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Original Research

Efficacy and Safety of a Patient Selection Tool for Predicted Discharge at an Ambulatory Surgical Center: A Pilot Study

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ABSTRACT

Background: There is a paucity of validated risk stratification tools to assess which patients can safely and predictably undergo outpatient total hip (THA) or knee arthroplasty (TKA) in an ambulatory surgery center (ASC).

Methods: Our novel patient selection tool was prospectively applied to 190 consecutive primary THA and TKA performed by a single surgeon at a single ASC. We identified the proportion of patients discharged home the same day, those requiring a one-night stay, or those with failed discharge within 23 hours. A retrospective chart review was performed to determine if any demographic parameters were risk factors for an overnight stay.

Results: Overall, 190 (100%) patients selected for outpatient THA and TKA were discharged home within 23 hours. One hundred and four patients (55%) were discharged the same day of surgery, whereas 86 (45%) required overnight stay and were discharged on postoperative day 1. Female sex (odds ratio [OR]: 4.1, 95% confidence interval [CI]: 2.0-8.2, $P < .001$), THA (OR: 2.5, 95% CI: 1.1-5.5, $P = .022$), and heavier body mass index (OR: 1.0, 95% CI: 1.0-1.2, $P = .022$) were identified as independent risk factors for staying overnight in the ASC.

Conclusions: In this pilot study, we found that 100% of outpatient THA and TKA-eligible patients were able to be discharged home by postoperative day 1. Additionally, we found that this selection tool is safe and effective at predicting short-stay discharge in an ASC.

Introduction

Over the last 5 years, there has been a considerable shift toward rapid recovery and short-stay total hip arthroplasty (THA) and total knee arthroplasty (TKA). Advances in perioperative protocols in conjunction with appropriate patient selection have proven successful in safely reducing patients' length of stay (LOS) following outpatient THA and TKA [1-5]. The Centers for Medicaid and Medicare Services removed TKA from its inpatient-only list in 2018 and removed THA in 2020. A 36.4% shift to the outpatient setting has occurred over this period of time and is projected to increase beyond 50% by 2026 [5-7]. Outpatient surgery is typically divided into cohorts of patients who are discharged on the same day of surgery (same day) or after a short stay (less than 23 hours). Patient selection is paramount for safely and effectively transitioning major surgeries, such as THA and TKA, to the ambulatory setting [8,9]. However, there is a paucity of validated, publicly available, and universally accepted risk stratification tools to assess those patients who can safely and predictably undergo same-day or short-stay discharge in an ambulatory surgery center (ASC).

Multiple generalized risk assessment indices [10-12] have been used to stratify medical risk factors in arthroplasty patients, but their utility in predicting candidates for rapid recovery is

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unfounded. More recently, selection tools specific to patients undergoing THA and TKA in the outpatient hospital setting have been described [13,14]. The Outpatient Arthroplasty Risk Assessment (OARA) score, for example, is a proprietary patient stratification tool scored across nine medical comorbidity categories and is available via paid subscription [13]. Although the tool possesses a more precise predictive ability than generalized scoring indices, it does not consider any social factors, which may be a limitation, according to the authors [13].

A novel selection tool (Fig. 1) developed by the senior author incorporates medical comorbidities, patient-specific factors, and social influences to best identify patients that can undergo safe outpatient THA or TKA [14]. The criteria were developed through a combination of clinical experience, a review of literature focusing on reasons for failed same-day discharge (SDD) in total joint arthroplasty [3,9,10,13,15-21], as well as guidance from colleagues in anesthesia and nursing. Certain patient variables are considered a hard-stop for eligibility, while patients deemed mild to moderate

Patient Selection Tool for the Arthroplasty and Spine Rapid Recovery Program in the Ambulatory Setting

1. Patients with the following conditions are NOT eligible (HARD STOP)

- ☐ Automatic implanted cardiac defibrillator *(spine only)*. Arthroplasty permitted if only for arrhythmia with persevered heart function
- ☐ History or family history of malignant hyperthermia
- ☐ BMI >40 kg/m2
- ☐ Diabetes (HgA1c>8.5)
- ☐ Platelet count below 100k on preoperative labs
- ☐ Transient ischemic attack or cerebrovascular accident (<1 year from event)
- ☐ End stage renal disease or creatinine >3
- ☐ CHF w/LV EF<40%
- ☐ History of mental illness (bipolar, schizophrenia, or severe depression requiring psychiatric monitoring)
- ☐ Alcohol/Drug Abuse
- ☐ Cognitive impairment
- ☐ Chronic Pain requiring narcotics *(spine patients to be considered case by case)*
- ☐ Chronic, uncontrolled atrial fibrillation (or other arrhythmia w/in 6 months of surgery) and/or unable to discontinue anticoagulation)
- ☐ Obstructive sleep apnea (severe OR non-compliant with treatment)
- ☐ Severe COPD requiring home oxygen or hospitalization and/or oral steroids within past year
- ☐ ASA >3

Sum of all checked items in Sections 2 and 3
RISK LEVEL: (mild ≤3 pts; moderate 4-5 pts.; high >5 pts)

2. Chronic Conditions (each worth 1 point toward risk score)

- ☐ BMI 35-40 kg/m2
- ☐ Diabetes (HgA1c <8.5)
- ☐ Active Smoker
- ☐ Depression (well-managed)
- ☐ Anxiety disorder requiring daily benzodiazepines
- ☐ Long-term steroid use
- ☐ Hemoglobin <10 mg/dL
- ☐ Transient ischemic attack (within 1-5 years from event)
- ☐ Cerebrovascular accident (>1 year from event)
- ☐ Peripheral vascular disease
- ☐ Carotid stenosis >50%
- ☐ Chronic Kidney Disease (Creatinine 2-3)
- ☐ Active cancer AND active chemo or cancer w/bone metastasis
- ☐ Multilevel spine fusion history AND in chronic pain
- ☐ Asthma requiring bronchodilators
- ☐ Shortness of breath (any cause)
- ☐ Chronic obstructive pulmonary disease not requiring oxygen
- ☐ *Obstructive sleep apnea (mild/moderate) and under treatment *(* requires pulmonology clearance note)*
- ☐ Antiplatelet therapy or other blood thinner (excluding aspirin)
- ☐ Pacemaker
- ☐ *CHF w/LV EF 40-60%
- ☐ *Coronary artery disease with history of PCI and/or CABG
- ☐ *Chronic, rate controlled atrial fibrillation (or other arrhythmia) AND able to discontinue anticoagulation *(* requires cardiac clearance)*

3. Lifestyle risk factors (each worth 1 point toward risk score)

- ☐ >75 years old
- ☐ Acute or chronic wound or pressure ulcer
- ☐ Hospitalization or emergency dept visit w/in prior 6 months
- ☐ History of falls
- ☐ Admission to SNF in past 6 months
- ☐ Noncompliance with home medication or with home treatment (ex. Blood glucose monitoring)
- ☐ Requires assistance with home medications
- ☐ Impaired Ambulatory Status (other than orthopedic issue) – such as a walker/wheelchair
- ☐ Poor health literacy
- ☐ Weak social support: *support at home must be identified (family member or close friend)*
- ☐ Limited access to transportation

Points Total: _____

Figure 1. Patient selection tool for the arthroplasty and spine recovery program in the ambulatory setting.

risk are able to undergo outpatient THA or TKA. Recently, this selection tool was retrospectively applied to an unselected, consecutive cohort of patients undergoing THA and TKA in the inpatient hospital setting [14]. The positive predictive value (PPV) and negative predictive value (NPV) of this tool were 86% and 96%, respectively. Given this tool's efficacy in predicting candidates for rapid recovery and discharge in an inpatient hospital cohort, our objective of this manuscript was to examine the efficacy of this patient selection tool in a selected cohort of outpatient arthroplasty patients.

We asked the following questions: (1) Can a novel patient selection tool predict same-day and one-night stay discharge at an ASC? (2) What comorbidity or demographic (including race, sex, and socioeconomic status) risk factors predict staying overnight or failed 23-hour discharge in an ASC? and (3) Is discharging patients the same day or after a one-night stay safe as measured by postoperative 90-day emergency department (ED) visits, readmissions, and complications?

Material and methods

Following institutional review board approval, our novel patient selection tool (Fig. 1) was prospectively applied to 190 consecutive patients who received elective unilateral total joint arthroplasties (THA or TKA) between July 2019 and October 2021. All procedures were performed by a single fellowship-trained adult reconstruction surgeon at an ASC. As part of our study design, all patients meeting the following criteria were to be excluded: patients undergoing revision THA or TKA, conversion THA or TKA requiring removal of hardware, or unicompartmental knee arthroplasty. However, no patients met exclusion criteria, leaving 190 patients that were deemed THA and TKA eligible based on a mild or moderate risk assessment score using the patient selection tool. All patients in the study underwent THA performed with the direct anterior approach or TKA via a medial parapatellar approach. The same technique and implant company were utilized in every case.

A retrospective chart review of our institutional electronic medical record system was then performed on the same consecutive 190 patients to assess demographic factors. Demographics collected included age at the time of surgery, body mass index (kg/m^2) (BMI), procedure type (TKA or THA), insurance status (Medicare, Medicaid, or Private), as well as self-reported variables including sex (female or male), marital status (married, single, divorced, separated, widowed, or unknown), as well as race (Caucasian, Asian, African American, multiracial, or unknown). Socioeconomic status was assessed by correlating a patient's zip code with median income per zip code based on United States Census data similar to prior studies [22]. The Charlson comorbidity index was calculated and stratified as in prior studies [23]. Patient demographics can be seen in Tables 1 and 2.

Utilizing the above patient demographics, we also aimed to determine if patient demographic factors such as race, sex, and socioeconomic status were risk factors for staying overnight or one-night stay discharge in an ASC. Ninety-day complication rates as well as ED visits were analyzed to determine the safety of the patient selection tool. Preoperatively, all patients selected for outpatient THA or TKA complete a one-on-one, virtual perioperative education class with a trained nurse that discusses medication and equipment usage, physical therapy, and wound care/bathing instructions.

All statistics were performed with STATA 14.0 (College Station, TX). Statistical significance was defined as $P < .05$. Continuous and categorical variables were assessed with two-tailed t-tests and chi-squared tests, respectively. Continuous variables were described as means with standard deviations, and categorical variables were

Table 1
Demographics of the whole cohort.

Variable	Mean	Standard deviation
Age	61.2	8.0
BMI	28.3	4.5
Median income per zip code ($)	106,014.00	34,970.33
Race		
African American	17	9.0%
Asian	7	3.7%
Caucasian	144	77.9%
Multiracial	17	9.0%
Unknown	1	0.4%
Insurance type		
Medicare	58	30.5%
Medicaid	24	12.6%
Private	108	56.8%
Marital status		
Single	29	15.3%
Married	135	71.1%
Divorced	15	7.9%
Widowed	9	4.7%
Separated	2	1.1%
CCI		
0	12	6.6%
1 and 2	142	91.8%
3 and 4	36	2.6%
5 and more	0	0%
Surgery type		
THA	52	27.4%
TKA	138	72.6%
Sex		
Female	94	49.5%
Male	96	50.5%

CCI, charlson comorbidity index.

Table 2
Demographics of same-day discharge vs staying overnight.

Variable	Same day (104)	Overnight (86)	*P* value
Age	59.7 ± 7.6	63.1 ± 8.0	.003[a]
BMI	27.7 ± 4.1	28.9 ± 4.9	.066
Socioeconomic status	108,152.90 ± 34,400	103,065.20 ± 35,649.95	.320
CCI			.007[a]
0	9 (8.7%)	3 (3.5%)	
1 and 2	85 (81.7%)	57 (66.3%)	
3 and 4	10 (9.6%)	26 (30.2%)	
5 and more	0 (0%)	0 (0%)	
Race			.113
African American	6 (5.8%)	11 (12.8%)	
Asian	2 (1.9%)	5 (5.8%)	
Caucasian	88 (84.6%)	60 (69.8%)	
Multiracial	8 (7.7%)	9 (10.5%)	
Unknown	0 (0%)	1 (1.2%)	
Insurance type			.477
Medicare	50	34	
Medicaid	13	13	
Private	41	39	
Marital status			.361
Single	13 (12.5%)	15 (17.4%)	
Married	78 (75%)	57 (66.3%)	
Divorced	6 (5.8%)	9 (10.5%)	
Widowed	5 (4.8%)	5 (5.8%)	
Separated	2 (1.9%)	0 (0%)	
Surgery type			<.001[a]
THA	17 (16.3%)	35 (40.7%)	
TKA	87 (83.7%)	51 (59.3%)	
Sex			<.001[a]
Female	39 (37.5%)	55 (64.0%)	
Male	65 (62.5%)	31 (36.0%)	

CCI, charlson comorbidity index.
[a] Statistically significant.

described as frequencies with proportions. Multivariate logistic regressions were performed both to determine if the patient selection tool discriminates against patient demographic factors as well as if any demographic variable predicts delayed discharge. Variables included in the regression analysis included age, BMI, race, sex, marital status, median income per zip code, and insurance type.

Results

In this pilot study, the patient selection tool was highly efficacious at predicting discharge home within one postoperative day after THA or TKA (n = 190, 100%). Of the 190 arthroplasty patients, 104 (55%) were successfully discharged home the same day of surgery, whereas 86 (45%) were discharged on postoperative day 1. No patients stayed more than one night in the ASC.

Multivariate logistic regression identified female (odds ratio [OR]: 4.1, 95% confidence interval [CI]: 2.0-8.2, $P < .001$) patients undergoing THA (OR: 2.5, 95% CI: 1.1-5.5, $P = .022$) or those with a heavier BMI (OR: 1.0, 95% CI: 1.0-1.2, $P = .022$) as independent risk factors for staying overnight in the ASC (Table 3). Race or socioeconomic status were not independent risk factors ($P = .078$ and $P = .816$, respectively). As no patients had a failed one-night stay discharge, we were unable to identify any risk factors for delayed discharge in this cohort.

Four (2.1%) patients had an ED visit within the first 90 days postoperatively. One patient returned to the ED for concern for swelling/deep vein thrombosis, but was found to have negative Doppler ultrasound results. Two patients had hip dislocations treated with closed reduction in the ED. The final patient presented to the ED for wound drainage, which required a bedside debridement for superficial wound necrosis. There was one 90-day readmission (0.5%) during this study, which was for a patient with recurrent hip instability who subsequently underwent a reoperation. This was the only reoperation in the cohort, yielding a reoperation rate of 0.5%. Also of note, in the TKA cohort, there were 3 patients requiring manipulations under anesthesia within 90 days postoperatively.

Discussion

In this pilot study model, we found that 100% of outpatient THA or TKA eligible patients, as determined by the patient selection tool, were able to be discharged home the same day or on postoperative day 1. Fifty-five percent of the patients were discharged the same day, and 45% were discharged on postoperative day 1. Female patients, those undergoing THA, and those with a heavier BMI (>35 kg/m^2) were independent risk factors for staying overnight in the ASC. As no patients required more than two nights of stay, we were unable to identify risk factors for delayed discharge in this cohort. Finally, we found this selection tool to be safe compared with readmission and complication rates reported in previous literature [10,24,25].

Table 3
Risk factors for staying overnight.

Variable	OR	95% CI	*P* value
Age	1.0	0.9-1.1	.894
BMI	1.1	1.0-1.2	.022[a]
CCI	1.8	0.8-3.9	.138
Socioeconomic status	1.0	1.0-1.0	.816
Race	1.4	1.0-2.0	.078
Insurance type	1.4	0.7-2.8	.417
Marital status	1.2	0.8-1.7	.370
Surgery type	2.5	1.1-5.5	.022[a]
Sex	4.1	2.0-8.2	<.001[a]

CCI, charlson comorbidity index.
One-unit change for age: 1 year, BMI: 1 kg/m^2, CCI: 1 point, socioeconomic status: $1.00.
[a] Statistically significant.

Various assessment tools have been used for patient selection in total joint arthroplasty; however, few are validated in the outpatient setting [10,13,15,26]. The OARA score developed by Meneghini et al. is a selection tool that predicts same-day or next-day discharge in the outpatient hospital setting and performs with a PPV and NPV of 81.6% and 33.5%, respectively [13]. It includes nine comorbidity areas that are scored based on physician assessment of disease severity, its optimization, and its potential to affect surgical outcomes. Another medical-based decision tool, the Ascension Seton Lower Extremity Inpatient-Outpatient (LET-IN-OUT) tool was reported by Trutner et al. in 2023. This 14-item questionnaire (yes/no) was retrospectively applied to 563 consecutive THA and TKA patients to predict short-stay discharge in the outpatient hospital setting [26]. According to the authors, a “no” in all 14 field items is required for an outpatient recommendation by an anesthesiologist or internist [26]. For predicting discharge within a 24-hour period, the LET-IN-OUT tool performed with a PPV of 86%, an NPV of 54%, a specificity of 82%, and a sensitivity of 54%. The use of machine learning models to predict LOS following total joint arthroplasty (THA and TKA) has also been successfully described by Park et al [27]. However, the application of such technology in everyday practice is unclear and may be less accessible than existing, more simplified tools.

When considering the reasons for failed SDD in primary THA or TKA, medical-based selection tools may fail to account for social factors such as home-to-hospital (or ASC) distance [28], patient motivation [29,30], and home support [30]. Independent risk factors identified for failed SDD in THA include active smoker status, case start time after 11 AM, and high self-reported pain scores [31]. Shen et al. noted logistical issues relating to timing of procedure, pain control, and failure to meet ambulation goals as main causes of failed SDD in TKA [30]. Although these specific perioperative metrics were not analyzed in this study, the current patient selection tool considers a comprehensive group of lifestyle risk factors into its score, such as access to transportation, social support, and compliance with home medication or treatment. It also selects against chronic pain patients requiring narcotics and patients with alcohol or drug abuse, as they may have less predictable pain control postoperatively.

Recently, this current patient selection tool was retrospectively applied to an unselected cohort of arthroplasty patients in a community hospital setting [14]. It was found to have a specificity of 92%, a sensitivity of 79%, a PPV of 86%, and an NPV of 96% for identifying and predicting which patients could be discharged within 23 hours. This shows improved predictive utility compared to general assessment tools currently being used such as the American Society of Anesthesiologists phyiscal status classification and Charlson comorbidity index with PPV of 56.4% and 70.3%, respectively [13]. Additionally, both the PPV (81.6%) and NPV (33.5%) values for the OARA are lower than those reported for the current selection tool, which is publicly available [14]. For predicting discharge within a 24-hour period, the LET-IN-OUT tool performed similarly to the current one in regard to PPV but possessed lower specificity (82%), sensitivity (54%), and NPV (54%) [26].

In our current study, this novel patient selection tool resulted in no patients undergoing delayed ASC discharge requiring more than a one-night stay. It was also shown to be safe with 90-day readmissions and ED visits compared to prior literature [3,13,14,32,33]. For example, a recent systematic review of 19 studies including 6519 outpatient THA, TKA, and unicompartmental knee arthroplasties reported an average 90-day readmission and reoperation rate of

2.01% and 1.63%, respectively, with variable rates of unplanned care episodes within the same time period (0.9%-11.4%) [3].

Our study identified independent risk factors for requiring an overnight stay in the ASC: female patients, those undergoing THA, and BMI >35 kg/m^2. Female sex and elevated BMI are associated with an increased LOS following inpatient THA or TKA [34-36]. Piuzzi et al. noted female sex as a risk factor requiring >1 overnight stay after TKA in over 3000 patients across 4 different hospitals. They found variation in the implementation of care pathways across the hospitals, resulting in procedural-related risk factors having more predictive utility for LOS [34]. In a retrospective review of 4138 TKA patients, BMI >31 kg/m^2 was associated with an increased LOS greater than 23 hours [37]. In prior literature, THA compared to TKA was associated with a shorter LOS in rapid recovery total joint arthroplasty [38]. Although case start times were not recorded in our study and little consensus exists regarding start time thresholds [39], it is intuitive that later start times are an inherent risk factor for an overnight stay. In our study, THA patients were typically scheduled later in the day per the surgeon's preference, which may have made an overnight stay more likely and confounded this outcome.

One area of interest has been the impact of racial and socioeconomic disparity in THA and TKA utilization, LOS, discharge disposition, and perioperative outcomes. The racial and ethnic disparity in inpatient THA and TKA care is well documented [40-43]. Recent studies evaluating sex and race in outpatient THA and TKA have found that the decrease in outpatient utilization is highly associated with comorbidity burden and preoperative baseline differences and is not contingent on race alone [19,44]. In this study, we failed to find race or socioeconomic status as a risk factor for staying overnight or failing short-stay arthroplasty.

This study did have several limitations. First, it is a single-surgeon series of only primary THA with a direct anterior approach and TKA patients, which could lack external validity for other procedures, techniques, perioperative protocols, and institutions. Second, this pilot study has a small sample size and is likely underpowered to detect other significant differences such as comorbidity burden stratification and lifestyle risk factors. Furthermore, the effect of surgical start time was not directly assessed as in previous studies. This may serve as a confounder when assessing the utility between SDD and next-day discharge; however, it seems unlikely to affect the utility of predicting successful short-stay arthroplasty (discharge <23 hours). Lastly, socioeconomic status was geographically based, which could lack external validity for other locations and institutions. For example, the average median income of our included cohort of patients was $106,014, which is atypically affluent and may affect the success rates for outpatient THA or TKA discharge.

Conclusions

We found that 100% of outpatient THA and TKA eligible patients, as determined by the patient selection tool, were able to be discharged home the same day of surgery or after a one-night stay. In this pilot study model, this selection tool is safe and effective at predicting successful short-stay discharge at an ASC. However, larger-volume studies are required to validate this selection tool and elucidate the effect of specific patient or surgeon factors on the success of outpatient arthroplasty.

Conflicts of interest

The authors declare there are no conflicts of interest.

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CRediT authorship contribution statement

Salvador A. Forte: Writing – original draft, Methodology. **Lucas Bartlett:** Writing – review & editing, Writing – original draft, Data curation. **Temisan Osowa:** Methodology, Data curation, Resources. **Jed Bondy:** Methodology, Data curation, Formal analysis. **Caroline Aprigliano:** Methodology, Formal analysis, Data curation. **Peter B. White:** Methodology, Formal analysis, Data curation, Writing – original draft. **Jonathan R. Danoff:** Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing.

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