



Original Article

Effect of Malnutrition Assessed by Comprehensive Nutritional Screening Tool on In-Hospital Mortality after Surgery for Gastrointestinal Perforation

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ABSTRACT

Purpose: This study examined the effects of malnutrition on in-hospital mortality after surgery for gastrointestinal (GI) perforation.

Materials and Methods: Patients who underwent surgery for GI perforation between 2010 and 2017 were analyzed retrospectively. The preoperative nutritional status was assessed by the Seoul National University Hospital-Nutrition Screening Index, a tool that comprehensively evaluates 11 factors that reflect the nutritional status. The risk factors for in-hospital mortality after surgery for GI perforation were evaluated by univariate and multivariate analyses.

Results: Four hundred and eighty-nine patients were divided into two groups: 439 patients in the survival group and 50 patients in the in-hospital mortality group. The risk of malnutrition was higher (93.6% vs. 65.9%, $P < 0.001$) in the in-hospital mortality group than in the survival group. The preoperative albumin level was lower, and the blood urea nitrogen level was higher in the in-hospital mortality group than in the survival group. Emergency surgery, lymphoma as a cause of perforation, and fecal-contaminated ascites were also identified as factors associated with in-hospital mortality. Multivariate analyses demonstrated that a high risk of malnutrition (HR=5.71, 95% CI 1.38~26.02, $P=0.017$), lymphoma as a cause of perforation (HR=4.12, 95% CI 1.17~14.51, $P=0.028$), low preoperative albumin (HR=4.77, 95% CI 2.35~9.69, $P < 0.001$), and high preoperative BUN (HR=1.03, 95% CI 1.01~1.05, $P=0.001$) had significant effects on the in-hospital mortality after surgery for GI perforation.

Conclusion: A high risk of malnutrition assessed by the composite index was associated with in-hospital mortality after surgery for a GI perforation.

Keywords: Gastrointestinal perforation, In-hospital mortality, Nutritional risk, Nutrition screening

INTRODUCTION

Gastrointestinal (GI) perforation is a typical disease requiring urgent surgical treatment. It is a life-threatening condition, which reportedly has a mortality rate of 20% despite advances in surgical skill.[1,2] Clinical outcomes after surgery for GI perforation are known to be affected by various factors

such as cause of perforation, underlying comorbidities, operative findings, and nutritional status.

Hypoalbuminemia is a known risk factor for in-hospital mortality after surgery for GI perforation.[3,4] It is a representative biochemical parameter that is considered to reflect nutritional status; however, it is reported that hypoalbuminemia is not suitable for accurate nutritional assessment because it

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is easily affected by an acute phase response in critically ill patients.[5,6] According to a study conducted by Putwatana et al. [7] a hypoalbuminemia level of less than 3.5 g/dL is a risk factor for complications after major abdominal surgery, but hypoalbuminemia does not properly reflect a patient's recent nutritional status because it can fluctuate depending on changes other than nutritional status such as water distribution or accumulation and disease statuses. Therefore, to demonstrate whether nutritional status affects clinical prognosis after surgery for GI perforation, the result of a comprehensive nutritional assessment, not that of a single parameter, should be included in the analysis.

This study aimed to evaluate the effect of malnutrition on in-hospital mortality after surgery for GI perforation and emphasized the importance of nutritional support in patients at risk of GI perforation.

MATERIALS AND METHODS

This was a retrospective cohort study whose protocol was approved by the institutional review board (IRB) of Seoul National University Hospital (SNUH) (IRB No. 1711-109-901). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1964 and later versions and adhered to the relevant guidelines.

This study was performed on adult patients (age ≥ 18 years) who underwent gastrointestinal perforation at SNUH between 2013 and 2017. Data collection was performed by a retrospective review of electronic medical records.

Nutritional status was evaluated using the Seoul National University Hospital-Nutrition Screening Index (SNUH-NSI)

developed by SNUH. SNUH-NSI consists of body weight change, appetite status, digestive symptoms, most recent laboratory results including serum levels of albumin, total cholesterol, hemoglobin, C-reactive protein (CRP) and total lymphocyte count within 2 weeks prior to hospitalization, age, body mass index (BMI), and diet type on the first day of hospitalization. Each factor is divided into three stages, R1, R2, and R3 according to the degree to which the severity of malnutrition is reflected. After combining all factors, the patients were finally classified into three groups: high-risk, moderate-risk, and low-risk groups. Initial nutritional assessment using SNUH-NSI was performed within 24 hours after admission for all hospitalized patients admitted to the SNUH (Table 1). This tool was validated by comparing the results of nutritional status assessment with those obtained from the Patient Generated Subjective Global Assessment (PG-SGA) from 174 patients who underwent gastrectomy.[8]

Data were collected regarding (1) patient demographics (age, sex, BMI, and underlying comorbidities), (2) preoperative factors (nutritional status, and laboratory test results), and (3) operation-related factors (type of operation, site of perforation, cause of perforation, and character of ascites).

While comparing patient characteristics, a P-value < 0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics 22 (IBM Cor. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.).

RESULTS

Among the 489 included patients, 50 patients were classified into the in-hospital mortality group and the others were

Table 1. Seoul National University Hospital-Nutrition Screening Index (SNUH-NSI)

	R1	R2	R3
Appetite	Bad	-	Normal/good
Change of weight	Yes	-	No
Difficulty in digesting	-	Yes	No
Diet type	Fluid diet	Soft blended diet of NPO	Normal regular diet
Serum-albumin (g/dL)	< 2.8	2.8~3.3	≥ 3.3
Serum-cholesterol (mg/dL)	-	< 130	≥ 130
Total lymphocyte count (cells/mm ³)	< 800	800~1,500	$\geq 1,500$
Hemoglobin (g/dL)	-	Male < 13.0 Female < 12.0	Male ≥ 13.0 Female ≥ 12.0
C-reactive protein (mg/dL)	-	> 1	≤ 1
BMI (kg/m ²)	-	< 18 or ≥ 25	18~25
Age (years)	-	> 75	≤ 75
Status of malnutrition	· P1; High-risk group of malnutrition; (more than 2 of R1) or (1 of R1 and more than 2 of R2) · P2; Medium-risk group of malnutrition; (1 of R1) or (more than 2 of R2) · P3; Low-risk group of malnutrition; the others		

BMI = body mass index; R = risk factor; NPO = nothing by mouth.

classified into the survival group. There were no significant differences between the two groups in age, sex, BMI, and several comorbidities including hypertension, diabetes mellitus, coronary artery disease, and cerebrovascular disease. The in-hospital mortality group showed significantly higher rates of chronic liver disease (9 [18.0%] vs. 38 [8.7%], $P=0.035$) and chronic kidney disease (11 [22.4%] vs. 38 [8.7%], $P=0.003$) than the survival group (Table 2).

Nutritional status was poorer and the rate of high risk of malnutrition was higher (93.6% vs. 65.9%, $P<0.001$) in the in-hospital mortality group than in the survival group. Regarding preoperative laboratory tests, albumin (2.5 ± 0.6 vs. 3.2 ± 0.7 , $P<0.001$) and total protein (4.9 ± 1.3 vs. 6.1 ± 2.4 , $P=0.001$) levels were lower, and levels of blood urea nitrogen (35.1 ± 20.1 vs. 22.1 ± 15.3 , $P<0.001$) and creatinine (1.83 ± 1.46 vs. 1.27 ± 1.27 , $P=0.004$) were higher in the in-hospital mortality group than in the survival group (Table 3).

As for operation related factors, emergency operation ($P=0.018$), lymphoma as a cause of GI perforation ($P<0.001$), and fecal-contaminated ascites ($P=0.014$) were identified as associated factors with in-hospital mortality group (Table 4).

In the multivariate analysis, a high risk of malnutrition, lymphoma as a cause of GI perforation, preoperative hypoalbuminemia less than 2.8 g/dL, and high preoperative BUN were identified as risk factors for in-hospital mortality after surgery for GI perforation. In particular, in the case of patients with a high risk of malnutrition, it was confirmed that the hazard ratio was more than 5 times higher ($HR=5.714$, 95% CI 1.381~26.019, $P=0.017$) than that in those who are not at a high risk of malnutrition (Table 5). Moreover, in the receiver-operating characteristic (ROC) curve analysis using preoperative albumin, a representative factor reflecting nutritional status, the area under the curve was 0.790 (95% CI 0.726~0.852) (Figure 1).

DISCUSSION

Factors known as risk factors in the clinical course of peritonitis include age, sex, cause of peritonitis, severity of peritonitis, and characteristics of ascites. Mannheim et al. created a scoring system that predicts the prognosis of peritonitis by considering the degree of influence of each factor. However,

Table 2. Patient demographics

	Survival (n=439)	In-hospital mortality (n=50)	P-value
Age (years)	60.4±17.0	65.1±14.1	0.057
Sex (M:F)	261:178	26:24	0.311
BMI (kg/m ²)	21.8±3.5	21.2±3.6	0.228
Comorbidities			
Hypertension	178 (40.6%)	23 (46.0%)	0.466
Diabetes	71 (16.2%)	11 (22.0%)	0.300
Chronic liver disease	38 (8.7%)	9 (18.0%)	0.035
Chronic kidney disease	38 (8.7%)	11 (22.4%)	0.003
Coronary artery disease	27 (6.2%)	6 (12.0%)	0.119
Cerebrovascular disease	18 (4.1%)	4 (8.0%)	0.266

Data are presented as mean±SD, or number (%).

BMI = body mass index.

Table 3. Preoperative factors

	Survival (n=439)	In-hospital mortality (n=50)	P-value
Nutritional risk			< 0.001
Low risk	30 (6.9%)	0 (0.0%)	
Moderate risk	119 (27.2%)	3 (6.4%)	
High risk	288 (65.9%)	44 (93.6%)	< 0.001
Albumin (g/dL)	3.2±0.7	2.5±0.6	< 0.001
Total protein (g/dL)	6.1±2.4	4.9±1.3	0.001
Blood urea nitrogen (mg/dL)	22.1±15.3	35.1±20.1	< 0.001
Creatinine (mg/dL)	1.27±1.27	1.83±1.46	0.004
C-reactive protein (mg/dL)	13.1±12.1	14.9±11.1	0.349

Data are presented as mean±SD, or number (%).

Table 4. Operation related factors

	Survival (n=439)	In-hospital mortality (n=50)	P-value
Type			0.018
Elective	104 (95.4%)	5 (4.6%)	
Emergency	311 (87.4%)	45 (12.6%)	
Perforation site			0.006
Stomach	37 (94.9%)	2 (5.1%)	
Duodenum	53 (93.0%)	4 (7.0%)	
Small intestine	99 (82.5%)	21 (17.5%)	
Appendix	43 (100.0%)	0 (0.0%)	
Colon and rectum	200 (90.9%)	20 (9.1%)	
Perforation cause			
Inflammatory bowel disease	16 (3.6%)	0 (0.0%)	0.391
Malignancy	112 (25.8%)	18 (13.8%)	0.102
Lymphoma	10 (2.3%)	6 (12.0%)	<0.001
Ascites			0.021
Clear	195 (92.4%)	16 (7.6%)	
Turbid	184 (90.2%)	20 (9.8%)	
Fecal contaminated	60 (81.1%)	14 (18.9%)	0.014
Stoma formation	178 (40.7%)	27 (54.0%)	0.072

Data are presented as number (%).

Table 5. Risk factors for in-hospital mortality after surgery for gastrointestinal perforation

	P-value	HR	95% CI
High risk of malnutrition	0.017	5.714	1.381~26.019
Lymphoma	0.028	4.115	1.167~14.509
Hypoalbuminemia <2.8 g/dL	<0.001	4.769	2.347~9.690
Blood urea nitrogen (mg/dL)	0.001	1.028	1.011~1.045

based on the results of several studies conducted after the Mannheim Prognostic Index, unstable hemodynamic status, preoperative anemia, high CRP levels, and some of the parameters used to assess nutritional status were identified as new risk factors for mortality due to peritonitis.[3,4]

Low preoperative albumin and cholesterol levels, known to reflect nutritional status, are the representative risk factors for in-hospital mortality after surgery for GI perforation. [3,4] It is known that more energy than usual is required for recovery after surgery,[9,10] but in most cases of surgery due to GI perforation, patients should fast for a few days. Even if adequate parenteral nutrition is performed during this period, the nutritional status of the patient is inevitably deteriorated, so the baseline nutritional status is very important to withstand this period. In this study, it was demonstrated that a high risk of malnutrition assessed using a composite tool, as well as preoperative hypoalbuminemia, is a risk factor for in-hospital mortality after surgery for GI perforation, and its hazard ratio was five times higher than that of each nutritional

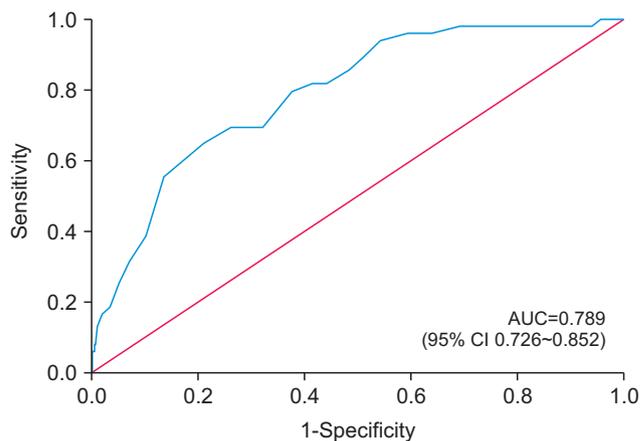


Fig. 1. Receiver operating characteristic curve for prediction of in-hospital mortality after surgery for gastrointestinal perforation according to preoperative albumin level.

parameter.

SNUH-NSI is a nutrition screening tool for screening patients with a high risk of malnutrition. To assess the nutritional status of a patient, a comprehensive evaluation of various parameters such as biochemical, clinical, and dietary parameters is required rather than using a single parameter.[11] Comprehensive nutritional assessment tools include the Subjective Global Assessment (SGA) and Patient Generated-SGA (PG-SGA); however, it is difficult to select patients with malnutrition by conducting an in-depth nutritional assessment

for all hospitalized patients.[12] For this reason, the Nutrition Risk Screening-2002 (NRS-2002), a tool that selects patients at risk of malnutrition through nutrition screening for many patients in a short time, was developed.[13] SNUH-NSI is also a type of nutrition screening tool, and all parameters except biochemical parameters should be entered during the history taking process at the time of hospitalization, and are automatically calculated and reported using these information. Therefore, it is efficient in terms of time required.

Lymphoma as a cause of perforation is another well-known risk factor for in-hospital mortality after surgery for GI perforation. GI perforation in lymphoma is a common complication. It is caused by the involvement of the tumor itself, but can also be caused by rapid tumor necrosis and tissue impairment after chemotherapy.[14-17] In the case of GI perforation after chemotherapy for lymphoma, it has been reported that the mortality rate is quite high because of the immunocompromised condition of the patient.[18,19] For this reason, preemptive surgical resection of the involved site before initiation of chemotherapy is considered in selected cases.

This study has several limitations. First, since GI perforation requires surgical treatment as soon as possible after diagnosis, there is no time for nutritional support before surgery. For the results of this study to be of great practical significance, preoperative intervention, for example, correction of hypoalbuminemia or transfusion, to improve nutritional status for a short period preoperatively, should have a positive effect on clinical outcomes. Second, since this was a retrospective study, there were missing data in some of the preoperative laboratory tests and operation-related factors. Moreover, there are many patients whose parameters already known to affect clinical prognosis, such as preoperative lactate level, were not measured. Therefore, such variables could not be included in the analysis.

In conclusion, a high risk of malnutrition assessed by composite index is significantly associated with in-hospital mortality after surgery for GI perforation. Prospective studies on whether correction of nutritional parameters during a short interval from diagnosis to emergency surgery can improve clinical prognosis are needed.

CONFLICTS OF INTEREST

The authors of this manuscript have no conflicts of interest to disclose.

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