

ORIGINAL RESEARCH



Preoperative malnutrition increases odds of hospital admission and extended length of stay following arthroscopic rotator cuff repair

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ABSTRACT

Background: Rotator cuff repair (RCR) is a common orthopedic procedure frequently performed in the outpatient setting. Malnutrition, as assessed by preoperative serum albumin <3.5 g/dL, has been independently associated with significantly higher risks of multiple adverse outcomes in several orthopedic procedures. The effect of preoperative hypoalbuminemia on short-term outcomes of RCR was previously unknown.

Hypothesis: we hypothesized that preoperative serum albumin <3.5 g/dL would be associated with higher odds of post-operative admission and prolonged length of stay.

Methods: This study represents a retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program database (NSQIP) for patients undergoing RCR between 2011 and 2015.

Results: Multivariate regression analysis adjusted for sex, ASA classification, age, BMI, and diabetes status (Table 3) showed preoperative hypoalbuminemia conferred a significantly increased adjusted odds ratio of postoperative admission (adjusted odds ratio 1.711, CI 1.134–2.583, $p = 0.011$) and extended length of stay (adjusted odds ratio 2.073, CI 1.073–4.003, $p = 0.030$).

Conclusion: Malnutrition as assessed by preoperative serum albumin <3.5 g/dL is significantly associated with increased odds of hospital admission and extended length of stay following arthroscopic RCR. This has clinical implications in surgical patient selection and risk stratification.

Level of evidence: III, Retrospective cohort study

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Introduction

Approximately 1524 per 100,000 Americans seek care from a physician for problems related to the rotator cuff every year [1]. Rotator-cuff-repair (RCR) surgery is a common arthroscopic orthopedic procedure performed in the outpatient setting with an estimated 270,000 procedures performed per year in the United States [2]. Rates of RCR have been steadily increasing and vary significantly by geographic location, with up to 18,335 cases per 100,000 persons in select areas of the United States in 2016 [3]. The rate of RCR is highest in individuals 45–74 years old, and cost-drivers of RCR include both patient-specific and surgeon-specific variables [2,4]. RCR is a cost-effective procedure which both improves patient quality of life and provides a national savings estimated at 3.44 USD billion per year [5].

A significant issue in an aging population is malnutrition, defined in recent consensus statements as 'a state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat-free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease' [6]. Malnutrition is widely known to adversely affect patient risks and outcomes in multiple medical settings, and hospital costs for malnourished patients have been estimated as increased by 308.9% compared non-malnourished patients [7]. Malnutrition may be assessed in

several ways which have been correlated to clinical outcomes, including anthropomorphic data, serologic laboratory values, and focused nutritional history [6].

Cross et al. in 2014 reviewed the literature involving the evaluation of malnutrition in orthopedic surgery and recommend preoperative serologic evaluation to identify patients at high risk of adverse outcomes due to malnutrition [8]. Serum albumin is currently the most widely used and easily attainable clinical marker of malnutrition in orthopedic surgery, with a serum concentration <3.5 g/dL suggestive of malnutrition [8]. Hypoalbuminemia <3.5 g/dL has previously been identified as an independent risk factor for adverse outcomes including higher mortality and major complication in several orthopedic procedures, with literature including geriatric hip trauma, total joint arthroplasty, and spine surgery, but not for RCR [8–12]. Here, we hypothesized that preoperative serum albumin <3.5 g/dL would be associated with higher odds of post-operative admission and prolonged length of stay.

Methods

Data source

This study used the National Surgical Quality Improvement Program (NSQIP) database from the American College of

Surgeons (ACS). Data from 2011 to 2015 were used. Nurse managers at approximately 750 medical centers follow patients for 30 days after specific procedures to track perioperative outcomes [13]. To provide random sampling, a specific number of patients for predefined procedures are selected randomly on an 8-day cycle [14]. Once the case limit for a specific procedure type has been reached, patients are no longer selected until the beginning of the next cycle. This cycle prevents a certain day of the week from being over-represented. Additionally, medical centers are excluded from the dataset if their follow-up rate is less than 80% or if there is greater than 5% disagreement between clinical reviewers and auditors. Information included in this dataset includes patient demographics, Current Procedural Terminology (CPT) codes, preoperative laboratory values, and 30-day patient outcomes.

Data selection and measures

All cases with CPT code 29827 (arthroscopically aided rotator cuff repair) were selected. Cases were excluded if they were missing any of the patient demographic information, including age, sex, race, American Society of Anesthesiologist (ASA) class, and diabetes mellitus status.

Some of the patients in this study had preoperative serum albumin levels obtained, although the reason for the measurement was not provided in the NSQIP database. It is possible that serum albumin may have been drawn for reasons unrelated to rotator cuff repair. However, in order to be included in the dataset, albumin levels had to be measured in the 90 days prior to the surgery. The median number of days from preoperative albumin measurement to surgery was 13 (interquartile range, 7 to 27). Hypoalbuminemia was defined as <3.5 g/dL. The primary outcome variables included were postoperative

admission to the hospital and extended length of stay. Postoperative admission was defined as at least one overnight stay in the hospital immediately following surgery, and extended length of stay was admission for two or more days. Specific reasons or symptoms leading to admission are not provided.

Statistical analysis

Analysis of the availability of serum albumin levels was initially performed using Chi-square testing and one-way Analysis of Variance (ANOVA). Risk factors for hypoalbuminemia were then assessed through Relative Risk calculations. Binary logistic regression models were then used to calculate the odds of postoperative admission and extended length of stay. All significant demographic factors as well as albumin levels were included in these regressions. An indicator variable for patients missing albumin measurements was included in these regressions to assess for bias associated with lack of preoperative lab work. *P* – values less than .05 were considered to be significant (SPSS Statistics V25.0, IBM Corporation, Armonk, NY, USA).

Results

After exclusion, we identified 15,846 total cases with CPT code 29,827 for arthroscopic RCR, of which 4,152 cases included serum albumin levels drawn within 90-days preprocedure. Ninety-four percent of the sample was <75 years old, 46% had BMI >30, and 58% were male. Multiple patient demographic factors were associated with significantly increased odds of admission after RCR (Table 1), including age >75 ($p < 0.001$), BMI > 30 ($p < 0.001$), female sex ($p < 0.001$), ASA

Table 1. Demographic associations with postoperative admission.

Variable	Group	N	Odds of Admission	95% Confidence Interval		p-value
				Lower Bound	Upper Bound	
Age	Under 75	14898	9.1%	8.6%	9.6%	<.001
	75 or Older	948	17.3%	14.9%	19.7%	
BMI	<18.5	67	7.5%	1.0%	13.9%	<.001
	18.5–24.9	2652	7.2%	6.2%	8.1%	
	25–29.9	5762	7.7%	7.0%	8.4%	
	30+	7365	12.1%	11.3%	12.8%	
Sex	Male	9239	8.4%	7.9%	9.0%	<.001
	Female	6607	11.2%	10.4%	12.0%	
Race	White	10776	9.9%	9.3%	10.4%	0.012
	Black	1218	10.1%	8.4%	11.8%	
	Hispanic	1182	7.6%	6.1%	9.1%	
	Asian	536	6.2%	4.1%	8.2%	
	Native American	93	7.5%	2.1%	13.0%	
	Unknown	2041	9.9%	8.6%	11.2%	
ASA Classification	1	1604	3.9%	2.9%	4.8%	<.001
	2	9357	7.9%	7.4%	8.5%	
	3	4742	14.2%	13.2%	15.1%	
	4	143	29.4%	21.8%	36.9%	
Diabetes Mellitus	No Diabetes	13457	8.8%	8.3%	9.2%	<.001
	NIDDM	1697	13.1%	11.5%	14.7%	
	IDDM	692	17.3%	14.5%	20.2%	
Serum Albumin	Normal Albumin	3998	11.0%	10.0%	11.9%	<.001
	Hypoalbuminemia	154	20.8%	14.3%	27.3%	
	Missing Albumin	11694	9.0%	8.5%	9.5%	

Displays demographic factors associated with increased odds of admissions following arthroscopic rotator cuff repair surgery from 2011–2015. BMI: Body Mass Index. NIDDM: Non-insulin-dependent diabetes mellitus. IDDM: Insulin-dependent diabetes mellitus.

Table 2. Risk factors for hypoalbuminemia.

Variable	Group	Hypoalbuminemia Prevalence	Relative Risk	95% Confidence Interval	
				Lower Bound	Upper Bound
Age	Under 75	3.4%	2.14	Reference	
	75 or Older	7.3%		1.41	3.27
Sex	Male	2.8%	1.67	Reference	
	Female	4.8%		1.22	2.29
ASA Class	Less than 3	2.7%	1.98	Reference	
	3 or greater	5.2%		1.44	2.70
Diabetes Mellitus	No Diabetes/NIDDM	3.4%	2.53	Reference	
	Insulin Dependent	8.6%		1.64	3.90

Displays demographic factors associated with increased prevalence of hypoalbuminuria in patients undergoing arthroscopic rotator cuff repair surgery from 2011–2015. NIDDM: Non-Insulin-Dependent Diabetes Mellitus.

Table 3. Odds ratios for perioperative outcomes in hypoalbuminemic patients. Significant effects bolded.

Outcome	Group	Adjusted Odds Ratio ⁺	95% Confidence Interval		
			Lower	Upper	Sig.
Postoperative Admission	Missing Albumin Data	0.940	0.833	1.061	0.315
	Hypoalbuminemia	1.711	1.134	2.582	0.011
Extended Length of Stay	Missing Albumin Data	0.826	0.647	1.053	0.123
	Hypoalbuminemia	2.073	1.073	4.003	0.030

⁺: Adjusted for sex, ASA classification, age, BMI, and diabetes status.

Displays odds ratios for postoperative admission and extended length of stay in patients undergoing arthroscopic rotator cuff repair surgery who were hypoalbuminemic preoperation. Odds ratios calculated via multivariate logistic regression adjusted for sex, ASA classification, age, BMI, and diabetes status.

classification ($p < 0.001$), and presence of diabetes mellitus ($p < 0.001$).

Of 4,152 cases with serum albumin data, 154 cases had serum albumin <3.5 g/dL. Significant risk factors for hypoalbuminemia (Table 2) included age > 75 (RR 2.14, CI 1.41–3.27), female sex (RR 1.67, CI 1.22–2.29), ASA class > 3 (RR 1.98, CI 1.44–2.70), and insulin-dependent diabetes mellitus (RR 2.53, CI 1.64–3.90).

Multivariate regression analysis adjusted for sex, ASA classification, age, BMI, and diabetes status (Table 3) showed preoperative hypoalbuminemia to confer a significantly increased adjusted odds ratio of postoperative admission (adjusted odds ratio 1.711, CI 1.134–2.583, $p = 0.011$) and extended length of stay (adjusted odds ratio 2.073, CI 1.073–4.003, $p = 0.030$). The missing albumin data variable was non-significant for both postoperative admission (adjusted odds ratio 0.940, CI 0.833–1.061, $p = 0.315$) and extended length of stay (adjusted odds ratio 0.826, CI 0.647–1.053, $p = 0.123$).

Discussion

Malnutrition has been shown to be an important risk factor for infections, poor patient outcomes and increased morbidity and mortality. This has been identified in the orthopedic trauma, total joint arthroplasty, and spine literature [9,10,12,15–19]. Malnutrition as assessed by serum albumin is common in orthopedic surgical patients, ranging from less than 10% in total shoulder arthroplasty patients to 45% in geriatric hip fracture patients [9,19]. As the demographic trends of the United States skew toward having older and more obese patients, malnutrition may become an even more significant factor in assessment of surgical candidates [20]. While it may be counter-intuitive, there is a significant literature base linking malnutrition and nutrient deficiency with obesity [21]. Our study shows that malnutrition is

significant risk factor in arthroscopic rotator cuff repair with regards to hospital admission and extended hospital stay.

The majority of rotator cuff repairs are performed as an outpatient procedure, a shift that was observed from 1996 to 2006 [1]. Several demographic factors were found to be significant risks factors for hospital admission following RCR, including age >75 , BMI >30 , female sex, ASA class 3 or 4, and having insulin-dependent diabetes mellitus in our study. Traven et al. found similar results using the modified frailty index-5 (mFI-5) tool. This tool incorporated comorbid diabetes, hypertension, congestive heart failure, chronic obstructive pulmonary disease, and functional status independence. For a every point increase in mFI-5 score, the risk of hospital readmission increased by 52% [22]. Similarly, Gil et al. discovered that age >65 , female sex, hypertension, BMI >35 , ASA class of 2 or greater, and open surgical technique were significant predictors of unexpected admission after rotator cuff repair [23,24].

Albumin is one of the several serum markers that can be a surrogate for malnutrition, hypoalbuminemia typically being defined at <3.5 g/dL [8,25]. Adjusting for potential cofounders, preoperative hypoalbuminemia was found to be a significant risk factor for hospital admission and extended hospital stay in the immediate post-operative period. While multiple comorbidities have been associated with admission after rotator cuff repair [23,24] hypoalbuminemia has not been commonly identified in the literature as it represents a frequently assessed lab value beyond the context of pre-operative risk stratification.

With this use of multiple linear regression, our investigation accounted for patient comorbidities that may occur alongside malnutrition including age, presence of diabetes mellitus, and obesity. In our patient cohort only about 26% of patients had preoperative albumin levels drawn, yet this was not found to be a confounding variable as shown by

the multivariate regression factoring in lack of preoperative labs. As such, clinicians should have lower threshold to screen for malnutrition in patients undergoing RCR when malnutrition is suspected. Greater knowledge of preoperative nutritional status may help clinicians properly counsel patients and select those that may need nutritional support or consultation prior to surgery. Our investigation does not reveal the effect of hypoalbuminemia on long-term outcomes following RCR, and further research is needed in this area.

There are several limitations in this study. The study utilized a large, geographically diverse database. This helps to generalize results to the population of the United States as a whole. However, because of lack of granularity in the database, we were not able to classify the severity of the injury along with exact surgical description. Patients with more severe injury or those with more substantial surgical intervention may be at high risk for postoperative admission. Furthermore, there are potential cofounders when investigating malnutrition. Patients who are malnourished frequently have additional medical comorbidities. Malnutrition was also more frequent in older patients within this cohort, with age also being identified as a risk for postoperative admission. In this study, a multivariate regression was utilized to account for some of these confounding comorbidities, but potentially not all comorbidities. While it is acknowledged that serum albumin is not the only laboratory, anthropomorphic, or clinical method of assessing nutrition status, there may be other more sensitive methods [25,26]. However, there is a growing body of literature supporting its utility in correlation with clinical outcomes related to malnutrition as represents a common serological value followed in the outpatient setting. Lastly, it must be noted that this review is retrospective in nature which has the potential for bias.

Conclusion

Malnutrition as assessed by preoperative serum albumin <3.5 g/dL is significantly associated with increased odds of hospital admission and extended length of stay following arthroscopic RCR. Clinicians should be vigilant about screening patients preoperatively for nutritional status and intervening to help improve patient care and limit health-care spending.

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Declaration of interest

No potential conflict of interest was reported by the authors.

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