The Journal of Arthroplasty xxx (2018) 1–7

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Inpatient Versus Outpatient Arthroplasty: A Single-Surgeon, Matched Cohort Analysis of 90-Day Complications

Brian Darrith, MD [a], Nicholas B. Frisch, MD, MBA [b], Matthew W. Tetreault, MD [a], Michael P. Fice, MD [a], Chris N. Culvern, MS [a], Craig J. Della Valle, MD [a, *]

[a] Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL
[b] Ascension Crittenton Hospital, Rochester, MI

ARTICLE INFO

Article history:
Received 15 June 2018
Received in revised form
9 October 2018
Accepted 10 October 2018
Available online xxx

Keywords:
outpatient hip arthroplasty
outpatient knee arthroplasty
complications
outpatient hip resurfacing
outpatient unicondylar knee replacement

ABSTRACT

Background: Although some prior work supports the safety of same-day arthroplasty performed in a hospital, concerns remain when these procedures are performed in a free-standing ambulatory surgery center. The purpose of this study is to compare 90-day complication rates between matched cohorts that underwent inpatient vs outpatient arthroplasty at an ambulatory surgery center.
Methods: A single-surgeon cohort of 243 consecutive patients who underwent outpatient arthroplasty was matched with 243 inpatients who had the same procedure. One-to-one nearest-neighbor matching with respect to gender, age, American Society of Anesthesiologists Score, and body mass index was utilized. The 486 primary arthroplasties included 178 unicondylar knees (36.6%), 146 total hips (30.0%), 92 total knees (18.9%), and 70 hip resurfacings (14.5%). Ninety-day outcomes including reoperation, readmission, unplanned clinic or emergency department visits, and major and minor complications were compared using a 2-sample proportions test.
Results: The 2 cohorts were similar in distribution of demographic variables, demonstrating successful matching. The inpatient and outpatient cohorts both had readmission rates of 2.1% ($P = 1.0$). With the number of subjects studied, there were no statistically significant differences in rates of major complications (2.1% vs 2.5%, $P = 1.0$), minor complications (7.0% vs 7.8%, $P = .86$), reoperations (0.4% vs 2.1%, $P = .22$), emergency department visits (1.6% vs 2.5%, $P = .52$), or unplanned clinic visits (3.3% vs 5.8%, $P = .19$).
Conclusion: This study suggests that arthroplasty procedures can be performed safely in an ambulatory surgery center among appropriately selected patients without an increased risk of complications.

As surgical and anesthetic techniques become more advanced, the primary joint arthroplasty patient's typical postoperative length of stay has decreased substantially. Previously, a week-long stay was not atypical [1], yet now patients often spend no more than 2 nights in the hospital with same-day discharge becoming increasingly more common [2,3]. Some authors have raised concerns that discharging patients too soon increases the risk for postoperative complications and readmission [2,4,5]. Others provide evidence for the safety and effectiveness of same-day discharge protocols for a variety of arthroplasty procedures—including total hip arthroplasty (THA), total knee arthroplasty (TKA), and unicondylar knee arthroplasty (UKA) [3,6–9]. Some have gone even further by saying that outpatient arthroplasty reduces complication risk or provides psychological benefits for patients [10,11].

Joint replacement is the single most expensive procedure covered by Medicare, costing a total of 6.6 billion for Medicare beneficiaries in 2013 alone [12], and the annual volume of joint replacement surgery is projected to increase [2,13]. It is reasonable that the Center for Medicare Services is considering a proposal to

All authors contributed to the literature review, writing, and editing of each section of this manuscript. Drs Darrith, Tetreault, and Fice collected the data and Culvern performed the statistical analysis.

The study was approved by the Rush Institutional Review Board.

Study Conducted at Rush University Medical Center, Chicago, IL.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to https://doi.org/10.1016/j.arth.2018.10.015.

* Reprint requests: Craig J. Della Valle, MD, Department of Orthopaedic Surgery, Rush University Medical Center, 1611 W. Harrison St, Suite 300, Chicago, IL 60612.

https://doi.org/10.1016/j.arth.2018.10.015
0883-5403/

Table 1
Patient Demographics of the Matched Cohorts.

Variable	All Patients (n = 486)		Inpatients (n = 243)		Outpatients (n = 243)		*P*-Values
	Mean	SD	Mean	SD	Mean	SD	
BMI	30.6	5.6	30.4	5.5	30.8	5.6	.47
Age	55.3	8.5	55.6	8.4	55.0	8.6	.50
	Number	%	Number	%	Number	%	
Female	182	37.4%	93	38.3%	89	37%	.78
ASA							
1	65	13.4%	32	13%	33	14%	1.0
2	342	70.4%	172	71%	170	70%	1.0
3	79	16.3%	39	16%	40	16%	1.0
Procedure							
UKA	178	36.6%	89	37%	89	37%	1.0
THA	146	30.0%	73	30%	73	30%	1.0
TKA	92	18.9%	46	19%	46	19%	1.0
Hip resurfacing	70	14.5%	35	14%	35	14%	1.0

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists score; UKA, unicondylar knee arthroplasty; THA, total hip arthroplasty; TKA, total knee arthroplasty.

allow Medicare reimbursement for outpatient TKA [14]. Given the emphasis that the contemporary healthcare system places on patient outcomes, especially postoperative complications, any perioperative protocol with the potential to improve outcomes or decrease costs without increasing the risk for major complications deserves further investigation. However, the current literature regarding outpatient arthroplasty is dominated by retrospective case series or comparative studies with less than 100 patients per cohort [6–9,11], which are underpowered to detect differences in relatively uncommon outcomes such as readmission and reoperation. There are large database studies which are well-powered yet come with inherent limitations such as no more than 30-day follow-up and the lack of orthopedic-specific postoperative outcomes [5,10,15]. The purpose of this study is to evaluate matched cohorts of patients who underwent UKA, THA, TKA, and hip resurfacing, comparing those who stayed at least 1 night in the hospital vs those who underwent outpatient surgery at an ambulatory surgery center.

Methods

Between January 1, 2013 and June 30, 2016, 1875 primary arthroplasties (UKA, THA, TKA, and hip resurfacings) were performed by the senior investigator. Of these, 243 (13.0%) were performed at an ambulatory surgical center. During this time period, patients signing up for primary arthroplasty procedures were routinely offered the option of having outpatient or inpatient surgery if the patient was considered to be of appropriate medical health for surgery at the ambulatory surgery center by the surgeon and anesthesiologist on staff at the surgery center. Although there was not a specific body mass index (BMI) or age cutoff for patients to be offered outpatient surgery, in general patients were

Table 2
Ninety-Day Outcomes for All Arthroplasty Types.

Outcomes	Inpatient (n = 243)			Outpatient (n = 243)			*P*-Value
	n	%	95% CI	n	%	95% CI	
Readmissions	5	2.1%	0.3-3.90	5	2.1%	0.3-3.9	1.0
Readmission, nonoperative	4	1.6%	0-3.2	2	0.8%	0-1.9	.69
Readmission, operative	1	0.4%	0.1-1.2	3	1.2%	0-2.6	.62
Reoperations	1	0.4%	0-1.2	5	2.1%	0.3-3.9	.22
Any complication	22	9.1%	5.5-12.7	25	10.0%	6.5-14.0	.76
Any major complication	5	2.1%	0.3-3.9	6	2.5%	0.5-4.5	1.0
MUA[a] (knees)	3	1.2%	0-2.6	0	0.0%	0-0	.25
Instability[a] (hips)	1	0.4%	0-1.2	3	1.2%	0-2.6	.62
Superficial SSI	1	0.4%	0-1.2	1	0.4%	0-1.2	1.0
Peripheral nerve injury	0	0.0%	0-0	1	0.4%	0-1.2	1.0
Ileus	0	0.0%	0-0	1	0.4%	0-1.2	1.0
Any minor complication	17	7.0%	3.8-10.2	19	7.8%	4.4-11.2	.86
Peri-incisional erythema	7	2.9%	0.8-5.0	5	2.1%	0.3-3.9	.77
Urinary tract infection	1	0.4%	0-1.2	2	0.8%	0-1.9	1.0
Pneumonia	0	0.0%	0-0	1	0.4%	0-1.2	1.0
Periprosthetic fracture (nonoperative)	0	0.0%	0-0	1	0.4%	0-1.2	1.0
Urinary retention	0	0.0%	0-0	1	0.4%	0-1.2	1.0
Distal deep vein thrombosis	0	0.0%	0-0	2	0.8%	0-1.9	.5
Rash	3	1.2%	0-2.6	3	1.2%	0-2.6	1.0
Superficial hematoma	1	0.4%	0-1.2	1	0.4%	0-1.2	1.0
Blood transfusion	1	0.4%	0-1.2	0	0.0%	0-0	1.0
Superficial SSI (nonoperative)	2	0.8%	0-1.9	1	0.4%	0-1.2	1.0
Miscellaneous	2	0.8%	0-1.9	2	0.8%	0-1.9	1.0
Emergency department visit	4	1.6%	0-3.2	6	2.5%	0.5-4.5	.52
Unplanned clinic visit	8	3.3%	1.0-5.0	14	5.8%	4.3-7.3	.19

CI, confidence interval; MUA, manipulation under anesthesia; SSI, surgical site infection.
[a] All percentages are out of 243 patients per group, except for MUA (knees only, 135 per group) and hip instability (108 per group).

Table 3
Ninety-Day Outcomes for Unicondylar Knee Arthroplasty.

Outcomes	Inpatient (n = 89)		Outpatient (n = 89)		*P*-Value
	Number	Percent	Number	Percent	
Readmissions	2	2.3%	2	2.3%	1.0
Readmission, nonoperative	2	2.3%	1	1.1%	1.0
Readmission, operative	0	0.0%	1	1.1%	1.0
Reoperations	0	0.0%	1	1.1%	1.0
Any complication	10	11.2%	12	13.5%	.82
Any major complication	1	1.1%	1	1.1%	1.0
MUA	1	1.1%	0	0.0%	1.0
Superficial SSI	0	0.0%	1	1.1%	1.0
Any minor complication	9	10.1%	11	12.4%	.81
Peri-incisional erythema	5	5.6%	2	2.2%	.44
Superficial SSI, nonoperative	1	1.1%	1	1.1%	1.0
Periprosthetic fracture, nonoperative	0	0.0%	1	1.1%	1.0
Urinary retention	0	0.0%	1	1.1%	1.0
Distal DVT	0	0.0%	1	1.1%	1.0
Urinary tract infection	0	0.0%	1	1.1%	1.0
Pneumonia	0	0.0%	1	1.1%	1.0
Rash	2	2.3%	2	2.3%	1.0
Miscellaneous[a]	1	1.1%	1	1.1%	1.0
Emergency department visit	3	3.4%	3	3.4%	1.0
Unplanned clinic visit	5	5.6%	9	10.1%	.40

MUA, manipulation under anesthesia; DVT, deep venous thrombosis; SSI, surgical site infection.
[a] See Table 7 for more details.

physiologically younger, without medical comorbidities that required an inpatient admission (such as chronic anticoagulation) and had an adequate support system to assist them in post-operative care. Because the inpatient facility and the ambulatory surgery center are 50 miles apart from each other, the logistical convenience associated with one facility vs the other was typically the primary motivation for a patient's decision. Furthermore, patients with complex orthopedic problems, such as requiring extensive removal of hardware, were not offered surgery at the outpatient facility. The ambulatory surgery center is a strictly outpatient facility and is "freestanding" in so far as it is neither on the campus nor affiliated with an inpatient hospital.

Each of these 243 consecutive outpatient cases [16] were matched with inpatients using one-to-one nearest-neighbor matching, based on the following criteria: surgical procedure, gender, American Society of Anesthesiologists Score (ASA), age, and BMI. Due to the relatively large number of inpatients available, matched pairs were very similar with 66% having exact gender, ASA, and within 1 year of age and 1 unit of BMI. The 243 inpatient preoperative radiographs were screened for orthopedic complexity that would have precluded performing the procedure at the ambulatory surgery center as described above, resulting in the exclusion of 2 of the 243 inpatients. The 2 associated outpatients were then rematched with 2 new inpatients who met the above inclusion criteria. This resulted in the inclusion of 243 outpatients and 243 inpatients, while dropping 1389 inpatients via the matching process. These 486 primary arthroplasties included 178 UKAs (36.6%), 146 THAs (30.0%), 92 TKAs (18.9%), and 70 hip resurfacings (14.5%). There were no significant differences in terms of gender, ASA, mean age, or mean BMI between the groups suggesting appropriate matching (Table 1). The mean length of hospitalization for the inpatients was 1.9 days (range 1.0-7.4).

The 90-day outcomes recorded for each patient included reoperation, readmission, unplanned clinic or emergency department (ED) visits, major complications (including death, myocardial infarction, stroke, thromboembolic events, acute renal failure, peripheral nerve injury, and surgical site infection [SSI]), and minor complications (blood transfusion, superficial hematoma, SSI treated nonsurgically, urinary tract infection, urinary retention, pneumonia,

Table 4
Ninety-Day Outcomes for Total Hip Arthroplasty.

Outcomes	Inpatient (n = 73)		Outpatient (n = 73)		*P*-Value
	Number	Percent	Number	Percent	
Readmissions	2	2.7%	3	4.1%	1.0
Readmission, nonoperative	1	1.4%	1	1.4%	1.0
Readmission, operative	1	1.4%	2	2.7%	1.0
Reoperations	1	1.4%	3	4.1%	.62
Any complication	5	6.9%	6	8.2%	1.0
Any major complication	2	2.7%	4	5.5%	.68
Instability	1	1.4%	3	4.1%	.62
Superficial SSI	1	1.4%	0	0.0%	1.0
Ileus	0	0.0%	1	1.4%	1.0
Any minor complication	3	4.1%	2	2.7%	1.0
Urinary tract infection	1	1.4%	0	0.0%	1.0
Rash	1	1.4%	1	1.4%	1.0
Miscellaneous	1	1.4%	1	1.4%	1.0
Emergency department visit	1	1.4%	3	4.1%	.62
Unplanned clinic visit	1	1.4%	1	1.4%	1.0

SSI, surgical site infection.

Table 5
Ninety-Day Outcomes for Total Knee Arthroplasty.

Outcomes	Inpatient (n = 46)		Outpatient (n = 46)		*P*-Value
	Number	Percent	Number	Percent	
Readmissions	0	0.0%	0	0.0%	N/A
Reoperations	0	0.0%	0	0.0%	N/A
Any complication	5	10.9%	5	10.9%	1.0
Any major complication	2	4.3%	0	0.0%	.50
MUA	2	4.3%	0	0.0%	.49
Any minor complication	3	6.5%	5	10.9%	.71
Peri-incisional erythema	2	4.3%	3	6.5%	1.0
Urinary tract infection	0	0.0%	1	2.2%	1.0
Distal DVT	0	0.0%	1	2.2%	1.0
Blood transfusion	1	2.2%	0	0.0%	1.0
Emergency department visit	0	0.0%	0	0.0%	N/A
Unplanned clinic visit	1	2.2%	3	6.5%	.62

N/A, not applicable; MUA, manipulation under anesthesia; DVT, deep venous thrombosis.

Table 6
Ninety-Day Outcomes for Hip Resurfacings.

Outcomes	Inpatient (n = 35)		Outpatient (n = 35)		*P*-Value
	Number	Percent	Number	Percent	
Readmissions	1	2.9%	0	0.0%	1.0
Readmission, nonoperative	1	2.9%	0	0.0%	1.0
Readmission, operative	0	0.0%	0	0.0%	N/A
Reoperations	0	0.0%	1	2.9%	1.0
Any complication	2	5.7%	2	5.7%	1.0
Any major complication	0	0.0%	1	2.9%	1.0
Peripheral nerve injury	0	0.0%	1	2.9%	1.0
Any minor complication	2	5.7%	1	2.9%	1.0
Delayed wound healing	1	2.9%	1	2.9%	1.0
Superficial SSI, nonoperative	1	2.9%	0	0.0%	1.0
Superficial hematoma	1	2.9%	1	2.9%	1.0
Emergency department visit	0	0.0%	0	0.0%	N/A
Unplanned clinic visit	1	2.9%	1	2.9%	1.0

N/A, not applicable; SSI, surgical site infection.

peri-incisional erythema, rash, and distal deep vein thrombosis below the knee). Each patient was available for 90-day follow-up.

Statistical Methods

All data were collected from the patients' medical records, and statistical analyses were conducted using Stata version 14.2 (StataCorp, LP, College Station, TX). After the outpatient cohort was matched with an equivalent number of inpatients for each of the 4 procedures, a Fisher's exact test was used to compare the 2 cohorts in terms of gender, t-test for age and BMI, and analysis of variance for ASA. Due to the closely matched cohorts and the relatively small incidence of study outcomes, differences between the inpatient and outpatient groups were compared using a Fisher's exact test. Post hoc power analysis revealed that 211 patients per group, 422 total patients, would detect a difference of 5% in the rate of complications between groups.

Results

Within the initial 90 days following surgery, the rates of postoperative complications between the inpatient and outpatient groups (9.1% vs 10.3%, $P = .76$), reoperations (0.4% vs 2.1%, $P = .22$), and readmissions (2.1% vs 2.1%, $P = 1.0$) were not significantly different with the sample size available for study (Table 2). When the 2 cohorts were stratified according to the procedure, there were no significant differences in any outcomes between the inpatient and outpatient groups (Tables 3-6). All the outpatients were discharged to home within 23 hours of surgery without any inpatient admissions; only 3 of them required an overnight stay at the ambulatory surgery center including 1 for pain control, 1 for nausea, and 1 based solely on patient preference to stay overnight.

The overall rates of major complication were 2.1% (n = 5) and 2.5% (n = 6) for the inpatient and outpatient groups, respectively ($P = 1.0$; Table 2). The most common major complication was hip instability (n = 4), and 3 of the 4 cases were treated with head and liner exchanges while the fourth was treated successfully nonoperatively. The 3 cases of arthrofibrosis requiring manipulation under anesthesia all occurred in the inpatient group, 2 after TKA and 1 after UKA. In each group, there was one case of superficial SSI that required superficial irrigation and debridement. The other 3 cases of superficial SSI were considered minor complications as they did not require surgical intervention. There were no deep infections in either group. Two of the 5 reoperations in the outpatient group occurred at the ambulatory surgery center on the day of surgery, including surgical exploration of the sciatic nerve for peroneal nerve palsy and a head and liner exchange for subluxation of THA identified in the recovery room.

The rate of minor complications was 7.0% (n = 17) for the inpatient and 7.8% (n = 19) for the outpatient cohort, respectively ($P = .86$). Peri-incisional erythema accounted for 33% (n = 12) of all minor complications. Other minor complications seen in both cohorts include urinary tract infection, rash (dermatitis secondary to surgical dressings), superficial hematoma, and superficial SSI treated with oral antibiotics alone (Tables 2 and 7).

Readmission rates were 2.1% (n = 5) for each cohort. This included 4 surgical readmissions, 3 patients with a superficial SSI treated nonoperatively, 1 THA dislocation treated nonoperatively, 1 readmission in the outpatient group for postoperative ileus and urinary retention, and 1 readmission in the inpatient group for concern of cellulitis in the operative lower leg, which was subsequently diagnosed as contact dermatitis and resolved without antibiotic treatment (Table 7). The outpatient group had nearly twice as many unplanned clinic visits (5.8% vs 3.3%), but this difference was not statistically significant with the sample size available for study. The incidence of ED visits was similar between groups (2.5% for outpatients vs 1.6% for inpatients, $P = .52$; Table 2).

Discussion

As outpatient arthroplasty procedures become more common, it is critical to ensure that patient safety is not compromised. Furthermore, if surgery performed at an outpatient center is to be cost-effective, then the risk of readmissions and complications must be similar. We carefully compared the outcomes of patients undergoing inpatient and outpatient procedures performed at an ambulatory surgery center and found that the risk of 90-day complications, readmissions, and reoperations was similar and lower than many historical cohorts of inpatient procedures with the sample size available for study [7,17–20].

Instability after THA and arthrofibrosis after knee replacement were the most common major complications identified, with an incidence for each that is comparable to previous publications with rates of early instability after THA ranging from 2.1% to 3.9% [21–23] and a 3.8% 90-day rate of arthrofibrosis requiring manipulation after TKA [24]. Because previous publications that utilize databases to evaluate outpatient arthroplasty do not contain orthopedic-specific complications such as instability and arthrofibrosis, we are unable to compare our results with these studies. Smaller case series of outpatient arthroplasty report rates of early

Table 7
List of all Complications, Reoperations, and Readmissions.

Study ID	Procedure	Male/Female	Age (y)	Readmission	Reoperation	Complication
Inpatient major complication (n = 5)						
In1	TKA	M	48	No	No	Manipulation under anesthesia at 5 wk
In2	UKA	F	55	No	No	Manipulation under anesthesia at 8 wk
In3	TKA	M	57	No	No	Manipulation under anesthesia at 6 wk
In4	THA	F	53	Yes	Yes	Superficial SSI, required superficial irrigation and debridement
In5	THA	M	56	Yes	No	Dislocation and closed reduction, readmitted, treated nonoperatively
Inpatient minor complications (n = 17)						
In6	HR	M	54	Yes	No	Superficial SSI, admitted for IV antibiotics
In7	UKA	F	66	Yes	No	Rash secondary to contact dermatitis
In8	UKA	M	65	Yes	No	Superficial SSI, treated with IV antibiotics
In9	TKA	M	57	No	No	Peri-incisional erythema, treated with oral antibiotics
In10	TKA	F	48	No	No	Peri-incisional erythema (suture abscess)
In11	UKA	F	73	No	No	Rash
In12	UKA	F	69	No	No	Peri-incisional erythema, treated with oral antibiotics
In13	UKA	M	60	No	No	Peri-incisional erythema, treated with oral antibiotics
In14	HR	M	61	No	No	Superficial hematoma
In15	UKA	F	61	No	No	Peri-incisional erythema, treated with oral antibiotics
In16	UKA	M	64	No	No	Partial plantaris tendon tear, nonoperative
In17	THA	M	65	No	No	Rash
In18	TKA	M	61	No	No	Blood transfusion, postoperative day 4
In19	THA	M	54	No	No	Urinary tract infection at 5 wk; groin numbness from positioner
In20	UKA	F	64	No	No	Peri-incisional erythema
In21	THA	M	56	No	No	Partial wound dehiscence treated nonoperatively
In22	UKA	F	29	No	No	Peri-incisional erythema, treated with oral antibiotics
Outpatient major complications (n = 6)						
Out1	THA	M	47	Yes	Yes	Dislocation treated with head and liner exchange
Out2	HR	M	55	No	Yes	Foot drop in PACU, immediate surgical exploration of sciatic nerve
Out3	THA	F	59	Yes	Yes	Dislocation treated with head and liner exchange
Out4	THA	F	47	No	Yes	Subluxation in PACU; head and liner exchange
Out5	UKA	M	64	Yes	Yes	Superficial SSI, treated with superficial irrigation and debridement
Out6	THA	F	66	Yes	No	Readmitted for postoperative ileus and urinary retention
Outpatient minor complications (n = 19)						
Out7	UKA	F	61	Yes	No	Superficial SSI, admitted for IV antibiotics
Out8	UKA	M	68	No	No	Nondisplaced tibial plateau fracture, nonoperative
Out9	TKA	M	61	No	No	Worsening of chronic partial DVT of popliteal vein
Out10	UKA	M	67	No	No	Postoperative urinary retention
Out11	UKA	F	64	No	No	Distal DVT
Out12	UKA	M	52	No	No	Rash
Out13	TKA	M	60	No	No	Peri-incisional erythema, treated with oral antibiotics
Out14	THA	F	54	No	No	Rash
Out15	THA	M	53	No	No	Groin numbness from positioner
Out16	UKA	F	59	No	No	Urinary tract infection at 6 wk
Out17	TKA	F	61	No	No	Urinary tract infection at 8 wk
Out18	UKA	F	46	No	No	Peri-incisional erythema, treated with oral antibiotics
Out19	TKA	F	50	No	No	Peri-incisional erythema, treated with oral antibiotics
Out20	UKA	F	68	No	No	Pneumonia at 1 wk, urinary tract infection at 8 wk
Out21	UKA	F	48	No	No	Postoperative fall with distal radius fracture requiring ORIF at 2 wk postoperative
Out22	HR	M	42	No	No	Superficial hematoma
Out23	UKA	M	38	No	No	Rash
Out24	UKA	F	62	No	No	Peri-incisional erythema treated with oral antibiotics
Out25	TKA	M	52	No	No	Peri-incisional erythema, treated with oral antibiotics

M, male; F, female; TKA, total knee arthroplasty; UKA, unicondylar knee arthroplasty; THA, total hip arthroplasty; HR, hip resurfacing; SSI, surgical site infection; IV, intravenous; PACU, postanesthesia care unit; DVT, deep vein thrombosis; ORIF, open reduction internal fixation.

dislocation after THA ranging from 0% to 2.0% and rates of knee manipulation for arthrofibrosis ranging from 0% to 5.7% at 90 days [25]. Interestingly, there were no deep infections in either group, but the incidence of superficial SSI, at 1.0% overall, is consistent with previously published reports [10].

In contrast to the current study, Lovecchio et al [5] concluded that outpatients have higher complication rates after TKA and THA, and they attributed this difference to the 4.1% incidence of blood transfusion occurring after the day of surgery in the outpatient cohort. However, this database analysis did not discuss the blood

management strategies utilized in either cohort. In the current study, the one patient requiring a blood transfusion was in the inpatient group and had a history of chronic renal failure with preoperative hemoglobin of 9.0 g/dL. The low prevalence of transfusion in our study is likely related to the routine administration of tranexamic acid prior to surgery.

The incidence of unplanned clinic visits was nearly doubled in the outpatient cohort, yet this difference did not reach statistical significance with our sample size. Although the perception may be that outpatient surgery decreases surgeon workload, in our experience performing outpatient surgery greatly increases the need for physician and physician extender contact with the patient. In our practice, we call patients frequently in the early postoperative period and the threshold to have patients come into the office for evaluation is low, evidenced by the higher rate of unplanned clinic visits. Hence, surgeons considering performing outpatient procedures should anticipate this increase in workload. Importantly, the risk of visit to an ED was only slightly higher in the outpatient group, suggesting that the increased attention paid to these patients did not lead to an increase in healthcare expenditures.

Similarly, the readmission rate for the 2 groups of patients was identical, at just over 2%. Given the high cost of readmissions, this is an important metric to consider when evaluating surgical procedures performed at an ambulatory surgery center. The readmission rates of this current study compare favorably to those reported previously. A single-institution series of 1781 THAs reported 139 readmissions (8.9%) in the 90 days following surgery, with the 3 leading causes of readmission being THA infection, dislocation, and wound complication [17]. Another study of inpatient THAs reports a 90-day readmission rate of 4.7% (11/232), with only 1 of the 11 readmissions occurring after postoperative day 30 [18]. A single-surgeon series of outpatient THAs performed at an ambulatory surgery center reported a 2% hospital admission rate (3/145) in the 90 days following surgery, which is similar to our own rate of readmission [19]. Large database studies of primary arthroplasty patients report similar readmission rates at 30-day follow-up: 2.0%-3.0% for inpatients and 1.4%-2.4% for outpatients [5,15,26], but the utility of comparing these 30-day values with our 90-day outcomes is limited given the shorter time of follow-up.

The current study's overall reoperation rate of 1.2% compares favorably to the 90-day reoperation rate reported in previous studies. Toy et al [19] found a 90-day reoperation rate of 2.8% (4/145) in their series of outpatient THA. Of 111 outpatient knee arthroplasties (86 TKAs and 25 UKAs), Berger et al [7] report 2 reoperations (1.8%) within the first 3 months, both for superficial irrigation and debridement after TKA. Similarly, a smaller series of 51 THA, TKA, and UKA patients only report 1 reoperation (2.0%) [20]. A series of 232 inpatient THAs report a 90-day reoperation rate of 1.3% [18], quite similar to the current study.

Although the reoperation rate was low in both groups, there was a trend toward a higher reoperation rate among the patients who had surgery at the ambulatory surgery center. Two of the 5 reoperations in the outpatient group in retrospect were judgment calls (decompression of a nerve palsy and revision of a subluxed hip), both of which the surgeon may have treated without immediate surgical intervention if they had been performed in the hospital. In the 1 randomized trial of inpatient vs outpatient surgery, Goyal et al [3] reported a 1.4% reoperation rate and no difference between groups, while database studies have reported 30-day reoperation rates ranging from 0.2% to 2.4%, depending on inclusion criteria [5,10,15,26,27]. When interpreting these previous database studies, it is important to consider the inherent selection bias when comparing all inpatient vs outpatient procedures, without appropriately matching the 2 cohorts, and to clarify the definition of "outpatient" arthroplasty [15,16]. Database studies using methodology similar to the current study, by including same-day discharge as the criteria for an outpatient procedure and by matching the 2 study groups, report 30-day reoperation rates that are similar to the 90-day reoperation rates reported in this study, making meaningful comparison between the rates challenging given the difference in length follow-up.

There are several important limitations to the current study. Given the retrospective nature of this study, the strength of evidence is inherently limited. Although we matched the patients carefully to obtain very similar cohorts (Table 1), it is still possible that some bias exists between the cohorts, and a prospective randomized trial would provide a stronger level of evidence to support the conclusions of the current study. Given the rarity of events, a multicenter study would be ideal to maximize sample size. Furthermore, our sample size while larger than most prior studies was relatively small which limits our statistical power to detect differences between the 2 groups. In addition, the duration of follow-up is limited to 90 days, and further follow-up will be required to address any differences in long-term outcomes. However, because our primary concern is the safety and perioperative outcomes of outpatient surgery, we do have the appropriate follow-up to answer our study question. Finally, our study includes 4 different arthroplasty procedures, which are equally represented in both study groups. Although the matching process ensures similar patient characteristics in each cohort, the numbers included for each procedure are not sufficiently powered to draw conclusions specific to each of the 4 procedures. However, the single-surgeon matched cohort design increases the internal validity of the study by maximizing similarity between the inpatient and outpatient cohorts.

In conclusion, our data suggest that in select patients total joint arthroplasty can be safely performed in a free-standing ambulatory surgery center with rates of readmission and complications which are similar to patients having a traditional inpatient stay. Given the potential benefits of reduced costs and increased patient satisfaction [2,25,28–32], future larger studies should be performed to confirm the current results.

Acknowledgment

The authors with to acknowledge Bryce Basques for his assistance in formulating the project proposal and initiating the IRB process.

References

[1] Kolisek FR, McGrath MS, Jessup NM, Monesmith EA, Mont MA. Comparison of outpatient versus inpatient total knee arthroplasty. Clin Orthop Relat Res 2009;467:1438–42.
[2] Lovald ST, Ong KL, Malkani AL, Lau EC, Schmier JK, Kurtz SM, et al. Complications, mortality, and costs for outpatient and short-stay total knee arthroplasty patients in comparison to standard-stay patients. J Arthroplasty 2014;29:510–5.
[3] Goyal N, Chen AF, Padgett SE, Tan TL, Kheir MM, Hopper RH, et al. Otto Aufranc Award: a multicenter, randomized study of outpatient versus inpatient total hip arthroplasty. Clin Orthop Relat Res 2017;475:364–72.
[4] Parvizi J, Mui A, Purtill JJ, Sharkey PF, Hozack WJ, Rothman RH. Total joint arthroplasty: when do fatal or near-fatal complications occur? J Bone Joint Surg Am 2007;89:27–32.
[5] Lovecchio F, Alvi H, Sahota S, Beal M, Manning D. Is outpatient arthroplasty as safe as fast-track inpatient arthroplasty? A propensity score matched analysis. J Arthroplasty 2016;31:197–201.
[6] Berger RA, Sanders SA, Thill ES, Sporer SM, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. Clin Orthop Relat Res 2009;467:1424–30.
[7] Berger RA, Kusuma SK, Sanders SA, Thill ES, Sporer SM. The feasibility and perioperative complications of outpatient knee arthroplasty. Clin Orthop Relat Res 2009;467:1443–9.
[8] Cross MB, Berger R. Feasibility and safety of performing outpatient unicompartmental knee arthroplasty. Int Orthop 2014;38:443–7.

[9] Gondusky JS, Choi L, Khalaf N, Patel J, Barnett S, Gorab R. Day of surgery discharge after unicompartmental knee arthroplasty: an effective perioperative pathway. J Arthroplasty 2014;29:516–9.
[10] Courtney PM, Boniello AJ, Berger RA. Complications following outpatient total joint arthroplasty: an analysis of a national database. J Arthroplasty 2017;32:1426–30.
[11] Dorr LD, Thomas DJ, Zhu J, Dastane M, Chao L, Long WT. Outpatient total hip arthroplasty. J Arthroplasty 2010;25:501–6.
[12] New Medicare data available to increase transparency on hospital utilization. Baltimore, MD: Centers for Medicare and Medicaid Services; 2015. https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2015-Fact-sheets-items/2015-06-01.html. [Accessed 10 January 2018].
[13] 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. J Bone Joint Surg Am 2007;89:780–5.
[14] CMS Proposes Hospital Outpatient Prospective Payment System and Ambulatory Surgical Center Payment System Changes for 2018, and Releases a Request for Information (CMS-1678-P). Baltimore, MD: U.S. Centers for Medicare & Medicaid Services; 2017. https://www.cms.gov/Newsroom/MediaReleaseDatabase/Fact-sheets/2017-Fact-Sheet-items/2017-07-13.html. [Accessed 10 January 2018].
[15] Bovonratwet P, Ondeck NT, Nelson SJ, Cui JJ, Webb ML, Grauer JN. Comparison of outpatient vs inpatient total knee arthroplasty: an ACS-NSQIP analysis. J Arthroplasty 2017;32:1773–8.
[16] Bovonratwet P, Webb ML, Ondeck NT, Lukasiewicz AM, Cui JJ, McLynn RP, et al. Definitional differences of 'outpatient' versus 'inpatient' THA and TKA can affect study outcomes. Clin Orthop Relat Res 2017;475:2917.
[17] Plate JF, Brown ML, Wohler AD, Seyler TM, Lang JE. Patient factors and cost associated with 90-day readmission following total hip arthroplasty. J Arthroplasty 2016;31:49–52.
[18] Elmallah RK, Cherian JJ, Amin H, Jauregui JJ, Pierce TP, Mont MA. Readmission rates in patients who underwent total hip arthroplasty. Surg Technol Int 2015;27:e7.
[19] Toy PC, Fournier MN, Throckmorton TW, Mihalko WM. Low rates of adverse events following ambulatory outpatient total hip arthroplasty at a free-standing surgery center. J Arthroplasty 2018;33:46–50.
[20] Parcells BW, Giacobbe D, Macknet D, Smith A, Schottenfeld M, Harwood DA, et al. Total joint arthroplasty in a stand-alone ambulatory surgical center: short-term outcomes. Orthopedics 2016;39:223–8.
[21] Phillips CB, Barrett JA, Losina E, Mahomed NN, Lingard EA, Guadagnoli E, et al. Incidence rates of dislocation, pulmonary embolism, and deep infection during the first six months after elective total hip replacement. J Bone Joint Surg Am 2003;85-A:20–6.
[22] Malkani AL, Ong KL, Lau E, Kurtz SM, Justice BJ, Manley MT. Early- and late-term dislocation risk after primary hip arthroplasty in the Medicare population. J Arthroplasty 2010;25(6 Suppl):21–5.
[23] Mahomed NN, Barrett JA, Katz JN, Phillips CB, Losina E, Lew RA, et al. Rates and outcomes of primary and revision total hip replacement in the United States Medicare population. J Bone Joint Surg Am 2003;85-A:27–32.
[24] Issa K, Rifai A, Boylan MR, Pourtaheri S, McInerney VK, Mont MA. Do various factors affect the frequency of manipulation under anesthesia after primary total knee arthroplasty? Clin Orthop Relat Res 2015;473:143–7.
[25] Pollock M, Somerville L, Firth A, Lanting B. Outpatient total hip arthroplasty, total knee arthroplasty, and unicompartmental knee arthroplasty. JBJS Rev 2016;4:e4.
[26] Nelson SJ, Webb ML, Lukasiewicz AM, Varthi AG, Samuel AM, Grauer JN. Is outpatient total hip arthroplasty safe? J Arthroplasty 2017;32:1439–42.
[27] Otero JE, Gholson JJ, Pugely AJ, Gao Y, Bedard NA, Callaghan JJ. Length of hospitalization after joint arthroplasty: does early discharge affect complications and readmission rates? J Arthroplasty 2016;31:2714–25.
[28] Aynardi M, Post Z, Ong A, Orozco F, Sukin DC. Outpatient surgery as a means of cost reduction in total hip arthroplasty: a case-control study. HSS J 2014;10:252–5.
[29] Carey K. Price increases were much lower in ambulatory surgery centers than hospital outpatient departments in 2007-12. Health Aff (Millwood) 2015;34:1738–44.
[30] Springer BD, Odum SM, Vegari DN, Mokris JG, Beaver Jr WB. Impact of inpatient versus outpatient total joint arthroplasty on 30-day hospital readmission rates and unplanned episodes of care. Orthop Clin North Am 2017;48:15–23.
[31] Bertin KC. Minimally invasive outpatient total hip arthroplasty: a financial analysis. Clin Orthop Relat Res 2005;435:154–63.
[32] Goldfarb CA, Bansal A, Brophy RH. Ambulatory surgical centers: a review of complications and adverse events. J Am Acad Orthop Surg 2017;25:12–22.