Hip and Knee Replacements in Canada, 2017–2018

Canadian Joint Replacement Registry Annual Report

1994 • 2019

Canadian Institute for Health Information
Institut canadien d'information sur la santé

Production of this document is made possible by financial contributions from Health Canada and provincial and territorial governments. The views expressed herein do not necessarily represent the views of Health Canada or any provincial or territorial government.

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ISBN 978-1-77109-821-2 (PDF)

How to cite this document:
Canadian Institute for Health Information. *Hip and Knee Replacements in Canada, 2017–2018: Canadian Joint Replacement Registry Annual Report*. Ottawa, ON: CIHI; 2019.

Cette publication est aussi disponible en français sous le titre *Arthroplasties de la hanche et du genou au Canada, 2017-2018 : rapport annuel du Registre canadien des remplacements articulaires*.
ISBN 978-1-77109-822-9 (PDF)

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Acknowledgements

Canadian Joint Replacement Registry (CJRR) data is provided by ministries of health, regional health authorities, orthopedic surgeons, nurses, medical records staff and others across Canada.

The Canadian Institute for Health Information (CIHI) thanks the Canadian Orthopaedic Association for its ongoing collaboration, which is essential to CJRR. We also thank the CJRR Advisory Committee for its invaluable advice and support in the delivery and uptake of the CJRR program, as well as the Scientific Working Group for its advice in the development of the revision risk curves. A special note of appreciation goes to the CJRR Advisory Committee chairs, Dr. Eric Bohm and Dr. Michael Dunbar, for their leadership and support in advancing CJRR over the past several years.

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CIHI also wishes to acknowledge the following individuals for their contribution to the development of this report:

- Carolyn Sandoval, Program Lead, CJRR
- Alina Dragan, Senior Analyst, CJRR
- Catherine Yu, Senior Analyst, CJRR
- Julia Di Bella, Senior Analyst, CJRR/Patient-Reported Outcome Measures
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Key findings

The Canadian Joint Replacement Registry (CJRR) was established in 2001 to collect clinical information on primary and revision hip and knee replacements with a view to improving functioning and mobility, reducing pain and improving quality of life for patients.

This year's report includes key statistics on approximately 130,000 hip and knee replacement surgeries performed in Canada in 2017–2018. In addition, the report examines factors affecting the need for an early revision (i.e., repeat surgery), using a large multi-year cohort of almost 357,000 initial hip or knee replacement surgeries that were followed for a period of up to 5 years. Given that early revisions are largely preventable, reducing the number of these revisions would lead to improved patient outcomes, health system cost efficiency and shorter wait times.

The demand for hip and knee replacements continues to increase, with about 130,000 surgeries and inpatient costs of more than $1.2 billion annually in Canada.

- In 2017–2018 in Canada, 58,492 hip replacements and 70,502 knee replacements were performed. This represents volume increases of 17.4% and 17.0%, respectively, compared with 5 years earlier.
- These joint replacement surgeries have an average acute length of stay of 4.5 days and also account for more than 585,000 acute care bed days.
- On average, in 2017–2018, close to $10,000 in inpatient costs (excluding physician payments and rehabilitation) was spent per joint replacement surgery in Canada, representing more than $1.2 billion spent annually on these surgeries.

More than 9,700 hip and knee replacement repeat (revision) surgeries were performed in 2017–2018, translating to more than $163 million in inpatient costs.

- Hip and knee revision surgeries represented 8.2% and 6.9% of hip and knee replacements performed in 2017–2018, respectively.
- On average, patients undergoing revision surgery stayed in hospital more than twice as long as patients undergoing primary surgery (8.9 days versus 4.2 days, respectively).
- The average inpatient cost for a revision surgery (excluding physician payments and rehabilitation) was more than $16,900 — almost 80% higher than that for a primary joint surgery (approximately $9,400).

This report's findings about early revision risk for hip replacements (based on Canadian registry data):

- **Overall:** The 5-year revision risk for total hip replacement due to osteoarthritis was approximately 3% or less across sex and age groups, ranging from 2.2% for men age 65 to 74 to 3.1% for women age 55 and younger.
- **Bearing surface:** The risk of having an early revision after a total hip replacement due to osteoarthritis appeared to be similar among all bearing surfaces, even after adjusting for age, sex and fixation.
- **Femoral fixation:** Using cementless fixation for partial hip replacement after a hip fracture resulted in a higher revision risk (compared with using cement), even after adjusting for age and sex, and regardless of the surgeon's annual volume of hip replacements performed.

This report's findings about early revision risk for knee replacements (based on Canadian registry data):

- **Overall:** The 5-year revision risk for total knee replacement due to osteoarthritis was highest in men and in younger age groups. The 5-year revision risk was approximately 6.5% or less across sex and age groups, ranging from 1.7% for women age 75 and older to 6.5% for men age 55 and younger.
- **Type:** Compared with total knee replacement surgeries, partial knee replacement surgeries had a significantly higher risk of revision, even after adjusting for age and sex.
- **Stability and mobility:** Mobile bearing prostheses were found to have a higher revision risk than fixed bearing prostheses. For both fixed and mobile bearing designs, those that were minimally stabilized (or cruciate-retaining) had a lower revision risk than those with posterior-stabilized designs. Models were adjusted for age and sex.

The Canadian Institute for Health Information (CIHI) continues to work with jurisdictions to expand CJRR prosthesis coverage to 90% nationally (current coverage is 72%). CIHI also has a patient-reported outcome measures (PROMs) program with initial focus on hip and knee replacement surgeries. National standards (tools, time points, minimum data set) have been published by CIHI and initial data collection and reporting are underway, starting with a pilot in Ontario. CIHI is also leading an international hip and knee PROMs working group with the Organisation for Economic Co-operation and Development (OECD) to develop and report on internationally comparable indicators and provide international standards for collection. The integration of these CIHI data sources, in addition to others on health care utilization, outcomes and costs, supports patient-centred and value-based health care delivery and analysis for this hip and knee replacement patient population.

About this report

Hip and Knee Replacements in Canada, 2017–2018: Canadian Joint Replacement Registry Annual Report provides an overview of key statistics related to hip and knee replacement surgeries performed in Canada based on national hospitalization and day surgery data sources (patients age 18 and older). The report also presents cumulative revision risk estimates based on Canadian Joint Replacement Registry (CJRR) data from provinces that are mandated to report to CJRR: Ontario, Manitoba and British Columbia. This year's set of revision risk curves is based on almost 357,000 primary surgeries with a follow-up period of up to 5 years and examines factors affecting early revisions. Early revisions are negative outcomes of hip and knee arthroplasty, as they are associated with poorer patient outcomes and experiences, additional and longer hospital stays and higher health care system costs. Reporting on revision risks provides insights on who is at highest risk of revision and can be used to target improvement efforts.

Companion data tables for this Canadian Institute for Health Information (CIHI) report are available on our website at www.cihi.ca/cjrr. *Hip and Knee Replacements in Canada: Canadian Joint Replacement Registry 2017–2018 Quick Stats* includes provincial and territorial results.

Refer to Appendix 2: Glossary for definitions of arthroplasty-related and statistical terms used in the report.

About the Canadian Joint Replacement Registry

CJRR is a pan-Canadian source of information about hip and knee replacements. It was launched in 2001 as a collaborative effort between CIHI and the Canadian Orthopaedic Association. CJRR was established to record and analyze clinical information and outcomes of primary and revision hip and knee replacements over time to improve care for these patients.

CJRR collects surgical and prosthesis information that complements demographic and administrative information captured in other CIHI databases: the Discharge Abstract Database (DAD), the Hospital Morbidity Database (HMDB) and the National Ambulatory Care Reporting System (NACRS).

In 2017–2018, submission to CJRR was mandatory for 3 provinces (Ontario, Manitoba and British Columbia) and 2 regions in Saskatchewan (Regina Qu'Appelle Health Region and Saskatoon Health Region). Submissions from all other provinces were voluntary during this time period. However, this landscape is evolving with more interest in participation.

Mandatory submission from all jurisdictions is the most effective way to ensure comprehensive capture of prosthesis and outcome information for all hip and knee replacement patients in Canada. CJRR coverage for 2017–2018 was 72% nationally, consistent with the previous year (Table 1). CJRR coverage is estimated by comparing the number of records submitted to CJRR with the total number of expected hip and knee replacement procedures as collected in the DAD/HMDB and NACRS. For more information, please see *Data Quality Documentation for Users: Canadian Joint Replacement Registry, 2017–2018* on the CJRR metadata web page.

Table 1 CJRR coverage

Jurisdiction	Number of procedures submitted to CJRR in 2017–2018	Number of procedures expected in CJRR* in 2017–2018	2016–2017 coverage	2017–2018 coverage
Newfoundland and Labrador	355	2,187	18.5%	16.2%
Prince Edward Island	0	620	0.0%	0.0%
Nova Scotia	2,944	4,400	63.6%	66.9%
New Brunswick	2,955	3,379	83.5%	87.4%
Quebec	5,674	24,378	23.9%	23.3%
Ontario†	50,431	55,318	94.5%	91.2%
Manitoba†	4,511	4,633	97.1%	97.4%
Saskatchewan	4,047	4,773	84.4%	84.8%
Alberta	6,284	12,971	32.4%	48.4%
British Columbia†	17,239	18,267	94.1%	94.4%
Territories‡	0	79	0.0%	0.0%
Canada	**94,439**	**131,005**	**71.2%**	**72.1%**

Notes

* For this table, the number of expected procedures is based on the number of hip and knee replacement Canadian Classification of Health Interventions (CCI) codes found in the DAD/HMDB and NACRS. Bilateral procedures were counted as 2 separate procedures in the coverage denominator, for consistency with CJRR data collection. Note that this "expected" number will differ from the number of hip and knee replacements reported for the DAD/HMDB and NACRS.

† Provinces with mandated submission to CJRR.

‡ Territories include Yukon and the Northwest Territories.

Numbers are based on the province/territory in which the joint replacement was performed.

CJRR data is based on surgery date, whereas DAD/HMDB and NACRS data is based on discharge date. However, for comparative purposes, the impact is estimated to be minimal.

Sources

Canadian Joint Replacement Registry, Discharge Abstract Database, Hospital Morbidity Database and National Ambulatory Care Reporting System, 2016–2017 and 2017–2018, Canadian Institute for Health Information.

Hip replacement surgeries in Canada

A national snapshot

Hip replacements aim to improve mobility and quality of life for patients, particularly after many years of trying to manage debilitating pain. It is the third most commonly performed inpatient surgery in Canada, with more than 58,000 done annually. Understanding the patient population and monitoring outcomes is particularly important for Canada's aging population.

Over the past 5 years (2013–2014 to 2017–2018), the number of hip replacement surgeries performed in Canada increased by 17.4%.

- In 2017–2018 in Canada, 58,492 hip replacements were performed, compared with 49,819 done 5 years earlier.
- Age-standardized rates also increased slightly over the past 5 years. In 2017–2018, the rate was 178 per 100,000 population age 18 and older — 4.7% higher than in 2013–2014 (170 per 100,000), indicating that the increase in volume is largely driven by the aging and growth of the population.
- Based on the most recent year, overall, 2 of every 3 patients who had a hip replacement were age 65 and older. Among women who had a hip replacement, 73.1% were in this age group, compared with 60.0% of men.
- Almost all hip replacements were performed in an inpatient setting and required an overnight stay. The median length of stay (LOS) was 3 days for primary replacements and 6 days for revisions, with similar findings for women and men.
- Only 184 (0.3%) hip replacements were performed in a day surgery setting.
- The most common reasons for having a primary hip replacement were degenerative arthritis (81.3%) and acute hip fracture (14.7%).
- Based on available inpatient cost data, the estimated average cost of a primary hip surgery in Canada in 2017–2018 was $11,500. This excludes physician payments and rehabilitation costs.

In 2017–2018 in Canada, 4,822 hip replacement revisions were performed, representing over $89 million based on average inpatient costs (excluding physician payments and rehabilitation).

- Revision surgeries are more complex than primary surgeries and have implications for both patients and health care systems, such as reduced functional mobility for patients,[1, 2] longer patient recovery time[1, 2] and higher procedure costs.
- The number of hip revisions performed in Canada in 2017–2018 increased slightly (by 2.2%) compared with 5 years earlier, when there were 4,719 such surgeries.
- Among all hip replacements done in 2017–2018, 8.2% were revision surgeries (similar to 8.3% in 2016–2017).

- The average inpatient cost for a hip revision surgery was estimated at about $18,600 — over 63% higher than for a primary hip surgery.
- Early revision is a negative outcome with implications for both patients and health care systems. Details on early revisions are provided later in the report.
- The most common reported reason for revision was aseptic loosening (24.7%), followed by instability (17.8%) and infection (17.7%).[i]
- Among all hip revisions reported in CJRR for 2017–2018, the following components were involved:[ii]
  - 26.3% had the femoral component replaced (with or without acetabular liner replacement);
  - 25.1% had the acetabular component replaced (with or without femoral head replacement);
  - 24.0% involved the replacement of both the femoral component and acetabular component;
  - 23.5% had the femoral head replaced (with or without acetabular liner revision);
  - 1.1% involved replacement of the acetabular liner only; and
  - 0.1% involved insertion of the cement spacer only.

Jurisdiction-level results and annual trends, as well as additional clinical- and hospital-related information, can be found in the companion data tables at www.cihi.ca/cjrr (*Hip and Knee Replacements in Canada: Canadian Joint Replacement Registry 2017–2018 Quick Stats*).

Studying factors affecting early revision

Over time, even replaced joints can wear down. Hip implants typically last 15 to 20 years before needing to be replaced by having a revision surgery.[3] However, having a revision surgery relatively soon after the primary surgery (i.e., early revision) is a negative outcome that has implications for both patients and health care systems.

Based on a large Canadian cohort from CJRR — surgeries that were followed for a period of up to 5 years after hip replacement surgery — we present cumulative revision risks for early revision (figures 1 to 6).[iii] Only data from provinces with mandated submission was included to ensure representativeness of the revision findings based on a high coverage rate.

Specifically, our analysis included 152,872 primary hip replacement surgeries reported to CJRR from Ontario, Manitoba and British Columbia (the 3 provinces with mandated submission) from 2012–2013 to 2017–2018. Details regarding the methodology and subgroups examined can be found in Appendix 1. Where possible, we also provided reasons for revision within different subgroups.

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i. For this report, to determine the most common reasons for revision, only procedures associated with a specific reason for revision were included (i.e., those with "other" indicated as the reason for revision were excluded). In addition, "infection" included only single-stage revisions and the first stage of a 2-stage revision.

ii. More than one component can be replaced during a surgery. See Appendix 1 for details about how the components were identified in CJRR.

iii. This analysis included surgeries that could be followed-up on for up to 6 years, but we present revision risk up to 5 years only due to small numbers.

Total hip replacement due to degenerative arthritis

Degenerative arthritis, also known as osteoarthritis, leads to restricted mobility due to joint pain and stiffness, and consequently to reduced quality of life. Patients often have a hip replacement after managing debilitating pain for many years. We examined the revision risk for this patient population separately, which represented over 90% of all primary total hip replacements, and undertook analysis investigating the effect of age, sex and bearing surface.

Based on our registry cohort, 111,123 patients had a primary total hip replacement due to degenerative arthritis, comprising 92.1% of patients with primary total hip replacement. 2,270 (2.0 %) had at least one revision during the study period.[iv]

Age and sex: The risk of having an early revision after a total hip replacement by age group varied for men but not for women.

- Within the cohort, one-third (34.3%) of primary replacements were performed in patients age 65 to 74, followed by those 75 and older (26.9%) and 55 to 64 (26.9%). The lowest proportion was found in patients younger than 55 (11.9%). More than half of these patients were women (55.1%). Women who had a total hip replacement were significantly older than their male counterparts (mean age of 68.9 versus 66.4, respectively).
- The 5-year revision risk for total hip replacement was approximately 3% or less across sex and age groups. Among men, 5-year revision risk ranged from 2.2% for those age 65 to 74 to 3.1% for patients 75 and older. Among women, 5-year revision risk ranged from 2.5% for those age 65 to 74 to 3.1% for patients younger than 55 (figures 1a and 1b).
- Among women, instability and infection were the most common reasons for revision for those younger than 65 (Table 2); periprosthetic fracture was the most common reason for those 65 and older. Among men, infection was the most common reason for revision across all age groups (Table 2); notably, periprosthetic fracture prevalence increased with age.

Bearing surface: The risk of having an early revision after a total hip replacement appeared to be similar across types of bearing surfaces studied.

- Bearing surface is the combination of the materials used for the femoral head and for the acetabular liner. Choosing which materials to use for the bearing surface of the implant is an important decision that is made ultimately by the orthopedic surgeon and can influence revision rates.[4, 5]
- Among the 97,214 procedures included in the bearing surface analysis,[v] the most common bearing surface combinations were metal-on-cross-linked-polyethylene (80.5%), ceramic-on-cross-linked-polyethylene (13.9%), ceramic-on-ceramic (3.3%) and metal-on-non-cross-linked-polyethylene (2.3%).

iv. Only the first revision was considered. For methodology details, refer to Appendix 1.
v. Only procedures that could be linked to product information in the Global Arthroplasty Product Library were included in this subgroup analysis and only the most common categories of bearing surfaces are presented. See Appendix 1 for details on methodology.

- After adjusting for age, sex and type of fixation, revision risks were similar across the different bearing surface combinations investigated (Figure 2).
- Infection was the most common reason for revision for all bearing surfaces except ceramic-on-cross-linked-polyethylene, which was most commonly revised due to instability reasons (Table 3).

Hip replacement due to acute hip fracture

One of the surgical treatment options for hip fractures is partial or total hip replacement, usually done as an urgent procedure. Because hip fracture patients are often older and more frail than people getting elective hip replacements, we analyzed them separately and looked at the effect of type of procedure, femoral fixation and surgeon hip arthroplasty volume.

Based on our registry cohort, 22,421 (14.7%) hip replacements were done to treat acute hip fracture between 2012–2013 and 2017–2018. Among those, 735 (3.3%) required at least one revision surgery during the study period.

Type of surgery: Early revision risks were similar for primary total versus partial hip replacement to treat acute hip fracture.

- Within the hip fracture cohort, patients were predominantly women (68.6%, compared with 57.7% for all primary hip replacements) and were older than the general hip replacement population (mean age 81.5 for hip fractures versus 70.5 for all hip replacements). Among the hip replacements done for hip fracture, 87.8% were partials (also known as hemiarthroplasty); bipolar was most common, followed by modular monopolar (60.5% and 21.1%, respectively).
- Bipolar hemiarthroplasty showed no difference in early revision risk compared with total hip replacement, monoblock monopolar or modular monopolar hemiarthroplasties, after adjusting for age, sex and fixation (Figure 3).
- Among patients age 70 and older who had a partial hip replacement, there were no differences in early revision risk between the different types of partial replacements[vi] (Figure 4).

Femoral fixation: Use of cementless femoral fixation had a higher risk of early revision for primary partial hip replacement in patients age 70 and older.

- Cementless femoral fixation[vii] was far more common than cemented femoral fixation in partial hip replacements for acute hip fracture (72.5% versus 27.5%).
- The risk of revision for cementless fixation was higher than for cemented fixation for the age group 70 and older after adjusting for sex (Figure 5b). The cumulative percentage revision at 5 years for cementless fixation in patients 70 and older was 4.2%, compared with 3.5% for cemented fixation.

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vi. Only curves for patients 70 and older are presented, since the number of qualifying procedures in the other age groups was too small to show meaningful results.

vii. Refer to Appendix 1: Methodological notes for a definition of femoral fixation.

Fixation and surgeon hip arthroplasty volume: Surgeon arthroplasty volume and femoral fixation were associated with early revision risk for primary partial hip replacement.

- Studies have shown that the risk for short-term complications, including early revision, is approximately inversely proportional to the volume of procedures carried out by the operating surgeon.[6] For this analysis, surgeons who performed 50 or more hip replacements in the fiscal year were considered high-volume.
- 8,382 of 14,263 cementless partial hip replacements (58.8%) were performed by high-volume surgeons, while 2,698 of 5,417 (49.8%) of cemented partial hip replacements were performed by high-volume surgeons.
- Regardless of surgeon volume, after adjusting for age and sex, cementless femoral fixation was associated with higher risk of revision than cemented femoral fixation for partial hip replacement for hip fracture. When cementless fixation was used, surgeon arthroplasty volume did not show a difference in risk. When cemented fixation was used, surgeon volume showed no difference in risk until 1.5 years; then, low-volume surgeons had more than 3 times the revision risk compared with high-volume surgeons (Figure 6).

Knee replacement surgeries in Canada

A national snapshot

Knee replacement surgery is an effective treatment for alleviating chronic knee joint pain and mobility limitations and leads to improved quality of life for most patients. It is the second most commonly performed inpatient surgery in Canada, with more than 70,000 done annually.

Over the past 5 years (2013–2014 to 2017–2018), the number of knee replacement surgeries performed in Canada increased by 17.0%.

- In 2017–2018 in Canada, 70,502 knee replacements were performed. This is a 17.0% increase compared with 5 years earlier, when there were 60,257 knee replacements.
- The age-standardized rate remained relatively steady over the 5 years studied. In 2017–2018, the rate was 214 hospitalizations per 100,000 population age 18 and older, representing a 3.4% increase from 2013–2014, which suggests that the increase is largely driven by the aging and growth of the population.
- Based on the most recent year, the age distribution by sex was very similar among patients undergoing a knee replacement. For both women and men, more than half (63.1%) of patients were age 65 and older.
- The median acute LOS in hospital was 3 days for primary replacements and 4 days for revisions, with similar findings for women and men.
- Only 301 (0.4%) knee replacements were performed in a day surgery setting.

- Degenerative arthritis, also known as osteoarthritis, was by far the most common underlying diagnosis reported to CJRR for knee replacement patients (98.8%).
- Based on available inpatient cost data, the estimated average cost of a primary knee surgery in Canada in 2017–2018 was about $7,800. This excludes physician payments and rehabilitation costs.

In 2017–2018 in Canada, 4,889 knee revisions were performed, translating to over $74 million in average inpatient costs annually.

- While revisions may represent a relatively small proportion of all joint replacements, these types of surgeries are more complex than primary surgeries and have implications for both patients and health care systems, such as reduced patient function,[1, 2] longer patient recovery time[1, 2] and higher procedure costs.
- The number of knee revisions performed in Canada in 2017–2018 increased by 17.4% compared with 5 years earlier, when there were 4,163 such surgeries.
- Among all knee replacements done in 2017–2018, 6.9% were revision surgeries, a smaller percentage than the year before (7.6%).
- The average inpatient cost for a knee replacement revision surgery was estimated at $15,300 — almost double the cost for a primary knee replacement surgery.
- The most common reported reasons for revision were aseptic loosening (26.7%), infection (21.2%) and instability (15.8%).[viii]
- Among all knee revisions reported in CJRR for 2017–2018, the following components were involved:[ix]
  - 51.4% had both the femoral and the tibial components replaced;
  - 24.5% had only the tibial insert replaced (with or without patella resurfaced);
  - 12.3% had the femoral component replaced (with or without replacement of the tibial insert; with or without patellar component);
  - 8.3% had only the tibial component replaced (with or without patellar component);
  - 3.0% involved replacement or insertion of the patellar component; and
  - 0.5% involved insertion of a cement spacer.

Jurisdiction-level results and annual trends, as well as additional clinical- and hospital-related information, can be found in the companion data tables at www.cihi.ca/cjrr (*Hip and Knee Replacements in Canada: Canadian Joint Replacement Registry 2017–2018 Quick Stats*).

viii. For this report, to determine the most common reasons for revision, only procedures associated with a specific reason for revision were included (i.e., those with “other” indicated as the reason for revision were excluded). In addition, “infection” included only single-stage revisions and the first stage of a 2-stage revision.

ix. More than one component can be replaced during a surgery. Refer to Appendix 1 for details about how the components were identified in CJRR.

Studying factors affecting early revision

Over time, even replaced joints can wear down. Knee implants typically last 15 to 20 years before needing to be replaced by having a revision surgery.[7] However, having a revision surgery relatively soon after the primary surgery (i.e., early revision) is a negative outcome that has implications for both patients and health care systems.

Based on a large Canadian cohort from the CJRR — surgeries that were followed for a period of up to 5 years after knee replacement surgery — we present cumulative revision risks for early revision (figures 7 to 10). Only data from provinces with mandated submission was included to ensure representativeness of the revision findings based on a high coverage rate.

Specifically, our analysis included 203,977 primary knee replacement surgeries reported to CJRR from Ontario, Manitoba and British Columbia (the 3 provinces with mandated submission) from 2012–2013 to 2017–2018. Details regarding the methodology and subgroups examined can be found in Appendix 1. Where possible, we also presented reasons for revision within different subgroups.

Knee replacements due to degenerative arthritis

Degenerative arthritis, also known as osteoarthritis, leads to restricted mobility due to joint pain and stiffness, and consequently to reduced quality of life. Patients often have a knee joint replaced after managing debilitating pain for many years. Since the vast majority of primary knee replacements are due to osteoarthritis, we examined the revision risk for this patient population only. We undertook analyses investigating the effect of age, sex, type of procedure, stability, mobility and patella usage on early revisions.

Based on our CJRR patient cohort, 199,891 primary knee replacements due to degenerative arthritis were performed in the study period, representing 98% of all primary knee replacements within the same time frame. Among those, 3,944 (2.0%) required at least one revision.

Type of surgery: Total knee replacements with patella resurfacing had a significantly lower early revision risk than all other types of knee replacement surgery.

- Knee replacements can be broadly classified into 2 categories: partial and total. A total knee replacement typically involves both the medial and lateral compartments of the tibiofemoral joint, with or without resurfacing of the patella. A partial knee replacement typically involves replacing one of the medial, lateral or patellofemoral compartments of the knee.
- Within the registry cohort, 94.8% of the primary knee replacements were total knee replacements and 5.2% were partial replacements. The latter were primarily medial compartment replacements (86% of all partial replacements in our cohort). Looking at early revisions in the cohort, 3,483 (1.8%) of those who had a total knee replacement and 461 (4.3%) of those who had a partial knee replacement needed at least one revision within the 5-year follow-up period.

- Primary total knee replacements had the lowest revision risk compared with all partial classes of primary knee replacements. For total knee replacement, revision risk was significantly lower when the patella was resurfaced, compared with no patella resurfacing. Among partial knee replacements, patellofemoral arthroplasty had the highest revision risk (Figure 7).
- Regardless of whether or not the patella was resurfaced, infection was the most common reason for revision (29.0% when patella was resurfaced, 37.0% with no patella resurfacing), followed by instability and aseptic loosening (Table 4).

Age and sex: Early revision risks were significantly higher among men and within younger age groups.

- Among the registry cohort, 7.3% of the primary replacements were done in patients younger than 55; 29.4% were age 55 to 64, 38.9% were age 65 to 74, and 24.4% were age 75 and older. Women received the majority of primary total knee replacements (61.3%). The mean age for men and women was 68.5 and 68.1, respectively.
- Across all patients, men had a higher revision risk than women and revision risk decreased significantly with increasing age. The 5-year revision risk for total knee replacement was approximately 6.5% or less across sex and age groups. Among men, the 5-year revision risk ranged from 2.1% for patients age 75 and older to 6.5% for patients younger than 55. Among women, 5-year revision risk ranged from 1.7% for patients age 75 and older to 5.0% for patients younger than 55 (figures 8a and 8b).
- Infection was the most common reason for revision. The proportion of revisions due to infection increased with age, from 21.0% and 29.4% in women and men younger than 55, respectively, to 39.6% and 58.7% in women and men age 75 and older, respectively (Table 5).

Stability: Knee surgeries involving cruciate-retaining prostheses had a lower revision risk compared with those involving posterior-stabilized ones.

- Stability refers to particular prosthetic features intended to substitute for the intrinsic stability of knee ligaments. Our analysis included minimally stabilized (also known as cruciate-retaining) and posterior-stabilized, which were the most common categories.
- Among the registry cohort, primary procedures with cruciate-retaining prostheses accounted for 37.5% of all prostheses investigated.
- Cruciate-retaining prostheses had a lower risk of revision compared with posterior-stabilized prostheses regardless of whether the patella was resurfaced or not.
- For cruciate-retaining prostheses, revision risk was similar up to 1 year whether the patella was resurfaced or not; however after that, procedures that involved resurfacing had a lower revision risk (from 0 to 1 year: HR = 0.99, 95% CI 0.82–1.19; from 1 year onward: HR = 1.43, 95% CI 1.20–1.70).[x] For posterior-stabilized prostheses, the revision risk was lower when the patella was resurfaced (HR = 1.20, 95% CI 1.10–1.31) (Figure 9).
- Regardless of whether resurfacing of the patella was involved, infection was the most common reason for revision (Table 6).

x. HR: Hazard ratio; CI: Confidence interval.

Mobility: Knee replacement surgeries involving mobile bearing prostheses were found to have a higher revision risk than fixed bearing prostheses.

- Bearing mobility refers to the intended movement of the tibial insert on the tibial component (fixed or not). Mobile bearings include inserts that move in 1 of 3 ways: rotating, sliding, or both rotating and sliding. Fixed bearings include a component that is not intended to move relative to its interface component.
- Among the registry cohort, 98% of knee replacements had a fixed bearing. For our analysis, all types of mobile bearings were combined.
- For fixed bearing designs, cruciate-retaining prostheses had a lower revision risk than posterior-stabilized designs, even after adjusting for age and sex (HR = 0.81, 95% CI 0.75–0.87). This was also found for mobile bearing inserts (from 0 to 2 years: HR = 0.45, 95% CI 0.25–0.79; from 2 years onward: HR = 0.19, 95% CI 0.08–0.40) (Figure 10).

Summary and future directions

CIHI continues to work with jurisdictions to expand CJRR prosthesis coverage toward 90% nationally (currently at 72.1%, an increase from 67.7% in 2013–2014). As of 2018–2019, CJRR hip and knee replacement prosthesis data is also submitted through CIHI's main hospitalization database, the DAD. With this additional submission option, uptake is expected to grow across jurisdictions. Increased coverage enables more robust and comprehensive data using prosthesis information for comparative reporting within Canada and with other countries.

This report identified several factors associated with the risk of early revisions, which could inform clinical practice patterns, health system delivery and procurement decisions. Hip and knee replacement surgeries continue to be in high demand and account for significant health system costs annually. Despite the increase in volumes primarily due to population growth and aging, wait times are still beyond the target time frames in some jurisdictions.[8] Reducing early revision surgeries can free up resources in the health systems and also improve patient outcomes, including quality of life.

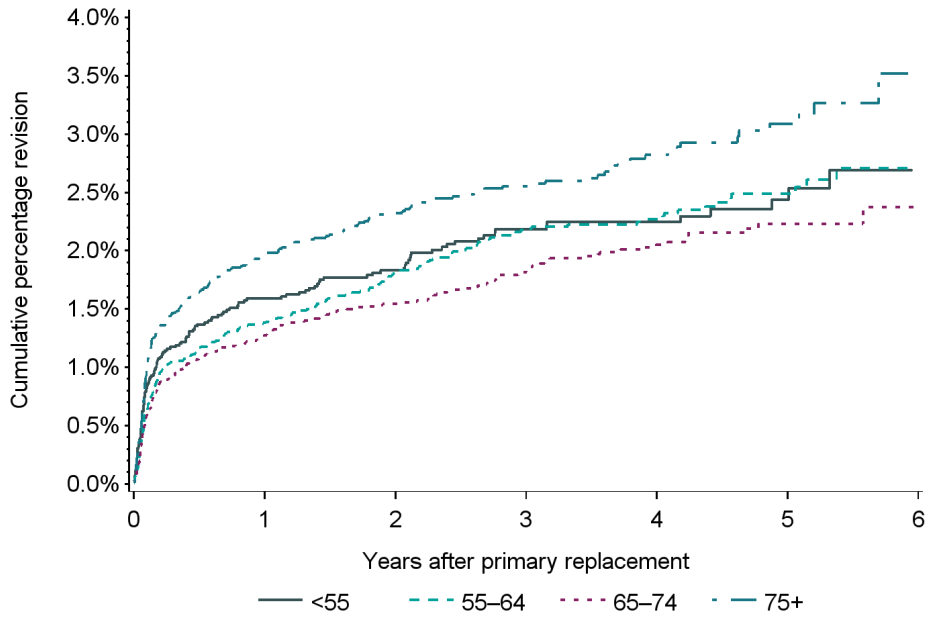
As part of its strategic priorities to support patient-centred health care delivery, CIHI also has a patient-reported outcome measures (PROMs) program with initial focus on hip and knee replacement surgeries. National standards for PROMs (tools, time points, minimum data set) have been published on CIHI's website and data collection is underway as part of an Ontario pilot using the national standard tools EQ-5D-5L and the Oxford Hip Score and Oxford Knee Score. CIHI also has obtained national licences for these tools, and they are available for sub-licensing for routine care. At the international level, CIHI, on behalf of Canada, is co-leading with the Organisation for Economic Co-operation and Development (OECD) a working group aimed at providing comparable reporting on existing hip and knee replacement PROMs. A demonstration project was conducted over the past year to finalize the indicators for reporting across member countries; the results, which include Canadian PROMs data from Manitoba and Alberta, will be released in the OECD's *Health at a Glance 2019* report in fall 2019.

CIHI is also involved in value-based health care initiatives that leverage CJRR data. For example, CIHI is an active participant in the Supply Chain Advancement Network in Health (SCAN Health). This collaboration aims to advance global capacity to adopt and scale best practices in health care supply chain innovation using real-world evidence, with joint replacement data being a use case example. The growth of national joint replacement prosthesis data (integrated with health care utilization, outcomes and costs) will result in the increased use of CJRR to support patient-centred and value-based health care delivery and analysis for this clinical population.

Hip replacement figures and tables

Figure 1a, men

Cumulative percentage revision for primary total hip replacement for men, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



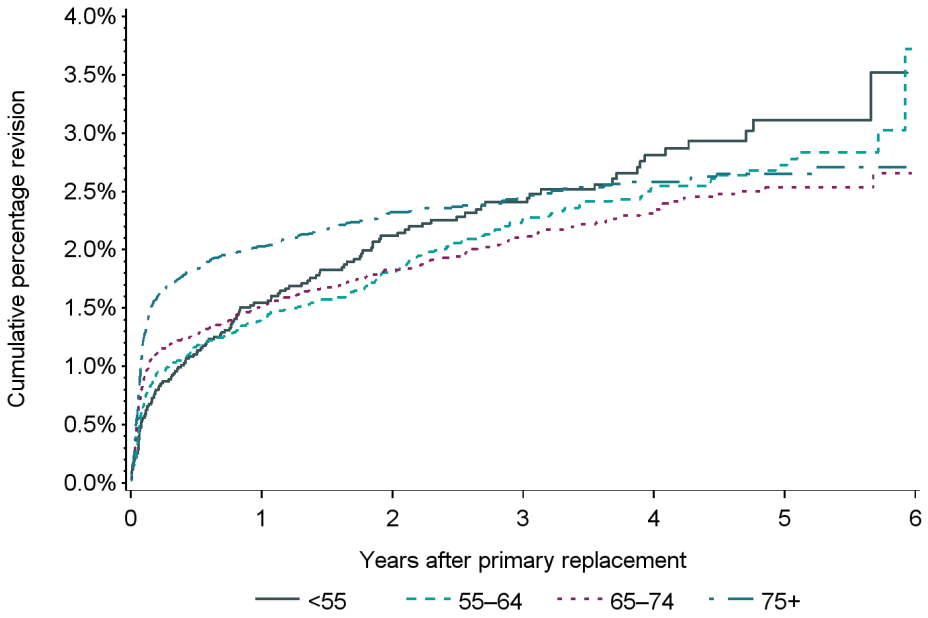
Age	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
<55	1	1.59	1.30–1.88	5,869
	2	1.83	1.51–2.15	4,605
	3	2.18	1.82–2.55	3,396
	4	2.25	1.87–2.62	2,186
	5	2.44	2.00–2.87	1,036
55–64	1	1.38	1.19–1.57	11,705
	2	1.82	1.59–2.06	8,847
	3	2.18	1.91–2.44	6,334
	4	2.27	1.99–2.55	3,919
	5	2.49	2.17–2.81	1,817
65–74	1	1.27	1.10–1.45	12,913
	2	1.54	1.34–1.74	9,751
	3	1.82	1.59–2.05	6,881
	4	2.05	1.79–2.31	4,306
	5	2.23	1.93-2.53	1,944
75+	1	1.97	1.71–2.23	8,902
	2	2.32	2.03–2.62	6,673
	3	2.55	2.24–2.87	4,701
	4	2.82	2.46–3.18	2,950
	5	3.09	2.67–3.51	1,331

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 1b, women

Cumulative percentage revision for primary total hip replacement for women, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



Age	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
<55	1	1.54	1.22–1.87	4,827
	2	2.12	1.73–2.51	3,749
	3	2.41	1.98–2.84	2,779
	4	2.81	2.31–3.31	1,762
	5	3.11	2.53–3.70	801
55–64	1	1.40	1.21–1.59	11,974
	2	1.81	1.59–2.04	9,097
	3	2.26	1.99–2.53	6,553
	4	2.55	2.24–2.85	4,108
	5	2.73	2.38–3.07	1,899
65–74	1	1.51	1.35–1.68	17,055
	2	1.82	1.64–2.01	12,915
	3	2.10	1.89–2.31	9,064
	4	2.31	2.07–2.54	5,696
	5	2.53	2.26–2.80	2,615
75+	1	2.03	1.82–2.23	14,671
	2	2.32	2.10–2.55	11,359
	3	2.47	2.23–2.71	8,100
	4	2.58	2.33–2.83	5,118
	5	2.65	2.39–2.92	2,415

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Table 2 Reasons for revision of total hip replacement for degenerative arthritis, by age and sex, 2012–2013 to 2017–2018

Sex	Age	Aseptic loosening	Infection	Instability	Periprosthetic fracture	Remaining reasons
Women	<55	15 (18.3%)	14 (17.1%)	20 (24.4%)	10 (12.2%)	23 (28.0%)
	55–64	41 (20.8%)	52 (26.4%)	40 (20.3%)	33 (16.8%)	31 (15.7%)
	65–74	41 (15.9%)	60 (23.3%)	52 (20.2%)	76 (29.5%)	29 (11.2%)
	75+	41 (16.8%)	53 (21.7%)	40 (16.4%)	87 (35.7%)	23 (9.4%)
Men	<55	19 (21.8%)	26 (29.9%)	19 (21.8%)	6 (6.9%)	17 (19.5%)
	55–64	41 (24.3%)	61 (36.1%)	28 (16.6%)	17 (10.1%)	22 (13.0%)
	65–74	39 (23.6%)	63 (38.2%)	25 (15.2%)	26 (15.8%)	12 (7.3%)
	75+	21 (14.5%)	47 (32.4%)	22 (15.2%)	34 (23.4%)	21 (14.5%)

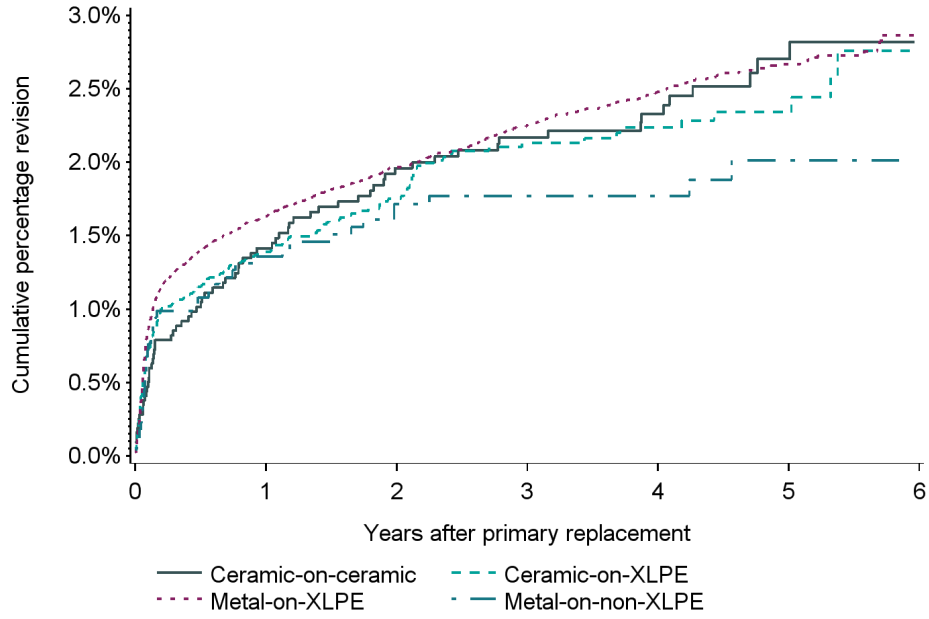
Note

Only procedures with a specific diagnosis were included. Records with reason for revision listed as “other” (n = 363) were excluded, as were those where the revision record in the DAD could not be linked to a reason for revision in CJRR (n = 560). Remaining reasons for revision included bearing wear, osteolysis, pain of unknown origin, implant fracture, implant dissociation, acetabular erosion, leg length discrepancy and stiffness.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 2 Cumulative percentage revision for primary total hip replacement, by bearing surface (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



HR — adjusted for age, sex and fixation

Ceramic-on-ceramic versus Metal-on-XLPE
HR = 0.90 (0.68–1.16), p = 0.413

Ceramic-on-XLPE versus Metal-on-XLPE
HR = 0.86 (0.73–1.01), p = 0.072

Metal-on-non-XLPE versus Metal-on-XLPE
HR = 0.81 (0.55–1.14), p = 0.255

Bearing surface of primary replacement	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Ceramic-on-ceramic	1	1.41	1.00–1.83	2,869
	2	1.96	1.46–2.46	2,543
	3	2.17	1.64–2.70	2,159
	4	2.33	1.77–2.89	1,640
	5	2.70	2.05–3.35	830
Ceramic-on-XLPE	1	1.39	1.18–1.60	8,749
	2	1.75	1.50–2.00	5,521
	3	2.13	1.83–2.43	3,616
	4	2.24	1.91–2.56	2,250
	5	2.34	1.99–2.70	997
Metal-on-non-XLPE	1	1.36	0.88–1.84	2,057
	2	1.72	1.17–2.27	1,840
	3	1.77	1.21–2.33	1,433
	4	1.77	1.21–2.33	1,010
	5	2.01	1.36–2.67	523
Metal-on-XLPE	1	1.63	1.54–1.72	63,762
	2	1.97	1.87–2.07	49,332
	3	2.25	2.14–2.37	35,182
	4	2.48	2.35–2.60	21,885
	5	2.67	2.53–2.81	9,829

Notes
XLPE: Cross-linked polyethylene.
HR: Hazard ratio.
p: p-value.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.
International Consortium of Orthopaedic Registries–International Society of Arthroplasty Registries (ICOR-ISAR). Global Arthroplasty Product Library. May 31, 2018, version.

Table 3 Reasons for revision of total hip replacement for degenerative arthritis, by bearing surface, 2012–2013 to 2017–2018

Bearing surface	Aseptic loosening	Infection	Instability	Periprosthetic fracture
Ceramic-on-ceramic	10 (25.6%)	15 (38.5%)	9 (23.1%)	5 (12.8%)
Ceramic-on-XLPE	26 (23.5%)	28 (25.5%)	39 (35.5%)	17 (15.5%)
Metal-on-non-XLPE	5 (16.1%)	16 (51.7%)	5 (16.1%)	5 (16.1%)
Metal-on-XLPE	183 (22.0%)	260 (31.4%)	162 (19.6%)	215 (26.0%)

Notes

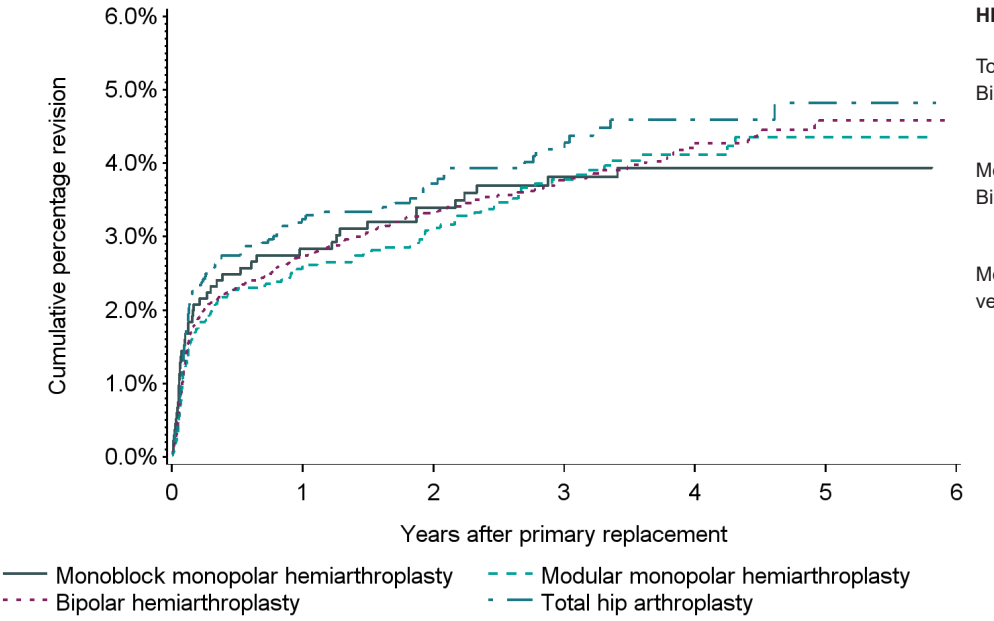
XLPE: Cross-linked polyethylene.

Only procedures with a specific diagnosis were included. Records with reason for revision listed as “other” (n = 335) were excluded, as were those where the revision record in the DAD could not be linked to a reason for revision in CJRR (n = 500). Due to low cell counts, reasons such as bearing wear, osteolysis, pain of unknown origin, implant fracture, implant dissociation, leg length discrepancy and stiffness were not included (n = 161).

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 3 Cumulative percentage revision for primary hip replacement, by type of procedure (primary diagnosis of acute hip fracture), 2012–2013 to 2017–2018



HR — adjusted for age, sex and fixation

Total hip arthroplasty versus Bipolar hemiarthroplasty
HR = 0.90 (0.71–1.12), p = 0.356

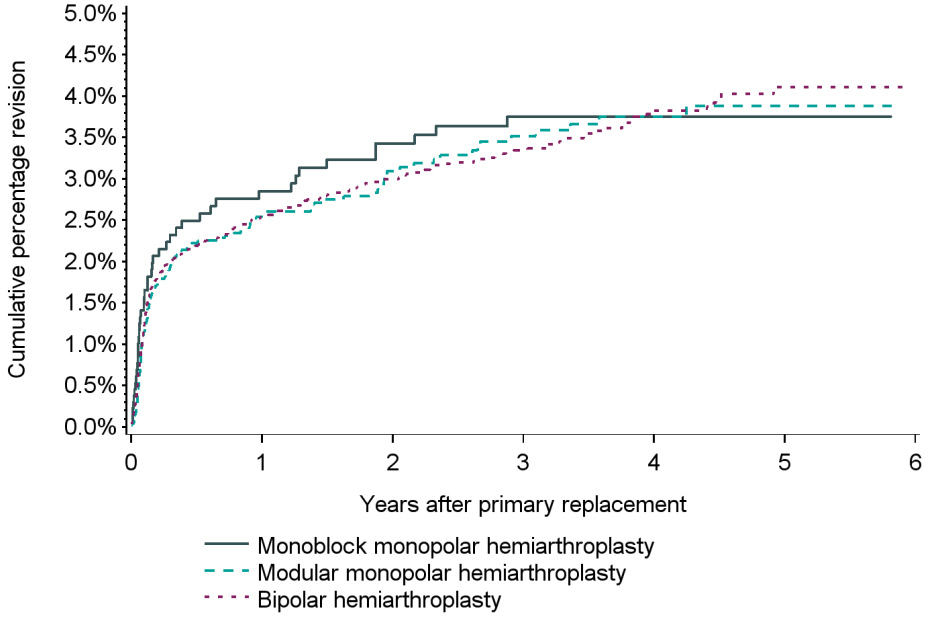
Modular monopolar hemiarthroplasty versus Bipolar hemiarthroplasty
HR = 0.96 (0.79–1.15), p = 0.658

Monoblock monopolar hemiarthroplasty versus Bipolar hemiarthroplasty
HR = 1.02 (0.74–1.36), p = 0.925

Type of hip arthroplasty	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Total hip arthroplasty	1	3.24	2.55–3.93	2,005
	2	3.72	2.96–4.48	1,424
	3	4.19	3.34–5.03	1,015
	4	4.59	3.66–5.52	625
	5	4.82	3.79–5.85	277
Modular monopolar hemiarthroplasty	1	2.59	2.11–3.06	3,316
	2	3.12	2.58–3.67	2,418
	3	3.78	3.14–4.42	1,663
	4	4.12	3.41–4.82	951
	5	4.35	3.58–5.13	373
Bipolar hemiarthroplasty	1	2.73	2.45–3.02	9,541
	2	3.32	2.99–3.65	6,999
	3	3.77	3.40–4.14	4,849
	4	4.27	3.84–4.71	2,924
	5	4.58	4.08–5.08	1,369
Monoblock monopolar hemiarthroplasty	1	2.83	1.92–3.75	1,088
	2	3.40	2.38–4.41	986
	3	3.81	2.72–4.90	827
	4	3.94	2.82–5.05	609
	5	3.94	2.82–5.05	313

Notes
HR: Hazard ratio.
p: p-value.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 4, age 70+ Cumulative percentage revision for primary partial hip replacement, by type of procedure (primary diagnosis of acute hip fracture, patients age 70 and older), 2012–2013 to 2017–2018



HR — adjusted for sex and fixation

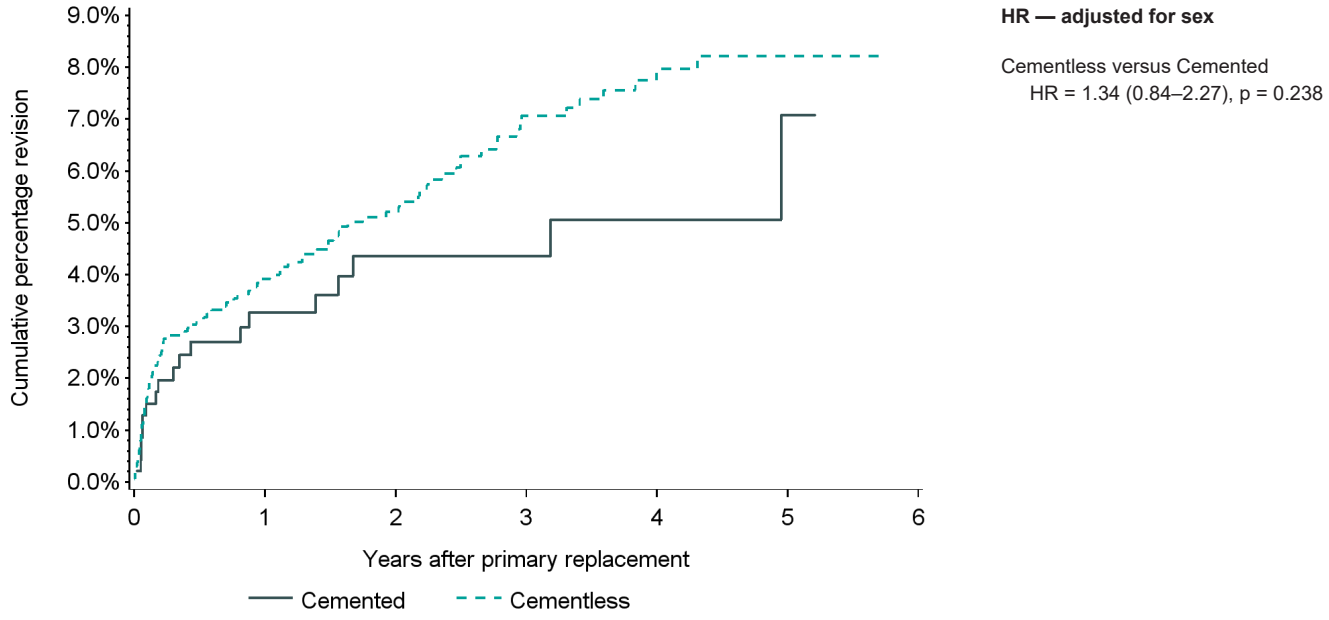
Modular monopolar hemiarthroplasty versus Bipolar hemiarthroplasty
HR = 0.97 (0.79–1.19), p = 0.774

Monoblock monopolar hemiarthroplasty versus Bipolar hemiarthroplasty
HR = 0.98 (0.71–1.33), p = 0.918

Type of hip arthroplasty	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Bipolar hemiarthroplasty	1	2.54	2.24–2.84	8,359
	2	2.99	2.66–3.33	6,116
	3	3.35	2.98–3.71	4,228
	4	3.82	3.39–4.26	2,521
	5	4.11	3.61–4.61	1,158
Modular monopolar hemiarthroplasty	1	2.57	2.07–3.07	2,967
	2	3.09	2.52–3.67	2,166
	3	3.52	2.87–4.16	1,480
	4	3.75	3.06–4.45	836
	5	3.88	3.14–4.63	326
Monoblock monopolar hemiarthroplasty	1	2.85	1.92–3.78	1,053
	2	3.43	2.39–4.46	959
	3	3.75	2.66–4.85	808
	4	3.75	2.66–4.85	596
	5	3.75	2.66–4.85	307

Notes
HR: Hazard ratio.
p: p-value.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 5a, age <70 Cumulative percentage revision for primary partial hip replacement, by femoral fixation and age (primary diagnosis of acute hip fracture, patients younger than 70), 2012–2013 to 2017–2018



Femoral fixation	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Cemented	1	3.27	1.57–4.96	323
	2	4.35	2.28–6.43	222
	3	4.35	2.28–6.43	147
	4	5.06	2.58–7.53	96
	5	7.08	2.47–11.68	45
Cementless	1	3.92	2.94–4.89	1,243
	2	5.21	4.05–6.37	940
	3	7.07	5.61–8.53	676
	4	7.96	6.32–9.61	435
	5	8.22	6.51–9.93	219

Notes

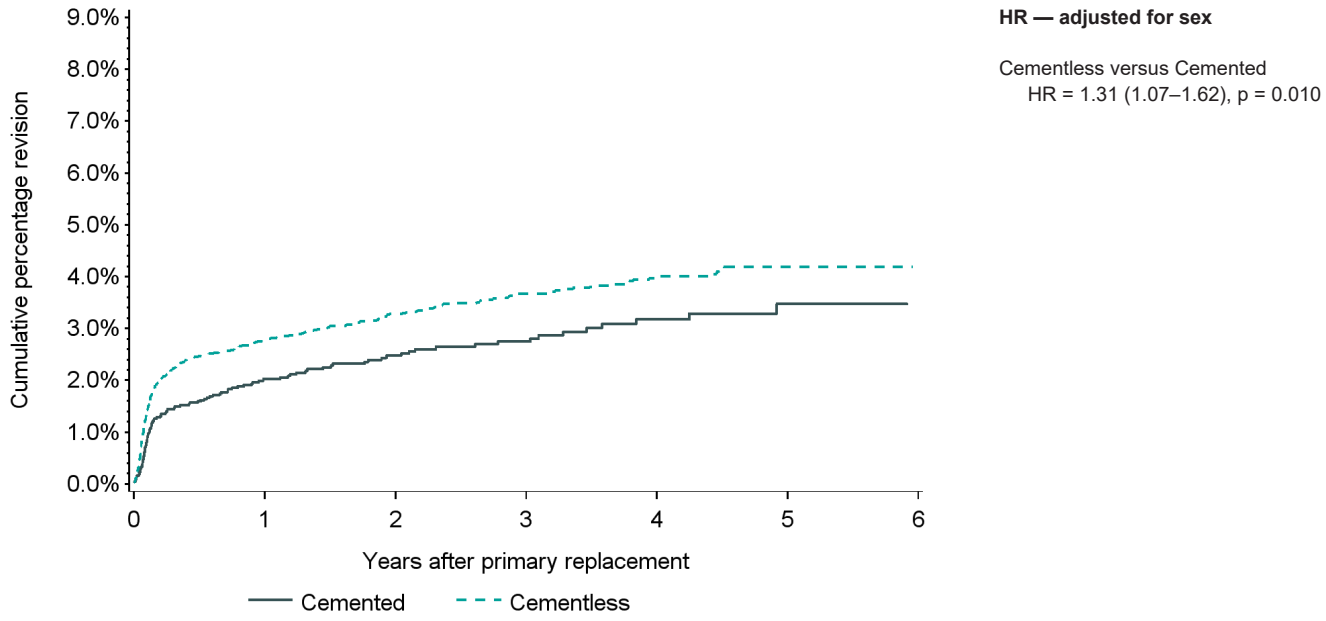
HR: Hazard ratio.

p: p-value.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

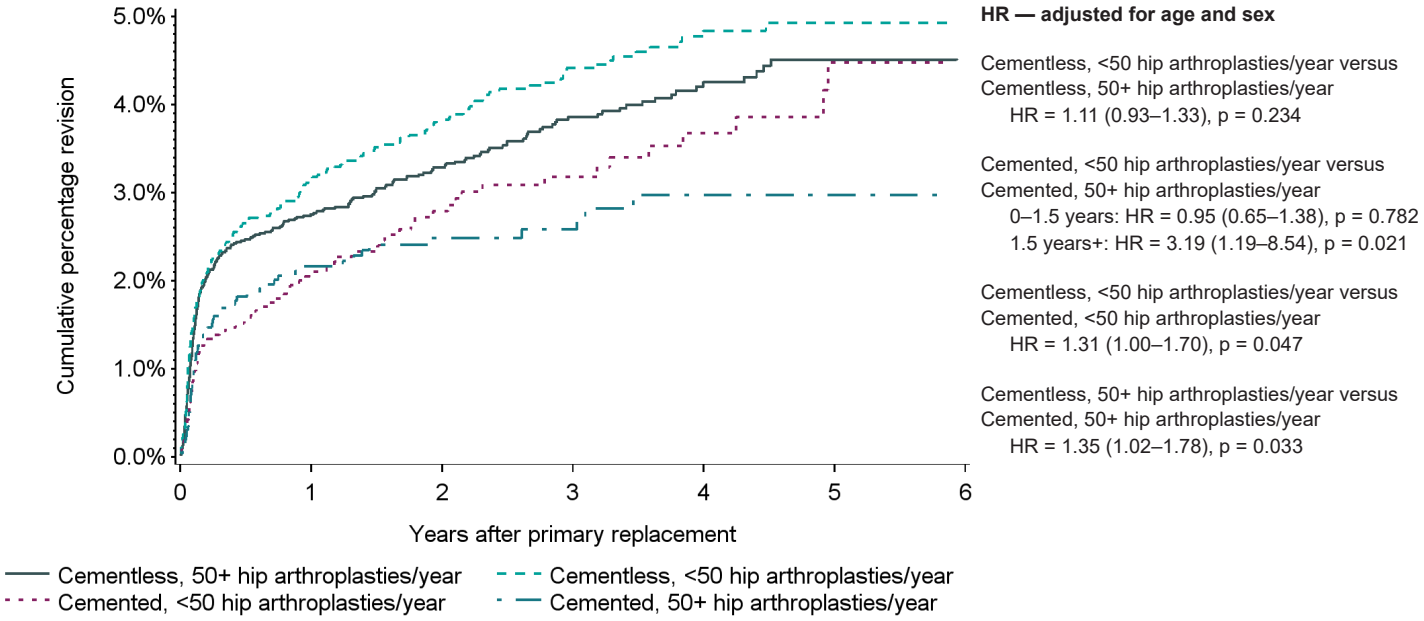
Figure 5b, age 70+ Cumulative percentage revision for primary partial hip replacement, by femoral fixation and age (primary diagnosis of acute hip fracture, patients age 70 and older), 2012–2013 to 2017–2018



Femoral fixation	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Cemented	1	2.02	1.60–2.44	3,340
	2	2.47	1.99–2.96	2,397
	3	2.75	2.22–3.28	1,654
	4	3.17	2.54–3.81	977
	5	3.47	2.71–4.23	485
Cementless	1	2.78	2.48–3.09	9,039
	2	3.28	2.94–3.61	6,844
	3	3.67	3.30–4.04	4,862
	4	4.01	3.59–4.42	2,976
	5	4.18	3.74–4.63	1,306

Notes
HR: Hazard ratio.
p: p-value.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 6 Cumulative percentage revision for primary partial hip replacement, by femoral fixation and surgeon hip arthroplasty volume (primary diagnosis of acute hip fracture), 2012–2013 to 2017–2018



Femoral fixation	Surgeon volume	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Cementless	50 or more procedures a year	1	2.75	2.39–3.12	6,024
		2	3.29	2.87–3.70	4,567
		3	3.86	3.39–4.33	3,214
		4	4.25	3.72–4.78	1,958
		5	4.51	3.92–5.10	889
	Fewer than 50 procedures a year	1	3.15	2.68–3.62	4,258
		2	3.82	3.29–4.36	3,217
		3	4.41	3.81–5.01	2,324
		4	4.84	4.17–5.51	1,453
		5	4.93	4.24–5.62	636
Cemented	50 or more procedures a year	1	2.16	1.58–2.75	1,821
		2	2.48	1.84–3.13	1,260
		3	2.58	1.91–3.25	830
		4	2.97	2.17–3.77	466
		5	2.97	2.17–3.77	234
	Fewer than 50 procedures a year	1	2.11	1.52–2.69	1,842
		2	2.79	2.09–3.49	1,359
		3	3.18	2.40–3.96	971
		4	3.68	2.76–4.59	607
		5	4.47	3.18–5.77	296

Notes

HR: Hazard ratio.

p: p-value.

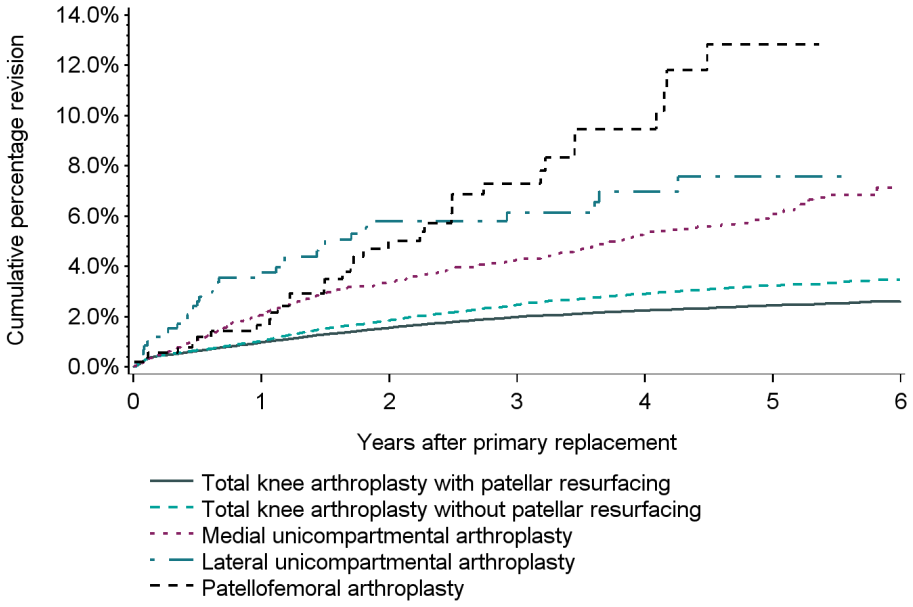
Surgeon volume refers to the number of hip arthroplasties performed by the surgeon in a fiscal year.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Knee replacement figures and tables

Figure 7 Cumulative percentage revision for primary total and partial knee replacement, by type of procedure (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



HR — adjusted for age and sex

Total knee arthroplasty without patellar resurfacing versus Total knee arthroplasty with patellar resurfacing
HR = 1.21 (1.13–1.30), p <0.0001

Medial unicompartmental arthroplasty versus Total knee arthroplasty with patellar resurfacing
HR = 2.02 (1.80–2.26), p <0.0001

Lateral unicompartmental arthroplasty versus Total knee arthroplasty with patellar resurfacing
HR = 2.82 (1.97–3.89), p <0.0001

Patellofemoral arthroplasty versus Total knee arthroplasty with patellar resurfacing
0–1 year: HR = 1.50 (0.68–2.81), p = 0.256
1 year+: HR = 4.60 (3.03–6.67), p <0.0001

Type of knee arthroplasty	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Total knee arthroplasty with patellar resurfacing	1	0.97	0.92–1.03	105,209
	2	1.55	1.48–1.62	82,346
	3	1.98	1.89–2.07	60,026
	4	2.24	2.15–2.34	38,769
	5	2.45	2.34–2.56	18,494
Total knee arthroplasty without patellar resurfacing	1	1.04	0.95–1.12	46,710
	2	1.84	1.72–1.96	34,611
	3	2.46	2.31–2.61	24,504
	4	2.90	2.73–3.07	15,360
	5	3.23	3.03–3.44	6,974
Medial unicompartmental arthroplasty	1	2.05	1.74–2.36	7,149
	2	3.38	2.97–3.79	5,617
	3	4.26	3.77–4.74	4,151
	4	5.34	4.75–5.93	2,718
	5	6.09	5.39–6.79	1,436
Lateral unicompartmental arthroplasty	1	3.74	2.17–5.32	478
	2	5.80	3.77–7.84	353
	3	6.14	4.01–8.27	273
	4	6.97	4.57–9.38	177
	5	7.57	4.91–10.24	100
Patellofemoral arthroplasty	1	1.66	0.51–2.80	403
	2	5.01	2.84–7.19	292
	3	7.30	4.51–10.09	204
	4	9.46	6.02–12.90	132
	5	12.84	8.18–17.49	59

Notes
HR: Hazard ratio.
p: p-value.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Table 4 Reasons for revision of total knee replacement for degenerative arthritis, by type of procedure, 2012–2013 to 2017–2018

Primary procedure type	Infection	Instability	Aseptic loosening	Arthritis in previously unresurfaced compartment	Remaining reasons
Total knee arthroplasty with patellar resurfacing	481 (37.0%)	299 (23.0%)	225 (17.3%)	0 (0.0%)	287 (22.1%)
Total knee arthroplasty without patellar resurfacing	194 (29.0%)	130 (19.4%)	115 (17.2%)	36 (5.4%)	195 (29.1%)

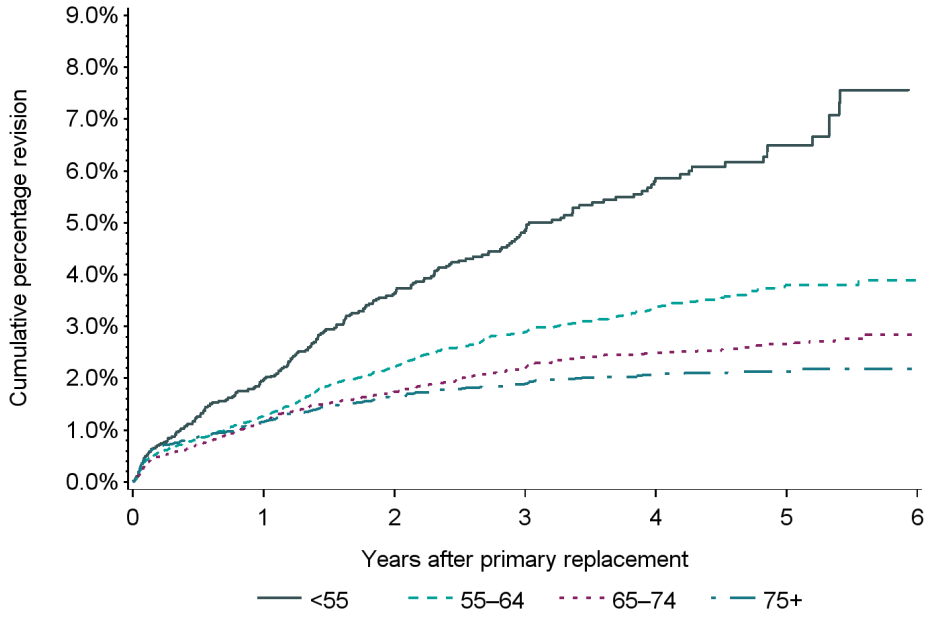
Note

Only procedures with a specific diagnosis were included. Records with reason for revision listed as "other" (n = 561) were excluded, as were those where the revision record in the DAD could not be linked to a reason for revision in CJRR (n = 953). Remaining reasons included pain of unknown origin, patella maltracking or instability, periprosthetic fracture (femur or tibia), bearing wear, implant dissociation, implant fracture, osteolysis and stiffness.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 8a, men Cumulative percentage revision for primary total knee replacement for men, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



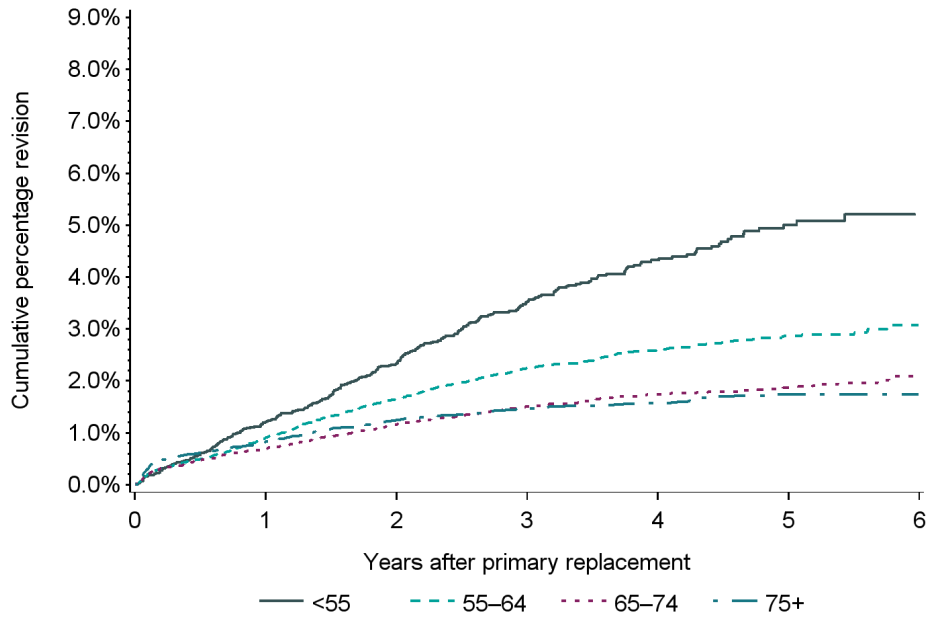
Age	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
<55	1	1.97	1.56–2.38	3,936
	2	3.65	3.07–4.23	3,119
	3	4.84	4.15–5.54	2,348
	4	5.86	5.04–6.69	1,493
	5	6.50	5.55–7.44	712
55–64	1	1.27	1.12–1.43	17,281
	2	2.22	2.00–2.43	13,342
	3	2.90	2.64–3.16	9,608
	4	3.35	3.05–3.65	6,047
	5	3.80	3.44–4.16	2,866
65–74	1	1.17	1.04–1.31	22,659
	2	1.75	1.58–1.91	17,312
	3	2.19	2.00–2.39	12,292
	4	2.49	2.27–2.72	7,839
	5	2.65	2.41–2.90	3,627
75+	1	1.16	1.00–1.32	14,416
	2	1.65	1.45–1.85	11,081
	3	1.89	1.67–2.11	7,932
	4	2.06	1.82–2.31	5,052
	5	2.13	1.88–2.39	2,375

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 8b, women

Cumulative percentage revision for primary total knee replacement for women, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



Age	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
<55	1	1.21	0.97–1.44	7,529
	2	2.33	1.99–2.67	5,919
	3	3.52	3.07–3.96	4,421
	4	4.32	3.80–4.85	2,849
	5	5.01	4.38–5.63	1,340
55–64	1	0.91	0.80–1.01	27,716
	2	1.65	1.50–1.80	21,347
	3	2.24	2.06–2.43	15,587
	4	2.59	2.38–2.80	10,043
	5	2.87	2.63–3.11	4,780
65–74	1	0.70	0.62–0.78	35,825
	2	1.16	1.05–1.27	27,441
	3	1.51	1.37–1.64	19,573
	4	1.74	1.59–1.90	12,460
	5	1.87	1.70–2.04	5,686
75+	1	0.83	0.72–0.94	22,557
	2	1.25	1.10–1.39	17,396
	3	1.47	1.31–1.63	12,769
	4	1.57	1.40–1.73	8,346
	5	1.74	1.54–1.93	4,082

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Table 5 Reasons for revision of total knee replacement for degenerative arthritis, by age and sex, 2012–2013 to 2017–2018

Sex	Age	Aseptic loosening	Infection	Instability	Remaining reasons
Women	<55	34 (19.3%)	37 (21.0%)	53 (30.1%)	52 (29.5%)
	55–64	82 (21.6%)	95 (25.1%)	96 (25.3%)	106 (28.0%)
	65–74	53 (15.6%)	105 (31.0%)	69 (20.4%)	112 (33.0%)
	75+	26 (12.9%)	80 (39.6%)	41 (20.3%)	55 (27.2%)
Men	<55	25 (19.8%)	37 (29.4%)	25 (19.8%)	39 (31.0%)
	55–64	55 (17.9%)	109 (35.4%)	71 (23.1%)	73 (23.7%)
	65–74	49 (17.0%)	124 (42.9%)	52 (18.0%)	64 (22.1%)
	75+	16 (10.7%)	88 (58.7%)	22 (14.7%)	24 (16.0%)

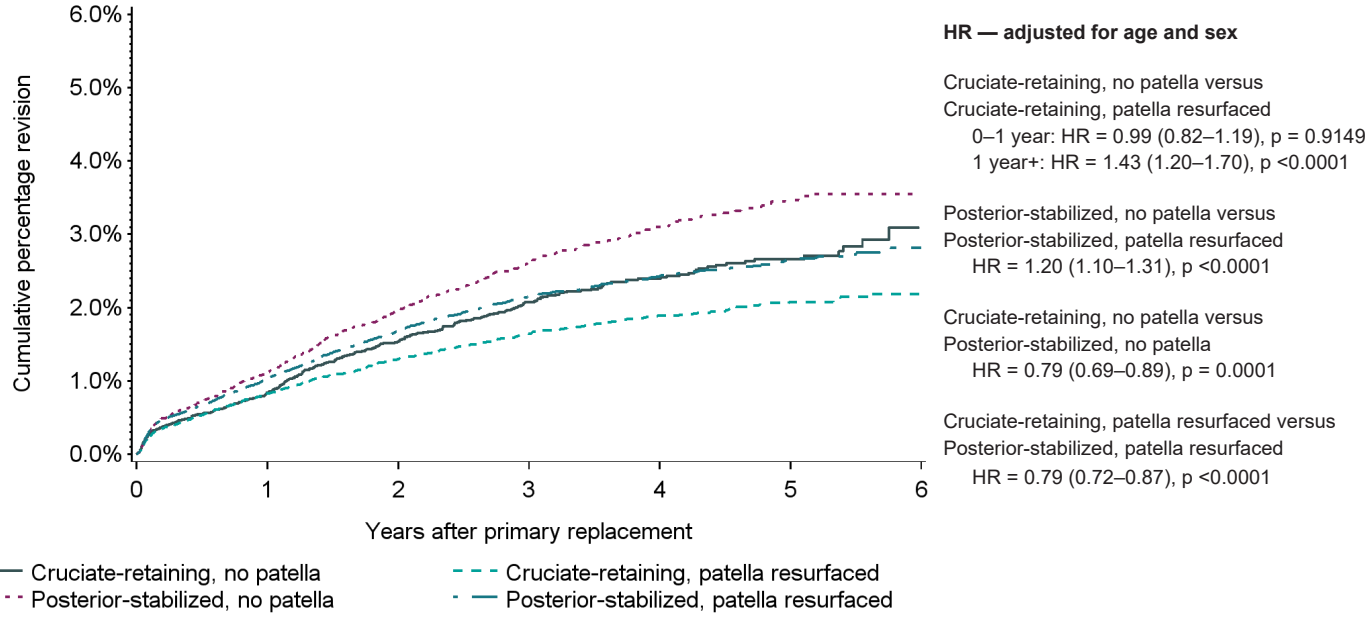
Note

Only procedures with a specific diagnosis were included. Records with reason for revision listed as “other” (n = 561) were excluded, as were those where the revision record in the DAD could not be linked to a reason for revision in CJRR (n = 953). Remaining reasons for revision included bearing wear, osteolysis, pain of unknown origin, patellar maltracking, periprosthetic fracture, implant fracture, implant dissociation, arthritis in previously unresurfaced compartment and stiffness.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 9 Cumulative percentage revision for primary total knee replacement, by stability and patella usage (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



Stability and patella usage	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Cruciate-retaining, no patella	1	0.84	0.72–0.97	17,194
	2	1.53	1.35–1.72	12,489
	3	2.07	1.84–2.30	8,849
	4	2.40	2.14–2.66	5,502
	5	2.66	2.36–2.96	2,554
Cruciate-retaining, patella resurfaced	1	0.83	0.74–0.91	36,640
	2	1.30	1.19–1.41	29,156
	3	1.64	1.51–1.77	21,742
	4	1.89	1.74–2.04	14,350
	5	2.08	1.90–2.25	6,902
Posterior-stabilized, no patella	1	1.12	1.00–1.23	26,604
	2	1.97	1.80–2.13	20,118
	3	2.61	2.41–2.82	14,279
	4	3.10	2.86–3.34	9,149
	5	3.47	3.19–3.75	4,130
Posterior-stabilized, patella resurfaced	1	1.03	0.96–1.10	64,539
	2	1.67	1.58–1.77	50,710
	3	2.15	2.03–2.26	36,835
	4	2.43	2.30–2.56	23,675
	5	2.65	2.50–2.79	11,283

Notes

HR: Hazard ratio.

p: p-value.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

International Consortium of Orthopaedic Registries–International Society of Arthroplasty Registries (ICOR-ISAR). Global Arthroplasty Product Library. May 31, 2018, version.

Table 6 Reasons for revision of total knee replacement for degenerative arthritis, by stability and patella usage, 2012–2013 to 2017–2018

Stability and patella usage	Infection	Instability	Aseptic loosening	Arthritis in previously unresurfaced compartment	Remaining reasons
Cruciate-retaining, no patella	54 (26.0%)	39 (18.8%)	42 (20.2%)	14 (6.7%)	59 (28.4%)
Cruciate-retaining, patella resurfaced	149 (39.7%)	87 (23.2%)	65 (17.3%)	0 (0.0%)	73 (19.5%)
Posterior-stabilized, no patella	129 (32.8%)	74 (18.8%)	57 (14.5%)	14 (3.6%)	119 (30.3%)
Posterior-stabilized, patella resurfaced	299 (34.8%)	195 (22.7%)	158 (18.4%)	0 (0.0%)	202 (23.5%)

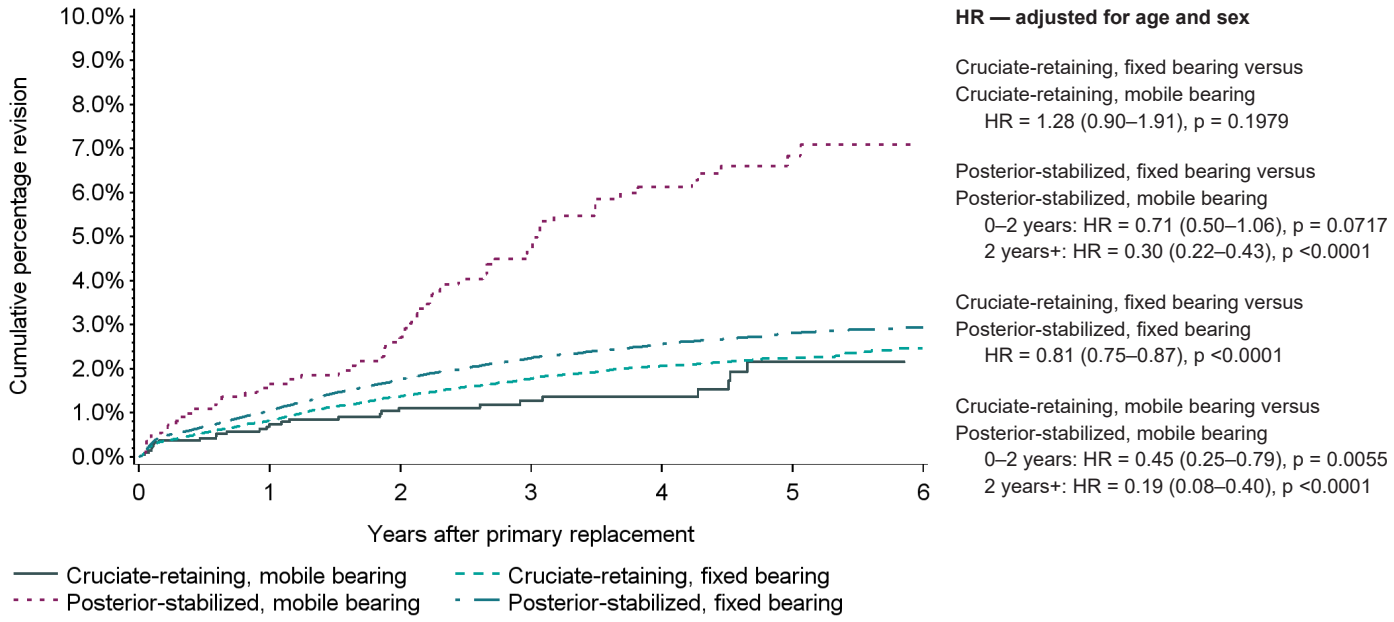
Note

Only procedures with a specific diagnosis were included. Records with reason for revision listed as "other" (n = 331) were excluded, as were those where the revision record in the DAD could not be linked to a reason for revision in CJRR (n = 953). Remaining reasons for revision included bearing wear, osteolysis, pain of unknown origin, patellar maltracking, periprosthetic fracture, implant fracture, implant dissociation and stiffness.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 10 Cumulative percentage revision for primary total knee replacement, by stability and mobility (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018



Stability and mobility	Years after primary replacement	Cumulative percentage revision (%)	95% confidence interval	Number at risk
Cruciate-retaining, fixed bearing	1	0.83	0.75–0.90	49,834
	2	1.37	1.27–1.47	38,903
	3	1.78	1.66–1.90	28,507
	4	2.06	1.92–2.20	18,490
	5	2.25	2.10–2.41	8,781
Cruciate-retaining, mobile bearing	1	0.74	0.37–1.11	1,816
	2	1.11	0.63–1.58	1,457
	3	1.27	0.75–1.80	1,106
	4	1.36	0.81–1.92	686
	5	2.16	1.20–3.11	300
Posterior-stabilized, fixed bearing	1	1.05	0.99–1.12	87,752
	2	1.75	1.67–1.84	68,352
	3	2.24	2.14–2.34	49,292
	4	2.56	2.45–2.68	31,479
	5	2.81	2.68–2.94	14,713
Posterior-stabilized, mobile bearing	1	1.66	0.90–2.42	1,004
	2	2.71	1.71–3.70	894
	3	4.74	3.39–6.08	793
	4	6.13	4.57–7.68	671
	5	6.84	5.14–8.54	386

Notes

HR: Hazard ratio.

p: p-value.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

International Consortium of Orthopaedic Registries–International Society of Arthroplasty Registries (ICOR-ISAR). Global Arthroplasty Product Library. May 31, 2018, version.

Appendix 1: Methodological notes

Revision risk curves

Study population

Primary hip and knee replacement surgeries (total or partial) performed in patients age 18 and older in provinces that have mandatory submission to CJRR (Ontario, Manitoba, British Columbia), followed up to a maximum of 6 years.

Data sources

- **Primary replacements:** Canadian Joint Replacement Registry, 2012–2013 to 2017–2018; Ontario, Manitoba and British Columbia only.
- **Revision surgeries:**[xi] Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018.
- The first occurrence of a revision surgery was identified by linkage to the primary surgery using encrypted health care number and the jurisdiction issuing the health care number, as well as a match for joint type (hip or knee) and replacement side (left or right). As such, surgeries with an invalid health care number or surgery side were excluded from the analysis.
- Note that same-day revisions were excluded from this analysis, as were primary procedures (from CJRR) for which a revision of the same side was found in the DAD at a date earlier than the primary surgery date.

Methodology

- Stratified Kaplan–Meier survival analysis was used to estimate the survival curves, and the Cox proportional hazards model was used to compare different groups while adjusting for age, sex or cement fixation as appropriate.

Unit of analysis

- 1 primary hip or knee joint replacement surgery.

xi. For codes used to identify hip and knee replacement revision surgeries in the DAD and NACRS, refer to *Hip and Knee Replacements in Canada: Canadian Joint Replacement Registry 2017–2018 Quick Stats*, available on CIHI's website at www.cihi.ca/cjrr.

Study outcome

- Time from the primary replacement to the first revision for a revised joint event. For censored surgeries, time from primary replacement to in-hospital death or the end of the study period (March 31, 2018) was used.[xii]
- Cumulative percentage revision at 1 to 5 years, presented with 95% confidence interval (95% CI) at each year.[xiii] Number of cases at risk is also reported. The cumulative percentage revision is displayed until the number at risk for the group reaches 40.
- Hazard ratios for specific comparisons adjusted for age, sex and cement fixation as appropriate presented with 95% confidence intervals and p-values. Analytical comparisons of revision rates using the proportional hazards model are based on all available data.
- The level of significance was set at 0.05 for all statistical tests.

Limitations

- The revision surgery could have been performed in any Canadian province or territory; however, each jurisdiction manages its own health care numbers, so any patient movements may result in slight under-reporting.
- Quebec does not provide CIHI with information on procedures done on individuals from out of province; thus any revision surgery done in Quebec following a primary surgery performed outside of Quebec for non-Quebec residents is not available for this analysis.
- This analysis assumes that the survivorship of a replacement on one side is independent from survivorship on the other side, even if performed on the same patient.
- Bilateral replacement patients are double-counted because different implant prostheses may be used for each side.
- Re-revisions are not included, even though patients may have more than one revision on the same side.
- Only in-hospital deaths could be identified using the data sources for this analysis, which could potentially influence the results for the oldest age group more than for other groups. As a result, the true probability of revision may be over-estimated.

xii. In-hospital death was identified using the DAD or NACRS. Patients who died during the primary replacement surgery were excluded from analysis.

xiii. The probabilistic complement of the Kaplan–Meier survivorship function at a given time point, multiplied by 100.

Definitions for derived categories

Revision procedures: Components replaced

- Component information is obtained from product information collected in CJRR.
- Hip revision procedures were grouped as follows:
  - Both femoral component and acetabular component replaced
  - Femoral head replaced (with or without acetabular liner revision)
  - Femoral component replaced (with or without acetabular liner replacement)
  - Acetabular component replaced (with or without femoral head replacement)
  - Acetabular liner replaced only
  - Insertion of cement spacer
- Knee revision procedures were grouped as follows:
  - Both femoral component and tibial component replaced
  - Femoral component replaced (with or without replacement of the tibial insert; with or without patellar component)
  - Tibial component replaced (with or without patellar component)
  - Tibial insert replaced (with or without revision of patella component)
  - Replacement or insertion of the patellar component only
  - Insertion of cement spacer

Bearing surface for total hip replacement

- For the bearing surface analysis, CJRR catalogue numbers submitted for the total hip replacements identified in the cohort were linked to the Global Arthroplasty Product Library.[9]
  - Bearing surface was determined as the bearing surface of the femoral head on the bearing surface of the acetabular articulating surface (the insert, if one existed; otherwise the acetabular component).
  - Bearing surfaces were categorized as ceramic, metal, cross-linked polyethylene and non-cross-linked polyethylene.
  - A joint replacement's bearing surface was considered missing if linkage to the Library indicated
    - Missing bearing surface for the femoral or acetabular articulating surface; and/or
    - More than one femoral or acetabular articulating surface identified.
- Fixation of the femoral component and of the acetabular cup was determined by linkage to the Library and was grouped as follows:
  - Cemented: Both femoral and acetabular components are to be used with cement.
  - Hybrid: Only one component is to be used with cement.

  - Cementless: Cement is not indicated for both components.
  - A joint replacement's fixation was considered unknown if there was no linkage to the Library for either the femoral or acetabular articulating surface or both.

Monopolar hemiarthroplasty: Monoblock versus modular

- Collected in CJRR using the data element Primary Procedure Type.
- Among procedures identified as monopolar hemiarthroplasties, the following criteria were used:
  - If it had a femoral component but no femoral head, it was considered a **monoblock** monopolar hemiarthroplasty.
  - If it had a femoral component and a femoral head, it was considered a **modular** monopolar hemiarthroplasty.
  - If it did not have a femoral component, the procedure type was **unknown**. These were removed from the cohort for analyses examining the procedure type of partial hip replacements.

Femoral fixation for partial hip replacement: Cement used versus cementless

- Determined based on cement information reported in CJRR.
- If no femoral component was reported, the fixation method was determined to be not available (1%); these were excluded from the cohort for analyses examining the effect of femoral fixation of hip replacements.

Surgeon arthroplasty volume

- Determined as the number of hip replacements a surgeon performed in a fiscal year. It was dichotomized as low volume (fewer than 50 hip replacements a year) and high volume (50 or more hip replacements a year) based on the univariate distribution of the variable.

Knee stability

- Stability can be determined from both the femoral component and the tibial insert; however, the stability of the insert is sufficient for determining stability of the construct. If the insert information was missing, stability of the femoral component was considered. Records where stability was other than minimally stabilized (cruciate-retaining) or posterior-stabilized, as well as those where stability information was not available, were excluded from the cohort for analyses examining the effect of stability.

Knee bearing mobility

- Mobility can be determined from both the tibial component and the tibial insert; however, the mobility of the insert is sufficient for determining mobility of the construct. If the insert information was missing, bearing mobility of the tibial component was considered. Bearing mobility was classified into mobile (rotating, sliding, rotating and sliding) and fixed. Records where mobility information was not available were excluded from the cohort for analyses examining the effect of knee bearing mobility.

Cost estimates

Cost estimates represent the estimated average acute inpatient cost in hospitals. The cost estimates do not include payments made to physicians, rehab or amortization expenses on land, buildings and building service equipment. Volumes are from 2017–2018 DAD/HMDB data and include adult inpatients only; estimated hospitalization average costs are calculated by multiplying the Resource Intensity Weight (RIW) by the national Cost of a Standard Hospital Stay (CSHS) from the 2017–2018 Canadian Management Information System Database (CMBD) using 2018 Case Mix Group+ (CMG+) methodology.

Appendix 2: Glossary

acetabulum

The acetabulum is the cup-shaped socket of the hip joint. In Latin, the word “acetabulum” means cup, specifically a vinegar cup. The acetabulum is a feature of the pelvis. The head (upper end) of the femur (the thigh bone) fits into the acetabulum and articulates with it, forming a ball-and-socket joint.

age-standardized rate

Age standardization is a common analytical technique used to compare rates over time, since it takes into account changes in age structure across populations and time.

aseptic loosening

Aseptic loosening is the loosening of the total joint without involvement of bacteria.

bipolar hemiarthroplasty

A bipolar hemiarthroplasty is a type of partial hip replacement in which the natural femoral head is replaced with a prosthetic femoral stem and head that articulates with an additional head that matches the size of the natural femoral head.

cumulative percentage revision

Cumulative percentage revision, also known as a joint replacement failure rate, is calculated as the probabilistic complement of the Kaplan–Meier survivorship function at the given time point, multiplied by 100. This estimates the percentage of replacements revised up until that time point (e.g., 2 years), accounting for right censoring due to death and to the end of the most recent fiscal data year.

degenerative arthritis

Degenerative arthritis refers to deterioration of the articular cartilage that lines a joint, which results in narrowing of the joint space and pain; it is also referred to as osteoarthritis.

fixation method

As hip and knee joint prostheses are inserted, they are fixed securely into position in the joint. The 3 major categories of fixation methods are

- Cemented, where components involved (femoral and acetabular for hip; femoral, tibial and patellar for knee) are fixed by bone cement;
- Cementless, where initial fixation is achieved through a press-fit, followed by bone ingrowth for long-term stability; and
- Hybrid, where a mixture of cemented and cementless fixation is used.

hemiarthroplasty

See *partial hip replacement*

hip bearing surface

The acetabular cup and the femoral head of a hip prosthesis unite to form an articulation. The site at which the movable parts unite is the bearing surface. This is the part of the implant that is subjected to the most wear and tear. Bearing surface options include combinations such as metal-on-polyethylene, metal-on-ceramic and ceramic-on-ceramic.

hip replacement

This surgery is performed to replace all or part of the hip joint with an artificial implant. The hip is essentially a ball-and-socket joint, linking the ball at the head of the thigh bone (femur) with the cup-shaped socket in the pelvic bone. A hip prosthesis is surgically implanted to replace the damaged bone within the hip joint.

knee bearing mobility

Bearing mobility refers to the intended movement of the tibial insert in the knee joint. Mobile bearings include tibial inserts that move in 1 of 3 ways relative to the tibial component: rotating, sliding, or both rotating and sliding. Fixed bearings include tibial inserts that are not intended to move relative to their tibial component.

knee replacement

Knee joint replacement is surgery to replace a painful damaged or diseased knee joint with an artificial joint. The orthopedic surgeon makes a cut over the affected knee. The patella (kneecap) is moved out of the way, and the ends of the femur (thigh bone) and tibia (shin bone) are cut to fit the prosthesis. Similarly, the under-surface of the patella cap is often cut to allow for placement of an artificial component.

knee stability

Knee stability refers to particular prosthetic features intended to substitute for the intrinsic stability of knee ligaments. The major categories are minimally stabilized (also known as cruciate-retaining) and posterior-stabilized.

median

The median is a measure of central tendency — the middle of a distribution. The median is less sensitive to extreme scores than the mean, which makes it a better measure for highly skewed distributions.

monopolar modular hemiarthroplasty

A monopolar modular hemiarthroplasty is a partial hip replacement that replaces the natural femoral head with a femoral stem prosthesis combined with an exchangeable head.

monopolar monoblock hemiarthroplasty

A monopolar monoblock hemiarthroplasty is a partial hip replacement that replaces the natural femoral head with a single component that consists of a femoral stem prosthesis with a fixed head.

partial hip replacement (also known as hemiarthroplasty)

This surgical procedure replaces half of the hip joint with an artificial surface and leaves the other part in its natural (pre-operative) state. This usually refers to replacing the femoral head, and is most commonly done to treat femoral neck fracture (“hip fracture”).

primary replacement

A primary replacement is the first replacement procedure, where the natural, worn joint is replaced with an artificial joint prosthesis.

revision

Revisions are modifications to or replacements of an existing artificial hip or knee joint prosthesis/component. A revision procedure may be necessary when an existing old or worn-out hip or knee component needs to be removed and replaced with a new or improved prosthesis. This may include removing one or more hip or knee components as necessary.

survival curve (or revision risk curve)

A plot of the proportion of subjects who have not yet experienced a defined event such as death or revision of prosthesis, versus time. It is also known as the cumulative percentage revision. The Kaplan–Meier estimator is the most commonly used method to calculate the survival curve. The curve takes account of subjects whose ultimate survival time is not known, a phenomenon called “censoring.”

Appendix 3: Text alternative for figures

Figure 1a, men: Cumulative percentage revision for primary total hip replacement for men, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each age group is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 4.0%. The 4 curves have a similar shape: a steep increase to around 1%, quite close to the baseline (year 0). After that, the increase is quite flat. The curve for age 75 and older is higher than the curves for the other 3 age groups, with a more profound steep increase, to about 1.5%, close to year 0. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 1b, women: Cumulative percentage revision for primary total hip replacement for women, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each age group is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 4.0%. 3 of the 4 curves (age groups younger than 55, 55 to 64 and 65 to 74) have a very similar shape with a steep increase, to about 1%, quite close to the baseline (year 0). The curve for age 75 and older is considerably higher than those for the other 3, with a more profound steep increase, to about 2%. After that, the increase is quite flat for all curves. Just after the 2-year mark, the 75 and older curve becomes closer to the others, and it overlaps with the first 2 younger groups after the 3-year mark, while the 65 to 74 curve starts to separate, becoming considerably lower. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 2: Cumulative percentage revision for primary total hip replacement, by bearing surface (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each bearing surface (ceramic-on-XLPE, ceramic-on-ceramic, metal-on-XLPE and metal-on-non-XLPE) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 3.0%. The 4 curves have a similar shape: a steep increase to around 1%, quite close to the baseline (year 0). After that, the increase is quite flat. After the 2-year mark, the curve for metal-on-non-XLPE is lower than the curves for the other 3 bearing surfaces and flat due to the low number of events. The table below the figure includes the related statistics.

Note
XLPE: Cross-linked polyethylene.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.
International Consortium of Orthopaedic Registries–International Society of Arthroplasty Registries (ICOR-ISAR). Global Arthroplasty Product Library. May 31, 2018, version.

Figure 3: Cumulative percentage revision for primary hip replacement, by type of procedure (primary diagnosis of acute hip fracture), 2012–2013 to 2017–2018

The cumulative percentage revision for each replacement type (total, monopolar monoblock, monopolar modular and bipolar hemiarthroplasty) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 6.0%. All curves look very similar, with a steep increase to about 2%, quite close to the baseline (year 0). After that, the increase is quite flat. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 4, age 70+: Cumulative percentage revision for primary partial hip replacement, by type of procedure (primary diagnosis of acute hip fracture, patients age 70 and older), 2012–2013 to 2017–2018

The cumulative percentage revision for each hemiarthroplasty type (modular monopolar, monoblock monopolar and bipolar) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 5.0%. The bipolar and modular monopolar curves look very similar, with a steep increase to just under 2%, quite close to the baseline (year 0); after that, the increase is quite flat. The curve representing the monoblock monopolar hemiarthroplasties is slightly higher than the other 2 curves. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 5a, age <70: Cumulative percentage revision for primary partial hip replacement, by femoral fixation and age (primary diagnosis of acute hip fracture, patients younger than 70), 2012–2013 to 2017–2018

The cumulative percentage revision for each of the 2 femoral fixation approaches, cemented and cementless, is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 9.0%. The cemented curve has a steep increase to 4% around the 2-year mark and the cementless curve has a steep increase to almost 8% past the 4-year mark. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 5b, age 70+: Cumulative percentage revision for primary partial hip replacement, by femoral fixation and age (primary diagnosis of acute hip fracture, patients age 70 and older), 2012–2013 to 2017–2018

The cumulative percentage revision for each of the 2 femoral fixation approaches, cemented and cementless, is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 9.0%. The curve for the cementless femoral fixation is slightly higher and increases in a steeper manner shortly after the baseline (year 0). After that, the increase is quite flat for both curves. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 6: Cumulative percentage revision for primary partial hip replacement, by femoral fixation and surgeon hip arthroplasty volume (primary diagnosis of acute hip fracture), 2012–2013 to 2017–2018

The cumulative percentage revision for each of the 4 groups studied (cemented, high volume; cemented, low volume; cementless, high volume; cementless, low volume) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 5.0%. The cemented curves (both low volume and high volume) are considerably lower than the cementless curves. All 4 curves have a steep increase shortly after the baseline (year 0); cemented curves reach just higher than 1%, while cementless ones are close to 2.5%. When comparing the cementless curves, the low-volume one is considerably higher than the high-volume ones. The table below the figure includes the related statistics.

Note
Surgeon volume refers to the number of hip arthroplasties performed by the surgeon in a fiscal year.
Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 7: Cumulative percentage revision for primary total and partial knee replacement, by type of procedure (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each knee replacement type (medial, lateral and patellofemoral partials, as well as total knee arthroplasties with and without patella resurfacing) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 14.0%. The total knee replacement curves are lower than the partial ones, with the total knee replacement with patella resurfacing being the lowest. Up until 2.5 years, the lateral unicompartmental curve is the highest. The patellofemoral curve has the steepest increase and after 2.5 years becomes the highest after overlapping the lateral curve. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 8a, men: Cumulative percentage revision for primary total knee replacement for men, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each age group is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 9.0%. The highest curve and the curve with the steepest increase is for the age group younger than 55. The other 3 curves almost overlap up until the 1-year mark, after which they start diverging, with the 75+ group being the lowest, followed by 65 to 74, then 55 to 64. The increase for those 3 curves is steady over time. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 8b, women: Cumulative percentage revision for primary total knee replacement for women, by age (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each age group is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 9.0%. The 4 curves have a very similar shape, although they diverge shortly after year 1, with the exception of the age groups 65 to 74 and 75 and older, which almost overlap. The increase is steady over time. The highest curve is for the age group younger than 55, then 55 to 64, followed by 65 to 74, then 75+. The table below the figure includes the related statistics.

Sources
Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.

Figure 9: Cumulative percentage revision for primary total knee replacement, by stability and patella usage (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each of the 4 groups studied (cruciate-retaining, no patella; cruciate-retaining, patella resurfaced; posterior-stabilized, no patella; posterior-stabilized, patella resurfaced) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 6.0%. All curves have a similar shape, although they diverge slowly after year 1. The posterior-stabilized with no patella curve is highest and cruciate-retaining with patella resurfaced is lowest. The cruciate-retaining with no patella and posterior-stabilized with patella resurfaced curves almost overlap. The table below the figure includes the related statistics.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.
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Figure 10: Cumulative percentage revision for primary total knee replacement, by stability and mobility (primary diagnosis of degenerative arthritis), 2012–2013 to 2017–2018

The cumulative percentage revision for each of the 4 groups studied (cruciate-retaining, mobile bearing; cruciate-retaining, fixed bearing; posterior-stabilized, mobile bearing; posterior-stabilized, fixed bearing) is plotted as a separate curve. The x-axis represents the number of years after primary replacement and ranges from 0 to 6 years. The y-axis represents the cumulative percentage revision and ranges from 0.0% to 10.0%. Both fixed curves (posterior-stabilized and cruciate-retaining) have a similar shape. The posterior-stabilized and mobile bearing curve is the highest and diverges significantly from all others after the 2-year mark. The table below the figure includes the related statistics.

Sources

Canadian Joint Replacement Registry (Ontario, Manitoba and British Columbia only), Discharge Abstract Database and National Ambulatory Care Reporting System, 2012–2013 to 2017–2018, Canadian Institute for Health Information.
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