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Original Article

Preoperative hypoalbuminemia and severe acute malnutrition as prognostic factors for postoperative complications in major abdominal surgery: A single-center retrospective study

Lestarina Veronica Haloho, Nurnaningsih, Endy Paryanto

Abstract

Background Hypoalbuminemia and malnutrition are common factors that can adversely affect wound healing and increase the risk of postoperative infections. Improvements in albumin and preoperative nutritional status are expected to reduce the incidence of complications following postoperative abdominal surgery.

Objective To evaluate the roles of hypoalbuminemia and poor preoperative nutritional status as prognostic factors for postoperative complications in pediatric patients undergoing major abdominal surgery.

Methods This retrospective cohort study included pediatric patients aged 1 month to 18 years who underwent major abdominal surgery and were treated in the pediatric intensive care unit (PICU) of Dr. Sardjito Hospital between January 1, 2017 to December 31, 2021. The primary was the incidence of postoperative complications within 14 days after the surgical procedure.

Results Out of the 201 pediatric patients included in the study, 54.7% were male. We observed an overall complication rate of 21.3% following abdominal surgery, with sepsis as the most frequent, affecting 14.9% of the cases. On average, postoperative complications occurred approximately 10.9 days after surgery. Multivariate analysis identified severe acute malnutrition [hazard ratio (HR) 2.09 (95%CI 1.01 to 4.33); P=0.047], preoperative hypoalbuminemia of >2.5 to 3.0 g/dL [HR 3.64 (95%CI 1.57 to 8.41); P=0.003], preoperative hypoalbuminemia ≤2.5 g/dL [HR 3.1 (95%CI 1.11 to 8.64); P=0.03], and age <1 year [HR 2.16 (95%CI 1.09 to 4.11); P=0.026] as significant prognostic factors for post-abdominal surgery complications in children.

Conclusion Preoperative severe acute malnutrition and preoperative hypoalbuminemia of ≤3 g/dL are significant prognostic factors for the occurrence of postoperative complications in pediatric patients undergoing abdominal surgery. Infants less than one year of age are at increased risk of such complications. **[Paediatr Indones. 2023;63:389-94; DOI: https://doi.org/10.14238/pi63.4.2023.389-94].**

Keywords: *postoperative complications; hypoalbuminemia; nutritional status; preoperative*

Surgical trauma can result in critical illness due to metabolic stress, which is a response to various phases of postoperative wound healing. The surgical wound healing process occurs through various stages ranging from hemostasis, inflammation, and proliferation to remodeling.[1] Surgery leads to a decrease in total body protein due to hypermetabolism from adrenal-sympathetic activation. This condition increases protein catabolism and amino acid oxidation.[2] Following surgery, albumin levels decrease by up to 33%, followed by an increase in infection markers which occurs 48 hours postoperatively.[3] The inflammatory process leads to decreased effectiveness of the biological immune response. In malnutrition, glycoprotein synthesis decreases and low protein reserves decrease amino acid synthesis. Various micronutrients, such as vitamin A, vitamin B complex, vitamin C, zinc, copper, and selenium also decrease. These micronutrients are

From the Department of Pediatrics, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada/RSUP Dr. Sardjito, Yogyakarta, Central Java, Indonesia.

Corresponding author: Lestarina Veronica, Department of Pediatrics, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada, RSUP Dr. Sardijto , Jalan kesehatan Sendowo No. 1, Yogyakarta, Central Java, Indonesia, Email: lestarinaveronica85@mail.ugm.ac.id.

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needed as cofactor for the synthesis of energy, protein, and anabolic activity required for wound healing and epithelization.[4] Preoperative hypoalbuminemia and poor nutrition are two factors most often causes complications after major abdominal surgery, such as surgical wound infection. Several other preoperative factors such as patient age, preoperative hemoglobin level, *American Society of Anesthesiologists* (ASA) score, and type of surgery also play a role in postoperative complications. The purpose of this study was to determine whether preoperative hypoalbuminemia and severe acute malnutrition status were prognostic factors for postoperative major abdominal surgery complications in children.

Methods

This study with a retrospective cohort design was conducted using medical record data of pediatric patients admitted in the PICU at Dr. Sardjito Hospital, Yogyakarta, from January 1, 2017 to December 31, 2021. The outcomes assessed were postoperative complications occurring within 14 days post-surgery, including sepsis, surgical site infection, and wound dehiscence.

Inclusion criteria were pediatric patients aged 1 month to 18 years who underwent elective and emergency major abdominal surgery and were postoperatively admitted to the PICU. Exclusion criteria were patients who died intraoperatively, underwent relaparotomy within 1 month after their previous surgery, or had incomplete medical record data.

The independent variables in our study were preoperative albumin levels and nutritional status. The albumin levels recorded were those taken before transfusions and up to a maximum of two weeks before surgery. Preoperative albumin level was categorized as follow: no hypoalbuminemia (≥3.5 g/dL), mild hypoalbuminemia (>3.0 to <3.5 g/dL), moderate hypoalbuminemia (>2.5 to 3.0 g/dL), or severe hypoalbuminemia (≤2.5 g/dL). Preoperative nutritional status was categorized into severe acute malnutrition and not severely malnourished (well-nourished, underweight, overweight, or obese). In addition, external variables were assessed, namely, type of surgery, preoperative hemoglobin levels, and ASA scores. Preoperative hemoglobin levels were those taken before transfusion, within two weeks prior to surgery. An ASA score of 3 or more was considered high risk.

Data were analyzed using *SPSS version 25.0* (*IBM*, Armonk, New York). Nominal data was expressed as frequencies and proportions, numerical data as Bivariate analysis was carried out to determine the characteristics and distribution of data. Data normality was analyzed using The Kolmogorov-Smirnov test. Survival rate data were analyzed using the Kaplan-Meier curve, followed by log-rank test analysis. We also performed Cox regression; the size of the association was expressed as hazard ratio (HR) and the absolute risk was calculated.

Results

Out of 201 pediatric subjects, 43 subjects experienced postoperative complications. The most common preoperative diagnoses in this study were biliary atresia (18.4%), intra-abdominal mass (15.4%), Hirschsprung's disease (14.4%), invagination (12.4%), and perforated appendicitis (10%). Sepsis was the most common postoperative complication (14.9%); 11.9% of patients died, with 7.5% due to postoperative sepsis (P<0.001). Of patients who underwent either emergency or elective surgery, 86.1% received prophylactic antibiotics. Characteristics of study subjects are summarized in **Table 1**. Based on Kaplan-Meier analysis, the mean time to the occurrence of postoperative complications was 10.9 days (95%CI 10.1 to 11.7 days) postoperatively.

Mean time to the occurrence of complications in patients with severe acute malnutrition was 9.2 days (95%CI 7.4 to 10.9; P=0.014). Mean time to complications was 8.0 days (95%CI 5.3 to 10.7 days; P=0.008) in subjects with moderate preoperative hypoalbuminemia (>2.5 to 3.0 g/dL), while in those with severe hypoalbuminemia (≤2.5 g/dL) it was 9.9 days (95%CI 6.8 to 13.0 days; P=0.008). Multivariate analysis revealed that severe acute malnutrition [HR=2.09 (95%CI 1.01 to 4.33); P=0.047), preoperative hypoalbuminemia of >2.5 to 3.0 g/dL [HR=3.64 (95%CI: 1.57 to 8.41); P=0.003), severe hypoalbuminemia of ≤ 2.5 g/dL [HR=3.1 (95%CI 1.11 to 8.64); P=0.03], and age

Table 1. Demographic characteristics of subjects

Characteristics	(N = 201)
Gender, n (%)	
Male	110 (54.7)
Female	91 (45.3)
Age, n (%)	
1 month to 1 year	73 (36.3)
>1 year	128 (63.7)
Nutritional status, n (%)	
Severe acute malnourishment	35 (17.4)
Other nutritional status	166 (82.5)
Undernourished	72 (35.8)
Well-nourished	84 (41.8)
Overweight	5 (2.5)
Obese	5 (2.5)
Preoperative albumin level, n(%)	
≥3.5 g/dL	125 (62.2)
>3.0 to <3.5 g/dL	47 (23.4)
>2.5 to 3.0 g/dL	15 (7.5)
≤2.5 g/dL	14 (7.0)
Preoperative hemoglobin level, n (%)	
≥10 g/dL	142 (70.6)
<10 g/dL	59 (29.4)
Prophylactic antibiotics, n (%)	
Yes	173 (86.1)
No	28 (13.9)
Comorbidities, n (%)\	
Hemophilia	1 (0.5)
Thalassemia	1 (0.5)
Congenital heart disease	5 (2.5)
Malignancies	6 (3.0)
Hyperthyroidism	1 (0.5)
Neurological disease	3 (1.5)
Chromosomal disease (syndrome)	10 (5.0)
Type of surgery, n (%)	
Elective	133 (66.2)
Emergency	68 (33.8)
ASA score, n (%)	
<3	151 (75.1)
≥3	50 (24.9)
Mean length of PICU stay (SD), days	7.11 (5.49)
Postoperative complications, n (%)	43 (21.3)
Sepsis	30 (14.9)
Superficial surgical site infections	6 (3.0)
Wound dehiscence	7 (3.5)
Mortality, n (%)	
Yes	24 (11.9)
No	177 (88.1)

ASA=*American Society of Anesthesiologists*

of 1 month to 1 year [HR=2.16 (95%CI 1.09 to 4.11); P=0.026] were significantly associated with postoperative complications. Other independent variables, such as type of surgery, preoperative hemoglobin levels, and ASA score, were not found to be significantly associated with postoperative complications. Individual risks and absolute risk differences of each prognostic factor can be seen in **Table 2**.

Discussion

In our study, 21.3% of subjects had complications after major abdominal surgery. This result was consisitent with the findings of a previous study which reported a 20% incidence of postoperative complications.[5] The most prevalent major postoperative complication was sepsis (14.9%). This figure was lower compared to that of another study (36.3%).[6]

We discovered that severe acute malnutrition was a significant prognostic factor for the occurrence of postoperative complications. Similarly, a study conducted at the same hospital on children who underwent laparotomy reported that 57.1% of pediatric patients with poor nutritional status experienced postoperative complications or death.[7] Another study in Indonesia reported that children with severe acute malnutrition were 136 times more likely to develop wound dehiscence after abdominal surgery.[4]

Postoperative metabolic stress changes the balance of nutrients and calories in the body.[8] This process demands a substantial amount of energy due to increased calorie consumption required for healing. Glycoprotein synthesis play a vital role in wound healing. Malnourished individuals also possess diminished reserves of various essential micronutrients such as vitamin A, vitamin B complex, vitamin C, zinc, copper, and selenium. Micronutrients serve are cofactors for energy synthesis, protein production, and anabolic activity, all of which are crucial for wound healing and tissue epithelialization.[4] Maintaining good preoperative nutritional status supports the metabolic responses necessary for healing.[9]

Preoperative albumin levels emerged as an important prognostic factor for the incidence of postoperative complications. Moderate (>2.5-3.0 g/dL) and severe (<2.5 g/dL) hypoalbuminemia were significantly associated with postoperative complications. Dewi et al. reported that preoperative albumin levels of ≤3.0 g/dL were predictors of increased risk of postoperative complications, such

Table 2. Analysis of potential prognostic factors and postoperative complications

Variables	Bivariate					Multivariate		
	HR	Absolute risk difference (%)	Absolute risk (%)	95%CI	P value	HR	95%CI	P value
Nutritional status								
Not malnourished			17.6					
Severe acute malnutrition	2.16	21.3	38.9	1.14 to 4.09	0.019	2.09	1.01 to 4.33	0.047*
Preoperative albumin level								
≥3.5 g/dL			17.6					
>3.0 to <3.5 g/dL	0.78	2.7	14.9	0.33 to 1.83	0.570	0.85	0.36 to 1.99	0.700
>2.5 to 3.0 g/dL	2.88	35.7	53.3	1.28 to 6.48	0.011	3.64	1.57 to 8.41	0.003*
≤2.5 g/dL	2.28	25.3	42.9	0.92 to 5.62	0.074	3.10	1.11 to 8.64	0.030*
Age								
>1 year			12.5					
1 month to 1 year	2.27	24.5	37.0	1.21 to 4.24	0.010	2.12	1.09 to4.11	0.026*
Type of surgery								
Elective			20.3					
Emergency	1.33	3.2	23.5	0.71 to 2.47	0.372			
Pre-operative hemoglobin level								
≥10 g/dL			21.1					
<10 g/dL	1.21	0.9	22.0	0.63 to 2.32	0.566			
ASA score								
<3			18.5					
≥3	1.49	11.5	30.0	0.79 to 2.79	0.214	1.03	0.51 to 2.08	0.933

HR=hazard ratio; CI=confidence interval; *) statistically significant

as sepsis and the need for relaparotomy.[6] A study also reported that a preoperative albumin level of 2.5 -3.45 g/dL predicts an increased risk of postoperative abdominal surgical site infection complications.[10]

Albumin serves a vital biological function in the body, specifically in maintaining plasma oncotic pressure and transporting bilirubin, fatty acids, and drugs.[11] A decreased albumin level results in reduced collagen synthesis and impaired wound granuloma formation. This situation disrupts surgical wound anastomosis, leading to poor tissue recovery. Hypoalbuminemia hampers immune responses, including macrophage activation, and the induction of macrophage apoptosis.[10] It also raises the risk of anastomotic leakage and intra-abdominal sepsis often accompanied by intestinal edema.[12] Preoperative albumin therapy in cases of hypoalbuminemia has been shown to reduce the risk of postoperative complications by half. Improvements in preoperative albumin levels lead enhanced oncotic pressure and a more robust innate immune response.[13]

Furthermore, we found that age of 1 month to 1 year was also a prognostic factor of postoperative complications [HR=2.16 (95%CI 1.09 to 4.11); P=0.026]. A previous study also indentified age of <1 year as a prognostic factor for postoperative complications. Children under 1 year of age have developing immune systems which can result in suboptimal healing of surgical wounds, thus increasing the risk of postoperative infection complications.[14]

In our study, type of surgery was not a significant prognostic factor of postoperative complications. This finding differs from that of a study which noted that emergency surgery was an independent predictor of risk of postoperative complications [OR 90.91 (95%CI 27.78 to 333.33); P=0.001]. This difference may be due to patients in the previous study not having received prophylactic antibiotics before emergency surgery.[15] In our study, 86.1% of patients who underwent either emergency or elective surgery received prophylactic antibiotics. The use of prophylactic antibiotics is expected to reduce the risk of postoperative infectious complications.

Furthermore, we found that neither preoperative hemoglobin level nor preoperative ASA score served as significant indicators for postoperative complications. In contrast, a previous study reported that an ASA score of 3 was a predictive factor for postoperative

complications in pediatric patients [OR 6.23 (95%CI 3.80 to 10.22); P< 0.001). The 2,024 patients studied encompassed a broader range of surgical procedures beyond abdominal surgeries.16 When we compare prior studies to our own, discrepancies in ASA score evaluations could be ascribed to variability in the clinical judgments of the healthcare professionals responsible for assessing the preoperative conditions of patients.

A limitation of our study is its retrospective design, which makes it impossible to rule out potential measurement and selection biases. Furthermore, we did not explore certain factors, including intraoperative variables, which might have contributed to the occurrence of postoperative complications.

In summary, severe acute malnutrition and preoperative hypoalbuminemia of ≤3 g/dL increase the risk of postoperative complications following abdominal surgery in children. Age of 1 month to 1 year is also associated with an increased risk of postoperative complications. Our study highlights the importance to ameliorate nutritional status and normalize hypoalbuminemia in abdominal surgery candidates whenever possible, especially in infants.

Conflict of interest

None declared.

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