Arthroplasty Today 30 (2024) 101517

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original Research

The Epidemiology of the Revision Total Hip Arthroplasty in the United States From 2016 to 2022

Sandeep S. Bains, MD, DC, MBA, Jeremy A. Dubin, BA, Christopher G. Salib, MD, Rubén Monárrez, MD, Ethan Remily, DO, Daniel Hameed, MD, Gabrielle N. Swartz, BS, Reza Katanbaf, MD, MBA, James Nace, DO, MPT, Ronald E. Delanois, MD*

Rubin Institute for Advanced Orthopedics, LifeBridge Health, Sinai Hospital of Baltimore, Baltimore, MD 21215, USA

A R T I C L E I N F O

Article history:
Received 20 November 2023
Received in revised form
16 July 2024
Accepted 13 August 2024
Available online xxx

Keywords:
Revision
Total hip arthroplasty
Dislocation
Infection
Epidemiology

A B S T R A C T

Background: The number of revision total hip arthroplasties (THAs) is projected to reach 572,000 cases annually by 2030 in the United States. This may be attributed to the successes of primary THAs combined with an aging population, patients desire to remain active, and expanded indications for younger patients. Given the evolving nature of revision THAs, an epidemiological analysis of (1) etiologies; (2) demographics, including age and region; and (3) lengths of stay (LOSs) may minimize the gap between appropriate understanding and effective intervention.

Methods: From 2016 to 2022, a national, all-payer database was queried. Incidences and indications were analyzed for a total of 102,476 patients who had revision THA procedures. Patients were stratified according to etiology of failure, age, US census region, primary payor class, and mean LOS.

Results: The most common etiologies for revision THA procedures were dislocation (16.7%) and infection (12.7%), followed by periprosthetic fracture (6.9%). The largest age group was 65-74 years (30.9%), followed by >75 years (28.6%), then 55-64 (26.5%). The South had the largest total procedure cohort (36.9%), followed by the Midwest (27.5%), then the Northeast (19.7%), and the West (15.9%). The mean LOS was 4.10 days (range, 1.0-20.0).

Conclusions: Dislocation and infection remain leading indications for revision THA. These findings can properly guide surgeons toward appropriate management as well as toward active steps to minimizing these outcomes.

Introduction

Primary total hip arthroplasty (THA) sits at the forefront of value, cost, and outcome discussions due to the shift toward value-based bundled payment models [1–3]. Several factors, such as expanded indications for younger patients, an aging population, and desires to remain active have led to a dramatic increase in the number of revision THA being performed [4,5]. From 2014 to 2030, it is estimated that the number of revision THA will increase between 78% and 182% and reach up to 572,000 cases annually by 2030 in the United States [4,6]. Such a spike warrants an evaluation of the indications of revision THA to assess the evolving nature of the procedure and allow for an appropriate intervention based on the findings.

The epidemiology of revision THA in the United States has been studied using large administrative databases. In 2006, Bozic et al. analyzed 51,345 revision THAs and found the most common cause of revision was instability (22.5%), mechanical loosening (19.7%), and infection (14.8%). In addition, they showed the procedure was mostly common performed in patients aged 75-84 years and the mean length of stay (LOS) was 6.2 days [7]. From 2009 to 2013, Guam et al. examined 258,461 revision THAs and found dislocation (17.3%) was the leading cause of revision followed by mechanical loosening (16.8%) and other mechanical problems (13.4%). They reported most procedures were performed in patients aged 75 years and more and the mean LOS was 5.3 days [8]. Schwartz et al. reviewed 50,220 revision THAs from 2002 to 2014

* Corresponding author. Rubin Institute for Advanced Orthopedics, LifeBridge Health, Sinai Hospital of Baltimore, 2401 West Belvedere Avenue, Baltimore, MD 21215, USA. Tel.: +1 410 601 2663.

E-mail address: delanois@me.com

https://doi.org/10.1016/j.artd.2024.101517

Table 1
Diagnosis codes associated with revision THA procedures.

Diagnosis codes	Total, all revisions	All component	Acetabular component	Femoral component	Hip revision, NOS	Arthrotomy removal of prosthesis	Liner removal
Number of revisions	102,476	43,844	11,367	24,865	3190	53,187	16,571
Aseptic loosening, n (%)	6923 (6.8)	4176 (9.5)	1366 (12.0)	2032 (8.2)	235 (7.4)	4457 (8.4)	1472 (8.9)
Bearing surface wear, n (%)	1514 (1.5)	960 (2.2)	360 (3.2)	385 (1.5)	37 (1.2)	902 (1.7)	454 (2.7)
Dislocation, n (%)	17,084 (16.7)	9474 (21.6)	3676 (32.3)	4130 (16.6)	952 (29.8)	10,641 (20.0)	4430 (26.7)
Implant failure, n (%)	2629 (2.6)	1692 (3.9)	510 (4.5)	788 (3.2)	71 (2.2)	1805 (3.4)	582 (3.5)
Mechanical complication, n (%)	5816 (5.7)	3730 (8.5)	1203 (10.6)	1385 (5.6)	207 (6.5)	3666 (6.9)	1289 (7.8)
Osteolysis, n (%)	1801 (1.8)	1208 (2.8)	379 (3.3)	471 (1.9)	42 (1.3)	1164 (2.2)	552 (3.3)
Pain, n (%)	1106 (1.1)	653 (1.5)	175 (1.5)	235 (0.9)	28 (0.9)	644 (1.2)	188 (1.1)
Prosthetic joint infection, n (%)	13,000 (12.7)	8681 (19.8)	1177 (10.4)	2612 (10.5)	391 (12.3)	8761 (16.5)	2268 (13.7)
Periprosthetic Fracture, n (%)	7078 (6.9)	3016 (6.9)	460 (4.0)	3632 (14.6)	286 (9.0)	4281 (8.0)	952 (5.7)
Surgical site infection, n (%)	3188 (3.1)	1763 (4.0)	282 (2.5)	768 (3.1)	110 (3.4)	2149 (4.0)	578 (3.5)

NOS, not other specified.

and showed periprosthetic fracture and infection were the leading causes of revision THA. They found the 55-64 and 65-74 age groups increased and the 75-84 age group decreased in revision incidences [6].

Several studies have used institutional databases in analyzing the epidemiology of revision THA at the expense of large, administrative databases, which allow insight into the causes of failure and types of revision THA procedures performed in a nationally representative population [9–11]. The International Classification of Diseases (ICD) introduced their Tenth edition (ICD-10) on October 1, 2015 as an update from their Ninth edition. It has not been evaluated in the context of incidences, indications, and various demographic metrics regarding revision THA. The objectives of this study were to examine (1) etiologies; (2) demographics, including age and region; and (3) LOS of revision THA.

Material and methods

We queried a national, all-payer database (PearlDiver, Colorado Springs, Colorado). It is one of the largest aggregations of healthcare data and all patients were tracked longitudinally. Therefore, this database allowed an accurate representation of the general US population. It includes more than 120 million Health Insurance Portability and Accountability–compliant records across all states within the United States. ICD-10 procedural and diagnoses and Current Procedure Terminology codes were solely used to identify the population of patients who underwent revision THA. Institutional review board exemption was granted to the retrospective nature of the study. From January 1, 2016 to April 30, 2022, a total of 102,476 patients underwent revision THA procedures. All patients had a primary diagnosis of osteoarthritis at the time of their index procedure. Data were assessed using PearlDiver subgroups, which stratified by patient age, gender, payor type, average cost of care, Charlson Comorbidity Index census region, patient diagnoses from the hospital stay, and LOS.

Results

During the period of this study, we identified 102,476 patients who underwent revision THA, in contrast to 814,648 who underwent primary THA. The most common etiologies for revision THA procedures were dislocation (16.7%) and infection (12.7%), followed by periprosthetic fracture (6.9%). In addition, dislocation was the leading cause for all component (21.6%), acetabular component (32.3%), femoral component (16.6%), hip revision Not Other Specified (29.8%), arthrotomy removal of prosthesis (20.0%), and liner removal (26.7%) (Table 1).

The South had the largest total procedure cohort (36.9%), followed by the Midwest (27.5%), then the Northeast (19.7%), and the West (15.9%) (Table 2). The largest age group was 65-74 years (30.9%), followed by > 75 years (28.6%), then 55-64 (26.5%)

Table 2
Revision THA procedure demographics by US census region.

Procedure	US census region				
	Northeast	Midwest	South	West	Total
All component, n (%)	7223 (6.3)	9357 (8.2)	13,218 (11.5)	5454 (4.8)	35,252
Acetabular component, n (%)	1548 (1.4)	2859 (2.5)	3743 (3.3)	1401 (1.2)	9551
Femoral component, n (%)	3535 (3.1)	4736 (4.1)	5483 (4.8)	2621 (2.3)	16,375
Hip revision, NOS, n (%)	379 (0.3)	461 (0.4)	1097 (1.0)	346 (0.3)	2283
Arthrotomy removal of prosthesis, n (%)	7286 (6.4)	10,415 (9.1)	14,401 (12.6)	6278 (5.5)	38,380
Liner removal, n (%)	2611 (2.3)	3741 (3.3)	4295 (3.7)	2104 (1.8)	12,751
Total, n (%)	22,582 (19.7)	31,569 (27.5)	42,237 (36.9)	18,204 (15.9)	114,592

NOS, not other specified.

Table 3
Revision THA procedures by age group.

Procedure	Age < 55	Age 55-64 y	Age 65-74 y	Age > 75	Total
All component, n (%)	4984 (14.0)	9447 (26.5)	10,995 (30.9)	10,179 (28.6)	35,605
Acetabular component, n (%)	1041 (10.9)	2434 (25.6)	3078 (32.3)	2972 (31.2)	9525
Femoral component, n (%)	1747 (10.6)	3924 (23.9)	4847 (29.5)	5886 (35.9)	16,404
Hip revision, not other specified, n (%)	182 (8.6)	572 (27.1)	597 (28.3)	758 (35.9)	2109
Arthrotomy removal of prosthesis, n (%)	4930 (12.7)	9759 (25.1)	11,825 (30.4)	12,439 (31.9)	38,953
Liner removal, n (%)	1480 (11.6)	3248 (25.5)	4037 (31.7)	3984 (31.2)	12,749
Total, n (%)	14,364 (12.5)	29,384 (25.5)	35,379 (30.7)	36,218 (31.4)	115,345

(Table 3). The mean LOS was 4.10 days (range, 1.0-20.0). The highest mean LOS was for hip revision, Not Other Specified at 4.6 days, while the shortest mean LOS was for acetabular component at 3.5 days (Table 4).

Female patients underwent the most revisions (57.8%) (Table 5). Commercial insurance plans were the most common payer (51.8%), followed by Medicare (41.8%), then Medicaid (4.7%), then government plans (1.1%), then cash (0.2%) (Table 6). The average Charlson Comorbidity Index ranged from 2.43 to 3.02 when patients were stratified by revision type (Table 7). Although the total number of revisions remained relatively consistent through this period, 2019 had the most revisions (21,215) (Fig. 1). Please note, the data from 2022 are only through April.

Discussion

Due to the sharp rise in the number of revision THAs being performed, complexity of management of the procedure, and the financial implications, mitigating the need for revision THAs remains a priority for orthopaedic surgeons [12]. An epidemiological analysis of the incidences and indications gives a historical and current appraisal of the nature of revision THAs over recent years. Our major finding was that dislocation and infection remain leading causes of revision THA with historically decreasing rates. We also found a historically low mean LOS at 4.1 days. Compared to the literature, these findings demonstrate lower rates of dislocation, infection, and LOS [4,8,11,13].

The present study is not without limitations. The US Department of Health and Human Services reports a 1.0% billing/coding error nationwide, which may mitigate the risk associated with medical billing and doing errors [14]. Additionally, a third-party source reviews all patients' record. Failure leading to revision THA may be multifactorial and overlap, including aseptic loosening, osteolysis, and polyethylene wear, which may not be captured. In our query, we minimized the effect of conversion THAs but it is worthy of acknowledgment. We note a reduction in the frequency of revision THA due to the SARS-CoV-2 (COVID-19) pandemic due to the limit on the number of elective arthroplasty procedures [15]. Several variables that were not analyzed and can be included in future studies include survivorship, postoperative outcomes, and cost. To improve the clinical relevance of administrative codes related to revision THA, detailed clinical documentation remains a priority. Patients were not given multiple procedure and diagnosis codes, which allowed accuracy in regards to consistent totals throughout the study. Patient selection may account for differences in results for database studies compared to institutional studies. The strengths of study lie in the first, to the authors knowledge, epidemiological study that uses a large, administrative database with the addition of ICD-10 procedure and diagnosis codes in the epidemiological analysis of revision THA from 2016 to 2022.

Rates of dislocation have decreased from 22.5% in 2006 to 16.7% in the present study in 2022 [7]. Several factors have led to the decrease in dislocation after THA including mitigating patient, surgeon, and intraoperative factors through appropriate interventions and an enhanced understanding of the current causes of hip instability. Patient factors, such as obesity, age < 50 and age >70, neurological conditions, and spinopelvic pathology have benefited from dual-mobility liners, constrained liners, and elevated liners. Surgeon factors include low-volume surgeons, which necessitate referral of high-risk patients. Intraoperative factors include posterior approach, increased native offset, anteversion, impingement, instability, and soft-tissue tensioning, which are mitigated through several means, such as capsular repair, lateralized lines, elevated liner, and dual-mobility liner [16]. This may be at odds with recent healthcare reform toward bundled payments, in which surgeons select against high-risk patients to maximize reimbursement opportunities [8]. However, bundled payment models incentivize understanding and

Table 4
Revision THA procedure mean length of stay.

Procedure	Total	Mean LOS (d)
All component	43,844	3.875
Acetabular component	11,367	3.48
Femoral component	24,865	4.056
Hip revision, not other specified	3190	4.638
Arthrotomy removal of prosthesis	53,187	4.516
Liner removal	16,571	3.716
Total	102,476	4.104

Table 5
Revision THA procedure demographics by gender.

Procedure	Gender		Total
	Male	Female	
All component, n (%)	19,058 (43.5)	24,788 (56.5)	43,846
Acetabular component, n (%)	4399 (38.7)	6968 (61.3)	11,367
Femoral component, n (%)	10,348 (41.6)	14,517 (58.4)	24,865
Hip revision, NOS, n (%)	1247 (39.1)	1944 (60.9)	3191
Arthrotomy removal of prosthesis, n (%)	22,485 (42.3)	30,704 (57.7)	53,189
Liner removal, n (%)	7092 (42.8)	9479 (57.2)	16,571
Total, n (%)	64,629 (42.2)	88,400 (57.8)	153,029

NOS, not other specified.

Table 6
Revision THA procedure payment breakdown.

Procedure	Payment						
	Cash	Commercial	Government	Medicaid	Medicare	Unknown	Total
All component, n (%)	91 (0.2)	26,624 (53.5)	634 (1.3)	2351 (4.7)	19,737 (39.6)	345 (0.7)	49,782
Acetabular component, n (%)	20 (0.2)	6769 (54.0)	218 (1.7)	513 (4.1)	4922 (39.3)	96 (0.8)	12,538
Femoral component, n (%)	56 (0.2)	14,207 (50.7)	335 (1.2)	1214 (4.3)	12,070 (43.1)	152 (0.5)	28,034
Hip revision, NOS, n (%)	4 (0.1)	1791 (48.6)	37 (1.0)	176 (4.8)	1670 (45.3)	5 (0.1)	3683
Arthrotomy removal of prosthesis, n (%)	93 (0.2)	31,057 (50.7)	594 (1.0)	3000 (4.9)	26,372 (43.0)	175 (0.3)	61,291
Liner removal, n (%)	25 (0.1)	9579 (51.8)	167 (0.9)	861 (4.7)	7815 (42.3)	45 (0.2)	18,492
Total, n (%)	289 (0.2)	90,027 (51.8)	1985 (1.1)	8115 (4.7)	72,586 (41.8)	818 (0.5)	173,820

NOS, not other specified.

reducing complications following THA to achieve higher quality care at a lower cost [17].

Rates of infection decreased from 14.8% in 2006 to 12.7% in 2022. Understanding of the timing and associated risk factors has led to improved strategies for patient management, including preoperative screening of patients for prior medical conditions [18]. In addition, the at-risk patient pool may be growing due to the increased utilization of THA combined with the increased longevity of the THA patients [19]. One retrospective case-control study found that each additional medical condition increased the risk of infection by 35% ($P = .041$) [20]. Ong et al. showed that compared to patients with no comorbid conditions, the increased risk of infection ranged from 47% to 157% as the Charlson index scores increased from 1-2 to 5+, respectively [19]. In addition to patient risk factors, other factors such as longer operating time, lack of antibiotic-impregnated cement, longer hospital stay, and simultaneous bilateral joint arthroplasty elevate the risk of infection [21–23].

We found an increase in patients aged 55-64 (23.4%-26.5%) and 65-74 (26.5%-30.9%) years undergoing all-component revision THA compared to 2013 [8]. This is consistent with Kurt et al. demonstrating young patients aged less than 65 years contributing to 50% of revision THA secondary to expanded indications for younger and more active patients [4]. One systematic review of 13 manuscripts in patients undergoing THA found patient age influenced prosthesis revision rates. Specifically, revision-free survival estimates were lower in older THA recipients (90%-97% vs 72%-86%, respectively) [24]. In the bundled payment era, one study showed that patients aged 65-69 years had lower mean 90-day episode-of-care costs by $14,100 compared to patients aged 85 years and more. They also found Northeast region to be an independent risk factor for increase in episode-of-care costs [25]. In our study, we found minimal geographic differences. Variability through different regions may be attributed to differences in the surgery, patient factors, and regional economics [8].

The mean LOS after THA decreased from 6.2 days in 2009 to 4.1 days in 2022 [7]. The incentivization of lower LOS as a quality metric to track progression in bundled payment models has played an instrumental role in leading to this historical improvement. Removal of THA from the inpatient-only list in 2018 has not only reduced costs without compromising patient care but has also led to administrative burden for surgeons and a source of confusion for patients [26,27]. These influences must be weighed against the focus of achieving a safe discharge to home to allow for enough therapy progression [28]. Additionally, awareness and management of factors including patient comorbidities, longer operating time, age >65 years, general anesthesia, and low socioeconomic status can be associated with mitigation of LOS [29].

Increased concerns in revision THA revolve around the complexity and heterogeneity of the patient population as well as higher complication rates. An epidemiological analysis highlights the relevant reasons for revisions through 2022. We found a historically low rate of dislocation, infection, and LOS. The growing focus on bundled payment models necessitates improved awareness of the underlying causes of revision THA.

Table 7
Revision THA procedure CCI score breakdown.

Procedure	CCI score (SD)
All component	2.46 (2.53)
Acetabular component	2.43 (2.52)
Femoral component	2.62 (2.60)
Hip revision, NOS	3.02 (2.88)
Arthrotomy removal of prosthesis	2.76 (2.70)
Liner removal	2.65 (2.65)

CCI, Charlson Comorbidity Index; NOS, not other specified.

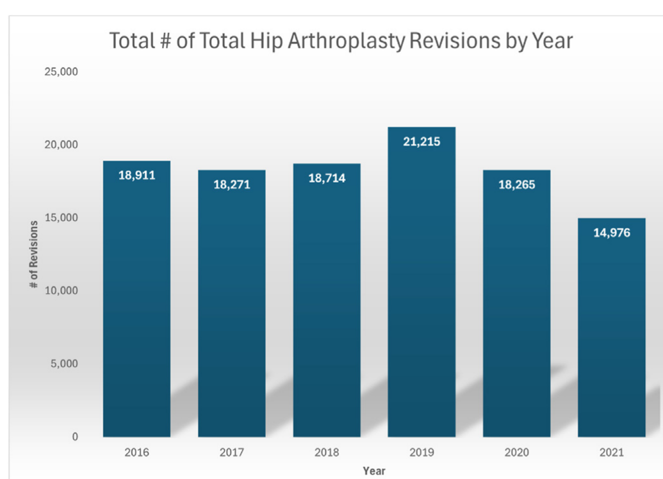

Figure 1. Total number of revision hip arthroplasties by year.

Conclusions

Dislocation and infection remain leading indications for revision THA. These findings can properly guide surgeons toward appropriate management as well as toward active steps to minimizing these outcomes.

Conflicts of Interest

Ronald E. Delanois receives research support from Johnson & Johnson, Biocomposites, CyMedica Orthopedics, Depuy Synthes Product, Flexion Therapeutics, Microport Orthopedics, Orthofix, Patient-Centered Outcomes Research Institute (PCORI), Smith & Nephew, Stryker, Tissue Gene, and United Orthopedic Corporation; is a Board or committee member of Baltimore City Medical Society; is in the medical/orthopaedic publications editorial/governing board of Journal of Knee Surgery.

James Nace is a Board or committee member of Arthritis Foundation; is in the medical/orthopaedic publications editorial/governing board of Journal of Arthroplasty, Journal of the American Osteopathic Medicine Association, Orthopedic Knowledge, Journal of Knee Surgery, Knee; is a paid consultant for Microport Orthopedics; receives research support from Microport Orthopedics, Stryker, and United Orthopedic Corporation.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101517.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Ethical approval

Exemption due to use of public database.

Consent for publication

Informed consent was obtained from all individual participants included in the study.

CRediT authorship contribution statement

Sandeep S. Bains: Writing – review & editing, Conceptualization. **Jeremy A. Dubin:** Writing – review & editing, Writing – original draft, Conceptualization. **Christopher G. Salib:** Writing – review & editing. **Rubén Monárrez:** Writing – review & editing. **Ethan Remily:** Writing – review & editing. **Daniel Hameed:** Writing – review & editing. **Gabrielle N. Swartz:** Data curation, Methodology, Writing – review & editing. **Reza Katanbaf:** Data curation, Formal analysis, Software, Writing – review & editing. **James Nace:** Writing – review & editing, Conceptualization. **Ronald E. Delanois:** Writing – review & editing, Conceptualization.

Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.artd.2024.101517.

References

[1] Palsis JA, Brehmer TS, Pellegrini VD, Drew JM, Sachs BL. The cost of joint replacement: comparing two approaches to evaluating costs of total hip and knee arthroplasty. JBJS 2018;100:326–33.
[2] Gabriel L, Casey J, Gee M, Palmer C, Sinha J, Moxham J, et al. Value-based healthcare analysis of joint replacement surgery for patients with primary hip osteoarthritis. BMJ Open Quality 2019;8:e000549.
[3] Castagnini F, Sudanese A, Bordini B, Tassinari E, Stea S, Toni A. Total knee replacement in young patients: survival and causes of revision in a registry population. J Arthroplasty 2017;32:3368–72.
[4] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. Jbjs 2007;89:780–5.
[5] Hamilton DF, Howie CR, Burnett R, Simpson AHRW, Patton JT. Dealing with the predicted increase in demand for revision total knee arthroplasty: challenges, risks and opportunities. Bone Joint J 2015;97:723–8.
[6] Schwartz AM, Farley KX, Guild GN, Bradbury TL. Projections and epidemiology of revision hip and knee arthroplasty in the United States to 2030. J Arthroplasty 2020;35:S79–85.
[7] Bozic KJ, Kurtz SM, Lau E, Ong K, Vail TP, Berry DJ. The epidemiology of revision total hip arthroplasty in the United States. J Bone Joint Surg Am 2009;91:128–33.
[8] Gwam CU, Mistry JB, Mohamed NS, Thomas M, Bigart KC, Mont MA, et al. Current epidemiology of revision total hip arthroplasty in the United States: national inpatient sample 2009 to 2013. J Arthroplasty 2017;32:2088–92.
[9] Kerzner B, Kunze KN, O'Sullivan MB, Pandher K, Levine BR. An epidemiological analysis of revision aetiologies in total hip arthroplasty at a single high-volume centre. Bone Jt Open 2021;2:16–21.
[10] Kelmer G, Stone AH, Turcotte J, King PJ. Reasons for revision: primary total hip arthroplasty mechanisms of failure. J Am Acad Orthop Surg 2021;29:78–87.
[11] Haynes JA, Stambough JB, Sassoon AA, Johnson SR, Clohisy JC, Nunley RM. Contemporary surgical indications and referral trends in revision total hip arthroplasty: a 10-year review. J Arthroplasty 2016;31:622–5.
[12] Vanhegan IS, Malik AK, Jayakumar P, Islam SU, Haddad FS. A financial analysis of revision hip arthroplasty: the economic burden in relation to the national tariff. J Bone Joint Surg Br 2012;94:619–23.
[13] Ulrich SD, Seyler TM, Bennett D, Delanois RE, Saleh KJ, Thongtrangan I, et al. Total hip arthroplasties: what are the reasons for revision? Int Orthop 2008;32:597–604.
[14] Centers for Medicare and Medicaid Services. Medicare fee-for-service supplemental improper payment data. CMS Gov; 2020.
[15] Bedard NA, Elkins JM, Brown TS. Effect of COVID-19 on hip and knee arthroplasty surgical volume in the United States. J Arthroplasty 2020;35:S45–8.
[16] Rowan FE, Benjamin B, Pietrak JR, Haddad FS. Prevention of dislocation after total hip arthroplasty. J Arthroplasty 2018;33:1316–24.
[17] Clair AJ, Evangelista PJ, Lajam CM, Slover JD, Bosco JA, Iorio R. Cost analysis of total joint arthroplasty readmissions in a bundled payment care improvement initiative. J Arthroplasty 2016;31:1862–5.
[18] Pulido L, Ghanem E, Joshi A, Purtill JJ, Parvizi J. Periprosthetic joint infection: the incidence, timing, and predisposing factors. Clin Orthop Relat Res 2008;466:1710–5.
[19] Ong KL, Kurtz SM, Lau E, Bozic KJ, Berry DJ, Parvizi J. Prosthetic joint infection risk after total hip arthroplasty in the Medicare population. J Arthroplasty 2009;24:105–9.
[20] Lai K, Bohm ER, Burnell C, Hedden DR. Presence of medical comorbidities in patients with infected primary hip or knee arthroplasties. J Arthroplasty 2007;22:651–6.
[21] Småbrekke A, Espehaug B, Havelin L, Furnes O. Operating time and survival of primary total hip replacements an analysis of 31 745 primary cemented and uncemented total hip replacements from local hospitals reported to the Norwegian Arthroplasty Register 1987–2001. Acta Orthop Scand 2004;75:524–32.
[22] Parvizi J, Saleh KJ, Ragland PS, Pour AE, Mont MA. Efficacy of antibiotic-impregnated cement in total hip replacement. Acta Orthop 2008;79:335–41.
[23] Engesæter LB, Espehaug B, Lie SA, Furnes O, Havelin LI. Does cement increase the risk of infection in primary total hip arthroplasty? Revision rates in 56,275 cemented and uncemented primary THAs followed for 0–16 years in the Norwegian Arthroplasty Register. Acta Orthop 2006;77:351–8.
[24] Corbett KL, Losina E, Nti AA, Prokopetz JJ, Katz JN. Population-based rates of revision of primary total hip arthroplasty: a systematic review. PLoS One 2010;5:e13520.
[25] Courtney PM, Bohl DD, Lau EC, Ong KL, Jacobs JJ, Della Valle CJ. Risk adjustment is necessary in Medicare bundled payment models for total hip and knee arthroplasty. J Arthroplasty 2018;33:2368–75.
[26] Lynch JC, Yayac M, Krueger CA, Courtney PM. Amount of CMS reduction in facility reimbursement following removal of total hip arthroplasty from the inpatient-only list far exceeds reduction in actual care cost. J Arthroplasty 2021;36:2276–80.
[27] Krueger CA, Kerr JM, Bolognesi MP, Courtney PM, Huddleston 3rd JI. The removal of total hip and total knee arthroplasty from the inpatient-only list increases the administrative burden of surgeons and continues to cause confusion. J Arthroplasty 2020;35:2772–8.
[28] Slover JD, Mullaly KA, Payne A, Iorio R, Bosco J. What is the best strategy to minimize after-care costs for total joint arthroplasty in a bundled payment environment? J Arthroplasty 2016;31:2710–3.
[29] Inneh IA, Iorio R, Slover JD, Bosco IIIJA. Role of sociodemographic, co-morbid and intraoperative factors in length of stay following primary total hip arthroplasty. J Arthroplasty 2015;30:2092–7.