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Original research

Presurgical optimization and opioid-minimizing enhanced recovery pathway for ambulatory knee and hip arthroplasty: postsurgical opioid use and clinical outcomes

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ABSTRACT

Background: Enhanced recovery after surgery (ERAS) pathways offer approaches to achieve successful ambulatory primary total knee and total hip arthroplasty (TKA/THA) while meeting the "Triple Aim" of healthcare: patient satisfaction, population health, and value. We evaluated outcomes from an ERAS pathway designed to maximize patients' eligibility for ambulatory TKA/THA while reducing costs, complications, and postsurgical opioid use.

Methods: This retrospective study included 220 consecutive unique commercially insured patients who underwent TKA (n = 113) or THA (n = 138) in an ambulatory surgery center between June 1, 2015 and November 16, 2017. The ERAS pathway encompassed early presurgical through home recovery periods. Key elements included presurgical patient engagement; creation of realistic expectations; optimization of modifiable medical, physical, and social factors; and creation of individualized multimodal opioid-sparing pain management. No home services were used. Adverse events and unplanned admissions within 30 and 60 days, satisfaction, and opioid use were analyzed descriptively.

Results: All patients (mean [range] age, 58 [22-84] years; 49% women) had same-day discharge. Within 30 days, 7 (2.8%) patients experienced an adverse event, 3 (1.2%) had an emergency department or urgent care visit without admission, and 8 (3.2%) had an unplanned admission. Within 60 days, 3 additional patients had an emergency department/urgent care visit. Most patients (206 [82.1%]) did not require a second opioid prescription. Patient satisfaction was high.

Conclusions: This ERAS pathway may help meet the Triple Aim for outpatient joint replacement, expand the eligible patient population, and reduce postsurgical opioid use. Further research is warranted.

Introduction

Although ambulatory total joint arthroplasty (TJA), including total knee and hip arthroplasty (TKA and THA), is growing rapidly, continued success requires commitment to achieving the "Triple Aim" of healthcare [1]: improving patient experience of care, improving population health, and reducing healthcare costs. Although examples of successful ambulatory TJA exist [2,3], critics credit these to careful patient selection based on clinical and social support standards [2]. There is a need for comprehensive care models that are practicable and effective in broader patient populations.

To meet the Triple Aim of healthcare, an ambulatory TJA program needs to ensure that patients cannot only be discharged home on the same day but also stay home safely and comfortably. Although this can be accomplished with use of home health services (eg, physical therapy, nursing), such care is costly [4], and in rural areas can be variable in quality and difficult to monitor. Poorly controlled pain and opioid-related nausea can delay discharge [5],

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and opioid-related adverse events (AEs) are associated with readmission [6], higher costs [6], and potential chronic postsurgical opioid use [7], all of which can derail the benefits of ambulatory surgery. In the setting of increased reliance on self-care, complications such as infection, thrombolytic events, and falls; emergency department (ED) or urgent care (UC) visits; unplanned hospital admissions; and return to surgery are of major concern.

Although largely limited to inpatient surgeries, enhanced recovery after surgery (ERAS) pathways can deliver the type of comprehensive care needed to meet all dimensions of the Triple Aim. However, there is limited published literature on postsurgical outcomes of ERAS pathways specifically designed for ambulatory TJA. The objective of this retrospective study is to describe a comprehensive outpatient ERAS pathway for TKA/THA and the postsurgical outcomes of the pathway. The pathway focused on expanding the eligible patient population, improving patient satisfaction, reducing postsurgical complications and costs, and minimizing the duration of postsurgical opioid use in the low-cost setting of a freestanding ambulatory surgery center (ASC).

Material and methods

This is a retrospective, single-center chart review of 220 consecutive unique commercially insured patients who underwent outpatient primary TKA or THA between June 1, 2015 and November 16, 2017, in a freestanding ASC. This study was approved by 2 Institutional Review Boards. Patient data were deidentified, and the Institutional Review Boards granted a waiver of written informed consent.

The comprehensive ERAS pathway is an outpatient program that was developed over >10 years by the senior author of this report in response to patients' needs and desire to improve outcomes. There were no inclusion or exclusion criteria for entry into the ERAS pathway. The ERAS pathway was initiated at the patient's first clinic visit with a presurgical program for conservative/nonsurgical care of arthritis and encompassed the period between decision to undergo TKA/THA through postsurgical at-home recovery (Appendix A). Key elements of the pathway included patient engagement; physical, medical, and social optimization; setting realistic expectations for pain; and presurgical development of an individualized, opioid-sparing, multimodal pain management program.

Patient engagement started with a program of conservative/nonarthroplasty care of knee and hip osteoarthritis, including physical optimization and pain control, consistent with clinical practice guidelines for the treatment of osteoarthritis [8,9]. As part of the conservative treatment for arthritis, physical therapy was used to individually customize an at-home strengthening and stretching program through exercises (1 h/d) and walking or other upright weight-bearing aerobic exercises (6 h/wk) to improve function and reduce pain. Other elements included assistance with weight loss, nonopioid pain medication trials, appropriate intra-articular steroid/viscosupplementation injections, and medical optimization of modifiable risk factors.

Medical optimization aimed to correct not only the medical problems (ie, modifiable risk factors) known to increase risk of complications but also those found by the senior author to affect outcomes and satisfaction through patient compliance and engagement. The conservative care of arthritis program was designed to not only treat arthritis symptoms but also expand the number of patients suitable for outpatient surgery by preparing the patients for successful outpatient TKA/THA when they wished to have one, minimizing delays to surgery when the patients decided to have TKA/THA.

Once conservative care of arthritis failed to meet the patient's expectations, he or she was assisted (if needed) in additional medical, physical, and social optimization to meet the criteria for same-day discharge. There were no inclusion or exclusion criteria for entry into this phase of the ERAS pathway, and all patients were assisted with meeting the goals for surgery for as long as needed. Patient engagement in his or her care was a critical aspect of preparation for surgery, and patients unwilling to engage, participate, and comply with the ERAS pathway were offered nonsurgical treatment of osteoarthritis and referral to care elsewhere.

As part of their social optimization, patients were required to have a "JointCoach"—a family member or friend—who assisted the patient throughout the entire presurgical and postsurgical period. The JointCoach often assisted during the conservative/nonarthroplasty care of arthritis program and was required to be present at the patient's decision for surgery appointment with the senior author to determine the patient's and JointCoach's readiness or if additional preparation was needed. The JointCoach was required to demonstrate both understanding and willingness to perform his or her duties. If either the patient or JointCoach was determined to be unprepared or unwilling, surgery was delayed until this could be rectified. The JointCoach was also required to be at the ASC on the day of surgery and to stay with the patient for 3 days after surgery to ensure compliance with postsurgical medication and adherence to exercise protocols. Early in the process, both the patient and JointCoach were educated in realistic expectations for pain, the dangers of opioid use, opioid tapering, sleep hygiene, exercise and walking programs, walker safety, wound care, and home preparation. Refresher education was provided by the senior author and staff, including nurses and mid-level providers, on the day of surgery.

A short course of presurgical physical therapy was initiated to educate patients on use of adaptive aids (eg, walker and shoe aids); home preparation and safety; activities of daily living; joint precautions; and postsurgical strengthening and exercise programs and icing and elevation for pain and edema control. Patients were only discharged from the surgical facility when they met discharge criteria and were considered to be medically, physically, and socially prepared to be in their home without the need for home services. As part of this discharge criterion, patients and JointCoaches had to demonstrate the ability to use postsurgery recovery aids; the ability to perform activities of daily living, exercises, and stair navigation; and an understanding of medications, home safety, precautions, and appropriate icing and elevation.

Patients underwent presurgical opioid medication trials to develop individualized plans for management of pain, nausea, itching, constipation, and urinary retention. No patients were excluded for chronic or presurgical opioid use. Information on previous opioid use and efficacy, as well as concomitant use of antinausea, anti-itch, and anticonstipation medications, was collected and combined with other patient information (eg, physical and medical history) to determine the appropriate dosages for the trial. If needed, multiple trials were performed to determine the best treatment plan. Polyethylene glycol and docusate sodium twice daily (for prevention of constipation), along with adequate fluids to prevent dehydration, were started 1 day before the opioid medication trial began; a program of constipation rescue medication was also available. Patients were instructed to take antinausea and anti-itch medications before food and to take their oral opioid 4 times daily after food for 2 days. Patients were also encouraged to be active. The goal was to provide a 60% reduction in discomfort without significant side effects. No opioids were prescribed before surgery and following the 2-day presurgical opioid medication trials, opioids were discontinued until after the surgery, and patients and their JointCoaches were directed to taper patients off opioid medications as soon as possible after surgery. Anticonstipation medications were initiated 3 days before surgery. The

Table 1
Surgical protocol.

Method	TKA	THA
Implant	SIGMA	CORAIL and PINNACLE cup
Approach	Subvastus	Anterior; Hana table, C-arm
Tourniquet use	No	No
Bipolar tissue sealer	Radiofrequency energy and saline hemostatic sealing device	Radiofrequency energy and saline hemostatic sealing device
Sutures	Spiral knotless tissue control device	Spiral knotless tissue control device
Skin closure system	2-Octyl cyanoacrylate and self-adhering mesh	2-Octyl cyanoacrylate and self-adhering mesh
Surgical dressing	Silver-impregnated occlusive dressing	Silver-impregnated occlusive dressing
Drain use	No	No

SIGMA, CORAIL, and PINNACLE are registered trademarks of DePuy Synthes (Raynham, MA). Hana is a registered trademark of Mizuho OSI (Union City, CA).

individualized opioid pain medication program (with anti-constipation, anti-itch, and antinausea medication) was initiated just prior to surgery. A nonopioid pain medication program (acetaminophen, meloxicam, or celecoxib), developed at the time of conservative care, was initiated 1 week presurgery and continued for at least 6 weeks postsurgery to facilitate rapid opioid tapering and postsurgical pain control.

Anesthesia was considered part of the multimodal pain management program. Intraoperatively, hypotensive and multimodal analgesia methods (Table 1) were applied to minimize trauma, pain, blood loss, and infection risk and promote early function and mobility.

Patients with no previous history of deep vein thrombosis (DVT) or pulmonary embolism (PE) received aspirin 325 mg immediately before surgery and knee-high compression stockings for 2 weeks; compression devices were used during surgery and while at the ASC. For both surgeries, a single dose of warfarin 1.25 mg was given postsurgically in the recovery area to meet the surgical facility's interpretation of Medicare requirements for anticoagulation. Patients without increased risk factors for DVT/PE and not currently taking chronic anticoagulation medication were not given additional warfarin but continued taking aspirin 325 mg daily for 6 weeks postsurgery. Exercises for the prevention of DVT were initiated in the recovery area, and ambulation was generally initiated within 1-2 hours after surgery. A similar process was followed for patients with a history of DVT or PE; however, these patients received aspirin 325 mg daily for 1 week and a warfarin protocol for 6 weeks. If the patient was currently using anticoagulants, they were given enoxaparin bridging presurgery as medically indicated and aspirin 325 mg daily for 1 week postsurgery. If currently using warfarin, the regular dose was restarted immediately postsurgery. The use of any other chronic blood thinner was restarted 3 days after surgery.

TKA was performed using the subvastus approach with an integrated knee system without tourniquet; in the senior author's experience, the subvastus approach limits risk of disrupting the

Table 2
Postsurgical complications.

Complication, n (%)	30 d			60 d		
	TKA (n = 113)	THA (n = 138)	Total (N = 251)	TKA (n = 113)	THA (n = 138)	Total (N = 251)
Severe AE[a]	2 (1.8)	4 (2.9)	6 (2.4)	2 (1.8)	4 (2.9)	6 (2.4)
Return to surgery	2 (1.8)	4 (2.9)	6 (2.4)	2 (1.8)	4 (2.9)	6 (2.4)
Deep wound infection	2 (1.8)	1 (0.7)	3 (1.2)	2 (1.8)	1 (0.7)	3 (1.2)
Fracture	0	2 (1.4)	2 (0.8)	0	2 (1.4)	2 (0.8)
Dislocation	0	1 (0.7)	1 (0.4)	0	1 (0.7)	1 (0.4)
Minor AE[b]	0	1 (0.7)	1 (0.4)	0	1 (0.7)	1 (0.4)
Urinary tract infection	0	1 (0.7)	1 (0.4)	0	1 (0.7)	1 (0.4)
Unplanned admission	4 (3.5)	4 (2.9)	8 (3.2)	4 (3.5)	4 (2.9)	8 (3.2)
Medical[c]	2 (1.8)	1 (0.7)	3 (1.2)	2 (1.8)	1 (0.7)	3 (1.2)
Ulcer/gastrointestinal complication[d]	2 (1.8)	0	2 (0.8)	2 (1.8)	0	2 (0.8)
Severe constipation	0	1 (0.7)	1 (0.4)	0	1 (0.7)	1 (0.4)
Surgical[e]	2 (1.8)	3 (2.2)	5 (2.0)	2 (1.8)	3 (2.2)	5 (2.0)
Infection or wound complication[f]	2 (1.8)	1 (0.7)	3 (1.2)	2 (1.8)	1 (0.7)	3 (1.2)
Fracture[g]	0	2 (1.4)	2 (0.8)	0	2 (1.4)	2 (0.8)
ED or UC visit without admission	1 (0.9)	2 (1.4)	3 (1.2)	2 (1.8)	4 (2.9)	6 (2.4)
Other medical event[h]	1 (0.9)	1 (0.7)	2 (0.8)	2 (1.8)	3 (2.2)	5 (2.0)
Dislocation[i]	0	1 (0.7)	1 (0.4)	0	1 (0.7)	1 (0.4)

[a] The following severe AEs were not experienced: deep vein thrombosis or PE, stroke or cerebrovascular accident, myocardial infarction, organ or space infection, wound dehiscence, unplanned intubation, peripheral nerve injury, ventilator >48 h, renal insufficiency or failure, cardiac arrest, sepsis, septic shock, and death.
[b] The following minor AEs were not experienced: pneumonia and superficial wound infection.
[c] The following unplanned medical admissions were not experienced: pneumonia, deep vein thrombosis or PE, myocardial infarction or other cardiovascular events, stroke, renal insufficiency or failure, urinary tract infection, sepsis or septic shock, anemia, pulmonary complication, and mental disorder.
[d] One patient experienced 2 separate gastrointestinal bleeds after 2 separate TKAs.
[e] The following unplanned surgical admissions were not experienced: dislocation, hernia or hematoma, mechanical failure or complication, acute pain, hemarthrosis, and sprain or contusion.
[f] One patient left the occlusive surgical dressing in place for 28 d before developing an infection. A second patient chronically picked at the nail beds and seeded the joint from the chronically infected cuticles (per infectious disease specialist). The third patient was noncompliant with postsurgical protocols and returned to an agricultural job within an unhygienic environment immediately after surgery.
[g] One patient was knocked down while training a horse; the second was a chronic opioid user who fell subsequent to self-administered opioid overdose.
[h] Included back pain, shortness of breath, ultrasound (for suspected deep vein thrombosis), reaction to rivaroxaban with ultrasound, and kidney stone (1 event each).
[i] Dislocation was treated at the ambulatory surgery center and did not involve an admission.

Table 3
Patient satisfaction.

Composite score	Responses, n (%)[a]
Recommendation of the facility[b]	n = 187
Yes, very much	179 (95.7)
Yes, a good amount	7 (3.7)
Yes, slightly	0
No, not at all	1 (0.5)
Pain management[c]	n = 561
Yes, very much	495 (88.2)
Yes, a good amount	62 (11.1)
Yes, slightly	1 (0.2)
No, not at all	3 (0.5)
Education about surgery, medication, and recovery[d]	n = 370
Yes, very much	337 (91.1)
Yes, a good amount	30 (8.1)
Yes, slightly	1 (0.3)
No	2 (0.5)
Discharge education[e]	n = 374
Yes, very much	331 (88.5)
Yes, a good amount	40 (10.7)
Yes, slightly	1 (0.3)
No	2 (0.5)
Communication with nurses[f]	n = 374
Yes, very much	366 (97.9)
Yes, a good amount	5 (1.3)
Yes, slightly	1 (0.3)
No	2 (0.5)
Communication with physician[g]	n = 371
Yes, very much	353 (95.1)
Yes, a good amount	15 (4.0)
Yes, slightly	0
No	3 (0.8)

[a] Sample size based on the number of responses, which in some cases exceeded the number of patients because some categories involved multiple questions.
[b] Would you recommend this surgical facility to others undergoing surgery?
[c] Composite score of 3 questions: (1) During your surgical facility stay, was your pain controlled most of the time? (2) During your surgical stay, were the nurses able to control your pain at a level where you were comfortable? (3) During the course of your joint replacement, was the pain control program effective in keeping your pain at a manageable level?
[d] Composite score of 3 questions: (1) Did you receive adequate educational materials about what to expect during the joint replacement process? (2) Did the educational materials give you a good understanding of the things you were accountable for doing in recovering from your joint replacement surgery? (3) Did the educational materials you received give you a clear understanding of why you need to take each of your medications?
[e] Composite score of 2 questions: (1) When you left the surgical facility, did you fully comprehend items that you were accountable for doing in recovering from your joint replacement surgery? (2) When you were discharged from the surgical facility, were you fully aware of the reasons for taking each of your medications?
[f] Composite score of 2 questions: (1) During your surgical facility stay, were the nurses and staff polite and did they treat you kindly? (2) During your surgical facility stay, did the nurses and staff explain items in a way that you could easily comprehend?
[g] Composite score of 2 questions: (1) During your stay at the surgical facility, was the surgeon polite and did he treat you kindly? (2) During your time at the surgical facility, did the surgeon explain important procedural items in a thorough manner?

extensor mechanism repair during the aggressive postsurgical flexibility and self-stretching protocol. THA was performed using the anterior approach with a complete hip system, acetabular cup system, and fracture table. Patients received spinal anesthesia; awake sedation; adductor canal block with bupivacaine HCl (TKA only); periarticular infiltration with liposomal bupivacaine 266 mg (EXPAREL; bupivacaine liposome injectable suspension; Pacira BioSciences, Inc., Parsippany, NJ), bupivacaine HCl, and adjuncts; anterior lateral femoral cutaneous nerve field block by the surgeon with liposomal bupivacaine 266 mg and bupivacaine HCl (THA only); and restricted intravenous opioids. Hemostasis was achieved using hypotensive anesthesia, tranexamic acid, electrocautery, and a bipolar tissue sealer. After surgery, patients and their JointCoach were moved to a private suite where they reviewed walker training, exercise, dressing care, medication management, icing and elevation, and complication avoidance. Patients were discharged home without health services on a multimodal pain management regimen (nonopioid analgesics and 7-day opioid supply). Staff at the ASC called patients the day after surgery. Patients were also given a triage line to call during business hours and the surgeon's/partners' numbers to call after business hours. They were encouraged to call at any time, including before visiting an ED or UC. The senior author's staff contacted patients 2-5 days after surgery to evaluate progress and answer questions. Patients were instructed to go to the ED if they experienced a heart attack or stroke, could not breathe, or fell and could not get up. Outpatient physical therapy was initiated within 3 business days of surgery and included 6 visits over 4 weeks, which was renewed at the 4-week postoperative visit for an additional 4 visits over 4 weeks if the physical therapist determined it medically appropriate.

Patients who provided e-mail addresses received Internet-based satisfaction surveys via CareSense (DePuy Synthes, Conshohocken, PA) at postsurgical week 2. The surveys were adapted from the Hospital Consumer Assessment of Healthcare Providers and Systems Survey, a national, standardized survey and data collection methodology for measuring patients' perspectives on hospital care [10].

Visits to the ED or UC and hospital admissions within 60 days postsurgery were determined by patient report and internal medical records pertaining to care in the 8-week postsurgical period. Patient reports and medical records were further validated using medical records obtained from regional medical facilities through which the patient may have obtained care. Opioid refills from the surgeon within the 8-week postsurgical period were assessed. AEs, as defined by a previous American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) study [11], were also assessed within 30 and 60 days postsurgery via patient survey, internal medical records, and regional medical facility records inquiries. Data were summarized descriptively and are presented as mean (standard deviation) for continuous variables and frequency (%) for categorical variables.

Results

During the analysis period, 220 unique, consecutive patients underwent 251 TKA (n = 113) or THA (n = 138) surgeries. No patient was excluded from the analyses. Patients' mean (range) age was 58 (22-84) years, 6.0% (n = 15) were ≥65 years old, and 49% (n = 124/251) were women. Twenty-seven patients (10.8%) had heart disease, and 15 (6.0%) had diabetes. All patients were discharged by 9 PM on the day of surgery. No patients were discharged with home services. Table 2 summarizes complications overall and by procedure. There were no directly surgery-related or day-of-surgery transfusions or day-of-surgery reports of DVT or PE. There were also no day-of-surgery hospital transfers or admissions. Six patients (2.4%) experienced 6 severe AEs. One patient had a minor AE. All AEs occurred within 30 days postsurgery. Two patients had unplanned medical admissions, including 1 patient with severe constipation and 1 patient with 2 gastrointestinal bleeds (associated with 2 separate TKAs and 1 transfusion), requiring overnight stays in a rural-access hospital. Five patients had unplanned surgical admissions: 2 (0.8%) for postoperative periprosthetic fractures >2 weeks postsurgery and 3 (1.2%) for deep infection 28-30 days postsurgery. Three patients (1.2%) had an ED or UC visit without hospital admission within 30 days, and 6 (2.4%) had an ED or UC visit without admission within 60 days. One of these patients presented at the ED with a dislocation but had returned to surgery at the ASC rather than the hospital. No patients died within 60 days after surgery. With the exception of ED or UC

Table 4
Comparison of complications with published ACS-NSQIP data.

Complication, n (%)	ACS-NSQIP	Current study	
	30 d (N = 121,669) [11]	30 d (N = 251)	60 d (N = 251)
Severe AE	2171 (1.78)[a]	6 (2.4)	6 (2.4)
Return to surgery	1046 (0.86)	6 (2.4)	6 (2.4)
Thrombolic event (DVT/PE)	790 (0.65)	0	0
Deep wound infection	209 (0.17)	3 (1.2)	3 (1.2)
Organ/space infection	163 (0.13)	0	0
Sepsis	152 (0.12)	0	0
Wound dehiscence	130 (0.11)	0	0
Myocardial infarction	74 (0.06)	0	0
Death	59 (0.05)	0	0
Unplanned intubation	38 (0.03)	0	0
Renal insufficiency	31 (0.03)	0	0
Septic shock	27 (0.02)	0	0
Stroke/CVA	25 (0.02)	0	0
Cardiac arrest requiring CPR	19 (0.02)	0	0
Ventilator >48 h	18 (0.01)	0	0
Renal failure	13 (0.01)	0	0
Dislocation	NR	1 (0.4)[b]	1 (0.4)[b]
Minor AE	450 (0.37)[a]	1 (0.4)	1 (0.4)
Superficial infection	240 (0.20)	0	0
Urinary tract infection	131 (0.11)	1 (0.4)	1 (0.4)
Pneumonia	88 (0.07)	0	0
Unplanned admission	3336 (2.74)[a]	8 (3.2)	8 (3.2)
Medical	1445 (1.19)	3 (1.2)	3 (1.2)
Thrombolic event (DVT/PE)	241 (0.20)	0	0
Ulcer/gastrointestinal complication	109 (0.09)	2 (0.8)	2 (0.8)
Pneumonia	65 (0.05)	0	0
MI, CHF, or other cardiovascular complications	56 (0.05)	0	0
Sepsis/septic shock	50 (0.04)	0	0
Pulmonary complications	35 (0.03)	0	0
Anemia	31 (0.03)	0	0
Renal insufficiency or failure	31 (0.03)	0	0
Urinary tract infection	29 (0.02)	0	0
Mental disorders	12 (0.01)	0	0
Stroke	12 (0.01)	0	0
Other medical reason	774 (0.64)	1 (0.4)	1 (0.4)
Surgical	1886 (1.55)[a]	5 (2.0)	5 (2.0)
Infection or wound complication	721 (0.59)	3 (1.2)	3 (1.2)
Hernia or hematoma	95 (0.08)	0	0
Acute pain	94 (0.08)	0	0
Dislocation	92 (0.08)	0[b]	0[b]
Fracture	87 (0.07)	2 (0.8)	2 (0.8)
Mechanical failure or complication	67 (0.06)	0	0
Hemarthrosis	16 (0.01)	0	0
Sprain or contusion	16 (0.01)	0	0
Other surgical reason	698 (0.57)	0	0

CHF, congestive heart failure; CPR, cardiopulmonary resuscitation; CVA, cerebrovascular accident; MI, myocardial infarction; NR, not reported.
[a] Number of unique patients with ≥1 event.
[b] One patient experienced a dislocation, which was treated at the ASC and thus was not considered an unplanned admission.

visits without hospital admission, no additional complications were identified 31-60 days postsurgery (Table 2).

Most patients reported that they would recommend the ASC "very much" or a "good amount" (99.5%) and were "very much" or a "good amount" satisfied with pain management (99.3%) and education and communication (>99.0%) (Table 3). Two hundred six patients (82.1%; TKA = 91/113 [80.5%]; THA = 115/138 [83.3%]) did not request a second opioid prescription within 8 weeks postsurgery.

Discussion

Patients participating in this outpatient patient-engaging opioid-minimizing ERAS pathway for TKA/THA were able to undergo surgery at a freestanding ASC. They experienced 100% same-day discharge home without home services, with low rates of complications and high levels of satisfaction, meeting at least 2 of the 3 Triple Aims. More than 80% did not require more than a 7-day opioid prescription from the surgeon.

Unique aspects of this ERAS pathway were the use of a comprehensive approach that began with a conservative/nonsurgical care of arthritis program and continued through the at-home recovery period. The pathway included education, customized multimodal pain management, and extended follow-up and outcomes assessment to ensure consistent quality. Patient engagement and assistance with medical, social, and physical optimization made it possible to include patients who likely would have been rejected from other ASC programs. The proactive, individualized approach was taken to manage pain, reduce opioid exposure, and promote recovery, as well as to expand the eligible patient population. Because pain and nausea are 2 of the most common reasons for delayed discharge in outpatient TJA [2,5], this approach may allow more patients to receive outpatient surgery, insurance, and clinical eligibility permitting. Additionally, the use of hypotensive anesthesia, tranexamic acid, bipolar tissue sealer, and no tourniquet enabled surgery to proceed without any day-of-surgery or directly surgery-related transfusions.

Hospital stay, stay at a skilled nursing facility (SNF), and use of home healthcare services substantially increase total costs of care

for TKA and THA [4]. Discharge to an SNF, in particular, can increase the costs of a 90-day episode-of-care for primary TKA and THA by $3189 and $4486 over discharge to home under self-care [4]. Patients undergoing TKA/THA as part of this ERAS pathway were discharged directly home, without a stay at the ASC and without use of an SNF or home healthcare, recovering in the comfort of their homes without compromising safety. These safe home discharges, together with the low rates of complications observed in our study, suggest that our approach has the potential to provide cost-effective care, the third of the Triple Aims. However, costs were not analyzed as part of the current study, and this outcome requires further evaluation, as there are many different cost contributors for TJA, including patient optimization, physical therapy, anesthesia, hospital stay, and UC and ED visits.

Rates of surgical complications were generally comparable with those previously reported in more selected patient populations [2], as well as those in the ACS-NSQIP database (Table 4) [11]. The NSQIP rates may be underreported compared with other large national databases [12], suggesting that our rates could be lower than other national averages. In the current study, more than 80% of patients did not ask the surgeon for an opioid prescription refill beyond their original 1-week prescription within 8 weeks postsurgery. Two retrospective studies of patients undergoing THA [13] and TKA [14] in the Humana administrative claims database showed that 26% and 38%, respectively, filled an opioid prescription in the second month after surgery. However, our opioid use data should be considered exploratory because prescription tracking during the analysis period was limited, and we were unable to determine how many received additional opioid prescriptions from a primary care or other provider or whether patients used all their medication. No patients were excluded from surgery for chronic presurgical opioid use, and we did not differentiate between chronic opioid users and opioid-naive patients, which could affect the number of requests for a second opioid prescription.

This study is limited by the retrospective design, potential for uncontrolled confounds, lack of a control group, and moderate sample size. All surgeries were performed by 1 surgeon, which may limit generalizability but may have increased the consistency of surgical and treatment protocols and infiltration techniques. Age was not an exclusion criterion, and 6% of patients were $\geq$65 years old; although this proportion is too small to extrapolate from, the current findings raise the question of whether older patients could safely receive outpatient TJA. The ERAS pathway was developed over an extended period, and at this time, not all of the procedures employed have been formally validated. Future studies will be required to determine the aspects of the program that best support positive patient outcomes and that enable reductions in total healthcare costs.

These findings suggest that a comprehensive opioid-minimizing ERAS pathway for primary TKA and THA designed to assist patients in eligibility for same-day discharge may help optimize clinical outcomes, reduce opioid requirements, and provide patient satisfaction, potentially reducing the overall cost of care. This protocol shows promise to offer the quality of care required to meet the Triple Aim. These results can serve to inform future prospective clinical trials.

Conclusions

Results of this retrospective, single-center chart review of commercially insured patients suggest that this comprehensive ERAS pathway, which incorporates anterior/subvastus surgical techniques without the use of a tourniquet, individualized opioid-minimizing pain management, presurgical optimization of modifiable risk factors, education, and engagement may help optimize outcomes for TKA/THA as needed to meet the Triple Aim. These results merit follow-up with additional studies in larger populations to further evaluate clinical and economic outcomes using this approach.

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Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.artd.2019.08.010.

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