



Original research

Transition to outpatient total hip and knee arthroplasty: experience at an academic tertiary care center

Mrishikesh C. Gogineni, MD ^{a,*}, Chancellor F. Gray, MD ^a, Hernan A. Prieto, MD ^a, Justin T. Deen, MD ^a, Andre P. Boezaart, MD, PhD ^{a,b}, Hari K. Parvataneni, MD ^a

^a Department of Orthopaedics and Rehabilitation, University of Florida, Gainesville, FL, USA

^b Department of Anesthesiology, University of Florida, Gainesville, FL, USA

ARTICLE INFO

Article history:

Received 27 August 2018

Received in revised form

6 October 2018

Accepted 28 October 2018

Available online 28 November 2018

Keywords:

Outpatient arthroplasty

Anesthesia

Ambulation

Urinary retention

Rapid recovery

ABSTRACT

Background: Interest in outpatient total hip arthroplasty (THA) and total knee arthroplasty (TKA) has increased recently as part of value-based care and early recovery protocols. Outpatient pathways require significant paradigm shifts, are not used widely, and are mostly implemented at outpatient surgery centers or orthopedic specialty hospitals. In this article, we report on the outcomes of implementation of an outpatient arthroplasty protocol at a tertiary care academic medical center.

Methods: We performed a retrospective review on a series of 105 consecutive patients who underwent THA or TKA following our newly implemented outpatient arthroplasty protocol. We compared these patients to a group of inpatient arthroplasty patients from the same time period.

Results: Eighty-three of 105 (79%) patients were successfully discharged home on the day of surgery. Successful same-day discharge was predicted by early ambulation ($P = .01$), TKA over THA ($P = .04$), and shorter duration of surgery ($P = .01$). General anesthesia correlated with better early ambulation distances ($P = .03$) and a lower incidence of urinary retention ($P = .049$). The outpatient readmission and complication rates were 0.95% and 1.9%, respectively, whereas the matched inpatient rates were 3.7% and 2.9%, respectively.

Conclusions: Outpatient THA and TKA in a well-selected patient is feasible in an academic multidisciplinary tertiary care hospital, with complication rates approximating inpatient surgery. The findings reported here can be used to further optimize outpatient arthroplasty protocols.

© 2018 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

The incidence of primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) has been increasing over the last two decades and is predicted to continue to increase in the future [1–3]. This expected increase is in both inpatient and outpatient settings, although the majority of the growth is expected in the outpatient

setting with only a modest increase in the inpatient setting [4]. This is further supported by the 2018 Outpatient Prospective Payment System rule recently released in November 2017 by the Centers for Medicare and Medicaid Services in which TKA has been removed from the inpatient-only list [5].

Outpatient lower extremity arthroplasty is not a new concept, with published reports dating back over a decade ago [6]. More reports have surfaced recently as interest in outpatient arthroplasty seems to be increasing. This has been driven by multiple factors including the implementation of clinical pathways [7,8] and rapid-recovery programs [9,10] which have allowed patients to recover faster, thus reducing length of stay [11,12], with outpatient surgery being a natural extension of this trend.

As part of an institutional, patient-centered quality initiative, we implemented a major redesign of total joint arthroplasty (TJA) care starting in November 2015 [13]. The goal of this initiative was to maintain high standards for patient safety and outcome quality

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.artd.2018.10.008>.

* Corresponding author. Department of Orthopaedics and Rehabilitation, University of Florida, 3450 Hull Rd, Gainesville, FL, 32607, USA. Tel.: +1 352 273 7001.

E-mail address: rishi.go@gmail.com

<https://doi.org/10.1016/j.artd.2018.10.008>

2352-3441/© 2018 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

while simultaneously reducing costs. This was a surgeon-led effort with engagement of a multidisciplinary task force consisting of anesthesiologists, acute pain specialists, case management, rehabilitation services, home care companies, hospital administrators, nursing leaders, and hospital quality and data personnel. Extensive changes were made in the preoperative, acute care, and postacute care periods. The redesign was focused on improved pain control, enhanced recovery, reduction in complications and readmissions, and reduced costs. Since its inception, there has been a consistent decrease in the hospital length of stay, reduced complications and readmissions, an increase in the rate of discharge to home, and a decrease in the rate of discharge to skilled nursing facilities [13].

As the redesign progressed, a subset of patients consistently met criteria for discharge on the day of surgery. There was no process in place to facilitate same-day discharge, so the natural evolution of our care redesign was to then develop an outpatient arthroplasty program. It should be noted that our care setting is a large tertiary care academic medical center, unlike the majority of published studies on outpatient arthroplasty programs that typically were performed in ambulatory surgery centers or orthopedic specialty hospitals [14–16]. Transition to outpatient surgery at orthopedic specialty hospitals (or facilities that have streamlined processes focused on musculoskeletal surgery) has been historically more feasible. There are no studies published on this transition at large multispecialty tertiary care centers where these types of transitions are typically more challenging.

We therefore sought to review the feasibility and outcomes related to the implementation of an outpatient arthroplasty protocol in a non-orthopedic multispecialty hospital setting. The primary outcome measure was the rate and predictors of successful same-day discharge to home. Our secondary outcomes were to compare readmissions and complications between the outpatient TJA patients and a loosely matched cohort of inpatients from the same time period.

Material and methods

Study design

After institutional review board approval was obtained, we conducted a retrospective chart review of a consecutive series of patients who were selected for our outpatient arthroplasty protocol. The protocol initiative was first implemented in December 2016, and the institutional review board approval period was from the beginning of the initiative up to March 2018. Surgeries were conducted at our hospital, a 1000-bed tertiary care multispecialty academic medical center. This institution is also the primary referral center for several counties, a level 1 trauma center, and a teaching hospital where resident and fellow education is an important commitment.

Data points included success or failure of same-day discharge, type of anesthesia (general vs spinal), method of regional anesthesia, duration of surgery, length of stay in the postanesthesia care unit (PACU) before discharge, ambulation distances (on the first attempt as well as total for the day in PACU) and time to first ambulation in PACU, patient complaints during physical therapy, preoperative hemoglobin levels, urinary retention rates, length of hospital stay for patients who failed to be discharged on the same day, unexpected visits to our after-hour orthopedic clinic and emergency room (ER), and readmissions and complications.

Outpatient protocol

Based on published studies [17–23], we established social, medical, surgical, and other inclusion criteria, which are summarized in Table 1.

Table 1
Inclusion criteria for outpatient protocol.

Surgical factors	Medical factors	Social factors
Primary THA or TKA	Age < 75 y	RAPT > 10
First/second case of the day	BMI < 35	Proximity to hospital
	No anemia, COPD, CHF	Private insurance
	No cirrhosis	
	No VTE history	
	No spinal stenosis	
	No BPH	
	No chronic narcotics	
	Surgeon discretion	

BMI, body mass index; BPH, benign prostate hyperplasia; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; RAPT, risk assessment and prediction tool; VTE, venous thromboembolism.

Risk assessment and prediction tool is used to predict the discharge destination of patients undergoing elective hip and knee arthroplasties [24].

Structured care pathways were developed for the preoperative, perioperative, and postoperative periods to ensure that care was streamlined and all care providers were coordinated with regard to common goals and expectations. The preoperative pathway first began with careful discussion with the patients about the outpatient surgery protocol. For those patients who had met the inclusion criteria, all were required to also participate in our institutional joint-replacement education program. Finally, patients were evaluated by our preanesthesia clinic, and full instructions regarding perioperative medication use and postoperative pain management and education regarding the continuous and other nerve blocks were provided. All patients were scheduled for the first or second surgical case of the day. Arrangements for outpatient or home physical therapy were made, and standard arthroplasty preoperative and postdischarge instructions were reviewed. A record of all outpatient candidates was maintained by our nurse navigator, and all clinical records were kept in our electronic medical record system (Epic, Verona, WI).

The perioperative pathway was broken down into four phases: (1) the block procedure room (BPR), (2) operating room (OR), (3) early PACU, and (4) transition area. In the BPR, all patients underwent insertion of a continuous femoral nerve block (CFNB) using stimulating catheters (Arrow UltraCath; Teleflex, Richmond, VA) with or without ultrasound assistance, and patients scheduled for TKA received an ultrasound-guided modified infiltration in the Interspace between the Popliteal Artery and the Capsule of the posterior Knee (IPACK) block. The modification involves liberal periarterial injection as well as IPACK of 20 mL of ropivacaine 0.5%. Patients who were scheduled for THA received only a CFNB, and the proceduralists aimed at advancing the catheters toward the lumbar plexus. The posterior capsules of the patients were intraoperatively infiltrated with a mixture of 20 mL of 0.25% bupivacaine and 1:200,000 epinephrine by the surgeon. After placing the CFNB, a bolus of 20 mL of ropivacaine 0.2% was administered through the catheter, which was then connected to a disposable infusion pump (ambIT; Summit Medical Products, Sandy, UT) that was set at a background infusion rate of 5 mL per hour of ropivacaine 0.2%, and a patient-initiated bolus of 5 mL locked out at 60 minutes between boluses or an elastometric disposable pump (AutoFuser; Teleflex, Wayne, PA) that was filled with 500 mL of 0.2% ropivacaine and set at an infusion rate of 5 mL per hour with no patient bolus facility. In the BPR, the patients were also asked to empty their bladders immediately before transfer to the OR.

In the OR, the use of indwelling urinary catheters was omitted, and spinal anesthesia or general anesthesia, with or without total intravenous anesthesia, was induced depending on the preferences of the patients, anesthesiologists, or surgeons. No attempt was made to randomize the patients for anesthetic type. Perioperative

medications administered are shown in Table 2, and the surgery proceeded in a standard fashion.

In the PACU, radiographs of the operated joints were obtained, and narcotics were minimized. Before any opioids were considered, a physician of the acute pain service (APS) would see the patient and evaluate the nerve block(s). If any of these were found to be insufficient, corrective actions were taken by the APS physicians which included small-dose single-injection ultrasound-guided subgluteal sciatic nerve blocks in case of severe posterior knee pain (after the sciatic nerve motor function had been evaluated), injecting a 10-mL bolus through the CFNB catheter if the pain was anterior to the hip or knee, or a single-injection ultrasound-guided obturator nerve block in case of posterior hip pain. Ultrasound bladder scans were performed as per our urinary retention protocol (in-and-out catheterization for >800 mL) upon admission to the PACU and thereafter every 2 hours. Within two hours of arrival in the PACU, patients were expected to start working with physical therapy to ambulate.

Case managers confirmed discharge needs, durable medical equipment, and home care arrangements. In the transition area, patients received further verbal and written instructions and education on medications, wound care, management of the continuous nerve block site, infusion, and infusion pump, and follow-up

instructions were given. The second antibiotic dose was administered, and physical therapy was continued. Patients were discharged and transferred to their vehicle after meeting established criteria: adequate ambulation and pain control, no nausea or vomiting, and normal bladder function.

Of note, unlike prior series on outpatient arthroplasty, all surgeries were performed as normal in the usual inpatient ORs, and patients were transferred to the general multispecialty inpatient PACU. There were no changes made to this protocol and no dedicated outpatient ORs, recovery rooms, or staffing. The only change was that once admitted to the PACU, patients worked with physical therapy and were discharged later in the day if criteria were met. If this was not deemed to be safe, they were admitted to the inpatient unit.

The postoperative pathway consisted of regular follow-up via telephone (on postoperative day 1, 2, 4, and 7), performed by our nurse navigator. All patients were seen at home on the evening of discharge by a home care nurse. Separate follow-up was also performed by the APS physicians and nurses until discontinuation of the CFNB, which was removed by the home care nurse. Surgeons of our arthroplasty division were available during regular clinic hours if patients needed to be seen unexpectedly. Furthermore, our orthopedic department offered an after-hour orthopedic clinic facility which functioned in the evening hours every day as an orthopedic urgent care and could also be used by our outpatient arthroplasty patients when needed. Follow-up clinic visits were routinely performed at two weeks (for TKAs only), 6 weeks, and 9–12 month points.

For our retrospective review, we included all patients who had agreed to participate in the outpatient arthroplasty protocol at their preoperative clinic visit and who were judged by the surgeon to satisfy the inclusion criteria. This cohort included some patients who elected transition to a brief inpatient stay on the day of surgery, using an intention-to-treat type analysis [25,26].

Inpatient protocol

Inpatient data during the same time frame were accessed for comparison. The outpatient data set was compared to an inpatient data set, which was loosely matched for age, body mass index, and surgeon using Business Objects/SAP suite of software (BusinessObjects XI, San Jose, CA), from our electronic medical record. More stringent matching with additional parameters was not possible due to a limitation of our software. Variables obtained included demographics, hospital length of stay, readmissions, and complications. Insurance data were used to eliminate noncommercial insurance patients (matching the outpatient group) to reduce selection bias and confounding variables.

Statistical analysis

Within our outpatient data set, we performed multivariate regression analyses to test for statistically significant relationships, using IBM SPSS Statistics, version 25 (IBM, Chicago, IL). Coefficients and odds ratios, depending on whether it was a scaled outcome or a categorical outcome, respectively, were obtained for all relationships. To further confirm our statistical findings, simpler one-on-one statistical tests were also used: (1) Chi-square and analysis of variance tests were used for categorical variables; (2) *t*-tests and Mann-Whitney tests were used for comparing means (for normal and non-normal distributions, respectively); (3) Pearson and Spearman correlation coefficients for testing scaled variables (again for normal and non-normal distributions, respectively).

Table 2
Perioperative medications.

Medication	Dosing information
Preoperative	
Pantoprazole	40 mg PO
Pregabalin (or gabapentin)	150–300 mg PO (600–1200 mg PO)
Tranexamic acid	1 g IV before incision and at wound closing
Continuous femoral nerve block (CFNB)	20 mL bolus of 0.5% ropivacaine, infusion of 0.2% ropivacaine at pump settings 5/5/60/1 ^a
IPACK for TKAs	20 mL of 0.5% ropivacaine
Intraoperative	
CFNB	Infusion of 0.2% ropivacaine at pump settings 5/5/60/1 ^a
Spinal anesthesia single shot	10–15 mg bupivacaine
General anesthesia with propofol ± inhalation anesthetic agents	
Fentanyl	50–100 mcg IV PRN
Dexamethasone	8 mg IV
Acetaminophen	1000 mg IV
Ketorolac	15–30 mg IV
Ondansetron	4–8 mg IV
Postoperative	
CFNB	Infusion of 0.2% ropivacaine at pump settings 5/5/60/1 ^a
Aspirin	81 mg BID PO for 6 weeks for VTE prophylaxis
Acetaminophen	500–1000 mg PO TID as first-line analgesic
Ibuprofen, naproxen, or celecoxib	NSAID of patient's choice for 2 weeks, if tolerated
Tramadol	50–100 mg PO q8h PRN as first-line analgesic
Hydrocodone-acetaminophen, 5–325 mg ^b	1–2 tabs PO q4–6h PRN as second-line analgesic
Oxycodone, 5 mg ^b	1–2 tabs PO q4–6h PRN as second-line analgesic

BID, twice a day; CFNB, continuous femoral nerve block; IPACK, Interspace between the Popliteal Artery and the Capsule of the posterior Knee; IV, intravenous; NSAID, nonsteroidal anti-inflammatory drug; PO, orally; PRN, as needed; TID, three times a day.

^a Settings for a pain pump device representing 5 mL/h of continuous infusion, 5 mL of a patient demand dose, 60-minute lockout, and one patient demand dose per lockout period.

^b Hydrocodone-acetaminophen was our preferred prescription, but if a patient had an allergy to or could not tolerate this medication, they were instead prescribed oxycodone.

Results

One hundred and five patients agreed to outpatient THA and TKA at their final preoperative clinic visit. Forty-nine patients (47%) underwent THA, and 56 patients (53%) underwent TKA. Demographic and outcome data for the outpatient group are shown in Table 3. The overall rate of successful discharge to home on the same day in our outpatient arthroplasty group was 79% (83/105).

Predictors of successful discharge were identified to be type of surgery (THA vs TKA), duration of surgery, and first ambulation distance (FAD) (Table 4). Several metrics were identified which predicted some of these parameters and are summarized in Table 5. No preoperative factors achieved both statistical and clinical significance.

Type of surgery

Patients who underwent TKA had a higher likelihood of discharge than those who underwent THA (88% vs 69%; odds ratio, 8.02; $P = .04$).

Duration of surgery

The likelihood of same-day discharge increased as the surgical durations decreased (odds ratio, 1.07; $P = .01$). The duration of surgery itself was predicted by age (coefficient, -0.98 ; $P < .01$) and gender (coefficient, -9.62 ; $P = .04$), specifically female and older patients tended to have shorter surgeries.

First ambulation distance in PACU

Patients who ambulated further on their first attempt in PACU had a higher likelihood of going home on day zero (odds ratio, 1.05; $P = .01$). The best predictors of FAD were general anesthesia (coefficient, 22.21; $P = .03$) and TKA (coefficient, 25.82; $P = .04$). FAD also was predictive of total ambulation distance (TAD) in PACU (coefficient, 0.70; $P < .01$), although TAD was not by itself predictive of successful same-day discharge.

Table 3

Demographic and outcome data of the outpatient group.

Variable	Value
Age in years, mean (range)	57.3 (24–80)
Gender, no. of patients, male:female	57:48
Body mass index in kg/m ² , mean (range)	30.0 (18.8–43.3)
Type of surgery, no. of patients, THA:TKA	49:56
ASA 1, no. of patients	4
ASA 2, no. of patients	58
ASA 3, no. of patients	40
Anesthesia type, no. of patients, general:spinal	43:62
Duration of surgery in minutes, mean (range)	106 (70–183)
PACU length of stay in minutes, mean (range)	351 (172–613)
Time to first ambulation in minutes, mean (range)	186 (16–428)
FAD in feet, mean (range)	43 (0–200)
TAD in feet, mean (range)	88 (0–290)
Preoperative Hgb in g/dL, mean (range)	14.3 (11.4–17.7)
Hospital length of stay in days, mean (range)	0.24 (0–2)
Urinary retention, no. of patients	23
Orthostatic hypotension, no. of patients	13
Successful same-day discharge rate	83/105 (79%)

ASA, American Society of Anesthesiologists Physical Status Classification System. Time to first ambulation is the duration from entering PACU to the first successful ambulation attempt.

First ambulation distance (FAD) is the distance ambulated on the first attempt in PACU.

Total ambulation distance (TAD) is the total distance ambulated throughout the day in PACU.

Preoperative Hgb is the most recent hemoglobin level before surgery.

Table 4

Predictors of successful same-day discharge.

	Patient discharged	Patient admitted	P-value
Type of surgery (% of cases)			
TKA	88%	12%	.04
THA	69%	31%	
Mean duration of surgery (min)	103	119	.01
Mean first ambulation distance (FAD) in PACU (feet)	52	9	.01

Data and statistical results for only the predictors of same-day successful discharge are presented.

FAD is the distance ambulated on first attempt in PACU.

Urinary retention

Urinary retention, defined as any patient needing in-and-out catheterization, was more common with spinal anesthesia (odds ratio, 3.86; $P = .049$) and resulted in longer PACU stays (coefficient, 0.36; $P < .01$). Based on our postoperative urinary retention protocol, the bladders of five patients (11.6%) had to be emptied by in-and-out catheterization in the patients who received general anesthesia vs 18 patients (29%) who received spinal anesthesia.

PACU stay

The average duration of PACU stay for patients successfully discharged on the same day was 351 minutes, and for the standard inpatient group, it was 236 minutes. The amount of time spent in PACU before ambulation (first ambulation time), for outpatients, was an average of 186 minutes.

Causes of failed discharge and ER visits

The causes of failure of same-day discharge resulting in admission are summarized in Table 6. There were a total of eight visits (7.6%) to the after-hour orthopedic clinic and 12 visits (11.4%) to the ER. The reasons for and timing of ER visits are shown in Table 7.

Matched inpatient cohort

Data reflecting the comparisons of lengths of hospital stay, readmission rates, and complication rates, between the outpatient and inpatient groups, are shown in Table 8.

Table 5

Statistically significant results of the outpatient group.

Relationship	P value (odds ratio or coefficient)
Increasing age → decreasing duration of surgery	<.01 (−0.98)
Female gender → decreasing duration of surgery	.04 (−9.62)
General anesthesia → increased FAD	.03 (22.21)
TKA → increased FAD	.04 (25.82)
Farther FAD → Farther TAD	<.01 (0.70)
Spinal anesthesia → higher urinary retention incidence	.049 (3.86)
Higher urinary retention incidence → longer PACU length of stay	<.01 (0.36)
Shorter duration of surgery → higher successful discharge rate	.01 (1.07)
Farther FAD → higher successful discharge rate	.01 (1.05)
TKA → higher successful discharge rate	.04 (8.02)

FAD, first ambulation distance; TAD, total ambulation distance.

All of the above relationships are statistically significant.

Odds ratios were used when the dependent variables were categorical data, and coefficients, when the dependent variables were continuous data.

FAD is the distance ambulated on first attempt in PACU.

TAD is total ambulation distance in PACU.

Table 6

Reasons for admission when unable to discharge same day.

Reason for admission	Number of times reason was implicated
Orthostatic hypotension	8
Patient decision	5
Urinary retention	4
Nausea	4
Leg buckling	3
Pain	3
Bilateral leg weakness	2
Foot drop	2
Chest pain	1
Pain pump not available	1

Some patients stayed for more than one reason.

Discussion

Outpatient and early discharge total joint arthroplasty is increasing in the United States as perioperative protocols including early mobilization, multimodal pain management, and regional anesthesia have optimized the postoperative course significantly [6–12]. Our rate of discharge on the day of surgery (79%) was lower than that reported by previously published studies. Hoffmann et al. published a systematic review showing discharge rates for ten separate studies, with a cumulative successful same-day discharge rate of 94.5% over a total of 1009 patients; however, the majority of these studies were conducted at ambulatory surgery centers or orthopedic specialty hospitals [27]. The setting for our study is a large tertiary care academic medical center, and our PACU is in the same building as our inpatient wards; thus, the trigger for admission may have a much lower threshold at our institution. For example, five patients changed their mind and decided to stay in the hospital but made this decision change at some point after their final preoperative clinic visit. They are included in the study because we followed an intention-to-treat analysis. There was also one admission attributed to the unavailability of a home-going pain pump. If these patients were excluded, our same-day discharge rate would certainly be higher (85%).

The distance that patients ambulated on their first attempt, or FAD, was an important predictor of success in the present study and one not found commonly in other similar studies. We found that there were significant associations between FAD and anesthesia type (general vs spinal anesthesia), as well as with type of surgery (THA or TKA). General anesthesia significantly correlated with a farther FAD in PACU. The type of anesthesia, however, did not seem to directly affect the TAD in PACU or TAD. This suggests that the effects of anesthesia on ambulation may be time sensitive, with

Table 7

Diagnoses/chief complaints of all ER visits within the outpatient group.

Diagnosis/chief complaint	Duration, postoperative
Chest pain	6 d
Chest pain	7 d
Chest pain	2.5 mo
Chest pain	2.5 mo
UTI	3 d
UTI, pneumonia, UTI	8 d, 10 d, 17 d
Urinary retention	3 mo
Syncope	1 d ^a
Hip dislocation	6 wk and again 4 mo
DVT check	4 d
Traumatic wound dehiscence	1 d, Readmitted ^a
Allergic dermatitis from tape	11 d

DVT, deep vein thrombosis; UTI, urinary tract infection.

ER visits were monitored for up to 90 days.

^a Only two ER visits were within 48 hours of surgery.**Table 8**

Comparison of length of stay, complications, and readmissions between the outpatient and matched inpatient groups.

	Outpatients (n = 105)	Inpatients (n = 136)	P value
Age (years, mean)	57.3	53.9	.08
Body mass index (kg/m ² , mean)	30.03	30.55	.46
Length of stay (days, mean)	0.24	1.53	<.01
Readmission rate	0.95%	3.70%	.18
Complication rate	1.90%	2.90%	.61

general anesthesia being more advantageous from an early ambulation standpoint. This early ambulation is certainly not to be discounted, as it suggested successful same-day discharge, with patients who walked farther on their first attempt in PACU, having a higher odds ratio of successful discharge. We should point out that the method of general anesthesia, such as total intravenous anesthesia or inhalational anesthesia, was not consistent, and details on this were not collected for this study. Overall, these patients could ambulate farther on their first attempt than patients who got spinal anesthesia. This is also supported by two previously published randomized controlled trials [28,29].

The type of surgery, either THA or TKA, was also significantly correlated with FAD, with TKA patients walking farther than THA patients, which then correlated with successful same-day discharge. In addition, the type of surgery itself also significantly correlated directly with successful same-day discharge, with TKA patients having higher odds of same-day discharge than THA patients. Higher same-day discharge rates for TKA over THA patients have been shown in other studies [30].

The type of anesthesia was also significantly correlated with urinary retention, with a higher incidence occurring in patients receiving spinal anesthesia. Urinary retention being associated with spinal anesthesia has been reported in other studies as well [31]. In our study, the presence of urinary retention did not directly correlate significantly with successful same-day discharge, but it did correlate with longer PACU stays.

The average PACU stay durations for the outpatients discharged on the same day and for the inpatient group are much longer in our institution than at ambulatory surgery centers performing outpatient arthroplasty [14,16]. In fact, even our average time to first ambulation (186 minutes) is longer than the average total recovery time in other studies (121–176 minutes) [14,16]. The long PACU duration in our study might be an inherent characteristic of large academic tertiary care centers with PACUs that cater to all types of surgeries, not only orthopedic. In our inpatient group, physical therapy did not routinely work with patients in PACU and would start mobilization after arrival on the inpatient unit. In our outpatient group, we requested our physical therapists to see all patients in the PACU, which itself was a change from their routine procedure and had inherent delays. Based on these results, having physical therapy treating patients even earlier might further improve outcomes. This change can be slow to implement in large institutions such as ours compared with ambulatory surgery centers.

The rate of visits to our hospital ER during the 90-day postoperative period was 11.4%, which is relatively high compared with other published studies [27]. However, most of these ER visits do not seem to be related to the arthroplasty surgery, such as chest pain 2.5 months later or urinary retention 3 months later. There was one patient who went to the ER due to allergic dermatitis from the surgical bandage. This could certainly have been handled at either our regular arthroplasty clinic or our after-hour orthopedic clinic, which indicates to us that there is likely some room for improvement in the education we provide to our patients regarding

available resources. It should also be noted that only two of the ER visits were within 48 hours of surgery, which suggests that a standard inpatient stay for patients of the other ER visits may not necessarily have made any difference in those patients eventually going to the ER. Although our ER visit rate is high, it is probably lower than what it might have been if there was no access to our after-hour orthopedic clinic.

Readmissions and complications during the 90-day post-operative period were low in our outpatient group and lower than those in the inpatient group (Table 8). The systematic review on outpatients by Hoffmann et al. reports a cumulative readmission rate of 0.89%, a minor complication rate of 1.29%, and a major complication rate of 0.10% [27], which are very similar to our outpatient group, suggesting that the safety profile of our outpatient group has not been compromised.

The strengths of our study are that this is a review of a consecutive series of patients through our outpatient arthroplasty protocol. In addition, multiple surgeons participated in the initiative, and the setting was an academic tertiary care hospital. These factors make it applicable to most centers that are considering outpatient surgery and are not orthopedic specialty hospitals. We also compared inpatients during the same time frame to assess for safety and non-inferiority.

There are some limitations to our study. The sample size is small, and our statistical tests should be interpreted with that in mind. However, it should be noted that other similar studies have similar sample sizes to ours [14–16,32]. We also were not able to easily obtain patient-reported outcomes, which could have been valuable data for comparing before and after surgery status, as well as inpatient and outpatient groups. For our inpatient group, ER visit data and other parameters were not available, resulting in our inability to perform more diligent matching between the inpatient and outpatient cohorts. Finally, we acknowledge the inherent variability in recording and encouraging ambulation distances.

Conclusions

Outpatient THA and TKA are feasible and reproducible in a large multispecialty academic tertiary care hospital and are not inferior to the inpatient setting for TJA. Anesthesia type, duration of surgery, patient factors, and procedure type all predicted success of same-day discharge. Considering that general anesthesia facilitates early ambulation and demonstrates lower rates of urinary retention, it is the authors preferred approach for outpatient TJA. The findings reported here can be used to optimize outpatient arthroplasty protocols at similar medical facilities. Our institution has already integrated the findings outlined here in our updated outpatient arthroplasty protocol.

Acknowledgments

This research was supported in part by fellowship funding from OMeGA.

References

- [1] 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.
- [2] Kurtz SM, Ong KL, Lau E, Bozic KJ. Impact of the economic downturn on total joint replacement demand in the United States. *J Bone Joint Surg Am* 2014;96:624.
- [3] Inacio MCS, Paxton EW, Graves SE, Namba RS, Nemes S. Projected increase in total knee arthroplasty in the United States — an alternative projection model. *Osteoarthritis Cartil* 2017;25:1797.
- [4] Bert JM, Hooper J, Moen S. Outpatient total joint arthroplasty. *Curr Rev Musculoskelet Med* 2017;10:567.
- [5] CMS. MLN matters MM10417 January 2018 update of the hospital outpatient prospective payment system (OPPS). <https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNMattersArticles/downloads/MM10417.pdf>; 2018. [Accessed 11 April 2018].
- [6] Bertin KC. Minimally invasive outpatient total hip arthroplasty: a financial analysis. *Clin Orthop Relat Res* 2005;435:154.
- [7] Kim S, Losina E, Solomon DH, Wright J, Katz JN. Effectiveness of clinical pathways for total knee and total hip arthroplasty: literature review. *J Arthroplasty* 2003;18:69.
- [8] 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] Ibrahim MS, Khan MA, Nizam I, Haddad FS. Peri-operative interventions producing better functional outcomes and enhanced recovery following total hip and knee arthroplasty: an evidence-based review. *BMC Med* 2013;11:37.
- [10] Berend KR, Lombardi AV, Mallory TH. Rapid recovery protocol for peri-operative care of total hip and total knee arthroplasty patients. *Surg Technol Int* 2004;13:239.
- [11] Maempel JF, Walmsley PJ. Enhanced recovery programmes can reduce length of stay after total knee replacement without sacrificing functional outcome at one year. *Ann R Coll Surg Engl* 2015;97:563.
- [12] Khan SK, Malviya A, Muller SD, et al. Reduced short-term complications and mortality following Enhanced Recovery primary hip and knee arthroplasty: results from 6,000 consecutive procedures. *Acta Orthop* 2014;85:26.
- [13] Gray CF, Prieto HA, Duncan AT, Parvataneni HK. Arthroplasty care redesign related to the Comprehensive Care for Joint Replacement model: results at a tertiary academic medical center. *Arthroplast Today* 2018;4:221.
- [14] Parcells BW, Giacobbe D, Macknet D, et al. Total joint arthroplasty in a stand-alone ambulatory surgical center: short-term outcomes. *Orthopedics* 2016;39:223.
- [15] Cross MB, Berger R. Feasibility and safety of performing outpatient unicompartmental knee arthroplasty. *Int Orthop* 2014;38:443.
- [16] 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.
- [17] Lovald S, Ong K, Lau E, Joshi G, Kurtz S, Malkani A. Patient selection in outpatient and short-stay total knee arthroplasty. *J Surg Orthop Adv* 2014;23:2.
- [18] Courtney PM, Rozell JC, Melnic CM, Lee G-C. Who should not undergo short stay hip and knee arthroplasty? Risk factors associated with major medical complications following primary total joint arthroplasty. *J Arthroplasty* 2015;30:1.
- [19] Belmont PJ, Goodman GP, Waterman BR, Bader JO, Schoenfeld AJ. Thirty-day postoperative complications and mortality following total knee arthroplasty: incidence and risk factors among a national sample of 15,321 patients. *J Bone Joint Surg Am* 2014;96:20.
- [20] Belmont Jr PJ, Goodman GP, Kusnezov NA, et al. Postoperative myocardial infarction and cardiac arrest following primary total knee and hip arthroplasty: rates, risk factors, and time of occurrence. *J Bone Joint Surg Am* 2014;96:2025.
- [21] Mednick RE, Alvi HM, Krishnan V, Lovecchio F, Manning DW. Factors affecting readmission rates following primary total hip arthroplasty. *J Bone Joint Surg Am* 2014;96:1201.
- [22] Waterman BR, Belmont Jr PJ, Bader JO, Schoenfeld AJ. The total joint arthroplasty cardiac risk index for predicting perioperative myocardial infarction and cardiac arrest after primary total knee and hip arthroplasty. *J Arthroplasty* 2016;31:1170.
- [23] Kingery MT, Cuff GE, Hutzler LH, Popovic J, Davidovitch RI, Bosco JA. Total joint arthroplasty in ambulatory surgery centers: analysis of disqualifying conditions and the frequency at which they occur. *J Arthroplasty* 2018;33:6.
- [24] Hansen VJ, Gromov K, Lebrun LM, Rubash HE, Malchau H, Freiberg AA. Does the risk assessment and prediction tool predict discharge disposition after joint replacement? *Clin Orthop Relat Res* 2014;473:597.
- [25] Montori VM, Guyatt GH. Intention-to-treat principle. *CMAJ* 2001;165:1339.
- [26] Sedgwick P. Intention to treat analysis versus per protocol analysis of trial data. *BMJ* 2015;350:1.
- [27] Hoffmann JD, Kusnezov NA, Dunn JC, Zarkadis NJ, Goodman GP, Berger RA. The shift to same-day outpatient joint arthroplasty: a systematic review. *J Arthroplasty* 2018;33:1265.
- [28] Harsten A, Kehlet H, Toksvig-Larsen S. Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroplasty: a randomized trial. *Br J Anaesth* 2013;111:391.
- [29] Harsten A, Kehlet H, Ljung P, Toksvig-Larsen S. Total intravenous general anaesthesia vs. spinal anaesthesia for total hip arthroplasty: a randomised, controlled trial. *Acta Anaesthesiol Scand* 2015;59:298.
- [30] Fraser JF, Danoff JR, Manrique J, Reynolds MJ, Hozack WJ. Identifying reasons for failed same-day discharge following primary total hip arthroplasty. *J Arthroplasty* 2018;33:3624.
- [31] Scholten R, Kremers K, van de Groes SAW, Somford DM, Koëter S. Incidence and risk factors of postoperative urinary retention and bladder catheterization in patients undergoing fast-track total joint arthroplasty: a prospective observational study on 371 patients. *J Arthroplasty* 2018;33:1546.
- [32] Goyal N, Chen AF, Padgett SE, et al. Otto aufranc award: a multicenter, randomized study of outpatient versus inpatient total hip arthroplasty. *Clin Orthop Relat Res* 2017;475:364.