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Relative Contribution of Outpatient Arthroplasty Risk Assessment Score Medical Comorbidities to Same-Day Discharge After Primary Total Joint Arthroplasty

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ABSTRACT

Background: Selection of patients who can safely undergo outpatient total joint arthroplasty (TJA) is an increasing priority given the growth of ambulatory TJA. This study quantified the relative contribution and weight of 52 medical comorbidities comprising the Outpatient Arthroplasty Risk Assessment (OARA) score as predictors of safe same-day discharge (SDD).

Methods: The medical records of 2748 primary TJAs consecutively performed between 2014 and 2020 were reviewed to record the presence or absence of medical comorbidities in the OARA score. After controlling for patients not offered SDD due to OARA scores and patients who were offered but declined SDD, the final analysis sample consisted of 631 cases, 92.1% of whom achieved SDD and 7.9% of whom did not achieve SDD. Odds ratios were calculated to quantify the extent to which each comorbidity is associated with achieving SDD.

Results: Demographic characteristics of analysis cases were consistent with a high-volume TJA practice in a US metropolitan area. Among testable OARA comorbidities, 53% significantly decreased the likelihood of SDD by 2.3 (body mass index [BMI] $\geq$40 kg/m^2) to 12 (history of post-operative confusion and pacemaker dependence) times. BMI between 30 and 39 kg/m^2 did not affect the likelihood of SDD ($P = .960$), and BMI $\geq$40 kg/m^2 had the smallest odds ratio in our study (2.28, 95% confidence interval 1.11-4.67, $P = .025$).

Conclusion: Study findings contribute to the refinement of the OARA score as a successful predictor of safe SDD following primary TJA while maintaining low 90-day readmission rates.

Enhancement of primary total joint arthroplasty (TJA) clinical and surgical protocols, cost containment and value-based healthcare initiatives, removal of total hip and knee arthroplasty from Medicare's Inpatient-Only list, and, most recently, the novel Coronavirus pandemic have coalesced to promote and expand the rapid growth of outpatient TJA. Identification of patients who can safely undergo outpatient TJA remains a top priority [1,2] for which conclusive evidence has yet to be defined.

To date, one medical risk assessment tool for safe outpatient TJA selection has been developed [3,4] and several studies have evaluated risk factors for complications and hospital readmission to identify appropriate inclusion and exclusion criteria for outpatient TJA [5–10]. The Outpatient Arthroplasty Risk Assessment (OARA) score assigns points to 52 comorbidities in 9 medical areas (hematological, cardiac, etc.) to generate a threshold score for safe patient selection [3,4]. Compared to American Society of Anesthesiology Physical Status and Romano Charlson Comorbidity Index scores, the OARA score was more predictive while maintaining low 90-day readmission rates for non-grave causes [3]. Additional support for the OARA score in terms of predicting overnight stay and need for blood transfusions has recently been reported [11–13].

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Due to the relative lack of outpatient data when the OARA score was developed, the number of points associated with each of its 52 comorbidities were assigned based on extensive physician experience with early discharge. Accordingly, the OARA score was designed to err in the direction of medical safety, not to excel at comprehensive outpatient selection. In addition, lacking sufficient outpatient TJA data, the relative contribution or importance of each comorbidity to safe patient selection could not be identified. The purpose of the present study is to quantify the relative contributions of the 52 medical comorbidities comprising the OARA score expressed as the odds of a decreased likelihood of same-day discharge (SDD) in the presence of each comorbidity.

Methods

Study Sample

Institutional Review Board approval was obtained to retrospectively review the perioperative medical records of 2748 primary TJAs consecutively performed between November 19, 2014 (the date of the first SDD at our institution) and December 31, 2020 by a single surgeon at an academic tertiary care hospital. One hundred sixty-four cases characterized by factors extending customary length of stay were excluded (Table 1). Remaining cases were culled to control for patients not offered SDD due to OARA scores/comorbidity status and patients who were offered but declined SDD. As shown in Figure 1, this resulted in a final sample of 631 patients, 92.1% of whom achieved SDD and 7.9% of whom did not achieve SDD. OARA score descriptive statistics (Table 2) are more similar among patients who achieved SDD, regardless of whether it was planned, compared to scores for planned SDD patients who did not achieve SDD.

Procedures

All patients underwent medical risk assessment and stratification within 4 weeks of surgery by a perioperative internal medicine specialist whose practice focuses exclusively on TJA. Patients and family members received comprehensive perioperative education and postoperative care by the surgeon, internal medicine specialist, and a multidisciplinary inpatient care team. Appropriate patients were offered outpatient surgery with SDD with the final decision made by patients. Expectations for discharge were communicated to patients in all educational material and by all physicians, nursing staff, physical therapists, and discharge planners involved in patient care. All patients were asked to attend a pre-operative total joints class taught by nursing staff with no additional preoperative educational or physical therapy requirements. The same rehabilitation protocol encouraging ambulation on the day of surgery was used for all patients. Upcoming surgeries were discussed during a routine coordinated care conference attended by key members of the multidisciplinary care team. The purpose of the meeting is to share information across disciplines, anticipate and answer questions, and proactively develop patient care plans.

A median parapatellar approach was used for all knee surgeries. Standard coronal plane femoral bone cuts were made with computer-aided navigation (Stryker Navigation, Kalamazoo, MI) and tibial cuts were performed with an extramedullary alignment guide. The posterolateral approach was used in all hip surgeries with the patient in a lateral decubitus position. Acetabular and femoral components were implanted with consistent surgical technique.

Surgeries were performed with standardized light general anesthesia and a low-dose intrathecal, single-shot spinal injection of either 0.40 mg of morphine with a median of 10.5 mg bupivacaine local anesthetic or 25 mcg of fentanyl with a median of 7.5 mg bupivacaine. In knees only, a periarticular injection of 0.2% (200 mg) ropivacaine, 0.5 mg epinephrine, 80 mcg clonidine, and 30 mcg ketorolac to equal 101.3 mL total volume was used immediately following component fixation. Ketorolac was removed for patients with renal insufficiency.

Table 1
Case Exclusions.

Exclusion Reason	N
Extended care facility placement delay	65
Simultaneous bilateral knee surgery	28
Orthopedic complexity (bone loss, retained hardware, etc.)	27
Surgery performed for fracture	20
Musculoskeletal disease	18
Extreme medical complication	6
Total	164

Measures

The standardized pre-operative history and physical therapy compiled by the internal medicine specialist was reviewed to record the presence or absence of 52 medical comorbidities included in the OARA score and described in Table 3. As previously described [3,4], each comorbidity is scored yes or no. All-cause readmissions within 90 days of discharge were manually extracted from the electronic medical record. Patient gender, age in years, body mass index (BMI) in kg/m^2, procedure, and length of stay were retrieved from our TJA registry.

Data Analysis

Demographic characteristics in patients who achieved and did not achieve SDD (regardless of whether SDD was planned) were compared using Student's *t*-test and chi-square tests with Fisher's exact test *P* values. Odds ratios (ORs) were calculated to assess whether and the extent to which each comorbidity was associated with achieved and non-achieved SDD. The unique contribution of each comorbidity was expressed as the odds of a decreased likelihood of achieving SDD in its presence. Cramér's V statistic was used to assess the degree of association among OARA comorbidities.

Results

Demographic characteristics of the 631 cases in the analysis sample are consistent with a high-volume TJA practice in a US metropolitan area (Table 4) with 55.5% being female, and an average age and BMI of 58.1 years and 31.8 kg/m^2, respectively. Gender, BMI, and procedure type did not statistically differ based on whether SDD was achieved ($P \geq .10$; Table 4). The mean difference in age between patients who did and did not achieve SDD was 3.6 years ($P < .015$; Table 4).

The prevalence of each OARA comorbidity in SDD and non-SDD patients is provided in Table 3. Per column 2 of Table 3, 14 OARA comorbidities—chronic post-operative pain control difficulty, sickle cell disease, warfarin use without bridge requirement, baseline blood pressure >180/110, diastolic dysfunction stage 3 or 4, mild/moderate and severe aortic stenosis, moderate and severe pulmonary hypertension, type 1 brittle diabetes, cirrhosis, stage 4 kidney disease, chronic hypoxemia, and severe upper respiratory infection (URI)—were not observed in sample cases. ORs could not be calculated for 19 additional comorbidities due to small numbers resulting in quasi-complete data separation. For the remaining 19 comorbidities, ORs were not statistically significant for 9 and were

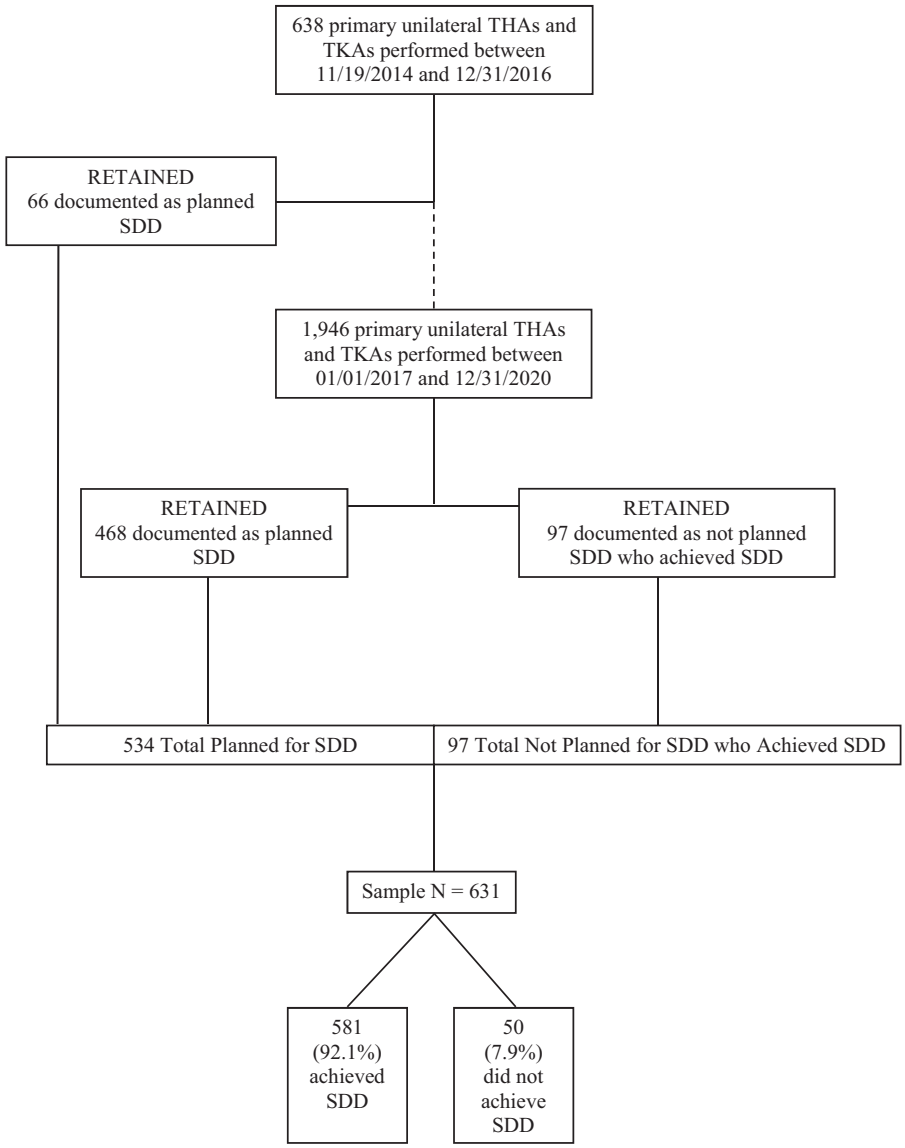

Fig. 1. Constitution of analysis sample. THA, total hip arthroplasty; TKA, total knee arthroplasty; SDD, same-day discharge.

statistically significant for 10. Comorbidities that did not statistically differentiate between SDD and non-SDD included BMI 30-39 kg/m^2, non-obstructive stable coronary artery disease, controlled diabetes with A1C < 7.0, uncontrolled diabetes with A1C ≥ 8.0, severe benign prostatic hyperplasia, controlled asthma, untreated obstructive sleep apnea, snoring or excessive daytime sleepiness, and mild URI ($P \geq .082$). Comorbidities that did statistically differentiate between SDD and non-SDD included BMI ≥40 kg/m^2, direct thrombin and factor Xa inhibitors, chronic stable evaluated anemia with Hb 11.0 to normal, chronic stable-evaluated anemia with Hb > 11.0, left ventricular (LV) systolic dysfunction without history of pulmonary edema, diastolic dysfunction stage 1-2, pacemaker dependence, uncontrolled diabetes with A1C 7.0-7.9, history of post-operative confusion, and stage 3 kidney disease ($P \leq .025$).

Table 2
Distribution of OARA Scores in Patients Who Were and Were Not Discharged on the Day of Surgery.

Descriptive Statistic	SDD Not Planned but Achieved	SDD Planned and Achieved	SDD Planned and Not Achieved
N	97	484	50
Mean	25.2	17.0	37.8
SD	32.7	23.3	40.0
Minimum value	0	0	0
Maximum value	185	130	150
First quartile	5	0	5
Second quartile	5	5	35
Third quartile	37.5	30	57.5

OARA Outpatient Arthroplasty Risk Assessment; SDD, same-day discharge; SD, standard deviation.

The relative contributions of statistically significant comorbidities are shown in Figure 2. Figure 2 combines the 3 levels of anemia (combined OR 4.52, 95% confidence interval [CI] 1.70-12.05, $P = .003$), LV systolic dysfunction and diastolic dysfunction (combined OR 6.12, 95% CI 1.48-25.24, $P = .012$), and the various levels of diabetes (combined OR 3.32, 95% CI 1.50-7.37, $P = .003$) shown in Table 3 to improve the precision of OR point estimates and to generate more reliable and interpretable ORs. As shown in Figure 2, the relative contributions of OARA comorbidities to decreasing the likelihood of SDD ranged from ORs of 2.28 (95% CI 1.11-4.67,

Table 3
Prevalence of OARA Comorbidities in Patients Who Achieved and Did Not Achieve SDD and the Relative Contribution of Each Comorbidity to the Likelihood of SDD.

OARA Comorbidity	Total Number With Comorbidity	% of Achieved SDD Patients With Comorbidity	% of Non-Achieved SDD Patients With Comorbidity	OR *P* Value	OR	OR 95% Lower CI	OR 95% Upper CI
N		581[a]	50[a]				
General							
BMI 30-39 kg/m^2	305	48.4	48.0	.960			
BMI ≥40 kg/m^2	75	11.0	22.2	**.025**	2.28	1.11	4.67
Chronic pre-operative narcotic use (>30 mg oxycodone equivalent per day)	2	0.3	0.0	Not tested			
Chronic post-operative pain control difficulty	0	0.0	0.0				
Chronic benzodiazepine use (>1 mg alprazolam equivalent per day)	4	0.7	0.0	Not tested			
Hematological							
Significant thrombophilic disease	6	1.0	1.9	Not tested			
Sickle cell disease	0	0.0	0.0				
Warfarin use without bridge requirement	0	0.0	0.0				
Direct thrombin and factor Xa inhibitors	14	1.4	12.0	**<.001**	9.77	3.24	29.40
Blood thinners	4	0.7	0.0	Not tested			
Chronic stable evaluated anemia, Hb 11.0 to normal	17	2.2	8.0	**.024**	3.80	1.19	12.12
Chronic stable evaluated anemia, Hb <11	5	0.5	4.0	**.024**	8.03	1.31	49.21
Unevaluated anemia	1	0.2	0.0	Not tested			
Cardiac							
Baseline blood pressure >180/110	0	0.0	0.0				
History of pulmonary edema	1	0.2	0.0	Not tested			
Left ventricular systolic dysfunction without history of pulmonary edema	5	0.5	4.0	**.024**	8.03	1.31	49.21
Diastolic dysfunction stage 1-2	5	0.5	4.0	**.024**	8.03	1.31	49.21
Diastolic dysfunction stage 3-4	0	0.0	0.0				
Stable coronary artery disease, non-obstructive	4	0.5	2.0	.240			
Stable coronary artery disease with history of MI/stent/PTCA/CABG	18	3.1	0.0	Not tested			
Mild to moderate asymptomatic aortic stenosis	0	0.0	0.0				
Severe asymptomatic aortic stenosis (aortic valve area <1.0)	0	0.0	0.0				
Pacemaker dependence	4	0.3	4.0	**.014**	12.06	1.66	87.54
Moderate pulmonary hypertension	0	0.0	0.0				
Severe pulmonary hypertension	0	0.0	0.0				
Endocrine							
Controlled diabetes (A1C < 7.0)	31	4.5	10.0	.092			
Uncontrolled diabetes (A1C 7.0-7.9)	12	1.6	6.0	**.041**	4.06	1.06	15.49
Uncontrolled diabetes (A1C ≥ 8.0)	2	0.2	2.0	.082			
Type 1 diabetic, brittle	0	0.0	0.0				
Excessive steroid use (>20 mg/d for 3 wk in the last year)	2	0.3	0.0	Not tested			
Gastrointestinal							
History of previous post-operative ileus	2	0.3	0.0	Not tested			
Cirrhosis	0	0.0	0.0				
Difficulty swallowing	5	0.9	0.0	Not tested			
Uncontrolled constipation	2	0.3	0.0	Not tested			
Neurological/psychological							
Memory disorder per history with normal screening	1	0.2	0.0	Not tested			
Memory disorder with MMSE <25 or abnormal Mini-Cog test	1	0.0	2.0	Not tested			
Uncontrolled depression	1	0.2	0.0	Not tested			
History of stroke	1	0.2	0.0	Not tested			
History of post-operative confusion	4	0.3	4.0	**.014**	12.06	1.66	87.54
Renal/urology							
Stage 3 kidney disease (GFR 30-60)	25	3.3	12.0	**.005**	4.03	1.53	10.62
Stage 4+ kidney disease (GFR <30)	0	0.0	0.0				
History of urinary retention	3	0.5	0.0	Not tested			
Severe benign prostatic hyperplasia (symptoms despite treatment)	5	1.5	5.9	.222			
Pulmonary							
Uncontrolled asthma (symptoms >2 times per week)	1	0.2	0.0	Not tested			
Controlled asthma	45	6.7	12.0	.170			
Asymptomatic COPD	3	0.5	0.0	Not tested			
Uncontrolled COPD or scheduled bronchodilator use	5	0.9	0.0	Not tested			
Chronic hypoxemia	0	0.0	0.0				
Untreated OSA	12	1.7	4.0	.272			
Snoring or excessive daytime sleepiness	109	17.7	12.0	.308			
Infectious disease							
Mild URI	4	0.5	2.0	.240			
Severe URI	0	0.0	0.0				

Not tested = could not be tested due to quasi-complete data separation.
OARA, Outpatient Arthroplasty Risk Assessment; BMI, body mass index; CABG, coronary artery bypass graft; CI, confidence interval; COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate; Hb, hemoglobin; MI, myocardial infarction; MMSE, Mini-Mental State Exam; OR, odds ratio; OSA, obstructive sleep apnea; PTCA, percutaneous transluminal coronary angioplasty; SDD, same-day discharge; URI, upper respiratory infection.
Bold text indicates statistical significance.
[a] Groups Ns for severe benign prostatic hyperplasia are 17 and 264, respectively.

Table 4
Sample Demographics.

Demographic	Total	Achieved SDD	Did Not Achieve SDD	*P* Value
N	631	581	50	
Female, n/%	350/55.5	317/54.6	33/66.0	.139
Age (y), mean (SD)	58.1 (10.0)	57.8 (10.0)	61.4 (9.1)	.015
BMI (kg/m^2), mean (SD)	31.8 (6.7)	31.6 (6.6)	33.3 (7.4)	.100
THA (vs TKA), n/%	288/45.6	262/45.1	26/52.0	.377

SDD, same-day discharge; BMI, body mass index; THA, total hip arthroplasty; TKA, total knee arthroplasty; SD, standard deviation.

$P = .025$) for BMI ≥40 to 12.06 (95% CI 1.66-87.54, $P = .014$) for history of post-operative confusion and pacemaker dependence. The non-statistically significant ($P = .960$; Table 3) contribution of BMI 30-39 kg/m^2 with equal prevalence of 48% in the 2 groups and the relatively low contribution of BMI ≥40 kg/m^2 (OR 2.28, 95% CI 1.11-4.67, $P = .025$) to a decreased likelihood of SDD are noteworthy.

Cramér's V ranged from 0.0 to 0.249 suggesting minimal association among OARA comorbidities, potentially attributable to low numbers of positive (yes) events for individual comorbidities (Table 3).

Eleven (1.9%) of the 581 SDD patients and none of the 50 non-SDD patients were readmitted to the hospital within 90 days of surgery. The 3 most common 90-day complications in SDD patients were hyponatremia (n = 2), infection resulting in deep irrigation and debridement with component retention (n = 2), and myocardial infarction (n = 2). One patient each was readmitted for aseptic index joint revision, resection of the index joint for infection, hematoma, non–joint-related sepsis, and venous thromboembolism.

Discussion

The presence of 10 of the 19 (53%) OARA comorbidities that could be tested (Table 3) significantly increased the likelihood of not achieving SDD by approximately 2 to 12 times. Reflecting the aim of this study, Figure 2 provides a visual depiction of the relative contribution of statistically significant ORs after combining 3 anemia-related variables, systolic and diastolic dysfunction, and 4 diabetes-related variables. Narrow CIs (Table 3) suggest point estimate accuracy for BMI ≥40 kg/m^2, diabetes, stage 3 kidney disease, and anemia which respectively reduced the likelihood of SDD by 2.28, 3.32, 4.03, and 4.52 times. Although they significantly distinguished between achieved and unachieved SDD, wide CIs (Table 3) suggest that point estimates for LV systolic or diastolic dysfunction (OR 6.12), direct thrombin and factor Xa inhibitors (OR 9.77), history of post-operative confusion (OR 12.06), and pacemaker dependence (OR 12.06) are less accurate. Of the 9 testable comorbidities that did not statistically differentiate between SDD and non-SDD, clinical conclusions are inappropriate for 4 of them—non-obstructive stable coronary artery disease, severe benign prostatic hyperplasia, untreated obstructive sleep apnea, and mild URI—due to their low prevalence in our sample. In addition, 2 of the non-statistically significant comorbidities—controlled diabetes with A1C < 7.0 and uncontrolled diabetes with A1C ≥ 8.0—were statistical trends (Table 3) and contributed to a statistically significant difference in combined analysis of all 4 diabetes variables (Fig. 2). More confidence in clinical conclusions may be associated with the absence of statistical differences for BMI 30-39 kg/m^2 (48.0% and 48.4%), controlled asthma (12.0% and 6.7%), and snoring or excessive daytime sleepiness (12.0% and 17.7%) due to their relatively high prevalence in both SDD and non-SDD patients, respectively. In general, however, the importance of larger groups and greater observed prevalence of comorbidities for comprehensive clinical interpretation of factors influencing the safety of SDD cannot be overstated.

It is difficult to compare our findings with published findings due, in part, to differences in the comorbidities examined. For example, unlike other studies, the OARA score does not account for malnutrition or smoking. Conversely, other studies have not accounted for OARA variables such as pre-operative narcotic or benzodiazepine use. Even when studies include the same underlying comorbidity such as chronic kidney disease, operational definitions vary from simply whether the comorbidity is a diagnosed disease to what extent the comorbid condition is "controlled." In addition, creatinine levels, glomerular filtration

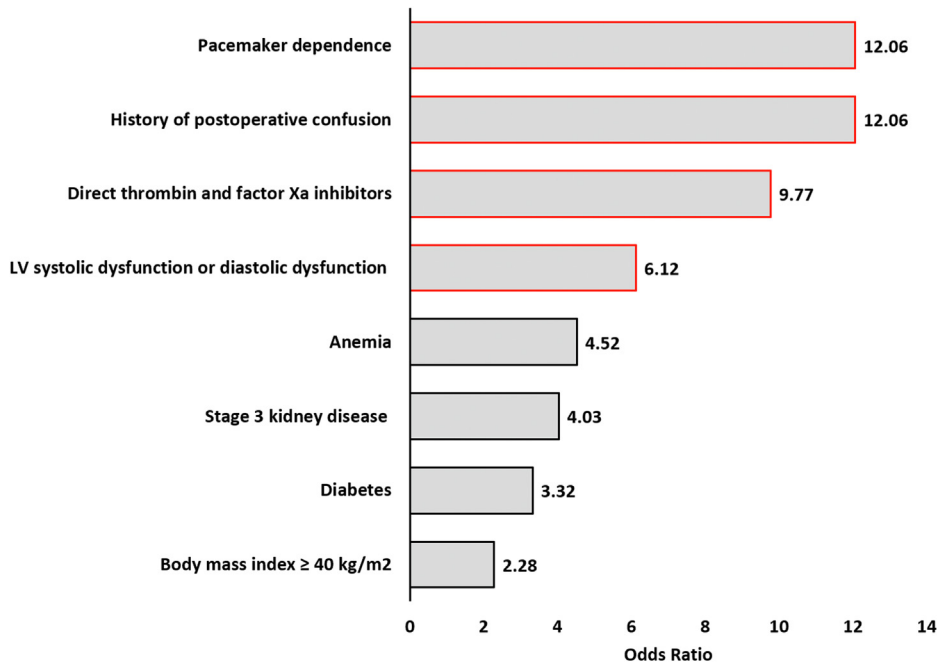

Fig. 2. Relative contribution of significant OARA comorbidities to a decreased likelihood of SDD. Black outlines indicate narrow 95% confidence intervals and red outlines indicate wide 95% confidence intervals. OARA Outpatient Arthroplasty Risk Assessment; SDD, same-day discharge.

rates, and dialysis dependence have been used as surrogates for diagnosed disease. Moreover, the composition of study samples varies from administrative datasets to detailed clinical datasets in which outpatient populations have been pre-selected based on age, BMI, and existing conditions such as diabetes and heart disease. In general, our findings confirm those of others reporting obesity, diabetes, and kidney disease as risk factors for outpatient TJA [5,7,9]. In contrast to observations that SDD is less likely for females [5–10], we observed no difference in the proportions of females achieving (54.6%) and not achieving (66%) SDD (Table 4; $P = .139$), and a small statistically significant mean difference of 3.6 years in the 2 groups (Table 4; $P = .015$). Patient gender and age are not included as OARA comorbidities, however, because female and older patients with appropriate OARA scores are considered to be safe for outpatient TJA unless otherwise contraindicated. In light of increasing clinical and healthcare policy concerns about the use of BMI to determine eligibility for TJA [14–16], it is also important to note that, in addition to BMI of 30-39 not being a significant differentiator of SDD, BMI $\geq$40 kg/m^2 had the second smallest OR in our study, although it increased the likelihood of failing SDD by 2.28 times, a statistically significant effect.

Limitations of this study include its retrospective design although all study data were collected and documented in the electronic medical record at the time of surgery. It also is a limitation that several of the comorbidities evaluated in this study were relatively rare, precluding quantification of contribution as predictors of SDD. We additionally acknowledge that other factors relevant to safe and successful SDD, especially the availability of reliable support upon discharge, are not accounted for in the OARA score. Successful outpatient TJA programs depend upon multiple components [17] following appropriate patient selection based on medical risk stratification. Study strengths included the availability of complete and comprehensive information for each of the 52 evaluated comorbidities for all patients, and a large sample size of patients treated with consistent perioperative protocols.

Although the availability of complete and comprehensive information for each of the 52 evaluated comorbidities is a strength for fully understanding the contribution of medical comorbidities to safe SDD following primary TJA, it is a potential barrier to use the OARA score by other surgeons and clinicians. For maximally efficient and effective use, outpatient risk assessment instruments must contain only those medical risk factors that discriminate between safe and unsafe outpatient TJA. Furthermore, each comorbidity must be appropriately weighted relative to its importance for safe outpatient surgery. This study advanced but did not finalize these objectives for the OARA score. It is hoped that additional research faithfully replicating the OARA score and the current analysis will be conducted to evaluate the validity and generalizability of the instrument to ensure safe selection of patients for outpatient TJA.

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