

# Factors Predictive of Early Complications Following Total Ankle Arthroplasty

Christopher Del Balso, MBBS, MSc<sup>1</sup> , Mansur M. Halai, BSc (Hons), MBChB<sup>2</sup> ,  
Mark D. MacLeod, MD<sup>1</sup>, David W. Sanders, MD, MSc<sup>1</sup>,  
and Abdel Rahman Lawendy, MD, PhD<sup>1</sup>

## Abstract

**Background:** The safety of outpatient total ankle arthroplasty (TAA), and factors predictive of early complications are poorly understood. The objective of this study was to determine the frequency of early complications in patients undergoing outpatient TAA compared to a matched inpatient TAA cohort. Factors predictive of early complications following TAA are elucidated.

**Methods:** A retrospective review of prospectively collected data from the 2011–2018 American College of Surgeons–National Surgical Quality Improvement Program (ACS-NSQIP) database was performed. An unadjusted analysis comparing complication rates in outpatient, and inpatient TAA was performed followed by a propensity score–matched cohort analysis. A multivariate logistic regression model was then used to identify significant independent predictors for complications, reoperation, and readmission following TAA.

**Results:** A total of 1487 patients (198 outpatient, 1289 inpatient) undergoing TAA were included in the study. Inpatient TAA was associated with increased 30-day readmission compared with outpatient TAA (3.54% vs 0.51%,  $P = .032$ ) in a matched cohort analysis. Thirty-eight (2.6%) patients had a minor complication, with 16 (1.1%) patients having a major complication after TAR. Nineteen (1.3%) patients underwent reoperation, and 42 (2.8%) patients were readmitted within 30 days of the index TAR. Multivariate analysis identified factors predictive of early complications to include length of stay (LOS) >2 days, smoking, hypertension, bleeding disorders, and diabetes mellitus.

**Conclusion:** From this relatively limited data set, outpatient TAA appears to be safe for management of end-stage ankle arthritis in select patients. Inpatient status was associated with an increased rate of 30-day readmission following TAA. Postoperative length of stay >2 days, smoking, hypertension, bleeding disorders, and diabetes mellitus were identified to be associated with early postoperative complications following TAA in this cohort.

**Level of Evidence:** Level III, retrospective cohort study.

**Keywords:** total ankle arthroplasty, outpatient, complications, reoperation, readmission

## Introduction

End-stage ankle arthritis affects 1% of the population.<sup>27</sup> Total ankle arthroplasty (TAA) was first introduced in the 1970s, offering an alternative to ankle arthrodesis. With more recent biomechanical innovations in implant designs, and advances in surgical techniques, TAA has become a mainstay treatment modality for ankle arthritis, with clinical outcomes similar to ankle arthrodesis.<sup>28</sup>

TAA is being performed in increasing numbers. A 670% increase in the utilization of TAA for management of

<sup>1</sup>Department of Surgery, Division of Orthopaedic Surgery, London Health Sciences Centre–Victoria Hospital, Western University, London, Ontario, Canada

<sup>2</sup>Department of Surgery, Division of Orthopaedic Surgery, St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada

### Corresponding Author:

Christopher Del Balso, MBBS, MSc, Department of Surgery, Division of Orthopaedic Surgery, London Health Sciences Centre – Victoria Hospital, Western University, 800 Commissioners Rd E, London, ON N6A 5W9, Canada.

Email: christopher.delbalso@lhsc.on.ca



end-stage ankle arthritis from 1993 to 2007 has been reported.<sup>24</sup> This increase was noted via evaluation of TAA being performed on an inpatient basis. Previous investigations using databases have been performed to analyze survivorship, and risk factors for failure of TAA also relied on identification of cases from inpatient discharges.<sup>16</sup> Little is known regarding the volume of TAA performed on an outpatient basis. Even less is understood regarding the safety of outpatient TAA. With a current health care climate that places pressures on surgeons and their associated institutions to reduce costs per episode of care, there is a trend toward the performance of total joint arthroplasty on an outpatient basis. There have been a number of studies evaluating the safety, efficacy, and financial feasibility of outpatient total hip and knee arthroplasty.<sup>9,11</sup> There is a paucity of research regarding the safety of outpatient TAA. The objective of this study was to use a national validated surgical database to determine the frequency of complications, reoperation, and readmission in patients undergoing outpatient TAA vs those whose procedure was performed on an inpatient basis. Secondly, this study sought to elucidate the predictors of complications, reoperation, and readmission following TAA.

## Methods

Prospectively collected data from the 2011-2018 American College of Surgeons–National Surgical Quality Improvement Program (ACS-NSQIP) database was used in this retrospective review. The manner in which data collection is undertaken for inclusion in the database can be found on the ACS-NSQIP website.<sup>3</sup> Patients undergoing a primary or revision TAA were identified using *Current Procedural Terminology* codes 27702 and 27703. There was no difference with respect to the timing of surgery (2011-2018) between the inpatient and outpatient cohorts. Patients with missing data were removed from the study. This study was exempt from review by our institutional review board.

Similar to previous ACS-NSQIP investigation involving TAA,<sup>18</sup> patient demographic variables included as part of the study were age (dichotomized into <65 and ≥65 years), sex, body mass index (<25.0, 25.0-29.9, 30.0-34.9, and ≥35.0), and comorbidities (diabetes mellitus, history of smoking, presence of chronic obstructive pulmonary disease, congestive heart failure, hypertension, dialysis-dependent, disseminated cancer, chronic steroid use, bleeding disorder, dyspnea, and functional health status). Operative and postoperative data included primary vs revision TAA, American Society of Anesthesiologists (ASA) grade (I-II and >II), admission status (inpatient vs outpatient surgery), total operative time (0-150 and >150 minutes), and length of stay (LOS; dichotomized into 0-2 and >2 days).

Complications were classified as minor (eg, urinary tract infection, surgical site infection, wound dehiscence, deep

vein thrombosis, and transfusion) or major (eg, death, pulmonary embolus, myocardial infarction, pneumonia, reintubation, sepsis, cerebrovascular accident, and acute renal failure). Reoperation and readmission within 30 days of the index procedure was recorded. Following an initial analysis of the entire study cohort, a secondary analysis of complications, reoperation, and readmission was performed in a matched outpatient-inpatient TAA cohort. Groups were hard-matched on the basis of sex, ASA grade, and primary vs revision TAA. Nearest-neighbor propensity score matching was then performed using age, body mass index, and comorbidities as variables.

## Statistical Analysis

Bivariate analysis using Pearson  $\chi^2$  tests were used to assess for significant associations for minor complications, major complications, reoperation, and readmission in all patients undergoing TAA. All variables with a *P* value <.1 from unadjusted analysis were then entered into multivariate logistic regression models, adjusted for each to other, to identify significant independent predictors for complications, reoperation, and readmission. Results from multivariate regression models have been reported as adjusted odds ratios (ORs) with 95% CIs. During matching, a caliper length of 0.2 SDs of the logit of the propensity score was used. For all statistical purposes, a *P* value <.05 was considered significant. Statistical analysis was performed using SPSS, version 26 (IBM, Armonk, NY).

## Results

A total of 1487 patients undergoing primary or revision TAA were included in the study cohort. Outpatient TAA was performed in 198 cases, with 1289 patients having undergone TAA as an inpatient. Differences in baseline characteristics between patients undergoing outpatient TAA vs those undergoing inpatient TAA are shown in Table 1. Minor complications, major complications, reoperation, and 30-day readmission data are compiled in Table 2. Patients undergoing inpatient TAA had an increased rate of readmission compared to those undergoing TAA as an outpatient (3.18% vs 0.51%, *P* = .038).

Given the differences between the outpatient TAA and inpatient TAA cohorts observed in Table 1, matching was performed such that no significant differences remained between groups with the exception of LOS (Table 3). There were no differences between groups with respect to minor complications, major complications, or reoperation. Readmission (within the 30 days of the index procedure) remained significantly increased in the inpatient TAA cohort relative the outpatient TAA group (3.54% vs 0.51%, *P* = .032) (Table 4).

**Table 1.** Clinical Characteristics of Inpatient and Outpatient Study Populations (N = 1487).<sup>a</sup>

	Inpatient, n (%)	Outpatient, n (%)	P Value
Sample size	1289 (86.7)	198 (13.3)	–
Demographics			
Age, y			<b>&lt;.001</b>
<65	591 (45.8)	134 (67.7)	
≥65	698 (54.2)	64 (32.3)	
Sex			.547
Male	675 (52.4)	98 (49.5)	
Female	614 (47.6)	100 (50.5)	
BMI			.121
<25.0	171 (13.3)	28 (14.1)	
25.0-29.9	456 (35.4)	66 (33.3)	
30.0-34.9	367 (28.5)	55 (27.8)	
≥35.0	294 (22.8)	49 (24.7)	
Comorbidities			
Diabetes mellitus	166 (12.9)	16 (8.1)	.055
Smokers	99 (7.7)	22 (11.1)	.100
COPD	30 (2.3)	4 (2.0)	.788
CHF	5 (0.4)	1 (0.5)	.809
Hypertension	741 (57.5)	90 (45.5)	<b>.002</b>
Dialysis-dependent	4 (0.3)	0 (0.0)	.433
Disseminated cancer	2 (0.2)	0 (0.0)	.695
Chronic steroid use	65 (5.0)	7 (3.5)	.358
Bleeding disorder	41 (3.2)	2 (1.0)	.090
Dyspnea	47 (3.6)	4 (2.0)	.242
Functional health status			.063
Independent	1256 (97.4)	198 (100.0)	
Partially dependent	22 (1.7)	0 (0.0)	
Unknown	11 (0.9)	0 (0.0)	
Operative and postoperative data			
Operative status			.901
Primary	1173 (91.0)	169 (85.4)	
Revision	125 (9.7)	29 (14.6)	
ASA grade			<b>.012</b>
I-II	765 (59.4)	136 (68.7)	
>II	524 (40.7)	62 (31.3)	
Operative time, min			.054
<150	667 (51.7)	117 (59.1)	
≥150	622 (48.3)	81 (40.9)	
Length of stay, d			<b>&lt;.001</b>
0-2	547 (42.4)	198 (100.0)	
>2	742 (57.6)	0 (0.0)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

<sup>a</sup>An unadjusted analysis was performed using Pearson  $\chi^2$  tests.

**Predictors of Minor and Major Complications**

Thirty-eight patients (2.6%) had a minor complication following TAR. Adjusted analysis in a multivariate regression

**Table 2.** Minor Complications, Major Complications, Reoperation, and Readmission in Inpatient and Outpatient TAA (N=1487).<sup>a</sup>

Complications	Inpatient, n (%) (n = 1289; 86.7%)	Outpatient, n (%) (n = 198; 13.3%)	P Value
Minor			<b>.608</b>
Urinary tract infection	8 (0.62)	1 (0.51)	
Surgical site infection	13 (1.01)	2 (1.01)	
Wound dehiscence	4 (0.31)	1 (0.51)	
Deep vein thrombosis	3 (0.23)	0 (0.0)	
Transfusion	6 (0.47)	0 (0.0)	
Major			
Death	2 (0.16)	1 (0.51)	<b>.403</b>
Pulmonary Embolus	2 (0.16)	0 (0.0)	
Myocardial infarction	2 (0.16)	0 (0.0)	
Pneumonia	4 (0.31)	0 (0.0)	
Reintubation	1 (0.08)	0 (0.0)	
Sepsis	2 (0.23)	0 (0.0)	
Cerebrovascular accident	1 (0.08)	0 (0.0)	
Acute renal failure	1 (0.08)	0 (0.0)	
Reoperation	18 (1.40)	1 (0.51)	<b>.298</b>
Readmission	41 (3.18)	1 (0.51)	<b>.038</b>

Abbreviation: TAA, total ankle arthroplasty.

<sup>a</sup>An unadjusted analysis was performed using Pearson  $\chi^2$  tests. A significantly increased rate of readmission (within 30 days of the index procedure) was observed in the inpatient TAA group (P = .038).

model revealed LOS >2 days (OR 2.64, 95% CI 1.36, 5.09; P < .001) as the only significant independent predictor for a minor complication (Table 5).

Sixteen (1.1%) patients had a major complication after TAR. Following adjusted analysis in a multivariate regression model, the following factors were significant independent predictors of a major complication: LOS >2 days (OR 4.19, 95% CI 1.53, 11.49; P = .048), smoking (OR 3.89, 95% CI 1.18, 12.86; P = .026), and diabetes mellitus (OR 3.02, 95% CI 0.93, 9.08; P = .046) (Table 5).

**Predictors of Reoperation and Readmission**

Nineteen (1.3%) patients underwent reoperation within 30 days of the index TAR. Multivariate analysis identified LOS >2 days (OR 4.08, 95% CI 1.60, 10.37; P = .003), bleeding disorder (OR 4.07, 95% CI 1.07, 15.58; P = .04), hypertension (OR 3.85, 95% CI 1.06, 13.94; P = .021), and diabetes mellitus (OR 2.90, 95% CI 1.05, 8.02; P = .041) to be significant independent predictors of reoperation (Table 5).

Forty-two (2.8%) patients were readmitted to hospital within 30 days of the index TAR. Multivariate analysis identified diabetes mellitus (OR 3.54, 95% CI 1.83, 6.85; P < .001), bleeding disorder (OR 3.35, 95% CI 1.16,

**Table 3.** Clinical Characteristics of Inpatients and Outpatients Matched on the Basis of Age, Sex, BMI, ASA Grade, and Operative Status (Primary vs Revision) (n = 396).<sup>a</sup>

	Inpatient, n (%) (n = 198)	Outpatient, n (%) (n = 198)	P Value
<b>Demographics</b>			
Age, y			>.999
<65	134 (67.7)	134 (67.7)	
≥65	64 (32.3)	64 (32.3)	
Sex			>.999
Male	98 (49.5)	98 (49.5)	
Female	100 (50.5)	100 (50.5)	
BMI			.532
<25.0	31 (15.7)	28 (14.1)	
25.0-29.9	56 (28.3)	66 (33.3)	
30.0-34.9	64 (32.3)	55 (27.8)	
≥35.0	47 (23.7)	49 (24.7)	
<b>Comorbidities</b>			
Diabetes mellitus	19 (9.6)	16 (8.1)	.760
Smokers	24 (12.1)	22 (11.1)	.754
COPD	6 (3.0)	4 (2.0)	.703
CHF	0 (0.0)	1 (0.5)	.317
Hypertension	96 (48.5)	90 (45.5)	.108
Dialysis-dependent	1 (0.5)	0 (0.0)	.317
Disseminated cancer	0 (0.0)	0 (0.0)	
Chronic steroid use	7 (3.5)	7 (3.5)	>.999
Bleeding disorder	4 (2.0)	2 (1.0)	.143
Dyspnea	6 (3.0)	4 (2.0)	.552
Functional health status			.154
Independent	196 (99.0)	198 (100.0)	
Partially dependent	2 (1.0)	0 (0.0)	
<b>Operative and postoperative data</b>			
Operative status			>.999
Primary	169 (85.4)	169 (85.4)	
Revision	29 (14.6)	29 (14.6)	
ASA grade			>.999
I-II	136 (68.7)	136 (68.7)	
>II	62 (31.3)	62 (31.3)	
Operative time, min			.086
<150	100 (50.5)	117 (59.1)	
≥150	98 (49.5)	81 (40.9)	
Length of stay, d			<.001
0-2	154 (42.4)	198 (100.0)	
>2	44 (57.6)	0 (0.0)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

<sup>a</sup>An unadjusted analysis was performed utilizing Pearson  $\chi^2$  tests. No differences between groups were noted with the exception of length of stay ( $P < .001$ ).

9.68;  $P = .026$ ), and LOS >2 days (OR 2.77, 95% CI 1.92, 4.41;  $P = .02$ ) to be significant independent predictors of readmission (Table 5).

**Table 4.** Minor Complications, Major Complications, Reoperation, and Readmission in Matched (Age, Sex, BMI, ASA Grade, and Primary vs Revision) Outpatient and Inpatient TAAs (n = 396).

Complications	Outpatient, n (%) (n = 198)	Inpatient, n (%) (n = 198)	P Value
Minor	4 (2.02)	5 (2.53)	.736
Major	1 (0.51)	2 (1.01)	.315
Reoperation	1 (0.51)	4 (2.02)	.177
Readmission	1 (0.51)	7 (3.54)	<b>.032</b>

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; TAA, total ankle arthroplasty.

<sup>a</sup>An unadjusted analysis was performed utilizing Pearson  $\chi^2$  tests. A significantly increased rate of readmission (within 30 days of the index procedure) remains observed in the inpatient TAA group ( $P = .032$ ).

## Discussion

TAA is being performed with increasing frequency for management of end-stage ankle arthritis. With pressure on health care providers to lower costs per episode of care, TAA is increasingly being performed on an outpatient basis. Despite this, the safety, and efficacy of outpatient TAA is poorly understood. This study, through use of a validated surgical database, revealed that outpatient TAA is safe with no increased risk of complications, reoperation, or readmission when compared to a matched inpatient cohort. Further, this study revealed an increased 30-day readmission rate in patients who underwent TAA as an inpatient. Most importantly, factors predictive of early complication, reoperation, and readmission in TAA were elucidated.

There is a paucity of research evaluating the safety of TAA performed on an outpatient basis. Total hip and knee arthroplasty are procedures that are more commonly performed than TAA. As such, a number of studies have been performed to evaluate complications rates, rates of reoperation, rates of readmission, patient satisfaction, and health system costs in outpatient vs inpatient total hip arthroplasty, and total knee arthroplasty. A retrospective analysis utilizing the NSQIP database found that bleeding requiring transfusion was the most common complication in both outpatient and inpatient total joint arthroplasty, with a lower rate in the outpatient group (6% vs 12%,  $P < .001$ ).<sup>11</sup> The study additionally found no difference in rate of wound complications, infection, venous thromboembolic events, myocardial infarction, or reintubation between outpatient and inpatient groups. Complication rates have been found to be similar or improved in outpatient total joint arthroplasty populations. Sher et al<sup>23</sup> found the rate of serious adverse events was 1.3% in the outpatient total joint arthroplasty group, compared to 1.9% for the inpatient group. In the present investigation, there were no differences in the minor complication rate between the outpatient TAA and

**Table 5.** Multivariate Analysis for Significant Independent Predictors of Minor Complications, Major Complications, Reoperation, and Readmission in TAA.

Predictor	Adjusted OR (95% CI)	P Value
Minor		
LOS, d		
0-2	Ref.	
>2	2.64 (1.36, 5.09)	<b>&lt;.001</b>
Major		
LOS, d		
0-2	Ref.	
>2	4.19 (1.53, 11.49)	<b>.048</b>
Smoking		
No	Ref.	
Yes	3.89 (1.18, 12.86)	<b>.026</b>
Diabetes mellitus		
No	Ref.	
Yes	3.02 (0.93, 9.08)	<b>.046</b>
Reoperation		
LOS, d		
0-2	Ref.	
>2	4.08 (1.60, 10.37)	<b>.003</b>
Bleeding disorder		
No	Ref.	
Yes	4.07 (1.07, 15.58)	<b>.04</b>
Hypertension		
No	Ref.	
Yes	3.85 (1.06, 13.94)	<b>.021</b>
Diabetes mellitus		
No	Ref.	
Yes	2.90 (1.05, 8.02)	<b>.041</b>
Readmission		
Diabetes mellitus		
No	Ref.	
Yes	3.54 (1.83, 6.85)	<b>&lt;.001</b>
Bleeding disorder		
No	Ref.	
Yes	3.35 (1.16, 9.68)	<b>.026</b>
LOS, d		
0-2	Ref.	
>2	2.77 (1.92, 4.41)	<b>.02</b>

Abbreviations: LOS, length of stay; Ref., referent; TAA, total ankle arthroplasty.

inpatient TAA group (2.02% vs 2.53%,  $P = .783$ ). The major complication rate was similar between outpatient and inpatient TAA groups as well (0.51% vs 1.01%,  $P = .315$ ). In an analysis of the Medicare population undergoing total hip arthroplasty, the outpatient group had a lower 30-day complication rate (3% vs 12%,  $P < .001$ ) and readmission rate (3% vs 4%,  $P < .001$ ) when compared to the inpatient group.<sup>13</sup> Although the reoperation rate was not significantly different between groups in the present investigation (0.51% vs 2.02%,  $P = .177$ ), the 30-day readmission rate was

significantly higher in the inpatient TAA group (0.51% vs 3.18%,  $P = .038$ ). The increased 30-day readmission rate in the entire inpatient TAA cohort may be explained by differences shown in Table 1, with younger (age <65 years) and healthier (ASA grade = I or II) patients undergoing outpatient TAA. However, the rate of 30-day readmission in the inpatient TAA group remained significantly elevated following matching of inpatient and outpatient TAA cohorts (0.51% vs 3.54%,  $P = .032$ ). Contrary to that observed here, a single-center retrospective review found an increasingly comorbid inpatient TAA cohort to have comparable complication rates to their short-stay TAA counterparts.<sup>1</sup> Perhaps the most notable finding of this study was the 15.5% reduction in perioperative costs associated with short-stay TAA.

Previous studies evaluating the safety of TAA performed on an outpatient basis have been plagued with limitations secondary to small sample size.<sup>7,19</sup> Studies evaluating TAA performed on an outpatient basis utilizing the NSQIP database have revealed promising results with respect to its safety. A previous study using the ACS-NSQIP database (2006-2015) demonstrated that outpatient TAA was not associated with a higher incidence of short-term complications relative to inpatient TAA, although this study did not utilize matching to account for differences in patient-specific risk factors.<sup>26</sup> Another investigation indicated that outpatient and short-stay discharge do not inherently increase the incidence of short-term complications and poor outcomes relative to standard inpatient hospitalization after TAA.<sup>20</sup> Neither of these studies evaluated the factors predictive of early complications. The present study indicates outpatient TAA is not associated with increased risk of complications, reoperation, or readmission, which reinforces previous findings.<sup>20,26</sup> The finding of increased 30-day readmission in patients undergoing TAA as an inpatient prompted evaluation of factors predictive of complications, reoperation, and readmission. These results will serve to guide patient selection for TAA and performance of this procedure on an outpatient basis. In a single institution investigation of patients undergoing TAA, patient comorbidities were not associated with 90-day hospital readmission or emergency department visitation.<sup>12</sup> In the present study, LOS >2 days, smoking, and diabetes mellitus were identified as predictors of postoperative complications, whereas predictors of reoperation and readmission included LOS >2 days, presence of a bleeding disorder, hypertension, and diabetes mellitus.

This study found hospital LOS >2 days to be predictive of complications, reoperation, and readmission following TAA. Given that in this study only patients undergoing TAA as an inpatient had an LOS >2 days, inpatient status alone can be implicated as a risk for complication, reoperation, and readmission following TAA. Previous study has shown LOS >2 days following TAA to be predictive of a nonhome

discharge.<sup>18</sup> Factors affecting LOS >2 days included age  $\geq 65$  years, female sex, operative time >150 minutes, and inpatient surgery.

Smoking is known to affect outcomes in foot and ankle surgery and was shown to be predictive of a major complication in this study. Smoking has an effect on overall bone health, with a systematic review of 132 studies finding substantial evidence to support an association of smoking with low bone mineral density, the incidence of fracture and delayed fracture union, peri-implant bone loss, and implant failure.<sup>2</sup> Complication rates have been reported to be increased in patients who smoke undergoing forefoot surgery.<sup>6</sup> Active smokers had a complication rate of 36.4%, compared to 16.5% in patients with a previous smoking history, and 8.5% in those who never smoked. Furthermore, patients who smoked at the time of surgery had significantly higher rates of delayed union (3%), infection (9.1%), delayed wound healing (10.6%), and persistent pain (15.2%) compared with nonsmokers. In smokers undergoing TAA, significantly increased rates of wound healing complications (hazard ratio, 3.08) requiring additional procedures were noted.

Diabetes mellitus is considered a relative contraindication to TAA. In this study, it was predictive of major complication and reoperation. This is in keeping with a previous national (US) database study, which demonstrated that after both ankle arthrodesis and TAA, diabetes mellitus was independently associated with a significantly increased risk of perioperative complications, nonhome discharge, and length of hospital stay during the index hospitalization.<sup>22</sup> A more recent national (Republic of Korea) database review of 2157 primary TAA also revealed diabetes mellitus, along with chronic pulmonary disease, to be associated with early failure in TAA.<sup>17</sup> In contrast, patients with diabetes and ankle arthritis who underwent TAA at a single institution had similar clinical outcomes compared with their nondiabetic counterparts.<sup>14</sup> Although patients with diabetes had increased body mass index, and worse ASA preoperative grades, they did not have a significantly different complication or infection rate. The contradictory findings in the latter study may be a testament to a rigorous perioperative management of patients with diabetes mellitus undergoing TAA at that institution.

The presence of a bleeding disorder was predictive of both reoperation and readmission within 30 days of the index TAA procedure in this study. Although the NSQIP database indicates the presence of a bleeding disorder, it does not allow for delineation of specific bleeding disorders. A previous ACS-NSQIP study (2011-2018) found increasing severity of anemia to be associated with extended hospital LOS and increased reoperation rates in patient undergoing TAA.<sup>21</sup> Presence of a bleeding disorder (relative risk = 4.5) was noted to be a risk factor for 30-day readmission in patients undergoing total hip arthroplasty as an

outpatient.<sup>8</sup> Case series on patients with inherited bleeding disorders undergoing TAA indicate favorable clinical results.<sup>4,15</sup> In a series of patients undergoing TAA with von Willebrand disease, a 33.3% rate of intraoperative and postoperative complications was observed at midterm follow-up.<sup>5</sup> The major concerns regarding arthroplasty in patients with bleeding disorders include an increased rate of deep infection, aseptic loosening, and heterotrophic bone formation.<sup>4</sup> Hematoma, hemarthrosis, wound complications, and infections are most likely responsible for reoperation and readmission within 30 days of TAA. Unfortunately, tranexamic acid, which has been shown to be effective in total knee and total hip arthroplasty in decreasing blood loss and transfusion risk, has not been found to be effective in reducing intraoperative blood loss, perioperative blood loss, or wound complications in TAA.<sup>25</sup> This stresses the importance of a multidisciplinary approach to perioperative management in these patients, specifically as it pertains to pharmacologic management of their bleeding disorder.

Hypertension was predictive of reoperation within 30 days of index TAA. In patients undergoing outpatient total knee arthroplasty, hypertension was shown to be a risk factor for 30-day readmission (relative risk = 2.5).<sup>10</sup> Similarly, hypertension as a comorbid condition (OR = 2.77) was found to increase risk of 90-day emergency department visits after primary total knee arthroplasty. With respect to TAA, no previous investigation has indicated hypertension to be predictive of reoperation, or any other early complication.

Limitations to this study include those that are inherent to the retrospective design. Only 13% of surgeries in this study were performed on an outpatient basis, limiting both the value of the comparison and the generalizability of our findings as the potential for selection bias is high. Additionally, there are several patient-specific variables that are not captured within the ACS-NSQIP database but would likely influence the decisions regarding performance of TAA on an outpatient basis. For example, patient comfort level and attitude toward outpatient surgery, their ability to successfully participate in the rehabilitation process, and the availability of home support may all play a role in the decision-making process. The study was underpowered for most of the outcomes we sought to study. To achieve 80% power, with the enrollment ratio of this study (outpatient vs inpatient), a sample of 41 823 patients would have been required to observe a difference between groups in minor complications, 13 330 patients for major complications, 9030 patients for reoperation, and 1973 patients for readmission. Post hoc analysis revealed a power of just 5.7% for predicting differences in the rate of minor complications, 6.9% for major complications, 9.4% for reoperation, and 60.7% for readmission between the groups. Therefore, further differences between the inpatient and outpatient TAA cohorts may exist that the current investigation is underpowered to reveal.

In conclusion, this database study suggests that inpatient TAA may be associated with an increased rate of 30-day readmission, but the cohort sizes were widely different, limiting the power and generalizability of this finding. Hospital LOS >2 days, smoking, and diabetes mellitus were identified to be associated with postoperative complications, whereas factors associated with reoperation and readmission included LOS >2 days, presence of a bleeding disorder, hypertension, and diabetes mellitus. This study indicates that outpatient TAA may be safe for the management of end-stage ankle arthritis in select patients. The criteria for determination of patient suitability for outpatient TAA is beyond the scope of this investigation and should be the focus of future study.

### Ethical Approval

Ethical approval for this study was waived by the Western University Research Ethics Board as the institutional hospitals are contributing sites to the ACS-NSQIP database.

### Declaration of Conflicting Interests

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### ORCID iDs

Christopher Del Balso, MBBS, MSc,  <https://orcid.org/0000-0003-4074-6424>

Mansur M. Halai, BSc (Hons), MBChB,  <https://orcid.org/0000-0001-5679-2076>

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