

## The nutritional risk is a independent factor for postoperative morbidity in surgery for colorectal cancer

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**Purpose:** The authors evaluate the prevalence of malnutrition and its effect on the postoperative morbidity of patients after surgery for colorectal cancer.

**Methods:** Three hundred fifty-two patients were enrolled prospectively. Nutritional risk screening 2002 (NRS 2002) score was calculated through interview with patient on admission. Clinical characteristics, tumor status and surgical procedure were recorded.

**Results:** The prevalence of patients at nutritional risk was 28.1 per cent according to the NRS 2002. The rate of postoperative complication was 27%. There was a significant difference in postoperative complication rates between patients at nutritional risk and those not at risk (37.4% vs. 22.9%,  $P = 0.006$ ). Nutritional risk was identified as an independent predictor of postoperative complications (odds ratio, 3.05;  $P = 0.045$ ). Nutritional risk increased the rate of anastomotic leakage ( $P = 0.027$ ) and wound infection ( $P = 0.01$ ).

**Conclusion:** NRS may be a prognostic factor for postoperative complication after surgery for colorectal cancer. A large scaled prospective study is needed to confirm whether supplementing nutritional deficits reduces postoperative complication rates.

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**Key Words:** Colorectal neoplasms, Complication, Malnutrition, Morbidity

### INTRODUCTION

The stress of surgery can increase the rate of perioperative morbidity and mortality [1]. Especially, the rate of postoperative complication is higher in gastrointestinal surgery, which results in increased hospital stay and cost [2]. The reported prevalence of malnutrition in gastrointestinal surgery patients ranges from 30% to 50% [3]. Malnutrition has been consistently associated with poor clinical outcomes, for example; impaired wound healing, higher infection rates and mortality as well as longer hospital stay, leading to increased overall costs [4,5]. Perioperative nutritional support in malnourished patients

decreases postoperative complications such as wound infections and sepsis [4,6]. Therefore, nutritional risk screening (NRS) may be helpful to decrease the rate of postoperative complications. Routine screening of patients to identify risk of malnutrition has been recommended by many national, international, and specialist organizations [7].

NRS 2002 was introduced at the European Society for Clinical Nutrition and Metabolism (ESPEN) in 2002 [8]. This method is a reliable, easily applied and reproducible tool for identifying patients at nutritional risk in hospital. Its predictive value was documented by a retrospective analysis of 128 randomized controlled trials of nutritional support [9].

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The aims of the present study were to evaluate the prevalence of malnutrition, by means of screening tool, NRS 2002, and to analyze the role of malnutrition in predicting postoperative complications in patients undergoing surgery for colorectal cancer.

## METHODS

All patients diagnosed with colorectal cancer and scheduled for elective surgery in a single center between February 2010 and July 2011 were enrolled in this study. During this period, a total of 545 patients went into hospital for surgery. We interviewed all patients at admission. Three hundred fifty-two patients who precisely answered their weight status and amount of oral intake status were enrolled in this study. There were no restrictions with regard to tumor stage or comorbidity. Data of patient characteristics, operative findings, pathologic reports, and postoperative outcome records were collected retrospectively. In addition, preoperative weight loss and amount of oral intake during 3 months before admission, nutritional risk as determined by the NRS 2002 at hospital admission, and patient social history: smoking status (active smoker) and alcohol consumption (intake over 70 g/day) were recorded. We defined a group of weight loss as decreased more than 5% in 3 months. A group of decrease of food oral intake was defined as decreased more than 25% in 3 months. Body height and weight were measured on the day of admission, and body mass index (BMI) was calculated. Serum albumin level was determined on the day of admission to hospital. Postoperative complications during hospital stay includes anastomotic leakage, intra-abdominal bleeding, ileus (more than two weeks), wound infection, intra-abdominal abscess, pneumonia, chylous leakage and so on.

### Nutritional risk screening 2002

The NRS 2002 is used to predict outcome based on risk parameters identified in the nutritional assessment [8]. Nutritional risk is evaluated by two components: impaired nutritional status and severity of disease. The NRS 2002 is based on four variables-weight loss, BMI, general condition and amount of food intake in the preceding week-in addition to the patient's age and the severity of the underlying disease. The total score, calculated from the impaired nutritional status section (score, 0–3), the score for severity of disease (indicator of stress metabolism and increased nutritional requirements; score 0–3) and age adjustment (score + 1 for age over 70 years), ranges from 0 to 7. Patients are classified as being at nutritional risk (score 3 or more) or not (score less than 3) according to the total score obtained.

## Statistical analysis

Statistical analyses were performed using PASW version 18.0 (SPSS Inc., Chicago, IL, USA). Continuous variables (age, BMI, and operative time) were dichotomized, using the mean value of each variable. Chi-square or Fisher exact test for categorical variables was used for statistical comparisons of clinical parameters, operative time, operative methods, preoperative nutritional status and NRS 2002. Multivariate analysis to detect risk factors for postoperative complications was conducted with a logistic regression model. Chi-square tests were also used to analyze morbidity variables associated with weight loss. A value of  $P < 0.05$  was deemed statistically significant.

## RESULTS

Ninety-five of 352 patients (27.0%) had complications; deaths were excluded from this analysis. There was one death in hospital (mortality rate 0.3%). The cause of death was acute myocardial infarction. Major postoperative complications are shown in Table 1.

There were 202 men and 150 female with a median age of 62.9 years (range, 20–92 years). The median BMI was 24.2 kg/m<sup>2</sup> (range, 16–33 kg/m<sup>2</sup>). One hundred fifty-four patients (43.8%) had comorbidity. The most common comorbidities were hypertension (138 patients, 39.2%), diabetes (18 patients, 5.1%), heart problem (7), pulmonary (6), liver cirrhosis (5) and others. Mean length of hospital stay was 8.2 days (range, 3–22 days).

Table 2 shows the results of the univariate and multivariate analyses for factors potentially contributing to postoperative complications. Age, sex, underlying disease and American Statistical Association (ASA) class were not risk factors for complication. Smoking was a significant risk factor of morbidity (18.4% vs. 44.1%,  $P = 0.001$ ). Tumor location and stage were not risk factors for postoperative complication. The mean operative time was 283 ± 95 minutes. Operative time and laparoscopic procedure were not independent factors for postoperative complication.

**Table 1.** Major postoperative complications (n = 352)

Variable	No. of patients (%)
Anastomotic leakage	17 (4.8)
Postoperative bleeding	24 (6.8)
Postoperative ileus	31 (8.8)
Wound infection grade IV	16 (4.5)
Intra-abdominal abscess	6 (1.7)
Pneumonia	13 (3.7)
Chylous leakage	4 (1.1)
Cardiac infarction	1 (0.3)
No. of patients with complication	95 (27.0)
Mortality	1 (0.3)

**Table 2.** Univariate and multivariate analyses for factors potentially contributing to postoperative complication

Variable	Total (n = 352)	No complication (n = 257)	Complication (n = 95)	P-value	Multivariate analysis	
					OR (95% CI)	P-value
Age (yr)				0.752		
<70	240 (68.2)	174 (72.5)	66 (27.5)			
≥70	112 (31.8)	83 (74.1)	29 (25.9)			
Sex				0.398		
Male	202 (57.4)	144 (71.3)	58 (28.7)			
Female	150 (42.6)	113 (75.3)	37 (24.7)			
Alcohol				0.119		
No	198 (56.3)	151 (76.3)	47 (23.7)			
Yes	154 (43.8)	106 (68.8)	48 (31.2)			
Smoker				0.001		0.001
No	234 (66.5)	191 (81.6)	43 (18.4)			
Yes	118 (33.5)	66 (55.9)	52 (44.1)		3.32 (1.99–5.52)	
ASA class				0.581		
1	107 (30.4)	79 (73.8)	28 (26.2)			
2	229 (65.1)	164 (71.6)	65 (28.4)			
3	16 (4.5)	14 (87.5)	2 (12.5)			
Underlying disease				0.269		
No	198 (56.3)	140 (70.7)	58 (29.3)			
Yes	154 (43.8)	117 (76.0)	37 (24.0)			
Tumor location				0.164		
Colon	228 (64.8)	172 (75.4)	56 (24.6)			
Rectum	124 (35.2)	85 (68.5)	39 (31.5)			
Stage				0.226		
I–II	153 (43.5)	117 (76.5)	36 (23.5)			
III–IV	199 (56.5)	140 (70.4)	59 (29.6)			
Operation				0.075		
Laparoscopy	268 (76.1)	202 (75.4)	66 (24.6)			
Open	84 (23.9)	55 (65.5)	29 (34.5)			
Operation time (min)				0.421		
<300	229 (65.1)	163 (71.2)	66 (28.8)			
≥300	123 (34.9)	94 (76.4)	29 (23.6)			
Body mass index (kg/m <sup>2</sup> )				0.094		
<18.5	11 (3.1)	8 (50.0)	8 (50.0)			
18.5–25	194 (55.1)	142 (75.1)	47 (24.9)			
≥25	147 (41.8)	107 (72.8)	40 (27.2)			
Preop weight loss				0.003		0.002
No	194 (55.1)	154 (79.4)	40 (20.6)			
Yes	158 (44.9)	103 (65.2)	55 (34.8)		2.31 (1.36–3.91)	
Oral intake				0.004		0.556
No change	280 (79.5)	214 (76.4)	66 (23.6)			
Decrease	72 (20.5)	43 (59.7)	29 (40.3)		1.26 (0.58–2.74)	
Preop albumin (g/mL)				0.072		
<4.0	165 (46.9)	113 (68.5)	52 (31.5)			
≥4.0	187 (53.1)	144 (77.0)	43 (23.0)			
NRS 2002 score				0.006		0.045
<3	253 (71.9)	195 (77.1)	58 (22.9)			
≥3	99 (28.1)	62 (62.6)	37 (37.4)		3.05 (0.98–9.49)	

Values are presented as number (%).

OR, odds ratio; CI, confidence interval; Preop, preoperative; NRS, nutritional risk screening.

The prevalence of patients at nutritional risk in this surgical population was 99 (28.1%) with NRS 2002. NRS 2002 was used to classify nutritional risk, the complication rate was higher for patients at risk and those not at risk (37.4% [37 of 99] vs. 22.9% [58 of 253],  $P = 0.006$ ). BMI and serum albumin were not risk factors of postoperative complication. Weight loss and decrease of food oral intake were risk factors of postoperative complication (20.6% vs. 34.8%,  $P = 0.003$  and 23.6% vs. 40.3%,  $P = 0.004$ ). Multivariate analysis indicated that malnutrition (odds ratio [OR], 3.05;  $P = 0.045$ ), heavy smoking (OR, 3.32;  $P = 0.001$ ) and weight loss (OR, 2.31;  $P = 0.002$ ) were independent risk factors influencing postoperative complications.

The postoperative hospital stays were longer in the nutritional risk group ( $8.9 \pm 4.2$  days) than in the no risk group ( $7.8 \pm 3.5$  days) ( $P = 0.019$ ). Results of analysis of the relationship between risk factors for postoperative complication and

duration of hospital stays are detailed in Table 3.

The relationship between malnutrition and each complication are shown in Table 4. Malnutrition was an independent risk factor for anastomotic leakage ( $P = 0.027$ ) and wound infection ( $P = 0.01$ )

## DISCUSSION

In this study, the overall morbidity rate was 27.0% and the mortality rate was 0.3% after elective surgery for colorectal cancer. This study supports the finding that measurements of nutritional risk can predict postoperative outcomes. NRS 2002 was a statistically significant predictor of morbidity. Similar to the present findings, a recent prospective study demonstrated that the NRS 2002 was successful in predicting postoperative complications in 186 patients undergoing elective surgery for colorectal cancer (OR, 2.43) [10]. The authors reported a nutritional risk prevalence of 39.2% in patients with NRS 2002, was higher to the data here.

Hendry et al. [11] reported that morbidity was related to ASA III–IV ( $P = 0.004$ ), male sex ( $P = 0.023$ ) and rectal surgery ( $P = 0.002$ ) in which 1,035 patients underwent colorectal surgery. And, this study demonstrated that low BMI is not an independent risk factor. However, there are clear limitations to the use of BMI for screening nutritional status. Some patients weigh less than is usual for their height but are otherwise fit and healthy, and a normal BMI does not exclude the presence of malnutrition.

The largest prospective randomized trial of preoperative total parenteral nutrition (TPN) was a multiinstitutional study conducted by the Veterans Administration [12]. Only in severely malnourished patients, significantly fewer nonseptic complications (e.g., anastomotic leaks, bronchopleural fistulas) occurred in patients receiving TPN (5% vs. 43%,  $P = 0.03$ ). Shukla et al. [13] studied 110 patients with benign or malignant gastrointestinal, breast, or oropharyngeal disease by comparing preoperative enteral nutrition with standard oral diets in patients undergoing major surgical procedures. Control patients

**Table 3.** The length of hospital stays and risk factors for postoperative complication

Variable	Hospital stay (day)	P-value
Postoperative complication		<0.001
No	7.3 ± 2.9	
Yes	10.5 ± 4.7	
NRS 2002		0.019
No risk	7.8 ± 3.5	
Risk	8.9 ± 4.2	
Weight loss		0.018
No	7.7 ± 3.4	
Yes	8.7 ± 4.1	
Oral intake		0.196
No change	7.9 ± 3.6	
Decrease	8.7 ± 4.3	
Smoking		0.056
No	7.9 ± 3.5	
Yes	8.7 ± 4.2	

Values are presented as mean ± standard deviation.  
NRS, nutritional risk screening

**Table 4.** Postoperative complications by malnutrition

Variable	No nutritional risk (n = 253)	Nutritional risk (n = 99)	P-value	OR (95% CI)
Anastomotic leakage (n = 17)	8 (3.2)	9 (9.1)	0.027	3.060 (1.149–8.185)
Postoperative bleeding (n = 24)	17 (6.7)	7 (7.1)	0.906	1.127 (0.451–2.835)
Postoperative ileus (n = 31)	19 (7.5)	12 (12.1)	0.170	1.699 (0.795–3.652)
Wound infection grade IV (n = 16)	7 (2.8)	9 (9.1)	0.010	3.510 (1.278–9.710)
Intra-abdominal abscess (n = 6)	4 (1.6)	2 (2.0)	0.775	1.284 (0.236–7.121)
Pneumonia (n = 13)	10 (4.0)	3 (3.0)	0.680	0.759 (0.215–2.827)
Chylous leakage (n = 4)	4 (1.6)	0 (0)	0.208	-

Values are presented as number (%).  
OR, odds ratio; CI, confidence interval.

received a standard oral diet and were compared to patients receiving 10 days of nasogastric enteral nutrition. Major complications were reduced from 30% in the control group to 10% in the enteral nutrient group in this study.

A recent meta-analysis of 107 studies reported that preoperative smoking was found to be associated with an increased risk of the following postoperative complications: general morbidity, wound complications, general infections, pulmonary complications, neurological complications, and admission to the intensive care unit [14]. Another meta-analysis of 140 studies investigated preoperative smoking and postoperative wound healing complications and found a higher risk of wound healing complications among smokers than among nonsmokers and smoking cessation intervention reduced surgical site infections (OR, 0.43; 95% confidence interval [CI], 0.21–0.85) [15]. In the present study, we confirmed that smoking was a high risk factor for ileus, wound infection, intra-abdominal abscess, pneumonia and anastomotic leakage.

Malnutrition was found to be associated with a significant risk of anastomotic leakage and wound infection. Zhu et al. [16] reported that preoperative malnutrition increased the rate of anastomotic leakage in which 132 patients underwent low anterior resection. In the series by Zhu et al. [16], anastomotic

leakage increased hospital length and cost. Kang et al. [17] further supported this finding that malnutrition (OR, 2.81; 95% CI, 2.32–3.40), on multivariate analysis, was an independent risk factor for anastomotic leakage after anterior resection for rectal cancer in 72,055 patients. Putwatana et al. [18] reported that malnutrition is an important risk factor for postoperative infectious and wound complications in patients undergoing major surgery.

In conclusion, the present study has demonstrated that patients at nutritional risk have higher complication rates after surgery for colorectal cancer. Especially, malnutrition increases the rate of anastomotic leakage and wound infection. Malnutrition was also a significant risk factor for the length of hospital stay. A large scaled prospective study of whether supplementing nutritional deficits reduces postoperative complication rates is required. It is expected that NRS 2002 would be helpful in screening malnutrition.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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