

**RESEARCH ARTICLE**

# Malnutrition in Joint Arthroplasty: Prospective Study Indicates Risk of Unplanned ICU Admission

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**Abstract**

**Background:** Malnutrition has been linked to poor outcomes after elective joint arthroplasty, but the risk of unplanned postoperative intensive care unit (ICU) admission in malnourished arthroplasty patients is unknown.

**Methods:** 1098 patients were followed as part of a prospective risk stratification program at a tertiary, high-volume arthroplasty center. Chronic malnutrition was defined as preoperative albumin <3.5 g/dL.

**Results:** The overall incidence of malnutrition was 16.9% (primary and revision arthroplasty patients). Average BMI was highest for patients in albumin category 3.0-3.5 (BMI 35.7). Preoperative albumin <3.0 and <3.5 g/dL translated to 15.4% and 3.8% rates of unplanned ICU admission, respectively, indicating nutritional status to be a factor in postoperative ICU admission.

**Conclusion:** Patients with poor nutritional status must be counseled on the risks of adverse medical complications.

**Keywords:** Albumin, Intensive Care Unit, Malnutrition, Risk Reduction, Total Joint Arthroplasty (replacement)

**Introduction**

The prevalence of malnutrition in surgical patients has been reported to be as high as 50% (1-2). A number of studies have examined the effect of this poor nutritional status on patient recovery following surgery. Pre-operative complications related to malnutrition in a variety of surgical fields include an increased risk of post-operative intubation, slower wound healing rates, and infection; in addition, malnutrition has been associated with an increased risk of patient mortality and increased hospital length of stay (3-9). Malnutrition is associated with older age, lower immune response, muscle wasting, apathy, and impaired cardiac function; these co-morbidities may further compound the effects of nutritional status and post-operative outcomes (10).

Inadequate nutrition has long been linked to adverse outcomes after orthopedic surgical procedures, including surgical site infections following total joint arthroplasty (TJA), persistent wound drainage, and failure of wound healing (11-15). More serious deep pre-prosthetic infections have also been reported at a higher rate in patients with malnutrition (16-17). Other complications

associated with malnutrition noted in the orthopedic surgery literature include post-operative hematoma formation, sarcopenia, and complications of the renal, cardiovascular, and neurovascular systems (4, 17).

While malnutrition has been linked to medical and surgical complications, it is unknown whether malnutrition influences in-hospital complications directly leading to the need for higher acuity of care during the hospital admission. The purpose of this study was to evaluate the effect of pre-operative serum albumin (as a surrogate for chronic malnutrition) and rates of unplanned postoperative admission to the intensive care unit (ICU) during the same hospitalization episode.

**Materials and Methods**

This study received institutional review board approval, as part of a larger institutional effort to examine and to reduce risk in elective joint arthroplasty patients. 1098 consecutive patients undergoing total joint arthroplasty from September 2012 to November 2013 were prospectively followed as part of a risk stratification

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program at an urban, tertiary, high-volume arthroplasty center; data from this study was reviewed and analyzed retrospectively. Simultaneous and staged bilateral joint arthroplasty patients were included in the total patient analyses, but excluded from primary arthroplasty-only subgroup analysis.

Definitions in the literature used for malnutrition include a serum albumin concentration < 3.5 g/dL, lymphocyte count < 1,500 cells/mm<sup>3</sup>, low serum pre-albumin, and low serum transferrin levels < 200 mg/dL (12-13). Of these markers, low levels of serum albumin have been shown to correlate with patient morbidity and mortality, and may be an appropriate surrogate for chronic nutritional status (7, 18-22). In our prospective database, serum albumin was consistently collected in this cohort of patients and therefore supported for analysis.

Patients were stratified according to pre-operative albumin level (g/dL) : <3.0, 3.0-3.5, 3.6-3.9, 4.0-4.5, and >4.6-5.0+. Demographics, complications, and mortality were recorded. The primary endpoint of interest was unplanned ICU admission. A pre-study power analysis demonstrated adequate numbers to satisfy an effect size of half a standard deviation at 80% power and with a type I error rate of 0.05.

## Results

16.7% of all patients (primary and revision arthroplasty; n=1098; Table 1) and 15.0% of primary arthroplasty patients (117 of 779 primary arthroplasty patients; Table 2) had a pre-operative albumin level <3.5 g/dL. The incidence of hypoalbuminemia in revision arthroplasty patients was 28.9% (45 of 156 patients; Table 3). All patients with chronic liver disease (n=13) had serum albumin <4 g/dL. The average BMI was highest for patients in albumin category 3.0-3.5 (BMI 35.7), while the lowest average BMI was for category <3.0 g/dL (BMI 29.6) (NS).

The rate of unplanned ICU admission was highest for albumin category <3.0 g/dL: 15.4% for primary/revision patients in aggregate, and 28.6% for primary arthroplasty patients alone. These rates of unplanned ICU admission were significant ( $P=0.003$  for aggregate patients and  $P=0.001$  for primary patients alone, when compared to

**Table 1. Risk of unplanned ICU admission stratified according to pre-operative albumin level for all total joint arthroplasty patients (primary and revision; n = 1098)**

Albumin category	Number of Patients	Unplanned ICU Admit	Unplanned % ICU Admit	Average BMI
< 3.0 g/dL	13	2	15.38%	29.62
3.0-3.5 g/dL	172	5	2.91%	35.68
≤ 3.5 g/dL	185	7	3.78%	35.25
3.6-3.9 g/dL	433	11	2.54%	34.05
4.0-4.5 g/dL	449	15	3.34%	31.24
4.6-5.0+ g/dL	31	1	3.23%	31.09

ICU = Intensive Care Unit

BMI = Body Mass Index

**Table 2. Risk of unplanned ICU admission stratified according to pre-operative albumin level for primary total joint arthroplasty patients (n=779). This group analysis excluded staged and simultaneous bilateral arthroplasty procedures**

Albumin category	Number of Patients	Unplanned ICU Admit	Unplanned % ICU Admit	Average BMI
< 3.0 g/dL	7	2	28.57%	31.43
3.0-3.5 g/dL	110	5	4.55%	34.85
≤ 3.5 g/dL	117	7	5.98%	34.65
3.6-3.9 g/dL	298	10	3.36%	33.94
4.0-4.5 g/dL	340	9	2.65%	30.94
4.6-5.0+ g/dL	24	0	0.00%	31.25

ICU = Intensive Care Unit

BMI = Body Mass Index

benchmark of patients with albumin >3.5 g/dL). 3.8% of all patients and 5.9% of primary arthroplasty patients with albumin <3.5 g/dL experienced unplanned ICU admission. The rate of unplanned admission was 2.9% for all other albumin categories (i.e. >3.5 g/dL;  $P=0.002$ ). Only one of the 45 revision arthroplasty patients with an albumin <3.5 g/dL was admitted to the ICU unplanned post-operatively (2.2% rate).

## Discussion

As elective arthroplasty is extended to more medically complex patients, elucidation of factors that might affect patient safety remains a primary goal. Pre-operative albumin is an easily measurable patient-specific factor that has been shown to correlate with malnutrition and to impact post-operative morbidity and mortality (18-19). While malnutrition has been linked to poor outcomes after elective joint arthroplasty, the risk of unplanned postoperative ICU admission in malnourished arthroplasty patients is unknown. The goal of this study was to examine the relationship between pre-operative serum albumin and the risk of unplanned ICU admission in a consecutive series of prospectively followed patients.

One recent study of 2,161 patients undergoing elective joint arthroplasty reported that 8.5% of the study population was malnourished, as defined by low albumin or transferrin values (17). A study performed three decades ago suggested that 29% of patients undergoing elective total hip arthroplasty were malnourished (11). Our study

**Table 3. Risk of unplanned ICU admission stratified according to pre-operative albumin level for revision total joint arthroplasty patients (n=156)**

Albumin category	Number of Patients	Unplanned ICU Admit	% Unplanned ICU Admit	Average BMI
< 3.0 g/dL	6	0	0.00%	27.5
3.0-3.5 g/dL	39	1	2.56%	35.9
≤ 3.5 g/dL	45	1	2.22%	34.8
3.6-3.9 g/dL	59	0	0.00%	33.4
4.0-4.5 g/dL	47	3	6.38%	30.4
4.6-5.0+ g/dL	5	1	20.0%	31.2

ICU = Intensive Care Unit

BMI = Body Mass Index

found a value between these previously reported values: 16.9% of elective total joint arthroplasty surgical patients were found to have malnutrition, defined simply as a pre-operative albumin <3.5 g/dL. Nearly a third of all revision patients in our study were malnourished. Further research is necessary to narrow the true prevalence of malnutrition in primary and revision arthroplasty patients; however, there does appear to be a high prevalence of this potentially modifiable risk factor for poor outcome.

Poor nutritional status has long been linked to both mild and serious adverse outcomes after orthopedic surgery procedures (11). The effect of malnutrition on wound healing is an important consideration. Malnutrition has been shown to lead to wound problems, such as an increased risk of surgical site infections following total joint arthroplasty (TJA), persistent wound drainage, as well as failure of wound healing following surgery or subsequent debridement (12-15). More serious pre-prosthetic infections (both acute and chronic) have also been reported at a higher rate in patients with malnutrition (16-17).

Previous studies have shown that obesity can be noted in a high percentage (42.9%) of malnourished patients; and in fact, complications occurred much more frequently in obese, malnourished patients than obese patients without malnutrition (13, 17). Our study supported the suggestion that BMI and nutritional status can be inversely related; average BMI was highest for malnourished patients with albumin level between 3.0-3.5 g/dL. The incidence of obesity in patients undergoing total joint replacements is on the rise; thus, it is important to not overlook nutritional status in this population (23). Further study and in larger patient groups must examine the true contributions of obesity and malnutrition to the need for advanced levels of care post-operatively, and whether these variables are independently associated with poor outcome.

In our study, 3.8% of all total joint arthroplasty patients and 5.9% of primary arthroplasty patients with albumin <3.5 g/dL experienced unplanned ICU admission. Interestingly, despite lower numbers of patients undergoing revision joint arthroplasty, those revision arthroplasty patients with albumin level > 3.5 g/dL more commonly experienced unplanned ICU admission. More study in larger groups of patients is needed to examine the role of revision arthroplasty, without or without hypoalbuminemia, in influencing ICU admission. Likewise, there appears to be a threshold effect of serum albumin <3 g/dL as greatly increasing the risk of unplanned ICU admission in all patients (primary/ revision combined) and primary arthroplasty patients alone. This study can alone point to this effect, and future study is examining this specific question of a potential hard-stop for patient malnutrition level pre-operatively.

Some previous studies have concluded that patients with malnutrition had longer postoperative length of stay (9, 17). This study focused on the relationship between serum albumin and risk of medical complications necessitating a higher post-operative level of care, resulting in unplanned admission to the ICU. Higher numbers of unplanned ICU admissions have important implications for hospital finances and resource management, and this risk analysis

may play a role in bundled payment programs, including at our institution.

Limitations of this study include a retrospective review of prospectively collected data. Future study will test the role of pre-operative malnutrition optimization and the resultant risks of poor outcome. Although the study has large numbers, increased study size and longer timeframe would strengthen the results. In addition, this study was performed at an urban, tertiary referral center; with accordant variations in nutritional status compared to a suburban, perhaps more homogeneous population. While the burden of revision arthroplasty did not seem to influence malnutrition status at our institution, the patient numbers were smaller for this subgroup. Although supported in the literature, the use of serum albumin as a surrogate for nutritional status is a controversial topic (18-19, 24-26). Addition of a marker of more acute nutritional status, or use of a combination of markers would add to our understanding. However, albumin is a routinely obtained lab value as part of our prospective study, so it was the only marker routinely available for analysis. In addition, low albumin has consistently been associated with increased patient morbidity and mortality in the literature, despite the controversy surrounding the accuracy of its prediction of nutritional status.

In conclusion, joint arthroplasty patients are commonly malnourished. Despite advances in medical pre-operative care and optimization prior to elective surgery, this percentage of malnourished patients has not been significantly decreased over time. Not only does this lead to increased risk of adverse medical complications, but poor nutrition may lead to unplanned ICU admission. Serum albumin may be an indicator of risk of medical complications necessitating higher post-operative level of care. Patients with poor nutritional status should be confirmed by pre-operative albumin measurement, and they must be counseled on the increased risk of adverse medical complications. Preferably, elective surgery should be delayed until medical status is optimized.

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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