

PREOPERATIVE SERUM ALBUMIN AND BODY MASS INDEX AS PREDICTORS OF SURGICAL SITE INFECTION IN EMERGENCY LAPAROTOMY: A PROSPECTIVE OBSERVATIONAL STUDY

Brahmbhatt Rajdeep Manojkumar¹, Vipin Agarwal², Ashok Kumar Singh³, Neelotpal Singodia¹, Shahnawaz Ahmad⁴

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Corresponding Author:

Dr. Neelotpal Singodia,

Email: rajdeepbaroot@gmail.com

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¹Junior Resident, Department of General Surgery, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India

²Professor, Department of General Surgery, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India

³Professor & Head, Department of General Surgery, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India

⁴Assistant Professor Department of General Surgery, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, Uttar Pradesh, India

ABSTRACT

Background: Surgical site infection (SSI) remains one of the most common postoperative complications following emergency laparotomy and contributes significantly to morbidity, prolonged hospitalization, and healthcare costs. Nutritional status plays a critical role in wound healing and immune function. This study aimed to evaluate the predictive value of preoperative serum albumin and body mass index (BMI) for the development of SSI in patients undergoing emergency laparotomy. **Materials and Methods:** A prospective observational study was conducted in the Department of General Surgery at Teerthanker Mahaveer Medical College and Research Centre, Moradabad, India. Eighty-five adult patients undergoing emergency laparotomy were enrolled using consecutive sampling. Preoperative serum albumin levels and BMI were recorded. Patients were followed for 30 days postoperatively for the occurrence of SSI according to Centers for Disease Control and Prevention criteria. Associations between serum albumin, BMI, and SSI were analyzed using chi-square tests and odds ratios, with $p < 0.05$ considered statistically significant. **Result:** The mean age of participants was 44.8 ± 13.6 years, and 65.9% were male. Hypoalbuminemia (serum albumin < 3.5 g/dL) was present in 44.7% of patients. The overall incidence of SSI was 30.6% (26/85). Patients with hypoalbuminemia had a significantly higher SSI rate compared with those with normal albumin levels (47.4% vs. 17.0%; $p=0.002$). Low serum albumin was associated with a 4.38-fold increased risk of SSI (OR: 4.38, 95% CI: 1.62–11.82). BMI was also significantly associated with SSI ($p=0.018$), with the highest infection rates observed among underweight (57.1%) and obese (40.0%) patients. Underweight patients had nearly four times higher odds of developing SSI than patients with normal or higher BMI (OR: 3.93, 95% CI: 1.25–12.31; $p=0.011$). The highest SSI incidence was observed in patients with both low serum albumin and low BMI (70%), demonstrating a significant synergistic effect of these nutritional parameters on postoperative infection risk ($p=0.001$). **Conclusion:** Preoperative hypoalbuminemia and abnormal BMI are significant predictors of surgical site infection following emergency laparotomy. Serum albumin was a particularly strong predictor of postoperative SSI, while the combination of low serum albumin and low BMI identified patients at the highest risk. Routine assessment of these simple and inexpensive nutritional parameters may facilitate early risk stratification and targeted perioperative interventions to reduce postoperative infectious complications.

INTRODUCTION

Surgical site infection (SSI) is defined by the Centers for Disease Control and Prevention (CDC) as an

infection occurring at or near the surgical incision within 30 days of the procedure, or within 90 days if an implant is involved, classified as superficial incisional, deep incisional, or organ/space

infection.^[1] SSIs are the most common preventable postoperative complication, occurring in 2%–4% of inpatient surgical procedures and representing the leading cause of hospital readmission.^[2] A systematic review of 488,594 patients reported a pooled 30-day SSI incidence of 11%, varying by procedure type and urgency,^[3] with SSIs accounting for approximately 20% of all hospital-acquired infections globally, disproportionately burdening low- and middle-income countries.^[4]

Emergency laparotomy carries a particularly elevated SSI risk, as patients are frequently hemodynamically unstable, malnourished, and present with contaminated operative fields with no opportunity for preoperative optimization.^[5] A prospective Indian study of 249 emergency laparotomy patients reported an SSI incidence of 17.12%, with hypoproteinemia ($p = 0.0016$) and obesity ($p = 0.0030$) as significant independent risk factors.^[6] Obesity further impairs wound healing, prolongs operative time, and increases comorbidity-related complications in this setting.^[7]

Serum albumin, the most abundant plasma protein, reflects nutritional status, hepatic synthetic reserve, and immune competence.^[8] In acute illness, hypoalbuminemia results from inflammatory capillary leakage, reduced synthesis, haemodilution, and increased catabolism.^[9] The landmark National VA Surgical Risk Study identified serum albumin as the strongest independent predictor of surgical morbidity and mortality among 62 preoperative variables.^[10] A multi-institutional study of 524 gastrointestinal surgery patients confirmed hypoalbuminemia as an independent SSI risk factor (RR = 5.68; 95% CI: 3.45–9.35; $p < 0.001$), also associated with deeper infections and prolonged hospital stay.^[11] In emergency laparotomy specifically, 56.4% of hypoalbuminemic patients developed SSI and 87.2% experienced wound dehiscence ($p < 0.001$).^[12]

Body mass index (BMI) is a readily available anthropometric measure reflecting nutritional extremes. Obesity (BMI > 30 kg/m²) has been established as an independent SSI predictor across abdominal wound classifications in a large NSQIP cohort,^[13] with a meta-analysis reporting up to 60% increased SSI risk in obese abdominal surgery patients.^[14] Underweight patients equally present increased susceptibility through protein-energy malnutrition, impaired immunity, and defective collagen synthesis.^[15] Despite growing evidence, no study has comprehensively evaluated serum albumin and BMI as concurrent SSI predictors in emergency laparotomy.^[16]

The present prospective observational study was therefore designed to assess the independent and combined predictive value of preoperative serum albumin and BMI for SSI in patients undergoing emergency laparotomy.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based prospective observational study was conducted in the Department of General Surgery, Teerthanker Mahaveer Medical College and Research Centre (TMMC&RC), Moradabad, Uttar Pradesh, India, over a period of 18 months following Institutional Ethics Committee approval.

Study Population: Adult patients undergoing emergency laparotomy for acute abdominal conditions — including perforation peritonitis, intestinal obstruction, ischemic bowel disease, abdominal trauma, and other surgical emergencies — were screened for eligibility. A total of 85 consecutive patients fulfilling the study criteria were enrolled.

Inclusion and Exclusion Criteria

Patients aged ≥ 18 years of either sex who underwent emergency laparotomy and provided written informed consent were included. Patients with severe anemia (hemoglobin < 7 g/dL), chronic liver disease, chronic kidney disease, HIV infection, immunocompromised states, or those receiving long-term corticosteroid or chemotherapy treatment were excluded, as these conditions independently alter serum albumin levels irrespective of nutritional status.^[17] Patients in whom accurate anthropometric measurements could not be obtained were also excluded.

Data Collection: Demographic characteristics, clinical history, comorbidities, perioperative laboratory parameters, and operative findings were recorded using a structured data collection proforma. Preoperative serum albumin was measured using standard automated biochemical analyzers within 24 hours prior to surgery. Body weight was measured using calibrated weighing scales and height using a stadiometer; BMI was calculated as weight in kilograms divided by height in meters squared.

Nutritional Assessment: Hypoalbuminemia was defined as a preoperative serum albumin level below 3.5 g/dL.^[17] BMI was categorized according to World Health Organization (WHO) criteria as underweight (< 18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥ 30.0 kg/m²).^[18]

Outcome Assessment: The primary outcome was the occurrence of SSI within 30 days of emergency laparotomy. SSI was diagnosed and classified as superficial incisional, deep incisional, or organ/space infection according to the 2017 Centers for Disease Control and Prevention (CDC) criteria.^[1] Patients were followed during hospitalization and through scheduled outpatient visits up to 30 days postoperatively.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences SPSS trail version. Continuous variables were expressed as mean $\pm$ standard deviation (SD) and categorical variables as

frequencies and percentages. A p-value < 0.05 was considered statistically significant.

Ethical Approval: The study protocol was approved by the Institutional Ethics Committee of Teerthanker Mahaveer Medical College and Research Centre, Moradabad. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment, in accordance with the Declaration of Helsinki.^[19]

Objective: The present prospective observational study was therefore designed with three objectives: first, to evaluate the association between preoperative serum albumin levels and SSI occurrence within 30 days of emergency laparotomy; second, to assess the relationship between BMI categories and postoperative SSI development; and third, to determine the combined predictive value of serum albumin and BMI as synergistic preoperative predictors of SSI in this high-risk surgical population.

RESULTS

Demographic and Baseline Characteristics

A total of 85 patients undergoing emergency laparotomy were included in this prospective observational study. The mean age of the participants was 44.8 ± 13.6 years, with the majority (67.1%) belonging to the 30–49-year age group. Males predominated, accounting for 65.9% (n = 56) of the study population, while females constituted 34.1% (n = 29). The mean preoperative serum albumin level was 3.32 ± 0.62 g/dL, and hypoalbuminemia (<3.5 g/dL) was present in 38 patients (44.7%). The mean body mass index (BMI) was 23.8 ± 4.2 kg/m². According to World Health Organization (WHO) BMI classification, 14 patients (16.5%) were underweight, 39 (45.9%) had normal BMI, 22 (25.9%) were overweight, and 10 (11.7%) were

obese. During the 30-day postoperative follow-up period, surgical site infection (SSI) developed in 26 patients (30.6%), whereas 59 patients (69.4%) remained free of SSI [Figure 1–4].

Association Between Preoperative Serum Albumin and Surgical Site Infection: A significant association was observed between preoperative serum albumin status and postoperative SSI occurrence. Among patients with hypoalbuminemia, 18 of 38 patients (47.4%) developed SSI, compared with only 8 of 47 patients (17.0%) with normal serum albumin levels. Chi-square analysis demonstrated a statistically significant relationship between hypoalbuminemia and SSI development ($\chi^2 = 9.58$, p = 0.002). Logistic regression analysis further revealed that patients with hypoalbuminemia had 4.38-fold higher odds of developing SSI than those with normal albumin levels (OR = 4.38, 95% CI: 1.62–11.82, p = 0.002), identifying low serum albumin as an independent predictor of postoperative infection [Table 1, Figure 1].

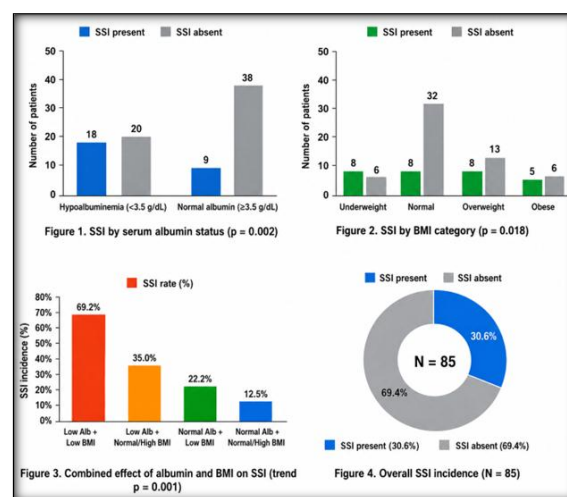


Table 1: Association between preoperative serum albumin status and SSI

Serum albumin	SSI present, n (%)	SSI absent, n (%)	Total
< 3.5 g/dL (hypoalbuminemia)	18 (47.4)	20 (52.6)	38
≥ 3.5 g/dL (normal)	8 (17.0)	39 (83.0)	47
Total	26 (30.6)	59 (69.4)	85

$\chi^2 = 9.58$; p = 0.002; SSI: surgical site infection

Association Between BMI Category and Surgical Site Infection

The incidence of SSI varied significantly across BMI categories ($\chi^2 = 10.12$, p = 0.018). The highest SSI rate was observed among underweight patients (57.1%), followed by obese (40.0%), overweight (31.8%), and normal BMI patients (17.9%). When BMI was dichotomized into low BMI (<18.5 kg/m²) and normal/high BMI (≥18.5

kg/m²), SSI occurred in 57.1% of underweight patients compared with 25.4% of patients with normal or higher BMI. This difference was statistically significant (p = 0.011), with underweight patients demonstrating nearly fourfold increased odds of SSI (OR = 3.93, 95% CI: 1.25–12.31) [Tables 2,3, Figure 2].

Table 2: Association between BMI category and SSI

BMI category	SSI present, n (%)	SSI absent, n (%)	Total
Underweight (< 18.5 kg/m ²)	8 (57.1)	6 (42.9)	14
Normal (18.5–24.9 kg/m ²)	7 (17.9)	32 (82.1)	39
Overweight (25.0–29.9 kg/m ²)	7 (31.8)	15 (68.2)	22
Obese (≥ 30.0 kg/m ²)	4 (40.0)	6 (60.0)	10
Total	26 (30.6)	59 (69.4)	85

$\chi^2 = 10.12$; p = 0.018; BMI: body mass index; SSI: surgical site infection

Table 3: Association between low BMI and SSI (dichotomized analysis)

BMI group	SSI present, n (%)	SSI absent, n (%)	Total
Low BMI (< 18.5 kg/m ²)	8 (57.1)	6 (42.9)	14
Normal/high BMI (≥ 18.5 kg/m ²)	18 (25.4)	53 (74.6)	71
Total	26 (30.6)	59 (69.4)	85

p = 0.011; OR = 3.93 (95% CI: 1.25–12.31); BMI: body mass index; SSI: surgical site infection

Combined Predictive Value of Serum Albumin and BMI for SSI: Evaluation of the combined nutritional parameters revealed a significant dose-response relationship between worsening nutritional status and SSI risk (trend p = 0.001). Patients with both hypoalbuminemia and low BMI exhibited the highest SSI incidence (70.0%), whereas those with normal albumin and normal/high BMI had the lowest incidence (16.3%). Intermediate SSI rates were observed among patients with low albumin and normal/high BMI (39.3%) and those with normal albumin and low BMI (25.0%). These findings demonstrate a synergistic effect of hypoalbuminemia and low BMI on postoperative SSI development, with patients exhibiting dual nutritional deficits experiencing more than fourfold higher SSI rates than nutritionally adequate patients (Figure 3).

DISCUSSION

Surgical site infection (SSI) remains a major cause of postoperative morbidity following emergency laparotomy, contributing to prolonged hospitalization, increased healthcare costs, and adverse patient outcomes.^[1-4] Identifying patients at increased risk of SSI is essential for implementing preventive strategies and improving surgical outcomes. The present study evaluated the association of preoperative serum albumin and body mass index (BMI) with postoperative SSI and demonstrated that poor nutritional status was significantly associated with increased infection risk. The overall SSI incidence in this study was 30.6%, which is comparable to rates reported in previous studies involving emergency abdominal surgery patients. Garale et al. reported a similarly high burden of SSI following emergency laparotomies, emphasizing the importance of identifying modifiable risk factors in this patient population.^[6] Emergency surgical procedures are often performed in physiologically compromised patients with limited opportunity for preoperative optimization, increasing the risk of postoperative complications.^[5]

A major finding of this study was the significant association between preoperative hypoalbuminemia and SSI development. Patients with serum albumin levels below 3.5 g/dL had a significantly higher SSI rate than those with normal albumin levels (47.4% vs. 17.0%; p = 0.002). Furthermore, hypoalbuminemic patients had more than fourfold increased odds of developing SSI. Serum albumin is a well-established marker of nutritional status and systemic inflammation, and low levels are associated with impaired wound healing, reduced immune function, and increased susceptibility to infection.^[8] These

findings are consistent with previous studies by Gibbs et al,^[10] Hennessey et al,^[11] and Anand et al,^[9] all of which identified hypoalbuminemia as an independent predictor of postoperative complications and SSI.

BMI was also significantly associated with SSI occurrence. Underweight patients demonstrated the highest SSI incidence (57.1%), while patients with normal BMI had the lowest infection rate (17.9%). Similar observations have been reported in previous studies, suggesting that malnutrition and inadequate nutritional reserves adversely affect wound healing and immune competence.^[7,13,14] Although obesity has been recognized as a risk factor for SSI, the present study highlights the substantial impact of undernutrition on postoperative outcomes.

An important finding was the combined effect of serum albumin and BMI on SSI risk. Patients with both hypoalbuminemia and low BMI exhibited the highest SSI incidence (70.0%), whereas those with normal albumin and normal/high BMI had the lowest incidence (16.3%). This significant trend suggests a synergistic relationship between these nutritional parameters and supports the use of both measures during preoperative risk assessment.

Limitations

This study was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings. The short follow-up period restricted assessment of long-term outcomes and SSI recurrence. Additionally, factors such as nutritional interventions, socioeconomic status, and patient compliance were not evaluated. Larger multicenter studies are required to validate these findings.

CONCLUSION

Preoperative hypoalbuminemia and low body mass index were significantly associated with an increased risk of surgical site infection following emergency laparotomy. Patients with both hypoalbuminemia and low BMI demonstrated the highest incidence of SSI, indicating a synergistic effect of poor nutritional status on postoperative outcomes. Routine assessment of serum albumin and BMI provides a simple, inexpensive, and effective method for identifying high-risk patients before surgery. Early nutritional optimization and targeted perioperative interventions may help reduce the burden of surgical site infections and improve postoperative outcomes in patients undergoing emergency laparotomy.

Human Subjects: Consent was obtained from all participants included in the study. The study protocol was approved by the Institutional Ethics Committee

of the participating institution and conducted in accordance with the Declaration of Helsinki.

REFERENCES

1. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surg.* 2017;152(8):784-91. doi: 10.1001/jamasurg.2017.0904. PMID: 28467526.
2. Agency for Healthcare Research and Quality. Surgical site infections [Internet]. PSNet Patient Safety Network; 2019 [cited 2024]. Available from: <https://psnet.ahrq.gov/primer/surgical-site-infections>
3. Nepogodiev D, Martin J, Biccadd B, Bhatt A, Glasbey J; National Institute for Health Research Global Health Research Unit on Global Surgery. Global burden of postoperative death. *Lancet.* 2019;393(10170):401. doi: 10.1016/S0140-6736(18)33139-8. PMID: 30722955.
4. Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet.* 2011;377(9761):228-41. doi: 10.1016/S0140-6736(10)61458-4. PMID: 21146207.
5. Sartelli M, Catena F, Di Saverio S, Ansaloni L, Malangoni M, Moore EE, et al. Current concept of abdominal sepsis: WSES position paper. *World J Emerg Surg.* 2014;9(1):22. doi: 10.1186/1749-7922-9-22. PMID: 24674057.
6. Garale MN, Rewatkar AK, Moktali AV, Dalvi A. Incidence and risk factors for surgical site infections following emergency laparotomies: a prospective observational study. *Cureus.* 2025;17(3):e80283. doi: 10.7759/cureus.80283. PMID: 40201888.
7. Marahanumaiah S, Suresh N, Rajkumar B, Priyadarshi A. Impact of obesity on surgical outcomes in patients undergoing emergency laparotomy: a prospective observational study. *Cureus.* 2025;17(6):e85887. doi: 10.7759/cureus.85887. PMID: 40396046.
8. Don BR, Kaysen G. Serum albumin: relationship to inflammation and nutrition. *Semin Dial.* 2004;17(6):432-7. doi: 10.1111/j.0894-0959.2004.17603.x. PMID: 15660573.
9. Anand S, Jain R, Singh VP. Preoperative serum albumin level as a predictor of abdominal wound-related complications after emergency exploratory laparotomy. *Cureus.* 2022;14(11):e32008. doi: 10.7759/cureus.32008. PMID: 36589182.
10. Gibbs J, Cull W, Henderson W, Daley J, Hur K, Khuri SF. Preoperative serum albumin level as a predictor of operative mortality and morbidity: results from the National VA Surgical Risk Study. *Arch Surg.* 1999;134(1):36-42. doi: 10.1001/archsurg.134.1.36. PMID: 9927128.
11. Hennessey DB, Burke JP, Ni-Dhonocho T, Shields C, Winter DC, Mealy K. Preoperative hypoalbuminemia is an independent risk factor for the development of surgical site infection following gastrointestinal surgery: a multi-institutional study. *Ann Surg.* 2010;252(2):325-9. doi: 10.1097/SLA.0b013e3181e9819a. PMID: 20647925.
12. Swaminathan A, Kaman L, Dahiya D, Singh R. Correlation between postoperative complications and serum albumin levels in abdominal surgery: a prospective observational study. *Cureus.* 2025;17(6):e61842. doi: 10.7759/cureus.61842. PMID: 40698225.
13. Aquina CT, Rickles AS, Probst CP, Kelly KN, Deeb AP, Monson JR, et al. Obesity and the risk for surgical site infection in abdominal surgery. *J Gastrointest Surg.* 2015;19(2):279-88. doi: 10.1007/s11605-014-2705-5. PMID: 27097626.
14. Qiao G, Liu Y, Wu Y, Ma Q, Liu H. Effect of body mass index on surgical site wound infection, mortality, and postoperative hospital stay in subjects undergoing possibly curative surgery for colorectal cancer: a meta-analysis. *Int Wound J.* 2023;20(1):141-51. doi: 10.1111/iwj.13860. PMID: 35790067.
15. Lohsiriwat V, Chinswangwatanakul V, Lohsiriwat S, Akaraviputh T, Boonnuch W, Methasade A, et al. Hypoalbuminemia is a predictor of delayed postoperative bowel function and poor surgical outcomes in right-sided colon cancer patients. *Asia Pac J Clin Nutr.* 2007;16(2):213-7. PMID: 17468079.
16. Vromans RPJ, van Gammeren AJ, Huisken J, Gobardhan PD, Smits LJT. Association between preoperative hypoalbuminemia and surgical site infection in abdominal surgery: a systematic review and meta-analysis. *Patient Saf Surg.* 2026;20(1):10. doi: 10.1186/s13037-026-00478-y. PMID: 40050986.
17. Anand S, Jain R, Singh VP. Preoperative serum albumin level as a predictor of abdominal wound-related complications after emergency exploratory laparotomy. *Cureus.* 2022;14(11):e32008. doi: 10.7759/cureus.32008. PMID: 36589182.
18. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. WHO Technical Report Series 894. Geneva: WHO; 2000. Available from: <https://www.who.int/publications/i/item/obesity-preventing-and-managing-the-global-epidemic>
19. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA.* 2013;310(20):2191-4. doi: 10.1001/jama.2013.281053. PMID: 24141714.