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Global Leadership Initiative on Malnutrition criteria for predicting surgical site infection in elective laparotomy patients

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ABSTRACT

Laparotomy surgery patients are at risk for complication including surgical site infections (SSI) which are associated with high morbidity and mortality. Malnutrition has been identified as a risk factor for the occurrence of SSI but preoperative malnutrition identification remains low. The Global Leadership Initiative on Malnutrition (GLIM) has published a new, practical, and easily applicable definition of malnutrition. This study aims to evaluate whether malnutrition according to GLIM criteria is a predictor of SSI in elective laparotomy patients. This prospective cohort study involved 123 subjects aged 18-65 years undergoing elective laparotomy, without diabetes history. Their malnutrition status was assessed using GLIM criteria with bioelectrical impedance analysis (BIA) to evaluate muscle mass. A total 62 subjects were categorized into the malnutrition group and the remaining into non-malnutrition group and then monitored for the presence of SSI up to 10 days postoperatively. SSI occurred in 13.8% of the subjects. The analysis showed a strong association between malnutrition and SSI in elective post laparotomy (RR 4.6; 95%CI 1.4-15.1; p=0.005). Malnutrition according to GLIM criteria is a significant predictor of SSI in elective post laparotomy patients.

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1. INTRODUCTION

Laparotomy is one of the invasive managements that carries a risk of complications in patients. The incidence of post-operative complications in some countries are reported to be 12.5%-13.2% [1], [2]. Surgical site infection (SSI) is one of the complications of laparotomy with an incidence of 15%-25% in gastrointestinal surgery and 9.8% in obstetrics and gynecology surgery, depending on the level of surgical contamination [3]. SSI has been shown to be associated with high morbidity, mortality, healthcare costs, and prolonged hospital stays [4], [5].

One of the factors that can impair the systemic host defense and also delay wound healing is malnutrition. The prevalence of perioperative malnutrition is estimated to be around 40%-65% [6]. Patients with malnutrition undergoing surgery especially cancer surgery experience early higher post-operative mortality rates, increased hospital costs, higher readmission rates, and prolonged hospital stays [7], [8]. Even though the relationship between malnutrition and poor surgical outcomes is known, the identification of surgical patients with malnutrition or at risk of malnutrition remains very low. A survey study showed that only 12.1% of digestive surgeons answered correctly regarding the parameters for diagnosing malnutrition in cancer patients [9]. Therefore, there is a need for accurate diagnosis of malnutrition which is practical to be used.

In 2019, Global Leadership Initiative on Malnutrition (GLIM) published the latest definition of malnutrition for adult patients, which includes phenotypic criteria such as weight loss, low body mass index (BMI), decreased muscle mass, and etiologic criteria such as reduced food intake or assimilation and inflammation [10]. Malnutrition criteria according to GLIM represent the latest and practical criteria for diagnosis malnutrition. It is easier to apply compared to previous malnutrition criteria, so GLIM criteria is being extensively researched to assess their validity and relevance in clinical practice, including in perioperative conditions [11]. One retrospective cohort study [12] demonstrates that cancer patients with malnutrition based on GLIM criteria are at 1.82 times higher risk of experiencing post abdominal surgery-related lung complications and another study [13] also revealed that patient with malnutrition according to GLIM criteria are at risk 1.3 times higher risk of experiencing severe surgical complications based on the revised accordion classification system.

Studies on malnutrition as a predictor of complications in laparotomy surgery, especially SSI, are still limited. The occurrence of SSI has been significantly shown to be more frequent in patients at risk of malnutrition based on the nutritional risk screening (NRS)-2002 scoring and American Society for Parenteral and Enteral Nutrition (ASPEN) malnutrition criteria when compared to non-malnourished patients. As far as the author's knowledge, there haven't been any studies that have examined the relationship between malnutrition based on GLIM criteria and the occurrence of SSI after surgery. The objective of this research is to determine whether malnutrition as defined by GLIM criteria, is a predictor factor for the occurrence of SSI in patients undergoing elective laparotomy at Dr. Cipto Mangunkusumo hospital.

2. METHOD

2.1. Study design, participants, and ethical approval

This research is a prospective cohort study conducted at Dr. Cipto Mangunkusumo hospital, Jakarta from March to June 2023. The study subjects are patients undergoing elective laparotomy surgery who meet the study criteria and have signed consent form. Patients scheduled for laparotomy surgery, aged 18-65 years, and able to stand are included. Patients with diabetes mellitus and cannot undergo bioelectrical impedance analysis examination (due to edema, electronic implants, metal implants, pregnancy, or extensive skin wounds) are excluded. The drop-out criteria used include patients who passed away and cannot be contacted during the 10-day post-operative monitoring period, or refuse to continue participating in the study. This research was approved by the Ethics Committee of the Faculty of Medicine, Universitas of Indonesia-Dr. Cipto Mangunkusumo Hospital with ethical clearance no. KET-112/UN2.F1/ETIK/PPM.00.02/2023.

2.2. Data collection and instrument

A total of 130 participants were included in this study, that calculated while considering 95% confidence level and 20% dropout rate. The participants selected using the consecutive sampling method. Data collection procedures included interviews to gather information on characteristics (age and gender), history of decreased food intake in last two weeks, weight loss history in last six months, and gastrointestinal complaints (nausea, vomiting, difficulty eating, diarrhea, constipation, or abdominal pain accompanied by description of intensity, frequency, and duration related to the symptoms), anthropometric measurements (body weight, height, and waist circumference), and body composition analysis using Seca® mBCA-525 to obtain appendicular skeletal mass index (ASMI) and fat free mass index (FFMI) values. Medical record data were also collected to obtain information on medical diagnoses, procedures, contamination surgery type, and the length of post-operative hospital stays.

2.3. Data analysis

The data collected were analyzed using statistical program for social science (SPSS) version 29. Univariate analysis was conducted on numerical scale data with the Kolmogorov-Smirnof normality test. Data with normal distribution were presented as mean and standard deviation while others were presented as median and range (minimum-maximum). Categorical scale data were presented as proportions (frequency distribution). Differences between the two groups were analyzed using the t-test or Mann-Whitney test (depending on the results of the normality test) for numerical and the Chi-square test for categorical data. Bivariate analysis to assess the relationship between malnutrition diagnosis based on GLIM criteria and the occurrence of SSI postoperatively was performed using the Chi-square test with a 95% confidence interval.

3. RESULTS AND DISCUSSION

A total 130 patients who met the study criteria and agreed to participate in the research were initially enrolled. At the end of the study, there were seven dropout subjects (5.4%). The subject selection flowchart is showed in Figure 1. In this study, the median age of the subjects was 44 years, with a range of 19-65 years. The majority of them were female. The median BMI of the subjects within normo-weight nutritional status. Most subjects were diagnosed with malignancy or suspected malignancy. Based on the contamination surgery type, the majority of subjects underwent clean-contaminated surgery. The median length of post-operative stay was four days, with a range of 2-30 days. The mean ASMI of the subjects was low based on the Asian Working Group for Sarcopenia (AWGS) cut-off while the mean FFMI was found normal in female subjects and low in male subjects. Table 1 shows characteristics of subjects.

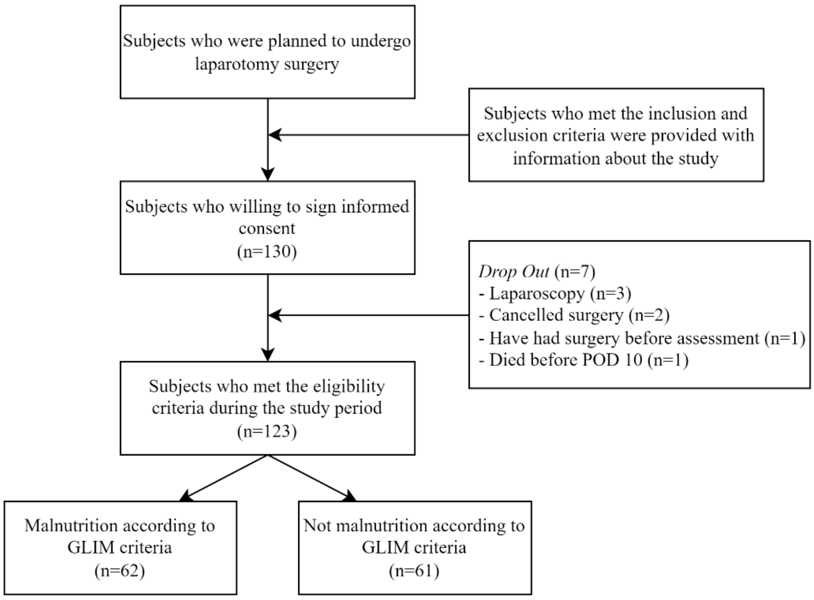

Figure 1. Flowchart of study subject selection

Table 1. Subject characteristics

Characteristics	All subjects n=123
Gender, n (%)	
Male	24 (19.5)
Female	99 (80,5)
Age, year	44 (19-65)†
Medical diagnosis, n (%)	
Malignancy/Suspect malignancy	74 (60,2)
Not malignancy	49 (39,8)
Contamination surgery type (n, %)	
Clean	30 (24.4)
Clean-contaminated	79 (64.2)
Contaminated	14 (11.4)
Length of post-operative stay, day	4 (2-30)†
BMI (kg/m^2)	22.9 (12.5-46.4)†
Underweight (n, %)	21 (17.1)
Normoweight (n, %)	44 (35.8)
Overweight (n, %)	19 (15.4)
Obesity grade I (n, %)	26 (21.1)
Obesity grade II (n, %)	13 (10.6)
ASMI (kg/m^2)	4.0±0.8*
Male	4.3±0.8*
Female	4.0±0.8*
FFMI (kg/m^2)	16.4±2.3*
Male	16.7±1.8*
Female	16.3±2.4*

*Mean ±standard deviation; † median (minimum-maximum); body mass index (BMI); appendicular skeletal mass index (ASMI); fat free mass index (FFMI)

There was a significant difference in all characteristic variables between the malnutrition and non-malnutrition groups based on GLIM criteria. In the malnutrition group based on GLIM criteria, it was found that the median age and length of post-operative stay were significantly higher, and the mean BMI, ASMI, and FFMI were lower than non-malnutrition group as shown in Table 2. Meanwhile, regarding the occurrence of SSI, studies indicate that there is no significant correlation between gender and the risk of SSI after abdominal surgery, after eliminating relevant confounding factors [14].

Table 2. Subject characteristics based on malnutrition group

Characteristics	Malnutrition according to GLIM criteria n=62	No Malnutrition according to GLIM criteria n=62	p
Gender, n (%)			0.007
Male	18 (29)	6 (9.8)	
Female	44 (71)	55 (90.2)	
Age, year	48 (20-65)†	42 (19-65)†	0.026
Medical diagnosis, n (%)			0.036
Malignancy/Suspect malignancy	43 (69.4)	31 (50.8)	
Not malignancy	19 (30.6)	30 (49.2)	
Contamination surgery type (n, %)			0.01
Clean	11 (17.7)	19 (31.1)	
Clean-contaminated	39 (62.9)	40 (65.6)	
Contaminated	12 (19.4)	2 (3.3)	
Length of post-operative stay, day	5.5 (2-30)†	3 (2-8)†	<0.001
BMI (kg/m^2)	19.9 (12.5-30.9)†	24.9 (18.6-46.4)†	<0.001
Underweight (n, %)	21 (33.9)	0 (0)	
Normoweight (n, %)	26 (41.9)	18 (29.5)	
Overweight (n, %)	5 (8.1)	14 (23)	
Obesity grade I (n, %)	7 (11.3)	19 (31.1)	
Obesity grade II (n, %)	3 (4.8)	10 (16.4)	
ASMI (kg/m^2)	3.8±0.8*	4.3±0.6*	0.018
Male	4.2±0.9*	4.5±0.4*	
Female	3.6±0.9*	4.3±0.7*	
FFMI (kg/m^2)	15.7±2.5*	17.1±2.0*	0.027
Male	16.3±1.9*	17.8±1.2*	
Female	15.5±2.6*	17.0±2.0*	
SSI (n, %)			
Superficial	9 (64.3)	3 (100)	
Deep	5 (35.7)	0 (0)	

* Mean±standard deviation; † median (minimum-maximum); body mass index (BMI); appendicular skeletal mass index (ASMI); fat free mass index (FFMI); surgical site infection (SSI)

This study showed that malnutrition according to GLIM criteria increases the risk of experiencing surgical site infections by 4.6 times, following elective laparotomy compared to non-malnutrition group as shown in Table 3. The relative risk in this study was higher compared to other similar studies. A study by Tan *et al.* [15] which examined 1,115 subjects found that malnourished cancer patients based on GLIM criteria were significantly at higher risk of wound healing-related complications (OR 2.54; 95% CI: 1.38-4.71) and infection-related complications including SSI, lung infections, urinary tract infections, and sepsis (OR 2.19; 95% CI: 1.67-3.21) post-surgery due to gastrointestinal malignancies. An observational study by Muresan *et al.* also indicated nosocomial infection events were more frequent in hospitalized cancer patients with malnutrition based on GLIM criteria compared to patients without malnutrition [16]. Another study by Portuondo *et al.* [12] showed a higher risk of SSI (OR 2.65; 95% CI: 1.12-6.22) in surgery patients with malnutrition based on ASPEN criteria, involving 456 subjects. The occurrence of SSI was also significantly reported in patients at risk of malnutrition. Skeie *et al.* [17] demonstrated that the incidence of SSI was significantly associated with the prevalence of malnutrition risk based on NRS 2002 criteria in 1,194 surgical patients (OR 1.81; 95% CI: 1.04-3.16). Although the relative risk in this study is higher and statistically significant, the wide range of confidence interval compared to other study should be noted. This wide range may be attributed to the small sample size and significant data variation, leading to larger standard errors in this study.

This study also showed high prevalence of SSI (13.8%) post-operatively in subjects, which aligned with several studies indicating that prevalence of SSI generally ranges from 2% to 17.8%. [18] A study at tertiary care center in India also found SSI incidence of 14.3% in patients undergoing elective laparotomy [19]. Birhanu's study in Ethiopia showed a higher prevalence of SSI at 19.3% in patients undergoing general surgery which blood transfusion, hemoglobin levels, presence of shock, previous surgery history, and prolonged hospital stays were significantly associated with SSI [20]. Based on the surgical contamination categories, the incidence of SSI is higher in the contaminated and dirty categories compared to clean and clean-contaminated categories. In a study involving 1,878 patients undergoing a clean-contaminated gastrointestinal surgery, it was found that 11.3% of patients experienced SSI, even though 65% of them underwent laparoscopy, which should have been a protective factor [21]. The prevalence of SSI in elective surgeries with clean and clean-contaminated categories is estimated to be around 6-15%, with the incidence of SSI in developing countries proven to be higher [18], [22]. Similar to this study which conducted in Indonesia as a developing country and dominated by clean-contaminated surgery, the prevalence of SSI in this study aligns with the estimates.

Table 3. Relationship malnutrition according to GLIM criteria and surgical site infection

Malnutrition status according to GLIM criteria	Surgical site infection		Total	p	RR (95% CI)
	Yes n (%)	No n (%)			
Malnutrition	14 (24.2)	48 (75.8)	62	0.005^cs	4.6 (1.4-15.1)
No malnutrition	3 (4.9)	58 (95.1)	61		
Total	17	106	123		

cs=Chi-square

In this study, it was found that contaminated surgical procedures were more common in the malnutrition group. This could be due to the fact that preoperative conditions in malnourished patients might lead to earlier contamination and acute inflammation in the surgical area, categorizing the surgery as contaminated. This study included surgeries related to gastrointestinal, gynecology, and urology. In gynecology surgery, malignancy and dirty contamination surgery are significant independent risk factors associated with SSI after hysterectomy procedures [23]. Another study by Atipo *et al.* [24] found a high incidence of SSI reaching 22.96% in urology surgery, particularly in older patients with comorbid factors such as diabetes mellitus, hypertension, and renal failure.

Subjects in this study divided into two groups based on their malnutrition status using GLIM criteria, which have advantages over other nutritional assessment tools. GLIM criteria show satisfactory accuracy, with a sensitivity of 86.6% and specificity of 81.6% for assessing malnutrition in hospitalized patients [25]. The systematic review by Brown *et al.* concluded that GLIM criteria predict poor clinical outcomes, including postoperative complications and longer hospital stays. It also found that although the parameters for phenotypic and etiologic criteria varied across different studies in the review, the results consistently showed that GLIM criteria were associated with poor clinical outcomes [26]. In the malnutrition group, weight loss of more than 5% in the last six months is the most frequently found phenotypic criterion. This aligned with study by Brito *et al.* that show 69.2% of subjects classified as malnourished based on GLIM criteria had experienced weight loss [25]. Weight loss and low BMI criteria are more commonly used as phenotypic criteria in various GLIM-related studies. Compared to low BMI, studies have shown that unintentional weight loss is a strong predictor of complications because it signifies a loss of fat and fat-free mass, which leads to reduced muscle strength. When someone loses fat mass, not only is fat storage reduced, but also nutritional reserves that impact immune and inflammatory responses, decreasing a person's ability to handle surgery. Additionally, low intake or depletion of nutritional reserves in skeletal muscle can also delay wound healing. This explains how malnutrition can lead to SSI [13].

A total 69.4% of subjects in the GLIM malnutrition group had a diagnosis malignancy or suspected malignancy. Metabolic changes in cancer patients, particularly changes in the utilization of nutrients caused by the tumor or cancer therapy, result in chronic inflammation and excessive catabolism. Chronic inflammation in malignancy fulfills the etiological criteria in the GLIM malnutrition. The mechanism via malnutrition affects the clinical outcomes of cancer patients include reduced nutrient intake due to the effects of altered nutrient metabolism and resting energy expenditure originating from the tumor systemically. Malnutrition also weakens the immune response and reduces tolerance to chemotherapy or immunotherapy [27].

Laparotomy is a trauma that can cause various degrees of inflammation and increased glycogen, fat, and protein catabolism, leading to a loss of body cell mass. When there is a decrease in perioperative muscle tissue, the recovery function is hindered. In patients with inadequate nutritional reserves, various complications can occur when the body cannot overcome inflammation and tissue healing [28]. Based on the site of infection, subjects in the malnutrition group experienced both superficial and deep SSI, while the non-malnutrition group only experienced superficial SSI. These results indicate that subjects with malnutrition experience more severe types of SSI compared to those without malnutrition. A study by Goins *et al.* [29] showed that gynecological cancer patients with malnutrition based on on European Society for Clinical Nutrition and Metabolism (ESPEN) criteria were significantly at higher risk for major complications, including deep SSI and organ complications for uterine, cervical, and ovarian malignancies.

Knowing evidence of significantly increased post-operative SSI in patients with malnutrition, it is important to implement early screening, assessment, and nutritional management before undergoing laparotomy. Zewudie *et al.* recommend perioperative nutritional management involving provision of 20-35 kcal/kg of energy while considering electrolyte and mineral status for cancer patients with malnutrition [30]. ESPEN recommends the need for screening and assessment in patients undergoing surgery. Severely malnourished patients requiring nutritional therapy 7-14 days before major surgery, which may necessitate delaying surgery until nutritional improvement is achieved. Nutritional therapy includes education and counselling, oral nutrition support, enteral nutrition, and parenteral nutrition (for severely malnourished patients when energy requirements cannot be met via oral or enteral [31].

This study was the first in Indonesia to assess malnutrition based on GLIM criteria as a predictor of post-laparotomy SSI. It was a prospective cohort study with a low dropout rate of 5.4%. Similar studies that investigate the association between malnutrition and SSI still use ASPEN criteria, while this study employs the latest, practical, and easily applicable GLIM malnutrition criteria. The study also uses a multi-frequency segmental BIA examination with parameters and cutoffs that conform to recommendations and ethnic considerations to determine low muscle mass according to the phenotypic criteria of GLIM. However, the study does have limitations. It does not analyze confounding factors such as duration of surgery, amount of intraoperative bleeding, and comorbid factors other than diabetes mellitus. Additionally, this study only determines the malnutrition status without assessing the severity of malnutrition.

4. CONCLUSION

Perioperative malnutrition has been shown to be associated with poor post-operative clinical outcomes, including surgical site infections. The easily applicable GLIM malnutrition criteria can be a valuable choice as an assessment tool for malnutrition in patients undergoing surgery. Based on this study, malnutrition according to GLIM criteria significantly increased the risk of experiencing SSI following elective laparotomy compared to those without malnutrition (4.6 times higher). Therefore, routine screening, assessment, and nutritional interventions in the 7-14 days leading up to surgery for patients scheduled for laparotomy are recommended. Further studies are also needed to determine confounding factors that may have an impact on the occurrence of SSI after laparotomy.

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