides of the body by means of a prosthesis within a specific period

**Body Mass Index**
Index for weight compared to body length (kg/m2); ≤18.5: underweight; >18.5-25: normal weight; >25-30: overweight; >30-40: obesity; >40: morbid obesity

**Bonegraft**
Bone transplant

**Case mix**
Term used to describe variation in the population, relating to factors such as diagnosis, patient age, gender and health condition

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

**Charnley score**
Clinical classification system; A: one joint affected; B1: both joints affected; B2: contralateral joint with a prosthesis; C: several joints affected or a chronic disease that affects quality of life

**Competing risk survival analyse**
Method to calculate survival taking into account various outcomes, in this case revision and death

**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

**Cuff arthropathy**
Osteoarthritis of the shoulder joint as a consequence of the tendons around the shoulder joint being affected

**Cuff rupture**
Rupture of a tendon of the muscles that are around the shoulder joint

**Cumulative incidence**
Added up incidence over a specific period of an event (such as revision of a prosthesis or death of a patient)

**Cumulative revision percentage**
Added up revision percentage over a specific period

**Difference score**
Difference in calculating score between pre-operative and 3 months postoperative scores

**Distal hemihumeral prosthesis**
Elbow prosthesis in which the distal part of the humerus (upper arm bone) is replaced

**Dual mobility cup**
Acetabular component that consists of a dual cup and, therefore, has two independent articulation points

**EQ-5D index score**
The EQ-5D index score measures quality of life. The score has a range of -0.329 to 1.0, with 1.0 representing the best possible quality of life.

**EQ-5D thermometer score**
The EQ-5D thermometer score measures the health situation. The score has a range of 0.0 to 100.0, with 0.0 representing the worst possible health situation and 100.0 the best possible health situation.

**Femur component**
Part of a hip or 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

**Flail elbow**
Situation after removal of an elbow prosthesis in which no joint is present any more between the upper and lower arm

**Girdlestone situation**
Revision procedure to a hip in which the hip joint or hip prosthesis is removed and no new prosthesis is implanted (often because of a bacterial infection)

**Glenoid baseplate**
Part of a reversed shoulder prosthesis: a metal plate that is screwed into the glenoid (shoulder cup) of the shoulder blade, on which the glenosphere is fixed

**Glenoid component**
The part of a shoulder prosthesis that is placed in the glenoid; the cup-shaped notch of the shoulder blade

**Glenoid liner**
Intermediate component (inside layer) of a total anatomical shoulder prosthesis that will be placed in a glenoid component (most often a metal one)

**Glenosphere**
The part of a reversed shoulder prosthesis that is placed on the glenoid baseplate which is screwed into the glenoid and is spherical in shape

**HOOS-PS score**
The HOOS-PS score measures the physical functioning of patients with osteoarthritis to the hip. The score has a range of 0.0 to 100.0, with 0.0 representing no effort and 100.0 the most possible effort.

**Hybrid fixation**
Fixation of a prosthesis in which (most often) one of both parts of a prosthesis is cemented and the other one uncemented

**Humerus component**
The part of a shoulder or elbow prosthesis that replaces the humerus (upper arm bone). The humeral component of a shoulder prosthesis may consist of two parts: the humeral head and the humeral stem component

**Humeral liner**
Intermediate component (inside layer) of a reversed shoulder prosthesis that will be placed in a metaphysical component

**Inlay**
Intermediate component (inner layer), made of polyethylene

**Insert**
Intermediate component (inner layer), made of polyethylene that is placed in the tibial component of a knee prosthesis

**Kaplan Meier survival analysis**
Method to calculate survival, in which only one end point is possible, in this case revision

**KOOS-PS score**
The KOOS-PS score measures the physical functioning of patients with osteoarthritis to the knee. The score has a range of 0.0 to 100.0, with 0.0 representing no effort and 100.0 the most possible effort.

**Lateral collateral ligament**
Lateral (outer) knee ligament or elbow ligament

**Lateral resurfacing arthroplasty**
Elbow prosthesis in which only the lateral side of the joint is replaced

**Malalignment**
Strain on a part of the body due to an abnormal position of a joint component with respect to other components

**Medial malleolus osteotomy**
Surgical approach of the ankle in which the medial malleolus (protruding part of the tibia on the inside of the ankle) is incised and later re-fixed to be able to have better access to the inside of the joint

**Meniscectomy**
Meniscus removal

**Metallosis**
Deposition of metal debris in soft tissues of the body

**Metaphysis component**
The part of a shoulder prosthesis that replaces the metaphysis (upper part) of the humerus (upper arm bone)

**NRS score**
Numeric Rating Scale score. The NRS (rest) score measures pain during rest. The NRS (activity) score measures pain during activity. The score has a range of 0.0 to 10.0, with 0.0 representing no pain and 10.0 representing the most possible pain.

**Olecranon**
The most proximal part of the ulna

**Osteoarthritis**
Disorder in which the cartilage of a joint is affected

**Osteochondral bone defect**
Defect of the joint surface in which both cartilage and underlying bone are affected

**Osteonecrosis**
Cellular death of bone tissue

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

**Osteotomy**
Incise the bone in order to correct the position, to shorten or lengthen the bone

**Oxford Hip score**
The Oxford Hip score measures the physical functioning and pain of patients with osteoarthritis to the hip. The score has a range of 12.0 to 60.0, with 12.0 representing no functional disability and 60.0 the most possible functional disability.

**Oxford Knee score**
The Oxford Knee score measures the physical functioning and pain of patients with osteoarthritis to the knee. The score has a range of 0.0 to 48.0, with 0.0 representing the most possible functional disability and 48.0 no functional disability.

**Patella component**
Part of a knee prosthesis that is implanted on the inner side of the knee cap

**Patellofemoral prosthesis**
Two-piece knee prosthesis that provides a prosthetic (knee) articulation surface between the patella and trochlea (furrow) of the thigh bone (femur)

**Primary prosthesis**
The first time (primary) a prosthesis is implanted to replace the original joint

**PROMs**
Patient Reported Outcome Measures

**Radial head component**
Part of an elbow prosthesis that replaces the head of the radius (spoke-bone)

**Radial head prosthesis**
Elbow prosthesis in which only the head of the radius (spoke-bone) is replaced

**Radial stem component**
Part of an elbow prosthesis that is implanted in the shaft of the patient's radius (spoke-bone)

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

**Resurfacing shoulder arthroplasty**
Shoulder prosthesis in which a metal cap is implanted on top of the humeral head

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

**Reversed shoulder prosthesis**
Adjusted type of total shoulder arthroplasty in which the parts are implanted in a reversed manner. A sphere (glenosphere) is implanted onto the glenoid and a stem with cup in the shaft of the shoulder head

**Revision arthroplasty**
Any change (insertion, replacement and/or removal) of one or more components of the prosthesis

**Shoulder hemiarthroplasty**
Shoulder hemiarthroplasty with humeral stem, stemless hemi shoulder prosthesis (without humeral stem) or resurfacing shoulder hemiarthroplasty

**Synovectomy**
Removal of inflamed mucosa in a joint

**Talus component**
Part of an ankle prosthesis that is inserted in the talus (ankle bone) of a patient

**Tibia component**
Part of a knee or ankle prosthesis that is inserted in the tibia (shin bone) of a patient

**Total arthroplasty**
Arthroplasty in which the entire joint of a patient is replaced

**Ulnar component**
Part of an elbow prosthesis that is inserted in the ulna of a patient

**Ulnar nerve**
One of the three nerves that runs along the elbow. This nerve largely runs along the ulna

**Unicondylar knee arthroplasty**
Replacement of half the knee (either inner or outer side) by a prosthesis

**Validity**
Level of accuracy and completeness of registered data

**Walch score**
Clinical classification system for level and type of wear of a shoulder joint; A1: humeral head centred, minimal erosion of shoulder cup; A2: humeral head centred, substantial erosion of shoulder cup; B1: Posterior subluxation of humeral head, posterior joint cavity narrow, subchondral sclerosis and osteophytes; B2: posterior subluxation of humerus head, retroversion of shoulder cup with posterior erosion; C: retroversion of shoulder cup over 25 degrees, irrespective of erosion

## Abbreviations

| | |
|---|---|
| **ASA** | American Society of Anaesthesiologists |
| **BMI** | Body Mass Index |
| **CI** | Confidence Interval |
| **DBIR** | Dutch Breast Implant Registry |
| **EPRs** | Electronic Patient Record System |
| **HCIM** | Health and Care Information Models |
| **HIS** | Hospital Information System |
| **LIR** | Dutch Implant Register |
| **LROI** | Dutch Arthroplasty Register |
| **NCDR** | National Cardiovascular Data Registry |
| **NOV** | Netherlands Orthopaedic Association |
| **NRS** | Numeric Rating Scale |
| **NVOG** | Dutch Society for Obstetrics and Gynaecology |
| **ODEP** | Orthopaedic Data Evaluation Panel |
| **PE** | Polyethylene |
| **PROM** | Patient Reported Outcome Measure |
| **SD** | Standard Deviation |
| **TEA** | Total Elbow Arthroplasty |
| **THA** | Total Hip Arthroplasty |
| **TKA** | Total Knee Arthroplasty |
| **TSA** | Total Shoulder Arthroplasty |
| **UMC** | University Medical Centre |
| **VWS** | [Ministry of] Health, Welfare and Sport |

# Participating hospitals

## General hospitals

Admiraal de Ruyter ziekenhuis H(O+T) K A S
Albert Schweitzer Ziekenhuis H(O+T) K S
Alrijne, location Diaconessenhuis Leiden H(O) K S
Alrijne, location Rijnland Ziekenhuis H(O) K S
Amphia Ziekenhuis H(O) K S E
Antonius Ziekenhuis H(O) K S
BovenIJ Ziekenhuis H(O+T) K
Bravis Ziekenhuis, location Franciscus Ziekenhuis H(O) K S E
Bravis Ziekenhuis, location Lievensberg Ziekenhuis H(O) K A S E
Canisius Wilhelmina Ziekenhuis H(O) K S
Catharina Ziekenhuis H(O) K S
Deventer Ziekenhuizen H(O+T) K S
Diakonessenhuis Utrecht H(O+T) K S E
Elisabeth-TweeSteden Ziekenhuis, location Sint Elisabeth Ziekenhuis H(O) K S E
Elisabeth-TweeSteden Ziekenhuis, location TweeSteden Ziekenhuis H(O) K S E
Elkerliek Ziekenhuis H(O) K S
Flevoziekenhuis H(O+T) K S E
Franciscus Gasthuis & Vlietland, location Sint Franciscus Gasthuis H(O) K S
Franciscus Gasthuis & Vlietland, location Vlietland Ziekenhuis H(O+T) K S
GelreZiekenhuizen, location Apeldoorn H(O+T) K S
GelreZiekenhuizen, location Zutphen H(O) K S E
Groene Hart Ziekenhuis H(O) K S
HagaZiekenhuis H(O+T) K A S
Havenziekenhuis H(O) K
Het Van Weel-Bethesda Ziekenhuis H(O+T) K S
IJsselland Ziekenhuis H(O+T) K S
Ikazia Ziekenhuis H(O) K S
Isala H(O+T) K S
Isala Diaconessenhuis Meppel H(O+T) K S
Jeroen Bosch Ziekenhuis H(O+T) K S E
LangeLand Ziekenhuis H(O+T) K S
Laurentius Ziekenhuis H(O) K A S E
Maasstad Ziekenhuis H(O) K S E
Martini Ziekenhuis H(O) K A S E
Máxima Medisch Centrum H(O) K S E
MC Zuiderzee H(O+T) K S
Meander Medisch Centrum H(O+T) K S
Medisch Centrum Haaglanden H(O+T) K S
Medisch Centrum Leeuwarden H(O+T) K S E
Medisch Spectrum Twente H(O) K S E
Noordwest Ziekenhuisgroep, location Gemini Ziekenhuis H(O+T) K S
Noordwest Ziekenhuisgroep, location Medisch Centrum Alkmaar H(O+T) K A S E
OCON H(O) K S
OLVG, locations Oost and West H(O) K A S E
Ommelander Ziekenhuisgroep H(O+T) K S
Reinier de Graaf Groep H(O+T) K S E
Rivas Zorggroep H(O) K S
Rode Kruis Ziekenhuis H(O+T) K S
Röpcke Zweers Ziekenhuis H(O+T) K S

Sint Maartenskliniek, location Boxmeer H(O) K E
Sint Maartenskliniek, location Nijmegen H(O) K A S E
Sint Maartenskliniek, location Woerden H(O) K A S E
Slingeland Ziekenhuis H(O+T) K S
Slotervaart Ziekenhuis H(O+T) K A S E
Spaarne Gasthuis H(O) K A S
Spijkenisse Medisch Centrum H(O) K S
St. Anna Ziekenhuis H(O) K S E
St. Antonius Ziekenhuis H(O) K S
St. Jans Gasthuis H(O+T) K S E
Streekziekenhuis Koningin Beatrix H(O) K S
Tergooi Ziekenhuizen H(O) K S E
Treant Zorggroep, location Refaja Ziekenhuis H(O+T) K S
Treant Zorggroep, location Scheper Ziekenhuis H(O+T) K S
Treant Zorggroep, location Bethesda Ziekenhuis H(O) K
VieCuri MC H(O+T) K S E
Waterlandziekenhuis H(O) K S
Westfriesgasthuis H(O+T) K S
Wilhelmina Ziekenhuis H(O+T) K S E
Zaans Medisch Centrum H(O) K A S
Ziekenhuis Amstelland H(O+T) K A S
Ziekenhuis Bernhoven H(O) K S E
Ziekenhuis Gelderse Vallei H(O+T) K S
Ziekenhuis Nij Smellinghe H(O) K S
Ziekenhuis Rijnstate H(O+T) K S
Ziekenhuis Rivierenland H(O+T) K S
Ziekenhuis St. Jansdal H(O) K S
Ziekenhuis Tjongerschans H(O+T) K S
ZiekenhuisGroep Twente H(T)
ZorgSaam Zeeuws-Vlaanderen H(O) K S
Zuyderland, location Atrium MC H(O+T) K S E
Zuyderland, location Orbis Medisch Zorgconcern H(O) K

H: hip; O: orthopaedic surgery; T: trauma surgery; K: knee; A: ankle; S: shoulder; E: elbow.

## University medical centres

Academisch Medisch Centrum Amsterdam H(O) K
Erasmus MC H(O+T) K S
LUMC H(O+T) K A S E
Maastricht UMC+ H(O+T) K A S E
Radboudumc H(O+T) K S E
Universitair Medisch Centrum Groningen H(O+T) K A S E
Universitair Medisch Centrum Utrecht H(O) K
VUmc Amsterdam H(O) K S

H: hip; O: orthopaedic surgery; T: trauma surgery; K: knee; A: ankle; S: shoulder; E: elbow.

## Private hospitals

Annatommie MC H(O) K A S
AVE Orthopedische Klinieken Huizen H(O) K S
Bergman Clinics H(O) K S
DC Klinieken H(O) K S
Kliniek ViaSana H(O) K S
KneeClinic K
Medinovakliniek, location Breda H(O) K S
Medinovakliniek, location Klein Rosendael K S
Medinovakliniek, location Zestienhoven H(O) K S
Medisch Centrum Amstelveen H(O) K A
Orthoparc Kliniek H(O)
Orthopedium H(O) K S
Reinaert Kliniek H(O) K
Victoria Kliniek H(O) K

H: hip; O: orthopaedic surgery; T: trauma surgery; K: knee; A: ankle; S: shoulder;.