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The Role of Malnutrition in Ninety-Day Outcomes After Total Joint Arthroplasty

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ABSTRACT

Background: Research has linked malnutrition to more complications in total joint arthroplasty (TJA) patients. The role of preoperative albumin in predicting length of stay (LOS) and 90-day outcomes remains understudied. Often, an albumin cut-off ≤3.5 g/dL is used as proxy for malnutrition, although this value remains understudied. This preoperative level may be missing some patients at risk for adverse events post TJA.

Methods: TJA patients at a single institution from 2013 to 2018 were reviewed for preoperative albumin level. In total, 4047 cases (total knee arthroplasty: 2058; total hip arthroplasty: 1989) had available data, including 90-day readmissions, 90-day emergency department (ED) visits, and postoperative LOS.

Results: About 5.6% experienced a readmission and 9.6% had at least one ED visit within 90 days. Overall prevalence of malnutrition was 3.6%, and this cohort experienced a longer average LOS (3.5 vs 2.2 days, $P < .0001$) and was more likely to experience a readmission (16% vs 5%, $P < .0001$) or ED visit (18% vs 9%, $P = .0005$). Additionally, albumin ≤3.5 g/dL was correlated with more frequent discharge to skilled nursing facility/rehab (30.8% vs 14.7%, $P < .0001$), increased risk for 90-day readmission with univariable (odds ratio [OR] 1.79, $P < .0001$) and multivariable logistic regression (OR 1.55, $P < .0001$), and increased risk for 90-day ED visits with univariable (OR 1.62, $P < .0001$) and multivariable regression (OR 1.35, $P < .0001$). The optimal albumin cut-off was 3.94 g/dL in a univariable model for 90-day readmission.

Conclusion: Screening for malnutrition may serve a role in preoperative evaluation. An albumin cutoff value of 3.5 g/dL may miss some at-risk patients.

Total joint arthroplasty (TJA) procedures are generally regarded as some of the most successful surgeries in medicine and provide significant benefit to patients and society [1]. However, TJA may consume a large amount of hospital resources, especially when postoperative complications occur [2]. A wide variety of preoperative variables including body mass index (BMI), anemia, uncontrolled diabetes, substance abuse, and malnutrition have been investigated for their value in predicting postoperative complications [3,4]. One of these predictive variables, malnutrition, has long been recognized for its association with poor surgical outcomes [5–7], and several groups have reported malnutrition being associated with wound healing problems and infection within orthopedics [8–11]. Despite its limitation as a negative acute phase reactant [12–14], albumin, as a measurement of malnutrition, has been shown repeatedly to correlate with higher complication rates after TJA [15–21]. However, the role of preoperative albumin in predicting bundled payment relevant events such as length of stay (LOS), 90-day readmissions, rates of discharge to skilled nursing facility (SNF)/rehab, and postoperative emergency department (ED) visits remains under-investigated [3,22].

The idea of hypoalbuminemia being classified around a cutoff point of 3.5 g/dL has been around for decades and began with assessments of severe protein malnutrition syndromes like Kwashiorkor [23] and surveys of the poor nutritional status in military personnel [24]. In 1963, The Interdepartmental Committee on

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Nutrition for National Defense in their Manual of Nutrition Systems suggested that a normal albumin concentration should be above 3.5 g/dL for identification of progressive protein malnutrition at an earlier stage [25]. In 1974, Bistrian et al [26] reported a significant correlation between anthropometric measurements of malnutrition (triceps skin fold and arm muscle circumference) and serum albumin in general surgical patients. The surgical community both inside and outside of orthopedics has historically embraced <3.4-3.5 g/dL as the norm for hypoalbuminemia [15,17,19,27–33]. Whether this cutoff level is appropriate within arthroplasty specifically remains under debate [34,35].

In light of the continued interest in using albumin to predict postoperative outcomes in TJA, the primary objectives of this study are to (1) measure the association among preoperative albumin and 90-day readmissions, 90-day ED visits, postoperative LOS, and discharge rates to SNF/rehab and (2) determine the optimal cutoff point of preoperative albumin to be classified at increased risk of poor postoperative outcomes.

Materials and Methods

The study cohort was retrospectively collected from the electronic medical record (EMR) at a single academic institution. The EMR was queried from 2013 to 2018 using Current Procedure Terminology codes for primary total hip arthroplasty (THA) (27130) and primary total knee arthroplasty (TKA) (27447). A total of 10,163 TJA cases were queried from the EMR between the dates January 1, 2013 and December 31, 2018. About 60.1% of them (6,108) did not have a preoperative albumin recorded. A total of 4047 surgeries with accompanying preoperative albumin levels from within 60 days prior to surgery were included in the cohort, including 2058 TKA surgeries (51%) and 1989 THA surgeries (49%). THA and TKA patients were then stratified by preoperative albumin using the commonly used cut-off of 3.5 g/dL. Patients without recorded albumin levels were excluded from the analysis.

Outcome variables collected were 90-day postoperative readmission rate, 90-day postoperative ED visit rate, inpatient LOS, and discharge rates to an SNF or rehab. Additionally, demographics and medical comorbidities were collected including age, BMI, gender, American Society of Anesthesiologists (ASA) score, race, tobacco use, marital status, and insurance type. Outcomes were collected through a chart review of each patient looking for related hospital readmissions prior to 90 days after surgery, visits to the ED prior to 90 days after surgery, discharge destination (SNF vs rehab), and LOS after surgery. All 4047 patients included in the study cohort were not lost to follow-up within 90 days after surgery.

Albumin levels were examined both as a categorical as well as continuous variable, with chi-squared testing used to compare categorical groups and *t*-test used for continuous variables (LOS). Univariable logistic regression was conducted to examine the effect of albumin level on the above outcome variables. Outcomes reaching statistical significance on univariable regression were then incorporated into a subsequent multivariable logistic regression model controlling for operative joint (knee/hip), age, BMI, gender, ASA score, race, tobacco use, marital status, and insurance type. Medical comorbidities were collected through chart review using current International Classification of Diseases coding. Categorical data were reported as a percentage and continuous data as a mean.

The Youden index was then employed to determine the optimal albumin cutoff point for the receiver operator characteristic curve in a univariable model for predicting 90-day readmission. This index value represents the level at which both sensitivity and specificity are maximized.

We performed a 1:1 propensity score-matched analysis to control for selection bias between the malnourished and non-malnourished patient cohorts, comparing the 146 malnourished patients to 146 matched patients who were not malnourished. To estimate the propensity score, a multivariate logistic regression analysis was used based on the following covariates: operative joint (knee/hip), age, BMI, gender, ASA score, race, tobacco use, marital status, and insurance type. Propensity score matching was then performed using greedy nearest neighbor matching. This matching was performed without replacement and using a caliper width of 0.5 times the pooled estimate of the standard deviations of the logit of the estimated propensity score. *P*-values <.05 were considered to be statistically significant. Propensity score matching was performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC). The other statistical analyses were performed using R version 3.5.0 (R Foundation, Vienna, Austria).

Results

A total of 4047 patients were included in the cohort, with 2058 TKA patients and 1989 THA patients having preoperative albumin and outcome data documented. Overall prevalence of malnutrition was 3.6% according to a historic albumin cut-off of <3.5 g/dL. Malnourished patients (<3.5 g/dL) experienced a longer LOS (3.5 vs 2.2 days, $P < .0001$), were more likely to experience a readmission (16% vs 5%, $P < .0001$), or present for evaluation to the ED (18% vs 9%, $P = .0005$). Additionally, hypoalbuminemia was correlated with more frequent discharge to SNF/rehab (30.8% vs 14.7%, $P < .0001$ [Table 1]).

When stratified by operative joint all descriptive statistical outcomes remained significant (Table 2).

Low albumin level was strongly associated with risk for 90-day readmission in a univariable logistic regression (odds ratio [OR] 1.79, $P < .0001$), an association that persisted in a multivariable model controlling for a variety of demographic and comorbidity factors (OR 1.55, $P < .0001$). This was also observed in univariable and multivariable models for 90-day ED visits (OR 1.62, $P < .0001$ and OR 1.35, $P < .0001$) (Table 3). According to analysis with the Youden function, the optimal cutoff value that maximized sensitivity and specificity in predicting 90-day readmission was found to be 3.94 mg/dL, although discrimination was limited (area under curve 0.61) (Figure 1).

The continuous variable albumin was then converted for binary analysis to malnourished (albumin <3.5) or non-malnourished (albumin ≥3.5). Prior to matching, being malnourished (albumin <3.5) was strongly associated with risk for 90-day readmission in a univariable logistic regression (OR 3.41, $P < .0001$), an association that persisted in a multivariable model controlling for a variety of demographic and comorbidity factors (OR 2.59, $P = .0001$).

A 1:1 propensity score-matched analysis was then performed to control for selection bias between the 2 patient cohorts. The 146 malnourished patients were matched to 146 patients who were not malnourished based on the same covariates as previous analysis: knee/hip, age, BMI, gender, ASA score, race, tobacco use, marital status, insurance type. There were significant covariate imbalances between comparison groups, and after propensity score matching,

Table 1
Descriptive Statistics for 4 Outcome Variables Comparing Patients With and Without Preoperative Albumin Levels Below 3.5.

Total Joint Arthroplasty	Albumin <3.5 (N = 146)	Albumin ≥3.5 (N = 3901)	*P*-Value
90-d Readmission (Overall)	23 (15.8%)	203 (5.2%)	<.0001
90-d ED visit (overall)	26 (17.8%)	361 (9.3%)	.0006
Length of stay (avg) (overall)	3.5 d	2.2 d	<.0001
Discharge to SNF/rehab (overall)	45 (30.8%)	574 (14.7%)	<.0001

ED, emergency department; SNF, skilled nursing facility.

Table 2
Descriptive Statistics for 4 Outcome Variables Comparing Patients With and Without Preoperative Albumin Levels Below 3.5 Stratified by Operative Joint.

Total Hip Arthroplasty	Albumin <3.5 (N = 77)	Albumin ≥3.5 (N = 1912)	*P*-Value
90-d readmission	12 (15.6%)	105 (5.5%)	.0002
90-d ED visit	12 (15.6%)	165 (8.6%)	.036
Length of stay (avg)	3.8 d	2.1 d	<.001
Discharge to SNF/rehab	24 (31.2%)	221 (11.6%)	<.0001
Total Knee Arthroplasty	**Albumin <3.5 (N = 69)**	**Albumin ≥3.5 (N = 1989)**	***P*-Value**
90-d readmission	11 (15.9%)	95 (4.8%)	<.0001
90-d ED visit	14 (20.2%)	190 (9.6%)	.0033
Length of stay (avg)	3.2 d	2.3 d	<.001
Discharge to SNF/rehab	21 (30.4%)	347 (17.4%)	.0056

ED, emergency department; SNF, skilled nursing facility.

covariate imbalances were significantly reduced. In a propensity score-matched analysis, the magnitude of association was slightly reduced, however being malnourished (albumin <3.4) remained strongly associated with risk for 90-day readmission (OR 2.29, $P = .0288$).

Similarly, the continuous variable 90-day ED visits was converted for binary analysis for comparison of patients with at least one visit to patients with no ED visits within 90 days of surgery. Being malnourished was associated with risk for 90-day ED visits in a univariate model (OR 2.12, $P = .006$); however, this association did not reach significance in a multivariable model prior to matching (OR 1.54, $P = .0618$) and in a propensity score matched analysis (OR 1.79, $P = .0989$).

The reasons for each 90-day readmission and 90-ED visit were also broken down more granularly (Tables 4 and 5). For the majority of reasons there was not a significant difference between the normal and malnourished group. However, there was a significantly higher rate of readmissions in patients admitted for prosthetic joint infection and altered mental status/delirium. There was also a significantly higher rate of ED visits in patients presenting for prosthetic joint infection and altered mental status/delirium.

Discussion

Readmission and postoperative emergency room visits represent significant expense to the patient, insurance providers, and health systems. The results of this study suggest that patients with hypoalbuminemia will stay on average 1.3 extra days in the hospital. This study also found a significant difference in readmission rates (16% vs 5%, $P < .0001$) and ED visits (18% vs 9%, $P = .0005$) according to albumin level, which remained significant in multivariable regression analyses before and after propensity score matching.

Little research has been done on the relationship between 90-day readmission rates and ED visits with preoperative malnutrition in primary TJA patients. Part of this may be because many studies use the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) which is limited to 30-day readmission data [36].

Prevalence of malnutrition due to hypoalbuminemia (<3.5 g/dL) was 3.5% in this study's cohort. This is similar to the prevalence (<3.5 g/dL) published by Bohl et al of 4.0% [15] and 3.8% published by Kamath et al [34]. However, Huang et al and Schroer et al both reported hypoalbuminemia prevalence (<3.5 g/dL) of 8.5% in their respective cohorts of TJA patients [3,17]. The discrepancy could be due in part to lack of reported albumin levels in some patients or differences in patient population.

This study also found 3.94 g/dL to be the optimal cut-off for 90-day readmission in TJA. However, the univariable model with only albumin had limited predictive discrimination, suggesting that malnutrition by itself may not be sufficient to predict readmission events. However, this finding agrees with other studies that suggest that the historical albumin cut-off of 3.5 g/dL should be reexamined. Despite the traditional surgical classification of malnutrition as albumin <3.4-3.5 g/dL [15,17,19,27–32], other recent studies outside of orthopedics have suggested updated albumin cutoff values. One group found that the cutoff rate for hospital resource usage in gastrectomy or pancreatic surgery increases below 3.25 g/dL [33]. Another suggested a threshold value of 3.2 g/dL for increased complications in patients undergoing surgery for gastrointestinal cancer [37].

A recent study within orthopedics by Nelson et al suggested a serum albumin threshold of 3.0 g/dL for increased perioperative complications after THA. The Nelson et al study comprised patient complication data collected from the NSQIP database that was analyzed as 6 composite complication ORs (any complication, any complication without transfusion, wound infection, systemic infection, cardiac/pulmonary complication, and any major complication). Three of these 6 composite complications reached statistical significance when serum albumin dropped below 3.0 g/dL (any complication, any complication without transfusion, and systemic infection) [35]. These lower cutoff modifications trend in the opposite direction of the increased value found in this study (3.94 g/dL). This may be in part due to different comorbidities

Table 3
Preoperative Albumin Was Examined as a Predictive Variable for 90-D Readmission and ED Visit, With Odds Ratios, *P*-Values, and AUC Calculated.

Method of Analysis	Outcome	Odds Ratio	95% CI	*P*-Value	AUC
Univariable regression: albumin only	90-d readmission	1.79	(1.47-2.17)	<.0001	0.61
	90-d ED visit	1.62	(1.39-1.89)	<.0001	0.59
Multivariable regression: albumin + covariates[a]	90-d readmission	1.55	(1.26-1.92)	<.0001	0.66
	90-d ED visit	1.35	(1.14-1.59)	<.0001	0.65

A univariable model with only albumin was generated, followed by a multivariable model containing albumin and 9 other covariates to control for confounding effects.
ASA, American Society of Anesthesiologists; AUC, area under curve; BMI, body mass index; CI, confidence interval; ED, emergency department.
[a] Covariates: knee/hip, age, BMI, gender, ASA, race, tobacco use, marital status, insurance type.

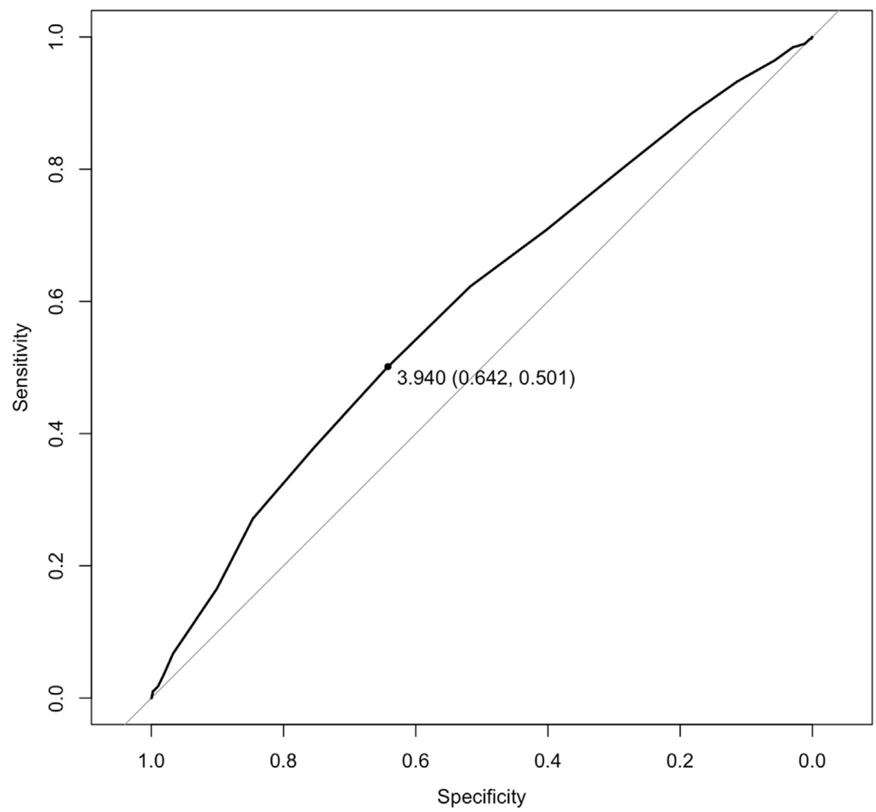

Fig. 1. Receiver operator characteristic curve for univariable logistic regression model composed of albumin alone as a predictor for 90-day readmission. Optimal cutoff point for albumin that maximizes predictive sensitivity/specificity is found to be at 3.94.

within patient populations, different surgical procedures/indications, different outcome measures, and the fact that NSQIP data contain 30-day instead of 90-day outcomes. In addition, this study was based on a large nationwide database which relies on coding accuracy and in the present study we had granular data from a single health system/EMR. However, these studies lend support to the need for re-examination of optimal albumin cutoff values. Further research needs to be done to clarify optimal values within different surgical subspecialties.

The increased LOS in patients with hypoalbuminemia reported in this study (3.5 vs 2.2 days, $P < .0001$) agrees with the findings reported by Bohl et al. They studied 49,603 patients undergoing TJA and reported a difference of 3.52 vs 3.10 days (95% confidence interval 0.34-0.49, $P < .001$) [15]. According to 2016 Kaiser State Health Facts, an extra day in the hospital costs an average of $2338 [38]. These added costs put increased strain both on health systems and patient finances. In addition to LOS impact on cost, other recent studies have addressed the overall increased financial burden associated with low preoperative albumin. Rudasill et al [22] reported a 16.2% increase in direct costs in patients undergoing primary TJA with an albumin <3.5 g/dL. Schroer et al performed a 90-day charges cost analysis on primary TJA patients based on 6 modifiable risk factors (MRFs) including anemia (hemoglobin <10 g/dL), malnutrition (albumin <3.4 g/dL), obesity (BMI >45 kg/m^2), uncontrolled diabetes (random glucose >180 mg/dL or A1C > 8), narcotic use, and tobacco use. They found malnutrition defined as albumin <3.5 g/dL to correlate with the largest hospital charge increase per capita ($788) of any MRF. The second highest MRF was tobacco use [3]. Despite increased attention [39,40], obesity incurred the lowest increased charge per capita [3]. Other studies have additionally shown hypoalbuminemia to be more predictive of postoperative complications than BMI [15,19,21,41]. Many obese patients also have malnutrition due to consumption of high calorie, yet nutritionally deficient foods [15,17].

Albumin has long been considered an imperfect indicator of malnutrition due to being a negative acute phase reactant [12–14]. However, much of the academic community accepts the imperfect nature of albumin as a measurement tool, but it has been shown repeatedly to correlate with higher complication rates after TJA [15–21]. The Department of Veterans Affairs in a large 44 center prospective cohort study reported hypoalbuminemia to be the number 1 predictor of increased 30-day patient morbidity in general, vascular, neuro, ENT, plastic, and orthopedic surgery [42]. A recent study found that malnourished patients with an albumin <3.5 g/dL were 2 times more likely to experience general postoperative complications after TKA [43]. Recent studies also show that malnourished orthopedic patients have higher rates of postoperative infection [15,19], pneumonia [15], LOS [15], blood transfusion [21], cardiac arrest [19,21], reintubation [19], and immediate postoperative intensive care unit admission [18]. Hypoalbuminemia has also been associated with a 6-fold increase in mortality following THA and TKA [18,21].

Despite its limitations, the value of albumin as a predictor of outcomes cannot be ignored. The next logical questions are whether hypoalbuminemia can be effectively corrected preoperatively and whether such a correction reduces complications. Studies outside the orthopedic surgery literature report lower rates of operative complications with correction of serum albumin prior to surgery after nutritional support [44–46]. A few orthopedic studies have recommended patients delay elective TJA until

Table 4
Reasons for 90-day Readmissions.

90-d Readmission Reason	Albumin <3.5 (n = 33)	Albumin >3.5 (n = 260)	*P*-Value
Surgical site infection	22 (66.7%)	121 (46.5%)	.0293
PJI	14 (42.4%)	44 (16.9%)	.00053
Cellulitis	3 (9.1%)	7 (2.7%)	.902
Sepsis	2 (6.1%)	2 (0.8%)	.0136
Hip dislocation/trauma/fall	2 (6.1%)	7 (2.7%)	.2908
Wound dehiscence/drainage/hematoma	1 (3.0%)	26 (10.0%)	.1922
Periprosthetic fracture	0 (0.0%)	11 (4.2%)	.2284
Fever of unknown origin	0 (0.0%)	3 (1.2%)	.5351
MUA	0 (0.0%)	7 (2.7%)	.340
Leg pain/swelling	0 (0.0%)	8 (3.1%)	.307
Loosened component	0 (0.0%)	2 (0.8%)	.613
Systemic inflammatory response syndrome	0 (0.0%)	1 (0.4%)	.7212
Muscle rupture/tendinitis	0 (0.0%)	3 (1.2%)	.535
Cardiopulmonary	2 (6.1%)	51 (19.6%)	.0567
Hypoxia/SOB	1 (3.0%)	4 (1.5%)	.5331
Pneumonia/pneumonitis/Bronchitis/URI	1 (3.0%)	4 (1.5%)	.5331
Pulmonary embolism/DVT	0 (0.0%)	11 (4.2%)	.2284
Arrhythmia/tachycardia	0 (0.0%)	7 (2.7%)	.340
Anemia	0 (0.0%)	5 (1.9%)	.4217
Asthma/COPD exacerbation	0 (0.0%)	4 (1.5%)	.4731
Other chest pain	0 (0.0%)	3 (1.2%)	.535
CHF exacerbation/pulmonary edema	0 (0.0%)	5 (1.9%)	.4217
STEMI/NSTEMI	0 (0.0%)	5 (1.9%)	.4217
Acute chest syndrome/sickle cell crisis	0 (0.0%)	1 (0.4%)	.7212
Flu-like symptoms	0 (0.0%)	1 (0.4%)	.7212
Obstructive sleep apnea	0 (0.0%)	1 (0.4%)	.7212
Neurological	3 (9.1%)	16 (6.2%)	.5187
Altered mental status/delirium	3 (9.1%)	4 (1.5%)	.0074
Syncope/presyncope/hypotension	0 (0.0%)	2 (0.8%)	.613
TIA	0 (0.0%)	2 (0.8%)	.613
Headache	0 (0.0%)	1 (0.4%)	.7212
Hypertensive encephalopathy/HTN	0 (0.0%)	1 (0.4%)	.7212
Intracranial hemorrhage	0 (0.0%)	1 (0.4%)	.7212
Serotonin syndrome	0 (0.0%)	1 (0.4%)	.7212
Unintentional opioid overdose	0 (0.0%)	1 (0.4%)	.7212
Vertigo/BPPV/tinnitus	0 (0.0%)	2 (0.8%)	.613
Alcohol withdrawal	0 (0.0%)	1 (0.4%)	.7212
Gastrointestinal	1 (3.0%)	44 (16.9%)	.0371
Cholecystitis	1 (3.0%)	2 (0.8%)	.2242
GI bleed	0 (0.0%)	14 (5.4%)	.1719
Clostridium difficile colitis	0 (0.0%)	7 (2.7%)	.3401
Small bowel obstruction/constipation/abdominal pain	0 (0.0%)	13 (5.0%)	.1888
Nausea/vomiting	0 (0.0%)	3 (1.2%)	.5351
Bowel perforation	0 (0.0%)	2 (0.8%)	.613
Achalasia	0 (0.0%)	1 (0.4%)	.7212
Acute appendicitis/bacterial peritonitis	0 (0.0%)	1 (0.4%)	.7212
Diverticulitis	0 (0.0%)	1 (0.4%)	.7212
Urinary/electrolyte	3 (9.1%)	20 (7.7%)	.7784
Urosepsis/UTI	2 (6.1%)	3 (1.2%)	.0403
Hyponatremia	1 (3.0%)	3 (1.2%)	.3815
Hematuria	0 (0.0%)	6 (2.3%)	.3779
AKI	0 (0.0%)	5 (1.9%)	.4217
Urinary retention/obstruction/frequency	0 (0.0%)	1 (0.4%)	.7212
Urolithiasis	0 (0.0%)	1 (0.4%)	.7212
Hypoglycemia	0 (0.0%)	1 (0.4%)	.7212
Other	2 (6.1%)	7 (2.7%)	.2908
Autoimmune related	2 (6.1%)	0 (0.0%)	.0001
Back pain/spondylolisthesis/lumbar stenosis	0 (0.0%)	7 (2.7%)	.3401

Data are presented as count (percent).
AKI, acute kidney injury; BPPV, benign paroxysmal positional vertigo; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; DVT, deep venous thrombosis; GI, gastrointestinal; HTN, hypertension; MUA, manipulation under anesthesia; NSTEMI, non-ST elevation myocardial infarction; PE, pulmonary embolism; PJI, prosthetic joint infection; SOB, shortness of breath; TIA, transient ischemic attack; URI, upper respiratory infection; UTI, urinary tract infection.

nutritional status correction [17,27]. However, no orthopedic study we are aware of has confirmed that preoperative nutritional correction decreases postoperative surgical complications. More investigation is needed into the feasibility and effectiveness of reversing low preoperative albumin and time needed to correct albumin levels in TJA.

This study has several limitations due to its retrospective nature. Patients who did not have a preoperative albumin concentration were excluded from analysis. A total of 6108 (60.1%) of primary TKA/THA patients in the EMR between 2013 and 2018 had no preoperative albumin reported. The inherent selection bias resultant from a retrospective analysis was controlled via propensity score matching analyses. This study is also limited by lack of research supporting the correction of low preoperative albumin in reducing operative complications prior to TJA.

Table 5
Reasons for 90-day ED Visits.

ED 90-d Reasons	Albumin <3.5 (n = 46)	Albumin >3.5 (n = 467)	*P*-Value
Surgical site related infection	34 (73.9)%	398 (85.2)%	.0447
PJI	13 (28.3)%	38 (8.1)%	.0001
Leg pain/swelling	5 (10.9)%	98 (21.0)%	.1022
Hip dislocation/trauma/fall	4 (8.7)%	41 (8.8)%	.9847
Surgical site cellulitis	1 (2.2)%	5 (1.1)%	.5067
Sepsis	1 (2.2)%	2 (0.4)%	.1385
Periprosthetic fracture	1 (2.2)%	4 (0.9)%	.3855
Wound dehiscence/drainage/hematoma	1 (2.2)%	26 (5.6)%	.3254
Fever of unknown origin	0 (0.0)%	4 (0.9)%	.5286
Other site cellulitis	0 (0.0)%	4 (0.9)%	.5286
Systemic inflammatory response syndrome	0 (0.0)%	1 (0.2)%	.7534
Muscle rupture/tendinitis	0 (0.0)%	1 (0.2)%	.7534
Cardiopulmonary	4 (8.7)%	87 (18.6)%	.0924
Hypoxia/SOB	2 (4.3)%	12 (2.6)%	.48
Pneumonia/pneumonitis/bronchitis/URI	1 (2.2)%	11 (2.4)%	.938
Flu-like symptoms	1 (2.2)%	0 (0.0)%	.0014
Pulmonary embolism/DVT	0 (0.0)%	16 (3.4)%	.2022
Arrhythmia/tachycardia	0 (0.0)%	15 (3.2)%	.2173
Anemia	0 (0.0)%	6 (1.3)%	.4393
Asthma/COPD exacerbation	0 (0.0)%	4 (0.9)%	.5286
Other chest pain	0 (0.0)%	15 (3.2)%	.2173
Allergic reaction	0 (0.0)%	2 (0.4)%	.6565
CHF exacerbation/pulmonary edema	0 (0.0)%	3 (0.6)%	.5856
STEMI/NSTEMI	0 (0.0)%	2 (0.4)%	.6565
Acute chest syndrome/sickle cell crisis	0 (0.0)%	1 (0.2)%	.7534
Neurological	5 (10.9)%	30 (6.4)%	.2539
Altered mental status/delirium	4 (8.7)%	1 (0.2)%	.0001
Syncope/presyncope/hypotension	1 (2.2)%	9 (1.9)%	.9081
Weakness	0 (0.0)%	3 (0.6)%	.5856
TIA	0 (0.0)%	2 (0.4)%	.6565
Anxiety	0 (0.0)%	1 (0.2)%	.7534
Headache	0 (0.0)%	3 (0.6)%	.5856
Hypertensive encephalopathy/HTN	0 (0.0)%	2 (0.4)%	.6565
Intracranial hemorrhage	0 (0.0)%	1 (0.2)%	.7534
Serotonin syndrome	0 (0.0)%	1 (0.2)%	.7534
Unintentional opioid overdose	0 (0.0)%	2 (0.4)%	.6565
Vertigo/BPPV/tinnitus	0 (0.0)%	4 (0.9)%	.5286
Alcohol withdrawal	0 (0.0)%	1 (0.2)%	.7534
Gastrointestinal	9 (19.6)%	76 (16.3)%	.5668
GI bleed	3 (6.5)%	14 (3.0)%	.2027
Small bowel obstruction/constipation/abdominal pain	2 (4.3)%	38 (8.1)%	.3605
Nausea/vomiting	2 (4.3)%	10 (2.1)%	.3448
Cholecystitis	1 (2.2)%	2 (0.4)%	.1385
Acute appendicitis/bacterial peritonitis	1 (2.2)%	1 (0.2)%	.0418
Clostridium difficile colitis	0 (0.0)%	3 (0.6)%	.5856
Dehydration/diarrhea	0 (0.0)%	2 (0.4)%	.6565
Incarcerated hernia	0 (0.0)%	2 (0.4)%	.6565
Food poisoning	0 (0.0)%	1 (0.2)%	.7534
Bowel perforation	0 (0.0)%	1 (0.2)%	.7534
Weight loss	0 (0.0)%	1 (0.2)%	.7534
Diverticulitis	0 (0.0)%	1 (0.2)%	.7534
Urinary/electrolyte	1 (2.2)%	32 (6.9)%	.2172
Hyponatremia	1 (2.2)%	1 (0.2)%	.0418
Hematuria	0 (0.0)%	6 (1.3)%	.4418
AKI	0 (0.0)%	4 (0.9)%	.5286
Urosepsis/UTI	0 (0.0)%	8 (1.7)%	.3709
Urinary retention/obstruction/frequency	0 (0.0)%	10 (2.1)%	.3162
Hypoglycemia	0 (0.0)%	2 (0.4)%	.6565
Catheter removal	0 (0.0)%	1 (0.2)%	.7534
Other	1 (2.2)%	18 (3.9)%	.1752
Autoimmune related	1 (2.2)%	0 (0.0)%	.0014
Breast pain	0 (0.0)%	1 (0.2)%	.7534
Insect bite	0 (0.0)%	1 (0.2)%	.7534
Loss of vascular access/PICC check	0 (0.0)%	3 (0.6)%	.5856
Neck pain	0 (0.0)%	1 (0.2)%	.7534
Subconjunctival hemorrhage	0 (0.0)%	1 (0.2)%	.7534
Toe pain/gout	0 (0.0)%	2 (0.4)%	.6565
Back pain/spondylolisthesis/lumbar stenosis	0 (0.0)%	9 (1.9)%	.3422

Data are presented as count (percent).
AKI, acute kidney injury; BPPV, benign paroxysmal positional vertigo; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; DVT, deep venous thrombosis; ED, emergency department; GI, gastrointestinal; HTN, hypertension; NSTEMI, non-ST elevation myocardial infarction; PICC, peripherally inserted central catheter; PJI, prosthetic joint infection; SOB, shortness of breath; TIA, transient ischemic attack; URI, upper respiratory infection; UTI, urinary tract infection.

Conclusion

Low albumin level is associated with a significant increase in postoperative LOS, rates of discharge to SNF/rehab, 90-day readmissions, and return to ED visits. Screening for patient's malnutrition status may serve a valuable role in routine preoperative evaluation for TJA. Additionally, a malnutrition cutoff value of 3.5 may be missing some at-risk patients.

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