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A Prospective Study on the Impact of Preoperative Nutritional Status and Serum Albumin Levels on Postoperative Outcomes and Anaesthetic Recovery in Major Abdominal Surgeries

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Abstract
Malnutrition and hypoalbuminemia are well-established predictors of adverse surgical outcomes. Serum albumin, a readily available and inexpensive biomarker, reflects both nutritional and inflammatory status and may serve as a useful tool for perioperative risk stratification. This study aimed to evaluate the association between preoperative serum albumin levels and postoperative outcomes and anaesthetic recovery in patients undergoing major abdominal surgeries. In this prospective observational study, 200 adult patients undergoing elective major abdominal surgery at a tertiary care centre were enrolled over a 9-month period. Patients were stratified into two groups based on preoperative serum albumin levels: <3.5g/dL and ≥3.5 g/dL. Postoperative complications, anaesthetic recovery metrics (e.g., extubation time, ICU stay) and length of hospital stay were compared. Multi variate logistic regression was used to identify independent predictors of morbidity. Hypoalbuminemia (<3.5 g/dL) was observed in 46% of patients. This group had significantly higher complication rates, including surgical site infections (20.7% vs. 5.6%), pulmonary complications (12.0% vs. 2.8%) and wound dehiscence (9.8% vs. 1.9%). Time to extubation (6.2 vs. 4.7 hours), ICU stay (2.7 vs. 1.4 days) and hospital stay (11.2 vs. 7.6 days) were all prolonged in the low-albumin group. Hypoalbuminemia was independently associated with increased risk of postoperative complications (adjusted OR 2.86., 95% CI: 1.49-5.51., p<0.01). Preoperative hypoalbuminemia is a strong, independent predictor of adverse postoperative outcomes in major abdominal surgery. Incorporating serum albumin into preoperative risk assessment protocols may facilitate early intervention strategies and improve surgical outcomes.

INTRODUCTION

Malnutrition remains one of the most frequently overlooked yet impactful predictors of poor surgical outcomes, particularly in patients undergoing major abdominal procedures. Preoperative nutritional status, often reflected by serum protein levels such as albumin and pre albumin, has long been recognized as a crucial determinant of perioperative morbidity, length of stay, and recovery time. In surgical patients, hypo albuminemia has been associated with impaired wound healing, delayed recovery, higher rates of infections and increased mortality risk[1]. Serum albumin serves as a readily available, inexpensive and objective biomarker of nutritional status. However, it also reflects systemic inflammatory responses, which may compound its interpretive value in the perioperative setting. Ge *et al.* showed that even transient postoperative decreases in albumin were predictive of adverse surgical outcomes, independent of intraoperative events[2]. Van Stijn *et al.* further demonstrated that albumin and recent weight loss were two of the strongest predictors of postoperative complications in elderly patients undergoing general surgery[3]. In gastrointestinal surgery patients, serum albumin below 3.5 g/dL has been significantly linked with postoperative complications and prolonged recovery[4]. Kudsk *et al.* highlighted albumin as one of the top predictors of surgical site complications, especially in major abdominal operations[5]. Albumin levels also correlate with anaesthetic recovery metrics including extubation timing and ICU stay, providing a broader window into systemic resilience. Recent studies emphasize that preoperative albumin is not only a nutritional marker but a potent predictor of systemic capacity to withstand surgical trauma. Loft us *et al.* showed that low serum albumin levels were among the most accurate predictors of 30-day postoperative risk in abdominal surgery patients[6]. Likewise, Badia-Tahull *et al.* identified hypo albuminemia as a primary predictor for poor outcomes following gastrointestinal procedures[7]. A more recent prospective cohort study by Kanemoto *et al.* confirmed that serum albumin, in combination with other laboratory markers, could be used to estimate surgical risks and postoperative functional outcomes[8]. In gastrointestinal malignancies specifically, low pre albumin levels were shown to significantly increase the risk of infectious complications[9]. Despite the increasing awareness of the importance of nutritional risk screening, serum albumin is still underutilized as a predictive measure for postoperative recovery and anaesthetic outcomes. This prospective study aims to assess the correlation between preoperative nutritional status, especially serum albumin levels and key postoperative outcomes in patients undergoing major abdominal surgeries at a tertiary care centre.

Aims and Objectives:

Aims: To evaluate the impact of preoperative nutritional status, particularly serum albumin levels, on postoperative outcomes and anaesthetic recovery in patients undergoing major abdominal surgeries.

Primary Objective: To assess the association between preoperative serum albumin levels and incidence of postoperative complications, including infections, delayed wound healing and length of hospital stay.

Secondary Objectives:

- To determine the correlation between serum albumin levels and anaesthetic recovery parameters such as time to extubation, time to return of bowel function and ICU stay.
- To analyze the relationship between nutritional status (as assessed by BMI and recent weight loss) and length of postoperative recovery.
- To stratify postoperative outcomes based on albumin thresholds (<3.5 g/dL vs ≥3.5 g/dL) and compare rates of morbidity and mortality between groups.

MATERIALS AND METHODS

This was a prospective observational study conducted over a 9-month period, from January to September 2017, at IQ City Medical College and Hospital, Durgapur. The study was approved by the Institutional Ethics Committee and informed consent was obtained from all participants. Based on previous studies that reported postoperative complication rates of 35-45% in hypoalbuminemic patients compared to 15-20% in those with normal albumin levels, a sample size of 180 patients was estimated to achieve 80% power with a two-tailed a of 0.05 and to detect a 20% difference in complication rates between groups. Accounting for a 10% dropout or loss-to-follow-up, 200 adult patients undergoing major abdominal surgeries were enrolled.

Inclusion Criteria:

- Adults aged 18-75 years undergoing elective major abdominal surgery (e.g., colorectal, gastric, hepatobiliary, or oncologic resections).
- Preoperative serum albumin measurement within 7 days prior to surgery.
- ASA Physical Status Classification I-III.

Exclusion Criteria:

- Emergency surgeries.
- Chronic liver disease, nephrotic syndrome, or other conditions affecting albumin metabolism.
- Patients receiving parenteral nutrition pre-operatively.
- Known immunodeficiency or ongoing steroid/ immunosuppressant therapy.
- Refusal to participate or incomplete data.

Baseline demographic and clinical data were recorded, including age, sex, BMI, comorbidities, ASA classification and nutritional history (recent weight loss, dietary intake). Serum albumin was measured using standard bromocresol green colorimetric assay.

Postoperative Outcomes were Recorded up to 30 Days Post-Surgery and Included:

- Surgical site infections (SSI).
- Wound dehiscence.
- Time to extubation (hours post-surgery).
- Time to first flatus/bowel movement.
- ICU length of stay (if applicable).
- Total length of hospital stay.
- 30-day readmission or mortality.

The primary outcome was the incidence of postoperative complications in relation to preoperative serum albumin levels (<3.5 g/dL vs ≥3.5 g/dL). Secondary outcomes included time to anesthetic recovery and hospitalization duration. Continuous variables were expressed as mean±standard deviation and compared using the Student's t-test or Mann-Whitney U test, as appropriate. Categorical variables were analyzed using chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant. Multi variate logistic regression was performed to identify independent predictors of postoperative morbidity.

RESULTS AND DISCUSSIONS

Demographics and Preoperative Clinical Profile: A total of 200 patients undergoing elective major abdominal surgery were included in the study. The mean age was 54.2±11.3 years, with a slight male predominance (59.0%). The mean body mass index (BMI) of the cohort was 23.8±4.1 kg/m². According to ASA physical status classification, 21.0% were classified as ASA I, 47.5% as ASA II and 31.5% as ASA III, indicating a distribution reflective of a typical surgical population in a tertiary care center. Notably, 46.0% of patients had preoperative serum albumin levels below 3.5 g/dL, a threshold associated with nutritional risk, while the remaining 54.0% had levels equal to or above this benchmark. These findings provided the foundation for subgroup analysis in relation to postoperative outcomes.

Table 1: Demographic and Preoperative Clinical Profile

Variable	Value
Age (mean±SD)	54.2±11.3
Male sex, n (%)	118 (59.0%)
BMI (mean±SD)	23.8±4.1
ASA I, n (%)	42 (21.0%)
ASA II, n (%)	95 (47.5%)
ASA III, n (%)	63 (31.5%)
Preoperative Albumin <3.5 g/dL, n (%)	92 (46.0%)
Preoperative Albumin ≥3.5 g/dL, n (%)	108 (54.0%)

Postoperative Complications and Outcomes: Postoperative complications were more frequently observed in patients with hypoalbuminemia (<3.5 g/dL) compared to those with normal albumin levels. Surgical site infections (SSI) occurred in 20.7% of the hypoalbuminemic group versus 5.6% in the normoalbuminemic group. Similarly, wound dehiscence was noted in 9.8% vs. 1.9% and pulmonary complications such as pneumonia were observed in 12.0% compared to 2.8%, respectively. Re-operations were more common in the hypo albuminemic group (4.3%) than in the normal albuminemia group (0.9%). Notably, 30-day mortality occurred exclusively in the low albumin group (3.3%), further underscoring the prognostic significance of serum albumin levels in perioperative risk stratification.

Table 2: Postoperative Complications Stratified by Preoperative Albumin Level

Complication	Albumin <3.5g/dL, n (%)	Albumin ≥3.5 g/dL, n (%)
Surgical Site Infection (SSI)	19 (20.7%)	6 (5.6%)
Wound Dehiscence	9 (9.8%)	2 (1.9%)
Pulmonary Complication (e.g., Pneumonia)	11 (12.0%)	3 (2.8%)
Re operation	4 (4.3%)	1 (0.9%)
30-day Mortality	3 (3.3%)	0 (0.0%)

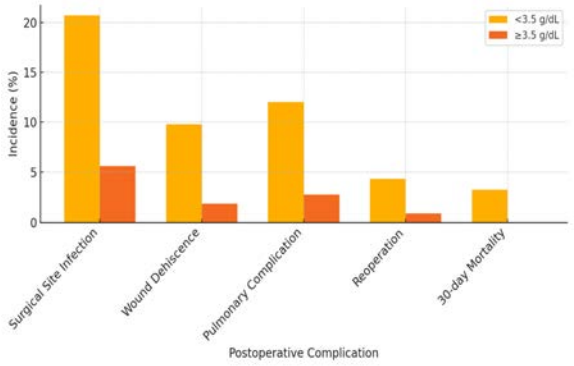

Fig. 1: Postoperative Complication Rates Stratified by Serum Albumin Level

This bar chart illustrates the incidence of key postoperative complications in patients with preoperative serum albumin levels <3.5 g/dL and ≥3.5g/dL. All complication types-including surgical site infections, wound dehiscence and pulmonary complications-were more prevalent in the hypoalbuminemia group, highlighting the impact of nutritional status on surgical morbidity.

Association Between Albumin Levels and Anesthetic Recovery: Significant differences were observed in anesthetic recovery parameters based on preoperative serum albumin levels. Patients with albumin <3.5 g/dL experienced prolonged recovery across all markers. The mean time to extubation was 6.2±1.4 hours in the hypoalbuminemic group compared to 4.7±1.1 hours in the normoalbuminemic group. Similarly, time to first flatus was delayed (3.9±1.1 vs. 2.6±0.8 days), indicating delayed bowel recovery. ICU stay was nearly twice as

long in the hypoalbuminemic cohort (2.7±1.2 vs. 1.4±0.9 days). These findings highlight the substantial influence of nutritional status on postoperative anesthetic and physiological recovery.

Table 3: Anesthetic Recovery Metrics Stratified by Preoperative Albumin Level

Parameter	Albumin <3.5 g/dL	Albumin≥3.5 g/dL
Time to Extubation (hours, mean±SD)	6.2±1.4	4.7±1.1
Time to First Flatus (days, mean±SD)	3.9±1.1	2.6±0.8
ICU Stay Duration (days, mean±SD)	2.7±1.2	1.4±0.9

Length of Hospital Stay and Read Missions: Hospitalization metrics also showed marked disparities between groups stratified by albumin levels. Patients with preoperative hypoalbuminemia (<3.5 g/dL) had a significantly longer mean hospital stay of 11.2±3.6 days, compared to 7.6±2.9 days for those with normal albumin levels. Additionally, the 30-day readmission rate was higher in the hypoalbuminemic group (14.1%) than in the normoalbuminemic group (3.7%). These findings reflect the burden of prolonged recovery and risk of complications in malnourished surgical patients.

Table 4: Hospital Stay Duration and Readmission Outcomes by Albumin Level

Outcome	Albumin <3.5 g/dL	Albumin ≥3.5 g/dL
Length of Hospital Stay (days, mean±SD)	11.2±3.6	7.6±2.9
30-day Readmission, n (%)	13 (14.1%)	4 (3.7%)

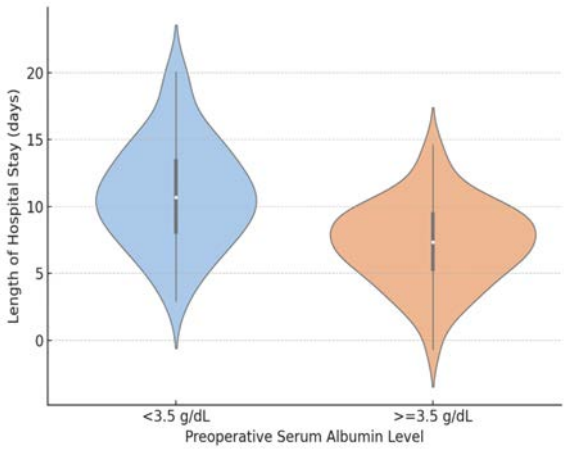

Fig. 2: Length of Hospital Stay Stratified by Preoperative Serum Albumin Levels

This violin plot demonstrates the distribution of hospital stay duration in days among patients with serum albumin levels <3.5 g/dL and ≥3.5 g/dL. Patients with hypoalbuminemia exhibited a broader spread and higher median stay, emphasizing the association between poor nutritional status and prolonged postoperative hospitalization.

Predictive Value of Albumin-Regression Analysis: A multivariate logistic regression analysis was performed to identify independent predictors of major postoperative complications. Preoperative serum albumin level <3.5 g/dL emerged as a strong independent predictor, with an adjusted odds ratio (AOR) of 2.86 (95% CI: 1.49-5.51., p<0.01). Additionally, ASA class III was also significantly associated with increased risk of complications (AOR: 2.19, p=0.03). Low BMI and advanced age showed a trend toward increased risk but did not reach statistical significance. These findings underscore the prognostic value of serum albumin in predicting postoperative morbidity independent of other clinical factors.

Table 5: Multi Variate Logistic Regression Analysis for Predicting Postoperative Complications

Variable	Adjusted Odds Ratio (95% CI)	p-value
Preoperative Albumin <3.5 g/dL	2.86 (1.49-5.51)	<0.01
ASA III (vs I/II)	2.19 (1.10-4.34)	0.03
BMI <18.5 kg/m²	1.77 (0.89-3.53)	0.11
Age >65 years	1.42 (0.73-2.74)	0.28

This prospective study highlights the significant role of preoperative serum albumin levels in predicting both short-term postoperative complications and recovery metrics among patients undergoing major abdominal surgeries. The observed association between hypoalbuminemia (<3.5 g/dL) and elevated complication rates, prolonged anesthetic recovery and increased hospital stay underscores the multifaceted impact of poor nutritional status in the perioperative period. Our demographic profile revealed a typical surgical population, with approximately 46% of patients presenting with serum albumin levels below 3.5 g/dL. This aligns with previous studies in gastrointestinal surgical cohorts that identified a similarly high prevalence of hypoalbuminemia[1]. Postoperative complications were markedly more common in the hypoalbuminemic group. Specifically, the incidence of surgical site infections, pulmonary complications and wound dehiscence was significantly elevated. Kudsk *et al.* also reported that preoperative albumin was one of the strongest predictors for major postoperative complications, particularly in abdominal procedures[10]. Lalhruaizela and Lalrinpuia emphasized that patients with serum albumin <3 g/dL had statistically significant increases in both early and late complications[4], findings nearly mirrored in our population. Importantly, hypoalbuminemia impacted not only complication rates but also anaesthetic recovery. The time to extubation, bowel movement and ICU stay were all delayed in the low-albumin group. Similar associations were found by Ge *et al.,* who demonstrated that even transient postoperative declines in albumin predicted delayed recovery and poorer surgical outcomes[11]. Our study complements these findings by reinforcing the predictive utility of preoperative albumin in determining intra-hospital functional recovery. Hospital length of stay was significantly longer in hypoalbuminemic patients (11.2±3.6 days vs. 7.6±2.9 days), consistent with studies by Galata *et al.* and Sungurtekin *et al.,* who found nutritional risk indexes to be correlated with

prolonged hospitalization and increased resource utilization[1,10]. Additionally, readmission rates were nearly four times higher among those with lower serum albumin, reiterating the long-term burden of under nutrition. Regression analysis further validated serum albumin <3.5 g/dL as an independent predictor of postoperative complications, even after adjusting for age, BMI and ASA grade. Van Stijn *et al.* similarly demonstrated that albumin remained a significant predictor of surgical morbidity in elderly patients after multi variable analysis[3]. Other investigators, including Bae *et al.* and Ataseven *et al.,* have emphasized the prognostic value of hypoalbuminemia not only for immediate complications but also for survival and long-term functional outcomes[9,11]. In summary, our findings align closely with a robust body of global evidence highlighting serum albumin as both a nutritional and inflammatory marker that can serve as a simple, accessible and powerful tool for risk stratification in elective abdominal surgery.

Limitations: This study has several limitations. First, although prospective, it was conducted at a single tertiary care center, which may limit the generalizability of the findings to other settings, particularly rural or resource-limited hospitals. Second, while serum albumin was used as a proxy for nutritional status, it may also reflect inflammatory burden and hepatic synthetic function, thereby confounding its interpretation as a pure nutritional marker. Third, postoperative complications were monitored only up to 30 days and long-term outcomes such as functional recovery or recurrence of complications were not assessed. Lastly, although multi variate analysis was performed, residual confounding from unmeasured variables such as surgical complexity or intraoperative fluid shifts cannot be excluded.

CONCLUSION

This prospective study underscores the strong prognostic utility of preoperative serum albumin levels in patients undergoing major abdominal surgeries. Hypoalbuminemia (<3.5 g/dL) was associated with increased postoperative complications, prolonged anaesthetic recovery, longer hospital stays and higher readmission rates. These findings reaffirm serum albumin as a simple, cost-effective and accessible biomarker for surgical risk stratification. Integration of nutritional assessment into routine preoperative evaluation may improve outcomes and guide perioperative optimization strategies.

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