Introduction

Demand for total joint arthroplasty (TJA) is expected to grow exponentially in the next 10 years. One estimate places the total number of hip and knee arthroplasties at over 4 million by 2030, an increase of 174% [1]. TJA has excellent short- and long-term clinical results and, in the recent years, has been successfully performed with rapid recovery protocols. There has been a trend toward short hospitalizations, which has been facilitated by refinements in surgical techniques, advancements in pharmacologic regimens, and modification of postoperative physical therapy pathways. The development of such clinical efficiencies, such as comprehensive pre and perioperative pathways, has allowed for the development of truly outpatient or ambulatory total joint surgery [2-6]. Today, there is an increasing interest in outpatient TJA as there are perceived advantages for the patient, potential cost reduction [7], and general benefits to the health-care system. Conversely, hidden costs from managing complications and readmissions have recently come under question [7,8]. Several studies have demonstrated that...
TJA performed in an outpatient setting is safe, effective, and efficient [9-15], however, these studies were all performed within the safety net of hospital outpatient departments [15]. Thus, patients who do not meet discharge criteria are easily transitioned to inpatient hospitalization. Furthermore, the definition of outpatient TJA in some studies has included overnight stay of under 23 hours [16]. Although there are potential benefits associated with TJA at an ambulatory surgical center (ASC), potential complications and safety of outpatient TJA at a standalone ASC continue to be quantified and demonstrate promising outcomes with complication rates <7% [2.17-19]. However, safety of major surgeries at ASCs continues to be questioned in mainstream media [20].

The objective of this study was to evaluate 30- and 90-day complication rates in patients who underwent TJA at a freestanding, independent ASC after development of a multidisciplinary pathway.

Material and methods

On receiving institution institutional review board approval, a retrospective review of electronic health records was performed for all patients who underwent total hip arthroplasty (THA), total knee arthroplasty (TKA), or unicondylar knee arthroplasty (UKA) at a freestanding ASC between August 2015 and March 2017 by one surgeon preference. Foley catheters were not used. Postoperative pain management consisted of celecoxib, oxycodone, or hydrocodone based on surgeon preference with minimization of IV narcotic administration. Venous thromboembolism (VTE) prophylaxis was used with enteric-coated aspirin 325 mg twice a day and mobile calf pumps, warfarin, or lovenox based on surgeon preference.

**Physical therapy protocol**

All patients were allowed to bear full weight immediately after TJA with the guidance of a physical therapist using an appropriate assistive device. All patients subsequently climbed stairs under physical therapy guidance.

**Follow-up protocol**

All patients received phone calls from the ASC nursing staff. Patients were seen daily at home by a physical therapist starting from the same day of surgery. Patients were also seen by a visiting nurse 3 times a week for 1 week. There was a uniform patient follow-up protocol with all patients seen postoperatively at 3, 6, and 12 weeks.

This study collected demographic information including age, sex, BMI, laterality, and preoperative American Society of Anesthesiologists physical classification system. The primary outcome measures included postsurgical recovery time in the ASC, intraoperative complications, adverse events within the ASC, postoperative hospitalizations, any postoperative complications within 30 and 90 days postoperatively, and length of follow-up.

**Data analysis and sample size calculation**

Continuous data are reported as mean ± standard deviation, and categorical data are reported as number (percent). The proportion of subjects having a 30- or 90-day complication with 95% confidence interval (CI) is reported. For purposes of the analysis, TKAs and UKAs were combined into 1 group. Analysis was performed using SPSS for Windows, version 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Investigators anticipated a <10% complication rate, expected proportion (P), of 0.10 ± 0.05 (width = 0.10) with a 90% confidence level, which called for approximately 100 charts [21].

**Results**

After instituting a multidisciplinary TJA pathway, a total of 115 consecutive patients underwent TJA at a freestanding ASC. Included were 37 (32%) THAs, 53 (46%) TKAs, and 25 (22%) UKAs with a mean age of 57 ± 7 years, BMI of 30 ± 5 kg/m², and 68 (59%) males. One hundred percent of patients were discharged directly to home postoperatively from the ASC. The mean postoperative recovery time including postoperatively convalescence, ambulation with physical therapy (PT), stair climbing with PT, and nursing care before discharge was 135 minutes for THA and 132 minutes for TKA.

Tables 1 and 2 outline the subject characteristics and comorbidities by joint. There were minimal complications postoperatively. There was 1 (0.9%, 95% CI 0–2) instance of a postoperative minimally displaced intertrochanteric femur fracture after THA due to a fall and treated nonoperatively within 30 days of surgery. There were 2 (2%, 95% CI 0–4) instances of arthrofibrosis requiring knee manipulation under anesthesia within 90 days of surgery. There were 2 (2%, 95% CI 0–4) instances of open reoperation within 90 days of surgery. One of these patients experienced a postoperative patellar tendon rupture after TKA. One of these patients experienced a hematogenous
infection after international travel after THA requiring 2-staged exchange (Table 3). There were zero incidents of intraoperative complications, blood transfusions, admission to the hospital, adverse events within the ASC, VTE, or readmissions for postoperative pain.

**Discussion**

The safety of initiating an outpatient TJA program at a freestanding ASC has been published previously in a limited fashion [4,6,17,18]. The safety of major surgery in ambulatory surgery centers has been questioned in mainstream media [20]. Limited studies have been published examining the safety of outpatient TJA in the ASC setting immediately after initiating a program [2]. The purpose of this study was to demonstrate the safety of outpatient TJA in a freestanding ASC immediately after establishing an evidence-based TJA outpatient program. As patient recovery pathways, anesthesia pathways, surgical techniques, and cost containment models have been refined and the Center for Medicare and Medicaid Services has allowed outpatient TKA in the hospital setting, there is significantly more interest in performing outpatient TJA. The current literature defines outpatient TJA in numerous ways including 23-hour stays, discharge to skilled nursing facility, discharge to a medically staffed hotel, or direct discharge to home. In addition, the site of surgery is also varied including traditional hospital setting, hospital-attached ASC, or freestanding ASC. For a surgeon contemplating initiating a TJA program at an ASC, there are currently limited data defining the safety curve during the outset of the program.

There are numerous studies demonstrating significant advantages of utilizing multimodal pain pathways to manage postoperative pain for patients undergoing TJA [22-24]. There are also numerous studies illustrating the advantages of IV and topical administration of TXA during TJA [25]. There are many studies showing the positives of early ambulation after TJA and utilization of aspirin, warfarin, or lovenox for VTE prophylaxis [26,27].

For this study, the surgeons and anesthesia team collaboratively formed an agreed-upon multidisciplinary TJA pathway before performing the first outpatient TJA. Using established evidence-based guidelines, the pathway allowed for surgeon preferences for preoperative pain medication, postoperative pain medication, use of gabapentin, administration of IV or topical TXA, and VTE prophylaxis. All surgeons adhered to strict patient selection criteria. All patients had preoperative visits with the surgical team, anesthesia team, and physical therapy team. All surgeons were high-volume TJA surgeons without previous outpatient TJA experience at a freestanding ASC. Two surgeons had performed same-day discharge TJA at the hospital before the program initiation.

The rate of major postoperative complications including 2 open reoperations within 90 days of surgery was 2%. The complications included a postoperative patellar tendon rupture status after TKA with an unresolved patella requiring primary repair and a hematogenous infection after whirlpool use in a developing country after THA requiring a 2-staged exchange.

There was a 100% rate of direct discharge to home after TJA at the ASC at a mean time of 135 minutes and 132 minutes for THA and TKA, respectively. There were zero incidents of intraoperative complications, blood transfusions, admission to the hospital, adverse events within the ASC, VTE, or readmissions for postoperative pain. As the results show, the rate of complications was relatively low for a newly initiated outpatient TJA program at a standalone ASC. The authors attribute this success to a collaborative effort with surgeons and anesthesia; preoperative patient visits with the surgeon, anesthesiologist, and PT; sound surgical technique; blood conservation techniques; following established evidence-based guidelines (pain management, prophylactic antibiotic administration, VTE prophylaxis, TXA administration); early ambulation postoperatively with PT guidance; use of appropriate home PT and nursing; and reliable patient communication and follow-up.

There are several limitations to this study. This study is a retrospective cohort review. There are 4 surgeons involved with utilization of different surgical techniques. The established collaborative pathway is evidence based but allows for surgeon preference in postoperative oral pain medication, surgical technique, and VTE prophylaxis. The patients underwent a thorough multidisciplinary preoperative review to determine candidacy for TJA at the ASC, and all patients understood the lack of availability for overnight stay at the ASC.

As the popularity of outpatient TJA increases, the study demonstrates the importance of forming a collaborative evidence-based pathway to minimize complications. The pathway allowed for evidence-based surgeon preference in postoperative oral pain medication, surgical technique, and VTE prophylaxis; this shows the generalizability to use a similar pathway for TJA at ASCs. Furthermore, the study demonstrates direct discharge to home within 3 hours of surgery is safe with few 30-day and 90-day complications. As payers, patients, and surgeons increasingly utilize ASCs for TJA,

### Table 1
Subject characteristics (N = 115).

| Characteristics                              | Hips (n = 37) | Knees (n = 78) |
|----------------------------------------------|--------------|---------------|
| Age at surgery (y)                          | 55 ± 8       | 58 ± 7        |
| Male gender                                 | 23 (62)      | 45 (58)       |
| Body mass index (kg/m²)                     | 29 ± 4       | 31 ± 5        |
| Side                                         |              |               |
| Right                                        | 13 (35)      | 38 (48)       |
| Left                                         | 24 (65)      | 40 (52)       |
| ASA class                                    |              |               |
| I                                            | 33 (89)      | 55 (71)       |
| II                                           | 4 (11)       | 23 (29)       |
| Recovery time (min)                         | 135 ± 32     | 132 ± 31      |
| Length of follow-up (wk)                    | 14.6 ± 9.9   | 23.1 ± 16.8   |

ASA, American Society of Anesthesiologists physical classification system.

a Data are expressed as mean ± standard deviation.
b Data are expressed as number (percent).
c Starts with the transfer of the patient from the operating room to postanesthesia care unit and concludes at the time the patient is discharged from the surgery center.

### Table 2
Subject comorbidities (N = 115).

| Comorbidity                  | Hips (n = 37) | Knees (n = 78) |
|------------------------------|--------------|---------------|
| Non–insulin-dependent diabetes | 1 (3)*      | 3 (4)         |
| Cardiac disease              | 0            | 2 (3)         |
| Kidney disease               | 0            | 1 (1)         |
| History of stroke            | 0            | 0             |
| Malnutrition                 | 0            | 0             |

* Data are expressed as number (percent).

### Table 3
30 and 90 day complications (N = 5).

| Number | Days | Complication                              | Treatment                     |
|--------|-----|-------------------------------------------|-------------------------------|
| 1      | 30  | Intertrochanteric femur fracture           | Nonoperative management       |
| 2      | 90  | Arthrofibrosis                            | Manipulation under anesthesia  |
| 1      | 90  | Patellar tendon rupture during therapy     | Surgical repair               |
| 1      | 90  | Hematogenous infection                    | Two-staged exchange arthroplasty |
the authors believe it will be important to form and review collaborative evidence-based pathways to improve safety and minimize complications. The study shows that initiating a TJA program at an ASC is safe after development of a multidisciplinary pathway.

Conclusions

Outpatient TJA with direct discharge to home at a standalone, independent ASC is a safe option after development of a multidisciplinary TJA pathway.

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