AAOS
American Academy of Orthopaedic Surgeons

AJRR American Joint Replacement Registry

ANNUAL REPORT 2023

10th year ANNIVERSARY

The Tenth Annual Report of the
AJRR on Hip and Knee Arthroplasty

Contents

Dedication

The *2023 Annual Report* is dedicated to Bryan D. Springer, MD, FAAOS. Dr. Springer has served many roles at the American Joint Replacement Registry since the first pilot program started in 2010. As Chair of the Data Committee, Dr. Springer was instrumental in leading the launch of the Registry Insights surgeon dashboard. He most recently completed a three-year term as Chair of the Steering Committee, where he focused on improving the accuracy and completeness of AJRR data via the minimum data set program as well as the new data element quality and coverage dashboard. His work with the Registry Analytics unit has accelerated the dissemination of AJRR data through numerous peer-reviewed publications and presentations. He has worked tirelessly to foster AJRR's partnerships with industry, payors, hospitals, and other national registries. The tremendous growth of AJRR is a testament to Bryan's dedication, vision, and steady leadership. We are fortunate that Bryan continues to serve AJRR through his role as the AAOS Representative to the AJRR Steering Committee and his seat on the AAOS Registry Oversight Committee.

James Huddleston, III, MD, FAAOS
Chair, AJRR Steering Committee

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Foreword

What a milestone – 10 years of published Annual Reports from the American Joint Replacement Registry (AJRR)! There is much value in registry data, and we now have a decade of clinical hip and knee arthroplasty data that helps us to improve the quality of care we deliver to our patients. With over 3.8 million (and counting) hip and knee arthroplasty procedures through 2023 from over 3.2 million patients currently captured in the Registry, the AJRR is the largest orthopaedic Registry by annual procedure count.

This year's AJRR Annual Report presents a glimpse into the data over the last decade through 2022 and provides clinical insights, national trends, and risk-stratified outcome analyses related to Medicare patients who undergo hip and knee arthroplasty procedures.

Additionally, we continue to amass more data about patient-reported outcome measures (PROMs), key data points that allow us to demonstrate the true value of hip and knee replacement. With the looming CMS mandate for collection of PROMs for Medicare fee-for-service patients, PROMs will play a more prominent role in assessing performance outcomes and determining the effectiveness of orthopaedic treatments. By the end of 2022, 496 sites out of 1,364 (36%) have submitted PROMs, which is a 24% increase in sites compared to the previous 2022 AJRR Annual Report.

These analyses were made possible by continued growth of the AJRR, as well as the successful integration of Medicare claims data into the AJRR. This linkage provides a more complete picture of our patient population and their associated comorbidities and outcomes, including longitudinal outcomes of patients who receive care at non-AJRR participating sites. The information in this year's Annual Report gives the most comprehensive picture to date of patterns of hip and knee arthroplasty practice and outcomes in the United States.

The AAOS Registry Oversight Committee and AJRR Steering Committee trust you will find the information interesting, useful, and in some cases, actionable. With the rapid growth of AJRR capabilities, we look forward to being able to provide our stakeholders with valuable data that can be used to change practice and improve patient outcomes.

In closing, I would like to thank the staff at AJRR for their continued dedication to this endeavor. The efforts of Nathan Glusenkamp, MA, Chief Quality and Registries Officer, Reagan Bayer, MBA, PMP, CSM, CMP, Director, Registries, Kyle Mullen, MPH, General Manager of Combined Analytics, Mita De, PhD, Director of Research, Bryan D. Springer, MD, past Chair of the AJRR Steering Committee, Scott M. Sporer, MD, FAAOS, Vice Chair of the AJRR Steering Committee, and James A. Browne, MD, FAAOS, Chair of the AJRR Publications Subcommittee and Editor, AJRR Annual Report, the AAOS Analytics Team, and all AJRR Committee members are integral to the success of our mission. As always, we appreciate your strong and consistent support of the AJRR and the patients we are so fortunate to serve.

Best Regards,

James I. Huddleston, III, MD, FAAOS
Chair, AJRR Steering Committee

Executive Summary

The American Joint Replacement Registry (AJRR) joined the AAOS Registry Program as the inaugural Registry in 2017. With oversight from the AAOS Registry Oversight Committee (ROC) and the AJRR Steering Committee, AJRR continues to work toward the AAOS Registry goals. Since then, the AAOS Registry Program has continued to grow adding registries from other anatomic sites and orthopaedic areas including the Shoulder & Elbow Registry (SER), the Musculoskeletal Tumor Registry (MsTR), the American Spine Registry (ASR) – a collaborative registry with the American Association of Neurological Surgeons (AANS) – and the Fracture & Trauma Registry (FTR).

The past year has been marked by a multitude of successes and growth for AJRR, including the 10th publication of the Annual Report. Much attention has been paid to ensuring AJRR maintains its position as the national Registry for total joint arthroplasty.

Additional highlights for the year include the following areas:

Patient-Reported Outcome Measures (PROMs) are increasingly being utilized to evaluate success of a hip or knee arthroplasty procedure. In fact, the AAOS has recently increased efforts in developing "PROMs in Practice" resources that are designed to equip orthopaedic surgeons with the tools and resources required to reduce the burdens of collecting and utilizing PROMs at their point of care. Visit www.aaos.org/proms for more information. In line with these PROMs initiatives, AJRR will support data capture and reporting on behalf of sites for the Centers for Medicare & Medicaid Services Hospital Inpatient Quality Reporting (IQR) Patient-Reported Outcome Performance Measure (PRO-PM). Updates to our PROMs platform and our PROMs file upload specification will be available in November 2023 respectively, allowing sites to utilize their registry data for the second voluntary and first mandatory reporting windows of the program.

AJRR continues to support its commitment to facilitating capture of this useful data. Specifically, AJRR continues to support the RegistryInsights® PROM platform for facilities to easily collect and upload PROM submissions to the Registry. Additionally, AJRR has formed multiple partnerships, expanding the Authorized Vendor Program to include even more PROM technological vendors. These efforts have led to substantial growth in PROMs capture. By the end of 2022, 496 sites out of 1,364 (36%) have submitted PROMs, which is a 24% increase in sites compared to the previous 2022 AJRR Annual Report.

Ambulatory Surgery Centers (ASCs) have been identified as an important part of the healthcare delivery system, and AJRR has made considerable effort to increase ASC participation in the Registry. The past year AJRR continued to provide ASCs and private practices access to data quality, analysis, and benchmarking. In fact, there are now 42,228 procedural cases reported by ASCs, an 84% increase over the previous year.

Tracking and Monitoring Outcomes with longitudinal patient information continues to be a focus of the AAOS Registry Program. To help sites best utilize Registry data for this purpose, RegistryInsights® expanded and enhanced its capabilities and utility for our users. This allows individual participating institutions access to their own real-time dashboard comparing their metrics to the AJRR national benchmark. Separately, the sites' surgeons have the ability to view their own dashboard based on data submitted on procedures they performed. Finally, for those needing more custom capabilities, AJRR offers either sites of service or surgeon- specific custom reports. AJRR has provided these reports to allow surgeons and participating institutions the ability to reuse their Registry data for internal performance measures or benchmarks.

Publications and Presentations based off AJRR data continue to be an important focus of AJRR. AJRR data has been published in several peer-reviewed journals such as the Journal of Arthroplasty (JOA), Journal of American Academy of Orthopaedic Surgeons (JAAOS), and Clinical Orthopaedics and Related Research (CORR). A series of podium presentations and posters have been presented at the following 2022 and 2023 Annual Meetings: AAOS, American Association of Hip and Knee Surgeons (AAHKS), International Society of Arthroplasty Registries (ISAR), The Knee Society, The Hip Society, and Western Orthopaedic Association (WOA). Topics have included AJRR data representativeness, revision risk factors, cement fixation status, infection, arthroplasty for femoral neck fracture, the use of dual mobility articulations, and more. Please see Appendix A for a full list of recent publications and presentations utilizing the AJRR database.

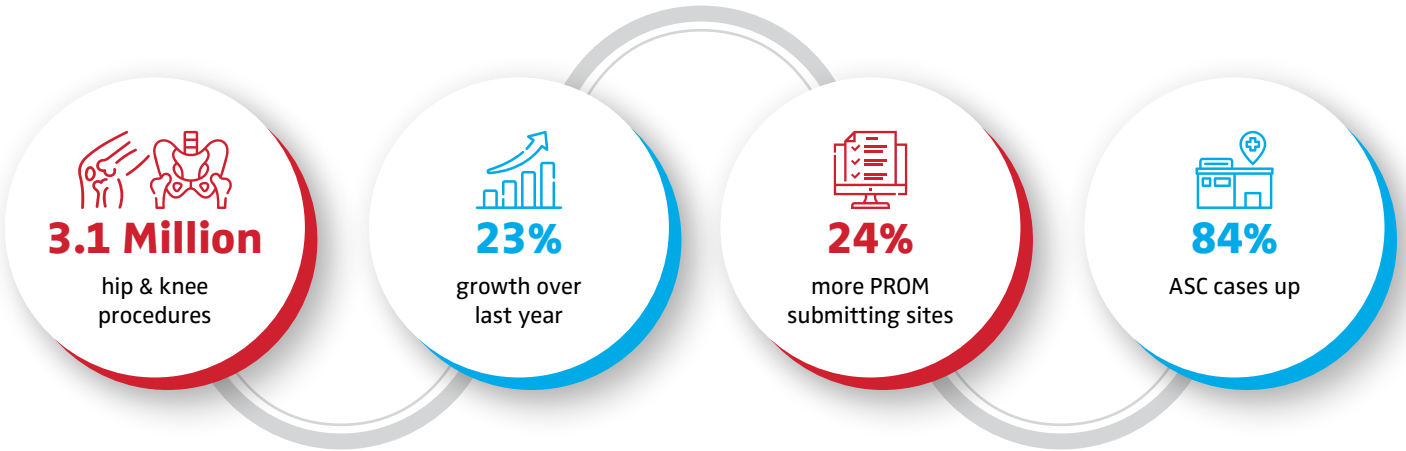
2023 AJRR Annual Report Highlights

The 2023 American Joint Replacement Registry (AJRR) Annual Report represents 3,149,042 primary and revision hip and knee arthroplasty cases after limiting to valid procedures dated 2012-2022. Primary knee (51.0%) and primary hip (33.4%) procedures constituted the majority of cases submitted. Sex breakdown was 58.5% female and 41.2% male for all cases. The average age of a total hip arthroplasty patient was 65.4 years and 67.4 years for total knee arthroplasty cases. While race was unreported in almost 14.2% of AJRR cases, when reported, non-Hispanic White was the predominant race (76.6%). Among AJRR surgeons performing either elective primary total hip arthroplasties or total knee arthroplasties, the mean 2022 procedure count was 39.2 and 56.0, respectively.

Many trends identified in previous AJRR Annual Reports were also applicable this past year. For hip arthroplasty procedures, there is still a trend towards increased use of ceramic heads. Usage of dual mobility constructs has been increasing in both the primary and revision setting over time although this trend appears to have leveled off in recent years. While hemiarthroplasties still predominate for the treatment of femoral neck fractures, total hip arthroplasty usage has increased substantially over the last ten years. The use of cement for femoral component fixation is slowly increasing for both elective primary total hip arthroplasty as well as arthroplasty for femoral neck fracture. Similar to prior reports, postoperative length of stay continues to decrease, and use of general anesthesia appears to be slowly decreasing.

For total knee arthroplasty procedures, the use of cruciate retaining and ultracongruent implants continues to increase at the expense of posterior stabilized designs. Although cemented fixation still predominates, the use of cementless fixation continues to increase and is now used in 20% of all primary total knee arthroplasty procedures. Use of conventional polyethylene continues to slowly decrease as the usage of highly cross-linked polyethylene inserts continues to increase. Partial knee arthroplasties continue to represent a small percentage of knee arthroplasty cases in the Registry. Postoperative length of stay continues to decrease, and use of general anesthesia appears to be decreasing with a slight increase in spinal anesthesia.

Finally, enhanced analytics is always the goal of each Annual Report. With the continued growth of AJRR, analyses with Registry data will continue to mature. For the first time this year, re-revision was explored as a primary outcome within the comparison of dual mobility and standard bearings for revision THA. The report also includes new analyses displaying cementless knee survivorship on a device-level as well as survivorship between THA and hemiarthroplasty in fracture patients. The report design has also been enhanced with a procedure volume heat map and color-coded tabs for ease of navigation throughout the report. Much time was spent establishing a consensus-driven methodology determined by multiple stakeholders. This framework provides a foundation ensuring strength in all analyses moving forward, progressing toward more sophisticated and detailed survivorship curves in the future.

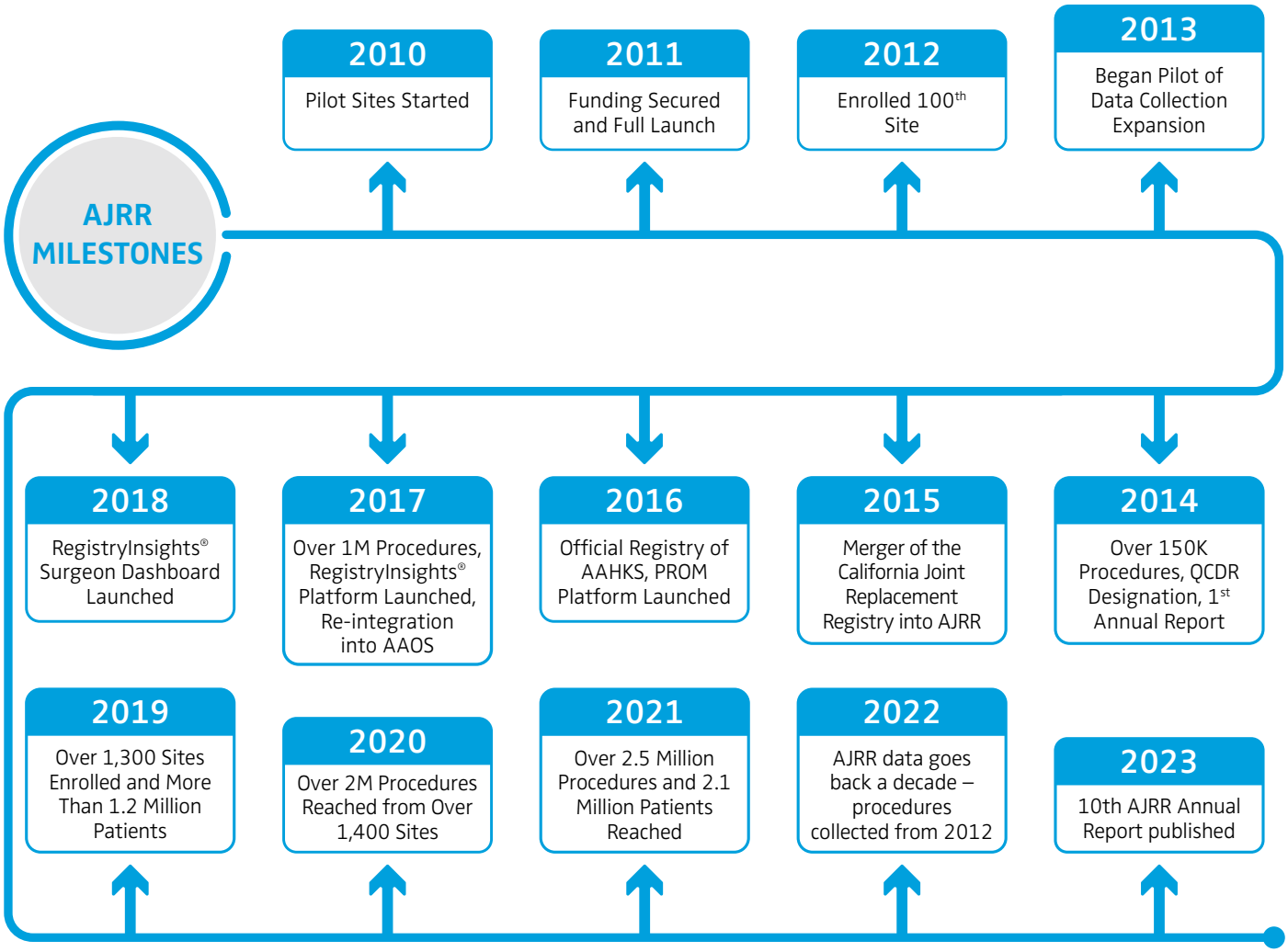


Our Vision

To be the National Registry for orthopaedics through comprehensive data and technology, resulting in optimal patient outcomes.

About AJRR

The American Joint Replacement Registry (AJRR) is the cornerstone of the AAOS Registry Program AJRR is overseen by the AJRR Steering Committee which reports to the AAOS Registry Oversight Committee and ultimately the AAOS Board of Directors with many stakeholders involved. By end of 2022, there were 1,364 institutions submitting data to the AJRR from across all 50 states and the District of Columbia; this represents a 9% increase in institutions and a 23% increase in procedures from the previous report.



The Power of Registry Data

Data Reporting and Data Specifications

Since the beginning of AJRR, updating data specifications has been a necessary part of the process. Not only can specification updates improve the quality of data collected, but updates are made to reduce the data entry burden and ensure adaptation to changes in healthcare and the orthopaedic profession. Updates to the data specifications are currently underway to align data collection with healthcare interoperability standards including mapping to SNOMED/LOINC and support for alignment with FHIR/HL7 data exchange specifications. A review of data elements collected at the time of this report can be found in Appendix B.

AJRR is committed to updating and refining its data specification when appropriate. These updates are handled through our Data Specification Sunset Cycle and include significant improvements in collection of procedural, post-discharge, and PROMs data. Moving forward, to transition and ensure routine enhancements, data specifications will be released and sunset on an as-needed basis. Specifically, the Data Specification Sunset Cycle simplifies the transition of data specifications by informing users of when new ones will be released, and older versions will be retired. On years when updated data specifications are prepared, AAOS will release an updated data specification and data dictionary as needed. Upon update of data specifications, AAOS will support the three most recent versions of data specifications. During this time, Registry staff will work with all key stakeholders through educational efforts that include webinars, email articles, and informative updates, communicating the changes made to the newest data specification. Finally, AAOS will transition over the update year to retire the oldest of the three versions and support the two latest versions. In general, making updates to a data specification is a lengthy process. Every change, large or small, requires thorough review and vetting from multiple areas of AJRR leadership. This continuous process is ongoing and thoughtful, ensuring perspectives from all involved parties are included.

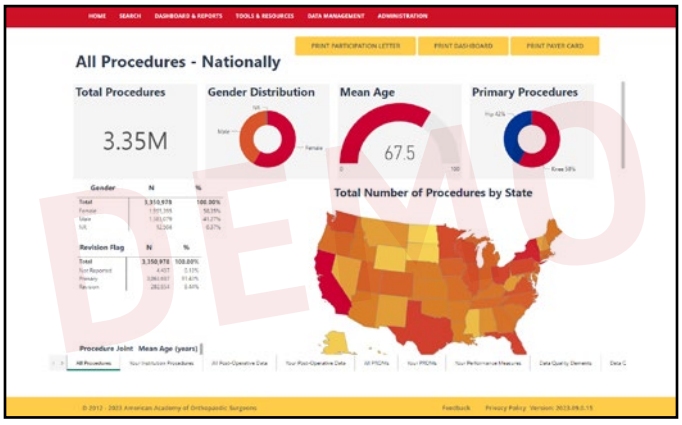
Centers for Medicare and Medicaid Services (CMS)

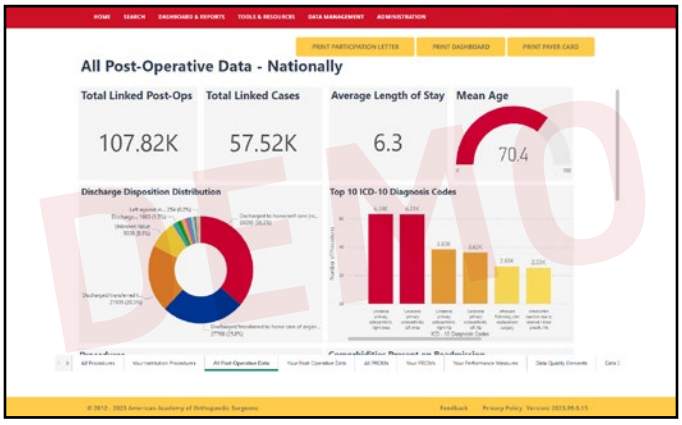
A long-term priority for AJRR has been to obtain claims data from the CMS to facilitate linkages between AJRR and Medicare to support AJRR's quality improvement and patient safety efforts. These linkages allow AJRR to obtain data including more complete comorbidity information, knowledge of revisions performed in non-AJRR institutions, and to fill-in data gaps where information was not submitted to AJRR. In total, the CMS files include inpatient (148 data elements), outpatient (122 data elements), and the National Death Index data. Twelve of the provided data elements in CMS directly match AJRR data elements and can help fill in gaps in Registry information. Any additional data elements in CMS not in AJRR have been analyzed for completeness to be used in further analyses.

Three Ways to Access Data

There are three main channels available to access data.

Custom Reports are created by the AJRR analytics team upon participant request to help understand and package site data in an actionable format. Custom reports can include site specific metrics and shape continuous improvements to the standard dashboards provided. In addition, aggregated reports across all data submitted including procedural, post-discharge, and PROMs data can be provided at each site level.





***RegistryInsights*® Dashboards** have on-demand clinical-specific visualizations. They compare institution data to national data and provide insights on performance benchmarks. Unlimited surgeon accounts with access to the entire hospital system, institution, and surgeon level dashboards are available. Surgeons can view their procedural, post-discharge, and PROMs data in a meaningful manner. In addition to standard reports, requests for custom reports can also be submitted for the following: National benchmarks for comparison measures or data quality initiatives (ie: TJC, Aetna IOQ, etc)

AAOS Registry Analytics Institute® (RAI) provides a resource to the scientific community to further understand and improve orthopaedic and musculoskeletal care by making data analyses available. Investigators can submit hypotheses about information available in AAOS Registries through the RAI page of the AAOS website. The RAI supports the AAOS mission while also providing clinicians and scientist-clinicians access to information beyond what is already published. Appropriate AAOS committees provide appropriate peer review and oversight before proposals are approved. Data analysis will be completed by AAOS Registry Analytics team members for all approved proposals. Selected awardees receive statistical support, data analyses, and potential monetary support.

AAOS Authorized Vendor Program

To minimize the data entry burden and enhance ease of data submission, AAOS has partnered with a vetted list of technological vendors through the Authorized Vendor Program. These third-party electronic health record and user interface-based technology vendors have made a commitment to prioritize data collection and submission by aiding sites in data collection, file configuration, and submission of procedural, post-discharge, and patient-reported outcome (PRO) data. As of October, 2023, AAOS is currently engaged with dozens of vendors. For a complete list of authorized vendors please see Appendix C.

AJRR Ankle Arthroplasty Module

Osteoarthritis (OA) is a global health concern and is a leading cause of pain, loss of function, and even disability. Arthritis can affect the ankle joint as well as other joints in the foot. Ankle OA often develops following ankle trauma and can be attributed to a majority of foot injuries. Over time, the smooth cartilage on the surface of the bones wears away, resulting in pain, inflammation, and swelling of the joint. One popular remedy is ankle replacement surgery, which replaces the damaged ankle joint with an artificial implant. The AJRR will be launching a new module to capture ankle arthroplasty procedures, Ankle Arthroplasty, in the coming months. Stay tuned for the expansion of the capture of joint arthroplasty procedures for further information.

''This year represents a significant milestone - the AJRRs publication of the 10th Annual Report. The AJRR is the world's largest total joint registry by annual procedural count and plays an important role monitoring implant performance, providing surgeons and hospitals with meaningful feedback via clinical dashboards, and providing a platform for registry-based research supported by the AJRR Research Analytics Institute®. The AAOS and AJRR provided support this year for our first AJRR registry science fellow. This commitment underscores that our Academy and the AJRR is dedicated to the central mission to utilize data in our registry to improve the health of joint replacement patients in the United States and worldwide through these research efforts.''

Richard L. Illgen, II, MD, FAAOS

Chair, AJRR Research Projects Sub-committee

Member, AJRR Steering Committee

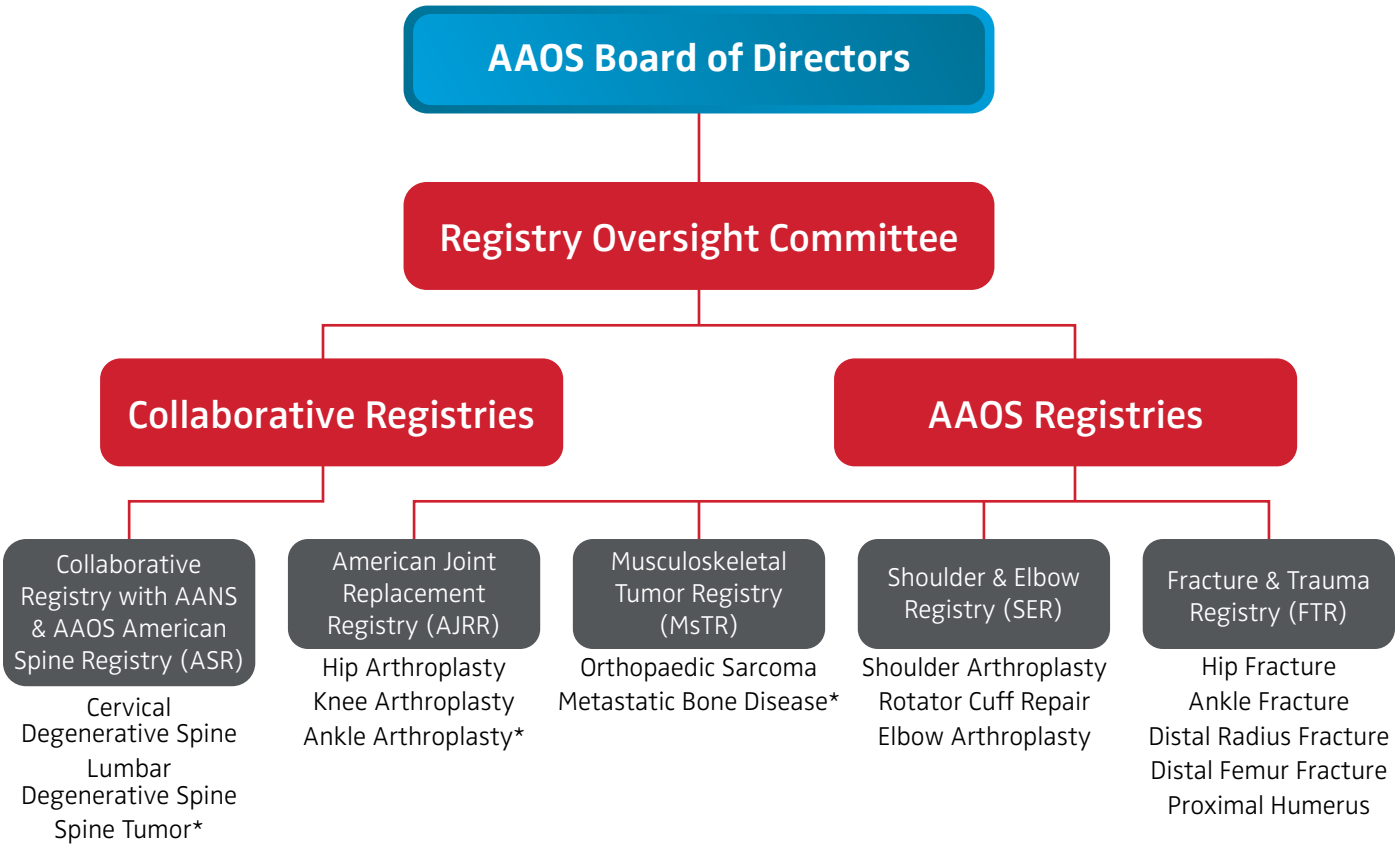
University of Wisconsin - School of Medicine and Public Health (UW-SMPH)

Department of Orthopaedics and Rehabilitation

AAOS Registry Program

Commitment to developing a family of registries across the spectrum of orthopaedic specialties remains one of AAOS' top priorities. AJRR became the cornerstone of the AAOS Registry Program in 2017, and in 2018, the addition of more registries including both procedural (Shoulder & Elbow Registry) and diagnosis-based (Musculoskeletal Tumor Registry) registries. The Musculoskeletal Tumor Registry (MsTR) completed its pilot in 2019 and converted into a full Registry in 2020. Additionally, in 2020, AAOS partnered with the American Association of Neurological Surgeons (AANS) to launch the American Spine Registry (ASR). In 2021, AAOS launched the Fracture & Trauma Registry (FTR) in a phased approach, with open enrollment beginning in 2022. FTR marks the first AAOS Registry "built on a synergistic approach" where surgeon leaders from across registry steering committees collaborated to develop modules applicable to their anatomic-specific specialties.

All registries receive governance from a Registry Oversight Committee that ultimately reports to the AAOS Board of Directors.



**Modules in development*

Strength Through Collaboration

AJRR was built on the concept of a multi-stakeholder model and the belief of smarter data collection and reuse. If a site or surgeon is using data for one quality use, it's important to reduce the data burden and use it for another purpose. With these goals in mind, AJRR continues to build and enhance its collaborative relationships through strategic alliances and affiliations with other organizations, including:

ABOS Maintenance of Certification (MOC)

The AAOS Registry Program has been approved by the American Board of Orthopaedic Surgery (ABOS) to support Maintenance of Certification. As of November 2018, a diplomate can receive Self-Assessment Education (SAE) credits for each year of registry participation as an alternative to 10 scored and recorded SAE credits needed to satisfy ABOS MOC requirements.

Aetna Institutes of Quality (IOQ) Orthopaedic Surgery

Aetna IOQ are healthcare sites that demonstrate high levels of quality and efficiency. Effective January 1, 2020, The Joint Commission started providing the IOQ quality review for Aetna's total hip and knee replacement (THKR) surgery program. Beginning January 1, 2022, sites are required to achieve the Joint Commission Advanced Certification for THKR, for which AJRR is the registry requirement. Sites may also obtain DNV Advanced Certification as a pathway to the IOQ designation.

Ambulatory Surgery Center Association (ASCA)

AJRR and ASCA run a collaborative program that provides the framework necessary for ASCs with low-volume and/or no technical capabilities. As the number of arthroplasty procedures performed in ASCs increases, it is important to capture data to understand efforts to improve quality, enhance practice efficiency, and reduce healthcare costs by groups migrating to this model of practice.

American Alliance of Orthopaedic Executives (AAOE)

AAOE is a premier management association serving orthopaedic practice executives, providing peer to peer networking and education for orthopaedic executives. AAOE provides content and resources for orthopaedic practice executives; encourages competence, excellence, and high standards for orthopaedic practice management; and facilitates connections to and between members, nonmembers, physicians, and affiliated groups. AAOE supports data submission to AAOS Registries.

American Association of Hip and Knee Surgeons (AAHKS)

AJRR is the official registry of AAHKS with continued collaboration on numerous initiatives. AAHKS members receive information on joining the Registry, AJRR is given complimentary advertisements in AAHKS publications as well as on their website, and the AAHKS journal, Arthroplasty Today, is AJRR's official journal.

American Hospital Association (AHA)

AHA is the national organization that represents and serves all types of hospitals, healthcare networks, and their patients and communities. Historically, AHA has been a strong collaborative partner with medical associations, aiding in guideline development to improve quality and the level of recommendations provided. The AHA continues to collaborate with AJRR by maintaining a seat on the Steering Committee.

American Joint Replacement Research Collaborative (AJRR-C)

The AAOS Registry Program and Mayo Clinic are collaborating through the AJRR-C center, funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) Core Centers for Clinical Research program (P30AR076312). AJRR-C is led by Mayo Clinic surgeons Drs. Daniel J. Berry and David Lewallen with the AAOS Registry Program as the resource core for the center. AJRR-C aims to build productive scientific collaborations to enhance national clinical research infrastructure and support the next generation of investigators. The multidisciplinary AJRR-C team provides customized methodology and educational support in areas of epidemiology, biostatistics, health sciences research and medical informatics to interested collaborators. AJRR-C also provides statistical support to AAOS for abstracts, presentations, and publications, including the annual reports. High-priority areas of work include methods for handling bias, confounding, risk adjustment in TJA studies, outlier identification, development and application of TJA-specific natural language processing and computer vision tools for mining the electronic health records, standardization of analyses and reporting of TJA outcomes, and infrastructure efforts for large, multicenter trials.

America's Health Insurance Plans (AHIP)

AHIP is the national association whose members provide coverage for healthcare and related services to hundreds of millions of Americans every day. Through these offerings, AHIP improves and protects the health and financial security of consumers, families, businesses, communities, and the nation. They are committed to market-based solutions and public-private partnerships that improve affordability, value, access, and well-being for consumers. AHIP continues to collaborate with AJRR by maintaining a seat on the AJRR Steering Committee.

BlueCross BlueShield Blue Distinction Specialty Care

Through Blue Distinction Specialty Care, ASCs may be required to have advanced certification from The Joint Commission, AAAHC, or DNV GL. Participation in the AJRR supports the registry requirement for obtaining one of these certifications.

Cigna Pathwell Bone & Joint SM

As part of its ongoing goal to provide quality care and improve the health and well-being of its customers, Cigna requires that providers who take part in its condition-specific care program also participate in and submit data to the AJRR as a quality metric.

International Society of Arthroplasty Registries (ISAR)

ISAR is a global consortium of joint replacement registries established by several mature national registries. The society facilitates the development of registry science and observational studies, encourages the development of new national registries around the world, and provides a forum for information sharing to enhance participating countries' ability to meet their own objectives. AJRR is proud to be an associate member of ISAR and the vendor for the International Protheses Library (IPL).

OrthoForum/OrthoConnect

The AAOS Registry Program is the official registry of OrthoForum and OrthoConnect. The OrthoForum and its sister organization, OrthoConnect, are a national specialty physician network whose membership includes many of the largest privately owned orthopaedic practices in the US. Established to meet the unique challenges that independent orthopaedic group practices face in today's musculoskeletal healthcare environment, the OrthoForum selects its members individually to participate in activities that advance each group's presence throughout their markets. These activities include benchmarking, innovation, business ventures, networking, and best practices.

Qualified Clinical Data Registry (QCDR)

The AAOS Registry Program is a CMS-designated QCDR. Participation in the AJRR can help physicians qualify for the Merit-based Incentive Payment System (MIPS) Quality Payment Program (QPP) and MIPS Promoting Interoperability (PI) category (previously known as Meaningful Use).

The Hip Society

Founded in 1968, The Hip Society was created to advance the knowledge and treatment of hip disorders to improve the lives of patients. The Society shares such values as education, innovation and collaboration, integrity, inspiration, and achievement. It supports the discovery and dissemination of information specific to hip disorders. Membership to The Hip Society is through invitation only and several members also serve on AJRR committees.

The Joint Commission Partnership

AAOS and The Joint Commission are in a collaboration to oversee scientific issues, performance measures, quality improvement activities, education, data sharing, and research related to the Advanced Total Hip and Knee Replacement (THKR) Certification. Effective July 1, 2019, AJRR became the sole pathway for meeting the THKR registry requirement.

The Knee Society

The Knee Society was incorporated in 1983 to support the creation of a society for education and research in the area of total knee arthroplasty as well as in the pathogenesis of osteoarthritis and other disease processes that lead to end stage arthritis of the knee. Membership to The Knee Society is by invitation only. Several members of The Knee Society also serve on AJRR committees.

Dedicated to Quality Improvement Initiatives

Advocacy and Quality of Care Improvement

AAOS continues to advocate for policies that will incentivize clinician participation in the AAOS Registry Program. The key advocacy issues for 2023 were ease of access to Medicare claims data for Qualified Clinical Data Registries (QCDR), cost of acquiring the claims data, quality reporting requirements in the Quality Payment Program (QPP), and patient-reported outcome measures (PROMs).

Medicare Claims Data

Background: The Centers for Medicare & Medicaid Services' (CMS) implementation of the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) as it relates to QCDRs and clinician-led clinical data registries has been far from satisfactory and has not been per statutory intent. Contrary to Section 105(b) of MACRA, CMS has not provided QCDRs with a meaningful way of accessing Medicare claims data to link to their own data. As an alternative, the AAOS Registry Program has been using the Research Data Assistance Center (ResDAC) process to access Medicare claims data for the last several years. The formal process to request ResDAC is very resource intensive and regular data upgrades come at a prohibitive cost. Other alternatives provided by CMS include the CMS Qualified Entity Certification Program wherein QCDRs can apply to be certified as quasi qualified entities (quasi QEs) if they wish to use their own data (combined with the CMS Medicare data) to publicly report. However, this program is limited to data on clinicians that specifically report to the particular QCDR.

Advocacy efforts: Throughout 2023, AAOS staff and AJRR leadership had been drafting letters and meeting regularly with the CMS leadership team to ease access to Medicare claims data and find more cost-effective alternative pathways. AAOS is also advocating on changing data sharing requirements so that Medicare data linked to our own registry data can be used for surgeon-level metric reporting. Such expanded data usage is helpful to track outcomes.

The Ability to Reuse Registry Data to enable performance measurement as well as facilitate national registry-driven quality improvement programs has been a focus of the Registry over the past few years. Now, AJRR data can be reused toward:

- The Joint Commission (TJC) Advanced Certification for Total Hip and Total Knee Replacement
- American Board of Orthopaedic Surgery (ABOS) Maintenance of Certification (MOC) program for Part II Self-Assessment Examination (SAE) credit
- Centers for Medicare & Medicaid Services (CMS) Inpatient Quality Reporting Program (IQR) THA/TKA Patient-Reported Outcome Performance Measure (PRO-PM)
- CMS Comprehensive Care for Joint Replacement (CJR) Model
- CMS Merit-based Incentive Payment System (MIPS) Promoting Interoperability (PI) and Quality Payment Program (QPP)
- Accreditation Association for Ambulatory HealthCare (AAAHC) Advanced Orthopaedic Certification
- Aetna Institutes of Quality (IOQ) Orthopaedic Surgery
- BlueCross BlueShield Blue Distinction Specialty Care
- Blue Shield of California waiver of prior authorization for their patients' hip or knee replacement procedures
- Bree Collaborative
- Cigna Pathwell Bone & Joint SM
- Det Norske Veritas & Germanischer Lloyd (DNV GL) Orthopaedic Center of Excellence
- The Alliance QualityPath

To find out more about these and other ways to reuse Registry data please click here.

Quality Measurement and Reporting

Background: For Performance Year (PY) 2023, CMS finalized a policy that a QCDR measure must be face valid and fully tested for all subsequent MIPS payment years for which it is approved. Measure testing requirements are onerous for medical specialty societies and are contrary to the policymakers' intent of incentivizing quality reporting through QCDRs. CMS has also begun to remove topped-out measures from the QPP which might be an issue for specialties with an insufficient number of approved measures. To maintain access to specialty-specific measures, AAOS fully tested and submitted five measures and worked with other orthopedic QCDRs to harmonize two additional measures for PY 2024. These measures are currently under review with CMS and will be announced in January 2024.

At the time of publication, CMS proposed adding two quality measure to the Orthopedic Surgery Specialty Set to address health equity (Quality Number TBD – Connection to Community Service Provider and Quality Number 487 – Screening for Social Drivers of Health). Quality Measure 487 will be included in the Improving Care for Lower Extremity Joint Repair MVP reportable through our QCDR.

In addition, CMS finalized adoption of the (1) Hospital-Level Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA) Patient-Reported Outcome performance measure beginning with two voluntary reporting periods (TKA/THA procedures performed between January 1, 2023 through June 30, 2023 and July 1, 2023 to June 30, 2024)), followed by mandatory reporting for TKA/THA procedures performed beginning on July 1, 2024 impacting the FY 2028 payment determination. And (2) Hospital-Level Risk-Standardized Complication Rate Following Elective Primary THA/TKA measure with additional complication measures beginning with the FY 2024 payment determination.

Advocacy efforts: AAOS provides regular comments on Medicare payment rules and has been successful in delaying the testing requirements at least until the end of the public health emergency. AAOS has raised concern with CMS that when abrupt changes are made, it has a ripple effect which negatively impacts the ability to robustly participate in quality reporting. In this regard, AAOS requested that CMS consider longer intervals between the proposed removal of measures and the finalization of such changes. AAOS continues to work with lawmakers and regulators to urge collaboration with specialty societies like us in measure development and harmonization to utilize our clinical expertise and existing infrastructure.

"As the largest orthopaedic registry in the world by annual procedure count, the AJRR provides invaluable insight into the trends within arthroplasty. The Annual Report along with the surgeon dashboards will continue to guide physician practice into the future and optimize patient outcomes."

Scott M. Sporer, MD, FAAOS

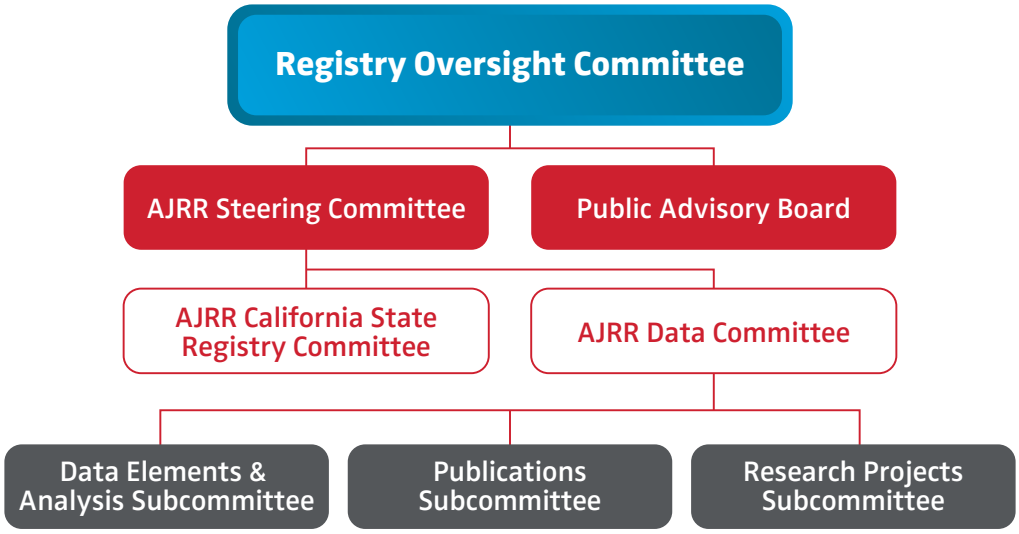
Vice Chair, AJRR Steering Committee

Midwest Orthopaedics at Rush and Central

Governance and Structure

In October 2017, AJRR was re-integrated back into AAOS and became the cornerstone of the AAOS Registry Program. Prior to this, AJRR was an independent 501(c)3 non-for-profit corporation with an independent Board of Directors. Once reintegrated, AJRR Board of Directors was transitioned to the AJRR Steering Committee.

Many of the original surgeon leaders on the Steering Committee have been involved in AJRR since the beginning. Their valuable service provided the knowledge needed to ensure a smooth transition to AAOS. The addition of members of the public has been pivotal to the success of the Registry. Their voices are included through the Public Advisory Board which allows for the inclusion of the patient perspective in all aspects of Registry governance.



2023 AAOS Registry Oversight Committee

Overseeing the AJRR Steering Committee is the Registry Oversight Committee (ROC). The ROC reports to the AAOS Board of Directors and provides guidance and recommendations for all major Registry initiatives.

The Registry Oversight Committee is led by the following orthopaedic surgeons:

William J. Maloney, MD, FAAOS, Chair
Stanford University School of Medicine (Redwood City, CA)

Antonia F. Chen, MD, MBA, FAAOS
RQC Liaison
Brigham and Women's Hospital (Boston, MA)

Michael J. Gardner, MD, FAAOS
FTR Representative
Stanford University Surgery (Redwood City, CA)

Grant E. Garrigues, MD, FAAOS, Chair
SER Representative
Midwest Orthopaedics at Rush (Chicago, IL)

Steven D. Glassman, MD, FAAOS
ASR Representative
Norton Leatherman Spine Center (Louisville, KY)

Daniel K. Guy, MD, FAAOS
Past President
Emory Southern Orthopedics (LaGrange, GA)

James I. Huddleston, III, MD, FAAOS
AJRR Representative
Stanford University (Woodside, CA)

Benjamin J. Miller, MD, MS, FAAOS
MsTR Representative
University of Iowa (Iowa City, IA)

Kurt P. Spindler, MD
Cleveland Clinic Foundation (Weston, FL)

Bryan D. Springer, MD, FAAOS
OrthoCarolina Hip and Knee Center (Charlotte, NC)

2023 AJRR Steering Committee

James I. Huddleston, III, MD, FAAOS, Chair
California State Registry Committee Representative
Stanford University (Woodside, CA)

Scott M. Sporer, MD, FAAOS, Vice Chair
AAOS Representative
Midwest Orthopaedics at Rush and Central DuPage Hospital (Wheaton, IL)

James A. Browne, MD, FAAOS
The Knee Society Representative
University of Virginia (Charlottesville, VA)

Antonia F. Chen, MD, MBA, FAAOS
AAOS Representative
Brigham and Women's Hospital (Boston, MA)

Paul J. Duwelius, MD, FAAOS
AAOS Representative
Orthopedic and Fracture Specialists (Portland, OR)

Brian R. Hallstrom, MD, FAOA, FAAOS
State Registry Representative
MARCQI Director
University of Michigan Medical Center

Richard L. Illgen II, MD, FAAOS
AAOS Representative
University of Wisconsin-School of Medicine and Public Health (Madison, WI)

William A. Jiranek, MD, FACS, FAAOS
AAHKS Representative
Duke University (Durham, NC)

Leslie Klemp, MS, RN, NE-BC, CPHQ
AHA Representative
Rush University Medical Center (Chicago, IL)

William J. Long, MD, FAAOS
Knee Society Representative
Hospital for Special Surgery (New York, NY)

Howard J. Marans, MD
PR Member - Aetna (Santa Ana, CA)

Joshua C. Rozell, MD
AJRR Research Fellow
NYU Langone (Brooklyn, NY)

Richard F. Seiden, Esq.
Patient/Public Representative (Manhattan Beach, CA)

James D. Slover, MD, FAAOS
The Hip Society Representative
Northwell Health (New York, NY)

Bryan D. Springer, MD, FAAOS
AJRR Representative
OrthoCarolina (Charlotte, NC)

Jeffrey B. Stambough, MD
AAHKS Representative
University of Arkansas for Medical Sciences (Little Rock, AR)

AJRR Committees

Many volunteers contribute to the success of the Registry. These individuals devote countless hours to ensure that the Registry is of the highest possible quality.

Below is a description of all AJRR Registry committees. Full membership can be found in Appendix D.

Young Physicians Committee

The Young Physicians Committee assist in management of the registry science curriculum. Committee members play an integral role in reviewing and authoring AJRR data driven publications and serving as champions for participating institutions and specialties. Their subject-matter expertise in registry data is utilized for a multitude of projects.
Chair: Jeffrey B. Stambough, MD

Data Elements and Analysis Subcommittee

This subcommittee monitors, receive requests, and makes recommendations for additions or deletions to data elements or assessment tools collected by AJRR. The subcommittee makes recommendations to the Data Management Committee for review prior to discussion and final approval by the AJRR Steering Committee.

This subcommittee works with staff and statisticians to determine, develop, and oversee the implementation of appropriate data analysis methodology and algorithms. The subcommittee's purview includes risk adjustment, scientific integrity of data, rigor of conclusions drawn from Registry data, and consideration of optimal reporting and data analysis to provide actionable data for the benefit of patients and other AJRR stakeholders.
Chair: Scott M. Sporer, MD, FAAOS

Our Mission

To improve orthopaedic care through the collection, analysis, and reporting of actionable data.

Publications Subcommittee

The Publications Subcommittee representatives review and ensure the integrity of all publications based on Registry data. Publications for review include potential abstracts, manuscripts, custom reports, as well as the Annual Report. The original Annual Report Subcommittee was rolled into the Publications Subcommittee and is one of the final signoffs on the completed Annual Report prior to the document being sent to the Commission and subsequently AJRR's Steering Committee for their review.
Chair: James A. Browne, MD, FAAOS

Research Projects Subcommittee

Members of the Research Projects Subcommittee review incoming external research proposals and requests and make recommendations for project approvals. The committee developed and now maintains the AAOS Registry Analytics Institute®. Members provide guidance for the process and grading of submitted proposals.
Chair: Richard L. Illgen II, MD, FAAOS

AJRR Commission

Established in 2014, the AJRR Commission is a group of arthroplasty specialist orthopaedic surgeons without relevant financial conflicts who serve as independent reviewers of the data published in this Annual Report. The Commission makes the final recommendation to the Steering Committee regarding the content of the Annual Report. The Commission members are known only to the Steering Committee to ensure members' independence and allow them to avoid undue outside influence pertaining to the report.

Public Advisory Board

The Public Advisory Board (PAB) provides direct input to the Steering Committee from both the patient and public perspective. The PAB members are drawn from a wide variety of public advocacy groups and members of the public who have had joint arthroplasties themselves.

Richard Seiden, Esq., Chair

Chris Michno

William Mulvihill, M.Ed.

Kristin Veno

Outgoing 2022 Volunteers

AJRR would like to express its gratitude and appreciation for the contributions made by all of our volunteers. The Registry would like to specifically recognize the work of the following volunteers whose terms concluded in 2022.

Public Advisory Board

Jane Beckette, MSN

"I remember when AJRR was just an idea that people were discussing, and it's amazing to see AJRR grow into one of the premier arthroplasty registries in the world over the last 10 years. I'm excited about the future of AJRR and gaining more data to better monitor implants and potentially improve outcomes for our patients."

Antonia F. Chen, MD, MBA, FAAOS
Member, AJRR Steering Committee
Brigham and Women's Hospital

Industry Collaborations

AJRR recognizes the importance of device surveillance and collecting quality data to improve outcomes. The Registry works with sites and manufacturers to understand how implants contribute to patient experience and quality of life. The AJRR allows for collaboration between providers and companies to evaluate the performance of implants based on national trends of longitudinal patient data.

Thank You to AJRR Supporters and Partners

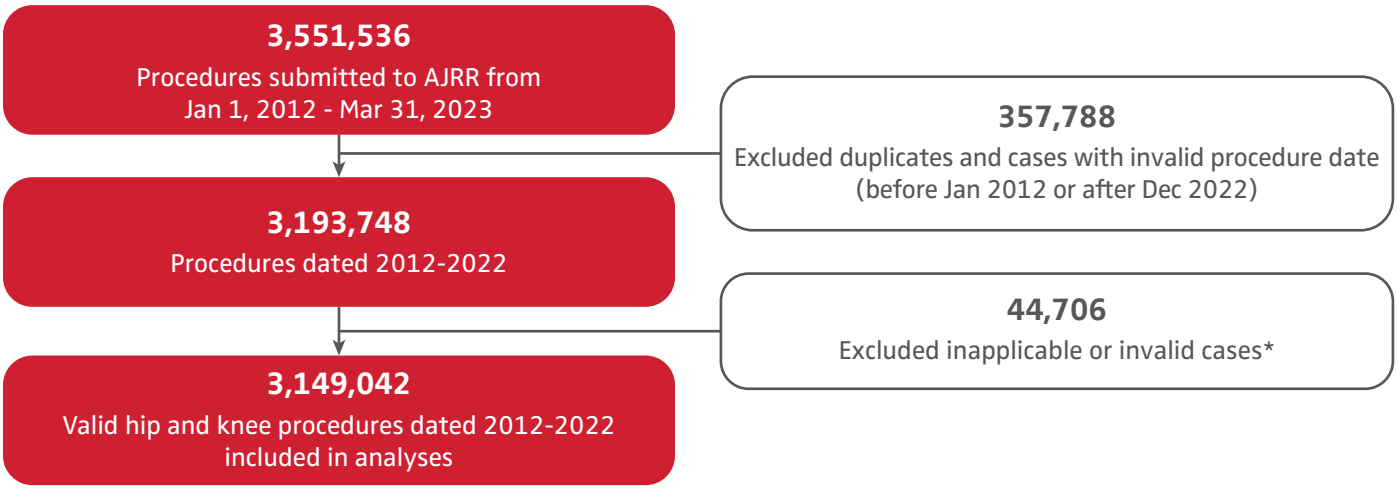
2023 Supporters

Registry Partners

"Ten years ago our first AJRR Annual report was 13 pages, had four figures and 8,000 procedures. Today our Annual Report is over 120 pages, has over 100 tables and figures and reports on over 3.1 million procedures. What progress we have made in 10 short years. Can't wait to see what the next 10 years holds."

Bryan D. Springer, MD, FAAOS
Member, AJRR Steering Committee
OrthoCarolina Hip and Knee Center

Overall Results



**Invalid data=joint procedures not in the hip or knee, procedure codes outside of approved AJRR data specifications, and hemiarthroplasty procedures without a diagnosis of femoral neck fracture.*

Analyses are completed using a core dataset of hip and knee procedures submitted to the AJRR from January 1, 2012 through Mar 31, 2023. Cases with invalid data or procedures dated before January 1, 2012 or after December 31, 2022 were further excluded. Data were considered invalid when procedure codes did not match approved codes listed in the AJRR data specifications as well as cases of hemiarthroplasty procedures without a diagnosis of femoral neck fracture. Data from the American Hospital Association (AHA) and Centers for Medicare & Medicaid Services (CMS) may be merged to supplement AJRR data when applicable, and this will be indicated in table/figure footnotes. Additional inclusion/exclusion criteria for each table or figure will be outlined as needed.

COVID-19 Impact Summary

Orthopaedic surgeons continue to navigate the challenges associated with the lingering COVID-19 pandemic. This year's AJRR Annual Report presents Figures 1.0 and 1.1 further monitoring the procedural case volume following the course of the pandemic. From January 2020 to April 2020, arthroplasty cases submitted to AJRR decreased from hospitals and ASCs by 90% and 96% respectively. As a testament to the commitment and resiliency of healthcare institutions, clinicians, and patients, reported procedures appeared to rebound to average procedural volume by June of 2020, only two months following the maximal impact of the pandemic. Interestingly, ASC procedure volume did not appear to be substantially impacted by this increase in COVID-19 incidence, as they saw a slow increase in procedure volume through the end of 2022.

Despite the lasting impact of the COVID-19 pandemic, the 2023 Annual Report had an overall cumulative procedural volume growth of 23% compared to the 2022 report.

INSIGHTS

Figure 1.0 Hospital Case Volume by Month, Jul 2019 - Dec 2022

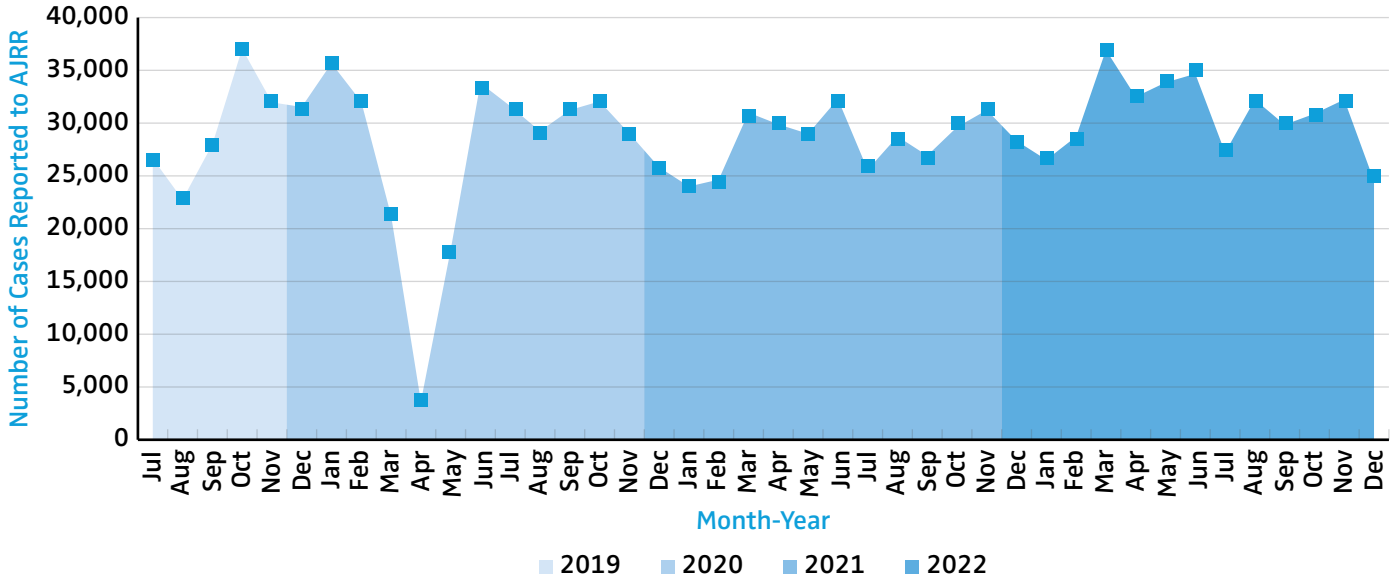
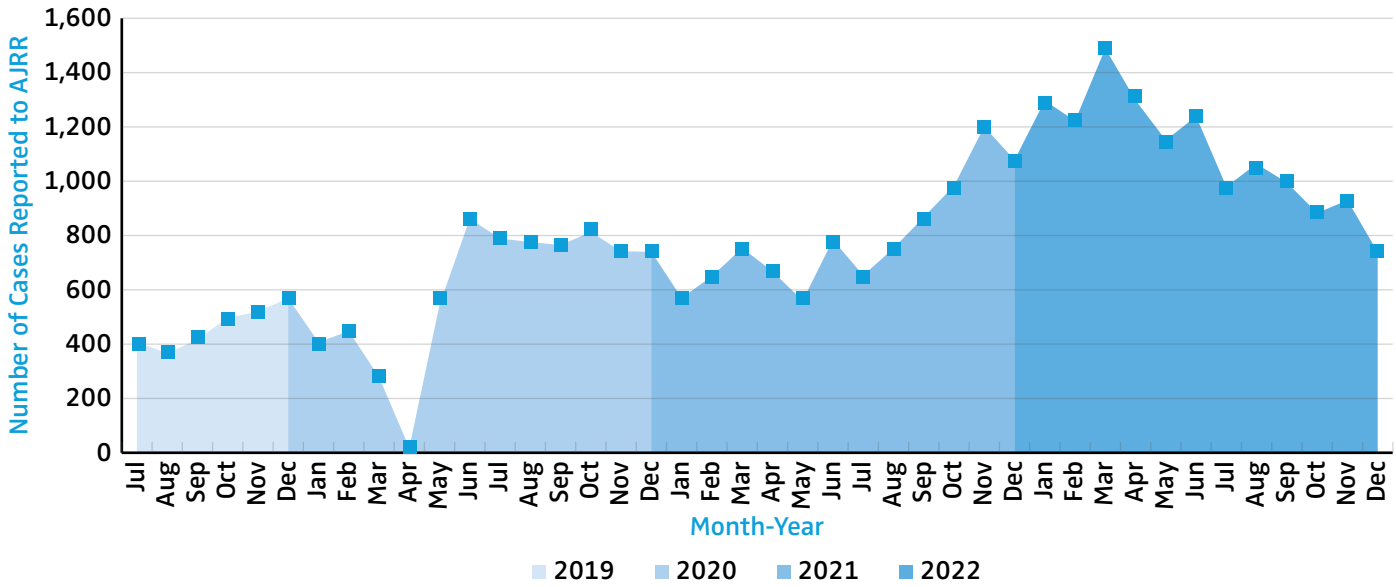


Figure 1.1 Ambulatory Surgical Center Case Volume by Month, Jul 2019 - Dec 2022

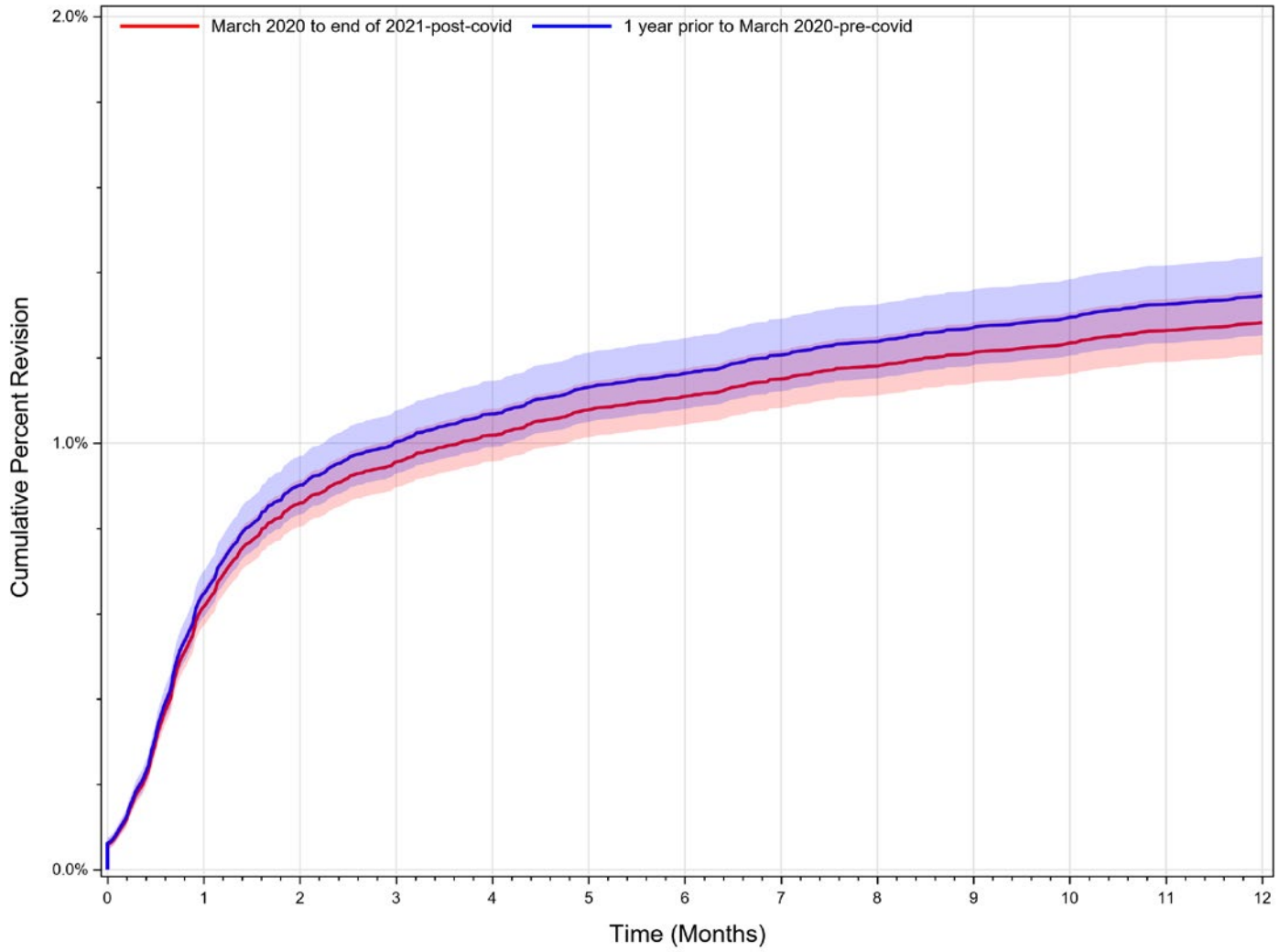


For this year's Annual Report, survivorship following the impact of COVID-19 was also evaluated to investigate difference of outcomes among primary elective THA and TKA patients. Comparing the outcome of all-cause revision between time-periods one-year pre vs. post declaration of a national COVID-19 emergency (Mar 2020) showed no significant difference in cumulative percent revision for primary elective THA and TKA procedures in Medicare patients.

INSIGHTS

Comparing cases one-year pre vs. post declaration of a national COVID-19 emergency (Mar 2020) for primary elective THA and TKA procedures in Medicare patients showed no significant difference in cumulative percent revision.

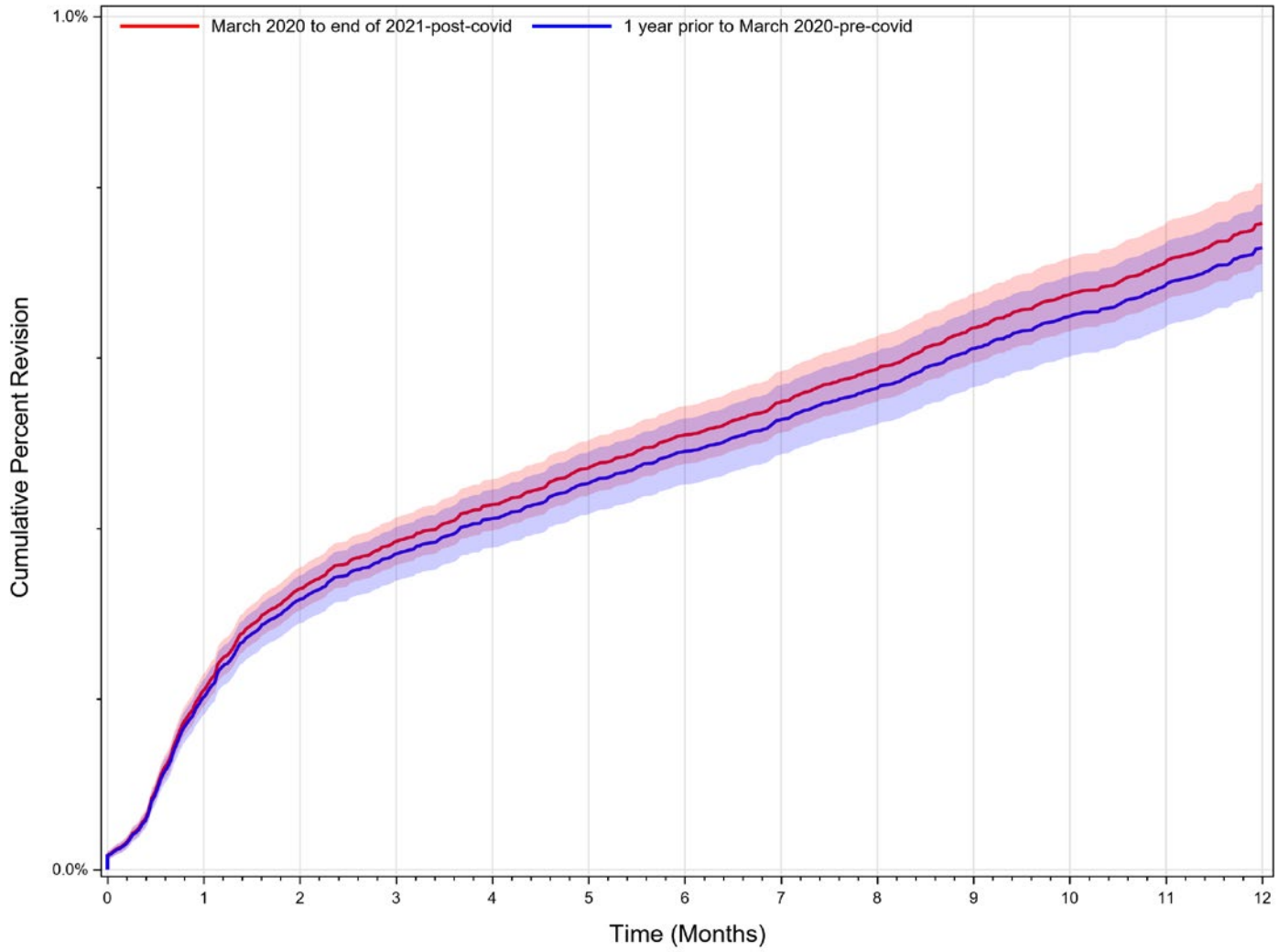
Figure 1.2 One-year Cumulative Percent Revision for Elective Primary Total Knee Arthroplasty Performed one year prior to COVID-19 Emergency vs. Procedures Performed Between March 2020 and the End of 2021 in Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2019-2021



Number at Risk (Months)	0	1	2	3	4	5	6	7	8	9	10	11	12
Pre-COVID Timeframe	109,133	108,874	108,726	108,656	108,590	108,540	108,489	108,452	108,410	108,344	108,288	108,251	108,191
Post-COVID Timeframe	158,487	151,667	142,427	133,886	125,765	117,867	110,980	102,495	94,303	86,615	78,988	72,611	66,338
Total	267,620	260,541	251,153	242,542	234,355	226,407	219,469	210,947	202,713	194,959	187,276	180,862	174,529

Age/Sex/CCI adjusted HR (95%CI), p-value
Post-COVID Timeframe vs. Pre-COVID Timeframe: *1.04 (0.938,1.152), p=0.4588*

Figure 1.3 One-year Cumulative Percent Revision for Elective Primary Total Hip Arthroplasty Performed one year prior to COVID-19 Emergency vs. Procedures Performed Between March 2020 and the End of 2021 in Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2019-2021



Number at Risk (Months)	0	1	2	3	4	5	6	7	8	9	10	11	12
Pre-COVID Timeframe	62,835	62,427	62,242	62,172	62,115	62,074	62,043	62,010	61,977	61,956	61,930	61,893	61,874
Post-COVID Timeframe	96,487	92,089	86,923	82,286	77,880	73,052	69,002	63,787	58,745	53,992	49,231	45,227	41,618
Total	159,322	154,516	149,165	144,458	139,995	135,126	131,045	125,797	120,722	115,948	111,161	107,120	103,492

Age/Sex/CCI adjusted HR (95%CI), p-value
Post-COVID Timeframe vs. Pre-COVID Timeframe: *0.953 (0.868,1.046), p=0.3133*

Procedural Data Metrics

The 2023 American Joint Replacement Registry Annual Report represents 3,149,042 primary and revision hip and knee arthroplasty procedures performed between 2012 and 2022 (Figure 1.4). The highest volume of cases were reported from California on the West coast, and many other regions are represented among the highest volume states including New York (East), Minnesota (Midwest), and Texas (South) (Figure 1.5). Primary knee (51.0%) and primary hip (33.4%) procedures comprised the majority of submitted cases (Figure 1.6). Sex breakdown was 58.5% female and 41.2% male for all cases (Figure 1.7). Most of the patients in the database were white (76.6%) although race was not recorded in 14.2% of cases (Figure 1.8). The patient's identified race category is based on the Department of Health and Human Services (HHS) Implementation Guidance, which is in accordance with the Office of Management and Budget Directive on Race and Ethnicity.

AJRR accepts historical data back to 2012. Therefore, annual volumes from prior years are continually being updated. The cumulative procedural volume grew by 23% in 2022 when comparing to the previous Annual Report (598,510 additional cases). The dataset utilized in this Annual Report represents a snapshot of AJRR data taken on Mar 31, 2022.

Figure 1.4 Cumulative Procedure Volume, 2012-2022 (N=3,149,042)

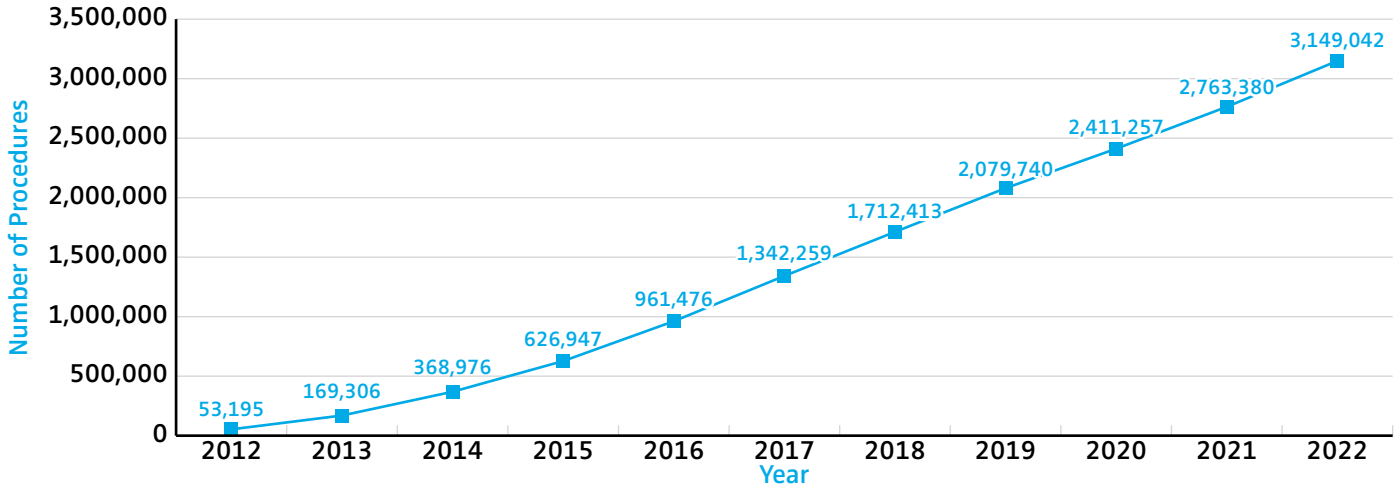


Figure 1.5 Arthroplasty Procedures by State, 2012-2022

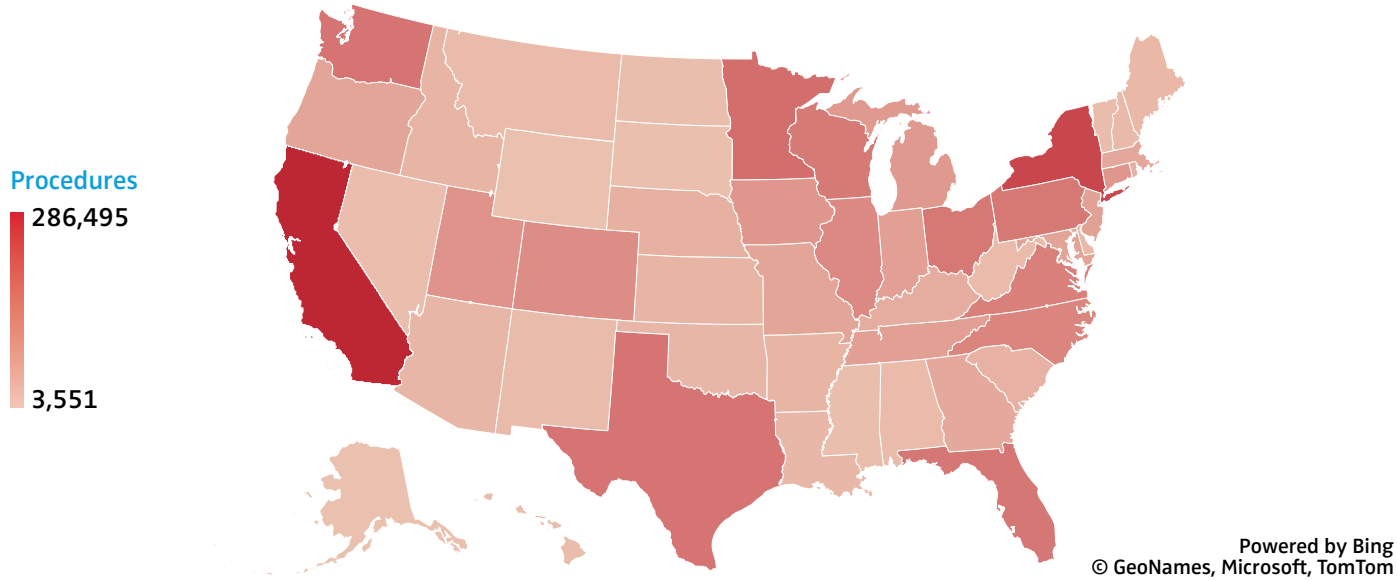


Figure 1.6 Distribution of Arthroplasty Procedures, 2012-2022 (n=3,149,042)

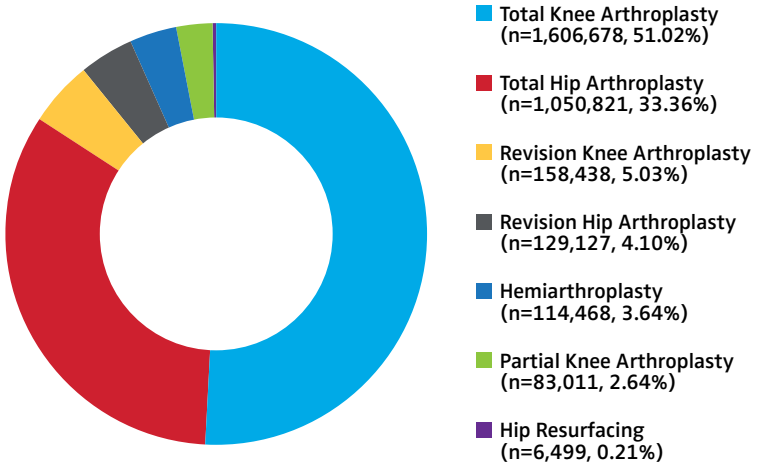


Figure 1.7 Sex of Patients Undergoing Procedures, 2012-2022 (n=3,149,042)

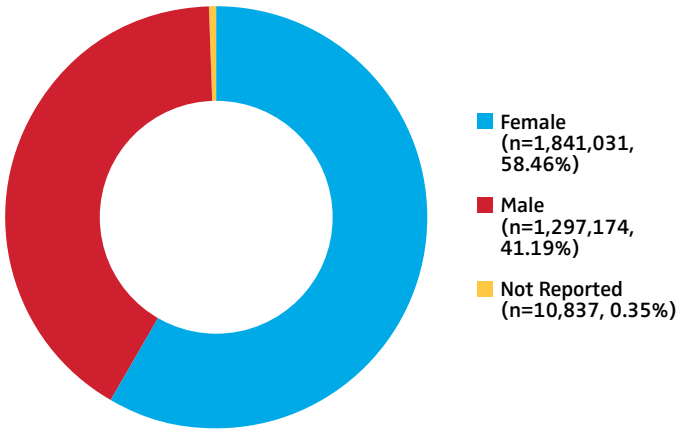
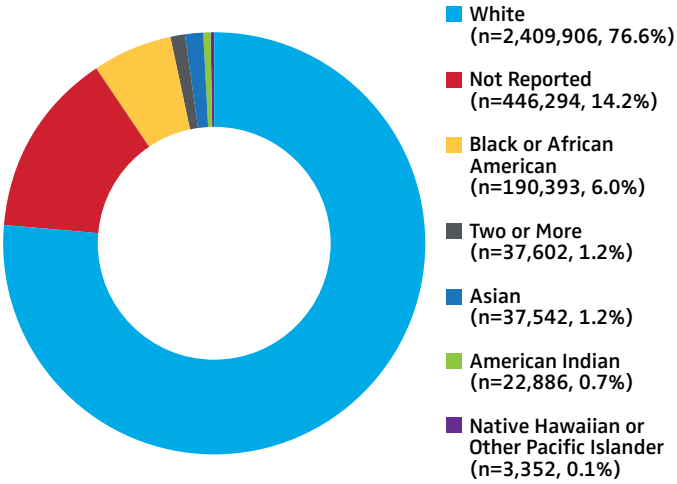


Figure 1.8 Race of Patients Undergoing Procedures, 2012-2022 (N=3,147,885)



Submitting Facilities

Since inception, facility enrollment and data submission have been a major priority including growth in the number of hospitals, ASCs, and private practice groups submitting data to the Registry. By end of 2022, there were 1,364 institutions submitting data to the AJRR from across all 50 states and the District of Columbia; this represents a 9% increase from the previous report. A list of all enrolled facilities and those that submitted data used in the 2023 Annual Report can be found in Appendix E.

The AJRR has no requirements on the frequency of data submission but recommends, as a best practice, at least quarterly. In addition to increasing facility enrollment, the Registry is focused on promoting active data submission. To help with this, the Registry has a Registry Support Team and Support Specialists to expedite submissions and minimize the data submission burden.

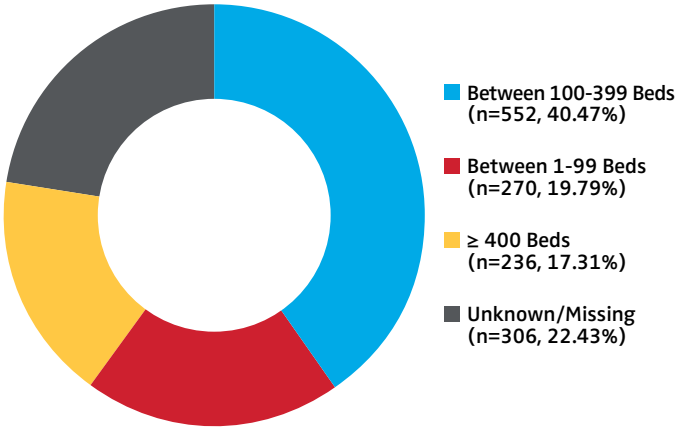
Similar to past years, the majority of arthroplasty procedures submitted to the Registry were performed in medium-sized hospitals (40.5%, 100-399 beds) and minor teaching institutions (37.2%, reported medical school affiliation or approved residency/internship program) (Figures 1.9 and 1.10). Non-teaching institutions performed slightly fewer than minor teaching institutions at 30.8%. Major (Hospitals with COTH designation) and minor teaching hospitals accounted for 61% of all AJRR submitting hospitals with institutional data available in the American Hospital Association (AHA) survey.

A recent study published in the Journal of the American Academy of Orthopaedic Surgeons found that the distribution of AJRR data across patient age, hospital volume, and geography were proportionally similar to the national experience with hip and knee arthroplasty in the United States.[1]

INSIGHTS

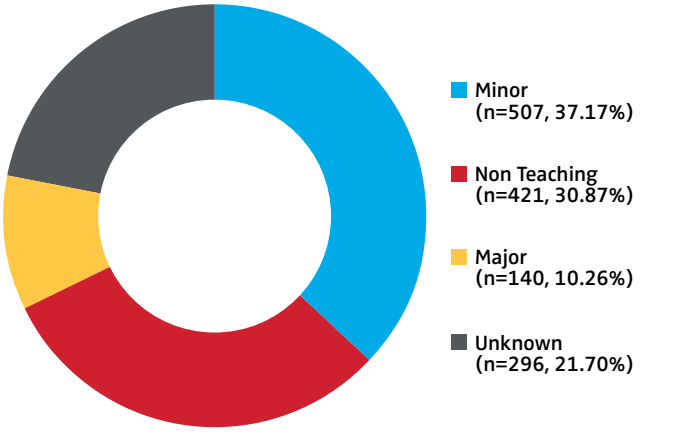
An analysis published in the Journal of the American Academy of Orthopaedic Surgeons suggests that AJRR data is generalizable to the larger U.S. cohort.

Figure 1.9 Distribution of Submitting Institution Size (bed count), 2012-2022 (N=1,364)*



Data supplemented with American Hospital Association (AHA) Annual Survey Database Fiscal Year 2015

Figure 1.10 Distribution of Submitting Institution Teaching Affiliation, 2012-2022 (N=1,364)*



Data supplemented with American Hospital Association (AHA) Annual Survey Database Fiscal Year 2015

Ambulatory Surgery Centers

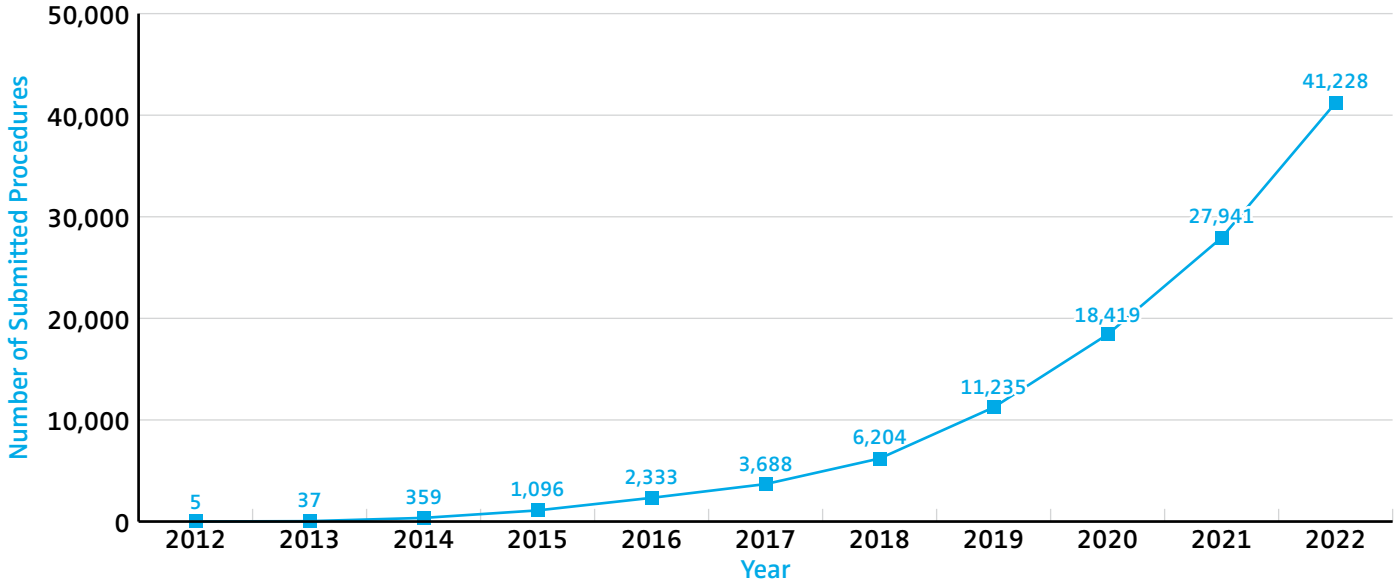
Ambulatory surgery centers (ASCs) play an increasingly important role in the delivery of total joint arthroplasty care in the United States. While historically much of the procedural information in the Registry has come from hospitals, the number of arthroplasties performed in outpatient settings continues to rise.[2] In late 2018, AAOS took the first steps toward growing its ASC representation by restructuring the Registry Engagement Team.

An ASC is classified by a submitting institution on their AJRR application and can be either freestanding or affiliated with a hospital. The number of procedures submitted by ASCs has grown exponentially between 2012 (n=5) and 2022 (n=41,228) and has increased by 84% since the 2022 AJRR Annual Report (Figure 1.11).

INSIGHTS

The number of procedures submitted by ASCs has grown exponentially between 2012 (n=5) and 2022 (n=41,228) and has increased by 84% since the 2022 AJRR Annual Report.

Figure 1.11 Cumulative Procedure Volume from Ambulatory Surgery Centers by Year, 2012-2022 (N=41,228)



Submitting Surgeons

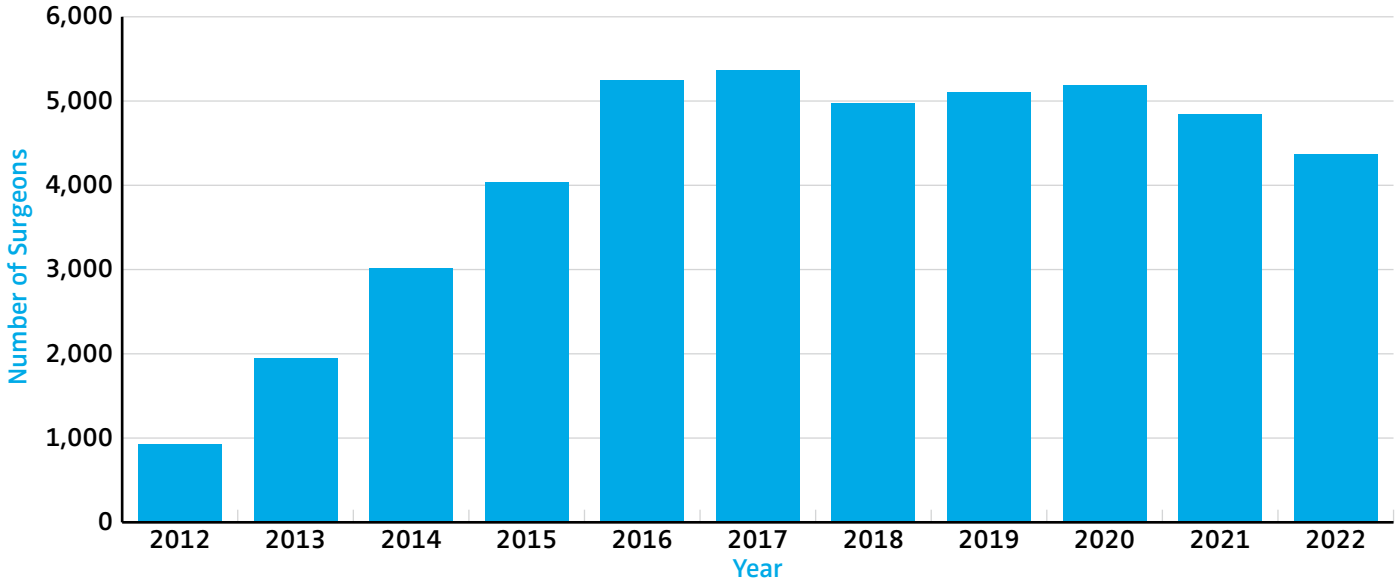
At present, 10,946 surgeons have submitted at least one procedure to the AJRR (Figure 1.12). As AJRR accepts historical data and many institutions submit towards the end of the following year, it is anticipated that the number of surgeons with cases submitted to the AJRR in recent years (2018-2022) will increase in future Annual Reports.

In 2022 alone, there were 4,370 surgeons represented with at least one procedure submitted to the AJRR. As part of the contract, AJRR participating institutions are required to submit data from all surgeons conducting hip or knee joint arthroplasty procedures at their facility. This is validated by annual audits (See Appendix F).

4,370 surgeons have submitted at least one procedure in 2022 to AJRR, a number which is expected to grow as sites continue to submit data.

INSIGHTS

Figure 1.12 Number of Surgeons Represented in Annual Procedure Submissions, 2012-2022



Data Completeness

In February 2017, AJRR significantly expanded data collection on elements in the following areas: procedural data, patient risk factors, comorbidities, and post-discharge complications. To allow time for participants to adjust to the additions, these changes were not made mandatory until June 2018. Elements that can automatically be extracted from an electronic health record (EHR), such as discharge disposition and length of stay, tend to have higher data completeness (Table 1.1). Other elements that require more manual submission such as anesthesia type or surgical approach are more difficult to submit. The data elements that are collected by AJRR and their completeness are frequently reviewed to ensure relevant data points are being captured. Making updates to a data specification is a lengthy process. Understanding how data is submitted to the Registry and what percentage has acceptable values can help guide these updates. This year, the Registries program has taken steps to increase transparency of completeness to participating institutions in dashboards to encourage more complete and valid submissions.

In February 2017, AJRR significantly expanded on the elements being collected to include procedural data, patient risk factors and comorbidities, and operative and post-discharge complications.

In the last year, a range of increases and decreases in data completeness were observed. Most notably, key demographic and procedural information such as age, sex, length of stay, procedure, and diagnosis information all exceed 95% completeness. Most of the elements described have remained stable compared to the previous Annual Report. Elements of interest such as BMI and robotic use have seen a slight increase in completeness. For many elements, "not reported" or "NR" is an accepted value, so this should be considered when assessing valid entries and utilization of available data.

Table 1.1 Completeness of AJRR Data Elements, 2012-2022

Specifications Version	Element	% Reported	% NR	% Invalid
AJRR Data 2012 - 2023Q1 (N=3,312,884)				
All Versions	Surgeon Information	97.3	0	2.73
	Principal Procedure Code	99.9	0	0.1
	Principal Diagnosis Code	95.4	0	4.63
	First Implant Catalog # Listed	92.4	0	7.58
	First Implant Lot # Listed	89.9	0	10.12
	Incision Start Time (Procedure Start Time)	73.7	25.28	1.02
	Skin Closure Time (Procedure End Time)	74.2	24.81	0.98
	Ethnicity	84.1	15.86	<0.1
	Race	85.8	14.16	0.04
	Date of Birth	100.0	0	0
	Sex	99.7	0.35	0
	City	94.7	5.32	0
	State	93.7	6.3	0
	Zip Code	96.1	0	3.94
AJRR Data 2012 - 2022Q1 Using 2017 or Newer Specifications (N=2,013,727)				
2017-2021 Versions	Comorbidity - at least one code reported	65.4	0	34.63
	Body Mass Index (BMI)	90.3	0	9.71
	Discharge Disposition Code	94.0	4.94	1.04
	Admission Date	98.4	1.56	0
	Discharge Date	98.5	1.52	0
	Length of Stay	98.4	0	1.59
	Surgical Approach (Hip/Knee)	10.2	82.96	6.83
	Computer Navigation	32.5	66.9	0.64
	Robotic Assisted	40.2	59.68	0.15
	Anesthesia Type	67.1	27.49	5.39
	Periarticular Injection	23.7	74.69	1.6
	ASA Classification	47.3	52.3	0.44
AJRR Data 2012 - 2022Q1 Using 2020 or Newer Specifications (N=288,126)				
2020 or Newer Versions	Tourniquet Use *(N=240,183 - knees only)*	44.1	55.89	0.01
	Trainee	7.5	91.41	1.07
	Payer Status	44.5	55.3	0.17

Hip Arthroplasty

Hip Overview

Between 2012 and 2022, AJRR has collected data on 1,317,887 hip arthroplasty procedures.

The majority of surgeons with data in AJRR perform both elective primary total hip arthroplasties and hip arthroplasties for fracture. For those surgeons performing elective primary total hip arthroplasty procedures in 2022, the mean procedure count was 39.2 with an interquartile range (25th-75th percentile) of 5-53 procedures (Table 2.1). The median procedure count per surgeon is lower, suggesting a higher frequency of lower volume surgeons in the Registry. This distribution of procedures is consistent with previous studies of hip arthroplasty in the United States.[3] Only surgeons with at least one relevant hip procedure were included. The types of hip procedures reported remained relatively constant as a percentage of all hip procedures performed in 2022 (Figure 2.1). The ''other procedures'' category includes procedures such as arthrotomy and conversion from prior hip surgery. The mean age for patients undergoing an elective primary total hip arthroplasty was 65.4 years. While hip resurfacing is reported infrequently in the AJRR, this patient population is younger with an average age of 53.2 years (Table 2.2, Figure 2.2).

When evaluating mean length of stay in the AJRR cohort, there was a significant decrease of over one day when comparing mean length of stay for elective primary total hip arthroplasties from 2012 (3.0 days) to 2022 (1.2 days) ($p<0.0001$). Length of stay in patients with a fracture treated with total hip arthroplasty or hemiarthroplasty has remained relatively constant over time (Figure 2.3). For this analysis, length of stay was calculated by subtracting admission date from discharge date discharge date for procedures from all reporting facilities.

Length of stay for elective total hip arthroplasty procedures continues to decrease, whereas length of stay for arthroplasty for hip fracture has remained stable over the past decade.

INSIGHTS

Table 2.1 Average Procedural Volume for Participating Surgeons, 2022

Procedure	Surgeons	Procedures	Mean	Median	25th Percentile	75th Percentile
Total Hip Arthroplasty	2,848	111,645	39.2	19	5	53
Hemiarthroplasty	2,052	10,379	5.1	3	1	6
Revision Hip Arthroplasty	1,902	12,375	6.5	3	1	8
THA for Fracture	1,372	4,368	3.2	2	1	4
Hip Resurfacing	19	46	2.4	1	1	2
Other Procedures	822	2,935	3.6	1	1	3

Figure 2.1 Distribution of Procedure Codes for All Hip Arthroplasty Procedures, 2012-2022 (N=1,317,887)

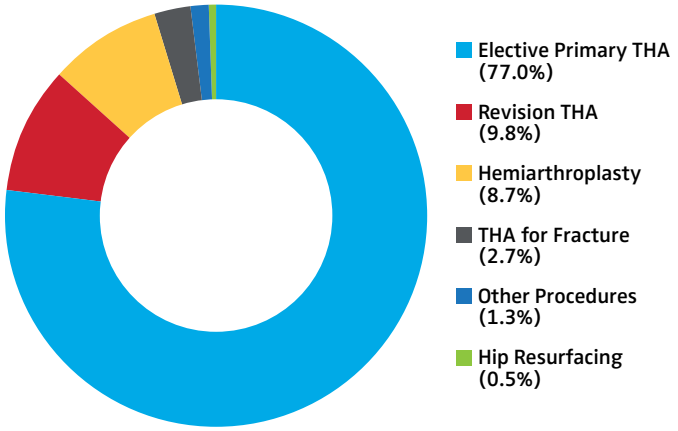


Table 2.2 Mean Age of Patients Undergoing Hip Arthroplasty Procedures, 2012-2022 (N=1,317,887)

Procedure	Total	Mean Age (Yrs)	Standard Deviation
Total Hip Arthroplasty	1,014,772	65.4	11.3
Revision Hip Arthroplasty	129,127	67.0	12.6
Hemiarthroplasty	114,468	81.9	9.6
THA for Fracture	36,049	71.7	11.6
Other Procedures	16,972	66.9	20.6
Hip Resurfacing	6,499	53.2	9.3

Figure 2.2 Age Distribution of Hip Arthroplasty Procedures 2012-2022 (N=1,300,915)

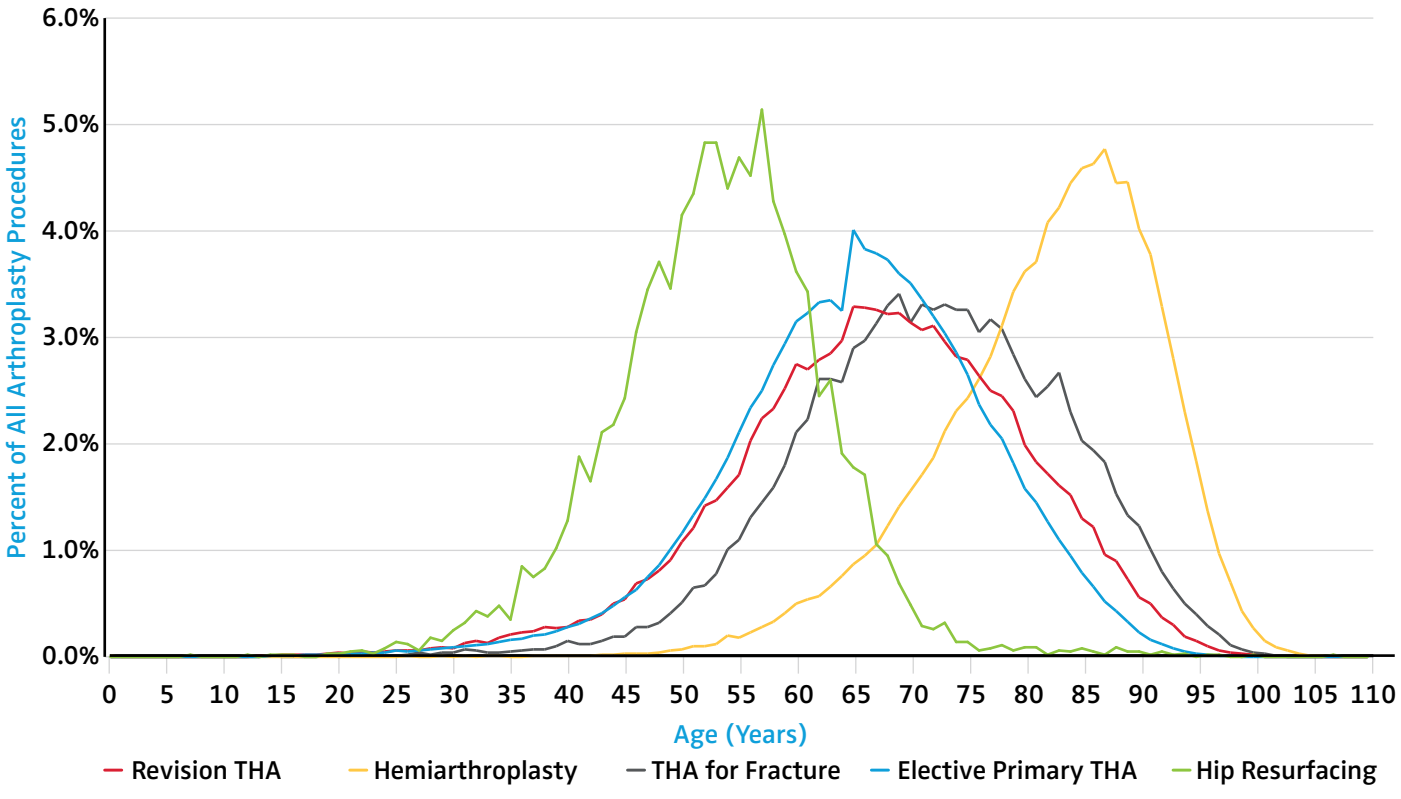
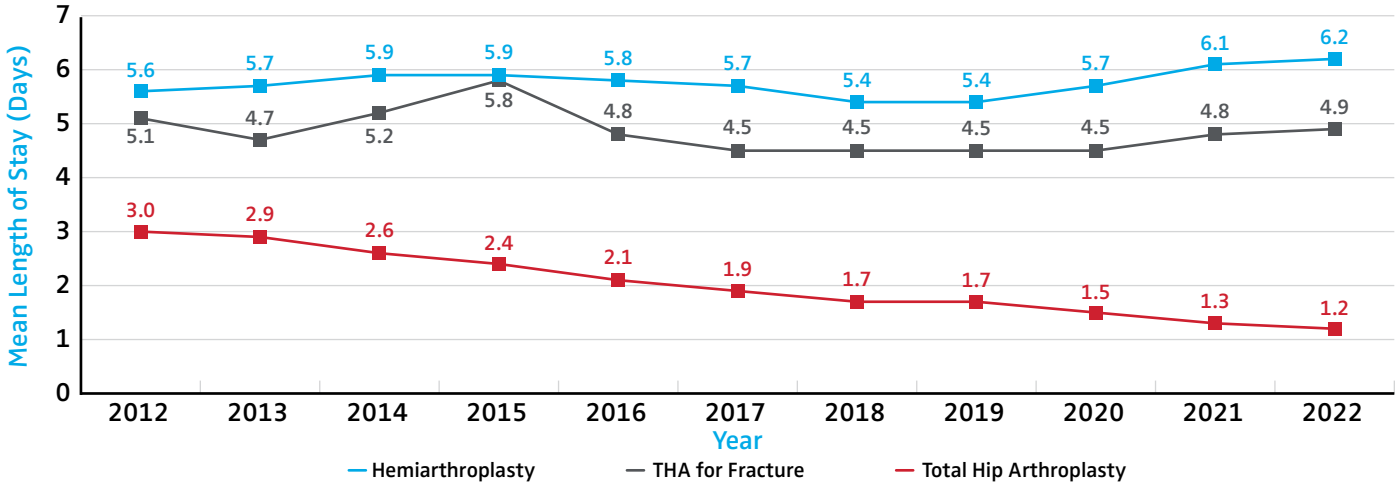


Figure 2.3 Mean Length of Stay for Hip Arthroplasty Procedures, 2012-2022 (N=752,866)



Arthroplasty for Femoral Neck Fracture

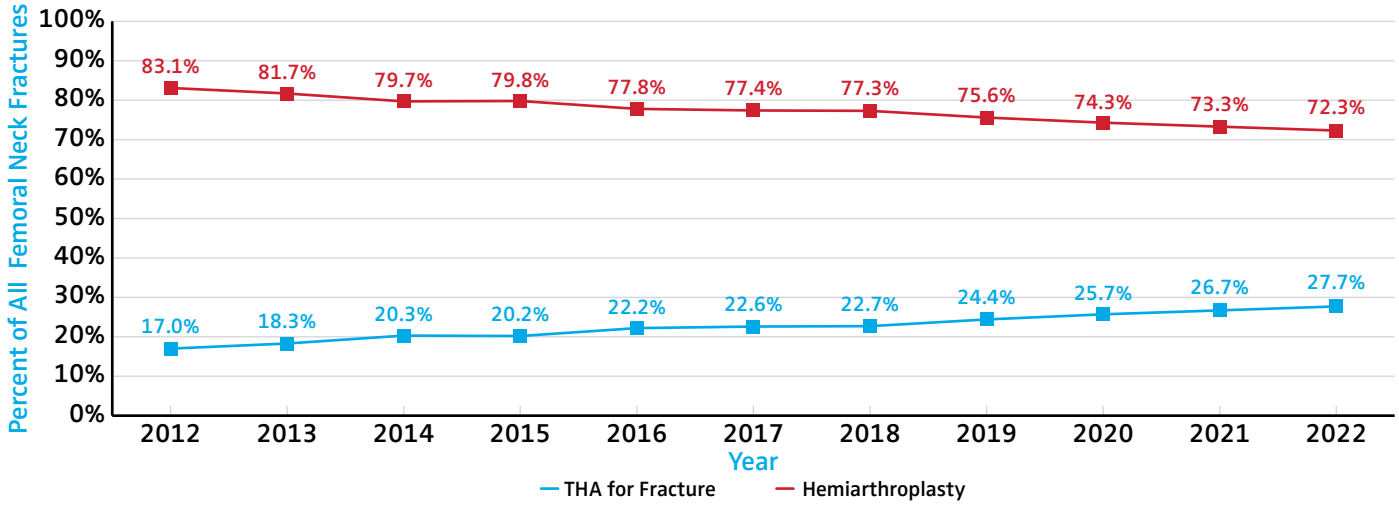
Between 2012 and 2022, AJRR has collected data on 150,344 hip arthroplasty procedures for femoral neck fracture.

In the AJRR population, displaced femoral neck fractures (FNF) are commonly treated with either hemiarthroplasty or total hip arthroplasty (THA). The optimal treatment for these fractures remains a topic of debate and is typically individualized to the patient.[3] Given that AJRR only collects arthroplasty procedures, patients treated with open reduction and internal fixation (ORIF) are not included. While historically AJRR has seen hemiarthroplasty predominate as the most frequent arthroplasty option for FNF, there has been a significant decrease in its use compared to THA between 2012 and 2022 (Figure 2.4). This finding is consistent with reports from other national registries.[5,6] In AJRR, for patients <60 years of age, THA was the more common treatment for displaced FNF. There is a relatively even split between THA and hemiarthroplasty between ages 60-69 years, and hemiarthroplasty becomes the predominant option for patients >69 years of age (Figure 2.5). THA for FNF is increasingly more common in females with each decade increase in age with females reaching a majority of cases in groups >50 years of age and over two-thirds of cases aged >69 years (Fig 2.6).

INSIGHTS

The trend towards increasing use of total hip arthroplasty instead of hemiarthroplasty for femoral neck fractures continues.

Figure 2.4a Total Hip Arthroplasty and Hemiarthroplasty Procedures Performed for Femoral Neck Fracture, 2012-2022

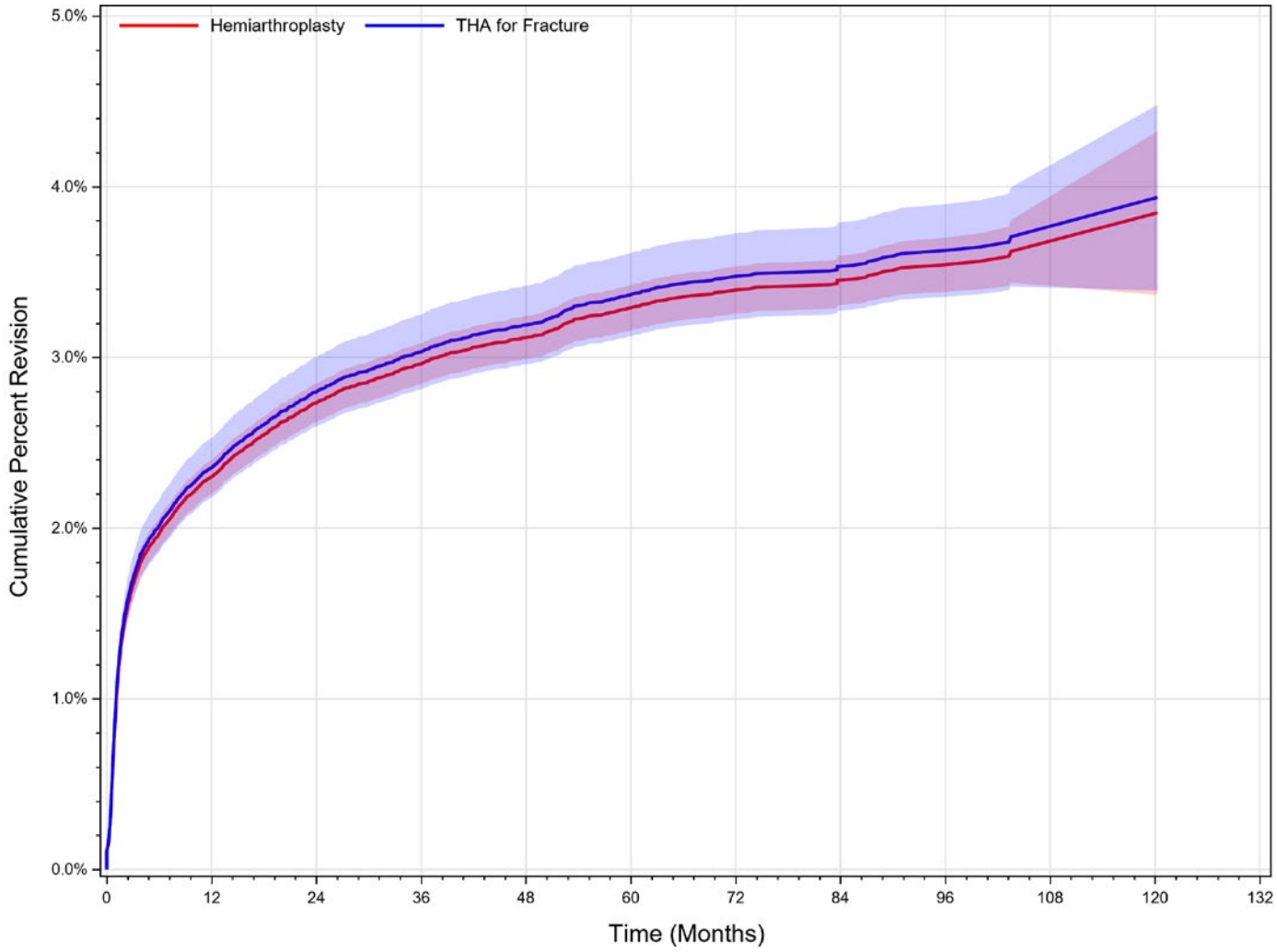


This year's Annual Report analyzed survivorship between THA and hemiarthroplasty for treatment of fracture in Medicare patients. Cumulative percent revision was not found to be significantly different between treatment methods for fracture patients aged 65 and older.

No significant difference was identified comparing cumulative percent revision between THA and hemiarthroplasty for fracture in Medicare patients aged 65 and older.

INSIGHTS

Figure 2.4b Cumulative Percent Revision for Total Hip Arthroplasty Compared to Hemiarthroplasty for Treatment of Fracture in Medicare Patients 65 Years of Age and Older, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Hemiarthroplasty	92,112	71,627	59,770	48,234	37,915	27,286	16,812	9,327	4,743	1,668	362	2
THA for Fracture	22,711	18,513	15,226	12,038	9,309	6,798	4,297	2,401	1,297	440	91	1
Total	114,823	90,140	74,996	60,272	47,224	34,084	21,109	11,728	6,040	2,108	453	3

Age/Sex/CCI adjusted HR (95%CI), p-value
Hemiarthroplasty vs. THA for Fracture: 0.976 (0.895,1.066), p=0.5931

Figure 2.5 Percent of Total Hip Arthroplasty and Hemiarthroplasty Procedures for Treatment of Femoral Neck Fracture by Age Group, 2012-2022 (N=150,344)

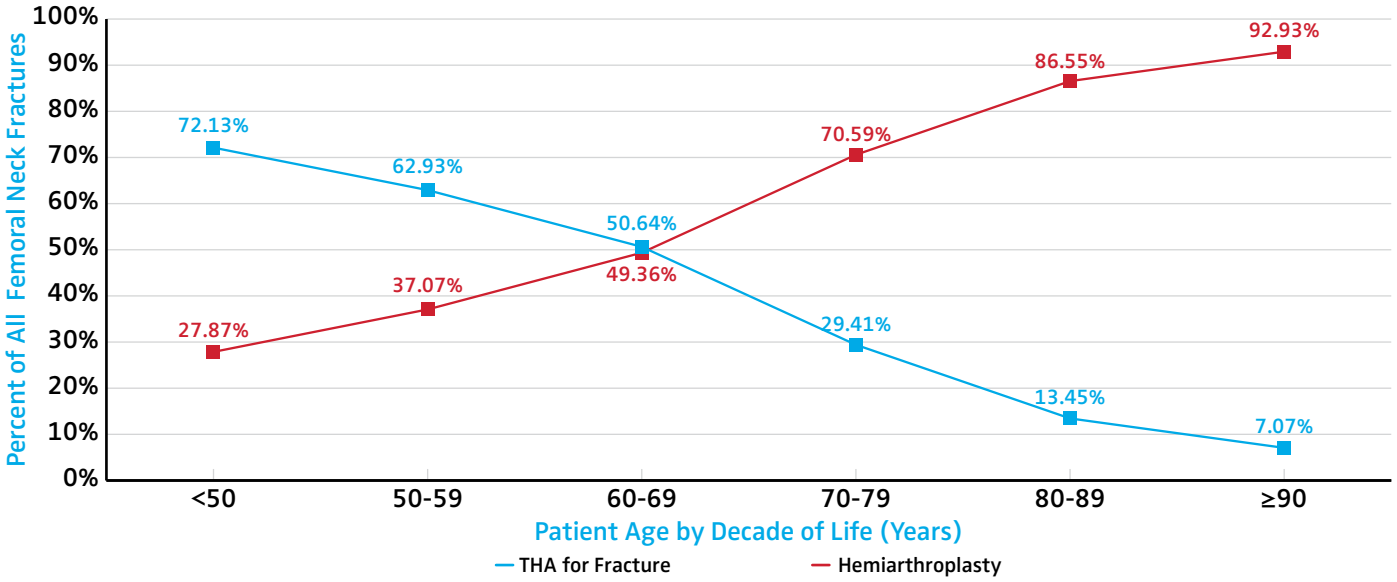
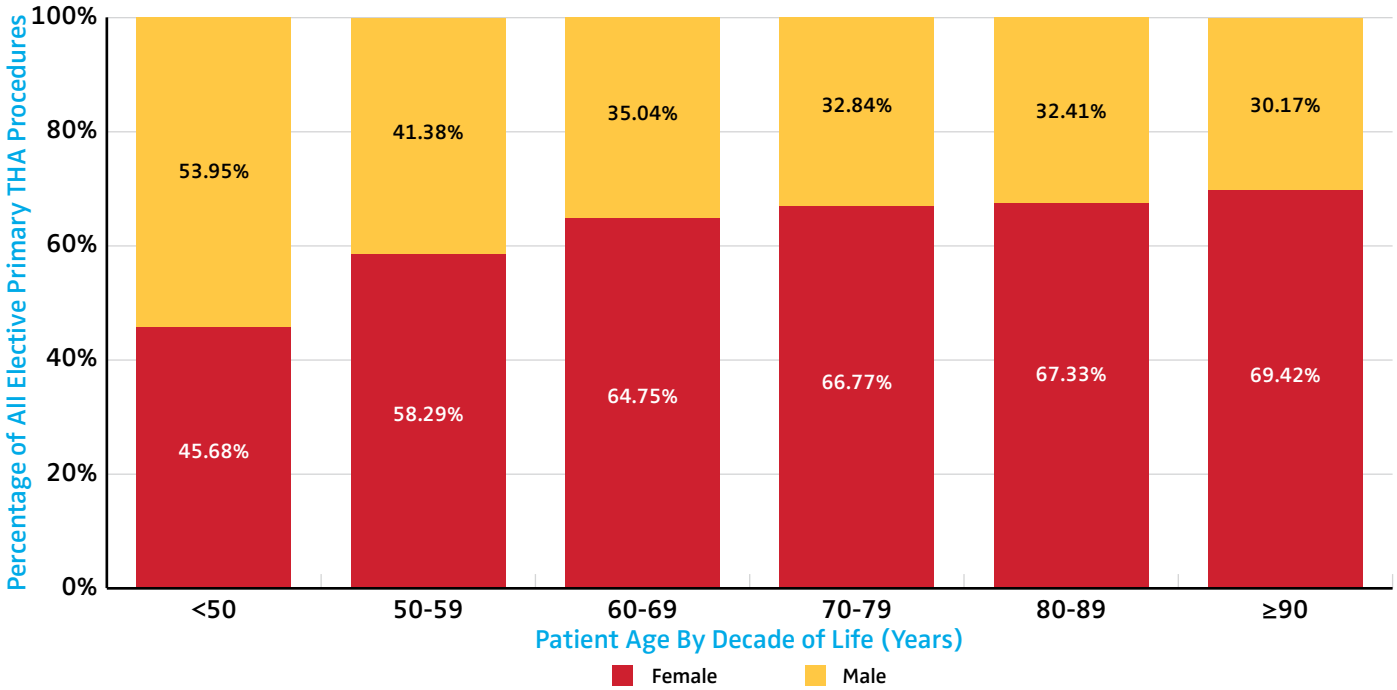


Figure 2.6 Sex Distribution for Total Hip Arthroplasty for Femoral Neck Fracture by Age Group, 2012-2022 (N=36,049)

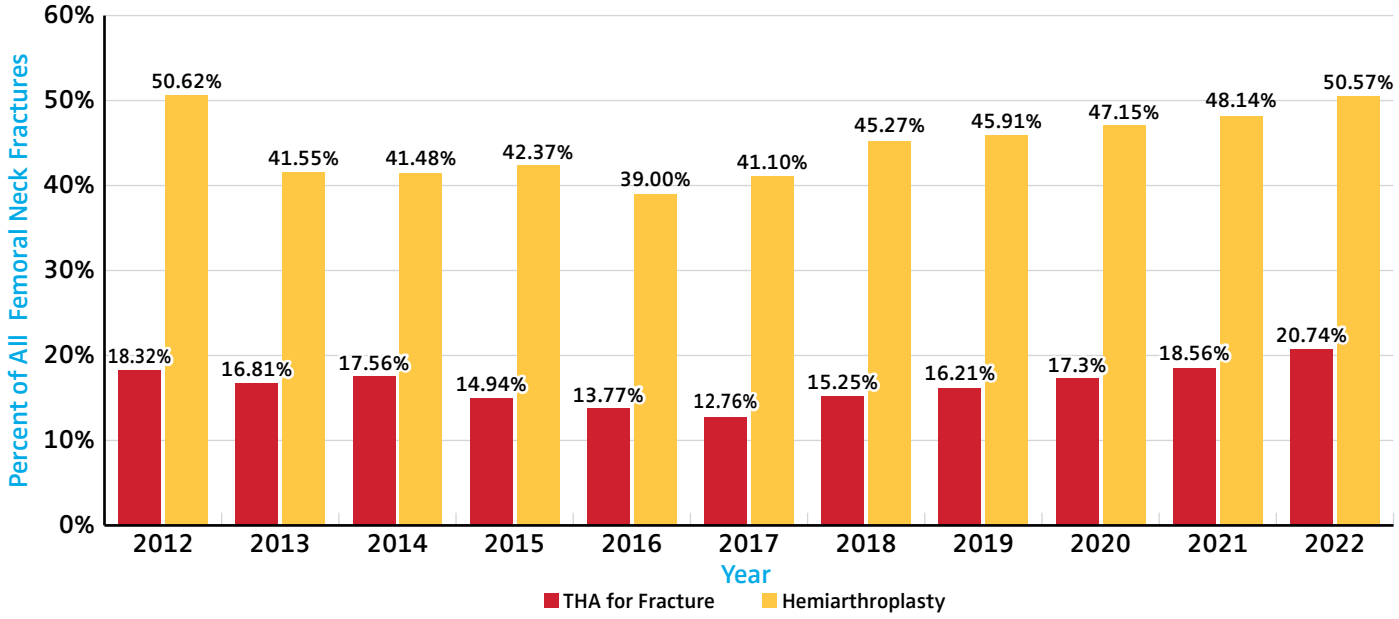


Both cemented and cementless fixation for femoral stems are frequently used in the treatment of femoral neck fractures. Cemented fixation was more commonly utilized for hemiarthroplasty than total hip arthroplasty. There has been an increasing utilization of cement for stem fixation in both hemiarthroplasty and total hip arthroplasty for femoral neck fractures over the past six years (Figure 2.7).

INSIGHTS

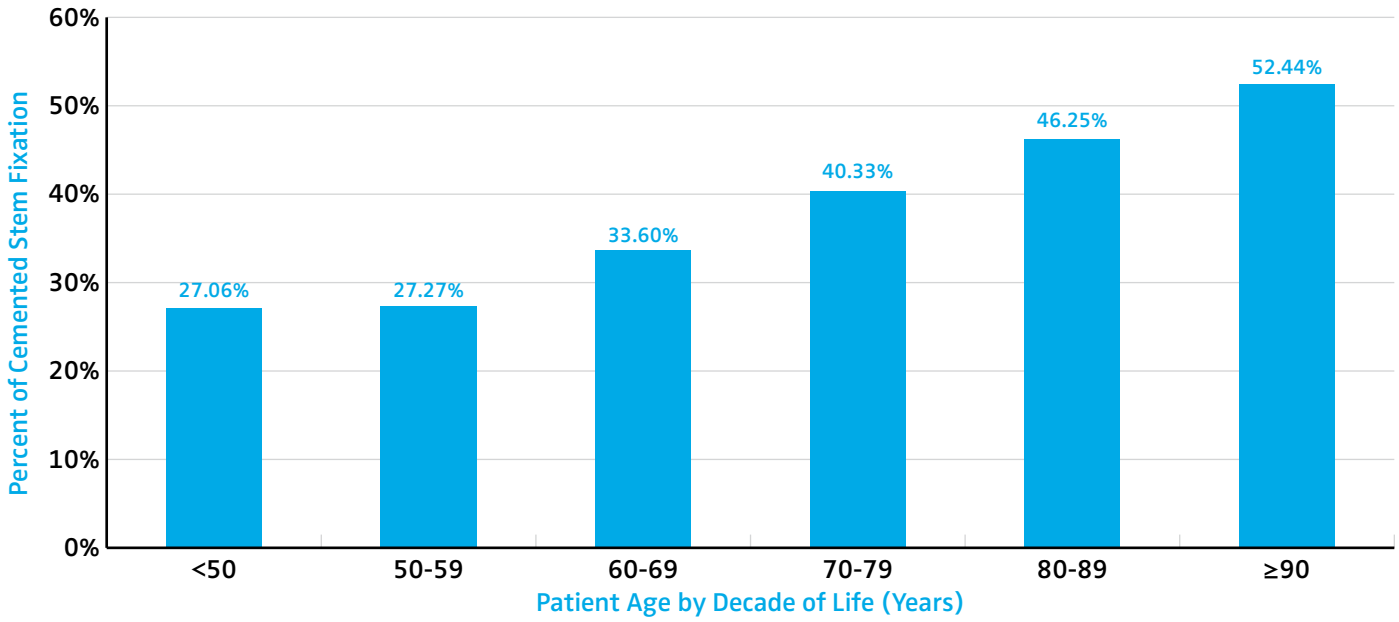
The use of cement for femoral stem fixation in the setting of arthroplasty for femoral neck fracture has been slowly increasing over the past six years.

Figure 2.7 Cemented Fixation for Femoral Stems in Total Hip Arthroplasty and Hemiarthroplasty for Femoral Neck Fracture, 2012-2022 (N=44,187)



Cemented femoral component fixation used in hemiarthroplasty for the treatment of FNF increased in utilization with each advancing decade of life (Figure 2.8). In contrast to the majority of international registries, however, only 52% of the oldest age group received cemented stems.[7-9] Internationally, cemented femoral stem fixation for femoral neck fractures still predominates; in 2022, the U.K. National Joint Registry reported that 81% of all stems used to treat femoral neck fractures were cemented.[8]

Figure 2.8 Percent of Cemented Stem Fixation Used in Hemiarthroplasty for Femoral Neck Fracture by Age Group, 2012-2022 (N=39,898)



Hip Resurfacing

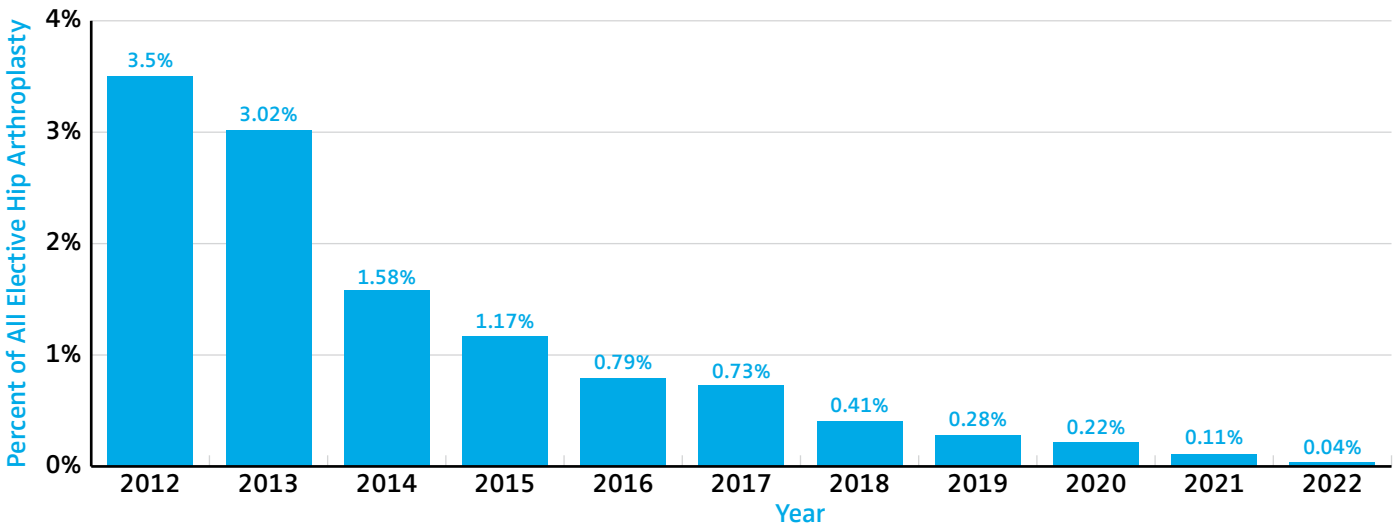
Between 2012 and 2022, AJRR has collected data on 6,462 hip resurfacing procedures.

Hip resurfacing as a percentage of the total number of elective hip arthroplasty procedures submitted to AJRR continues to decline (N=46 by 2022) likely due to the diminished enthusiasm for metal-on-metal articulations (Figure 2.9).[10] Males under the age of 60 made up 75% of hip resurfacing cases reported by only 16 surgeons.

INSIGHTS

Hip resurfacing as a percentage of the total number of elective hip arthroplasty procedures submitted to AJRR continues to decline and are mostly performed in young males.

Figure 2.9 Hip Resurfacing as a Percentage of Elective Hip Arthroplasty Procedures, 2012-2022 (N=6,462)



Elective Primary Total Hip Arthroplasty

Between 2012 and 2022, AJRR has collected data on 1,014,772 elective primary total hip arthroplasty procedures.

Similar to previous AJRR Annual Reports, more than half of patients <60 years of age undergoing elective primary total hip arthroplasty were male. After the age of 60, females predominate, and this proportion increases with each additional decade of life (Figure 2.10).

Since 2012, AJRR data has shown an increase in use of 36mm heads, though this has remained relatively stable over the last five years. A corresponding decrease in utilization of 32mm femoral heads over this time period is also seen ($p<0.0001$). Use of larger (>40mm) head sizes has increased slightly, and smaller (<28mm) head sizes have been relatively stable over time accounting for only 3,441 cases in 2022. The Registries team is actively working to confirm any dual mobility constructs being misclassified as 28mm cases, as these data rely on accuracy of component reporting and completeness of device descriptions. The use of dual mobility articulations in both primary and revision hip arthroplasty as reported to AJRR increased substantially since 2012 but has seen a slight decrease in utilization in 2022 (Figure 2.11).

INSIGHTS

The increased utilization of larger diameter heads ≥40mm and dual mobility over the past decade continues but may be slowing.

Figure 2.10 Sex Distribution for Elective Primary Total Hip Arthroplasty Procedures by Age Group, 2012-2022 (N=1,008,964)

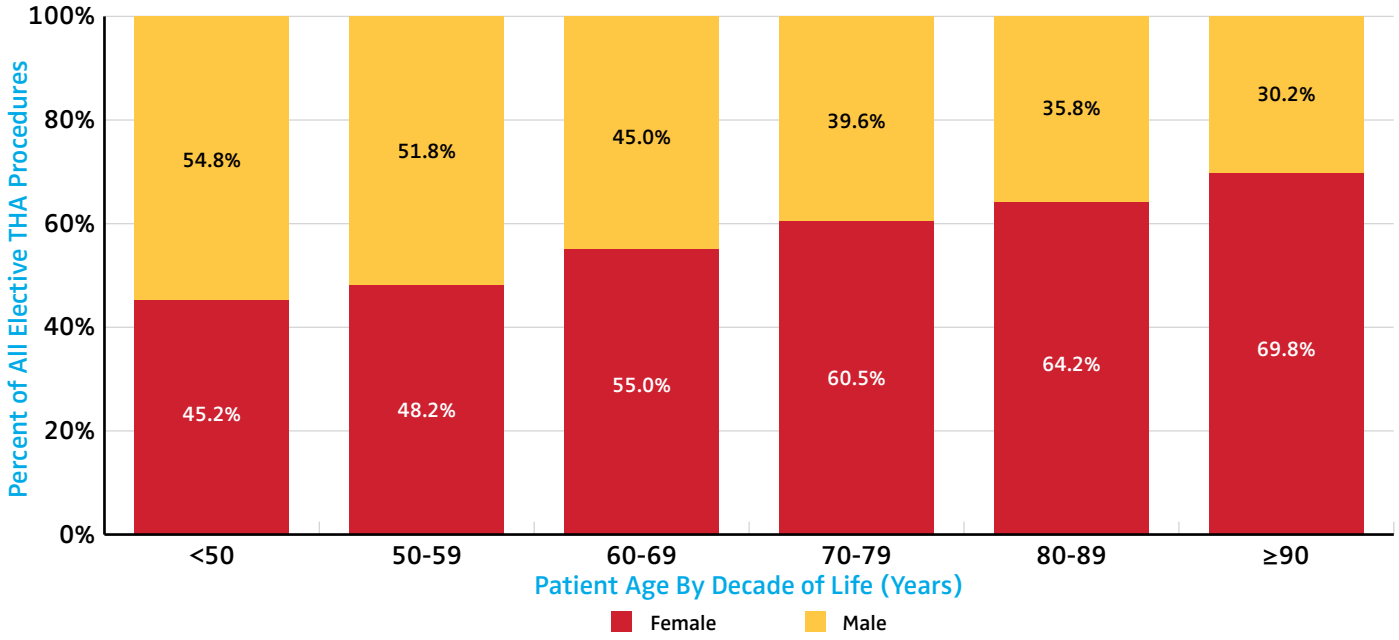
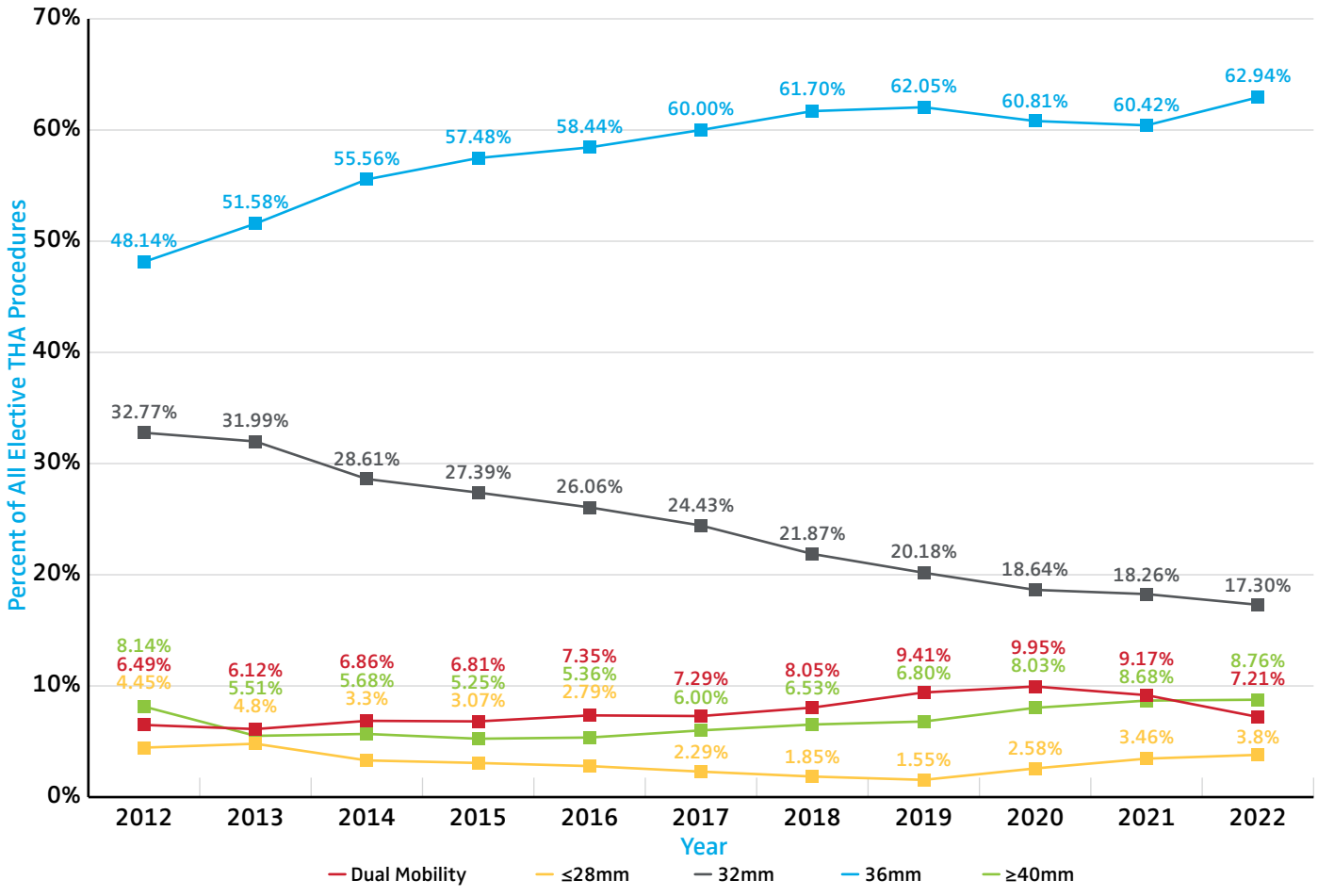


Figure 2.11 Percent Dual Mobility Usage and Femoral Head Sizes Implanted in Elective Primary Total Hip Arthroplasty, 2012-2022 (N=825,539)

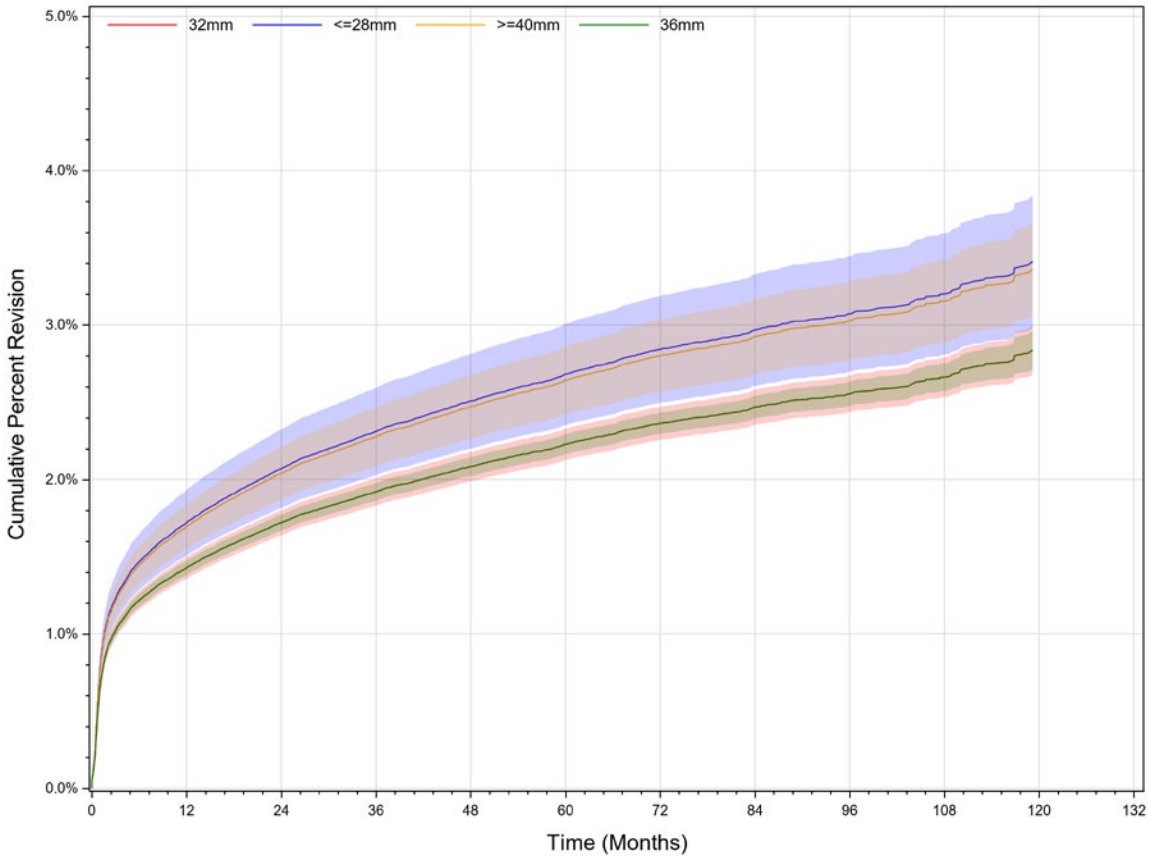


Unless otherwise noted, all survival analyses are limited to Medicare patients aged 65 years and older and merged with available CMS claims data in order to maximize outcome capture of cases performed at non-AJRR reporting institutions. After adjusting for age, sex, and Charlson Comorbidity Index (CCI), the cumulative percent revision rate of elective primary THA cases in patients greater than 65 years of age is higher when utilizing smaller diameter (28mm or less) and larger diameter (40mm and greater) femoral heads compared to those procedures utilizing 36mm femoral heads (Figure 2.12). The 32mm and 36mm heads were not found to be statistically different. These differences may reflect different underlying baseline risk in patients who received smaller or larger diameter heads. The cumulative percent revision rate did not differ between 32 and 36mm heads.

The cumulative percent revision rate of elective primary THA cases in patients greater than 65 years of age is higher when utilizing smaller diameter (28mm or less) and larger diameter (40mm and greater) femoral heads compared to those procedures utilizing 36mm femoral heads. The 32mm and 36mm heads were not found to be statistically different.

INSIGHTS

Figure 2.12 Cumulative Percent Revision for Diameter of Femoral Heads for Elective Primary Total Hip Arthroplasty in Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
32mm	89,405	81,351	73,452	65,258	54,732	43,434	30,715	19,217	11,092	5,106	1,523	6
36mm	236,262	210,009	183,976	157,700	125,624	93,865	62,549	36,769	19,722	8,086	2,319	6
≤28mm	10,004	8,364	6,924	5,897	5,166	4,288	3,203	2,139	1,331	708	196	1
≥40mm	24,946	21,410	18,185	15,092	11,817	8,697	5,797	3,515	2,003	954	379	1
Total	360,617	321,134	282,537	243,947	197,339	150,284	102,264	61,640	34,148	14,854	4,417	14

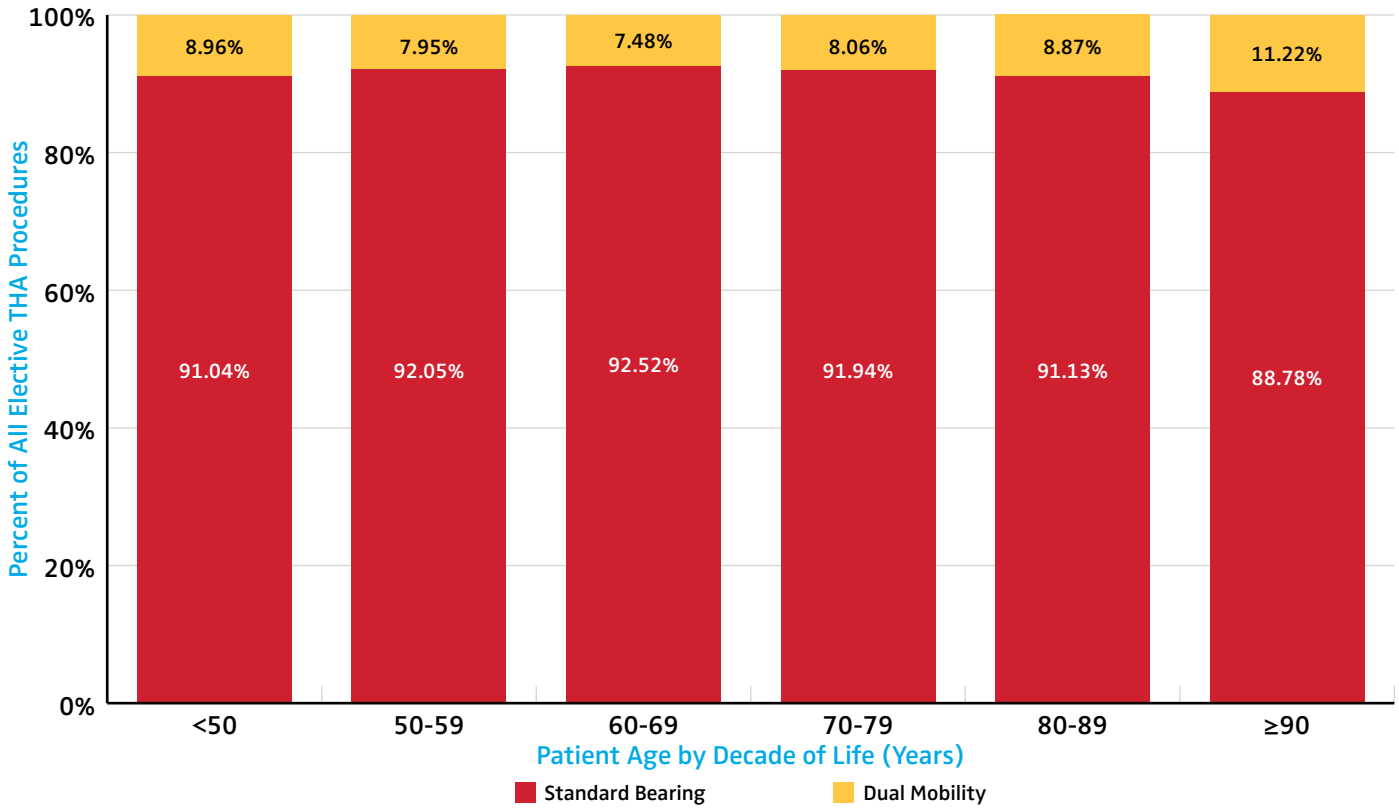
Age/Sex/CCI adjusted HR (95%CI), p-value
32mm vs. 36mm: *1(0.943,1.059), p=0.9898*
≤28mm vs. 36mm: *1.206(1.059,1.374), p=0.0047*
≥40mm vs. 36mm: *1.188(1.082,1.305), p=0.0003*

Dual mobility constructs show most frequent use in the oldest (≥90) and youngest (<50 years) groups of patients.

INSIGHTS

AJRR illustrated a significant increase in dual mobility usage for elective primary hip arthroplasty procedures when comparing 2012 to 2022 though there was a slight pull-back in 2022. The increase in popularity over time may be explained by the perception of increased stability and reduced risk of dislocation with larger diameter dual mobility articulations.[11] These constructs were used most commonly in the oldest (>90 years) and youngest (<50 years) patients and least frequently in the 60-69 year age range (Figure 2.13).

Figure 2.13 Dual Mobility Usage as a Percent of all Elective Primary Total Hip Arthroplasty Procedures by Age Group, 2012-2022 (N=825,539)

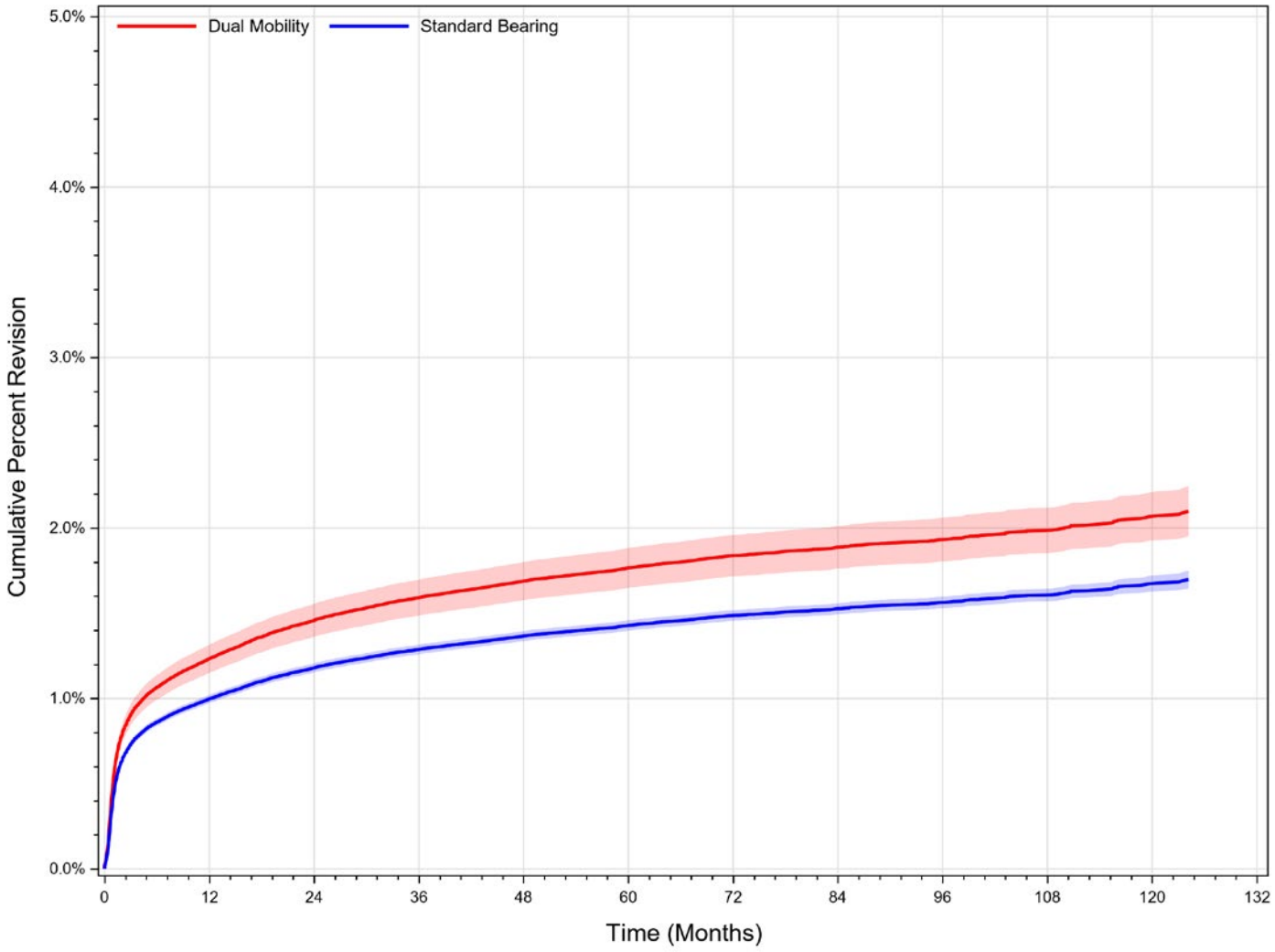


As reported to AJRR for all ages, there was increased revision when comparing dual mobility to conventional femoral head usage for elective primary total hip arthroplasty procedures after adjusting for age, sex, and CCI (HR=1.238, 95% CI, 1.154-1.329, p<0.0001) (Figure 2.14). Findings were similar when looking at patients ≥65 years of age as reported to either AJRR or CMS (Figure 2.15). As previously noted, this represents an association rather than a causal relationship and does not account for potential confounders, such as the patient's inherent risk of dislocation.

INSIGHTS

A higher cumulative incidence of revision surgery is associated with dual mobility bearings when compared to conventional femoral heads for elective primary total hip arthroplasty procedures, which may reflect underlying patient characteristics and baseline risk for dislocation.

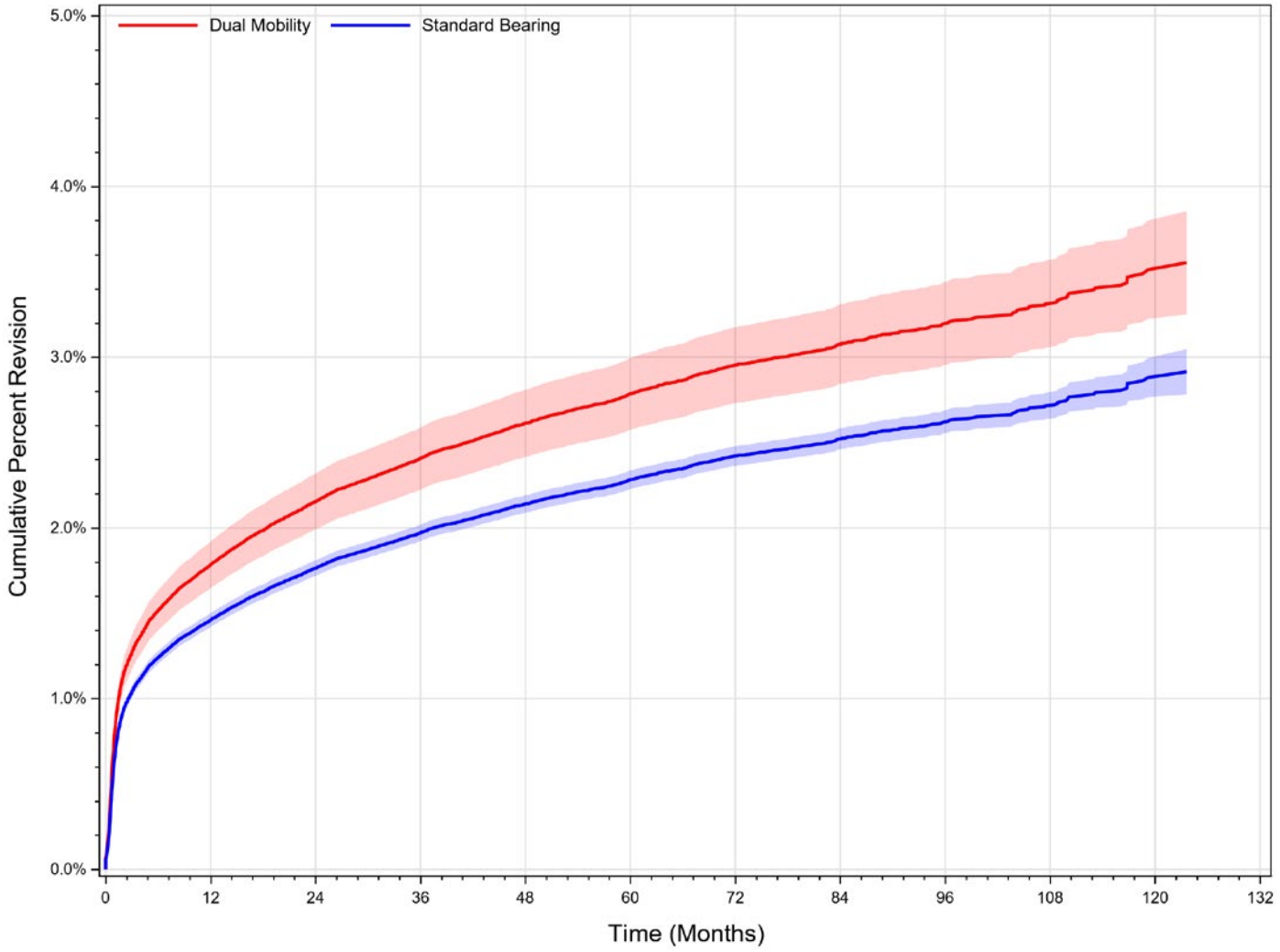
Figure 2.14 Cumulative Percent Revision for Dual Mobility Used for Elective Primary Total Hip Arthroplasty for Patients with Primary Osteoarthritis as Submitted Only to AJRR, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Dual Mobility	51,203	47,401	40,740	33,772	27,219	20,360	14,258	8,934	5,024	2,478	1,036	228
Standard Bearing	624,159	594,691	549,687	490,107	420,476	337,879	249,978	166,412	97,485	49,693	18,999	3,320
Total	675,362	642,092	590,427	523,879	447,695	358,239	264,236	175,346	102,509	52,171	20,035	3,548

Age/Sex/CCI adjusted HR (95%CI), p-value
Dual Mobility vs. Standard Bearing: *1.238(1.154,1.329), p<0.0001*

Figure 2.15 Cumulative Percent Revision for Dual Mobility Used for Elective Primary Total Hip Arthroplasty for Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Dual Mobility	26,207	23,125	19,360	15,741	11,649	8,227	5,274	2,987	1,535	661	220	1
Standard Bearing	328,398	303,442	276,313	242,551	196,595	150,249	102,860	62,160	34,441	14,922	4,367	14
Total	354,605	326,567	295,673	258,292	208,244	158,476	108,134	65,147	35,976	15,583	4,587	15

Age/Sex/CCI adjusted HR (95%CI), p-value
Dual Mobility vs. Standard Bearing: *1.224(1.124,1.332), p<0.0001*

For all elective primary total hip arthroplasty procedures, ceramic head usage has continued to increase, while there has been a corresponding and statistically significant decrease in cobalt chromium (CoCr) usage ($p<0.0001$) (Figure 2.16). This increase in ceramic head use is likely explained by concerns over trunnion and taper corrosion more commonly seen with CoCr heads.[12] CoCr femoral heads are used more commonly in patients >70 years of age, but ceramic still predominates across age groups accounting for more than 65% of patients older than 90 (Figure 2.17). Over the last decade, ceramic on polyethylene (CoP) has consistently risen in its application while metal on polyethylene (MoP) combinations have declined. Dual-mobility systems and ceramicized metal on polyethylene (CMoP) combinations have increased in utilization in elective primary hip arthroplasty nearly two-fold since 2012 in elective primary hip arthroplasty (Figure 2.18).

INSIGHTS

The use of metal-on-polyethylene articulations in elective primary total hip arthroplasty continues to decrease, with less than 5% of procedures utilizing this bearing in 2022.

Figure 2.16 Composition of Femoral Heads for All Elective Primary Total Hip Arthroplasty Procedures Excluding Dual Mobility by Year, 2012-2022 (N=748,575)

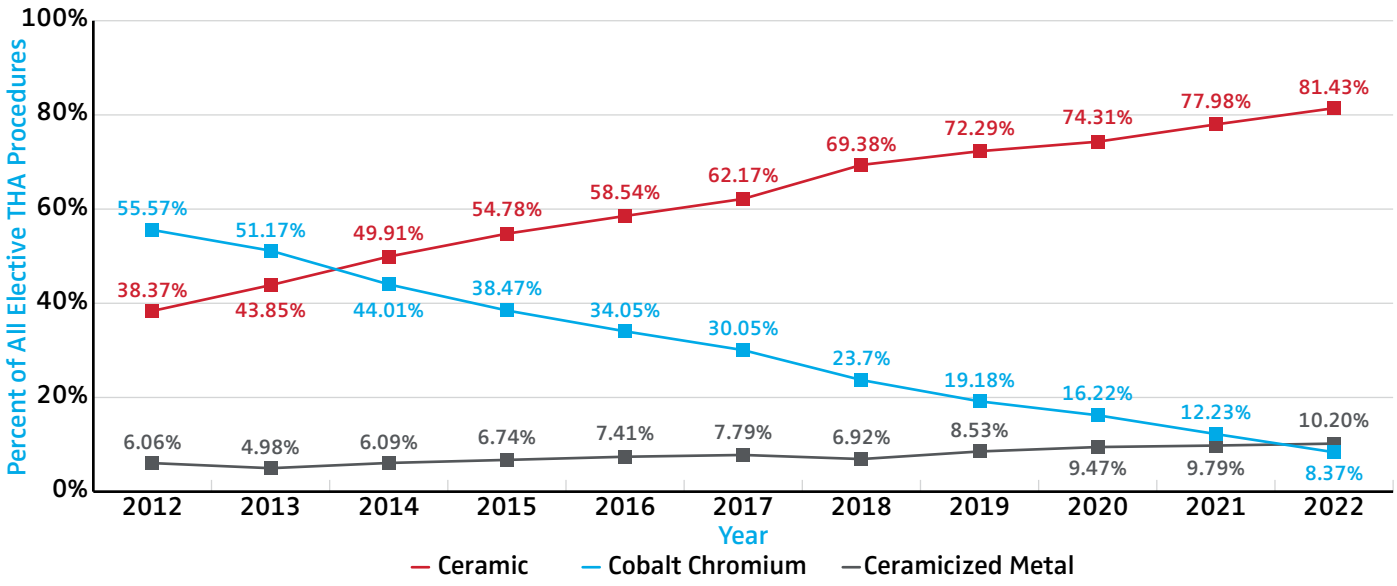


Figure 2.17 Composition of Femoral Heads for All Elective Primary Total Hip Arthroplasty Procedures Excluding Dual Mobility by Age Group, 2022 (N=82,578)

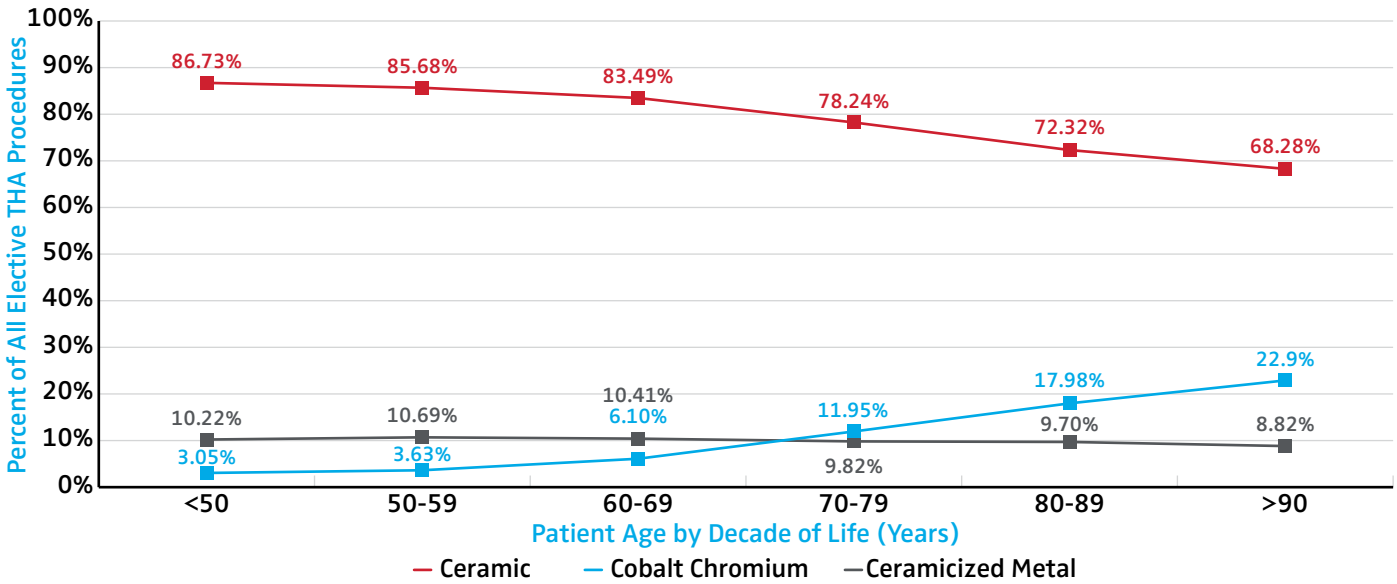
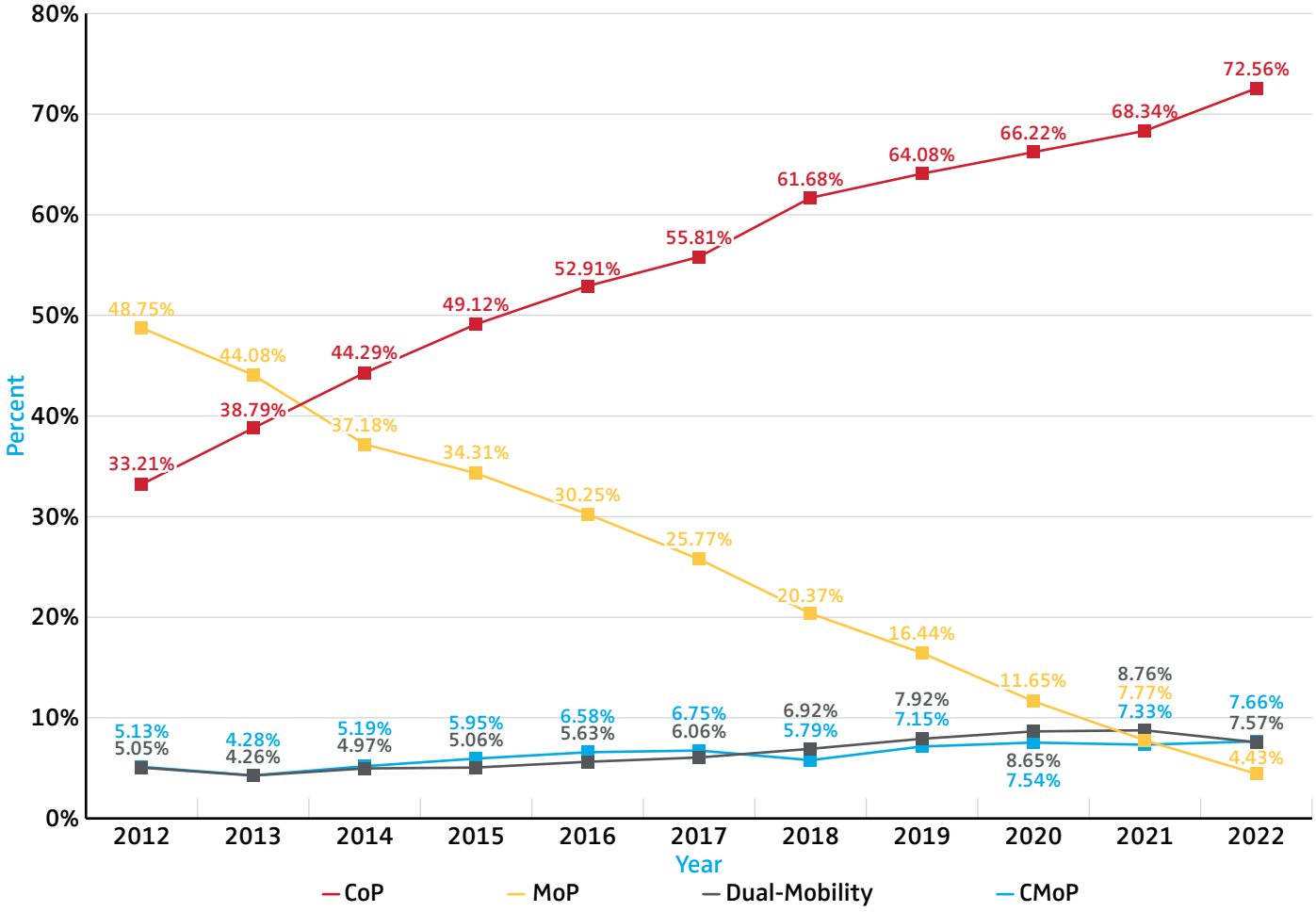


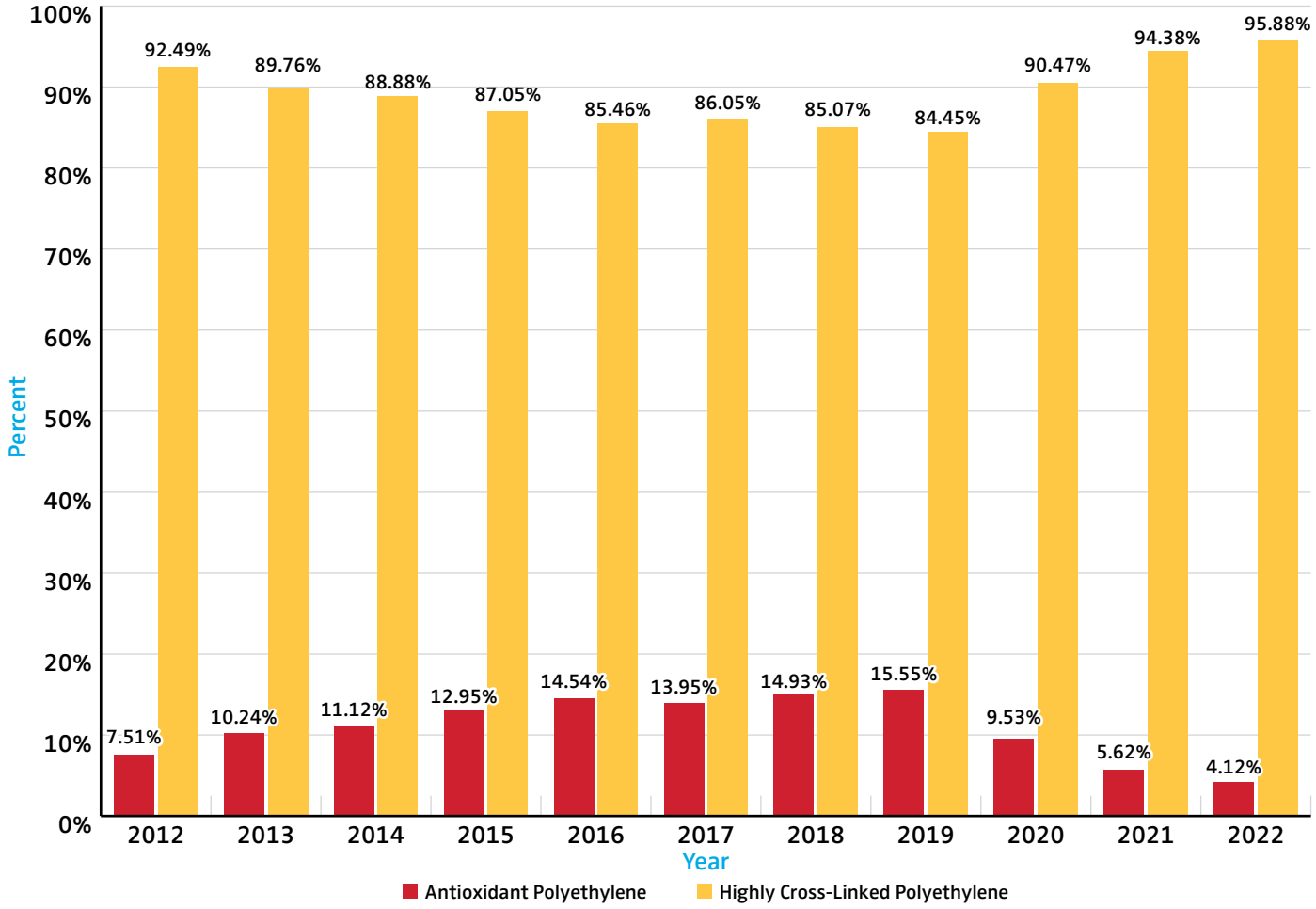
Figure 2.18 Elective Primary Total Hip Arthroplasty Bearing Surface Materials by Year, 2012-2022 (N=882,050)



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Total N	14,268	29,749	53,729	71,728	98,076	110,855	109,576	107,962	91,579	92,087	102,441	**882,050**

For both cobalt chromium and ceramic heads used by surgeons in the AJRR cohort, highly cross-linked polyethylene was more commonly utilized compared to antioxidant polyethylene for all elective primary total hip arthroplasty procedures (Figures 2.19). The threshold for classification of a polyethylene liner as highly cross-linked polyethylene is a total radiation dose of 50 kGy (5 Mrad) or more. Antioxidant polyethylene is defined as a highly cross-linked polyethylene liner with an antioxidant component infused or blended in manufacturing. The use of antioxidant polyethylene had remained fairly stable since 2015 with a notable decline in recent years to just 4.1% in 2022. The use of conventional polyethylene (UHMWPE) in the AJRR primary total hip arthroplasty cohort has become vanishingly small with <1.0% of annual cases, as surgeons have almost entirely moved to either highly cross-linked or antioxidant polyethylene alternatives. After adjusting for age, sex, and CCI, highly cross-linked and antioxidant polyethylene showed no statistical difference in cumulative percent revision (Figure 2.20).

Figure 2.19 Elective Primary Total Hip Arthroplasty Liner Polyethylene Material by Year, 2012-2022 (N=724,810)

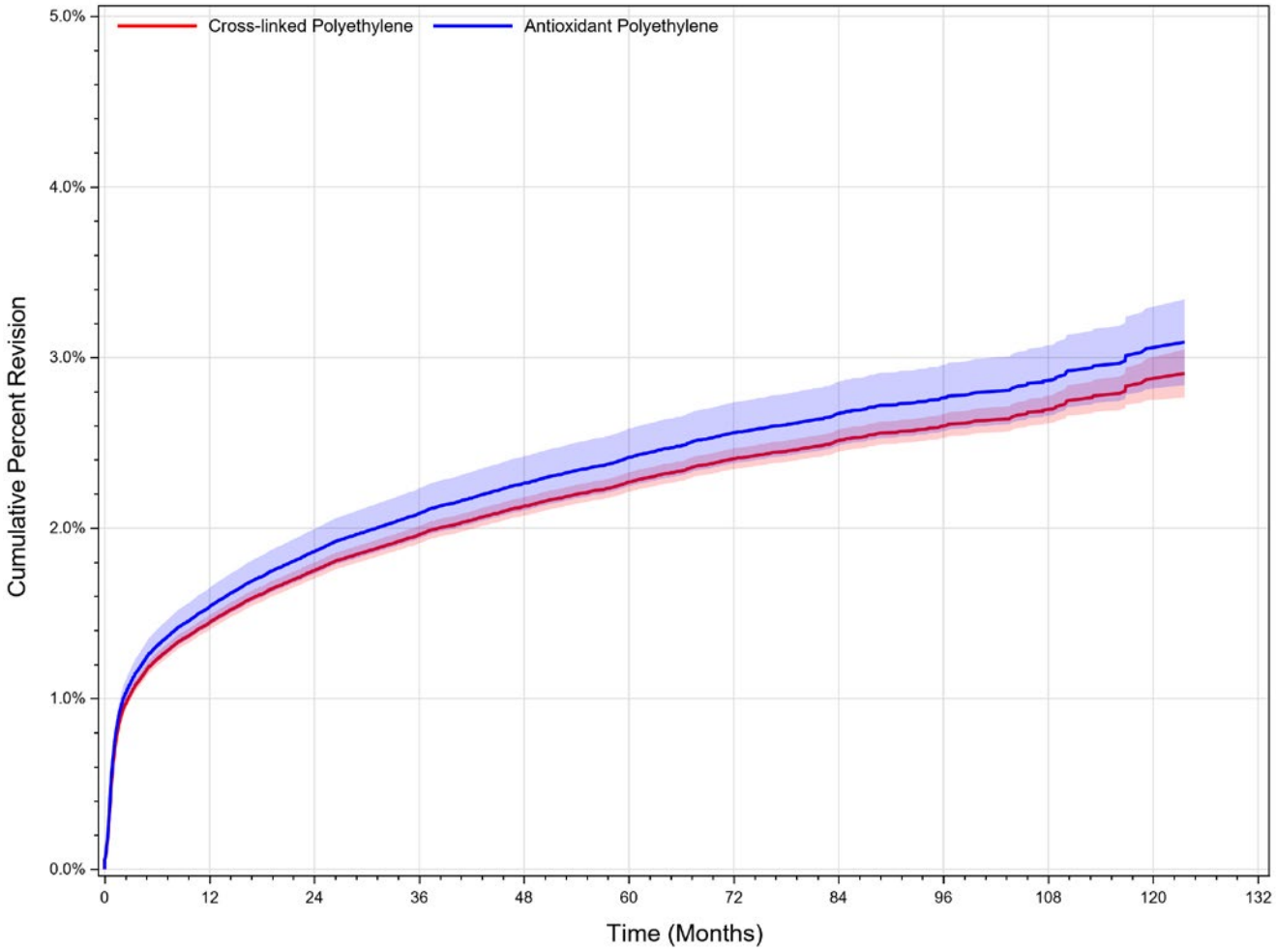


	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Total N	12,962	27,692	50,567	68,727	93,074	102,824	99,958	96,335	70,529	56,402	45,740	**724,810**

Highly cross-linked and antioxidant polyethylene showed no statistical difference in cumulative percent revision after adjusting for age, sex, and CCI.

INSIGHTS

Figure 2.20 Cumulative Percent Revision for Polyethylene Material for Elective Primary Total Hip Arthroplasty for Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Antioxidant Polyethylene	33,007	31,741	30,566	27,904	21,679	15,746	10,245	5,391	2,679	1,050	301	1
Cross-linked Polyethylene	293,178	270,490	245,019	213,784	173,913	133,815	92,025	55,893	30,888	13,481	3,965	14
Total	326,185	302,231	275,585	241,688	195,592	149,561	102,270	61,284	33,567	14,531	4,266	15

Age/Sex/CCI adjusted HR (95%CI), p-value
Cross-linked Polyethylene vs. Antioxidant Polyethylene: *0.94(0.869,1.016), p=0.1180*

Cementless femoral component fixation for elective primary total hip arthroplasty dramatically outweighs the use of cemented fixation in the AJRR population. From 2012-2022, only 3.58% of all elective primary total hip arthroplasty procedures in AJRR utilized cemented femoral component fixation. When examining usage by age in 2022, there was a significant increase in cemented fixation with advancing age (p<0.0001) (Figure 2.21) and over time (p<0.0001) (Figure 2.22).

The trend towards increasing use of cement for femoral component fixation in primary elective THA has increased over 69% since 2013. In 2022, almost 5% of femoral stems were cemented, which represents the highest percentage utilization since the inception of AJRR.

INSIGHTS

Figure 2.21 Cemented and Cementless Femoral Stem Fixation in Elective Primary Total Hip Arthroplasty Procedures by Age Group, 2022 (N=75,499)

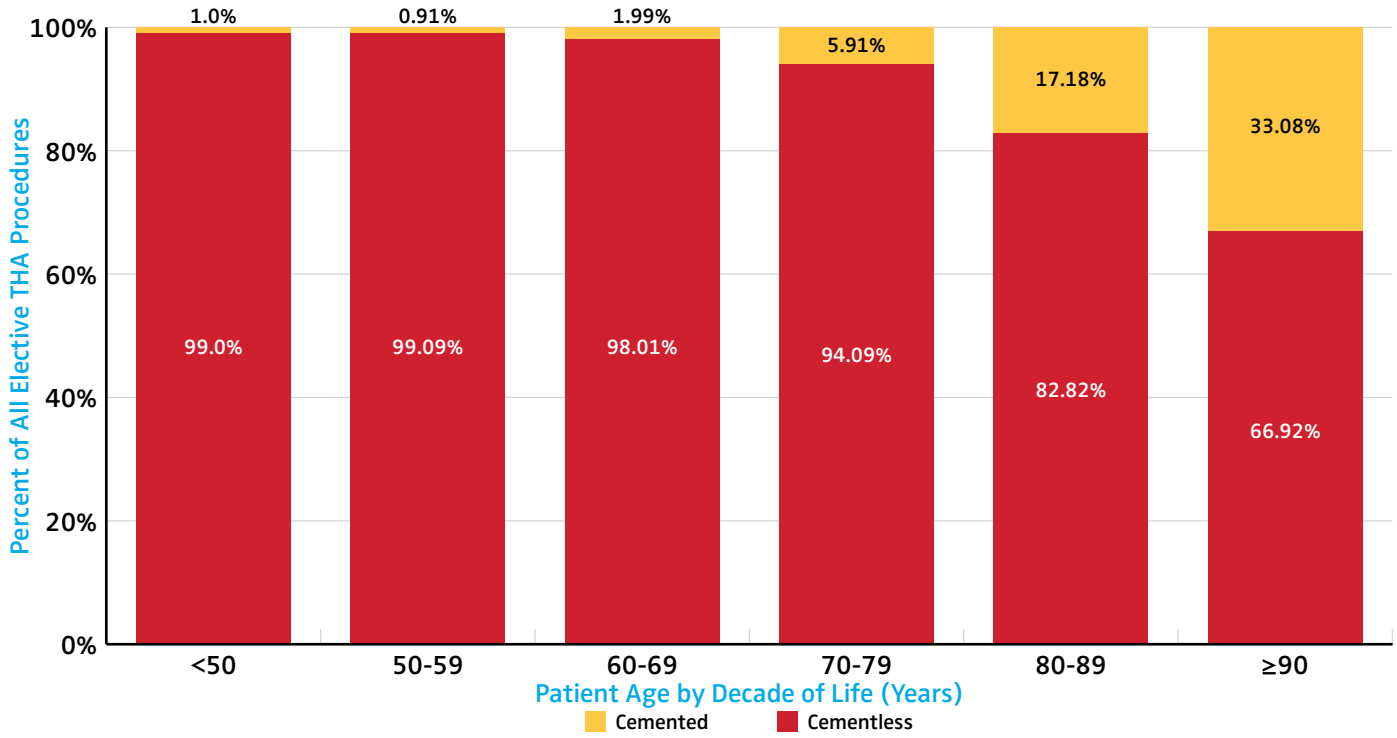
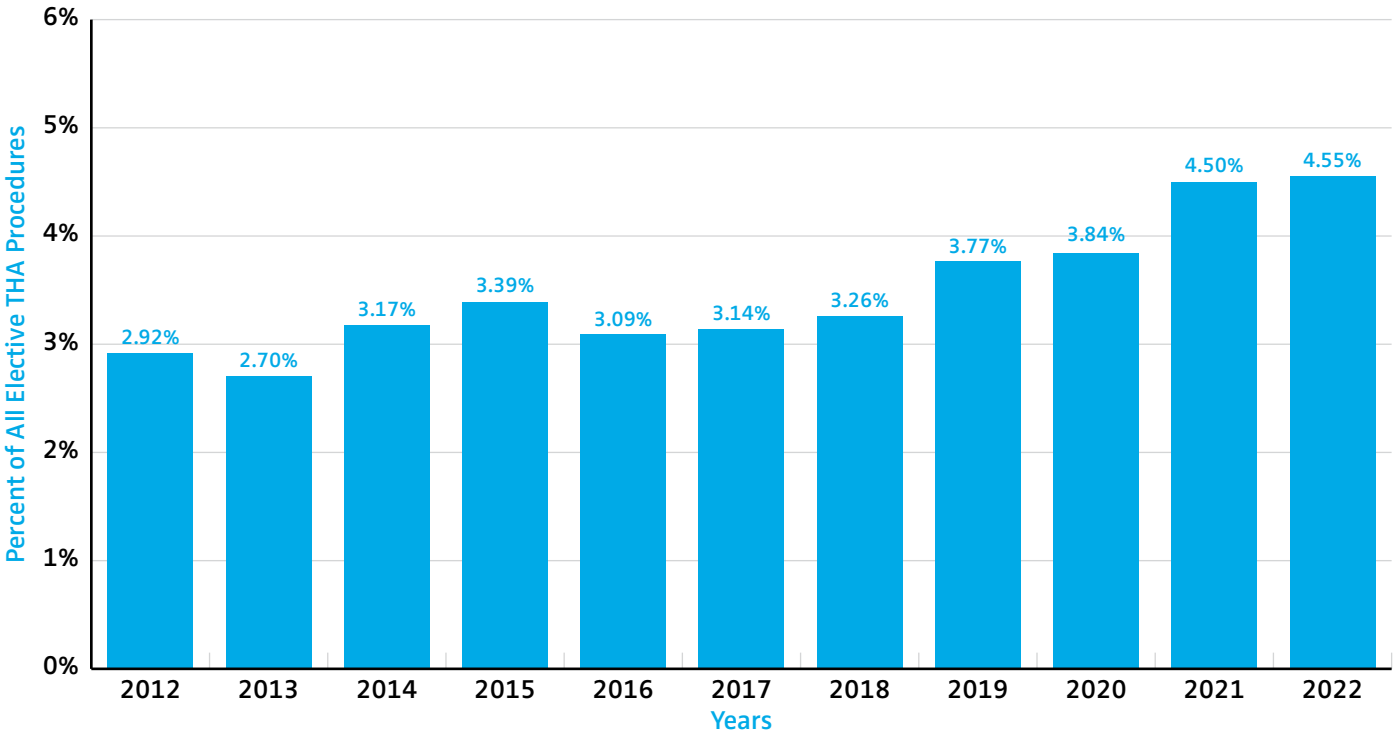


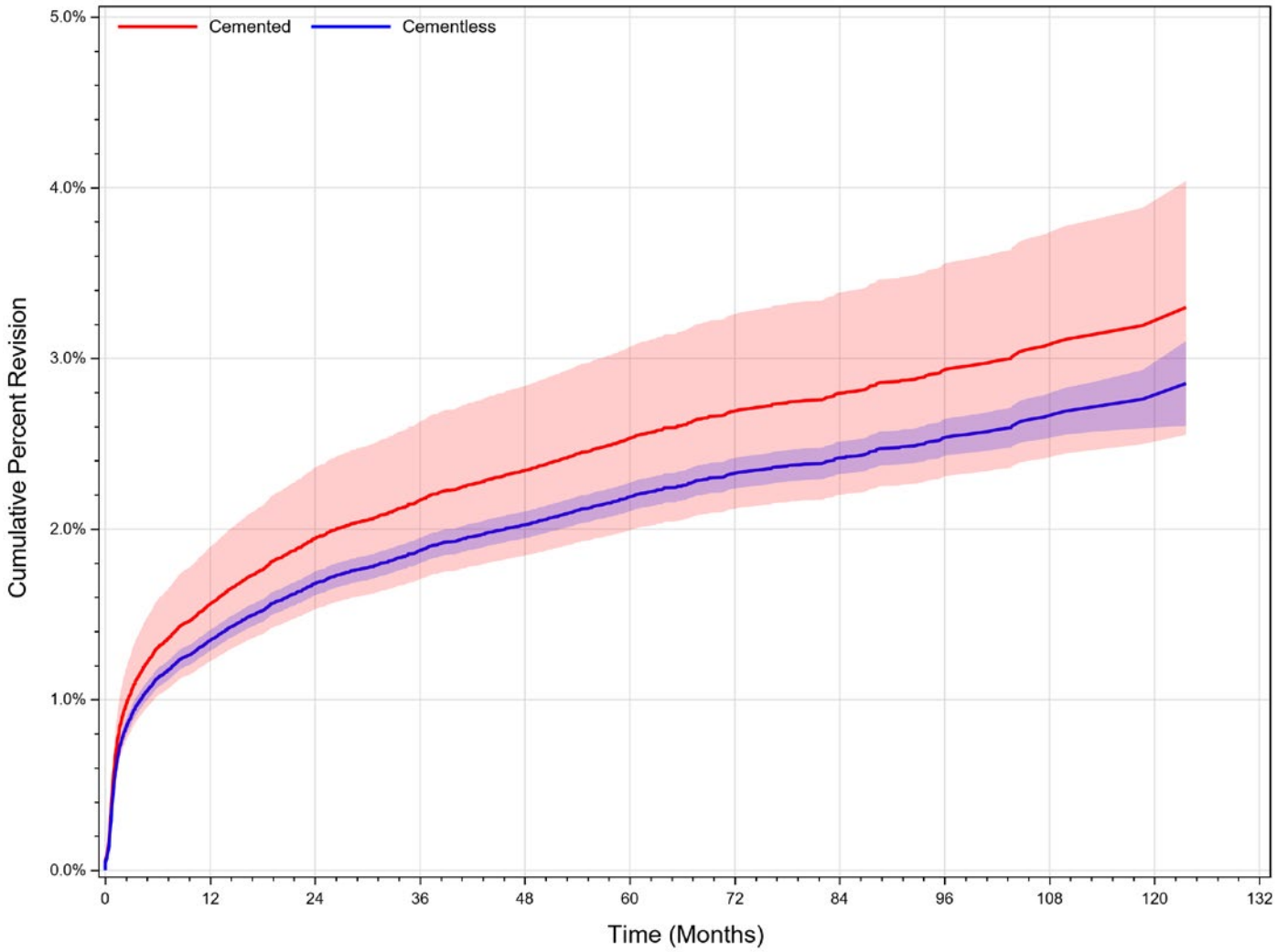
Figure 2.22 Cemented Femoral Stem Fixation in Elective Primary Total Hip Arthroplasty Procedures, 2012-2022 (N=27,469)



The use of cemented femoral component fixation in the AJRR remains lower than that seen in international registries. The 2022 Annual Report for the National Joint Registry reported much higher use of cemented femoral component fixation across all age groups (30.7%).[8] The Australian Orthopaedic Association National Joint Replacement Registry also reports a higher use of cemented fixation compared to AJRR, although the use of cementless stem fixation has been increasing from 51.3% in 2003 to 61.6% in 2021.[7] In their 2022 Annual Report, the Swedish Arthroplasty Register noted that the proportion of cemented prostheses in that year was 52%. They also commented that completely cementless fixation has been increasing from 2% in 2000 to 32% in 2021.[9]

When examining cumulative percent revision of cementless versus cemented femoral component fixation for patients ≥65 years of age as reported to either AJRR or CMS, cemented femoral components had statistically equivalent cumulative percent revision in males but significantly lower cumulative percent revision in females (Figures 2.23-2.24). It is important to note this does not account for potential confounders that were not examined.

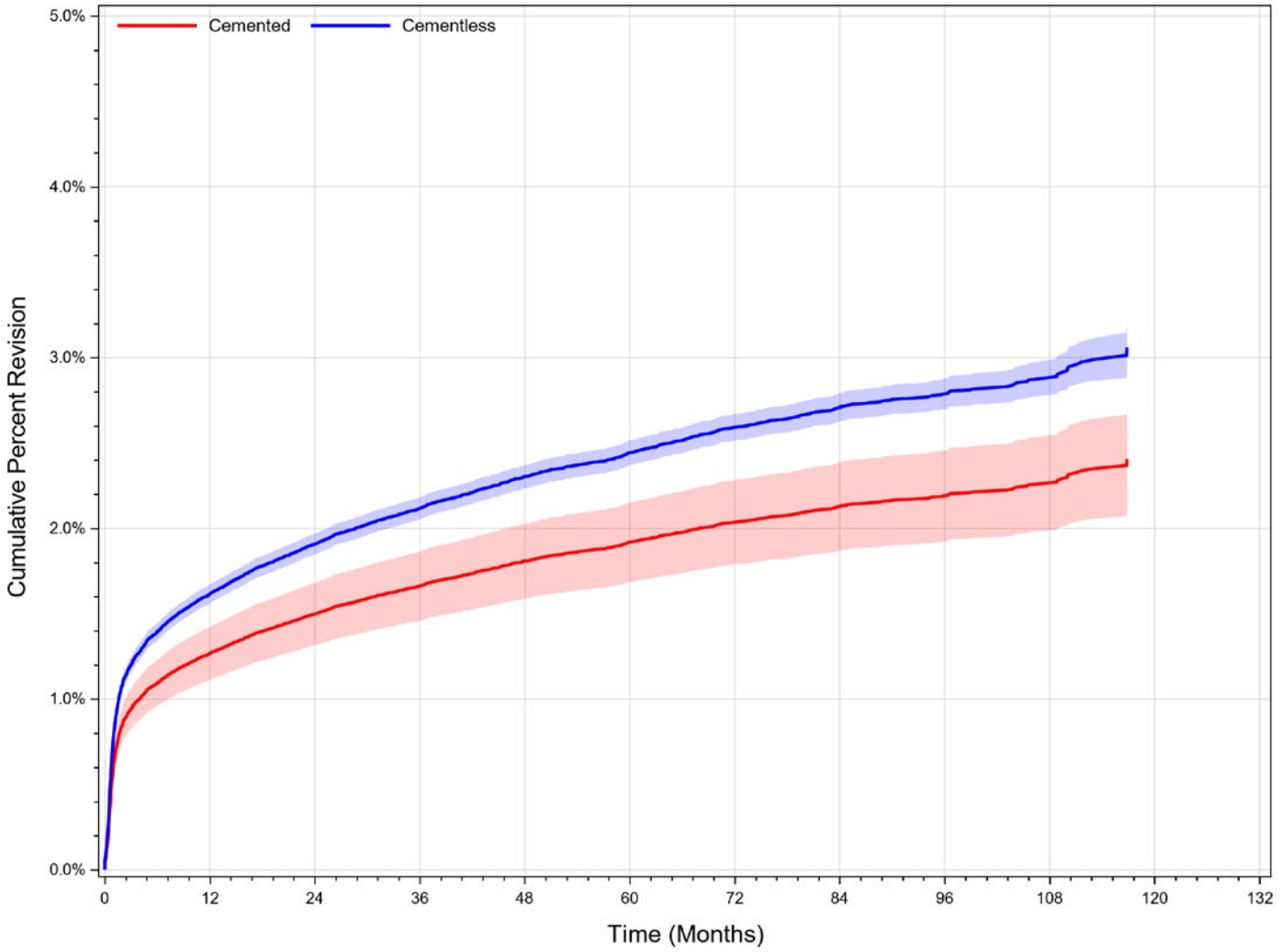
Figure 2.23 Cumulative Percent Revision for Femoral Stem Fixation Used for Elective Primary Total Hip Arthroplasty for Male Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	3,360	2,952	2,484	2,099	1,680	1,295	914	523	253	97	32	1
Cementless	137,194	123,113	108,630	94,120	76,459	58,429	39,619	24,021	13,224	5,708	1,704	3
Total	140,554	126,065	111,114	96,219	78,139	59,724	40,533	24,544	13,477	5,805	1,736	4

Age adjusted HR (95%CI), p-value
Cemented vs. Cementless: *1.159(0.925,1.453) p=0.2002*

Figure 2.24 Cumulative Percent Revision for Femoral Stem Fixation Used for Elective Primary Total Hip Arthroplasty for Female Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	14,539	12,730	10,717	9,049	7,147	5,341	3,640	2,163	1,097	429	159	1
Cementless	201,804	180,696	159,896	139,183	112,921	86,091	58,974	35,709	19,845	8,683	2,536	10
Total	216,343	193,426	170,613	148,232	120,068	91,432	62,614	37,872	20,942	9,112	2,695	11

Age adjusted HR (95%CI), p-value
Cemented vs. Cementless: *0.783(0.684,0.896) p=0.0004*

Revision for periprosthetic fracture can be analyzed based on the fixation method of the femoral component. Figure 2.25 displays the results of a cause-specific survivorship model accounting for death and revision of non-target diagnoses as competing risks. While both curves resulted in high initial survival through the first six months, cemented fixation showed a statistically significant reduction in revision due to periprosthetic fracture compared to cementless fixation in elective primary THA patients ≥65 years of age (HR=0.287, 95% CI, 0.192-0.43, p<0.0001).

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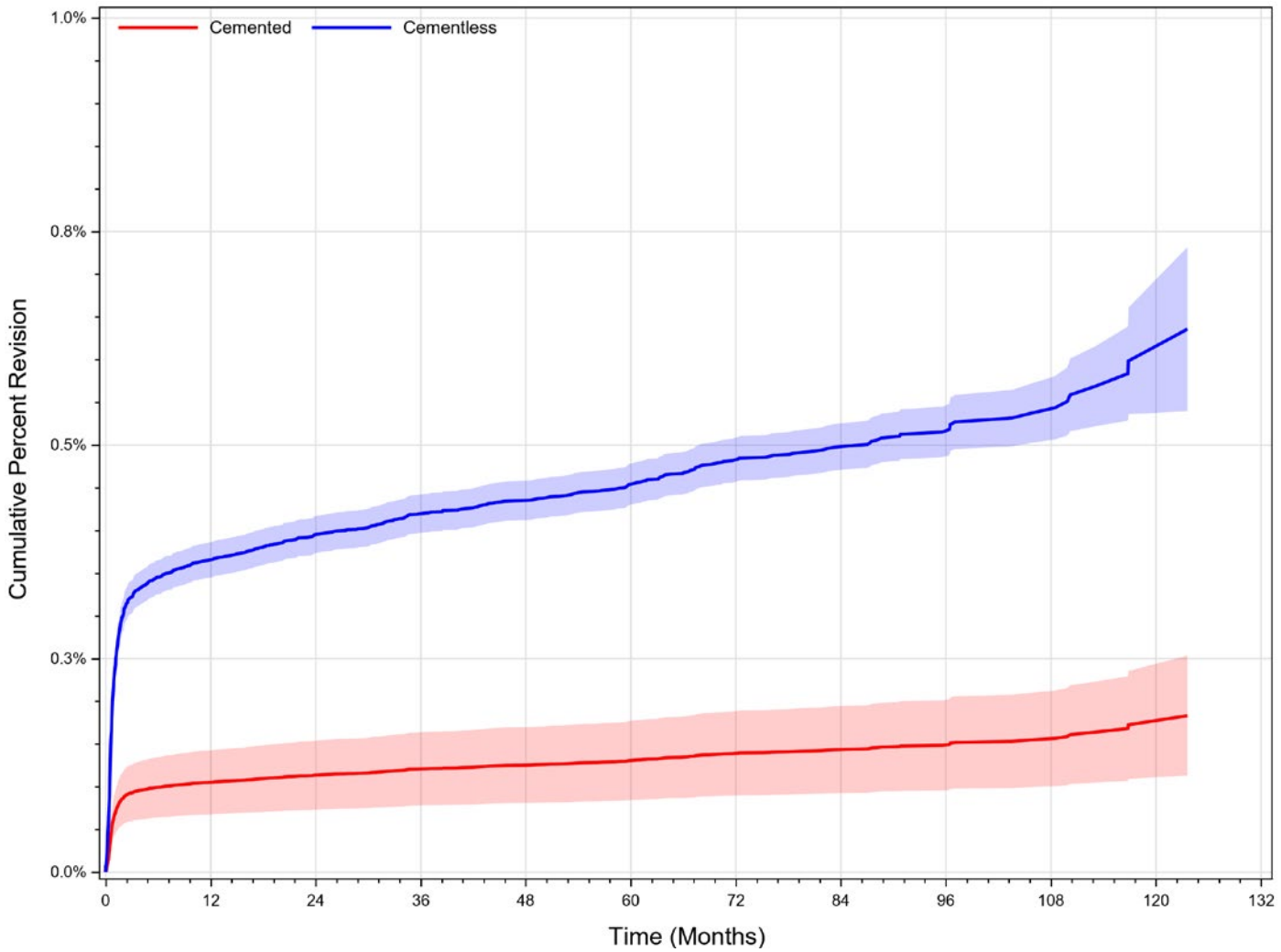
Adjusting for age, sex, and CCI, cemented fixation showed a statistically significant reduction in early revision due to periprosthetic fracture compared to cementless fixation in elective primary THA for patients ≥65 years of age.

Figure 2.25 Cumulative Percent Revision due to Periprosthetic Fracture for Elective Primary Total Hip Arthroplasty Patients 65 Years of Age and Older, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	17,899	15,682	13,201	11,142	8,824	6,633	4,553	2,686	1,349	525	189	1
Cementless	338,998	303,809	268,526	233,303	189,380	144,520	98,593	59,730	33,066	14,391	4,240	13
Total	356,897	319,491	281,727	244,445	198,204	151,153	103,146	62,416	34,415	14,916	4,429	14

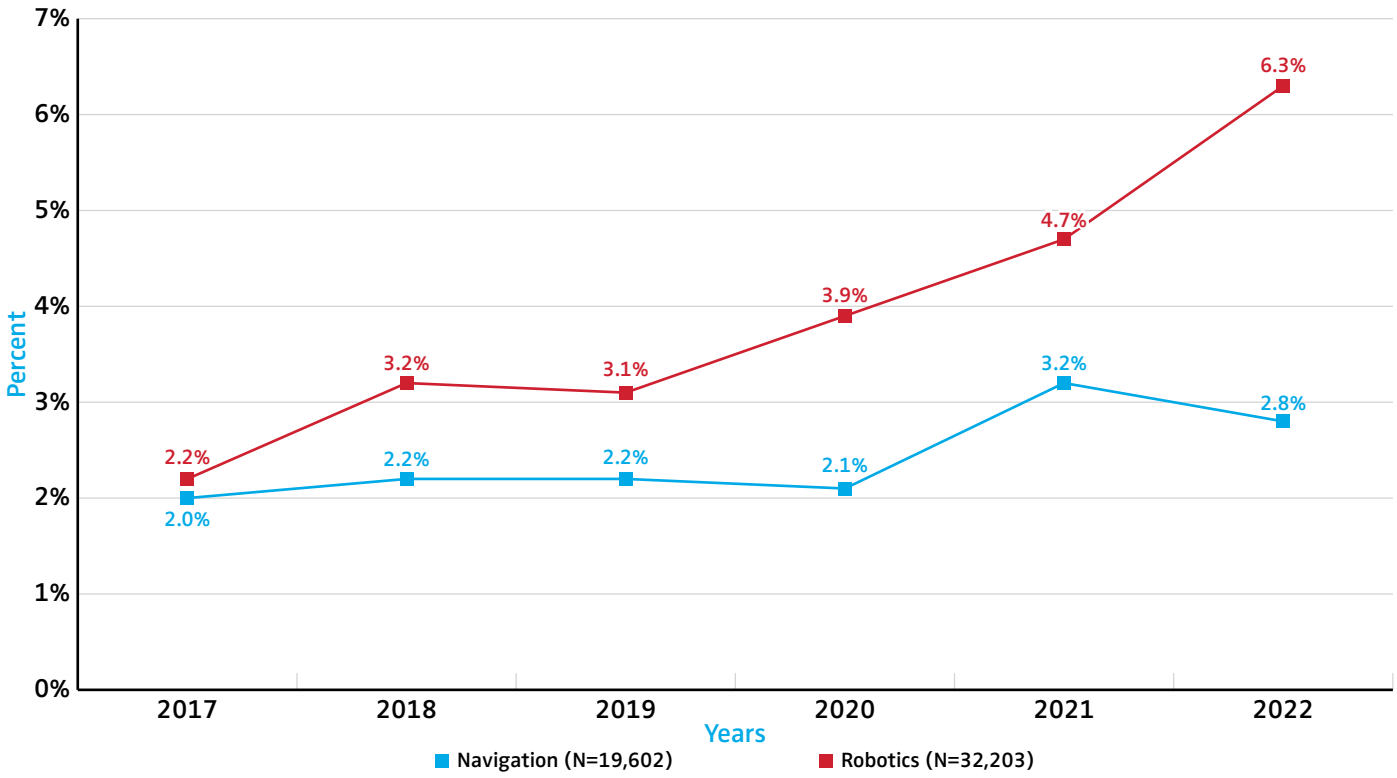
Age/Sex adjusted cause-specific HR (95%CI), p-value
Cemented vs. Cementless: 0.287(0.192,0.43), p=<0.0001

The utilization of both computer navigation and robotics has increased substantially over the past few years. The percentage of elective primary total hip arthroplasty cases utilizing robotic assistance is now over 6% (Figure 2.26).

INSIGHTS

Utilization of robotics in THA has almost tripled since 2017, and computer navigation use has increased 40% in that same time period.

Figure 2.26 Rate of Technology Use for Assistance in Elective Primary Total Hip Arthroplasty, 2017-2022

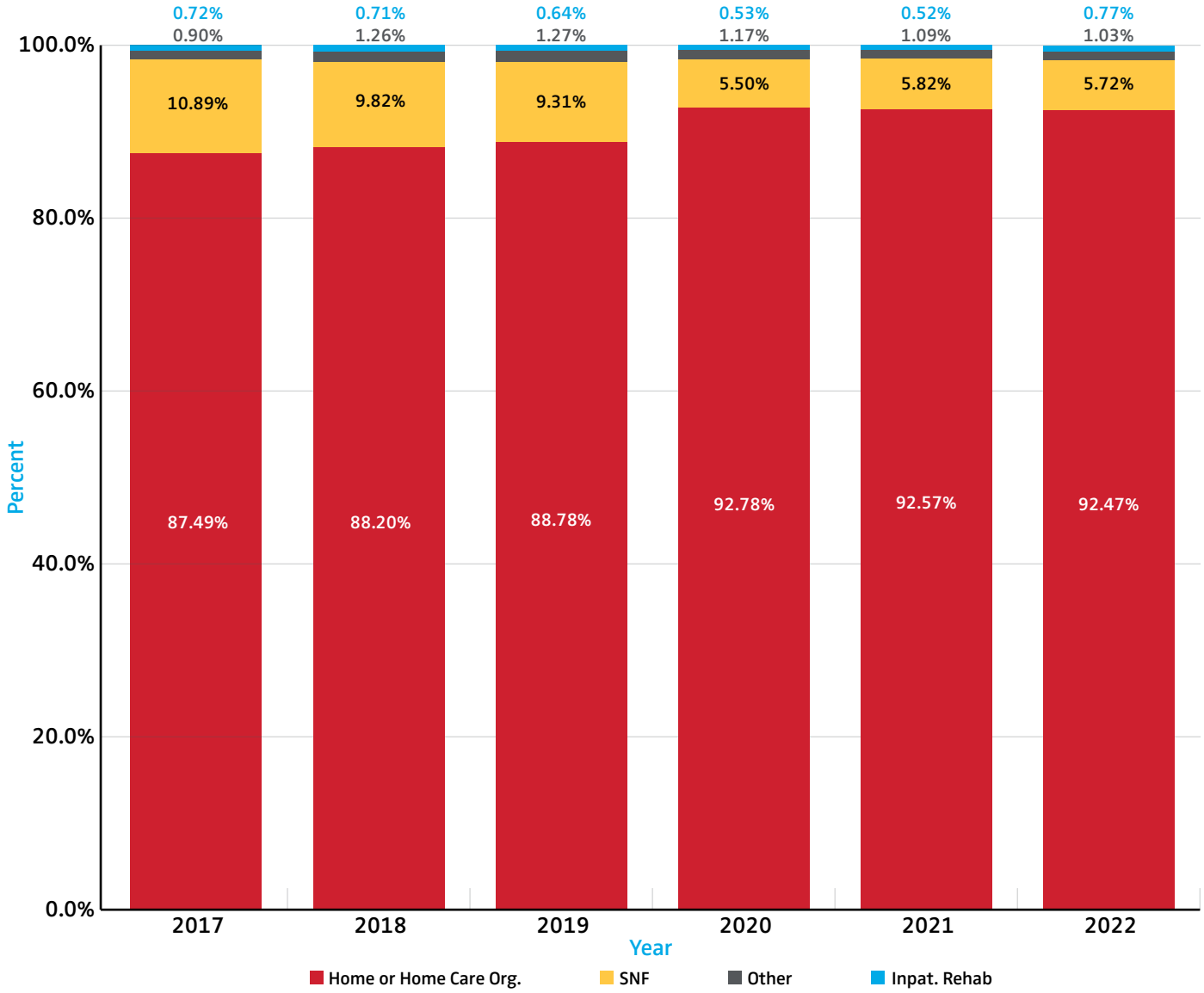


AJRR data can also be used to look at resource utilization and practice trends over time. Figure 2.27 tabulates the discharge disposition reported for elective THA cases for the years 2017 through 2022, when data collection began. AJRR collects the CMS-defined Patient Discharge Status Code values. Discharge to home, represented by discharge codes 1 and 6, are reported in over 92% of cases over the last three years. Discharge to a skilled nursing facility (SNF) is reported in approximately 8% of cases. Other discharge codes represent only a small portion of cases.

Approximately 93% of patients are now being discharged to home following elective primary total hip arthroplasty with far fewer patients being discharged to skilled nursing facilities compared to just a few years ago.

INSIGHTS

Figure 2.27 Total Hip Arthroplasty Discharge Disposition Codes by Year, 2017-2022 (N=603,314)



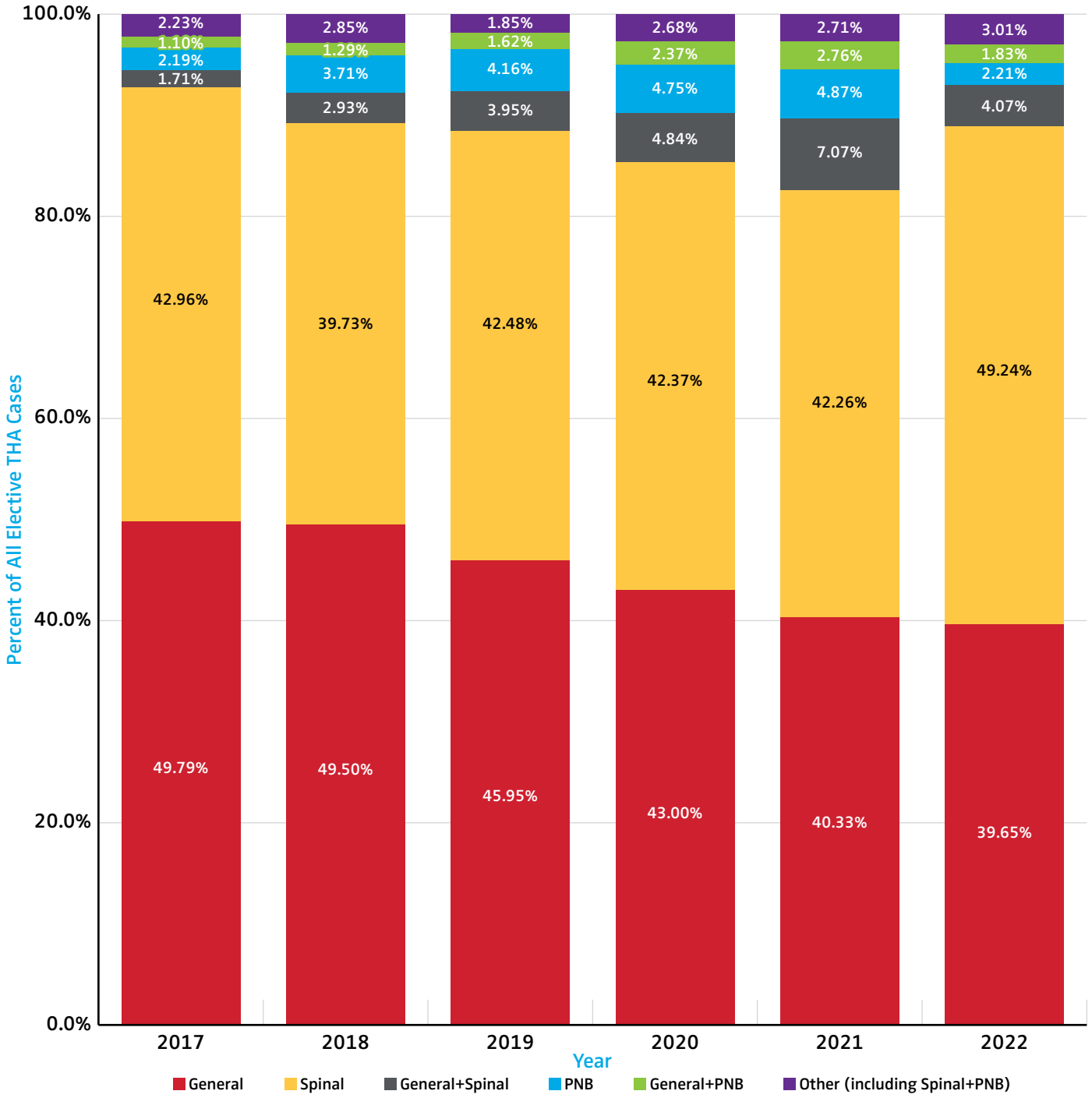
Code	Code Value
Home	Discharged to home/self-care (routine charge).
Home Care Org.	Discharged/transferred to home care of organized home health service organization.
SNF	Discharged/transferred to skilled nursing facility (SNF) with Medicare certification in anticipation of covered skilled care — (For hospitals with an approved swing bed arrangement, use Code 61 - swing bed. For reporting discharges/transfers to a non-certified SNF, the hospital must use Code 04 - ICF.)
Inpat. Rehab	Discharged/transferred to an inpatient rehabilitation facility including distinct units of a hospital (eff. 1/2002).

Figure 2.28 shows a tabulation of the two primary anesthesia techniques chosen for patients undergoing an elective primary total hip arthroplasty. Fewer patients appear to be receiving general anesthesia for primary total hip arthroplasty with increasing use of regional anesthesia over time.

INSIGHTS

Fewer patients appear to be receiving general anesthesia for primary total hip arthroplasty with increasing use of regional anesthesia over time.

Figure 2.28 Elective Primary Total Hip Arthroplasty Anesthesia Technique by Year, 2017-2022 (N=300,027)



The AJRR can also be used to follow the utilization of individual implants over time. The following figures provide utilization data of implants used in elective primary total hip arthroplasty procedures in AJRR by year for the years 2012 through 2022. Figure 2.29 tabulates the most implanted stem, cup, and bearing surface combinations for the most frequent stems by year. The Actis Duofix stem and a Pinnacle cup with a ceramic and polyethylene (CoP) bearing surface was the most frequently implanted combination by 2022 with Accolade II/Trident II CoP combination following a similar utilization trajectory over recent years as a close second. Figure 2.30 tabulates the eight most implanted stem components used in THA by year and shows that 2014-2021 the Accolade II stem has been implanted most frequently with Actis Duofix slightly surpassing that rate in 2022. Figure 2.31 tabulates the eight most implanted cup components in THA by year and shows that since 2012 the Pinnacle cup has been implanted most frequently with Trident II rising to a close second in 2022.

Figure 2.29 Elective Primary Total Hip Arthroplasty Femoral Stem/Acetabular Component Combinations by Year, 2012-2022 (N=771,240)

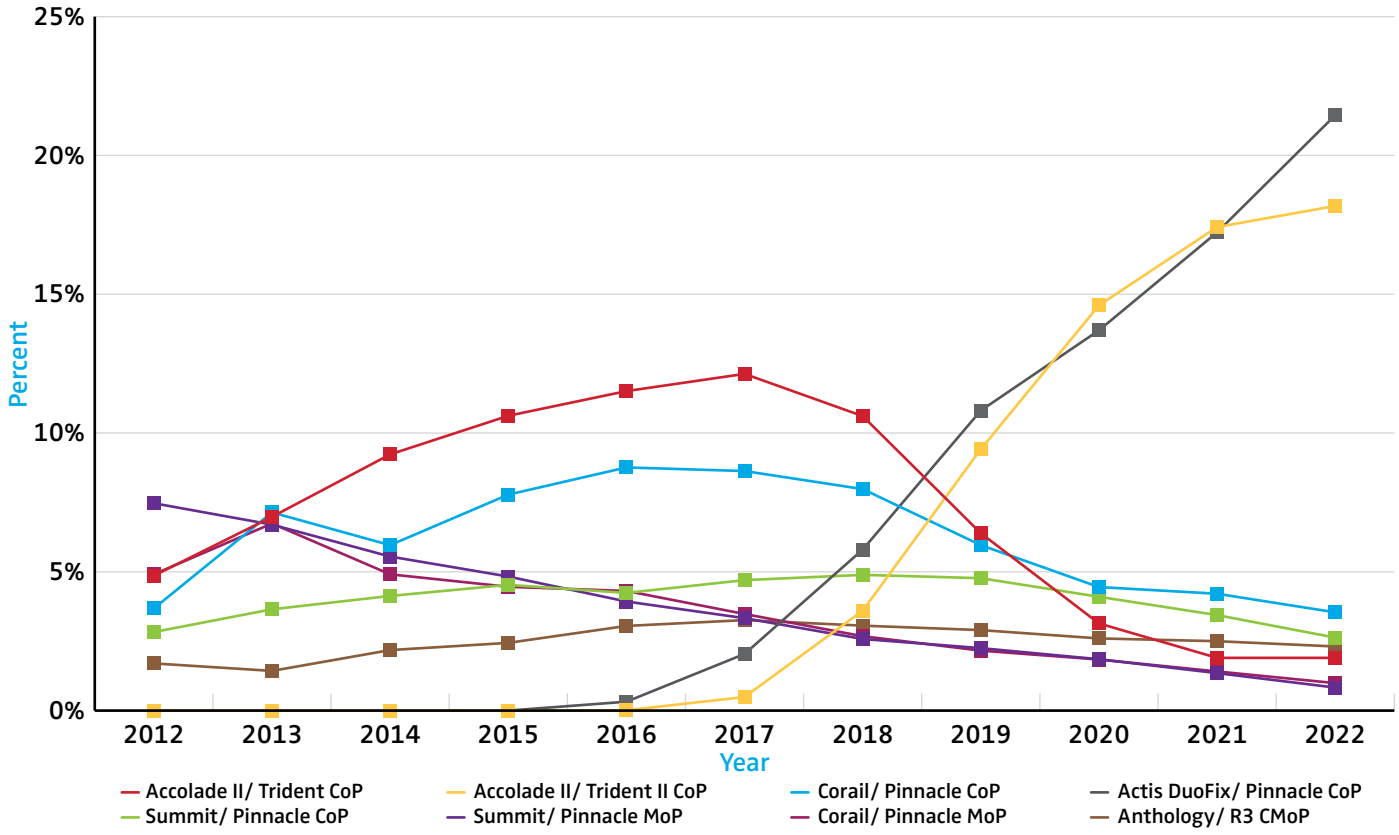


Figure 2.30 Elective Primary Total Hip Arthroplasty Femoral Stem Components by Year, 2012-2022 (N=814,102)

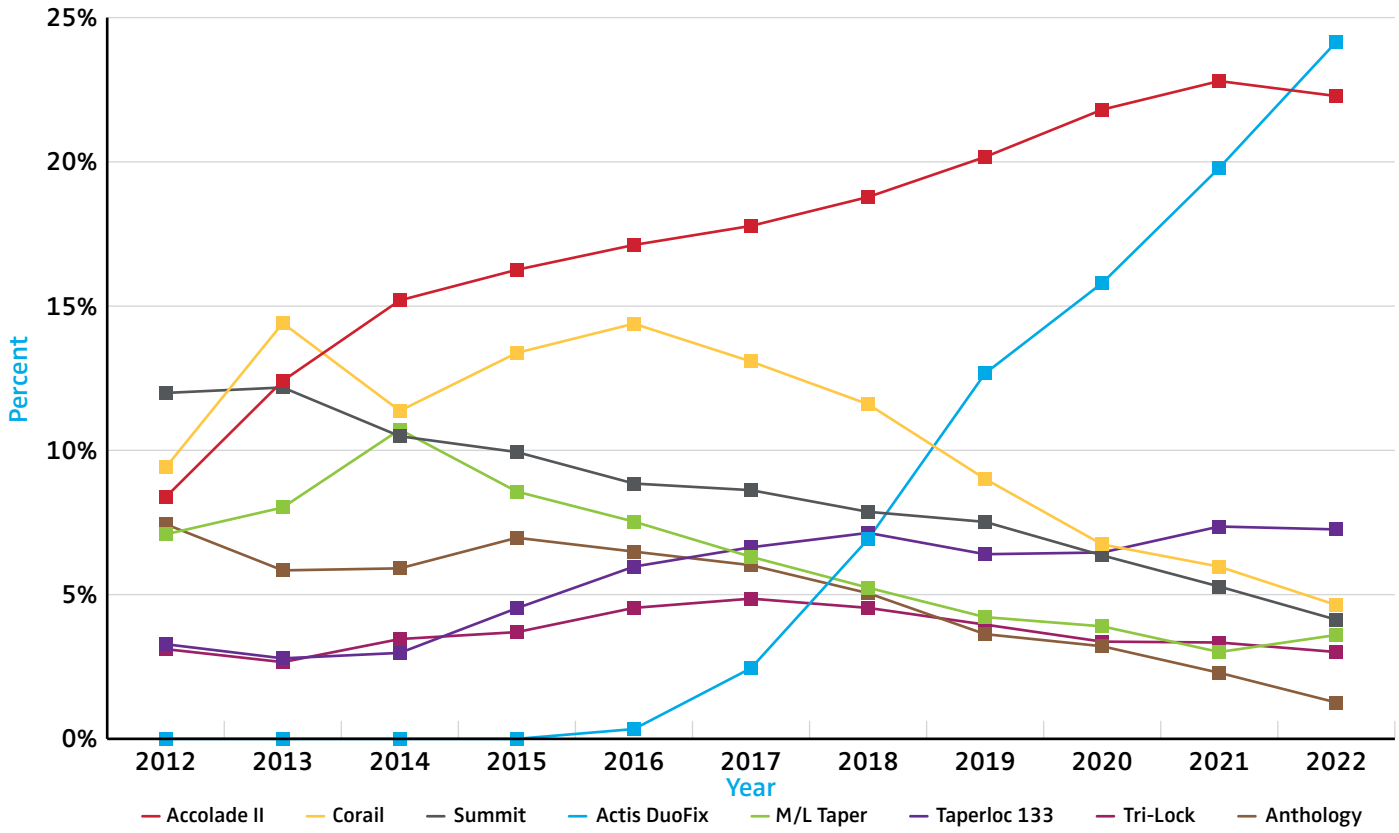
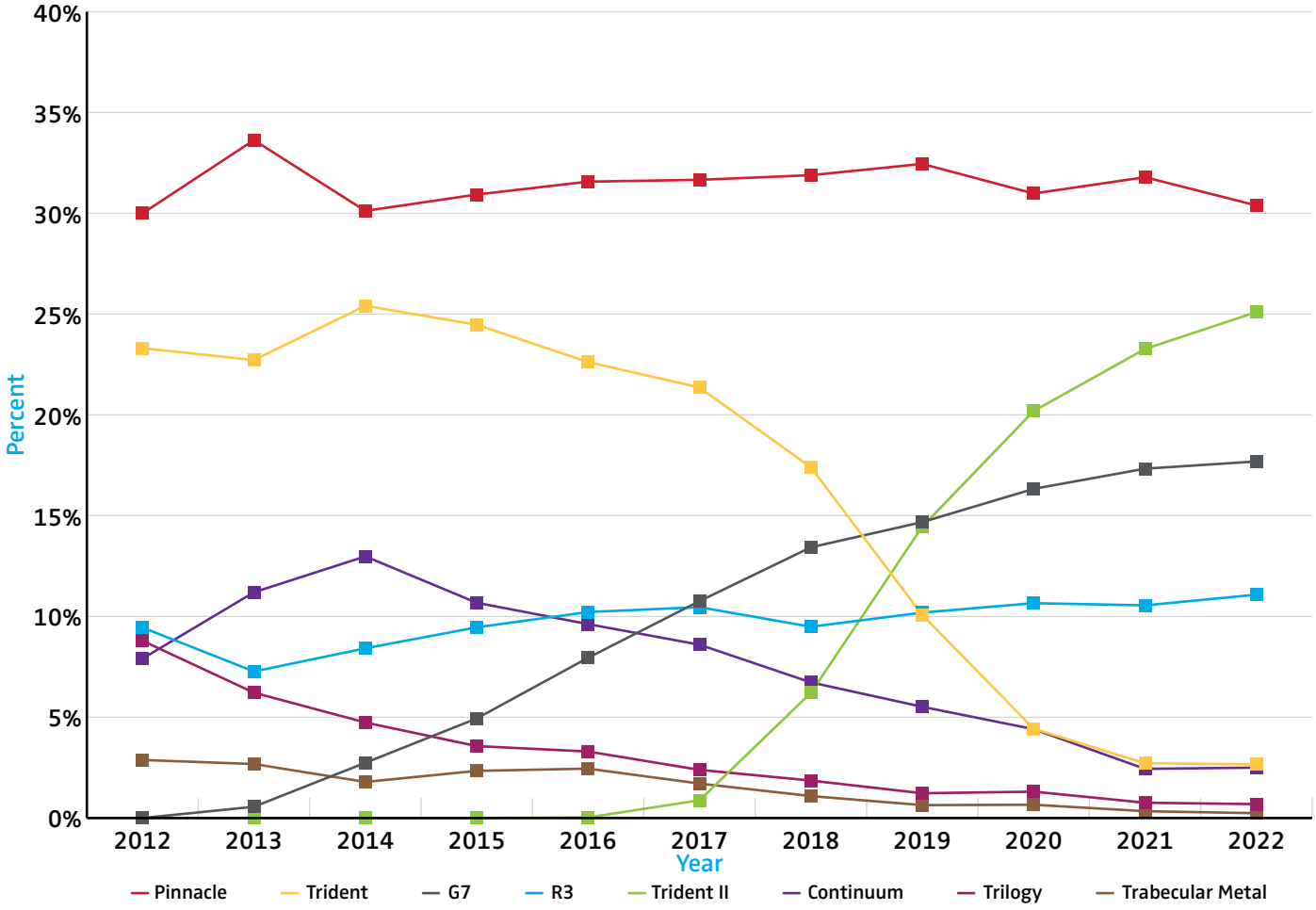


Figure 2.31 Elective Primary Total Hip Arthroplasty Acetabular Components by Year, 2012-2022 (N=840,819)



One important and powerful aspect of the AJRR is the ability to look at cumulative revision rates specific to different implants. The majority of the variation in the hip device-specific survivorship curves appear to occur within one year of the primary procedure. Early failure is typically a result of infection, dislocation, or periprosthetic fracture, which may or may not be related to the implant itself. The tables below (2.3-2.6) display cumulative percent revision stratified by hip constructs as well as bearing and fixation types with 95% confidence intervals. The aggregate cumulative percent revision of included devices was less than 1.5% at one year and less than 2.7% at ten years for both cementless and cemented devices. It is important to reiterate that this analysis does not adjust for any potential confounders of patient, procedure, or hospital characteristics. Metal-on-metal hip constructs were excluded from all analyses. Cemented acetabular components are utilized very rarely and did not have sufficient procedure volume to be included in this supplement but will be included in future publications if numbers permit.

The aggregate cumulative percent revision of included devices was less than 1.5% at one year and less than 2.7% at ten years for both cementless and cemented hip devices.

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Table 2.3 Unadjusted Cumulative Percent Revision of Cementless Hip Arthroplasty Construct Combinations for Primary Total Hip Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Acetabular Shell	Femoral Stem	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Pinnacle	Corail	39,884	566	0.90 (0.81, 1.00)	1.24 (1.13, 1.35)	1.40 (1.28, 1.52)	1.55 (1.42, 1.69)	1.69 (1.50, 1.90)
Pinnacle	Actis DuoFix	35,110	279	0.67 (0.59, 0.76)	0.86 (0.76, 0.97)	0.90 (0.80, 1.02)	0.94 (0.81, 1.08)	—
Trident II-Tritanium	Accolade II	29,211	503	1.49 (1.36, 1.64)	1.84 (1.68, 2.01)	1.88 (1.72, 2.05)	—	—
Pinnacle	Summit	27,355	592	1.55 (1.41, 1.70)	1.92 (1.76, 2.09)	2.14 (1.97, 2.32)	2.32 (2.13, 2.51)	2.49 (2.24, 2.76)
Trident	Accolade II	24,780	600	1.52 (1.37, 1.67)	2.10 (1.93, 2.29)	2.41 (2.22, 2.61)	2.59 (2.38, 2.81)	2.83 (2.56, 3.12)
Pinnacle	Tri-Lock	17,855	334	1.12 (0.97, 1.28)	1.59 (1.41, 1.78)	1.87 (1.67, 2.08)	2.02 (1.80, 2.24)	2.15 (1.90, 2.43)
G7	Taperloc 133	15,721	277	1.38 (1.20, 1.57)	1.71 (1.51, 1.93)	1.98 (1.75, 2.23)	1.98 (1.75, 2.23)	1.98 (1.75, 2.23)
R3	Anthology	15,019	331	1.56 (1.37, 1.77)	2.01 (1.80, 2.25)	2.28 (2.04, 2.55)	2.43 (2.16, 2.71)	2.63 (2.30, 2.98)
Trident-Tritanium	Accolade II	14,416	510	1.96 (1.74, 2.19)	2.83 (2.57, 3.11)	3.29 (3.01, 3.59)	3.64 (3.33, 3.97)	3.94 (3.50, 4.41)
Continuum	M/L Taper	12,172	385	2.08 (1.84, 2.35)	2.71 (2.43, 3.01)	3.16 (2.85, 3.49)	3.37 (3.04, 3.71)	3.47 (3.13, 3.85)
R3	PolarStem	9,557	141	1.19 (0.99, 1.43)	1.50 (1.26, 1.77)	1.68 (1.40, 2.01)	1.96 (1.55, 2.44)	—
G7	Taperloc 133 Microplasty	8,159	173	1.69 (1.42, 1.98)	1.99 (1.70, 2.32)	2.12 (1.82, 2.46)	2.36 (2.01, 2.75)	2.36 (2.01, 2.75)
R3	Synergy	7,333	227	2.48 (2.14, 2.85)	2.92 (2.55, 3.33)	3.07 (2.69, 3.49)	3.29 (2.87, 3.74)	3.63 (2.95, 4.42)
Trilogy	M/L Taper	4,708	164	1.94 (1.57, 2.36)	2.69 (2.25, 3.18)	3.20 (2.71, 3.75)	3.62 (3.08, 4.23)	4.63 (3.82, 5.54)
Trident II	Accolade II	4,505	64	1.28 (0.98, 1.64)	1.48 (1.14, 1.88)	—	—	—
Pinnacle	S-ROM	4,124	112	1.27 (0.96, 1.64)	2.17 (1.75, 2.66)	2.65 (2.17, 3.20)	3.15 (2.58, 3.81)	3.65 (2.78, 4.70)
G7	Echo Bi-Metric	3,402	63	1.32 (0.98, 1.75)	1.69 (1.29, 2.18)	1.99 (1.53, 2.54)	2.11 (1.61, 2.73)	—
G7	M/L Taper	3,115	59	1.58 (1.19, 2.07)	2.04 (1.56, 2.63)	2.12 (1.62, 2.72)	2.12 (1.62, 2.72)	—
Continuum	Trabecular Metal	2,886	83	2.11 (1.64, 2.69)	2.59 (2.05, 3.22)	2.89 (2.31, 3.56)	3.03 (2.43, 3.74)	3.03 (2.43, 3.74)
FMP	Linear	2,443	36	1.06 (0.71, 1.54)	1.36 (0.95, 1.88)	1.41 (1.00, 1.95)	1.63 (1.14, 2.26)	1.63 (1.14, 2.26)
Trident	Secur-Fit Max	2,381	65	1.68 (1.22, 2.26)	2.42 (1.86, 3.10)	2.66 (2.07, 3.38)	2.82 (2.19, 3.56)	2.94 (2.28, 3.74)
R3	Synergy HA	2,375	71	1.69 (1.23, 2.27)	2.31 (1.76, 2.99)	2.84 (2.21, 3.59)	3.06 (2.39, 3.85)	3.71 (2.82, 4.79)
Trident	Accolade TMZF	2,119	64	1.18 (0.79, 1.71)	1.42 (0.98, 1.99)	1.99 (1.46, 2.66)	2.58 (1.96, 3.34)	3.52 (2.68, 4.52)
Trident II-Tritanium	Insignia	1,936	8	0.41 (0.20, 0.79)	—	—	—	—
Trident	Secur-Fit	1,644	54	1.89 (1.31, 2.64)	2.60 (1.91, 3.47)	3.29 (2.48, 4.27)	3.61 (2.74, 4.66)	3.61 (2.74, 4.66)
Trabecular Metal	M/L Taper	1,616	52	2.23 (1.59, 3.04)	2.79 (2.07, 3.68)	2.87 (2.13, 3.77)	3.32 (2.50, 4.32)	3.47 (2.61, 4.52)
G7	Avenir-Muller	1,581	21	1.01 (0.61, 1.61)	1.29 (0.81, 1.95)	1.37 (0.87, 2.05)	1.37 (0.87, 2.05)	—
Trident	Secur-Fit Plus Max	1,572	26	0.95 (0.56, 1.54)	1.41 (0.91, 2.10)	1.41 (0.91, 2.10)	1.66 (1.10, 2.41)	1.79 (1.19, 2.59)
Mallory Head	Taperloc 133	1,507	23	0.93 (0.54, 1.52)	1.26 (0.79, 1.93)	1.41 (0.90, 2.12)	1.52 (0.98, 2.27)	1.73 (1.09, 2.61)
Continuum	VerSys	1,378	36	1.38 (0.86, 2.11)	2.54 (1.80, 3.50)	2.64 (1.87, 3.61)	2.75 (1.96, 3.75)	2.75 (1.96, 3.75)
Continuum	Avenir-Muller	1,374	35	1.97 (1.33, 2.81)	2.48 (1.76, 3.41)	2.56 (1.82, 3.51)	2.56 (1.82, 3.51)	2.56 (1.82, 3.51)
FMP	TaperFill	1,374	29	1.53 (0.98, 2.29)	2.05 (1.39, 2.90)	2.14 (1.47, 3.02)	2.14 (1.47, 3.02)	—
Trilogy	VerSys	1,348	42	1.86 (1.23, 2.69)	2.17 (1.49, 3.07)	2.99 (2.15, 4.05)	3.21 (2.33, 4.31)	3.64 (2.61, 4.92)
Continuum	Fitmore	1,285	47	2.57 (1.81, 3.55)	3.21 (2.34, 4.28)	3.55 (2.63, 4.68)	3.76 (2.80, 4.93)	3.76 (2.80, 4.93)
Trident II-Tritanium	Corail	1,185	10	0.68 (0.32, 1.29)	0.87 (0.45, 1.55)	0.87 (0.45, 1.55)	—	—
Continuum	Taperloc 133	1,165	23	1.38 (0.82, 2.18)	1.65 (1.03, 2.52)	2.10 (1.37, 3.10)	2.10 (1.37, 3.10)	—
Trident II-Tritanium	Actis DuoFix	1,129	15	0.98 (0.52, 1.70)	1.74 (0.97, 2.90)	1.74 (0.97, 2.90)	—	—
Trinity	TriFit TS	1,122	26	1.97 (1.27, 2.91)	2.38 (1.59, 3.42)	2.38 (1.59, 3.42)	2.38 (1.59, 3.42)	2.38 (1.59, 3.42)
Continuum	Accolade II	1,113	22	1.80 (1.14, 2.71)	1.98 (1.28, 2.93)	1.98 (1.28, 2.93)	1.98 (1.28, 2.93)	—
EMPOWR	Linear	1,092	17	1.03 (0.55, 1.79)	2.19 (1.24, 3.59)	—	—	—
Trident II-Tritanium	Secur-Fit	1043	27	2.11 (1.36, 3.12)	2.60 (1.74, 3.74)	2.89 (1.90, 4.19)	—	—
Restoration ADM	Accolade II	979	14	1.12 (0.60, 1.95)	1.46 (0.84, 2.38)	1.46 (0.84, 2.38)	1.46 (0.84, 2.38)	1.46 (0.84, 2.38)

Table 2.3 Continued on the next page

Table 2.3 Unadjusted Cumulative Percent Revision of Cementless Hip Arthroplasty Construct Combinations for Primary Total Hip Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022 *(Continued)*

Acetabular Shell	Femoral Stem	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Escalade Acetabular System	Ovation Hip Stem	930	15	1.30 (0.71, 2.20)	1.57 (0.90, 2.57)	1.74 (1.01, 2.80)	1.74 (1.01, 2.80)	—
Trident	Citation	911	26	1.54 (0.88, 2.51)	2.12 (1.32, 3.22)	2.36 (1.51, 3.52)	2.63 (1.71, 3.85)	3.80 (2.32, 5.84)
Novation	Alteon	904	36	1.99 (1.23, 3.07)	2.43 (1.57, 3.60)	3.12 (2.10, 4.46)	6.50 (3.87, 10.06)	—
G7	Corail	895	15	1.23 (0.66, 2.13)	1.58 (0.91, 2.58)	1.75 (1.02, 2.82)	1.75 (1.02, 2.82)	—
Trident-Tritanium	Secur-Fit Max	839	25	1.43 (0.78, 2.42)	2.26 (1.41, 3.45)	2.51 (1.61, 3.75)	2.87 (1.86, 4.21)	3.43 (2.22, 5.03)
Trident-Tritanium	Secur-Fit	839	41	2.03 (1.23, 3.16)	3.69 (2.57, 5.13)	4.42 (3.17, 5.97)	4.84 (3.52, 6.45)	5.39 (3.77, 7.40)
Trident II-Tritanium	Secur-Fit Max	825	21	2.06 (1.25, 3.21)	2.77 (1.76, 4.15)	2.77 (1.76, 4.15)	—	—
Pinnacle	AML	800	21	1.25 (0.65, 2.22)	2.18 (1.32, 3.39)	2.48 (1.54, 3.77)	2.65 (1.67, 3.99)	2.91 (1.84, 4.36)
R3	Echelon	786	23	1.27 (0.66, 2.26)	2.52 (1.57, 3.84)	3.25 (2.11, 4.78)	3.25 (2.11, 4.78)	3.25 (2.11, 4.78)
Mpact	MasterLoc	775	20	2.20 (1.33, 3.42)	2.55 (1.59, 3.89)	2.76 (1.73, 4.16)	—	—
Trident-Tritanium	Accolade TMZF	738	29	1.63 (0.89, 2.75)	2.44 (1.50, 3.75)	3.26 (2.15, 4.73)	3.76 (2.54, 5.35)	4.43 (2.96, 6.34)
RingLoc+	Taperloc 133	725	26	2.21 (1.32, 3.48)	3.04 (1.96, 4.48)	3.49 (2.32, 5.02)	3.65 (2.45, 5.22)	3.65 (2.45, 5.22)
Continuum	M/L Taper Kinectiv	716	25	2.10 (1.23, 3.36)	2.84 (1.80, 4.27)	3.16 (2.04, 4.66)	3.56 (2.34, 5.17)	3.85 (2.53, 5.58)
R3	Corail	709	6	0.28 (0.06, 0.97)	0.42 (0.12, 1.18)	0.71 (0.27, 1.59)	0.89 (0.37, 1.87)	—
G7	Actis DuoFix	687	8	1.28 (0.60, 2.43)	1.28 (0.60, 2.43)	1.28 (0.60, 2.43)	—	—
G7	Trabecular Metal	686	16	1.60 (0.85, 2.77)	2.47 (1.41, 4.01)	2.84 (1.62, 4.60)	2.84 (1.62, 4.60)	—
EMPOWR	TaperFill	675	6	0.89 (0.37, 1.85)	0.89 (0.37, 1.85)	—	—	—
R3	Anthology AFIT	655	6	0.92 (0.39, 1.91)	0.92 (0.39, 1.91)	0.92 (0.39, 1.91)	—	—
Versafitcup DM	AMIStem-H	641	16	2.18 (1.25, 3.55)	2.50 (1.49, 3.93)	2.50 (1.49, 3.93)	2.50 (1.49, 3.93)	2.50 (1.49, 3.93)
Trabecular Metal	Trabecular Metal	630	17	1.91 (1.04, 3.22)	2.25 (1.29, 3.66)	2.66 (1.58, 4.18)	2.93 (1.76, 4.57)	2.93 (1.76, 4.57)
G7	Fitmore	610	13	1.67 (0.86, 2.96)	2.06 (1.13, 3.47)	2.35 (1.30, 3.92)	2.35 (1.30, 3.92)	—
Trabecular Metal	VerSys	590	21	2.20 (1.24, 3.64)	2.72 (1.62, 4.27)	2.89 (1.75, 4.49)	3.55 (2.23, 5.33)	4.06 (2.50, 6.17)
Restoration ADM	Novation	588	7	0.68 (0.23, 1.65)	0.68 (0.23, 1.65)	0.85 (0.33, 1.89)	1.03 (0.43, 2.13)	1.52 (0.61, 3.23)
Consensus	TaperSet	561	19	1.96 (1.04, 3.38)	3.10 (1.88, 4.81)	3.10 (1.88, 4.81)	3.65 (2.26, 5.55)	—
Trident	ABG II	553	17	2.35 (1.32, 3.88)	2.53 (1.45, 4.10)	3.09 (1.87, 4.79)	3.09 (1.87, 4.79)	3.09 (1.87, 4.79)
Dynasty BioFoam	ProFemur Gladiator	541	12	1.66 (0.82, 3.03)	1.86 (0.96, 3.29)	2.32 (1.27, 3.92)	2.32 (1.27, 3.92)	2.32 (1.27, 3.92)
Regenerex RingLoc+	Taperloc 133	532	16	2.26 (1.23, 3.80)	2.63 (1.51, 4.26)	2.87 (1.67, 4.57)	3.27 (1.91, 5.19)	3.27 (1.91, 5.19)
Provident	Provident	529	13	1.70 (0.84, 3.10)	2.10 (1.11, 3.61)	2.31 (1.26, 3.89)	2.73 (1.49, 4.58)	2.73 (1.49, 4.58)
Trident II-Tritanium	Secur-Fit Plus Max	515	5	0.97 (0.37, 2.15)	0.97 (0.37, 2.15)	0.97 (0.37, 2.15)	—	—
Restoration ADM	Secur-Fit Plus Max	495	27	3.64 (2.24, 5.56)	5.05 (3.36, 7.23)	5.48 (3.71, 7.74)	5.48 (3.71, 7.74)	—
G7	Summit	484	5	0.83 (0.28, 2.00)	1.09 (0.41, 2.43)	1.09 (0.41, 2.43)	1.09 (0.41, 2.43)	—
Ranawat-Burstein	Taperloc 133	453	10	1.32 (0.55, 2.74)	2.00 (0.99, 3.64)	2.00 (0.99, 3.64)	2.51 (1.23, 4.55)	2.51 (1.23, 4.55)
Dynasty BioFoam	ProFemur Z	422	32	4.74 (2.99, 7.07)	6.40 (4.33, 9.01)	7.36 (5.12, 10.11)	7.63 (5.34, 10.43)	7.63 (5.34, 10.43)
G7	Taperloc Complete XR	413	7	1.21 (0.46, 2.67)	1.93 (0.85, 3.82)	1.93 (0.85, 3.82)	1.93 (0.85, 3.82)	—
Continuum	Taperloc 133 Microplasty	404	6	1.26 (0.48, 2.78)	1.53 (0.64, 3.16)	1.53 (0.64, 3.16)	1.53 (0.64, 3.16)	—
Overall	—	337,129	6,834	1.39 (1.35, 1.43)	1.85 (1.80, 1.89)	2.11 (2.06, 2.16)	2.32 (2.27, 2.38)	2.58 (2.49, 2.67)

Table 2.4 Unadjusted Cumulative Percent Revision of Cementless Stems in Hip Arthroplasty Constructs for Primary Total Hip Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Femoral Stem	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Accolade II	75,489	1,748	1.61 (1.52, 1.70)	2.17 (2.06, 2.27)	2.48 (2.36, 2.6)	2.73 (2.60, 2.88)	2.98 (2.78, 3.20)
Corail	43,364	602	0.88 (0.80, 0.98)	1.21 (1.11, 1.32)	1.37 (1.26, 1.49)	1.52 (1.40, 1.65)	1.66 (1.47, 1.86)
Actis DuoFix	37,496	311	0.70 (0.62, 0.79)	0.91 (0.81, 1.01)	0.95 (0.84, 1.06)	0.98 (0.86, 1.12)	—
Summit	28,389	608	1.53 (1.39, 1.67)	1.90 (1.75, 2.07)	2.12 (1.95, 2.30)	2.30 (2.12, 2.49)	2.47 (2.23, 2.73)
M/L Taper	22,245	684	1.98 (1.80, 2.17)	2.63 (2.43, 2.85)	3.04 (2.81, 3.28)	3.32 (3.08, 3.58)	3.68 (3.37, 4.00)
Taperloc 133	22,243	415	1.39 (1.24, 1.55)	1.75 (1.58, 1.94)	2.02 (1.83, 2.22)	2.10 (1.89, 2.31)	2.14 (1.92, 2.37)
Tri-Lock	18,301	343	1.12 (0.98, 1.28)	1.58 (1.41, 1.77)	1.86 (1.67, 2.07)	2.03 (1.82, 2.26)	2.16 (1.92, 2.43)
Anthology	15,628	342	1.55 (1.37, 1.76)	1.99 (1.78, 2.23)	2.26 (2.03, 2.52)	2.42 (2.16, 2.70)	2.61 (2.30, 2.96)
PolarStem	10,170	153	1.23 (1.03, 1.46)	1.52 (1.29, 1.79)	1.69 (1.42, 2.00)	1.95 (1.56, 2.40)	—
Taperloc 133 Microplasty	9,937	204	1.60 (1.36, 1.86)	1.91 (1.65, 2.20)	2.06 (1.78, 2.36)	2.22 (1.93, 2.55)	2.36 (1.97, 2.81)
Synergy	7,817	251	2.51 (2.18, 2.88)	3.00 (2.63, 3.40)	3.20 (2.81, 3.61)	3.43 (3.01, 3.87)	3.74 (3.10, 4.48)
Echo Bi-Metric	4,898	128	1.78 (1.44, 2.18)	2.31 (1.91, 2.76)	2.77 (2.31, 3.28)	2.92 (2.44, 3.47)	2.92 (2.44, 3.47)
Trabecular Metal	4,699	133	2.09 (1.71, 2.53)	2.59 (2.16, 3.08)	2.88 (2.42, 3.40)	3.01 (2.53, 3.55)	3.01 (2.53, 3.55)
Secur-Fit Max	4,509	127	1.80 (1.44, 2.22)	2.55 (2.12, 3.05)	2.80 (2.34, 3.33)	3.00 (2.50, 3.56)	3.22 (2.67, 3.84)
S-ROM	4,501	121	1.32 (1.01, 1.68)	2.19 (1.79, 2.66)	2.64 (2.18, 3.16)	3.10 (2.56, 3.72)	3.58 (2.74, 4.57)
Linear	3,911	62	1.03 (0.75, 1.38)	1.58 (1.21, 2.02)	1.63 (1.25, 2.08)	1.94 (1.45, 2.56)	1.94 (1.45, 2.56)
VerSys	3,830	113	1.75 (1.37, 2.21)	2.42 (1.96, 2.95)	2.78 (2.28, 3.35)	3.13 (2.58, 3.76)	3.45 (2.81, 4.20)
Secur-Fit	3,777	129	1.99 (1.58, 2.47)	2.84 (2.34, 3.42)	3.52 (2.94, 4.18)	3.84 (3.21, 4.55)	4.06 (3.32, 4.90)
Avenir-Muller	3,433	66	1.43 (1.07, 1.87)	1.79 (1.39, 2.28)	1.94 (1.52, 2.46)	2.00 (1.56, 2.53)	2.00 (1.56, 2.53)
Secur-Fit Plus Max	3,018	77	1.66 (1.25, 2.16)	2.30 (1.81, 2.89)	2.47 (1.95, 3.09)	2.63 (2.09, 3.28)	3.29 (2.19, 4.74)
Accolade TMZF	3,015	96	1.29 (0.94, 1.75)	1.66 (1.25, 2.16)	2.26 (1.78, 2.84)	2.80 (2.25, 3.45)	3.73 (2.99, 4.60)
Synergy HA	2,610	76	1.61 (1.18, 2.15)	2.18 (1.67, 2.80)	2.75 (2.15, 3.45)	3.00 (2.36, 3.75)	3.63 (2.77, 4.66)
TaperFill	2,242	37	1.25 (0.85, 1.78)	1.68 (1.20, 2.29)	1.76 (1.26, 2.40)	1.76 (1.26, 2.40)	—
Insignia	2,235	9	0.40 (0.20, 0.74)	—	—	—	—
Fitmore	2,205	70	2.23 (1.67, 2.91)	2.80 (2.17, 3.56)	3.09 (2.41, 3.89)	3.41 (2.67, 4.27)	3.41 (2.67, 4.27)
Ovation Hip Stem	1,648	28	1.53 (1.02, 2.22)	1.70 (1.15, 2.44)	1.84 (1.24, 2.63)	1.84 (1.24, 2.63)	—
ABG II	1,488	44	2.22 (1.56, 3.06)	2.50 (1.79, 3.40)	3.13 (2.30, 4.15)	3.13 (2.30, 4.15)	3.13 (2.30, 4.15)
Citation	1,439	55	2.29 (1.61, 3.17)	3.04 (2.24, 4.04)	3.41 (2.54, 4.47)	3.83 (2.88, 4.98)	4.63 (3.44, 6.08)
Novation	1,267	31	0.79 (0.41, 1.41)	0.95 (0.52, 1.61)	1.68 (1.08, 2.52)	2.06 (1.37, 2.99)	3.36 (2.21, 4.89)
TriFit TS	1,206	26	1.83 (1.18, 2.71)	2.21 (1.48, 3.18)	2.21 (1.48, 3.18)	2.21 (1.48, 3.18)	2.21 (1.48, 3.18)
M/L Taper Kinectiv	1,199	44	2.09 (1.39, 3.02)	3.01 (2.14, 4.12)	3.54 (2.57, 4.75)	4.00 (2.92, 5.32)	4.21 (3.07, 5.61)
AMIStem-H	1,198	27	1.59 (0.99, 2.42)	2.00 (1.32, 2.92)	2.17 (1.45, 3.12)	2.17 (1.45, 3.12)	2.42 (1.59, 3.53)
ProFemur Gladiator	1,166	22	1.46 (0.89, 2.28)	1.68 (1.05, 2.57)	1.97 (1.25, 2.96)	1.97 (1.25, 2.96)	2.51 (1.40, 4.14)
Alteon	1,017	37	1.87 (1.17, 2.85)	2.28 (1.49, 3.35)	2.96 (2.00, 4.21)	6.34 (3.74, 9.89)	—
AML	863	23	1.28 (0.68, 2.21)	2.13 (1.31, 3.28)	2.54 (1.62, 3.78)	2.69 (1.73, 3.98)	2.94 (1.90, 4.35)
Echelon	821	25	1.46 (0.80, 2.48)	2.66 (1.70, 3.96)	3.34 (2.21, 4.84)	3.34 (2.21, 4.84)	3.34 (2.21, 4.84)
MasterLoc	817	20	2.09 (1.26, 3.25)	2.42 (1.51, 3.69)	2.62 (1.65, 3.97)	—	—
Taperloc	806	32	3.35 (2.27, 4.77)	3.68 (2.52, 5.18)	3.86 (2.66, 5.39)	4.26 (2.96, 5.91)	4.26 (2.96, 5.91)
Alpine	709	11	0.56 (0.19, 1.38)	1.13 (0.54, 2.14)	1.44 (0.74, 2.55)	1.78 (0.91, 3.16)	—
Anthology AFIT	660	6	0.91 (0.38, 1.90)	0.91 (0.38, 1.90)	0.91 (0.38, 1.90)	—	—
Taperloc Complete XR	628	10	1.27 (0.60, 2.41)	1.73 (0.88, 3.07)	1.73 (0.88, 3.07)	1.73 (0.88, 3.07)	1.73 (0.88, 3.07)
Provident	579	17	1.73 (0.89, 3.06)	2.27 (1.27, 3.75)	2.91 (1.73, 4.59)	3.31 (1.96, 5.20)	3.31 (1.96, 5.20)
TaperSet	570	20	2.11 (1.15, 3.55)	3.23 (1.98, 4.95)	3.23 (1.98, 4.95)	3.77 (2.36, 5.66)	—
Mallory-Head	560	16	1.61 (0.80, 2.93)	2.37 (1.33, 3.91)	3.04 (1.81, 4.79)	3.04 (1.81, 4.79)	3.04 (1.81, 4.79)
ProFemur Z	521	34	3.84 (2.42, 5.74)	5.18 (3.50, 7.32)	5.99 (4.16, 8.26)	6.71 (4.75, 9.13)	6.71 (4.75, 9.13)
ProFemur Renaissance	466	14	0.64 (0.18, 1.77)	1.73 (0.82, 3.26)	2.43 (1.29, 4.17)	3.18 (1.82, 5.14)	3.18 (1.82, 5.14)
OMNI ARC Hip	459	9	0.88 (0.30, 2.13)	1.44 (0.60, 2.99)	2.47 (1.20, 4.52)	2.47 (1.20, 4.52)	2.47 (1.20, 4.52)
Profemur	418	15	2.88 (1.57, 4.82)	3.62 (2.11, 5.74)	3.62 (2.11, 5.74)	3.62 (2.11, 5.74)	—
Overall	360,467	7,471	1.42 (1.38, 1.46)	1.88 (1.83, 1.92)	2.15 (2.10, 2.20)	2.37 (2.32, 2.43)	2.64 (2.56, 2.73)

Table 2.5 Unadjusted Cumulative Percent Revision of Cementless Acetabular Components in Hip Arthroplasty Constructs for Primary Total Hip Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Acetabular Shell	N Total	N Revised	1 Yrs	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Pinnacle	130,552	2,015	1.03 (0.98, 1.09)	1.41 (1.34, 1.48)	1.61 (1.54, 1.69)	1.79 (1.70, 1.87)	1.95 (1.83, 2.07)
G7	44,196	838	1.48 (1.37, 1.60)	1.84 (1.71, 1.97)	2.06 (1.92, 2.21)	2.16 (2.01, 2.32)	2.16 (2.01, 2.32)
R3	40,299	909	1.63 (1.51, 1.76)	2.09 (1.95, 2.24)	2.38 (2.22, 2.54)	2.56 (2.39, 2.74)	2.83 (2.57, 3.12)
Trident II-Tritanium	39,956	655	1.41 (1.3, 1.53)	1.78 (1.64, 1.92)	1.82 (1.68, 1.97)	—	—
Trident	37,119	912	1.46 (1.35, 1.59)	2.01 (1.87, 2.16)	2.36 (2.21, 2.52)	2.58 (2.41, 2.76)	2.97 (2.73, 3.23)
Continuum	26,359	778	1.98 (1.82, 2.15)	2.57 (2.38, 2.76)	2.93 (2.73, 3.15)	3.14 (2.92, 3.36)	3.27 (3.01, 3.54)
Trident-Tritanium	19,537	710	2.01 (1.82, 2.22)	2.91 (2.68, 3.15)	3.36 (3.12, 3.62)	3.70 (3.43, 3.98)	4.17 (3.75, 4.62)
Trilogy	8,920	282	1.76 (1.50, 2.05)	2.40 (2.10, 2.74)	2.94 (2.60, 3.32)	3.27 (2.90, 3.68)	3.91 (3.41, 4.44)
Trident II	5,305	82	1.41 (1.11, 1.75)	1.61 (1.29, 2)	—	—	—
Trabecular Metal	4,913	160	2.00 (1.63, 2.42)	2.50 (2.09, 2.97)	2.95 (2.49, 3.45)	3.36 (2.86, 3.92)	3.95 (3.26, 4.74)
FMP	4,143	70	1.23 (0.93, 1.60)	1.58 (1.23, 1.99)	1.64 (1.28, 2.07)	1.84 (1.43, 2.34)	1.84 (1.43, 2.34)
Restoration ADM	3,175	72	1.48 (1.10, 1.95)	1.93 (1.50, 2.46)	2.25 (1.76, 2.82)	2.37 (1.86, 2.98)	2.53 (1.95, 3.22)
Trinity	2,668	60	1.73 (1.29, 2.29)	2.10 (1.60, 2.71)	2.53 (1.92, 3.26)	2.75 (2.03, 3.63)	2.75 (2.03, 3.63)
Mpact	2,341	61	1.93 (1.43, 2.55)	2.50 (1.92, 3.21)	2.78 (2.14, 3.55)	2.78 (2.14, 3.55)	—
Dynasty BioFoam	2,306	82	2.00 (1.48, 2.63)	2.98 (2.34, 3.74)	3.49 (2.78, 4.31)	3.75 (3.01, 4.62)	3.75 (3.01, 4.62)
Mallory Head	2,089	30	0.91 (0.57, 1.39)	1.20 (0.80, 1.74)	1.30 (0.88, 1.87)	1.46 (0.99, 2.07)	1.56 (1.06, 2.21)
EMPOWR	2,018	31	1.26 (0.84, 1.83)	1.95 (1.29, 2.85)	—	—	—
Legend	1,966	35	1.38 (0.93, 1.97)	1.82 (1.28, 2.51)	1.91 (1.35, 2.63)	—	—
Novation	1,904	66	1.63 (1.13, 2.28)	2.16 (1.57, 2.89)	3.04 (2.31, 3.93)	4.50 (3.30, 5.95)	8.27 (4.22, 14.04)
RingLoc+	1,761	55	1.99 (1.41, 2.72)	2.45 (1.80, 3.25)	2.99 (2.26, 3.87)	3.19 (2.43, 4.10)	3.19 (2.43, 4.10)
Escalade Acetabular System	1,456	20	0.97 (0.56, 1.59)	1.13 (0.67, 1.79)	1.49 (0.94, 2.25)	1.49 (0.94, 2.25)	—
Regenerex RingLoc+	1,281	35	1.64 (1.05, 2.45)	2.27 (1.55, 3.19)	2.68 (1.89, 3.68)	2.81 (1.99, 3.85)	2.81 (1.99, 3.85)
Ringloc Ranawat-Burstein	1,197	42	2.51 (1.73, 3.51)	3.10 (2.23, 4.20)	3.32 (2.40, 4.46)	3.61 (2.62, 4.84)	4.13 (2.82, 5.80)
Versafitcup DM	969	27	1.96 (1.22, 2.99)	2.38 (1.55, 3.48)	2.48 (1.63, 3.61)	2.85 (1.92, 4.06)	2.85 (1.92, 4.06)
Interface Acetabular System	959	25	1.56 (0.92, 2.51)	2.22 (1.42, 3.32)	2.60 (1.71, 3.78)	2.77 (1.83, 4.00)	2.77 (1.83, 4.00)
PROCOTYL PRIME	857	14	1.17 (0.60, 2.08)	1.68 (0.93, 2.83)	2.27 (1.12, 4.12)	—	—
Consensus	765	24	1.83 (1.05, 2.98)	2.68 (1.69, 4.03)	3.02 (1.94, 4.46)	3.41 (2.24, 4.97)	3.41 (2.24, 4.97)
Logical	749	16	1.74 (0.98, 2.88)	2.05 (1.20, 3.29)	2.05 (1.20, 3.29)	2.54 (1.40, 4.24)	—
Universal	707	16	1.41 (0.73, 2.51)	1.84 (1.03, 3.05)	2.38 (1.41, 3.75)	2.38 (1.41, 3.75)	2.38 (1.41, 3.75)
Restoris PST	690	42	4.06 (2.76, 5.72)	4.78 (3.36, 6.56)	5.51 (3.97, 7.38)	6.10 (4.47, 8.05)	6.10 (4.47, 8.05)
Polarcup	676	15	1.92 (1.08, 3.18)	1.92 (1.08, 3.18)	2.42 (1.40, 3.92)	2.42 (1.40, 3.92)	2.42 (1.40, 3.92)
Reflection	652	24	2.46 (1.46, 3.87)	3.10 (1.96, 4.65)	3.66 (2.38, 5.34)	3.91 (2.56, 5.67)	3.91 (2.56, 5.67)
Provident	541	13	1.66 (0.82, 3.03)	2.05 (1.09, 3.53)	2.26 (1.24, 3.81)	2.66 (1.46, 4.47)	2.66 (1.46, 4.47)
Bencox	521	19	2.13 (1.13, 3.67)	3.83 (2.33, 5.89)	4.57 (2.66, 7.23)	4.57 (2.66, 7.23)	—
Converge	465	10	1.51 (0.67, 2.96)	2.15 (1.11, 3.79)	2.15 (1.11, 3.79)	2.15 (1.11, 3.79)	2.15 (1.11, 3.79)
Novae Sunfit	455	9	1.32 (0.55, 2.73)	1.58 (0.70, 3.10)	1.91 (0.89, 3.63)	2.36 (1.13, 4.38)	—
Klassic HD	443	6	1.35 (0.57, 2.80)	1.35 (0.57, 2.80)	1.35 (0.57, 2.80)	1.35 (0.57, 2.80)	—
Overall	394,910	8,260	1.43 (1.39, 1.46)	1.89 (1.85, 1.93)	2.18 (2.13, 2.23)	2.40 (2.34, 2.45)	2.66 (2.58, 2.74)

Table 2.6 Unadjusted Cumulative Percent Revision of Cemented Stems in Hip Arthroplasty Constructs for Primary Total Hip Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Femoral Stem	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Accolade C	2,741	40	0.91 (0.61, 1.33)	1.24 (0.86, 1.73)	1.80 (1.27, 2.48)	1.80 (1.27, 2.48)	2.08 (1.38, 3.03)
Summit	2,629	64	1.49 (1.08, 2.01)	2.29 (1.75, 2.94)	2.64 (2.03, 3.36)	2.85 (2.19, 3.65)	2.85 (2.19, 3.65)
Avenir	2,059	27	0.93 (0.58, 1.42)	1.35 (0.89, 1.96)	1.63 (1.05, 2.42)	1.63 (1.05, 2.42)	—
Synergy	1,737	42	1.62 (1.11, 2.31)	2.18 (1.55, 2.97)	2.74 (1.97, 3.70)	2.90 (2.08, 3.92)	2.90 (2.08, 3.92)
Exeter	1,682	39	1.61 (1.09, 2.31)	2.32 (1.66, 3.15)	2.40 (1.73, 3.25)	2.40 (1.73, 3.25)	3.03 (1.82, 4.74)
VerSys	1,525	37	1.51 (0.99, 2.22)	1.80 (1.22, 2.58)	2.39 (1.67, 3.31)	3.12 (2.16, 4.36)	3.12 (2.16, 4.36)
VerSys Advocate	1,500	28	1.07 (0.64, 1.70)	1.75 (1.16, 2.53)	1.91 (1.29, 2.73)	1.91 (1.29, 2.73)	2.20 (1.42, 3.26)
Omnifit	1,146	17	0.79 (0.39, 1.45)	1.11 (0.61, 1.89)	1.73 (1.04, 2.71)	1.73 (1.04, 2.71)	1.73 (1.04, 2.71)
C-Stem	985	9	0.62 (0.26, 1.30)	1.05 (0.52, 1.95)	1.05 (0.52, 1.95)	1.05 (0.52, 1.95)	1.05 (0.52, 1.95)
Spectron	761	18	1.58 (0.86, 2.67)	2.36 (1.43, 3.68)	2.64 (1.60, 4.10)	2.64 (1.60, 4.10)	—
Echo FX	687	8	0.90 (0.38, 1.87)	1.15 (0.50, 2.31)	1.45 (0.66, 2.81)	1.45 (0.66, 2.81)	1.45 (0.66, 2.81)
AMIStem-C	578	8	0.71 (0.24, 1.72)	1.10 (0.46, 2.30)	1.43 (0.62, 2.87)	2.10 (0.85, 4.34)	—
Overall	18,030	337	1.19 (1.04, 1.36)	1.72 (1.53, 1.92)	2.08 (1.86, 2.32)	2.23 (1.99, 2.50)	2.37 (2.08, 2.69)

Revision Hip Arthroplasty

Between 2012 and 2022, AJRR has collected data on 129,127 revision hip arthroplasty procedures.

The data submitted to AJRR contains variability in coding with respect to primary reason for revision. Reason for revision surgery was determined by the diagnosis codes submitted for each revision. AJRR accepts up to 10 diagnosis codes which can be submitted as either ICD (International Classification of Diseases)-9 or-10 codes depending on the year of the procedure. AJRR continues to refine the way that revision procedures are classified to improve the accuracy of the diagnostic categories over time.

The reasons for revision were examined and categorized as follows: periprosthetic osteolysis, fracture/ periprosthetic fracture/fracture related sequelae, articular bearing surface wear and osteolysis, infection and inflammatory reaction, other mechanical complications, aseptic loosening, instability related codes, pain, and hematoma/wound complications. All ten code fields were queried for target codes from these categories, and if none of the submitted codes matched a defined category, the reason for revision was placed in an ''other'' group.

Figure 2.32 displays the case distribution of all revision procedures in AJRR patients reported to either AJRR or CMS. Each reason for revision was queried independently as to allow for cases to exist in more than one category when multiple diagnoses are reported. An additional 26,354 cases are not presented as they contain erroneous or irrelevant diagnoses such as osteoarthritis, cardiac diagnoses, and comorbidities; these cases are regularly revisited for any missed classifications. The most common reason for hip revision surgery overall was infection at 17.6% (Figure 2.32). Revision surgeries can also be further examined based on their occurrence from the time of the index primary procedure. An early revision is considered one that occurred <3 months after the primary procedure. There were 12,375 early ''linked'' revision procedures in AJRR or CMS (Table 2.7). A ''linked'' revision is one in which the patient had the primary surgery in a facility that submitted data to AJRR and a revision that was also submitted to the AJRR or CMS. Although not all patients will return to the same facility for their revision procedure, a significant majority of revisions done in the early postoperative period are expected to return to the same AJRR hospital as the primary.[12] Among early revisions, 11,762 had a primary diagnosis that was relevant using the methodology above. For all early revisions, the primary reason was again infection (28.7%) followed by instability and fracture at 21.9% and 21.4%, respectively (Figure 2.33).

INSIGHTS

Infection remains the most common reason for all revision as well as early revision surgery following total hip arthroplasty, followed by instability and fracture, when looking at linked revisions at AJRR facilities.

Figure 2.32 Distribution of Diagnosis Associated with All Hip Revisions, 2012-2022 (N=95,495)

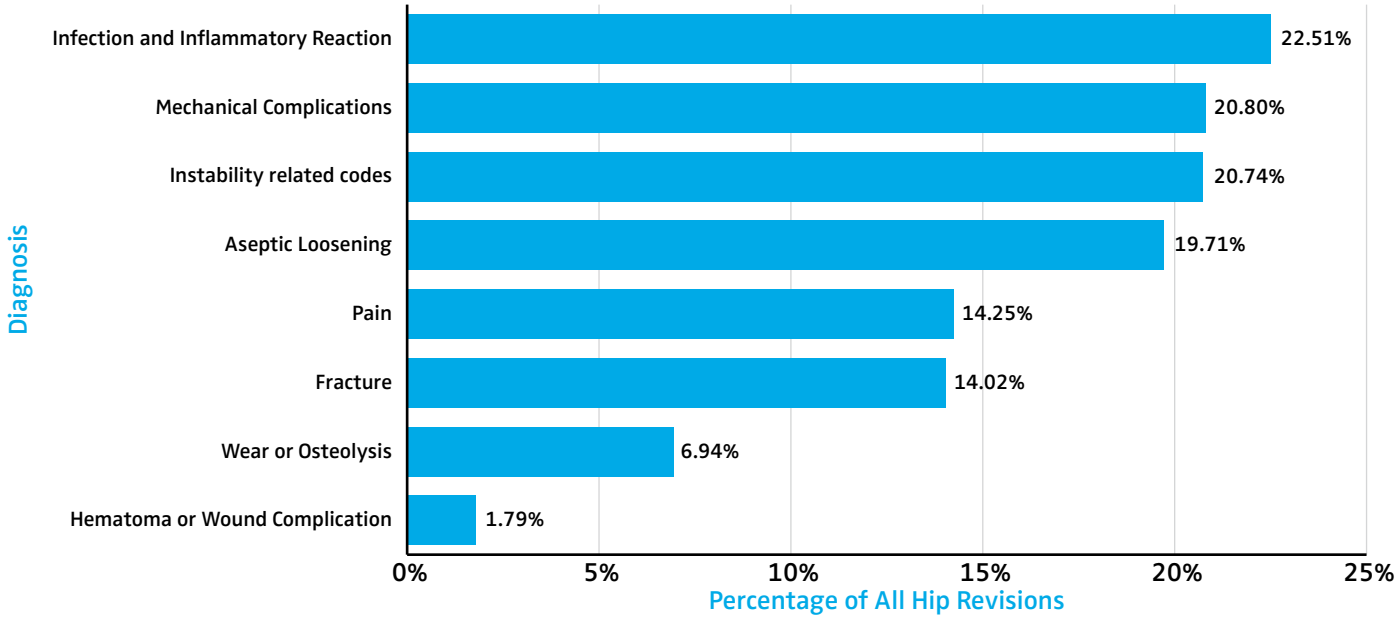
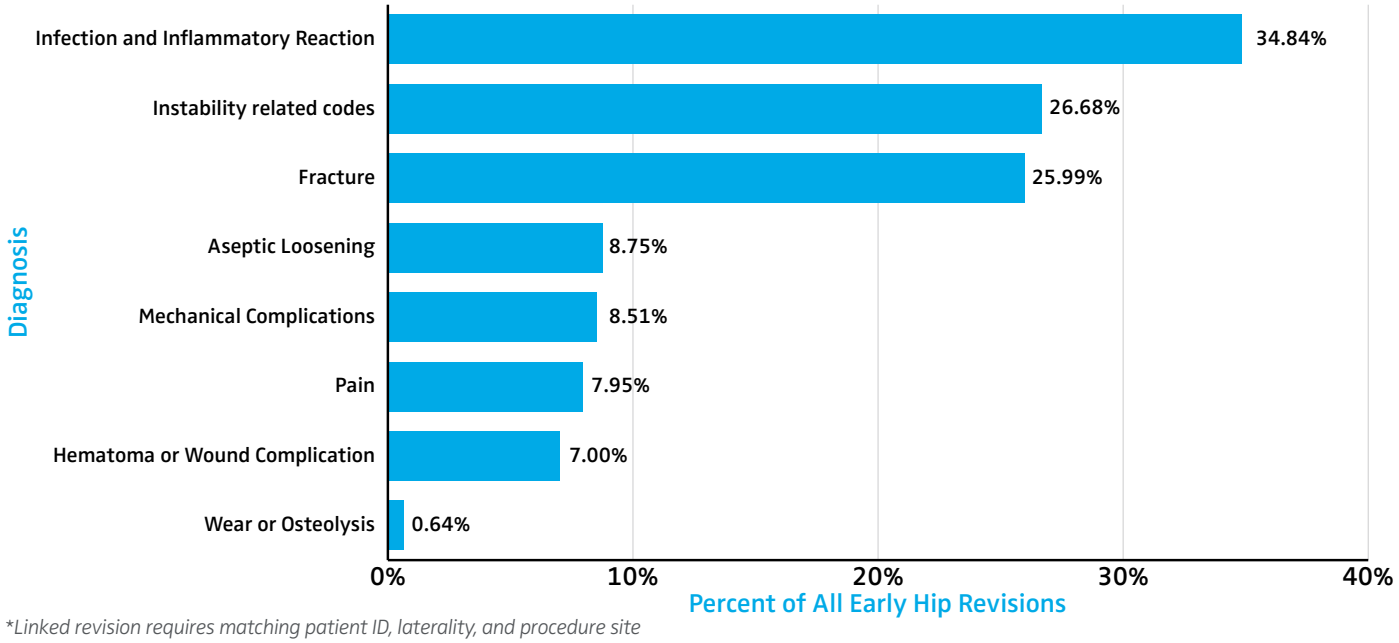


Table 2.7 Distribution of Time Interval Between Elective Primary Hip Arthroplasty Procedures and Revision for Linked Patients, 2012-2022*

Time	Frequency	Percent
< 3 Months	12,375	48.76
3 to <6 Months	2,412	9.5
6-12 Months	2,682	10.57
>1 Year	7,909	31.16

**Linked revision requires matching patient ID, laterality, and procedure site*

Figure 2.33 Distribution of Diagnosis Associated With all Early "Linked" Hip Revisions, 2012-2022 (N=9,696)*



**Linked revision requires matching patient ID, laterality, and procedure site*

The prevalence of early hip revisions between the ages of 50 and 90 appears fairly stable regardless of patient age (Figure 2.34). When reviewing the percentage of all hip arthroplasty revisions with a primary diagnosis of infection, the percentage varies from 9.7-23.7% over the years 2012-2022 (Figure 2.35). Similarly, for hip revisions due to instability/dislocation, the value appears to be increasing before dropping off in 2018 and leveling off through 2022 (Figure 2.36). As AJRR collects historical data, these numbers could change with further data collection.

As with primary total hip arthroplasty, AJRR saw a statistically significant increase in dual mobility usage for revision hip arthroplasty procedures since 2012 (10.2%) with a slight pull-back in recent years to 18.8% of articulations classified as dual mobility in 2022 (Figure 2.37). Not surprisingly, there has been a significant increase in overall dual mobility usage for revisions specifically to treat dislocation/instability from 2012 to 2022 (12.9% to 46.0%, $p<0.0001$) although the trend may be slowing (Figure 2.38). Some dual mobility heads may erroneously be classified as smaller diameter heads if reporting is insufficient to distinguish as dual mobility.

Figure 2.34 Early "Linked" Revisions as a Percent of Elective Primary Hip Arthroplasty Procedures by Age Group, 2012-2022 (N=12,408)

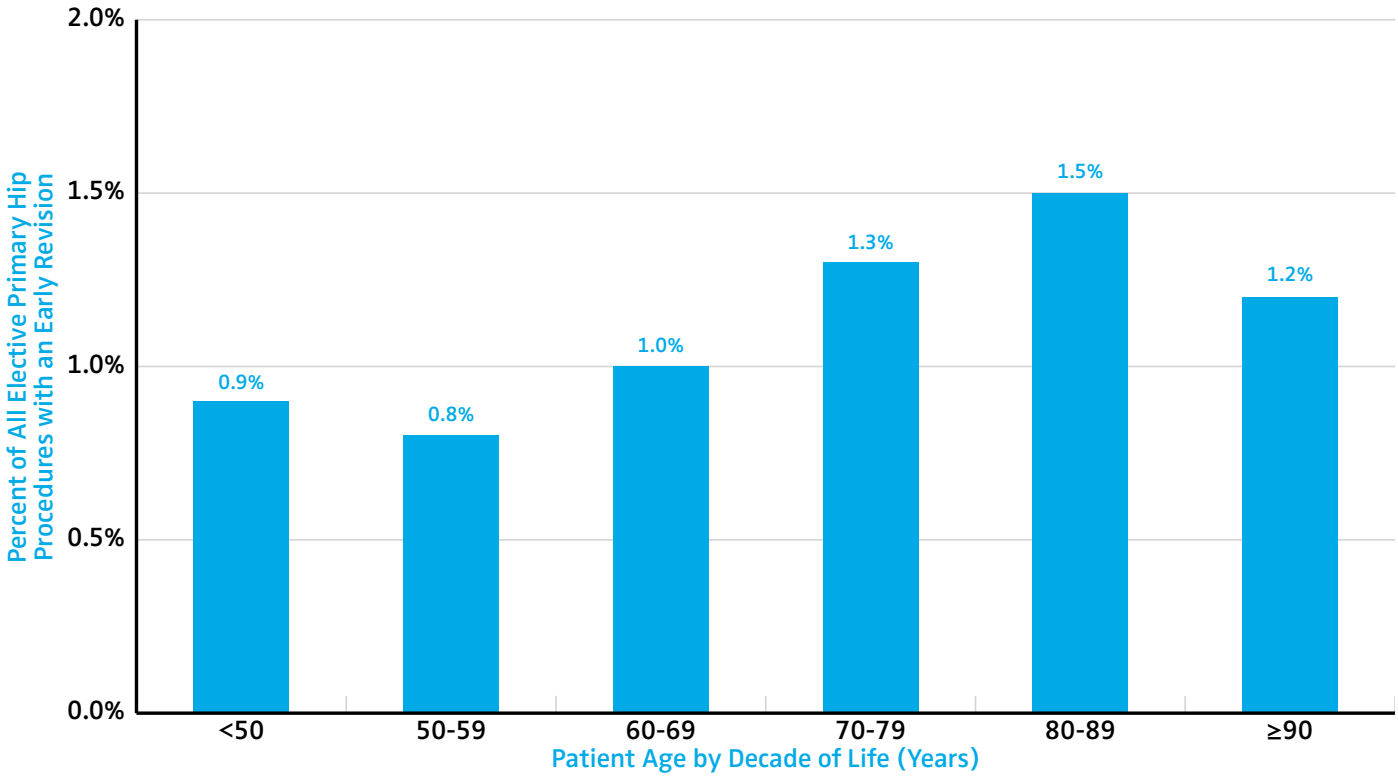


Figure 2.35 Revisions Due to Infection as a Percentage of All Hip Revisions, 2012-2022 (N=20,742)

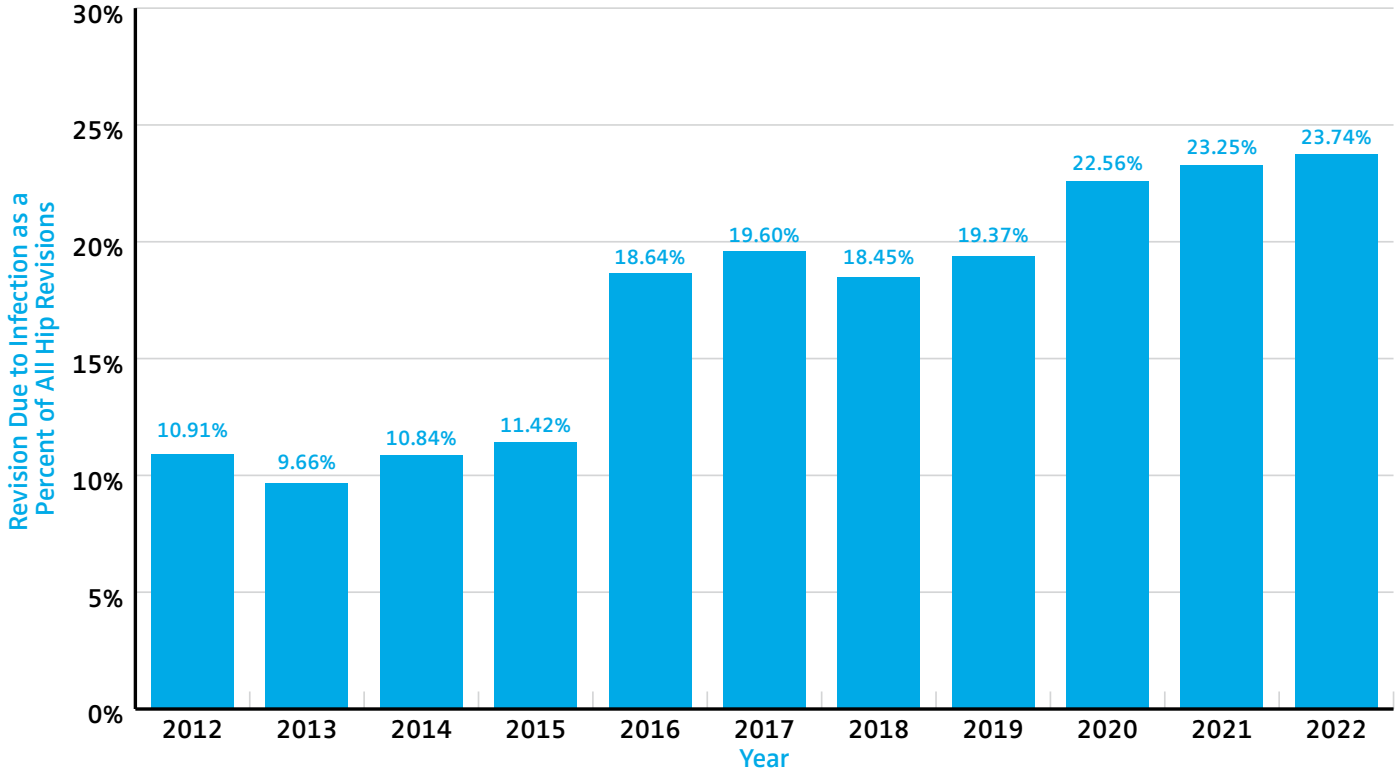


Figure 2.36 Revisions Due to Instability as a Percentage of All Hip Revisions, 2012-2022 (N=19,128)

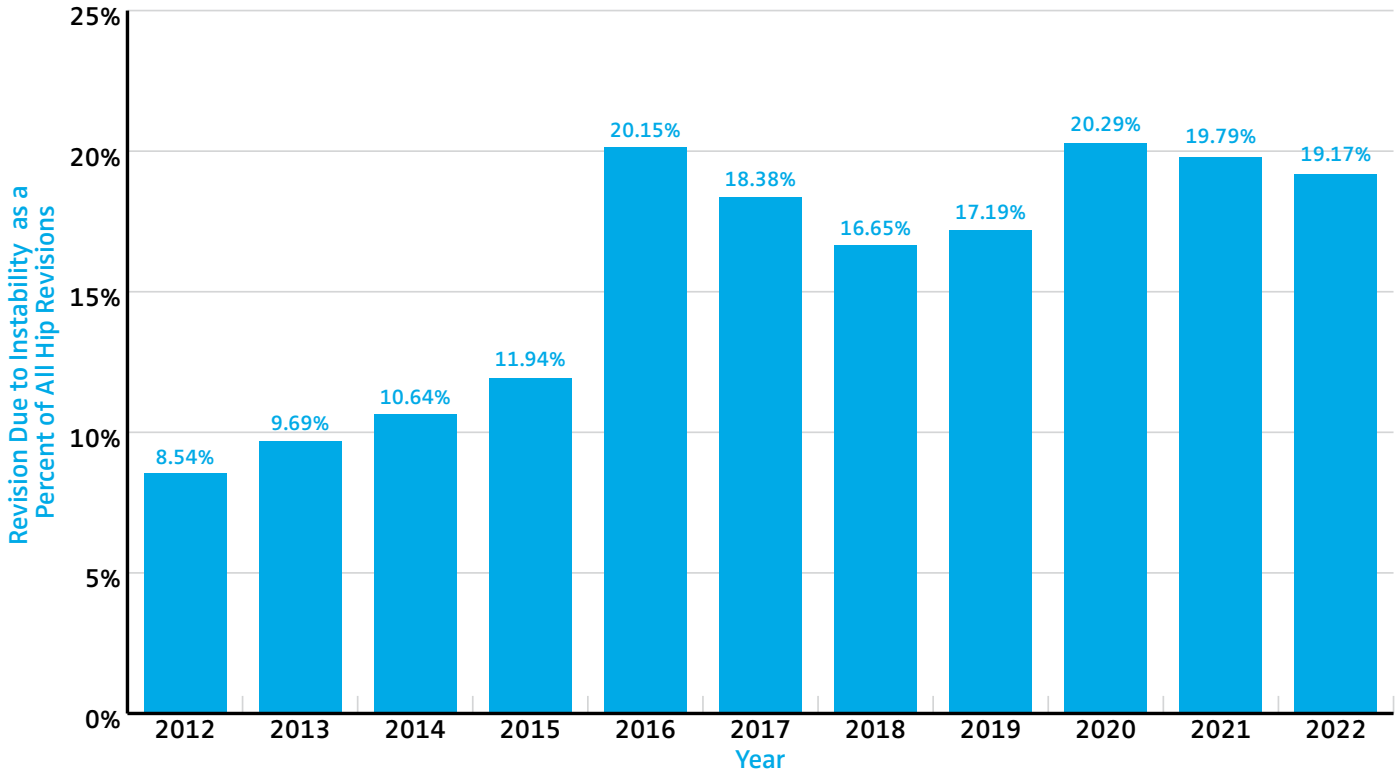


Figure 2.37 Percent Dual Mobility Usage and Femoral Neck Head Sizes Implanted for Hip Revisions, 2012-2022 (N=86,793)

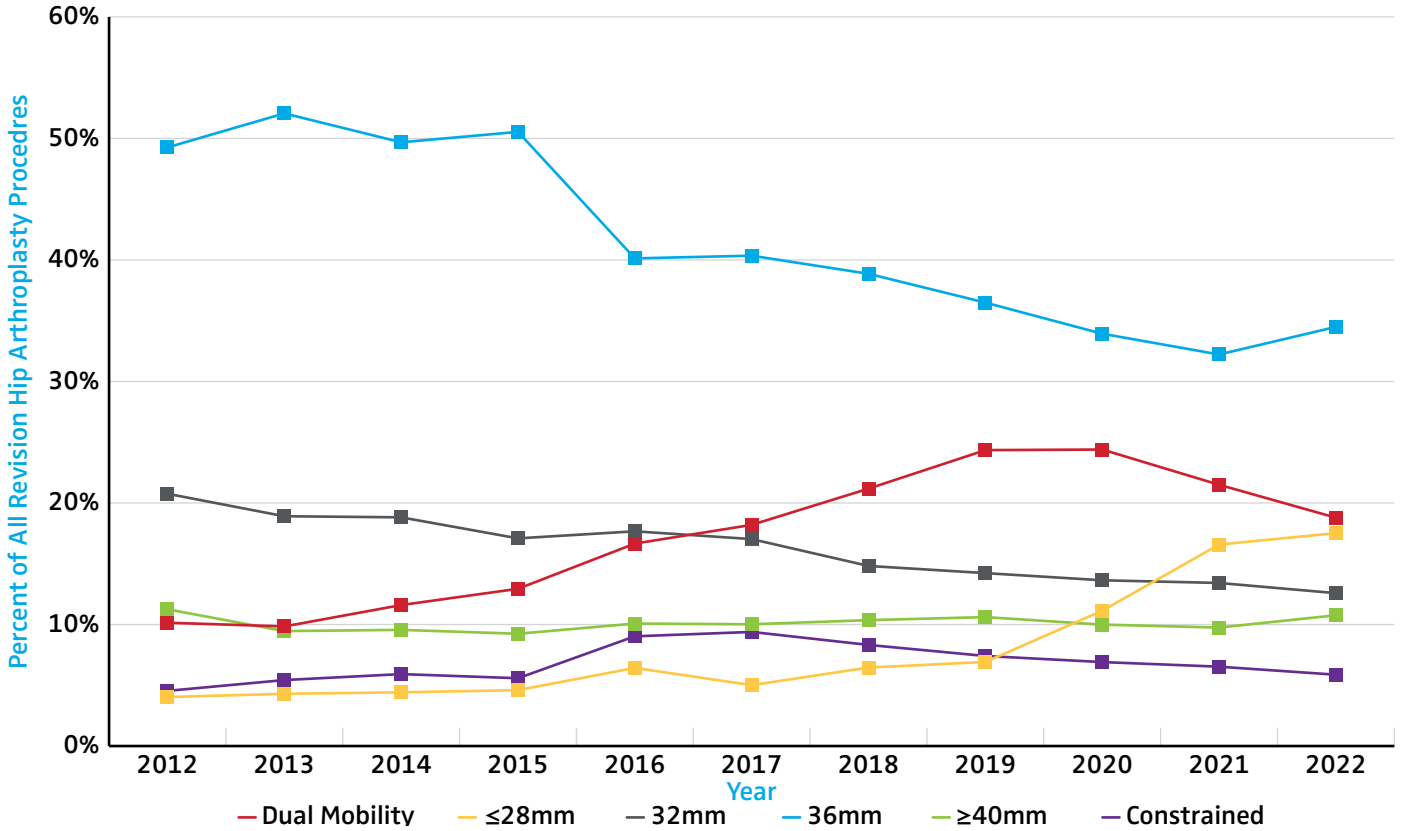
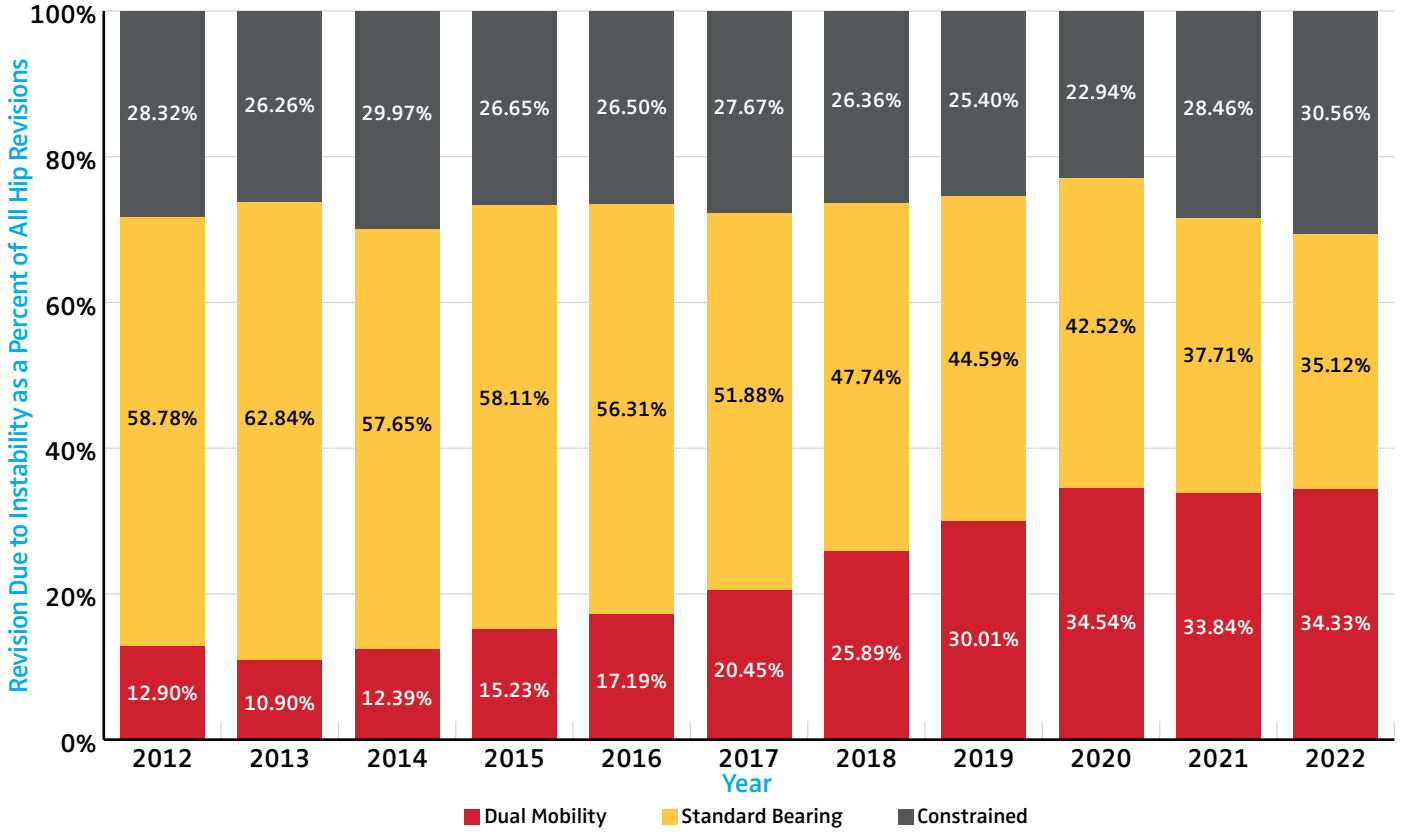


Figure 2.38 Dual Mobility Usage for Hip Revisions Secondary to Dislocation/Instability, 2012-2022 (N=17,389)



The following two figures provide utilization data of implants used in revision hip arthroplasty procedures in AJRR. Figure 2.39 tabulates the eight most commonly used stem components used in revision THA by year. Over the 11-year period, the Restoration Modular stem was implanted most frequently. Figure 2.40 tabulates the eight most commonly used cup components in THA by year and shows that over the 11-year period, the most frequently implanted cup has varied. In the last five years, the G7 component was the most frequently implanted cup.

INSIGHTS

Over the last three years, dual mobility articulations were used in more than one third of revision procedures done to address dislocation/instability.

Figure 2.39 Revision Hip Arthroplasty Stem Components by Year, 2012-2022 (N=49,783)

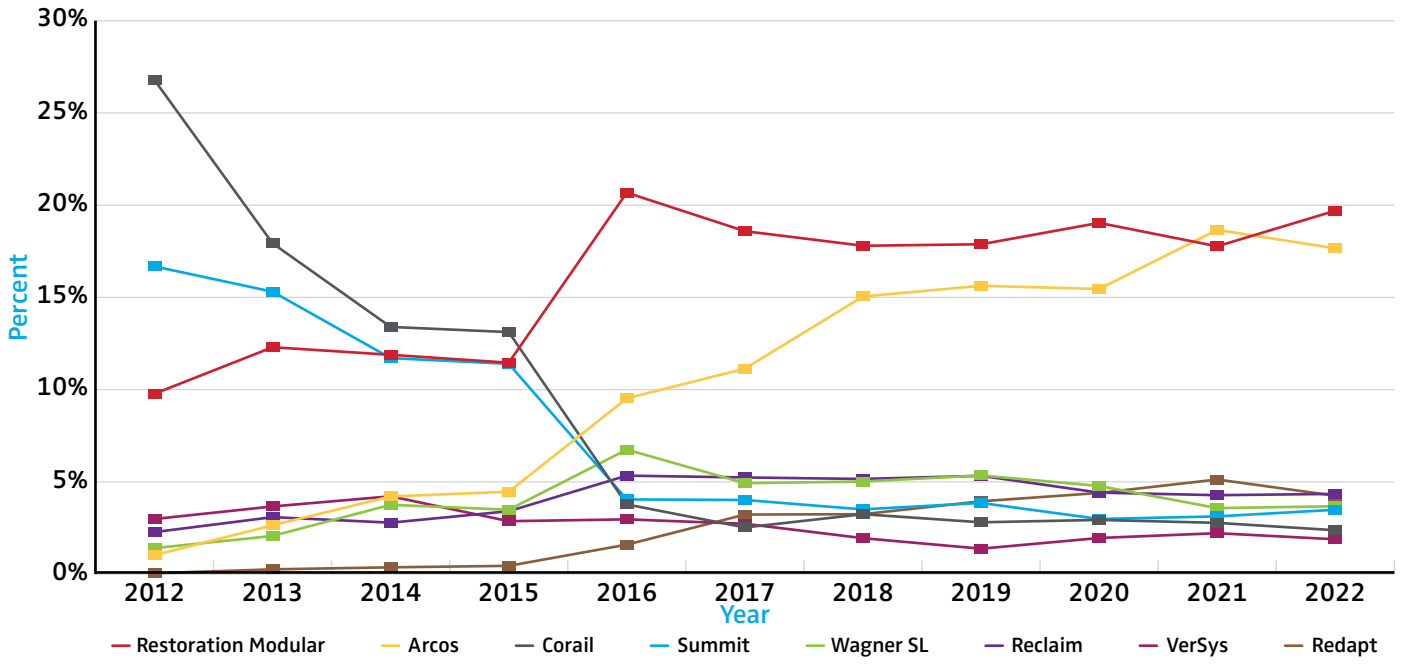


Figure 2.40 Revision Hip Arthroplasty Cup Components by Year, 2012-2022 (N=50,146)

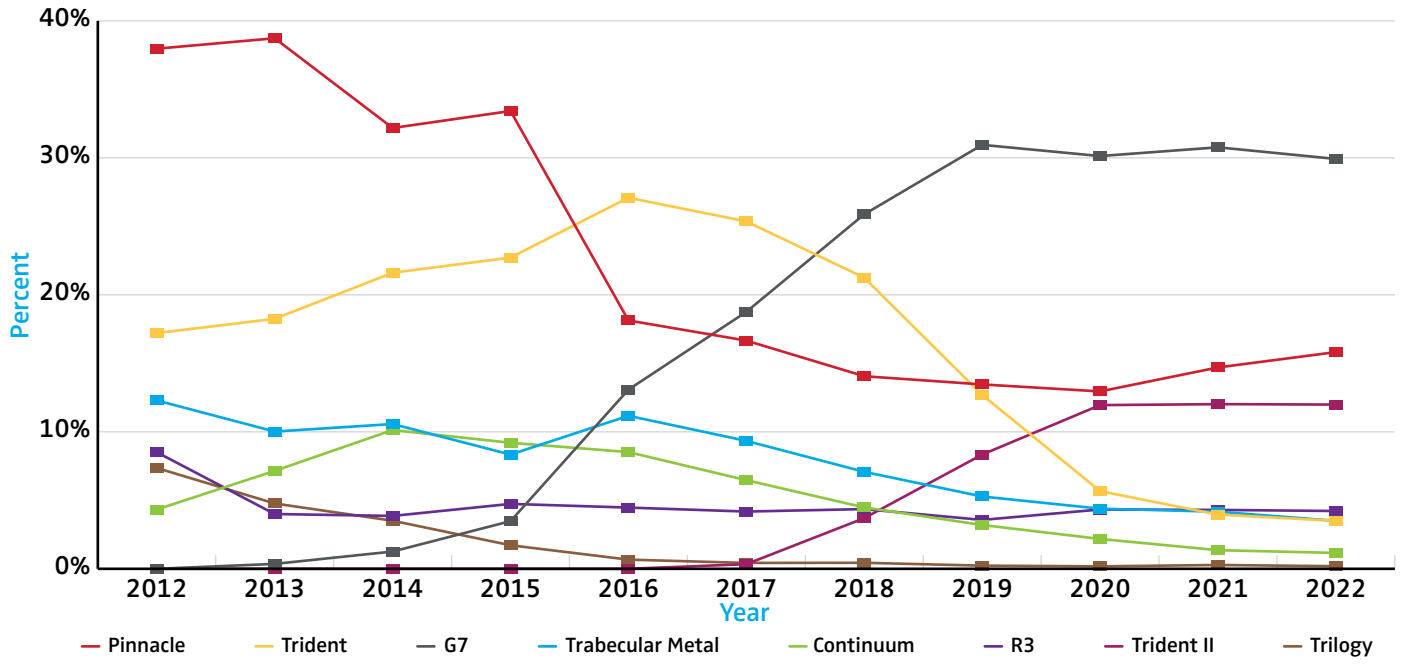


Figure 2.41 shows the liner types utilized by year for revision hip arthroplasty. Highly cross-linked polyethylene was more commonly utilized compared to antioxidant polyethylene for all revision hip arthroplasty procedures. This mirrors the observation in primary total hip arthroplasty (Figure 2.24). In contrast with elective THA, a few percent of revision hip procedures (<5%) report using conventional polyethylene.

Figure 2.41 Revision Hip Arthroplasty Liner Polyethylene Material by Year, 2012-2022 (N=71,555)

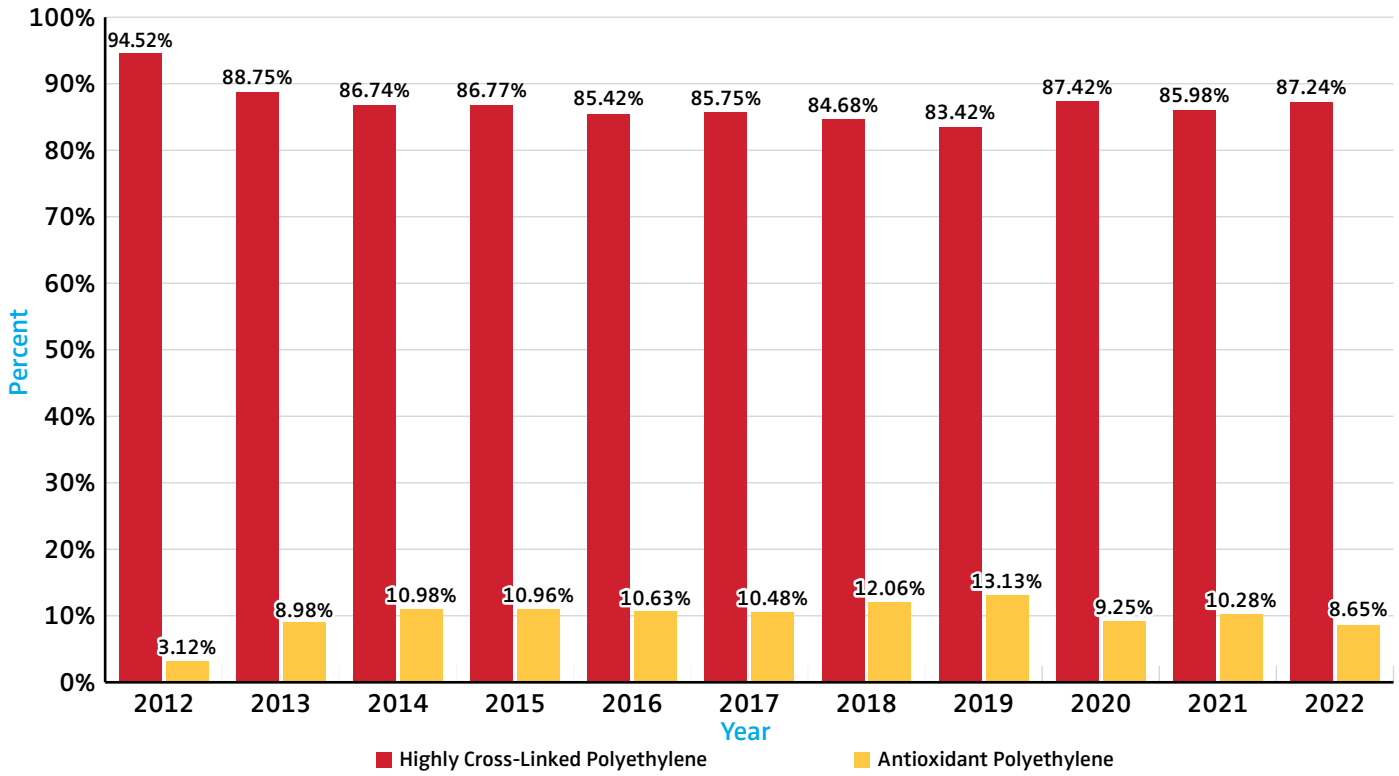
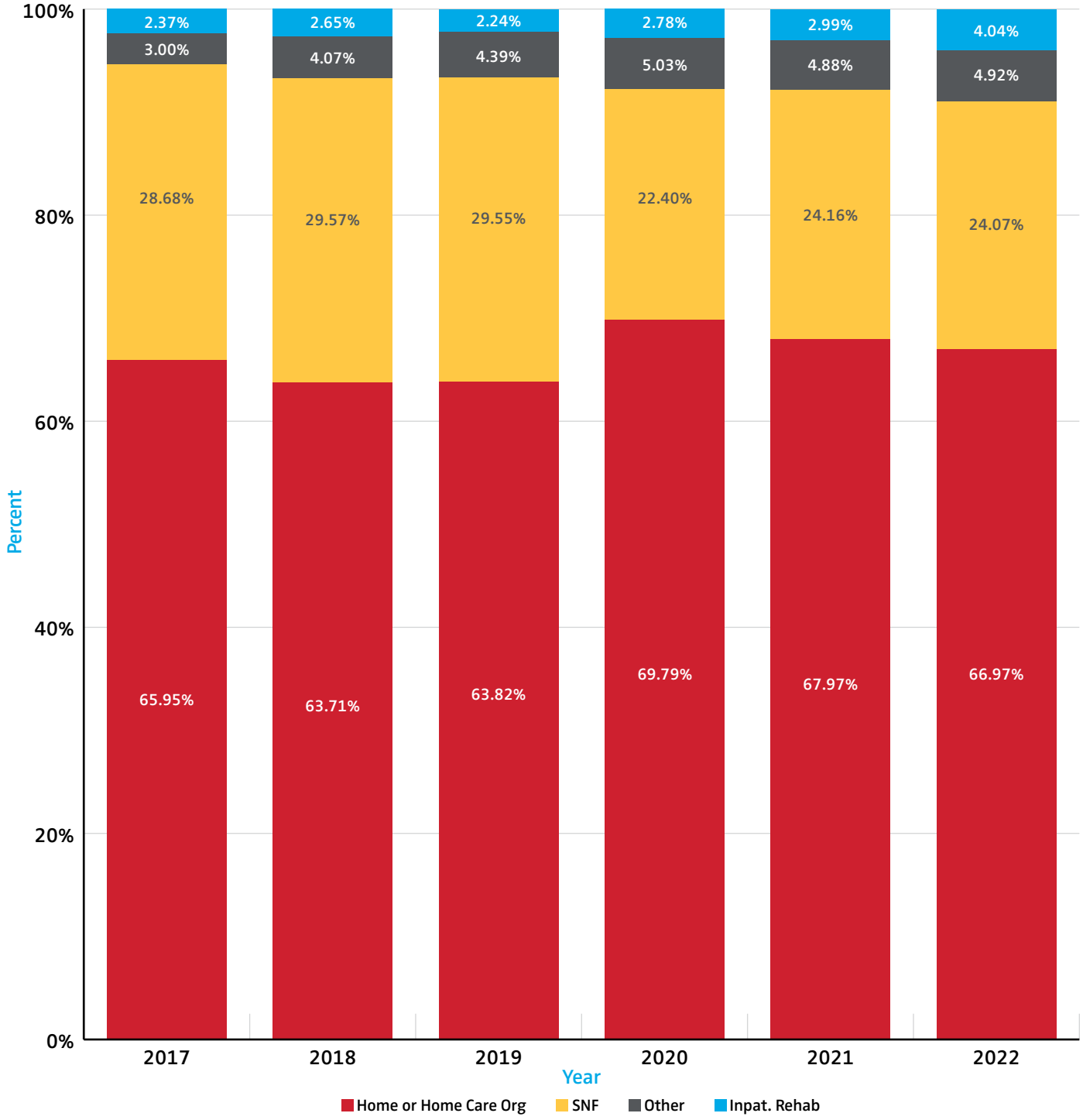


Figure 2.42 shows a tabulation of discharge disposition after revision hip arthroplasty since 2017 when these data were collected. AJRR data shows that most patients were released to home or self-care with a slight decline in those discharged to skilled nursing facilities from 2018-2022. However, nearly one quarter of patients were discharged to a skilled nursing facility in 2022, which is more than four times higher than the rate seen with primary total hip arthroplasty.

INSIGHTS

The percentage of patients discharged to a skilled nursing facility following revision THA declined over the last four years to less than a quarter of revision hip arthroplasty patients.

Figure 2.42 Revision Hip Arthroplasty Discharge Disposition Codes by Year, 2017-2022 (N=74,371)



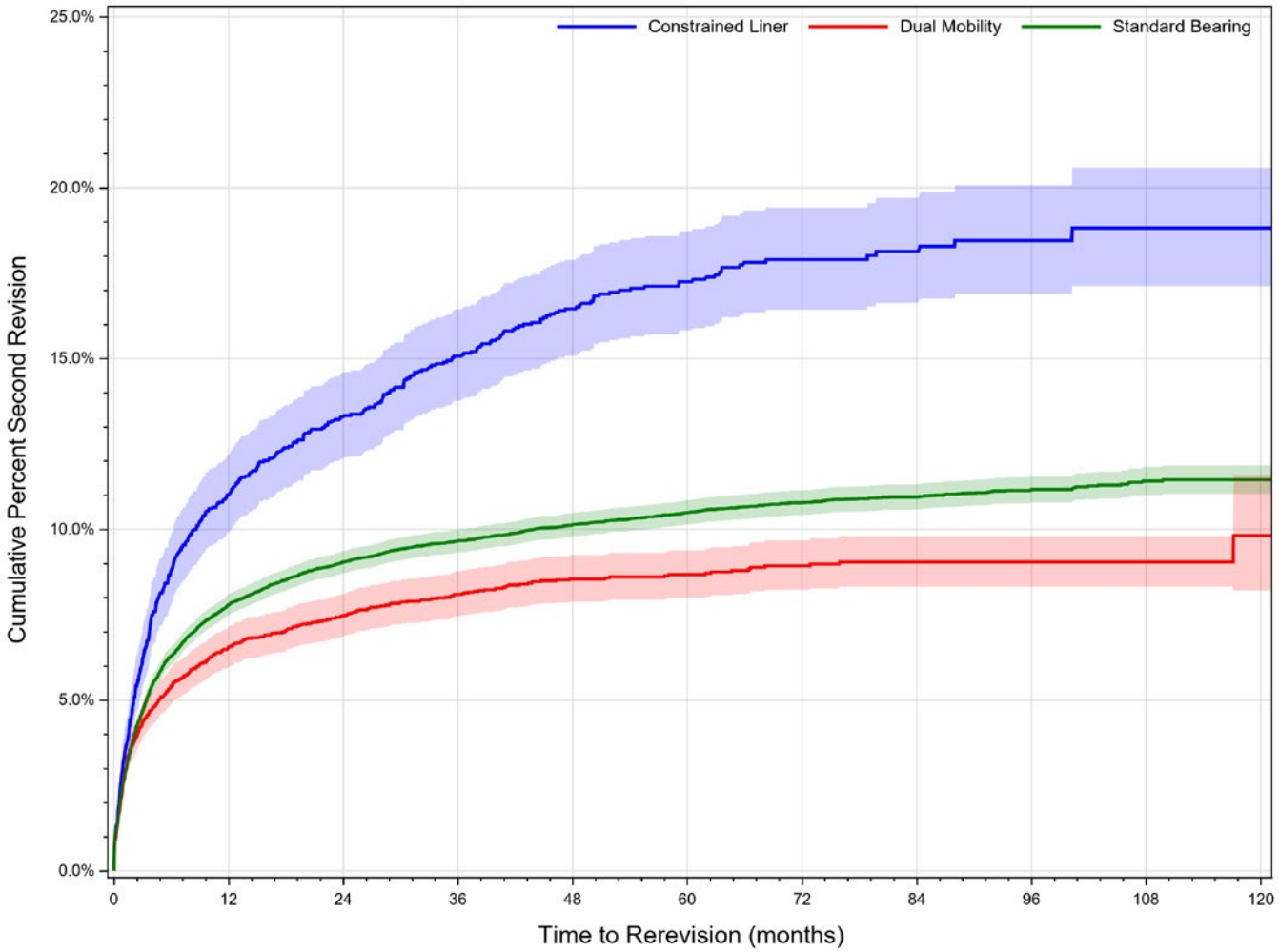
Code	Code Value
Home	Discharged to home/self-care (routine charge).
Home Care Org.	Discharged/transferred to home care of organized home health service organization.
Inpat. Care	Discharged/transferred to other short-term general hospital for inpatient care.
SNF	Discharged/transferred to skilled nursing facility (SNF) with Medicare certification in anticipation of covered skilled care--(For hospitals with an approved swing bed arrangement, use Code 61 - swing bed. For reporting discharges/transfers to a non-certified SNF, the hospital must use Code 04 - ICF.)
Inpat. Rehab	Discharged/transferred to an inpatient rehabilitation facility including distinct units of a hospital (eff. 1/2002).

Revision following revision total hip arthroplasty (re-revision) was investigated for the first time in this year's Annual Report (Figure 2.43). Dual mobility compared to constrained and standard bearings was used as the focal comparison for the first re-revision figure. After adjusting for age, sex, and CCI, dual mobility was identified to have a significantly reduced cumulative percent re-revision compared to standard and constrained bearings. Similarly, standard design cases were found to have significantly reduced cumulative percent re-revision over the constrained cohort.

After adjusting for age, sex, and CCI, dual mobility cases were found to have a significantly reduced cumulative percent re-revision compared to standard and constrained design cases in Medicare patients aged 65 and older.

INSIGHTS

Figure 2.43 Cumulative Percent Re-Revision after Revision Total Hip Arthroplasty for Dual Mobility and Standard Bearings in Medicare Patients 65 Years of Age and Older, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120
Constrained Liner	2,941	2,330	2,034	1,761	1,470	1,158	816	520	284	112	36
Dual Mobility	7,090	5,912	5,033	4,141	3,193	2,378	1,678	1,139	585	223	79
Standard	31,322	25,798	22,823	20,259	17,574	14,614	11,784	9,176	5,456	2,490	778
Total	41,353	34,040	29,890	26,161	22,237	18,150	14,278	10,835	6,325	2,825	893

Age/Sex/CCI adjusted HR (95%CI), p-value
Standard vs. Dual Mobility: 1.235 (1.128,1.1352), p<0.001
Constrained vs. Dual Mobility: 1.998 (1.766,2.259), p<0.001

Patient-Reported Outcome Measures (PROMs) - Total Hip Arthroplasty

Patient-reported outcome measures (PROMs) have received increased attention within AJRR and the wider practice of orthopaedic surgery. In the U.S., value-based payment models made capture of PROMs a prerequisite for various public and private alternative payment models. Internationally, in 2014 the International Society of Arthroplasty Registries (ISAR) Steering Committee established a working group in this area to advise on best practices.[15]

AJRR collects patient-reported outcome measures and encourages sites to submit this data at set intervals: a baseline measure obtained prior to the surgery, a measure 90-days post-dischargely, and at one-year postoperatively. Patient-reported outcome measures capture information on the patient's overall health and function from the patient's perspective. The recommended intervals allow comparison over the course of a patient's care, but on a broader scope, provide a better picture of national outcomes and trends. AJRR provides national benchmarking for participating sites to review and compare this uniquely reported data.

With a growing emphasis on the value of PROMs data, the Registry in turn has expanded the ways in which sites submit this data. The Registry provides a tool for sites to collect PROMs data electronically on all eligible patients, via email or a computer or tablet device in the clinical setting. Sites also have the option to submit PROMs data through other methods, perhaps collected via a third-party vendor or a local system.

INSIGHTS

Based on the HOOS, JR. score, 92% of patients achieved a meaningful improvement after elective primary total hip arthroplasty.

Quick Facts:

- Collection of PROMs was initiated in the California Joint Replacement Registry (CJRR) in early 2011 and following incorporation of CJRR within AJRR began for the larger U.S. population in April 2016.
- To help assist AJRR institutions with PROM data collection, AJRR offers a PROMs platform within RegistryInsights® at no additional cost that allows for PROM storage and capture (both preoperatively and postoperatively). However, sites may utilize their existing PROMs solution if preferred.
- AJRR collects PROMs at any time but recommends at a minimum a preoperative (<90 days before the procedure) and a one-year postoperative PROM.
- As of 2019, AJRR recommends and supports (on their PROM platform) the collection of HOOS JR., KOOS JR., PROMIS-10, and VR-12. Other PROMs are collected but not used for analyses.
- As of December 31, 2022, 496 sites out of 1,364 (36%) have submitted PROMs, which is a 24% increase in sites compared to the previous 2022 Annual Report.
- AAOS has launched a PROMs in Practice initiative that aims to influence the active clinical use of PROMs at the point of musculoskeletal care. More information about this can be found on the AAOS website.
- The completion rate for "linked" outcomes (those where both a preoperative and one-year postoperative PROM is available on the same procedure) varies between 24-30%.

The number of institutions submitting PROMs to AJRR has increased by 24% over the past year.

INSIGHTS

Table 2.8 Preoperative and 1-Year Postoperative PROM Mean Scores After Elective Primary Hip Arthroplasty by PROM, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Pre or 1-year Postoperative	N	Mean	Standard Deviation
HOOS, JR. (Hip Disability and Osteoarthritis Outcome Score)	Score	Preoperative	72,367	48	16.2
		Postoperative	30,676	85.8	15.5
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	Preoperative	54,465	48.6	8.6
		Postoperative	23,079	52.4	8.7
	Physical T	Preoperative	54,468	39.5	7
		Postoperative	23,078	49.5	9.3
VR-12 (The Veterans RAND 12 Item Health Survey)	Mental Health Component	Preoperative	19,149	51.2	12.6
		Postoperative	8,938	55.9	9.7
	Physical Health Component	Preoperative	19,016	30.2	9.2
		Postoperative	8,946	45.7	10.6

Table 2.9 Overall Change Between Preoperative and 1-Year Postoperative PROM Scores after Elective Primary Hip Arthroplasty by PROM, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Patients with Preoperative Score	Patients with Linked Postoperative Score	Response Rate, Percentage of Patients Who Completed a Preoperative and 1-Year Score	Patients with Meaningful Improvement*
HOOS, JR. (Hip Disability and Osteoarthritis Outcome Score)	Score	72,367	18,617	25.70%	91.50%
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	54,465	13,488	24.80%	38.80%
	Physical T	54,468	13,488	24.80%	72.20%
VR-12 (The Veterans RAND 12 Item Health Survey)	Mental Health Component	19,149	5,488	28.70%	39.10%
	Physical Health Component	19,016	5,494	28.90%	81.40%

**Meaningful improvement was calculated by minimal clinical important difference (MCID). MCID was determined to be a positive change score of half the pooled standard deviation.*

Table 2.10 Age-Stratified Change Between Preoperative and 1-Year Postoperative PROM Scores after Elective Primary Hip Arthroplasty by PROM for Patients 55 Years and Over, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Age Group (Years)	Patients with Preoperative Score	Patients with Linked Postoperative Score	Response Rate, Percentage of Patients Who Completed a Preoperative and 1-Year Score	Patients with Meaningful Improvement*
HOOS, JR. (Hip Disability and Osteoarthritis Outcome Score)	Score	55-64	20,310	5,011	24.70%	92.60%
		65-74	27,196	7,600	27.90%	91.70%
		75-84	13,153	3,508	26.70%	89.70%
		>85	2,054	460	22.40%	88.00%
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	55-64	14,719	3,381	23.00%	41.70%
		65-74	20,825	5,739	27.60%	39.30%
		75-84	10,153	2,680	26.40%	34.10%
		>85	1,554	360	23.20%	30.30%
	Physical T	55-64	14,721	3,382	23.00%	74.70%
		65-74	20,827	5,738	27.60%	73.20%
		75-84	10,153	2,680	26.40%	67.30%
		>85	1,555	360	23.20%	59.20%

**Meaningful improvement was calculated by minimal clinical important difference (MCID). MCID was determined to be a positive change score of half the pooled standard deviation.*

Knee Arthroplasty

Knee Overview

Between 2012 and 2022, AJRR has collected data on 1,848,127 knee arthroplasty procedures.

The majority of knee surgeons submitting data to AJRR are performing primary total knee arthroplasties. The mean per surgeon volume of total knee arthroplasties in 2022 was 56 with a median of 26 and an interquartile range (25th-75th percentile) of 7-69 (Table 3.1). These volumes are similar to what has previously been reported.[16] Partial knee arthroplasties include medial unicompartmental, lateral unicompartmental, and patellofemoral arthroplasty. Only surgeons with at least one relevant knee procedure were included.

The mean age for individuals undergoing total knee arthroplasty was 67.4 (SD 9.4) years (Table 3.2 and Figure 3.1). There was a statistical difference in the average age between patients undergoing total knee arthroplasty (67.4 years) and partial knee arthroplasty (64.5 years) ($p<0.0001$) as well as total knee and revision knee arthroplasty ($p<0.0001$).

When examining mean length of stay as reported to AJRR, there has been a significant decrease of 1.7 days for total knee arthroplasties comparing 2012 (2.9 days) to 2022 (1.2 days). A significant decrease in mean length of stay for partial knee arthroplasties of 1.7 days was also seen (Figure 3.2) ($p<0.0001$). For this analysis, length of stay was calculated by subtracting admission date from the discharge date for procedures from all reporting facilities. Data to accurately calculate length of stay was provided on only 62% of all knee cases.

INSIGHTS

Mean length of stay following revision total knee arthroplasty has remained fairly constant over time despite substantial decreases for partial and primary total knee arthroplasty.

Table 3.1 Average Procedural Volume for Participating Surgeons, 2022

Procedure	Total Surgeons	Total Procedures	Per Surgeon Mean	Per Surgeon Median	25th Percentile	75th Percentile
Partial Knee Arthroplasty	1,197	8,701	7.3	3.0	1.0	7.0
Revision Knee Arthroplasty	2,310	23,085	10.0	4.0	2.0	11.0
Total Knee Arthroplasty	3,479	194,695	56.0	26.0	7.0	69.0

Table 3.2 Mean Age of Patients Undergoing Knee Arthroplasty Procedures, 2012-2022 (N=1,848,127)

Procedures	Total	Mean Age (Years)	Standard Deviation
Partial Knee Arthroplasty	83,011	64.5	10.8
Revision Knee Arthroplasty	158,438	66.6	10.5
Total Knee Arthroplasty	1,606,678	67.4	9.4

Figure 3.1 Age Distribution of Knee Arthroplasty Procedures, 2012-2022 (N=1,848,127)

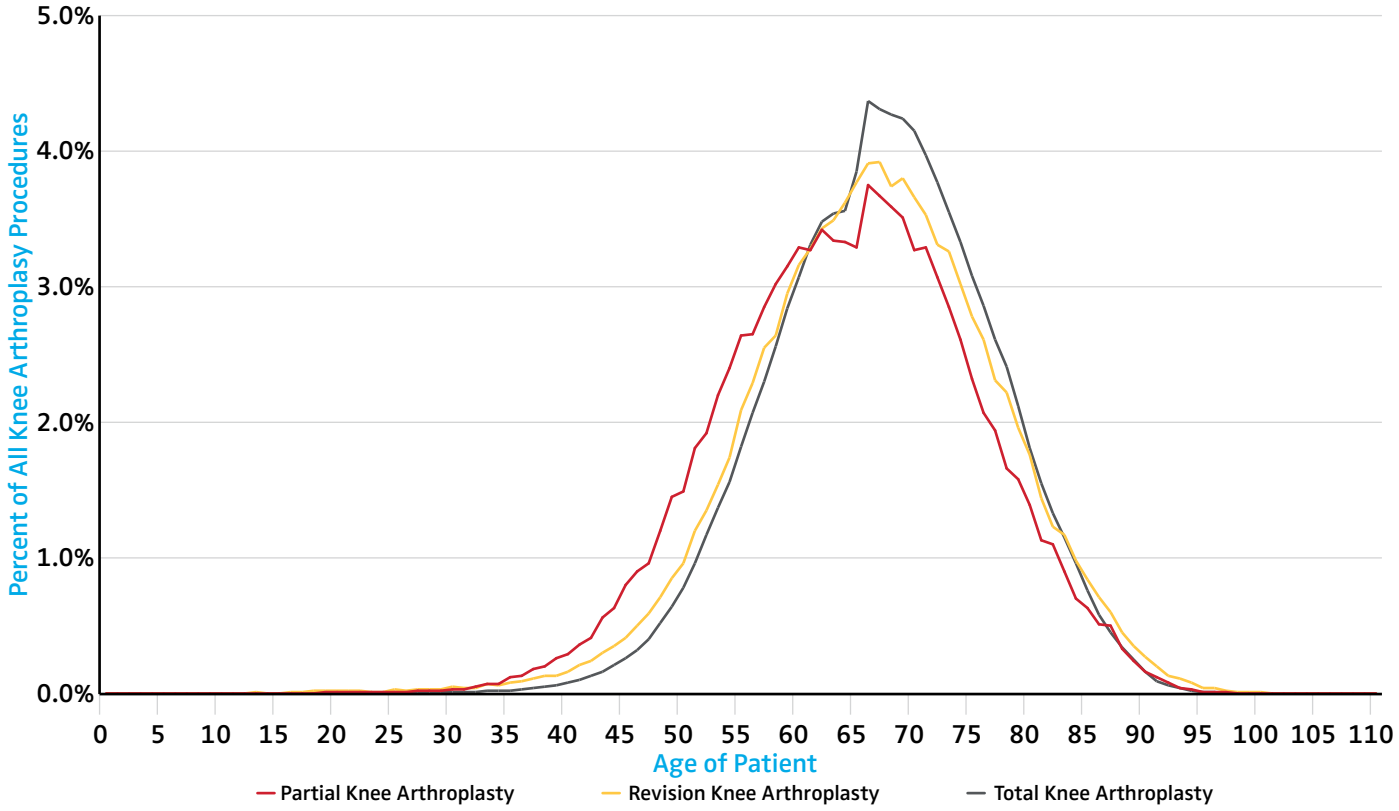
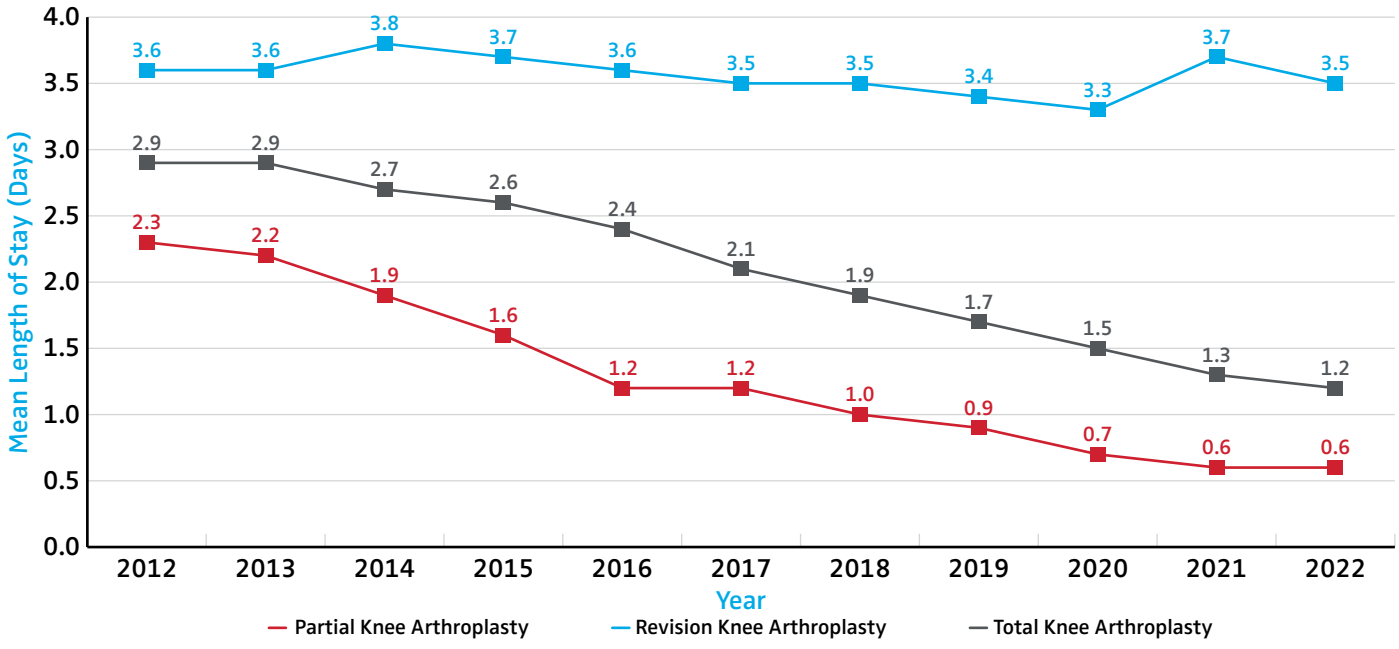


Figure 3.2 Mean Length of Stay for Knee Arthroplasty Procedures, 2012-2022 (N=1,151,042)



Primary Total Knee Arthroplasty

Between 2012 and 2022, AJRR has collected data on 1,606,678 primary total knee arthroplasty procedures.

More than half of patients at all age points receiving a total knee arthroplasty were female (Figure 3.3). The sex distribution of patients increases slightly over each decade but remains fairly consistent as age increases. More than half of all primary total knee arthroplasty procedures utilized posterior stabilized implants until 2019 when that rate dropped below 50%. Cruciate retaining designs increased annually since 2017 to reach 56.1% in 2022. The use of ultracongruent components doubled from 2012-2020 but has slightly decreased in the last two years (Figure 3.4).

INSIGHTS

The trend towards increased use of cruciate retaining designs for primary total knee arthroplasty continues at the expense of posterior stabilized designs.

Figure 3.3 Sex Distribution of All Total Knee Arthroplasty Procedures by Age Group, 2012-2022 (N=1,601,427)

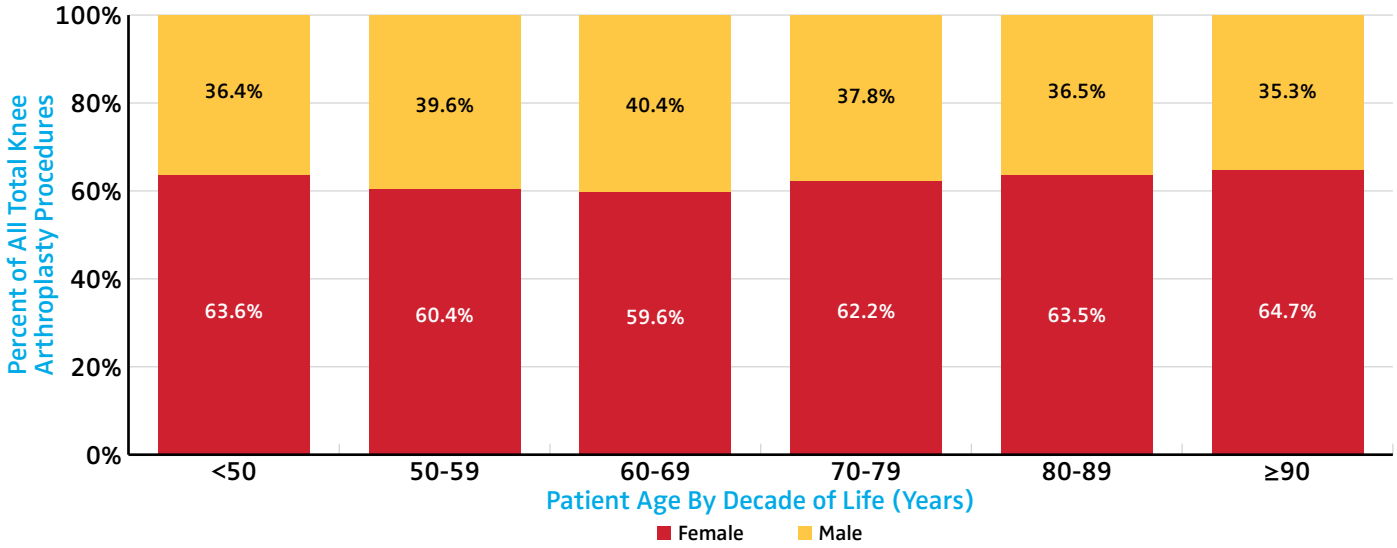
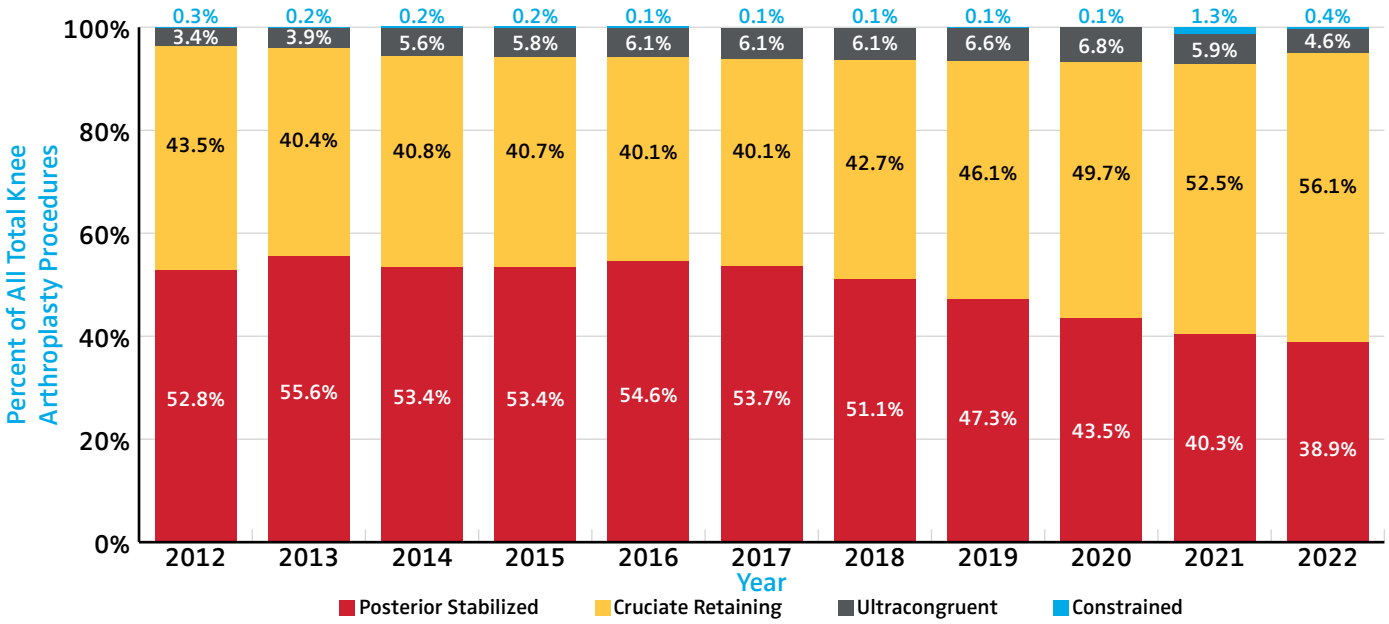


Figure 3.4 Distribution of Primary Total Knee Arthroplasty Implant Designs, 2012-2022 (N=1,245,884)

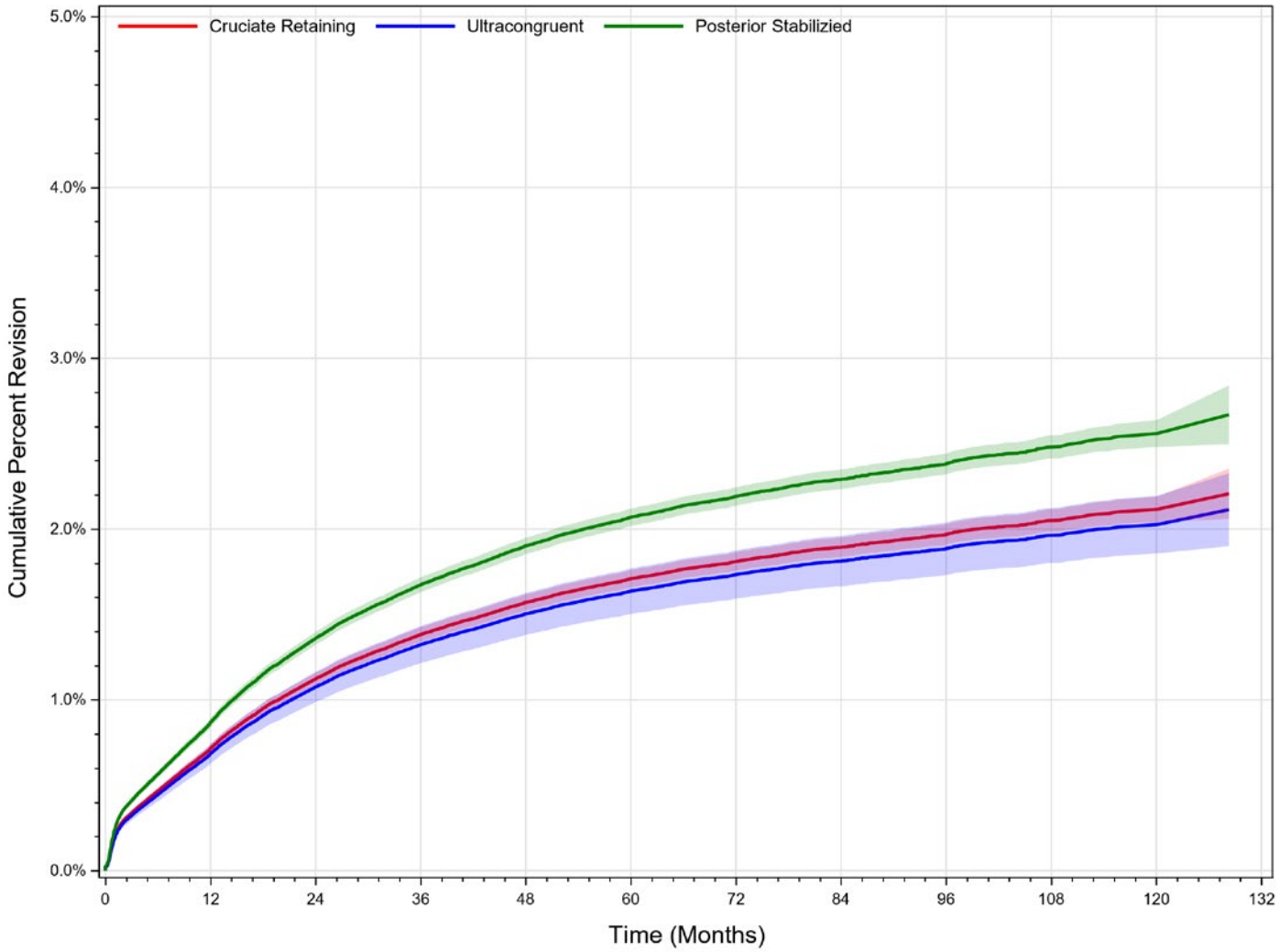


After adjusting for age, sex, and CCI in patients ≥65 years of age as reported to either AJRR or CMS, ultracongruent and cruciate retaining designs showed significantly reduced cumulative percent revision compared to posterior stabilized designs; adjusted hazard ratio (HR) of 0.8 (Figure 3.5). This analysis does not account for numerous potential confounders and the reasons for revision may be unrelated to the implant type. See Appendix G for cumulative percent revision curve methodology.

INSIGHTS

Cruciate retaining and ultracongruent implants are associated with reduced rates of cumulative revision when compared to posterior stabilized designs in the AJRR.

Figure 3.5 Cumulative Percent Revision for Primary Total Knee Arthroplasty Implant Designs in Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cruciate Retaining	296,510	262,554	227,876	196,959	160,467	124,299	86,536	54,266	30,635	14,340	4,561	4
Posterior Stabilizied	331,098	303,431	275,340	246,563	208,284	165,077	114,311	69,399	38,317	17,301	4,612	1
Ultracongruent	39,755	36,220	31,914	27,574	22,125	16,938	11,046	6,661	3,488	1,227	328	1
Total	667,363	602,205	535,130	471,096	390,876	306,314	211,893	130,326	72,440	32,868	9,501	6

Age/Sex/CCI adjusted HR (95%CI), p-value
Cruciate Retaining vs. Posterior Stabilizied: 0.824(0.79,0.86), p<0.0001
Ultracongruent vs. Posterior Stabilizied: 0.789(0.718,0.867), p<0.0001

For primary total knee arthroplasty procedures in the AJRR, antioxidant polyethylene usage substantially increased at the expense of non-antioxidant polyethylene inserts (including conventional UHMWPE and highly cross-linked) between 2012 and 2022 (Figure 3.6). No statistical difference was found across polyethylene groups, when comparing cumulative percent revision adjusted for age, sex, and CCI in Medicare patients aged 65 and older. A highly cross-linked polyethylene insert is defined by having received a total radiation dose of 50 kGy (5 Mrad) or more. Antioxidant polyethylene is a highly cross-linked polyethylene with an antioxidant component infused or blended in manufacturing (Figure 3.7).

INSIGHTS

The use of conventional polyethylene continues to decrease in primary total knee arthroplasty.

INSIGHTS

The majority of primary total knee arthroplasties continue to include a resurfaced patella although a slight decrease in resurfaced patellae over time is apparent.

Patellar resurfacing in the AJRR shows a decreased utilization over time but was still performed in 89% of procedures in 2022 (Figure 3.8). While patellar resurfacing remains the predominant practice in the U.S., this is not necessarily the case in other international registries. In 2022, the Australian Orthopaedic Association National Joint Replacement Registry reported patellar resurfacing at the time of the primary total knee replacement had increased from a low of 41.5% in 2005 to 76.1% in 2021.[7] The Swedish Arthroplasty Register reported use of patellar resurfacing has been decreasing since the mid-1980s and in 2021 there were no reported cases of patellar resurfacing for total knee arthroplasty.[9]

Figure 3.6 Primary Total Knee Arthroplasty Insert Polyethylene Material by Year, 2012-2022 (N=1,261,461)

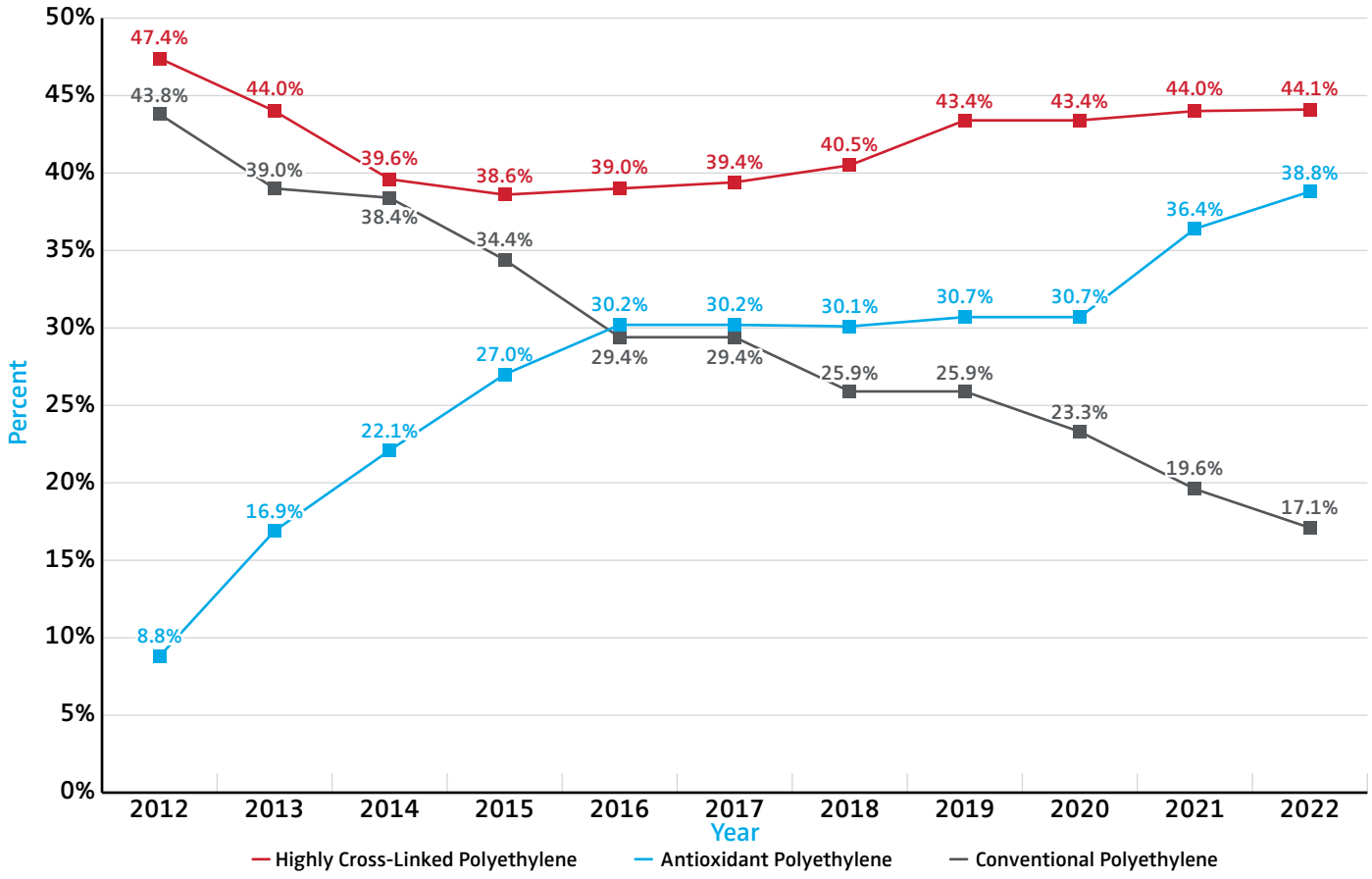
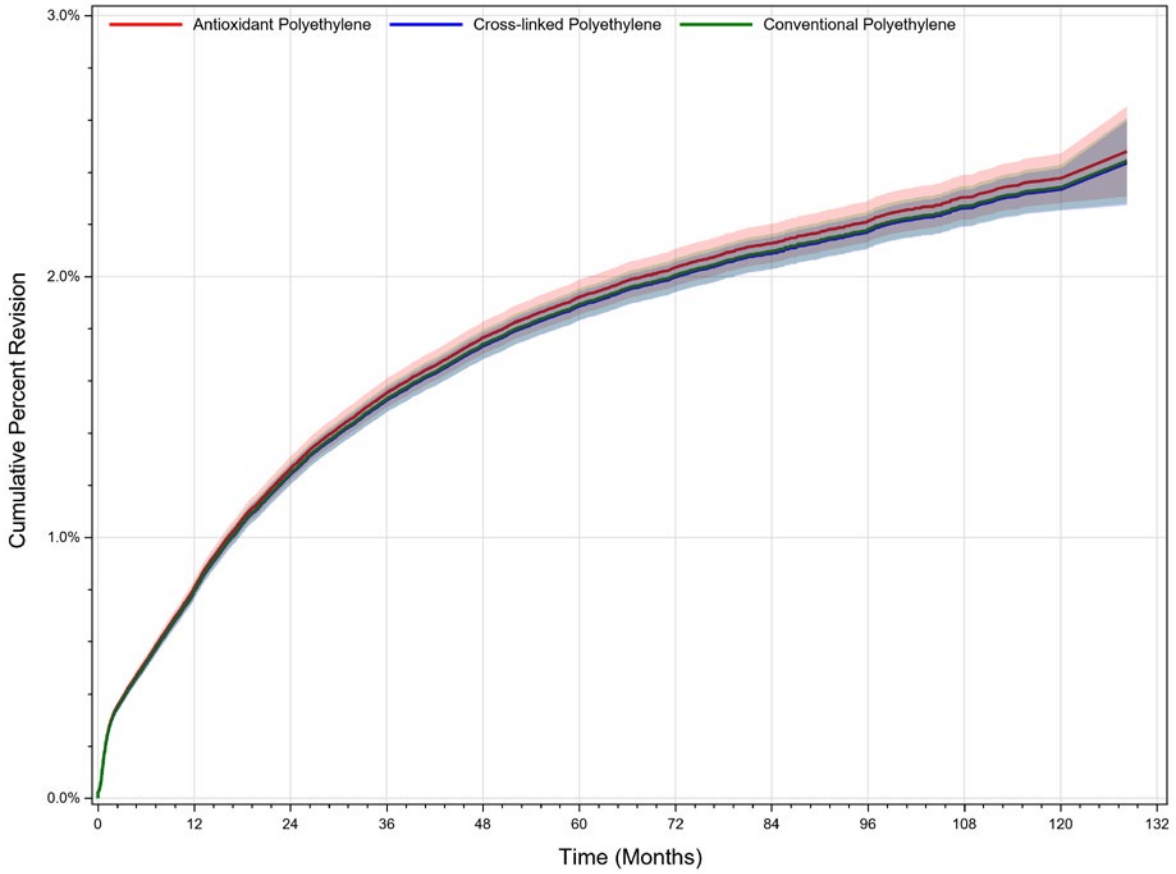


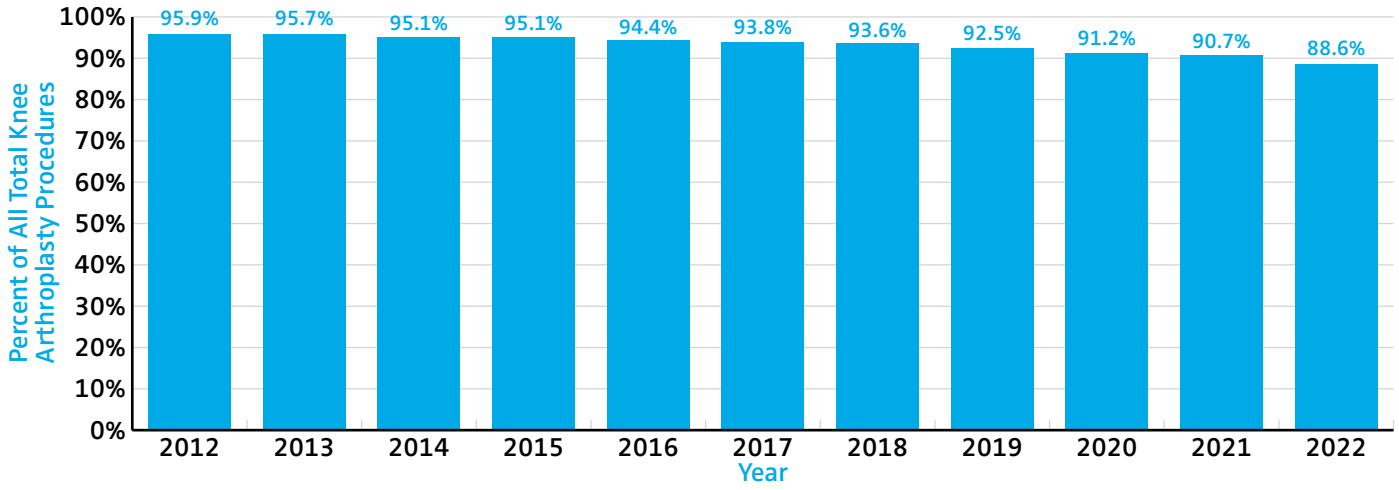
Figure 3.7 Cumulative Percent Revision for Polyethylene Material for Primary Total Knee Arthroplasty for Medicare Patients 65 Years of Age and Older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Antioxidant Polyethylene	191,967	167,344	143,728	123,680	100,409	75,827	48,349	25,585	11,381	3,778	540	1
Conventional Polyethylene	210,804	196,558	180,473	163,705	140,602	113,647	82,186	53,613	31,601	14,717	4,614	1
Cross-linked Polyethylene	266,535	238,838	210,674	183,226	149,315	116,503	81,420	51,301	29,582	14,425	4,364	4
Total	669,306	602,740	534,875	470,611	390,326	305,977	211,955	130,499	72,564	32,920	9,518	6

Age/Sex/CCI adjusted HR (95%CI), p-value
Antioxidant Polyethylene vs. Conventional Polyethylene: 1.015(0.963,1.069), p=0.5810
Cross-linked Polyethylene vs. Conventional Polyethylene: 0.996(0.95,1.045), p=0.8769

Figure 3.8 Percentage of Primary Total Knee Arthroplasty with Patellar Resurfacing, 2012-2022 (N=1,135,842)

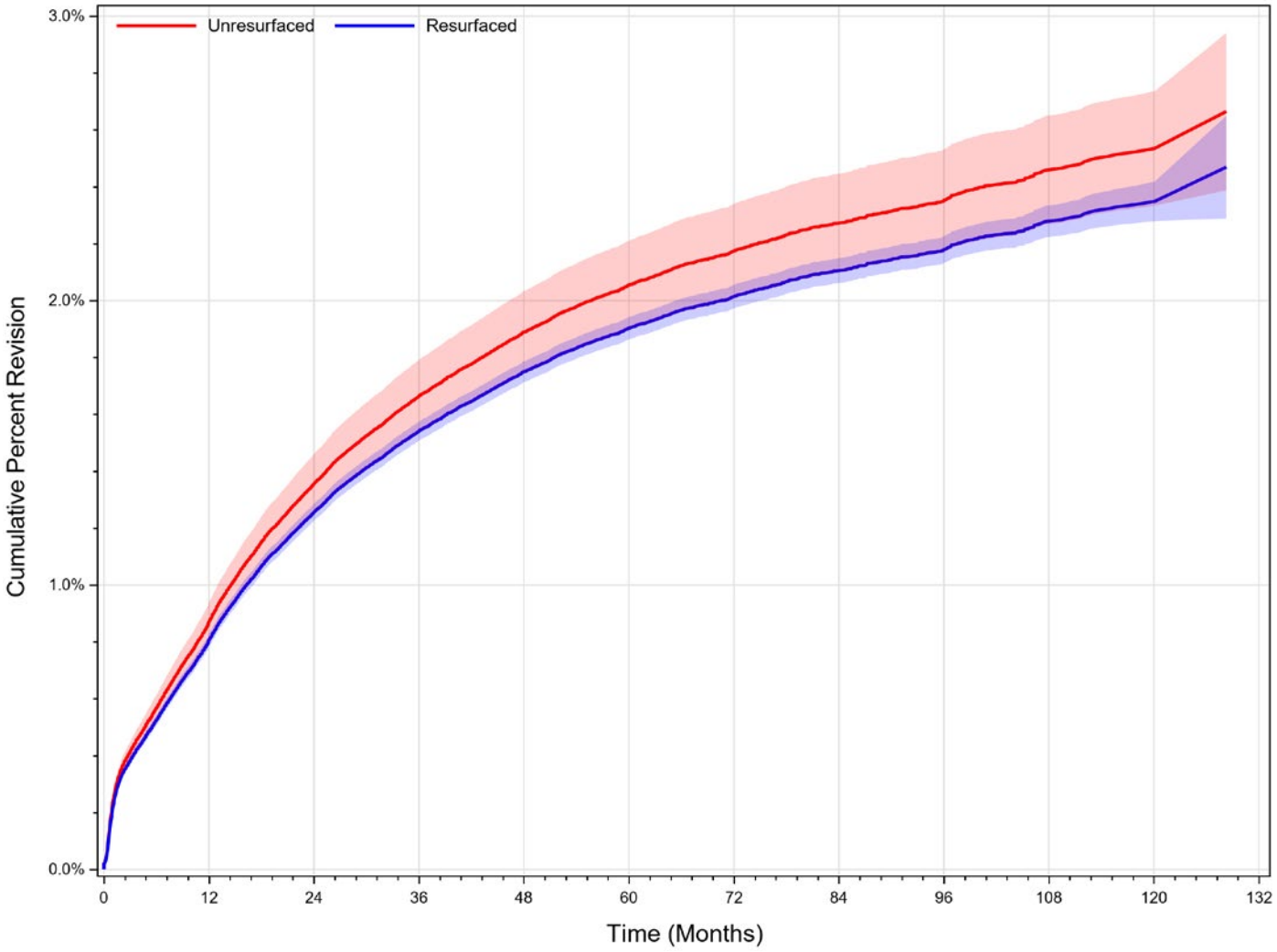


Cases with resurfaced patellae showed no difference in cumulative percent revision compared to cases where the patella was left unresurfaced in patients 65 years of age and older in either AJRR or CMS after adjusting by age, sex, and CCI (HR=1.081, 95% CI, 0.992-1.178, p=0.077). However, there were far more procedures with resurfaced patellae, and this finding does not account for numerous potential confounders (Figures 3.9).

Patellar resurfacing did not have a statistically different cumulative percent revision compared to those without resurfacing in patients aged 65 years and older.

INSIGHTS

Figure 3.9 Cumulative Percent Revision for Total Knee Arthroplasty Patellar-Resurfacing in Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Resurfaced	565,574	509,856	452,519	398,435	330,099	257,276	177,013	108,003	58,534	25,953	7,371	4
Unresurfaced	37,929	32,093	26,893	22,349	17,354	12,930	8,284	4,863	2,638	1,096	314	2
Total	603,503	541,949	479,412	420,784	347,453	270,206	185,297	112,866	61,172	27,049	7,685	6

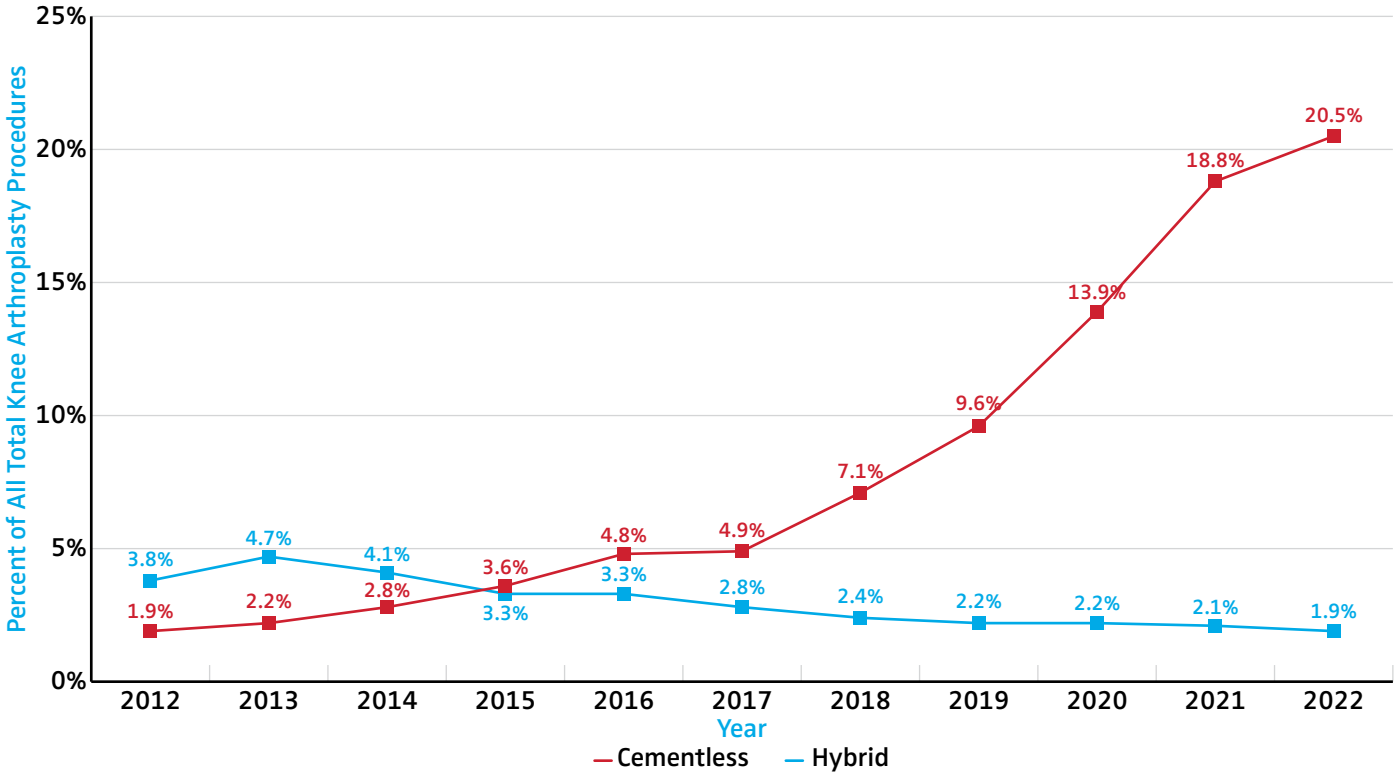
Age/Sex/CCI adjusted HR (95%CI), p-value
Unresurfaced vs. Resurfaced: *1.081(0.992,1.178), p=0.0770*

In the United States, the use of polymethylmethacrylate (bone cement) for the fixation of primary total knee arthroplasty components is typical. However, the use of cementless fixation has seen a substantial increase since 2012 ($p<0.0001$) (Figure 3.10). Similarly, the Swedish Arthroplasty Register reported in their 2022 Annual Report that cementless fixation had become slightly more common and was now used in 9.1% of the total knee arthroplasties.[9] In the 2022 National Joint Registry, more than 84% of all primary total knee arthroplasties utilized all cemented fixation and 4.1% used all cementless or hybrid total knee replacements.[8]

INSIGHTS

The use of cementless fixation in primary total knee arthroplasty is rapidly increasing in the AJRR and was reported for 20% of all primary total knee arthroplasties in 2022.

Figure 3.10 Distribution of Hybrid and Cementless Fixation Utilization for Primary Total Knee Arthroplasty, 2012-2022 (N=1,134,357)

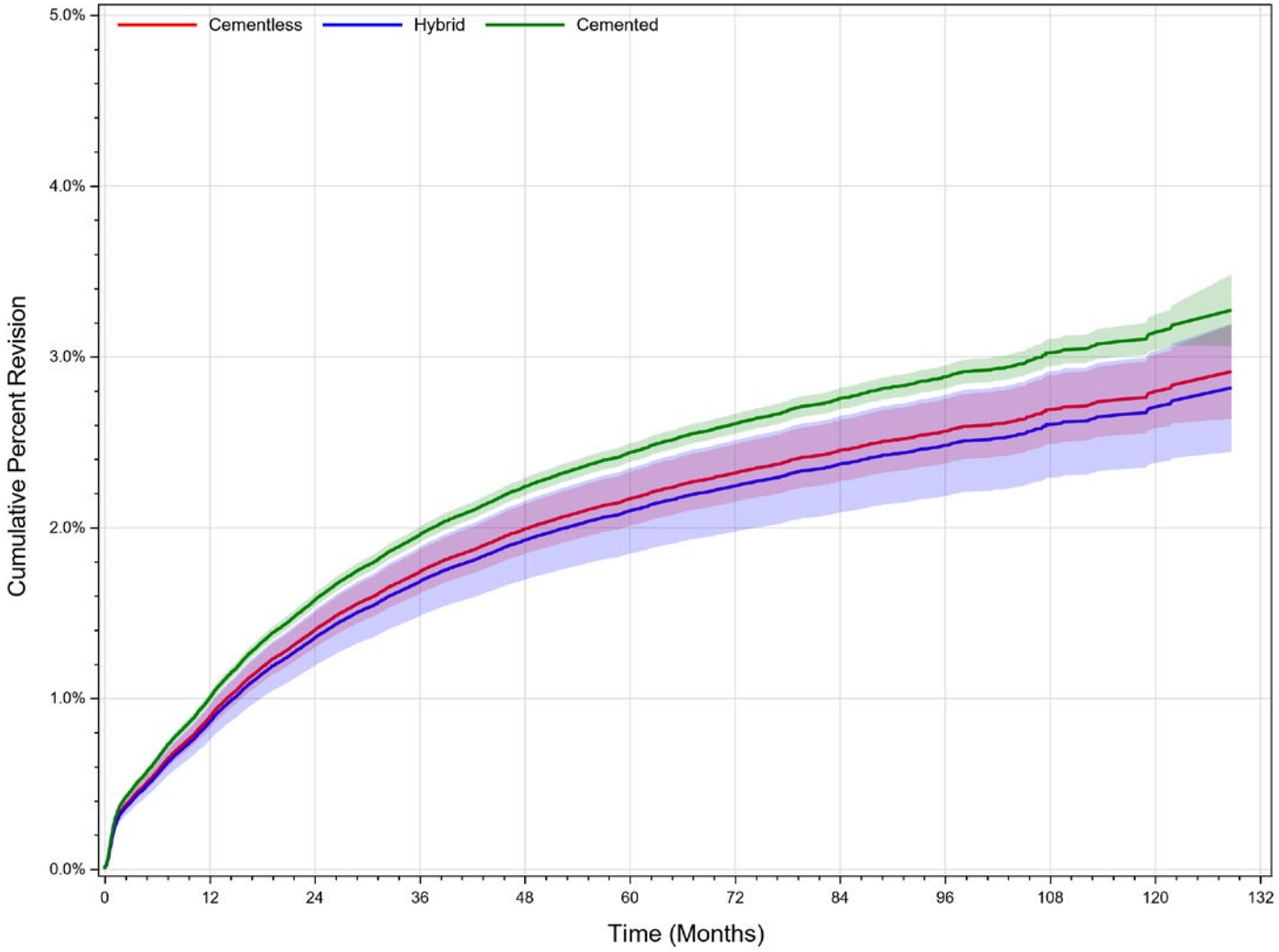


INSIGHTS

Compared to cemented fixation, cementless fixation for primary total knee arthroplasty is associated with a reduced rate of cumulative percent revision in all-age men but a significantly increased rate in women age 65 and older.

Cementless and hybrid fixation were found to be associated with decreased cumulative percent revision compared to cemented fixation in males for both <65 and 65 and older cohorts in the AJRR database. Conversely, cemented fixation was found to have significantly lower cumulative revision in females aged 65 and older; no significant difference was found in young females (Figures 3.11-3.14). This finding does not account for numerous potential confounders.

Figure 3.11 Cumulative Percent Revision for Cemented Versus Cementless Fixation Primary Total Knee Arthroplasty in Male Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



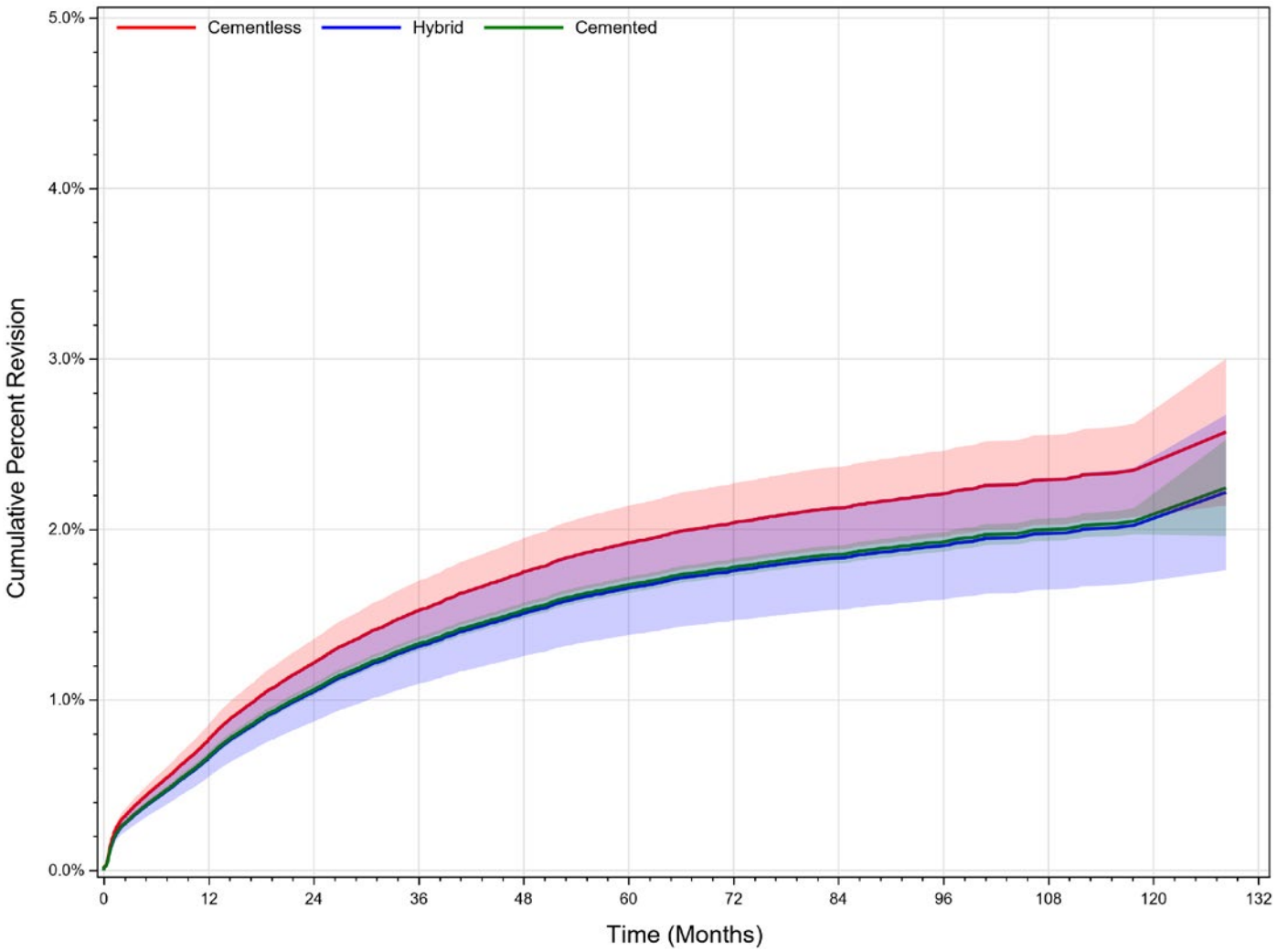
Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	373,105	329,914	294,946	260,352	218,740	173,740	122,036	76,529	42,561	19,028	5,598	4
Cementless	47,354	34,676	25,536	18,775	13,303	9,154	5,833	3,029	1,501	574	162	1
Hybrid	12,620	11,518	10,480	9,542	8,452	7,069	5,335	3,533	2,193	1,004	274	1
Total	433,079	376,108	330,962	288,669	240,495	189,963	133,204	83,091	46,255	20,606	6,034	6

Age/CCI adjusted HR (95%CI), p-value
Cementless vs. Cemented: *0.888(0.815,0.967) p=0.0065*
Hybrid vs. Cemented: *0.859(0.753,0.979) p=0.0227*

INSIGHTS

No significant differences were found between fixation cohorts for primary total knee arthroplasty when evaluating revision for infection in patients ≥65 years of age.

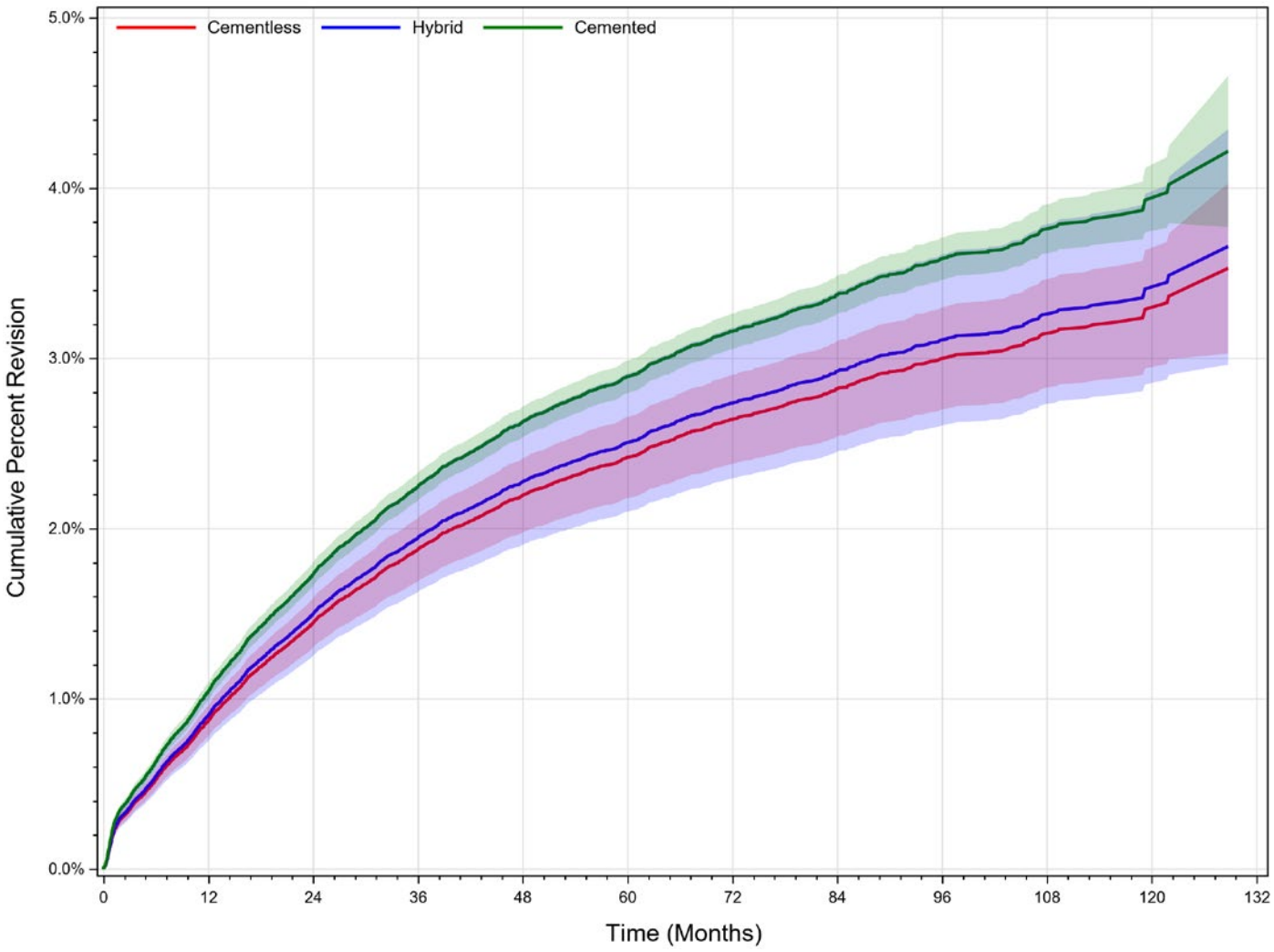
Figure 3.12 Cumulative Percent Revision for Cemented Versus Cementless Fixation Primary Total Knee Arthroplasty in Female Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	337,844	305,981	272,994	241,144	199,807	156,088	107,231	66,369	36,681	16,236	4,557	1
Cementless	22,108	16,902	12,225	8,920	6,069	4,046	2,668	1,381	543	183	45	2
Hybrid	8,647	7,949	7,162	6,447	5,495	4,576	3,422	2,255	1,398	640	139	1
Total	368,599	330,832	292,381	256,511	211,371	164,710	113,321	70,005	38,622	17,059	4,741	4

Age/CCI adjusted HR (95%CI), p-value
Cementless vs. Cemented: *1.148 (1.007,1.309) p=0.0384*
Hybrid vs. Cemented: *0.988 (0.827,1.181) p=0.8978*

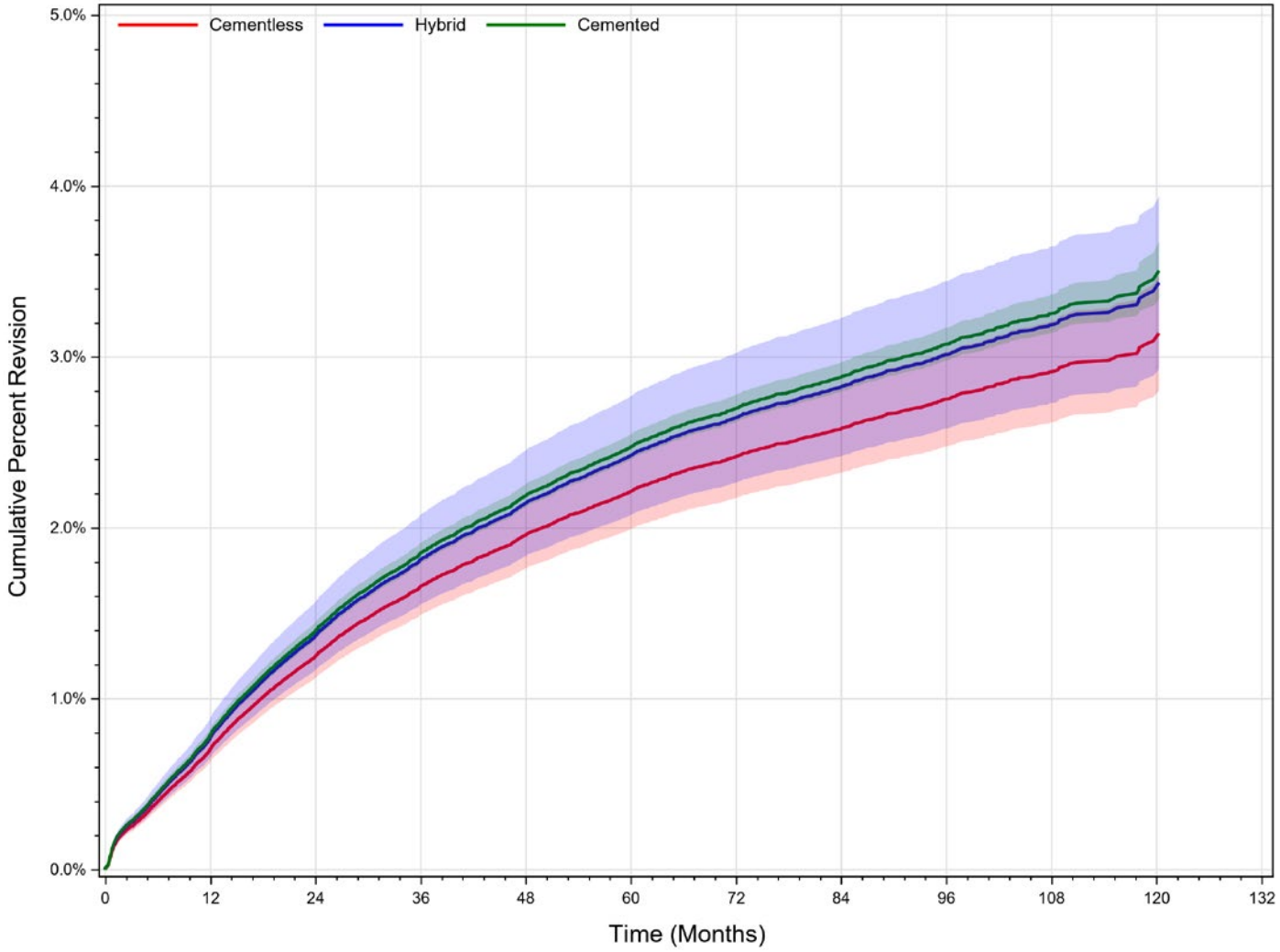
Figure 3.13 Cumulative Percent Revision for Cemented Versus Cementless Fixation Primary Total Knee Arthroplasty in Male Patients less than 65 Years of Age with Primary Osteoarthritis in AJRR Only, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	141,277	127,596	115,230	102,490	87,755	71,064	51,155	33,013	18,644	8,402	2,583	1
Cementless	23,316	17,785	13,359	10,066	7,372	5,248	3,313	1,731	924	385	110	1
Hybrid	5,857	5,349	4,879	4,447	4,009	3,341	2,490	1,648	1,049	491	142	1
Total	170,450	150,730	133,468	117,003	99,136	79,653	56,958	36,392	20,617	9,278	2,835	3

Age/CCI adjusted HR (95%CI), p-value
Cementless vs. Cemented: *0.833 (0.741,0.937) p=0.0024*
Hybrid vs. Cemented: *0.864 (0.721,1.036) p=0.1148*

Figure 3.14 Cumulative Percent Revision for Cemented Versus Cementless Fixation Primary Total Knee Arthroplasty in Female Patients less than 65 Years of Age with Primary Osteoarthritis in AJRR Only, 2012-2022

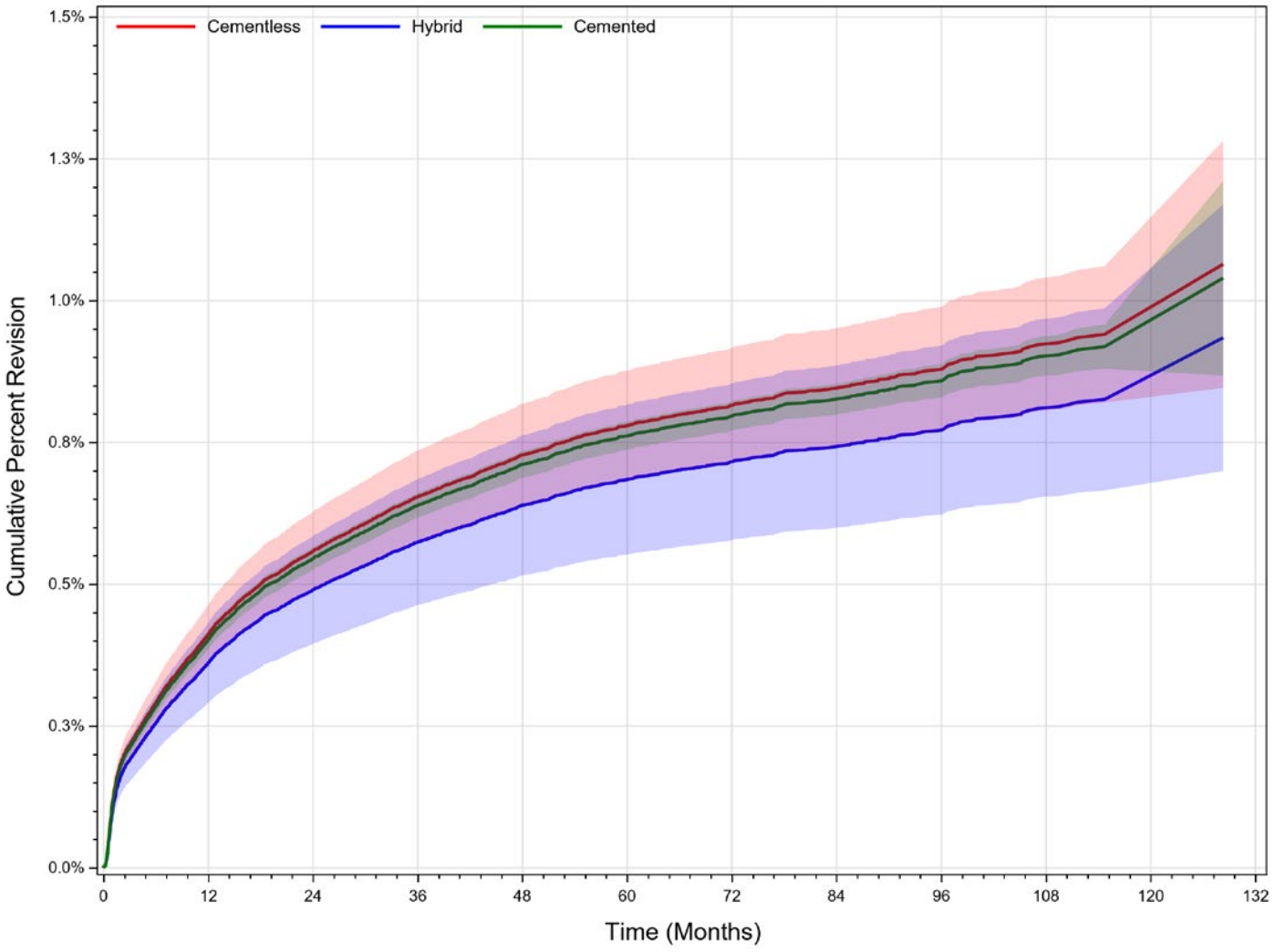


Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	209,764	189,038	170,589	151,632	129,143	104,221	74,652	47,937	27,481	12,178	3,558	1
Cementless	25,852	19,499	14,482	10,895	7,803	5,444	3,546	1,837	910	361	101	2
Hybrid	7,556	6,875	6,249	5,626	4,986	4,234	3,193	2,174	1,447	697	176	1
Total	243,172	215,412	191,320	168,153	141,932	113,899	81,391	51,948	29,838	13,236	3,835	4

Age/CCI adjusted HR (95%CI), p-value
Cementless vs. Cemented: *0.894 (0.797,1.002) p=0.0536*
Hybrid vs. Cemented: *0.98 (0.831,1.155) p=0.8063*

Diagnosis-specific survival rates with the end-point of infection were analyzed based on the method of component fixation. Figure 3.15 displays the results of diagnosis-specific cumulative percent revision. There was no significant difference in revision due to infection in elective primary TKA patients ≥65 years of age. This relationship was not statistically significant as was seen in prior Annual Reports.

Figure 3.15 Cumulative Percent Revision for Infection of Cemented Versus Cementless Fixation for a Primary Total Knee Arthroplasty in Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Cemented	547,708	496,406	443,425	391,482	325,343	254,791	175,145	107,999	59,470	26,395	7,435	4
Cementless	41,751	32,199	23,441	17,040	11,698	7,800	5,092	2,619	1,091	365	92	1
Hybrid	14,814	13,711	12,438	11,289	9,738	8,154	6,146	4,047	2,489	1,136	266	1
Total	604,273	542,316	479,304	419,811	346,779	270,745	186,383	114,665	63,050	27,896	7,793	6

Age/Sex adjusted cause-specific HR (95%CI), p-value
Cementless vs. Cemented: *1.024 (0.889,1.179), p=0.7436*
Hybrid vs. Cemented: *0.898 (0.733,1.1), p=0.2987*

The utilization of both computer navigation and robotics has increased substantially over the past few years. The percentage of elective primary total knee arthroplasty cases utilizing robotic assistance is now over 13% (Figure 3.16).

INSIGHTS

Over the past 6 years, the utilization of robotics in TKA has increased over 6-fold and is now reported in over 13% of procedures, whereas computer navigation use has remained relatively stable.

Figure 3.16 Rate of Technology Use for Assistance in Total Knee Arthroplasty, 2017-2022

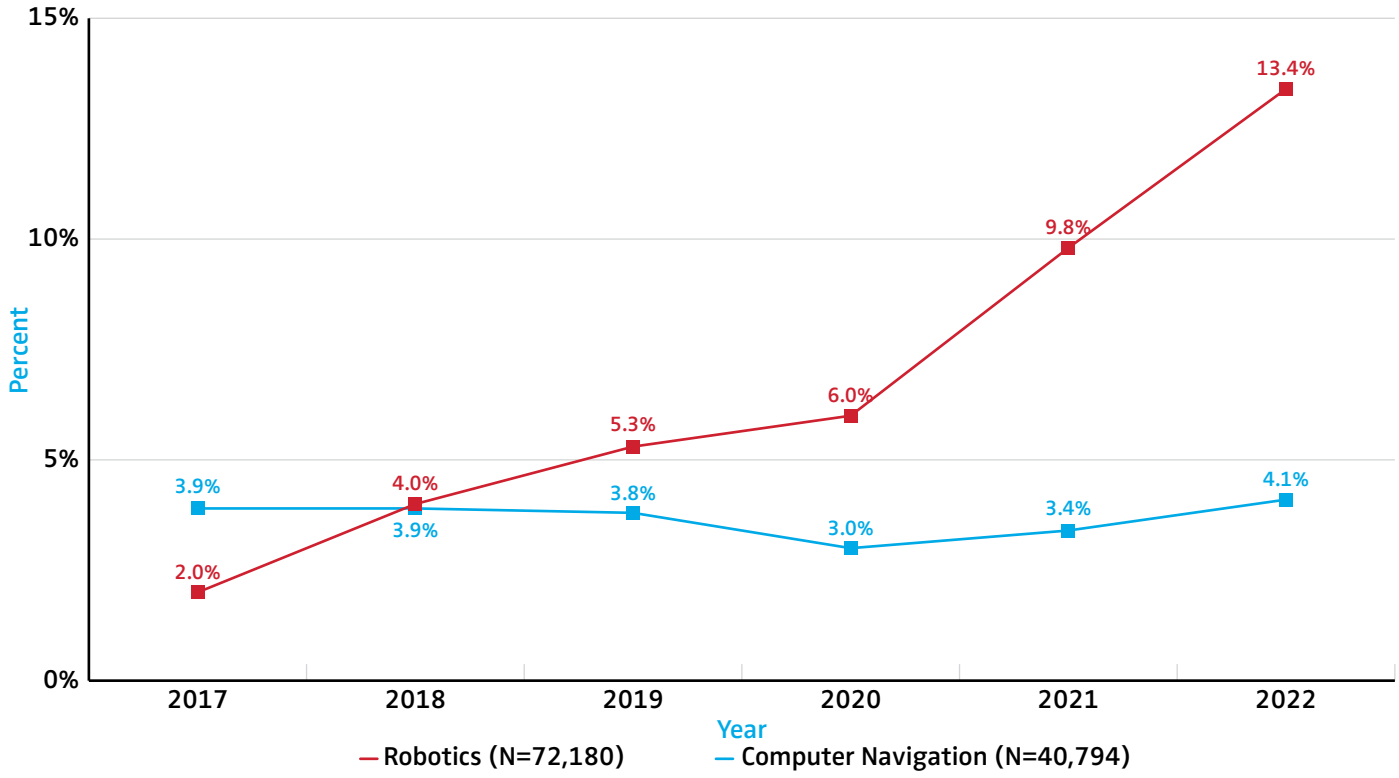
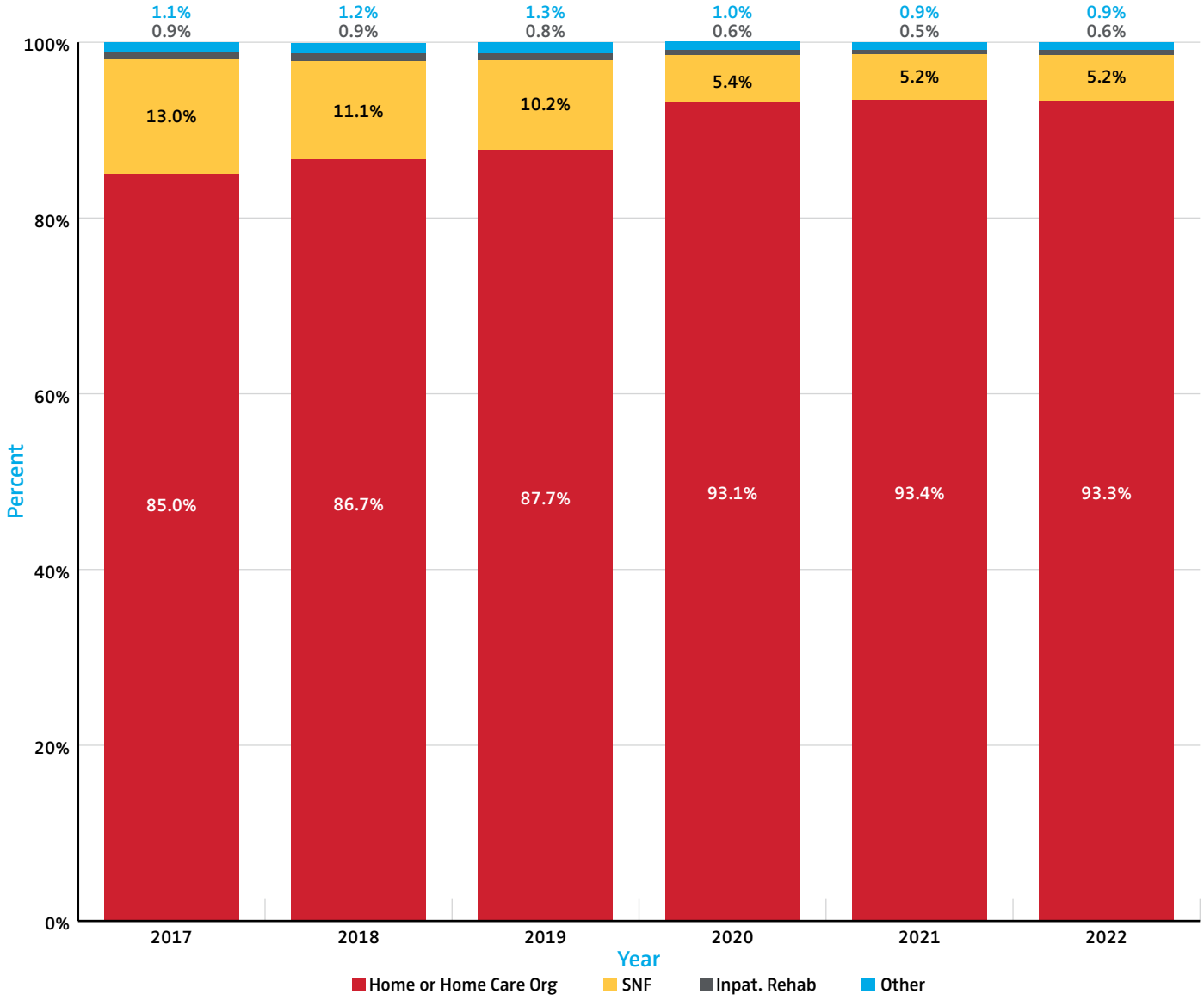


Figure 3.17 tabulates the discharge disposition reported for primary total knee arthroplasty procedures by year for the years 2017 through 2022, when data collection began. AJRR collects the CMS-defined Patient Discharge Status Code values. Discharge to home, represented by discharge codes 1 and 6, are reported in approximately 93% of procedures for the last three years. Discharge to a skilled nursing facility (SNF) dropped from 13.0% in 2017 to only 5.2% in 2022. Other discharge codes represent only a small portion of cases.

INSIGHTS

The percentage of patients being discharged to skilled nursing following primary total knee arthroplasty continues to decrease and now represents less than 6% of all discharges.

Figure 3.17 Total Knee Arthroplasty Discharge Disposition Codes by Year, 2012-2022 (N=910,086)



Code	Code Value
Home	Discharged to home/self-care (routine charge).
Home Care Org.	Discharged/transferred to home care of organized home health service organization.
SNF	Discharged/transferred to skilled nursing facility (SNF) with Medicare certification in anticipation of covered skilled care--(For hospitals with an approved swing bed arrangement, use Code 61 - swing bed. For reporting discharges/transfers to a non-certified SNF, the hospital must use Code 04 - ICF.)
Inpat. Rehab	Discharged/transferred to an inpatient rehabilitation facility including distinct parts units of a hospital (eff. 1/2002).

The use of general anesthesia without a regional block continues to decrease for primary total knee arthroplasty.

INSIGHTS

Figure 3.18 shows a tabulation of primary anesthesia techniques chosen for patients undergoing an elective primary total knee arthroplasty. Since 2017, general anesthesia use has decreased 31% while the slightly more commonly used spinal anesthesia has remained relatively steady. Use of combinations such as general and spinal with peripheral nerve block (PNB) have both more than doubled since 2017, and combined, account for approximately 20% of 2022 cases with anesthesia data.

Figure 3.18 Primary Total Knee Arthroplasty Anesthesia Type by Year, 2017-2022 (N=555,670)

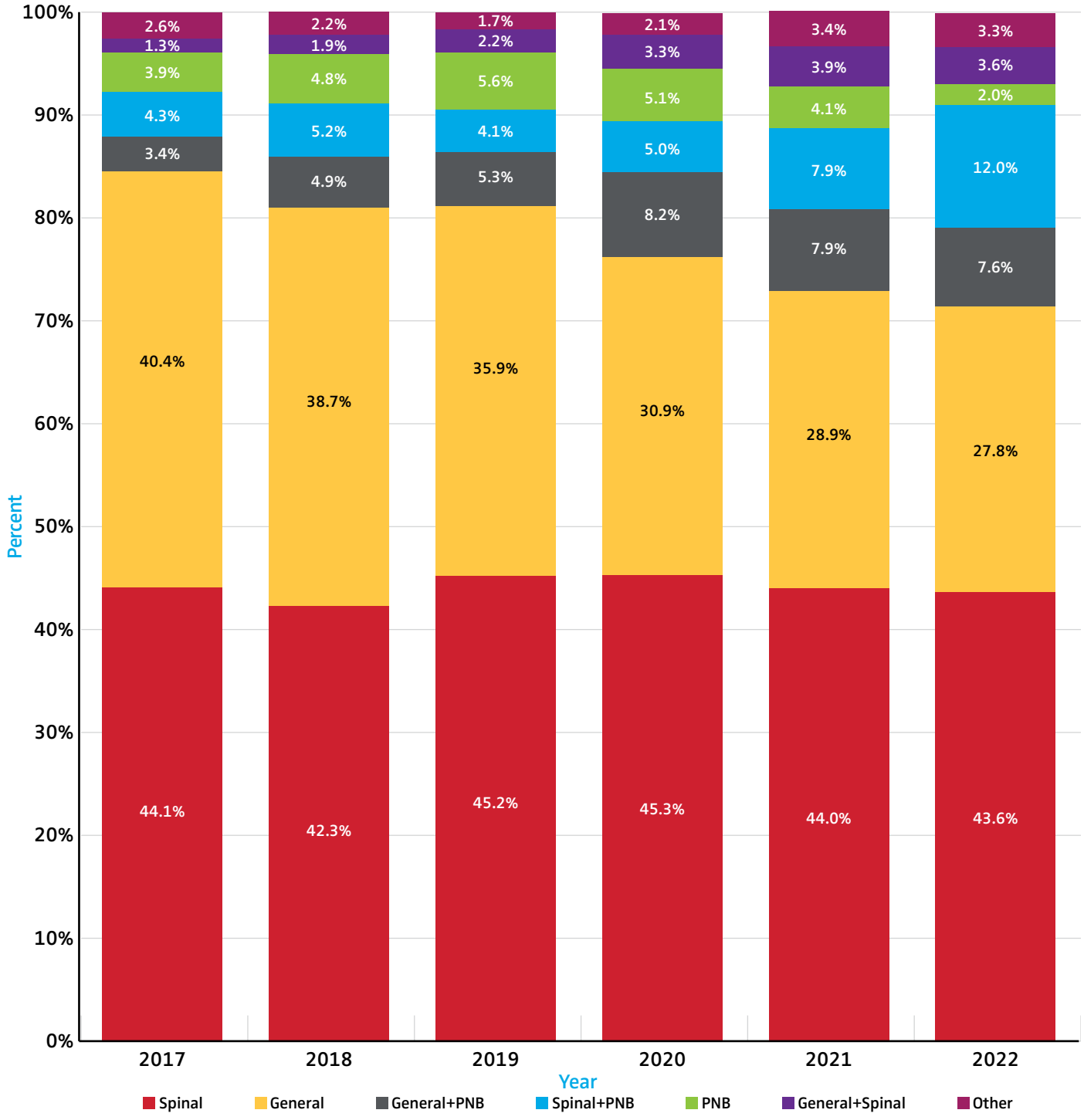
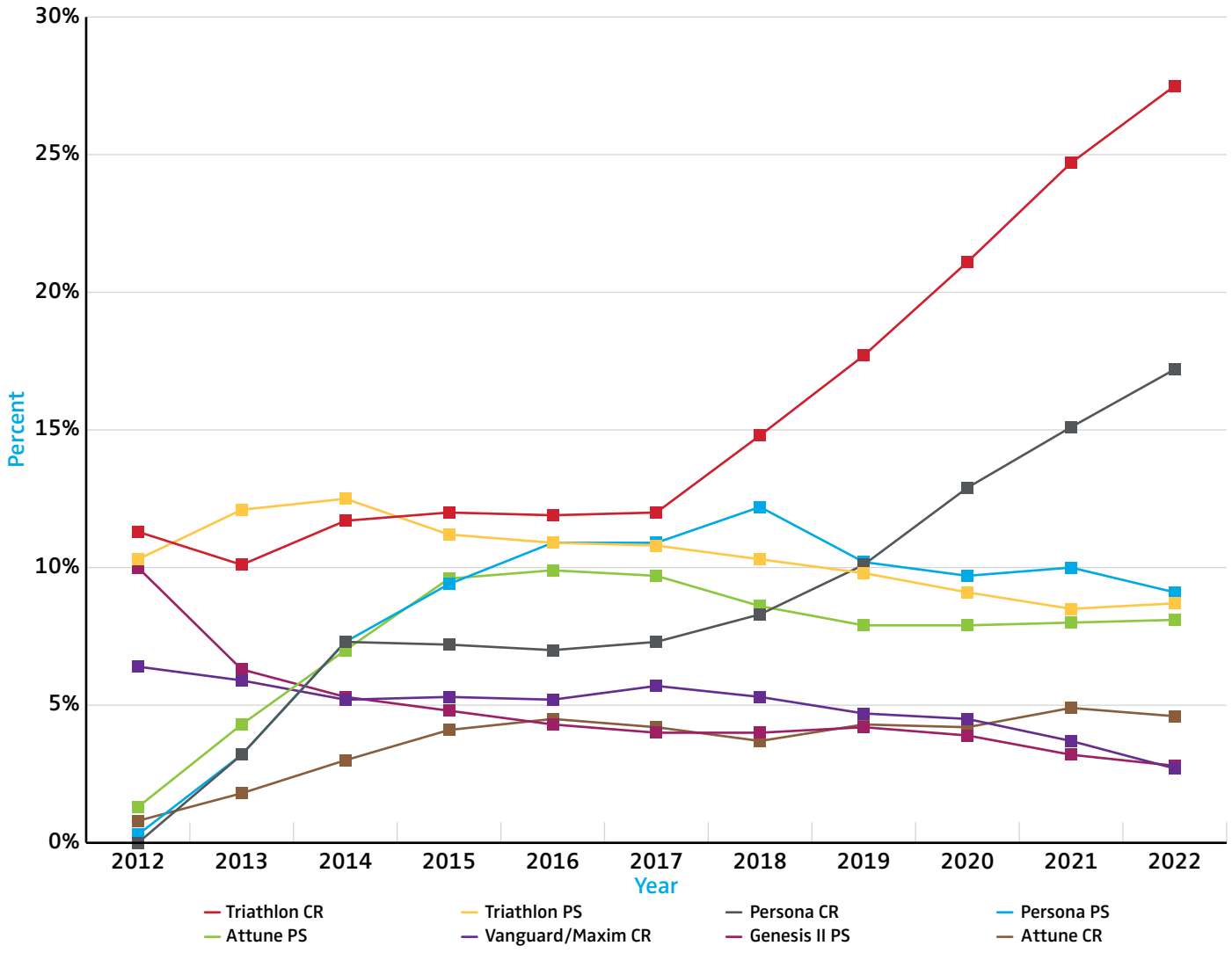


Figure 3.19 provides utilization data of implants used in primary total knee arthroplasty procedures in AJRR by year for the years 2012 through 2022. The eight most commonly implanted femoral and tibial component combinations along with their overall bearing design for TKA by year shows that for the eleven-year period, the combinations most frequently implanted have varied. Since 2015, the Triathlon cruciate retaining knee has been the most frequently implanted construct overall in the registry.

Figure 3.19 Primary Total Knee Arthroplasty Femoral/Tibial Component Combinations by Year, 2012-2022 (N=1,223,864)



The ability to look at revision rates for particular implants is one of the great strengths of the AJRR. The tables below (3.3-3.5) display cumulative percent revision stratified by knee constructs as well as bearing and fixation types with 95% confidence intervals. Unlike the hip device-specific survivorship curves which showed some divergence in the first year, the knee-device curves showed very little divergence for both posterior stabilized and minimally stabilized (cruciate retaining) constructs. With the exception of Optetrak Logic CR, all TKA device constructs included in analysis have a cumulative percent revision of less than 2.3% at three years and less than 4.1% at final follow-up for each respective device. The aggregate of included cemented, hybrid, or cementless devices was less than 2.2% cumulative percent revision at ten years.

Table 3.3 Unadjusted Cumulative Percent Revision of Cemented Knee Arthroplasty Construct Combinations for Primary Total Knee Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Femoral Component	Tibial Component	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Triathlon CR	Triathlon	80,782	1,053	0.67 (0.62, 0.73)	1.20 (1.13, 1.29)	1.46 (1.37, 1.56)	1.61 (1.51, 1.72)	1.79 (1.65, 1.95)
Persona PS	Persona	69,949	1,172	0.74 (0.68, 0.81)	1.49 (1.40, 1.58)	1.84 (1.73, 1.95)	2.09 (1.96, 2.22)	2.15 (2.01, 2.29)
Persona CR	Persona	67,253	737	0.61 (0.55, 0.67)	1.10 (1.02, 1.19)	1.31 (1.21, 1.41)	1.45 (1.34, 1.57)	1.57 (1.41, 1.74)
Triathlon PS	Triathlon	63,209	1,127	0.87 (0.80, 0.95)	1.56 (1.46, 1.66)	1.87 (1.76, 1.98)	2.00 (1.88, 2.12)	2.22 (2.07, 2.38)
Attune PS	Attune	55,797	1,048	0.79 (0.72, 0.87)	1.61 (1.50, 1.72)	2.01 (1.89, 2.14)	2.26 (2.12, 2.41)	2.58 (2.29, 2.89)
Vanguard CR	Maxim	31,925	473	0.66 (0.57, 0.75)	1.27 (1.15, 1.40)	1.55 (1.41, 1.70)	1.69 (1.54, 1.85)	1.88 (1.68, 2.10)
Genesis II PS	Genesis II	29,559	647	1.01 (0.90, 1.13)	1.92 (1.76, 2.09)	2.33 (2.15, 2.51)	2.54 (2.34, 2.74)	2.63 (2.41, 2.87)
Attune CR	Attune	27,486	368	0.65 (0.56, 0.75)	1.21 (1.08, 1.35)	1.50 (1.34, 1.66)	1.66 (1.49, 1.84)	1.70 (1.51, 1.90)
Sigma CR	PFC Sigma	21,202	272	0.59 (0.49, 0.70)	0.99 (0.86, 1.13)	1.25 (1.10, 1.42)	1.40 (1.23, 1.58)	1.58 (1.38, 1.79)
Journey II PS	Journey II	21,052	416	1.08 (0.95, 1.23)	1.97 (1.78, 2.18)	2.27 (2.06, 2.50)	2.31 (2.09, 2.54)	2.77 (2.12, 3.55)
Sigma PS	PFC Sigma	20,349	367	0.72 (0.61, 0.85)	1.37 (1.22, 1.54)	1.76 (1.58, 1.96)	2.00 (1.80, 2.22)	2.12 (1.90, 2.35)
Vanguard PS	Maxim	16,519	350	0.93 (0.79, 1.09)	1.79 (1.59, 2.01)	2.22 (1.99, 2.47)	2.37 (2.13, 2.63)	2.58 (2.29, 2.90)
NexGen LPS-Flex PS	NexGen	15,122	319	0.82 (0.69, 0.98)	1.55 (1.36, 1.76)	1.99 (1.77, 2.23)	2.23 (1.99, 2.48)	2.43 (2.14, 2.76)
Genesis II CR	Genesis II	14,683	230	0.74 (0.61, 0.89)	1.41 (1.22, 1.62)	1.71 (1.50, 1.95)	1.84 (1.61, 2.10)	1.84 (1.61, 2.10)
Legion PS	Genesis II	14,426	262	0.82 (0.68, 0.97)	1.52 (1.33, 1.74)	1.97 (1.74, 2.23)	2.17 (1.91, 2.46)	2.34 (1.98, 2.74)
Sigma PS	MBT	8,607	209	0.83 (0.65, 1.04)	1.57 (1.32, 1.85)	2.20 (1.89, 2.54)	2.66 (2.31, 3.06)	3.16 (2.70, 3.69)
Legion CR	Genesis II	7,026	109	0.69 (0.52, 0.91)	1.48 (1.20, 1.80)	1.78 (1.46, 2.14)	1.85 (1.52, 2.23)	1.85 (1.52, 2.23)
Natural-Knee II GS CR	Natural-Knee II GS	6,726	92	0.57 (0.41, 0.77)	1.08 (0.85, 1.35)	1.39 (1.12, 1.71)	1.55 (1.25, 1.90)	1.65 (1.32, 2.03)
Evolution MP PS	Evolution MP	6,593	135	0.71 (0.52, 0.93)	1.68 (1.37, 2.02)	2.22 (1.86, 2.64)	2.51 (2.10, 2.97)	2.55 (2.13, 3.02)
EMPOWR 3D CR	EMPOWR	5,253	85	0.89 (0.66, 1.17)	1.55 (1.23, 1.93)	1.92 (1.54, 2.37)	1.92 (1.54, 2.37)	—
Apex Knee CR	Apex Knee	4,968	96	0.90 (0.66, 1.19)	1.85 (1.48, 2.27)	2.24 (1.81, 2.73)	2.40 (1.92, 2.95)	2.40 (1.92, 2.95)
GMK Sphere CR	GMK Primary	4,555	60	0.71 (0.50, 1.00)	1.44 (1.10, 1.86)	1.66 (1.26, 2.14)	1.66 (1.26, 2.14)	—
NexGen CR-Flex CR	NexGen	4,165	66	0.48 (0.30, 0.73)	1.17 (0.88, 1.54)	1.44 (1.11, 1.85)	1.61 (1.25, 2.05)	1.94 (1.40, 2.62)
Sigma CR	MBT	3,289	70	0.88 (0.61, 1.25)	1.55 (1.16, 2.02)	2.19 (1.72, 2.75)	2.31 (1.82, 2.91)	2.31 (1.82, 2.91)
EMPOWR PS	EMPOWR	1,993	30	1.02 (0.64, 1.55)	1.55 (1.06, 2.19)	1.64 (1.13, 2.31)	1.64 (1.13, 2.31)	—
NexGen CR-Flex CR	NexGen Pegged	1,900	29	0.70 (0.39, 1.17)	1.33 (0.88, 1.95)	1.54 (1.04, 2.20)	1.73 (1.17, 2.45)	1.73 (1.17, 2.45)
NexGen LPS-Flex GS PS	NexGen	1,532	37	0.85 (0.48, 1.43)	1.86 (1.26, 2.66)	2.35 (1.65, 3.25)	2.63 (1.87, 3.59)	2.98 (2.02, 4.22)
LCS Complete CR	MBT	1,278	23	0.55 (0.25, 1.09)	1.18 (0.69, 1.90)	1.64 (1.03, 2.48)	1.97 (1.28, 2.91)	1.97 (1.28, 2.91)
Optetrak Logic PS	Optetrak Logic	1,231	41	0.97 (0.54, 1.66)	1.87 (1.22, 2.75)	2.29 (1.56, 3.24)	3.96 (2.84, 5.35)	3.96 (2.84, 5.35)
NexGen CR	NexGen	1,036	10	0.29 (0.08, 0.81)	0.50 (0.19, 1.12)	0.85 (0.40, 1.63)	1.13 (0.58, 2.03)	1.13 (0.58, 2.03)
Apex Knee PS	Apex Knee	979	8	0.51 (0.20, 1.14)	0.69 (0.28, 1.46)	1.14 (0.51, 2.25)	1.14 (0.51, 2.25)	—
Unity Knee System CR	Unity Knee System	852	7	0.70 (0.30, 1.47)	0.70 (0.3, 1.47)	1.20 (0.42, 2.80)	1.20 (0.42, 2.80)	—
3DKnee CR	Foundation	749	19	2.00 (1.17, 3.21)	2.27 (1.38, 3.53)	2.40 (1.48, 3.69)	2.59 (1.61, 3.95)	2.59 (1.61, 3.95)
GMK Primary PS	GMK Primary	658	18	0.76 (0.29, 1.69)	1.83 (1.00, 3.09)	2.46 (1.47, 3.88)	2.88 (1.77, 4.43)	2.88 (1.77, 4.43)
LCS Complete PS	MBT	648	5	0.00 (., .)	0.68 (0.23, 1.65)	0.86 (0.33, 1.92)	0.86 (0.33, 1.92)	0.86 (0.33, 1.92)
Optetrak Logic CR	Optetrak Logic	641	38	1.09 (0.49, 2.16)	2.50 (1.49, 3.94)	5.17 (3.58, 7.16)	7.23 (5.10, 9.83)	—
Unity Knee System PS	Unity Knee System	531	5	0.19 (0.02, 1.01)	1.03 (0.33, 2.59)	1.47 (0.52, 3.35)	1.47 (0.52, 3.35)	1.47 (0.52, 3.35)
Natural-Knee II CR	Natural-Knee II	525	5	0.77 (0.26, 1.87)	0.96 (0.37, 2.14)	0.96 (0.37, 2.14)	0.96 (0.37, 2.14)	0.96 (0.37, 2.14)
GMK Sphere CR	GMK Sphere	475	6	0.64 (0.18, 1.76)	0.64 (0.18, 1.76)	2.59 (0.93, 5.75)	2.59 (0.93, 5.75)	—
NexGen PS	NexGen	454	12	0.88 (0.30, 2.13)	1.99 (0.99, 3.62)	2.50 (1.33, 4.03)	2.50 (1.33, 4.30)	4.08 (1.57, 8.52)
NexGen CR	NexGen Pegged	432	5	0.93 (0.31, 2.24)	0.93 (0.31, 2.24)	1.24 (0.47, 2.75)	1.24 (0.47, 2.75)	1.24 (0.47, 2.75)
Overall	—	616,409	10,061	0.76 (0.73, 0.78)	1.43 (1.40, 1.46)	1.77 (1.73, 1.80)	1.96 (1.92, 2.00)	2.13 (2.08, 2.18)

Table 3.4 Unadjusted Cumulative Percent Revision of Hybrid Knee Arthroplasty Construct Combinations for Primary Total Knee Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022*

Femoral Component	Tibial Component	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Sigma CR	PFC Sigma	2,746	35	0.44 (0.24, 0.75)	1.04 (0.71, 1.48)	1.31 (0.93, 1.82)	1.37 (0.97, 1.88)	1.37 (0.97, 1.88)
Triathlon CR	Triathlon	2,074	39	0.88 (0.54, 1.36)	1.77 (1.25, 2.44)	2.04 (1.47, 2.77)	2.18 (1.56, 2.96)	2.18 (1.56, 2.96)
Vanguard CR	Maxim	2,019	43	1.40 (0.95, 1.99)	1.93 (1.39, 2.62)	2.21 (1.61, 2.95)	2.21 (1.61, 2.95)	2.40 (1.72, 3.27)
Persona CR	Persona	1,253	21	0.58 (0.26, 1.15)	1.51 (0.90, 2.39)	1.92 (1.19, 2.95)	2.19 (1.34, 3.40)	—
Apex Knee CR	Apex Knee	719	16	1.39 (0.72, 2.47)	2.23 (1.33, 3.51)	2.23 (1.33, 3.51)	2.23 (1.33, 3.51)	2.23 (1.33, 3.51)
Sigma CR	MBT	599	7	0.83 (0.32, 1.85)	1.02 (0.43, 2.11)	1.30 (0.57, 2.59)	1.30 (0.57, 2.59)	1.30 (0.57, 2.59)
Natural-Knee II GS CR	Natural-Knee II	514	7	0.39 (0.08, 1.33)	1.20 (0.50, 2.48)	1.20 (0.50, 2.48)	1.47 (0.65, 2.91)	1.47 (0.65, 2.91)
Triathlon PS	Triathlon	439	5	0.46 (0.09, 1.54)	0.70 (0.20, 1.94)	1.05 (0.35, 2.56)	1.51 (0.55, 3.41)	1.51 (0.55, 3.41)
Overall	—	10,363	173	0.82 (0.66, 1.01)	1.48 (1.26, 1.74)	1.73 (1.49, 2.01)	1.83 (1.57, 2.12)	1.90 (1.63, 2.22)

**Hybrid constructs include those with a cemented tibial and cementless femoral component*

Table 3.5 Unadjusted Cumulative Percent Revision of Cementless Knee Arthroplasty Construct Combinations for Primary Total Knee Arthroplasty in Patients ≥65 Years of Age with Primary Osteoarthritis, 2012-2022

Femoral Component	Tibial Component	N Total	N Revised	1 Yr	3 Yrs	5 Yrs	7 Yrs	10 Yrs
Triathlon CR	Triathlon	36,559	436	0.78 (0.69, 0.88)	1.31 (1.19, 1.45)	1.55 (1.39, 1.72)	1.73 (1.53, 1.95)	1.73 (1.53, 1.95)
Triathlon PS	Triathlon	7,075	130	1.13 (0.90, 1.40)	1.96 (1.63, 2.34)	2.24 (1.86, 2.68)	2.50 (2.03, 3.05)	2.50 (2.03, 3.05)
Persona CR	Persona	2,296	36	1.02 (0.67, 1.51)	2.05 (1.38, 2.94)	3.09 (1.42, 5.85)	3.09 (1.42, 5.85)	—
Attune PS	Attune	1,033	8	0.61 (0.26, 1.28)	0.94 (0.44, 1.83)	—	—	—
Attune CR	Attune	699	12	1.46 (0.75, 2.59)	1.76 (0.91, 3.11)	2.87 (1.11, 6.06)	—	—
Natural-Knee II GS CR	Natural-Knee II	690	9	0.43 (0.12, 1.21)	1.08 (0.48, 2.13)	1.52 (0.74, 2.79)	1.52 (0.74, 2.79)	1.52 (0.74, 2.79)
Vanguard CR	Regenerex	523	7	0.76 (0.26, 1.85)	1.34 (0.60, 2.63)	1.34 (0.60, 2.63)	1.34 (0.60, 2.63)	1.34 (0.60, 2.63)
Sigma CR	MBT	505	4	0.40 (0.08, 1.35)	0.84 (0.28, 2.04)	0.84 (0.28, 2.04)	0.84 (0.28, 2.04)	0.84 (0.28, 2.04)
Overall	—	49,380	642	0.84 (0.76, 0.92)	1.43 (1.32, 1.55)	1.68 (1.54, 1.83)	1.86 (1.69, 2.05)	1.92 (1.71, 2.14)

Partial Knee Arthroplasty

Between 2012 and 2022, AJRR has collected data on 76,564 partial knee arthroplasty procedures.

Medial or lateral unicompartmental knee arthroplasty (UKA) utilization as a percentage of TKA use has fluctuated since the inception of AJRR in 2012. UKA accounted for just 3.0% of all primary knee arthroplasties reported to AJRR for 2017. These numbers have slightly increased to 4.0% by 2022 (Figure 3.20). Since there was a slight increase from the 3.0% usage seen in 2017, and AJRR collects historical data not submitted in real time, further changes in usage prevalence may be expected as data continues to be collected. Note should also be made that this does not necessarily represent the incidence of UKA in the United States, as these percentages just reflect the cases that are submitted to the registry.

Internationally, the Swedish Arthroplasty Register noted in 2022 that the use of UKA accounted for almost 12.8% of their primary knee arthroplasty cases (a small increase from the previous year).[17] Similarly, in 2022, the Australian Orthopaedic Association National Joint Replacement Registry reported a small increase but remaining as a small proportion of all knee arthroplasty procedures (7.4%).[7]

The use of patellofemoral arthroplasty (PFA) in the AJRR remains a small percentage of unicompartmental arthroplasty and has been <1% of knee arthroplasties since 2012 (Figure 3.21). These low numbers are consistent with international registries, where the New Zealand Joint Registry reported from 1999-2022 a total of 143,007 primary knee arthroplasties of which only 887 (0.6%) represented patellofemoral prostheses.[17] The National Joint Registry of England and Wales and the Swedish Arthroplasty Register reported PFA in 2022 at 1.1% and 0.6% respectively.[8,9] Only 0.9% of all surgeons who submitted primary knee arthroplasty procedures to AJRR performed PFAs, and only 23.8% performed medial and/or lateral UKAs in 2022 (Table 3.6).

Figure 3.20 Medial or Lateral Unicompartmental Knee Arthroplasty as a Percentage of All Primary Knee Arthroplasty, 2012-2022 (N=76,564)

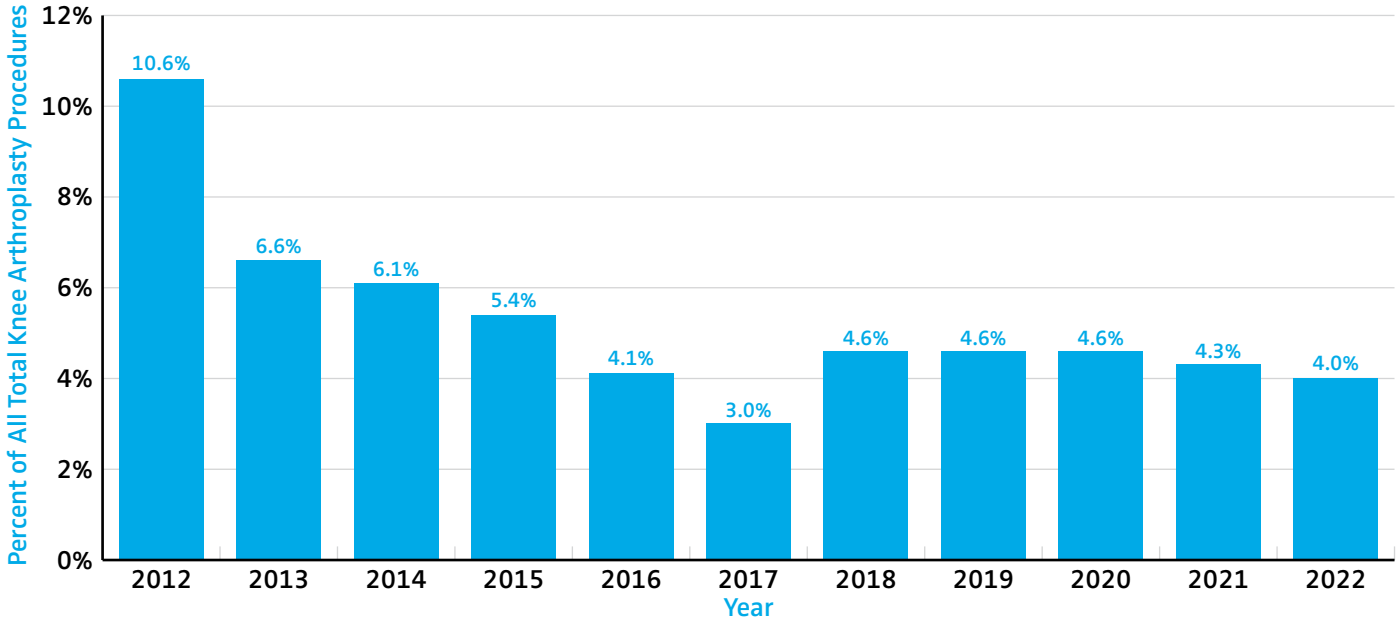


Figure 3.21 Patellofemoral Arthroplasty as a Percentage of All Primary Knee Arthroplasty, 2012-2022 (N=6,447)

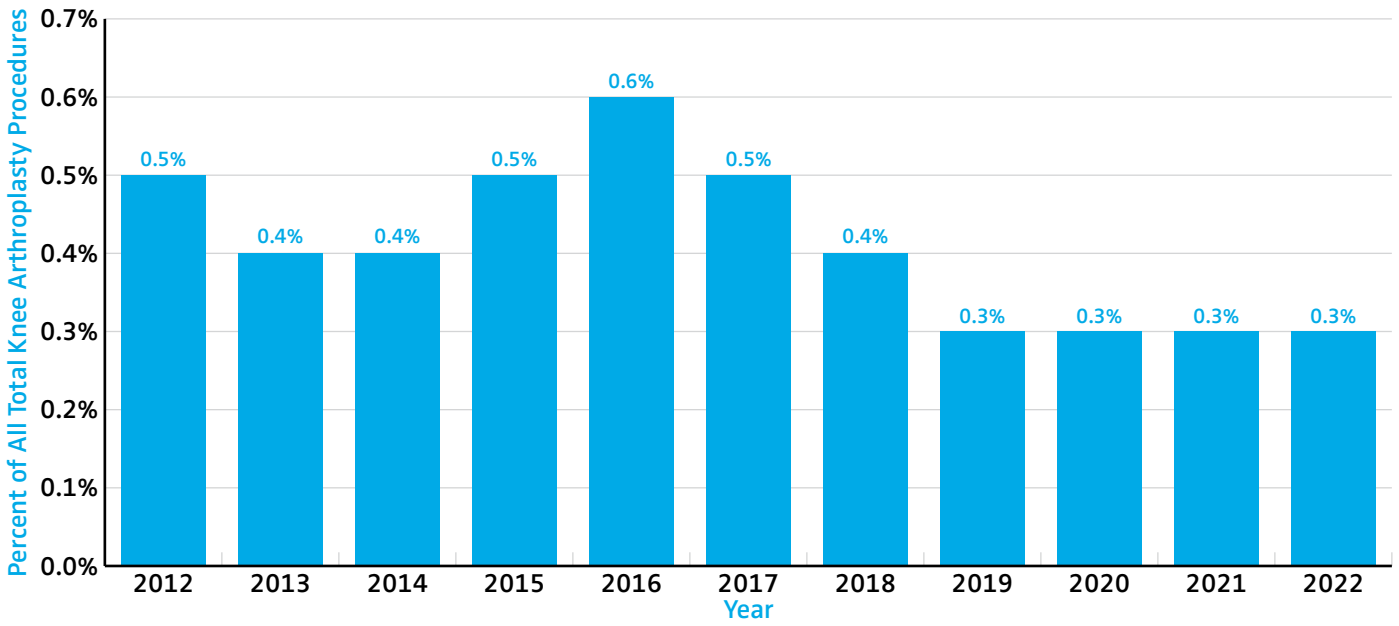


Table 3.6 Surgeons Performing Patellofemoral and Unicompartmental Knee Arthroplasty, 2012-2022

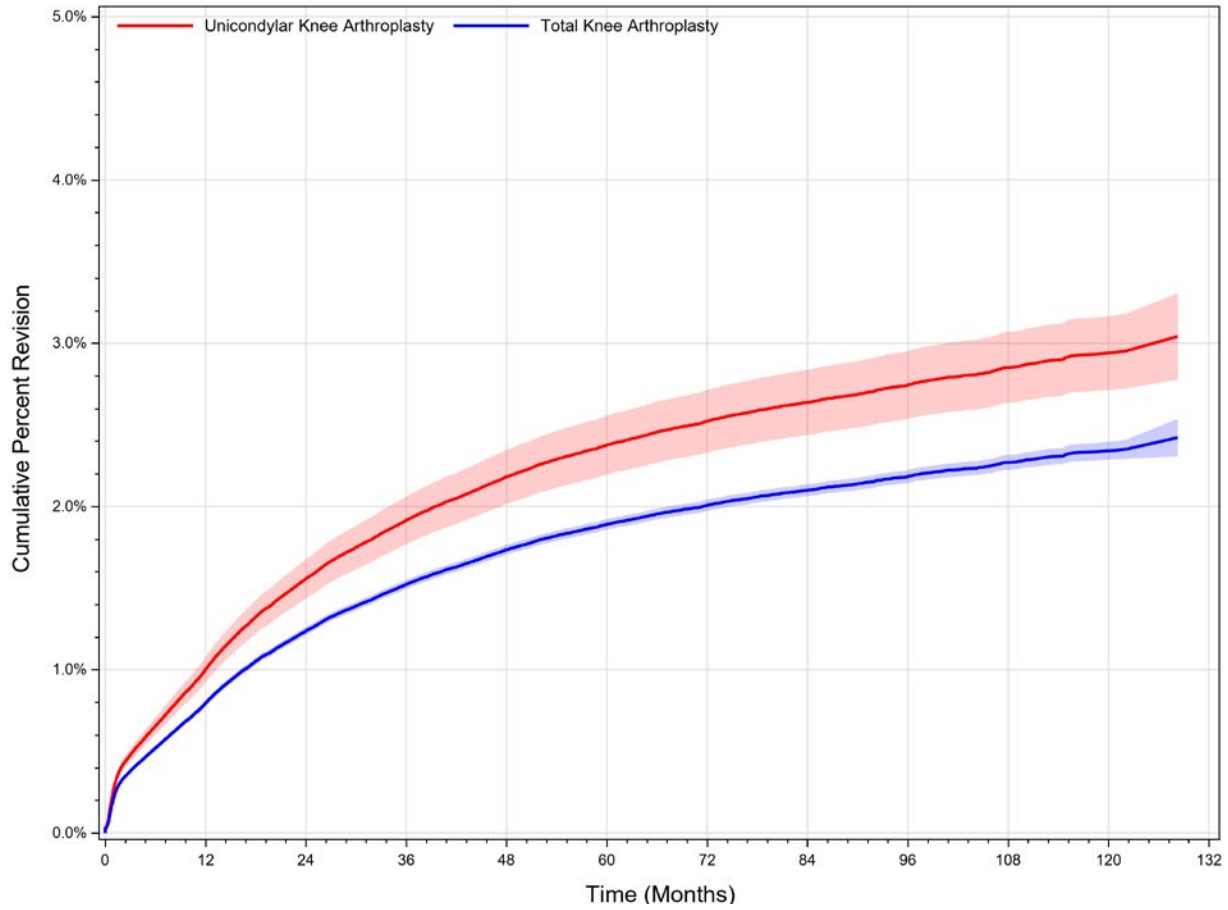
Surgeons Performing Type of Knee Arthroplasty	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Surgeons Performing Unicompartmental Knee Arthroplasty	200 (20.81%)	428 (21.59%)	704 (22.89%)	936 (22.99%)	1,056 (21.28%)	985 (19.79%)	1,151 (23.23%)	1,253 (23.77%)	1,230 (23.01%)	1,137 (22.90%)	1,100 (23.80%)
Suregeons Performing Patellofemoral Arthroplasty	40 (4.16%)	82 (4.14%)	134 (4.36%)	164 (4.03%)	105 (2.12%)	90 (1.81%)	90 (1.82%)	74 (1.40%)	69 (1.29%)	55 (1.11%)	42 (0.91%)
Total number of Surgeons submitting TKA	721 (75.03%)	1,472 (74.27%)	2,237 (72.75%)	2,971 (72.98%)	3,802 (76.61%)	3,902 (78.40%)	3,713 (74.95%)	3,945 (74.83%)	4,046 (75.70%)	3,772 (75.99%)	3,479 (75.29%)

In the AJRR or CMS database, total knee arthroplasty procedures demonstrated significantly decreased cumulative percent revision compared to unicondylar knee arthroplasty constructs in patients ≥65 years of age after adjusting for age, sex, and CCI (HR=1.261, 95% CI, 1.158-1.374, p<0.0001) (Figure 3.22). This finding is aligned with other mature registries. In 2022, the National Joint Registry reported the chance of revision with UKA at any estimated time point being approximately doubled or more than that of TKA and overall revision with cemented UKA was more than three times higher than TKA at 10 years.[8] We recognize that overall cumulative percent revision for UKA may be lower than other registries. This may be due to lack of capture of all conversion procedures due to coding limitations, and the Registries team is working to evolve methodology and resolve this limitation.

INSIGHTS

The cumulative incidence of revision, adjusted for age, sex, and CCI, is significantly higher with unicompartmental knee arthroplasty when compared with primary total knee arthroplasty.

Figure 3.22 Cumulative Percent Revision of Total Knee Versus Unicondylar Knee Constructs for Femoral Components in Medicare Patients 65 Years of Age and older with Primary Osteoarthritis, 2012-2022



Number at Risk (Months)	0	12	24	36	48	60	72	84	96	108	120	132
Total Knee Arthroplasty	835,844	743,129	650,883	563,419	461,449	359,619	248,897	155,640	89,050	40,746	11,499	6
Unicondylar Knee Arthroplasty	31,377	28,325	24,753	21,374	17,302	13,499	10,902	8,002	5,033	2,440	964	6
Total	867,221	771,454	675,636	584,793	478,751	373,118	259,799	163,642	94,083	43,186	12,463	12

Age/Sex/CCI adjusted HR (95%CI), p-value
Unicondylar Knee Arthroplasty vs. Total Knee Arthroplasty: *1.261 (1.158,1.374), p<0.0001*

Figure 3.23 provides utilization data of implants used in partial knee arthroplasty procedures in AJRR. The eight most commonly used femoral and tibial combinations in UKA by year shows that the combinations most frequently implanted have also varied over time. For 2022, the Restoris MultiCompartmental Knee (MCK) was the most frequently implanted combination with the Oxford Partial Knee System following a similar utilization level since 2012. Over the last four years, the Persona Knee component has seen a steep increase in utilization to become the second most common implant by 2022.

Figure 3.23 Unicondylar Knee Arthroplasty Femoral/Tibial Component Combinations by Year, 2012-2022 (N=52,952)

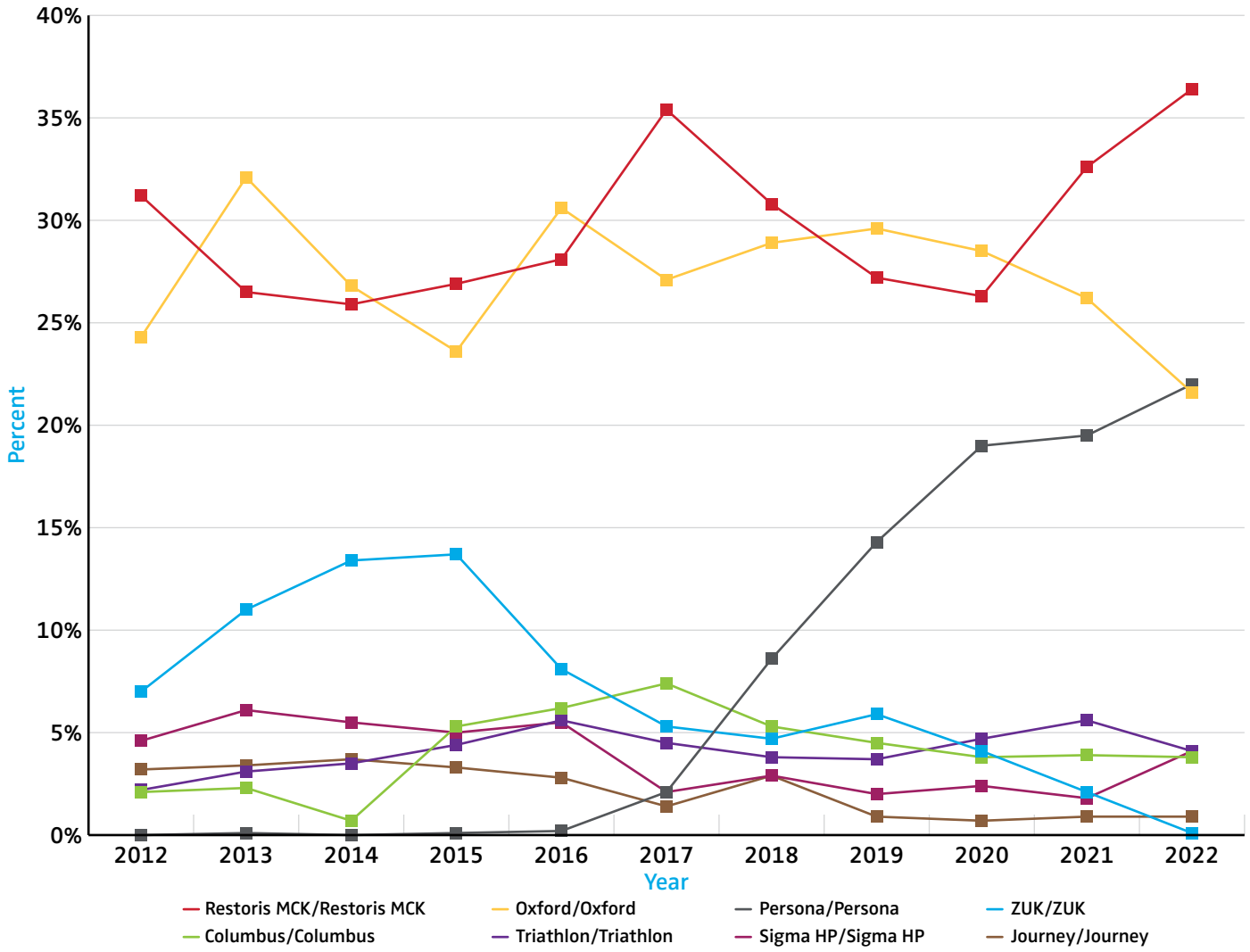
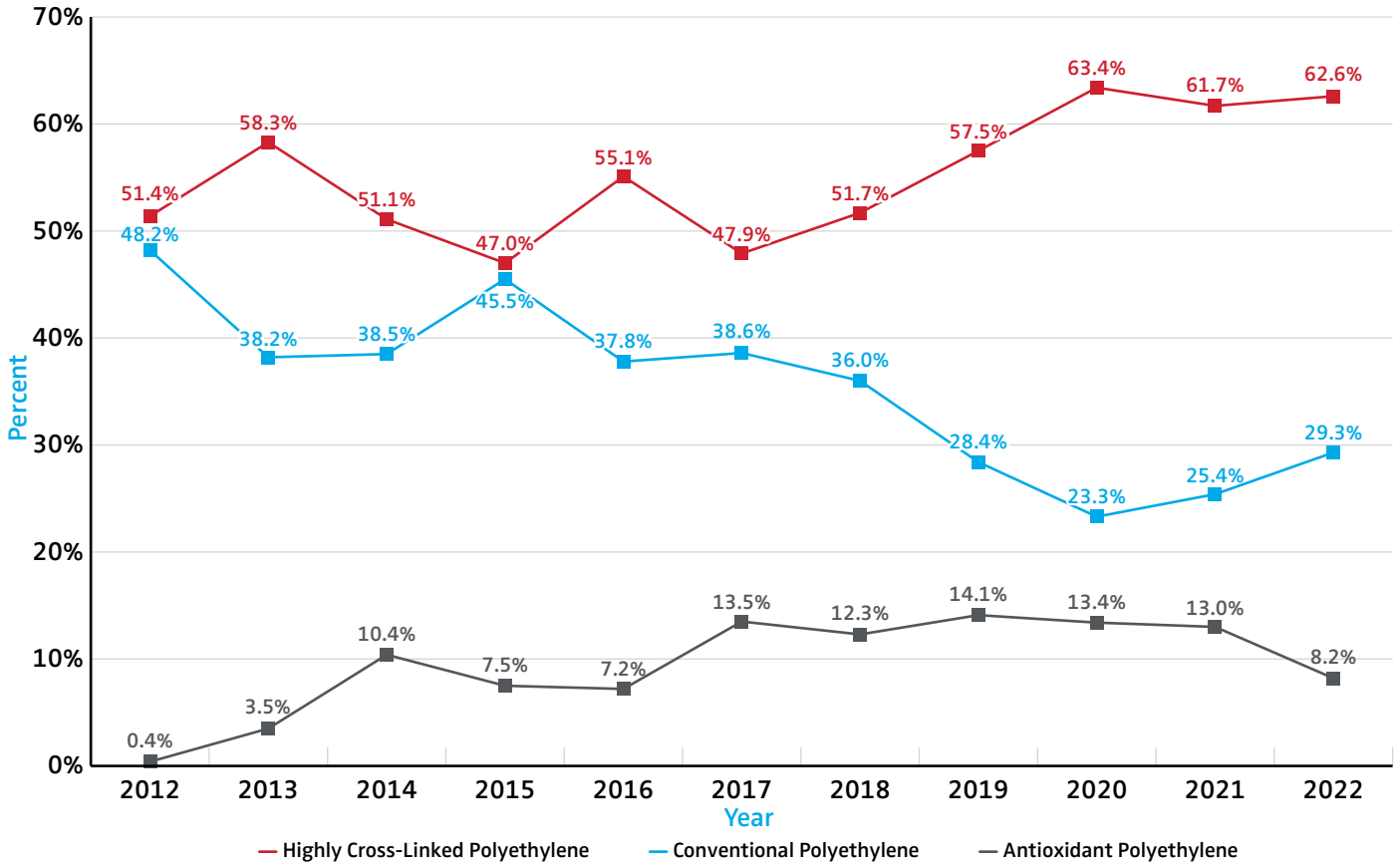


Figure 3.24 shows the polyethylene insert types utilized by year for partial knee arthroplasty. These results show that highly cross-linked polyethylene is the most frequently used material. The use of conventional polyethylene has substantially decreased with a slight increase in the last two years while the use of antioxidant polyethylene for UKA has remained relatively stable since 2014 accounting for 8.2% of cases in 2022.

INSIGHTS

The use of conventional polyethylene inserts has substantially decreased in unicompartmental knee arthroplasty but has shown a slight increase in recent years.

Figure 3.24 Unicondylar Knee Arthroplasty Insert Polyethylene Material by Year, 2012-2022 (N=44,640)



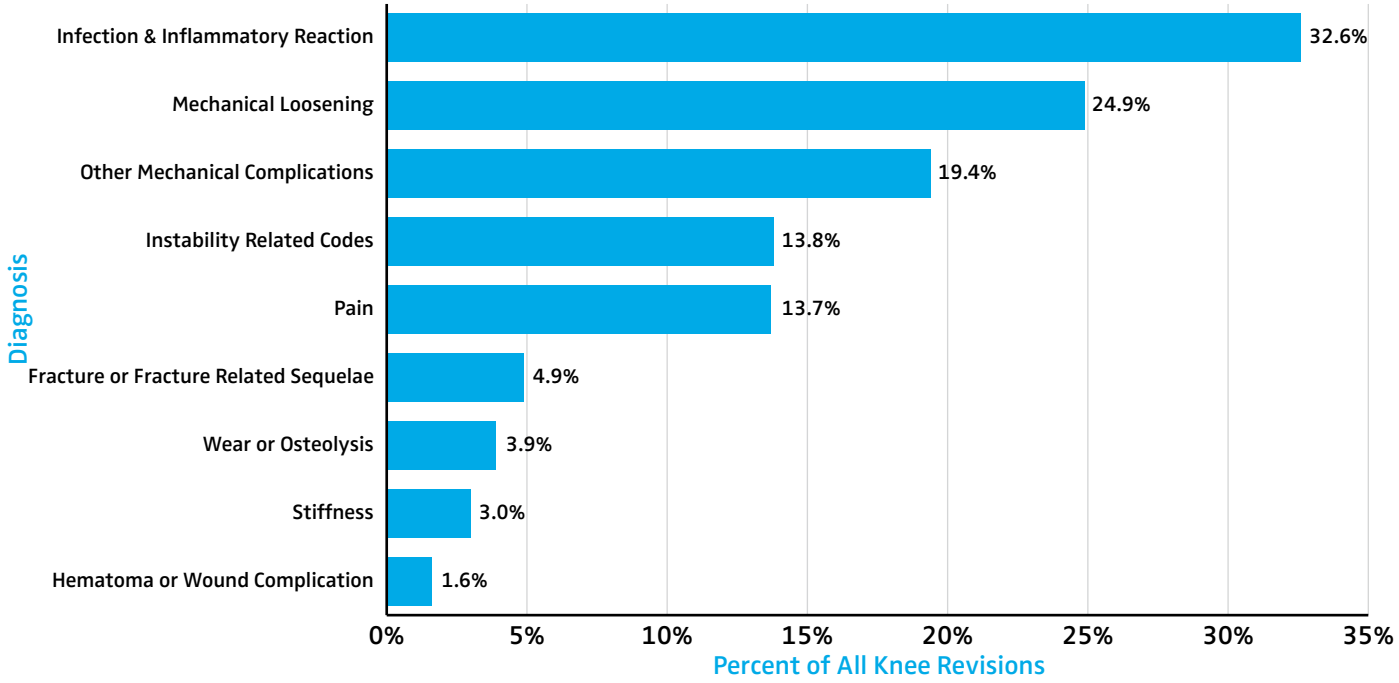
Revision Knee Arthroplasty

Between 2012 and 2022, AJRR has collected data on 158,438 revision knee arthroplasty procedures.

As discussed in the revision hip arthroplasty section, a substantial amount of work is ongoing to better identify and characterize the reasons for revision knee arthroplasty procedures. The data submitted to AJRR contains variability in coding with respect to primary reason for revision. Substantial efforts involving surgeon leadership continue to be undertaken to identify best practices for this critical coding step. First, reason for revision was determined by the diagnosis codes submitted for each revision. AJRR accepts up to 10 diagnosis codes which can be submitted as either ICD (International Classification of Diseases)-9 or -10 codes depending on the year of the procedure.

Figure 3.25 displays the case distribution of all revision procedures in AJRR patients reported to either AJRR or CMS. Each reason for revision was queried independently as to allow for cases to exist in more than one category when multiple diagnoses are reported. An additional 14,850 (10%) cases are not presented as they contain erroneous or irrelevant diagnoses such as osteoarthritis, cardiac diagnoses, and comorbidities; these cases are regularly revisited for any missed classifications. The reason for revision was then examined and categorized as follows: fracture (fracture, fracture related sequelae), other mechanical complications, articular bearing surface wear and/or osteolysis, instability related codes, infection and inflammatory reaction, mechanical loosening, pain, stiffness, and hematoma/wound complications. If the primary code submitted did not fall into one of these categories, the subsequent reported codes were examined for a match. Using this methodology, the most common reason for knee revision surgery was infection and inflammatory reaction at 29.5% (Figure 3.25).

Figure 3.25 Distribution of Diagnosis Associated with All Knee Revisions, 2012-2022 (N=140,499)



Revision surgeries can also be further examined based on their occurrence from the time of the index primary procedure. An early revision is considered one that occurred <3 months after the primary procedure. There were 7,560 early "linked" revision procedures in AJRR (Table 3.7). In a study quantifying the level of migration of primary arthroplasty patients ≥65 years of age, Etkin et al. noted only 0.62% of Medicare patients moved out of state and to a different county one year after the primary procedure.[13] Migration to a different state or county increased to >10% at 5 years and 18% at 10 years. As a result, AJRR might be more likely to capture an early revision, as those are most likely to return to the same AJRR hospital as the primary.[13] Among early revisions, 7,088 procedures had a primary diagnosis that was relevant using the methodology above. For all early revisions, the primary reason was again infection and inflammatory reaction (50.3%) (Figure 3.26).

INSIGHTS

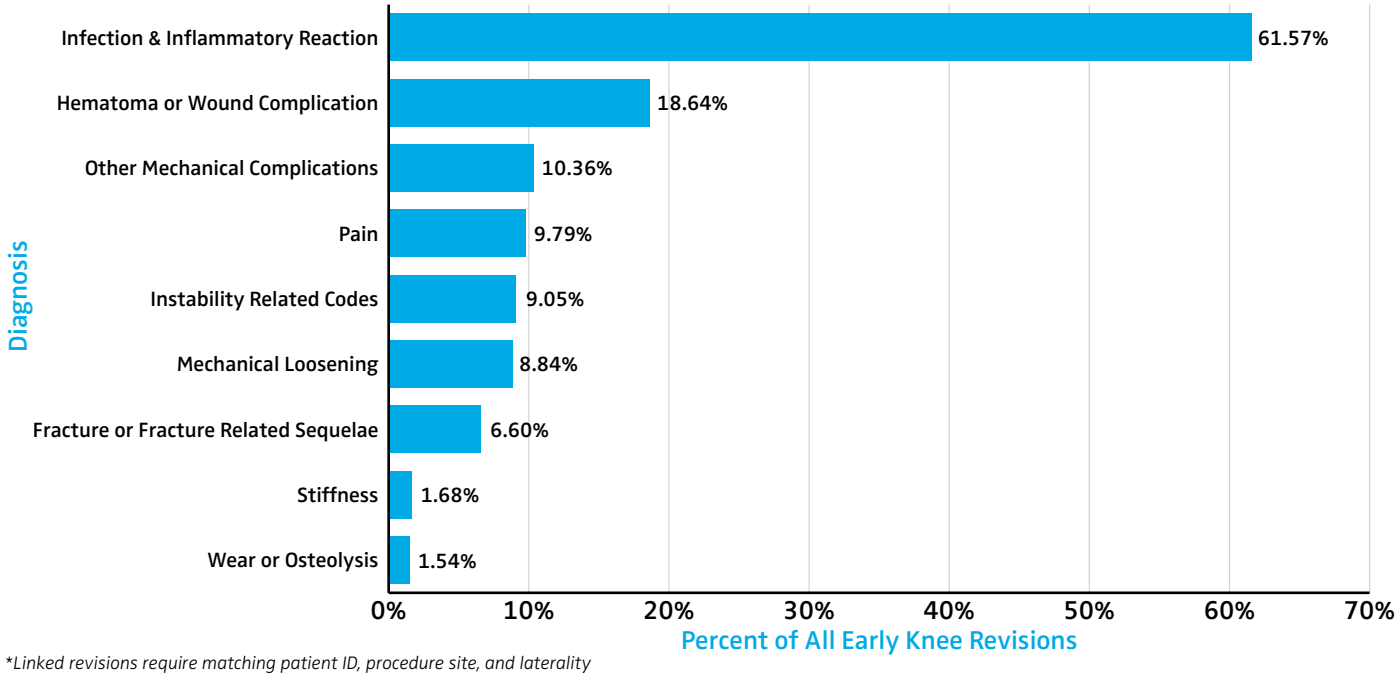
Infection remains the most common reason for revision surgery following total knee arthroplasty, particularly for early revisions within three months of the index surgery.

Table 3.7 Distribution of Time Interval Between Primary Total Knee Arthroplasty and Revision Procedures for "Linked" Patients, 2012-2022*

Time	Frequency	Percent
<3 Months	7,560	22.6
3 to <6 Months	2,473	7.4
6-12 Months	4,907	14.6
>1 Year	18,589	55.4

**Linked revisions require matching patient ID, procedure site, and laterality*

Figure 3.26 Distribution of Diagnosis Associated with Early "Linked" Knee Revisions, 2012-2022 (N=5,789)*



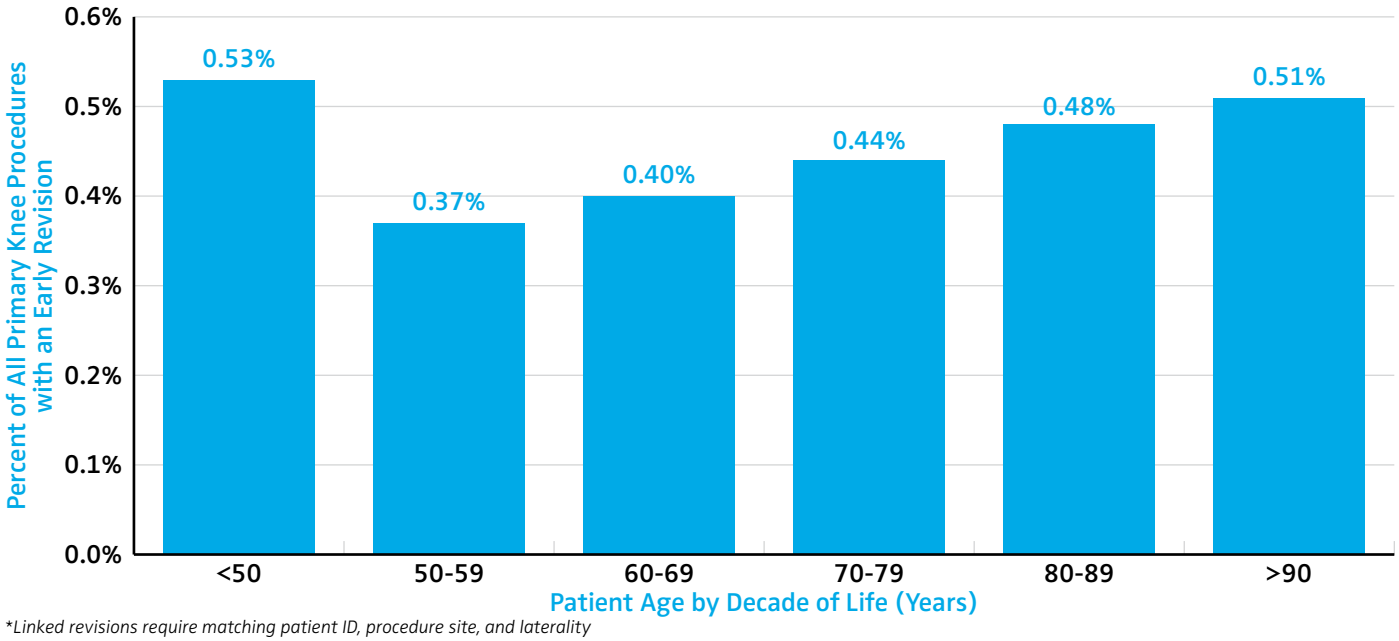
*Linked revisions require matching patient ID, procedure site, and laterality

Patients <50 years of age had the highest incidence of early revision following total knee arthroplasty.

INSIGHTS

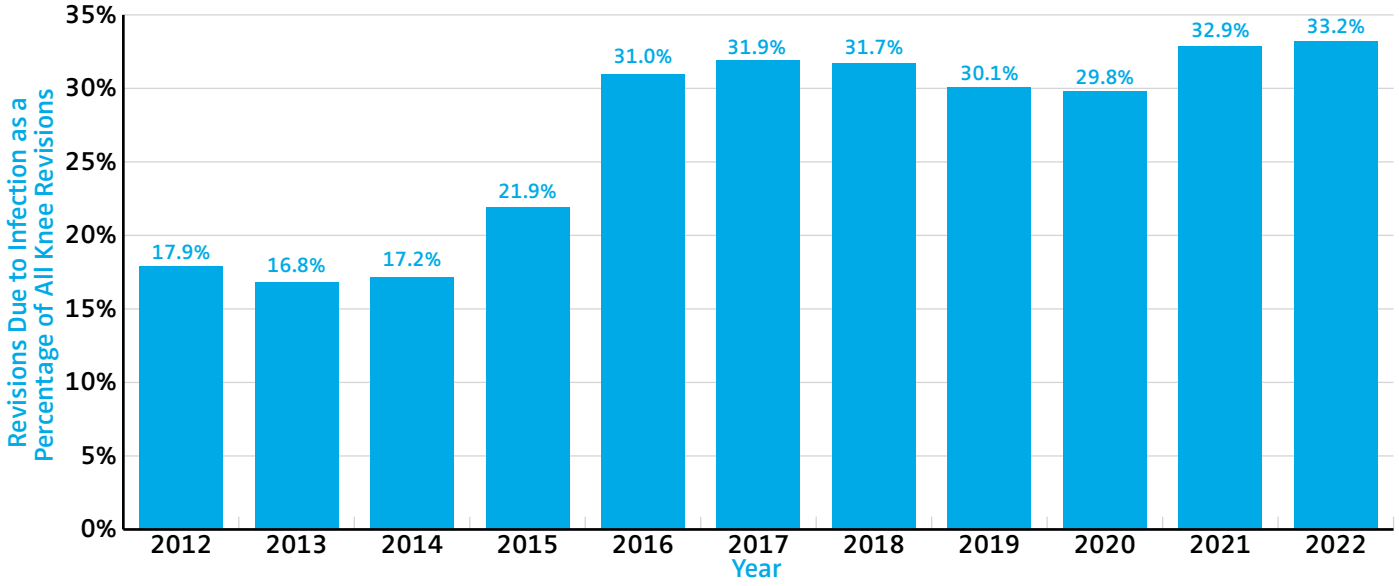
As reported to AJRR, the percentage of primary total knee arthroplasty procedures with an early revision (<3 months from primary procedure) ranged from 0.37% to 0.55% and was most common in the <50 age group (Figure 3.27). When comparing the percentage of revisions for all total knee arthroplasties with a primary diagnosis of infection, there has been an increase from 17.9% in 2012 to 33.2% in 2022 (Figure 3.28).

Figure 3.27 Early "Linked" Revisions as a Percent of All Primary Total Knee Arthroplasty Procedures by Age Group, 2012-2022 (N=6,710)*



*Linked revisions require matching patient ID, procedure site, and laterality

Figure 3.28 Percent of Revision Knee Arthroplasty Procedures Due to Infection, 2012-2022 (N=45,866)



Antioxidant polyethylene usage in revision knee arthroplasties has been significantly increasing since 2012 ($p<0.001$) (Figure 3.29). Non-antioxidant polyethylene inserts include both highly cross-linked polyethylene and conventional polyethylene. Figure 3.30 provides utilization data of implants used in revision total knee arthroplasty procedures in AJRR by year for the years 2012 through 2022. Over the study period, the utilization of Triathlon components and the Sigma/MBT system has predominated. In recent years, an increased usage of Attune and Persona systems and a declining usage of Sigma/MBT are observed.

Over the past two years, both highly cross-linked polyethylene and antioxidant polyethylene inserts were more commonly utilized than conventional polyethylene for revision TKA procedures.

INSIGHTS

Figure 3.29 Revision Knee Arthroplasty Insert Polyethylene Material by Year, 2012-2022 (N=26,659)

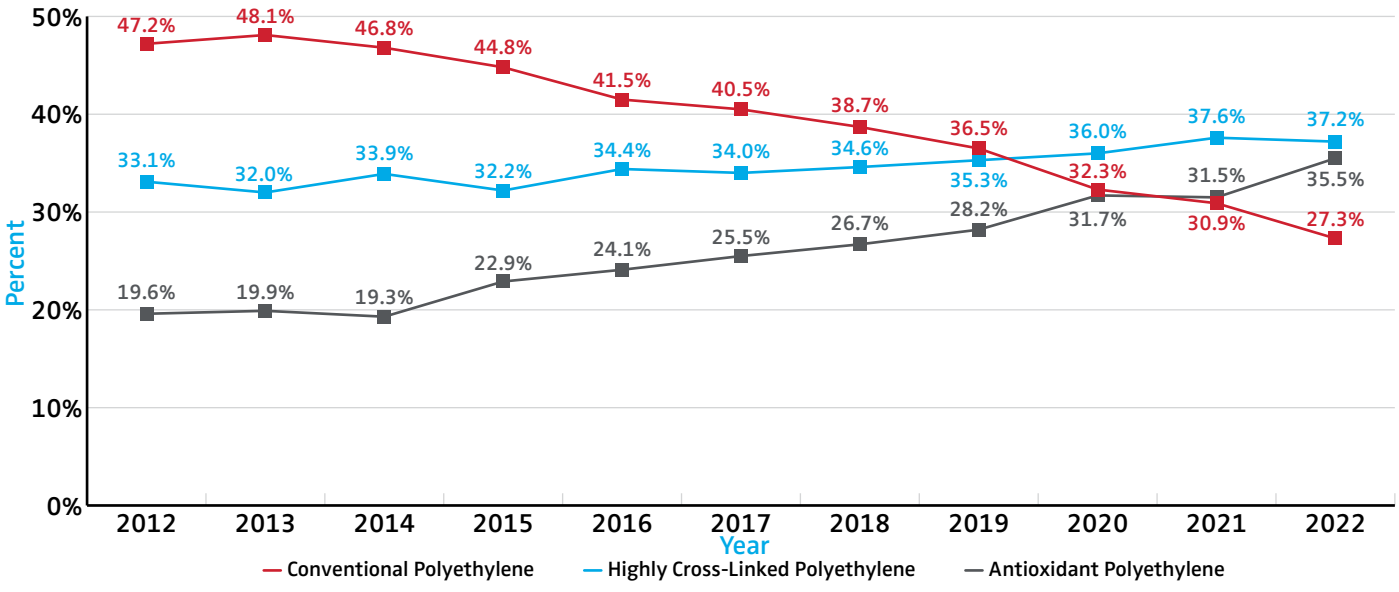


Figure 3.30 Revision Total Knee Arthroplasty Femoral/Tibial Component Combinations by Year, 2012-2022 (N=58,040)

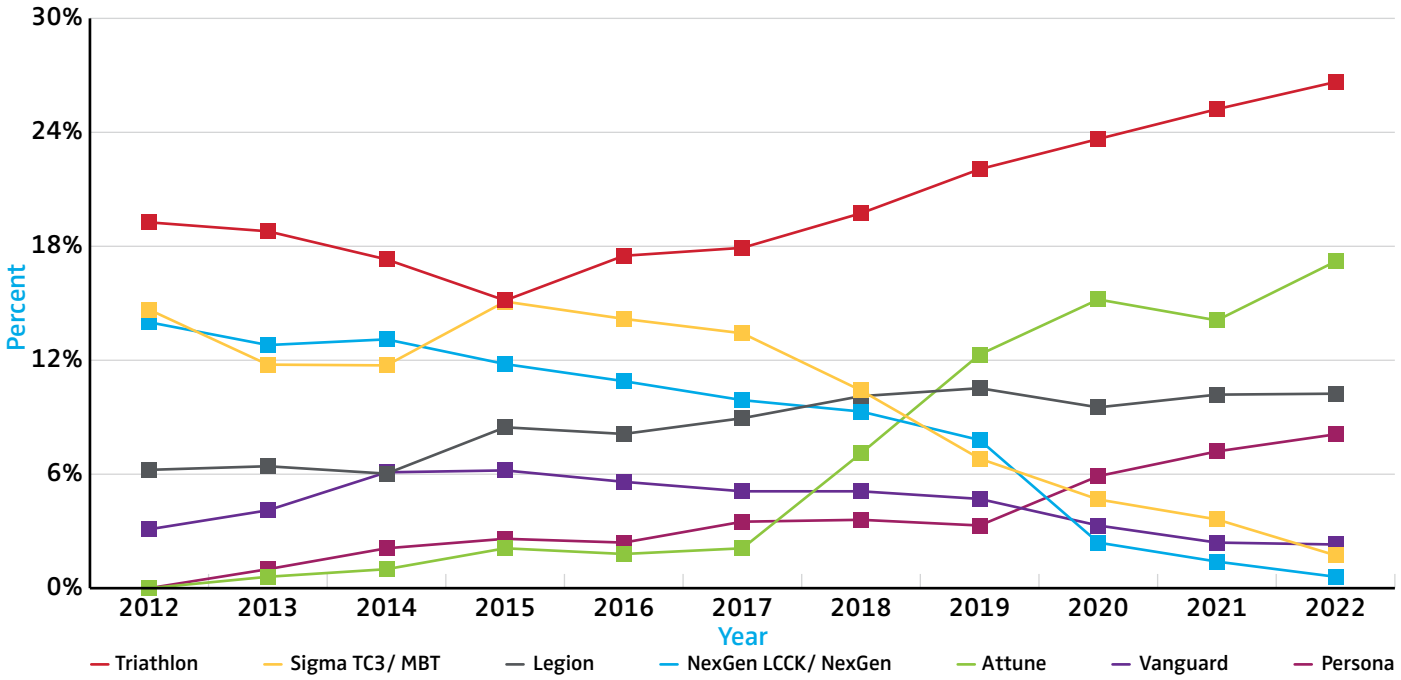
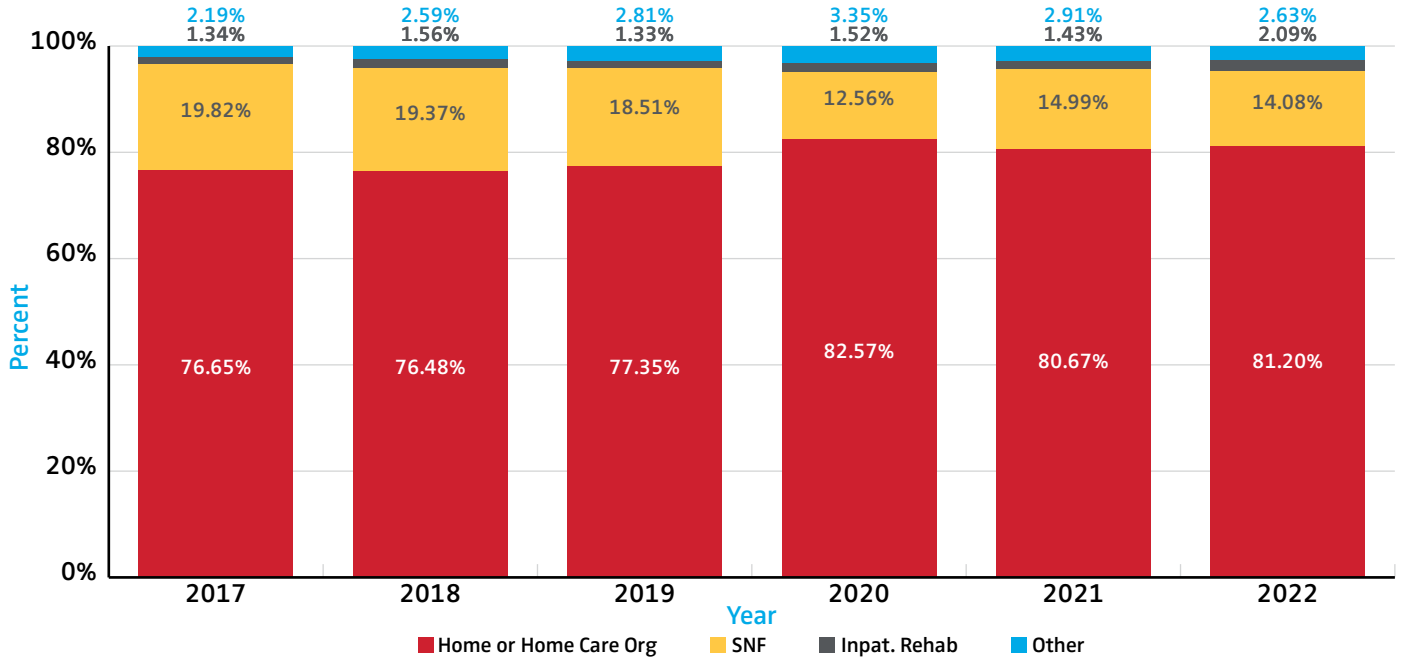


Figure 3.31 tabulates the discharge disposition reported for revision TKA cases for the years 2017 through 2022, when data collection began. AJRR collects the CMS-defined Patient Discharge Status Code values. Discharge to home, represented by discharge codes 1 and 6, occurred following over 80% of revision TKAs in the last three years. Discharge to a skilled nursing facility (SNF) dropped to 14% by 2022. Other discharge codes represent only a small portion of cases.

Figure 3.31 Revision Knee Arthroplasty Discharge Disposition Codes by Year, 2012-2022 (N=100,226)



Code	Code Value
Home	Discharged to home/self-care (routine charge).
Home Care Org.	Discharged/transferred to home care of organized home health service organization.
SNF	Discharged/transferred to skilled nursing facility (SNF) with Medicare certification in anticipation of covered skilled care--(For hospitals with an approved swing bed arrangement, use Code 61 - swing bed. For reporting discharges/transfers to a non-certified SNF, the hospital must use Code 04 - ICF.)
Inpat. Rehab	Discharged/transferred to an inpatient rehabilitation facility including distinct parts units of a hospital (eff. 1/2002).

Patient-Reported Outcome Measures (PROMs) - Total Knee Arthroplasty

Patient-reported outcome measures (PROMs) have received increased attention within AJRR and the wider practice of orthopaedic surgery. In the U.S., value-based payment models made capture of PROMs a prerequisite for various public and private alternative payment models. Internationally, in 2014 the International Society of Arthroplasty Registries (ISAR) Steering Committee established a working group in this area to advise on best practices.[15]

AJRR collects patient-reported outcome measures and encourages sites to submit this data at set intervals: a baseline measure obtained prior to the surgery, a measure 90-days post-dischargely, and at one-year postoperatively. Patient-reported outcome measures capture information on the patient's overall health and function from the patient's perspective. The recommended intervals allow comparison over the course of a patient's care, but on a broader scope, provide a better picture of national outcomes and trends. AJRR provides national benchmarking for participating sites to review and compare this uniquely reported data.

With a growing emphasis on the value of PROMs data, the Registry in turn has expanded the ways in which sites submit this data. The Registry provides a tool for sites to collect PROMs data electronically on all eligible patients, via email or a computer or tablet device in the clinical setting. Sites also have the option to submit PROMs data through other methods, perhaps collected via a third-party vendor or a local system.

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Based on the KOOS, JR. score, 86% of patients achieved a meaningful improvement after total knee arthroplasty.

Quick Facts:

- Collection of PROMs was initiated in the California Joint Replacement Registry (CJRR) in early 2011 and following incorporation of CJRR within AJRR began for the larger U.S. population in April 2016.
- To help assist AJRR institutions with PROM data collection, AJRR offers a PROMs platform within RegistryInsights® at no additional cost that allows for PROM storage and capture (both preoperatively and postoperatively). However, sites may utilize their existing PROMs solution if preferred.
- AJRR collects PROMs at any time but recommends at a minimum a preoperative (<90 days before the procedure) and a one-year postoperative PROM.
- As of 2019, AJRR recommends and supports (on their PROM platform) the collection of HOOS JR., KOOS JR., PROMIS-10, and VR-12. Other PROMs are collected but not used for analyses.
- AAOS has launched a PROMs in Practice initiative that aims to influence the active clinical use of PROMs at the point of musculoskeletal care. More information about this can be found on the AAOS website.
- As of December 31, 2022, 496 sites out of 1,364 (36%) have submitted PROMs, which is a 24% increase in sites compared to the previous 2022 AJRR Annual Report.
- The completion rate for "linked" outcomes (those where both a preoperative and one-year postoperative PROM is available on the same procedure) varies between 24-30%.

Similar levels of meaningful improvement in KOOS, JR. scores were seen across all age groups, with patients older than 75 years of age having less improvement compared to younger patients on the PROMIS-10 quality of life assessment tool.

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Table 3.8 Preoperative and 1-Year Postoperative PROM Mean Scores After Primary Knee Arthroplasty by PROM, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Pre or 1-year Postoperative	N	Mean	Standard Deviation
KOOS, JR. (Knee Disability and Osteoarthritis Outcome Score)	Score	Preoperative	119,471	47.3	14.4
		Postoperative	49,670	76.2	16.2
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	Preoperative	91,370	49.3	8.2
		Postoperative	38,337	51.9	8.5
	Physical T	Preoperative	91,364	40.3	6.6
		Postoperative	38,337	48.1	8.6
VR-12 (The Veterans RAND 12 Item Health Survey)	Mental Health Component	Preoperative	32,053	52.1	12.6
		Postoperative	15,186	55.7	10.1
	Physical Health Component	Preoperative	31,851	31.5	9.4
		Postoperative	15,185	43.3	10.5

Table 3.9 Overall Change Between Preoperative and 1-Year Postoperative PROM Scores after Primary Knee Arthroplasty by PROM, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Patients with Preoperative Score	Patients with Linked Postoperative Score	Response Rate, Percentage of Patients Who Completed a Preoperative and 1-Year Score	Patients with Meaningful Improvement*
KOOS, JR. (Knee Disability and Osteoarthritis Outcome Score)	Score	119,471	30,994	25.90%	85.50%
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	91,370	23,419	25.60%	33.40%
	Physical T	91,364	23,420	25.60%	63.70%
VR-12 (The Veterans RAND 12 Item Health Survey)	Mental Health Component	32,053	9,526	29.70%	33.60%
	Physical Health Component	31,851	9,533	29.90%	73.00%

**Meaningful improvement was calculated by minimal clinical important difference (MCID). MCID was determined to be a positive change score of half the pooled standard deviation.*

Table 3.10 Age-Stratified Change Between Preoperative and 1-Year Postoperative PROM Scores after Primary Knee Arthroplasty by PROM for Patients 55 Years and Over, 2012-2022

Patient-Reported Outcome Measure (PROM)	PROM Component	Age Group (Years)	Patients with Preoperative Score	Patients with Linked Postoperative Score	Response Rate, Percentage of Patients Who Completed a Preoperative and 1-Year Score	Patients with Meaningful Improvement*
KOOS, JR. (Knee Disability and Osteoarthritis Outcome Score)	Score	55-64	32,266	7,716	23.90%	86.00%
		65-74	50,916	14,329	28.10%	85.50%
		75-84	24,087	6,262	26.00%	84.00%
		>85	2,615	593	22.70%	86.30%
PROMIS-10 (Patient-Reported Outcomes Measurement Information System 10)	Mental T	55-64	23,973	5,492	22.90%	36.50%
		65-74	39,378	11,054	28.10%	33.20%
		75-84	18,750	4,923	26.30%	29.60%
		>85	2,062	458	22.20%	27.70%
	Physical T	55-64	23,969	5,492	22.90%	65.60%
		65-74	39,380	11,056	28.10%	64.60%
		75-84	18,747	4,923	26.30%	59.40%
		>85	2,062	458	22.20%	57.00%

**Meaningful improvement was calculated by minimal clinical important difference (MCID). MCID was determined to be a positive change score of half the pooled standard deviation.*

Appendices and References

Appendix A

Recent AJRR Publications and Presentations

The goal of the AAOS Registry Analytics Institute® (RAI) is to provide a resource to the scientific community to further understand and improve orthopaedic and musculoskeletal care by making data analyses available. RAI also provides physicians and clinician-scientists access to information beyond what is already published in the AJRR Annual report. Investigators can submit hypotheses regarding information in AAOS registries and linked CMS clinical databases. The AJRR Research Subcommittee provides a systematic and transparent peer review process for proposal approval. Data analysis for approved clinical projects are completed by the AAOS combined analytics team. Completed RAI approved clinical projects have been submitted to a variety of orthopaedic conferences for presentation and to peer reviewed journals for publication. Please see a list of recent posters, presentations, and publications derived from AJRR data projects below. Click to learn more about the RAI application process or review all previous publications and presentations here.

Publications:

1. Dislocation Rates of Primary Total Hip Arthroplasty in Patients with Prior Lumbar Spine Fusion and Lumbar Degenerative Disc Disease with and without Utilization of Dual Mobility Cups: A Joint Registry Study. Malkani AL, Nessler JM, Mullen KJ, MPH; Yep PJ, Illgen RL.Richard L. Illgen II, MD. J Journal of the American Academy of Orthopaedic Surgeons. 2023;31:e271-e277. DOI: 10.5435/JAAOS-D-22-00767

2. Timing and Factors Associated with Total Knee Arthroplasty Infection. Engh CA, Yep PJ, Donnelly PC, Hopper RH and Mullen KJ. Journal of Arthroplasty. 2023 Jun;38(6S):S308-S313.e2. doi: 10.1016/j.arth.2023.03.054

3. Increased Revision Risk With Mobile Bearings in Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry. Vishal Hegde MD, Jamil Kendall MD, Kathryn Schabel MD, Christopher E. Pelt MD, Patrick Ye, MS, MPH, Kyle Mullen MPH, Ayushmita De PhD, Ryland Kagan MD. Journal of Arthroplasty. 2023 Jan 11;S0883-5403(23)00007-4. doi: 10.1016/j.arth.2023.01.007

4. Highlights of the 2022 American Joint Replacement Registry Annual Report. Vishal Hegde, MD, Jeffrey B. Stambough, MD, Brett R. Levine, MD, and Bryan D. Springer, MD. Arthroplasty Today. 2023 Jun; 21: 101137. doi: 10.1016/j.artd.2023.101137

5. Dual Mobility Articulation in Revision Total Hip Arthroplasty: An American Joint Replacement Registry Analysis of Patients Aged 65 years and Older. Jesse E Otero, Nathanael D Heckman, Heena Jaffri, Kyle Mullen, Susan M Odum, Jay R Lieberman, Bryan D Springer. Journal of Arthroplasty. 2023 May 23;S0883-5403(23)00547-8. doi: 10.1016/j.arth.2023.05.023

6. Cemented Femoral Fixation in Total Hip Arthroplasty Reduces the Risk of Periprosthetic Femur Fracture in Patients 65 Years and Older: An Analysis From the American Joint Replacement Registry: Mackenzie Kelly MD, Antonia F. Chen MD, MBA b, Sean P. Ryan MD c, Zachary M. Working MD Kimberly R. Porter PhD, MPH, Ayushmita De PhD, Kyle Mullen MPH, Ryland Kagan MD. Journal of Arthroplasty. 2023 Apr 25;S0883-5403(23)00395-9. doi: 10.1016/j.arth.2023.04.039

8. The epidemiology of antibiotic loaded bone cement and systemic antibiotic prophylactic usage in primary cemented or hybrid total knee arthroplasty among countries in Africa, Europe, North America, and Oceania: A register based descriptive international study 2010-2020. Tesfaye Hordofa Leta, Anne Marie Fenstad, Stein Håkon Låstad Lygre, Stein Atle Lie, Martin Lindberg-Larsen), Alma B Pedersen, Annette W-Dahl, Ola Rolfson, Erik Bülow, James A Ashforth, Liza N vanSteenbergen, Rob Nelissen, Dylan Harries, Richard de Steiger, Olav Lutro, Keijo T Mäkelä, Jinny Willis, Michael Charles Wyat, Christopher Frampton, Alexander Grimberg, Arnd Steinbrück, Yinan Wu, Cristiana Armaroli, Marco Molinari, Roberto Picus, Kyle Mullen, Richard Illgen, Ioan C. Stoica, Andreea Vorovenci, Dan Dragomirescu, Havard Dale, Christian Brand, Bernhard Christen, Joanne Shapiro, J. Mark Wilkinson, Richard Armstrong, Kate Wooster, Geir Hallan, Jan-Erik Gjertsen, Richard Chang, Heather A Prentice, Elizabeth Paxton, Ove Furnes. 2023 (94). Acta Orthopaedica. Doi.org/10.2340/17453674.2023.17737

9. Increased Revision Risk With Mobile Bearings in Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry. Vishal Hegde MD, Jamil Kendall MD, Kathryn Schabel MD, Christopher E Pelt MD, Patrick Yep MPH MSP, Kyle Mullen MPH, Ayushmita De PHD, Ryland Kagan MD. Journal of Arthroplasty. 2023. July 2023. doi.org/10.1016/j.arth.2023.01.007

Posters and Presentations

1. Is American Joint Replacement Registry Data Consistent with International Survivorship in Knee Arthroplasty? A Comparative Analysis. Bryan D. Springer MD, James I. Huddleston MD, Kyle Mullen MPH, Patrick Donnelly MS, Edward Caton, Keith Tucker MD. 2023 Knee Society Podium Presentation. Sept 7-9. Monterey, CA

2. Is American Joint Replacement Registry Data Consistent with International Survivorship in Hip and Knee Arthroplasty? A Comparative Analysis. Bryan D. Springer MD, James I. Huddleston MD, Kyle Mullen MPH, Patrick Donnelly MS, Edward Caton, Keith Tucker MD. Poster Presentation. 2023 AAHKS Annual Meeting. November 2-5. Gaylord, Texas. Poster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

3. Mode of fixation & survivorship in primary total knee arthroplasty in the American Joint Replacement Registry. David Martin MD, David Rossi MD, Brett Bukowski MD, Brian Nickel MD, David Hennessy MD, Olivia Sterling, Kyle Mullen MPH, Richard Illgen MD. Poster Presentation. 2023 AAHKS Annual Meeting. November 2-5. Gaylord, Texas.

4. Press-fit versus Cemented Total Knee Arthroplasty (TKA): Utilization Varies by Age, Gender, BMI, Race, and Geographic Location. Sahir S. Jabbouri, MD, Emily Jimenez, MPH, Kyle Mullen, MPH, Jenna Bernstein, MD. Poster Presentation. 2023 Ortho Summit 2023. September 19-23. Boston, MA.

5. Equivalent Rates of 90-day Revision for Instability Between Dual Mobility Total Hip Arthroplasty and Hemiarthroplasty for Acute Femoral Neck Fractures. Brenden A Shi. Kyle Mullen MPH, Olivia Sterling, Alexander Stavrakis MD. ePoster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

6. Does Resurfacing the Patella Increase the Risk of Extensor Mechanism Injury Within the First Two Years After Total Knee Arthroplasty? David E. DeMik, MD, PharmD; Juan David Lizcano, MD; Emily Jimenez, MPH; Jess H. Lonner, MD; Chad A. Krueger, MD. ePoster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

7. Effect of Robotic Assistance on Early Revisions and Aseptic Loosening in Cementless Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry. Gregory Kirchner, MD MPH, Emily Jimenez, MPH; Kyle Mullen, MPH; Lucas E Nikkel, MD. Poster Presentation. 2023 AAHKS Annual Meeting. November 2-5. Gaylord, Texas. Podium Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

8. Early Revisions after Robotic-Assisted versus Conventional Total Knee Arthroplasty. Gregory Kirchner, MD MPH, Emily Jimenez, MPH; Kyle Mullen, MPH; Lucas E Nikkel, MD. Poster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

9. Antibiotic Laden and Non-Antibiotic Bone Cement in Primary Total Knee Arthroplasty: Does Antibiotic Laden Bone Cement Reduce Acute Periprosthetic Joint Infection? Blake O. Nourie, MD, Nicholas F. Cozzarelli, BS, Patrick Donnelly MPH, Chad A. Krueger, MD, Yale A. Fillingham, MD. Presentation. 2023 Pennsylvania Orthopaedic Society. September 27-29. Philadelphia, PA. Presentation. 2023 Eastern Orthopaedic Association. October 25-28. Charleston, SC. ePoster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

10. Periprosthetic Fractures: A Rising Tide of Total Hip Arthroplasty failures noted in the American Joint Replacement Registry and the role of Cemented Stems in preventing them. Adam A Sassoon MD MS, Ayushmita PhD, Ryan D. Stancil MD, Daryl F Cannady MD, Jeremiah Taylor MD, and Emily Jimenez MPH. Podium Presentation. 2023 AAHKS Annual Meeting. November 2-5. Gaylord, Texas. ePoster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

11. Effects of Gender and Fixation on the Outcomes of Hemiarthroplasty for Femoral Neck Fracture: Analysis of the American Joint Replacement Registry. Anna Cohen-Rosenblum MD MSc, Susan Odum PhD, Ayushmita De PhD, Kara Sarrel MD, Bryan Springer MD. 2023 Hip Society Annual Meeting. October 5-8. Durham, NC. Poster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

12. Effects of Gender and Fixation on the Outcomes of Total Hip Arthroplasty for Femoral Neck Fracture: Analysis of the American Joint Replacement Registry. Anna Cohen-Rosenblum MD MSc, Susan Odum PhD, Ayushmita De PhD, Kara Sarrel MD, Bryan Springer MD. Poster Presentation. 2023 AAHKS Annual Meeting. November 2-5. Gaylord, Texas. Poster Presentation. 2024 AAOS Annual Meeting; February 12-16. San Francisco, CA.

13. Periprosthetic Fractures: A Rising Tide of Total Hip Arthroplasty failures noted in the American Joint Replacement Registry and the role of Cemented Stems in preventing them. Adam A Sassoon MD MS, Ayushmita PhD, Ryan D. Stancil MD, Daryl F Cannady MD, Jeremiah Taylor MD, and Emily Jimenez MPH. Poster Presentation. 2023 Western Orthopaedic Association. Coeur d'Alene, ID. August 2-5. Poster Presentation. 2022 12th International Congress of Arthroplasty Registries, May 13-15 in Montreal, Canada.

14. The epidemiology of antibiotic loaded bone cement and systemic antibiotic prophylactic usage in primary cemented or hybrid total knee arthroplasty among countries in Africa, Europe, North America, and Oceania: A register based descriptive international study 2010-2020. Tesfaye Hordofa Leta, Anne Marie Fenstad, Stein Håkon Låstad Lygre, Stein Atle Lie, Martin Lindberg-Larsen), Alma B Pedersen, Annette W-Dahl, Ola Rolfson, Erik Bülow, James A Ashforth, Liza N vanSteenbergen, Rob Nelissen, Dylan Harries, Richard de Steiger, Olav Lutro, Keijo T Mäkelä, Jinny Willis, Michael Charles Wyat, Christopher Frampton, Alexander Grimberg, Arnd Steinbrück, Yinan Wu, Cristiana Armaroli, Marco Molinari, Roberto Picus, Kyle Mullen, Richard Illgen, Ioan C. Stoica, Andreea Vorovenci, Dan Dragomirescu, Havard Dale, Christian Brand, Bernhard Christen, Joanne Shapiro, J. Mark Wilkinson, Richard Armstrong, Kate Wooster, Geir Hallan, Jan-Erik Gjertsen, Richard Chang, Heather A Prentice, Elizabeth Paxton, Ove Furnes. Podium Presentation. 2022 12th International Congress of Arthroplasty Registries, May 13-15 in Montreal, Canada.

16. Femoral Component Design Influences Risk of Periprosthetic Femur Fracture After Total Hip Arthroplasty: An Analysis from the American Joint Replacement Registry. Mackenzie Kelly, MD, Antonia F Chen, MD, MBA, Sean P Ryan, MD, Zachary Working, MD, Ayushmita De, PhD, Kyle Mullen, MPH, Kimberly Porter MPH, PHD, Ryland Kagan, MD. Poster Presentation. 2022 12th International Congress of Arthroplasty Registries, May 13-15 in Montreal, Canada.

17. Collared femoral stem design for total hip arthroplasty reduces risk of periprosthetic femur fracture in patients 65 years or older: An Analysis from the American Joint Replacement Registry. Mackenzie Kelly MD, Antonia F Chen MD MBA MD, Sean P Ryan MD, Zachary Working MD, Ayushmita De PhD, Kyle Mullen, MPH, Kimberly Porter MPH, PHD, Ryland Kagan, MD. PodiumP resentation. 2022 12th International Congress of Arthroplasty Registries, May 13-15 in Montreal, Canada.

18. Analyzing utilization rates of premium technologies in total knee arthroplasty between safety-net hospitals and non-safety-net hospitals. Andrew G. Chapple PhD, Peter C. Krause MD, Stefan D. Sarkovich, Vinod Dasa MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

19. Demographics and Outcomes of Commercial Antibiotic Cement Usage for Infection Prophylaxis During Primary Total Knee Arthroplasty In Patients Over 65 Years Old: An American Joint Replacement Registry Study. Benjamin Ricciardi MD, Caroline Thirukumaran PhD, John G. Ginnetti MD, Kimberly Porter PhD, Nathan Kaplan MD, Thomas G. Myers MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

20. Femoral Component Design Influences Risk of Periprosthetic Femur Fracture After Total Hip Arthroplasty: An Analysis from the American Joint Replacement Registry. Antonia F. Chen MD MBA, Ayushmita De PhD, Kimberly Porter PhD, Kyle Mullen MPH, Mackenzie Kelly MD, Ryland P. Kagan MD, Sean P. Ryan MD, and Zachary M. Working MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

21. Lower Revision Risk with All-Polyethylene Tibial Components in Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry. Adam A. Sassoon MD MS, Ayushmita De PhD, Benjamin Kelley MD, Jamil Kendall MD, John Andrawis, MD, Kyle Mullen MPH, Patrick Yep, Ryland P. Kagan MD. Podium Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

22. Increased Revision Risk with Rotating Platform Bearings in Total Knee Arthroplasty: An Analysis of the American Joint Replacement Registry. Christopher E. Pelt MD, Jamil Kendall MD, Kathryn Schabel MD, Kyle Mullen MPH, Patrick Yep, Ryland P. Kagan MD, and Vishal Hegde MD. Podium Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

23. Cemented Femoral Fixation for Total Hip Arthroplasty Reduces the Risk of Periprosthetic Femur Fracture in Patients 65 Years or Older: An Analysis From the American Joint Replacement Registry. Antonia F. Chen MD MBA, Ayushmita De PhD; Kimberly Porter PhD, Kyle Mullen MPH, Mackenzie Kelly MD, Ryland P. Kagan MD, Sean P. Ryan MD, and Zachary M. Working MD. Podium Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

24. Dual Mobility Articulation in Revision Total Hip Arthroplasty: An American Joint Replacement Registry Analysis. Bryan D. Springer MD, Heena Jaffri MPH, Jay R. Lieberman MD, Jesse E. Otero MD, Kyle Mullen MPH, Nathanael D. Heckmann MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

25. Dual Mobility Outcomes in Primary Total Hip Arthroplasty: An American Joint Replacement Registry Analysis. Bryan D. Springer MD, Heena Jaffri MPH, Jay R. Lieberman MD, Jesse E. Otero, MD, Kyle Mullen MPH, Nathanael D. Heckmann MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

26. Revision Rate Following Unipolar vs. Bipolar Hemiarthroplasty. David N. Kugelman MD, Joseph X. Robin MD, Kenneth A. Egol MD, Ran Schwarzkopf MD, Roy Davidovitch MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

27. Trends in Complications and Outcomes in Patients Aged 65 and Younger Undergoing Total Hip Arthroplasty: Data from the American Joint Replacement Registry. Akash Shah MD, David A. Cieremans MS, James D. Slover MD, Morteza Meftah MD, Ran Schwarzkopf MD. Poster Presentation. 2023 AAOS Annual Meeting; March 7-11. Las Vegas, NV.

Appendix B

Data Element Review

Procedural

Patient

- Name (Last, First)
- Date of Birth
- Social Security Number
- Diagnosis (ICD-9/10)
- Gender
- Ethnicity
- Height and Weight/BMI

Site of Service

- Name (NPI)
- Address

Surgeon

- Name
- National Provider Identifier (NPI)

Procedure

- Type (ICD-9/10 and CPT)
- Date of surgery
- Laterality
- Implants
- Surgical Approach
- Anesthesia Technique
- Discharge Disposition
- Implants (Manufacturer, Lot #)
- Operative Duration
- Computer/Robotic Assisted Surgery
- Tourniquet Use
- Blood Transfusion
- TXA Usage
- PT Day 0
- VTE Prophylaxis
- Perioperative Antibiotics
- Multi-modal Pain Management

Post-discharge, Complications

Patient Risk Factors (ICD-9/10)*

- Comorbidities (ICD-9/10, CPT)
- CJR Risk Variables
- Height + Weight/Body Mass Index
- Length of Stay
- American Society of Anesthesiologists (ASA) Score
- Charlson Index
- Operative and Post-discharge Complications

**Comorbidities listed of focus, all comorbidities are accepted*

Post-discharge Complications

- Early revisions
- All-cause readmissions

Patient-Reported Outcome Measures (PROMs)

Hip dysfunction and Osteoarthritis Outcome Score for Joint Replacement (HOOS, JR.)*

Knee injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS, JR.)*

Patient-Reported Outcomes Measurement Information System (PROMIS) 10-item Global Health*

The Veterans RAND 12 Item Health Survey (VR-12)*

Harris Hip Score

Hip disability and Osteoarthritis Outcome Score (HOOS)

Knee injury and Osteoarthritis Outcome Score (KOOS)

Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)

Oxford Hip and Knee Scores

The Knee Society Knee Scoring System

Western Ontario and McMaster Universities Arthritis Index (WOMAC)

**PROMs recommended by AJRR and supported on the PROM platform*

Appendix C

AAOS Authorized Vendor Program

The AAOS Authorized Vendor Program was created to minimize the data entry burden and enhance the data submission process. The following vendors have been approved for this program.

- ✓Algos Pathways
- ✓American Association of Orthopedic Executives (AAOE)
- ✓Amkai Solutions
- ✓Cedaron
- ✓Cerner*
- ✓Clarify Health Solutions
- ✓CODE Technology
- ✓Consensus Medical Systems, Inc.
- ✓Direct Difference
- ✓Duet Health
- ✓Epic*
- ✓FORCE Therapeutics
- ✓HOPCo
- ✓Invivolink, Inc.
- ✓Kermit
- ✓MedTrak, Inc. (CareSense System)
- ✓Medtronic
- ✓MiCare Path
- ✓Mytonomy
- ✓[m]pirik
- ✓Navion HealthCare Solutions
- ✓Neuralframe
- ✓OM1
- ✓Ortech, Inc.
- ✓OrthoSensor, Inc.
- ✓OrthoVitals
- ✓OutcomeMD
- ✓PatientIQ
- ✓Pro-Mapp Health
- ✓Q-Centrix
- ✓Ratchet Health
- ✓Ready Surgery
- ✓Revo Health
- ✓Santovia
- ✓Twistle
- ✓URS-Oberd, Inc.
- ✓ValidCare
- ✓VisionTree
- ✓VitalHealth Software
- ✓Vox Telehealth
- ✓Wellbe, Inc.

**Vendors who have data extract templates*

For updates to the list and more information on the AAOS Authorized Vendor Program, please visit here.

Appendix D

AJRR Committees

Young Physicians Committee (YPC)

Jeffrey B. Stambough, MD–Chair
University of Arkansas

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Nathanael Heckmann, MD
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Vishal Hegde, MD
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Lucas E. Nikkel, MD
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Adam S. Olsen, MD, MS
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Nicolas S. Piuzzi, MD
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Sean P. Ryan, MD
Duke University Medical Center

Ahmed Siddiqi, DO, MBA
Orthopaedic Institute of Central Jersey

Wendy W. Wong, MD, FAAOS
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Mayo Clinic School of Medicine

AJRR Data Elements and Analysis Subcommittee (DEAS)

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OrthoCarolina

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Oregon Health and Sciences

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Texas Orthopedics

Brian T. Nickel, MD
University of Wisconsin

Jesse E. Otero, MD, PhD
OrthoCarolina

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NYU Langone Orthopedic Hospital

Jeffrey B. Stambough, MD
University of Arkansas

Timothy Wright, PhD
Hospital for Special Surgery

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Patient/Public Representative (Cincinnati, OH)

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Patient/Public Representative (Baltimore, MD)

Appendix E

Participating Institutions

Instituitions that joined AJRR by 8/1/23 are included. Those that contributed data for this *Annual Report* by 8/30/23 are highlighted in blue.

Alabama

Cullman Regional Medical Center
Huntsville Hospital
Jack Hughston Memorial Hospital
South Baldwin Regional Medical Center
St. Vincent's Birmingham
Mobile Infirmary
USA Health University Hospital

Alaska

Alpine Surgery Center
Central Peninsula Hospital
Creekside Surgery Center
Providence Alaska Medical Center
Providence Kodiak Island Medical Center
PeaceHealth Orthopedic & Sports Medicine in Ketchikan
Alaska Regional Hospital

Arizona

Arizona Spine & Joint Hospital
Banner-University Medical Center South
Banner-University Medical Center Tucson
Carondelet St. Joseph's Hospital
Flagstaff Medical Center
Mayo Clinic in Arizona
Mountain Vista Medical Center
North Valley Surgery Center
Northwest Medical Center
OASIS Hospital*
Verde Valley Medical Center
Chandler Regional Medical Center
Gateway Surgery Center
Mercy Gilbert Medical Center
Oro Valley Hospital
Shane Martin, MD of Greater Phoenix Orthopedics
Sonoran Orthopaedic Trauma Surgeons
St. Luke's Medical Center
Tempe St. Luke's Hospital
University Orthopedic Specialists

Arkansas

Arkansas Specialty Surgery Center
Arkansas Surgical Hospital
CHI St. Vincent Hot Springs*
CHI St. Vincent Infirmary
Martin Knee & Sports Medicine Center
Mercy Hospital Fort Smith
Mercy Hospital Northwest Arkansas
Mercy Orthopedic Hospital Fort Smith
Northwest Health Physicians' Specialty Hospital
Northwest Medical Center-Bentonville
Northwest Medical Center-Springdale
OrthoSurgeons
University of Arkansas for Medical Sciences
Washington Regional Medical Center
White River Medical Center
National Park Medical Center

California

Adventist Health Bakersfield
Adventist Health Hanford
Adventist Health Lodi Memorial
Adventist Health St. Helena*
Alta Bates Summit Medical Center | Alta Bates Campus
Alta Bates Summit Medical Center | Summit Campus
Arroyo Grande Community Hospital
Bakersfield Memorial Hospital*
Barton Memorial Hospital
California Pacific Medical Center
Casa Colina Hospital and Centers for Healthcare*
Cedars-Sinai Medical Center
Clovis Community Medical Center
Community Hospital of the Monterey Peninsula
Community Memorial Hospital
Dameron Hospital
Doctors Medical Center of Modesto
Eisenhower Medical Center
El Camino Hospital, Los Gatos Campus
Emanuel Medical Center
Enloe Medical Center
Feather River Hospital
French Hospital Medical Center*
Fresno Surgical Hospital
Glendale Adventist Medical Center
Golden State Orthopedics & Spine
Goleta Valley Cottage Hospital*
Hoag Orthopedic Institute
Howard Memorial Hospital
Huntington Hospital*
Inland Valley Medical Center
John Muir Health, Concord Medical Center
John Muir Health, Walnut Creek Medical Center
Keck Medicine of USC
Long Beach Medical Center
Los Robles Regional Medical Center
Marian Regional Medical Center
Marina del Rey Hospital
Memorial Medical Center*
Mercy General Hospital*
Mercy Hospital of Folsom
Mercy Medical Center Merced*
Mercy San Juan Medical Center
Methodist Hospital of Sacramento*
Mills-Peninsula Medical Center
Mission Hospital-Mission Viejo

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Monterey Peninsula Surgery Center
NorthBay Medical Center
NorthBay VacaValley Hospital
Novato Community Hospital*
Ojai Valley Community Hospital
Orange Coast Medical Center
Palomar Medical Center Escondido
Palomar Medical Center Poway*
Petaluma Valley Hospital
PIH Health-Whittier
Pomona Valley Hospital Medical Center
Presidio Surgery Center*
Providence Holy Cross Medical Center
Providence Little Company of Mary Medical Center-San Pedro
Providence Little Company of Mary Medical Center Torrance
Providence Saint John's Health Center
Providence Saint Joseph Medical Center
Providence Santa Rosa Memorial Hospital
Providence St. Joseph Hospital Eureka
Providence St. Joseph Hospital of Orange
Providence St. Jude Medical Center*
Providence St. Mary Medical Center
Providence Tarzana Medical Center
Queen of the Valley Medical Center
Redwood Memorial Hospital
Riverside Community Hospital
Riverside University Health System*
Ronald Reagan UCLA Medical Center
Saddleback Medical Center
Saint Agnes Medical Center
Salinas Valley Memorial Healthcare System
San Antonio Regional Hospital*
Santa Barbara Cottage Hospital*
Scripps Green Hospital
Sequoia Hospital
Sharp Chula Vista Medical Center
Sharp Coronado Hospital
Sharp Grossmont Hospital
Sharp Memorial Hospital
Shasta Regional Medical Center
Simi Valley Hospital
Sonoma Valley Hospital
Sonora Regional Medical Center
St. Joseph Hospital Eureka
St. Joseph's Medical Center
St. Mary Medical Center
St. Bernardine Medical Center
Stanford Health Care
Stanford Health Care Tri-Valley*
Sutter Alhambra Surgery Center
Sutter Medical Center, Sacramento Surgery Center
Sutter Sierra Surgery Center
Sutter Surgical Hospital North Valley
Tahoe Forest Hospital
Temecula Valley Hospital
The Bahamas Surgery Center
The Center for Orthopedic Surgery
Torrance Memorial Medical Center*
Tri-city Medical Center
UCLA Santa Monica Medical Center
UCSF Medical Center
Ukiah Valley Medical Center
Washington Hospital Healthcare System
West Coast Joint and Spine Surgery Center
West Hills Hospital & Medical Center
White Memorial Medical Center
Alvarado Hospital Medical Center
Campus Surgery Center
Carlsbad Surgery Center
Coast Surgery Center
Corona Regional Medical Center
Desert Regional Medical Center
Dignity Health-St. Mary Medical Center
Dominican Hospital
Eden Medical Center
Fort Sutter Surgery Center
Good Samaritan Hospital
Henry Mayo Newhall Hospital
La Jolla Orthopedic Surgery Center
La Veta Surgery Center
Loma Linda University Health
Mammoth Hospital
Memorial Hospital Los Banos
Mercy Hospital Downtown-Bakersfield
Mercy Medical Center Redding
Mission Valley Heights Surgery Center
North Bay Regional Surgery Center
North Tahoe Orthopedics
Northridge Hospital Medical Center
Otay Lakes Surgery Center
Palmdale Regional Medical Center
Poway Surgery Center
Rancho Springs Medical Center*
Redlands Community Hospital
San Leandro Surgery Center
Santa Rosa Surgery and Endoscopy Center
St. John's Pleasant Valley Hospital
St. John's Regional Medical Center
Stockton Surgery Center
Surgery Center of Long Beach
Sutter Amador Hospital
Sutter Auburn Faith Hospital
Sutter Auburn Surgery Center
Sutter Davis Hospital Outpatient (Ambulatory) Surgery Center
Sutter Elk Grove Surgery Center
Sutter Fairfield Surgery Center
Sutter Maternity & Surgery Center
Sutter North Surgery and Endoscopy Center
Sutter Roseville Medical Center Surgery Center
Sutter Solano Medical Center Surgery Center
Sutter Tracy Community Hospital
UCSF Medical Center at Mount Zion
USC Verdugo Hills Hospital

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Colorado

Animas Surgical Hospital
Avista Adventist Hospital
Boulder Community Health
Castle Rock Adventist Hospital
Colorado Joint Replacement
Crown Point Surgery Center
Denver Health Medical Center
Littleton Adventist Hospital
Longmont United Hospital
Mercy Regional Medical Center
North Suburban Medical Center
OrthoColorado Hospital
Parker Adventist Hospital
Penrose Hospital
Porter Adventist Hospital
Pueblo Bone & Joint Clinic, LLC
Rose Medical Center*
Sky Ridge Medical Center*
St. Anthony Hospital
St. Anthony North Health Campus
St. Anthony Summit Medical Center
St. Francis Medical Center
St. Mary-Corwin Medical Center
St. Mary's Medical Center
St. Thomas More Hospital
Steamboat Orthopaedic & Spine Institute
Swedish Medical Center
The Medical Center of Aurora
UCHealth Grandview Hospital
UCHealth Greeley Medical Center
UCHealth Longs Peak Hospital
UCHealth Medical Center of the Rockies
UCHealth Memorial Hospital Central
UCHealth Pikes Peak Regional Hospital
UCHealth Poudre Valley Hospital
UCHealth University of Colorado Hospital
UCHealth Yampa Valley Medical Center
Valley View Hospital
Panorama Orthopedics & Spine Center
Penrose-St. Francis Urgent Care
Presbyterian St. Luke's Medical Center
UCHealth Broomfield Hospital
UCHealth Highlands Ranch Hospital
UCHealth Inverness Orthopedics and Spine Surgery Center

Connecticut

Backus Hospital*
Bridgeport Hospital Milford Campus-Milford
Danbury Hospital*
Glastonbury Surgery Center
Hartford Hospital*
MidState Medical Center*
Norwalk Hospital*
Saint Francis Hospital and Medical Center*
St. Vincent's Medical Center*
The Hospital of Central Connecticut-New Britain General Campus
Windham Hospital*
Yale New Haven Health Bridgeport Hospital*
Yale New Haven Health Greenwich Hospital*
Yale New Haven Health Lawrence + Memorial Hospital
Yale New Haven Health Saint Raphael Campus*
Yale New Haven Hospital York Street Campus
Johnson Memorial Hospital
Middlesex Hospital
Saint Mary's Hospital
Sharon Hospital
Valley Orthopaedic Specialists, LLC
Waterbury Hospital
Western Connecticut Orthopedic Surgical Center

Delaware

Bayhealth Hospital, Kent Campus
Bayhealth Hospital, Sussex Campus
Christiana Hospital*
St. Francis Hospital
Wilmington Hospital
First State Orthopaedics
Orthopaedic Associates of Southern Delaware, P.A.

District of Columbia

Providence Hospital
Sibley Memorial Hospital-Johns Hopkins Medicine
George Washington University Hospital

Florida

AdventHealth Altamonte Springs
AdventHealth Carrollwood*
AdventHealth Celebration
AdventHealth North Pinellas*
AdventHealth Ocala
AdventHealth Orlando
AdventHealth Waterman
AdventHealth Wesley Chapel
AdventHealth Winter Park
AdventHealth-Zephyrhills Hospital*
Andrews Institute Ambulatory Surgery Center
Ascension St. Vincent's Medical Center Clay County Hospital
Ascension St. Vincent's Medical Center Riverside Hospital
Ascension St. Vincent's Southside Hospital
Aventura Hospital and Medical Center
Baptist Hospital
Bartow Regional Medical Center
Blake Medical Center
Brandon Regional Hospital
Broward Health North*
Cape Coral Hospital

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Cleveland Clinic Florida
Cleveland Clinic Florida-Weston
Cleveland Clinic Indian River Hospital
Cleveland Clinic Tradition Hospital
Coral Gables Hospital*
Doctors Hospital of Sarasota
Dr. P. Phillips Hospital*
Fawcett Memorial Hospital
Flagler Hospital
Florida Medical Center
Fort Walton Beach Medical Center
Gulf Breeze Hospital
Gulf Coast Medical Center
Gulf Coast Regional Medical Center
Health Central Hospital
Holy Cross Hospital
Indian River Medical Center
JFK Medical Center
Jupiter Medical Center
Kendall Regional Medical Center
Largo Medical Center
Lee Memorial Hospital
Martin Memorial Medical Center
Mayo Clinic in Florida*
Mease Countryside Hospital
Mease Dunedin Hospital
Medical Center of Trinity
Memorial Hospital Jacksonville*
Memorial Hospital of Tampa
Memorial Hospital West*
Morton Plant Hospital
Morton Plant North Bay Hospital
North Florida Regional Medical Center
Oak Hill Hospital
Ocala Regional Medical Center
Orlando Health Orlando Regional Medical Center
Orlando Health South Seminole Hospital
Orthopaedic Surgery Center
Orthopaedic Surgery Center of Ocala
Osceola Regional Medical Center
Palms of Pasadena Hospital
Regional Medical Center Bayonet Point
Rockledge Regional Medical Center
Sarasota Memorial
Sarasota Memorial Hospital-Venice
South Bay Hospital
South Florida Baptist Hospital
St. Anthony's Hospital
St. Joseph's Hospital-North
St. Joseph's Hospital Tampa
St. Joseph's Hospital-South
St. Lucie Medical Center
Tallahassee Memorial HealthCare*
The Orthopaedic Institute
Toman Orthopedics and Sports Medicine
UF Health Shands Hospital
University Hospital & Medical Center
University of Florida Health
University of Miami Hospital
Westside Regional Medical Center
Winter Haven Hospital
AdventHealth Palm Coast Parkway
Andrews Institute for Orthopaedics & Sports Medicine
Broward Health Medical Center
Cleveland Clinic Martin South Hospital
Florida Joint & Spine Institute
Lakewood Ranch Medical Center
Manatee Memorial Hospital
Medical Center Clinic
Orlando Health Jewett Orthopedic Institute
Orlando Orthopaedic Center
OrthoCare Florida
Orthopedic Center of Palm Beach County
Orthopedic Special Surgery of Palm Beaches
Pensacola Orthopaedics & Sports Medicine
Physicians Regional Medical Center-Collier Boulevard
Physicians Regional Medical Center-Pine Ridge
Wellington Regional Medical Center
West Florida Hospital
Weston Outpatient Surgical Center

Georgia

Atlanta Medical Center
Atlanta Medical Center South
Cartersville Medical Center
Coffee Regional Medical Center
Coliseum Medical Centers
Colquitt Regional Medical Center
Eastside Medical Center
Houston Medical Center
Memorial University Medical Center
Navicent Health
Northwest Plaza ASC, LLC
Optim Medical Center-Tattnall
Optim Surgery Center
Perry Hospital
Piedmont Atlanta Hospital
Piedmont Augusta
Piedmont Columbus Regional Northside Campus
Piedmont Fayette Hospital
Piedmont Henry Hospital
Piedmont Newnan Hospital
Redmond Regional Medical Center
Southeast Georgia Health System-Brunswick Campus
Southeast Georgia Health System-Camden Campus
St. Francis Hospital*
WellStar Cobb Hospital
WellStar Douglas Hospital
WellStar Kennestone Hospital
WellStar Paulding Hospital
WellStar Spalding Regional Hospital
WellStar West Georgia Medical Center
Wellstar Windy Hill Hospital*
Advanced Center for Joint Surgery

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AdventHealth Redmond
Coliseum Northside Hospital
Emory Decatur Hospital
Emory Johns Creek Hospital
Emory Saint Joseph's Hospital
Emory University Hospital Midtown
Emory University Orthopaedics & Spine Hospital*
Floyd Medical Center
St. Mary's Good Samaritan Hospital
St. Mary's Hospital
Summit Sports Medicine & Orthopedic Surgery

Hawaii

Adventist Health Castle
Hawaii Pacific Health
Pali Momi Medical Center
Straub Clinic and Hospital
The Queen's Medical Center*
Wilcox Memorial Hospital

Idaho

Cassia Regional Medical Center
Kootenai Outpatient Surgery
Madison Memorial Hospital
Northwest Specialty Hospital
St. Alphonsus Medical Center Nampa Campus
St. Alphonsus Regional Medical Center
St. Joseph Regional Medical Center
St. Luke's Boise Medical Center
St. Luke's Meridian Medical Center

Illinois

Adult & Pediatric Orthopedics
Advocate Lutheran General Hospital
AMITA Health Adventist Medical Center Hinsdale
AMITA Health Alexian Brothers Medical Center Elk Grove Village
AMITA Health Resurrection Medical Center Chicago
AMITA Health Saint Joseph Hospital Chicago
AMITA Health Saint Joseph Hospital Elgin
AMITA Health St. Alexius Medical Center Hoffman Estates
AMITA Health St. Mary's Hospital Kankakee
Blessing Health System
Centegra Hospital McHenry
Centegra Hospital Woodstock
DuPage Medical Group
Evanston Hospital
FHN Memorial Hospital
Genesis Medical Center, Silvis
Gibson Area Hospital
Glenbrook Hospital
Highland Park Hospital
HSHS St. Anthony's Memorial Hospital*
Memorial Medical Center-Springfield
Mount Sinai Hospital
Northwestern Medicine Central DuPage Hospital
Northwestern Medicine Delnor Hospital
Northwestern Medicine Kishwaukee Hospital*
Northwestern Medicine Lake Forest Hospital
Northwestern Memorial Hospital
OrthoIllinois
Orthopedic & Sports Medicine Clinic
OSF Saint Anthony Medical Center
OSF Saint Anthony's Health Center
OSF Saint Elizabeth Medical Center
OSF Saint Francis Medical Center
OSF Saint James-John W. Albrecht Medical Center
OSF St. Joseph Medical Center
OSF St. Mary Medical Center
Palos Community Hospital
Rockford Memorial Hospital
Rush University Medical Center
Skokie Hospital
South Shore Hospital
UnityPoint Health-Methodist
UnityPoint Health-Proctor
UnityPoint Health-Trinity Rock Island
Valley Ambulatory Surgery Center
Weiss Memorial Hospital
Advocate BroMenn Medical Center
Advocate Christ Medical Center
Advocate Condell Medical Center
Advocate Eureka Hospital
Advocate Good Samaritan Hospital
Advocate Good Shepherd Hospital
Advocate Illinois Masonic Medical Center
Advocate Sherman Hospital
Advocate South Suburban Hospital
Advocate Trinity Hospital
AMITA Health Adventist Medical Center La Grange
Bonutti Orthopedic Clinic
Center For Minimally Invasive Surgery
Decatur Orthopaedic Center
Gold Coast Surgicenter
Gottlieb Memorial Hospital
HSHS St. John's Hospital
Loyola University Medical Center
Memorial Hospital of Carbondale
Mercy Hospital & Medical Center
NorthShore Orthopaedic & Spine Institute
OSF Heart of Mary Medical Center
OSF Holy Family Medical Center
OSF Sacred Heart Medical Center
OSF Saint Luke Medical Center
OSF Saint Paul Medical Center
Raycraft & Jones Orthopaedics
Riverside Medical Center
Sarah Bush Lincoln Health Center
SIH Herrin Hospital
Swedish American Hospital

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Indiana

Allied Physicians Surgery Center
Columbus Regional Health Orthopedics and Sports Medicine
Elkhart General Hospital*
Franciscan Health Carmel
Franciscan Health Indianapolis
Franciscan Health Moorseville
Hancock Regional Hospital
Indiana Regional Medical Center
Indiana University Health West Hospital
IU Health Ball Memorial Hospital
IU Health Bloomington Hospital*
IU Health North Hospital
IU Health Saxony Hospital*
IU Health Saxony Surgery Center
Main Hospital*
Major Health Partners Medical Center
Memorial Hospital and HealthCare Center
OrthoIndy Northwest
Plymouth Medical Center
Porter Regional Hospital
Riverview Health Westfield Hospital
Schneck Medical Center
St. Joseph Regional Medical Center
St. Mary Medical Center*
The Orthopedic Hospital
Indiana Hand to Shoulder Center
Indiana University Health Methodist Hospital*
Indiana University Health White Memorial Hospital
IU Health Arnett Hospital
IU Health Bedford Hospital
IU Health Beltway Surgery Centers*
IU Health Blackford Hospital
IU Health Eagle Highlands Surgery Center*
IU Health Jay Hospital
IU Health Meridian South Surgery Center
IU Health Morgan*
IU Health Paoli Hospital
IU Health Tipton Hospital
IU Health University Hospital
Memorial Hospital of South Bend*
Munster Specialty Surgery Center
Parkview Ortho Hospital
Riley Hospital for Children at IU Health
Senate Street Surgery Center*
Sidney & Lois Eskenazi Hospital

Iowa

Allen Hospital
Buena Vista Regional Medical Center
CHI Health Mercy Council Bluffs*
Finley Hospital
Genesis Medical Center, Davenport
Great River Orthopaedic Specialists
Iowa Lutheran Hospital
Iowa Methodist Medical Center
Iowa Specialty Hospital-Clarion
Lakes Regional Healthcare
Marengo Memorial Hospital
Mercy Medical Center-Cedar Rapids
Mercy Medical Center-Clinton
Mercy Medical Center-Des Moines
Mercy Medical Center-Dubuque
Mercy Medical Center-Sioux City
Mercy Medical Center-West Lakes
MercyOne North Iowa Medical Center
Methodist West Hospital
Mississippi Valley Surgery Center
Orthopaedic Outpatient Surgery Center
Spencer Hospital
St. Luke's Hospital
St. Luke's Regional Medical Center
UnityPoint Health-Trinity Bettendorf
UnityPoint Health-Trinity Muscatine
UnityPoint Health-Trinity Regional Medical Center
UnityPoint Marshalltown
University of Iowa Hospitals & Clinics
Advanced Surgery Center of Central Iowa
CHI Health Mercy Corning
MercyOne Des Moines Medical Center
MercyOne New Hampton Medical Center
MercyOne Primghar Medical Center
Steindler Orthopedic Clinic

Kansas

AdventHealth Shawnee Mission
Ascension Via Christi Hospital in Manhattan
Hays Medical Center
Hutchinson Regional Medical Center
Kansas City Orthopaedic Institute
Lawrence Memorial Hospital*
LMH Health
Menorah Medical Center
Newton Medical Center
St. Catherine Hospital
Stormont-Vail Health*
The University of Kansas Health System
Wesley Medical Center
Wesley Woodlawn Hospital & ER
AdventHealth Ottawa
Bob Wilson Memorial Hospital
St. Rose Ambulatory & Surgery Center

Kentucky

Hardin Memorial Hospital*
Jewish Hospital
King's Daughters Medical Center
Mercy Health-Lourdes Hospital
Methodist Hospital
Norton Audubon Hospital
Norton Brownsboro Hospital
Norton Hospital
Norton Women's & Children's Hospital
Owensboro Health Regional Hospital
Pomeroy & Rhoads Orthopaedics, PLLC

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Saint Joseph East
St. Elizabeth Hospital Edgewood
TriStar Greenview Regional Hospital
Baptist Health Louisville
Bluegrass Orthopaedics
South Central Kentucky Orthopedics
UofL Health-UofL Hospital

Louisiana

Doctors Hospital at Deer Creek
East Jefferson General Hospital
Lafayette General Medical Center
Lafayette Surgical Specialty Hospital
Ochsner Baptist-A Campus of Ochsner Medical Center
Ochsner Hospital for Orthopedics & Sports Medicine
Ochsner Medical Center*
Ochsner Medical Center-Kenner
Ochsner Medical Center-West Bank Campus
Our Lady of Lourdes Regional Medical Center
Park Place Surgical Hospital
Specialists Hospital Shreveport
Thibodeaux Regional Medical Center
Willis-Knighton Medical Center*
AVALA
Christus Ochsner St. Patrick Hospital
Lafayette Bone & Joint Clinic
Red River Surgery Center
Tulane Lakeside Hospital
West Bank Surgery Center

Maine

Central Maine Orthopaedics
Falmouth Orthopedic Center
Maine Medical Center*
MaineGeneral Medical Center
Northern Light Mercy Hospital*
OA Centers for Orthopaedics
St. Mary's Regional Medical Center

Maryland

Anne Arundel Medical Center
Atlantic General Hospital
GBMC HealthCare*
Harborside Surgery Center
Holy Cross Germantown Hospital
Holy Cross Hospital
Howard County General Hospital
Johns Hopkins Bayview Medical Center*
MedStar Union Memorial Hospital
Meritus Medical Center
Peninsula Regional Medical Center*
Saint Agnes Healthcare*
Suburban Hospital
SurgCenter of Western Maryland, LLC
Surgery Center of Easton
University of Maryland Baltimore Washington Medical Center
University of Maryland Charles Regional Medical Center
University of Maryland Harford Memorial Hospital
University of Maryland Medical Center
University of Maryland Medical Center Midtown Campus
University of Maryland Rehabilitation & Orthopaedic Institute
University of Maryland Shore Medical Center at Easton
University of Maryland St. Joseph Medical Center
University of Maryland Upper Chesapeake Health
Western Maryland Health System
Capitol Orthopaedics and Rehabilitation, LLC
Frederick Health Hospital
Greenspring Surgery Center, LLC
Sinai Hospital of Baltimore

Massachusetts

Berkshire Medical Center
Beth Israel Deaconness Hospital-Plymouth
Beth Israel Deaconness Medical Center
Beverly Hospital
Boston Medical Center
Brigham and Women's Faulkner Hospital
Brigham and Women's Hospital
Charlton Memorial Hospital*
Emerson Hospital
Good Samaritan Medical Center
Holy Family Hospital*
Lahey Hospital & Medical Center
Lowell General Hospital
Massachusetts General Hospital
New England Baptist Hospital*
Orthopedic Surgery Center of the North Shore
Quincy Medical Center
Saint Anne's Hospital*
Signature Healthcare Brockton Hospital
South Shore Hospital
Sports Medicine North Orthopedic Surgery
St. Luke's Hospital*
Boston Out-Patient Surgical Suites, LLC
Longview Orthopaedic Center, LLC
Mercy Medical Center
Mercy Medical Center of Sisters of Providence
Tobey Hospital*

Michigan

Ascension Borgess Medical Center
Ascension Providence Hospital, Southfield
Ascension Providence Rochester Hospital
Ascension St. Mary's Hospital*
Bronson Battle Creek Hospital

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Bronson LakeView Hospital
Bronson Methodist Hospital
Bronson South Haven Hospital
Henry Ford Hospital
Henry Ford Macomb Hospital
Henry Ford West Bloomfield Hospital
Henry Ford Wyandotte Hospital
Holland Hospital
Hurley Medical Center
McLaren Flint
McLaren Greater Lansing
Mercy Health Hackely
Mercy Health Muskegon
Mercy Health St. Mary's
Michigan Surgical Hospital
MidMichigan Medical Center-Midland
Munson Healthcare Cadillac Hospital
Munson Medical Center
OSF St. Francis Hospital & Medical Group
Red Cedar Surgery Center, LLC*
Sparrow Health System
Spectrum Health Hospitals Blodgett Hospital
Spectrum Health Lakeland
Spectrum Health Ludington Hospital
St. Joseph Mercy Ann Arbor*
St. Joseph Mercy Brighton Health Center
St. Joseph Mercy Chelsea
St. Joseph Mercy Oakland Hospital
St. Mary Mercy Livonia Hospital
St. Joseph Mercy Livingston Hospital
University of Michigan Health System
UP Health System-Marquette
William Beaumont Hospital
Alliance Surgery Center
Ascension Genesys Hospital
Ascension Macomb-Oakland Hospital, Madison Heights Campus
Ascension Macomb-Oakland Hospital, Warren Campus
Ascension Providence Hospital, Novi Campus
Ascension River District Hospital
Ascension St. John Hospital
Memorial Healthcare
Mercy Health Lakeshore
Mercy Health Southwest
Muskegon Surgery Center

Minnesota

Abbott Northwestern Hospital*
Alomere Health
Buffalo Hospital
Cambridge Medical Center
CHI St. Gabriel's Health
Crosstown Surgery Center
Cuyuna Regional Medical Center*
Douglas County Hospital
Eagan Surgery Center
Essentia Health-St. Joseph's Medical Center (Brainerd)*
Essentia Health-St. Mary's Medical Center
Fairview Northland Medical Center
Fairview Ridges Hospital
Fairview Southdale Hospital
HealthEast Clinic-Woodwinds
HealthEast St. John's Hospital
HealthEast St. Joseph's Hospital
Hennepin County Medical Center
High Pointe Surgery Center
Lakeview Hospital
Mayo Clinic Health System in Austin
Mayo Clinic Health System in Mankato
Mayo Clinic Health System in Red Wing
Mayo Clinic in Rochester
Mercy Hospital
Mercy Hospital-Unity Campus
Minnesota Valley Surgery Center, LLC
New Ulm Medical Center
North Memorial Health Hospital
Orthopaedic & Fracture Clinic
Owatonna Hospital
Park Nicollet Methodist Hospital
Regina Hospital
Regions Hospital
Ridgeview Medical Center
River's Edge Hospital and Clinic
Riverwood Healthcare Center
St. Cloud Hospital
St. Francis Regional Medical Center
St. Gabriel's Hospital
St. Luke's
Two Twelve Surgery Center
United Hospital
University of Minnesota Medical Center
Vadnais Heights Surgery Center*
WestHealth Surgery Center
Abbott Northwestern-WestHealth
St. Cloud Surgical Center
TRIA Orthopaedic Center

Mississippi

Baptist Medical Center
Columbus Orthopaedic Outpatient Center*
Merit Health River Oaks
Mississippi Valley Surgery Center and Endoscopy Center
OrthoSouth Southaven Surgery Center
Singing River Hospital
St. Dominic Hospital
Univeristy of Mississippi Medical Center
North Mississippi Medical Center
Ocean Springs Hospital
Specialty Surgical Center

Missouri

CoxHealth
Mercy Hospital Carthage
Mercy Hospital Jefferson
Mercy Hospital Joplin

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Mercy Hospital Lebanon
Mercy Hospital Lincoln
Mercy Hospital South
Mercy Hospital Springfield
Mercy Hospital St. Louis
Mercy Hospital Washington
Mercy Orthopedic Hospital Springfield
Meyer Orthopedic & Rehabilitation Hospital
Missouri Orthopaedic Institute
Mosaic Life Care
North Kansas City Hospital*
Pawsat, M.D. & Maeda, M.D. P.C.
Phelps County Regional Medical Center
Saint Francis Medical Center
Saint Luke's East Hospital*
Saint Luke's Surgicenter-Lee's Summit, LLC*
Signature Medical Group
Southeast Hospital
St. Joseph Outpatient Surgery Center, LLC
St. Luke's Hospital
St. Luke's Hospital-Chesterfield
The Surgical Center at Columbia Orthopaedic Group
Total Joint Center of the Northland*
Truman Medical Center-Lakewood*
Orthopedic Associates
SSM Health DePaul Hospital - St. Louis*
SSM Health St. Mary's Hospital - Jefferson City

Montana

Benefis Health System
Bozeman Health Deaconess Hospital
Great Falls Clinic Hospital
Providence St. Joseph Medical Center
St. Patrick Hospital
Frances Mahon Deaconess Hospital*

Nebraska

CHI Health Immanuel
CHI Health Lakeside
CHI Health Midlands
Creighton University Medical Center-Bergan Mercy
Great Plains Health
Lincoln Surgical Hospital
Midwest Surgical Hospital
Nebraska Medicine
Nebraska Orthopaedic Hospital
CHI Health Good Samaritan
CHI Health St. Elizabeth
Columbus Community Hospital
Creighton Univeristy Medical Center
MercyOne Oakland Medical Center

Nevada

MountainView Hospital
Northern Nevada Medical Center*
Renown Regional Medical Center
Renown South Meadows Medical Center
Southern Hills Hospital & Medical Center
Sunrise Hospital & Medical Center
Centennial Hills Hospital Medical Center
Desert Springs Hospital
Henderson Hospital
Orthopaedic Institute of Henderson
Orthopedic Specialty Hospital of Nevada
Reno Orthopedic Surgery Center
Spring Valley Hospital Medical Center
Summerlin Hospital Medical Center
Valley Hospital Medical Center

New Hampshire

Atlantic Coast Surgical Suites
Concord Hospital
Dartmouth-Hitchcock Medical Center
Elliot Hospital
Lighthouse Surgical Suites, LLC*
North Atlantic Surgical Suites
Northridge Surgical Suites*
Portsmouth Regional Hospital
Concord Orthopaedics
Southern NH Medical Center

New Jersey

Bayshore Medical Center
Chilton Medical Center
Englewood Hospital
Hackensack University Medical Center*
Holy Name Medical Center
Jersey City Medical Center
Jersey Shore University Medical Center*
JFK Medical Center
Morristown Medical Center*
Newton Medical Center
Northern Monmouth Regional Surgery Center
Ocean Medical Center
Overlook Medical Center*
Palisades Medical Center
Princeton Medical Center*
Raritan Bay Medical Center
Riverview Medical Center*
Robert Wood Johnson University Hospital New Brunswick
Robert Wood Johnson University Hospital Somerset
Southern Ocean Medical Center
St. Francis Medical Center
St. Peter's University Hospital
The Valley Hospital
Virtua Marlton Hospital
Virtua Memorial Hospital
Virtua Voorhees Hospital
Clara Maass Medical Center
Community Medical Center
Eastern Orthopedic Associates
Hudson Crossing Surgery Center
Lourdes Medical Center of Burlington County
Monmouth Medical Center

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Monmouth Medical Center Southern Campus
Newark Beth Israel Medical Center
Robert Wood Johnson University Hospital Hamilton
Robert Wood Johnson University Hospital Rahway
Saint Barnabas Medical Center
St. Luke's Warren Campus
Surgical Center at Millburn, LLC
The Center for Ambulatory Surgery

New Mexico

Memorial Medical Center-Las Cruces
MountainView Regional Medical Center
Presbyterian Hospital
Presbyterian Rust Medical Center
UNM Sandoval Regional Medical Center
CHRISTUS St. Vincent Regional Medical Center

New York

Crouse Hospital
Glen Falls Hospital
Highland Hospital*
Hospital for Special Surgery
Huntington Hospital*
John T. Mather Memorial Hospital
Kenmore Mercy Hospital
Lenox Hill Hospital*
Long Island Jewish Forest Hills
Long Island Jewish Medical Center*
Long Island Jewish Valley Stream
Lourdes Hospital
Maimonides Medical Center
Mohawk Valley Health System
Montefiore Medical Center*
Mount Sinai Brooklyn
Mount Sinai Queens
Mount Sinai St. Luke's*
Mount Sinai West
Newark-Wayne Community Hospital
NewYork-Presbyterian Brooklyn Methodist Hospital
NewYork-Presbyterian Queens
NewYork-Presbyterian/Columbia University Irving Medical Center
North Shore University Hospital*
Northern Westchester Hospital*
NYC Health + Hospitals/Elmhurst*
Oswego Hospital
Phelps Hospital
Plainview Hospital
Rochester General Hospital
Samaritan Hospital
South Shore University Hospital*
St. Charles Hospital*
St. Francis Hospital
St. Joseph's Hospital Health Center
St. Peter's Hospital
Staten Island University Hospital*
Syosset Hospital
The Hospital for Joint Diseases
The Mount Sinai Hospital*
UHS Binghamton General Hospital
UHS Wilson Medical Center
Unity Hospital
Upstate University Hospital-Community Campus
Upstate University Hospital-Downtown Campus
Winthrop-University Hospital
Wyoming County Community Health System
Wyoming County Community Hospital
Albany Memorial Hospital
Excelsior Orthopaedics
Jamaica Hospital Medical Center
Mercy Hospital of Buffalo
Mount Sinai South Nassau*
Mount St. Mary's Hospital and Health Center
NewYork-Presbyterian Lawrence Hospital
NewYork-Presbyterian Lower Manhattan Hospital
NewYork-Presbyterian/Weill Cornell Medical Center
Northern Dutchess Hospital
Peconic Bay Medical Center
Putnam Hospital
Rochester Surgery Center*
Saint Mary's Hospital
Sisters of Charity Hospital
Sisters of Charity Hospital, St. Joseph Campus
Stony Brook University Hospital
UPMC Chautauqua
Vassar Brothers Medical Center
White Plains Hospital

North Carolina

Atrium Health Mercy, a facility of Carolinas Medical Center
Blue Ridge Surgery Center
Capital City Surgery Center
Columbus Regional Healthcare System
Cone Health Annie Penn Hospital
Cone Health Wesley Long Hospital
Davie Medical Center*
ECU Health SurgiCenter
EmergeOrtho-Triangle Orthopedic Associates
FirstHealth Moore Regional Hospital
Greensboro Orthopaedics
Hugh Chatham Memorial Hospital*
Lexington Medical Center
Mission Hospital
Moses H. Cone Memorial Hospital
New Hanover Regional Medical Center
North Carolina Specialty Hospital*
Northern Hospital of Surry County
Novant Health Brunswick Medical Center
Novant Health Charlotte Orthopaedic Hospital
Novant Health Clemmons Medical Center

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Novant Health Forsyth Medical Center
Novant Health Huntersville Medical Center
Novant Health Kernersville Medical Center
Novant Health Matthews Medical Center
Novant Health Rowan Medical Center
Novant Health Thomasville Medical Center
Novant Health UVA Prince William Medical Center
Sentara Albemarle Medical Center
Surgical Center of Greensboro
The Surgical Center of Morehead City
Wake Forest Baptist Medical Center
WakeMed Cary Hospital
WakeMed North Hospital
WakeMed Raleigh Campus
AdventHealth Hendersonville
Atrium Health Lincoln
Atrium Health's Carolinas Medical Center
Carolina Sports Medicine & Orthopaedic Specialists
Cary Orthopaedics
Duke Ambulatory Surgery Center Arringdon
ECU Health Beaufort Hospital, a campus of ECU Health Medical Center
ECU Health Chowan Hospital
ECU Health Duplin Hospital
ECU Health Edgecombe Hospital
ECU Health North Hospital
ECU Health Roanoke-Chowan Hospital
High Point Medical Center
The Outer Banks Hospital
Viewmont Surgery Center
Wayne Memorial Hospital

North Dakota

CHI St. Alexius Health Bismark*
Sanford Medical Center Fargo
Sanford Medical Center-Bismarck*

Ohio

Adena Regional Medical Center*
Bethesda Butler Hospital
Bethesda North Hospital
Blanchard Valley Health System
Cleveland Clinic Fairview Hospital
Cleveland Clinic Lakewood
Cleveland Clinic Main Campus
Crystal Clinic Orthopaedic Center
Euclid Hospital
Firelands Regional Medical Center
Fort Hamilton Hospital
Genesis Healthcare System
Good Samaritan Hospital*
Grandview Medical Center
Grant Medical Center
Greater Dayton Surgery Center
Greene Memorial Hospital
Hillcrest Hospital
Indu and Raj Soin Medical Center
Kettering Medical Center
King's Daughters Medical Center Ohio
Licking Memorial Hospital
Lutheran Hospital
Marymount Hospital
McCullough-Hyde Memorial Hospital
Medina Hospital
Mount Carmel East
Mount Carmel New Albany
Mount Carmel St. Ann's
Mount Carmel West
Northpointe Surgical Suites*
OhioHealth Mansfield Hospital*
Ohio Specialty Surgical Suites*
Ohio Valley Surgical Hospital*
Ontario Hospital
Orthopedic ONE
Selby General Hospital
South Pointe Hospital
Southview Medical Center
Southwest General Health Center
St. Vincent Medical Center (Sisters of Charity-OH)
Summa Health System-Barberton Campus
Sycamore Medical Center
The Christ Hospital Health Network*
The Jewish Hospital-Mercy Health
The Ohio State University Wexner Medical Center
The Surgical Hospital at Southwoods
TriHealth Evendale Hospital
Trumbull Regional Medical Center*
UH Ahuja Medical Center
UH Bedford Medical Center, a campus of Regional Hospitals
UH Cleveland Medical Center
UH Conneaut Medical Center
UH Elyria Medical Center
UH Geauga Medical Center
UH Geneba Medical Center
UH Parma Medical Center
UH Portage Medical Center
UH Richmond Medical Center, a campus of Regional Hospitals
UH St. John Medical Center
White Fence Surgical Suites
Amherst Family Health Center
Ashtabula County Medical Center
Cleveland Clinic Children's Hospital for Rehabilitation
Cleveland Clinic Mercy Hospital
First Settlement Orthopaedics
Mercy Health-West Hospital
Mercy Health Anderson Hospital
Mercy Health Clermont Hospital
Mercy Health Fairfield Hospital
MetroHealth System
Northside Regional Medical Center
Summa Health Wadsworth-Rittman Medical Center

Oklahoma

Ascension St. John Jane Phillips
Community Hospital North Campus
Community Hospital South Campus
Duncan Regional Hospital*

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Mercy Hospital Ada
Mercy Hospital Ardmore
Mercy Hospital Oklahoma City
Norman Regional Hospital
Northwest Surgical Hospital
Southwestern Medical Center
St. John Broken Arrow
St. Mary's Regional Medical Center*
Stillwater Medical Center
Hillcrest Hospital South

Oregon

Adventist Health Portland
Good Samaritan Regional Medical Center
Hope Orthopedics
Legacy Emanuel Medical Center
Legacy Good Samaritan Medical Center
Legacy Meridian Park Medical Center
Legacy Mount Hood Medical Center
Legacy Silverton Medical Center
Oregon Health & Science University
PeaceHealth Orthopedics at Peace Harbor
Providence Hood River Memorial Hospital
Providence Medford Medical Center
Providence Milwaukie Hospital
Providence Newberg Medical Center
Providence Portland Medical Center
Providence Seaside Hospital
Providence St. Vincent Medical Center
Providence Willamette Falls Medical Center
Salem Health
Samaritan Albany General Hospital
St. Alphonsus Medical Center Baker City
St. Alphonsus Medical Center Ontario
St. Charles Health System
Tillamook Regional Medical Center
Willamette Surgery Center
Willamette Valley Medical Center*
Bend Surgery Center
CHI Mercy Health Mercy Medical Center
Hillsboro Medical Center
Oregon Orthopedic & Sports Medicine Clinic
Oregon Surgical Institute
Orthopedic + Fracture Specialists
Portland Knee Clinic
South Portland Surgical Center

Pennsylvania

Abington-Lansdale Hospital, Jefferson Health
Abington Hospital-Jefferson Health
ACMH Hospital
Advanced Surgical Hospital
Barry A. Ruht MD PC
Bryn Mawr Hospital*
Butler Memorial Hospital
Conemaugh Memorial Medical Center*
Doylestown Hospital
Doylestown Surgery Center*
Excela Health Latrobe Hospital
Excela Health Westmoreland Hospital
Geisinger Community Medical Center
Geisinger Lewistown Hospital
Geisinger Medical Center
Geisinger Shamokin Area Community Hospital
Geisinger South Wilkes-Barre
Geisinger Wyoming Valley Medical Center
Heritage Valley Beaver
Indiana Regional Medical Center
Jefferson Hospital
Lancaster General Hospital
Lankenau Medical Center*
Mercy Fitzgerald Hospital
Monongahela Valley Hospital
Moses Taylor Hospital
Mount Nittany Medical Center
Nazareth Hospital
Orthopaedic & Spine Specialists
OSS Orthopaedic Hospital*
Paoli Hospital*
Penn Highlands Healthcare
Penn Presbyterian Medical Center
Penn State Milton S. Hershey Medical Center
Pennsylvania Hospital
Phoenixville Hospital*
Reading Hospital*
Regional Hospital of Scranton
Riddle Hospital*
Rothman Orthopaedic Institute
St. Clair Hospital
St. Mary Medical Center
Thomas Jefferson University Hospital
UPMC Altoona
UPMC Carlisle
UPMC East
UPMC Hamot
UPMC Hanover
UPMC Horizon
UPMC Jameson
UPMC Magee-Womens Hospital
UPMC McKeesport
UPMC Memorial
UPMC Mercy
UPMC Northwest
UPMC Passavant-McCandless
UPMC Pinnacle
UPMC Pinnacle Community Osteopathic*
UPMC Pinnacle Harrisburg
UPMC Pinnacle Lititz
UPMC Pinnacle West Shore*
UPMC Presbyterian
UPMC Shadyside
UPMC St. Margaret
UPMC Williamsport*
ValueHealth Muve-Warminster
ValueHealth Muve-West Chester*
WellSpan Gettysburg Hospital

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WellSpan Surgery & Rehabilitation Hospital
WellSpan York Hospital
Allegheny General Hospital
Chan Soon-Shion Medical Center at Windber
Geisinger Jersey Shore Hospital
Geisinger Woodbine Lane
Heritage Valley Sewickley
Mercy Catholic Medical Center-Mercy Philadelphia Campus
North Pointe Surgery Center
Richards Orthopaedics Center & Sports Medicine
Rothman Orthopaedic Specialty Hospital
St. Luke's Allentown Campus
St. Luke's Anderson Campus
St. Luke's Carbon Campus
St. Luke's Easton Campus
St. Luke's Upper Bucks Campus
St. Luke's University Hospital - Bethlehem Campus
Surgery Center of Allentown
The Hospital of the University of Pennsylvania
UPMC Children's Hospital of Pittsburgh

Rhode Island

Kent Hospital*
South County Hospital*
The Miriam Hospital*
Yale New Haven Health Westerly Hospital

South Carolina

Beaufort Memorial Hospital*
Bon Secours St. Francis Hospital*
Carolina Orthopedics
Carolina Pines Regional Medical Center
Chapin Surgery Center
East Cooper Medical Center
Grand Strand Medical Center
Medical University of South Carolina*
Oconee Memorial Hospital
Palmetto Health Baptist
Palmetto Health Richland
Pelham Medical Center
Prisma Health Baptist Hospital
Prisma Health Patewood Hospital*
Providence Orthopedic Hospital
Roper St. Francis Hospital
Roper St. Francis Mount Pleasant Hospital
Self Regional Healthcare
Trident Medical Center
Baptist Easley Hospital
Carolina Coast Surgery Center
Conway Medical Center
McLeod Health Cheraw
McLeod Health Clarendon
McLeod Health Dillon
McLeod Health Seacoast
McLeod Regional Medical Center
Novant Health Gaffney Medical Center
Prisma Health Baptist Parkridge Hospital
St. Francis Downtown

South Dakota

Avera McKennan Hospital & University Health Center
Black Hills Surgical Hospital
Sanford USD Medical Center
Dunes Surgical Hospital

Tennessee

Baptist Memorial Hospital-Collierville
Baptist Memorial Hospital-Memphis*
Bristol Regional Medical Center*
CHI Memorial Hospital Chattanooga
Erlanger Baroness Hospital
Erlanger East Hospital
Fort Loudoun Medical Center
Fort Sanders Regional Medical Center
Henry County Medical Center
Huntsville Hospital
Indian Lake Surgery Center
Indian Path Community Hospital
Johnson City Medical Center
LeConte Medical Center
Maury Regional Medical Center
Methodist Medical Center of Oak Ridge
Morristown-Hamblen Healthcare System
OrthoSouth Germantown Surgery Center
OrthoTennessee
Parkridge East Hospital
Parkridge Medical Center
Parkwest Medical Center
Physicians Regional Medical Center
Physicians Surgery Center
Premier Orthopedic Surgery Center
Roane Medical Center
Saint Thomas Midtown Hospital
Saint Thomas River Park Hospital
Saint Thomas Rutherford Hospital
Saint Thomas West Hospital
St. Francis Hospital
Tennessee Orthopaedic Alliance
TriStar Centennial Medical Center
TriStar Hendersonville Medical Center
TriStar Horizon Medical Center
TriStar Skyline Medical Center
TriStar Southern Hills Medical Center
TriStar StoneCrest Medical Center
TriStar Summit Medical Center
Turkey Creek Medical Center
University of Tennessee Medical Center
Vanderbilt University Medical Center
Wolf River Surgery Center
CHI Memorial Hospital Hixson
Claiborne Medical Center
Cookeville Regional Medical Center*
Cumberland Medical Center
Mid-Tennessee Bone & Joint Clinic, P.C.

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Texas

AdventHealth Central Texas
Ascension Seton Hays
Ascension Seton Medical Center Austin
Ascension Seton Northwest Hospital
Ascension Seton Southwest
Ascension Seton Williamson
Baptist Beaumont Hospital of Southeast Texas
Baylor Scott & White All Saints Medical Center-Fort Worth
Baylor Scott & White Medical Center-Carrollton
Baylor Scott & White Medical Center-Frisco*
Baylor Scott & White Medical Center-Garland
Baylor Scott & White Medical Center-Grapevine
Baylor Scott & White Medical Center-Irving
Baylor Scott & White Medical Center-McKinney
Baylor Scott & White Medical Center-Plano
Baylor Scott & White Medical Center-Uptown*
Baylor Scott & White Medical Center-Waxahachie
Baylor Scott & White Surgical Hospital Fort Worth*
Baylor Surgical Hospital at Las Colinas
Baylor University Medical Center*
CHRISTUS Good Shepherd Medical Center-Longview*
CHRISTUS Good Shepherd Medical Center-Marshall
CHRISTUS Mother Frances Hospital-Tyler*
Christus Southeast Texas Hospital-St. Elizabeth
CHRISTUS Spohn Hospital Corpus Christi-Memorial
College Station Medical Center
Collom & Carney Clinic Association
Cornerstone Regional Hospital
Corpus Christi Medical Center
Covenant Children's Hospital
Covenant Health Plainview*
Covenant Medical Center
Covenant Specialty Hospital
Dallas Orthopedic & Shoulder Institute
Dell Seton Medical Center at The University of Texas
Del Sol Medical Center
Doctors Hospital at Renaissance*
El Paso Specialty Hospital
Harlingen Medical Center
HCA Houston Healthcare Clear Lake
Hill Country Memorial Hospital
Houston Methodist Hospital
Houston Methodist Sugar Land Hospital
Inov8 Surgical
JPS Health Network
Lake Granbury Medical Center*
Las Palmas Medical Center
Legent Orthopedic Hospital
Medical City Dallas Hospital
Medical City Denton
Memorial Hermann Memorial City Medical Center*
Memorial Hermann Orthopedic & Spine Hospital
Memorial Hermann Rockets Orthopedic Hospital*
Memorial Hermann Southwest Hospital
Methodist Hospital
Methodist Hospital for Surgery
Methodist Stone Oak Hospital
Methodist Texsan Hospital
Metropolitan Methodist Hospital
Midland Memorial Hospital
Muve-Lakeway Ambulatory Surgical Center, LLC
Nix Health
North Central Surgical Center Hospital*
Northeast Baptist Hospital*
Northeast Methodist Hosptial
Paris Orthopedics & Sports Medicine
Scott & White Memorial Hospital-Temple
Seton Highland Lakes Hospital
South Texas Spine and Surgical Hospital*
South Texas Surgical Hospital
St. David's Georgetown Hospital
St. David's Medical Center
St. David's North Austin Medical Center
St. David's Round Rock Medical Center
St. David's South Austin Medical Center
St. David's Surgical Hospital
St. Joseph Health System
Texas Health Arlington Memorial Hospital*
Texas Health Harris Methodist Hospital Fort Worth*
Texas Health Harris Methodist Hospital Southwest Fort Worth*
Texas Health Presbyterian Hospital Denton
Texas Health Presbyterian Hospital Flower Mound
Texas Health Presbyterian Hospital Plano*
Texas Health Presbyterian Hospital Rockwall
Texas Health Surgery Center Addison
Texas Health Surgery Center Cleburne
Texas Institute for Surgery
Texas Orthopaedic Associates
Texas Orthopedic Hospital*
Texas Orthopedics, Sports & Rehabilitation Associates
Texas Spine and Joint Hospital
Texoma Medical Center*
The Carrell Clinic

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The Medical Center of Southeast Texas
The Physicians Centre Hospital
United Regional HealthCare System*
University Hospital
UT Southwestern Medical Center
W.B. Carrell Clinic
Wise Health Surgical Hospital
Advanced Surgical Care of Boerne
Advent Orthopaedics
Covenant Hospital Levelland
Cross Timbers Orthopedics
Doctors Hospital of Laredo
Edinburg Regional Medical Center
Fort Duncan Regional Medical Center
Jeff Zhao, D.O.
McAllen Medical Center
Methodist McKinney Hospital, LLC
North Central Baptist Hospital
Northwest Texas Healthcare System
Peterson Health
Seton Medical Center Harker Heights
St. Luke's Health-Lakeside Hospital
Stefan Kreuzer
Texas Health Surgery Center Heritage
Texas Orthopedics
University of Texas Health Science Center at San Antonio

Utah

Altaview Hospital
American Fork Hospital
Bear River Valley Hospital
Cedar City Hospital
Dixie Regional Medical Center
Heber Valley Hospital
Intermountain Medical Center
Lakeview Hospital
Layton Hospital
LDS Hospital
Logan Regional Hospital
Maple Grove Hospital
McKay-Dee Hospital
McKay-Dee Surgical Center
Mountain View Hospital
North Memorial Health at Maple Grove Medical Center
North Memorial Health Hospital
Ogden Regional Medical Center*
Park City Hospital
Primary Children's Hospital
Riverton Hospital
Salt Lake Regional Medical Center
Sevier Valley Hospital
St. Mark's Hospital
Timpanogos Regional Hospital
TOSH-The Orthopedic Specialty Hospital
Univeristy of Utah Health
Utah Valley Hospital
Cedar Orthopedic Surgery Center
Orem Community Hospital

Vermont

Central Vermont Medical Center
Copley Hospital
Northeastern Vermont Regional Hospital
Rutland Regional Medical Center
The University of Vermont Medical Center
Northwestern Medical Center, Inc.

Virginia

Carilion New River Valley Medical Center*
Carilion Roanoke Memorial Hospital*
CJW Medical Center*
Henrico Doctors' Hospital
Inova Fair Oaks Hospital
Inova Loudoun Hospital
Inova Mount Vernon Hospital
Johnston Memorial Hospital
Mary Washington Hospital
Novant Health Prince William Medical Center
Novant Health UVA Haymarket Medical Center
OrthoVirginia
Reston Hospital Center*
Riverside Doctors' Hospital Williamsburg
Riverside Regional Medical Center
Riverside Tappahannock Hospital
Riverside Walter Reed Hospital
Sentara CarePlex Hospital
Sentara Leigh Hospital
Sentara Martha Jefferson Hospital
Sentara Norfolk General Hospital
Sentara Northern Virginia Medical Center
Sentara Obici Hospital
Sentara Princess Anne Hospital
Sentara RMH Medical Center
Sentara Virginia Beach General Hospital
Sentara Williamsburg Regional Medical Center
The Surgery Center of Lynchburg
University of Virginia Health System University Hospital*
VCU Medical Center
Virginia Hospital Center
Centra Health
Inova Fairfax Hospital

Washington

Capital Medical Center
Central Washington Hospital
Everett Bone and Joint
EvergreenHealth Medical Center
Harrison Medical Center
Highline Medical Center
Kadlec Regional Medical Center
Lakewood Surgery Center
Legacy Salmon Creek Medical Center
MultiCare Allenmore Hospital & Medical Center
MultiCare Auburn Medical Center
MultiCare Deaconess Hospital
MultiCare Good Samaritan Hospital
MultiCare Tacoma General Hospital

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Multicare Valley Hospital*
Northwest Hospital & Medical Center
Overlake Medical Center
PeaceHealth Orthopedic & Sports Medicine at Medical Office Plaza
Proliance Center for Outpatient Spine and Joint Surgery of Puget Sound
Proliance Eastside Surgery Center
Proliance Highlands Surgery Center
Providence Centralia Hospital
Providence Holy Family Hospital-Spokane
Providence Mount Carmel Hospital
Providence Regional Medical Center Everett Colby Campus
Providence Sacred Heart Medical Center
Providence St. Joseph's Hospital
Providence St. Mary Medical Center*
Providence St. Peter Hospital
Samaritan Healthcare
Seattle Orthopedic Center Surgery
Seattle Surgery Center
Skagit Northwest Orthopedics
St. Anthony Hospital
St. Clare Hospital
St. Elizabeth Hospital
St. Francis Hospital
St. Joseph Medical Center
Swedish Health Ballard Campus
Swedish Health Edmonds Campus
Swedish Health First Hill Campus
Swedish Health Issaquah Campus
The Surgery Center at Rainier
The Surgery Center at TCO Kennewick
Trios Health
Valley Medical Center
Virginia Mason Medical Center
Walla Walla General Hospital
Yakima Valley Memorial Hospital
Cascade Valley Hospital
Dan Downey, MD
Edmonds Center for Outpatient Surgery
MultiCare Covington Medical Center
Olympia Surgery Center
Olympic Medical Center
PeaceHealth Orthopedics & Sports Medicine in Lynden
Providence Regional Medical Center Everett Pacific Campus
Skagit Valley Hospital
Southwest Seattle Ambulatory Surgery Center
Wenatchee Valley Hospital & Clinics

West Virginia

Cabell Huntington Hospital*
Mon Health Center for Outpatient Surgery*
Ruby Memorial Hospital
Thomas Memorial Hospital*
West Virginia University Hospital*
Grant Memorial Hospital

Wisconsin

Amery Hospital & Clinic
Ascension NE Wisconsin - St. Elizabeth Campus
Ascension SE Wisconsin Hospital - Elmbrook Campus
Ascension SE Wisconsin Hospital - Franklin Campus
Ascension St. Mary's Hospital
Ascension St. Michael's Hospital
Aurora BayCare Medical Center
Aurora Lakeland Medical Center
Aurora Medical Center in Grafton
Aurora Medical Center in Kenosha
Aurora Medical Center in Manitowoc County
Aurora Medical Center in Oshkosh
Aurora Medical Center in Summit
Aurora Medical Center in Washington County
Aurora Memorial Hospital of Burlington
Aurora Sheboygan Memorial Medical Center
Aurora Sinai Medical Center
Aurora St. Luke's Medical Center
Aurora St. Luke's South Shore of Aurora HealthCare Metro, Inc.
Aurora West Allis Medical Center
Beaver Dam Community Hospitals
Beloit Memorial Hospital*
Berlin Memorial Hospital
Columbus Community Hospital
Community Memorial Hospital
Fort HealthCare
Froedtert Hospital
Froedtert Community Memorial Hospital*
Gundersen Health System
Hayward Area Memorial Hospital
HSHS St. Mary's Hospital Medical Center
HSHS St. Nicholas Hospital
HSHS St. Vincent Hospital
Hudson Hospital & Clinic
Lakeview Hospital
Lakeview Medical Center
Marshfield Clinic Wasau Center
Marshfield Medical Center-Beaver Dam
Marshfield Medical Center-Eau Claire*
Marshfield Medical Center-Marshfield
Marshfield Medical Center-Minocqua
Marshfield Medical Center-Neillsville
Marshfield Medical Center-Rice Lake
Marshfield Medical Center-Weston
Mayo Clinic Health System-Franciscan Healthcare
Mayo Clinic Health System in Eau Claire
Memorial Medical Center
Mercyhealth Hospital & Trauma Center
Mercyhealth Hospital and Medical Center-Walworth
Midwest Orthopedic Specialty Hospital*
Monroe Clinic Hospital

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OakLeaf Surgical Hospital
Oconomowoc Memorial Hospital*
Orthopedic & Sports Surgery Center
Orthopedic Hospital of Wisconsin
Osceola Medical Center
Prairie Ridge Health
ProHealth Waukesha Memorial Hospital
Ripon Medical Center
River Falls Area Hospital
Sauk Prairie Hospital
Southwest Health
SSM Health St. Clare Hospital-Janesville
St. Agnes Hospital
St. Croix Regional Medical Center
St. John's Hospital
St. Joseph's Hospital, West Bend
ThedaCare Medical Center-New London
ThedaCare Medical Center-Shawano
ThedaCare Medical Center-Waupaca
ThedaCare Regional Medical Center-Appleton
ThedaCare Regional Medical Center-Neenah
Tomah Memorial Hospital
UnityPoint Health-Meriter
University of Wisconsin Hospitals and Clinics
Vernon Memorial Healthcare
Watertown Regional Medical Center
Waupun Memorial Hospital
Westfields Hospital & Clinic
Wisconsin Specialty Surgery Center*
Ascension All Saints Hospital-Spring Street Campus
Ascension NE Wisconsin - Mercy Campus
Aspirus HealthCare
Aurora Medical Center in Milwaukee
Divine Savior Healthcare
Marshfield Clinic Minocqua Center
Orthopedic & Sports Medicine Specialists of Green Bay
SSM Health St. Clare Hospital-Baraboo
SSM Health St. Mary's Hospital-Madison

Wyoming

Cheyenne Regional Medical Center
Fairview Lakes Medical Center
Mountain View Regional Hospital
Powder River Surgery Center
St. John's Medical Center
Summit Medical Center*
Wyoming Medical Center

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Appendix F

Audit of Registry Data

The AAOS Registry Program and AJRR are committed to providing data reports that are valid and accurate. To ensure the Registry Program achieves this objective, internal quality controls are in place, in addition to an external audit of data from the previous year. This is an annual effort, and AJRR continued a contractual relationship with Advent Advisory Group© to serve as the vendor for auditing a sample of 2022 data. Advent Advisory Group is a National Committee for Quality Assurance (NCQA) licensed audit organization which provides audit, consulting, data validation, and technical assistance to health services organizations nationwide. With over 25 years of experience, Advent Advisory's staff of auditors, clinicians, analysts, statisticians, certified coders, and programmers perform validation services for a variety of health care organizations, including health plans, provider organizations, clinical registries, data aggregators, and health information exchanges. The intention of this audit was to select and review a sample of 2022 data. The Registry randomly selected 27 actively submitting AJRR sites, both hospitals and ambulatory surgical centers (ASCs), from January 1 to December 31, 2022 to participate. The participating sites included diverse representation of urban and rural locations, and both small practices and large centers. The audit process ensures data submitted to AJRR correctly represents the data in the facility medical records, and that the data reflected all hip and knee arthroplasty procedures performed at that site within the specified timeframe. The audit was completed in September 2023.

Two of the randomly selected sites for the 2023 audit were unable to participate due to personnel changes and inability to complete the request by the established timeline. The sites were issued an exclusion and will be included for participation in the 2024 Audit. Per the AJRR contractual agreements, audit participation is required when selected for a given year.

The overall record assessment rate was 94.5% (Median 97.5%), which is consistent with prior Annual Reports. Since inception of the AJRR Annual Audit, the overall audit agreement rate has consistently exceeded 90%, above the 85% acceptable threshold, indicating high reliability of the data within the AJRR. Challenges in the completeness agreement include formatting issues with reports that participants submitted to Advent, therefore creating mismatches on the Primary Procedure Codes submitted. Mismatches were also linked to documentation of laterality and institution NPI, which are recommended but can be supplemented beyond raw data submission through registry processing and validation. There were no anomalous observations to suggest any cherry picking or selection of only the best cases being submitted.

This audit reflects agreement between the information in the institution record and the information as reported to AJRR. The audit does not reflect whether data and resulting codes assigned in the hospital record were the most appropriate or accurate for the procedure performed. Efforts to address accuracy and appropriateness of the submitted data, especially at the point of data entry, will continue in collaboration with all participating sites.

Appendix G

2023 AJRR Annual Report Cumulative Percent Revision Curve Methodology

Dataset Development

All AJRR patients undergoing a primary total joint replacement or revision surgery were identified using International Classification of Disease (ICD)-9/10 and Current Procedural Terminology (CPT) codes in both the AJRR and the Centers for Medicare & Medicaid Services (CMS) dataset. Revisions were "linked" to primary when known laterality was the same for both a primary and revision, and when revision surgery and the revision procedure postdated the primary procedure. AJRR collects a discrete laterality data element. Since ICD-9 does not identify laterality, but ICD-10 does, when laterality was in question, it was cross-referenced with AJRR data as well as the modifiers LT and RT from CPT codes as provided in AJRR and the CMS data.

For ICD-9 codes, the assumption was made that a revision code postdating a primary procedure was a "linked" revision, which was later validated in the AJRR database. ICD-10 coding allows for (but does not require) both removal and replacement codes but has the advantage of including laterality. The same postdating assumptions were made with either acceptable single codes for revision or with the dual code permutations. In short, appropriate laterality was used to identify revision and primary procedures when ICD-10 coding was used and, when ICD-9 was used, subsequent revisions were linked to previous primary procedures with laterality verified at a later step.

Patients were tracked for the data set of 2012-2022. Their follow-up was from time of procedure until 12/31/2021 and the primary time-scale was "months to revision." Patients were tracked for potential outcomes (e.g., death, dislocation, and instability) from the procedure date until 12/31/2022. Patients were right censored if they did not have the outcome of interest. Death was identified from the National Death Index (2012-2016) or AJRR data (collected as an optional discrete data element, 2012-2022).

Primary procedures were counted as failed and the survivorship recorded if revision was identified or found within either the AJRR or Medicare dataset. Failure of the primary arthroplasty was the outcome, unless specified otherwise.

The CMS Research Data Assistance Center (ResDAC) data team provided AJRR with a unique identifier that matches an AJRR case record to a CMS claim file. Observations from ICD-9 codes were excluded where patients were noted to have mismatched laterality for primary and revision, or revisions without a previous record of a primary in the AJRR database. When laterality remained unknown after these methods, the primary and revision procedures were not "linked" and were subsequently removed from analyses. A merged AJRR and CMS dataset was used for all survivorship analyses unless otherwise specified.

Analysis and Interpretation

Cumulative percent revision curves were constructed using the Cox proportional hazards model with the endpoint of all-cause revision rate, with patients being censored at death or at the end of the analysis period. These curves can be interpreted as the cumulative risk of revision in patients who are still alive at a specific timepoint. Additionally, a competing-risk proportional sub-distribution hazards model was used to measure overall prognostic risk of revisions, but results from this model were only presented when the hazard ratios or statistical significance were substantially different from the original cox proportional hazards model. These two models have been shown to produce similar results in international joint replacement registries.[18] Patients were tracked for the data set of 2012-2022. Their follow- up was from time of procedure until 12/31/2022 and the primary timescale was "months to revision." Patients were considered "not failed" if they did not have the outcome of interest (revision within the study period). Primary procedures were counted as failed and the survivorship recorded if revision was identified or found within either the AJRR or Medicare dataset. If a patient does not appear as a revision or death event in AJRR or CMS databases, they were assumed to have a functioning implant throughout the cutoff date of analysis. Cumulative incidence was applied in the presence of patient death, so these competing risk events did not impact the analyses or event rate calculations.

Direct adjustment methods were used to produce adjusted cumulative percent revision curves based on the empirical age, sex, and CCI distribution of the full dataset.[19] 95% confidence intervals were computed for the entire adjusted curves and are graphically represented. When comparing groups, the 95% confidence intervals and p-values of the hazard ratios were used to determine statistical significance. When interpreting any cumulative percent revision curve produced, it is important to consider that these analyses represent retrospective observational data from a large registry and administrative database. Therefore, causation cannot be established and only associations are offered. Based off any association likely further analyses are needed to appropriately determine the root cause.

Finally, information collected in the Registry is not on a component specific basis. AJRR does not have insight on component specific failure. For example, if four components were implanted in a patient who had a subsequent revision, it is unknown which of the four components failed. Therefore, AJRR reports on a construct basis and not on component basis.

SAS Version 9.4 was used for all statistical analyses

References

1. Porter KR, Illgen RL, Springer BD, Bozic KJ, Sporer SM, Huddleston JI, Lewallen DG, Browne JA. Is American Joint Replacement Registry Data Representative of National Data? A Comparative Analysis. J Am Acad Orthop Surg. 2022 Jan 1;30(1):e124-e130. doi: 10.5435/JAAOS-D-21-00530. PMID: 34437310.

2. Bert JM, Hooper J, Moen S. Outpatient Total Joint Arthroplasty. Current Reviews in Musculoskeletal Medicine. 2017:567-574. doi:10.1007/s12178-017-9451-2.

3. Bozic KJ, Maselli J, Pekow PS, Lindenauer PK, Vail TP, Auerbach AD. The Influence of Procedure Volumes and Standardization of Care on Quality and Efficiency in Total Joint Replacement Surgery. The Journal of Bone and Joint Surgery-American. 2010;92(16):2643-2652. doi:10.2106/jbjs.i.01477.

4. Guyen O. Hemiarthroplasty or total hip arthroplasty in recent femoral neck fractures? Orthopaedics & Traumatology: Surgery & Research. 2018. doi:10.1016/j.otsr.2018.04.034.

5. Hongisto MT, Pihlajamäki H, Niemi S, Nuotio M, Kannus P, Mattila VM. Surgical procedures in femoral neck fractures in Finland: A nationwide study between 1998 and 2011. International Orthopaedics. 2018;38(8):1685-1690. doi:10.1007/s00264-014-2346-6.

6. Harris IA, Cuthbert A, Steiger RD, Lewis P, Graves SE. Practice variation in total hip arthroplasty versus hemiarthroplasty for treatment of fractured neck of femur in Australia. The Bone & Joint Journal. 2019;101-B(1):92-95. doi:10.1302/0301-620x.101b1.bjj-2018-0666.r1.

7. Australian Orthopaedic Association National Joint Replacement Registry. Hip, Knee & Shoulder Annual Report 2022. https://aoanjrr.sahmri.com/documents/10180/732916/AOA+2022+AR+Digital/f63ed890-36d0-c4b3-2e0b-7b63e2071b16. Accessed Sep 8, 2023.

8. National Joint Registry. National Joint Registry 19th Annual Report. https://reports.njrcentre.org.uk/Portals/0/PDFdownloads/NJR%2019th%20Annual%20Report%202022.pdf. Accessed Sep 8, 2023.

9. Swedish Arthroplasty Register. The Swedish Arthroplasty Register Annual Report 2022. https://registercentrum.blob.core.windows.net/sar/r/SAR-Annual-Report-2022_EN-HkgQE89Nus.pdf. Accessed Sep 8, 2023.

10. Bedard NA, Burnett RA, Demik DE, Gao Y, Liu SS, Callaghan JJ. Are Trends in Total Hip Arthroplasty Bearing Surface Continuing to Change? 2007- 2015 Usage in a Large Database Cohort. J Arthroplasty. 2017; 32(12):3777–3781. doi: 10.1016/j. arth.2017.07.044.

11. Darrith B, Courtney PM, Valle CJ. Outcomes of dual mobility components in total hip arthroplasty. Bone Joint J, 2018;100 B(1):11-19. doi:10.1302/0301-620x.100b1.bjj-2017-0462.r1.

12. Mistry JB, Chughtai M, Elmallah RK, et al. Trunnionosis in total hip arthroplasty: a review. J Orthop Traumatol. 2016;17(1):1-6.

13. Etkin CD, Lau EC, Watson HN, Kurtz SM, Gioe TJ, Springer BD, Etkin CD, Lau EC, Watson HN, Kurtz SM, Gioe TJ, Springer BD, Lewallen DG, Bozic KJ. Bozic KJ. What Are the Migration Patterns for U.S. Primary Total Joint Arthroplasty Patients? Clinical Orthopaedics and Related Research. 2019;477(6):1424–1431. doi: 10.1097/corr.0000000000000693.

14. McGrory BJ, Etkin CD, Lewallen DG. Comparing contemporary revision burden among hip and knee joint replacement registries. Arthroplasty Today. 2016;2(2):83-86. doi:10.1016/j.artd.2016.04.003.

15. Garellick G. Electronic Supplementum no 362: ISAR meeting Gothenburg 2015, Sweden. Acta Orthop 2016;87(eSuppl 362):3-8.

16. Wilson S, Marx RG, Pan T-J, Lyman S. Meaningful Thresholds for the Volume-Outcome Relationship in Total Knee Arthroplasty. J Bone Jt Surg. 2016;98(20):1683-1690. doi:10.2106/JBJS.15.01365.

17. The New Zealand Joint Registry. The New Zealand Joint Registry 24 Year Report. https://www.nzoa.org.nz/sites/default/files/NZJR%20Twenty%20Four%20Year%20Report__29Aug2023.pdf. Accessed Sep 8, 2023

18. Van Der Pas, S, Nelissen, R, Fiocco, M: Different competing risks models for different questions may give similar results in arthroplasty registers in the presence of few events: Illustrated with 138,234 hip (124,560 patients) and 139,070 knee (125,213 patients) replacements from the Dutch Arthroplasty Register. Acta Orthopaedica 2018; 89:145–151.

19. Zhang X, Zhang MJ. SAS macros for estimation of direct adjusted cumulative incidence curves under proportional subdistribution hazards models. Comput Methods Programs Biomed. 2011;101(1):87-93. doi:10.1016/j.cmpb.2010.07.005.

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