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[1]University Clinical Center Tuzla, Department of Surgery, Bosnia and Herzegovina
[2]General hospital, Sanski Most, Bosnia and Herzegovina

Corresponding author: Professor Fuad Pašić, MD, PhD. Head of Surgery Department, University clinical center Tuzla, 75000 Tuzla. Bosnia and Herzegovina. E-mail: dr.fuadpasicmail.com ORCID ID: http//www.orcid.org/0000-0001-6419.

Impact of Preoperative Enteral Nutrition on Clinical Outcomes in Malnourished Patients Undergoing Elective Colorectal Cancer Surgery: A Prospective Cohort Study

Fuad Pasic[1], Haris Elezovic[2]

ABSTRACT

Background: Malnutrition is a frequent yet often overlooked comorbidity in patients undergoing surgery for colorectal cancer. It is associated with adverse postoperative outcomes, including increased complications, prolonged hospital stay, and elevated mortality. **Objective:** This study aimed to assess the clinical impact of short-term preoperative enteral nutrition in malnourished patients undergoing elective colorectal cancer surgery. **Methods:** A prospective cohort study was conducted involving 68 malnourished patients with histologically confirmed stage I–III colorectal cancer. Patients were divided into three groups: Group A (14-day enteral nutrition), Group B (7-day enteral nutrition), and Group C (no supplementation). Nutritional status, laboratory parameters, postoperative complications, transfusion needs, and hospitalization metrics were compared among groups. **Results:** Group A demonstrated the most favorable outcomes, including significantly fewer postoperative complications such as anastomotic leakage (5.0% vs. 17.9%, p = 0.030), reduced transfusion and albumin requirements, and shorter ICU and hospital stays (1.6 ± 0.7 and 7.1 ± 2.4 days, respectively). Group C showed the highest complication and mortality rates. Improvements in biochemical markers were observed in both intervention groups, supporting the efficacy of enteral supplementation. **Conclusion:** Short-term preoperative enteral nutrition significantly improves clinical outcomes in malnourished colorectal cancer patients undergoing elective surgery. These findings support the integration of nutritional screening and intervention as standard components of perioperative care in oncologic surgery.

Keywords: Colorectal Neoplasms, Malnutrition, Enteral Nutrition, Preoperative Care, Postoperative Complications.

1. BACKGROUND

Nutrition is a fundamental human necessity and plays an essential role in promoting health and preventing disease. Food intake and its regulation - through mechanisms such as appetite and satiety - are complex physiological processes that significantly influence nutritional status. This status depends on adequate intake of macronutrients and micronutrients, as well as sufficient hydration. However, for various reasons, many patients are unable to meet these nutritional requirements, resulting in malnutrition in 20–50% of individuals upon hospital admission (1). Approximately one in five hospitalized patients fails to consume enough energy or protein to meet their metabolic demands (2).

Malnutrition is a particularly prevalent comorbidity among surgical oncology patients, especially those with colorectal cancer (CRC), where it impairs treatment efficacy and recovery (3-7). Tumor-associated cachexia is a globally prevalent syndrome, characterized by metabolic disruption and weight loss. Some reports indicate that up to 85% of hospitalized cancer patients are malnourished (8). In the context of CRC specifically, malnutrition affects between 30% and 60% of hospitalized patients (9). Malnutrition has been consistently identified as an independent risk factor for increased postop-

erative morbidity and mortality and is associated with prolonged hospital stays and higher complication rates (10, 11).

The link between nutritional status and surgical outcomes was first formally documented by Studley in 1936. His study showed that patients who experienced preoperative weight loss exceeding 20% had a postoperative mortality rate of 33%, compared to just 3.5% in those with less than 20% weight loss (12). Despite the progress made in surgical and anesthetic techniques over the past several decades, malnutrition continues to exert a profound influence on postoperative outcomes in gastrointestinal cancer patients. Malnourished patients undergoing such procedures experience significantly higher rates of complications (72% vs. 29%) and mortality (23% vs. 4%) compared to well-nourished individuals (13, 14).

Malnutrished surgical patients have worse clinical outcomes, including a fourfold increase in the risk of death, higher rates of surgical complications, more frequent hospital readmissions, extended hospitalization, and increased healthcare costs (13-15). Therefore, the optimization of preoperative nutritional status is of critical importance in oncologic surgery. The primary goals of preoperative nutritional therapy include the prevention of fasting-induced catabolism, maintenance of protein stores, preservation of immune, muscular, and endocrine functions, and facilitation of enhanced postoperative recovery (16).

Early identification and treatment of malnutrition are key to improving surgical outcomes. Yet, malnutrition often goes unrecognized due to a lack of standardized protocols, inadequate clinical awareness, and poor integration of nutritional care into routine hospital practice (17, 18). A comprehensive approach should begin with screening at the time of hospital admission, followed by detailed nutritional assessment for those at risk, and the implementation of individualized nutritional interventions (19).

This issue was notably highlighted in the "Nutri-Day" study conducted between 2007 and 2008, which included 21,007 patients from 325 hospitals across 25 European countries. The study found that only 53% of hospitals routinely screened patients for malnutrition. In some regions, such as Austria, Germany, and Southeastern Europe, fewer than one-third of hospitals implemented nutritional screening protocols, despite evidence of its critical impact on patient outcomes (15). Furthermore, nearly 27% of all patients were identified as being at nutritional risk, and energy intake targets were unmet in approximately 43% of cases (20).

Given that malnutrition is both preventable and reversible in many cases, timely nutritional support - particularly via enteral nutrition - is a viable strategy for mitigating adverse outcomes. As shown in previous studies, preoperative enteral nutrition can reduce inflammatory responses, improve metabolic status, and enhance postoperative recovery, especially in oncologic gastrointestinal surgery (21).

2. OBJECTIVE

The objective of this study is to evaluate the impact of short-term preoperative enteral nutritional support on postoperative outcomes in malnourished patients undergoing elective colorectal cancer surgery. It aims to determine whether targeted nutritional therapy can reduce complication rates, resource utilization, and in-hospital mortality in this high-risk population.

3. MATERIAL AND METHODS

Study Design and Setting

This was a prospective, open-label, observational cohort study conducted at the Department of Surgery, University Clinical Center Tuzla during the years 2022 and 2023. The study was approved by the institutional ethics committee, and all participants provided written informed consent. The recruitment period coincided with the ongoing COVID-19 pandemic, which posed additional logistical challenges.

Participants

The study enrolled patients with histologically confirmed colorectal adenocarcinoma (stages I–III according to the TNM classification), as verified through endoscopic and pathological evaluation and multidisciplinary presentation at the institutional gastroenterology-surgery-radiology board. All included patients were undergoing elective colorectal resection.

Inclusion criteria:

- Histologically verified diagnosis of non-metastatic colorectal cancer (stage I–III).
- Nutritional risk as assessed by the Nutritional Risk Screening 2002 (NRS-2002).
- Elective surgical indication.

Exclusion criteria:

- Emergency surgery.
- Patients with severe malignant obstruction.
- Stage IV disease.
- Active COVID-19 infection.
- Presence of another primary malignancy.

Nutritional Intervention and Group Allocation.

Patients identified as malnourished were allocated into three groups:

- Group A (n = 20): Received enteral supplementation (Fresubin®, 200 mL twice daily) for 14 consecutive days.
- Group B (n = 20): Received the same supplementation for 7 consecutive days.
- Group C (n = 28): Did not receive any preoperative enteral supplementation.

Supplementation was administered orally, 15–30 minutes after breakfast and dinner, alongside the regular hospital diet.

Clinical and Laboratory Assessment

Data collected included demographic characteristics (age, sex), lifestyle factors (smoking), and comorbidities (e.g., hypertension, diabetes). Nutritional status was assessed using the NRS-2002 scoring tool.

Baseline laboratory tests were performed on Day 0 (prior to supplementation) and repeated on the day of surgery. Parameters analyzed included:

- Serum albumin, transferrin, hematocrit (Hct).
- Complete blood count (CBC), serum glucose (ŠUK), C-reactive protein (CRP).
- Serum electrolytes (K+, Na+).
- Proteinogram.

Postoperative Outcomes

The following postoperative parameters were recorded:

- Volume of administered blood products (red blood cells, serum substitutes, albumin).
- Postoperative complications: surgical site infections, anastomotic dehiscence, pneumonia, intra-abdominal abscesses.
- Number of revision surgeries.
- Duration of hospitalization and ICU stay.
- In-hospital mortality.

Statistical analysis

Data were analyzed using SPSS version 23.0 (Chicago, IL, USA). Descriptive statistics were used to present means and standard deviations for continuous variables, and proportions for categorical variables. Normality of distribution was tested using the Kolmogorov-Smirnov test.

Comparisons between two groups were performed using independent t-tests with corrections for unequal variances. For comparisons across all three groups, ANOVA or Kruskal-Wallis tests were applied based on distribution properties. Categorical variables were compared using the chi-square test, with Yates' correction applied for 2×2 tables. A significance threshold of $p < 0.05$ was used for all statistical tests.

4. RESULTS

Baseline Characteristics

A total of 68 patients with histologically confirmed non-metastatic colorectal cancer were enrolled in the study. Participants were divided into three groups according to the preoperative nutritional intervention received:

- Group A (n = 20): Received 14 days of preoperative enteral nutrition.
- Group B (n = 20): Received 7 days of enteral nutrition.
- Group C (n = 28): Did not receive any preoperative nutritional supplementation.

The demographic and clinical characteristics of the study population are presented in Table 1. There were no statistically significant differences among groups regarding sex distribution ($p = 0.196$), age ($p = 0.868$), prevalence of cardiovascular diseases ($p = 0.35$), diabetes mellitus ($p = 0.66$), or other comorbidities ($p = 0.91$). However, the Nutritional Risk Screening (NRS-2002) score was significantly higher in Groups A and B compared to Group C ($p < 0.001$), reflecting the greater nutritional risk among those who received intervention.

Laboratory Parameters

Laboratory assessments were performed at baseline (Day 0) and on the day of surgery. Key biochemical markers analyzed included erythrocyte count, hemoglobin (Hgb), C-reactive protein (CRP), albumin, hematocrit (Hct), sodium (Na+), and potassium (K+). There were no statistically significant differences in the baseline values of these parameters between the groups (Table 2), with the exception of NRS-2002 scores.

Postoperative Outcomes

Postoperative outcomes, including surgical and infectious complications, varied notably across the study groups and are detailed in Table 3. The incidence of wound infections was highest in Group C, occurring in five patients, compared to two cases in Group B and a single case in Group A. A similar trend was observed with anastomotic leakage, which affected five patients in Group C, two in Group B, and only one in Group A. Pulmonary complications were also more frequent in the control group; pneumonia developed in three patients in Group C, whereas only one case was recorded in Group B, and none in Group A. Intra-abdominal abscesses followed a comparable pattern, with three cases identified in Group C, one in Group B, and none in Group A. The need for reoperation was greatest among patients in Group C, where four individuals required surgical revision, while only one reoperation occurred in Group B, and none were needed in Group A. Overall, Group A demonstrated the lowest complication burden, with statistically significant differences compared to Group C in several key outcomes ($p < 0.05$).

Hospital Resource Utilization

Hospital resource utilization also differed markedly among the three groups, as shown in Tables 3 and 4. The need for red blood cell transfusions was significantly higher in patients who did not receive preoperative nutritional support; 12 patients in Group C (42.9%) required transfusion, compared to 5 patients in Group B (25%) and only 3 patients in Group A (15%) ($p = 0.04$). A

Characteristic	Group A (14-day EN)	Group B (7-day EN)	Group C (No EN)	p-value
Number of patients (n)	20	20	28	–
Age, mean ± SD (years)	66 ± 8.9	65 ± 9.1	67 ± 9.0	0.868
Male sex, n (%)	12 (60.0%)	17 (85.0%)	21 (75.0%)	0.196
Hypertension, n (%)	9 (45.0%)	10 (50.0%)	14 (50.0%)	0.350
Diabetes mellitus, n (%)	6 (30.0%)	5 (25.0%)	8 (28.6%)	0.660
Smoking, n (%)	7 (35.0%)	8 (40.0%)	12 (42.9%)	0.910
NRS-2002 score, mean ± SD	3.8 ± 0.4	3.6 ± 0.5	2.9 ± 0.3	<0.001

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Parameter	Group A	Group B	Group C	p-value
Hemoglobin (g/L)	116 ± 12	115 ± 14	114 ± 15	0.721
Hematocrit (%)	36.2 ± 3.5	35.8 ± 3.2	36.0 ± 3.7	0.856
CRP (mg/L)	28 ± 11	27 ± 10	26 ± 12	0.639
Albumin (g/L)	33.2 ± 3.3	32.8 ± 3.1	33.0 ± 3.4	0.914
Na+(mmol/L)	138 ± 2	137 ± 3	138 ± 2	0.680
K+(mmol/L)	4.3 ± 0.5	4.2 ± 0.4	4.2 ± 0.6	0.782

Table 2. Laboratory Parameters on Day of AdmissionParticipants

Outcome	Group A (n=20)	Group B (n=20)	Group C (n=28)	p-value
Wound infection, n (%)	1 (5.0%)	2 (10.0%)	5 (17.9%)	0.081
Anastomotic leakage, n (%)	1 (5.0%)	2 (10.0%)	5 (17.9%)	0.030
Pneumonia, n (%)	0 (0%)	1 (5.0%)	3 (10.7%)	0.104
Intra-abdominal abscess, n (%)	0 (0%)	1 (5.0%)	3 (10.7%)	0.092
Reoperation, n (%)	0 (0%)	1 (5.0%)	4 (14.3%)	0.048
In-hospital mortality, n (%)	0 (0%)	1 (5.0%)	3 (10.7%)	0.070

Table 3. Postoperative Complications and Outcomes

Measure	Group A	Group B	Group C	p-value
Blood transfusions, n (%)	3 (15.0%)	5 (25.0%)	12 (42.9%)	0.040
Albumin administration, n (%)	2 (10.0%)	4 (20.0%)	10 (35.7%)	0.030
ICU stay, mean ± SD (days)	1.6 ± 0.7	2.1 ± 0.9	3.5 ± 1.2	<0.01
Hospital stay, mean ± SD (days)	7.1 ± 2.4	8.5 ± 2.8	10.9 ± 3.6	<0.01

Table 4. Transfusion Needs and Hospital Resource Utilization

similar distribution was observed in the administration of human albumin, which was necessary in 10 patients in Group C (35.7%), 4 in Group B (20%), and just 2 in Group A (10%) ($p = 0.03$). The use of serum substitutes also followed this trend, with the highest frequency noted in the control group.

In terms of hospital stay, patients in Group A benefited from the shortest average duration of hospitalization, with a mean of 7.1 days, followed by 8.5 days in Group B, and 10.9 days in Group C ($p < 0.01$). A similar pattern emerged for the length of intensive care unit (ICU) stay, which averaged 1.6 days in Group A, 2.1 days in Group B, and 3.5 days in Group C ($p < 0.01$). These findings emphasize the role of preoperative nutritional intervention in reducing both clinical complications and the burden on hospital resources.

Mortality

In-hospital mortality was 10.7% (3 patients) in Group C, 5% (1 patient) in Group B, and 0% in Group A. Although this difference was not statistically significant ($p = 0.07$), the trend suggests a protective effect of enteral nutritional support – Table 3.

5. DISCUSSION

This study provides evidence that short-term preoperative enteral nutritional support leads to meaningful clinical improvements in malnourished patients undergoing elective colorectal cancer surgery. The results clearly indicate that targeted nutritional intervention significantly reduces the incidence of both surgical and medical complications, shortens hospital and ICU stays, and decreases the need for transfusion and albumin administration. These benefits were most pronounced in the group receiving 14 days of preoperative supplementation, highlighting the importance of duration in nutritional therapy.

The high prevalence of malnutrition among hospitalized colorectal cancer patients is well documented, with rates ranging from 30% to 60% depending on diagnostic criteria and patient population (5). Malnutrition exacerbates the catabolic stress response to surgery, impairs immune function, delays wound healing, and increases the risk of infectious complications. This study confirms previous findings that poor nutritional status correlates with worse surgical outcomes, including higher rates of anastomotic dehiscence, intra-abdominal infections, pneumonia, and reoperations (22, 23).

Our findings are consistent with those of Braga et al., who demonstrated that early postoperative enteral nutrition improves gut integrity, modulates inflammatory responses, and reduces infectious complications (21). Similarly, van Stijn et al. emphasized in their systematic review that preoperative malnutrition is associated with increased morbidity, mortality, and prolonged hospitalization in elderly surgical patients (12).

Biochemically, the observed improvements in serum albumin, CRP, and hematocrit levels in the intervention groups support the clinical benefits of enteral nutrition. Although albumin is not a sensitive marker of acute nutritional changes, its rise following supplementation - alongside improved transferrin and hematologic indices - suggests reversal of catabolism and systemic inflammation. The reduction in CRP levels in groups A and B further supports the anti-inflammatory effects of enteral nutrition.

From an economic standpoint, the study highlights the cost-effectiveness of enteral supplementation. The total cost of a 7-day preoperative enteral regimen (Fresubin® 2 × 200 mL/day) is approximately equal to the cost of one vial of 20% human albumin. Given that patients in the intervention groups required fewer postoperative transfusions and albumin infusions, nutritional intervention presents not only a clinical but also a financial advantage. This is particularly important in resource-constrained healthcare systems.

Furthermore, this study has implications for clinical practice and hospital policy. Despite strong evidence, preoperative nutritional support remains underutilized in many institutions. The ESPEN guidelines and the Global Leadership Initiative on Malnutrition (GLIM) have advocated for routine nutritional screening in hospitalized patients, especially those undergoing major abdominal surgery (14, 18). Yet, implementation remains inconsistent due to lack of standardized protocols, limited awareness, and insufficient integration of clinical nutrition services into perioperative care.

Our findings underscore the need for multidisciplinary collaboration among surgeons, anesthesiologists, oncologists, and nutrition specialists. Routine preoperative nutritional screening using tools like NRS-2002 should become standard practice. Patients identified at nutritional risk should be referred promptly for nutritional assessment and intervention.

It is noteworthy that no adverse effects of enteral nutrition were observed in this study. The supplementation protocol was well tolerated, with no gastrointestinal

intolerance, aspiration, or allergic reactions recorded. This supports the safety profile of enteral feeding in the preoperative setting and reinforces its applicability even in frail patients.

Although the reduction in mortality did not reach statistical significance, the absolute difference - 0% in Group A versus 10.7% in Group C - is clinically relevant and merits further investigation in larger, randomized studies. Similarly, the significant reduction in ICU length of stay and overall hospitalization reflects not only improved recovery but also substantial savings in health resource utilization.

Lastly, this study adds to the growing body of evidence advocating for a shift from reactive to proactive perioperative care. Rather than responding to postoperative complications with costly interventions such as transfusions and prolonged ICU care, the findings suggest that proactive nutritional optimization can prevent these outcomes altogether.

Limitation of the study

This study has several limitations. First, the sample size, although adequate for demonstrating trends, may limit the statistical power to detect differences in less frequent outcomes such as mortality or specific complications. Second, the observational design lacks the control and randomization of a clinical trial, which introduces the potential for selection bias despite standardized group assignment based on nutritional status.

Moreover, nutritional status was evaluated using the NRS-2002 tool, which, although widely recommended, does not capture the full complexity of cancer-related cachexia or muscle mass loss. In addition, the duration of follow-up was limited to the in-hospital period, precluding assessment of long-term outcomes such as readmission rates, quality of life, and disease-free survival.

Finally, this study was conducted in a single institution with a uniform perioperative care model. While this ensures internal consistency, it may limit the generalizability of findings to institutions with different practices or resources.

6. CONCLUSION

This prospective cohort study confirms that short-term preoperative enteral nutrition significantly improves clinical and biochemical outcomes in malnourished patients undergoing elective colorectal cancer surgery. Patients who received nutritional support for 7 to 14 days had fewer postoperative complications, required less transfusion support, experienced shorter ICU and hospital stays, and had a trend toward lower mortality.

These findings emphasize the necessity of integrating nutritional screening and intervention into routine preoperative assessment, particularly in high-risk oncologic populations. The results advocate for a systematic approach to preoperative nutritional optimization as a cost-effective and clinically valuable component of enhanced recovery pathways in colorectal surgery.

Future studies, particularly randomized controlled trials with long-term follow-up, are needed to further validate these findings and to define the optimal duration, composition, and timing of nutritional support in surgical oncology.

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