Keeping the Lights On: The Impact of the COVID-19 Pandemic on Elective Total Joint Arthroplasty Utilization in the United States

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☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ABSTRACT

BACKGROUND: It was estimated that up to 30,000 primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) procedures would be cancelled each week during the moratorium on elective surgeries in the United States (US). The purpose of this study was to analyze the impact of the COVID-19 pandemic on elective total joint arthroplasty (TJA) utilization in the US.

METHODS: A retrospective study was conducted using the PearlDiver database. Patients who underwent primary elective THA and TKA were identified and filtered by state and month from January through September of both 2019 and 2020. The volume of these procedures immediately following the moratorium on elective surgeries were compared to the same months the previous year.

RESULTS: For THA, overall, there was a 27.39% reduction in THA volume from 2019 to 2020 in March and an 88.94% reduction in April. For TKA, overall, there was a 31.28% reduction in TKA volume in March and a 96.61% reduction in April. When the states were separated into two cohorts by 2020 presidential election vote, there was a significantly larger decrease in THA and TKA volume observed in the 25 states and Washington DC that voted democrat compared to the 25 states that voted republican in both March ($p < 0.05$) and April ($p < 0.05$). Both THA (118.29%) and TKA (101.02%) volume returned to pre-pandemic levels by June.

CONCLUSION: Overall, this study demonstrated that elective TJA utilization did reduce as anticipated following the CMS moratorium on elective surgeries but quickly returned to pre-pandemic levels by June.

KEYWORDS: arthroplasty; knee; hip; coronavirus; COVID-19

LEVEL OF EVIDENCE Level III

INTRODUCTION

Total joint arthroplasties (TJA) are highly successful and cost-effective procedures for patients with advanced osteoarthritis and have become one of the most commonly performed elective orthopaedic procedures in the world(1–3). The annual number of TJA procedures is increasing. A 2019 study prior to the coronavirus (COVID-19) pandemic projected that the demand for TJA would increase by 75% by 2025 and 401% by 2040, likely resulting in over 1 million total joints being performed annually(4,5).

On March 11, 2020, the World Health Organization declared COVID-19 a pandemic, and a US nationwide emergency was declared two days later(6). Individual states began to lockdown on March 15, 2020 and the response to the pandemic that followed varied significantly between states(7). On March 18, 2020, the Centers for Medicare and Medicaid Services (CMS) announced that all elective surgeries should be delayed(8). By March 24, 2020, 33 states across the US had issued guidance in the form of a mandate or recommendation on limiting elective surgeries(9). Many states did not permit surgeries to be performed unless a delay of surgery would cause significant harm to the health, livelihood, or quality of life of the patient(10). No specific list of approved or banned surgeries was provided, leaving this decision to the surgeon, hospital, and patient. During the height of the pandemic, it was estimated that up to 30,000 primary hip and knee arthroplasty procedures would be canceled each week while the moratorium remained in place(11). A study by Brown et al. of 360 patients who had their TJA operation cancelled due to COVID-19 demonstrated that 88% of patients wanted to reschedule their operation as soon as possible despite anxiety regarding the risk of COVID-19 infection during hospitalization and uncertainty of when their procedure would be scheduled(12). In the first 12 days following the CMS moratorium on elective surgeries, Barnes et al. demonstrated that there was a reduction in total hip arthroplasty (THA) and total knee arthroplasty (TKA) volume of 92 and 94% respectively(13). However, there is a paucity of literature examining TJA volume in the months following this initial period.

As we move into more mature stages of the pandemic, initial COVID-19 lockdown impacts on elective orthopaedic surgery can be examined. The purpose of this study was to analyze the impact of the COVID-19 pandemic on elective TJA utilization in the six-month period following the CMS moratorium on elective surgeries. A secondary aim was to examine the difference in the impact on TJA volume by state.

MATERIALS AND METHODS

Data Source and Study Design

Patient records were queried from the PearlDiver Mariner Database (PearlDiver Inc., Colorado Springs, CO, USA), a commercially available administrative claims database which contains deidentified patient data from the inpatient and outpatient settings. The database contains the medical records of patients across the United States from 2010 through the first quarter of 2021 which are collected by an independent data aggregator. This study utilized the "M151Ortho" dataset within PearlDiver, which contains a random sample of 151 million patients. All health insurance payors are represented including commercial, private, and government plans. Researchers extract data using Current Procedural Technology (CPT) and International Classification of Diseases, Ninth and Tenth revision (ICD-9/ICD-10) codes. Institutional Review Board exemption was granted as provided data was deidentified and compliant with the Health Insurance Portability and Accountability Act. No outside funding was received for this study.

A retrospective cohort study was conducted to investigate the impact of the COVID-19 pandemic on primary elective TJA utilization in the US. THA was defined with CPT-27130 and associated ICD-9/10 procedural codes. In order to isolate primary elective THA, patients with a record of prior hemiarthroplasty, revision surgery, or diagnosis codes reflecting the presence of an artificial hip joint were excluded. Additionally, patients with hip avascular necrosis, pathologic hip fractures, hip infectious processes, or conversion from prior hip surgery (i.e., CPT-27132) at the time of the primary THA were excluded.

TKA was defined with CPT-27447 and associated ICD-9/10 procedural codes. In order to include only primary elective TKA, patients with a record of prior unicompartmental knee arthroplasty, other knee reconstructive procedures, revision arthroplasty, or diagnosis codes reflecting the presence of an artificial knee joint were excluded. Patients with knee infections and distal femur and/or proximal tibia fractures at the time of the primary TKA were also excluded.

Both the THA and TKA cohorts were then filtered into several time periods. First, two internal control time periods representing January and February of both 2019 and 2020, were queried and compared to the same months the previous year to ensure there was not a significant change in database enrollment between years that could explain any observed changes in TJA utilization during the lockdowns. Next, the cohorts were filtered by March and April of both 2019 and 2020 to observe the change in volume of both THA and TKA procedures immediately following the beginnings of the moratorium on elective surgeries announced on March 18th, 2020 compared to the same months the previous year(8). Finally, the cohorts were filtered by May through September of 2019 and 2020 to observe the change in volume compared to the same months of the previous year of both THA and TKA procedures immediately following the April 19, 2020 CMS recommendation which announced regions with adequate workforce, testing, and supplies could resume providing procedural care that had been previously postponed(14). These cohorts were then filtered by state in order to observe the change in volume by state. Politics played a significant role in the state-by-state response to COVID-19(7,15). As such, the 50 states plus Washington DC were then categorized as voting Republican or voting Democratic depending on their 2020 US presidential election results to identify if there was a difference in the reduction in TJA volumes associated with state political lean(16). All codes used to define inclusion and exclusion criteria are available in **Appendix Table A**.

Statistical Analysis

Statistical analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) with an α level set to 0.05. The total number of cases were aggregated for both THA and TKA in to two cohorts one of the 25 states voting Republican and one of the 25 states plus Washington DC voting Democrat by 2020 US presidential election results(16). The change from 2019 to 2020 of the aggregate case numbers were compared between the two cohorts utilizing *chi*-square tests for each month.

Study Populations

After applying exclusion criteria, a total of 624,968 patients who underwent primary elective THA and 1,313,834 patients who underwent primary elective TKA were identified. The exact breakdown of number of operations by state in 2019 and 2020 is available upon request.

RESULTS

Control to Ensure Equivalent Database Enrollment

For THA, overall, there was a 5.91% reduction in THA volume from 2019 to 2020 in January and a 2.92% reduction in February. When the states were separated into two cohorts by 2020 election vote, there was no significant difference in the change compared to the previous year in THA volume observed in the 25 states and the District of Columbia that voted Democratic versus the 25 states that voted Republican in January (6.05% vs 5.75%, $p = 0.924$) or February (3.70% vs 1.96%, $p = 0.594$). **(Figure 1) (Table 1)**

For TKA, overall, there was a 9.48% reduction in TKA volume from 2019 to 2020 in January and a 2.39% reduction in February. When the states were separated into two cohorts by 2020 election vote, there was no significant difference in the change compared to the previous year in TKA volume observed between the two political cohorts in January (9.95% vs 8.99%, $p = 0.656$) or February (3.99% vs 0.77%, $p = 0.177$). **(Figure 2) (Table 2)**

Change in Utilization From March and April 2019 to March and April 2020

For THA, overall, there was a 27.39% reduction in THA volume from 2019 to 2020 in March and an 88.94% reduction in April. When the states were separated into two cohorts by 2020 election vote, there was a significantly larger decrease in THA volume observed in the Democratic cohort compared to the Republican cohort in both March (31.13% vs 22.81%, $p = 0.002$) and April (91.36% vs 85.85%, $p < 0.001$).

For TKA, overall, there was a 31.28% reduction in TKA volume from 2019 to 2020 in March and a 96.61% reduction in April. When the states were separated into two cohorts by 2020 election vote, there was a significantly larger decrease in TKA volume observed in the Democratic cohort compared to the Republican cohort in both March (37.46% vs 24.64%, $p < 0.001$) and April (97.57% vs 95.64%, $p < 0.001$).

Change in Utilization From May Through June 2019 to May Through June 2020

Overall, THA volume rebounded to 65.62% of 2019 volume in May and 118.29% of 2019 volume in June. When the states were separated into two cohorts by 2020 election vote, there was a significantly larger rebound observed in the 25 states that voted Republican in May (83.30% vs 53.29%, $p < 0.001$) and June (127.62% vs 111.00%, $p < 0.001$).

Overall, TKA volume rebounded to 51.86% of 2019 volume in May and 101.02% of 2019 volume in June. When the states were separated into two cohorts by 2020 election vote, there was a significantly larger rebound observed in the 25 states that voted Republican in May (66.82% vs 38.25%, $p < 0.001$) and June (111.21% vs 91.28%, $p < 0.001$).

Change in Utilization From July Through September 2019 to July Through September 2020

For THA, overall, there was a 1.74% increase in THA volume from 2019 to 2020 in July, a 2.12% increase in August, and a 4.95% increase in September. When the states were separated into two cohorts by 2020 election vote, there was no significant difference in the increase in

THA volume observed between the two political cohorts in July (1.24% vs 2.38%, p = 0.733), August (0.28% vs 4.43%, p = 0.232), or September (3.73% vs 6.46%, p = 0.439).

For TKA, overall, there was a 7.46% decrease in TKA volume from 2019 to 2020 in July, a 2.39% decrease in August, and a 5.32% decrease in September. When the states were separated into two cohorts by 2020 election vote, there was no significant difference in the decrease in TKA volume observed between the two political cohorts in July (9.38% vs 5.44%, p = 0.096), August (0.36% vs 4.38%, p = 0.116), or September (5.86% vs 4.75%, p = 0.648).

DISCUSSION

With the COVID-19 pandemic mandated and/or recommended moratorium on elective surgical cases throughout the US, it was predicted that the number of elective TJA would plummet. Overall, this study demonstrated that elective TJA utilization did reduce across the country in 2020 as anticipated during March and April to <10% of the previous year's volume. There was a swift increase in both THA and TKA volume in May and June following the April 19, 2020 CMS recommendation that regions with adequate workforce, testing, and supplies could resume providing procedural care that had been previously postponed(14). States responded to this recommendation in unique ways. New York placed restrictions on elective surgeries based on the number of cases and the capacity of each of the hospitals in each county(10). Alabama restricted elective surgical procedures if the surgery would reduce the availability of personal protective equipment available for healthcare providers(10). Most states, however, restricted elective surgical cases from being performed, while only allowing cases that would lead to significant patient harm or reduced quality of life if not performed urgently or within a stated time period(10).

States that voted Republican as an aggregate demonstrated a significantly smaller reduction in volume in March and April and demonstrated a significantly larger rebound than states that voted Democratic in May and June. This is likely a result of differing state recommendations and policy, assessments of risk and benefit from the surgeons, population and hospital distributions in specific states, surges within each state, infection and death rates, and patient autonomy, preference, and perception of COVID-19 risk. This association between political lean and differential response to the pandemic has been demonstrated to have had an impact on vaccination, infection, and death rates(17–19). Chen et al. demonstrated that in the beginning of the pandemic (February 10, 2020 – July 8, 2020), counties who voted Democratic (defined as those who voted Democratic in the 2016 election) had higher death rates than counties that voted Republican (18). However, by October 7, 2020 – December 5, 2020 of the same year the counties that voted Republican demonstrated a significantly higher death rate with an expectation of the gap to continue to widen(18). A study by Neelon et al. demonstrated similar results utilizing state gubernatorial lean(19). Of note, however, case numbers in most states did rebound to similar or higher numbers compared to pre-pandemic data by June and July regardless of whether a state voted Republican or Democratic.

Differences in state-by-state response also are possibly due to differing patient attitudes about TJA. A study by Dittman et al. demonstrated that 78% of patients undergoing consultation for primary hip or knee arthroplasty believed that their condition warranted surgery despite the pandemic(20). While Pietrzak et al. demonstrated that 88.65% of patients wanted their TJA procedure despite the pandemic(21). The same study demonstrated patients with comorbidities were 8.4-fold less likely to want TJA than those without comorbidities(21). Wilson et al. demonstrated that lower joint-function scores and higher pain levels were associated with patient reported need for immediate surgery(22). A study by Chen et al. demonstrated that a majority of patients (71.5%) disagreed that the pandemic would negatively affect the outcome of their TJA(23). In the same study, the most cited reassuring factors were surgeon support, preoperative COVID-19 testing, and adequate personal protective equipment(23). Johnson et al. also demonstrated that one-third of patients felt their TJA should not be categorized as elective(24). As such, patients may not feel their TJA is a truly elective procedure and the impact of patient perception on the continued TJA utilization throughout the US observed in this study during the pandemic cannot be understated.

Regardless of patient preference and perception, the statewide moratoriums on elective procedures resulted in a significant decrease in the early months of the COVID-19 pandemic. This created financial challenges to the surgeons, their clinics, hospitals, and staff. As orthopaedic surgery reimbursement is only $1,200 per single TJA without consideration of overhead and practice expenses, a decrease in case volume can have significant financial impacts on a surgeon's ability to support a practice(25). Mavrogenis et al. demonstrated that throughout the COVID-19 pandemic, nearly 98% of all orthopaedic surgeons suffered some monetary impact(26). Paul et al. demonstrated the financial losses to orthopaedic surgeons, noting that the highest impacted states included Alabama, Georgia, and Missouri(27). In a survey of Louisiana Orthopaedic Association members, Kale et al. demonstrated that a majority of surgeons had applied for government assistance or took out loans during COVID-19 to support practice, personnel, and overhead costs(28).

Prior to the COVID-19 pandemic, musculoskeletal surgery as a whole accounted for up to $21.1 billion in net income per year to the US hospital system, but during the initial 8 weeks of the pandemic, estimated losses were $3.5 billion, highlighting the significant impact on surgeons' practices across the country(29). However, once limitations were either removed or reduced, orthopaedic surgeons quickly returned to the operating room for elective procedures. Continued functioning of orthopaedic practices following the initial few months of the pandemic were necessary to sustain the livelihood of not only the surgeons but of the many staff members and ancillary services that rely on those clinics and surgical cases.

Limitations

There are several limitations to this study. First, the possibility of coding errors is inherent with any analysis of administrative claims data. However, such instances are rare and made up only 0.7% of Medicare and Medicaid payments in 2021(30). Nonetheless, because this analysis relied on claims data, it is possible there were miscoded indications for the TJA that could have caused non-elective TJA to be included. As the PearlDiver database only provides data for a specific group of patients there is sampling bias present. Additionally, differing database enrollment could account for some observed trends. However, this is unlikely to have caused any significant changes as this study demonstrated that the THA and TKA volume for January and February of 2020 (the months immediately preceding the study period) compared to the same months one year prior were not significantly different between the two state cohorts. This suggests database enrollment had not significantly changed leading up to the pandemic. Due to the nature of a database study, it is not possible to know the exact indication for the included TJA. As such, some included TJA may have in reality been non-elective. However, by excluding fractures, infections, etc., it is likely a vast majority of included TJAs were elective. The differences demonstrated between states during the nationwide moratoriums represent a snapshot in time and the observed variance may be due to the timing of the regulations rather than differences in the regulations themselves. There may be inappropriate generalizations regarding states that voted Democratic or Republican as the states were taken as an aggregate cohort based on election results and not examined individually. As such, these results may not be applicable to all the individual states included in each cohort. Additionally, some differences between the Republican and Democratic cohorts, while significant, represented small actual percentages and reliable conclusions may not be able to be made on these small percent differences. Finally, most of the observed change in volume in March likely occurred in the final 12 days of that month following the CMS moratorium on elective surgeries. However, PearlDiver can only filter by month this study was unable to separate this month in to smaller time points to observe this change.

CONCLUSION

Overall, this study demonstrated that elective TJA utilization did reduce as anticipated across the US during March and April of 2020 following the CMS moratorium on elective surgeries. However, THA and TKA utilization quickly returned to pre-pandemic levels by June of 2020. There were significant differences in the reduction in volume in March and April as well as the rebound in volume in May and June between states. These differential rates of change in volume were significantly associated with the state's 2020 general US Presidential election vote. These findings are likely the result of multiple factors including differences in state regulations during the pandemic, infection and death rates, personal protective equipment availability, population distributions, and patient perceptions.

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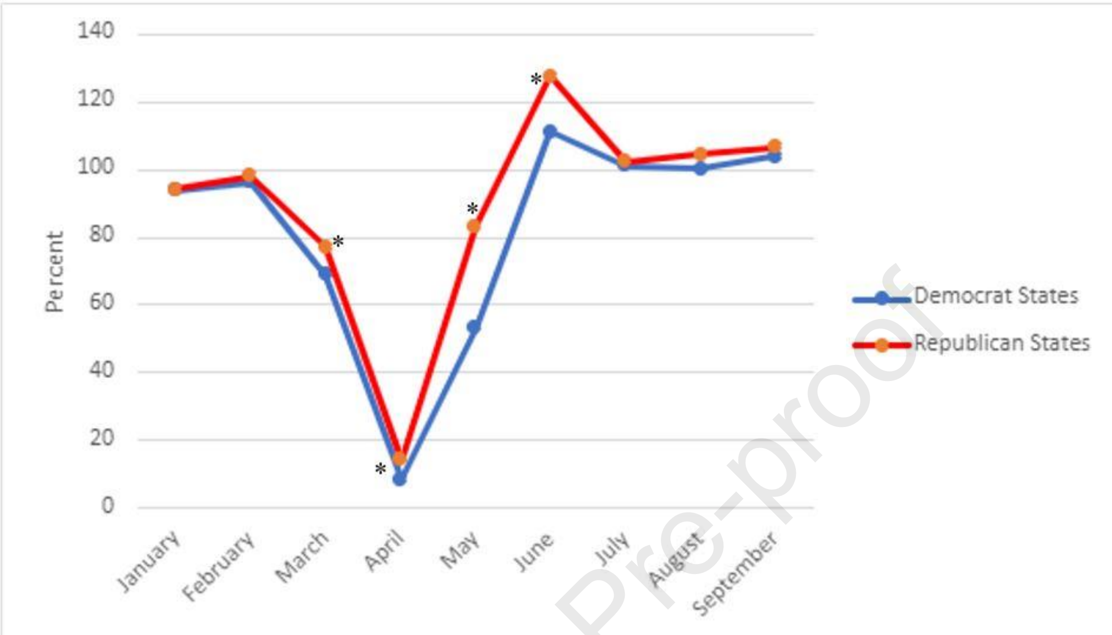
Table 1. 2020 total hip arthroplasty utilization as a percent of 2019 utilization in the same month

	THA Utilization (% of 2019 volume)		
	Democrat States	Republican States	p-value
January	93.95	94.25	0.924
February	96.29	98.04	0.594
March	68.87	77.19	**0.002**
April	8.64	14.15	<**0.001**
May	53.29	83.30	<**0.001**
June	111.00	127.62	<**0.001**
July	101.24	102.38	0.733
August	100.28	104.43	0.232
September	103.73	106.46	0.439

Table 2. 2020 total knee arthroplasty utilization as a percent of 2019 utilization in the same month

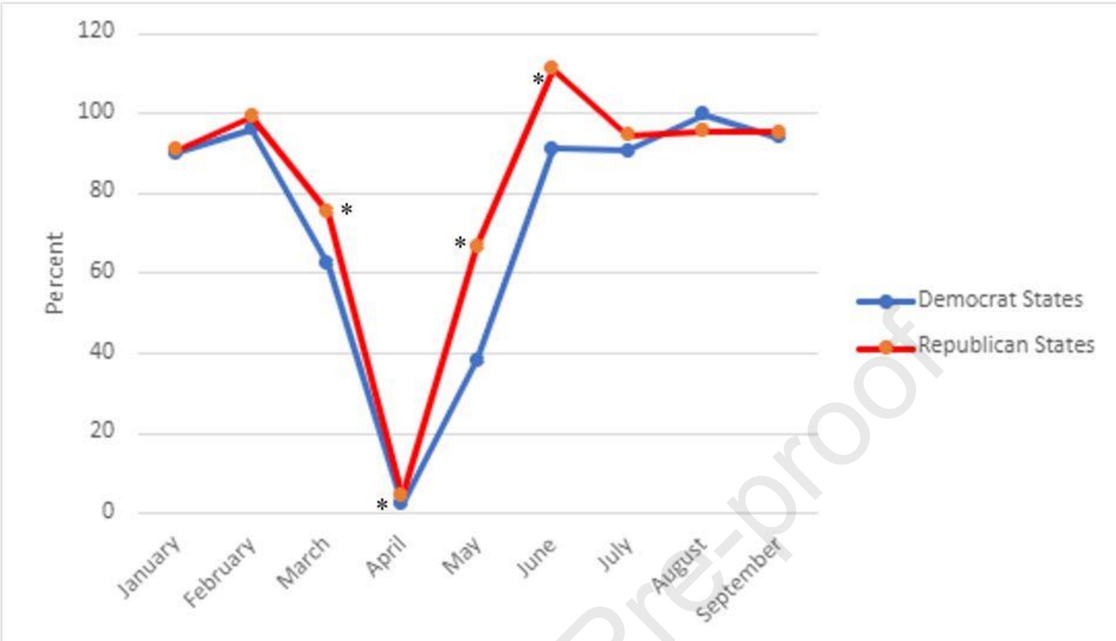
	TKA Utilization (% of 2019 volume)		
	Democrat States	Republican States	p-value
January	90.05	91.01	0.656
February	96.01	99.23	0.177
March	62.54	75.36	**<0.001**
April	2.43	4.36	**<0.001**
May	38.25	66.82	**<0.001**
June	91.28	111.21	**<0.001**
July	90.62	94.56	0.096
August	99.64	95.62	0.116
September	94.14	95.25	0.648

Figure 1. By month total hip arthroplasty volume in 2020 as a percent of the volume in 2019 in the same month



Asterix (*) indicate significant differences between the change in volume in that month between Republican voting and Democratic voting states (p<0.05)

Figure 2. By month total knee arthroplasty volume in 2020 as a percent of the volume in 2019 in the same month



Asterix (*) indicate significant differences between the change in volume in that month between Republican voting and Democratic voting states (p<0.05)

Appendix: PearlDiver Codes

Table A.1: Codes used to define inclusion/exclusion criteria and other demographic and clinical variables

Criteria	Code(s)
Inclusion Criteria	
THA	CPT-27130, ICD-9-P-8151, ICD-10-P-0SR9019, ICD-10-P-0SR901A, ICD-10-P-0SR901Z, ICD-10-P-0SR9029, ICD-10-P-0SR902A, ICD-10-P-0SR902Z, ICD-10-P-0SR9039, ICD-10-P-0SR903A, ICD-10-P-0SR903Z, ICD-10-P-0SR9049, ICD-10-P-0SR904A, ICD-10-P-0SR904Z, ICD-10-P-0SR9069, ICD-10-P-0SR906A, ICD-10-P-0SR906Z, ICD-10-P-0SR90J9, ICD-10-P-0SR90JA, ICD-10-P-0SR90JZ, ICD-10-P-0SRB019, ICD-10-P-0SRB01A, ICD-10-P-0SRB01Z, ICD-10-P-0SRB029, ICD-10-P-0SRB02A, ICD-10-P-0SRB02Z, ICD-10-P-0SRB039, ICD-10-P-0SRB03A, ICD-10-P-0SRB03Z, ICD-10-P-0SRB049, ICD-10-P-0SRB04A, ICD-10-P-0SRB04Z, ICD-10-P-0SRB069, ICD-10-P-0SRB06A, ICD-10-P-0SRB06Z, ICD-10-P-0SRB0J9, ICD-10-P-0SRB0JA, ICD-10-P-0SRB0JZ
TKA	CPT-27447, ICD-9-P-8154, ICD-10-P-0SRC069, ICD-10-P-0SRC06A, ICD-10-P-0SRC06Z, ICD-10-P-0SRC0J9, ICD-10-P-0SRC0JA, ICD-10-P-0SRC0JZ, ICD-10-P-0SRD069, ICD-10-P-0SRD06A, ICD-10-P-0SRD06Z, ICD-10-P-0SRD0J9, ICD-10-P-0SRD0JA, ICD-10-P-0SRD0JZ
Exclusion Criteria	
Prior Hip Hemiarthroplasty	CPT-27125
Presence of Artificial Hip Joint	ICD-9-D-V4364, ICD-10-D-Z96641, ICD-10-D-Z96642, ICD-10-D-Z96643, ICD-10-D-Z96649
Avascular Necrosis Hip	ICD-9-D-73342, ICD-10-D-M87051, ICD-10-D-M87052, ICD-10-D-M87059
Conversion from Prior Hip Surgery	CPT-27132
Pathologic Fracture Hip	ICD-9-D-73314, ICD-9-D-73315, ICD-10-D-M84459A, ICD-10-D-M84559A, ICD-10-D-M84659A
Septic Arthritis Hip	ICD-9-D-71105, ICD-9-D-71106, ICD-9-D-71145, ICD-9-D-71146, ICD-10-D-M00851, ICD-10-D-M00852, ICD-10-D-M00859
Presence of Artificial Knee Joint	ICD-9-D-V4365, ICD-10-D-Z96651, ICD-10-D-Z96652, ICD-10-D-Z96653, ICD-10-D-Z96659
Unicompartmental Knee Arthroplasty	CPT-27446, ICD-10-P-0SRC0L9, ICD-10-P-0SRC0LA, ICD-10-P-0SRC0LZ, ICD-10-P-0SRC0M9, ICD-10-P-0SRC0MA, ICD-10-P-0SRC0MZ, ICD-10-P-0SRD0L9, ICD-10-P-0SRD0LA, ICD-10-P-0SRD0LZ, ICD-10-P-0SRD0M9, ICD-10-P-0SRD0MA, ICD-10-P-0SRD0MZ,
Revision Total Knee Arthoplasty	CPT-27440, CPT-27441, CPT-27442, CPT-27443, CPT-27445, CPT-27446, CPT-27486, CPT-27487, CPT-27488, ICD-9-P-0080, ICD-9-P-0081, ICD-9-P-0082, ICD-9-P-0083, ICD-9-P-0084, ICD-9-P-8155, ICD-9-P-8155, ICD-10-P-0SPC0JZ, ICD-10-P-0SPC0JZ
Knee Infection	ICD-9-D-71106, ICD-10-D-M009, ICD-10-D-M00061, ICD-10-D-M00062, ICD-10-D-M00069, ICD-10-D-M00161, ICD-10-D-M00162, ICD-10-D-M00169, ICD-10-D-M00261, ICD-10-D-M00262, ICD-10-D-M00269, ICD-10-D-M00861, ICD-10-D-M00862, ICD-10-D-M00869, ICD-10-D-M01X61, ICD-10-D-M01X62, ICD-10-D-M01X69, ICD-10-D-M01X61, ICD-10-D-M01X62, ICD-10-D-M01X69, ICD-10-D-T8453XA, ICD-10-D-T8453XD, ICD-10-D-T8453XS, ICD-10-D-T8454XA, ICD-10-D-T8454XD, ICD-10-D-T8454X
Knee Fracture	CPT-27487, ICD-9-D-82100, ICD-9-D-82110, ICD-9-D-82120, ICD-9-D-82123, ICD-9-D-82129, ICD-9-D-82130, ICD-9-D-82132, ICD-9-D-82133, ICD-9-D-82139, ICD-9-D-73316, ICD-9-D-73393, ICD-9-D-82300, ICD-9-D-82302, ICD-9-D-82310, ICD-9-D-82312, ICD-9-D-82380, ICD-9-D-82382, ICD-9-D-82390, ICD-9-D-82392, ICD-10-D-M84453A, ICD-10-D-M84453A, ICD-10-D-M84453A, ICD-10-D-M84453A, ICD-10-D-M84453A, ICD-10-D-S7290XC, ICD-10-D-S72409A, ICD-10-D-S72453A, ICD-10-D-S72456A, ICD-10-D-S72499A, ICD-10-D-S72409B, ICD-10-D-S72453B, ICD-10-D-M84469A, ICD-10-D-M84369A, ICD-10-D-S82109A, ICD-10-D-S82101A, ICD-10-D-S82831A, ICD-10-D-S82102A, ICD-10-D-S82832A, ICD-10-D-

	S82109B, ICD-10-D-S82109C, ICD-10-D-S82101B, ICD-10-D-S82831B, ICD-10-D-S82102B, ICD-10-D-S82832B, ICD-10-D-S82201A, ICD-10-D-S82401A, ICD-10-D-S82202A, ICD-10-D-S82402A, ICD-10-D-S82201B, ICD-10-D-S82201C, ICD-10-D-S82401B, ICD-10-D-S82202B, ICD-10-D-S82402B
Unicompartmental arthroplasty	ICD-10-P-0SRC0L9, ICD-10-P-0SRC0LA, ICD-10-P-0SRC0LZ, ICD-10-P-0SRC0M9, ICD-10-P-0SRC0MA, ICD-10-P-0SRC0MZ, ICD-10-P-0SRD0L9, ICD-10-P-0SRD0LA, ICD-10-P-0SRD0LZ, ICD-10-P-0SRD0M9, ICD-10-P-0SRD0MA, ICD-10-P-0SRD0M