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Original Research

Outpatient Versus Inpatient Total Joint Arthroplasty: Do Medically and Socially Complex Patients Require More Resources but Achieve Similar Outcomes?

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A B S T R A C T

Background: This study compared outcomes between patients undergoing outpatient total joint arthroplasty (TJA) at an ambulatory surgery center (ASC) versus a cohort of medically and socially complex patients undergoing TJA at a tertiary healthcare system.

Methods: An institutional database at a single academic center was retrospectively reviewed for patients who underwent primary TJA since the opening of an ASC from August 2021 to January 2024. A total of 716 (outpatient: 374; inpatient: 342) total knee arthroplasties and 458 (outpatient: 196; inpatient: 262) total hip arthroplasties met inclusion criteria.

Results: Patients in the inpatient total knee arthroplasty group had a higher proportion of patients requiring an emergency department visit (11.4% vs 4.5%; $P = .008$) and admission (6.7% vs 2.7%; $P = .025$) within the first 90 days after surgery than the outpatient group; however, 2-year revision-free (97.9% vs 97.9%; $P = .75$) survival was similar between groups. Patients in the inpatient total hip arthroplasty group had a higher proportion of patients requiring an emergency department visit (13.0% vs 4.6%; $P = .035$) and admission (7.3% vs 1.0%; $P = .018$) within the first 90 days after surgery compared to the outpatient group; however, there was no difference in 2-year revision-free survival (96.4% vs 99.5%; $P = .059$).

Conclusions: Medically and socially complex patients undergoing TJA required additional resources during the 90-day postoperative window; however, they achieved similar survivorship as patients who met criteria for outpatient surgery.

Introduction

Outpatient total joint arthroplasty (TJA) has been shown to be safe without increased complications in a large subset of patients given proper patient selection and education preoperatively [1-8]. In the last decade, outpatient TJA has become increasingly prevalent as advancements have been made in perioperative management, surgical technique, and multimodal pain control [4,9,10]. This increase in prevalence has resulted in criteria expansion without compromising patient safety or outcomes. While this provides several benefits such as reduced costs and decreased burden to the healthcare system, it alters the role of tertiary referral centers in arthroplasty, as the proportion of medically and socially complex patients (ie, patients with multiple chronic conditions in addition to economic disadvantages, limited health literacy, unstable housing, minimal social support, and barriers to healthcare access) requiring inpatient services increases [9,10].

The new Comprehensive Care for Joint Replacement model set forth by the Centers for Medicare and Medicaid Services (CMS) aims to improve patient care coordination, establish a prospective payment system, and set quality standards for hospitals via total hip arthroplasty (THA)/total knee arthroplasty (TKA) patient-reported outcomes-based performance measure metrics [11-16].

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With the increased prevalence of outpatient TJA, CMS has reduced facility reimbursement, which studies have shown exceeds the actual reduction in care costs [11,12]. While questions remain regarding prospective payment of outpatient TJA, the patient population for inpatient TJA is becoming more medically and socially complex, which is increasing the cost of care for TJA when inpatient stays are required. Currently, there is limited information on the role of hospitals in managing these patients as well as how these patients' outcomes compare to those undergoing outpatient TJA.

This study aimed to compare (1) 90-day emergency department (ED) visits and admissions; (2) 2-year reoperation-free, revision-free, and infection-free survivorship; and (3) patient-reported outcome measures (PROMs) between patients undergoing outpatient TJA at an ambulatory surgery center (ASC) versus a cohort of medically and socially complex patients undergoing TJA at a hospital who required inpatient care within 1 healthcare system. We hypothesized that the more medically and socially complex inpatient group would have greater 90-day hospitalization; however, they would have comparable survivorship and PROMs as the outpatient TJA group.

Material and methods

Inclusion and exclusion criteria

At a tertiary referral academic center, an institutional database was queried for patients aged >18 years who underwent primary TKA or THA between August 2021 and January 2024 since the opening of a hospital-owned ASC. All TJAs were performed by 1 of 5 fellowship-trained arthroplasty surgeons at either the ASC or the hospital. Patients who met criteria for the ASC (Table 1) were given the option of outpatient surgery at the ASC or the hospital, and the location was ultimately decided via shared decision-making between the surgeon and patient [17]. Patients who did not meet ASC criteria had surgery at the hospital and same-day discharge (SDD) was determined based on physical therapy clearance, lack of complications, pain control, and patient home support.

The goal of this study was to compare the outcomes of outpatient TJA patients who met ASC criteria to patients who underwent TJA at the hospital and required inpatient resources secondary to their medical and/or social condition within the same healthcare system. To achieve this, all patients with <1-year follow-up were excluded, and all remaining patients were stratified by procedure of TKA and THA. Outpatient TKA and THA patients who underwent their surgery at the ASC were used as the control cohorts. To create the medically and socially complex patient cohort, propensity score matching using the nearest neighbor method, 1.0 calipers, and a 1:1 ratio that accounted for age, body mass index (BMI), Elixhauser comorbidity index (ECI), area deprivation index (ADI), and social vulnerability index (SVI) was used to exclude hospital patients who were direct matches to the control outpatient group, and therefore would have been eligible for outpatient surgery at the ASC. Any patient who was an SDD in the inpatient cohort was also excluded. This effectively created a TKA and THA inpatient cohort that was significantly more medically and socially complex compared to the outpatient cohort (Fig. 1). Patients only ultimately underwent surgery after careful preoperative optimization and multidisciplinary evaluation deemed them suitable candidates that required the resources of a tertiary center for safe management.

Variables

All included patient demographics, comorbidities, procedure details, 90-day ED visits, 90-day admissions, reoperations,

Table 1
Criteria for TKA at ASC.

Patient exclusion criteria for total knee arthroplasty at ambulatory surgery center by system
Cardiovascular system
• Uncontrolled hypertension (SBP > 180 and/or DBP > 100)
• Cardiac clearance for patients with CAD, valvular disease, cardiomyopathy, and arrhythmia
• CAD with evidence of myocardial ischemia (positive stress test)
• Myocardial infarction within 6 mo
• Unstable angina, high-risk CAD, or cardiomyopathy with reduced EF (EF must be >49%)
• Coronary angioplasty <30 d
• *<6 mo after bare metal stent OR drug eluting stent*
• Cardiac stents (regardless of type and duration) and cessation of aspirin prior to surgery
• Moderate to severe valvular disease
• Hypertrophic obstructive cardiomyopathy
• New onset arrhythmia or nonoptimized arrhythmia management or ongoing arrhythmia work-up (need completion of work-up, successful management with demonstration of stability for 1 mo, and cardiology follow-up)
• Cardiac implantable electronic devices (pacemakers, ICDs, loop recorders)
• Postural orthostatic tachycardia syndrome
• History of significant vasovagal episodes/ongoing vasovagal episodes
Pulmonary system
• Home oxygen
• Active smoker (surgery exclusion; nicotine/cotine levels checked)
• Moderate to severe COPD
• Moderate to severe restrictive pulmonary disease
• History of PE/DVT requiring plan for enoxaparin, coumadin, or oral anticoagulants anticoagulation (ASC on-call attending anesthesiologist review)
• Pulmonary hypertension (RVSP >45 or RV dysfunction on echo, or dyspnea)
• Moderate to severe obstructive sleep apnea AND noncompliance/unavailable CPAP or BiPAP machine for home use (ASC on-call attending anesthesiologist review)
• Severe obstructive sleep apnea AND BMI >35 kg/m^2
• Central sleep apnea
• Poorly controlled asthma, or recent asthma exacerbation/pneumonia with ongoing signs/symptoms/acute treatment (ie, oral steroids, antibiotics)
• Difficult airway, ventilation, intubation (ASC on-call attending anesthesiologist review)
Endocrine system
• Adrenal insufficiency
• BMI equal to or more than 40 kg/m^2
• Poorly controlled diabetes mellitus, abnormal A1C (ASC on-call attending anesthesiologist decision with orthopaedic surgery team)
• Use of insulin
• Symptomatic hyperthyroidism
Gastrointestinal system
• MELD score >10
• Active liver disease: elevated liver enzymes, jaundice, ascites, GI bleeding, and hepatic encephalopathy.
Genitourinary system
• Chronic kidney disease (> Stage 3: eGFR > 30 mL/min)
• Dialysis patients
Neurologic system
• Uncontrolled seizures (seizure in past 6 mo) and/or inadequate antiseizure medication levels
• TIA, CVA within 6 mo of the procedure
• No stroke residual interfering with mobility, ambulation, and physical therapy
• Myasthenia gravis or myasthenic syndrome
• Guillain-Barré syndrome
Hematologic system
• Sickle cell anemia
• DVT, PE within 3 mo of surgery
• Bleeding disorders (risk of bleeding, blood, blood products, and/or desmopressin administration in the perioperative period)
• Anemia: transfusion with previous TKA, iron-deficient anemia requiring transfusions (ASC on-call attending anesthesiologist decision with orthopaedic surgery team)
• Thrombocytopenia
Psychiatric
• Unstable anxiety, depression, bipolar, psychosis, behavioral issue, and/or lack of motivation for same-day discharge
• Psycho-social issues interfering with same-day discharge

Table 1 (*continued*)

Patient exclusion criteria for total knee arthroplasty at ambulatory surgery center by system
Infectious disease
• *Clostridium difficile*
• CRE
• Open wound with MRSA
Chronic pain
• Currently on oral opioid regimen, seeing chronic pain physician for pain management, use of Suboxone (ASC on-call attending anesthesiologist decision with orthopaedic surgery team)
• Dependence history on suboxone
PONV
• Requiring admission and/or readmission with past surgeries actively treated with aggressive antiemetics
PT
• Patients with PT concerns for same-day discharge (anesthesia, surgery, PT discuss)

ASC, ambulatory surgery center; BiPAP, bilevel positive airway pressure; BMI, body mass index; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure; CRE, carbapenem-resistant Enterobacterales; CVA, cerebral vascular accident; DBP, diastolic blood pressure; DVT, deep vein thrombosis; EF, ejection fraction; eGFR, estimated glomerular filtration rate; GI, gastrointestinal; ICD, implantable cardioverter defibrillator; MELD, model for end-stage liver disease; MRSA, methicillin-resistant staphylococcus aureus; PE, pulmonary embolism; PONV, postoperative nausea and vomiting; PT, physical therapy; RVSP, right ventricular systolic pressure; RV, right ventricle; SBP, systolic blood pressure; TIA, transient ischemic attack; TKA, total knee arthroplasty [17].

[a]Specific patient-specific and/or procedure-specific questions are directed to the on-call anesthesiologist.

revisions, and PROMs were collected. Scheduled admissions that were not related in any way to the arthroplasty performed were not included as an admission. Reoperations included any surgery that did not involve the removal or replacement of one of the components. Revisions were considered any surgery that involved removal and replacement of any components. ECI and American Society of Anesthesiologists (ASA) scores were used as metrics to describe patient comorbidities [18]. ADI and SVI national percentiles were used as metrics to describe social disadvantage at the census-tract level [19-23]. Patient-reported outcome measure information system (PROMIS) pain interference (PI), physical function (PF), and depression T scores were reported as generic PROMs for both TKA and THA [24]. Knee disability and osteoarthritis outcome score for joint replacement and hip disability and osteoarthritis outcome score for joint replacement (KOOS JR and HOOS JR) were used to evaluate joint-specific PROMs. Raw scores on a 0 (perfect knee health)−28 (total knee disability) and 0 (perfect hip health)−24 (total hip disability) scale were used for KOOS JR and HOOS JR, respectively [25,26].

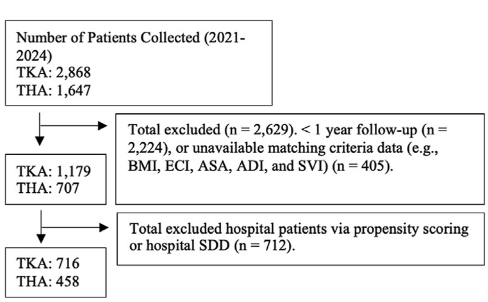

Figure 1. Overview of cohort selection.

Statistical analysis

Normally distributed continuous variables were denoted as mean with standard deviation, and non-normally distributed continuous variables denoted as median with interquartile range. These continuous variables were then compared using 2-sample *t*-test if normal or Mann-Whitney *U* test if they were non-normally distributed. Categorical variables were described as frequency and proportion. They were compared using Chi-squared test. The Kaplan-Meyer method and log-rank test was used to compare short-term (2-year) all-cause reoperation-free, revision-free, and infection-free survivorship. P values $\leq$ 0.05 were considered significant. Standardized mean difference was used to measure effect size with values > 0.2 indicating a small effect, > 0.5 a medium effect, and > 0.8 a large effect. Assumption for respective tests was checked prior to analysis. R statistical programming language (version 4.1; R Foundation for Statistical Computing, Vienna, Austria) was used to perform statistical analysis [27]. Institutional review board approval was granted before the initiation of the study and Strengthening of Reporting of Observational Studies in Epidemiology guidelines were followed [28].

Demographics

TKA

A total of 716 patients undergoing TKAs met inclusion criteria, with 374 in the outpatient group and 342 in the medically and socially complex inpatient group. The follow-up time was more than 1 year for both groups. The inpatient cohort had a higher mean age ($P < .001$), BMI ($P < .001$), ECI ($P < .001$), ADI ($P < .001$), and SVI ($P < .001$). The most common comorbidities in the inpatient group were hypertension (83.9%), obesity (39.8%), and depression (38.9%). Additionally, the inpatient group had a higher proportion of females, Black patients, Hispanic patients, patients with ASA classification of 3, patients with smoking history, and patients requiring general anesthesia (Table 2).

THA

A total of 458 patients undergoing THAs met inclusion criteria, with 196 in the outpatient group and 262 in the medically and socially complex inpatient group. The follow-up time was more than 1 year for both groups. The inpatient cohort had a higher mean BMI ($P < .001$), ECI ($P < .001$), ADI ($P < .001$), and SVI ($P < .001$). The most common comorbidities in the inpatient group were hypertension (72.1%), depression (39.7%), and obesity (33.6%). Additionally, the inpatient group had a higher proportion of Black patients, patients with ASA classification of 3, patients with smoking history, and patients requiring general anesthesia (Table 3).

Results

TKA

Healthcare utilization

Patients in the inpatient group had a mean length of stay of 2.0 ± 1.7 ($P < .001$) with 15.8% of patients requiring a skilled nursing facility upon discharge ($P < .001$). ED visits at 30 days after surgery were similar between groups; however, the inpatient group had a higher proportion of patients requiring at least 1 ED visit within the first 90 days after surgery (11.4% vs 4.5%; $P = .008$). The most common reasons for an ED visit within 90 days of surgery were gastrointestinal complications, knee pain, and other non-orthopaedic complications (ie, suicide attempt, jaw pain, altered mental status, issue with a peripherally inserted central catheter,

Table 2
Demographics: ASC patients vs complex hospital patients in total knee arthroplasty.

Demographics	Outpatient (n = 374)	Inpatient (n = 342)	*P*	SMD
Follow-up (mean [range])	1.7 (0.5)	1.8 (0.5)	**.002**	0.228
Age (mean [SD])	65.1 (8.5)	71.6 (8.2)	**<.001**	0.781
Gender (n [%])			**<.001**	0.329
Male	181 (48.4)	111 (32.5)		
Female	193 (51.6)	231 (67.5)		
Race (n [%])			**.002**	0.33
White	310 (82.9)	246 (71.9)		
Black	46 (12.3)	82 (24.0)		
Asian	11 (2.9)	7 (2.0)		
Native Hawaiian	3 (0.8)	1 (0.3)		
American Indian	0 (0.0)	1 (0.3)		
Not reported	4 (1.1)	5 (1.5)		
Ethnicity (n [%])			**.016**	0.217
Hispanic	3 (0.8)	10 (2.9)		
Not Hispanic	362 (96.8)	330 (96.5)		
Not reported	9 (2.4)	2 (0.6)		
Weight (kg) (mean [SD])	86.5 (24.1)	91.7 (18.6)	**.001**	0.241
BMI (kg/m^2) (mean [SD])	28.8 (8.9)	32.9 (6.1)	**<.001**	0.535
ECI (mean [SD])	2.1 (1.5)	4.4 (2.2)	**<.001**	1.205
ASA (n [%])			**<.001**	0.712
1	6 (1.6)	0 (0.0)		
2	229 (61.2)	103 (30.1)		
3	139 (37.2)	237 (69.3)		
4	0 (0.0)	2 (0.6)		
ADI (mean [SD])	38.2 (23.4)	48.4 (24.0)	**<.001**	0.429
SVI (mean [SD])	35.0 (26.0)	52.6 (27.8)	**<.001**	0.655
Smoking status (n [%])			**<.001**	0.365
Active	7 (1.9)	6 (1.8)		
Former	99 (26.5)	149 (43.6)		
Never	268 (71.7)	187 (54.7)		
Anesthesia type (n [%])			**<.001**	0.737
General	36 (9.6)	104 (30.4)		
Monitored anesthesia care	7 (1.9)	39 (11.4)		
Regional	331 (88.5)	199 (58.2)		
Laterality			.506	0.086
Right	188 (50.3)	178 (52.0)		
Left	186 (49.7)	163 (47.7)		
Transfusion (n [%])			.964	0.077
0	374 (100.0)	341 (99.7)		
1	0 (0.0)	1 (0.3)		

ADI, area deprivation index; ASA, American Society of Anesthesiologists; ASC, ambulatory surgery center; BMI, body mass index; ECI, Elixhauser comorbidity index; TKA, total knee arthroplasty; SD, standard deviation; SMD, standardized mean difference; SVI, social vulnerability index.
Demographics: ASC patients versus complex hospital patients in total knee arthroplasty. $P < .05$ = bold.

Table 3
Demographics: ASC patients vs complex hospital patients in total hip arthroplasty.

Demographics	Outpatient (n = 196)	Inpatient (n = 262)	*P*	SMD
Follow-up (mean [range])	1.6 (0.5)	1.8 (0.5)	**.003**	0.280
Age (mean [SD])	64.6 (9.2)	64.7 (14.2)	.943	0.007
Gender (n [%])			.071	0.180
Male	96 (49.0)	105 (40.1)		
Female	100 (51.0)	157 (59.9)		
Race (n [%])			**.001**	0.428
White	158 (80.6)	183 (69.8)		
Black	30 (15.3)	71 (27.1)		
Asian	2 (1.0)	0 (0.0)		
American Indian	0 (0.0)	6 (2.3)		
Not reported	6 (3.1)	2 (0.8)		
Ethnicity (n [%])			.383	0.126
Hispanic	2 (1.0)	4 (1.5)		
Not Hispanic	191 (97.4)	257 (98.1)		
Not reported	3 (1.5)	1 (0.4)		
Weight (kg) (mean [SD])	81.6 (22.2)	89.3 (20.6)	**<.001**	0.357
BMI (kg/m^2) (mean [SD])	27.6 (7.7)	31.6 (6.3)	**<.001**	0.575
ECI (mean [SD])	2.0 (1.6)	4.1 (2.2)	**<.001**	1.068
ASA (n [%])			**<.001**	0.837
1	3 (1.5)	0 (0.0)		
2	128 (65.3)	80 (30.5)		
3	63 (32.1)	176 (67.2)		
4	0 (0.0)	6 (2.3)		
ADI (mean [SD])	38.0 (21.8)	52.7 (24.2)	**<.001**	0.637
SVI (mean [SD])	34.6 (26.7)	50.3 (28.5)	**<.001**	0.569
Smoking status (n [%])			**.001**	0.351
Active	3 (1.5)	14 (5.3)		
Former	66 (33.7)	119 (45.4)		
Never	127 (64.8)	129 (49.2)		
Anesthesia type (n [%])			**<.001**	0.572
General	13 (6.6)	69 (26.3)		
Monitored anesthesia care	25 (12.8)	32 (12.2)		
Regional	156 (79.6)	161 (61.5)		
Laterality			.990	0.010
Right	100 (51.0)	135 (51.5)		
Left				
Transfusion (n [%])			.323	0.152
0	196 (100.0)	259 (98.9)		
1	0 (0.0)	1 (0.4)		
2	0 (0.0)	2 (0.8)		

ADI, area deprivation index; ASA, American Society of Anesthesiologists; ASC, ambulatory surgery center; BMI, body mass index; ECI, Elixhauser comorbidity index; SD, standard deviation; SMD, standardized mean difference; SVI, social vulnerability index; TKA, total knee arthroplasty.
Demographics: ASC patients versus complex hospital patients in total hip arthroplasty. $P < .05$ = bold.

hyponatremia, and a patient who left without being seen). Of the patients who went to the ED multiple times within 90 days (2.3% vs 1.1%), 6 returned to the ED for the same reason. Of these 6, 3 were in the inpatient group and 3 were in the outpatient group. The reasons for multiple repeat ED visits for the inpatient group were headache, knee pain, and syncope. The reasons for repeat ED visits in the outpatient group were heart failure, abdominal mass-related pain, and chest pain. Admission at 30 days was similar between groups but the inpatient group had a higher proportion of patients requiring at least 1 admission within the first 90 days after surgery (6.7% vs 2.7%; $P = .025$). The most common reasons for an admission were gastrointestinal complications, manipulation under anesthesia, and periprosthetic joint infection (Table 4).

Reoperation-free, revision-free, and infection-free survival

There was no difference in reoperation rate (5.3% vs 7.8%; $P = .233$) between groups nor was there a difference in 2-year reoperation-free survival (94.6% vs 91.4%; $P = .15$) (Table 4 & Fig. 2). There was no difference in revision rate (2.0% vs 1.6%; $P = .871$) between groups nor was there a difference in 2-year revision-free survival (97.9% vs 97.9%; $P = .75$) (Table 4 & Fig. 2). There was no difference in infection rate (1.2% vs 1.3%; $P = 1.000$) between groups nor was there a difference in 2-year infection-free survival (98.8% vs 98.6%; $P = .83$) (Table 4 & Fig. 2).

PROMs

Patients in the inpatient group had worse median preoperative, 6-week, 6-month, and 1-year PROMIS PI scores. They also had less median improvement at the 1-year time point (−6.0 [−11.2, −2.0] vs −8.0 [−15.0, −4.0]; $P = .013$). Median preoperative, 6-week, 6-month, and 1-year PROMIS PF scores were also worse in the inpatient group. They also had less median improvement at the 1-year time point (5.0 [1.0, 9.5] vs 7.0 [3.0, 11.0]; $P = .011$). Additionally, patients in the inpatient group had worse median preoperative, 6-week, 6-month, and 1-year PROMIS depression scores; however, they had similar median improvement at the 1-year time point (−4.0 [−9.0, 0.0] vs −2.0 [−8.0, 0.0]; $P = .101$). Patients in the inpatient group had worse median preoperative KOOS JR score; however, 6-week, 6-month, and 1-year KOOS JR scores were similar between groups. They also had similar median improvement at the

Table 4
Ambulatory surgery center patients vs complex hospital patients: early hospital utilization, reoperation rates, and patient-reported outcome measures in total knee arthroplasty.

Healthcare utilization	Outpatient (n = 374)	Inpatient (n = 342)	*P*	SMD
LOS (mean [SD])	0.0 (0.0)	2.0 (1.7)	**<.001**	1.632
Disposition (n [%])			**<.001**	0.679
Home health service	0 (0.0)	10 (2.9)		
Home or self-care	374 (100.0)	278 (81.3)		
Skilled nursing facility	0 (0.0)	54 (15.8)		
ED visits (30 d)			.082	0.192
0	359 (96.0)	319 (93.3)		
1	14 (3.7)	19 (5.6)		
2	0 (0.0)	4 (1.2)		
3	1 (0.3)	0 (0.0)		
ED visits (90 d)			**.008**	0.256
0	357 (95.5)	303 (88.6)		
1	13 (3.5)	31 (9.1)		
2	3 (0.8)	6 (1.8)		
3	1 (0.3)	2 (0.6)		
Reasons for ED visits (90 d)			.272	1.468
Back pain	1 (4.5)	0 (0.0)		
Other cardiovascular complication	2 (9.1)	0 (0.0)		
Chest pain	2 (9.1)	0 (0.0)		
DVT rule out	3 (13.6)	2 (5.4)		
Fall	0 (0.0)	2 (5.4)		
Fever	0 (0.0)	1 (2.7)		
GI complication	3 (13.6)	5 (13.5)		
Hypoglycemia	0 (0.0)	1 (2.7)		
Knee pain	4 (18.2)	4 (10.8)		
Other nonorthopaedic	2 (9.1)	6 (16.2)		
Periprosthetic fracture	0 (0.0)	1 (2.7)		
Pulmonary embolism	0 (0.0)	2 (5.4)		
Renal complication	0 (0.0)	4 (10.8)		
Sepsis	0 (0.0)	1 (2.7)		
Shoulder pain	1 (4.5)	0 (0.0)		
Stroke	0 (0.0)	1 (2.7)		
Syncope	2 (9.1)	4 (10.8)		
Wound complication	2 (9.1)	3 (8.1)		
Admissions (30 d)			.363	0.105
0	368 (98.4)	332 (97.1)		
1	6 (1.6)	9 (2.6)		
2	0 (0.0)	1 (0.3)		
Admissions (90 d)			**.025**	0.202
0	364 (97.3)	319 (93.3)		
1	8 (2.1)	21 (6.1)		
2	2 (0.5)	2 (0.6)		
Reasons for admissions			.525	1.580
Back pain	1 (9.1)	0 (0.0)		
Fall	0 (0.0)	1 (4.0)		
GI complication	3 (27.3)	5 (20.0)		
Heart failure exacerbation	1 (9.1)	0 (0.0)		
Hypoglycemia	0 (0.0)	1 (4.0)		
Manipulation under anesthesia	1 (9.1)	5 (20.0)		
Other cardiovascular complication	1 (9.1)	1 (4.0)		
Other nonorthopaedic complication	0 (0.0)	2 (8.0)		
Periprosthetic fracture	0 (0.0)	1 (4.0)		
PJI	2 (18.2)	2 (8.0)		
Pulmonary embolism	0 (0.0)	2 (8.0)		
Renal complication	0 (0.0)	3 (12.0)		
Sepsis	0 (0.0)	1 (4.0)		
Syncope	1 (9.1)	0 (0.0)		
Wound complication	1 (9.1)	1 (4.0)		
Reoperation rate (n [%])	29 (7.8)	18 (5.3)	.233	0.101
Total reoperations (n [%])			.158	0.147
0	345 (92.2)	324 (94.7)		
1	26 (7.0)	18 (5.3)		
2	3 (0.8)	0 (0.0)		
Revision rate (n [%])	6 (1.6)	7 (2.0)	.871	0.033
Total revisions (n [%])			.483	0.091
0	368 (98.4)	335 (98.0)		
1	5 (1.3)	7 (2.0)		
2	1 (0.3)	0 (0.0)		
Infection rate (n [%])	5 (1.3)	4 (1.2)	1.000	0.015
Total infections (n [%])			.165	0.145
0	369 (98.7)	338 (98.8)		
1	2 (0.5)	4 (1.2)		
2	3 (0.8)	0 (0.0)		
PROMs				
PROMIS PI (median [IQR])				
Preoperation	62.0 [58.0, 66.0]	64.0 [62.0, 68.0]	**<.001**	0.556
6-wk	56.0 [53.0, 62.0]	60.0 [56.0, 64.0]	**<.001**	0.372
6-mo	55.0 [51.0, 59.0]	58.0 [53.0, 62.0]	**<.001**	0.396
1-y	53.0 [49.0, 59.0]	57.0 [53.0, 62.5]	**<.001**	0.533
1-y delta	−8.0 [−15.0, −4.0]	−6.0 [−11.2, −2.0]	**.013**	0.226
PROMIS PF (median [IQR])				
Preoperation	40.0 [36.0, 44.0]	35.0 [32.0, 39.0]	**<.001**	0.781
6-wk	42.0 [38.0, 46.0]	38.0 [33.0, 42.8]	**<.001**	0.590
6-mo	46.0 [41.0, 48.2]	41.0 [36.0, 45.0]	**<.001**	0.697
1-y	47.0 [42.0, 51.5]	41.0 [36.0, 47.0]	**< .001**	0.802
1-y delta	7.0 [3.0, 11.0]	5.0 [1.0, 9.5]	**.011**	0.216
PROMIS depression (median [IQR])				
Preoperation	48.0 [39.0, 52.0]	51.0 [45.0, 56.5]	**<.001**	0.423
6-wk	43.0 [34.0, 50.0]	46.0 [34.0, 53.0]	**<.001**	0.323
6-mo	45.0 [34.0, 48.5]	46.0 [34.0, 53.0]	**.005**	0.316
1-y	43.0 [34.0, 50.0]	46.0 [34.0, 52.0]	**.022**	0.244
1-y delta	−2.0 [−8.0, 0.0]	−4.0 [−9.0, 0.0]	.101	0.162
KOOS JR (median [IQR])				
Preoperation	14.0 [11.0, 18.0]	16.0 [13.0, 19.0]	**.003**	0.284
6-wk	12.0 [8.0, 14.0]	10.0 [7.0, 13.0]	.378	0.440
6-mo	6.0 [4.0, 10.0]	7.0 [4.0, 12.0]	.119	0.220
1-y	5.0 [3.0, 9.0]	6.5 [4.0, 12.0]	.261	0.215
1-y delta	−9.0 [−13.0, −6.0]	−6.0 [−12.0, −2.0]	.094	0.305

DVT, deep vein thrombosis; ED, emergency department; GI, gastrointestinal; IQR, interquartile range; KOOS JR, knee disability and osteoarthritis outcome scores for joint replacement; LOS, length of stay; PF, physical function; PI, pain interference; PJI, periprosthetic joint infection; PROMs, patient-reported outcome measures; PROMIS, patient-reported outcome measures information system; SD, standard deviation; SMD, standardized mean difference.
ASC patients versus complex hospital patients: early hospital utilization, reoperation rates, and patient-reported outcome measures in total knee arthroplasty. $P <$ .05 = bold.

1-year time point (−6.0 [−12.0, −2.0] vs −9.0 [−13.0, −6.0]; $P =$ .094) (Table 4).

THA

Healthcare utilization

Patients in the inpatient group had a mean length of stay of 2.3 ± 2.4 ($P <$ .001) with 10.3% of patients requiring a skilled nursing facility upon discharge ($P <$ .001). ED visits at 30 days after surgery were similar between groups; however, the inpatient group had a higher proportion of patients requiring at least 1 ED visit within the first 90 days after surgery (13.0% vs 4.6%; P = .035). The most common reasons for an ED visit within 90 days after surgery were chest pain, gastrointestinal complications, and other non-orthopaedic complications (ie, leukemia, headache, sickle cell crisis, cystitis, constipation, delayed hemolytic transfusion reaction, and a patient who left without being seen). Of the people who went to the ED multiple times (3.8% vs 0.5%), 5 returned to the ED for the same reason and all of these patients were from the inpatient group. The reasons for multiple repeat ED visits were sickle cell crisis, chest pain, stroke, and dislocation. Admissions at 30 days (5.0% vs 0.5%; P = .014) and 90 days (7.3% vs 1.0%; P = .018) were also higher in the inpatient group. The most common reasons for an admission within 90 days after surgery were periprosthetic joint infection, gastrointestinal complications, and dislocation (Table 5).

Reoperation-free, revision-free, and infection-free survival

There was a difference in reoperation rate (5.7% vs 1.5%; P = .041) between groups and there was a difference in 2-year reoperation-free survival (94.3% vs 98.5%; P = .022) (Table 5 & Fig. 3). There was no difference in revision rate (3.1% vs 0.5%; P = .871) between groups nor was there a difference in 2-year revision-free survival (96.4% vs 99.5%; P = .059) (Table 5 & Fig. 3). There was no difference in infection rate (3.1% vs 0.5%; P = 1.000) between groups nor was there a difference in 2-year infection-free survival (96.9% vs 99.5%; P = .051) (Table 5 & Fig. 3).

PROMs

Patients in the inpatient group had worse median preoperative, 6-week, 6-month, and 1-year PROMIS PI scores; however, they had similar median improvement at the 1-year time point (−11.0 [−14.0, −4.0] vs −11.0 [−17.2, −5.0]; P = .320). Patients in the inpatient group had worse median preoperative, 6-week, 6-month, and 1-year PROMIS PF scores. They also had less median improvement at the 1-year time point (7.0 [3.0, 11.5] vs 9.0 [5.0, 14.0]; P = .006). Additionally, patients in the inpatient group had worse median preoperative, 6-week, 6-month, and 1-year PROMIS depression scores; however, they had similar median improvement at the 1-year time point (−5.0 [−9.0, 0.0] vs −2.5 [−8.0, 0.0]; P = .171). Patients in the inpatient group had worse median preoperative and 6-month HOOS JR scores; however, 6-week and 1-year HOOS JR scores were similar between groups. They also had similar median improvement at the 1-year time point (−10.0 [−12.0, −5.0] vs −12.0 [−12.0, −10.0]; P = .439) (Table 5).

Discussion

With the expansion of outpatient TJA, the role of hospitals in arthroplasty has been altered as the relative proportion of medically and socially complex patients undergoing surgery at the hospital has increased [10]. In a health system with an ASC, while there are still some patients who choose the hospital for their surgery because of preference, timing, or convenience, many patients who meet criteria for outpatient TJA often undergo surgery at the ASC. This study sought to compare the outcomes of patients who met criteria for outpatient surgery and underwent TJA at an ASC to a cohort of medically and socially complex patients who had surgery at the hospital and truly required inpatient care. The inpatient cohort was created by excluding all patients whose

Table 5
ASC patients versus complex hospital patients: early hospital utilization, reoperation rates, and patient-reported outcome measures in total hip arthroplasty.

Healthcare utilization	Outpatient (n = 196)	Inpatient (n = 262)	*P*	SMD
LOS (mean [SD])	0.0 (0.1)	2.3 (2.4)	**<.001**	1.351
Disposition (n [%])			**<.001**	0.573
Home health service	0 (0.0)	10 (3.8)		
Home or self-care	196 (100.0)	225 (85.9)		
Skilled nursing facility	0 (0.0)	27 (10.3)		
ED visits (30 d)			.340	0.144
0	187 (95.4)	242 (92.4)		
1	9 (4.6)	19 (7.3)		
3	0 (0.0)	1 (0.4)		
ED visits (90 d)			**.035**	0.320
0	187 (95.4)	228 (87.0)		
1	8 (4.1)	24 (9.2)		
2	1 (0.5)	6 (2.3)		
3	0 (0.0)	3 (1.1)		
4	0 (0.0)	1 (0.4)		
Reasons for ED visits (90 d)			**.043**	2.205
Chest pain	3 (20.0)	4 (10.0)		
Dislocation	2 (13.3)	2 (5.0)		
DVT rule out	3 (20.0)	2 (5.0)		
Fall	0 (0.0)	2 (5.0)		
Fever	1 (6.7)	0 (0.0)		
GI complication	2 (13.3)	5 (12.5)		
Hip pain	0 (0.0)	3 (7.5)		
Leg pain	1 (6.7)	0 (0.0)		
Other nonorthopaedic	0 (0.0)	12 (30.0)		
Periprosthetic fracture	0 (0.0)	3 (7.5)		
PJI	0 (0.0)	2 (5.0)		
Pneumonia	1 (6.7)	0 (0.0)		
Pulmonary embolism	1 (6.7)	0 (0.0)		
Stroke	0 (0.0)	1 (2.5)		
Syncope	1 (6.7)	1 (2.5)		
Wound complication	0 (0.0)	3 (7.5)		
Admissions (30 d)			**.014**	0.275
0	195 (99.5)	250 (95.0)		
1	1 (0.5)	13 (5.0)		
Admissions (90 d)			**.018**	0.320
0	194 (99.0)	242 (92.7)		
1	1 (0.5)	12 (4.6)		
2	1 (0.5)	6 (2.3)		
3	0 (0.0)	1 (0.4)		
Reasons for admissions			.362	2.966
Chest pain	0 (0.0)	1 (4.5)		
COVID	0 (0.0)	1 (4.5)		
Dislocation	0 (0.0)	2 (9.1)		
GI complication	0 (0.0)	3 (13.6)		
Leukemia	0 (0.0)	1 (4.5)		
NSTEMI	0 (0.0)	2 (9.1)		
Other cardiovascular complication	0 (0.0)	1 (4.5)		
Periprosthetic fracture	0 (0.0)	2 (9.1)		
PJI	1 (50.0)	5 (22.7)		
Pulmonary embolism	1 (50.0)	0 (0.0)		
Renal complication	0 (0.0)	1 (4.5)		
Sickle cell crisis	0 (0.0)	2 (9.1)		
Wound complication	0 (0.0)	1 (4.5)		
Reoperation rate (n [%])	3 (1.5)	15 (5.7)	**.041**	0.226
Total reoperations (n [%])			.214	0.241
0	193 (98.5)	247 (94.3)		
1	3 (1.5)	11 (4.2)		
2	0 (0.0)	2 (0.8)		
3	0 (0.0)	1 (0.4)		
5	0 (0.0)	1 (0.4)		
Revision rate (n [%])	1 (0.5)	8 (3.1)	.110	0.193
Total revisions (n [%])			.148	0.195
0	195 (99.5)	254 (96.9)		
1	1 (0.5)	7 (2.7)		
2	0 (0.0)	1 (0.4)		

Table 5 (*continued*)

Healthcare utilization	Outpatient (n = 196)	Inpatient (n = 262)	*P*	SMD
Infection rate (n [%])	1 (0.5)	8 (3.1)	.110	0.193
Total infections (n [%])			.262	0.200
0	195 (99.5)	254 (96.9)		
1	1 (0.5)	5 (1.9)		
2	0 (0.0)	2 (0.8)		
3	0 (0.0)	1 (0.4)		
PROMs				
PROMIS PI (median [IQR])				
Preoperation	63.0 [60.0, 67.0]	67.0 [64.0, 72.0]	**<.001**	0.642
6-wk	54.0 [51.0, 56.0]	59.0 [54.0, 63.0]	**<.001**	0.608
6-mo	54.0 [52.0, 60.0]	58.0 [54.0, 64.0]	**.002**	0.401
1-y	53.0 [47.0, 56.0]	58.0 [52.0, 63.0]	**<.001**	0.595
1-y delta	−11.0 [−17.2, −5.0]	−11.0 [−14.0, −4.0]	.320	0.118
PROMIS PF (median [IQR])				
Preoperation	39.0 [35.0, 41.0]	33.0 [29.0, 38.0]	**<.001**	0.825
6-wk	43.0 [39.0, 47.0]	38.0 [33.0, 43.0]	**<.001**	0.684
6-mo	46.0 [39.5, 48.5]	40.0 [34.0, 45.0]	**<.001**	0.654
1-y	48.0 [43.0, 53.0]	41.0 [35.0, 46.0]	**< .001**	0.826
1-y delta	9.0 [5.0, 14.0]	7.0 [3.0, 11.5]	**.006**	0.247
PROMIS depression (median [IQR])				
Preoperation	49.0 [42.0, 53.0]	52.5 [46.0, 58.0]	**<.001**	0.463
6-wk	44.0 [34.0, 48.0]	46.0 [34.0, 51.0]	**.037**	0.252
6-mo	46.0 [34.0, 51.0]	48.0 [39.0, 53.0]	**.042**	0.368
1-y	46.0 [34.0, 50.0]	47.0 [39.0, 52.0]	**.025**	0.359
1-y delta	−2.5 [−8.0, 0.0]	−5.0 [−9.0, 0.0]	.171	0.150
HOOS JR (median [IQR])				
Preoperation	12.0 [10.0, 15.0]	14.0 [11.0, 17.0]	**.002**	0.358
6-wk	8.5 [6.8, 10.2]	10.0 [10.0, 13.0]	.340	0.755
6-mo	2.0 [1.5, 4.0]	5.0 [3.0, 7.0]	**.003**	0.459
1-y	3.5 [1.0, 6.2]	5.0 [2.2, 12.0]	.117	0.667
1-y delta	−12.0 [−12.0, −10.0]	−10.0 [−12.0, −5.0]	.439	0.251

DVT, deep vein thrombosis; ED, emergency department; GI, gastrointestinal; HOOS JR, hip disability and osteoarthritis outcome scores for joint replacement; IQR, interquartile range; LOS, length of stay; NSTEMI, non-ST-segment elevation myocardial infarction; PF, physical function; PI, pain interference; PJI, periprosthetic joint infection; PROMs, patient-reported outcome measures; PROMIS, patient-reported outcome measures information system; SD, standard deviation.
ASC patients vs complex hospital patients: early hospital utilization, reoperation rates, and patient-reported outcome measures in total knee arthroplasty. $P < .05$ = bold.

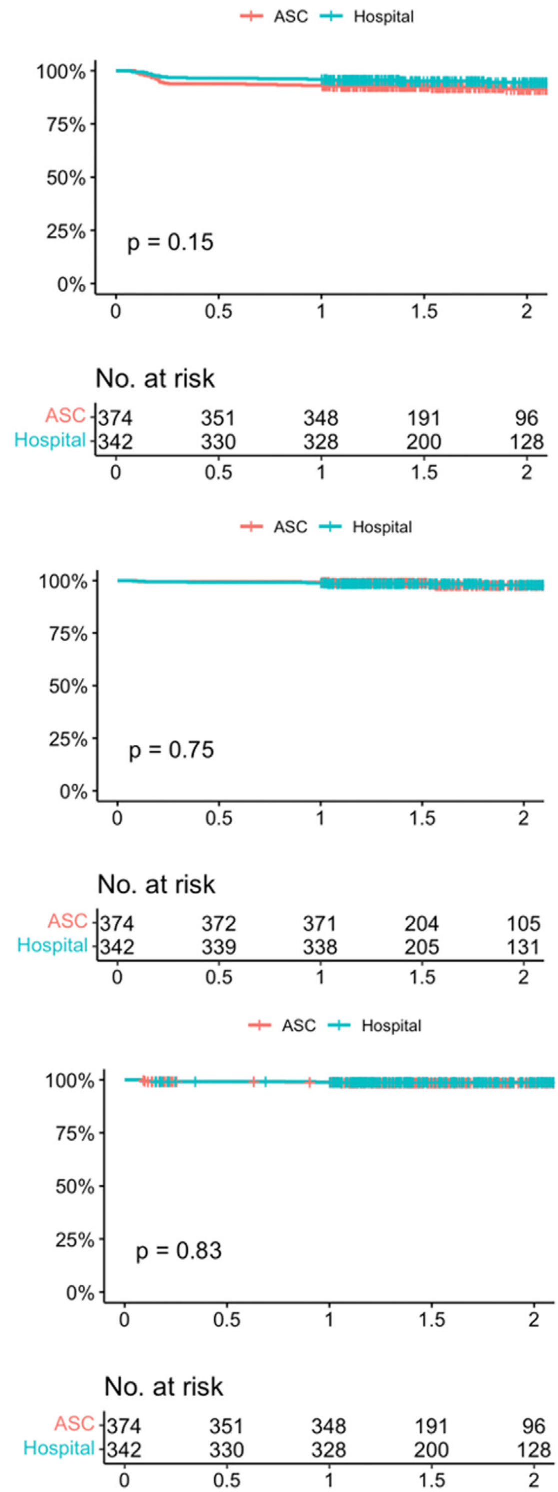

Figure 2. Two-year survivorship in total knee arthroplasty ambulatory surgery center patients versus inpatients: (top) reoperation-free survival; (middle) revision-free survival; (bottom) infection-free survival.

surgery was done at the hospital that were matched to the outpatient cohort using propensity score matching. After the exclusion of matched patients and any patients who underwent SDD TJA at the hospital, the final inpatient TKA and THA cohorts were shown to be significantly more medically and socially complex than the outpatient cohort.

As hypothesized, results of this study showed that the inpatient cohort that required hospital services secondary to increased medical and social complexity had greater 90-day postoperative ED visits and admissions after TJA when compared to an outpatient cohort. However, as expected, the reoperation-free, revision-free, and infection-free survival at 2 years was similar between groups. While similar survivorship suggests comparable surgery success, generic and joint-specific PROMs tended to be worse in the inpatient cohort.

The proportion of patients undergoing outpatient TJA is increasing with SDD TKA going from 1.2% in 2016 to 62.4% in 2020 and SDD THA going from 2.0% to 54.5% over the same period [2,29]. In the present study over the collection period from August 2021 to

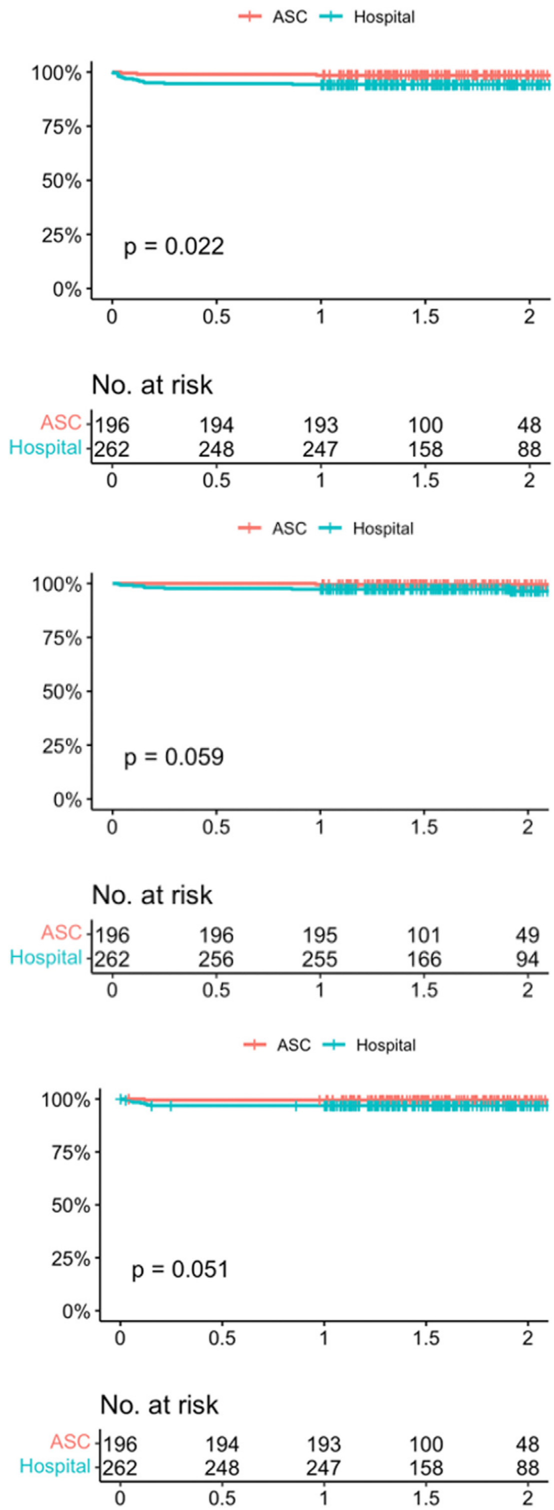

Figure 3. Two-year survivorship in total hip arthroplasty ambulatory surgery center patients versus inpatients: (top) reoperation-free survival; (middle) revision-free survival; (bottom) infection-free survival.

January 2024, 30.9% of TKAs were done at the ASC as well as 27.2% of THAs. The outpatient TJA trend was started during the COVID-19 pandemic and has persisted as outpatient TJA has been shown to decrease costs while maintaining safety and not compromising outcomes [29]. However, since TJA was removed from the CMS inpatient only list, studies have shown that hospitals are getting $3157 less for outpatient TKA and $1637 less for outpatient THA, although facility costs savings are only $972 and $825, respectively [11,12,29]. Consequently, prospective payment appears to be inappropriate in the outpatient arthroplasty setting [11,12,30-32].

As this trend continues, it is important to recognize how both the relative proportion of medically and socially complex patients undergoing arthroplasty in the hospital is increasing and how this can impact reimbursement [10,33-35]. Studies have shown that increased medical comorbidities and social difficulties can increase the risk of complication in the 90-day postoperative period [18,35,36]. These findings are supported in the present study, as the inpatient group tended to have a higher rate of ED visits and admissions during the 90-day postoperative period. However, this study also found that these same patients still had comparable 2-year reoperation-free, revision-free, and infection-free survival to those undergoing outpatient arthroplasty at an ASC. Consequently, hospitals still serve a vital role within arthroplasty for these medically and socially complex patients who require higher levels of healthcare utilization to achieve a good outcome. It is also important to consider what system-based practices can be implemented to minimize these higher levels of healthcare utilization. However, as outpatient arthroplasty continues to increase and CMS continues to progress toward site-neutral prospective payment, hospital reimbursement to care for these complex patients may be negatively impacted.

Comprehensive Care for Joint Replacement, the prospective payment model set forth by CMS, employs risk adjustment for reimbursement based on patient comorbidities and age to prevent financial disincentives for treating high-risk patients [15,16]. This is accomplished through the CMS-Hierarchical Condition Category model which categorizes associated diagnoses based on clinical significance and expected costs in conjunction with patient age. However, this model is capped at CMS-Hierarchical Condition Category count of 4 and it does not account for social factors [15]. ASA classification and comorbidity indices such as ECI and Charlson comorbidity index have been used extensively in the literature and have been shown to be associated with patient outcomes after TJA [18,37-40]. Similarly, indices measuring social deprivation such as ADI and SVI have been shown to be associated with outcomes after TJA. These metrics may be critical for appropriate risk adjustment in TJA to ensure reimbursement remains appropriate and not alter incentives for providers and provider systems [23,41-43].

With the initiation of the THA/TKA patient-reported outcomes-based performance measure, similar concerns arise regarding risk adjustment when grading PROMs. As demonstrated in the present study, medically and socially complex patients do not tend to achieve equivalent improvement in PROMs to healthier patients eligible for outpatient TJA. Given that hospitals are going to be graded based on PROMs, risk adjustment is also critical here [16]. Although up to 3 risk factors such as age, pain in other extremities, BMI, narcotics, race, ethnicity, depression, health literacy, and back pain can be reported as adjusters, generic PROMs are not being collected as quality metrics and patient comorbidities, and patient social vulnerability are not being accounted for in risk adjustment. In the movement toward patient-centered and value-based care, prospective payment and quality standard models should include generic PROMs and account for patient comorbidities and social circumstances as these significantly impact patients, providers, and healthcare systems.

There are several potential limitations to this study. Given that this is a retrospective study, patients were not preoperatively classified as either strictly outpatient or strictly inpatient secondary to medical or social need thus to retrospectively identify these patients without bias propensity score matching based on comorbidities and social metrics was used to exclude patients in the inpatient group who were similar to the outpatient group. Wide calipers of 1.0 were used to ensure there was at least 1 inpatient match for each outpatient control. Furthermore, the retrospective nature of this study prevents conclusions regarding causation particularly considering that system-based practices varied between surgery sites and surgeons which can also impact these outcomes. PROM reporting rates are denoted at the bottom of Tables 4 and 5. Finally, follow-up time is limited to 2 years for survivorship as the health system ASC was opened in August 2021.

Conclusions

Medically and socially complex patients undergoing TJA required additional resources during the 90-day postoperative window; however, they achieved similar survivorship as patients that met criteria for outpatient surgery. These results highlight the important role tertiary centers serve in TJA. Furthermore, it demonstrates that risk adjustment is critical for appropriate reimbursement after TJA requiring an inpatient stay as well as for setting appropriate PROM standards.

Conflicts of interest

Michael P. Bolognesi received royalties from Smith & Nephew, Total Joint Orthopaedics, and Zimmer; is an unpaid consultant for Amedica; holds stock or stock options in Amedica and Total Joint Orthopaedics; received research support from Biomet, Exactech, Inc., KCI, Zimmer, and DePuy as a Principal Investigator; received other financial or material support from Acelity and AOA Omega; is in the medical/orthopaedic publications editorial/governing board of Journal of Arthroplasty and Arthroplasty Today; and is a board member of AAHKS, EOA, and AAOS. William Jiranek received royalties from DePuy, A Johnson & Johnson Company; holds stock or stock options in Biomech Holdings, LLC and Parvizi Surgical Innovation; and is a board member in the American Association of Hip and Knee Surgeons and Hip Society. Sean P. Ryan is a paid consultant for Zimmer; received research support from Zimmer and Smith & Nephew as a Principal Investigator. Thorsten Seyler received royalties from Total Joint Orthopedics, Inc., Pattern Health, and Restor3d; is a paid consultant for Smith and Nephew, Total Joint Orthopedics, Inc., and Heraeus; received research support from Next Science and Zimmer as a Principal Investigator; received royalties, financial or material support from Lippincott Williams and Wilkins; and is a board member in the American Association of Hip and Knee Surgeons and Musculoskeletal Infection Society. Samuel Wellman received speakers bureau/paid presentations for TJO and Zimmer; is a paid consultant for Smith & Nephew and TJO; holds stock or stock options in Joint Development, LLC; received research support from Biomet, DePuy, A Johnson & Johnson Company, Medacta, Smith & Nephew, Stryker, and Zimmer as a Principal Investigator; received royalties, financial or material support from TJO; is in the medical/orthopaedic publications editorial/governing board of Journal of Arthroplasty; and is a board member of the American Association of Hip and Knee Surgeons. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2025.101631.

Ethics approval

This study received ethical approval from the Institutional Review Board at Duke University (Pro#00115126).

CRediT authorship contribution statement

Justin Leal: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Christine J. Wu:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Niall H. Cochrane:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Thorsten M. Seyler:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **William A. Jiranek:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Samuel S. Wellman:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Michael P. Bolognesi:** Writing – review & editing, Supervision, Investigation, Conceptualization. **Sean P. Ryan:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

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